MAINTENANCE *Manual*

GASOLINE • DIESEL • GMC • TRUCKS

2½ TON • 6 x 6

Built for

UNITED STATES ARMY

MODELS CCKW 352 & 353

CONTRACT NUMBER W-398-QM-11595

PUBLISHED NOVEMBER 15, 1942

General Motors Truck

TM 10-1563

WAR DEPARTMENT

Washington, November 15, 1942

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By order of the Secretary of War:

G. C. MARSHALL,
Chief of Staff

Official:
J. A. ULIO,
Major General,
The Adjutant General

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Maintenance Manual

GMC 2½-TON 6 x 6

Models CCKW-352 & 353

GASOLINE • DIESEL • GMC • TRUCKS



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GENERAL MOTORS TRUCK & COACH
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GMC 2½-TON 6x6 TRUCK

MODEL CCKW-353

General Motors Truck & Coach *Division of* Yellow Truck & Coach Manufacturing Company

Introduction

This Maintenance Manual applies on GMC trucks indicated by model numbers shown on cover. It was compiled by GMC for use by the United States Army—in accordance with latest Army specifications—and has been officially approved for such use by the War Department, whose authentication notice appears on inside front cover.

A copy of this book is placed in each truck on which it applies before the vehicle leaves the factory. To definitely identify the book with the truck, the Army has assigned a Technical Manual (abbreviated TM) number to the publication. This TM number appears in upper right and lower left corners of cover, and in addition, this same TM number appears on the truck in the form of a publication plate as illustrated on page 4. Thus, to be sure of what Manual or Parts List to use, look at publication plate in driver's cab for TM number and use only the book having corresponding TM number on its cover.

How To Use This Manual

Adhering strictly to Army specifications, this book is arranged according to the Army's "Functional Group Code" which is represented by the quick reference index along the right hand margin of the first page. Groups appear in the book in the same order shown in index.

The first page of each group referred to in the quick reference index is indicated with a black thumb dot including the group number. Thus, each group may be located quickly by bending book slightly to expose these thumb dots which line up with corresponding group numbers in index on first page.

To make contents of this book even more quickly located, each group has its own quick reference index. This appears at the beginning of each group and consists of a list of all principal paragraphs contained in the group — each paragraph is numbered and appears numerically throughout the group. Wherever possible, material is shown in each group in the following order:

DESCRIPTION AND OPERATION
TROUBLE SHOOTING AND GENERAL SOLUTIONS
INSPECTION AND ADJUSTMENT
REMOVAL AND INSTALLATION
REPAIR
SPECIFICATIONS
TOOL EQUIPMENT

TO SUMMARIZE: Select group from index on first page — bend book back slightly to expose tab on first page of group — note paragraph number of subject wanted — refer to paragraph for detailed information.

GENERAL DATA

Type	270
Horsepower—S.A.E.	34.35
Displacement—Cu. In.	269.5
Bore	$3^{25}/_{32}$"
Stroke	4"
Cylinders	6
Engine Governed Speed (R.P.M.)	2750

CAPACITIES

Fuel Tank (gallons)	40
Engine Crankcase—Refill—including filter (quarts)	11
Cooling System (quarts)	19
Transmission (pints or pounds) (early type without P.T.O.)	13
Transmission (pints or pounds) (late type without P.T.O.)	9
Transmission (pints or pounds) (early type with P.T.O.)	14
Transmission (pints or pounds) (late type with P.T.O.)	10
Oil Bath Air Cleaner (quarts)	1
Winch (for trucks so equipped) (pints or pounds)	3¾
Models CCKW-352 and 3—Split Type	
Transfer Case (pints or pounds)	7
Front Axle Differential (pints or pounds)	7
Rear Axle Differential (pints or pounds)	7
Models CCKW-352 and 3—Banjo Type	
Transfer Case (pints or pounds)	4
Front Axle Differential (pints or pounds)	13
Front Rear Axle Differential (pints or pounds)	13
Rear Rear Axle Differential (pints or pounds)	10½

DIMENSIONS

NOTE: Height, Width and Length dimensions shown apply only when these trucks are equipped with cargo body, bows and tarpaulin.

	CCKW-352	CCKW-353
Turning Radius (front axle disengaged)	RH 68'-LH 70'	RH 70'-LH 72'
Height (Overall)	108"	108"
Width (Overall)	88"	88"
Length (Overall) with cargo body but without winch	231"	256"
Length (Overall) with cargo body and with winch	245"	270"
Road Clearance	17¼"	17¼"

MODEL IDENTIFICATION

GMC truck models on which this publication applies are:

CCKW-352.....145" Wheelbase
CCKW-353.....164" Wheelbase

Letters are used to indicate specific body style and winch equipment. This letter appears in the serial number directly after the model number shown above, and is one of the following, depending on equipment used:

"A"—Cargo Body—No Winch.
"B"—Cargo Body—With Winch.
"C"—Stock Rack.
"D"—Fuel Tank Body—No Winch.
"E"—Fuel Tank Body—With Winch.
"F"—Van Type Body.
"G"—Water Tank Body.

Numbers are used to indicate type of axles used. These numbers appear in serial number directly after the letters shown above, and is one of the following, depending on axle used:

"1"—Axles having "Split Type" housings.
"2"—Axles having "Banjo Type" housings.

TORQUE WRENCH SPECIFICATIONS

Recommended specifications for proper torque to apply at points throughout the vehicle are as given below. Figures shown are foot pounds of torque with threads clean and dry. If threads are cleaned and oiled, the figures shown may be reduced about 10%.

Description	Ft. Lb. Torque
Axle Flange Nuts	35-40
Differential Carrier (Banjo Type)	60-70
Differential Carrier (Split Type)	25-30
Generator	22-26
Starter	40-50
Connecting Rod Bearing Bolts	40-50
Cylinder Head	60-70
Engine Mountings (Front)	35-42
Engine Mounting (Rear)	70-80
Flywheel to Crankshaft	35-40
Main Bearing Caps	70-80
Exhaust Manifold	15-20
Intake Manifold	15-20
Boggie Mountings	140-155
Spring Mounting—Front ("U"-Bolts, ¾")	170-185
Spring Mounting—Rear ("U"-Bolts, ⅞")	200-220
Steering Mounting to Frame	160-170
Transfer Case Caps	20-25
Universal Joints	20-25

PUBLICATION PLATE



"Publication Plate"—gives **TM** number of Maintenance Manual and Parts List to use for each vehicle and is located in Driver's cab. Additional information on **TM** number application is given on Page 3 of this book.

Group D—Driver's Instructions

D

	Paragraph
GENERAL	
Instructions To Drivers	1
Trouble Shooting and General Solutions	2
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GENERAL

1. INSTRUCTIONS TO DRIVERS

Our instructions to Drivers constitute one of the most important purposes of this manual—as it is our contention that good driving embraces more than the basic actions of starting, operating and stopping a motor vehicle. By adhering to good driving practices and through complete knowledge of the vehicle, a good Driver will obtain the utmost in reliable performance and stamina inherent in all GMC vehicles.

The natural function of a GMC truck is smooth and rhythmic without sharp clicks, knocks, or unusual sounds. The good Driver soon becomes accustomed to the operation or "feel" of his vehicle and, regardless of his knowledge of its mechanical construction, is quick to detect any changes in its normal operation. On the other hand the Driver is not expected to rely entirely upon sound or instinct for trouble diagnosis—and, accordingly, instruments are provided which indicate the condition of such vital items as engine temperature, engine oil pressure, electrical charging rate, quantity of fuel, etc., all of which are useful aids to good driving.

In addition to the information contained in this section, we particularly refer all Drivers to "Trouble Shooting and General Solutions" in each group of this book. Careful study of these items will enable the Driver to recognize even gradual changes in the mechanical condition of various units, and will thus encourage the application of corrective service **before** failure and **before** costly repairs become necessary.

Whether or not the Driver is thoroughly acquainted with properly handling a truck, or is only a beginner, the information given in this section of the book should be studied carefully to assure complete familiarity with the details of operation which apply to these particular vehicles.

2. TROUBLE SHOOTING AND GENERAL SOLUTIONS

Engine operating troubles may be classified into three groups, or conditions, as follows:

1—Failure to start. 2—Misfiring. 3—Uneven Running.

Diagnosing these conditions is simplified by use of chart as shown on page two. Apply starter in usual manner, follow the chart and these suggestions:

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DRIVER'S INSTRUCTIONS

1. If starter cranks engine normally but **engine does not start:**

(a) Test for spark as shown. If no spark is obtained, causes of engine failing to start are listed in Group No. 1.

(b) If spark is weak, causes of engine failing to start are as shown in Group No. 2.

(c) If no spark is evident, engine fails to start for one or more reasons as listed in Group No. 3.

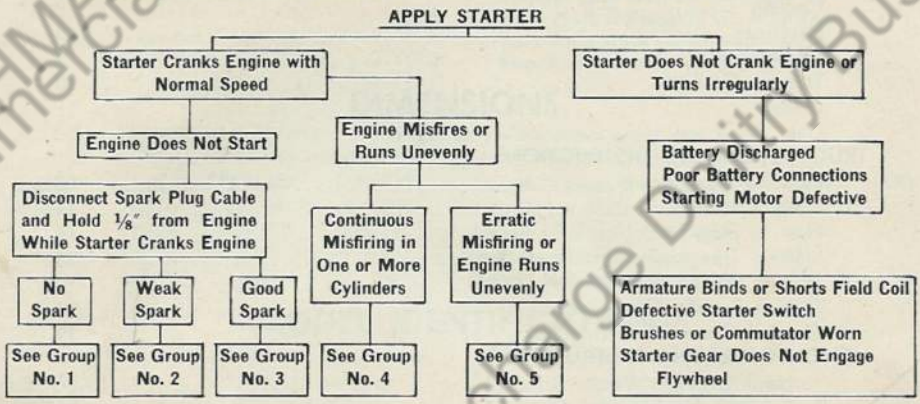
2. If starter cranks engine normally but engine **misfires or runs unevenly:**

(a) Causes of continuous misfiring are as shown in Group No. 4.

(b) Causes of erratic misfiring or engine running unevenly are shown in Group No. 5.

3. If upon applying starter, it does not crank engine, or turns irregularly, note causes shown in chart.

ENGINE FAILS TO START—MISFIRES—OR RUNS UNEVENLY



GROUP NO. 1—ENGINE WILL NOT START—SPARK TEST INDICATES "NO SPARK"

Note: The ammeter on instrument panel will be a valuable aid in localizing defect in circuit which results in "NO SPARK."

A. Ammeter Shows No Discharge—zero reading:

If ammeter shows no discharge, it is an indication that primary circuit is interrupted and current is not allowed to complete circuit to battery. The following conditions apply:

(1) Breaker points are excessively burned or pitted ..... Clean or replace
(2) Breaker points in distributor not closing ..... Readjust or replace
(3) Loose connections from starter to ignition switch ..... Clean and tighten
(4) Primary wire from ignition switch to coil or from coil to distributor may be broken or connections loosened ..... Repair or tighten
(5) Ignition coil primary windings may be open ..... Replace ignition coil
(6) Ignition switch is defective ..... Replace

B. Normal Ammeter Reading—needle oscillates between two and five amperes discharge while starter is cranking engine:

When ammeter reading is normal (slight oscillation) it indicates that primary circuit is complete—therefore checking should be confined to secondary circuits as follows:

(1) High tension wire from coil to distributor may be broken or grounded ..... Repair or replace
(2) Defective ignition coil or condenser ..... Install new part
(3) Defective distributor rotor or distributor cap ..... Install new part
(4) High tension wires may be wet ..... Dry thoroughly

C. Ammeter Indicates Abnormal Discharge—more than two to four amperes:

This condition is an indication that a "short" exists (between the ammeter and the ignition coil; or, in event of a shorted primary winding in ignition coil, "short" may exist in distributor as follows:

(1) Distributor points may not be opening ..... Readjust points
(2) Condenser may be "shorted" ..... Install new condenser
(3) Primary winding in ignition coil may be "shorted" ..... Install new coil
(4) Breaker point arm in distributor may be grounded ..... Clean or replace
(5) Wire from ammeter to ignition switch or from ignition switch to ignition coil may be "shorted" or grounded ..... Repair or replace

DRIVER'S INSTRUCTIONS

GROUP NO. 2—ENGINE WILL NOT START—SPARK TEST INDICATES "WEAK SPARK"

1. Distributor points may be burned or badly pitted ..... Clean or replace
2. Defective distributor condenser ..... Install new condenser
3. Defective ignition coil ..... Install new coil
4. Loose electrical connections throughout circuit will cause "voltage drop" ..... Locate and tighten
5. High tension (secondary) wires may be defective or wet ..... Clean or replace
6. Defective distributor cap ..... Install new cap
7. Defective distributor rotor or broken rotor brush ..... Install new rotor

GROUP NO. 3—ENGINE WILL NOT START—SPARK TEST INDICATES "GOOD SPARK"

When test indicates a good spark is occurring at each spark plug, the ignition system may be eliminated and the fuel system should be checked as follows:

A. If inspection reveals gasoline to be present in carburetor—the following apply:

(1) Carburetor may contain dirt and water ..... Remove and clean
(2) Carburetor may be flooded through excessive use of choke or incorrect float level adjustment ..... Adjust float level
(3) Choke control may not be operating ..... Check linkage

B. If no gasoline is reaching carburetor, the following should be checked:

(1) Fuel tank empty ..... Add fuel
(2) Fuel lines may be clogged ..... Remove and clean
(3) Fuel pump may be inoperative ..... Disconnect outlet line and test
(4) Vent in fuel tank cap may be plugged ..... Remove and clean
(5) Tank fuel line may contain an air leak ..... Install new line

GROUP NO. 4—ENGINE MISFIRES—CONTINUOUS MISFIRING IN ONE OR MORE CYLINDERS

A. Faulty spark plugs are a frequent cause of engine misfiring—check the following:

(1) Is recommended type plug being used? ..... See Engine Tune-Up
(2) Clean and readjust spark plugs ..... Use feeler gauge
(3) Inspect porcelain at lower end. (A) If porcelain is very white, plug is too hot—use colder plug. (B) If color is light brown, plug is correct—replace with same type. (C) If black or oily, plug is too cold—use hotter plug.

B. If the possibility of faulty plugs has been eliminated proceed to check the following:

(1) High tension wires may be leaking ..... Replace
(2) Distributor cap may be defective ..... Replace
(3) Cylinder may have insufficient or uneven compression ..... Test and repair—See engine tune-up

GROUP NO. 5—ENGINE RUNS UNEVENLY—ERRATIC MISFIRING

A. Engine may run unevenly at idling speed for one or more of the following reasons:

(1) Faulty spark plugs or gaps adjusted too wide ..... Replace or adjust
(2) Ignition coil and condensers may be defective ..... Install new parts
(3) Distributor breaker points may be faulty, sticking, or improperly adjusted ..... Adjust or replace
(4) For reasons given in group No. 2 above.
(5) For reasons given in group No. 3 above.
(6) Valve mechanism in poor condition—valve sticking open, weakened valve springs, incorrect tappet clearance ..... Service valves
(7) Defective cylinder head gasket ..... Replace gasket
(8) Uneven cylinder compression ..... See engine tune-up

B. Uneven engine operation at high speed may be due to one of the following (also see items under "A" above):

(1) Weakened valve spring ..... Replace
(2) Weakened distributor breaker arm tension springs ..... Replace points
(3) Breaker points adjusted too wide ..... Readjust
(4) Incorrect type spark plugs ..... Replace

DRIVER'S INSTRUCTIONS

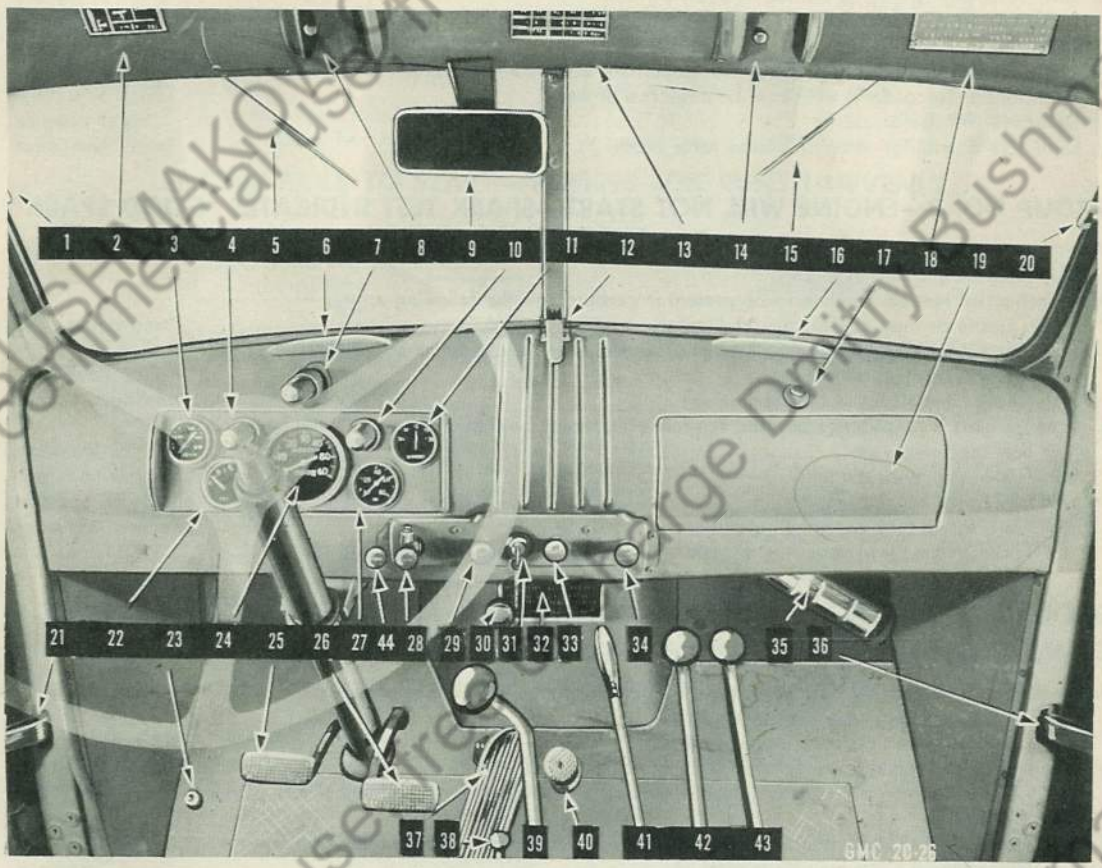


Fig. 1 Interior of Driver's Cab—Showing Controls and Instruments

1. L.H. Windshield Quadrant Thumb Screw
2. Shifting Instruction Plate
3. Temperature Gauge
4. Temperature and Fuel Gauge Light
5. Windshield Wiper Blade—L.H.
6. Defroster Opening—L.H.
7. Instrument Light
8. L.H. Windshield Wiper Control Button
9. Rear View Mirror
10. Ammeter and Oil Gauge Light
11. Ammeter
12. Windshield Lock
13. Road Speed Caution Plate
14. R.H. Windshield Wiper Control Button
15. Windshield Wiper Blade—R.H.
16. Defroster Opening—R.H.
17. Package Compartment Door Lock
18. Winch Operating Plate—(On trucks with winch)
19. Package Compartment
20. R.H. Windshield Quadrant Adjusting Screw
21. Door Check Strap
22. Fuel Gauge
23. Dimmer Switch
24. Speedometer
25. Clutch Pedal
26. Brake Pedal
27. Oil Pressure Gauge
28. Light Switch
29. Throttle Button
30. Ventilator Control Handle
31. Ignition Key and Switch
32. Serial Number Plate
33. Choke Button
34. Instrument Panel Light Switch
35. Fire Extinguisher
36. Door Check Strap
37. Accelerator Pedal
38. Power Take-Off Lever—(On trucks with winch)
39. Transmission Shift Lever
40. Starter Button
41. Hand Brake Lever
42. Transfer Case High and Low Shift Lever
43. Transfer Case Front Axle Declutching Lever
44. Blackout Driving Lamp Switch

DRIVER'S INSTRUCTIONS

3. INSPECTION

Each Driver is responsible for the vehicle he operates, and beyond following good driving practices, this requires that certain periodic inspections be performed, conditions observed and reported for correction. Inspections that are to be made by the Driver are shown in the Preventive Maintenance section of this Manual.

Following items appear in the same sequence as Functional Group Code arrangement listed on title page of this Manual. The first page of each group in this book should also be referred to by drivers seeking more information on the items discussed below.

CONTROLS AND INSTRUMENTS

4. ENGINE

The engine is its own operating gauge and needs no recording dial on the instrument panel for the driver to read. The sound of the engine and its response to the control action of the driver are sufficient. To the experienced and alert driver, any unusual change in engine operation will be the signal for immediate inspection and service.

A. Oil Level Indicator Rod—Daily check of oil supply should be made. Remove indicator rod at right hand side of engine and determine level of oil in crankcase. Oil should be up to "Full" mark on rod.

B. Oil Pressure Gauge—This gauge indicates pressure of engine lubrication oil. Pressure reading may vary according to operating conditions—however, if oil pressure should fall to zero, while engine is running, stop engine immediately and determine cause. This gauge does not indicate the **Amount** of oil in crankcase.

5. CLUTCH

A. Clutch Pedal—Depressing clutch pedal disengages engine from transmission so that transmission gears may be shifted. Clutch pedal should never be released suddenly whenever engine is running. Driving with foot on pedal will cause needless wear of clutch facings and of release bearing.

6. FUEL

A. Hand Primer—When vehicle has been standing for long periods of time, or has been drained of fuel, it is advisable to assure supply of fuel at carbureter by operating hand primer at fuel pump. Hand primer and fuel pump are located on right hand side of engine.

B. Choke—Choke should only be pulled out far enough to allow engine to run smoothly during warm up period and should be pushed in as soon as possible after engine is started. Choke should only be used when necessary. If not properly used, fuel mixture will be too rich, and may cause serious damage by allowing unburned fuel to pass piston rings and into crankcase and dilute lubricating oil.

C. Fuel Gauge—Gasoline gauge indicates level of fuel in tank, and is only operative when ignition switch is turned on.

D. Throttle Button—When button is pushed in, engine will run at idling speed. Button may be pulled out approximately 1/2" when starting engine. It can also be used when starting truck on steep hills.

E. Accelerator Pedal—This pedal is used to control engine speed with the foot while driving the truck.

7. COOLING

A. Engine Water Temperature Indicator—This instrument indicates temperature of water in cooling system. Water temperature is dependent upon operating conditions, load, etc., however, temperature range should be within 160° F. to 185° F. If temperature should reach 212° F. (boiling point) vehicle should be stopped and trouble corrected before proceeding.

8. ELECTRICAL

A. Ignition Switch—Ignition switch key must be turned "on" before engine can be started. Never allow ignition key to remain turned "on" with engine not running except when making tests.

B. Ammeter—Ammeter indicates rate of flow of electric current being supplied to battery by generator or rate of discharge from battery. At low engine speeds, needle may move to negative side.

C. Light Switch—Blackout light switch has four positions as follows:

1. Knob pressed in—**All** lights **"Off."**
2. Knob pulled out to latch stop, turns on blackout head and tail lamp, also blackout stop lights.
3. Latch stop depressed and knob pulled outward one position (from latch stop position), turns on all "Service" lights. In this position, either upper or lower headlamp beam is selected by foot switch.
4. Knob pulled **All** the way out turns on "Service Stop" lights only for truck and trailer.

D. Driving Lamp Switch—Pull out to illuminate the black-out driving lamp. Main light switch must be in blackout position to use driving lamp.

E. Headlamp Dimmer Switch—After headlamps are turned on, upper or lower headlamp beam is selected by pressing down on foot switch. The use of this switch permits driver to "dim" lights when passing other vehicles, or to turn on "bright" lights when needed.

F. Instrument Panel Light Switch—This switch is used to turn instrument panel lights on after headlamps have been turned on. Ignition switch and speedometer light is also operated by this switch.

G. Starter Control Lever—Engine starter is operated by stepping down on pedal. Initial movement of pedal engages starter pinion with flywheel teeth; further move-

DRIVER'S INSTRUCTIONS

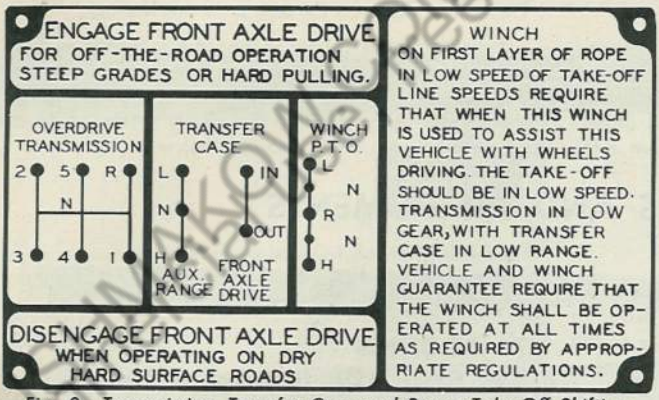


Fig. 2 Transmission, Transfer Case and Power Take-Off Shifting Arrangement Plate (For Trucks Equipped with Winch)

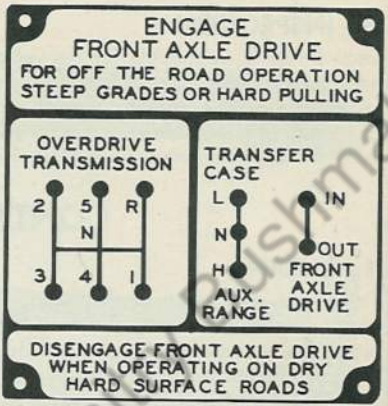


Fig. 3 Transmission and Transfer Case Shifting Arrangement Plate (For Trucks Not Equipped with Winch)

ment completes electrical circuit between battery and starter causing starter to rotate, thus cranking engine through gear engagement. When engine starts, foot should be removed from pedal immediately. **Caution: Do not step on pedal while engine is running.**

9. TRANSMISSION

A. Shift Arrangement Plate—Positions for shifting of transmission and transfer case control levers are outlined on this plate which is shown in Fig. 2, for trucks equipped with winch. See Fig. 3, for trucks not equipped with winch.

B. Transmission Shift Lever—This lever is used to select various gear ratios or speeds provided in transmission. There are five speeds forward and one reverse. (See shifting arrangement plates Figs. 2 and 3.) Transmission shift lever should be in neutral position when engine is started.

10. TRANSFER CASE

A. Transfer Case High and Low Lever—This lever is used to shift transfer case into "high," "neutral" or "low" speeds as desired by operator. Arrangement of this lever is such that low speed cannot be engaged unless front axle is also engaged. Arrangement of shift lever positions are illustrated in Figs. 2 and 3. Shifting instructions are given in Paragraph 18.

B. Front Axle Declutching Lever—This lever permits selection of front axle engaged or disengaged positions. Front axle must be engaged before transfer case can be operated in "low" range. With front axle engaged, transfer case may be operated in either "high" or "low" range. See Figs. 2 and 3 for shifting arrangement.

C. Power Take-Off Shifting Lever—Used only on vehicles equipped with winch. Whenever winch is being operated, power take-off must be shifted into "low", "high" and "reverse" as operating conditions require. Clutch must be disengaged whenever shifting into or out of speeds provided. Hinged locking plate, attached to floor board, beside shifting lever provides positive means of locking lever in "neutral" position when winch is not being operated. Always lock lever with locking plate when winch is not being used to prevent accidental engagement of power take-off.

11. BRAKES

A. Brake Pedal—Depressing brake pedal applies brakes at all wheels. Physical effort applied at brake pedal displaces fluid in master cylinder which operates power unit. Power unit consists of a power cylinder, a valve for controlling power cylinder, and a hydraulic slave cylinder; all of which operate in unison to apply brakes at each wheel. **Avoid** driving with foot on brake pedal as brakes will be partially applied and cause needless wear of brake linings. Smooth and even application of brakes whenever possible is a good driving practice.

B. Hand Brake Lever—Hand brake lever operates brake at rear of transfer case. Whenever vehicle is parked, lever should be applied by pulling toward rear as far as possible. Before attempting to move vehicle, lever should be in released position—as far forward as it will go. When pulled back, lever will lock in position to hold brakes. Lever may be released by pressing release handle (on lever) and pushing forward.

12. CAB

A. Windshield Wiper—Dual windshield wipers are vacuum operated. Separate control switches are provided for independent operation of each windshield wiper.

B. Windshield Wiper Buttons—Buttons are pulled out to turn windshield wipers **"On"** and pushed in to turn wipers **"Off."**

C. Windshield Quadrant—One on each side of windshield is provided and act as supports and guides for holding windshield in open position.

DRIVER'S INSTRUCTIONS

D. Windshield Quadrant Thumb Screws—Windshield can be opened outward and upward after these thumb screws are loosened. Thumb screws must be tightened down securely to hold windshield in open position.

E. Windshield Lock—This lock consists of a spring type clamp and lever arrangement which engages hook on windshield and when pulled downward, locks windshield in fully closed position. When windshield is closed and locked the thumb screws should also be tightened down securely against quadrant to prevent looseness at side of windshield and as a precaution against loss of the screws.

F. Door Check—A metal strap limits opening angle of doors and in addition, design of this part tends to hold door in either open or closed position until further manually operated.

G. Rear View Mirror—This mirror permits driver to see through rear window of cab when body equipment does not obscure vision. Outside rear view mirror provides satisfactory rear vision at all times.

H. Speedometer—Speedometer indicates road speed of vehicle in miles per hour. **Never** allow vehicle speed to exceed maximum permissible road speeds as shown in Fig. 4. This is particularly important when descending hills where extreme caution is required. It is a willful neglect of good driving practices to permit excessive vehicle and engine speeds.

I. Package Compartment—Located on R.H. side of instrument panel is a handy built-in container for any small articles such as this Maintenance Manual, Flashlight, Glasses, Gloves, Etc.

J. Package Compartment Door Lock—Pressing downward on button unlocks door of package compartment.

K. Defroster Openings—These are items of standard construction which permit installation of heater-defroster connections during cold weather.

MAXIMUM PERMISSIBLE ROAD SPEEDS IN THE FOLLOWING GEAR POSITIONS

TRANSMISSION IN	TRANSFER CASE IN HIGH RANGE	TRANSFER CASE IN LOW RANGE
OVERDRIVE	45	20
DIRECT	37	16
THIRD	20	9
SECOND	10	4
FIRST	6	2
REVERSE	6	2

BASED ON 2750 R.P.M. ENGINE MAXIMUM SPEED
6.6 - 1 AXLE RATIO & 7.50 - 20 TIRES

Fig. 4 Permissible Speed Range in Various Transmission and Transfer Case Gear Ratios

L. Ventilator Control—This handle is attached to linkage which is moved downward to open ventilator on cowl.

M. Serial Number Plate—Numbers on this plate identify vehicle—they should always be stated when ordering parts or requesting any other service.

N. Fire Extinguisher—Special care should be exercised to **see that all drivers are completely familiar with the removal and operation of this item.** It is mounted on dash panel with a positive lock. This lock consists of a spring type clamp which must be opened. **Before** extinguisher can be removed. After clamp has been sprung open fire extinguisher can easily be pulled off mounting bracket. It is operated by turning handle to left and then working up and down like a pump. Best results will be obtained by directing stream of liquid at base of flame unless used on burning liquids—in which case extinguisher should be directed against inside of liquid container, above surface of liquid.

TRUCK OPERATING INSTRUCTIONS

13. HOW TO START ENGINE

Before starting the engine (at the beginning of the day's run) it is important that the vehicle be ready for operation. The following procedure is suggested:

1. Add water to radiator if necessary. Check fan belt to see that it is in place and properly adjusted to assure adequate cooling.
2. Add oil if any is required. Oil level should be up to "full" mark on dip stick. Also inspect oil and fuel lines for leaks.
3. Note condition of tires and see that they are properly and evenly inflated.
4. See that there is an adequate fuel supply.
5. Test lights and horn.

How to start engine:

1. Pull hand brake lever back to set brakes.
2. Transmission shift lever should be in neutral position. See Shifting Diagram.
3. Pull out hand throttle about 1/2" (20 M.P.H.). This is not necessary if engine is warm.
4. Pull choke button until 1/2 open to obtain proper fuel and air mixture for starting. This should not be necessary if engine is warm. In extremely cold weather, choke may be pulled all the way out.
5. Insert ignition switch key and turn to "on" position.
6. Push clutch pedal down to floor and hold down until after engine starts.
7. Depress starter lever to start engine. Release lever as soon as engine starts.
8. Make necessary throttle and choke adjustments to obtain even idling speed and, with shifting levers in neutral position, gradually let out clutch pedal.

After engine is started

Look at the instruments:

1. See if oil gauge registers oil pressure.
2. See if ammeter indicates correct generator action.

Never race engine to speed up the warm-up period;

DRIVER'S INSTRUCTIONS

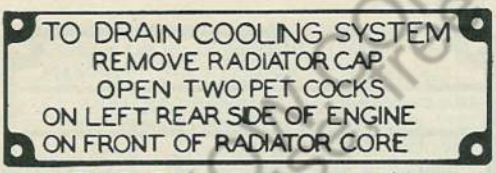


Fig. 5 Cooling System Caution Plate

allow engine to run at a fast idle until it is thoroughly warm and ready for operation.

Listen for unusual sounds, knocks or noises which may indicate improper functioning of any unit.

14. HOW TO START TRUCK

1. Push clutch pedal down to disengage clutch.
2. Move transfer case shifting lever into either "high" or "low" speed position. (Front axle must be engaged before shifting transfer case in "low" speed. With transfer case in "high" range, front axle may be either engaged or disengaged).
3. Move transmission gear shift lever into "first" speed position. See Shifting Diagram.
4. Release hand brake lever.
5. Step down on accelerator pedal to speed up engine. Release clutch pedal slowly and push accelerator pedal down as necessary to prevent engine from stalling while truck starts forward.
6. Let up on accelerator pedal as truck speed increases, depress clutch pedal, move transmission lever into neutral and then into next higher speed. Depress accelerator pedal and release clutch as explained above. Repeat this operation until transmission gears have been shifted progressively from low to high ratio. See Shifting Diagram.

After Truck is Started—The driver should be continuously alert to detect unusual noises or improper action of brakes and other units. The driver should glance frequently at instrument board to note action of ammeter, oil gauge, fuel gauge and temperature gauge.

15. HOW TO STOP TRUCK

1. Remove foot from accelerator pedal and apply brakes by pressing down on foot pedal.
2. Depress clutch pedal when speed of truck has been reduced to idling speed of engine.
3. Move transmission shift lever into neutral position. Release clutch pedal and apply hand brake when truck has come to complete stop.

16. SHIFTING TRANSMISSION INTO LOWER SPEED

Transmission should **always** be shifted to next lower speed **before** engine begins to labor or before vehicle speed is reduced appreciably. Shifting into lower transmission gear ratios is best accomplished by using the "Double Clutch" method. This is done as follows:

1. Depress clutch pedal and release accelerator pedal at same instant.
2. Move transmission gear shift lever into neutral position.
3. Release clutch pedal and accelerate engine to synchronize gears.
4. Depress clutch pedal again and move shift lever (do not apply excessive pressure) into next low speed position.
5. Then release clutch and accelerate engine to obtain desired road speed.

In general, it is advisable to use the same transmission speed going down hill as would be required to climb the same hill.

17. SHIFTING INTO REVERSE SPEED

Before attempting to shift into reverse, truck must be brought to a complete stop.

1. Push clutch pedal down to disengage clutch.
2. Move gear shift lever as far as possible to right then toward front. (See Figs. 2 or 3 in this group or plate above windshield in cab).
3. Release clutch pedal and accelerate engine in same manner as previously explained in Paragraph 14.

18. SHIFTING TRANSFER CASE GEARS

Instructions for shifting transfer case and disengagement of front axle are as follows:

A. Front Axle Engagement (Through Transfer Case):

1. Use front axle drive in off-the-road operation—on steep grades, and during hard pulling.
2. It should first be remembered that only the "high" range can be employed when front axle is disengaged—and that if it is desired to shift into "low" range, the front axle must first be engaged.
3. After front axle is engaged, transfer case may be operated in either "high" or "low" range.
4. If, after operating in low range with front axle engaged, it is desired to disengage front axle, it is first necessary to shift transfer case into "neutral" position and then move front axle shift lever into disengaged position—further operation would then have to be in "high" range.
5. Front axle may be engaged or disengaged at any vehicle speed without releasing clutch—provided transfer case is in "high" range.
6. Transmission gear shift position does not in any way affect the selection of, or shifting of, high and low range in transfer case.

B. Shift Transfer Case From High to Low Speed

1. This shift should be made while vehicle is still on hard ground and before difficult terrain is encountered.
2. Front axle must be engaged for this shift.
3. Depress clutch pedal and move transfer case shift lever into neutral.
4. Release clutch pedal and accelerate engine to approximately double that of vehicle speed.
5. Depress clutch pedal again and move shift lever forward (without applying excessive pressure) into low speed position.

DRIVER'S INSTRUCTIONS

6. Then release clutch and accelerate engine. This method of shifting is termed "double-clutching," a little practice will enable driver to accomplish shift smoothly and efficiently.

C. Shift Transfer Case From Low to High Speed

1. This can be accomplished at any time—regardless of vehicle speed.

2. To do this, the "double-clutch" method is employed, simply depress clutch pedal and move shift lever into neutral.

3. Release clutch pedal and synchronize engine speed with vehicle speed.

4. Then depress clutch pedal and move shift lever toward rear into high speed position.

19. GENERAL OPERATING INSTRUCTIONS

The following information describes the recommended practices for operation under unusual conditions.

A. Steep Grades—When descending steep grades, always shift into a lower transmission speed. This will prevent the attainment of excessive vehicle speed and will reduce the amount of brake application required. To shift from high to lower speed the double-clutching method should be employed as explained in Paragraph 16.

Caution: Do not permit the truck to exceed maximum road speeds **in any gear** when driving downhill because excessive engine speed developed under such conditions is harmful to the engine.

When ascending steep grades, always shift into lower transmission speeds before vehicle begins to labor. This can be accomplished most successfully when vehicle still has sufficient momentum to permit changing gears without bringing vehicle to a stop. **Caution:** When shifting to a lower gear at any rate of vehicle speed, make sure that engine speed is synchronized with vehicle speed before clutch is engaged. If clutch is engaged when engine is operating at lower than relative vehicle speed, the entire drive line may be subjected to serious damage.

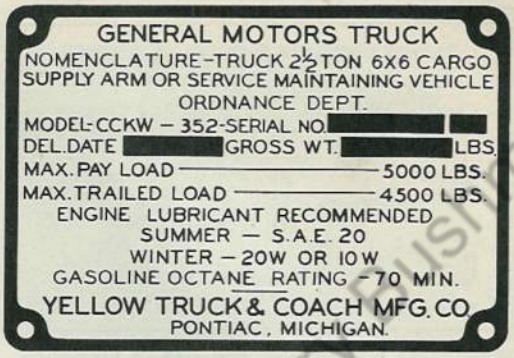


Fig. 6 Serial Number and Operating Data Plate

B. Operation in Soft Terrain—Operating conditions in which sand, gravel or mud are encountered requires considerable skill by the driver to maintain complete control of the vehicle and at the same time prevent damage to mechanical units of the vehicle.

1. Always engage the front axle drive in off-the-road operation, on steep grades and during hard pulling.

2. Do not attempt to "jump" or "lug" the vehicle out of deep sand or a mud hole, etc. If the vehicle is helplessly mired in sand or mud, the winch on vehicle so equipped should be employed as shown in Fig. 7, or truck should be towed out by another vehicle.

How to Operate Winch—It is important that driver of trucks equipped with "winch" be entirely familiar with the operation and many applications of this unit.

Winch is driven by power take-off at left side of transmission. Engagement for lifting or lowering of winch cable is through shift lever located in cab. Power take-off unit has two speeds for lifting and one reverse speed for lowering. Two neutral positions—one between low and reverse, other between high and reverse—are also provided. Arrangement of power take-off shift lever positions are shown on gear shift arrangement plate in driver's compartment of cab; also, in Fig. 2.

WINCH OPERATING INSTRUCTIONS

20. TO HOOK ON WITH WINCH

Move sliding jaw clutch shown in Fig. 8 to disengaged position and pull cable from drum by hand.

21. TO PULL WITH WINCH

1. Engage sliding clutch (Fig. 8), being sure that shift handle poppet is locked.

2. Depress clutch pedal and shift power take-off control lever into low or high speed position.

(Note: When load is heavy, use low speed gear. If load is light, use high speed gear.)

3. Release clutch pedal, at same time accelerate engine as necessary to pull or lift load on winch cable.

Caution: When winch is being used to assist vehicle, with wheels driving, always have power take-off in **Low** speed; also, transmission and transfer case should be in **Low** range.

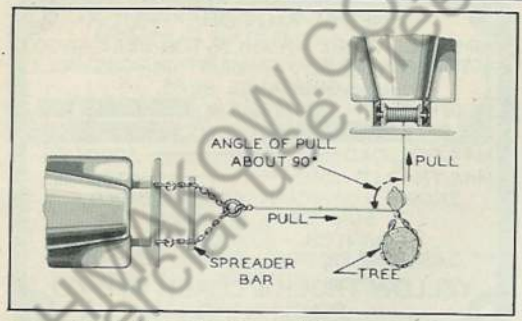
Winch pulling speeds are based on maximum engine speed of 1000 R.P.M. which should not be exceeded when using winch.

Caution: When it is necessary to pull with cable at an angle other than 90° to axis of drum, use pulley at a point in front of vehicle, as illustrated in Fig. 7, so that cable is pulled **Straight** into winch drum.

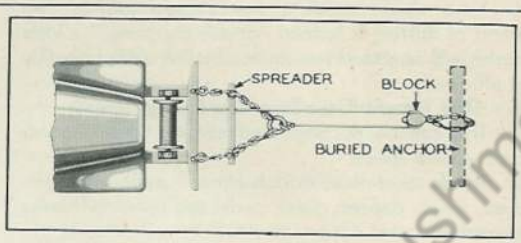
22. TO REVERSE WITH WINCH

1. Depress clutch pedal and shift power take-off control lever into reverse speed position.

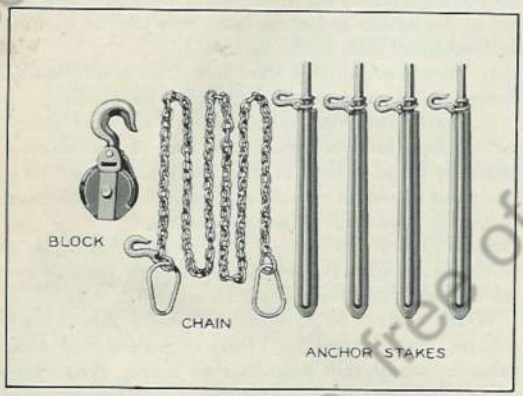
DRIVER'S INSTRUCTIONS



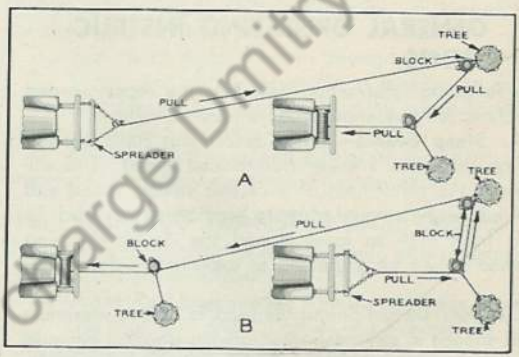
Using Single Block Rigging and Tree as Anchorage to Make an Angular Pull



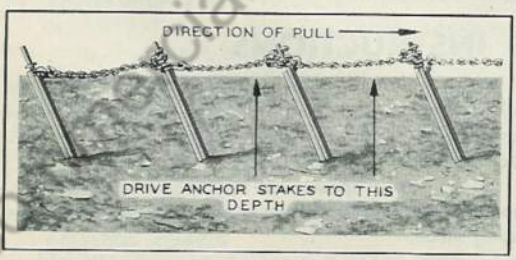
Using Single Block Anchored Rigging to Aid Vehicle Over Exceptionally Heavy Going



Block, Chain and Multiple Anchor Stakes, the Use of Which Is Illustrated Below



Using Single Block Rigging and Tree as Anchorage to Make Slight Angular Pull. "A" Vehicle in Front Is Winching Vehicle in Rear. "B" Vehicle in Rear Is Winching Vehicle in Front



Set Multiple Anchor Stakes for Winch Operation as Shown



Illustrating Use of an "A" Frame to Lift and Move Mired Vehicle

Fig. 7 Typical Illustrations Showing Various Ways of Utilizing Winch and Rigging

DRIVER'S INSTRUCTIONS

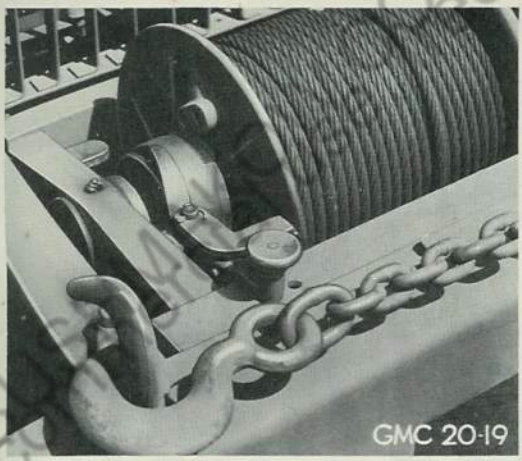


Fig. 8 Sliding Jaw Clutch Must Be Engaged at All Times (Except When Unwinding Cable by Hand)

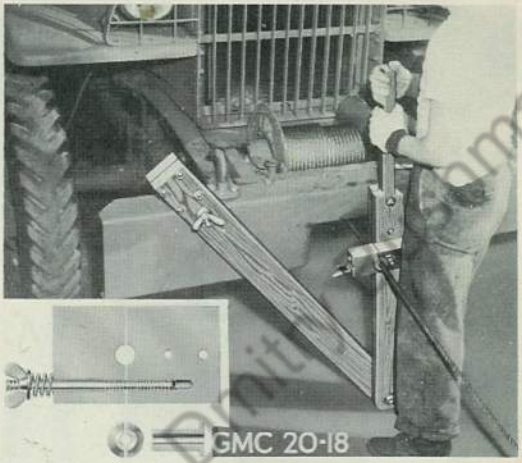


Fig. 9 Construction and Application of Winch Cable Winding Fixture

2. Release clutch pedal. It is not necessary to accelerate engine when in reverse speed. **Never try to lower load with jaw clutch disengaged. Use reverse.**

23. TO STOP WINCH

1. Depress clutch pedal and shift power take-off control lever into neutral position. Two neutral positions are provided; one between low and reverse, other between high and reverse. See shifting arrangement plate in driver's compartment of cab.

Keep power take-off shift lever **Locked** with hinge lock on floor of cab at **All Times** when winch is **Not** in operation. This will prevent accidental kicking or jarring of winch into gear.

24. WINDING CABLE ON DRUM

Two methods of winding cable on winch drum may be used:

1. Pull cable out straight and secure to stationary object. **Engage** jaw clutch and shift winch into forward speed. Allow cable to pull truck towards object, keeping a slight pressure on truck brake pedal. **Caution:** Winding on first layer of cable is most important. Coils of cable must be tight against each other to prevent coils on next layer from pressing down between them. Cable should be wound on drum evenly and slowly to obtain this result. After first layer is on, watch beginning and end of each layer.

2. A fixture, such as illustrated in Fig. 9, may be used to maintain slight tension on cable and guide it into drum.

Fixture is not obtainable from Factory or its Branches but must be made up locally. Two main sections can be made from heavy lumber such as 2" x 4" strips or larger. Guide block as shown in Fig. 9 is of metal approximately 4" x 4" x 6", split through drilled hole to permit insertion of cable and split bushing and tightening by means of a stud with large wing nut to obtain the desired cable tension. The end of fixture may be securely clamped to front bumper with "hooked" bolt or "C" clamp, as in Fig. 9. Pivot point is at ground level. This will permit swinging free arm, with guide block, back and forth to guide cable and wind it in even layers on drum.

If cable is rusting, it should be well covered with ordinary engine lubricating oil.

TABULATED DATA

25. TOOL EQUIPMENT

Each truck is equipped with a set of tools as listed and illustrated in Fig. 10 of this group. These tools are entirely adequate for making minor adjustments to the vehicle, changing tires and performing numerous first echelon maintenance operations.

Special service tools, not included with truck, are required to perform various mechanical operations in the assembly and disassembly of such units as Engine, Transmission, Axle, etc. Each group throughout this book contains a list of such tools and the vendor from whom they may be obtained.

DRIVER'S INSTRUCTIONS

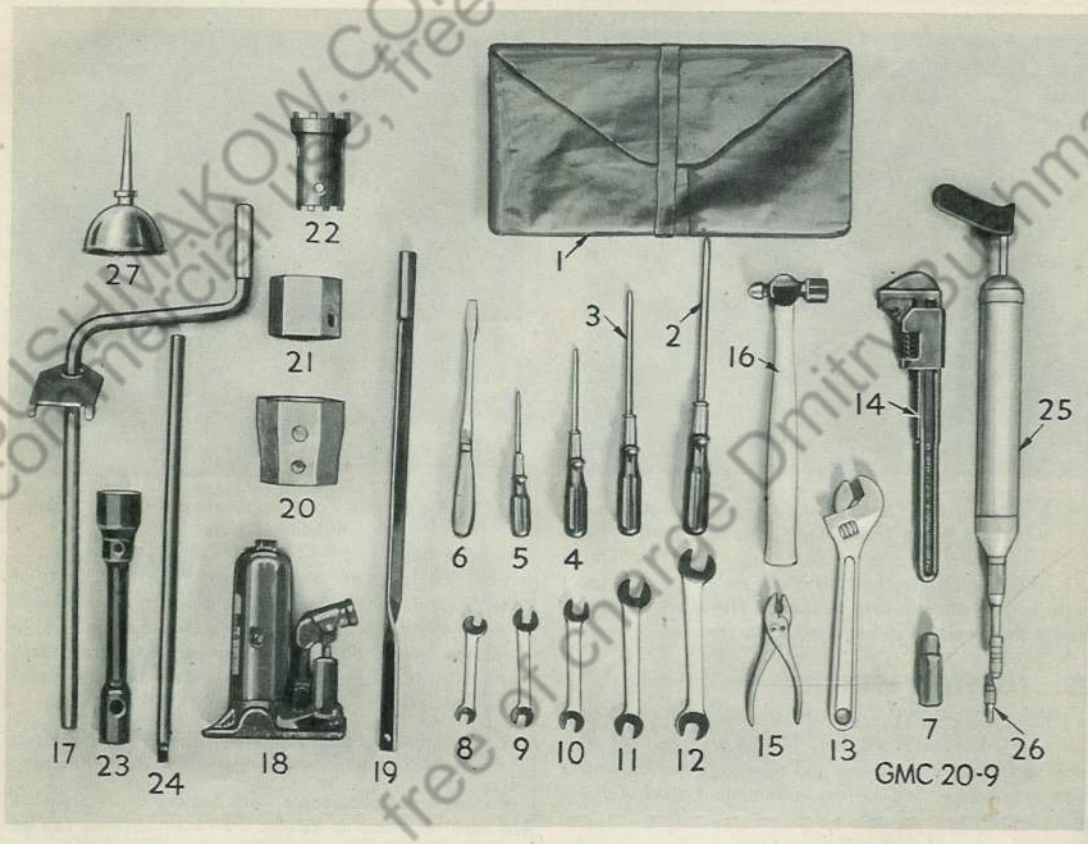


Fig. 10 Tool Equipment in Tool Compartment

Standard Tool Equipment for These Vehicles Consists of the Following:

1. Tool Bag
2. Screw Driver (Cross Recess No. 4)
3. Screw Driver (Cross Recess No. 3)
4. Screw Driver (Cross Recess No. 2)
5. Screw Driver (Cross Recess No. 1)
6. Screw Driver (Plain)
7. Spark Plug Wrench
8. Double End Wrench $\frac{3}{8}$"—$\frac{7}{16}$"
9. Double End Wrench $\frac{9}{16}$"—$\frac{11}{16}$"
10. Double End Wrench $\frac{5}{8}$"—$\frac{25}{32}$"
11. Double End Wrench $\frac{7}{8}$"—$\frac{3}{4}$"
12. Double End Wrench $\frac{1}{2}$"—$\frac{29}{32}$"
13. Adjustable End Wrench (Crescent)
14. Adjustable Wrench
15. Combination Pliers 6"
16. Ball Pein Hammer 1 lb.
17. Starting Crank—With Bumper Bracket
18. Lifting Jack
19. Lifting Jack Handle
20. Wheel Bearing Nut Wrench—Large (For Split Type Axles)
21. Wheel Bearing Nut Wrench—Small (For Split Type Axles)
22. Wheel Bearing Nut Wrench—(For Banjo Type Axles)
23. Wheel Wrench
24. Wheel Wrench Handle
25. Lubrication Gun (16 oz.)
26. Lubrication Gun Fitting Adapter
27. Oil Can (Located on Bracket Attached to Engine Side of Dash Panel)
28. 1 Pair of Single Tire Chains—Not illustrated
29. 2 Pairs of Dual Tire Chains—Not illustrated

Group L—Lubrication

	Paragraph
GENERAL	
The Importance of Lubrication	1
What Lubricants to Use	2
LUBRICATION CHART	
Description of Chart	3
Localized Views	4
Pre-Lubricated Units	5
MISCELLANEOUS DATA	
Special Services	6
Changing Engine Oil	7
Tool Equipment	8

GENERAL

1. THE IMPORTANCE OF LUBRICATION

One of the most vital factors in the maintenance of any machine is its lubrication. The application of the right lubricant in the right place and at the right time will not only increase the useful life of the vehicle but will go a long way toward assuring daily trouble-free operation as well. It is essential first, that the right lubricants be selected; secondly, that the lubricant be applied at regular intervals, and thirdly, that the lubricant be applied at the right place.

It is the purpose of this portion of the book to give the essentials of lubrication as applied to these particular vehicles. By referring to subjects as outlined above and following the recommendations given therein, using the right lubricant—at the right place—at the right time, will be a simple matter.

2. WHAT LUBRICANTS TO USE

There are only four types of lubricants in use by the U. S. Army for lubrication of these vehicles. These are: Engine Oil, Universal Gear Lubricant, General Purpose Grease, and Heavy Duty Wheel Bearing Grease. Water pump grease should not be used on these vehicles as water pump is lubricated at time of manufacture and requires no added lubricant throughout its life.

These four types of lubricants must conform strictly to definite specifications as follows:

A. Engine Oil—Engine oil must conform with U. S. Army specification No. 2-104. These oils are available in SAE viscosities 10, 30 and 50. Refer to table at bottom of Lubrication Chart on page L-2 for application of oil at various atmospheric temperatures.

B. Universal Gear Lubricant—As noted on Lubrication Chart, this lubricant, as applied to these particular vehicles, is used in front and rear axles, transmission, transfer case, steering gear and center bearing. This lubricant must conform with Federal specification No. VV-L-761 and is available in two grades—SAE-80 and SAE-90. Refer to table at bottom of Lubrication Chart on page L-2 for proper grade to use at various atmospheric temperatures.

C. General Purpose Grease (Chassis Grease)—This is available in three grades—No. 0, No. 1 and No. 2. No. 0 and No. 1 are chassis greases intended for general purpose chassis lubrication—No. 0 being recommended for winter operation and No. 1 for summer. No. 2 is primarily a wheel bearing grease to be used for all temperatures except as stated under Heavy Duty Wheel Bearing Grease shown below.

These lubricants must conform to the following U. S. Army Specifications:

Grease	U. S. Army Specification
No. 0	No. 2-106
No. 1	No. 2-107
No. 2	No. 2-108

D. Heavy Duty Wheel Bearing Grease—This is identified as No. 3 grease and is intended for heavy duty, high temperature, wheel bearing lubrication only. Normally, No. 2 grease should be used for this purpose; but, with extreme temperature conditions (over 90° F.) when wheel bearing grease leakage is experienced due to worn oil seals, No. 3 heavy duty wheel bearing grease may be used as a temporary expedient. Lubricant must conform with U. S. Army specification No. 2-110.

LUBRICATION CHART

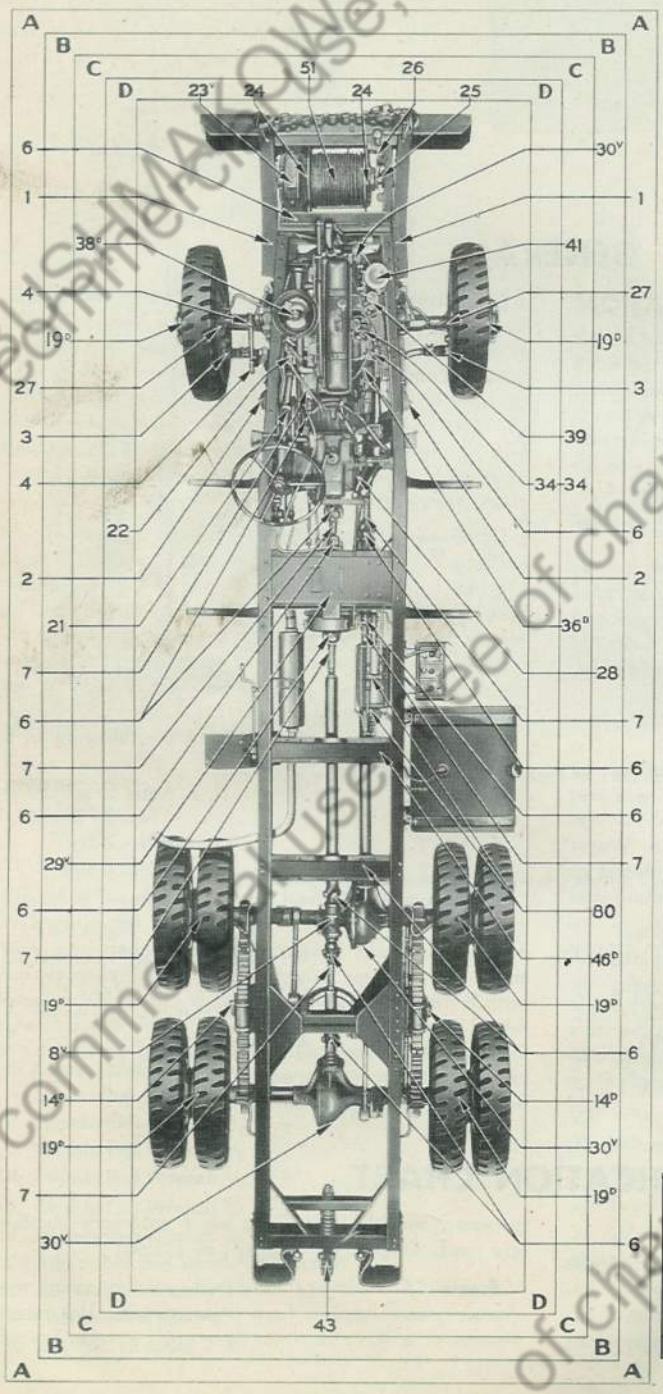
3. DESCRIPTION OF CHART

Lubrication Chart shown on Page L-2 is designed by the Army, for the Army, and includes all necessary information for the proper lubrication of these vehicles. Outstanding features of this chart are the frames that surround and the manner in which reference numbers are used. Purpose of frames is as follows:

Frame "A"—Fittings indicated are lubricated with chassis grease applied from pressure gun. The vehicle must be on a lift or you must lie or crouch on the ground.

LUBRICATION CHART

GMC 2½-TON 6x6 TRUCK
MODELS CCKW-352 & 353



	Daily	250 Miles or Weekly*	1000 Miles or Monthly*	6000 Miles or Semi-Annual*	
1					Spring Shackle
2					Spring Bolt
3					Tie Rod End
4					Drag Link
6					Universal Joint
7					Slip Joint
8v					Prop. Shaft Center Brg.
				14d	Rear Spring Bearing
				19d	Wheel Bearings
21					Linkage
22					Steering Gear Housing
23v					Winch Worm Housing
24					Winch Drum Bearing
25					Winch Shaft
26					Winch Clutch
27					Front Axle Universal
		28			Transmission
		29v			Transfer Case
		30v			Axle Housing
34					Distributor
36				36d	Starter
38d					Air Cleaner
39					Crankcase
41d					Oil Filter
43					Pintle Hook
				46d	Power Cyl. Air Cleaner
51					Winch Cable
80					Power Cylinder

*—Whichever occurs first.
d—Requires Disassembly.
v—Clean Vent.

TOOLS

Clean Rag—Screwdriver—Adjustable Wrench.

INSTRUCTIONS

Clean fitting or area around filler plugs. Lubricate each item in order shown on chart, except those requiring disassembly.

Clean all vents. Check lubricant level and add if required to keep level up to filler or level holes.

Disassemble or drain units at intervals specified.

Below Vehicle

Frame A—Chassis Grease.

Frame B—Gear Lubricant—Except Items 14 and 19 use Wheel Bearing Grease, Items 21 and 46 use Engine Oil, and Item 80 use SAE 10 Engine Oil plus 5% kerosene.

Above Vehicle

Frame C—Engine Oil.

Frame D—Chassis Grease—Except Item 22 and Item 23 Gear Lubricant, and Item 34 Engine Oil and Grease.

Type of Lubricant	Lowest Expected Temperature		
	Above 32° F.	Between 32° F. & 0° F.	Below 0° F.
Engine Oil	30	10	*10
Gear Lubricant	90	90	80
Chassis Grease	1	1	0
Wheel Bearing Grease	2	2	2

*Plus 10% Kerosene or Diesel Fuel

LUBRICATION

You don't have to interrupt the order to change lubricant or dispenser or crawl out from under except to pass the axles. All you need for the first frame is a pressure gun, screwdriver, adjustable wrench, and a rag for cleaning.

Frame "B"—These fittings can be lubricated, and the lubricants can be changed without interrupting the order indicated. Points are accessible from beneath vehicle. Gear cases don't have to be drained unless they need it, because they are handled on schedule. Wheel bearings and spring seat bearings require disassembly and should be lubricated separately because these jobs cannot conveniently be handled in a motor park.

Frame "C"—Gives locations lubricated with engine oil. Points are accessible from above vehicle. Since the crankcase oil is changed on a separate schedule, the oil change is considered a separate operation. Whenever oil change is made, oil filter element should be replaced with a new one.

Frame "D"—Indicates fittings accessible from above vehicle. Vehicle need not be on hoist or over pit. A wrench is required for the steering gear housing plug and winch worm housing plug.

To save confusion, shock absorbers, hydraulic brakes and batteries are omitted from these charts. Drivers must report any deficiency in shock absorbers, brakes or the battery, so a mechanic can check them.

This routine provides examination of parts of the vehicle which are relatively inaccessible. Any leaks of water, oil, grease or gasoline, excessive rusting of chassis parts, broken, bent or damaged bolts, rivets, brackets or other members can be seen easily and reported.

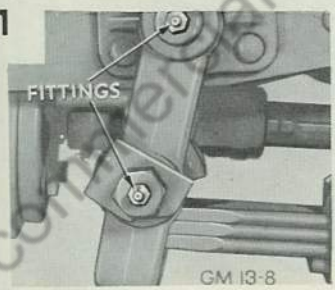
Vents are provided on closed housings to relieve the pressure due to expansion of the lubricant. Vents are indicated on the chart with a "V" next to the number. These are to be cleaned as part of the lubrication. To clean, unscrew vent, remove and wash in kerosene; blow dry and re-install.

4. LOCALIZED VIEWS

The item numbers shown in the frames surrounding the lubrication chart are set up by the Army, thus any missing numbers such as 9, 10, etc., apply on items not used in the construction of these GMC trucks. Items which do appear, however, are also illustrated by a localized view shown on pages immediately following the chart. These localized views show lubrication points in detail and are arranged in numerical order.

LOCALIZED VIEWS

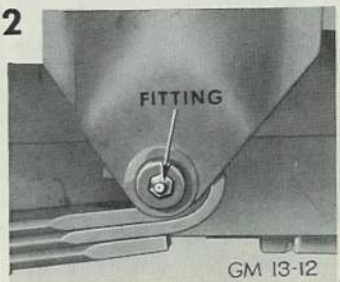
1



1. Front Spring Shackle

4 Fittings (2 each shackle).
Pressure Gun—Chassis Grease.
Every 1000 miles, lubricate from under chassis, until grease shows at sides.

2



2. Front Spring Bolt

2 Fittings (1 each bolt).
Pressure Gun—Chassis Grease.
Every 1000 miles, lubricate from under chassis, until grease shows at sides.

3

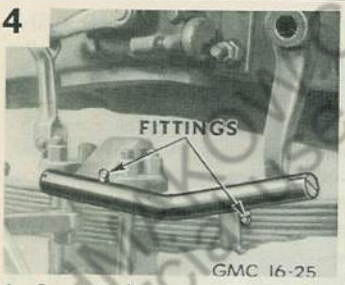


3. Tie Rod Ends

2 Fittings (1 each end).
Pressure Gun—Chassis Grease.
Every 1000 miles, lubricate from under chassis, until grease shows at top of rod.

LUBRICATION—LOCALIZED VIEWS

4



4. *Drag Link*

2 Fittings (1 each end).
Pressure Gun—Chassis Grease.
Every 1000 miles, lubricate from under chassis, until grease shows around seats.

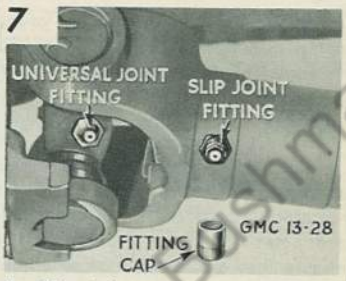
6



6. *Universal Joints*

10 Fittings—12 Fittings if equipped with Winch.
Pressure Gun—Chassis Grease (heavy straight petroleum oil is preferred but chassis grease may be used if such oil is not available).
Every 1000 miles, lubricate from under chassis, until lubricant shows through relief fitting in center of journal.

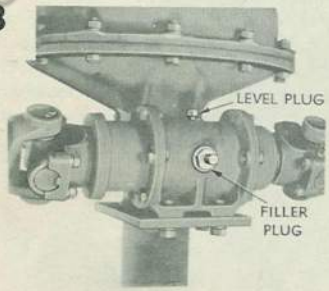
7



7. *Slip Joints*

5 Fittings—6 Fittings if equipped with Winch.
Pressure Gun—Chassis Grease.
Every 1000 miles, lubricate from under chassis, until lubricant shows through vent at end of shaft.

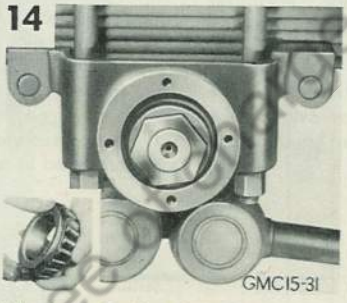
8



8. *Propeller Shaft Center Bearing*

Remove filler and level plugs.
Pump Gun—Gear Lubricant—Capacity ⅜ Pint.
Every 1000 miles, lubricate from under chassis, through filler hole, until lubricant is visible at level hole. Clean vent in filler plug and replace filler and level plugs.

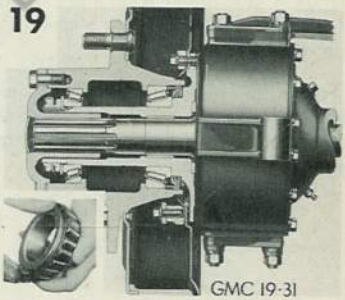
14



14. *Rear Spring Bearings*

One each side of vehicle.
No. 2 Wheel bearing grease. Capacity, approximately ½ pint or 8 oz.
Every 6000 miles, remove spring seat and bearings.
Clean and repack; reassemble and adjust bearings.

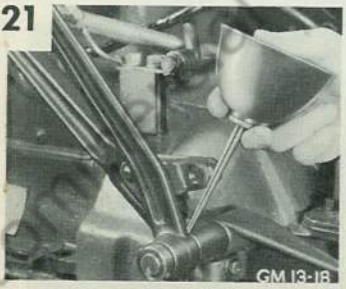
19



19. *Wheel Bearings*

Inner and outer—Each wheel.
Wheel bearing grease. (Refer to paragraphs 2c and 2d.) Capacity, approximately ½ pint or 8 oz.
Every 6000 miles, remove hub and bearings.
Clean and repack; reassemble and adjust bearings.

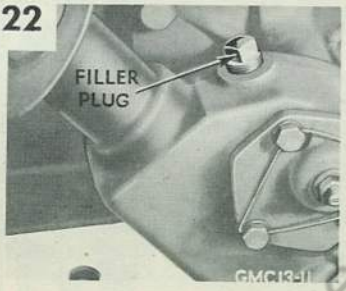
21



21. *Linkage*

Oil Can—Engine Oil.
Transfer case control lever bushings and rods, hand brake linkage, brake pedal pull rod clevis pins, clutch pedal linkage, clutch and brake pedal shaft. Every 1000 miles, lubricate from under chassis. Oil clevis pins and bushings.

22



22. *Steering Gear Housing*

Filler Hole (Remove pipe plug).
Pump Gun—Gear Lubricant.
Inspect every 1000 miles, lubricate from under left side of hood, until lubricant is level with filler hole. Replace plug. Capacity ½ pint or 8 oz.

23



23. *Winch Worm Housing*

Filler hole and level holes (remove plugs).
Pump Gun—Gear Lubricant. Check level every 1000 miles. Lubricate from front of chassis, through filler hole (top) until lubricant is up to level hole (side). Vent is located under name plate, keep area around name plate clean. Drain at bottom of housing. Capacity 3¾ pints.

LUBRICATION—LOCALIZED VIEWS

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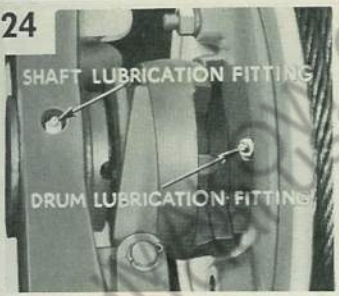
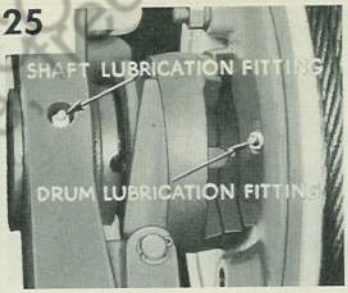


24. *Winch Drum Bearing*

2 Fittings (one each end of drum).
Pressure Gun—Chassis Grease.
Every 1000 miles, lubricate from front of chassis, until grease shows.

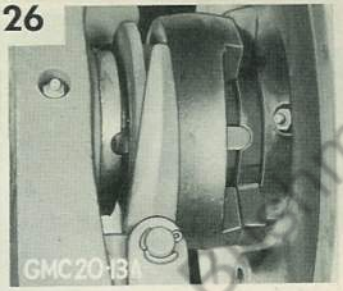
25



25. *Winch Shaft*

One Fitting (right end of shaft).
Pressure Gun—Chassis Grease.
Every 1000 miles, lubricate from front of chassis, until grease shows at end of shaft.

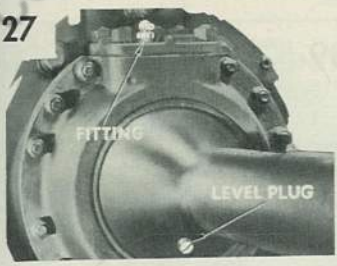
26



26. *Winch Clutch*

Sliding surface of jaw clutch, yoke groove and linkage.
Oil Can—Engine Oil.
Inspect every 1000 miles. Lubricate from front of chassis, when inspection shows clutch to be dry. Clean and re-oil when clutch sticks.

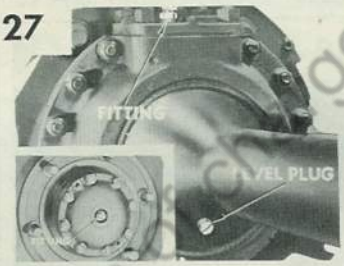
27



27. *Front Axle Universal—Bendix-Weiss*

"Split" Axle. 2 Fittings and 2 level plugs (each side of vehicle).
Pressure Gun—Chassis Grease.
Every 1000 miles, remove level plug (lower) and lubricate through fitting (upper) until lubricant is visible at level hole. Replace level plug. Lubricate from under chassis.

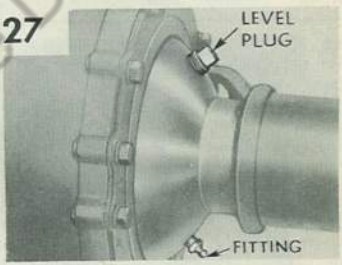
27



27. *Front Axle Universal—Rzeppa*

"Split" Axle. 2 Fittings, 2 temporary plugs and 2 level plugs (each side of vehicle).
Pressure Gun—Chassis Grease.
Every 1000 miles, remove level plug (lower), add 3 or 4 shots through upper fitting. Then remove temporary plug, install fitting and lubricate until visible at level hole. Replace level and temporary plugs.
Lubricate from under and side of chassis.

27



27. *Front Axle Universal*

"Banjo" Axle. 2 Fittings and 2 level plugs (each side of vehicle).
Pressure Gun—Chassis Grease.
Every 1000 miles, remove level plug (upper) and lubricate through fitting (lower), until lubricant is visible at level hole. Replace level plug Lubricate from under chassis.

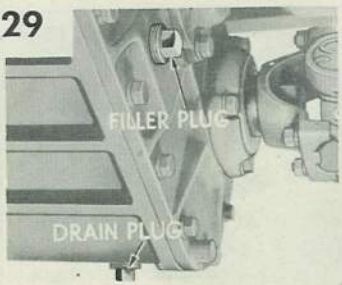
28



28. *Transmission*

Filler Hole—Gear Lubricant.
Check level every 250 miles (weekly). Keep lubricant to level of filler hole. Drain every 6000 miles, or more often if lubricant has thickened or oxidized. Drain only when lubricant is warm, preferably immediately after operation. Capacity 13 Pints (14 Pints with power take-off) on early models. 9 Pints (10 Pints with power take-off) on late models.

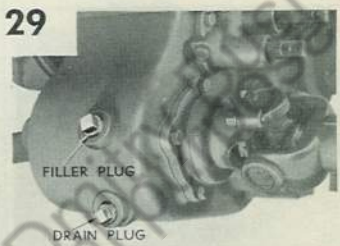
29



29. *Transfer Case*

"Split" Axle Housings.
Filler Plug—Pump Gun—Gear Lubricant. Check lubricant level and clean vent every 250 miles (weekly). Keep lubricant to level of filler hole. Drain every 6000 miles, or more often if lubricant has thickened or oxidized. Drain when lubricant is warm, preferably immediately after operation. Capacity 7 pints.

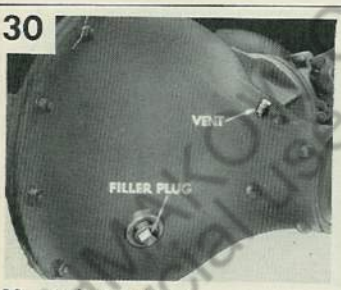
29



29. *Transfer Case*

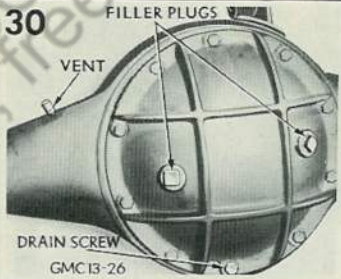
"Banjo" Axle Housings.
Filler Plug—Pump Gun—Gear Lubricant. Check lubricant level and clean vent every 250 miles (weekly). Keep lubricant to level of filler hole. Drain every 6000 miles, or more often if lubricant has thickened or oxidized. Drain when lubricant is warm, preferably immediately after operation. Capacity 4 pints.

LUBRICATION—LOCALIZED VIEWS



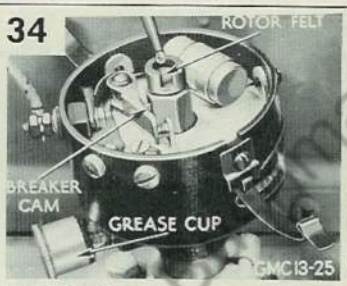
30. Axle Housings

"Split" Type—One Front—Two Rear.
Filler Plug—Pump Gun—Gear Lubricant. Check lubricant level and clean vent every 250 miles (weekly). Keep lubricant to level of filler hole. Drain every 6000 miles, or more often if lubricant has thickened or oxidized. Drain when lubricant is warm, preferably immediately after operation. Capacity 7 pints.



30. Axle Housings

"Banjo" Type—One Front—Two Rear.
Filler Plug—Pump Gun—Gear Lubricant. Check lubricant level, clean vent every 250 miles (weekly). Keep lubricant to level of lower filler hole. Drain every 6000 miles—more often if lubricant has thickened or oxidized. Drain when lubricant is warm, preferably immediately after operation. Capacity 13 pts. front and front rear; 10½ pts. rear.



34. Distributor

Grease Cup, Wick and Breaker Arm.
No. 2 Grease and Engine Oil. Lubricate every 1000 miles from right side of vehicle, under hood. Turn grease cup one full turn, refill when empty. Remove distributor cap and rotor and oil felt under rotor, with 2 or 3 drops of engine oil. Spread grease sparingly on drive shaft cams.



36. Starter

Two Oilers—One Each End—Oil Can—Engine Oil.
Every 1000 miles, fill oiler at commutator (front) end from under right side of hood. At 6000 mile inspection periods, lubricate drive end bushing through oiler, while starter is removed.



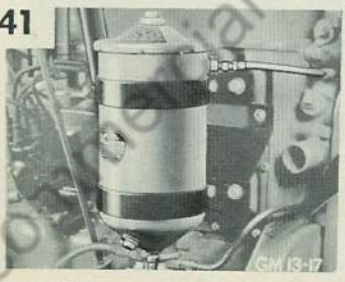
38. Air Cleaner

Filter element and reservoir. Engine oil.
Check oil level in cleaner bowls. Rub finger through oil to detect dirt. If cleaner is dirty remove filter element and wash in kerosene, dry and dip in fresh engine oil. Clean reservoir and fill to "oil level" mark. Use SAE 30 below 32°F. and SAE 50 above 32°F. or heaviest available. Service daily.



39. Crankcase

Remove level indicator and clean with wiping cloth. Replace and again remove. Oil level should be up to "Full" mark. Remove filler cap and replenish if necessary through filler pipe. Replace indicator and filler cap. To drain, remove plug at bottom of oil pan. Refer to Paragraph 7 for intervals. Capacity, 11 Qts., including filter.



41. Oil Filter

Change element when dirty and when the oil is changed. Remove cover. Remove drain plug and allow sludge to drain. Remove old element. Install new military standard element. Replace drain plug. Replace cover, using new gasket. Run engine for several minutes and check for leaks. Check oil level on dip stick and add sufficient to bring level up to "Full" mark.



43. Pintle Hook

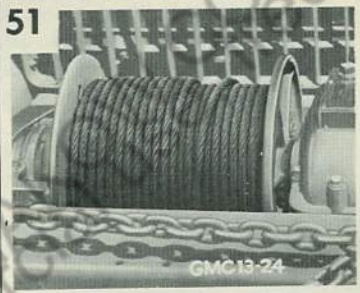
Pins and Connections.
Oil Can—Engine Oil.
Lubricate from rear of chassis, every 1000 miles.



46. Power Cylinder Air Cleaner

Remove air cleaner from under side of chassis. Remove filter element. Wash filter element in kerosene; dry and dip in new engine oil. Clean shell in kerosene and dry. Service every 6000 miles or 6 months, whichever occurs first. Under continued adverse conditions, unit should be cleaned more often.

LUBRICATION



51. Winch Cable

Oil Can—Engine Oil.
Every 1000 miles, inspect full length of cable, and lubricate if surface is not oily or if rust is apparent.



80. Power Cylinder

2 Plugs (one on side, one at rear end).
Use SAE 10 Engine Oil plus 5% Kerosene. Every 6000 miles or semi-annually, whichever occurs first, remove plugs and apply ½ ounce lubricant in each hole. Replace plugs. Apply brakes several times to distribute oil along power cylinder shell.

5. PRE-LUBRICATED UNITS

Some parts of the vehicle are lubricated at the factory and either require no further lubrication or should be lubricated only at the time the assembly is torn down and reassembled. Such items are as follows:

A. Clutch Release Bearing—Clutch release bearing is ball type, packed with sufficient lubricant at time of manufacture to last life of bearing. Apply light coat of No. 3 grease to shift fork groove, also pack groove inside bearing sleeve with grease to lubricate surface between sleeve and transmission main drive gear cap.

B. Clutch Pilot Bearing—Clutch pilot bearing is ball type, shielded on one side. Fill cavity in crankshaft behind bearing with No. 3 grease, at time of assembly. Shielded side of bearing must always be toward rear when installing.

C. Clutch Shaft Splines—Clutch shaft splines should be coated lightly with No. 3 grease at time of assembly.

D. Steering Column Upper Bearing—Ball bearings, used near upper end of steering column, should be lubricated with No. 3 grease at time of assembly.

E. Steering Column Horn Contacts—Coat horn button contact washer with light coating of chassis grease at time of assembly, to prevent corrosion.

F. Clutch Shift Fork Ball Stud—Coat ball stud socket in shift fork with No. 3 grease at time of assembly.

G. Generator Bearings—Bearings used at each end of generator are ball type, sealed on both sides and packed with sufficient lubricant at time of manufacture to last life of bearings; therefore, no further attention is necessary.

H. Power Take-Off—Power take-off is lubricated by supply of lubricant in transmission.

I. Water Pump—Water pump bearings are lubricated at time of manufacture, with sufficient lubricant to last the lifetime of bearings. Therefore, no further attention need be given to bearing lubrication.

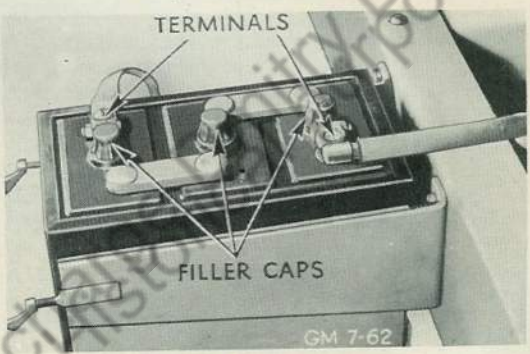
6. SPECIAL SERVICES

In addition to points throughout the vehicle that require lubrication, the battery, shock absorbers and master cylinder should also be given attention at each lubrication period. Service information pertaining to these units is as follows:

A. Battery Terminals—Every 250 miles inspect battery terminals for tightness and evidence of corrosion, also inspect level of electrolyte in each battery cell.

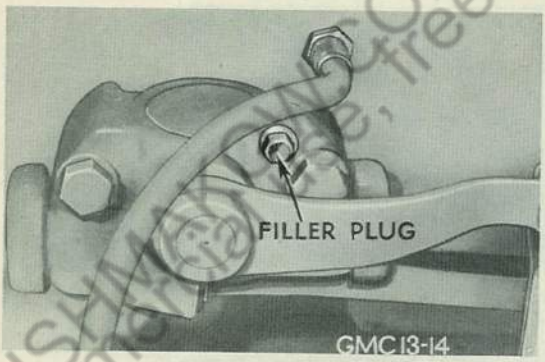
Terminals which are corroded should be cleaned thoroughly. Apply coating of grease to prevent corrosion.

Battery level should be kept ⅜" above plates. Whenever electrolyte is less than ⅜" above plates, bring to proper level by adding pure distilled water. During summer or in tropical climates battery level should be checked more frequently.

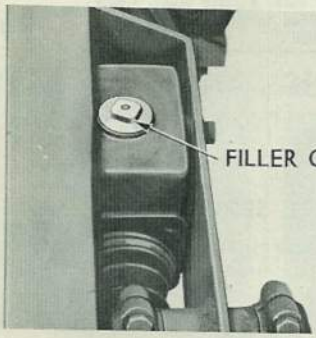


Battery

LUBRICATION



Shock Absorber



Brake Master Cylinder

B. Shock Absorbers—Fluid level in each shock absorber should be checked every 6,000 miles or semi-annually. Disconnect link between shock absorber arm and axle. Wipe dirt off around filler plug and remove plug. Fill to capacity with Light Shock Absorber Fluid. Pull down arm several times to expel air from cylinder.

Repeat filling and pumping operation until all air is removed and housing is filled to level of filler hole. Install plug and connect link.

C. Master Cylinder—Level of hydraulic fluid in brake master cylinder should be checked every 1,000 miles or monthly. Keep fluid level up to within 1" of filler cap.

When additional fluid is necessary, use only Delco Super No. 9 or Wagner Lockheed 21. Do not use gasoline, kerosene or other liquids containing any petroleum product.

7. CHANGING ENGINE OIL

The frequency with which crankcase oil must be changed depends upon the type of oil used, the severity of and the type of operation, and the condition of the engine. It is therefore impossible to make a general recommendation concerning mileage intervals between oil changes. The oil should be changed often enough to keep it non-abrasive and non-corrosive and to keep the engine clean. Oil changing is closely related to air cleaner efficiency and to oil filter element changing, the frequency of which also depends upon the conditions of operation mentioned above.

8. TOOL EQUIPMENT

In addition to the regular lubrication dispensers, the only other tools required when lubricating these vehicles are as shown with the lubrication chart, these being: a screwdriver, an adjustable wrench and a clean rag. It should be noted that the tool equipment furnished with these trucks includes an adapter for the lubrication pressure gun, and this adapter is to be used at points where lubrication fitting would otherwise be inaccessible, such as at winch.

SERVICE BULLETIN REFERENCE

Bulletin No.	Description

Group PM—Preventive Maintenance

	Paragraph
Special Services	1
Daily—After Operation	2
Daily—Before Operation	3
Daily—During Operation	4
Daily—At Halt	5
Weekly	6
Monthly	7
Semi-Annually	8
Preparing Vehicle for Long-Term Storage	9

DESCRIPTION

Preventive maintenance is a "repair before failure" plan which reduces materially the initial causes of vehicle failure. Experience has proven that preventive maintenance is a simple and efficient means of reducing out-of-service time, increasing equipment life and eliminating the element of neglect which is too often responsible for sudden, unexpected failures of vehicle.

To function satisfactorily, preventive maintenance must be systematic. It must provide for vehicle inspection and service at regular intervals and the procedure for this service must not be left to chance but rather to a definite outline of operation.

Preventive maintenance outlined in this group embraces the most essential phases of vehicle maintenance, as it provides for continuous inspection and service of **all** functional units under **all** operating conditions.

Preventive maintenance starts with the driver—who should be trained for the part which he takes in the system. He is called upon to perform inspections and minor adjustments which, if neglected, might lead to vehicle failure at a critical time. Aside from the information contained in Driver's Instruction group, the driver should also be familiar with mechanical construction of the vehicle in order for him to make accurate diagnosis and reports on the vehicle's condition.

Keeping records in connection with preventive maintenance is recommended as **they provide a basis for establishing routine vehicle service operation,** and, at the same time, spotlight careless driver's abuse and inefficient servicing by mechanics.

Preventive maintenance system is outlined in the following paragraphs.

1. SPECIAL SERVICES

A new preventive maintenance schedule is provided that will relieve the driver and other personnel of the necessity of constantly being on the alert for conditions that will require the performance of some special services. Conditions enumerated below may be encountered frequently during operation of these vehicles. Therefore, all personnel concerned should be thoroughly familiar with the trouble likely to result and the services that should be performed as a result of such conditions. This check list is intended to serve as a reminder of the various services likely to be necessary.

A. Placing New or Used Vehicle in Service—

If a used vehicle is being returned to service, perform the procedure outlined in Par. 7. If a new vehicle is being placed in service, proceed as follows:

Before Operation:

A1. Perform complete monthly preventive maintenance service as outlined in Par. 7.

A2. Inspect wheel bearing lubricant for correct type and quantity. Remove wheel, hub and drum assemblies to perform this operation.

A3. Inspect brake master cylinder fluid and refill to proper level if necessary.

A4. Tighten intake and exhaust manifold nuts while engine is warm.

A5. With engine at normal operating temperature, tighten cylinder head nuts with torque wrench. After tightening cylinder head nuts, readjust valve clearances.

A6. Check crankcase oil level and add required quantity of 10W oil.

During first 500 miles of operation:

A7. Perform preventive maintenance procedure in Pars. 2, 3, 4 and 5 daily—in Par. 6, weekly.

A8. Do not allow vehicle speed to exceed 25 m.p.h. in high gear and proportionately slower in lower gear ratios.

A9. Avoid operations requiring use of full power of engine.

At 500 miles:

A10. Perform complete monthly preventive maintenance procedure outlined in Par. 7.

A11. Perform complete tune-up of engine, electrical system and fuel system.

A12. Drain oil, while engine is hot, and refill with oil specified for climatic and operating conditions.

During second 500 miles of operation:

A13. Perform procedure in Pars. 2, 3, 4 and 5 daily; in Par. 6, weekly.

A14. Do not allow vehicle speed to exceed 35 m.p.h. in high gear and proportionately slower in lower gear ratios.

A15. Avoid operations requiring constant use of full power of engine.

PREVENTIVE MAINTENANCE

At first 1,000 miles:

A16. Perform complete monthly preventive maintenance service outlined in Par. 7.

A17. Drain oil, while engine is hot, and refill with oil specified for climatic and operating conditions.

After first 1,000 miles:

A18. Perform complete preventive maintenance procedure outlined in Pars. 2, 3, 4 and 5 daily; Par. 6, weekly.

A19. Avoid operations requiring constant use of full power of engine during the first few thousand miles. During the first few thousand miles, drivers should be constantly alert to the cautions contained in Par. 4.

A20. Perform preventive maintenance procedure as outlined in Par. 7 monthly; in Par. 8, semi-annually according to the standard practice.

B. High or Low Mileage Operation—

At high mileage operation, perform procedure in Pars. 7 and 8 more frequently. For low mileage operation, proceed as follows:

B1. Perform special services described in this paragraph when necessary.

B2. Once each week drive vehicle at least 25 miles with engine thoroughly warmed up and perform the preventive maintenance service outlined in Pars. 2, 3, 4 and 5.

B3. Once each week perform preventive maintenance service outlined in Par. 6.

B4. Once each month perform preventive maintenance service outlined in Par. 7.

B5. Once each 6 months change the engine oil and warm the engine up thoroughly before draining the oil.

C. Seasonal Changes—

From above freezing to below freezing:

C1. Add anti-freeze to cooling system.

C2. Test and add anti-freeze as required during operation.

C3. Use lubricants specified for climatic and operating conditions.

C4. Keep battery fully charged. Remember that at a gravity lower than 1.002 batteries will freeze at 0° F.

C5. Keep moisture out of fuel system.

C6. Take necessary precautions to see that engine is operated at normal operating temperature.

C7. Use a more volatile gasoline.

C8. Adjust exhaust manifold heat control valve and adjust carburetor and accelerator pump.

From below freezing to above freezing:

C9. Remove anti-freeze from cooling system and flush the system.

C10. Use lubricant specified for climate.

C11. Use a less volatile gasoline.

C12. Adjust exhaust manifold heat control valve and carburetor and accelerator pump.

D. Icing Conditions—

D1. Drive at slower speeds. Stop vehicle frequently and inspect all controls as slush freezing on bottom of vehicle will interfere with vehicle control.

D2. Remove sleet from gasoline.

D3. Remove slush and mud from controls when parking vehicle.

D4. Do not set hand brake when parking. Do not park in water which may freeze.

E. Extremely Cold Climates—

E1. Perform services enumerated in preceding Items C1 to C8.

E2. Change engine oil more frequently.

E3. Use lubricant specified for climate.

E4. Partially cover radiator if necessary to maintain normal engine operating temperature.

E5. Keep battery charged to a specific gravity of at least 1.220 which is the minimum requirement for operation in temperatures of 20° below 0° Fahrenheit; and at least 1.240 for temperatures below 40° below 0. This is important to prevent batteries from freezing.

E6. Check all hose connections for leaks.

F. Extremely Hot Climates—

F1. Perform services outlined above in Items C9 to C12.

F2. Use a less volatile gasoline.

F3. See that fuel pump and fuel lines are in perfect condition.

F4. Clean cooling system inside and out.

F5. Add battery water more frequently.

F6. Avoid overheating and prevent damage to tires by avoiding high speeds and over loads.

G. Driving Through Water and Mud—

G1. Wash chassis after operation.

G2. Lubricate chassis more frequently.

G3. Perform services outlined below for any assemblies of vehicles that are submerged.

H. Extreme Dust and Sand—

H1. Keep dust and sand out of engine..

H2. Service the air cleaner more frequently.

H3. Clean breather cap more frequently.

H4. Change engine oil more frequently.

H5. Change oil filter element more frequently.

I. Off-road Operations—

I1. Select road for minimum of hazards.

I2. Make reconnaissance on foot in front of each vehicle when necessary.

J. Submerges—

J1. Perform temporary expedients for submerged vehicles.

J2. As soon as possible, completely disassemble and clean parts of submerged assemblies.

2. DAILY—AFTER OPERATION

This procedure is particularly important, because at this time the driver inspects and tests various units to find any defects that may have developed during the previous operation. The driver should correct any conditions found and report those that he cannot handle. This procedure should never be entirely omitted even in extreme tacti-

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cal situations but may be reduced to bare fundamental services outlined in Paragraph 5. When performing these operations, the driver should remember and consider any irregularities noticed during the day's operation.

A. In Cab—Before Stopping Engine—

A1. Hand brake-lever ratchet should keep lever in applied position and brakes should hold.

A2. Engine noises—See if engine idles smoothly and investigate any unusual noises noticed during operation.

A3. Temperature gauge—See if engine temperature is normal.

A4. Oil pressure gauge—See if oil pressure is correct.

A5. Ammeter—Ammeter action should be normal. Ammeter should show no excessive discharge or charge. Reading should be close to zero at idling speed.

A6. Fuel gauge—Note approximate amount of fuel required to fill tank.

A7. Windshield wiper — Test operation — See if wiper blades are missing and report.

B. Under Hood—Engine Still Running—

B1. Engine—Note and report excessive engine vibration.

B2. Fan belt—Note and report excessive looseness or rubbing of belt on pulleys. Avoid getting hand near fan or belt during this inspection.

B3. Examine ignition wires for bad insulation or poor contact.

B4. Carburetor—Note and report improper functioning of linkage and controls.

B5. Check engine mounting bolts for looseness.

B6. Check carburetor controls for excessive play.

B7. Inspect fuel and oil lines and report leaks.

B8. Examine the mounting of accessories such as starter, generator, fuel pump, etc.

C. In Cab—After Stopping Engine—

C1. Horn—Be sure horn will sound.

C2. Fire extinguisher—Remove from bracket, shake and judge from sound and weight whether it is full. When extinguisher is replaced, bracket should hold it firmly with the handle in locked position. Every vehicle should have a filled fire extinguisher in good working order at all times.

C3. Rear view mirror—Adjust for correct rear vision. Report if in unsatisfactory condition.

D. Under Hood—Engine Stopped—

D1. Radiator—Remove cap and replenish water if low.

D2. Water leaks—Examine core and connections for leaks.

D3. Fan belt—Press belt halfway between pulleys. It should deflect about ¾". Belt should not be too tight or too loose. Replace if frayed.

D4. Engine oil—Remove oil level rod. Dry with a clean cloth and check oil level. Note condition of oil for presence of dirt or water. Add oil as required.

D5. Oil leaks—Inspect all engine parts for evidence of oil leakage. Report condition if unable to repair.

D6. Carburetor air cleaner—Check oil level in cleaner bowls. Rub finger through oil to detect dirt. If cleaner is dirty, service according to instructions in group 03.

D7. Spark plug, distributor and coil—See that all cables are attached to plugs. Note and report any chafed or broken wires.

D8. Fuel leaks—Examine carburetor fuel filter fuel pump and connections for fuel leaks.

E. Under Vehicle—

E1. Steering mechanism—Inspect carefully. Be sure steering knuckle arms, tie rod and drag link are not bent. Note excessive play in linkage and look for lubricant leaks from steering gear and knuckle housings.

E2. Tires—Remove all foreign matter such as nails, glass or stones from tires or between duals. Kick all dual tires to detect flats—it is impossible to detect flats on dual wheels just by looking at them.

Replace any missing valve caps and check for improperly located valve stems.

If a tire was changed during the run, be sure that duals were properly matched, that tire with greatest wear is on the inside dual, that directional tread tires are properly mounted and that directional dual and non directional dual tires are not used on wheels of same driving axle.

E3. Spare tire carrier—See that carrier holds tire securely, that lock operates and that there are no damaged parts.

E4. Springs and suspensions—Examine springs for broken leaves, shifted leaves, loose or missing rebound clips, etc. Report condition if defective.

E5. Brake lines—Check for leaks. See that clips and springs are tight and in place.

E6. Driving axles—Examine for lubricant leaks. Note temperature.

E7. Transmission—Examine for lubricant leaks. Note temperature.

E8. Transfer case—Examine for lubricant leaks. Note temperature.

E9. Propeller shaft—Remove any foreign material found around shaft. Tighten loose universal joint bolts. Report missing parts.

F. Exterior—Front, Right Side, Rear and Left Side—

F1. Lights—Inspect light switches and action of lights at all positions. During blackouts, inspect the lights with switch in blackout position only. Be sure all switches are in "off" position after lights are inspected and that all lights are out. If lamps are loose, tighten them. Report broken brackets and cracked lenses.

F2. Windshield—Clean the windshield. Report if broken.

F3. Wheels and axle flanges—Tighten any loose nuts and bolts and axle shaft flanges. Report damaged axles, rims, bolts and nuts or missing parts.

F4. Brake drums and wheel hubs—Place hand cautiously on each brake drum and wheel hub. All drums should be approximately the same temperature. Report wheel hubs that are too hot to touch with the hands, as

this may indicate unlubricated, damaged or improperly adjusted bearings.

F5. Sheet metal—Report all damaged, loose or missing sheet metal parts.

F6. Power take-off and winch. See that cable is tight and evenly wound; if not, rewind cable. Report defective cable. Examine drive shaft and universal joints to be sure nothing is wound around them.

F7. Bumpers, towing hooks, pintle and chains—Tighten loose parts. Report damaged or missing parts. Be sure lock is equipped with a lock pin for towed load.

F8. Load, tarpaulin fastenings—Make sure all ropes are lashed securely. Check for proper condition and location of load and tarpaulin.

F9. Trailer lighting and brake connection—See if cables are frayed or broken and that trailer connection plug is not damaged or missing.

F10. Tools, tire chains and equipment—Make sure all tools and equipment that have been assigned to vehicle are in place and in good condition.

3. DAILY—BEFORE OPERATION

Many things can happen to a vehicle between the "daily after operation" inspection and before the time the vehicle is again operated. Sabotage may be attempted. Moisture may ground or short-circuit electrical connections. Tires may have become deflated and leakage may result in the loss of engine oil, fuel or water. A check for such defects is necessary before resuming operation.

This procedure should never be entirely omitted, even in extreme tactical situations.

A. Exterior—Before Starting Engine—

A1. Vehicle in general—Leaks—Look on ground under vehicle for leaks of oil, water or fuel. Look for any injury to vehicle or signs of tampering. Be sure tarpaulin is firmly fastened and has not been disturbed. Raise hood and look for signs of tampering with engine.

A2. Radiator—Remove cap and replenish if low. Water level should not have changed since preceding inspection. If so, look for leaks.

A3. Engine oil—Check oil level. Oil level or condition of oil should not have changed since last inspection. If so, look for leaks and correct or report.

A4. Fuel—Examine carburetor fuel filter fuel pump and connections for leaks.

A5. Refuel tank—When refueling tank, contact filler hose nozzle to tank first so any sparks from static electricity which might occur will be falling from nozzle. Do not fill tank entirely to top of filler neck. Leave space for expansion. See that filler cap vent is open.

B. In Cab—Starting Engine—

B1. Starter—When starting engine, note action of starter which should be smooth and steady. If starter cranks engine slowly or irregularly, it may indicate a low battery or defective starter. If no sound is heard after depressing starter switch, battery may be low or starter gears locked.

Turn on lights and again depress starter switch. Lights will dim noticeably if battery is low or connections are loose. Tighten battery to starter and ground connections if they are loose. If starter is defective, report. After engine is started, let it run at a fast idle so that ammeter shows a good charge. This will also allow engine to warm up and be ready for operation. In the meantime, proceed with the following:

B2. Instruments, horn and windshield wiper—Inspect instruments for proper reading. Test function of windshield wiper and horn.

B3. Fire extinguisher—Same as item C2 in Par. 2.

C. Exterior—

C1. Lights—Same as items F1 in Par. 2.

C2. Windshield—Same as item F2 in Par. 2.

C3. Load, tarpaulin, etc.—Same as item F8 in Par. 2.

C4. Trailer lighting and brake connection—Same as item F9 in Par. 2.

C5. Tools, tire chains and equipment—Same as item F10 in Par. 2.

D. Under Vehicle—

D1. Tires—Same as E2 in Par. 2.

D2. Examine steering connections.

D3. Ground beneath vehicle—Inspect ground beneath vehicle for evidence of oil, fuel or water leaks.

E. In Cab—Engine Warmed Up—

E1. Engine—Listen to sound of engine to determine unusual noises which may indicate trouble. Normal operating temperature may be determined by the temperature gauge, by smooth engine idling with choke fully released, oil pressure gauge indicates normal operating pressure. Normal warm-up period will vary; in cold weather it can be shortened by covering the radiator.

4. DAILY—DURING OPERATION

In preventive maintenance, it is the attention to little things that counts—such as: unusual noises or odors and slight irregularities in vehicle performance. Taking the necessary steps to correct any defects that develop completes the preventive procedure.

While the vehicle is in motion, a good driver listens for any sound which may be a sign of trouble such as rattles, knocks, squeaks or hums. He looks for steam from the radiator or smoke from any part of the vehicle. He knows and watches for the odor of an overheated generator, overheated brakes, boiling anti-freeze, fuel vapor from a leaky fuel system or other such signs of trouble. Every time he uses the brakes, shifts the gears, changes speeds or turns, he considers it a test and notes any unsatisfactory or unusual performance.

A. General—Listen for such noises as the following, which usually indicate the trouble specified.

A1. Squeaks in engine — generator or water pump trouble.

A2. Engine knocks—An alert driver can do much to avoid serious damage to the engine by reporting the first signs of engine knocks.

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A3. Spark ping—Not serious during acceleration.

A4. Hissing sound—Escape of steam due to overheating.

A5. Grinding noise under floor boards—Transmission, power take-off or transfer case trouble.

A6. Heavy vibration beneath vehicle—Loose or bent propeller shaft.

A7. Continuous hum in wheels—Improper wheel bearing adjustment.

A8. Squealing of tires on turns—Improper inflation or excessive speed.

A9. Axle hum—Improperly adjusted or worn axle gears.

B. Instruments—Glance frequently at instruments for proper reading.

C. Steering—First sign of pulling to one side or the other may indicate the need for tire inflation or repair. Note and report excessive play in steering mechanism or front wheel shimmy.

D. Brakes—Note and report inefficient action of brakes.

E. Clutch—Note and report inefficient action of clutch. Clutch pedal should have approximately 2½" free travel.

F. Transmission—Gears should shift smoothly and transmission should operate quietly.

G. Performance—Be on the alert for lack of power and any other condition which may indicate engine trouble. In this way, the alert driver can avoid a complete breakdown. Always stop the vehicle **before** trouble stops the engine and the condition will be easier to correct.

5. AT HALT

Some troubles are difficult to identify during operation and the driver should take advantage of every halt to locate and correct anything that might cause failure during operation. Driver should report any condition that he cannot correct.

A. In Cab—

A1. Hand brake—Same as item A1 in Par. 2.

B. Exterior—Front, Right Side, Rear and Left Side—

B1. Windshield—Same as item F2 in Par. 2.

B2. Brake drums and wheel hubs—Same as item F3 in Par. 2.

B3. Load, tarpaulin fastenings, etc.—Same as item F8 in Par. 2.

B4. Trailer lighting and brake connections—Same as item F9 in Par. 2.

C. Under Vehicle—

C1. Steering mechanism—Same as item E1 in Par. 2.

C2. Tires—Same as item E2 in Par. 2.

C3. Springs and suspensions—Same as item E4 in Part 2.

C4. Driving axles—Same as E6 in Par. 2.

C5. Transmission—Same as E7 in Par. 2.

C6. Transfer case—Same as E8 in Par. 2.

D. Under Hood—

D1. Radiator—Same as D1 in Par. 2.

D2. Water leaks—Same as D2 in Par. 2.

D3. Fan belt—Same as D3 in Par. 2.

D4. Engine oil—Same as D4 and 5 in Par. 2.

6. WEEKLY

The weekly preventive maintenance outline is a general adjustment and inspection of certain factors that may affect vehicle performance.

A. In Cab—

A1. Cab floor mat and floor—Inspect condition of floor mat and see if floor boards are tight or broken.

A2. Cab lining—Report torn or damaged door panels.

A3. Upholstery—Repair or report excessively torn upholstery or springs that project through seat cover.

A4. Clutch pedal free travel—Free travel of clutch pedal should be maintained to approximately 1". Inspect and report any other defective clutch action.

B. Exterior, Front, Right Side, Rear and Left Side—

B1. Cab—Inspect hood latch bracket carefully as a loose latch may permit hood to fly open during operation and block driver's vision.

B2. Fenders and bracket—Report if damaged.

B3. Bumpers, tow hooks, etc.—Same as item F7 in Par. 2.

B4. Brush guard—Tighten all loose mounting bolts.

B5. Door locks and handles—Check action of handles and see if lock and striker plate hold door fully closed. Check door for easy closing and opening action. Tighten loose screws.

B6. Door hinges—Tighten loose screws or bolts and replace any that are missing.

B7. Door window regulation—Check operation.

B8. Battery—Clean top of battery and terminals with clean water or with a solution of water and baking soda if available. Tighten terminals if loose. Remove plugs and if electrolyte is not well over top of plate, report condition so that distilled water may be added. Replace plugs.

C. Under Vehicle—

C1. Steering knuckles—front driving axles—Look for lubricant leaks from steering knuckle housing which may indicate need of replenishing water or to repair oil seals.

C2. Shock absorbers—Examine and tighten linkage and mounting bolts. Check for leakage of fluid from shock absorbers.

C3. Transfer case mounting—Check and tighten transfer case mounting bolts.

D. Under Hood—

D1. Engine—Obtain a clean cloth and remove oil and dirt from engine and accessories.

E. Exterior—Final—

E1. Check of lubrication—Remove level plug from all driving axles, transmission, transfer case and steering

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knuckles and be sure lubricant is at correct level. Be sure to replace plug. Check oil seals.

E2. General tightening—Tighten axle housing, transmission and transfer case cap screws and replace any that are missing. Tighten axle flange and wheel nuts.

E3. Vehicle—Clean—Wipe out inside of cab. Clean all glass.

E4. Tires—Inflate tires to correct pressure, using gauge. Do not attempt to bring tires to proper inflation pressure while they are excessively hot.

7. MONTHLY (OR 1,000 MILES, WHICHEVER OCCURS FIRST)

The purpose of this procedure is to perform lubrication inspection and services that will correct deficiencies which may interfere with dependable operation during the forthcoming month. The driver should accompany the mechanic and assist him when possible or provide a suitable report of vehicle operating condition.

A. Vehicle Service Record—

A1. Note repairs made since last monthly procedure.

A2. Note oil mileage.

A3. Note fuel mileage.

B. Road Test and Inspection—

B1. Fulfill procedure outlined in Par. 3.

B2. Use procedure outlined in Par. 4.

B3. Use procedure outlined in Par. 2.

C. Services—Complete instructions for inspection and adjustment services to be performed on each of the following units are contained in their respective groups of this manual. Refer to these groups as indicated.

C1. Tires—Refer to group 13.

C2. Wheel bearings—Refer to group 13.

C3. Steering knuckles—Refer to group 10.

C4. Brakes, Hydraulic System—Refer to group 12.

C5. Brakes, Vacuum System—Refer to group 12.

C6. Steering gear and linkage—Refer to group 14.

C7. Springs, shackles and suspensions—Refer to group 16.

C8. Shock absorbers—Refer to group 16.

C9. Axles, front and rear—Refer to groups 10 and 11.

C10. Clutch—Refer to group 02.

C11. Transmission—Refer to group 07.

C12. Transfer case—Refer to group 08.

C13. Propeller shaft and universal joints—Refer to group 09.

C14. Back lash in axles, propeller shaft slip joints, universal joints, axle gears, transfer case gears and transmission gears—Refer to respective group.

C15. Engine—Refer to group 01.

C16. Air cleaner—Refer to group 03.

C17. Cooling system—Refer to group 05.

C18. Engine tune-up and test—Instructions for complete engine tune-up are outlined in Engine group 01.

D. Lubrication—

D1. The complete procedure for monthly or 1,000 mile lubrication should be fulfilled. Instructions for this service, including illustrations of points to be lubricated and specifications for type of lubricant, are contained in Lubrication group L of this manual.

D2. Engine oil—General instructions for selection and application of engine oil are given in Lubrication group L.

D3. Oil filter—General instructions for servicing oil filter and replacement of oil filter element are given in Engine group 01.

D4. Winch and power take-off—Refer to Lubrication group L.

E. Final Road Test by Mechanic With Driver—

E1. Follow "Daily—Before Operation" procedure in Par. 3.

E2. Follow "Daily—During Operation" procedure in Par. 4.

E3. Follow "Daily—After Operation" procedure in Par. 2.

8. SEMI-ANNUAL (OR EACH 6,000 MILES, WHICHEVER OCCURS FIRST)

This procedure includes the same subjects as outlined in the monthly schedule in Par. 7 with the exception that the lubrication, as well as other mechanical service operations, are based on a semi-annual or 6,000 mile interval. This, of course, requires a great amount of attention and thoroughness in inspection, adjustment and lubrication of every part of the vehicle if dependable operation is to be obtained during the succeeding six months.

The driver should accompany the mechanic and assist when possible or provide a suitable report of the operating condition of the vehicle.

9. PREPARING VEHICLE FOR LONG-TERM STORAGE

For any reason vehicles must be placed in storage for a long period of time, it is important that certain precautions be taken to make sure that the vehicle will be in good condition for operation when required. The following applies:

A. Paint—A suitable storage space should be provided if possible which will protect the vehicle from the elements of rain, snow and sun which act on the metal surfaces of the vehicle. If this is not possible, the vehicle should be washed thoroughly and a suitable coating of lusterless wax applied.

B. Tires—

B1. Trucks should be jacked up so that tires will be clear of floor or ground.

B2. Keep inflated to slightly above operating pressure.

B3. If possible, remove wheels and tires and store in a cold dark place.

B4. Pack horizontally instead of vertically.

C. Battery—

C1. Remove batteries from vehicle to facilitate servicing.

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C2. Check gravity in these batteries at regular intervals of six weeks except in extremely hot weather when inspection period should be cut down to three weeks.

C3. Recharge batteries every six weeks to bring gravity reading to 1.280 or above. In no case should the gravity be allowed to fall below 1.220.

C4. Check and correct water level at each inspection prior to recharging.

D. Cooling System—If vehicles are to be stored in temperatures below 32° F., sufficient anti-freeze must be provided or the system must be drained. A full cooling system is less subject to rust and corrosion than an empty one and is, therefore, preferable. If sytem is drained, it is recommended that a suitable inhibitor be added to the cooling solution and the engine run for a short time before draining.

E. Engine—

Special precautions must be taken to prevent serious damage to engine during storage periods. Suggestions given in following outline provide for the correct practice under all conditions. Under **no circumstances** should engine be run five or ten minutes each day merely to maintain battery charge as, under these conditions, operating temperatures do not rise sufficiently to drive off condensation or prevent dilution of the oil. The following procedure is recommended:

(A). Where vehicles are stored less than two weeks: The engine should be run each day with engine operating at a fast idle until temperature reaches at least 160° F., and then run for 30 minutes with the temperature as indicated. It may be necessary in some instances to cover radiator in order to obtain this temperature.

(B). Where vehicle will be in storage longer than two weeks: The same procedure as above should be followed, except at the end of the thirty-minute period of operation the air cleaner should be removed and, with the engine operating, 10-W oil should be introduced through the carbureter until the engine stalls. Thereafter, until vehicle is placed into continuous service, the engine should not be run, but it should be turned over several times weekly with the starter. A quick charger, or some other suitable means, should be employed to properly condition batteries.

Whenever vehicles are not operated at normal engine operating temperatures, condensation causing rust may result in damage to engine parts. It is, therefore, essential that the foregoing procedure be followed to obtain satisfactory performance when vehicle is again placed in service.

(C). If it is suspected that vehicles have been subject to condensation and rust, engine should be inspected. Inspect valve cover, valve mechanism, side covers and oil filler tubes. If these show evidence of rust, the engine pan should be removed and inspected for evidence of rust, checking cylinder wall, piston pins and bearings. Then engine should be cleaned and flushed. The following procedure is suggested:

1. Drain engine and oil filters.

2. Wire-brush and clean over-head mechanism, oil filter covers and oil filler tube.

3. Remove and discard oil filter element.

4. Fill engine with eighteen quarts of 50% neutral flushing oil and 50% of No. 1 distillate and run for one hour at engine operating temperature of at least 185° F. (Cover radiator if necessary.)

5. Remove and clean oil pan, cleaning out all flushing fluid from the engine and oil filter. Be sure to wash out bottom of filter housing. Install new oil filter element and install fresh oil of the proper viscosity.

F. Fuel System—The fuel system must be completely drained to prevent the formation of gum residue from evaporated gasoline, during long term storage.

E1. Drain all gasoline from tank.

E2. Run engine until carbureter and fuel pump are empty.

E3. Work throttle up and down to facilitate draining carbureter while engine is running.

E4. If doubt exists as to carbureter being completely empty of gasoline, it should be removed, disassembled and thoroughly cleaned.

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SERVICE BULLETIN REFERENCE

Bulletin No.	Description

BUSHMAKOV.COM Commercial use, free of charge Dmitry Bushmakov Historical purpose

Group 01 — Engine

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01

GENERAL

1. DESCRIPTION

Engine is GMC, six (6) cylinder, valve-in-head type; pistons are stephead design, removable through top of block; crankshaft and connecting rod bearings are precision, replaceable type. For complete information on design characteristics of the parts which comprise the basic engine, refer to respective subject paragraphs. Engine fuel and electrical units and related items are fully described in respective groups of this manual.

Important! If vehicle is equipped with Radio Interference Suppression it will definitely affect the manner in which various service operations on the engine are to be performed—particularly partial disassembly as well as removal of engine from the truck. Before such work is begun, refer to "Radio Interference Suppression" in the Miscellaneous Electrical group of this book. There, each and every part of engine affected by "Radio Suppression" is clearly identified and illustrated.

2. TROUBLE SHOOTING AND GENERAL SOLUTIONS

There are two kinds of "trouble shooting" which, in general, apply to engines.

A. Temporary Starting Failures are usually due to loss of adjustment, or lack of maintenance in ignition and fuel systems. Conditions of this kind can usually be quickly identified and easily corrected. A chart, which clearly points the way to systematic "trouble shooting" of such minor conditions, is included in "Driver's Instructions" group of this book.

B. Where More Involved Difficulties seriously affect the operation of the engine, the cause may be attributed to excessively worn parts resulting from neglect of maintenance or poor driving practices. Trouble shooting these conditions requires careful diagnosis of the symptoms in order to determine the cause and probable remedy. Chart in this section does not contain all of the possible causes for engine trouble, but merely shows those which require first consideration. In cases of engine difficulty, refer to chart and check causes listed therein to determine the condition or conditions responsible for the manner in which engine performs, and then service the engine as required to overcome the difficulty.

3. INSPECTION AND ADJUSTMENT

Preliminary engine inspection is necessary to assure the proper operating condition of the engine. These inspections are outlined in "Driver's Instructions" and in "PM" group. Inspection of internal engine parts can be accomplished only after engine has been completely disassembled. Instructions for this service are contained in "Repair" section of this group.

Engine adjustments consist of regularly performing the operations included in the engine tune-up cycle. The

ENGINE

Poor Compression

1. Incorrect Valve Lash—
   Readjust valves.
2. Worn Valve Face and Seat—
   Regrind valves and seats.
3. Valve Stems or Lifters Sticking—
   Inspect and service or replace.
4. Valve Stems or Guides Worn—
   Install new parts.
5. Valve Springs Weak or Broken—
   Install new springs.
6. Cylinder Head Gasket Leaking—
   Install new gasket and tighten cylinder head bolts.
7. Piston Rings Broken, Worn or Stuck—
   Install new rings.
8. Pistons Worn—
   Install new pistons.
9. Piston Ring Grooves Worn—
   Install new pistons.
10. Cylinder Scored or Excessively Worn—
    "Recondition" cylinder.

Excessive Fuel Consumption

1. Poor Driving Practices.
2. Test vehicle in actual operation. Provide suitable type of fuel meter during test.
3. Refer to "Fuel" group.

Lack of Power

1. Overheating—
   See Cooling System.
2. Poor Compression—
   Refer to engine "tune-up" instructions.
3. Ignition System Faulty—
   Refer to "Electrical" group.
4. Air Cleaner Restricted—
   Service air cleaner element.
5. Low Octane Fuel—
   Use correct fuel.

Valves Sticking

1. Incorrect Valve Lash—
   Readjust valves.
2. Insufficient Clearance Between Valve Stem and Guide—
   Clean valve stems—ream valve guides.
3. Valve Springs Weak or Broken—
   Test and replace.
4. Valve Stems Scored or Dirty—
   Remove and clean.
5. Valve Lifters Sticking—
   Remove and service.
6. Use of Fuel with High Gum Content—
   Obtain good quality fuel.

Burned Valves and Seats

1. Improper Valve Lash—
   Readjust valve lash.
2. Weak Valve Springs—
   Install new valve springs.
3. Excessive Carbon Deposits at Valve—
   Remove and clean-up, regrind.
4. Valves Sticking in Guides—
   Inspect and service valves and guides.
5. Valve Head Ground Too Thin—
   Install new valves.
6. Valve Seats Too Narrow—
   Reface valves.
7. Fuel Mixture Flow Restricted—
   Refer to "Fuel" group.
8. Overheating—
   See "Cooling System."
9. Valve Lifter Sticking, Holding Valve Open—
   Inspect and service lifters.
10. Overspeeding—
    Correct such poor driving practices.

Noisy Valves

1. Valve Lash Incorrectly Adjusted—
   Readjust valves—follow procedure.
2. Worn Rocker Arm Face and Valve Stem—
   Install new parts.
3. Valves Loose in Guides—
   Install new parts.
4. Weak Valve Springs—
   Install new springs.
5. Valves Sticking—
   Refer to "Valves Sticking".

Excessive Oil Consumption

1. Piston Rings Broken, Worn or Stuck—
   Inspect and install new rings.
2. Piston Rings Improperly Fitted—
   Follow fitting procedure.
3. Piston Ring Slots Clogged With Carbon—
   Remove and clean thoroughly.
4. Cylinder Bore Out-of-Round or Excessively Tapered—
   Recondition cylinders.
5. Cylinder Bore Scored or Badly Worn—
   Recondition cylinders.
6. Crankshaft and Connecting Rod Bearings Worn—
   Install new bearings, follow instructions.
7. Overheating—
   See "Cooling System."
8. Improper Grade and Viscosity of Oil—
   Follow recommendations in "Lubrication" group.
9. Oil Level Too High—
   Follow dip stick markings.
10. Oil Leaks at Gaskets and Seals—
    Install new gaskets and seals.
11. Overspeeding Engine—
    Correct this poor driving practice.

ENGINE

Popping, Spitting and Spark Knock

1. Inferior Grade of Fuel—
   Use good grade of fuel.
2. Defective Ignition System—Spark Advanced Too Far—
   Refer to engine "Tune-up."
3. Carbureter Not Properly Adjusted—
   Refer to "Fuel" group.
4. Valve Lash Adjusted Too Close—
   Readjust valve lash—follow instructions.
5. Excessive Carbon Deposits—
   Remove cylinder head and clean.
6. Weak Valve Springs—
   Install new springs.
7. Valves Not Seating Properly—Overheated—
   Regrind valves.
8. Piston and Rings in Poor Condition—
   Recondition or install new parts.
9. Heat Control Valve Improperly Adjusted—
   Follow instructions in this group.

Low Oil Pressure

1. Improper Grade and Viscosity of Oil—
   Follow recommendations in "Lubrication" group.
2. Oil Pressure Relief Valve Stuck—
   Remove, clean and test spring; replace.
3. Oil Pump Screen Clogged—
   Remove and clean thoroughly.
4. Excessive Crankshaft and Connecting Rod Bearing Clearance—
   Install new bearings, follow procedure.
5. Excessive Oil Pump Gear to Housing Clearance—
   Install new oil pump parts.
6. Faulty Oil Gauge—
   Test with gauge known to be accurate.

Excessive Cylinder and Piston Wear

1. Lack of Oil—
   Add oil and check quantity daily.
2. Dirty Oil—
   Drain and refill, change oil filter element.
3. Improper Grade and Viscosity of Oil—
   Follow recommendation in "Lubrication" group.
4. Overheating—
   Refer to "Cooling System" group.
5. Piston and Rod Improperly Installed—
   Replace pistons.
6. Piston Rings Not Properly Fitted—
   Refer to fitting procedure.
7. Piston Rings Stuck or Broken—
   Install new rings, clean ring grooves.
8. Air Cleaner Neglected—
   Service air cleaner.
9. Carbureter Fuel Mixture Too Rich—
   Readjust carbureter, refer to "Fuel" group.
10. Overspeeding Engine—Especially when Cold—
    Correct this poor driving practice.

Connecting Rod Bearing Failure

1. Lack of Oil—
   Add oil and check supply daily.
2. Low Oil Pressure—
   Refer to subject "Low Oil Pressure."
3. Improper Grade and Viscosity of Oil—
   Follow recommendations in "Lubrication" group.
4. Crankshaft Surface Rough—
   Regrind and install new bearings.
5. Restricted Oil Passage—
   Clean thoroughly.
6. Bearings Worn or Sprung—
   Install new bearings.
7. Bearings Improperly Fitted—
   Follow fitting procedure.
8. Bearings Loose in Connecting Rod and Cap—
   Install and "spread", see instructions.
9. Connecting Rod Out-of-Alignment—
   Test and realign rods.

Overheating

1. Inefficient Cooling System—
   Refer to group 05.
2. Improper Grade and Viscosity of Oil—
   Follow recommendations in "Lubrication" group.
3. Fuel Mixture Too Lean—
   Refer to "Fuel" group.
4. Air Cleaner Restricted—
   Service air cleaner frequently.
5. Ignition System Faulty—
   Refer to "Electrical" group.
6. Ignition Timing Incorrect—
   Refer to "Engine Tune-up."

Crankshaft Bearing Failure

1. Lack of Oil—
   Add oil and check supply daily.
2. Low Oil Pressure—
   Refer to subject "Low Oil Pressure" in this chart.
3. Improper Grade and Viscosity of Oil—
   Follow recommendations in "Lubrication" group.
4. Crankshaft Bearing Journal Worn or Out-of-Round—
   Regrind journals, install new bearings.
5. Crankshaft Oil Passage Restricted—
   Remove and clean.
6. Bearings Worn or Sprung—
   Install new bearings, follow procedure.
7. Bearings Improperly Fitted—
   Follow fitting procedure.
8. Crankshaft or Bearings Out-of-Alignment—
   Inspect and replace.

ENGINE

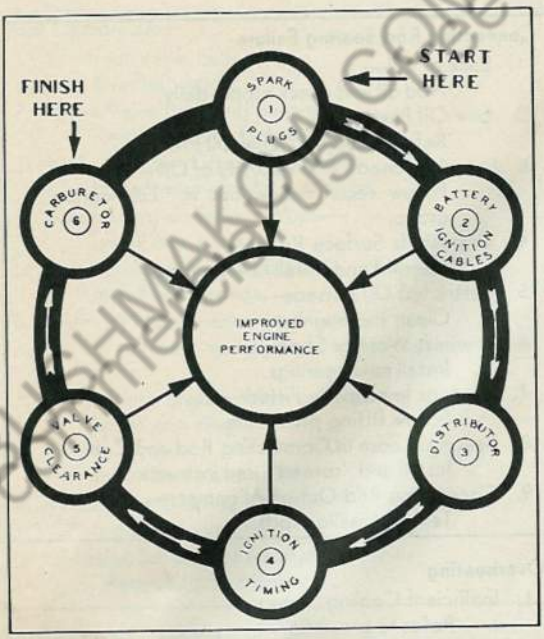

Fig. 1 Engine Tune-Up Cycle

tune-up cycle is a logical inspection and adjustment procedure for each unit in the ignition and fuel systems. Periodic tune-up is essential if continuous operation and satisfactory performance are to be obtained.

Satisfactory results from engine tune-up operations cannot be obtained if "hit-and-miss" methods are used; a systematic procedure is essential. Only by performing tune-up operations in the order given and by carefully following factory-recommended clearances and specifications can satisfactory results be obtained.

Tools Required: To satisfactorily perform all the following operations, regular tune-up equipment, such as compression gauge, vacuum gauge, voltmeter, ammeter, etc., are necessary.

A. Compression Test—Before starting with tune-up procedure, a test of engine compression should be made—for an engine without fairly even compression in all cylinders cannot be successfully tuned. Compression pressure depends upon cranking speeds, engine temperature, compression ratio and the condition of the engine. If the reading indicated by the compression gauge is reasonably high and uniform for all cylinders, compression pressure may be considered normal.

1. Remove all spark plugs from the engine. Turn ignition switch "off" and pull hand throttle all the way out.

2. Insert an accurate compression gauge at spark plug hole and crank engine a few turns with starting motor. Note highest compression gauge reading while engine is being cranked. Do this at each cylinder and record the reading.

3. Compression should be equal in each cylinder within approximately five (5) pounds. Compression reading of approximately 110 pounds is desirable. If compression is too low, the cause (either piston rings, valves or cylinder head gasket) should be located and corrected. Loss of compression through piston rings can usually be detected by inserting a liberal quantity of oil through spark plug hole on top of piston. Allow a few moments for oil to spread around piston and then take a second compression reading. If compression increases materially in the cylinder so treated, it is an indication of defective piston ring seal. An extremely low reading in two adjacent cylinders might indicate a leaky cylinder head gasket.

B. Spark Plugs—Wipe off spark plugs and note marking in porcelain section which indicates type of plug. "AC", type 44, is used for average temperatures and normal operation.

1. Clean plugs thoroughly. An abrasive type cleaner is recommended.

2. Inspect porcelain for cracks and replace with new plug if cracks are found.

3. Adjust spark gap to .025". Use a round feeler gauge. Bend side electrode only when regapping. Remember—too wide a gap reduces speed and power; too narrow a gap causes uneven engine operation.

C. Battery and Ignition Cables.

1. Clean both ends of each battery cable thoroughly and see that connections are tight.

2. Check voltage throughout entire primary electrical circuit to locate and correct possible voltage drop. Refer to instructions in "Electrical" group of this book.

3. Visually inspect ignition system high and low tension cables. Terminal at each end of cable must be clean and tight. If cable insulation shows evidence of deterioration, a new set of cables should be installed.

D. Distributor—Service on this unit must be thoroughly and carefully performed as follows:

1. Remove distributor cap and examine it carefully for cracks. Clean contact points if they are corroded.

2. Remove rotor from end of shaft. Clean the rotor point and check the spring for weakness and failure to contact center post in distributor cap.

3. Inspect distributor points for evidence of arcing or burning. "Clean up" distributor points with breaker point file. Do not remove excessive amounts of the point material. Never use emery cloth to clean distributor points. If cleaning up in this manner does not remove pitted or burned areas, the points should be discarded and replaced with new ones.

4. Crank engine until breaker arm follower is on highest point of distributor points with a feeler gauge and adjust to provide .018" to .024" clearance.

5. Test condenser as instructed in "Electrical" group of this book. A weak condenser is usually responsible for excessively burned distributor points.

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E. Ignition Timing—A periodic check of ignition timing is necessary to assure ignition and combustion in cylinders at the proper time. A neon timing light should be used for this operation.

1. Loosen manual advance bolt and set manual advance mechanism on center mark.
2. Loosen distributor clamp bolt.
3. Attach one lead of timing light to No. 1 spark plug. Attach the other lead to convenient ground.
4. Run engine at idling speed.
5. Hold timing light close to timing hole in flywheel housing. Neon flashes should be simultaneous with appearance of timing marks on flywheel. Rotate distributor, if necessary, to advance or retard spark until neon flashes are properly synchronized with flywheel markings.

F. Valve Lash—This is a procedure which requires strict adherence to the following instructions:

Specially designed wrenches are in common use for adjustment of overhead valve. If such a wrench, similar to that shown in Fig. 2, is not available, an ordinary box end wrench and screw driver may be used.

1. Before proceeding with the valve lash adjustment, the engine must be thoroughly warmed up to normalize the expansion of the valve operating parts. This is very important, since during the warm-up period valve clearance is subject to considerable variation. After normal engine operating temperatures are obtained, allow the engine to idle slowly and proceed as follows.
2. Remove valve rocker arm cover stud nut and disconnect radio noise suppression bond strap. Remove cover carefully to avoid damaging gasket between cover and cylinder head.
3. Loosen valve rocker arm ball stud nut and insert .012" feeler gauge between rocker arm and valve or cap. Adjust rocker arm ball stud until proper clearance is indicated by feeler gauge.
4. Tighten rocker arm ball stud nut. Be careful to prevent turning of ball stud while nut is being tightened.
5. Run feeler gauge through under rocker arm again to make sure that adjustment has not been lost while tightening nut.
6. Repeat foregoing operations 3, 4 and 5 at all rocker arms.

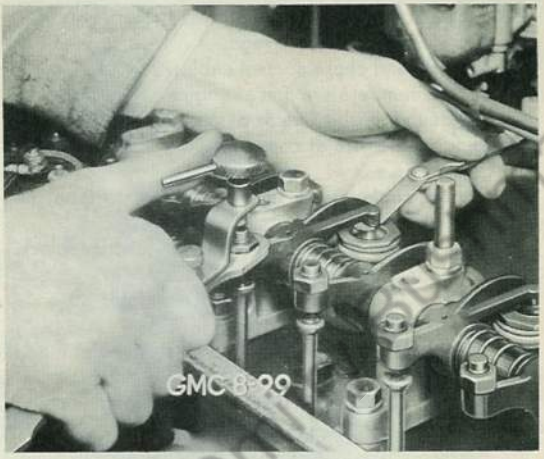

Fig. 2—Valve Lash Should Be Adjusted With Engine at Normal Operating Temperature

7. Always check valve lash after cylinder head is installed or cylinder head bolts are tightened.

G. Carbureter and Air Cleaner

1. Remove and clean air cleaner thoroughly.
2. Remove carbureter and clean thoroughly. Measure fuel level as instructed in "Fuel System" group and readjust if necessary.
3. Check setting of accelerator pump rod to obtain the correct seasonal adjustment as described in "Fuel" group.
4. Adjust carbureter idling screw until engine runs evenly and steadily with leanest possible mixture. Engine should be thoroughly warmed up before making this adjustment.
5. A vacuum gauge should be used in connection with carbureter adjustment. Adjust idling screw until a steady reading of 18" to 20" is obtained.

NOTE: The vacuum gauge, when used according to instructions by the manufacturer, will reveal such conditions as improper carbureter adjustment or leaky manifold gaskets as well as indicate the efficiency of valves and piston rings.

ENGINE REMOVAL AND INSTALLATION

4. TO REMOVE ENGINE

All usual service operations on these engines can be performed without removing engine from chassis—however, when complete engine disassembly is made to accomplish periodic inspection or major overhaul, service equipment may, in most cases, be utilized to best advantage when power plant is removed from vehicle. The following procedure for power plant removal is given, the sequence of which may be varied to conform with local conditions.

Tools Required—Removal of engine from chassis involves, in addition to common hand tools, the use of chain falls and suitable engine lifter hooks.

1. Drain cooling system.
2. Disconnect hood bracket at cab and lay hood back against cab.
3. Remove radiator, fenders, brush guard and hood sides as an assembly.
4. Close shut-off valve at fuel tank. Disconnect fuel filter to fuel pump line at filter and then remove fuel filter assembly.
5. Disconnect the following:

ENGINE

(a) Starter control rod from starter motor lever.
(b) Accelerator control linkage.
(c) Throttle and choke control cables.
(d) Engine temperature line at engine.
(e) Oil gauge flexible line at dash panel.
(f) Ignition coil wire at coil.
(g) Horn wire.
(h) Starter cable at starting motor switch (tape the end carefully).
(i) Generator and regular harness at junction block.
(j) Windshield wiper hose at manifold.
(k) Power cylinder vacuum line at manifold.
(l) Exhaust pipe at manifold.
(m) Radio noise suppression bond strap—right and left hand at oil pan.
(n) Radio noise suppression bond strap—engine cover to dash panel.
(o) Radio noise suppression bond strap—flywheel bottom cover to frame.

6. Remove fan blade assembly.

7. Remove control lever boot and cap and remove floor and tow boards.

8. Disconnect clutch and brake pedal control rods from pedals.

9. Remove clutch and brake pedal and bracket assembly from transmission.

10. Disconnect propeller shaft universal joint at transmission.

11. Disconnect and remove transmission strut rod.

12. Disconnect transfer case and declutching control rod from control lever.

13. Disconnect transfer case shifting control rods at both levers on cross shift.

14. Remove hand brake lever assembly from transmission.

15. Remove transmission cover and gear shift tower assembly. Cover transmission carefully to prevent entrance of dirt.

16. Remove engine front support bolts.

17. Remove engine rear support bolts from top of insulators.

18. Lift complete power plant assembly out of chassis. Use chain falls in connection with suitable clamps (under manifold on left hand side of engine and cylinder head on right hand side) to properly support and balance the engine as it is being removed. Valve rocker shaft hooks are suitable if properly used to prevent damage to rocker shaft.

5. TO INSTALL ENGINE

For installation of power plant, reverse the sequence of the foregoing removal operations giving particular attention to the following.

1. Be sure that engine insulators and oil shields are properly installed.

2. Use 2 wrenches when connecting oil gauge flexible line to prevent twisting or damaging composition portion of oil line.

3. Make sure that transmission strut rod is installed and properly adjusted as instructed in "Transmission" group.

4. Carefully follow wiring diagram in "Electrical" group of this book when rewiring generator and regulator circuit at junction block.

5. Radio noise suppression bond strap connections must be clean and tight. Make sure that "shake-proof" lock washers are installed as required. Refer to "Miscellaneous Electrical" group.

REPAIR

6. ENGINE ASSEMBLY

The complete procedure for removal, disassembly, repair and assembly of the internal parts of the engine is outlined in various paragraphs of this group. Refer to first page of this group for paragraph arrangement.

7. CYLINDER BLOCK

Cylinder block and crankcase are integrally cast in one piece. This unit supports the crankshaft and camshaft in their respective bearings and contains drilled oil passages to provide for the distribution of oil to bearing surfaces throughout the engine.

A. Removal and Installation—Irreparable damage to cylinder block, which necessitates the replacement of this part, requires the removal of the complete engine from the chassis. All normal service operations on cylinder block, such as boring, honing, cleaning, etc., may be performed without removing unit from the vehicle. Cylinder head assembly, connecting rods and pistons must be removed for these operations. Instructions are given in their respective paragraphs.

B. Ridge Reaming Cylinder Bore—Remove ridge at top of cylinder bore with a suitable ridge reamer, such as illustrated in Fig. 4, before removing pistons from cylinders. This is necessary to prevent damage to piston lands and rings during their removal.

1. Cover top of pistons carefully to prevent cuttings from reaching bearings, etc.

2. Position ridge reamer carefully to avoid cutting below top of upper ring position in bore.

3. Adjust cutters for depth with great care to avoid cutting more metal than is required to remove ridge.

C. Reconditioning Cylinder Bores—Boring and honing equipment, such as that illustrated in Fig. 7, is required to completely and satisfactorily recondition cylinder bores. The instructions furnished by the manufac-

ENGINE

1. Pulley
2. Oil Line
3. Push Rod Cover
4. Rod Bearing
5. Connecting Rod
6. Pin Bushing
7. Pin Retainer
8. Piston
9. Piston Ring
10. Piston Ring
11. Piston Pin
12. Fuel Pump
13. Gasket
14. Distributor
15. Cover Gasket
16. Oil Level Rod
17. Tube
18. Head Gasket
19. Plug
20. Cover
21. Plug
22. Housing
23. Dowel Pin
24. Ball Stud
25. Extension
26. Bracket
27. Support Bolt
28. Engine Support
29. Support Bracket
30. Spacer
31. Flywheel Pan
32. Plug
33. Plug
34. Baffle
35. Cover Gasket
36. Fitting
37. Gasket
38. Body
39. Cylinder Block
40. Plate Gasket
41. Bolt
42. Nozzle
43. Bolt
44. Cover Plate
45. Retainer Bolt
46. Support Plate
47. Retainer
48. Engine Support
49. Oil Slinger
50. Cover Oil Seal
51. Gear Cover
52. Shield
53. Shield

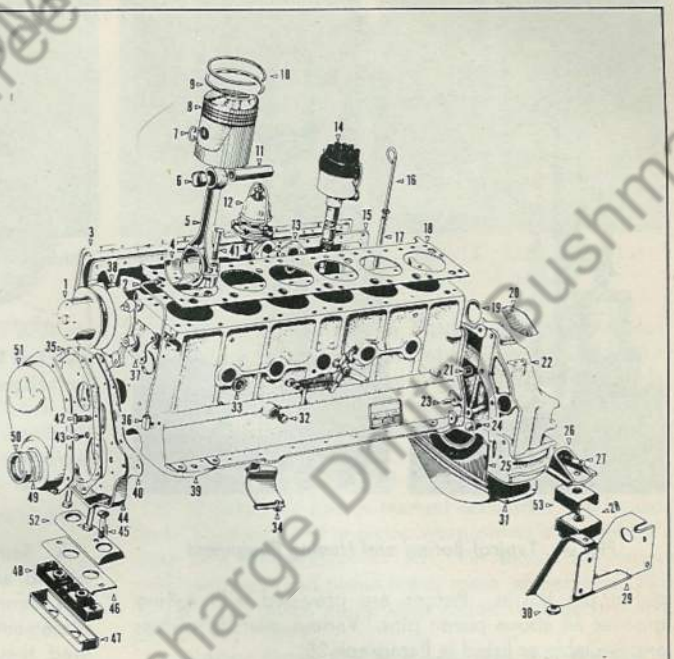

Fig. 3 Disassembled View of Cylinder Block and Piston Parts

turers of the particular equipment used should be followed to obtain satisfactory results. Reconditioning cylinder bores requires the removal of cylinder head assembly (Par. 15) and of connecting rod and piston assemblies (Par. 11).

1. Check cylinder bores with an accurate dial indicator to determine extent of "taper" or "out-of-round" (Fig. 5).

2. Cylinder bores which are not badly scored, tapered or out-of-round and which need but little cleaning up to bring them within satisfactory limits may be reconditioned by honing.

3. Before reboring a cylinder, first determine the oversize piston to be used. Add amount of oversize piston to standard size of cylinder bore as given in paragraph 26; subtract approximately .002" for honing. This balance will provide correct setting for boring equipment.

4. When using a micrometer in connection with the dial indicator for measurement of bore size, care must be taken to exactly duplicate reading of dial indicator in bore while micrometer is being used.

5. After refinishing operations are completed, or whenever engine is disassembled, it is essential that unit be cleaned thoroughly. Fig. 6 shows typical method of cleaning oil passages, etc., with steam-chemical cleaner.

8. PISTONS

Pistons are "step-head" type and are ground by a process known as "cam grinding." This process provides a slightly greater diameter of piston at thrust surfaces than at



Fig. 4 Ridge Reaming Cylinder Bore

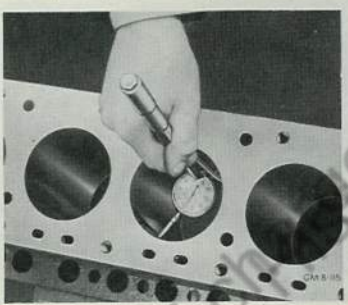

Fig. 5 Dial Indicating Cylinder Bore



Fig. 6 Steam Cleaning Crankcase

ENGINE



Fig. 7 Typical Boring and Honing Equipment

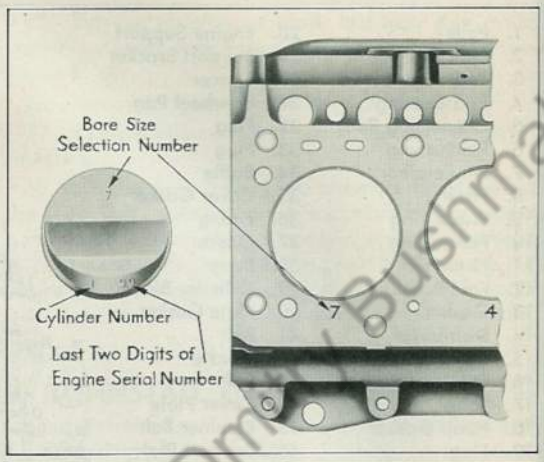

Fig. 11 Identification of Stampings of Cylinder Block and Piston

piston pin bosses. Pistons are provided with 4 ring grooves all above piston pins. Various oversize pistons are available as listed in Paragraph 25.

A. Pistons—Connecting rod and piston assemblies are removable only through top of engine after cylinder head, oil pan and connecting rod bearing caps have been removed.

1. To accomplish complete replacement of pistons requires careful consideration of all information under Piston, Pins, Connecting Rods and Cylinder Block.

2. Pistons are usually stamped at the factory to identify them by cylinder number, bore size selection number and engine serial number. Location and identification of these stampings are shown in Fig. 11.

3. **Important:** When removing pistons from engine, be sure that number cast on side of piston is noted. Pistons having different 3-digit casting numbers are not interchangeable. Pistons having number "75" suffixing the casting number's first three digits are interchangeable only with those pistons having the same 3-digit casting number.

B. Semi-finished Pistons—All finished pistons are cam ground, and, as cam grinding requires special equipment, it is recommended that finished pistons be used for replacement. However, if semi-finished pistons are to be used, they will be supplied .060" oversize with centering boss on head of piston. Conventional parallel cam grinding equipment may be used in the following manner.

1. Turn piston .010" to .015" larger than cylinder size.

2. Grind on centers in connection with special cam to obtain clearances as given in Paragraph 25.

3. Brake sharp edges on ring lands and remove centering boss on piston head.

C. Fitting Pistons—Diameter of piston at top of skirt is less than at bottom of skirt. See Paragraph 25 for piston diameter and clearances at which pistons are to be fitted and Figs. 8 and 9 on locations and manner in which these measurements are taken. The following fitting procedure requires the use of a micrometer, a spring scale and a feeler ribbon. The greatest of accuracy and care must be exercised when fitting pistons to cylinder walls.

1. Clean the cylinder walls and pistons thoroughly and wipe dry with a clean cloth.



Fig. 8 Clearance Points on Piston



Fig. 9 Measuring Piston Diameter

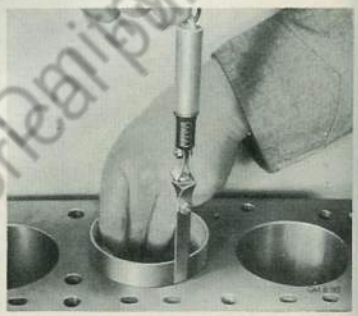

Fig. 10 Fitting Pistons

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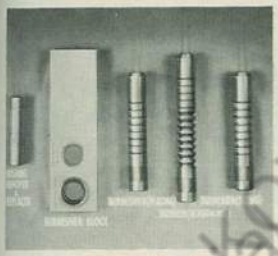

Fig. 12 Piston Pin Bushing Replacement Tool Set



Fig. 13 Removing and Replacing Tool

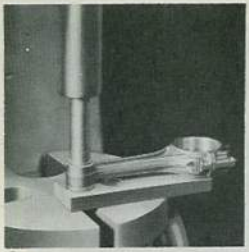

Fig. 14 Installing First Bushing

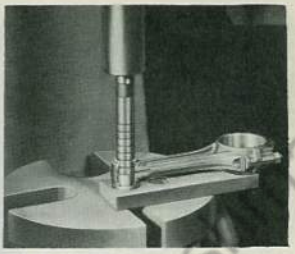

Fig. 15 Burnishing First Bushing

2. Insert piston and feeler ribbon in cylinder bore as shown in Fig. 10. Piston should be inserted all the way into cylinder, upside down, with "step head" side facing away from camshaft side of block. Feeler ribbon of thickness noted in Paragraph 26, must be full length of cylinder bore and on side of piston exactly opposite from piston step head.

3. Attach a spring scale and withdraw feeler ribbon. At the same time, note reading in pounds on scale. Amount of pull required to withdraw feeler is given in Paragraph 25.

4. Do not attempt to fit pistons with less clearance than specified.

D. To Install Pistons—Piston installation in cylinder is simplified by the use of a piston ring compressor.

1. Assemble piston to connecting rod with step head and "T" slot on piston opposite oil spray hole in rod (Fig. 26).

2. Install piston pins. Refer to Instructions in Paragraph 9 for fitting procedure.

3. Install piston rings on piston in accordance with instructions outlined in Paragraph 10 and illustrated in Fig. 23.

4. Use a suitable ring compressor and install piston and connecting rod assembly in cylinder block with step head facing away from cam shaft side of block.

9. PISTON PINS

Piston pins are tubular type and "float" in piston bosses and connecting rod bushings. Pins are retained with spring type locks which fit in grooves in piston wall.

A. Fitting Piston Pins in Pistons—Piston assemblies furnished for service replacement are complete with pins installed and accurately fitted. To determine piston hole ream size for installation of **oversize** pins, add amount of oversize pins to standard ream size of piston pin hole as given in Paragraph 25.

1. Piston and pin should be clean and dry.

2. If piston pin boss is reamed accurately, pin should be a "hand-push" fit in piston when piston is heated 30° more than temperature of pin. Pin should not enter piston when pin and piston are at room temperature. Pin should enter piston easily when piston is heated to approximately 170° F.

B. Fitting Piston Pins in Connecting Rod Bushing—Special replacement bushings and a set of installation tools are available for service use. Bushings are only .004" undersize after they are seated in rod and permit the application of simple broaching operations. Replacements procedure outlined here **must be followed in exact order given** if satisfactory results are to be obtained.

Tools are painted and stamped for identification. The end of seating burnisher is stamped No. 1 and painted red; the broach is stamped No. 2 and painted white; and the sizing burnisher is stamped No. 3 and painted blue. The tools are used in numerical order and the red, white and blue sequence of colors will provide a simple reminder of the proper order in which the tools are to be used.

1. Place connecting rod on block with piston pin bushings centered over removal hole of block and push both bushings out of rod with remover and replacer tool as shown in Fig. 13.

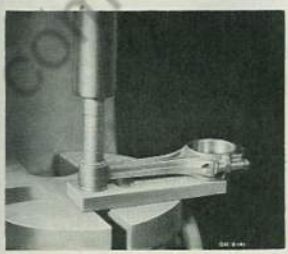

Fig. 16 Installing Second Bushing

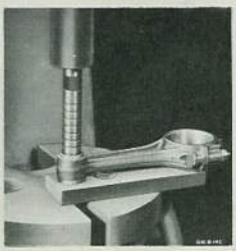

Fig. 17 Burnishing Second Bushing



Fig. 18 Broaching Both Bushings

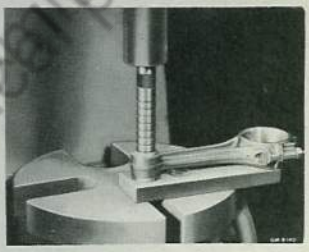

Fig. 19 Final Burnishing of Both Bushings

ENGINE



Fig. 20 See Instructions for Fit of Pin in Rod and Piston

2. Place upper end of rod in raised portion of block (see Fig. 14) and press first bushing into rod until edge of bushing is just flush with edge of rod.

3. Turn rod over so that bushing is next to block and seat bushing in rod, using burnisher No. 1—red as shown in Fig. 15.

4. With rod in same position as in item 3, press second bushing in rod so edge of bushing is just flush with edge of rod, Fig. 16.

5. Now turn rod over again and press burnisher No. 1—red through both bushings, Fig. 17.

6. Apply coating of oil to broach No. 2—white, and press broach through both bushings as shown in Fig. 18.

7. Turn rod over again and press sizing burnisher No. 3—blue, through both bushings. See Fig. 19.

8. Remove any portion of bushings which might extend beyond edges of rod.

9. If edges of bushing are burred or are sharp, use a large tapered reamer or scraper to obtain smooth edges.

10. Make sure that oil holes and oil grooves are clean and free from cuttings.

11. Piston pin should then be a "thumb-push" fit in connecting rod bushing at normal room temperature of 70°, see Fig. 20.

12. To determine bushing bore diameter for installation of oversize pin, add amount of pin oversize to standard bushing bore size as given in Paragraph 25.

13. With piston, pin and connecting rod properly assembled, make sure that spring locks fit snugly in grooves at each end of pin. Use a pair of long-nosed pliers to handle spring locks. Do not use a screw driver, chisel, or other blunt instrument.

10. PISTON RINGS

Piston ring arrangement used in production of these engines consists of 3 compression rings and 1 oil ring. The upper compression ring is an inside bevel type, and the two lower compression rings are taper face type. Piston ring sets furnished by the Service Department are specially designed for replacement purposes. Selection of service replacement piston ring sets should be based on the condition of the cylinder bore and installed in accordance with instructions accompanying each set. Refer to Fig. 23.

A. To Install Piston Rings—To properly and accurately fit piston rings to the piston as well as the cylinder bore requires considerable care and precision as well as adherence to the following procedure.

1. Place new ring in cylinder, pressing it down about halfway into bore with a piston so that ring will be square with cylinder walls.



Fig. 21 Measuring Piston Ring End Gap

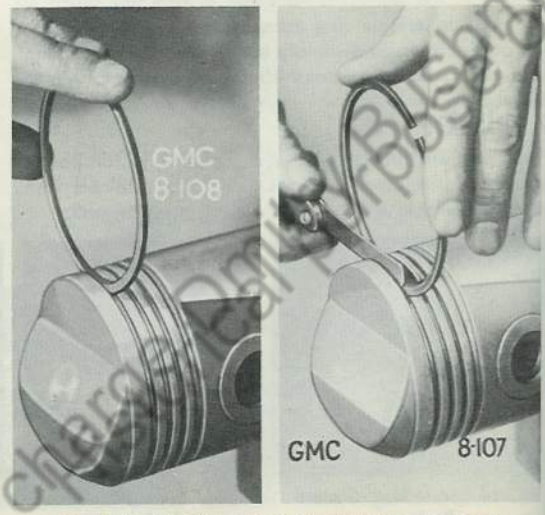

Fig. 22 Checking Fit of Ring in Piston Grooves

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2. Measure gap between ends of ring as shown in Fig. 21. If gap is less than that listed in Paragraph 25, remove ring and dress ends with a fine cut file until proper clearance is obtained. This may be done by placing file in vise and moving both ends of ring squarely across both cutting faces of file.

3. Clean ring grooves of piston thoroughly. If new rings are being installed in used pistons, a suitable ring groove cleaner should be provided.

4. Roll each ring around its respective groove on piston. Ring should roll freely but not loosely.

5. Measure clearance between ring and groove as shown in Fig. 22. Correct clearance is noted in Paragraph 26.

6. Install rings on piston in the correct order. See Fig. 23. A suitable ring installation tool should be used. Compression rings are stamped "Top" and should be installed with this stamping towards top of piston.

7. When piston and rings are installed in cylinder, ring gaps should be staggered around circumference of piston so that no two gaps are in line vertically; also, do not place ring gaps over piston pins.

11. CONNECTING RODS

Connecting rods are rifle drilled to provide lubricant under pressure to piston pins and bushings. An oil spray hole in rod just above bearing cap bolt directs oil against thrust side of cylinder wall.

A. To Remove Connecting Rods—Connecting rod and piston assemblies are removable only through top of block after cylinder head and oil pan have been removed. Refer to Paragraphs 15 and 19 for instructions on removing cylinder head and oil pan.

1. Connecting rods are usually stamped with cylinder number in which they were installed. This number appears on lower end of rod and cap near clamp bolt as shown in Fig. 25. If number is not visible, use a numbering stamp to positively identify rod before removal. Do not file or cut marks in rod.

2. Remove connecting rod bolt nuts. Tap cap lightly on side with soft hammer to assist removal.

B. To Assemble and Install Connecting Rod—It is extremely important that connecting rod be properly assembled to piston. Oil spray hole in rod must be opposite from piston "step head" and "T" slot. See Fig. 27.

It is essential that connecting rod be checked for twist on a suitable alignment fixture such as illustrated in Fig. 24. Types of equipment for performing this operation may vary and may not require the assembly of piston to rod; however, in all cases the pin should be installed in rod so that pin, bushing and rod are included in alignment checking operation.

1. Assembly and installation of connecting rod and piston also requires attention to instructions in Paragraph 9 on "Fitting Piston Pins."

2. Install connecting rod and piston assembly in top of cylinder bore with oil spray hole in rod facing toward camshaft side of engine. Use a suitable ring compressor. Piston step head is opposite camshaft. Correct relation of piston to cylinder block is indicated in Fig. 3.

3. Bearings must be installed in accordance with instructions in Paragraph 12.

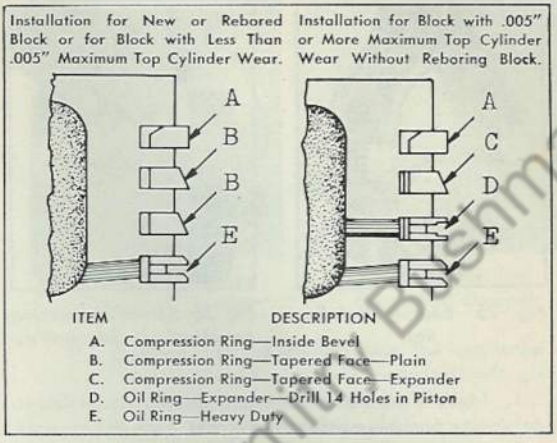

Fig. 23 Install Rings in Order Shown

4. Install bearing caps, bolts and nuts. Nuts are of the "self-locking" type and require tightening to the recommended torque specification to obtain self-locking of the nut. Cotter pins are not used to lock connecting rod bolt nuts on these engines.

5. All 6 connecting rod and piston assemblies are installed in the same manner and same relative position in the engine.

12. CONNECTING ROD BEARINGS

Bearings are precision replaceable type which, when correctly installed, provide proper clearance without reaming, boring or scraping—and **without the use of shims.** Bearings are retained by locking notches in each bearing half and corresponding notches in rod and cap.

Note: For instructions on installing bushings used at piston pin end of rod, refer to Paragraph 9.

A. Inspection Prior to Bearing Installation—This operation requires great care in the use of a micrometer.

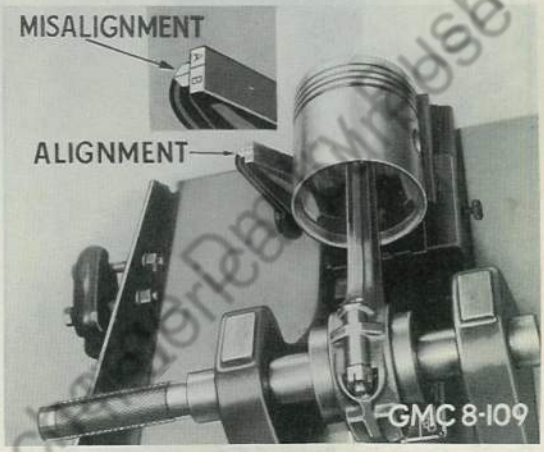

Fig. 24 Connecting Rod Alignment Fixture

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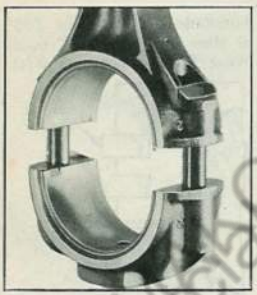

Fig. 25 Bearing Installation

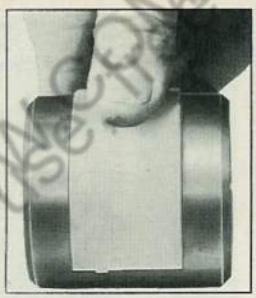

Fig. 26 Spreading Bearing on Mandrel. See Instructions

1. Make a careful visual examination of crankpins to determine possible existence of scores, nicks or flat spots.

2. Measure diameter of crankpin with a micrometer. This could be done at several points on each crankpin to determine extent of taper or out-of-round. If crankpin is excessively tapered or out-of-round, the shaft should be reground for installation of undersize bearing. If shaft is slightly worn, but not out-of-round, and requires but little cleaning up, it may be possible to obtain correct clearances with .002" undersize bearings which are available for this purpose.

B. To Install Connecting Rod Bearings—Procedure for reinstalling connecting rod bearings which have been used differs from procedure for installing new bearings in that used bearings must be spread on a mandrel (Fig. 27) before being reinstalled. This operation is necessary because the ends of used bearings tend to spring inwards, away from cap or rod, when bolt tension is removed. Install bearings as follows.



Fig. 27 Connecting Rod and Piston Assembly—Oil Hole in Rod Is Opposite Step Head

1. If bearings which were removed are being reinstalled, spread each half of bearing as follows:

(a) Obtain a suitable mandrel having a polished surface $2\frac{3}{16}$" in diameter.

(b) Place bearing on mandrel and press down firmly as shown in Fig. 26.

(c) Check fit of bearing in rod or cap. Bearing should be spread sufficiently to require light finger pressure to seat in place.

2. Observe following additional precautions when installing either used or new bearings.

(a) Never use a used bearing half with a new half. Always replace both halves.

(b) Be certain bearing is seated firmly in place with notch in bearing engaging notch in cap or rod.

(c) Never file cap or rod and never use shims to obtain correct fit.

3. After bearings are installed in cap and rod, proceed with installation by fitting bearing in accordance with instructions in "C" below.

C. Bearing Fitting—Fit of each connecting rod bearing on crank pin should be checked whenever bearings have been removed. This applies whether new bearings are being installed or old bearings are being reinstalled. Proceed as follows:

1. Select a $\frac{1}{4}$" x 1" x .003" shim made from a piece of brass feeler stock.

2. Coat shim with light engine oil and place on center of bearing in cap (see Fig. 38 for example).

3. Place connecting rod in position on crankpin and assemble cap to rod. Be certain locking notches in cap and rod are at same parting line (Fig. 25).

4. Use plain threaded bearing cap nuts and tighten with torque wrench. Draw nuts up evenly to 40-50 foot-pounds torque.

5. Move connecting rod endwise on crankpin. Bearing should be fairly tight if fit is correct.

6. If bearing is loose with shim in place, install .002" undersize bearing and repeat operations 2 through 5. With .002" undersize bearings installed, and with .003" shim removed, a check must be made to be sure that a minimum of .0015" clearance exists. A .002" feeler shim may be used for this purpose. If there are any ridges or scratches on journal, clean up as instructed in Paragraph 13C before installing undersize bearing.

7. If bearing is loose with .002" undersize bearing and with .003" shim in place crankshaft should be replaced or reground and .010", .020", or .030" undersize bearing used. See "Specifications" for crankpin regrinding limits for use with undersize bearings.

8. When proper fit has been obtained, remove cap, remove shim and replace cap on rod installing self locking nuts.

9. Tighten cap nuts evenly with torque wrench. Draw nuts up to 40-50 foot-pounds torque.

10. Rod should move freely on crankpin after cap has been replaced without using shim. **Be certain shim is removed.**

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13. CRANKSHAFT, DAMPER AND SEALS

Crankshaft and damper are each balanced separately and may, therefore, be replaced individually.

A. To Remove Crankshaft—Crankshaft removal involves removal of engine from chassis as outlined in Paragraph 17. Then proceed as outlined in the following nine items.

1. Drain engine oil and remove oil pan and clutch housing lower pan.
2. Remove clutch assembly and clutch driven member. Refer to Group 02.
3. Remove crankshaft damper assembly. See Fig. 28.
4. Remove timing gear cover assembly. Note that two bolts are accessible only from inside of engine as shown in Fig. 53.
5. Remove camshaft and gear assembly and crankshaft timing gear (Paragraph 17).
6. Remove timing gear cover plate from cylinder block.
7. Remove oil pump and intake assembly with outlet pipe. See Paragraph 19, Fig. 62.
8. Remove crankshaft and connecting rod bearing caps. Note cylinder number which is stamped for identification on all bearing caps.
9. Lift crankshaft out of engine.



Fig. 28 Removing Crankshaft Damper



Fig. 29 Installing Crankshaft Damper

B. To Install Crankshaft—Reverse the sequence of removal operations when reinstalling crankshaft giving particular attention to the following.

1. Use new lock plates and gaskets.
2. Install a new rear oil seal as later instructed in this paragraph.
3. Measure crankshaft end play as shown in Fig. 31. End thrust is taken at rear intermediate bearing, and clearance at this point should be measured between bearing and crank throw.

C. Crankshaft Inspection—This operation requires the use of a micrometer, dial indicator, "V"-blocks or lathe centers, as well as great care and precision in the use of these instruments.

1. Camshaft Gear
2. Thrust Plate
3. Gasket
4. Camshaft Bearing
5. Camshaft
6. Camshaft Bearing
7. Camshaft Bearing
8. Camshaft Bearing
9. Plug
10. Flywheel
11. Crankshaft Gear
12. Spacer
13. Bearing—upper
14. Crankshaft
15. Bearing—upper
16. Bearing—upper
17. Bearing—upper
18. Flywheel Bolt
19. Cap Bolt
20. Lock
21. Bearing Cap
22. Bearing—lower
23. Bolt
24. Lock
25. Bearing Cap
26. Bearing—lower
27. Oil Pump
28. Lock
29. Bearing Cap
30. Bearing—lower
31. Lock
32. Bearing Cap
33. Bearing—lower
34. Oil Seal
35. Oil Pan Gasket
36. Oil Intake
37. Oil Pan Gasket
38. Oil Pan Gasket
39. Oil Pan
40. Oil Pan Gasket

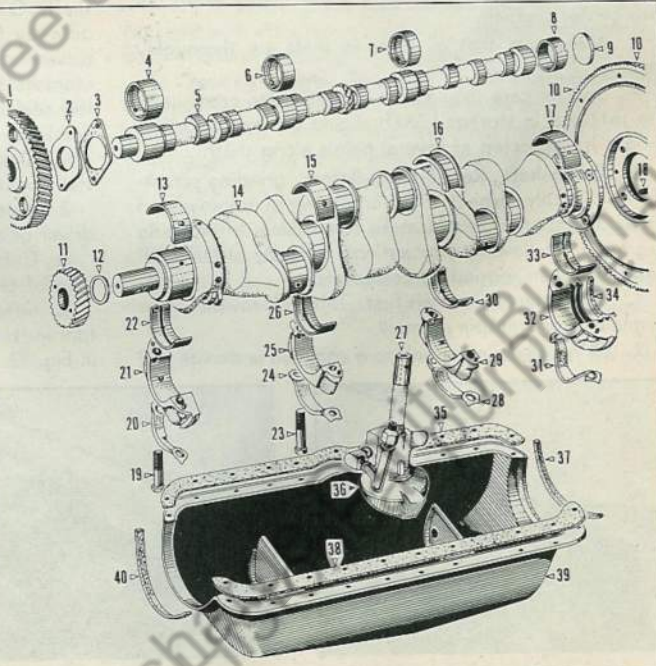

Fig. 30 Disassembled View of Crankshaft, Camshaft and Oil Pump Parts

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Fig. 31 Measure Crankshaft End Play at Rear Intermediate Bearing

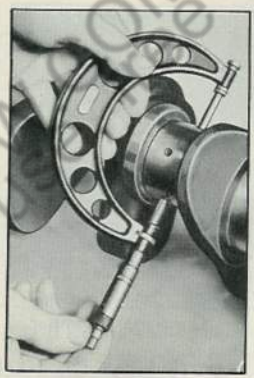

Fig. 32 Measure Crankshaft Journals at Several Points on Diameter

1. Make a careful visual examination of crankshaft journals for scoring, nicks or flat spots.

2. Carefully measure journals and crankpins with a micrometer to determine extent of "taper", "out-of-round" or wear.

Minor defects at crank pin journals may be cleaned up with a suitable tool while crankshaft is still in vehicle. Crankshaft main bearings must be reground, however.

3. Place crankshaft on "V"-blocks or in lathe centers and test for alignment by using a dial indicator on the two center journals.

4. Make sure that oil holes in shaft are thoroughly clean.

5. Special care should be exercised when crankshafts are retained in storage. Shaft should be stored so that weight is supported at several points along shaft.

D. Crankshaft Regrinding—Before grinding crankshaft, carefully inspect it for cracks, worn keyways and other defects that would make it worthless after being reground. Following precautions must be strictly adhered to when regrinding crankshaft.

1. Regrind main journals first. This will provide better alignment for crankpin journals.

2. Grind all main journals to a common undersize and all crankpin journals to a common undersize. It is not necessary that main journals and crankpin journals undersize be the same. See "Specifications" (Paragraph 25) for regrinding sizes.

3. It is absolutely necessary that fillet radius be maintained. See "Specifications" (Paragraph 25) for sizes. Proper method of maintaining this radius is to dress edge of grinding wheel to proper radius.

4. All main journals and crankpin journals should be paper lapped.

5. After regrinding crankshaft it is absolutely necessary that sharp edges be removed from around all oil holes in journals. This is done by breaking the edge approximately .005" by using a small pencil grinder or with a carborundum stone cut down to a rounded point on one end and spun by hand around the inside edge of oil hole.

6. Make sure oil holes in shaft are thoroughly clean and all abrasive is removed from shaft.

E. Crankshaft Damper—A special tool, consisting of a combination puller and driver, is available for removing and installing crankshaft damper. The application of this tool is illustrated in Figs. 28 and 29.

1. Whenever necessary to service either the crankshaft damper or pulley, the balanced assembly, consisting of both parts, should be used. Do not attempt to repair damper. If unit is damaged in any way, replace with new assembly.

F. Crankshaft Rear Oil Seal—A special packing is provided which forms an oil seal at rear end of crankshaft. Oil slinger on crankshaft directs major portion of oil away from seal and oil returns to oil pan. A special driver is available for installation and compression of crankshaft upper oil seal. If such a driver is not used, the seal may be satisfactorily pressed into groove in crankcase and cap as shown in Figs. 33 and 35.

1. Crankshaft should be removed from engine to install upper half of oil seal.

2. Install seal in groove of crankcase with special driver or as illustrated in Fig. 33.

3. Cut off protruding ends of packing flush with surface of crankcase as shown in Fig. 34.

4. Install seal in bearing cap using a smooth rounded tool working from both ends towards center as illustrated in Fig. 35.

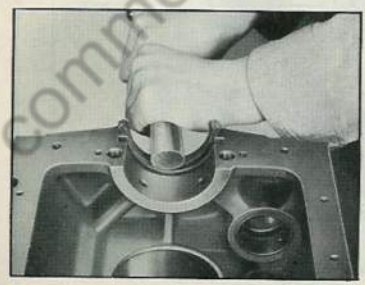

Fig. 33 Installing Crankshaft Upper Oil Seal

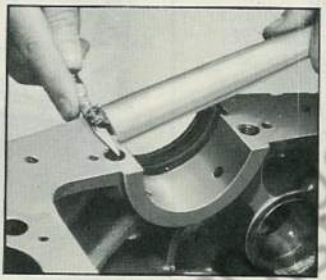

Fig. 34 Cut-Off Oil Seal Ends Flush with Crankcase

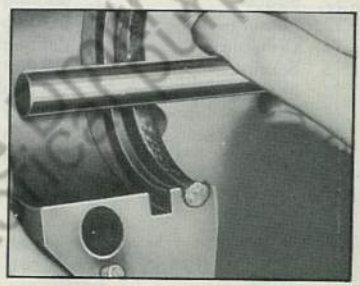

Fig. 35 Installing Oil Seal in Bearing Cup

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14. CRANKSHAFT BEARINGS

Crankshaft bearings are precision replaceable type which, when properly installed, provide correct clearance without reaming, boring or scraping and **without the use of shims.** Upper and lower bearing halves are retained by lock notches in bearing and corresponding notches in crankcase and cap. Undersized bearings are stamped with the amount of undersize for bearing size identification.

A. To Remove Crankshaft Bearings—Crankshaft main bearings may be removed without removing crankshaft from vehicle by removing, installing and fitting one bearing at a time. Whenever one main bearing needs to be replaced remove each of the other main bearings for inspection and replace if necessary. If any bearing is chipped or there are indications that bearing metal has run, all main and connecting rod bearings should be inspected and all oil passages cleaned thoroughly. Remove bearings as follows:

1. Straighten tangs of lock plate with a chisel, remove bolts and tap bearing cap with a soft-faced hammer and remove bearing cap and lower half of bearing. Do not pry cap or dowels may be damaged.
2. Lift lower half of bearing from cap.
3. Remove upper half of bearing by rotating crankshaft and tapping plain edge of bearing lightly to start it rolling around shaft. If bearing is tight, bend the two ends of a cotter pin to form a "T" and place head of cotter pin in oil hole in shaft (Fig. 37). Rotate shaft to remove bearing.

B. To Install Crankshaft Bearings—Observe following precautions when installing either used or new bearings:

1. Never use a used bearing half with a new half. Always replace both halves.
2. Be certain bearing seats firmly in cap or block with notch in bearing engaging notch in cap or block.
3. Never file cap or block and never use shims to obtain correct fit.
4. Do not interchange upper and lower halves of rear bearing. Upper (crankcase) half has oil holes which must register with oil feed holes in crankcase. Lower (cap) half has no oil holes.
5. Crankshaft main bearings are not interchangeable.

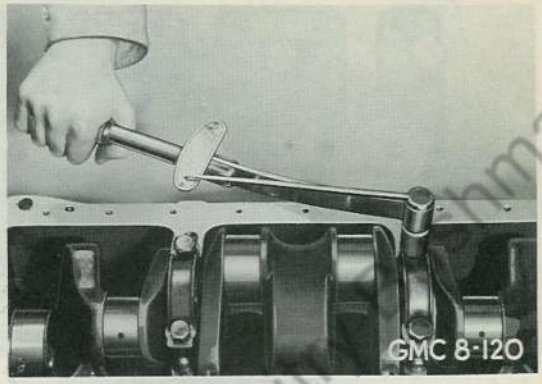

Fig. 36 Use of Torque Wrench on Crankshaft Bolts

Front and front intermediate bearings are almost identical in appearance and extra care must be taken to be certain correct bearing is installed at each position. Bearing ends must be flush with crankcase and cap (see Fig. 39).

6. Inspect crankshaft bearing journals and recondition or replace shaft if journals are scratched, pitted, out-of-round, tapered or if there are any ridges. If shaft is reground use undersize bearings as shown in specifications. .002" undersize bearings may be used when only slight cleaning up is required (see Paragraph 13C).
7. After bearings are installed in cap and crankcase, proceed with installation by fitting bearings in accordance with instructions in "C" below.

C. Bearing Fitting—Fit of each main bearing should be checked whenever bearings have been removed. This applies whether new bearings are being installed or old bearings are being reinstalled. Proceed as follows:

1. Select a 1/4" x 1" x .003" shim made from a piece of brass feeler stock.
2. Coat shim with light engine oil and place on center of bearing as shown in Fig. 38.
3. Install bearing cap with shim in place and tighten bolts evenly to 70-80 foot-pounds torque using a torque wrench.
4. Turn flywheel 1" either direction. **Caution: Do not**

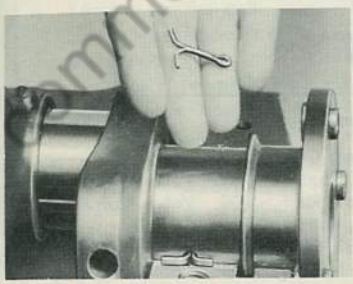

Fig. 37 Use of Cotter Pin for Tight Bearing Removal

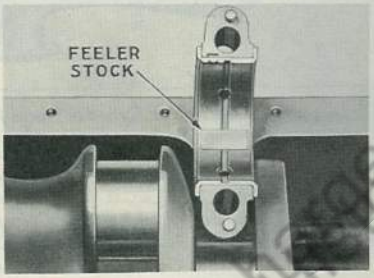

Fig. 38 Feeler Stock for Checking Bearing Clearance. See Instructions

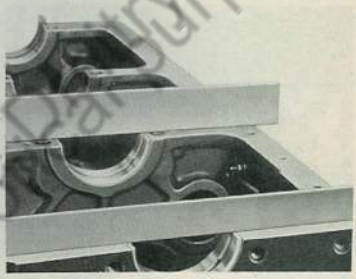

Fig. 39 Bearings Are Not Interchangeable. See Instructions

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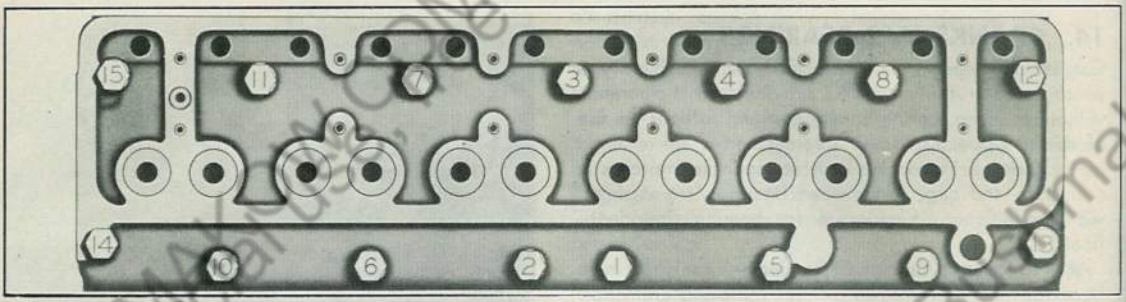

Fig. 40 Tighten Cylinder Head Bolts with Torque Wrench—In Sequence Shown

turn flywheel more than 1" in either direction or shim may damage bearing. With this shim in place, bearing should be sufficiently tight to cause at least a slight drag and may be tight enough to seize.

5. If bearing is not tight enough to cause at least a slight drag, remove and install .002" undersize bearing. Repeat operations 3, 4 and 5.

6. If .003" shim, installed in .002" undersize bearing, does not cause shaft to have a drag, shaft should be reconditioned or replaced. See regrinding sizes and undersize bearing sizes in "Specifications."

7. When bearing is sufficiently tight with .003" shim in place, remove bearing cap, remove shim, and reinstall cap without shim. Tighten cap bolts with torque wrench.

8. Turn flywheel. Bearing must be free on shaft with no drag whatsoever.

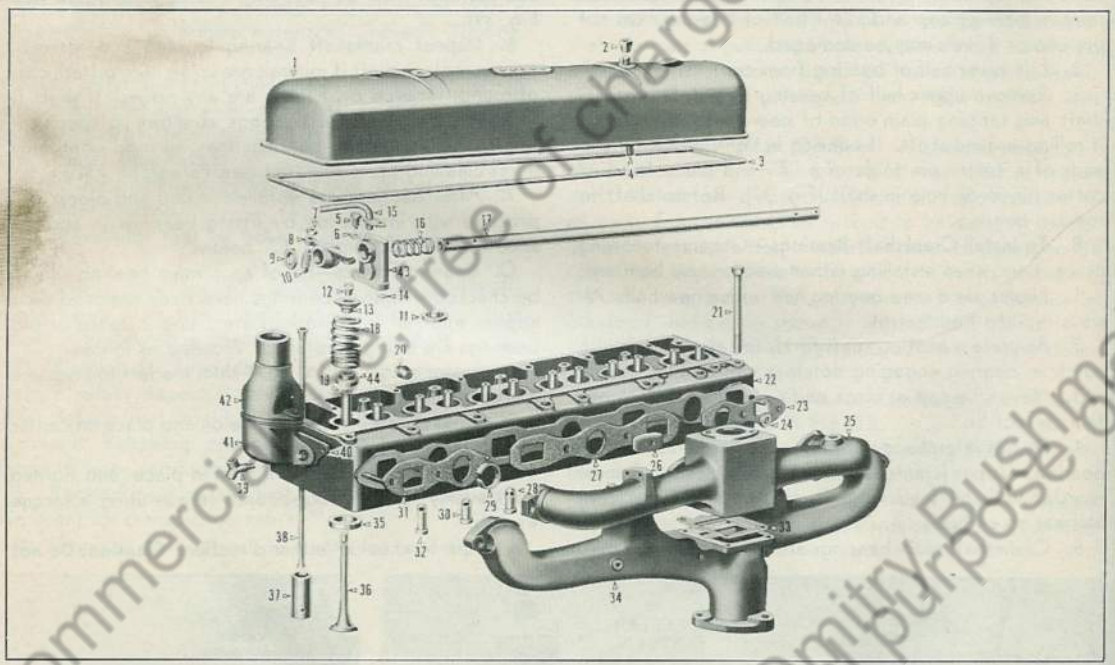

Fig. 41 Disassembled View of Cylinder Head Parts

1. Valve Cover
2. Cover Nut
3. Cover Gasket
4. Cover Stud
5. Locating Screw
6. Nut
7. Adj. Screw Nut
8. Rocker Arm
9. Washer
10. Adjusting Screw
11. Oil Shield—Intake Only
12. Valve Key
13. Spring Retainer
14. Pipe Gasket
15. Overflow Pipe
16. Rocker Shaft Spring
17. Rocker Arm Shaft
18. Valve Spring
19. Valve Stem Guide
20. Plug
21. Cylinder Head Bolt
22. Cylinder Head
23. Manifold Gasket
24. Manifold Gasket
25. Intake Manifold
26. Manifold Clamp
27. Manifold Gasket
28. Water Nozzle
29. Manifold Pilot
30. Water Nozzle
31. Manifold Gasket
32. Water Nozzle
33. Manifold Gasket
34. Exhaust Manifold
35. Valve Insert
36. Valve
37. Valve Lifter
38. Valve Push Rod
39. Oil Inlet
40. Housing Gasket
41. Thermostat Housing
42. Water Outlet
43. Shaft Bracket
44. Spring Seat

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9. When final adjustment of rear main bearing is obtained remove cap and coat crankcase at bearing parting line with suitable sealing compound. Then replace cap.

10. When bearings are in final adjustment install bearing cap bolt locks and bend corners up against bolt heads.

15. CYLINDER HEAD

Cylinder head assembly in addition to forming the upper part of each combustion chamber, contains the intake and exhaust valve operating mechanism, intake and exhaust valve ports, as well as cored passages for cooling and nozzles for directing application of water against exhaust valve ports.

A. To Remove Cylinder Head—Complete cylinder head assembly can be removed as a unit without disturbing water pump, fan or other engine accessories except manifolds and ignition coil, as described in following operations.

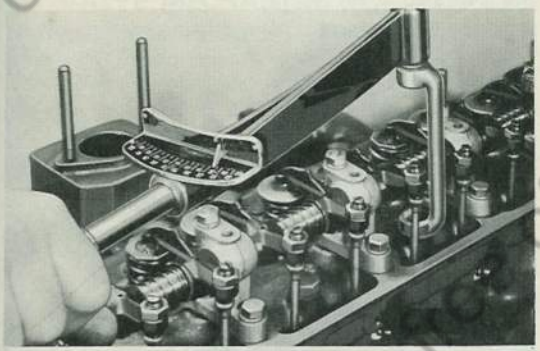


Fig. 42 Use of Torque Wrench on Cyl. Head Bolts

1. Drain water from radiator and cylinder block.
2. Disconnect water temperature control tube from cylinder head. Also, disconnect water outlet fitting.
3. Disconnect windshield wiper line and power cylinder vacuum line from intake manifold.
4. Remove stud nuts which attach intake and exhaust manifold to cylinder head, then disconnect and remove manifold and carburetor, etc., as an assembly.
5. Remove ignition coil.
6. Disconnect ignition cables at spark plugs.
7. Disconnect oil line at front of cylinder head.
8. Disconnect temperature gauge line by removing fitting from cylinder head.
9. Remove oil filter.
10. Remove valve push rod cover.
11. Disconnect radio noise suppression bond strap. Then remove cylinder head cover.
12. Remove valve rocker arm and shaft as a complete assembly.
13. Lift valve push rods out of engine.
14. Remove cylinder head to block bolts and carefully lift cylinder head off of block.

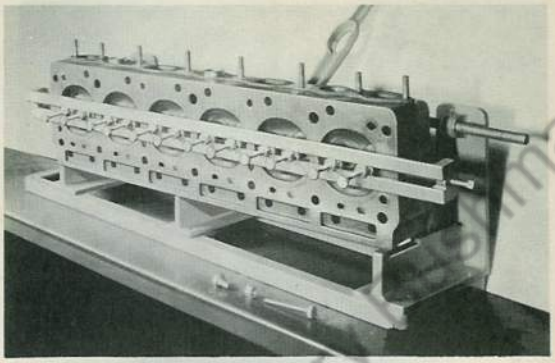


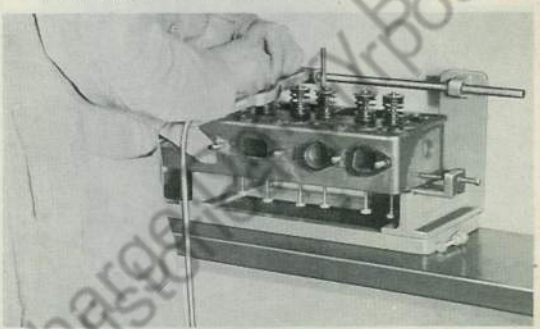
Fig. 43 Cylinder Head Fixture

B. To Install Cylinder Head—Cylinder head can be reinstalled by reversing the sequence of removal operations except as follows:

1. Valve push rod should not be inserted until after cylinder head is remounted on block. This is necessary to avoid damaging push rods.
2. Before installing cylinder head, make sure that the head and block are clean and free from carbon and dirt.
3. Always use a new gasket. Be sure that gasket is installed with side marked "Top" towards cylinder head.
4. Tighten cylinder head bolts in the order shown in Fig. 40. A suitable torque wrench should be used to obtain uniform tightening of the cylinder head bolts (Fig. 42.) The factory-recommended torque is given in Paragraph 25. Tighten bolts while cylinder head is cold, then run engine until normal operating temperatures are obtained and give bolts a final tightening with torque wrench.

Important: Uniform tightening of cylinder head bolts is essential for trouble-free operation. Under or over-tightening of these bolts should be avoided, as it frequently results in distortion of cylinder head, water leaks, blown cylinder head gaskets, and usually leads to serious engine difficulty.

5. Always check valve lash after installing cylinder



To Foot Extension

Fig. 44 Use of Cylinder Head Fixture for Removing Valves

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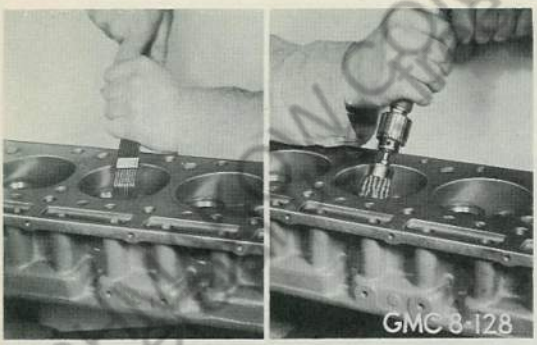

Fig. 45 Typical Methods of Cleaning Cylinder Head

head or tightening cylinder head bolts.

6. Use new shakeproof lockwashers when reinstalling ignition coil.

C. Valve Seats—Removal and Installation—Exhaust valve seats are replaceable type of special metal pressed into the cylinder head. Intake valve seats are integral with cylinder head. The following instructions, therefore, apply only on the removal and installation of exhaust valve seat "inserts".

Valve seat inserts, standard size and .010" oversize, are available for replacement and, if special facilities are available, the following procedure may be used; otherwise, it is recommended that new cylinder head be installed.

1. Remove used insert from cylinder head. Where special tool is not available, the insert may be removed by drilling two holes, (slightly smaller in diameter than width of insert) one on each side of insert. Depth of these drilled holes must not exceed thickness of insert. A sharp chisel should be used to cut remaining metal between drilled holes and edges of insert. Insert will then be in two pieces and can easily be removed. Regardless of the method used for removal, special care should be taken not to damage cylinder head.

2. If oversize inserts are to be installed, counterbore exhaust valve ports to dimensions given in "Specifications". It is extremely important that head be counterbored within these limits, and that bore be concentric with hole in valve stem guide within .003" total indicator reading.

3. Pack new inserts in "dry ice" for at least 15 minutes before they are to be installed.

4. Apply heat gradually to cylinder head around the area where insert is to be installed until head reaches a temperature of approximately 180° to 200°.

5. Press insert squarely into head with extreme care to avoid cocking and to obtain proper seat.

D. Reconditioning Valve Seats—Due to extreme hardness of the insert metal, valve seats should be refinished with special grinding equipment such as illustrated in Fig. 46. Instructions are usually supplied by the manufacturers of such equipment and should be followed carefully to obtain best results. The following items should be considered when reconditioning valve seats.

1. Clean cylinder head thoroughly. Typical methods are illustrated in Fig. 45.

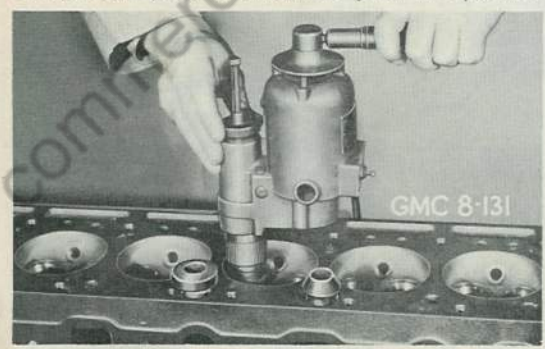

Fig. 46 Grinding Valve Seats. Note Angle of Stones for Narrowing Seats

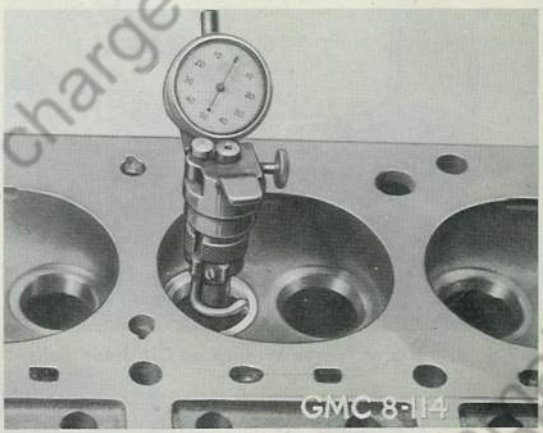

Fig. 47 Use of Dial Indicator on Valve Seat

2. Clean valve guides thoroughly. Valve grinder pilot must fit snugly in valve guide, and this is possible only if guides are clean and free from foreign substances.

3. Install and expand valve grinder pilot until it is securely tightened in place.

4. Select the correct angle grinding stone and see that it is trued properly to obtain the desired angle of seat.

5. After grinding, mount valve seat indicator on pilot as shown in Fig. 47. The circumference of seat must be true within .002".

6. Valve seats should be narrowed down after grinding, if necessary, by using proper angle stone (also shown in Fig. 46) to obtain the correct width of seat as given in "Specifications". Good judgment must be used when narrowing seat to assure correct seat contact with center of valve face. This is very important if maximum life of the valve grinding job is to be obtained.

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Fig. 48 Typical Valve Grinding Equipment

16. VALVE MECHANISM

The valve mechanism consists of intake and exhaust valves, valve springs and caps, guides, lifters, push rods, valve rocker shaft and rocker arms. Intake and exhaust valves are actuated by individual rocker arms mounted on rocker shaft and operated by push rods and lifters from cam shaft.

A. Valves—Intake and exhaust valves have 30° angle. All data and dimensions necessary for proper servicing of valve is given in "Specifications". Equipment for complete valve service and instructions for reconditioning valves are given in the following items 1 to 6.

1. Cylinder head assembly should be removed from engine as instructed in Paragraph 15 and placed in a suitable disassembly and assembly fixture as illustrated in Fig. 43. This type of fixture supports cylinder head and includes movable and adjustable screws for supporting valves. Tighten screws down on valve heads and then lock screw position with check nut. This arrangement holds valves in position while springs are being compressed for removal of valve retainer locks. Lever may be operated either by hand or by foot with extension. Fig. 44.

2. Compress valve springs and remove small retainers which lock each valve. Intake valve spring caps must be removed before retainers are accessible. After retainers, spring caps and springs are removed, valves may be withdrawn from opposite side of head.

3. Clean and inspect valves carefully. See that all carbon or other foreign matter is removed from valve head and stem.

4. Inspect end of valve stem and, if excessively pitted or worn by action of rocker arm, the valve should be discarded.

5. Install valve in suitable grinder such as shown in Fig. 48 and, after making sure that the grinding wheel is properly trued, set chuck at the proper angle and take a light cut from the face of the valve. Care should be taken while grinding not to remove too much material from valve face.

6. Test valve for perfect contact with seat in cylinder head. This may be done by marking lines about 1/4" apart on face of valve with a lead pencil. Then, insert valve in guide and, with valve face contacting seat, give a 1/2 turn to the right and a 1/2 turn to the left. If all pencil marks are removed, the operation may be considered satisfactory; if, on the other hand, one or more lines or pencil marks remain untouched, the valve or seat should be reground, and lapped if necessary, until it seats properly.

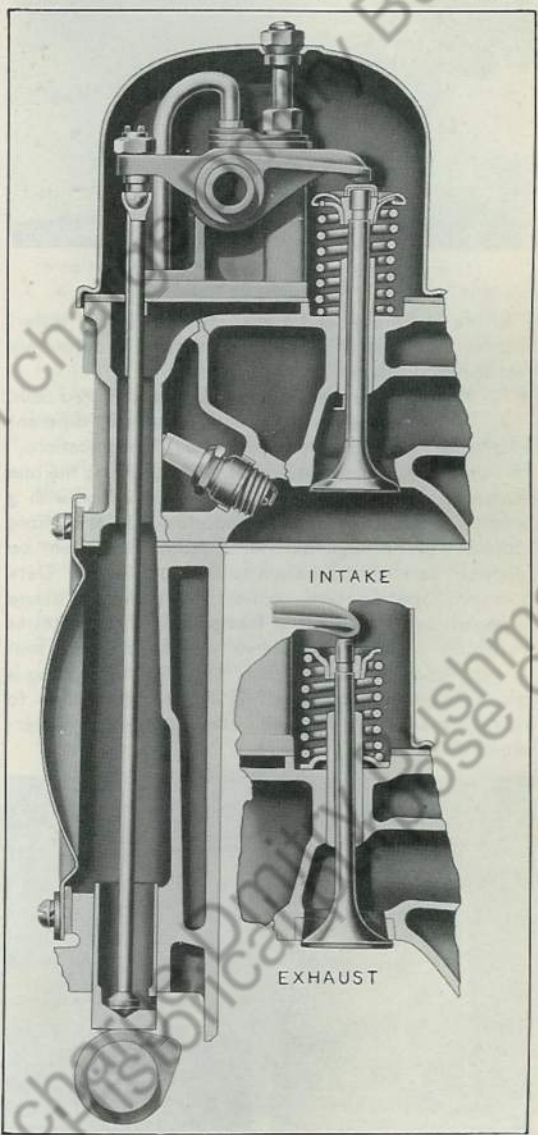

Fig. 49 Valve Mechanism

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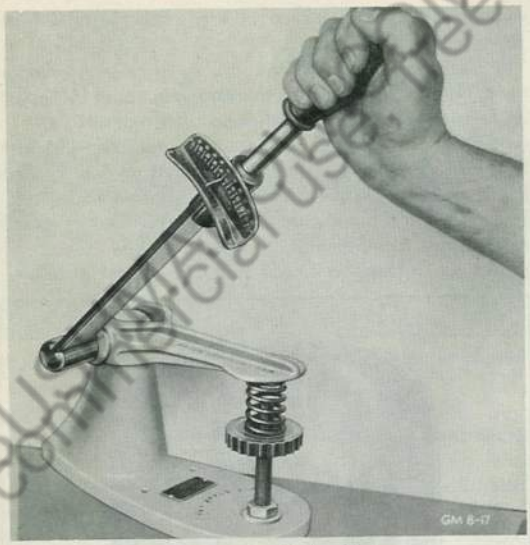

Fig. 50 Testing Valve Springs

B. Valve Springs and Caps—A valve spring tester, such as illustrated in Fig. 50, is necessary to accurately test spring pressure.

1. Inspect valve springs for broken or fractured coils.

2. Test valve springs for **pounds** pressure at different lengths of spring compression. See "Specifications." This should be done on a suitable tester, such as the one illustrated in Fig. 50 which is used in connection with a torque wrench. It is extremely important that instructions supplied by the manufacturer of testing equipment be followed carefully to obtain satisfactory results. Data given in "Specification" section lists required pressure in **pounds** by weight, **not in foot pounds.** Type of tester illustrated automatically converts pressure from "foot pounds" into "pounds." When torque wrench reading is taken and multiplied by two (2) at time tester clicks to indicate that spring has been compressed to predetermined length.

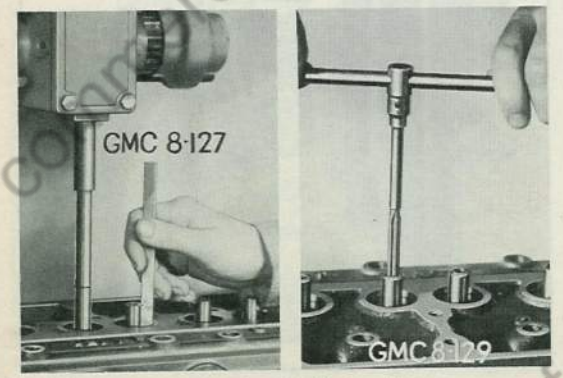

Fig. 51 Valve Guide Installation

3. Intake valve springs are covered with a cap or shield which fits over end of intake valve as shown in Fig. 49.

4. Seats are provided for each exhaust valve spring and must be installed between lower end of spring and cylinder head as shown in Fig. 49.

C. Valve Stem Guides—An arbor press should be used in connection with valve guide removal and replacement. A special reamer is required to obtain correct inside diameter of guide after installation. Cylinder head must be removed and valve mechanism disassembled to service valve guides.

1. Clean the valve guides thoroughly and check clearance between new valve and guide. If clearance is excessive, new valve guide should be installed.

2. Press new guide into cylinder head in the manner illustrated in Fig. 51 until dimension from counterbored spring seat in cylinder head is 61/64". Be sure exhaust valve spring seat is removed when measuring this dimension.

D. Valve Lifters and Push Rods—Valve lifters are located slightly off center from cam on camshaft. This

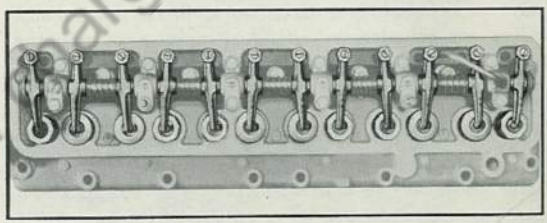

Fig. 52 Valve Rocker Arm Arrangement

tends to revolve lifter and prevents excessive wear at any one point.

1. Test fit of lifters in crankcase. They should be free without excessive looseness. See "Specifications" for proper clearances.

2. Always remove push rods before cylinder head is removed and replace them after cylinder head is installed to prevent possible damage to rod.

3. Inspect push rods whenever they are removed. Rods should not be bent or twisted.

E. Valve Rocker Shaft—A single rocker shaft, full length of engine, is used.

1. Clean oil holes in rocker shaft thoroughly. If necessary to clean the inside of this hollow shaft, the plug at each end must be removed.

2. Measure diameter of rocker shaft at point of rocker arm contact to determine extent of wear.

Note: Late type pressed steel rocker shaft brackets are interchangeable with die-cast aluminum type in sets of 6 only.

F. Valve Rocker Arm—Twelve rocker arms are used —six are right hand offset and six are left hand offset. They are installed as shown in Fig. 52.

1. Clean oil holes in rocker arms.

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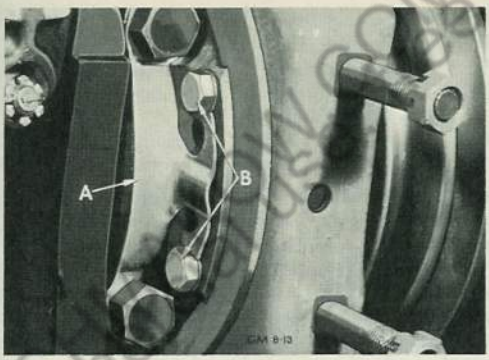

Fig. 53 Timing Gear Cover Bolts (B) and Lock (A) are Accessible After Oil Pan is Removed

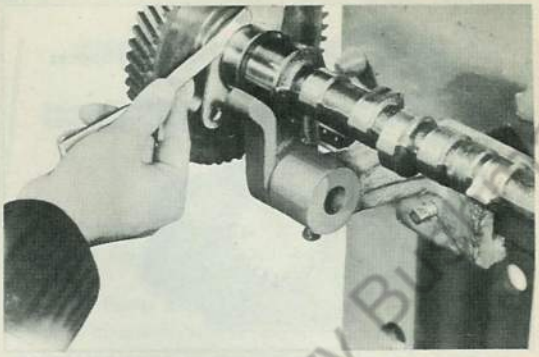

Fig. 54 Measure Clearance Between Thrust Plate and Front Journal as Shown

2. Check clearances between rocker arm and shaft. Excessive clearance resulting from worn rocker arms or shaft should be corrected by installing new parts.

3. If valve contact face of rocker arm is excessively pitted or grooved, rocker arm should be discarded and a new one installed. Grinding of valve rocker arm face is not recommended as removal of excessive metal might result in loss of hardened surface.

G. Valve Lash—Complete instructions for performing valve lash operations are given in Paragraph 3 of this group. Always check valve lash after installing cylinder head or tightening cylinder head bolts.

17. CAMSHAFT AND TIMING GEAR

Camshaft consists of a straight shaft on which are ground eccentric cams for valve operation. Camshaft also provides the drive for ignition distributor and fuel pump.

Camshaft timing gear removal necessitates removal of the camshaft. Instructions for this service are included in the following subject.

A. To Remove Timing Gear Cover, Gears and Camshaft—Timing gears may be removed without removing engine from chassis. This is done as follows:

1. Drain radiator and remove core, shell and grill assembly as instructed in "Cooling" group.

2. Remove crankshaft damper and fan drive pulley assembly as shown in Fig. 28. Refer to Paragraph 13.

3. Remove oil pan, after which the two timing gear cover inner bolts are accessible (see Fig. 53). Remove remainder of timing gear cover bolts.

4. Pull crankshaft timing gear with a suitable puller such as shown in Fig. 55. NOTE: This operation is unnecessary if only camshaft is being removed. Before removing timing gears, make sure that timing marks on gears are legible. If not, they should be marked clearly before removing.

5. To remove camshaft timing gear, it is necessary to withdraw camshaft and press shaft out of gear as shown in Fig. 56. Hole in thrust plate is large enough to clear key in shaft, and damage to plate can thereby be avoided, if thrust plate is moved to keyway side of shaft before gear is taken off. Camshaft may be removed from engine as follows:

(a) Remove valve push rods and lifters.
(b) Remove distributor assembly and fuel pump.
(c) Remove camshaft gear thrust plate retaining bolts. These bolts are accessible through holes in gear.

B. Camshaft and Timing Gear Inspection—Gears should be subjected to a careful visual inspection to detect worn or scuffed teeth or fractures which would render

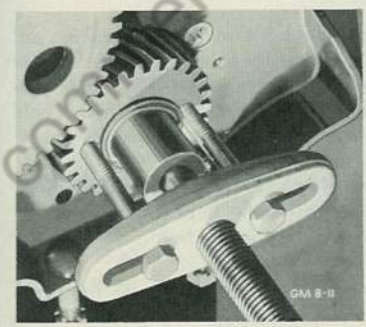

Fig. 55 Removing Crankshaft Gear



Fig. 56 Press Camshaft Out of Timing Gear



Fig. 57 Installing Crankshaft Gear

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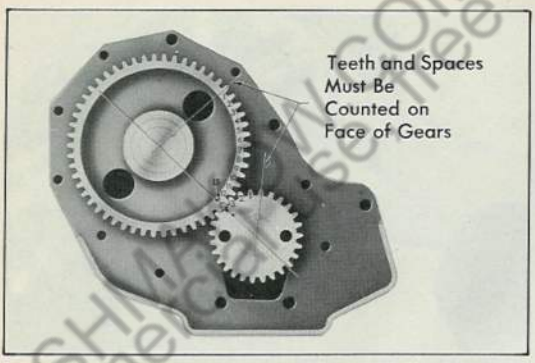

Fig. 58 Timing Marks on Gears Must Be Matched as Shown

these parts unfit for further surface.

2. Camshaft journals should be measured with a micrometer to determine extent of wear.

3. Carefully examine eccentric cams for scores or scuffings. If minor scratches are found, they may be removed with a hone.

C. To Install Timing Gear—Aside from common hand tools required for removal of these parts, a special driver should be used to reinstall crankshaft gear. An arbor press should be used for installation of camshaft gear.

1. Install thrust plate on camshaft. Press timing gear onto shaft until the specified clearance is obtained between camshaft front journal and thrust plate. See "Specifications."

2. Insert key in keyway on crankshaft and, with crankshaft gear properly aligned, drive gear onto shaft with a suitable driver such as illustrated in Fig. 57.

3. Install camshaft and gear assembly in cylinder block and make sure that timing mark on camshaft gear matches with that on crankshaft gear.

4. Tighten camshaft gear retainer bolt securely.

D. To Check Valve Timing—If, after engine is completely assembled, doubt exists regarding correct installation of timing gears, it is possible to check valve timing without removing timing gear cover to visually check timing gear marks. This may be done as follows:

1. Crank engine until No. 1 intake valve is closed and pointer on clutch housing opening is in line with U.D.C. mark on flywheel.

2. Carefully adjust No. 1 intake valve lash to .014".

3. Crank engine until lash is JUST tight with a .002" feeler between rocker arm and valve cap. If timing is correct, pointer at flywheel opening should then be 1/8" from steel ball towards U.D.C. mark on flywheel.

4. If foregoing instructions indicate that valve timing is not correct, timing gear cover must be removed and timing gear marks checked. See Fig. 58.

E. Timing Gear Cover Oil Seal and Gaskets—A special driver is essential if oil seal is to be accurately installed in timing gear cover. The replacement of this oil seal is recommended whenever timing gear is removed.

1. Before using driver in connection with oil seal installation, be sure that under side of timing gear cover is properly supported as illustrated in Fig. 59.

2. Always use new gaskets for timing gear cover and for timing gear plate. Use of old gaskets may result in oil leakage and may require premature disassembly to replace these relatively inexpensive items.



Fig. 59 Timing Gear Cover Oil Seal Installation

18. CAMSHAFT BEARINGS

Replacement of camshaft bearings can be successfully accomplished in the manner described only when engine is removed from chassis and disassembled.

To remove, replace and line ream camshaft bearings, a special set of tools is necessary. This set consists of a removing and replacing bar, four sleeves, a bracket which is attached to rear of cylinder block and a special camshaft bearing reamer. Complete set is illustrated in Fig. 60.

A. To Remove Camshaft Bearing—

1. Remove camshaft and gear as instructed in Paragraph 17.

2. Drive out expansion plug at rear of camshaft rear bearing.

3. Assemble tool bracket loosely to rear of cylinder block.

4. Start bearing puller bar through front bearing and install puller sleeve over bar for each bearing before bar has passed through that particular bearing. Then pass bar through hole in bracket. Now tighten bolts that hold bracket to crankcase and install thrust bearing and puller handle on bar.

5. Turn puller handle to remove all four bearings at one time. An extension handle is provided to aid in starting bearings that are extremely tight.

B. To Install Camshaft Bearings—

1. Locate and mark position of oil hole on front face of each bearing bore in crankcase. This should be done to make sure that oil holes in bearing will be in line with oil holes in crankcase after bearings have been installed.

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2. Insert new front camshaft bearing on puller bar and start bar through front bearing bore. Place puller sleeve with new bearing over bar before passing bar through each bearing bore in crankcase. Pass end of bar through puller bracket and install bearings and handle.

3. Line up oil holes in each bearing with oil hole location marks made as per Item 1 above.

4. Rotate handle to pull all four (4) bearings into place simultaneously.

5. Remove puller bar and bracket.

6. Stake each bearing into hole provided in bore for that purpose. This is done by inserting a $\frac{9}{32}$" diameter round-nosed drift through oil hole in crankshaft bearing support. Bearing can then be indented or staked into place by striking drift a few blows with a hammer. Note: This operation requires removal of crankshaft from engine.

C. To Ream Camshaft Bearing—Special camshaft bearing line reamer has all four (4) cutters mounted on bar so that camshaft bearings will be in perfect alignment after reaming operation.

1. Pass reamer through first, second and third bearings. Then start reamer cutters through all four bearings and turn reamer **slowly** until cutters have passed through bearings. While bearings are being reamed, a liberal supply of kerosene should be used.

2. Remove reamer by pulling it back through bearings, at the same time turning reamer slowly **in the same direction** as when reaming the bearings.

3. Blow all cuttings from bearing with compressed air and clean all surfaces and oil holes thoroughly. Install camshaft and check all bearing clearances with a feeler gauge. Proper clearances are noted in "Specifications."

4. Install new expansion plug in cylinder block at rear of camshaft rear bearing.

5. Reassemble engine.

19. OIL PUMP

Gear type oil pump is mounted in left hand side of engine and is accessible after oil pan is removed.

A. To Remove and Install Oil Pump—

1. Before oil pump can be successfully removed, crankcase main oil line should be disconnected at crankcase.

2. Loosen check-nut and setscrew which retains oil pump housing to bracket at upper end of housing.

3. When reinstalling oil pump, do not tighten setscrew excessively as this may cause distributor shaft to bind. Be sure lock nut is tight.

B. To Disassemble and Assemble Oil Pump—Special attention should be given to operation 4.

1. Remove oil pump screen retaining wire and remove screen.

2. Remove oil pump screen cover attaching bolt, then remove cover.

3. Remove remaining oil pump cover screws after which cover may be removed and gears and shafts withdrawn from pump housing.

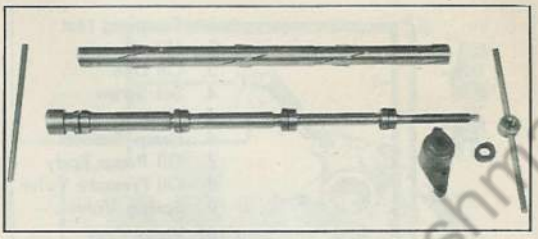

Fig. 60 Camshaft Bearing Tools

C. Oil Pump Inspection and Repair—Whenever oil pump is disassembled, all parts should be thoroughly cleaned and carefully checked against "Specifications." If parts are excessively worn, it is recommended that a new oil pump assembly be installed.

1. Test relief valve spring for pounds-pressure when compressed to length shown in "Specifications."

2. Examine oil pump gears very carefully for scores and nicks.

3. See that drive gear is tight on drive shaft.

4. Make sure that idler gear is free on idler shaft and yet not excessively worn or loose.

5. Measure clearance between housing and gear as shown in Fig. 63. Excessive clearance at this point can only be corrected by replacement of worn parts.

6. Place a straight-edge across face of housing and measure clearance between straight-edge and gear with a feeler as shown in Fig. 64. Excessive clearance at this point may be reduced by grinding housing with an abrasive on a perfectly flat surface.

D. Oil Intake—Oil enters pump through a covered basket-shaped fine mesh screen. Screen is covered by inverted cup which prevents surging of oil from exposing suction tube to air.

1. Screen should be removed and cleaned whenever oil pan is removed. Periodic cleaning operations are re-

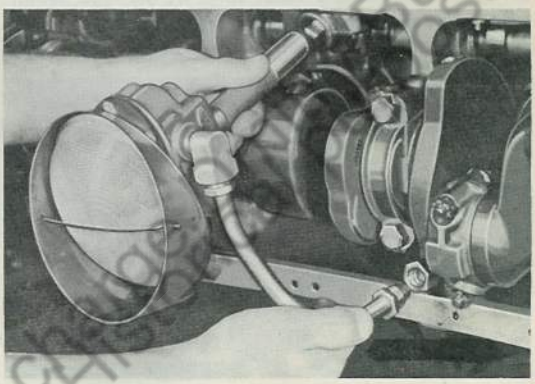

Fig. 61 Remove Oil Pump and Oil Line As An Assembly

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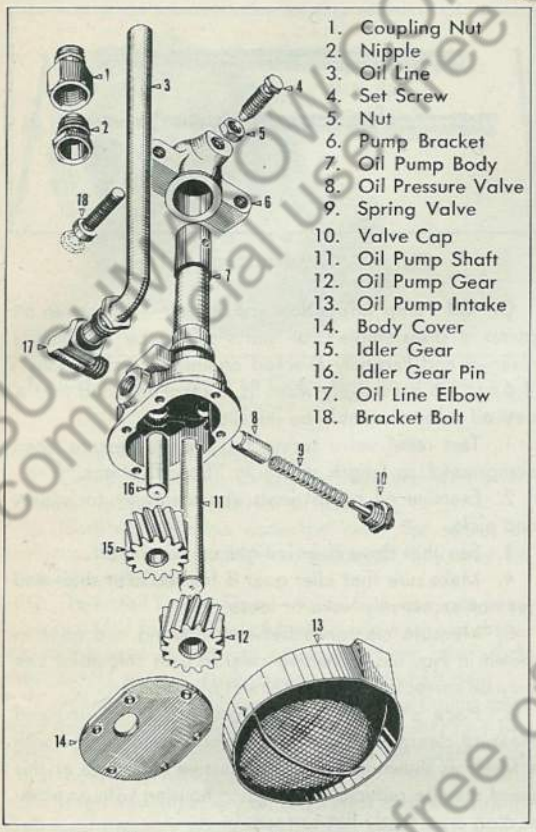

Fig. 62 Disassembled View of Oil Pump

quired. Neglect of this important service may result in loss of oil pressure and insufficient lubrication throughout the engine.

2. Screen may be readily removed by detaching retaining wire from cover and withdrawing screen.

E. Pressure Relief Valve—Oil pump is fitted with a non-adjustable pressure relief valve of the type shown in Fig. 62. Relief valve consists of a plunger, a spring and a cap. When oil pressure is raised above operating requirements, pressure overcomes spring tension and unseats plunger which allows oil to be bypassed through bypass hole.

F. Checking Oil Pressure—When oil pressure drops below normal, the following inspection should be made before oil pan is removed or pump is disassembled.

1. Check the oil level and condition of the oil.
2. Check accuracy of oil gauge. Temporarily install a gauge known to be accurate.
3. Inspect external oil lines for leaks.
4. Check condition of the bearings.
5. Disassemble, inspect and test oil pump and relief valve. Use latest type relief valve which does not have small by-pass hole.

G. Crankcase Main Oil Line—A short angular tube is used for oil delivery from pump to crankcase. Removal of crankcase oil line can be accomplished without damage only as follows:

1. Loosen oil pump housing retainer screws.
2. Disconnect oil line at crankcase.
3. Remove oil pump and oil line asan assembly before disconnecting oil line at pump.

H. Oil Pan—Oil pan is provided with baffle plates to prevent surging of oil. Periodic removal and cleaning of oil pan is essential. This service should be performed at least every 10,000 miles.

1. To remove oil pan, drain oil, replace draing plug, then remove all oil pan cap screws.

2. It is recommended that new gaskets be used when oil pan is reinstalled. Do not overlook oil pan gaskets which are retained in front and rear main bearing cap as these gaskets should also be replaced. Oil pan gaskets must be installed exactly according to the following procedure if oil leaks are to be avoided.

(a) Don't place gaskets on oil pan during installation.
(b) Use a small amount of shellac to hold gaskets securely on underside of block.
(c) Install **side** gaskets first.
(d) Then install **end** pieces of cork in grooves of bearing caps.
(e) Now place oil pan in position and insert a few screws to hold pan while remainder of screws are being installed and tightened.

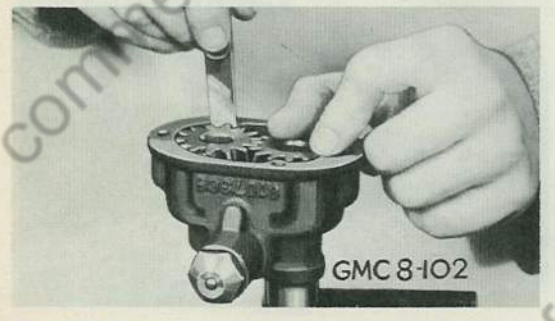

Fig. 63 Checking Oil Pump Gear to Housing Clearance



Fig. 64 Checking Oil Pump Gear to Cover Clearance

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20. OIL FILTER

Replaceable element type filter is used as illustrated in Fig. 66. Part of the oil passing through valve rocker shaft oil line is directed through oil filter where foreign elements in oil are absorbed. Oil filtered in this manner is then returned directly to engine oil pan through fuel pump mounting fitting.

A. Oil Filter Maintenance—The best insurance for continuous function of the oil filter is periodic inspection and frequent replacement of filtering element. Oil filter element changing periods are directly related to oil changing periods, type and quality of oil used, severity of and type of engine operation. It is, therefore, impossible to recommend a definite mileage period that will meet all types of service.

In view of the foregoing, it is recommended that frequent inspection be made of the oil and of the filter element to determine the most advisable intervals between engine oil and filter element changes.

While oil filter will adequately remove dust and dirt entering oil, the element should be renewed before it becomes clogged with these substances, regardless of mileage. Vehicles operating in dusty areas require renewals more often than those which do not encounter such conditions.

B. Replacement of Oil Filter Element—

1. Unscrew nut which retains cover and remove cover, gasket and spring.
2. Drain oil filter housing to remove solid matter and water which may have settled in sump in bottom of housing.
3. Use only genuine element for replacement purposes. See "Specifications."
4. Before replacing cover and gasket, carefully inspect gasket and see that it is in good condition.

21. MANIFOLDS

Intake and exhaust manifolds are each one-piece castings and are mounted on cylinder head with studs, clamps and nuts which provide uniform attachment.

A. Adjustments—All bolts and nuts used in connection with intake and exhaust manifold mounting to cylinder head must be tightened evenly to prevent breakage and to permit uniform expansion during engine operations. The most necessary adjustments in connection with maintaining proper manifold temperatures consist of setting the manifold heat control valve for seasonal operation. The manifold heat control illustrated in Fig. 67 consists of a lever and butterfly valve located in exhaust manifold. This butterfly valve directs flow of hot exhaust gases through heat chamber of intake manifold and thereby aids in fuel vaporization for maximum economy. Proper position of heat control valve for various operating conditions are as follows:

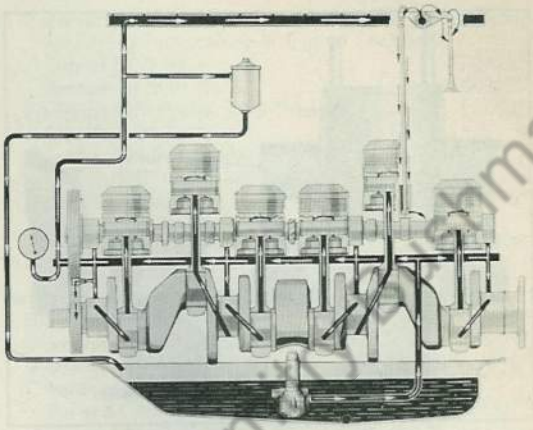

Fig. 65 Engine Oiling Diagram

1. Normal operation in cold weather, valve should be open—in "On" position.
2. During cold weather with heavy loads, at high speeds or on rough terrain, the valve should be in "Medium" position. This position should also be used during mild weather operation with small loads and low speeds.
3. For warm weather, or during mild weather with heavy loads at high speeds, etc., valve should be closed—in "Off" position.
4. To adjust manifold heat control valve, refer to Fig. 67 and proceed as follows:

(a) Loosen lock nut (4).
(b) Loosen screw (3).
(c) Move lever (5) to desired position.
(d) Retighten screw (3) into recess in manifold and then tighten lock nut.

1. Oil Filter Cover Nut
2. Cover Nut Gasket
3. Filter Cover
4. Filter Cover Gasket
5. Oil Filter Spring
6. Oil Filter Element
7. Inlet Fitting
8. Oil Filter Body
9. Drain Plug
10. Outlet Fitting

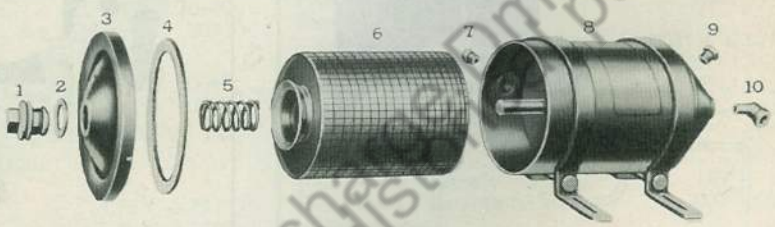

Fig. 66 Oil Filter Parts

ENGINE

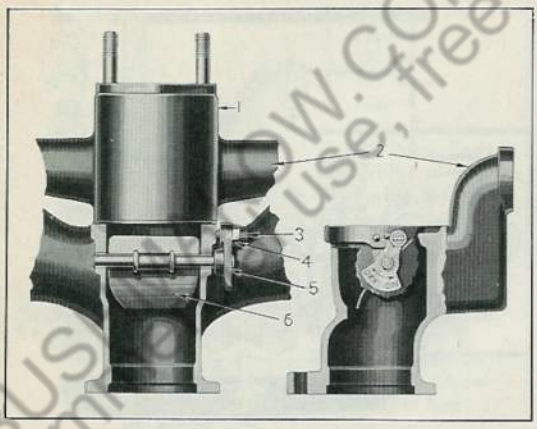

Fig. 67 Manifold Heat Control

1. Intake Manitold
2. Exhaust Manifold
3. Slot Headed Screw
4. Lock Nut
5. Lever
6. Valve

22. FLYWHEEL AND RING GEAR

Flywheel, on which a steel ring gear is shrunk, is balanced statically and dynamically before being assembled to crankshaft and may, therefore, be replaced as a separate unit.

1. When flywheel is being replaced by new part compare timing marks on new flywheel with those on removed part.

2. Tighten flywheel bolts securely, using shake-proof lockwashers under each bolt. It is important that flywheel bolts be inspected, and tightened if necessary, whenever clutch is removed.

3. Mount dial indicator in suitable position and check flywheel for run-out. See "Specifications." Rear main bearing cap must be removed if necessary to replace special pilot studs on inner side of flywheel.

23. ENGINE MOUNTING

Engine is mounted at three points. The single mounting at front is through timing gear cover plate, oil shield and insulator to frame cross member, as illustrated in Fig. 68. Two mounting insulators are used at rear of engine, one on each side, as illustrated in Fig. 69.

A. Engine Mounting Inspection—Mounting bracket bolts at rear of engine and insulator bolts at all three mounting points should be inspected at regular intervals for any evidence of looseness. The insulator bolt should be tightened to hold engine firmly in place and to prevent excessive looseness and movement of engine.

B. Engine Mounting Insulator Replacement—Replacement of insulator can readily be accomplished by removing nuts or bolts from insulator assemblies and raising engine slightly to provide sufficient clearance for insulator removal.

24. ACCESSORY DRIVE

A pulley is used in connection with crankshaft damper at front of engine to provide a means of driving water pump fan and generator. This pulley is balanced as part of the crankshaft damper assembly, therefore, whenever necessary to service the pulley or the crankshaft damper, the complete assembly consisting of both parts should be used. The friction surfaces of the pulley should be examined regularly in order to locate possible roughness which might reduce the normal life of the water pump and generator belt.

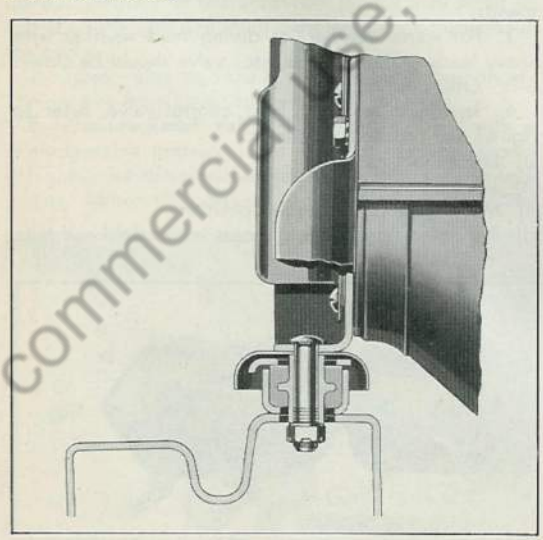

Fig. 68 Engine Front Mounting

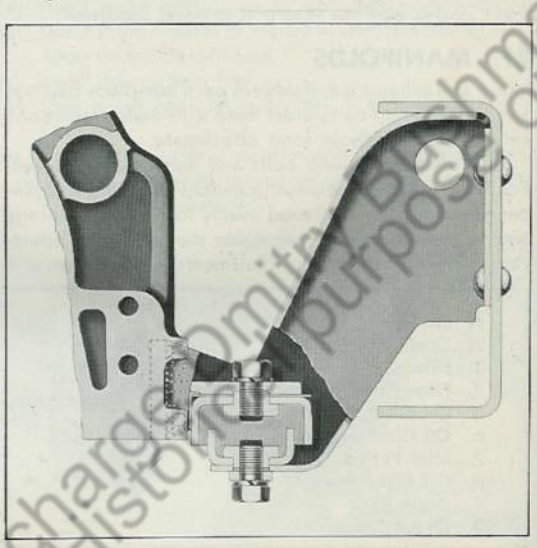

Fig. 69 Engine Rear Mounting

ENGINE

25. SPECIFICATIONS

Type	Valve-In-Head
Number of Cylinders	6
Bore	$3\frac{5}{32}$"
Stroke	4"
Piston Displacement—Cu. In.	269.52
Compression Ratio	6.75 to 1
Horsepower—SAE	34.35
Firing Order	1-5-3-6-2-4
Cylinder Block	
Bore Size	3.780"-3.782"
Maximum Oversize Permissible	.060"
Crankshaft	
Number of Bearings	Four
Bearing Journal Diameter (Standard):	
Front	2.6845"–2.6835"
Front—Intermediate	2.7155"–2.7145"
Rear—Intermediate	2.7465"–2.7455"
Rear	2.7775"–2.7765"
Conn. Rod Journal	2.311"–2.312"
Bearing Jornal Diameter (.010" Undersize)	
Front	2.6745"–2.6735"
Front—Intermediate	2.7055"–2.7045"
Rear—Intermediate	2.7365"–2.7355"
Rear	2.7675"–2.7665"
Connecting Rod Journal	2.302"–2.301"
Bearing Journal Diameter (.020" Undersize)	
Front	2.6645"–2.6635"
Front—Intermediate	2.6955"–2.6945"
Rear—Intermediate	2.7265"–2.7255"
Rear	2.7575"–2.7565"
Connecting Rod Journal	2.292"–2.291"
Bearing Journal Diameter (.030" Undersize)	
Front	2.6545"–2.6535"
Front—Intermediate	2.6855"–2.6845"
Rear—Intermediate	2.7165"–2.7155"
Rear	2.7475"–2.7465"
Connecting Rod Journal	2.282"–2.281"
Bearing Journal Fillet Radius:	
Main Journals	$\frac{3}{32}$"–1/8"
Connecting Rod Journals	$\frac{2}{32}$"–$\frac{7}{64}$"
Thrust Taken	Rear Intermediate
End Thrust	.003"–.008"
Run-Out at Intermediate Journal	.002"
Crankshaft Bearing	
Quantity	4
Material	Steel-Backed Babbitt
Undersize Bearing Available	.002"–.010"–.020"–.030"
Bearing Clearance	.0008"–.0033"
Torque Wrench Pull (Foot Lbs.)	70–80
Size Feeler Shim for Checking Brg. Clearance	.003"
Flywheel and Housing	
Flywheel Run Out	.004"
Concentricity of Housing Bore	.010"
Piston	
Diameter of Piston at Ring Lands: (Refer to Engine Section)	
Top Land (A)	3.757"–3.753"
2nd Land (B)	3.761"–3.757"
3rd Land (C)	3.764"–3.760"
4th Land (D)	3.743"–3.737"
Clearance Between Piston and Cylinder Block. Refer to Fitting Instructions in Engine Section.	
Top of Skirt (E)	.00425"
Bottom of Skirt (F)	.00325"
Fit Piston with Feeler Shim Thickness	.003"
Lbs. Pull on Scale	4
Oversize Pistons Available	.005"–.010"–.020"–.030"–.040"–.050"–.060"–.065 rough ground
Piston Pin Hole Ream	.9898"–.9896"
Ring Groove Width	
Compression	.1265"–.1255"
Oil	.1895"–.1880"
Piston Pin	
Diameter—Grind	.9900"–.9898"
Diameter—Conn. Rod Bushing	.9901"–.9905"
Diameter—Hole in Piston	.9898"–.9896"
Clearance Between:	
Pin and Conn. Rod Bushing	.0001"–.0007"
Pin and Piston Hole	Selected Hand Press
Oversize Pins Available	.0025"–.005"–.010"
Compression Ring	
Quantity	3
Type—Upper	Inside Bevel—Butt Joint
Type—Center and Lower	Taper Face—Butt Joint
Width	.1240"–.1230"
Gap	.008"–.015"
Ring and Groove Clearance	.0015"–.0025"
Oil Ring	
Quantity	1
Type	Butt Joint—Heavy Duty Type
Width	.1865"–.1860"
Gap	.008"–.015"
Ring and Groove Clearance	.002"–.0025"
Connecting Rod	
Upper Bore	1.0455"–1.0465"
Lower Bore	2.4563"–2.4568"
Connecting Rod Bearing—Upper	
Type	Two Bronze Bushings
Diamond Bore	.9901"–.9905"
Bushing to Piston Pin Clearance	.0001"–.0007"
Connecting Rod Bearing—Lower	
Material	Copper Lead
Bearing Clearance	.0015"–.0036"
Size Feeler Shim for Checking Brg. Clear.	.003"
Size Mandrel for Bearing Spread Ground and Polished Bar Dia.	$2\frac{9}{16}$"
Undersize Bearings Available	.002"–.010"–.020"–.030"
Torque Wrench Pull (Foot Lbs.)	40–50
Camshaft	
Number of Bearings	4
Bearing Journal Diameter	
Front	2.0297"–2.0287"
Front—Intermediate	1.9672"–1.9662"
Rear—Intermediate	1.9047"–1.9037"
Rear	1.8422"–1.8412"
Run-Out at Intermediate Bearing	.0015"
Thrust Taken	Front
Thrust Plate Thickness	.189"–.184"
Thrust Plate Clearance to Shaft	.003"–.006"
Camshaft Bearing	
Quantity	4
Material	Steel-Backed Babbitt

ENGINE

Diameter—Ream	
Front	2.0317"–2.0307"
Front—Intermediate	1.9692"–1.9682"
Rear—Intermediate	1.9067"–1.9057"
Rear	1.8442"–1.8432"
Bearing Clearance	.001"–.003"
Cylinder Head	
Torque Wrench Pull (Ft. Lbs.)	60–70
Valve Seat Width—Exhaust	.062"–.093"
Valve Seat Width—Intake	.035"–.060"
Intake Valve	
Lash—Hot	.012"
Seat Angle	30°
Diameter Head	1–41/64"
Length—Overall	4.809"–4.779"
Stem Diameter	.3412"–.3407"
Guide Ream	.3437"–.3427"
Stem to Guide Clearance	.0015"–.003"
Intake Opens	4° BUDC
Intake Closes	56° ALDC
Intake Period	240°
Exhaust Valve	
Lash—Hot	.012"
Seat Angle	30°
Diameter Head	1.425"–1.430"
Length—Overall	4.890"–4.880"
Stem Diameter	.3407"–.3397"
Guide Ream	.3437"–.3427"
Stem to Guide Clearance	.002"–.004"
Exhaust Opens	55° 30′ BLDC
Exhaust Closes	27° 30′ AUDC
Exhaust Period	263°
Diameter of Counterbore for .010" Oversize Exhaust Valve Seat Inserts	1.572"–1.573"
Valve Lifter	
Diameter	.990"–.989"
Valve Spring	
Free Length	2 1/8"
Lbs. Pressure @ 1.821"	54–62
Lbs. Pressure @ 1.505"	124–140
Valve Rocker	
Rocker Shaft Diameter	.7920"–.7910"
Rocker Arm—Ream	.7935"–.7925"
Timing Gears	
Backlash	.003"–.004"
Crankshaft Gear—Metal	27 Teeth
Camshaft Gear—Fibre	54 Teeth
Oil Pump	
Lbs. Pressure @ 1000 R.P.M.	35–40
Gear Backlash	.003"–.006"
Gear Width	1.249"–1.247"
Drive Gear Bore	.5395"–.5385"
Idler Gear Bore	.5425"–.5415"
Housing Bore	.543"–.541"
Diameter:	
Drive Shaft	.5405"–.5400"
Idler Shaft	.5405"–.5400"
Clearance Between:	
Gear to Housing (Radial)	.001"–.003"
Gear to Housing Lower Edge	.0015"–.0045"
Relief Valve to Housing	.003"–.006"
Pressure Relief Spring	
Free Length	2-45/64"
Lbs. Pressure @ 1 11/16"	13 1/2–16 1/2
Oil Filter	
Make	AC
Element Number	1504256

26. TOOL EQUIPMENT

In addition to common hand tools ordinarily used in connection with engine service, the following special tools (or their equivalent) should be made available to perform service operations as indicated below.

Tool	Number	Description	May be obtained from
(J)	267	Valve Guide Remover and Replacer	Kent-Moore Organization, Detroit, Mich.
(J)	971	Camshaft Gear Press Plate	Kent-Moore Organization, Detroit, Mich.
(J)	995	Timing Cover Oil Seal Driver	Kent-Moore Organization, Detroit, Mich.
(J)	1287	Crankshaft Damper Puller	Kent-Moore Organization, Detroit, Mich.
(J)	1656	Cylinder Head Holding Fixture and Valve Spring Compressor	Kent-Moore Organization, Detroit, Mich.
(J)	1725	Crankshaft Gear Puller	Kent-Moore Organization, Detroit, Mich.
(J)	1726	Crankshaft Gear Replacer	Kent-Moore Organization, Detroit, Mich.
(J)	1800	Camshaft Bearing Replacement Set	Kent-Moore Organization, Detroit, Mich.
(KMO)	187-1A	Torque Wrench Adapter	Kent-Moore Organization, Detroit, Mich.
(MT)	1000	Torque Wrench	Sturdevant Tool Co., Addison, Ill.
(MT)	1001	Valve Spring Tester	Sturdevant Tool Co., Addison, Ill.
(H)	JU-41	Valve Seat Grinder and Stones with Dial Gauge	Hall Manufacturing Co., Toledo, Ohio
(H)	217	Ridge Reamer	Hall Manufacturing Co., Toledo, Ohio
(H)	Model H	Cylinder Hone	Hall Manufacturing Co., Toledo, Ohio
(A)	Model C-2	Cylinder Boring Bar	Automotive Maintenance Co. 2100 Commonwealth, Chicago, Ill.
(S)	Model 620	Valve Refacing Machine	Sioux Tool Co., Sioux City, Iowa
(G)	RC-1	Piston Ring Compressor	G and G Sales Co., 7118 W. Chicago, Detroit, Mich.
(G)	GT-2	Ring Groove Cleaner	G and G Sales Co., 7118 W. Chicago, Detroit, Mich.
(J)	1602	Piston Pin Bushing Replacement Kit	Kent-Moore Organization, Detroit, Mich.

Group O2 — Clutch

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To Install Clutch	5
REPAIR	
To Disassemble Clutch	6
Inspection and Repair (Clutch Disassembled)	7
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Clutch Disc and Facings	9
Clutch Cover, Pressure Plate and Springs	10
Clutch Release Mechanism	11
Clutch Pilot Bearing	12
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GENERAL

1. DESCRIPTION AND OPERATION

The basic clutch design consists of two separate assemblies—the clutch Disc Assembly and the Clutch Cover and Pressure Plate Assembly. The driven disc transfers engine power from flywheel to clutch shaft of transmission. The clutch cover and pressure plate provide attachment or release of driven disc to flywheel.

The clutch provides a means of controlling movement of vehicle by engaging or disengaging engine from transmission and its operation is as follows:

A. Clutch is always in "engaged" position unless purposely "disengaged" by driver as when shifting gears, and disengagement is obtained only by depressing clutch pedal.

B. Action of clutch is illustrated in Fig. 1 which shows relative positions of parts when clutch is "engaged" and "disengaged". Note that when engaged, clutch disc is contacting face of flywheel, being firmly held in this position by clutch pressure plate—which, in turn, is forced toward flywheel by pressure exerted upon it by the diaphragm spring. With clutch in this engaged position, engine and transmission are connected.

C. Pressing down on clutch pedal disengages clutch, thus severing connection between engine and transmission. Refer to Fig. 1 again and note that in "disengaged" position, clutch disc does not touch flywheel. Disengagement occurs when release bearing is forced against inner (small) fingers of diaphragm spring; this spring pivots on inner pivot ring while its outer (large) ends are connected to clutch pressure plate. This diaphragmatic action causes pressure plate and clutch disc to move away from flywheel, thus accomplishing clutch disengagement. When clutch pedal is released, release bearing no longer contacts fingers of diaphragm spring which now pivots on outer pivot ring and causes pressure to bear on outer diameter of pressure plate.

D. To better understand action of the diaphragm spring, refer to Fig. 3. Pressing on clutch pedal causes diaphragm spring to pivot on inner pivot ring, pulling clutch disc and pressure plate away from flywheel, disengaging clutch. Releasing clutch pedal causes diaphragm spring, by its own action, to pivot on outer pivot ring, thus pressing on outer diameter of pressure plate and forcing clutch disc into contact with flywheel, engaging clutch.

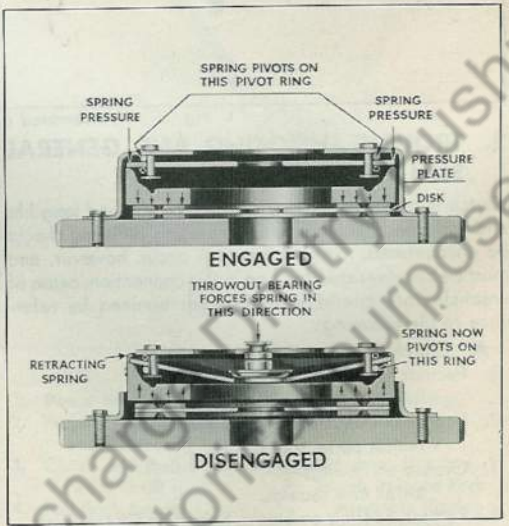
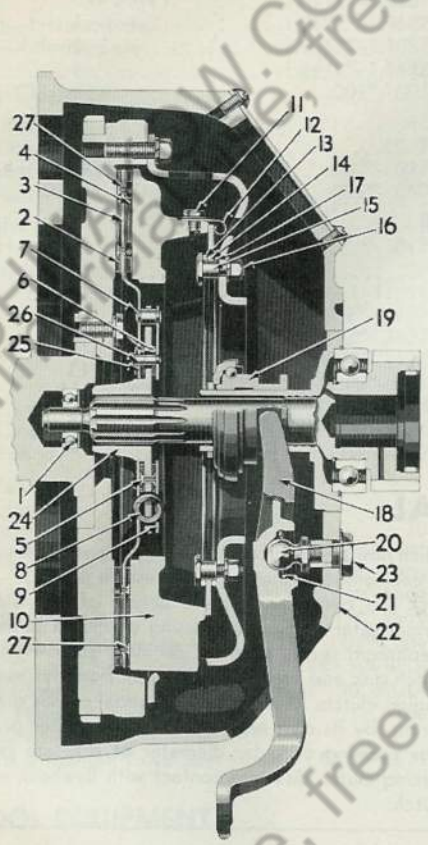
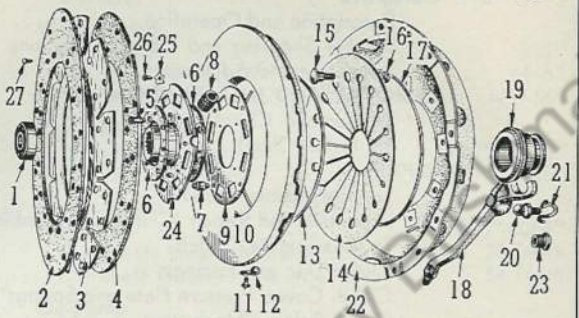


Fig. 1 Engaged and Disengaged Positions

CLUTCH





1. Pilot Bearing
2. Facing
3. Driven Plate
4. Facing
5. Friction Washer Rivet
6. Friction Washer
7. Stop Pin
8. Torsion Spring
9. Drive Washer
10. Pressure Plate
11. Retracting Spring Bolt
12. Pressure Plate Retracting Spring
13. Inner Pivot Ring
14. Diaphragm Spring
15. Retaining Bolt
16. Retaining Bolt Nut
17. Outer Pivot Ring
18. Release Fork
19. Release Brg. and Support
20. Release Fork Ball Stud
21. Ball Stud Retaining Spring
22. Clutch Cover
23. Ball Stud Support
24. Driven Member Hub
25. Friction Spring
26. Friction Spring Stud
27. Facing Rivet

Fig. 2 Disassembled and Sectional View of Clutch

2. TROUBLE SHOOTING AND GENERAL SOLUTIONS

Clutch is designed for maximum efficiency and long life and with reasonable care, no operating difficulty should be encountered. Natural wear will occur, however, and must be compensated for, and in this connection, cause of unsatisfactory operation may be determined by reference to the following:

A. Clutch Slippage—

1. Facings Worn—
   Replace facings.
2. Improper Adjustment—No Free Travel—
   Adjust pedal free travel.
3. Grease on Facings—
   Install new facings.
4. Release Bearing on Sleeve Seized on Clutch Shaft—
   Replace and lubricate.
5. Clutch Disc Hub Binding on Splines—
   Replace and Lubricate.
6. Insufficient Spring Tension—
   Replace diaphragm spring.
7. Incorrect Type of Facings—
   Install genuine facings.
8. Pressure Plate Binding in Clutch Cover—
   Check for clearance between driving lugs and cover.

B. Clutch Grabbing or Chattering—

1. Clutch Not Being Operated Properly—
   Road test with driver.
2. Facings Oil or Grease Soaked—
   Replace facings.
3. Worn Splines on Clutch Shaft or in Hub—
   Inspect and replace parts.
4. Facings Loose on Driven Disc—
   Replace facings.

CLUTCH

5. Loose Engine Mountings—
   Inspect and tighten.
6. Any Excessive Looseness Throughout Drive Line—
   (a) Inspect transmission clutch shaft.
   (b) Inspect propeller shaft universal joints and splines.
   (c) Inspect differential gear splines.
   (d) Inspect axle shaft mounting and splines.
7. Pressure Plate or Flywheel Scored or Rough—
   Replace defective parts.
8. Pressure Plate Binding in Cover—
   Measure clearance between pressure plate lugs and cover.
9. Loose Transmission Strut Rod—
   Tighten—see instruction in Group 07.

C. Rattling—

1. Weak Retracting Springs—
   Replace springs.
2. Excessive Clearance at Driving Lugs—
   Replace cover or pressure plate—or both.
3. Release Fork Loose on Ball Stud—
   Replace ball stud.

D. Noise—In addition to trouble shooting information given above, the following instructions outline the method of locating and overcoming noises, which sometimes are connected with clutch operation.

1. A rattling noise when clutch is released is usually caused by insufficient tension of retracting springs against diaphragm spring. There should be no clearance between loop of retracting spring and diaphragm spring. The remedy for noises resulting from looseness at this point consists of replacement of the retracting springs. This can readily be accomplished by removing cover at bottom of clutch housing and replacing springs in the manner illustrated in Fig. 11.

2. If replacement of retracting springs does not correct the rattling noise, clearance between driving lugs on pressure plate and slots in clutch cover should be measured. If this clearance exceeds .006", pressure plate, or cover, or both, should be replaced if necessary to obtain proper clearance.

3. Rattling noise in clutch release mechanism may be caused by—

(a) Clutch release fork ball stud loose in fork or support.

(b) Clutch pedal loose on shaft—or pedal pull back spring disconnected.

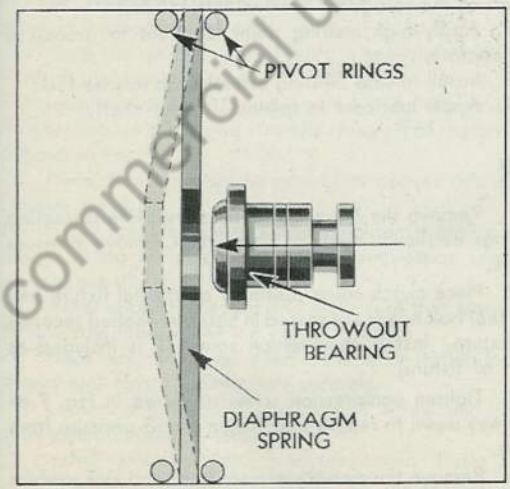


Fig. 3 Action of Diaphragm Spring

3. INSPECTION AND ADJUSTMENT

The following preliminary inspection should be made to determine the general operating condition of the clutch.

1. Test action of clutch pedal by hand. There should be 2½" free travel of pedal before clutch starts to disengage.

2. See that clutch pedal pull back spring is properly installed.

3. Check action of clutch during disengagement and engagement. It should be smooth without indication of binding or excessive looseness.

The simplicity and efficiency of this clutch design is such that only one adjustment is necessary. This adjustment is for the amount of **free** clutch pedal travel, being the distance clutch pedal moves before causing release bearing to contact fingers of diaphragm spring. As

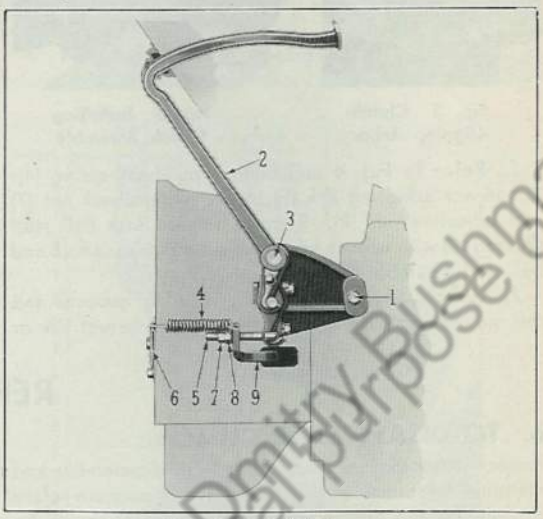


Fig. 4 Pedal Linkage

1. Pedal Shaft Bracket
2. Pedal Assembly(Pedal and Extension)
3. Clutch and Brake Pedal Shaft
4. Pull Back Spring
5. Clutch Pedal Adjusting Link
6. Pull Back Spring Bracket
7. Check Nut
8. Adjusting Link Nut
9. Clutch Release Fork Assembly (Spring and Ball Stud)

CLUTCH

clutch facings wear, fingers of diaphragm spring move toward release bearing, thus reducing clearance at this point and at the same time lessening clutch pedal travel. Correct adjustment of clutch pedal may be made by referring to Fig. 4 and following these instructions:

1. Loosen check nut (7) on adjusting link (5).
2. Turn adjusting nut (8) in or out as may be required to obtain 2½" free travel of foot pedal before clutch starts to release. Free pedal travel should be checked with finger on pedal and not with foot as this adjustment is very sensitive.
3. With 2½" free pedal travel definitely established, turn up check nut (7) firmly against adjusting nut (8) to prevent adjustment from coming loose.

REMOVAL AND INSTALLATION

4. TO REMOVE CLUTCH

Clutch cannot be removed from vehicle without first removing the transmission, and instructions for removal of that unit are contained in Transmission group of this book. With transmission out of vehicle, clutch is removed as follows:



Fig. 5 Clutch Aligning Arbor

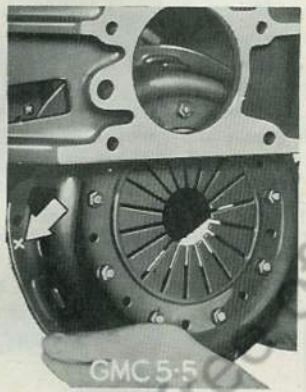


Fig. 6 Installing Clutch Assembly

1. Refer to Fig. 4 and unhook pull-back spring (4); disconnect adjusting link (5) by removing check nut (7) and adjusting nut (8). Remove release fork ball stud (20, Fig. 2) with wrench which will permit release fork and ball stud assembly to be taken out.
2. Clutch should be supported during removal and this may be done by using clutch shaft of correct size or temporarily installing special aligning arbor tool as shown in Fig. 5.
3. Loosen clutch cover to flywheel mounting bolts one turn at a time until diaphragm spring pressure is fully released, otherwise clutch cover might be distorted. Completely remove all mounting bolts after which clutch assembly may be lowered and removed from vehicle.

5. TO INSTALL CLUTCH

To properly center clutch disc during installation of clutch cover assembly, the use of a special pilot or aligning arbor tool as shown in Fig. 5 is recommended.

1. Hand crank engine until "X" mark on flywheel moves around and is visible from underside of clutch housing.
2. Install clutch disc, cover and pressure plate assembly. Aligning arbor tool, as illustrated in Fig. 5, should be used.
3. Rotate clutch cover until "X" mark on cover (shown in Fig. 6) registers with "X" mark on flywheel.
4. Install bolts for attachment of cover to flywheel. Each bolt should be tightened gradually, a turn at a time to prevent distortion of cover as spring pressure is being taken up.
5. After cover is securely attached to flywheel, remove clutch aligning arbor.
6. Install clutch release fork and linkage in the reverse order of the foregoing removal instructions.
7. Apply high melting point lubricant to groove in release fork.
8. Install release bearing assembly on release fork.
9. Apply lubricant to splines of clutch shaft.

REPAIR

6. TO DISASSEMBLE CLUTCH

Inspect clutch before proceeding with disassembly and measure clearance between the three pressure plate driving lugs and slots in cover. This clearance should be between .002" and .006". There should be sufficient clearance to permit pressure plate to move freely in cover. If clearance is excessive, noisy clutch operation usually results.

Instructions for disassembly and assembly of this unit are based around the use of a special fixture, the application of which is illustrated throughout this group. The availability of this fixture is noted in Paragraph 15.

1. Remove the three clutch pressure plate retracting springs as shown in Fig. 11 and then remove pressure plate.
2. Place clutch cover assembly on special fixture and see that bolt heads are seated in hexagon-shaped recesses in fixture. Install compression screw (1 is included as part of fixture).
3. Tighten compression screw as shown in Fig. 7 all the way down to relieve diaphragm spring pressure from bolts.
4. Remove the nine (9) retainer bolts and lock washers which attach cover to spring. Tap lightly on cover a few

CLUTCH

times with a soft hammer and lift cover from fixture.

5. Remove upper pivot ring.

6. Loosen and remove compression screw after which diaphragm spring pivot ring and bolts may be taken out of fixture for inspection.

7. INSPECTION AND REPAIR—CLUTCH DISASSEMBLED

The first step in connection with clutch inspection is to wash each part with suitable cleaning fluid. **Caution:** Clutch release bearing is permanently packed with lubricant and should not be soaked in cleaning fluid as this will dissolve the lubricant and render bearing unfit for further use.

1. Examine diaphragm spring and pivot rings for any indication of distortion or fractures.

2. Inspect pressure plate for any indication of scores or scuffing of contact surfaces. If pressure plate is excessively worn, it may be salvaged by grinding to refinish the surface and installing shims to compensate for the metal removed. The following applies.

(a) Pressure plate may be reground not to exceed .045" total reduction in thickness of plate. If it is necessary to remove more than this amount in order to "true up" the pressure plate, a new part should be installed.

(b) Shims of a thickness equal to the amount of metal removed from the pressure plate must be installed between cover and pivot ring as shown in Fig. 8. Operation of clutch mechanism will not be affected by addition of shims. Addition of more shims than required to equal amount of metal removed from pressure plate will not increase spring pressure and is not recommended.

(c) Shims are available in thicknesses of .015". Therefore, pressure plate must be reground in steps of .015" and one shim installed for each .015" removed.

8. TO REASSEMBLE CLUTCH

Follow instructions in the order given:

1. Place the nine (9) special bolts in hexagon recesses in clutch assembling fixture.

2. Install lower pivot ring around bolts and make sure that lugs on pivot ring straddle three (3) of the bolts as shown in Fig. 9.

3. Place diaphragm spring over bolts, convex side up, as shown in Fig. 10.

4. Install compression screw and tighten it until diaphragm spring is flattened out and compression screw rests against its stop.

5. Install upper pivot ring and make sure that lugs on ring straddle three (3) of the bolts.

6. Place clutch cover over bolts and install lock washers and nuts. Tighten nuts securely.

7. Loosen and remove compression screw and lift clutch assembly out of fixture.

8. Install pressure plate in clutch cover. Refer to Fig. 11 and note relative position of "O" marks on drive lug of pressure plate and on flange of cover. Pressure

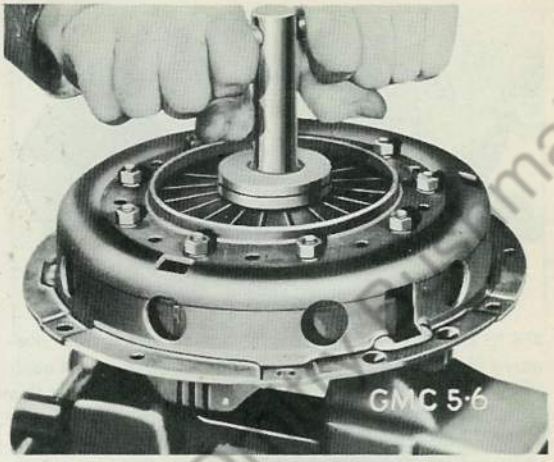


Fig. 7 Compressing Diaphragm Spring

plate must be assembled with these "O" marks in the correct relation to each other as illustrated. This is necessary in order to maintain clutch balance.

9. Install the three (3) retracting springs on pressure plate as shown in Fig. 11. There must be no clearance between retracting spring and diaphragm spring.

9. CLUTCH DISC AND FACINGS

This unit is made up of two composition facings attached to a driving plate, which, in turn, is mounted on a spring-loaded hub

A. To Remove Clutch Facings—A suitable riveting fixture, such as that shown in Fig. 12, is required if facings

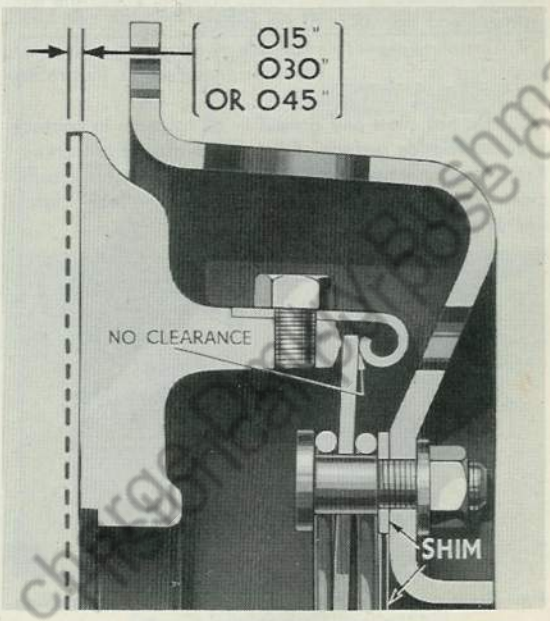


Fig. 8 Pressure Plate Shims (See Instructions)

CLUTCH



Fig. 9 Lower Pivot Ring Lugs Must Straddle Bolts as Shown

are to be replaced without damage to clutch disc. Remove facings from disc by drilling through center of each rivet. Do not attempt to punch rivets out of disc, as this may cause driven plate to become sprung or distorted. Rivets should be drilled from head or smooth side as drilling from the opposite side may cause rivets to spin.

B. Inspection—

1. Facings should be examined for possible existence of grease or other foreign materials which might have caused unsatisfactory clutch operation. If facings are contaminated with grease or lubricant, the source should be located and the condition eliminated.

2. Inspect torsion springs in clutch disc hub and replace any defective parts.

3. Examine splines of clutch hub and see that hub moves freely on splines of transmission clutch shaft. If splines are worn, discard hub and install a new part.

C. To Install Clutch Facing—When installing new facings, the use of genuine parts only is recommended, as variations in facing thickness and material affect the adjustment and operation of the clutch.

1. Install rivets with a suitable riveting fixture such as illustrated in Fig. 12. Rivet arrangement is illustrated in Fig. 13.

2. **Do not allow any grease or oil to come in contact with the friction surface of the clutch disc.** Even greasy hands touching the friction surfaces will transfer a sufficient amount of grease to seriously affect clutch operation.

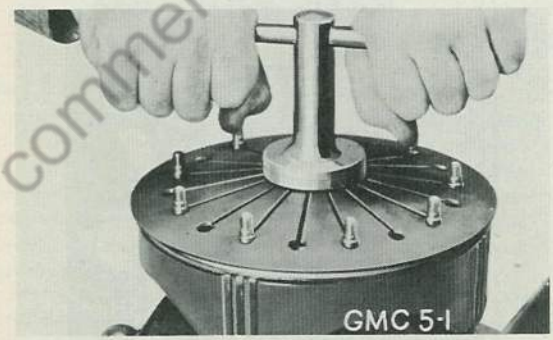


Fig. 10 Compress Diaphragm Spring Before Installing Upper Pivot Ring and Cover

10. CLUTCH COVER, PRESSURE PLATE AND SPRING

This unit is designed around a single dish-shaped diaphragm spring. The action of this spring, during clutch disengagement, may be compared to the flexing action of the bottom of an ordinary oil can. This diaphragm type spring exerts great force in only one direction; and, when it is buckled through center in the opposite direction, it exerts a relatively light pressure. When clutch pedal is depressed, the release fork forces the release bearings against fingers of the diaphragm spring which overcomes the spring pressure and disengages clutch. When letting up on clutch pedal, diaphragm spring returns to normal position and clutch is reengaged. Refer to Paragraphs 4 and 5 for removal and installation of this assembly.

11. CLUTCH RELEASE MECHANISM

The clutch release mechanism consists of clutch pedal, release fork and release bearing. Clutch pedal is mounted on shaft and is connected to release fork through linkage as shown in Fig. 4. Release fork is ball-stud mounted in clutch housing. Inner end of fork engages groove in release sleeve for actuation of release bearing.

A. Clutch Pedal—Clutch pedal may be removed from pedal shaft after small hairpin lock is withdrawn from shaft. Bushing in pedal is pressed into position and then burnished to obtain correct diameter as noted in "Specification," Paragraph 14.

B. Clutch Release Fork—Release fork may be removed and reinstalled without removing transmission or clutch housing as follows:

1. Remove clutch housing underpan.

2. Disconnect clutch release fork from pedal adjusting link.

3. Loosen and remove release fork ball stud from inner side of clutch housing, using a suitable wrench.

4. Remove fork and ball stud assembly from clutch housing.

5. To remove ball from fork assembly, lift retainer spring (Item 21, Fig. 2) out of fork and withdraw ball stud.

6. Inspect the ball to determine the extent of wear; or if part is scored, it should be discarded. Try fit of ball stud in release fork with retainer spring installed. Ball should be snug without end play. See Fig. 14.

7. Pack ball seat in fork with high melting point lubricant.

8. Install ball stud (20) and retainer spring (21). **Caution:** Be sure to place ends of ball retainer spring downward so that spring will be completely seated in grooves in fork.

9. Reinstall fork and ball stud assembly in proper position. See that fingers at inner end of fork are in groove of release bearing sleeve. Then thread ball stud into support and make sure that stud and support are drawn up tightly. Any looseness at this point will affect

CLUTCH



Fig. 11 Removing Retracting Springs

proper operation of clutch.

10. Adjust clutch pedal free travel as instructed in Paragraph 3.

C. Clutch Release Bearing—Clutch release bearing (Item 19, Fig. 2) is ball thrust type and is pressed onto release sleeve.

1. Replacement of release bearing and sleeve assembly requires removal of transmission from vehicle.

2. Clutch release bearing is of the sealed type, prelubricated at assembly and does not require further lubrication throughout the life of the bearing.

3. When release bearing is removed, special care should be exercised to see that it is not soaked in gasoline or other cleaning fluid as this will dissolve the lubricant and render the bearing unfit for further service.

4. Apply a moderate supply of high melting point lubricant to release fork groove in release bearing sleeve.

5. Before bearing is reinstalled, it should be checked carefully to determine possible roughness which might result in early failure and require premature replacement of this part.

12. CLUTCH PILOT BEARING

This bearing is an oil-sealed type which fits in recess of crankshaft and provides a pilot for clutch shaft of transmission. This bearing needs attention only when clutch is removed from vehicle.

A. To Remove Pilot Bearing—Transmission and clutch must be removed from chassis before pilot bearing is accessible. The following instructions for pilot bearing removal are based on the use of a special puller tool as illustrated in Fig. 15. A suitable puller of this kind should be used to remove this bearing without damage.

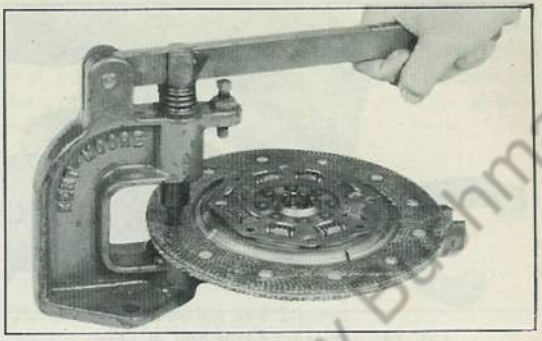


Fig. 12 Clutch Riveting Fixture

1. Adjust puller with thumb screw until fingers on puller are closed. Insert puller through bore of bearing as far as it will go. Then tighten thumb screw to spread fingers of puller behind bearing. Slide weight sharply against stop nut on puller shaft several times to remove the bearing.

B. Bearing Inspection and Lubrication — Bearing should be examined very carefully and tested to determine possible roughness which would render the bearing unfit for further service. Before bearing is installed, apply lubricant to the balls and races.

C. To Install Pilot Bearing—Great care must be exercised to provide correct bearing installation. When bearing is installed, it must be in exact alignment with pilot hole in flywheel housing. A special driver as illustrated in Fig. 16 is available for this purpose which includes a centering collar for clutch housing pilot hole and also provides a pilot for the bearing.

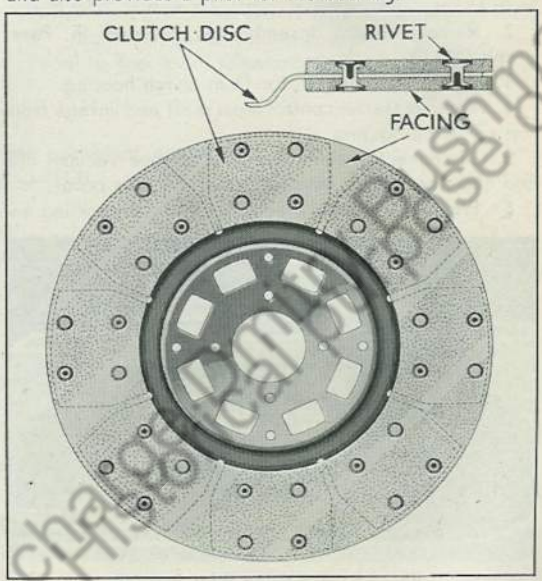


Fig. 13 Clutch Riveting Locations

CLUTCH



Fig. 14 Checking Fit of Ball in Yoke

1. Place bearing on end of driver.
2. Install tool and bearing assembly in transmission pilot hole of flywheel housing.
3. Move handle forward until bearing begins to enter hole in crankshaft.
4. Tap end of driver with a light hammer until bearing is properly seated.

13. CLUTCH HOUSING

Clutch housing is made up of two parts. The upper half is a steel casting and is attached directly to engine with 6 bolts and is located with 3 dowel pins. The lower half is bolted to lower surface of upper half.

A. Clutch Housing Removal—Replacement of clutch housing is greatly simplified when engine is removed from chassis. However, if replacement becomes necessary, it may be accomplished without removing engine as follows:

1. Remove transmission. Refer to Group O7 for instructions.
2. Remove clutch assembly as outlined in Paragraph O6.
3. Remove starting motor from clutch housing.
4. Remove starter control cross shaft and linkage from top of clutch housing.
5. Disconnect vacuum line and remove vacuum line and clip from clutch housing inspection hole cover.
6. Provide a suitable means of rigidly supporting engine at rear.
7. Remove engine mounting insulator bolt at both sides of clutch housing.
8. Remove engine mounting brackets—one on each side of clutch housing.
9. Disconnect radio suppression bond straps. Remove clutch housing underpan.
10. Remove clutch housing.

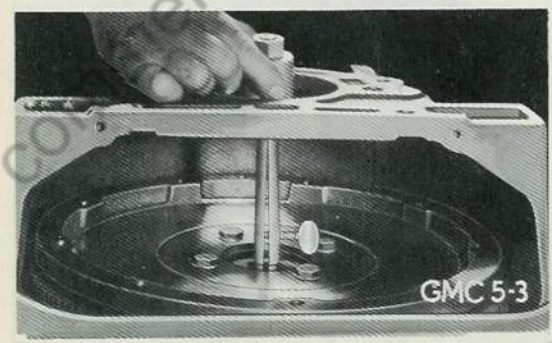


Fig. 15 Removing Pilot Bearing

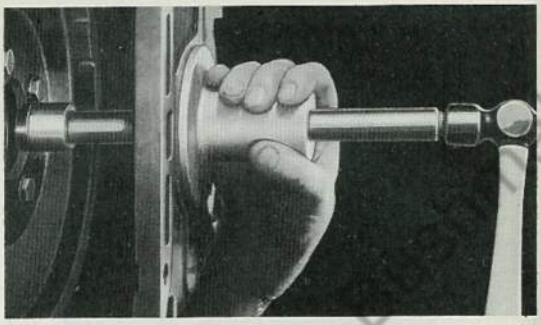


Fig. 16 Replacing Pilot Bearing

B. Clutch Housing Installation—Housings furnished for service are completely machined and when perfectly assembled to crankcase with bolts and dowel pins should be in correct alignment.

1. Clutch housing can be reinstalled by reversing the sequence of instructions given under "To Remove Clutch Housing."
2. When reconnecting radio suppression bond straps, be certain that connections are clean and tight.
3. After clutch housing is reinstalled, follow instructions given under "Clutch Housing Inspection."

C. Clutch Housing Inspection—All machine surfaces of clutch housing should be inspected for scores or nicks. After the housing is installed, it should be checked with a dial indicator to determine run-out of pilot hole and squareness of rear face as follows:

1. Attach dial indicator mounting bracket to flywheel

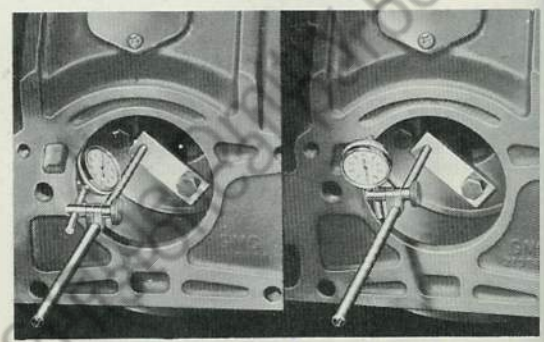


Fig. 17 Clutch Pilot Hole Run-Out and Rear Face of Clutch Housing

with a flywheel mounting bolt as illustrated in Fig. 17.

2. Place dial indicator feeler tip so that it is in contact with inner surface of pilot hole.

3. Rotate flywheel and note reading on dial indicator. Refer to "Specifications" for run-out limits.

4. Operations 1, 2 and 3 above may be repeated for checking squareness of rear face of housing except that dial indicator feeler tip must be resting on machine surface of housing approximately 1/4" from edge of pilot hole. Refer to "Specification" group for limits.

TABULATED DATA

14. SPECIFICATIONS

Type ..... Single Plate, Dry Disc

Make

Cover ..... Inland Mfg. Co.
Number 754379
Driven Number ..... Long
Number CM-5311

Driven Disc and Facings

Total Frictional Area. Sq. In. 136.17
Facings—Quantity 2
Outside Diameter ..... 11 1/2"
Inside Diameter ..... 6 3/4"
Thickness ..... .154"–.158"
Torsion Dampener Springs
Free Length ..... 1.023"–1.037"
Lbs. Pressure @ .900" 195–215
Driven Disc Out-Of-True—Not to Exceed .025"
Measured 11/2" in From Outside Diameter on Flywheel Side

Clutch Pressure Spring

Type ..... Diaphragm
Quantity 1
Number 753930
Outside Diameter ..... 9"

Clutch Release Bearing and Support

Type ..... Sealed Ball
Make ..... New Departure
Number (Bearing & Support Assy.) 2140122

Clutch Pilot Bearing

Type ..... Shielded Ball
Make ..... New Departure
Number 907109

Clearance Between

Pressure Plate Drive Lugs and Cover ..... .002"–.006"
Splines in Driven Disc Hub and Transmission Gear Shaft ..... .0005"–.0055"

Clutch Housing Pilot Hole Runout

Not to Exceed ..... .010"

Clutch Pedal

Adjustment 2 1/2" Free Travel Before Release Bearing Contacts Clutch Spring Finger
Pedal to Toe Board Clearance—See Instructions

15. TOOL EQUIPMENT

The following special tools, or their equivalent, are recommended for use when servicing CLUTCH.

Tool No.	Name	Supplier Code
J-164	Pilot Bearing Remover	KM
J-1113	Clutch Fixture	KM
J-1895	Clutch Housing Pilot Hole Dial Indicator	KM
K-410	Pilot Bearing Driver	KM
K-411	Clutch Aligning Arbor	KM

TOOL SUPPLIER

Supplier Code	Name	Address
KM	Kent-Moore Organization	Detroit, Mich.

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CLUTCH

SERVICE BULLETIN REFERENCE

Bulletin No.	Description

BUSHMAKOV.COM commercial use, free of charge Dmitry Bushmakov historical purpose

Group O3 — Fuel System

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GENERAL	
Description and Operation	1
Trouble Shooting and General Solutions	2
Inspection and Adjustment	3
REPAIR	
Carbureter	4
Fuel Pump	5
Fuel Filter	6
Accelerator Pedal and Linkage	7
Hand Throttle	8
Choke Control	9
Fuel Tank	10
Fuel Tank Filler Cap	11
Fuel Lines	12
Fuel Gauge	13
Governor	14
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Tool Equipment	16

GENERAL

1. DESCRIPTION AND OPERATION

Fuel system consists of: controls, fuel gauge, fuel tank, fuel lines, fuel filter, fuel pump, governor, carbureter, air cleaner.

Fuel stored in fuel tank is drawn through fuel filter into fuel pump. Pump forces fuel, as required, into carbureter. There it is properly mixed with air that has been cleaned by air cleaner and drawn into combustion chamber of engine by vacuum caused by downward stroke of pistons. After combustion, exhaust gases are carried off by exhaust system.

2. TROUBLE SHOOTING AND GENERAL SOLUTIONS

Many symptoms which might indicate fuel system trouble are in reality due to faulty ignition. Before making extensive adjustments or repairs on carbureter or fuel pump, check ignition system thoroughly. Refer to Chart on page 03-2.

3. INSPECTION AND ADJUSTMENT

INSPECTION

Following items should be inspected to prevent leaks or excess wear.

A. Air Cleaner—Inspect condition of air cleaner element and oil. To do this:

1. Remove wing nut and cover.
2. Lift element out of cleaner and examine to determine extent of dirt and foreign accumulations. Clean properly.
3. See that oil is to proper level.

B. Fuel Filter—See that cover bolt is tight and that drain plug is in place and tight.

C. Fuel Pump—Bowl clamp nut and mounting stud nuts must be tight.

D. Fuel Lines—See that all line connections are tight.

E. Fuel Tank—Mounting strap nuts must be tight as any movement of tank will eventually wear hole in tank. Also inspect tank for any leaks.

F. Fuel Tank Filler Cap—See that filler cap is in place and turned down tight. Cap should be replaced immediately after filling tank to prevent any dirt entering fuel system.

G. Fuel Gauge—Inspect electrical connections to see that they are tight and clean.

H. Exhaust System—See that manifold to exhaust pipe connection is tight and does not leak. Also exhaust pipe to muffler and muffler to tail pipe clamps must be tight.

ADJUSTMENT

There are certain adjustments to be made on fuel system which are occasioned by normal operation. These adjustments are described in following outline and should be performed with diligence and care.

A. Air Cleaner—Oil bath air cleaner is mounted directly to top of carbureter and is designed to remove dust and dirt from air entering carbureter and engine. Air entering cleaner passes into oil chamber. Due to impact and sudden reversal of air flow, most of dirt in air is thrown into oil and settles to bottom of cleaner. Partially cleaned air passes through a dense oil wetted mesh where remaining dust is trapped. This dust and dirt is loaded with minute particles of abrasive which, if permitted to enter engine, would cause rapid wear of moving parts resulting in loss of power and increased oil and fuel consumption.

FUEL SYSTEM

Excessive Fuel Consumption

1. Dirty Air Cleaner—
   Clean as directed in "Adjustments" in this group.
2. Improper Carbureter Adjustment—
   (a) Adjust idling screw.
   (b) Adjust choke control.
   (c) Adjust accelerator pump stroke.
   (d) Adjust fuel level
3. Fuel Leaks (in Fuel Lines)—
   (a) Tighten connections.
   (b) Replace line.
4. Fuel Leaks (at Carbureter)—
   (a) Tighten cover to body screws.
   (b) Replace cover to body gasket.
5. Fuel Leaks (at Fuel Pump)—
   (a) Tighten knurled nut at top of fuel bowl.
   (b) Replace bowl gasket.
   (c) Replace diaphragm.
6. Fuel Leaks (at Fuel Filter)—
   (a) Tighten cover bolt at top of filter.
   (b) Tighten drain plug.
   (c) Replace bowl to cover gasket.
7. Fuel Leaks (at Fuel Tank)—
   (a) Repair tank.
   (b) Replace tank.
8. Engine Not Properly Tuned—
   See "Engine Tune-up" in "Engine" group of this book.
9. Improper Engine Temperature—
   Refer to "Cooling System" group of this book.
10. Vehicle Overloaded—
    Load only to rated capacity.
11. Tires Under-inflated—
    Inflate to proper pressure.
12. Brakes Dragging—
    Refer to "Brake" group of this book.
13. Excessive Idling—
    Stop engine when vehicle will not be moving for long periods.
14. Controls Frozen—
    (a) Free up and lubricate choke valve shaft.
    (b) Free up and lubricate throttle valve shaft.
    (c) Free up and lubricate accelerator linkage.
15. Carbureter Parts Worn from Normal Operation—
    Overhaul carbureter.

Fast Idling

1. Improper Throttle Control Adjustment—
   (a) Adjust control wire at carbureter.
   (b) Adjust control wire housing clamp at carbureter.
   (c) Tighten control mounting nut at instrument panel.
2. Throttle Control Frozen—
   Free up and lubricate throttle valve shaft.
3. Improper Return Spring Tension—
   Replace accelerator return springs.

Engine Will Not Idle

1. Throttle Plate Closing Too Far—
   Adjust throttle stop screw.
2. Improper Fuel Mixture—
   (a) Adjust idling screw.
   (b) Clean or replace idling jet.
   (c) Clean priming hole.

Low Fuel Pressure

1. Air Leaks—
   (a) Tighten all fuel line connections.
   (b) Tighten fuel pump bowl knurled nut.
   (c) Tighten fuel filter cover bolt.
2. Fuel Pump Diaphragm Broken—
   Replace diaphragm.
3. Fuel Pump Valves Leaking—
   Replace valves and gaskets.
4. Fuel Pump Linkage Worn—
   Overhaul pump.
5. Fuel Tank Filler Cap Intake Valve Not Functioning Correctly—
   Replace cap.

Engine Stumbles on Acceleration

1. Carbureter Accelerating System Not Functioning Properly—
   (a) Adjust accelerator pump for proper stroke.
   (b) Clean or replace accelerator jet.
   (c) Clean or replace accelerator pump check valve.
   (d) See "Engine Tune-up" in "Engine" group of this book.

Trouble Shooting Chart

Importance of keeping air cleaner in proper condition should be impressed on those responsible for mechanical upkeep of engine. Air cleaner **must** be cleaned at regular intervals; at least every 1,000 miles or more often if conditions warrant. Under adverse conditions or extensive operation on dusty or sandy terrain, unit should be cleaned every day or at least every 250 miles. In the event vehicle operates in dust storm areas, cleaner should be cleaned immediately after such storms occur.

1. Remove air cleaner from vehicle by loosening clamp screw and removing cleaner from carbureter.

2. Clean oil bath air cleaner in following manner:

(a) Remove wing nut at center of top cover so that cover can be taken off. Lift out filter unit.

(b) Clean filter element thoroughly by slushing in a pan of suitable cleaning fluid. This operation should be repeated until all dirt has been removed.

(c) Blow filter dry and clean with air pressure. Do not use extremely high pressure as mesh will become compressed and render filter unsatisfactory for further use.

(d) Dip filter in SAE 50 (SAE 30 below 32° F.) engine oil and allow surplus to drain off.

FUEL SYSTEM



Fig. 1 Disassembled View of Air Cleaner

(e) Wash reservoir in suitable cleaning fluid and wipe out with a clean cloth.

(f) Fill to "Oil Level" stamped on inside of cleaner body, using SAE 50 (SAE 30 below 32° F.) engine oil.

(g) Replace filter unit and cover. Be sure that cork gasket in cover is in good condition and forms a tight seal.

(h) Install wing nut and tighten securely.

3. Replace complete unit on carbureter, making sure that gasket in throat of air cleaner contacts top of carbureter to form positive seal. Tighten clamp screw enough to maintain this seal but not so tight that it distorts carbureter and causes choking.

B. Carbureter—All mixture adjustments, except idling, are determined by calibration of various jets and can only be changed by disassembling carbureter and installing different jets. Sizes of jets used in this carbureter are listed in "Specifications" at end of this group, and should not be changed unless recommended by factory service department.

1. Before adjusting idling mixture, warm up engine so that intake manifold is at least warm to the hand (120° F. or higher). Slow engine down to idling speed.

Remove windshield wiper tube from manifold fitting and attach vacuum gauge. Turn idling screw gradually to right or left until vacuum reading as indicated in "Specifications" is obtained. Turn screw clockwise for richer mixture or counter-clockwise for leaner mixture.

If engine idles too fast after mixture adjustment is made, adjust stop screw on throttle lever until desired speed is obtained. Regulation of idling speed in no way affects function of carbureter at higher speeds.

2. Adjustment of accelerator pump stroke is provided so that maximum engine performance may be obtained under all climatic conditions. Hair pin cotter (20, Fig. 4) at top of piston rod can be located in three positions. Piston will give long stroke when cotter is in lower position and is used in cold climates. Short stroke of piston, with cotter in top position, is used in extremely hot climates, high altitudes or with high test fuel. Medium stroke, with cotter in center position, should be satisfactory for all normal temperatures or operating conditions. Adjustment is accomplished in following manner:

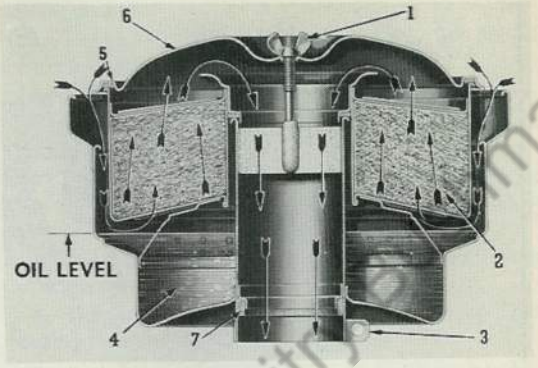

Fig. 2 Assembled View of Air Cleaner

1. Wing Nut
2. Filter Element
3. Clamp
4. Oil Reservoir
5. Cover Gasket
6. Cover
7. Throat Gasket

(a) Remove air cleaner.

(b) Remove carbureter cover to body screws.

(c) Remove carbureter cover, being careful not to damage gasket.

(d) Move hairpin clip to proper position as described above.

(e) Reassemble cover and air cleaner, making sure gaskets are in good condition and that all screws are drawn up tight to prevent leaks.

3. Correct fuel level in carbureter bowl is particularly important in order to obtain greatest fuel economy and must be held closely to limits shown in "Specifications" at end of this group. In no case should float be set so that dimension is less than given. Adjustment is accomplished in following manner:

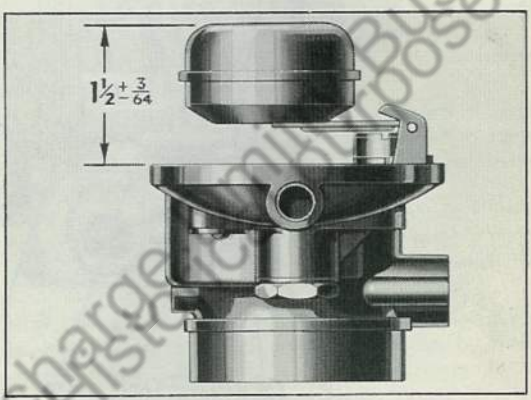

Fig. 3 Carbureter Float Adjustment

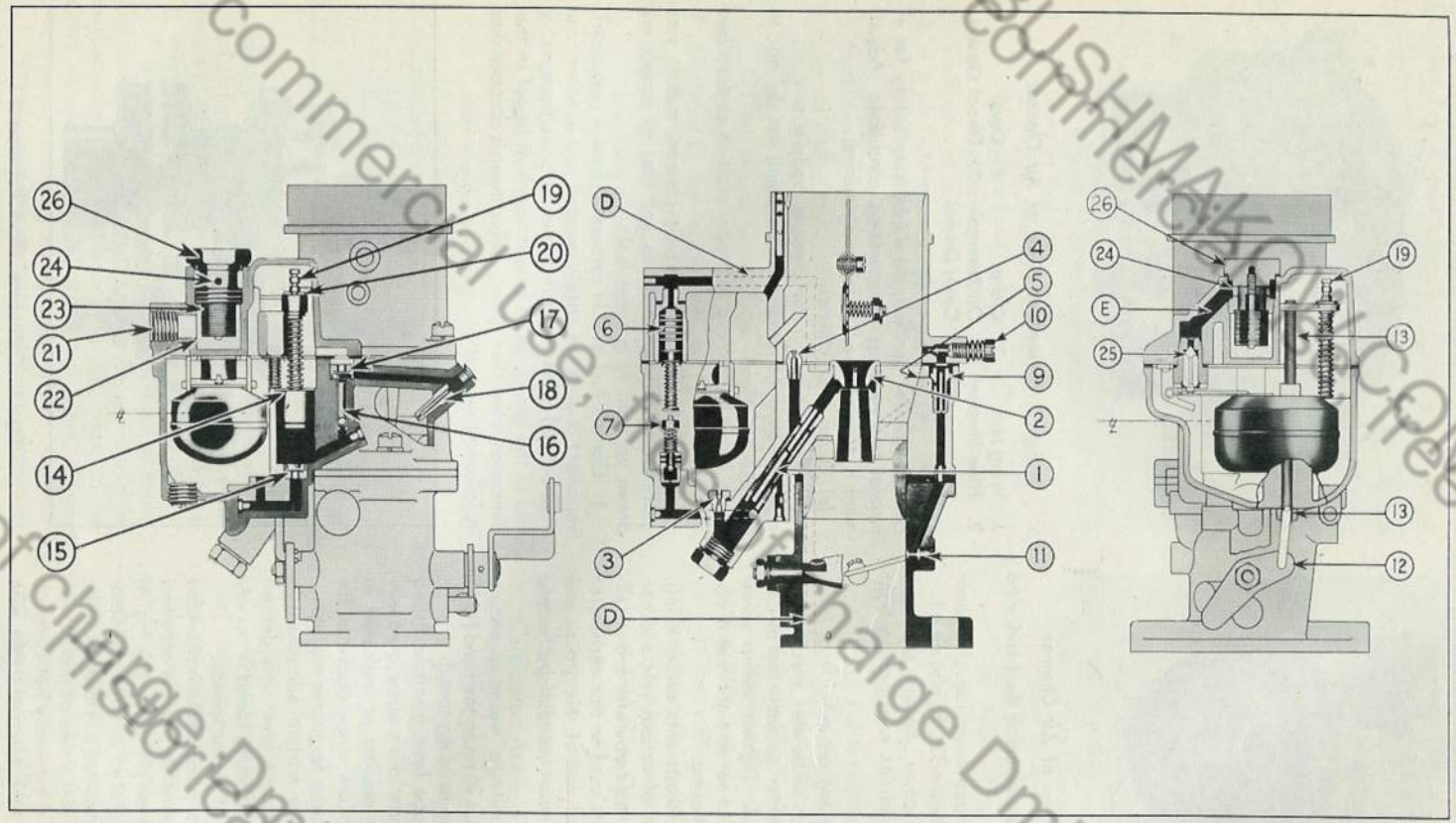

Fig. 4 Sectional View of Carbureter

1. Main Discharge Jet
2. Secondary Venturi
3. Main Jet
4. Well Vent
5. Channel
6. Vacuum Cylinder
7. Power Jet and Valve Assembly
9. Idling Jet
10. Idling Adjusting Screw
11. Priming Hole Plug
12. Pump Lever
13. Pump Rod Assembly
14. Pump Piston
15. Pump Check Valve
16. Check Valve Weight, Ball and Seat
17. Air Vent Check Valve
18. Accelerator Jet
19. Pump Rod Assembly
20. Hair Pin Cotter
21. Inlet
22. Fuel Sump
23. Fuel Filter (Not used on these Vehicles)
24. Filter Hole
25. Fuel Valve Needle
26. Hex Head Plug
D. Channel
E. Channel

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FUEL SYSTEM

(a) Remove air cleaner.
(b) Remove carbureter cover to body screws.
(c) Remove carbureter cover, being careful not to damage gasket.
(d) Turn cover upside down and with conventional depth gauge measure height of float as shown in Fig. 3.
(e) Float arm may be bent to obtain correct measurement.
(f) Reassemble cover and air cleaner, making sure gaskets are in good condition and that all screws are drawn up tightly.

C. Throttle Control Button—Correct throttle control button adjustment is obtained in following manner:

1. Tighten throttle wire lock nut (5, Fig. 24) behind instrument panel.
2. Push in throttle button all the way.
3. Check clearance between collar (8, Fig. 24) and carbureter throttle lever. There should be 1/4" clearance between lever and throttle wire collar.

D. Choke Control Button—Proper adjustment of carbureter choke control button is important in order to maintain maximum fuel economy and is obtained in following manner:

1. Tighten choke wire lock nut (5, Fig. 24) behind instrument panel.
2. Loosen set screw at carbureter end of choke wire.
3. Push in choke button until there is 1/16" clearance between button and instrument panel.
4. Inspect carbureter choke valve (air shutter) to be sure that it is fully opened; that is, valve should be in vertical position.
5. Insert choke wire in throttle lever swivel and tighten set screw securely.
6. Tighten wire housing clamp sufficiently to hold housing securely.

E. Fuel Pump—Fuel bowl should be removed frequently and cleaned of all accumulated foreign matter. Screen should also be cleaned or replaced if necessary.

F. Fuel Filter—Drain filter frequently to remove any accumulated or foreign matter by removing plug at bottom of bowl.

REPAIR

4. CARBURETER

The carbureter, Fig. 4, is a Zenith downdraft unit of double venturi design. It is a balanced unit which maintains proper depression ratio between air intake and fuel bowl.

A. Air System—All air entering carbureter must pass through air cleaner, which excludes dirt and foreign matter. Primary venturi determines volume of air passed through carbureter while secondary venturi increases velocity of air stream at jet. Air cleaner restrictions have but a minimum influence on mixture ratio.

B. Main Jet System—The main jet is often referred to as "high speed" jet because its greatest influence is exerted at higher engine speeds. It is a direct suction jet, and discharges its fuel into air stream at secondary venturi.

C. Compensating System — Compensating system consists of the main discharge jet and the well vent.

The flow of fuel from the main jet and power jet is controlled by the size of the well vent and the size of the main discharge jet.

The proper seating of main discharge jet and of the well vent is insured by a tapered seat.

D. Vacuum By-Pass—With the use of vacuum operated power jet piston, carbureter and governor have by-pass hole so that vacuum for operation of piston can be taken from a point below governor valve.

Vacuum must necessarily by-pass through the governor and below shut-off valve in order for the power jet to function properly.

A by-pass screw is inserted in vacuum passage to block off vacuum passage below throttle valve, allowing vacuum to by-pass through so that operation of power jet will not be affected.

E. Power Jet System—Power jet operates only when extra fuel is needed for development of maximum power.

The power jet system consists of power jet, which regulates volume of fuel and power jet piston which, actuated by manifold vacuum, causes power jet valve to open. A series of channels connect power jet vacuum piston with carbureter barrel below the throttle plate.

At part throttle operation, manifold vacuum is sufficient to overcome tension of the power jet piston spring and piston is held up in its cylinder. Under certain conditions such as sustained high speeds, lugging with wide open throttle or when throttle is opened suddenly, manifold vacuum drops. This permits vacuum piston to descend in its cylinder and causes power jet valve to open and permit fuel to flow through the proper jet.

This fuel, added to main jet supply, furnishes proper mixture for full power development.

F. Idling System—The idling system consists of idling jet which measures the fuel and idling adjusting screw which regulates the air. Idling jet receives fuel which has been measured by main jet.

At idling speeds, with throttle plate almost closed, there is a strong suction past the edge of throttle plate, and therefore on the primary hole through which the idling mixture is discharged.

G. Acceleration—Acceleration is accomplished by accelerating pump which is manually controlled by movement of throttle. Downward stroke of pump piston forces fuel from pump cylinder into air stream through accelerating jet, thus furnishing necessary additional fuel for

FUEL SYSTEM

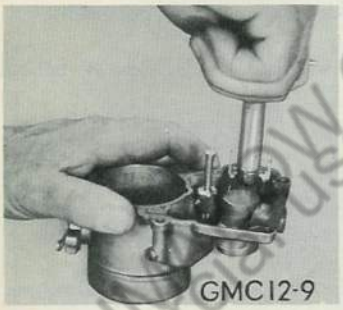


Fig. 5 Removing Fuel Valve Seat. Tool C161-85

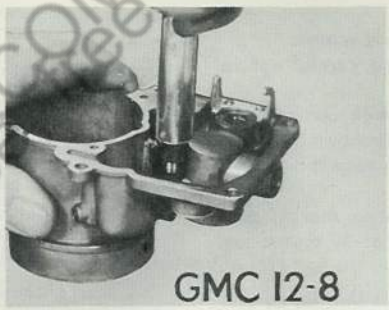


Fig. 6 Removing Vacuum Cylinder. Tool C161-10



Fig. 7 Removing Main Discharge Jet. Tool C161-1

acceleration. An air vent is provided between pump and discharge opening, controlled by check valve to prevent accelerating jet from supplying fuel except during downward movement of piston.

Lenth of piston stroke determines amount of fuel supplied to accelerating jet. See "Carbureter Adjustments" for instructions on how to adjust.

H. To Remove Carbureter—Removal of carbureter can be made in following manner:

1. Remove air cleaner.
2. Disconnect choke control and hand throttle.
3. Disconnect carbureter throttle control rod.
4. Disconnect carbureter fuel line at carbureter.
5. Remove carbureter to manifold stud nuts and remove carbureter.

I. To Install Carbureter—When installing carbureter, special attention should be given to gasket between carbureter and governor to see that it has hole located in such a position that vacuum can by-pass freely through carbureter and governor housing.

1. Place carbureter on manifold studs and replace nuts.
2. Connect carbureter fuel line.
3. Connect carbureter throttle control rod.
4. Connect hand throttle and choke controls.
5. Replace air cleaner.

J. To Disassemble Carbureter—To properly repair Zenith Series 28 Carbureter, special Zenith tools are required. References are made to these tools throughout the following instructions by Zenith numbers. (Refer to Fig. 4 for caption numbers in parenthesis).

1. Remove hex headed plug (26) using $\frac{3}{16}$" wrench.
2. Remove cover assembly screws (there are six of these).
3. Raise cover assembly slightly and loosen gasket from bowl assembly so you may lift cover and gasket clear of bowl assembly without damaging float. Remove gasket from cover assembly.
4. Remove float axle, using small screwdriver to push axle out of slotted end of hinge bracket, using fingers or pliers to remove it rest of way in order to remove float and fuel valve needle (25).
5. Remove fuel valve seat, using service tool C161-85 as illustrated in Fig. 5.
6. Remove vacuum cylinder assembly (6), using $\frac{7}{16}$" thin walled box wrench (service tool C161-10) as illustrated in Fig. 6.
7. Remove idling adjustment screw and spring (10).

Note: Do not remove identification disc, float hinge bracket or either of two bowl vents.

A round aluminum identification tag riveted to carbureter bowl cover specifies assembly outline number to which carbureter was originally built. When ordering special parts such as throttle bodies, throttle lever and



Fig. 8 Removing Power Jet and Valve Assy. Tool C161-9



Fig. 9 Removing Main Jet



Fig. 10 Removing Idling Jet

FUEL SYSTEM

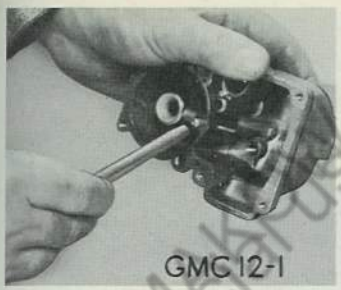


Fig. 11 Removing Well Vent. Tool C161-80

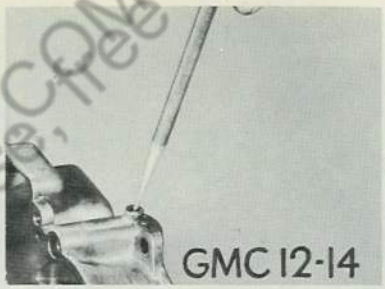


Fig. 12 Removing Channel Plug. Tool C161-21

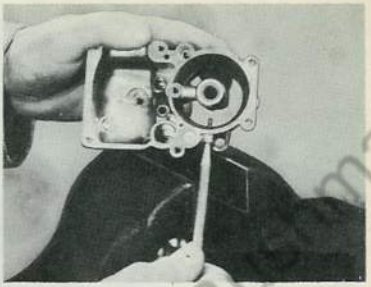


Fig. 13 Removing Accelerator Jet. Tool C161-21

stop lever assemblies, etc., be sure to specify outline number of carbureter to prevent errors in selecting parts required.

8. Remove lower plug, using $1/2$" wrench.

9. Remove pump lever nut and lockwasher, using $\frac{5}{16}$" open end wrench and loosen lever (12) on shaft.

10. Remove bowl to barrel assembly screws, using screwdriver.

11. Lift bowl from barrel and at same time remove pump lever from throttle shaft, also remove link retaining spring.

12. Hold pump rod assembly (19 and 13) down to bottom of its travel and remove link.

13. Remove venturi and gasket.

14. Remove pump and pump rod assembly. **Note:** It may be necessary firsf to file burrs or rough spots from sides of pump at hole for link.

15. Note which of three notches cotter is used in (20).

16. Remove main discharge jet (1), using service tool C161-1 as illustrated in Fig. 7.

17. Remove power jet and valve assembly (7), using service tool C161-9 as illustrated in Fig. 8.

18. Remove main jet (3) and gasket, with screwdriver as illustrated in Fig. 9. Main jet (3), generally used in 28 Series, is C52-7 which closely resembles C52-3 (old number D1015) compensator jet, but is marked with a star to identify it. These jets should not be interchanged as flow characteristics are different.

19. Remove idling jet (9) with screwdriver as illustrated in Fig. 10.

20. Remove well vent (4) with $\frac{3}{16}$" wrench (service tool C161-80) as illustrated in Fig 11.

21. Remove channel plug and accelerator jet (18), using C161-21 extractor as illustrated in Figs. 12 and 13.

Note: C161-21 accelerator jet and plug extractor is used in the following manner: Drill No. 46 hole in center of plug. Insert tapered thread end of tool into hole just drilled and screw down (anti-clockwise) until tool is firmly fastened into plug. Then strike tool sharply with a light hammer to lift plug out.

Use C161-21 extractor in same manner to remove accelerator jet. No drilling operation is required.

22. Remove air vent check valve assembly (17), using service tool C161-5 as illustrated in Fig. 14, as follows:

Insert tapered thread end into air vent check valve body and screw down (anti-clockwise) until tool is firmly fastened into body. Then raise sliding weight up sharply against stop bar a few times to remove check valve assembly. One end of stop bar of C161-5 tool is machined to fit air vent check valve body and is used to install valve.

23. Turn bowl upside down to allow retainer washer, weight (16) and pump refill check ball to fall out.

24. Remove pump check valve assembly (15), using service tool C161-5 as illustrated in Fig. 15, after first bending retainer lugs with small screwdriver and removing valve disc.



Fig. 14 Removing Air Vent Check Valve. Tool C161-5



Fig. 15 Removing Pump Check Valve. Tool C161-5

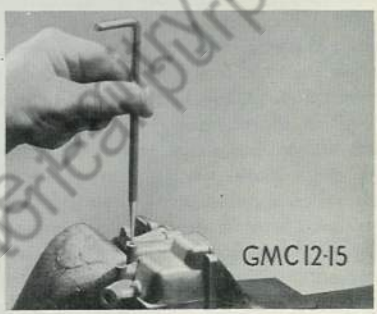


Fig. 16 Removing Lead Channel Plug. Tool C161-21

FUEL SYSTEM



Fig. 17 Installing Lead Channel Plug. Tool C161-19

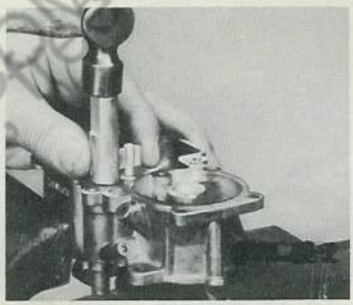


Fig. 18 Installing Pump Check Valve. Tool C161-53

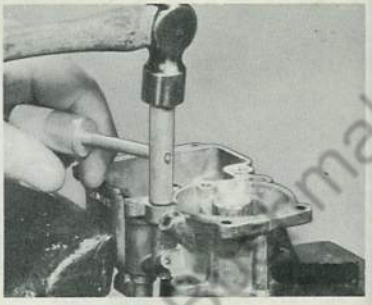


Fig. 19 Installing Air Vent Check Valve. Tool C161-5

25. Remove lead channel plugs, using No. 46 drill and C161-21 extractor as illustrated in Fig.16.

Note: Do not remove following parts:

a. Pump refill check valve seat (16).

b. Secondary venturi (2).

c. Idle channel bushing, located in channel below idling jet (9).

26. If air shutter shaft or shutter must be replaced, proceed as follows:

a. File off riveted end of air shutter screw.

b. Remove screw with screwdriver.

27. The location of priming hole plug in relation to throttle plate is extremely important for uniform idling and part throttle operation. To maintain a uniform relation between priming hole plug and throttle plate, factory assembles throttle shaft and plate in throttle body before drilling body for priming hole plug, locating hole in a definite relation to the throttle plate in each case. It is readily apparent from above that throttle plates and throttle bodies cannot be interchanged indiscriminately. When it becomes necessary to replace throttle shaft or throttle plate, we suggest following routine:

(a) Unscrew throttle stop screw (or remove throttle advance lever) to permit complete closing of throttle plate.

(b) Hold throttle in tightly closed position and mark inside of throttle body close to throttle plate with steel scriber.

(c) Using this scribed line as guide, replace throttle shaft or plate. If new plate used shows a noticeable variation from old one, select another new plate to get one that fits very close to the scribed line when installed.

(d) If throttle body has to be replaced, we recommend obtaining complete throttle body assembly including shaft, plate, priming plug, etc., built to outline number which appears on identification tag on bowl cover.

28. If throttle plate is to be removed, riveted ends of throttle plate screws must be filed before they are removed.

Note: Do not disturb the priming plug (11); or if carbureter is used with speed governor, do not disturb hollow channel screw at flange in channel shown at (D).

K. To Inspect Carbureter—After disassembling carbureter, clean all parts in a reliable solvent. Blow out all fuel and vacuum channels with compressed air. Carefully inspect all parts for marks or ridges and any other signs which would indicate wear. Such parts should be replaced by new ones to assure satisfactory operation.

L. To Reassemble Carbureter—Reassemble carbureter in following manner. (Refer to Fig. 4 for caption numbers in parenthesis.)

1. Reassemble throttle parts as suggested under item 27 of disassembly.

2. Rivet ends of throttle plate screws, being careful to avoid springing shaft; use mandrel in vise and tinner's riveting hammer.

3. Install lead channel plugs, using service tool C161-19 and light hammer as illustrated in Fig. 17.

4. Replace pump check valve assembly (15), using service tool C161-53 as illustrated in Fig. 18, as follows:

(a) Place carbureter in a vise as shown.

(b) Place check valve assembly in position in housing.

(c) Drive check valve into position with tool as shown in Fig. 18.

5. Place pump refill check ball on seat followed by the weight (16) and retainer washer.

6. Replace air vent check valve assembly (17), using service tool C161-5, as illustrated in Fig. 19 as follows: One end of stop bar of C161-5 tool is machined to fit air vent check valve body. Install air vent check valve by lightly hammering end of tool to drive valve down as far as tool with permit.

Note: This assembly is same as pump check valve assembly (15) but is installed with opposite side up.

7. Replace accelerator jet (18), using C161-51 tool as illustrated in Fig. 20 as follows: One end of this tool is machined to fit the accelerator jet and is used to install the jet by lightly hammering the tool to drive the jet in as far as the tool will permit.

8. Install new accelerating jet channel plug, using light hammer.

9. Install well vent (4), using service tool C161-80, as illustrated in Fig. 11, or $\frac{3}{16}$" wrench (no gasket).

10. Replace idling jet (9) as illustrated in Fig. 10; no gasket is required.

FUEL SYSTEM

Note: There is a small drilling (size .8 mm) shown at (5). This hole admits a fixed quantity of air in addition to that supplied by the idling adjustment. This small channel must be clean.

11. Replace main jet (3) as illustrated in Fig. 9 and new gasket.

Note: Main jet generally used in 28 Series is C52-7 which closely resembles C52-3 (old number D1015) compensator jet, but is marked with a star to identify it. These jets should not be interchanged as flow characteristics are different.

12. Install power jet and valve assembly (7), using service tool C161-9 as illustrated in Fig. 8 (no gasket).

13. Install main discharge jet (1), using service tool C161-1 as illustrated in Fig. 7 (no gasket).

14. Install pump and rod assembly (19 and 13). **Note:** Hair pin cotter (20) should be in same groove as before disassembly. **Note:** Guide rods have three grooves at upper end to determine length of pump stroke, e.g., pump is assembled with hair pin cotter in top groove when $1/2$ stroke is required; second groove for $3/4$ stroke; and in third groove from end for full stroke of pump.

15. Place venturi and gasket in position in bowl assembly. **Note:** Notch in venturi fits over discharge arm of bowl assembly.

16. Place bowl in position on barrel and—

17. Install assembly screws and lockwashers.

18. Install pump lever retainer nut and lockwasher, using $\frac{5}{16}$" wrench.

19. Connect pump lever to shaft. Install pump link and retaining spring. Long end of link is connected to pump rod.

20. Install lower plug, and new gasket, using $1/2$" wrench.

21. Reassemble air shutter and shaft.

22. Rivet end of air shutter screw. Be careful to avoid springing the shaft. Use small mandrel in vise and tinner's riveting hammer.

23. Install idling adjustment screw and spring (10).

24. Replace vacuum cylinder assembly (6) and new gasket, using service tool C161-10 as illusttrated in Fig. 6.

25. Install new fuel valve seat and new gasket, using service tool C161-85, as illustrated in Fig. 5, followed by new fuel valve needle, float and float axle.

26. Hold cover assembly upside down as shown in Fig. 3, and observe position of float with relation to cover. To obtain correct fuel level, with normal fuel pump pressure, measurements should be as shown in "Specifications" at end of this section.

27. Place cover assembly in position with new gasket and install assembly screws with lockwashers. **Note:** Assembly screws should be tightened evenly.

M. To Adjust Carbureter After Reassembly—After carbureter has been completely assembled and installed on vehicle, idling mixture must be adjusted as previously explained in this group. See "Adjustments."



Fig. 20 Installing Accelerator Jet. Tool C161-51

5. FUEL PUMP

Fuel pump illustrated in Fig. 21 is a diaphragm type and and is mechanically operated from an eccentric on camshaft. In addition to camshaft operation while engine is running, pump is equipped with a hand-operated lever which may be used to pump an initial supply of fuel into carbureter in case vehicle has run out of fuel or carbureter bowl has been emptied for any reason.

Diaphragm is pulled downward by linkage to camshaft and is pushed upward by diaphragm spring. In its downward movement diaphragm causes a vacuum in pump chamber which opens inlet valve and draws fuel in through bowl and strainer to fill this vacuum. Upward movement causes inlet valve to close and outlet valve to open, forcing fuel through fuel line to carbureter.

Movement of diaphragm occurs only when carbureter needs fuel and is directly proportional to amount of fuel used by engine.

A. Testing Fuel Pump—In order to obtain maximum fuel economy, it is important to test fuel pump to determine whether or not it is giving enough yield to insure sufficient fuel flowing to carbureter at all times, also whether or not fuel pump may be exerting an overpressure.

These tests are separate and distinct from each other and must be made with pump mounted on engine. Tests can be made before pump is overhauled to determine condition of unit. Tests should be made also after pump is overhauled to test performence.

In making **Capacity** test, it is necessary to determine only that a sufficient amount of fuel is flowing. This may be accomplished by disconnecting fuel pump to carbureter line and attaching a suitable bleeder hose to fuel pump outlet so that fuel may be caught in a container. With outlet of bleeder hose at carbureter level, or slightly higher, flow of fuel should be as shown in "Specifications" at end of this section.

In making second, or **Pressure** test, it is necessary to determine only that pump does not produce an overpressure. With a standard pressure gauge attached to

FUEL SYSTEM

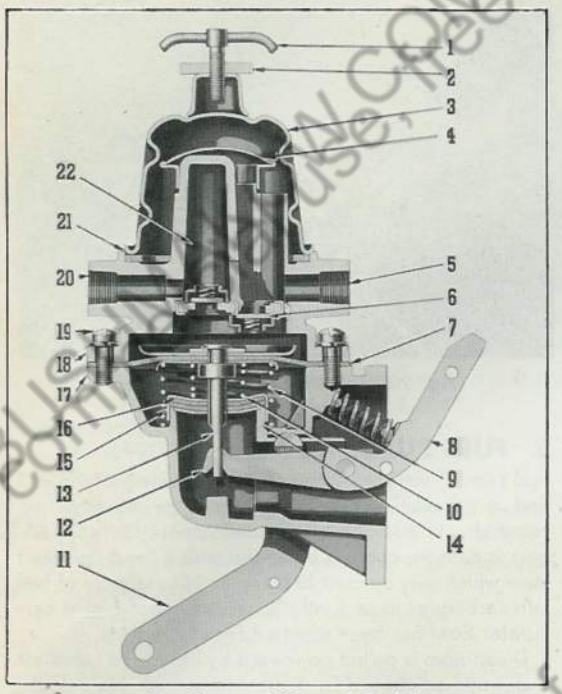


Fig. 21 Sectional View of Fuel Pump

1. Bowl Clamp
2. Knurled Nut
3. Fuel Filter Bowl
4. Filter Screen
5. Fuel Inlet
6. Inlet Valve
7. Diaphragm
8. Cam Operated Lever
9. Diaphragm Spring
10. Oil Seal Spring
11. Hand Operated Priming Lever
12. Connecting Link
13. Diaphragm Pull Rod
14. Oil Seal Lower Retainer
15. Oil Seal
16. Oil Seal Upper Retainer
17. Body
18. Cover
19. Cover to Body Screw
20. Fuel Outlet
21. Bowl Gasket
22. Outlet Valve

outlet of fuel pump, pressure should be as shown in "Specifications" at end of this section.

As long as above tests do not show a pressure over maximum shown in "Specifications" but give at least minimum flow in capacity, or first test, efficient engine operation from standpoint of fuel pump is assured.

In the event fuel pump analyzer is used, follow instructions supplied by analyzer manufacturer.

B. To Remove Fuel Pump—

1. Raise hood and remove hood right-hand side panel for easier accessibility.
2. Close shut-off valve at fuel filter.
3. Disconnect fuel pump fuel lines.
4. Disconnect oil filter return lines at pump mounting stud.
5. Remove pump mounting studs and remove pump from vehicle.

C. To Install Fuel Pump—

1. Place fuel pump in position on engine.
2. Install mounting studs, making sure hollow stud is in correct place for oil filter return line.
3. Connect oil filter return line to mounting stud.
4. Connect fuel pump inlet and outlet line.
5. Open shut-off valve at fuel filter
6. Install hood side panel and close hood. **Note:** Make sure new shakeproof lockwashers are used when replacing hood side panel. Refer to "Radio Interference Suppression" section of Electrical group in this book.

D. To Disassemble Fuel Pump—If tests explained previously in this section reveal need of overhauling pump, proceed in following manner: (Refer to Fig. 21)

1. Loosen knurled nut (2) at top of fuel bowl and turn clamp (1) down so that bowl is free to be lifted off.
2. Remove filter screen (4) under fuel bowl at fuel inlet.
3. Remove screws (19) so that upper and lower halves of pump can be taken apart.
4. Press down on diaphragm pull rod (13) and move lower end of rod away from link (12) so as to disconnect rod and link. Diaphragm assembly (7) can now be lifted out of lower half of pump.
5. Remove valve assembly retainer screws and remove valve retainer.
6. Remove valve assemblies (6 and 22).

E. To Inspect Fuel Pump—After fuel pump has been disassembled, following inspections should be made, replacing any parts not found to be entirely satisfactory: (Refer to Fig. 21)

1. Inspect diaphragm (7) and replace if worn.
2. Inspect linkage and pull rod (13) and replace if worn.
3. Inspect inlet and outlet valves (6 and 22) to make sure that they are clean and that spring is closing valve washer.
4. Inspect oil seal (15) and replace if worn.
5. Inspect fuel bowl gasket (21) and replace if necessary.
6. Clean strainer (4) or replace as necessary.

F. To Assemble Fuel Pump—Assemble fuel pump in following manner: (Refer to Fig. 21)

1. Install oil seal to diaphragm push rod in following manner: Assemble oil seal spring (10), upper retainer (16), two leather seals (15), and lower retainer (14) with convex side out. This is extremely important in order to prevent any oil working up into pump from the crankcase.
2. Install large diaphragm (7) in lower half of housing. Insert diaphragm assembly in position as shown in Fig. 21. Raise inner end of link (12) with screwdriver and hook diaphragm pull rod (13) to link.
3. Install valve assemblies (6 and 22) and gaskets, making sure to install inlet valve with spring down and outlet valve with spring up. Inlet valve is assembled in

cover assembly next to tapped passage marked "INT."

4. Install valve retainer with convex side up, and replace the two retainer screws.

5. Assemble top cover assembly (18) to fuel pump body (17) and tighten cover screws alternately and securely.

6. Assemble screen (4) on cover (18) and asssemble fuel filter bowl (3) to cover, making sure that cork gasket (21) is in good condition and that knurled nut (2) is tightened to prevent air leaks at this point.

G. To Adjust Fuel Pump After Resassembly—After fuel pump has been assembled and installed on vehicle, pump should be tested as previously explained under "Testing Fuel Pump."

6. FUEL FILTER

Fuel filter, illustrated in Fig. 22, is mounted on right-hand frame side rail between fuel tank and fuel pump. Laminated type filtering element is designed to remove water and dirt from fuel, thereby increasing life and efficiency of carbureter and engine parts.

A. To Remove Fuel Filter—

1. Disconnect filter inlet and outlet lines.

2. Remove filter mounting bolts and remove filter from vehicle.

B. To Install Fuel Filter—

1. Place filter in position on mounting bracket.

2. Install mounting bolts.

3 Connect filter inlet and outlet fuel lines.

C. To Disassemble Fuel Filter—Filter may be disassembled in following manner: (Refer to Fig. 22)

1. Remove cover bolt (1) at top of filter, which allows cover to be removed.

2. Filter element (6) and spring (9) may then be stripped off bowl stem.

3. Remove drain plug (5) from bowl stem.

D. To Clean and Inspect Fuel Filter—After disassembling filter, element should be thoroughly cleaned of all foreign matter. Use a reliable cleaning solution and be sure all particles are removed from between plates of element. Inspect gaskets for condition and replace if necessary.

E. To Assemble Fuel Filter—Assemble filter in following manner: (Refer to Fig. 22)

1. Place element spring (9) over stem in filter bowl.

2. Place element (6) over stem in filter bowl compressing spring.

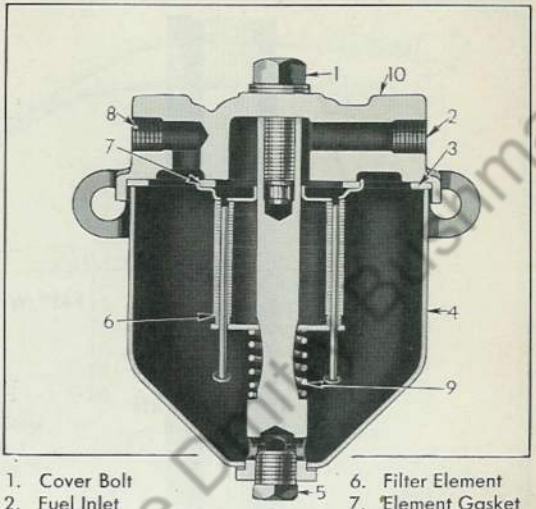
3. Assemble cover (10) to bowl (4), making sure gaskets are in correct position.

4. Install hex headed cover bolt (1) and tighten sufficiently to prevent filter leaking.

5. Install drain plug (5) and tighten securely.

7. ACCELERATOR PEDAL AND LINKAGE

Treadle type accelerator pedal operates carbureter throttle by means of rods, levers, linkage and return springs. Levers and linkage are fastened to side of cylinder block and are connected to accelerator pedal and carbureter throttle by rods. Return springs are provided to return throttle to closed position when accelerator pedal is released or throttle button pushed in.



1. Cover Bolt
2. Fuel Inlet
3. Bowl Gasket
4. Bowl
5. Drain Cock
6. Filter Element
7. Element Gasket
8. Fuel Outlet
9. Spring
10. Cover

Fig. 22 Sectional View of Fuel Filter

A. To Remove and Install Accelerator Pedal and Linkage—Removal and installation of accelerator pedal and linkage may be readily accomplished by referring to Fig. 24.

B. Adjustments After Reassembly—It is important that levers and linkage work freely and do not bind.

8. HAND THROTTLE

Wire and flexible housing type hand throttle is to be used when starting engine or when making engine adjustments. For proper use, refer to "Driver's Instructions" at front of this book.

A. To Remove Hand Throttle—Removal of hand throttle may be accomplished in following manner: (Refer to Fig. 24)

1. Remove collar or stop (8) at carbureter throttle end of wire.

2. Loosen control wire clip screw (7).

3. Disconnect radio bond strap at dash.

4. Remove locknut (5) and lockwasher (6) behind instrument panel and pull entire assembly out through instrument panel.

B. To Install Hand Throttle—Install hand throttle as follows: (Refer to Fig. 24)

1. Thread control wire and housing through proper hole in instrument panel, sliding lockwasher (6) and locknut (5) over control as it is moved through panel.

2. Continue to thread control through dash panel,

FUEL SYSTEM

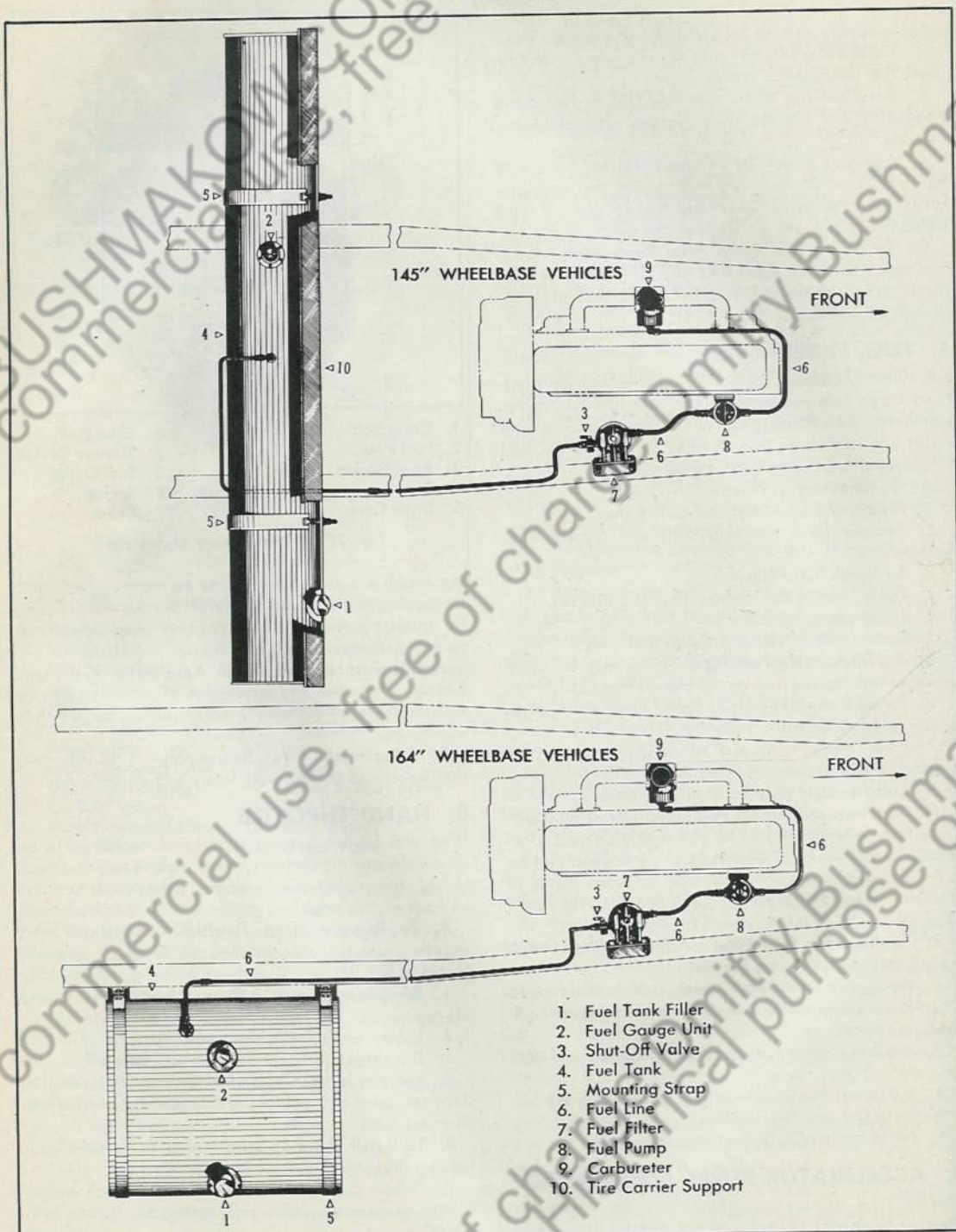


Fig. 23 Fuel Tank and Lines

FUEL SYSTEM

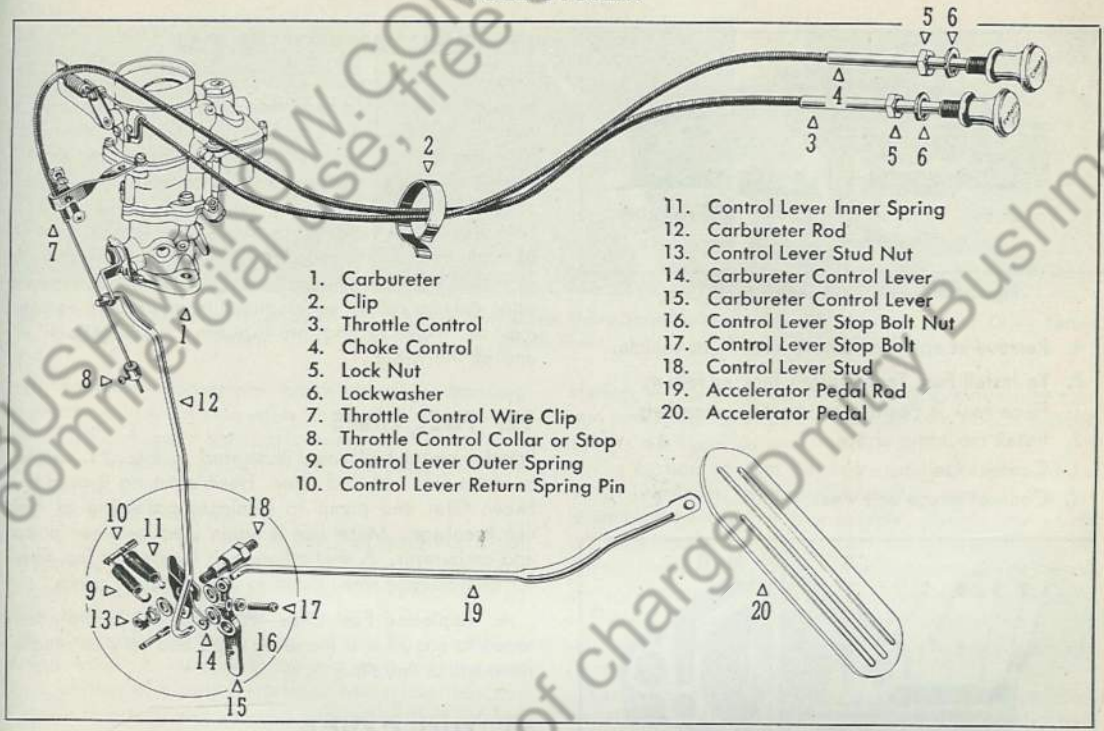


Fig. 24 Accelerator, Throttle, and Choke Control

control clip (2) and assemble end of flexible housing in clip (7) at carbureter.

3. Thread wire through end of carbureter rod (12) and install stop (8).

4. Connect radio bond strap at dash.

C. Adjustments After Reassembly—Adjust hand throttle control as previously described in this group under "Adjustments."

9. CHOKE CONTROL

Wire and flexible housing type choke control is to be used to obtain a richer mixture of fuel when starting engine. For proper instructions on how to use, refer to "Driver's Instructions" at front of this book.

A. To Remove Choke Control—Removal of choke control may be accomplished in following manner: (Refer to Fig. 24)

1. Loosen screw at carbureter choke lever swivel.

2. Loosen control wire clip screw at carbureter end of flexible housing.

3. Disconnect radio bond strap at dash.

4. Remove locknut (5) and lockwasher (6) behind instrument panel and pull entire assembly out through instrument panel.

B. To Install Choke Control—Install choke control as follows: (Refer to Fig. 24)

1. Thread control wire and housing through proper hole in instrument panel, sliding lockwasher (6) and locknut (5) over control as it is moved through panel.

2. Continue to thread control through dash panel, control clip (2) and assembly end of flexible housing in clip at carbureter.

3. Thread wire through choke lever swivel.

4. Connect radio bond strap at dash.

C. Adjustments After Reassembly—Adjust choke control as previously described in this group under "Adjustments."

10. FUEL TANK

Fuel tanks are mounted in one or two positions, depending upon wheelbase of vehicle. Tank is mounted on right-hand frame side rail just back of cab. Location is illustrated in Fig. 23. Tanks are held rigidly in place with mounting straps.

A. To Remove Fuel Tank—

1. Disconnect gauge unit wire.

2. Disconnect fuel tank to fuel filter line at fuel tank.

3. Remove hex nuts and hinge pins from mounting straps.

FUEL SYSTEM

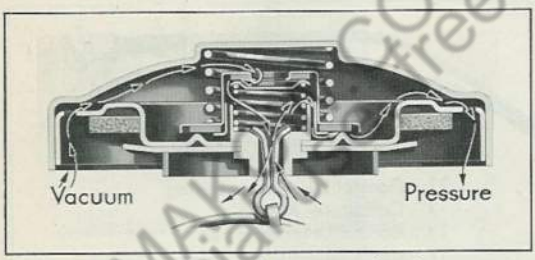


Fig. 25 Fuel Tank Pressure Filler Cap

4. Remove straps and remove tank from vehicle.

B. To Install Fuel Tank—Install tank as follows:

1. Place tank in position on mounting brackets.
2. Install mounting straps.
3. Connect fuel line.
4. Connect gauge unit wire.

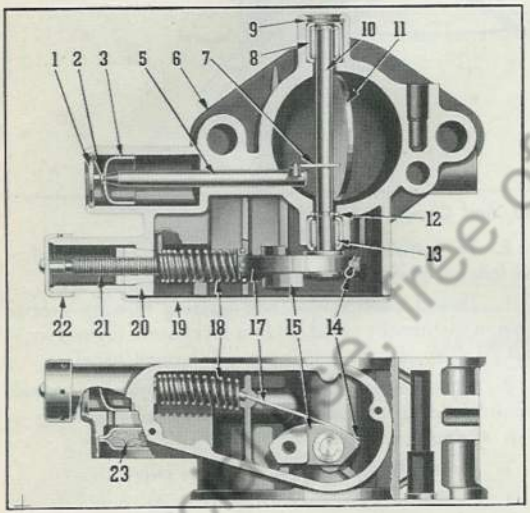


Fig. 26 Sectional View of Governor

1. Stabilizer Piston Plug
2. Stabilizer Piston Clip
3. Stabilizer Piston
5. Stabilizer Piston Rod
6. Governor Body
7. Throttle Valve Arm
8. Throttle Shaft Bearing
9. Bearing Plug
10. Throttle Shaft
11. Throttle Valve Plate
12. Bearing Clip
13. Throttle Shaft Bearing
14. Cam Ribbon Clip
15. Throttle Shaft Cam
17. Cam Ribbon
18. Operating Spring
19. Oper. Spring Cover
20. Adj. Screw Bushing
21. Adjusting Screw
22. Adjusting Screw Cap
23. Air Filter

C. To Repair Fuel Tank—Do not apply heat, such as used in welding or soldering, to tank until it has been cleaned of all traces of gasoline.

11. FUEL TANK FILLER CAP

Pressure type cap, as illustrated in Fig. 25, is easily accessible from right-hand side of vehicle and is secured to filter neck by chain and snap ring. Cap contains both a spring-loaded pressure (relief) valve and a spring-loaded vacuum (intake) valve which completely seals end of fuel tank filler neck. This type cap prevents fuel in both liquid and vapor form from being lost as a result of high atmospheric temperature, high vapor pressure of fuel or continual churning and splashing of fuel. Valves open only to relieve excess pressure or vacuum as case may be. Valve settings are listed in "Specifications" at end of this group.

12. FUEL LINES

Special metal fuel lines, illustrated in Fig. 23, extend between fuel tank and filter. Flexible tubing is used between filter and pump to eliminate possibility of fuel line breakage. Metal line is again used between pump and carbureter. A shut-off valve is located at fuel filter for convenience when cleaning lines, filter or pump.

A. Replacing Fuel Lines—Fuel lines are securely fastened to engine and frame by clips, and may be readily removed or installed.

13. FUEL GAUGE

Fuel gauge registers amount of fuel in tank and is operated electrically by gauge unit in tank. Electrical current for operating gauge first passes through ignition switch, therefore, gauge will not register when switch is in "off" position.

A. Testing Fuel Gauge—For electrical test to determine efficiency of gauge, refer to "Miscellaneous Electrical Group." In the event either unit proves unsatisfactory, replacement of the unit is the only remedy.

14. GOVERNOR

Velocity type governor, illustrated in Fig. 26, is mounted between carbureter and intake manifold and is used to protect engine by limiting engine r.p.m. Governor is adjusted for correct engine speed and sealed at factory.

The velocity type governor is entirely automatic and consists essentially of a body and throttle valve plate which is mounted off-center. Being mounted off-center, throttle valve plate is drawn towards the closed position by velocity of fuel mixture as it passes through governor. This closing action of throttle valve plate is opposed by a cam and spring which tend to hold throttle valve open. Contour of cam and calibration of spring provide proper balance between closing action of throttle valve plate and opening action of cam and spring; thus governing engine by restricting fuel flow.

FUEL SYSTEM

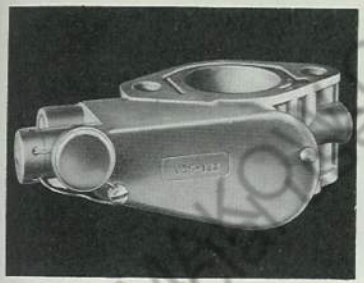


Fig. 27 Model Number is Stamped on Housing as Shown

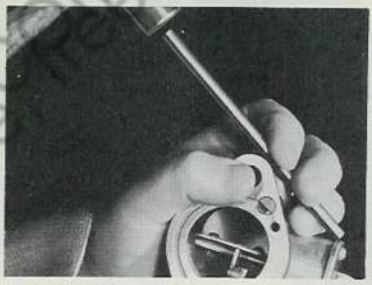


Fig. 28 Start Cover Drive Screw with Blunt Tool

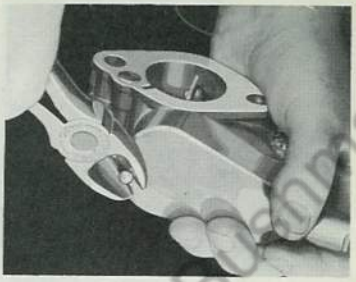


Fig. 29 Remove Cover Drive Screw with Pliers as Shown

A. To Remove Governor—Governor may be removed from vehicle in same manner as carbureter, as governor will lift off carbureter studs after removal of carbureter. Refer to "To Remove Carbureter" described earlier in this group.

B. To Install Governor—

1. Care should be taken to see that governor is not installed upside down as position differs with downdraft and updraft carbureters. Governor is marked with an arrow indicating carbureter side.

2. The gasket between carbureter and governor is slotted to allow vacuum to by-pass through governor for operation of power jet piston. Make sure that this gasket is in good condition and installed so that vacuum openings are not obstructed.

3. A by-pass screw is installed in power jet vacuum passage in carbureter and under no circumstances should this screw be left out when installing carbureter.

4. Install carbureter and air cleaner as described previously in this group under their respective headings.

C. Governor Adjustment—A speed adjustment (22, Fig. 26) is provided on governor which is set and sealed at factory. This adjustment should not be changed from factory setting. In the event operation of vehicle indicates an adjustment necessary, this is in reality an indication that governor should be removed from vehicle and cleaned.

D. To Clean Governor—Carbon, gum or other substances will form on mechanism of governor under normal operation. This condition particularly affects throttle valve shaft bearings and stabilizer piston.

The carbon or gum substances may be removed by either immersing the complete unit or parts of the disassembled governor into a reliable solvent—one which will effectively clean yet will not damage the metal parts. However, the more effective method is to completely disassemble governor and then clean each part.

The recommendations of solvent manufacturer should be followed as to length of time parts are immersed, rinsed, etc.

Parts should be thoroughly blown out with compressed air after immersion in solvent, particularly parts illustrated in Figs. 36 and 37.

E. To Disassemble Governor—Governor may be disassembled for cleaning or repair in following manner. A special Handy Wrench is required to properly repair governor and is referred to in the following instructions by Handy number. (Refer to Fig. 26 for caption numbers in parenthesis.)

1. Check governor model before proceeding, as this is essential to obtain correct recalibration. Model number is stamped on operating spring housing cover as illustrated in Fig. 27, also given in "Specifications" at end of this section.

2. Remove governor seal, operating spring housing cover slotted screw and drive screw and remove cover.



Fig. 30 Remove Cam Ribbon Hairpin Clip as Shown

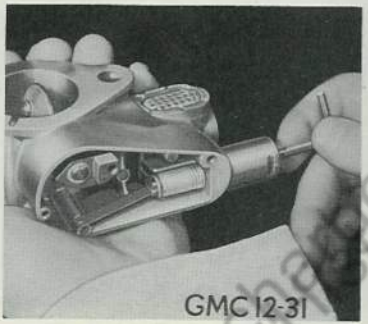


Fig. 31 Use of Hex Set Screw Wrench in Removing Operating Spring



Fig. 32 Use of Special Wrench in Removing Operating Spring

FUEL SYSTEM



Fig. 33 Remove Adjusting Screw with Drift Pin as Shown

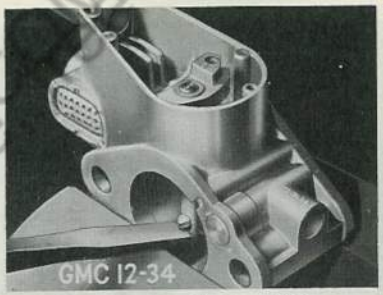


Fig. 34 Pry Out Shaft and Cam as a Unit

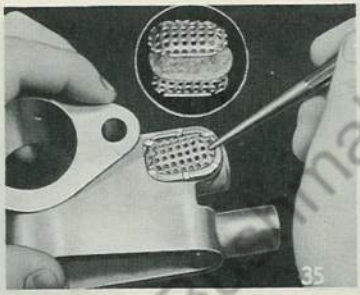


Fig. 35 Remove Air Filter Outer Cover as Shown

When removing cover, the use of sharp tools should be avoided—and under no circumstances should any attempt be made to pry it off as this cover must fit air tight when reassembled. Refer to Fig. 28 and use blunt instrument to merely free the drive screw. With screw slightly moved, it may be removed with side cutting pliers as illustrated in Fig. 29.

3. Remove cam ribbon hairpin clip (14) in manner illustrated in Fig. 30.

4. Unhook cam ribbon (17) from cam pin, being careful not to distort or damage cam ribbon. This may be accomplished by turning adjusting screw counter-clockwise to relieve spring tension.

5. Remove adjusting screw assembly (21) as follows:

(a) Using a 1/8" hex set screw wrench in manner illustrated in Fig. 31, turn adjusting screw counter-clockwise as far as it will go.

(b) Using special Handy hollow wrench No. 24283 in manner illustrated in Fig. 32 turn adjusting screw bushing (20) counter-clockwise far enough to allow adjusting screw to be turned out of operating spring by repeating operation (a).

(c) With adjusting screw pilot threads turned tight against bushing (20) drive adjusting screw and bushing assembly from governor body using light hammer and drift pin in manner illustrated in Fig. 33. Be careful not to damage pilot threads.

6. Remove throttle valve plate (11).

7. Remove throttle valve shaft (10) and cam (15) as an assembly. Cam is mounted on shaft in a definite relation to throttle valve plate and must be carefully pried out as a unit in manner illustrated in Fig. 34.

8. Remove valve shaft bearing clip (12) and bearing (13) from shaft.

9. Remove air filter outer cover in manner illustrated in Fig. 35, being careful not to break off casting projections that hold cover in place.

10. Remove air filter and inner cover.

F. To Inspect Governor—Before reassembling governor, all parts should be carefully cleaned and inspected for marks or ridges and other signs which would indicate wear. Such parts should be replaced by new ones to assure satisfactory operation. Method of cleaning governor is described previously in this group under "To Clean Governor."

G. To Assemble Governor—After governor has been thoroughly cleaned, assemble in following manner:

1. Install new air filter felt with covers in proper relation, as shown in insert of Fig. 35. It may be necessary to bend outer cover to get it under the several casting projections. However, cover may be spread out again by tapping it with hammer as illustrated in Fig. 38.

2. Assemble bearing (13) to valve shaft (10). This bearing is tapered and must be installed correctly. There is printing on smaller end of bearing while larger end is plain. Install larger (plain) end on shaft first.

3. Move bearing on shaft until bearing is against cam, then install clip (12).



Fig. 36 Cleaning Throttle Valve Shaft Bearing with Compressed Air



Fig. 37 Cleaning Stabilizer Piston with Compressed Air



Fig. 38 Spread Filter Outer Cover as Shown

FUEL SYSTEM



Fig. 39 Install Shaft and Cam as a Unit

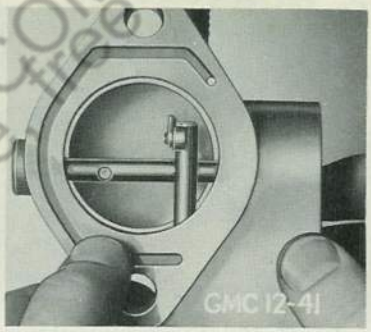


Fig. 40 Use Light to Center Throttle Plate

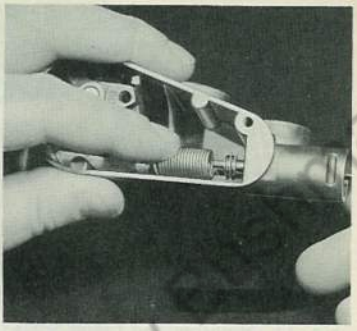


Fig. 41 Install Operating Spring to Adjusting Screw as Shown

4. Press cam, shaft and bearing assembly into governor body. Here again care must be exercised so that cam is not damaged nor position of it changed on shaft. Apply a hollow tool over end of shaft and against cam as illustrated in Fig. 39 and tap end of tool or use arbor press to force assembly into place. Press shaft assembly into governor body until valve plate surface of shaft is centered into governor throat. If shaft is pressed in too far, it may be moved back as described in item 7 under disassembly.

5. Install throttle valve plate so that valve plate arm will engage stabilizer piston rod (5). Arm must fit into piston rod groove. First tighten valve plate attaching screw lightly. Then, center valve plate and tighten both screws.

Installing valve plate correctly is extremely important. There must be no rubbing against side of governor throat. Close valve plate and hold governor up to the light as illustrated in Fig. 40 so that light around valve plate will indicate when it is properly centered. Rotate valve plate several times to be certain it does not bind.

6. Turn adjusting screw bushing (20) on adjusting screw (21) about two-thirds of the way and insert into adjusting screw housing of governor body.

7. Attach operating spring (18) to adjusting screw (21) in following manner:

(a) Insert extended pilot end of spring (18) into guide channel in governor body and hold spring in place as illustrated in Fig. 41.

(b) Turn adjusting screw into spring two or three coils.

8. Attach cam ribbon (17) to retaining pin on cam (15) and install clip (14).

9. Rotate throttle valve plate (11) to separate coils of operating spring (18) as illustrated in Figs. 42 and 43 and count **Active** coils of spring in manner illustrated in Fig. 43. Active coils begin at cam ribbon anchor and end at beginning of adjusting screw pilot threads and are clearly illustrated in Fig. 42. Using 1/8" hex set screw wrench turn adjusting screw (21) into operating spring (18) until number of **Active** coils remaining in operating spring is as given in "Specifications" at end of this group. **This Adjustment Is Very Delicate and Must Be Made Accurately and According to Specifications.**

10. Install operating spring housing cover making sure gasket is in perfect condition and attaching screws are tight. Use oversize drive screw if necessary. This operation is also important as cover and governor body **Must Be Air Tight.**

H. To Recalibrate Governor—Install governor on engine and recalibrate in following manner:

1. Install a tachometer on engine.
2. Start engine and allow it to warm up.

Active coils of spring begin at point "Zero" (spring anchor) and end at point "A" (where spring enters adjusting screw pilot threads).

To obtain any number of full active coils point "A" must be parallel with point "Zero" as shown.

Each turn of adjusting screw adds or subtracts one coil. To obtain fractional coils turn adjusting screw as required. Each complete turn counter-clockwise, looking at adjusting screw end of governor, adds one coil. Each complete turn clockwise subtracts one coil. For example: To set 10¼ coils turn adjusting screw until 10 active coils are included between "Zero" point and point "A," to add ¼ coil turn adjusting screw counter-clockwise ¼ turn.

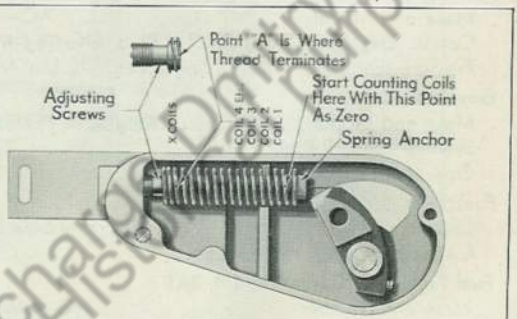


Fig. 42 Operating Spring Coil Diagram

FUEL SYSTEM



Fig. 43 Separate and Count Spring Coils as Shown

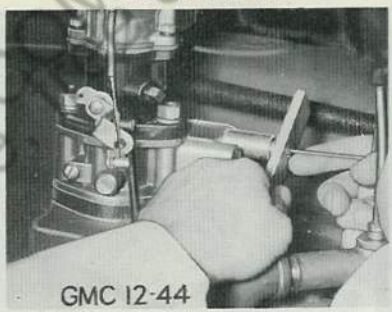


Fig. 44 Use of Special Wrenches to Calibrate Unit

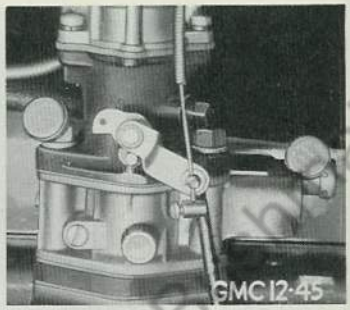


Fig. 45 Seal Governor as Shown

3. Assemble Handy special hollow wrench No. 24283 to adjusting screw bushing (20) and 1/8" hex set screw wrench in adjusting screw (21) as shown in Fig. 44.

4. Accelerate engine and run at wide-open throttle.

5. Hold adjusting screw (21) stationary with hex set screw wrench and turn adjusting screw bushing (20) with special hollow wrench No. 24283 in direction necessary to bring engine r.p.m. to that shown in "Specifications."

6. Remove hex set screw wrench from governor and tap special hollow wrench with hammer to set adjusting screw bushing in governor body.

7. Remove special hollow wrench from governor and install adjusting screw cap.

8. Seal governor by passing sealing wire through hole in cover screw, through adjusting screw cap, and through female half of seal. Twist ends of wire together securely inside female half and insert male half.

TABULATED DATA

15. SPECIFICATIONS

Carbureter

Make and Model	Zenith—28AVII
Identification Plate	2135998-9778A
Accelerator Jet	12
Fuel Valve Seat	40
Idling Jet	14
Main Jet	28
Power Jet	16
Venturi	29
Main Discharge Jet	70
Well Vent	20
Governor Plug	C-138-38
Float Level	1 1/2"

Air Cleaner

Make and Type	AC—Oil Bath

Fuel Pump

Make and Model	AC—AF
Capac. (Eng. r.p.m. 2000-2500)	1 Pt. or Over in 1 Min.
Pressure (Engine at lowest idling speed)	3 3/4 Lbs. Max.

Governor

Make and Model	King Seely—V5-146
Setting—Eng. R.P.M. (Max.)	2750
Operating Spring Active Coils	12

Fuel Tank

Location	R.H. Frame Side Rail
Capacity (Gals.)	40

Fuel Tank Filler Cap

Make and Number	AC—850018
Exhaust Valve Opens at (Lbs. Pressure Per Sq. In.)	1 1/2
Vacuum Valves Open at (Lbs. Pressure Per Sq. In.)	1/2

Fuel Filter

Location	R.H. Frame Rail Between Tank & Pump
Make and Type	AC—T2

Manifold

At Idling Speed (350 R.P.M.) 18 to 20 Inches When Tested with Standard Vacuum Gauge.

16. TOOL EQUIPMENT

The following special tools, or their equivalent, are recommended for use when servicing FUEL SYSTEM.

Tool No.	Name	Supplier Code
C-161-1	Carbureter Main Discharge Jet Tool	Z
C-161-5	Carbureter Air Vent Check Valve Tool	Z
C-161-9	Carbureter Power Jet and Valve Tool	Z
C-161-10	Carbureter Vacuum Cylinder Tool	Z
C-161-19	Carbureter Channel Plug Tool	Z
C-161-21	Carbureter Accelerator Jet Remover	Z
C-161-51	Carbureter Accelerator Jet Replacer	Z
C-161-53	Carbureter Pump Check Valve Tool	Z
C-161-80	Carbureter Well Vent Tool	Z
C-161-85	Carbureter Fuel Valve Seat Tool	Z
KMO-364	Tool Set (Includes above 10 items)	KM
G-8	Vacuum Gauge	AE
24283	Governor Wrench	H

TOOL SUPPLIER

Supplier Code	Name	Address
AE	Allen Electric and Equip. Co.	Kalamazoo, Mich.
KM	Kent-Moore Organization	Detroit, Mich.
Z	Zenith Carburetor Corp.	Detroit, Mich.
H	King Seeley Corp.	Ann Arbor, Mich.

Group 04 — Exhaust System

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REPAIR	
Exhaust Manifold Heat Control Valve	3
Exhaust Pipe	4
Muffler	5
Tail Pipe	6

GENERAL

1. DESCRIPTION

Exhaust system consists of a exhaust pipe, muffler, tail pipe and attaching parts for these units. Purpose of the exhaust system is to carry exhaust gases away from engine and to muffle or to reduce combustion noises of engine.

2. TROUBLE SHOOTING

The driver should always be on the alert to detect possible failure of any unit in the exhaust system. The first indication of leakage throughout the system will be apparent from the odor of exhaust gas in the engine compartment of driver's cab, also by a gradual increase in sound of combustion noises. Either of these conditions call for the immediate installation of new parts.

REPAIR

3. EXHAUST MANIFOLD HEAT CONTROL VALVE

Exhaust manifold is equipped with an adjustable heat control valve which directs heat around the fuel vaporizer section of the intake manifold. All service information in connection with the exhaust manifold heat control valve is given in Engine group 01 of this manual.

4. EXHAUST PIPE

Whenever exhaust pipe is removed, always use new gasket between pipe and manifold and see that sleeve is installed, as shown in the accompanying illustration.

5. MUFFLER

Relative location of muffler in relation to the exhaust system is illustrated in Fig. 1. After operation over rough terrain, muffler should be inspected to see that it has not been damaged and that it is securely mounted to chassis. The muffler may be replaced by removing the rear support bracket and the exhaust pipe clamped at front of muffler.

6. TAIL PIPE

Tail pipe is clamped to rear side of muffler and is formed to direct exhaust gases into slip steam of rear wheel. A U-bolt is used for attachment of exhaust pipe at outlet end.

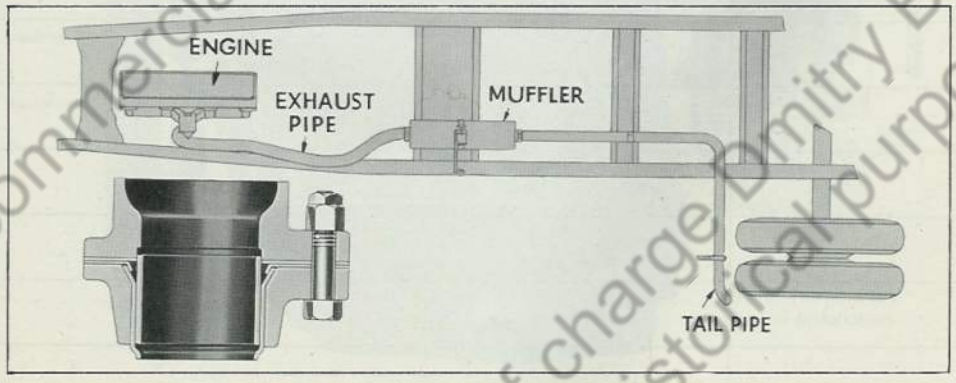

Fig. 1 Typical Exhaust System

WARNING—CARBON MONOXIDE

Never start or run an engine in a closed garage. The exhaust gases from all motor vehicles are highly dangerous. They contain carbon monoxide gas—which is colorless, tasteless and odorless, but nevertheless is a deadly poison.

SERVICE BULLETIN REFERENCE

Bulletin No.	Description

BUSHMAKOV.COM commercial use, free of charge Dmitry Bushmakov Historical purpose

Group O5 — Cooling System

	Paragraph
GENERAL	
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Trouble Shooting and General Solutions	2
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05

GENERAL

1. DESCRIPTION AND OPERATION

The units which comprise the cooling system include Radiator, Cap, Fan, Water Pump, Thermostat, Temperature Indicator and the various tubes, fittings, etc., which direct the circulation of water. All of these units cooperate to automatically maintain engine operating temperature.

Water is drawn from bottom of radiator by action of water pump and is force-circulated through water jackets in engine cylinder block and head. Water pump action completes the circulation and returns water through upper connection to radiator where it is cooled by action of fan drawing air through radiator core. Refer to Fig. 1. Thermostat assists in maintaining operating temperature by restricting flow of water until a predetermined temperature is reached. Water temperature control tube is provided to relieve and prevent accumulation of excessive heat at rear of engine. Temperature gauge at instrument panel is the driver's guide as it provides a constant indication of engine temperature and of the general condition of the cooling system.

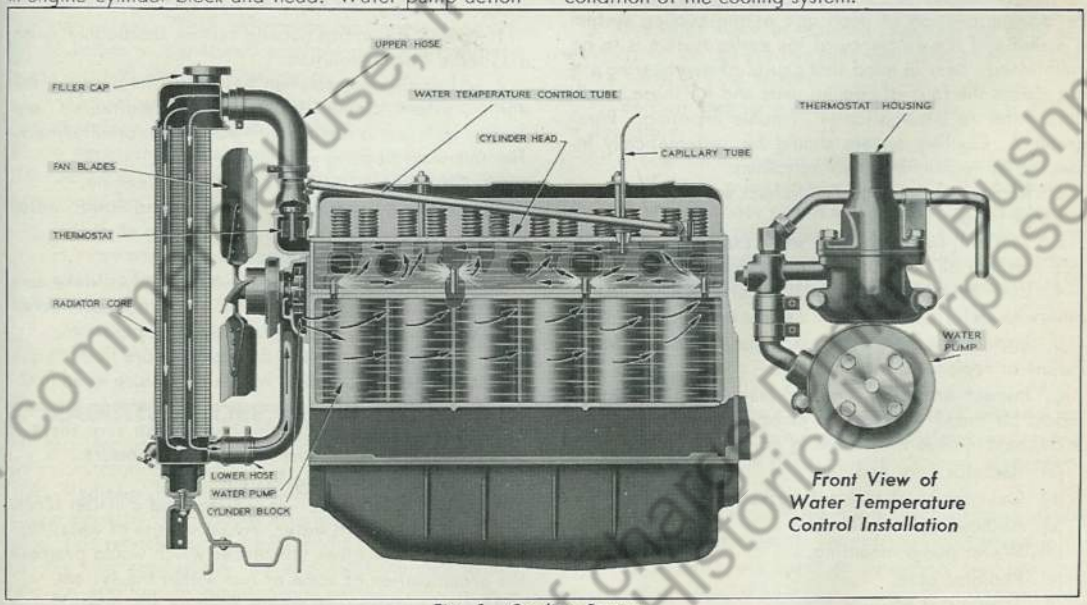


Fig. 1 Cooling System

COOLING SYSTEM

2. TROUBLE SHOOTING AND GENERAL SOLUTIONS

A. Overheating—
1. Lack of water—
Refill system.
2. Belts Loose or Bottoming in Pulleys—
Adjust or replace.
3. Thermostat Remains Closed—
Replace thermostat.
4. Water Pump Inoperative—
Overhaul water pump.
5. Cooling System Clogged—
Clean entire system.
6. Incorrect Ignition Timing—
Retime ignition.
7. Brakes Dragging—
Adjust brakes properly.
8. Radiator Core Air Passages Clogged—
Clean radiator core.

B. Overcooling
1. Thermostat Remains Open—
Replace thermostat.

C. Loss of Cooling Liquid—
1. Defective Hose Connections—
Tighten all connections.
2. Defective Water Pump Seal—
Replace seal.
3. Leaks in Radiator Core—
Remove core—test and repair.

3. INSPECTION

Periodic inspection of each unit of the cooling system is essential if the efficiency of the entire system is to be maintained. Bear in mind that causes of overheating are not always the fault of cooling units and for these conditions, refer to information in "Trouble Shooting," Paragraph 2. Cooling system should be systematically inspected at regular intervals as follows:

1. Remove radiator cap and check water level. Keep radiator filled.
2. Test anti-freeze solution when used.
3. Inspect all hose connections. Tighten if necessary.
4. Examine all hose carefully. If cracked, swollen or otherwise deteriorated, install new hose.
5. Inspect fan belt and test it for tension by hand. Adjust or replace as required.
6. Inspect entire system for leaks. This inspection should be made with engine at operating temperature and should include the following points:
(a) Radiator core and cap.
(b) Cylinder head to block gasket.
(c) All hose and connections.
(d) Water pump mounting.
(e) Radiator core.
(f) Thermostat housing.
7. See that radiator core is not clogged with dirt or insects.
8. Disconnect fan belt and test water pump operation. Pump should operate smoothly without excessive end play in shaft.
9. Inspect radiator mountings, support braces and tie rod.
10. Determine extent of rust accumulation within system. This may be accomplished by draining small quantity of water from radiator and cylinder block.

4. COOLING SYSTEM MAINTENANCE

Aside from the inspection procedure outlined in paragraph 3, the cooling units should be serviced at regular intervals to maintain the efficiency of the system. This service includes Draining, Cleaning and Filling the system.

A. Draining the Cooling System—Whenever cooling system is drained, be sure both radiator and cylinder block are empty.

One drain cock is provided at bottom of radiator and is accessible from front lower side of brush guard. The other drain cock is located at left rear side of engine cylinder block. To completely drain system, it is necessary to remove radiator filler cap.

Caution: If system is drained and not refilled immediately, a suitable tag should be marked "no water" and attached to steering wheel.

B. Cleaning the Cooling System—Entire cooling system should be cleaned at least twice a year—more often if inspection reveals unusual accumulation of rust, scale, etc. This service should always be performed before and after using anti-freeze solution. The following procedure is recommended:

1. Clean the entire cooling system thoroughly, using a suitable cleaner solution.
2. After cleaning solution has served its purpose, the entire system should be thoroughly neutralized and flushed before it is refilled with fresh water or anti-freeze. The following flushing instructions apply.
(a) Open drain cocks at radiator and engine.
(b) Disconnect and remove upper and lower water connection.
(c) Remove thermostat.
(d) Flush radiator and engine separately. Make sure that both hose connections at radiator are disconnected from engine during the engine flushing operation.
(e) A combination air and water pressure flushing gun is recommended. Carefully regulate pressure when flushing radiator as excessive pressure might damage the unit, especially if it is partially clogged. Make sure there is an unobstructed outlet before applying pressure.

C. Filling the Cooling System—
1. Close drain cocks—at radiator and cylinder block.
2. Use clean (soft) water. Avoid the use of water that contains alkali or other substances which would promote the accumulation of scale or rust within the system.
3. Use suitable anti-freeze solution for operation in

COOLING SYSTEM

atmospheric temperatures below 32° F.

4. Always allow an overheated engine to cool before adding water or anti-freeze.

Never pour cold water into an overheated engine, as sudden changes in temperature may crack cylinder head, etc.

D. Rust Prevention—The treatment of cooling systems with a suitable inhibitor (such as GMC-PH-7) for the prevention of rust and scale formation is recommended. The following applies:

1. Do not use excessive amount of inhibitors in the cooling system.

2. Do not add inhibitors in connection with anti-freeze already containing them.

3. Soluble oil may be used in amounts not to exceed 1% of the volume of the system. Six (6) ounces is sufficient for this cooling system.

4. Potassium bichromate may be used in proportion of 2 ounces to each 5 gallons of water.

5. Inhibitors are **not** cleaners. They form a thin protective coating on the metal surfaces within the cooling system and thus prevent rust accumulation, etc.

5. COLD WEATHER OPERATION

Cooling systems must be protected against freezing when vehicle is operated in atmospheric temperatures below 32° F. Selection of the proper type of anti-freeze and maintenance of the system during its use are important factors in vehicle operation during cold weather.

A. Anti-freeze—There are three general types of anti-freeze commercially available which may be used to prepare anti-freeze solutions satisfactorily for use in truck cooling system. These anti-freeze substances are commonly known as denatured alcohol, methanol (synthetic wood alcohol) and ethelyne glycol.

1. Alcohol and methanol are subject to evaporation and, therefore, require frequent testing and the adding of the necessary quantity of this anti-freeze to protect the cooling system for the lowest anticipated temperature conditions.

2. Ethelyne glycol, if used in an absolutely leak-proof system, does not usually require replacement for, due to its higher boiling point, only water is lost by evaporation.

3. Solutions containing salt, magnesium chloride, sodium silicate or other inorganic salts; honey, glucose, sugar, kerosene, or other oils are not satisfactory for use in cooling systems.

4. Radiator glycerine, chemically treated in accordance with formula approved by The Radiator Glycerine Producers Association to avoid corrosion, is satisfactory for use in cooling system.

ANTI-FREEZE CHART
(19 Quart Capacity)

Temp.	Alcohol	Methanol	Ethylene Glycol
+10° F.	6	4¾	4¾
0° F.	7	6	6½
—10° F.	8½	7	7½
—20° F.	9½	8¼	8½
—30° F.	12	9½	9

B. Maintenance During Cold Weather Operation—Cooling system requires a regular inspection and servicing procedure during operation in cold weather. The following is recommended:

1. Inspection of connections and gaskets should be made to determine existence of leaks which might result in loss of anti-freeze.

2. The cooling solution must be tested frequently to determine the strength of the anti-freeze and the protection obtained. A testing device should be provided and used in strict accordance with the instructions supplied by the manufacturer for testing the particular type of anti-freeze being used.

3. Add anti-freeze as required to obtain the required protection. Do not use two different types of anti-freeze in the same cooling system.

4. Perform regular inspection operations as outlined in paragraph 3.

5. If solution in cooling system becomes frozen solid, place vehicle in a warm place until ice is completely thawed out and under no circumstances should engine be run while in this condition. If radiator is only partly frozen and a heated garage is not available, place some type of blanket over radiator and run engine slowly until ice is thawed.

REPAIR

6. RADIATOR CORE, SHELL AND GRILLE

The radiator consists of two tanks and a core of fin and tube construction.

A. Radiator Maintenance—Efficient cooling of the engine depends upon proper maintenance of the radiator core. This service must be performed regularly to maintain the efficiency of the unit as part of the cooling system. In addition to maintenance of the radiator as a functional part of the cooling system, it is essential to remove the radiator core from the vehicle at least every 20,000 miles and give it a thorough cleaning, inspection and repair.

If radiator core requires painting, it should be sprayed with special radiator paint. Do not use paint mixed with oil as such paint will form an insulation and prevent proper dissipation of heat.

COOLING SYSTEM

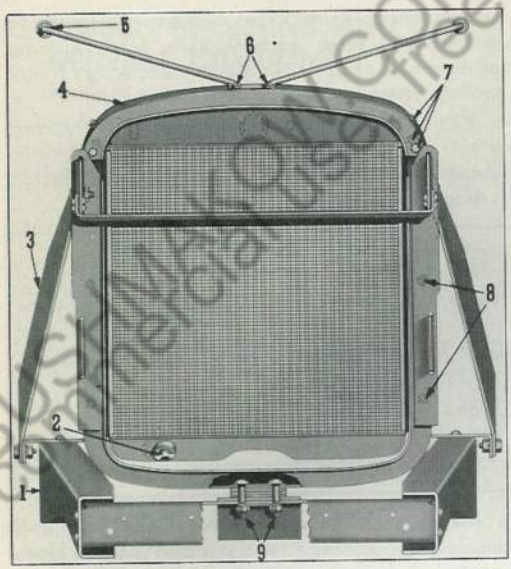


Fig. 2 Radiator Core Installation

1. Frame
2. Radiator Drain Cock
3. Radiator Brace
4. Radiator Upper Support
5. Tie Rod Adjusting Nut
6. Radiator Tie Rod Screws
7. Radiator Upper Support Screws
8. Fan Shroud and Radiator Support Screws
9. Lower Support Bolts, Nuts, and Lock Nuts

B. To Remove Radiator Core—Radiator core may be removed without disturbing brush guard or fenders as follows. **Caution:** When removing radiator core, support or fan shroud, care should be exercised to note location and use of double-shake-proof lockwashers throughout. These lock washers must be reinstalled in their exact original location to assure proper radio noise suppression. If doubt exists as to their correct relation, refer to illustrations in Miscellaneous Electrical Group.

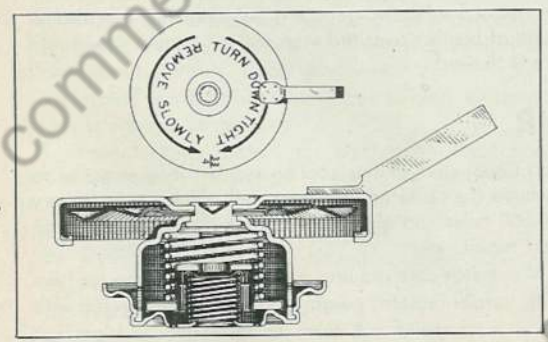


Fig. 3 Radiator Sealing Cap

1. Drain radiator.
2. Remove 2 screws which mount tie rod to radiator upper support.
3. Disconnect tie rod at cowl.
4. Disconnect upper radiator hose at radiator.
5. Spread clips and remove wiring harness at radiator upper tank.
6. Remove 3 screws at each end of radiator upper support.
7. Remove radiator upper support.
8. Disconnect radiator lower hose—at radiator.
9. Disconnect radio noise suppression bond strap at left and right-hand side of radiator lower tank.
10. Remove 3 screws on each side of radiator which attach fan shroud to radiator support.
11. Remove 2 radiator lower support bolts. These bolts are accessible from underneath the vehicle.
12. Remove lower support.
13. Place fan shroud back of fan and lift radiator straight up to remove from vehicle.

C. To Install Radiator—Procedure outlined in foregoing paragraphs may be reversed to accomplish reinstallation of the radiator, except as follows:

1. The 2 paper retainers removed from lower mounting are used to facilitate production assembly only and are not required for reinstallation.

2. Adjust radiator tie rod carefully to provide proper position of radiator core and proper clearance between core and fan blades.

(a) Tie rod should be adjusted before lower mounting bolts are tightened.

(b) Minimum clearance of 3/4" must be obtained between lower end of core and fan blade.

(c) Be sure both nuts at each end of tie rod at cowl are securely tightened after proper clearance has been obtained and that new shakeproof lockwashers are used.

7. RADIATOR FILLER CAP

Radiator filler cap is of the sealing type which maintains a supply pressure of under 4 pounds on the cooling liquid when engine warms up to operating temperature. This increase in pressure raises the boiling point of the cooling liquid and permits a slightly higher operating temperature, which results in improved engine performance and economy without the danger of overheating.

Radiator sealing cap consists of a special filler cap with a spring loaded valve. The overflow pipe in the filler neck is located above valve seat so that no liquid or air can escape when cap is in position. When pressure rises above 4 pounds, the valve opens and relieves the system until pressure returns to 4 pounds. This arrangement also reduces loss of cooling solution by evaporation or surging.

A. To Remove Filler Cap—Design of the sealing cap and the filler neck provide 2 stages for removing cap. The first stage raises valve from special rubber gas-

COOLING SYSTEM

ket in filler neck so that all pressure is relieved through overflow pipe. The first stage is reached by turning cap to the left until it reaches the safety stop. In this position cap should be loose—so that it can be pressed down against gasket approximately $\frac{1}{16}$" to $\frac{1}{8}$". Prongs of cap may be bent with pliers, if necessary, to maintain this condition. Cap should not be too loose, however, or valve may not seal when cap is in the fully closed position. To remove:

1. **Loosen Cap Slowly When Engine Is Hot.** If escaping air or steam is heard, remove hand from filler cap until it stops. Then continue turning cap until safety stop is reached.
2. By stopping at the first stage, any danger of being burned by hot water or steam is avoided.
3. To remove cap completely after pressure has been relieved, press the cap downward, turn it to the extreme left, and then lift it off.

8. THERMOSTAT

The thermostat is provided to maintain operating temperatures of engine within a definite range for maximum efficiency. Thermostat consists of a valve actuated by a thermostatic element. This unit is installed in a housing at cylinder head water outlet above the water pump. Thermostat valve "cracks" or just starts to open at approximately 160° and continues to open in gradual stages until temperature reached approximately 185°, at which point it is fully open.

There are no repairs or adjustments that can be made on the thermostat and, if conditions indicate that the unit is not functioning properly, it should be removed and tested. To service thermostat, proceed as follows:

1. Disconnect and remove thermostat housing from cylinder head water outlet.
2. Remove thermostat from housing.
3. Test thermostat operation. This may be done by placing thermostat in water and heating the water gradually until opening temperature of thermostat is reached.
4. Do not attempt to repair thermostat. If test indicates that unit is not functioning properly, install a new thermostat in system.
5. Always be sure that thermostat having correct operating range is used. Temperature at which thermostat starts to open is stamped on flange of unit for identification.

9. ENGINE TEMPERATURE GAUGE

Temperature gauge on instrument panel indicates operating temperature of engine. This gauge is operated from thermal unit inserted in engine cylinder head.

If it is suspected that temperature gauge is not functioning properly, unit should be removed and tested or replaced by a gauge known to be accurate.

10. FAN AND BELT

Fan blade is installed on water pump pulley and is driven by belt from crankshaft in connection with generator and water pump. Drive belt must be kept at proper tension to maintain efficiency of the units which it drives and to obtain maximum life of the belt.

A. To Adjust Fan Belt—This adjustment should be made whenever inspection shows that belt does not have sufficient tension as indicated in Fig. 4.

1. Loosen generating mounting and brace bolts.
2. Move generator away from engine until correct belt tension is obtained. A light pressure on belt at a point midway between pulleys should cause $\frac{1}{2}$" deflection as shown in Fig. 4. Do not adjust belt too tight.
3. Make sure that generator bolts are tightened securely after correct belt adjustment is obtained.

B. To Replace Belt—

1. Loosen generator mounting and brace bolts.
2. Move generator toward engine as far as possible.
3. Install new belt; over fan blades first, then over crankshaft, then over water pump and generator pulley.

11. WATER PUMP

Water pump assembly is of the packless type and is mounted on front end of cylinder block. Drive is by V-type belt from crankshaft pulley in conjunction with generator. Function of water pump is primarily to maintain circulation of liquid in cooling system.

Refer to Fig. 5. Pump shaft (4) forms inner race for double row ball bearing of sealed type upon which shaft turns. Bearing (4) is held in place in pump housing by retaining cap (3) pressed over end of housing (5) and is accessible after fan (1) and pulley (2) have been removed from shaft (4). End thrust in shaft is also taken by this ball bearing. Bearing is packed with lubricant at time of manufacture, and sealed; no further lubrication being required throughout life of bearing.

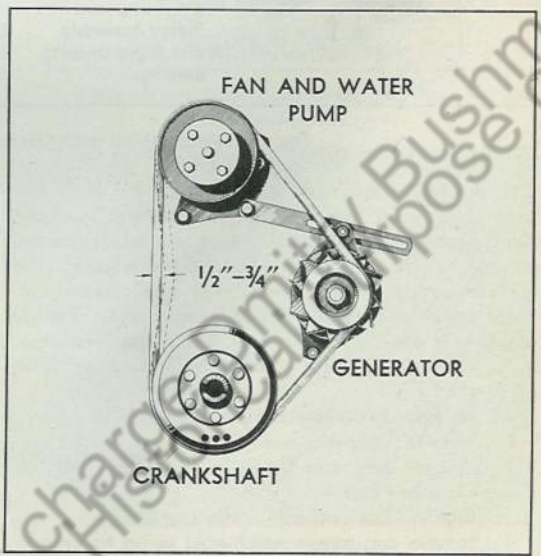


Fig. 4 Belt Adjustment

COOLING SYSTEM

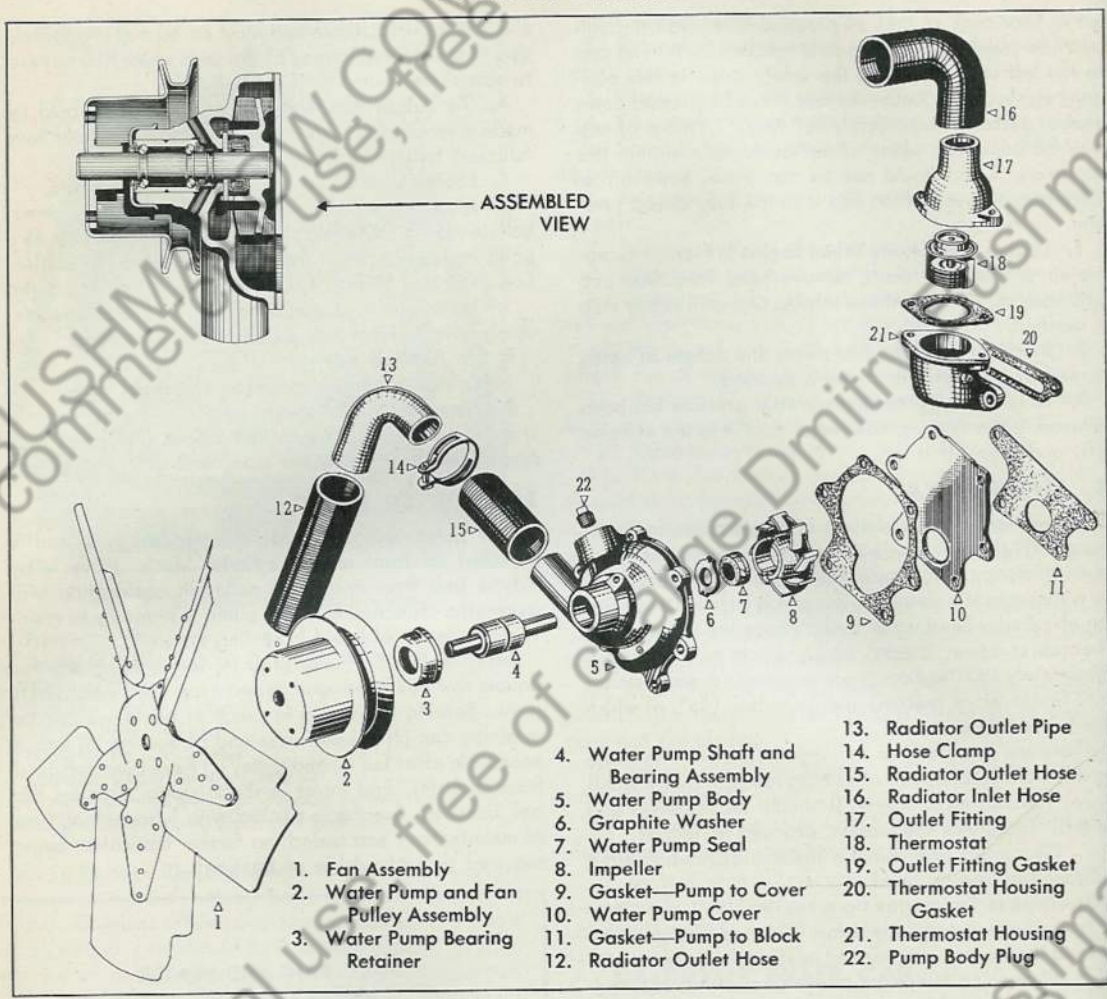


Fig. 5 Disassembled and Assembled View of Water Pump and Fan

If bearing replacement is necessary, new shaft and bearing (4) must be installed as complete assembly. Pump packing is non-adjustable type, consisting of composition washer (6) and rubber seal (7) with springs and retainers enclosed. This arrangement maintains constant pressure between impeller (8), seal and washer. Rubber seal is held against impeller and composition washer so as to effectively prevent water from leaking out along pump shaft (4).

A. To Remove Water Pump—

1. Drain radiator and engine water jacket.
2. Back off generator brace to relieve fan belt tension and remove belt.
3. Remove hose connection at water pump.
4. Remove cap screws which hold pump to cylinder block. Take off water pump and fan assembly.

B. To Disassemble Pump—(See Fig. 5)

1. Remove fan and pulley (1 and 2).
2. Remove cover (10) from back of pump body (5).
3. Remove hub (2) from shaft (4) with suitable puller.
4. Pull off bearing retainer cap (3), now accessible from outside of housing.
5. With forward end of pump body properly supported in arbor press, as shown in Fig. 6, shaft and bearing assembly (4) may be pressed out of impeller (8) and through housing (5).
6. Remove and discard water seal assembly (7) and graphite washer (6). A new seal should be installed whenever water pump is disassembled for servicing.

C. Inspection—

1. No attempt should be made to clean or lubricate pump shaft bearing (4) as this is a shielded type bearing,

COOLING SYSTEM

packed at time of manufacture with sufficient lubricant to last throughout life of bearing. To clean properly, use cloth moistened in cleaning fluid and wipe off surplus lubricant or foreign matter which may be around bearing or on shaft.

Never immerse water pump shaft and bearing (4) in cleaning fluid as this will dissolve lubricant and render bearing unfit for further service.

2. If bearing is found to be noisy, entire shaft and bearing assembly (4) must be replaced since shaft forms part of bearing assembly.

3. Replace impeller (8) if it is found to be corroded or loose on shaft.

4. Inspect face of housing (5) against which seal washer turns; surface should be free from nicks and scores. Use a suitable tool, such as the one illustrated in Fig. 7, to restore a smooth, square surface. Tool is used as follows:

(a) Install tool on pump housing, making sure that cutter is properly centered over seat surface.

(b) Tighten adjusting nut to obtain slight pressure of cutter against seat.

(c) Rotate shaft to take cut from seat surface.

D. To Assemble Pump—(See Fig. 5)

1. Press shaft and bearing assembly (4) into housing (5) until outer race bottoms on housing. Support housing under shaft boss and **apply pressure on outer race of bearing** to prevent damaging housing and bearing.

2. Install bearing retainer (3) by pressing it onto pump housing.

3. Install new seal (7) in impeller (8) and insert graphite washer (6).

4. Lay impeller (8) on flat surface of arbor press, as shown in Fig. 8, and then carefully press shaft and housing assembly INTO IMPELLER, **applying pressure** on shaft. With shaft (4) and housing (5) pressed into impeller (8) in this manner, it will still be necessary to press impeller further into housing. To do this, place assembly on arbor press with pulley hub end of shaft downward and press impeller into housing until .010"-.035" clearance is obtained between inner edge of impeller blades and inner surface of pump housing.

5. Install pulley by pressing it onto shaft with arbor press. Outer end of pulley (2) should be $4\frac{29}{32}$" from impeller end of water pump housing, with cover plate (10) and gasket removed. With pulley installed, check for pulley run-out, which must not exceed .015".

12. ENGINE WATER FITTINGS

Composition rubber hose is used at upper and lower radiator connections and at points of steam relief tube attachment.

A. Radiator Hose Connections—Hose connections are provided between lower end of radiator and water pump for engine water inlet and between upper end of radiator and cylinder head for engine water outlet. These connections must be inspected at regular intervals to de-

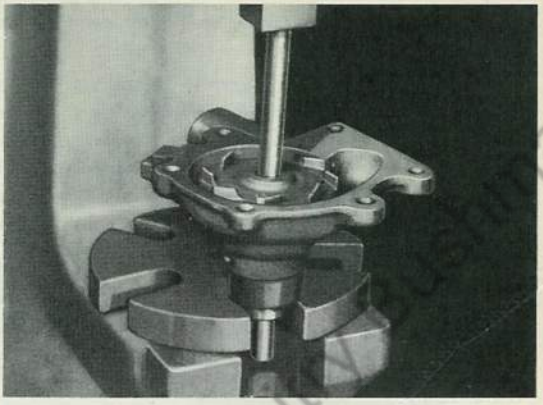


Fig. 6 Support Water Pump Body as Shown When Pressing Shaft and Bearing Out of Impeller and Body. Be Sure Bearing Retainer Cap is Removed First

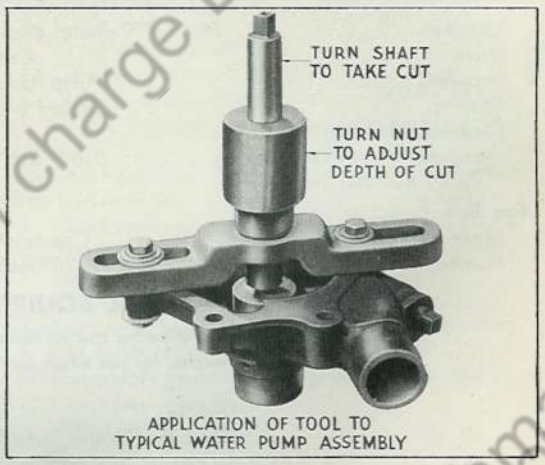


Fig. 7 Water Pump Body Seat Refinishing Tool Set and Tool Application

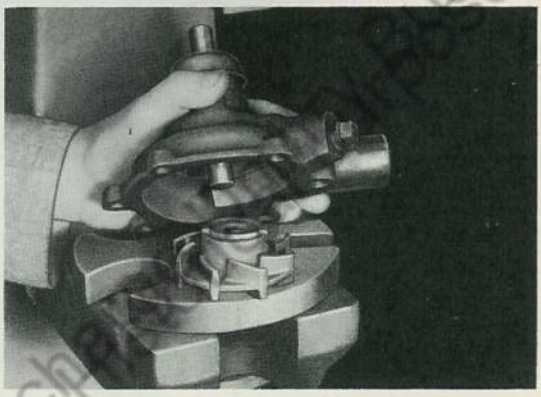


Fig. 8 Press Shaft, Bearing and Housing Assembly INTO Impeller

COOLING SYSTEM

tect deterioration of the rubber hose. Both clamps must be kept tight to prevent leakage.

B. Water Temperature Control—In addition to the thermostat which automatically controls flow of water from engine to radiator, a water temperature control tube is used which provides continuous circulation of water from rear of engine to front of engine. Refer to Fig. 1 which illustrates water temperature control tube installation. Note that special fitting provides a three way connection for tube from rear of engine to water pump and thermostat housings. This arrangement assures uniform temperatures throughout engine under all operating conditions.

This system functions automatically and requires no service other than that water temperature control tube arrangement should be thoroughly cleaned along with regular cooling system maintenance service.

TABULATED DATA

13. SPECIFICATIONS

Cooling Capacity (Quarts)	19
Water Pump	
Make	Chevrolet
Type	Packless
Water Pump Assembly (Including Fan Pulley)	Assembly No. 2103002
Location	Front of Cylinder Block
Drive	Belt
Impeller Location	Pump Body
Bearings	Sealed Ball
Clearance Between Inner Edge Impeller Blades and Housing	.010"–.035"
Pulley Run-Out Installed	.015"
Fan Belt	
Make	Chevrolet
Number	2090464
Length	44-21/64
Adjustment	Moving Generator
Deflection	1/2" to 3/4"
Radiator Core	
Make	Harrison
Type	Fin and Tube
Number	3115921
Model	R.209-A-41
Frontal Area—Sq. In.	433
Thickness	3 3/8"
Thermostat (See Instructions)	
Early Type	
Part No. 3113995—Starts to Open	143°
Fully Open	170°
Late Type	
Part No. 3108579—Starts to Open	160°
Fully Open	185°

14. TOOL EQUIPMENT

The following special tools, or their equivalent, are recommended for use when servicing COOLING SYSTEM.

Tool No.	Name	Supplier Code
CS-1036	Water Pump Pulley Puller	CS
J-1720	Water Pump Seat Refinisher	KM

TOOL SUPPLIER

Supplier Code	Name	Address
CS	Curtiss and Smith Manufacturing Corp.	Pottstown, Penn.
KM	Kent-Moore Organization	Detroit, Mich.

SERVICE BULLETIN REFERENCE

Bulletin No.	Description

Group 06W — Wiring

	Paragraph
Description	1
Circuits	2
Electrical Tune-Up	3
Maintenance of Wiring	4
Wiring Harnesses	5
Junction Blocks	6
Ground Wire and Straps	7

1. DESCRIPTION

Electrical system of this vehicle is 6-volt with wires adequately marked with various "tracer" colors, and grouped, whenever practical, in wiring harnesses. Connection points at junction blocks, junctions, and instruments are plainly marked for accessibility and accuracy when making electrical connection.

Units included in various other electrical functioning systems are described, in detail, in succeeding groups of this manual. This wiring group describes the general care and maintenance of wiring and harnesses. In addition to general wiring instructions, procedures necessary to accomplish a general tune-up of system are also described.

2. CIRCUITS

Circuit diagram, Fig. 2, illustrates, in a schematic manner, the various electrical circuits throughout vehicle system. Testing for continuity of circuit can be readily made with conventional test light or buzzer test equipment on any electrical functioning unit or system. If circuit diagram, as illustrated, is accurately followed, a point-to-point test can be made of any circuit to establish circuit continuity.

Each wire in electrical system is of a specific size. Insulation of each wire is of a distinctive color or pattern of colors to aid in recognizing wires in various circuits. Chart, Fig. 1, illustrates patterns used in system.

3. ELECTRICAL TUNE-UP

Together with regular maintenance of the electrical circuit wires, harnesses, and connections, electrical tune-up procedures are recommended to maintain entire electrical functioning systems.

Electrical tune-up is the orderly process of checking vehicle electrical equipment to determine if it is within original specifications. In addition, if it is not, to return equipment to those original specifications so that new vehicle performance is restored.

A comprehensive analysis of electrical system must include checks on battery, starting motor, generator, regulator, distributor, coil, spark plugs, and all wiring.

The following table itemizes briefly a systematic procedure of checking. Detailed instructions on various phases of electrical maintenance are described in respective electrical groups of this manual. Sequence of operations shown in following table may be slightly altered to suit conditions. However, procedures are placed in a generally accepted sequence and should be so accomplished whenever possible.

A. Battery—(Refer to Group 06S for details)
1. Check specific gravity.
2. Check water level.
3. Check each cell under load.
4. Recharge or replace if necessary.
5. Tighten hold-down bolts.
6. Clean and paint carrier.

B. Cable and Leads
1. Check condition of cables.
2. Clean and tighten terminals.

C. Voltage Drop—(Refer to Group 06S for details)
1. Check between battery ground terminal and frame.
2. Check between ungrounded terminal and starting motor stud terminal.
3. Check between starting motor housing and frame.

D. Starting Motor—(Refer to Group 06S for details)
1. Examine brushes—replace if necessary.
2. Check brush spring tension.
3. Examine armature—clean or true-up as necessary.
4. Check controls for binding condition.

E. Generator—(Refer to Group 06G for details)
1. Check bearing wear.
2. Adjust belt if necessary.
3. Lubricate.
4. Examine brushes—replace if necessary.
5. Check brush spring tension.
6. Check for "thrown" solder on armature.
7. Check brush pig-tail connections.
8. Clean up armature.

F. Regulator—(Refer to Group 06G for details)
1. Note action of charging indicator, condition of battery, and ability of generating system to keep battery up to charge.
2. Check and adjust regulator as described in Group 06G.

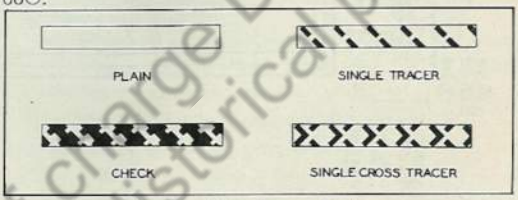


Fig. 1. Wire Tracer Patterns

WIRING

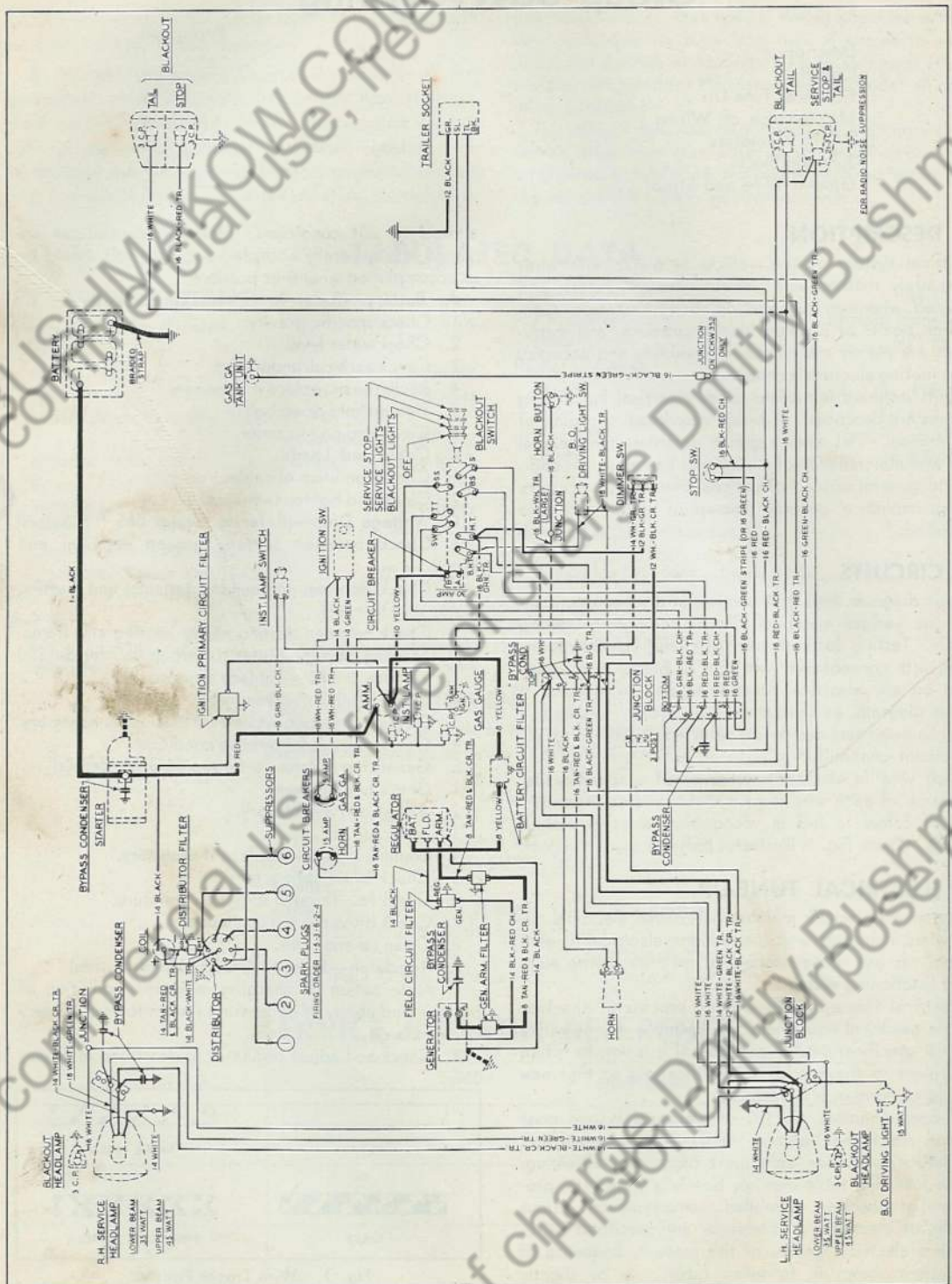


Fig. 2. General Electrical Circuit Diagram

WIRING

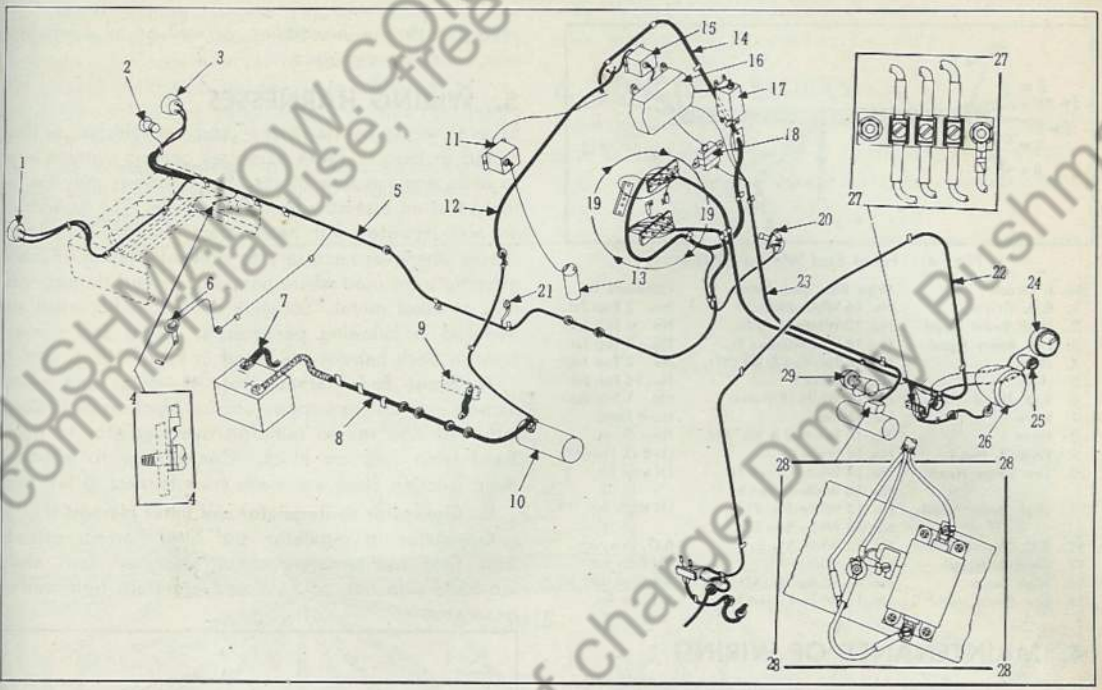


Fig. 3. Schematic Wiring Harness Diagram

1. R.H. Tail and Stop Lamp
2. Trailer Socket
3. L.H. Tail and Stop Lamp
4. Trailer Socket Ground
5. Chassis Wiring Harness (See Fig. 6)
6. Gas Gauge Tank Unit
7. Battery Ground Strap
8. Battery to Starter Cable
9. Engine Ground Strap (on hand brake sector bracket)
10. Starting Motor
11. Ignition Filter (See Group 06D)
12. Starting Motor to Ammeter Wire
13. Ignition Coil
14. Cab Wiring Harness Assembly (See Fig. 7)
15. Battery Circuit Filter (See Group O6S)
16. Regulator (See Group O6G)
17. Armature Filter (See Group O6G)
18. Field Circuit Filter (See Group O6G)
19. Junction Blocks (See Fig. 8)
20. Dimmer Switch
21. Stop Light Switch Connection
22. Front End Wiring Harness (See Fig. 4)
23. Generator to Reg. Filter Harness (See Fig. 5)
24. B.O. Driving Light (left only)
25. B.O. Head Lamp (both sides)
26. Service Head Lamp (both sides)
27. Junction Block (both sides)
28. Generator
29. Horn

G. Ignition System—(Refer to Group 06D for details)

1. Distributor.

(a) Remove cap and clean sockets. Examine for cracks or carbonized "short" paths.

(b) Examine rotor.

(c) Examine points and clean if necessary.

(d) Check point opening—adjust if necessary.

(e) Check timing and adjust if necessary.

2. Spark Plugs.

(a) Remove, clean, and adjust.

(b) Examine wires and suppressors—replace wires if swollen or frayed.

3. Coil.

(a) Check coil on tester.

4. Condenser.

(a) Check condenser for capacity, short, and resistance.

5. Electrical Accessories (Refer to Group 06M for details).

(a) Check all accessories such as horn and fuel gauge.

(b) Check location and installation of all "Radio Interference Noise Suppression" units.

6. Lights (Refer to Group 06L for details).

(a) Check action of main switch.

(b) Examine all bulbs.

(c) Check lamp mountings.

(d) Clean lenses.

WIRING

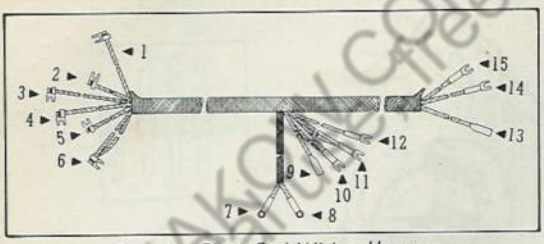


Fig. 4. Front End Wiring Harness

No. & Circuit	Wire Size and Color	Connects To
1. B.O. Driving	No. 16 White-Black Tr.	No. 3 Post Jct.
2. High Beam Head	No. 12 White-Blk. XTr.	No. 4 Top Jct.
3. Low Beam Head	No. 14 White-Green Tr.	No. 3 Top Jct.
4. Horn	No. 16 Tan-Red & Blk. XTr.	No. 2 Top Jct.
5. Horn	No. 16 Black	No. 16 Top Jct.
6. B.O. Head	No. 16 White (2 Wires)	No. 1 Top Jct.
7. Horn	No. 16 Black	Horn Term.
8. Horn	No. 16 Tan-Red & Blk. XTr.	Horn Term.
9. LH-B.O. Head	No. 16 White	LH-B.O. Head
10. Low Beam Head	No. 14 White-Green Tr.	LH Low Jct.
	No. 16 White-Green Tr.	
11. High Beam Head	No. 12 White-Blk. XTr.	LH High Jct.
	No. 14 White-Blk. XTr.	
12. B.O.-Driving	No. 16 White-Blk. Tr.	B.O. Driv. Jct.
13. RH-B.O. Head	No. 16 White	RH B.O. Jct.
14. High Beam	No. 14 White-Blk. XTr.	RH High Jct.
15. Low Beam	No. 16 White-Green Tr.	RH Low Jct.

4. MAINTENANCE OF WIRING

A. Connections—Wiring terminals and connections at junctions and units should be inspected regularly. These connections must be kept absolutely tight at all times. Bear in mind—**a clean and tight electrical connection is a good connection.**

B. Splices—If a splice is made in a line, solder must be used to bond the splice. Insulating tape should be used profusely to protect all bare wires.

C. Clips and Grommets—Examine and tighten all harness clips at regular intervals. If rubber grommets show signs of deterioration, replace immediately with new parts.

D. Fire and Water—If vehicle is flooded, or has been subjected to fire, wiring harnesses should be replaced with new assemblies, as well as all other wire which may be damaged.

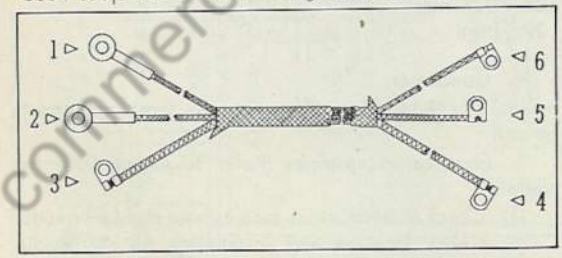


Fig. 5. Generator to Regulator & Filter Wiring Harness

No. & Circuit	Wire Size and Color	Connects To
1. Generator	No. 14 Black	Gd. on Gen.
2. Generator	No. 14 Blk.-Red Ck.	"Fld" on Gen.
3. Generator	No. 8 Tan-Red & Blk. Ck.	Filter on Gen.
4. Generator	No. 8 Tan-Red & Blk. Ck.	Arm. Filter
5. Generator	No. 14 Black-Red Ck.	Field Filter
6. Generator	No. 14 Black	Gd. on Reg.

5. WIRING HARNESSES

Several wiring harnesses are used on vehicles, as illustrated in Fig. 3. These harnesses contain various wires to units and junction blocks. Each harness may be removed as an assembly from the vehicle. The assemblies are well insulated with heavy loom, and are clipped to chassis whenever necessary to prevent chafing. Rubber grommets are used where harnesses extend through side rails or sheet metal. Location of various harnesses are itemized in following paragraphs. Wires and connections in each harness are listed in Figs. 4, 5, 6, and 7.

A. Front End Harness (Fig. 4)—Front end wiring harness extends from upper junction block on dash, along left-hand side rail to radiator, over radiator to right-hand lamp junction block. Connections to left-hand lamp junction block are made from harness at left side.

B. Generator to Regulator and Filter Harness (Fig. 5)—Generator to regulator and filter harness extends from field and armature circuit filters on dash, along left-hand side rail, to field and armature terminals on generator.

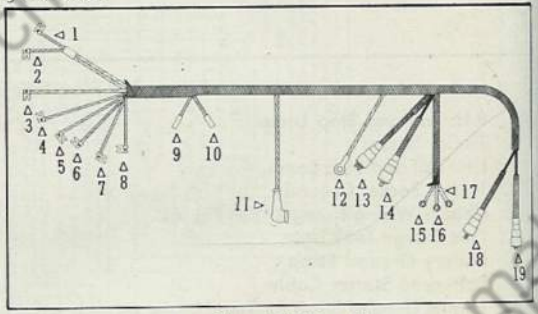


Fig. 6. Chassis Wiring Harness

No. & Circuit	Wire Size and Color	Connects to
1. Service stop & tail	No. 16 Black-Green Tr.	No. 5 Top junc.
2. Blackout tail	No. 16 White	No. 1 Top junc.
3. "TL" Trailer socket	No. 16 Black-Green Ck.	No. 1 Bottom junc.
4. B.O. Stop (R.H.)	No. 16 Black-Red Tr.	No. 6 Bottom junc.
5. Service stop	No. 16 Red-Black Tr.	No. 2 Bottom junc.
6. "SL" Trailer socket	No. 16 Black-Red Ck.	No. 3 Bottom junc.
7. Stop switch	No. 16 Red	No. 5 Bottom junc.
8. Gas gauge unit	No. 16 Black-Green Stripe	No. 4 Bottom junc.
9. Stop switch	No. 16 Red	Stop switch
10. Stop switch	No. 16 Black-Red Ck.	Stop switch
11. Gas gauge	No. 16 Black-Green Stripe	Gas gauge unit
12. Trailer socket gd.	No. 12 Black	Pintle bracket
13. Service tail light	No. 16 Black Green Tr.	Service tail socket
- Service stop light	No. 16 Red-Black Tr.	Service stop socket
14. Left hand B.O. tail	No. 16 White	Left hand B.O. tail socket
15. Trailer socket	No. 12 Black	"GR" Trailer socket
16. Trailer socket	No. 16 Black Red Ck.	"SL" Trailer socket
17. Trailer	No. 16 Black-Green Ck.	"TL" Trailer socket
18. Right hand B.O. stop	No. 16 Black-Red Tr.	Right hand B.O. stop plug
19. Right hand B.O.-tail	No. 16 White	Right hand B.O. tail plug

WIRING

C. **Chassis Wiring Harness** (Fig. 6)—Chassis wiring harness extends from upper and lower dash junction blocks, along left-hand side rail to rear cross member, to right and left-hand stop and tail lamps. Wires from this harness connect to gas gauge tank unit, and stop light switch on hydraulic master cylinder.

D. **Cab Wiring Harness** (Fig. 7)—Cab wiring harness extends from instrument panel unit, through dash, to dash junction blocks.

E. **Wiring Assemblies** (Fig. 3)—Other wiring assemblies, as illustrated, connect various units.

6. JUNCTION BLOCKS

Three junction blocks are provided on engine side of dash as illustrated in Fig. 8. A head lamp junction block is provided on engine side of each front fender shield with connections.

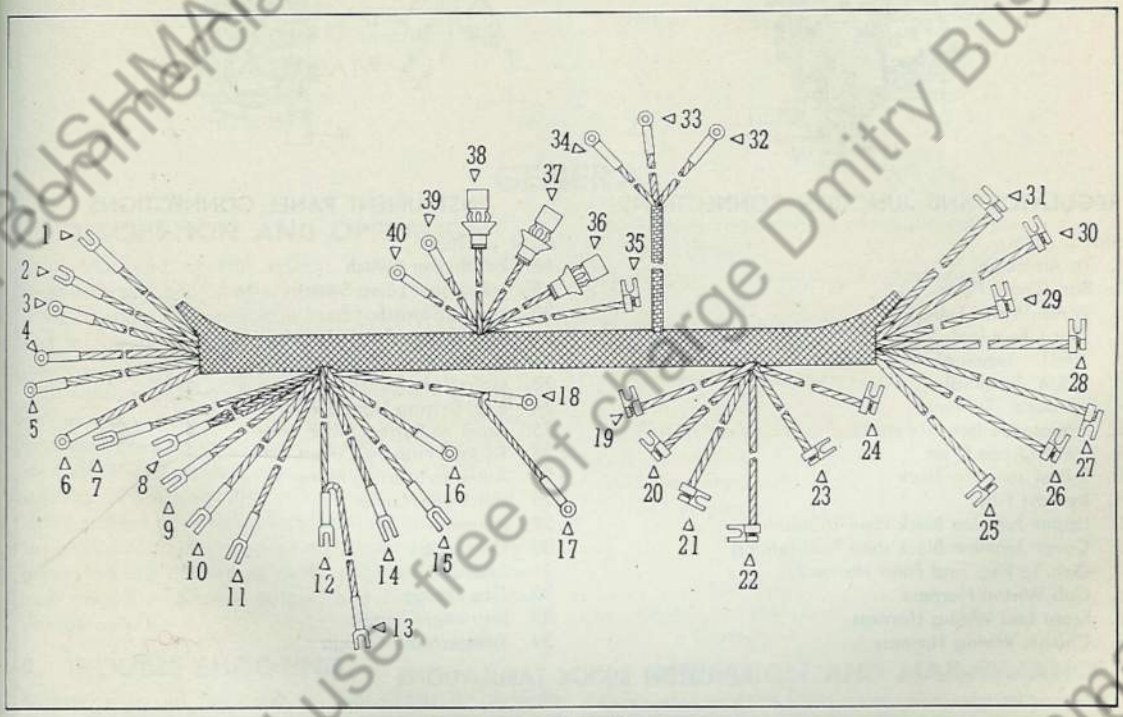
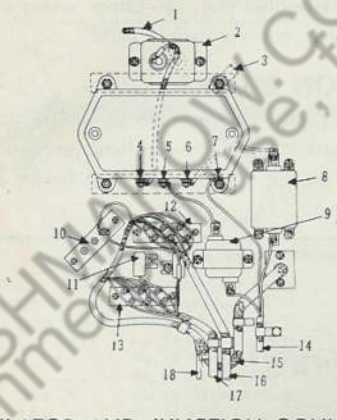


Fig. 7. Cab Wiring Harness

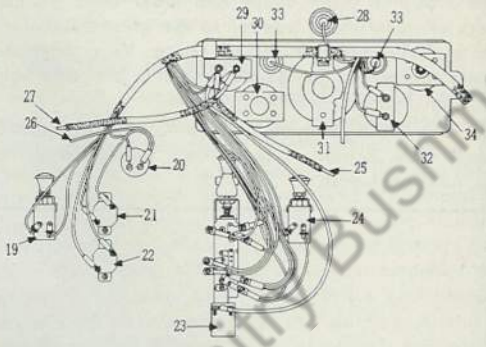
No. & Circuit	Wire Size and Color	Connects to
1. Inst. panel lights	No. 16 Green-Black Ck.	Inst. light sw.
2. Inst. panel light	No. 16 Black-Green Tr.	Inst. light sw.
3. Gas gauge	No. 16 White-Red Tr.	Gauge circuit breaker
4. Horn	No. 16 Tan-Red & Black XTr.	Horn circuit breaker
5. Horn	No. 16 Tan-Red & Black XTr.	Horn circuit breaker
6. Ign. switch feed	No. 14 Green	Ign. switch
7. B.O. Driving light	No. 16 White-Black Tr.	B.O. Light sw.
8. Dimmer switch	No. 12 Black-Green Tr.	
Feed to gas gauge	No. 16 Black-Green Tr.	"HT" junc. - main sw.
Service stop on tail	No. 16 Black-Green Tr.	
9. R.H. B.O. stop	No. 16 Black-Red Tr.	"BS" junc. - main sw.
10. Stop light switch	No. 16 Red	"SW" junc. - main sw.
11. Stop light switch	No. 16 Black-Red Ck.	"SS" junc. - main sw.
12. Blackout lights	No. 16 White	"BHT" junc. - main sw.
13. B.O. Driving light	No. 16 White-Black Tr.	B.O. Light switch
14. Service stop	No. 16 Red-Black Tr.	"S" junc. - main sw.
15. "TL" Trailer socket	No. 16 Green-Black Ck.	"TT" junc. - main sw.
16. Horn	No. 16 Tan-Red-Blk. XTr.	Ammeter
17. Switch feed	No. 10 Yellow	"B" main sw.
18. Ign. switch feed	No. 14 Green	Ammeter
19. "TL" Trailer socket	No. 16 Green-Black Ck.	No. 1 Bottom junc.
20. Service stop	No. 16 Red-Black Tr.	No. 2 Bottom junc.
21. Stop switch	No. 16 Black-Red Ck.	No. 3 Bottom junc.
22. Stop switch	No. 16 Red	No. 5 Bottom junc.
23. R.H. B.O. stop	No. 16 Black-Red Tr.	No. 6 Bottom junc.
24. Gas gauge	No. 16 Green	No. 4 Bottom junc.
25. Horn	No. 16 Tan-Red & Black XTr.	No. 2 Top junc.
26. Horn	No. 16 Black-White Tr.	No. 6 Top junc.
27. Dimmer switch	No. 14 White-Green Tr.	No. 3 Top junc.
28. Service tail	No. 16 Black-Green Tr.	No. 5 Top junc.
29. Blackout tail	No. 16 White	No. 1 Top junc.
30. Dimmer switch	No. 12 White-Black XTr.	No. 4 Top junc.
31. B.O. Driving light	No. 16 White-Black Tr.	No. 1 Post (3 post)
32. Dimmer switch	No. 12 White-Black XTr.	"High" dimmer sw.
33. Dimmer switch	No. 14 White-Green Tr.	"Low" dimmer sw.
34. Dimmer switch	No. 12 Black-Green Tr.	"Batt." dimmer sw.
35. Horn	No. 16 Black-White Tr.	Horn term. on steer. column
36. Inst. panel lights	No. 16 Green-Black Ck.	Inst. light plug
37. Inst. panel lights	No. 16 Green-Black Ck.	Inst. light plug
38. Inst. panel lights	No. 16 Green-Black Ck.	Inst. light plug
39. Gas gauge	No. 16 Green	"Tank" on gas gauge
40. Gas gauge	No. 16 White-Red Tr.	"Ign." on gas gauge

WIRING



REGULATOR AND JUNCTION CONNECTIONS

Point	Item
1.	To Ammeter
2.	Bat. Circuit Filter
3.	Wind. Wiper Tube Clip
4.	"Bat." Terminal
5.	"FIELD" Terminal
6.	"ARM" Terminal
7.	"Ground" Terminal
8.	Armature Filter
9.	Field Circuit Filter
10.	3-Post Junction Block
11.	By-Pass Filter
12.	Upper Junction Block (See Tabulations)
13.	Cover Junction Block (See Tabulations)
14.	Gen. to Reg. and Filter Harness
15.	Cab Wiring Harness
16.	Front End Wiring Harness
17.	Chassis Wiring Harness



INSTRUMENT PANEL CONNECTIONS

Point	Item
18.	To Dimmer Switch
19.	Instrument Lamp Switch
20.	Ignition Switch
21.	Gas Gauge Circuit Breaker
22.	Horn Circuit Breaker
23.	Main Light Switch
24.	B.O. Driving Light Switch
25.	Amm. to Battery Filter Wire
26.	To Ign. Primary Circuit Filter
27.	Amm. to Starting Motor Wire
28.	Instrument Lamp
29.	Ammeter
30.	Oil Gauge
31.	Speedometer
32.	Gas Gauge
33.	Instrument Lamps
34.	Temperature Gauge

JUNCTION BLOCK TABULATIONS

TOP JUNCTION BLOCK		
TERM. NO.	WIRE SIZE & COLOR	CIRCUIT
1	16 WHITE	LIGHT SW. TO B.O. HEAD & TAIL
2	16 TAN-RED & BLACK CR. TR.	CIRCUIT BREAKER TO HORN
3	14 WHITE-GREEN TR.	DIM. SW. (LOW BEAM) TO HEAD LAMP
4	12 WHITE-BLACK CR. TR.	DIM. SW. (HIGH BEAM) TO HD. LAMP
5	16 BLACK-GREEN TR.	LIGHT SW. TO SERVICE TAIL
6	16 BLACK & 16 BLACK WHITE TR.	HORN TO HORN BUTTON (JUNCTION)

BOTTOM JUNCTION BLOCK		
TERM. NO.	WIRE SIZE & COLOR	CIRCUIT
1	16 GREEN-BLACK CH.	LIGHT SW. TO TRAILER TAIL
2	16 RED-BLACK TR.	LIGHT SW. TO SERVICE STOP
3	16 RED	LIGHT SW. TO STOP SW. (FEED)
4	16 GREEN & GREEN & BLK. STRIPE	GAS GAUGE TO TANK UNIT
5	16 RED-BLACK CH.	STOP SW. (RETURN) & TRAIL. STOP
6	16 BLACK-RED TR.	B.O. STOP

Fig. 8. Connections at Regulator, Instrument Panel, and Junction Blocks

7. GROUND WIRES AND STRAPS

Ground wires and their locations are as follows:

A. Battery—Strap from negative terminal to frame side rail.

B. Bond Straps—All bond straps used in connection with "Radio Suppression."

C. Engine—Strap from hand brake sector bracket to motor support bolt.

D. Regulator—Wire from ground screw on regulator to generator body.

E. Head Lamps (Service)—Wire from lamp connection to fender shield.

F. Trailer Socket—From socket to pintle hook brace on left side.

Ground wire connections and points where connections are made must be clean, and tight at all times. Bonding straps used in radio noise suppression system should not be confused with system ground wires or straps. Radio noise suppression bond straps are described in "Radio Noise Suppression" section in Group O6M.

Group 06G — Generator and Regulator

	Paragraph
GENERAL	
Description and Operation	1
Trouble Shooting and General Solutions	2
Inspection and Maintenance	3
System Operation Tests	4
REPLACEMENT AND REPAIR	
Generator	5
Regulator	6
Regulator Adjustments	7
Wiring and Connections	8
TABULATED DATA	
Specifications	9
Tools	10

GENERAL

1. DESCRIPTION AND OPERATION

Generator and control system comprises generator, three-unit regulator, battery, ammeter, and connecting wires. Purpose of system is to keep battery fully charged and to furnish when engine speeds permit, current for ignition, lighting system, and other electrical accessories.

Generator is driven by engine crankshaft with belt in conjunction with water pump and fan. As speed of engine reaches a predetermined point, action of generator creates electrical current which, limited by setting and specifications of regulator unit, charges battery and furnishes current to vehicle electrical systems. The regulating units automatically opens and closes circuit between generator and battery as needs require, controls maximum generator ampere output, and controls generator voltage output.

2. TROUBLE SHOOTING

Reference should be made to procedures in "System Operation Tests," Paragraph 4, before attempting to localize various trouble symptoms or causes. The symptoms, causes, and remedies of trouble which may be experienced in generating system are itemized in following paragraphs.

A. Fully Charged Battery and High Charging Rate (See Paragraph 4, Subject B)

1. Voltage regulator out of adjustment—
   Adjust.
2. Defective voltage regulator—
   Replace.
3. Shorted generator field—
   Repair.
4. Poor ground connection between generator and regulator—
   Correct.

B. Low Battery and Low or No Charging Rate (See Paragraph 4, Subject C)

1. Wiring damaged—
   Check and correct.
2. Voltage regulator out of adjustment—
   Adjust.
3. Current regulator out of adjustment—
   Adjust.
4. Regulator contact points dirty—
   Clean.
5. Generator defective—
   Check.
6. Cut-out relay out of adjustment—
   Adjust.

C. Noisy Generator

1. Belt tension—
   Adjust.
2. Defective bearings—
   Replace.
3. Brushes not seating—
   Correct.

3. INSPECTION AND MAINTENANCE

Generator and control system units require periodic inspection and maintenance operations to keep system at peak efficiency. Detailed maintenance instructions are described under respective paragraphs of this group. The following procedure is suggested:

A. Generator

1. Check bearing play.
2. Inspect and adjust drive belt.
3. Examine brushes—replace if necessary.
4. Test brush spring tension.
5. Examine armature for roughness and "thrown" solder.
6. Inspect brush pig-tail connections.
7. Inspect mounting bolts. Tighten if necessary.

B. Regulator

1. Inspect wiring connections at regulator.
2. Observe action of ammeter.

Adjust units in regulator if necessary.

C. Wires

1. Check condition of all wires in circuit—replace if worn or swollen.

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GENERATOR AND REGULATOR

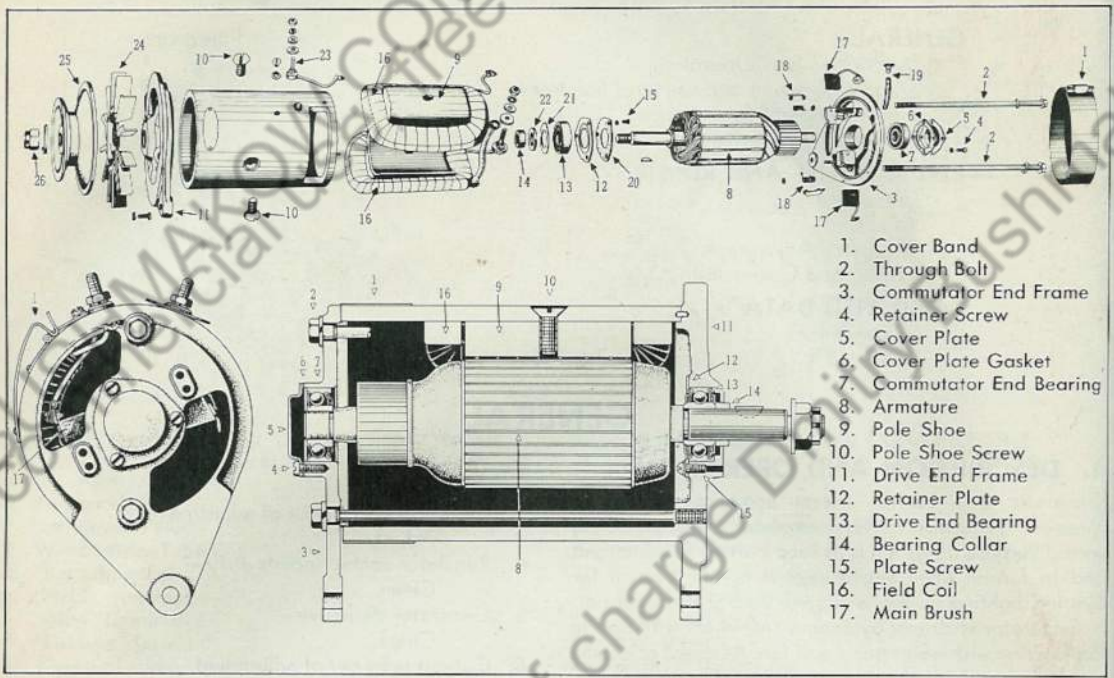


Fig. 1 Disassembled and Assembled View of Generator

4. SYSTEM OPERATION TESTS

As the generator and its controlling regulator are definitely related in the operation of generating system, separate tests and adjustments on each unit should only be made after certain tests on entire system have been accomplished. These tests will determine which unit is at fault before making any adjustments on either generator or regulator.

Testing and checking procedures on generator and regulator units are **precision** operations. These procedures must be accomplished with precision tools and instruments and by personnel who are thoroughly skilled. **Do not attempt to test or adjust any of these units without the use of accurate instruments** nor in any other manner than described in this group.

The ammeter on instrument panel is merely an indicator to show whether or not generator is charging. An accurate test ammeter must be used to check exact output of generator. Refer to Fig. 14 for correct meter hook-up for test and adjustment procedures.

A. Fully Charged Battery and Low Charging Rate—This condition indicates that generator and regulator are functioning properly. Verify this by noting charging rate at medium generator speed. Then crank engine with starter for about 10 seconds to partly discharge battery. Run generator again at medium speed and note charging rate. Since battery voltage has been lowered, generator output should show an increase for a short period.

1. Check current regulator unit by bridging voltage regulator unit contact points with a jumper lead (See Fig. 14) to prevent voltage regulator unit operating. Turn on all lights or other electrical loads, and increase generator speed until output remains constant. The output reading is the value for which current regulator is set.

2. If output fails to increase to specified value, current regulator setting is probably low. Adjust current regulator a sspecified under "Current Regulator," Paragraph 7. If it is impossible to adjust regulator to specified output, check conditions as outlined under "Low Battery and Low or No Output."

B. Fully Charged Battery and High Charging Rate—This condition indicates that voltage regulator unit is not reducing generator output as it should. A high charging rate to a fully charged battery will cause battery to gas and overheat. It also produces excessive voltage in electrical circuit which will cause armature, ignition coil, distributor point, and lamp bulb failure. A fully charged battery and high charging rate can be caused by one of the following conditions:

1. Voltage regulator out of adjustment.

2. Defective winding in voltage regulator unit which prevents unit operating.

3. Direct short between generator charging circuit and generator field circuit, either in regulator or generator, which prevents resistance being inserted into generator field circuit when contact points open.

GENERATOR AND REGULATOR

4. Poor ground connection between generator or regulator.

Above conditions may be localized in following manner:

5. Hold voltage regulator unit armature down manually. If output now drops off as contact points are opened, voltage regulator needs either adjustment or a new winding assembly.

6. If output continues high as points are separated, a short exists between charging circuit and generator field circuits. Localize the short in following manner:

(a) Remove **"Field"** lead from "Field" terminal of regulator.

(b) If output drops off, short is in regulator. Inspect for burned leaks, windings, or charred insulation.

(c) If output continues high with "Field" terminal removed, short is in wiring or generator.

(d) Remove wire from **"F"** terminal of generator.

(e) If output now drops off, short is in wiring.

(f) If output continues high, the generator is at fault.

C. Low Battery and Low or No Charging Rate—Check circuit for loose connections, frayed or damaged wire if above condition exists. High resistance in charging circuit, due to these conditions, will cause voltage regulator to operate as though battery were fully charged, reducing generator output, even though battery is in a partly discharged condition. If trouble is not in wiring, make following checks:

1. Bridge regulator terminals marked **"Armature"** and **"Field"** temporarily with a jumper lead. Gradually increase engine speed. Do not run generator at excessive speed with terminals bridged. Bridging terminals removes all external regulation and may allow generator output to reach an excessive value. With terminals bridged, one of three following actions will result as generator speed increases.

(a) Generator output will increase to or above its specified value. This indicates:

(1) That voltage regulator unit is adjusted for too low a value.

(2) That current regulator is set for too low a value.

(3) Voltage or current regulator unit contact points are oxidized and must be cleaned or,

(4) Generator field circuit is open at some point within regulator, either at connections or in voltage regulator windings.

(b) Generator output does not increase to its specified value, which indicates the generator is at fault. Make bench test.

(c) Generator does not charge either with or without **"Armature"** and **"Field"** terminals bridged, which indicates that either generator or cut-out relay is at fault. In this case, check as follows:

(1) With **"Armature"** and **"Field"** terminals bridged and generator running at medium speed, inspect cut-out relay.

(2) If contact points are closed and there is no charging current, charging circuit is open between regulator and battery.

(3) If contact points remain open under above conditions, connect a voltmeter of sufficient capacity between **"Armature"** terminal of regulator and convenient ground of generator. Check generator voltage build up. If voltage builds up satisfactorily without causing cut-out relay contact points to close, the cut-out relay is either out of adjustment or shunt winding in cut-out relay is open.

(4) **Caution: Do not close relay contact points manually while battery is connected.**

D. Arcing and Action of Points—Excessive arcing or sluggish action of contact points in either voltage or current regulator unit indicates:

1. Resistance unit is open.
2. Defective winding in regulator winding assembly.
3. Contact points pitted or oxidized.
4. Contact points not meeting with correct alignment or pressure.
5. Shorted field coil in generator.
6. Poor ground connection between generator and regulator.

REPLACEMENT AND REPAIR

5. GENERATOR

Generator (Fig. 1) on this vehicle is shunt-wound, two-brush type mounted on left side of engine and driven with belt by crankshaft in conjunction with water pump. Generator is cooled by air forced through openings in end of generator with fan mounted behind drive pulley.

A. Maintenance—The cover band should be removed and commutator and brushes inspected at regular intervals. High speed operation, dust and dirt encountered on ventilated units, and taking full output from generator are all factors which increase bearing, commutator, and brush wear. Generators should be inspected at least every 5,000 miles. The following procedure is suggested:

1. Inspect commutator and, if dirty, clean with a strip of No. 00 sandpaper. **Do not use emery cloth.** All dust must be blown from generator after commutator has been cleaned.

If commutator is rough, out-of-round, or has high mica, remove armature from generator as described under "Disassembling." Turn commutator down in lathe, removing only enough material to true-up and remove roughness and high mica. Undercut mica after commutator has been turned down.

2. Check brush spring tension. Excessive spring tension will cause commutator and brushes to wear rapidly. Low spring tension will cause a reduced generator

GENERATOR AND REGULATOR



Fig. 2 Field Coil Test for Continuous Circuit



Fig. 3 Field Test for Ground

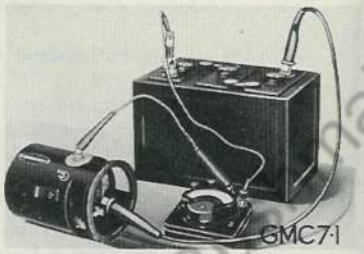


Fig. 4 Field Test for Internal Short

output and arcing and burning of commutator and brushes. Check pig-tail lead connections at brushes to see that they are tight.

A poor connection in charging circuit will cause generator to build up excessive voltage which may result in burned field or armature windings. A poor connection in generator field circuit will cause a low output.

3. Replace worn brushes. Brushes may be seated by use of a "bedding" stone. With generator operating at medium speed, press stone firmly against commutator and move it back and forth along commutator to cover area contacted by brushes. Brushes should seat satisfactorily in a short period. Blow generator out with compressed air, after using stone, to remove all particles of abrasive. **Do not use emery cloth or sandpaper to seat brushes.**

4. Check generator drive belt and tighten if necessary. Low belt tension will cause a reduced and unsteady output. Excessive belt tension will cause rapid wear on belt and bearing. Replace belt if it is frayed or worn.

B. Test—Before generator is removed from engine for further internal and operation tests and repairs, make certain that tests outlined under "System Operation Tests," Paragraph 4, have been accomplished in a logical manner. If symptoms definitely point to trouble in generator, unit may then be removed and further checked.

There are several conditions which may require removal of generator and further checks made. When various tests and checks are made, use instruments such as or equivalent to those listed under "Tabulated Data" at end of this section.

Briefly, these conditions are (1) no output, (2) unsteady or low output, (3) excessive output, or (4) noisy generator. If these conditions exist in generator as determined by "System Operation Tests," make further checks as follows:

1. NO OUTPUT. Refer to **"Low Battery and Low or No Charging Rate"** tests under "System Operation Tests," Paragraph 4, and if condition points to generator unit, proceed as follows:

(a) Remove cover band and check for sticking or worn brushes and commutator bars. Burned bars, with other bars fairly clean, indicate open circuited coils. If brushes are making good contact with commutator, and commutator appears fairly clean, use test leads and light as follows:

(b) Raise grounded brush and insulate it from commutator. Check with test points from armature terminal to frame. If test lamp lights, generator is grounded. Insulate other brush and check field, commutator, and brush holder to locate ground.

(c) If generator is not grounded, check field for open circuit (after disassembly).

(d) If field is not open, check for shorted field. Refer to "Tabulated Data" at end of this section for correct field draw at listed voltage. Excessive current draw indicates shorted field.

(e) Remove armature and check on growler for short circuit.

2. UNSTEADY OR LOW OUTPUT.

(a) Check drive belt tension.

(b) Check brush spring tension and brushes for sticking. (Refer to instructions under "Maintenance.")

(c) Inspect commutator. (Refer to instructions under "Commutator.")

3. EXCESSIVE OUTPUT. Excessive output usually results from a grounded generator field-grounded internally or in regulator. Tests made under heading "Fully Charged Battery and High Charging Rate" under general heading **"System Operation Tests"** will disclose which unit is grounded. If tests prove that ground is in generator unit, this ground can be localized by further tests at pole shoes, field, or at "F" terminal.

4. NOISY GENERATOR. Noisy generator may be caused by loose mounting or drive pulley; worn, dry or dirty bearings; improperly seated brushes.

C. To Remove Generator—Generator can be removed from engine in following manner:

1. Disconnect generator terminals.
2. Loosen belt adjusting arm so that generator can be pushed toward engine.
3. Remove belt from generator pulley.
4. Remove generator mounting bolts.

D. To Install Generator—

1. Install generator to mounting.
2. Adjust drive belt to proper tension.

GENERATOR AND REGULATOR



Fig. 5 Terminal Test for Continuous Circuit

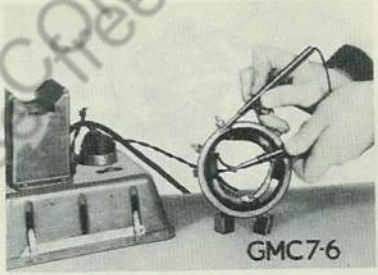


Fig. 6 Terminal Test for Ground



Fig. 7 Insulated Brush Holder Test

3. Make wire connections as illustrated in Fig. 21.

E. Polarity—If generator or regulator has been disconnected for repair or adjustment purposes, generator should be polarized after units are reconnected, and **before engine is started.**

Reversed polarity will cause regulator points to vibrate excessively and burn. Make certain that generator is correctly polarized by connecting **momentarily** with a jumper lead between "Bat." terminal and **"Arm"** terminal **before starting the engine.** This allows a momentary surge of battery current to generator which automatically gives generator the correct polarity with respect to battery it is to charge.

F. To Disassemble Generator (Fig. 1)—

1. Place generator in holding vise.
2. Remove pulley and fan—use suitable puller.
3. Remove cover band (1) brush lead screws, through bolts (2) and commutator end frame assembly (3).
4. Remove drive end frame (11) and armature (8).
5. Commutator end bearing (7) may be removed from frame by removing three screws (4) and cover plate (5).
6. Drive end bearing (13) may be removed from drive end frame (11) by removing three screws (15) and plate (12).
7. Do not wash bearings (13 and 7) in any solvent. These bearings are pre-lubricated and sealed at time of manufacture and require no further lubricant during life of bearings.
8. Field coils may be withdrawn from generator frame by removing pole shoe screws (10). Field coils should be tested as described under "Testing Generator Parts" before removal.
9. By-pass condenser and filter unit may be removed from generator body by removing retaining screws.

G. Testing Generator Parts—Various parts of generator may be tested as follows: Test instruments such as or equivalent to those listed under "Tabulated Data" at end of this group should be used. Illustrations showing application of test instruments are merely typical. Instructions furnished by manufacturer of test instruments should be followed.

1. FIELD COIL TEST FOR CONTINUOUS CIRCUIT: Place prods as illustrated in Fig. 2. If test lamp does not light, field coils are open circuited and should be replaced.

2. FIELD COIL TEST FOR GROUND: Disconnect grounded end of field winding from generator frame. Place one test prod on generator frame (Fig. 3) and other on field terminal. If lamp lights, field coils are grounded and should be replaced.

3. FIELD COIL BALANCING TEST: Slide insulation off soldered connections between the two field coils. Make test with battery, ammeter, and two leads as shown in Fig. 4. Place one test lead on soldered connection and other on one end of either field coil. Take ammeter reading. Remove lead from end of field coil and place it on end of other field coil. Take reading. Field coils should draw current as indicated in "Tabulated Data." Replace the coil which draws the most current.

4. BRUSH LEAD TO NEGATIVE TERMINAL TEST FOR CONTINUOUS CIRCUIT: Place one test prod on negative terminal (Armature) and other on end of wire as shown in Fig. 5. If test lamp does not light, wire is open circuited and should be replaced.

5. GENERATOR NEGATIVE TERMINAL TEST FOR GROUND: Place one test prod on terminal and one on frame of generator as shown in Fig. 6. If test lamp lights, terminal insulation is broken down and should be replaced.

6. MAIN BRUSH TEST FOR GROUND: Place one test prod on negative brush and other on end frame, as shown in Fig. 7. If test lamp lights, negative brush holder is grounded and should be replaced.

7. ARMATURE TEST FOR GROUND: Place one test prod on armature core, and other to commutator bars, as shown in Fig. 8. If test lamp lights, armature is grounded and should be replaced.

8. ARMATURE TEST FOR SHORT: Place armature on growler. Place saw blade over armature core, rotate armature and test. (Fig. 9.) If saw blade vibrates, armature is short circuited. To determine whether armature windings or commutator is shorted, clean out between the commutator bars and recheck armature. If saw blade still vibrates, armature is short-circuited and should be replaced.

GENERATOR AND REGULATOR



Fig. 8 Armature Test for Ground



Fig. 9 Armature Test for Short

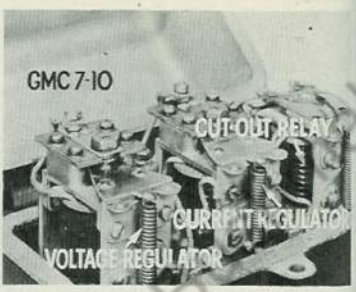


Fig. 10 Regulator Units

9. ARMATURE TO COMMUTATOR LEADS: Check to see that armature to commutator leads are properly soldered to commutator. Loose end should be resoldered, using Rosin flux. **Do not use acid flux when soldering electrical connections.**

10. COMMUTATOR: Check commutator for roughness. Turn down in lathe if necessary. Under cut mica and test on growler.

H. To Assemble Generator (See Fig. 1)—

1. Install drive end of armature shaft into drive end frame (11) and bearing (13). Make certain that plate (12) and screws (4) are in plate. Install collar (14) on shaft.
2. Install generator frame and field coils over armature.
3. Install commutator end frame and brush assembly on armature shaft.
4. Install through bolts.
5. Attach field coil leads and brush leads as follows:
   (a) "Armature" terminal lead should be attached to insulated brush holder.
   (b) Field coil lead to "Field" terminal.
   (c) Field coil ground to screw on frame.
   (d) Ground brush pigtail to brush holder.
6. Install by-pass condenser and filter on body of generator.

6. REGULATOR

Regulator (Fig. 10) is three-unit type containing cut-out relay, voltage regulator, and current regulator. The regulator unit is mounted on engine side of dash on left-hand side. Wiring connections to unit terminals are as illustrated in Fig. 21.

A. Cut-Out Relay—Cut-out relay is an automatic switch which automatically closes circuit between generator and battery when generator voltage rises above that of battery, and automatically opens circuit between generator and battery when generator voltage falls below that of battery.

B. Voltage Regulator — Voltage regulator controls generator voltage and does not allow it to rise above a value determined by voltage regulator setting.

C. Current Regulator — Current regulator controls maximum generator output (amperage) and does not allow output to exceed value determined by current regulator setting.

D. Maintenance—Regular inspection should be made of regulator wiring connections, point condition, and cover gasket.

1. WIRING CONNECTIONS: Tighten all wiring connections (Fig. 21) at periodic intervals.
2. POINTS: If voltage or current regulator contact points appear to arc excessively, it is possible they have become oxidized, and points should be cleaned. **Do not use emery cloth and sandpaper to clean contacts** as particles of emery or sand might imbed in point surface and prevent normal operation. Use a spoon or riffler file (See Fig. 11).
3. COVER GASKET: Examine cover gasket at inspection intervals. If gasket is cracked, replace with new part. In event vehicle is subjected to flooding condition, remove cover of regulator, and thoroughly dry inside of cover. Examine all parts for rust or moisture.



Fig. 11 Clean Contact Points as Shown

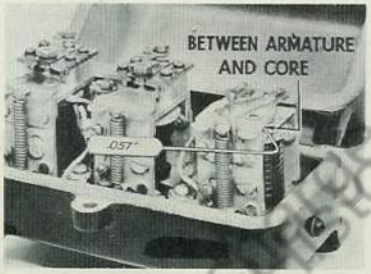


Fig. 12 Measuring Cut-Out Air Gap

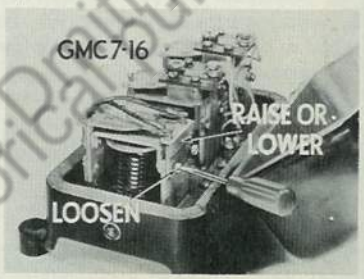


Fig. 13 Adjusting Cut-Out Air Gap

GENERATOR AND REGULATOR

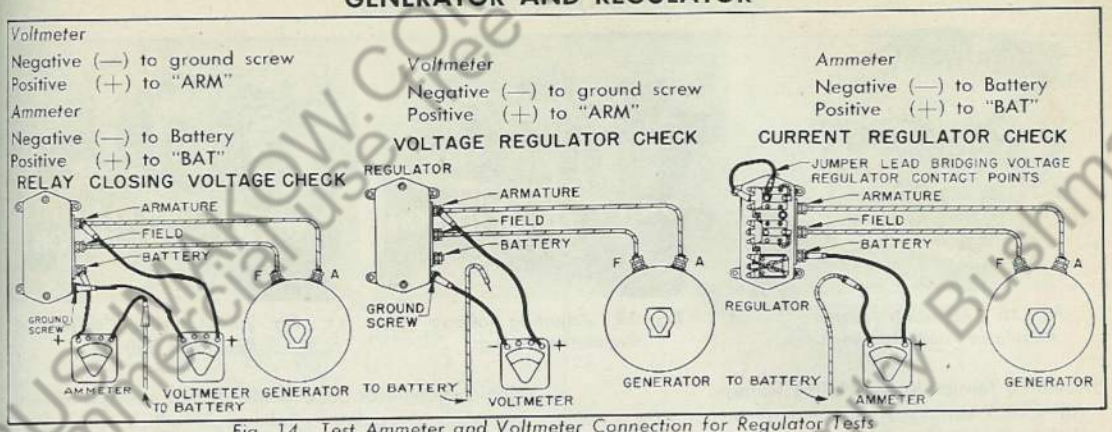


Fig. 14 Test Ammeter and Voltmeter Connection for Regulator Tests

7. REGULATOR ADJUSTMENTS

Bear in mind that regulator tests and adjustments are precision operations. No attempt should be made to test or adjust regulator units unless precision instruments and tools are used, and a thorough knowledge of test procedures is obtained.

If regulator units are not functioning properly as indicated by tests previously described under "System Operation Tests," various electrical and mechanical adjustments may be accomplished as described in succeeding paragraphs.

All electrical checks must be made with regulator at operating temperature (145° F.) and in operating position. Regulator may be checked at end of a run, or after unit has been operated for 45 minutes until operating temperature has been reached.

Illustrations in Fig. 14 show typical methods of hooking up test voltmeter and ammeter.

A. Cut-Out Relay Adjustment—

1. AIR GAP. Adjust air gap in following manner:

(a) DISCONNECT REGULATOR when making cut-out relay air gap and point opening adjustments. Cut-out relay points **must not be** closed by hand with battery connected. This would allow a heavy current to flow into regulator and generator which would seriously damage those units.

(b) Measure air gap between armature and core (not between brass pin in the armature and core) with points closed. See Fig. 12. This dimension should be as listed in "Tabulated Data."

(c) If air gap requires adjustment, loosen two adjusting screws, Fig. 13, holding lower contact brackets as required. Be sure points are lined up, and tighten screws well after adjustment.

2. POINT OPENING: Adjust point opening in following manner:

(a) Measure point opening as shown in Fig. 15. If dimension is not same as listed in "Tabulated Data," adjust opening by bending armature stops as shown in Fig. 15.

(b) If points do not close at same instant, spring fingers should be bent slightly until they do meet simultaneously.

3. CLOSING VOLTAGE: Adjust closing voltage in following manner:

(a) Test with voltmeter between **armature** terminal and **ground screw,** as shown in Fig. 14.

(b) Gradually increase generator speed and note voltage at which cut-out relay points close. Refer to "Tabulated Data" for closing voltage.

(c) If necessary to adjust, loosen lock screw and turn eccentric screw to adjust tension of spiral spring, Fig. 16. Increasing spring tension increases closing voltage, and



Fig. 15 Measuring and Adjusting Cut-Out Point Opening



Fig. 16 Adjusting Relay Closing Voltage



Fig. 17 Checking Voltage Regulator Point Opening

GENERATOR AND REGULATOR

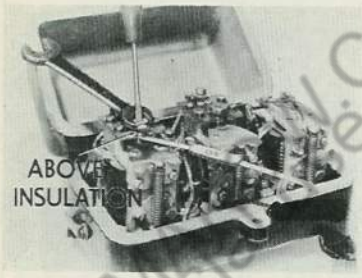


Fig. 18 Adjusting Voltage Regulator Point Openings

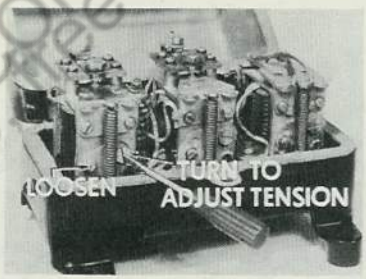


Fig. 19 Adjusting Voltage Regulator Setting

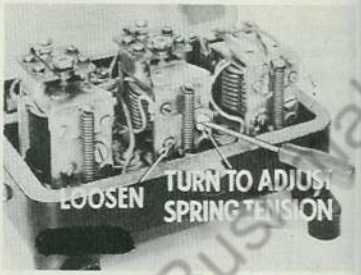


Fig. 20 Adjusting Current Regulator Setting

decreasing tension lowers closing voltage.

(d) Check setting by bringing generator to a stop, and then slowly increasing speed until points close.

(e) Relay closing voltage must be below voltage regulator setting (See "Tabulated Data"), otherwise voltage regulator will operate and hold voltage below value required to close cut-out relay.

4. OPENING: Relay points open with 0-3.0 amps. reverse current. Ammeter should be connected as shown in Fig. 14.

B. Voltage Regulator Adjustment—

1. POINT OPENING: Adjust point opening in following manner:

(a) Check point opening with armature held down against core, Fig. 17. Opening should be same as listed in "Tabulated Data."

(b) To adjust, loosen lock nut and turn contact screw (See Fig. **18**).

(c) Spring holding upper contact screw should rise slightly above fibre insulator when points come together. (Fig. 18.) This provides a "wiping" action which improves their operation.

2. VOLTAGE SETTING: Adjust voltage setting in following manner:

(a) Connect a test voltmeter between **armature** terminal and **ground screw**, and disconnect lead from **battery** terminal. (Fig. 14.)

(b) With unit hot, operating temperature, run generator at a medium speed and note voltage setting. Refer to "Tabulated Data."

(c) To adjust, loosen lock screw and turn eccentric screw to change spiral spring tension, Fig. 19. Increasing tension increases voltage setting, decreasing tension lowers voltage setting.

(d) Tighten lock screw and check setting by reducing generator speed until cut-out relay points open, then bringing generator back to speed. This reduces residual magnetism in regulator winding cores which would otherwise produce an erroneous setting.

C. Current Regulator Adjustment—

1. POINT OPENING: Adjust point opening in following manner:

(a) Point opening should be checked and adjusted in same manner as described under "Voltage Regulator." Refer to "Tabulated Data" for correct point opening.

2. CURRENT SETTING: Adjust current setting in following manner:

(a) Connect a test ammeter into circuit at BATTERY terminal, and bridge voltage regulator contact points with a jumper lead to prevent it from operating, as illustrated in Fig. 14.

(b) Turn on lights or other electrical accessories to prevent high voltage. Operate generator at medium speed. When regulator has reached operating temperature, note current reading. See "Tabulated Data."

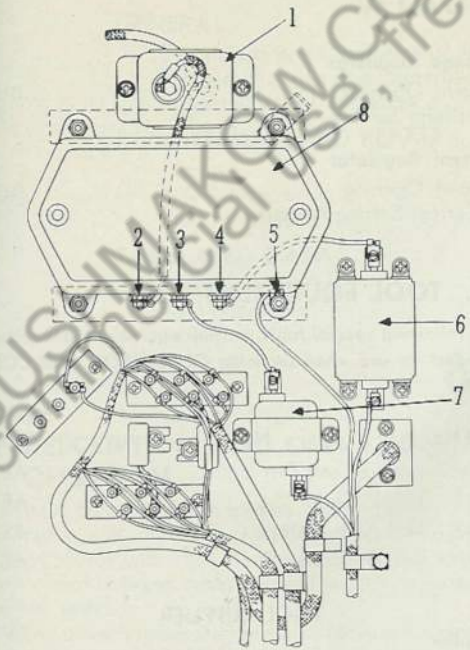
(c) To adjust, loosen lock nut and turn eccentric screw to change spiral spring tension. Increasing tension increases current setting, decreasing tension lowers setting. See Fig. 20.

8. WIRING AND CONNECTIONS

The general wiring diagrams illustrated in Group 06W of this book show all electrical circuits. A portion of those diagrams is illustrated in Fig. 21 and shows only generating circuit as well as wiring connections at regulator and junction blocks.

When wire replacements are made, the correct wire sizes must be used. Periodic inspections should be made of all wires and connections in the generating circuit. Connections should be **clean** and **tight,** and all wires must be adequately insulated.

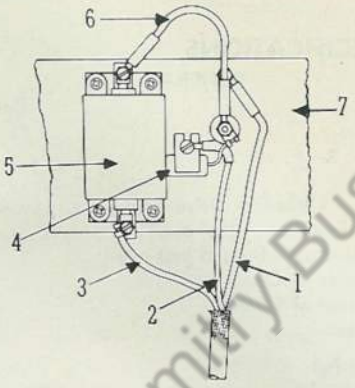
GENERATOR AND REGULATOR



Regulator Connections

(Refer to Group 06D for Identification of Connections)

1. Battery Circuit Filter
2. "Bat" Terminal
3. "Fld" Terminal
4. "Arm" Terminal
5. Ground Terminal
6. Generator Armature Filter
7. Field Circuit Filter
8. Regulator Cover



By-Pass Condenser and Filter Connections at Generator

1. No. 14 Black-Red Check—Field
2. No. 14 Black—Ground
3. No. 8 Red and Black X Tr.—To Filter
4. By-Pass Condenser
5. Filter
6. Jumper to Ground
7. Generator Body

GENERATING CIRCUIT WIRING DIAGRAM

Refer to Wiring Diagram in Group O6W for Other Electrical Circuits

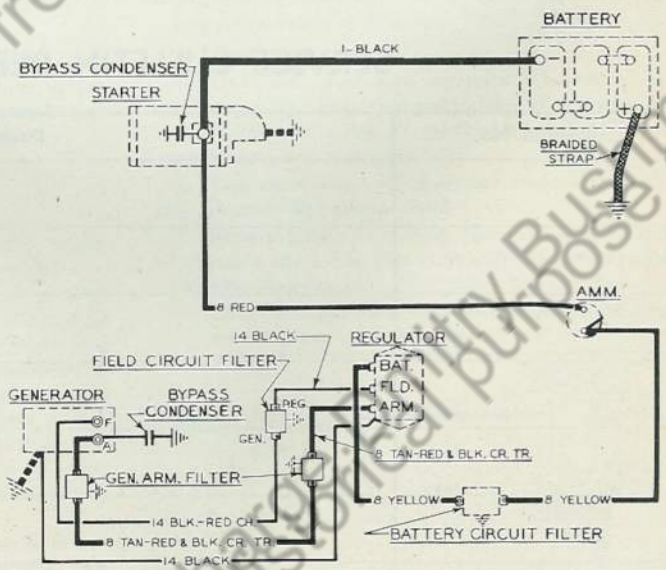


Fig. 21 Generator and Regulator Circuits

GENERATOR AND REGULATOR

TABULATED DATA

9. SPECIFICATIONS

GENERATOR

Make	Delco-Remy
Model No.	1105861
Voltage	6
Amperes	40
Rotation — Viewed at Drive End	Clockwise
Armature End Play — (not over)	.005"
Commutator out-of-round (not over)	.002"
Brush Tension — Oz.	25
Field Current at 6 Volts	
Amperes	1.82 – 1.94

Cold Out-Put

Amperes	40
Volts	8.0
R.P.M.	1850

REGULATOR

Make	Delco-Remy
Model No.	1118468

Cut-Out Relay

Air Gap	.057"
Point Opening	.020"
Points Close—Volts	6.5–6.9
Points Open—Reverse Current—Amps.	0–3.0

Voltage Regulator

Point Opening	.015"
Voltage Setting—Volts	7.5

Current Regulator

Point Opening	.015"
Current Setting Amperes	40

10. TOOL EQUIPMENT

The following special tools, or their equivalent, are recommended for use when servicing GENERATOR AND CONTROL.

Tool No.	Name	Supplier Code
E-30	Growler and Test Light	AE
E-109	Under Cutter	AE
E-192	Volt-Amp Tester	AE
G-3	Tension Scale	AE

TOOL SUPPLIER

Supplier Code	Name	Address
AE	Allen Electric and Equip. Co.	Kalamazoo, Mich.

SERVICE BULLETIN REFERENCE

Bulletin No.	Description

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Group O6S—Starting Motor System

GENERAL — Paragraph

Description and Operation of System 1
Trouble Shooting and General Solutions 2
Inspection and Maintenance 3

REPLACEMENT AND REPAIR

Battery 4
Line Voltage 5
Starting Motor 6

TABULATED DATA

Specifications 7
Tool Equipment 8

GENERAL

1. DESCRIPTION AND OPERATION OF SYSTEM

Starting system comprises battery, starting switch, starting motor, and interconnecting cables from battery to starting motor unit. The starting motor cranks engines when circuit between motor and battery is completed at starting switch.

When driver presses starter pedal, initial movement of pedal which is inter-connected with starting motor shift lever, causes starting motor pinion to mesh with flywheel teeth. Further movement of pedal causes starting motor shift lever to contact and engage starting switch, thus completing electrical circuit to rotate motor and crank engine.

When engine has started, action of overrunning clutch on starting motor shaft releases starter pinion from flywheel teeth. After pedal is released by driver, spring on starter shaft and return spring attached to shaft lever returns starting mechanism to off position.

2. TROUBLE SHOOTING AND GENERAL SOLUTIONS

When diagnosing trouble symptoms in starting motor systems, three factors must be taken into consideration. These are (1) condition of battery, (2) condition of cable and terminals, or continuity of electric circuit, and (3) mechanical and electrical condition of starting motor unit.

If engine fails to start after repeated and satisfactory operations of starting motor, cause of failure of engine to start cannot be attributed to starting motor system, but to other functioning systems of engine such as ignition, fuel, etc. Reference should be made to other "Trouble Shooting" tables in this manual to determine cause of engine failure.

Do not operate starting motor more than ten to fifteen seconds at one time. If engine does not fire after that period of time, allow a period of five to ten seconds to elapse before again using starting motor. Continued operation of the starting motor creates an intense drain on battery and will eventually discharge that unit.

Chart on next page itemizes symptoms, causes, and probable remedies of trouble that may be experienced in starting system.

3. INSPECTION AND MAINTENANCE OF SYSTEM

It is recommended that following inspections be made of entire system each week; however, during severe operations, such as extremely cold weather or hot weather operations, inspection intervals should be more frequent.

INSPECTION AND MAINTENANCE PROCEDURES

Inspection Points as follows:

A. Battery—

1. Cell test. Test with accurate hydrometer and specific gravity. Fully charged battery should read between 1.260 and 1.300. If reading is below 1.225, remove battery and recharge.

2. Cell water level. Fill each cell until water level is approximately 3/8" above plates.

3. Battery terminals. Clean terminals with solution of ammonia and water, then coat with petrolatum before tightening terminal nuts.

4. Ground strap. Check connection of ground strap to frame. Replace cable if corroded.

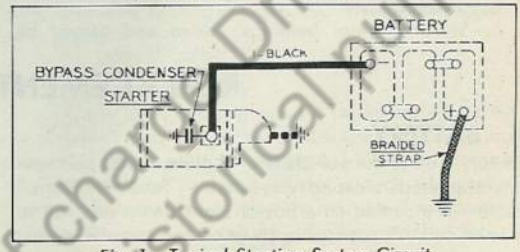

Fig. 1 Typical Starting System Circuit

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STARTING MOTOR SYSTEM

SYMPTOM, CAUSE AND PROBABLE REMEDY

Starter Will Not Operate

Discharged battery—
Recharge battery.
Terminal loose—
Tighten battery and starting motor switch terminals.
Defective starting switch—
Replace switch.
Defective starting motor brushes—
Replace brushes.
Defective starting motor—
Remove and test.

Noisy Starting Motor Action

Loose starting motor mounting bolts—
Tighten.
Defective drive assembly—
Replace.
Flywheel teeth missing—
Replace flywheel.
Loose brush holders—
Replace or tighten.
Lack of lubrication—
Lubricate.
Worn commutator—
Undercut.
Worn bushings—
Replace.

Over-Discharged Battery

Incorrect voltmeter adjustments—
Adjust as described in Group 06-G.

Slow Starting Motor Speed

Discharged battery—
Recharge battery.
Loose or dirty terminals
Clean and tighten.
Worn brushes—
Replace.
Sticking brushes—
Check brush spring tension.
Dirty or worn commutator—
Clean or undercut.
Worn bushings—
Replace.
Armature rubbing field coils—
Tighten field coils in starter housing and check bushings.

Discharged Battery

Loose or dirty terminals—
Clean and tighten.
Excessive resistance in cables—
Check line voltage.
Generator not charging—
Inspect and test regulator as indicated in Group 06-G.
Cells shorted—
Test and repair.
Cells dry—
Replenish with water.

Overheated Battery

Incorrect regulator adjustment—
Adjust as described in Group 06-G.

Trouble Shooting Chart

B. Starting Motor—

1. Brushes and armature. Clean armature and replace brushes if necessary.

2. Starting switch. Check terminals at starting switch and tighten.

3. Starting motor mounting bolts. Tighten starting motor mounting bolts if necessary.

4. Starting pedal controls. Test action of starting pedal. Lubricate pins or replace pull-back spring if controls bind.

C. Lubrication—

1. Starting motor bearings. Drive end cannot be lubricated until motor is removed from engine. Commutator end should be lubricated at periods indicated in Group "L," Lubrication.

D. Cables—

1. Between starting motor and battery. Replace if chafed or worn.

2. Between motor and ammeter. Replace if chafed or worn.

E. Line Voltage—

1. Starting motor cables. Test for line voltage drop.

REPLACEMENT AND REPAIR

4. BATTERY

Battery used in this vehicle is a 19-plate, 6 volt unit having rated ampere capacity as listed in "Tabulated Data." Battery is mounted on a box on right frame side rail to rear of cab. A removable cover on box permits inspection and test of battery.

A. Operation—Battery is an electro-chemical device for storing electrical energy and when properly used, has two major functions. The first function is to govern, directly or indirectly, the voltage of vehicle's electrical system. The second function is to provide electrical energy to starting motor and ignition circuit while engine

STARTING MOTOR SYSTEM

is being started. Battery also supplies energy, under limited conditions, to lights and other electrical accessories.

The battery consists of three cells connected in series, giving a terminal voltage of six volts. Each cell is made up of an acid-proof compartment in which two groups of plates, positive and negative, are immersed in electrolyte, a solution of sulphuric acid and water.

The battery delivers energy when it is connected to an electrical circuit. This energy is derived from chemical reaction of sulphuric acid in the electrolyte and active materials in plates. During course of energy producing reactions, sulphuric acid is absorbed and water produced, thus decreasing specific gravity of electrolyte.

After reaction between plates and electrolyte has continued for a considerable length of time, amount of available acid is so small as to prevent further delivery of useful energy and the battery is said to be discharged.

The generator is designed to restore to battery energy consumed in starting and then to assume burden of supplying complete electrical load. If generator fails in its duty and battery becomes run-down, charging from an outside source is necessary.

B. Maintenance and Test—Procedures as itemized under "Inspections and Preventive Maintenance," should be accomplished at least once a week. The battery is the starting point for any check of vehicle electrical system. The condition of battery must be determined before proceeding with other checks. Following detailed maintenance procedures are recommended:

Check water level in each cell. This level should be about 3/8" above plates. Before adding pure distilled water to cells, take hydrometer reading. Water should be added just before a run during cold weather.

2. Check battery specific gravity with hydrometer at all three cells. Correct hydrometer reading for atmospheric temperature. Add four points (.004) to reading for every 10° above 60°. Subtract four points for every 10° below 60°.

3. Freezing point of electrolyte depends on its specific gravity and condition of battery charge. Following table gives freezing temperature of battery solution at various specific gravities:

Freezing Temperature vs. Specific Gravity

Specific Gravity	Freeze Temp. Deg. F.	Specific Gravity	Freeze Temp. Deg. F.
1100	+18	1220	—31
1120	+14	1240	—51
1140	+ 8	1260	—75
1160	+ 2	1280	—92
1180	— 6	1300	—95
1200	—17		

4. If corrected reading is below 1.225, battery should be removed and recharged. If it is above 1.225, make an additional check at each cell as described in succeeding paragraph. Hydrometer reading merely discloses chemical condition of battery. Additional information on actual operating condition of battery is needed to get a true picture of battery's ability to deliver current under operating load.

5. Check each cell under operating loads, as when starting motor is cranking engine and drawing from 150 to 250 amperes from battery.

6. With ignition switch off or high tension lead removed from ignition coil to prevent engine from starting, operate starting motor and quickly check each cell of battery with an accurate, low reading voltmeter.

7. If voltage of any cell falls below 1.7 volts at 80° Fahrenheit or if there is a difference between cell reading of more than 1/10 volt, battery should be removed from vehicle for further check. At temperature below 80° Fahrenheit, cell voltages will normally drop to lower values. This is due to lowered efficiency of battery as well as greater current draw made necessary by higher cranking torque.

8. Check line voltage as described under "Line Voltage."

9. Battery terminals and cables should be checked at regular intervals. When corrosion is present on terminals, they should be removed from battery and thoroughly cleaned with a solution of ammonia and water. Coat terminals with petrolatum, then install on terminal posts of battery.

C. Charging—Battery may be tested and charged with conventional testing and charging equipment such as or equivalent to those listed in "Tabulated Data" section of this book. These instruments, if used as manufacturer directs, will indicate condition of battery prior to recharging or repairing.

D. To Remove Battery—Battery can be removed, for charging or replacement purposes after both terminals are disconnected and battery hold-down bolts are loosened. Use a conventional post type battery carrier when lifting unit from its compartment. Do not lift battery out of compartment with screw driver placed under cell connections.

E. To Install Battery—Before battery is replaced into compartment, check condition of battery ground strap. This ground strap is attached to frame side rail with two bolts. If ground strap is replaced, make certain that mating surfaces on strap and side rail are absolutely clean and free from paint and oil. Tighten hold-down bolts securely.

5. LINE VOLTAGE

Check cable leads and connections to determine if they are in good condition without excessive resistance. Excessive resistance produces abnormal voltage drop which may lower voltage at starting motor to such a low value that normal operation of starting motor will not be obtained. Abnormal voltage drop can be detected with a low reading voltage in following manner:

STARTING MOTOR SYSTEM

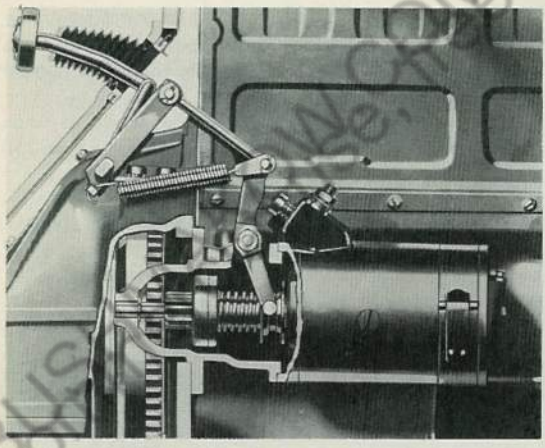

Fig. 2 Starting Motor Controls

1. Check voltage drop between grounded battery terminal (negative) and vehicle frame.

2. Place one prod of voltmeter on battery terminal and other on vehicle frame. With starting motor cranking engine, voltage reading should be less than 1/10 volt. If more than this, there is excessive resistance in this circuit.

3. Check voltage drop between ungrounded battery terminal and starting motor terminal stud while motor is operated. If reading is more than 1/10 volt, there is excessive resistance in circuit.

4. Check voltage drop between starting motor housing and vehicle frame. This must be less than 1/10 volt.

If excessive resistance is found in any of the three circuits, disconnect cables, and clean the connections. If cables appear frayed, replace with new one of **correct** size. Check condition of ground strap and replace if necessary.

6. STARTING MOTOR

Starting motor is direct-drive manual shift type, which engages with flywheel gear through drive unit consisting of pinion, spring, shifting collar, and over-running clutch.

When starter pedal button is depressed, initial movement of shift lever pushes drive unit rearward to engage pinion teeth with flywheel ring gear teeth. Upper end of shift lever engages starting switch button after pinion has fully engaged flywheel gear, or when spring is sufficiently compressed to force pinion into mesh as soon as armature rotates.

Enclosed in driving unit is an over-running clutch which automatically disconnects drive unit from armature shaft after engine starts and before starter lever is released.

A. Starting Motor Maintenance—Maintenance of starting motor unit includes periodic check of condition of unit. While mounted on engine, test for capacity, etc., after unit has been removed, and test of component parts for shorts and continuous circuit. In addition to foregoing series of checks and maintenance, lubrication of the unit must be accomplished at regular intervals.

B. Checking on Vehicle—If symptoms as itemized in "Trouble Shooting" table indicate that trouble is within starting motor unit, following inspections and tests should be made before removing unit from engine:

1. Inspect brushes and replace if they show appreciable wear. New brushes should be worn in by using a strip of No. 00 sandpaper between brush and commutator.

2. Rough side of sandpaper should be toward brush and should conform to contour of commutator. After sanding operation, blow out dust with compressed air.

3. Inspect brush arms and replace if necessary.

4. Check brush spring tension. Weak brush spring tension causes arcing due to poor contact between commutator and brushes. Excessive spring tension causes abnormal wear of commutator due to increased friction between brushes and commutator.

5. Test spring tension of all brush arms with small spring scale. Scale should be connected at brush directly under heads of screws which hold brush to arm. A direct pull should be given and reading taken just as brushes leave surface of commutator. Refer to "Tabulated Data" section for tension specifications.

6. Remove cover band to inspect condition of commutator. If commutator is dirty, place a strip of No. 00 sandpaper between brush and commutator while armature is revolving. After such polishing operations, remove dust from commutator and brushes with compressed air. If commutator is rough or badly worn, starting motor should be removed, disassembled, and armature turned down.

C. To Remove Starting Motor—Remove unit in following manner:

1. Remove return spring from shift lever.
2. Disconnect shift lever from manual control linkage.
3. Disconnect cable connections at starting switch.
4. Remove motor to engine mounting bolts.
5. Pull assembly straight back to withdraw from engine.

D. To Install Motor—Before replacing starting motor, make certain that drive end bearing is thoroughly oiled. The only opportunity to oil this bearing is while starting motor is withdrawn from engine. At the same time, fill oil cup at commutator end with oil as indicated in Group "L" Lubrication.

Install starting motor to engine in reverse manner to that described under "Removal." Refer to Group O6M, Wiring for method of connecting by-pass condenser to starting motor terminal.

E. Checking Motor on Bench—If starting motor does not operate properly after foregoing checks have been made, unit should be removed from vehicle and tested on bench. Suitable instruments such as or equivalent to those indicated under "Tabulated Data" should be used

STARTING MOTOR SYSTEM

to make bench tests. Two bench tests, **no-load** and **torque**, should be made on starting motor to determine condition before unit is disassembled and component parts tested.

F. No-Load and Torque Test Results—Rated torque, current draw, and no-load speed as listed in "Tabulated Data" indicate normal condition of starting motor.

Interpretation of results on no-load and torque tests follow:

1. LOW FREE SPEED AND HIGH CURRENT DRAW WITH LOW DEVELOPED TORQUE MAY RESULT FROM:

(a) Tight, dirty or worn bearings. Bent armature shaft or loose field.

(b) Shorted armature—Check armature on growler.

(c) Grounded armature or field. Check by raising grounded brushes and insulating them from commutator with cardboard. Then check with test lamp between insulated terminals and frame. If test lamp lights, raise other brushes from commutator and check fields and armature separately to determine whether fields or armature is grounded.

2. FAILURE TO OPERATE WITH HIGH CURRENT DRAW INDICATES:

(a) A direct ground in switch, terminal, or fields.

(b) Frozen shaft bearing which prevent armature from turning.

3. FAILURE TO OPERATE WITH NO CURRENT DRAW INDICATES:

(a) Open field circuit. Inspect internal connections and trace circuit with test lamp.

(b) Open armature coils. Inspect commutator for badly burned bars. Running free speed, an open armature will show excessive arcing at commutator bar which is open.

(c) Broken or weakened brush springs, worn brushes, high mica on commutator, or other causes which would prevent good contacts between brushes and commutator. Any of these conditions will cause burned commutator bars.

4. LOW NO-LOAD SPEED WITH LOW TORQUE AND LOW CURRENT DRAW INDICATES:

(a) An open field winding. Raise and insulate ungrounded brushes from commutator and check fields with test lamp.

(b) High internal resistance due to poor connections, defective leads, dirty commutator, and causes listed under "3-(c)."

5. HIGH FREE SPEED WITH LOW DEVELOPED TORQUE INDICATES:

Shorted fields. There is no easy way to detect shorted fields, since field resistance is already low. If shorted fields are suspected, replace the fields and check for improvement in performance.

G. To Disassemble Starting Motor—Remove parts in following sequence. Refer to Fig. 7.

1. Remove cover band (3), switch (13), through bolts

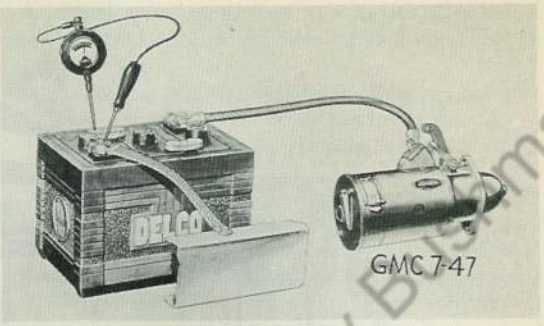

Fig. 3 Check Cell Voltages Under Load

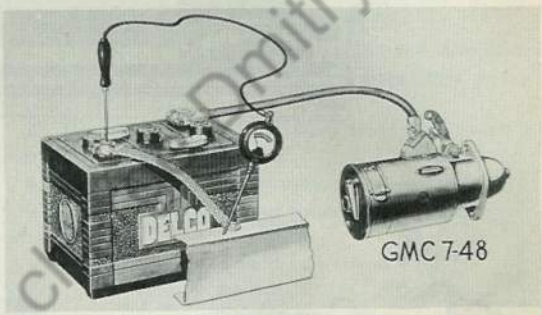

Fig. 4 Check Voltage Drop Between Grounded Terminal and Frame

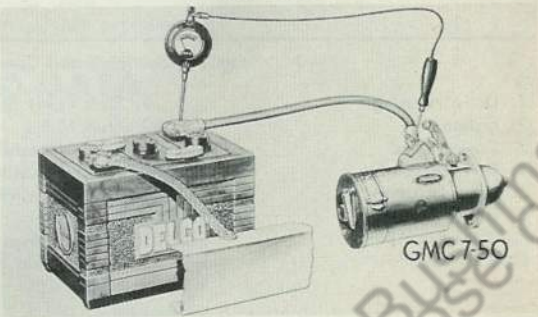

Fig. 5 Check Voltage Drop Between Ungrounded Terminal and Stud

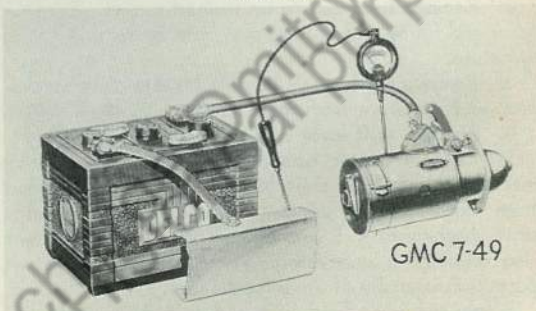

Fig. 6 Check Voltage Drop Between Motor Body and Frame

STARTING MOTOR SYSTEM

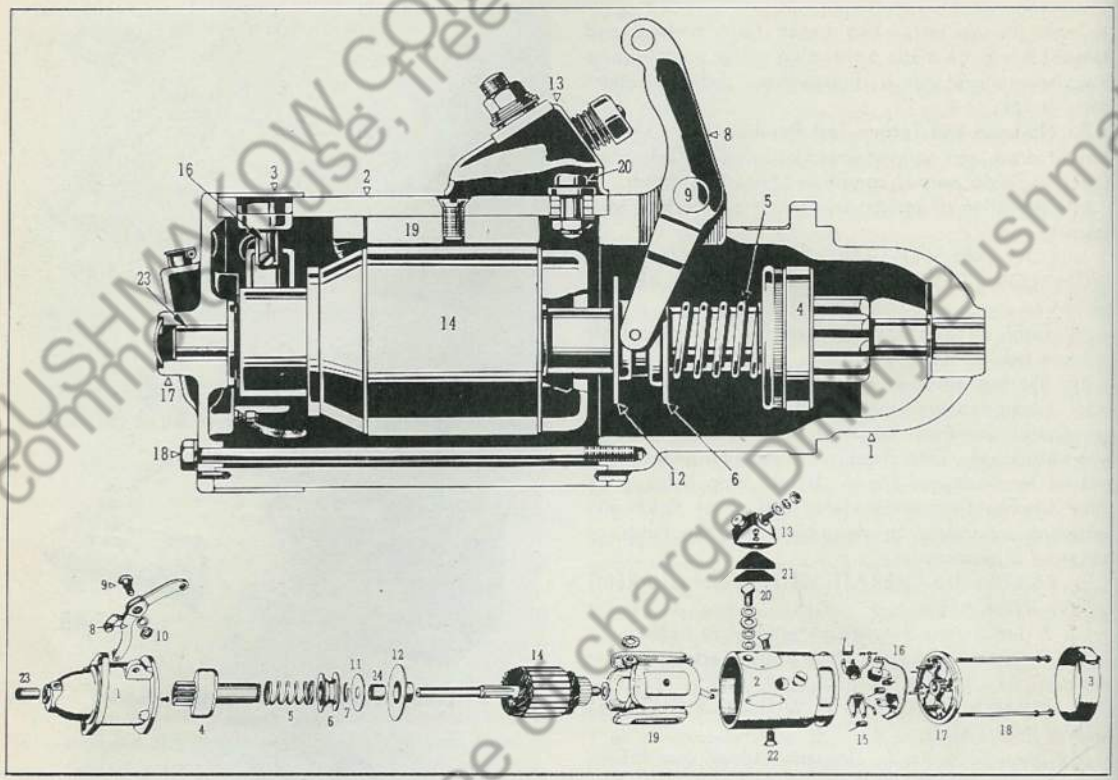

Fig. 7 Sectional and Component Parts of Starting Motor

1. Drive Housing
2. Frame
3. Cover Band
4. Drive Assembly
5. Drive Spring
6. Drive Sleeve
7. Drive Lock Ring
8. Shift Lever
9. Shift Lever Stud
10. Stud Nut
11. Brake Washer
12. Center Bearing Plate
13. Starter Switch
14. Armature
15. Brush Springs
16. Brushes and Holders
17. Commutator End Frame
18. Through Bolts
19. Coils and Pole Shoes
20. Terminal Stud
21. Switch Insulation
22. Shoe Screw
23. Housing Bushing
24. Center Bushing

(18), commutator and frame (17), by-pass condenser (Fig. 8).

2. Remove field coil to brush lead screws. Commutator end frame and brushes may then be removed from armature.

3. Remove motor drive housing (1) with drive mechanism and armature from main housing.

4. Remove shift lever stud and nut (9).

5. Remove center bearing attaching screw. Drive mechanism including shift lever can then be removed from motor drive housing. To disassemble the motor drive mechanism (4, 5, and 6), compress spring until lock ring on shaft is uncovered. Removal of lock ring will permit disassembly of drive mechanism.

Before removing field coils and pole shoes, make coil tests as described under "Testing Starting Motor Parts."

Field coils and pole shoes (19) can be removed in following manner:

6. Terminal stud (20) and nut are soldered to field coils. In order to remove this stud, it will be necessary to hold a hot soldering iron against thread end of stud while unscrewing stud nut. Do not hold iron against stud for any long period as heat of iron will be conducted into field coils through coil ribbons.

7. After terminal stud is removed, remove four pole shoe screws (22) which will permit withdrawal of field coils from starter housing.

H. Inspection of Parts—Inspect starter switch terminals, contacts, and insulation. If these parts appear to be defective or worn, replace with new switch assembly.

Wash all drive mechanism in gasoline with the exception of clutch and pinion assembly (4).

STARTING MOTOR SYSTEM

Check brushes and commutator as described under "Starting Motor Maintenance."

I. Testing Starting Motor Parts—

1. FIELD COIL TEST FOR CONTINUOUS CIRCUIT: Use test light similar to that used for testing generator coils. Place prods on field coil leads. If test lamp does not light, fields are open circuited.

2. FIELD COIL TEST FOR GROUND: Place one prod to motor frame and other to field coil leads. If lamp lights, coils are grounded.

3. INDIVIDUAL FIELD COIL TEST FOR GROUND: Break soldered connections between coils and test each one separately.

4. ARMATURE TEST FOR GROUND: Place one prod on armature and other on commutator. If lamp lights, armature is grounded and should be replaced.

5. ARMATURE TEST FOR SHORT CIRCUIT: Place armature on growler. Place hack saw blade over armature coil, rotate armature and test. If saw blade vibrates, armature is shorted and should be replaced.

6. COMMUTATOR: Inspect for roughness and burned bars. Burned bars are usually caused by coil leads being loose in commutator riser bars. Resolder loose leads, using rosin flux. Turn down on lathe and clean up with No. 00 sandpaper. Retest after soldering operations.

7. INSULATED BRUSH HOLDER TEST FOR GROUND: Place one test prod to cover and other to insulated brush holder. If lamp lights, brush holder is grounded and should be replaced.

8. Check brush leads from end frame. Check and clean all terminals and insulation. Check condition of housing bushing.

J. To Reassemble Starting Motor—Reassemble starting motor in following manner: (Refer to Fig. 7.)

1. Reassemble field coils and pole shoes to starting motor body.

2. Install terminal stud (20) and nut to field coil. Tighten stud nut. Place a small bit of solder on thread end of stud. Hold hot soldering iron on stud **just long enough to run solder** on next nut stud and coil ribbon.

3. Thread shift lever (8) into slot in motor drive housing.

4. Place drive mechanism into housing and engage bosses on lever in grooves of sleeve (6).

5. Install shift lever stud (9) in housing and shift lever.

6. Install center bearing plate (12), fibre brake washer (11) and center bearing plate screw.

7. Place drive end of armature shaft through drive mechanism and drive housing.

8. Install starting motor frame on drive housing.

9. Install commutator end frame and brush assembly on commutator.

10. Make brush and field coil connections.

11. Install through bolts.

12. Install switch on body.

13. Install Radio Suppression By-Pass Condenser.

K. Test After Assembly—Make bench test of unit as previously explained.

TABULATED DATA

7. SPECIFICATIONS

BATTERY

Make	Delco-Remy
Model	
Charged and Filled	19C-1
Dry and Uncharged	19C-1-F
Dry and Charged	19C-1-D
Plates per Cell	19
Voltage	6
Terminal Grounded	Negative
Ampere Hours @ 20 Hr. Rate	155
Specific Gravity	
Fully Charged	1260-1300
Recharge at	1200

STARTING MOTOR

Make	Delco-Remy
Model	1107418
Rotation	Clockwise
Gear Reduction	
Flywheel Teeth	139
Starter Pinion Teeth	9
Ratio	15.44 to 1
End Play in Shaft	.005"-.050"
Commutator—Out-of-Round	.003"
Brush Tension—Oz.	24-28
No Load Test	
Amperes	65
Volts	5.0
R.P.M.	6000
Torque Test	
Amperes	570
Volts	3.15
Torque (Foot Lbs.)	15

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STARTING MOTOR SYSTEM

8. TOOL EQUIPMENT

The following special tools, or their equivalent, are recommended for use when servicing STARTING MOTOR AND BATTERY.

Tool No.	Name	Supplier Code
E-30	Growler and Test Light	AE
E-68A	Torque Tester	AE
E-109	Under Cutter	AE
E-192	Volt-Amp Tester	AE
F-8	Low Reading Volt Meter	AE
F-131	Battery Tester	AE
F-160	Battery Charger	AE
G-3	Tension Scale	AE

TOOL SUPPLIER

Supplier Code	Name	Address
AE	Allen Electric and Equip. Co.	Kalamazoo, Mich.

SERVICE BULLETIN REFERENCE

Bulletin No.	Description

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Group 06D — Ignition System

	Paragraph
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Description and Operation	1
Trouble Shooting and General Solutions	2
Inspection and Adjustments	3
REPAIR	
Ignition Switch	4
Ignition Coil	5
Distributor	6
Condenser	7
Spark Plugs	8
Low and High Tension Wiring	9
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GENERAL

1. DESCRIPTION AND OPERATION

Ignition system comprises ignition switch, source of electrical energy (battery or generator), ignition coil, condenser, distributor, low and high tension wiring, and spark plugs. All of these factors combine to produce electrical energy of sufficiently high voltage to ignite fuel vapors in engine combustion chambers.

There are two distinct electrical circuits in ignition system, primary and secondary (Fig. 1). When these electrical circuits are kept in mind, as well as functions of various units in system to accomplish these circuits, a better understanding may be had of operation of entire system.

A. Circuits.

The **primary** low tension circuit includes source of electrical energy (battery or generator), distributor contact points and circuit-breaker mechanism, primary circuit of ignition coil, and condenser.

The **secondary** high-tension circuit includes secondary circuit of coil, distributor rotor and cap, high-tension wiring, and spark plugs.

Briefly, these ignition circuits function in following manner: After **ignition switch** is turned on, the primary circuit is completed—and—broken by **distributor** circuit-breaker mechanism, causing a build-up and collapse of a magnetic field in **ignition coil.**

When distributor points open, the current has a tendency to continue to flow and forms an arc across the points. The **condenser,** which is connected across distributor points, reduces this arc because it has ability or capacity to store up electrical energy.

The current flows into and charges the condenser. Condenser action causes a quick reduction of current flow in primary circuit. This results in a rapid collapse of ignition coil magnetic field which induces high voltage into secondary circuit. This high voltage is distributed to correct cylinder **spark plug** by means of distributor rotor and cap.

B. Spark Control—Two spark controls are provided on distributor to compensate for varied speeds of engine and different grades of fuel used.

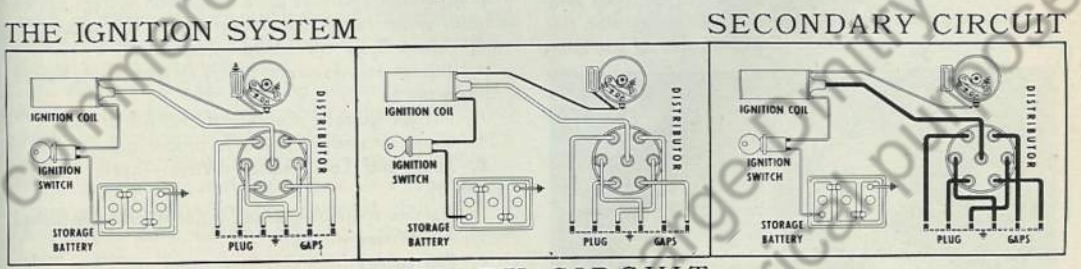

Fig. 1 Typical Ignition System Circuit

IGNITION SYSTEM

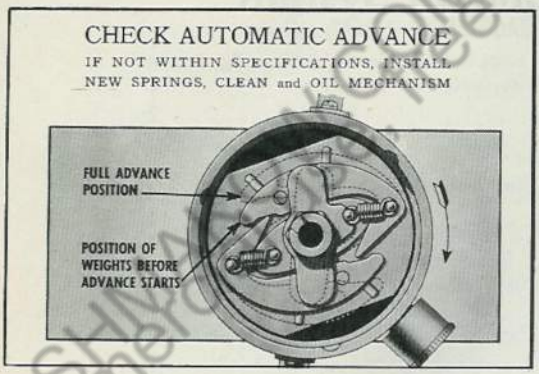

Fig. 2 Centrifugal Advance

1. **Centrifugal Advance**—Where speed variations are encountered, a spark advance based on engine speed is necessary to develop maximum power. This mechanism is mounted on a distributor shaft and consists of counter-weights and springs.

As engine speed increases, the weights gradually throw-out and rotate cam to give desired spark advance for speed at which engine is running. The correct weights, cam contour, and spring calibration have been selected after tests were made to determine correct spark advance at a point where maximum power develops. See Fig. 2.

2. **Manual Advance**—In addition to automatic advance control, manual advance, Fig. 3, is provided by which initial setting may be varied to suit quality of fuel used. Bear in mind, that advance specifications on this distributor are determined after careful test and with the use of high grade fuel. Because of various grades of fuel which may be used, slight readjustment of initial setting may be necessary to obtain satisfactory engine performance and fuel economy. Refer to Paragraph 3 for instruction regarding this manual advance.

2. TROUBLE SHOOTING

In diagnosing any ignition system trouble, the driver or mechanic should visualize ignition wiring diagram and keep in mind fundamental action of the two ignition circuits, primary and secondary. The checker must also bear in mind that many symptoms usually attributed to defects in ignition circuits are in some instances occasioned by defects in other engine operating systems.

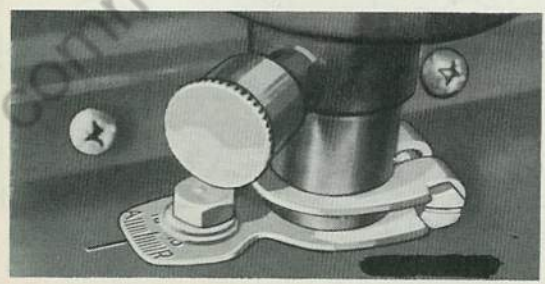

Fig. 3 Distributor Manual Advance

There are some symptoms that can be visually and audibly detected which definitely point to defects in ignition systems; however, other engine operating systems should have routine checks before deciding that ignition system is at fault.

For the convenience of the driver who is frequently required to "trouble-shoot" difficulties in the ignition system, the complete ignition trouble-shooting chart is provided in the Driver's Instructions group of this manual.

In addition to "Trouble-Shooting" information in Driver's Instructions" group the following ignition system items should be considered.

1. **Lack of Power—Overheating**
   - (a) Late Timing ..... Adjust
2. **Back Firing—**
   - (a) Crossed Plug Wires ..... Correct
3. **Missing at High Speed—Under Load**
   - (a) Plug Gaps Incorrect ..... Adjust
   - (b) Point Tension Weak ..... Adjust
   - (c) Point Gap Too Wide ..... Adjust
   - (d) Defective Plug ..... Correct
   - (e) Defective Coil ..... Replace
4. **Pre-Ignition—**
   - (a) Wrong Type Plugs ..... Use Correct Plug
5. **Excessive "Ping" at High Speed Under Load—**
   - (a) Manual Advance Set Incorrectly ..... Correct

3. INSPECTION AND ADJUSTMENTS

Entire ignition system should not only be inspected at regular intervals, but preventive maintenance operations should be performed on various units to keep system operating efficiently. Only by an orderly process of inspection of various units and accomplishment of necessary maintenance and adjustments can ignition system be expected to perform efficiently.

The inspection procedures as outlined in following paragraphs are in logical sequence; however, they may be altered to suit conditions. Detailed instructions on maintenance of various units in ignition system are described under respective paragraphs in this group.

A. Spark Plugs—(Refer to Paragraph 8)

1. Inspect porcelains and points. If excessively burned, replace plugs.
2. Inspect gaskets. Replace if crushed or torn.
3. Clean and adjust points to proper gap.

B. High and Low Tension Wires—(Refer to Paragraph 9).

1. Examine spark plug wires. If damaged or oil soaked, replace with new wires.
2. Pull cables from distributor cap and clean terminals thoroughly. Reinstall cables and see that they are fully seated.
3. Examine cable from coil to distributor. Replace if deteriorated.

IGNITION SYSTEM



Fig. 4 Setting Contact Points



Fig. 5 Cam or Contact Angle

4. Check connections on all wires. Clean, tighten, or replace as necessary.

C. Distributor—(Refer to Paragraph 6).

1. Remove cap and examine for carbonized "short" paths.
2. Clean high tension sockets with small round brush.
3. Clean the inside of cap.
4. Remove rotor and inspect. If excessively burned, replace with new part.
5. Examine points. Clean and adjust as necessary.
6. Lubricate distributor.
7. Check condenser connections.
8. Remove distributor if necessary and check on instrument.

D. Ignition Coil—(Refer to Paragraph 5).

1. Examine wire connections.
2. Remove and test if necessary.

E. Timing

1. Check timing.
2. Test operation for fuel used. (Manual advance.)

Adjustments—There are four major system adjustments which must be made to maintain efficient operation and to compensate for normal wear of parts. These service adjustments are, (1) spark plug gap, (2) contact point opening, (3) initial distributor timing, and (4) manual advance adjustment. In addition to these adjustments, various other electrical tests should be made to check efficiency of system units. Such adjustments and tests which pertain specifically to units are described under respective unit paragraphs.

A. Spark Plug Gaps—Setting gap in spark plug is a **Precision Operation** and should be treated as such. Gap should be set according to dimension shown in "Tabulated Data." When regapping is necessary, bend side electrode only—not center electrode. It is not only necessary to set gap to proper dimension, but **all** plugs should have **same** dimension. Use a standard round feeler gauge.

B. Contact Point Opening—Contact point opening must be set to proper limits. Points set too closely may tend to burn or pit rapidly. Points with excessive separation tend to cause a weak spark at high speed.

1. **Checking Opening**—Point opening of new points may be checked with a feeler gauge; however, a feeler gauge should not be used when checking used points since the roughness of such points makes it impossible to set point opening correctly by this method. Use a dial indicator or an **Angle Contact** meter to check point opening of used points. Fig. 4.

Cam or contact angle is angle in degrees of cam rotation through which points remain closed. This angle increases with decreased point opening. As rubbing block of a new breaker arm wears in, corners are rounded and contact angle increases. Therefore, with a new arm, set contact angle about 3 degrees less than with an arm worn by several thousand miles of operation. Angle given in "Tabulated Data" is subject to a variation of 2 degrees, plus or minus, depending on these conditions. See Fig. 5.

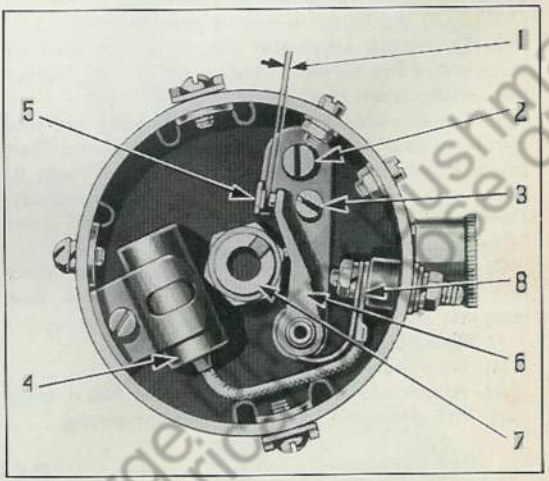

Fig. 6 Breaker Point and Plate

1. Point Opening
2. Clamp Screw
3. Eccentric Screw
4. Condenser
5. Breaker Plate
6. Breaker Lever
7. Cam
8. Insulated Terminal

IGNITION SYSTEM

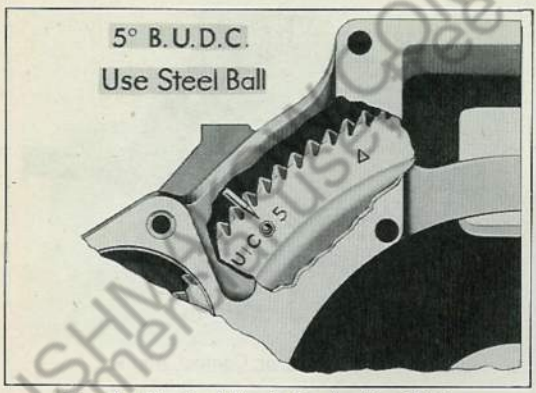

Fig. 7 Flywheel Marks for Ignition Timing

2. **Adjusting Openings**—Crank engine slowly until breaker arm rests on high point of cam.

Loosen clamp screw (Fig. 6) and turn eccentric screw until point opening measures that which is listed in "Tabulated Data." Tighten clamp screw after proper point opening has been obtained.

C. Initial Distributor Timing—After distributor has been repaired and reinstalled, retime ignition in following manner:

1. Set No. 1 piston in firing position. Turn engine with crank until ignition timing pointer on flywheel housing registers with timing mark on flywheel (Fig. 7).

2. Locate No. 1 spark plug wire terminal on distributor cap. Place cap in proper position on distributor and mark housing opposite No. 1 terminal so that its relative position will be known when cap is removed.

3. Insert distributor in running position.

4. Set manual adjustment (Fig. 3) so that mark on block is mid-way between advance and retard. Tighten manual adjustment bolt.

5. Loosen clamp bolt on distributor body and turn distributor counter-clockwise until points are closed. Then rotate distributor clockwise until points just begin to open—with rotor pointing to mark on distributor body. Tighten clamp bolt and check timing as described under "Checking Ignition Timing."

D. Checking Ignition Timing—Check ignition timing with use of a timing light (see Tabulated Data). Test lamp may also be used.

1. **Timing Light.**

(a) Set manual advance at mid point.

(b) Attach one lead of timing light to No. 1 spark plug. Attach the other lead to convenient ground.

(c) Run engine at idling speed.

(d) Hold light close to flywheel peek hole.

(e) Neon flashes are then checked against flywheel markings (Fig. 7) which indicate piston position at time firing occurs.

(f) Distributor can be retarded or advanced (loosen clamp bolt) until Neon flashes are perfectly synchronized with flywheel marking.

2. **Test Lamp**—(Engine not running).

(a) Loosen clamp bolt on distributor.

(b) Connect test light in parallel with distributor points by connecting one lead of lamp to primary terminal on distributor housing, and grounding other lead.

(c) Turn engine over slowly with crank until No. 1 is about to fire. Continue to crank very slowly and stop at exact instant test lamp lights.

(d) Check location of pointer in relation to flywheel marking (Fig. 7). If pointer is within $\frac{1}{16}$" of mark, timing may be considered satisfactory. Turn distributor as necessary to bring setting within proper limits. Tighten clamp bolt when adjustments are made.

E. Manual Advance—The preceding instructions pertaining to initial timing of distributor are the result of extensive research and tests. From these tests are determined the correct ignition timing mark (Fig. 7) for engine used in this vehicle. These tests are made with high octane rating fuel. The engine will perform satisfactorily and economically with that fuel and with initial setting as described.

The manual advance (Fig. 3) is provided for the purpose of compensating for different grades of fuel. This manual advance, set at zero or mid-way when initial setting is made, can be advanced or retarded to permit maximum performance with particular grade of fuel that may be used in service.

1. **Testing**—In order to determine setting of manual advance for maximum performance of engine, a road test should be made, using the same grade of fuel as will be used in service. After initial setting is made as previously described, spark plugs should be cleaned and properly set. Engine should be thoroughly warmed up to operating temperature.

2. **Adjusting**—Manual advance should be set to provide smooth engine performance with a slight "ping" under full throttle at comparatively low vehicle speed. Bear in mind, that this setting may vary on different vehicles and that several tests should be made to determine the exact borderline between effortless engine performance and that which produces an excessive degree of "clatter" or "ping."

REPAIR

4. IGNITION SWITCH

Ignition switch is lock type, mounted on instrument panel. Wiring connections to switch are illustrated in Fig. 13, and in complete wiring diagram shown in Group 06W.

A. Operation—The switch is operated when key is inserted into lock and turned to "on" or "off" position. When switch is turned on, low voltage circuit is completed to ignition system. As a precautionary measure,

IGNITION SYSTEM

fuel gauge is energized only when ignition switch is in "on" position. Function of fuel gauge is discussed in Paragraph 06M of this manual.

B. Testing—Ignition switch may be tested for poor internal contacts in following manner:

1. Contact points of distributor must be closed.
2. Connect voltmeter across switch terminals.
3. Turn switch to "on" position. Voltmeter should read battery voltage.
4. Turn switch to "off" position. Voltmeter should read "0" volts.
5. Do not attempt to repair defective switches. Replace with new part.

C. Removal and Installation—Disconnect battery before removing switch. Make certain that correct wires are connected to terminals when unit is replaced. Wire sizes and tracer colors are shown in Fig. 13. Terminal connections must be tight and clean.

D. Test After Installation—After unit is replaced, turn switch on and watch action of ammeter. If switch is operative and connections are correct, ammeter should show slight discharge with switch in "on" position while engine is being cranked.

5. IGNITION COIL

Ignition coil is oil-filled and hermetically sealed to prevent entrance of moisture. High tension terminal is protected by a porcelain insulator which has high resistance to leakage across its surface and is not damaged by electrical leakage which might occur. Purpose of ignition coil is to transform energy from low voltage source (battery or generator) into energy at sufficiently high voltage to jump gap at spark plug.

A. Operation—There are two electrical circuits within coil, the primary and the secondary. The primary is wound with comparatively few turns of heavy wire usually on outside of secondary. Each end of primary winding is connected to a low tension terminal.

The secondary is wound with many layers of fine wire around iron core. Each layer is insulated from adjacent layer. One end of secondary winding is connected to a primary terminal, and the other end to secondary terminal.

When contact points in distributor close, current from generator or battery flows through primary circuit, creating a magnetic field around windings and core. When distributor points open, current in primary circuit does not stop flowing instantly but flows into condenser which is connected in parallel with points. As previously explained, condenser action causes quick collapse of magnetic field which induces a voltage in primary as well as in secondary windings. This voltage increases until it is sufficiently high to produce a spark at spark plug.

B. Testing—As no definite period can be given for ultimate life of ignition coil, periodical tests of this unit should be made at 5,000-mile intervals. This interval may be changed, depending upon severity of service to which vehicle is subjected. If there is any doubt as to coil's ability, tests should be made regardless of mileage.

For an accurate test, ignition coil should be removed from engine. A visual inspection should first be made of condition of terminals and wires before removing coil. Coil should be tested with accurate instrument such as or equivalent to instrument listed at end of this section. Instructions furnished by manufacturer of instrument should be followed when making the tests.

The most common ignition coil defects indicated on testing instruments are: (1) open circuit primary, (2) open circuit secondary, (3) shorted-turns primary or secondary, (4) high voltage break-down in secondary, (5) high resistance in primary connections.

C. Replacement—Ignition coil is mounted directly above distributor, with high tension terminal down. The coil case should be properly grounded through mounting bracket. The high and low tension leads must be firmly connected to coil terminals.

D. Connections — Battery is **negative** grounded. Switch is connected to coil positive terminal, and distributor primary to coil negative terminal.

6. DISTRIBUTOR

The distributor (Fig. 9) mounted on right-hand side of engine, is equipped with centrifugal type of spark control. The unit is driven from camshaft by spiral cut gears. Lower end of distributor shaft is tongued and engages slot on upper end of oil pump shaft to drive oil pump. See Fig. 8.

The distributor is a mechanical unit designed to assist in induction of primary voltage to secondary voltage

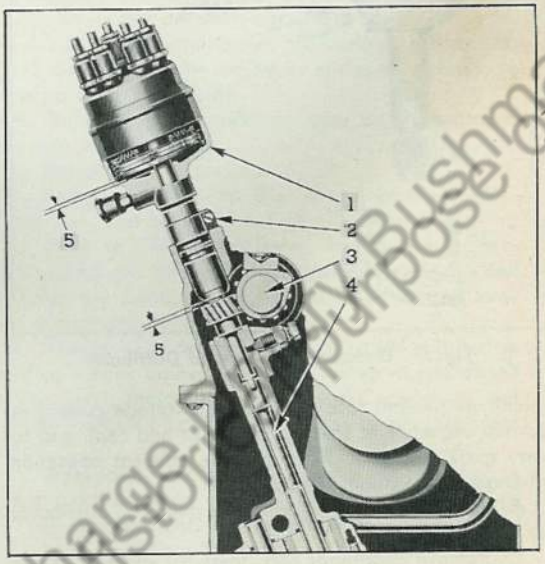

Fig. 8 Distributor Drive and Mounting

1. Distributor
2. Clamp
3. Camshaft
4. Oil Pump
5. Clearance

IGNITION SYSTEM

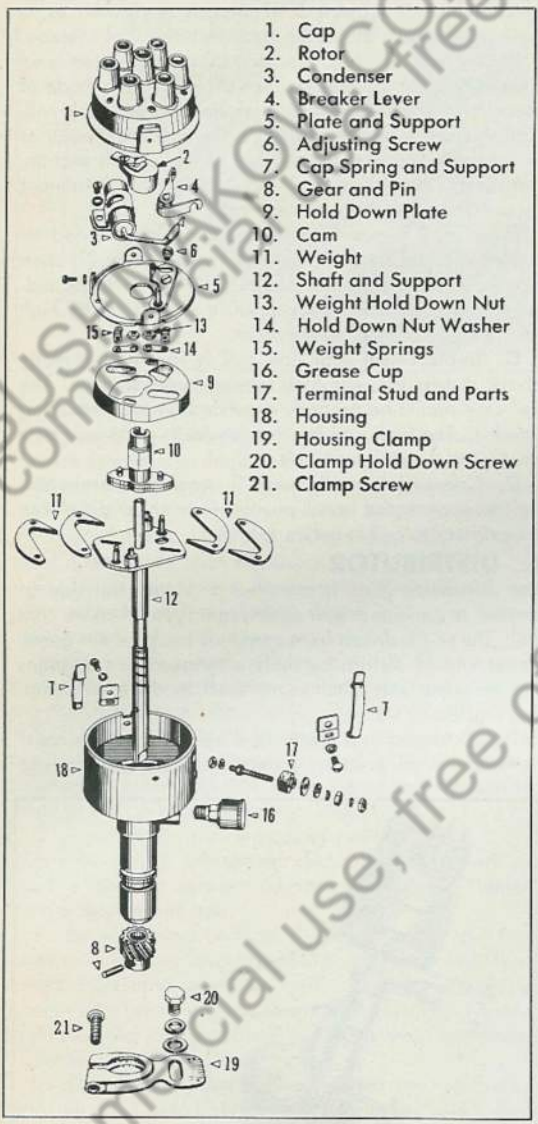

Fig. 9 Disassembled View of Distributor

(point mechanism) to distribute high voltage current in correct sequence to spark plugs (rotor and cap), and to vary spark automatically to provide efficient operation of engine (centrifugal control).

A. Inspection—Inspect following points on distributor at regular intervals:

1. Remove distributor cap. (Figs. 10 and 11.) If cap is cracked or shows evidence of leaks (carbonized paths indicating secondary current leaks), replace with new part.
2. Inspect rotor for cracks and excessive wear.
3. Inspect for burned points.
4. Inspect all wiring. Cracked or swollen wires should be replaced.

B. Lubrication—The only unit in ignition system requiring lubrication is the distributor. Breaker arm pivot and cam faces should be lubricated with small quantity of petrolatum. Refer to Lubrication group.

C. Care of Points—Contact points that are burned or pitted should be replaced or dressed with a clean, fine-cut contact file. File should not be used on other metals and should not be allowed to become greasy or dirty. **Do not use emery cloth to clean contact points.** Contact surfaces, after considerable use, may not appear bright. This is not necessarily an indication that they are not functioning satisfactorily.

Oxidized contact points may be caused by high resistance or loose connections in condenser circuit, oil or foreign materials on contact surfaces, or most commonly, high voltages. Check for these conditions where burned contacts are experienced.

D. Contact Point Pressure—Contact point pressure must fall within limits shown in "Tabulated Data." Weak tension will cause point chatter and ignition miss at high speed. Excessive tension will cause undue wear of contact points, cam and rubbing block. See Fig. 12.

E. To Remove Distributor—Distributor assembly may be removed for overhaul and repair purposes in following manner:

1. Turn engine over with crank until timing pointer on flywheel housing is exactly on ignition mark. (Fig. 2.)
2. Locate No. 1 spark plug terminal on distributor cap. Mark distributor housing opposite No. 1 terminal. Remove distributor cap. Distributor rotor should point toward mark on body.
3. Remove manual adjustment clamp bolt.
4. Lift distributor assembly straight up.
5. Do not turn engine while distributor is out.

J. To Install Distributor—

1. Check position of flywheel. Pointer should be on ignition mark. (Fig. 7.)
2. Before distributor is inserted in place, see that rotor is turned to mark on distributor (No. 1 position-plug firing).
3. While holding rotor toward mark, insert distributor into crankcase. Tongued portion of distributor shaft should then mesh with oil pump shaft without difficulty. Low tension terminal on distributor body should point toward rear of engine when distributor is in correct running position.
4. It is important that slight clearance be maintained between upper and lower end of housing at points shown in Fig. 8. When distributor is first placed in operating position, lower end of housing will contact drive gear. Before tightening clamp remove cap, and place fingers under housing and thumb on rotor. While holding rotor down, raise housing $\frac{1}{32}$". Be sure to equalize clearance at

IGNITION SYSTEM



Fig. 10 Installing Cables



Fig. 11 Cleaning Distributor Sockets

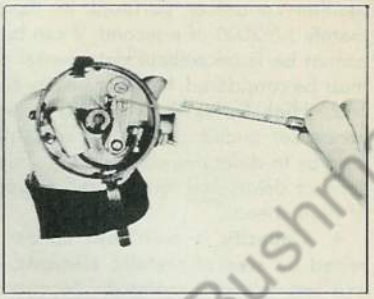

Fig. 12 Testing Breaker Arm Tension

top and bottom. Tighten clamp bolt while distributor is held in position.

5. Install manual control clamp bolt.

6. Connect correct spark plug wires to distributor cap. (See "Firing Order" in "Tabulated Data" and end of this section.)

7. Retime distributor as directed under Paragraph 5.

F. To Disassemble Distributor—If necessary to overhaul distributor for repairs or replacement parts proceed in following manner: (Refer to Fig. 9)

1. Remove cap (1) and rotor (2).

2. Remove condenser (3), breaker lever (4), contact point and support screw, adjusting screw (6), and contact point and support (5).

3. Remove insulated terminal (17), cap spring (7), and primary terminal.

4. Remove gear (8), and pull main shaft and weight assembly through distributor housing.

5. Remove weight hold down plate retaining plate nut and nut washer. Remove weight springs.

6. Remove weight hold down plate (9).

7. Remove cam assembly (10), and weights (11).

8. Filter can be removed from distributor body by removing retainer screws.

G. To Assemble Distributor—Assemble distributor in following manner: (Fig. 9)

1. Assemble weights (11) over pivot pins on main shaft and weight plate (12).

2. Install cam (10), weight hold down plate (9), nuts (13), and washers (14), and springs (15). After tightening nuts securely, lock them by bending tangs on lockwashers.

3. Lubricate shaft and install it in distributor housing. Reinstall shaft gear and pin.

4. Install breaker plate (5), in distributor housing.

5. Assemble distributor cap springs (7), to side of distributor housing. Spring screws and nuts also hold breaker plate in place.

6. Install primary terminal and insulated terminal.

7. Install contact point and support (5), breaker lever (4), and adjusting screw.

8. Install condenser (3), and grease cup (16).

9. Adjust points as described in Paragraph 3.

10. Attach filter to distributor body as illustrated in Group O6M.

H. To Test After Assembly—There are several tests which should be made on a distributor by using a special instrument. These tests are particularly necessary after distributor has been overhauled. With an instrument such as or equivalent to the "Syncrograph" (listed in "Tabulated Data"), many tests can be made on distributor with unit removed from engine. Such an instrument will make following tests:

1. Cam angle.
2. Centrifugal spark advance.
3. Worn cams.
4. Play in shafts.
5. Point pressure.
6. Defective points, etc.

Instructions furnished by manufacturers should be followed when making tests with instruments. "Tabulated Data" at end of this section lists all test data necessary to check operation of distributor.

7. CONDENSER

The condenser is mounted in body of distributor and is connected across distributor points as shown in Fig. 6. The purpose of condenser, as previously explained, reduces distributor point arc by its ability or capacity to store up electrical energy.

A. Replacement—Condenser can be removed in following manner:

1. Remove distributor cap.

2. Remove retainer clip (Fig. 6) and terminal. Condenser can then be lifted out of distributor body.

3. Refer to "Tabulated Data" for correct replacement condenser. Make certain that retaining clip and terminals are tight. Pig-tail should be "formed" away from distributor point arms as shown.

B. Testing—Condenser should be tested with instrument such as or equivalent to that shown at end of this section. Four factors affect condenser operation, and each factor must be considered in making any condenser tests.

1. **Breakdown** is a failure of insulating material, a direct short between metallic elements of condenser. This condition prevents any condenser action.

2. **Low Insulation Resistance** or leakage prevents condenser from holding charge. A condenser with low insulation resistance is said to be "weak." All condensers are subject to leakage, which up to a certain limit is not objectionable. When it is considered that

IGNITION SYSTEM

ignition condenser performs its functions in approximately 1/12000 of a second, it can be seen that leakage cannot be large without detrimental effects. This phase must be considered, however, in any condenser test.

3. **High Series Resistance** is excessive resistance in condenser circuit due to broken strands in condenser lead or to defective connections. This will cause burned contact points and ignition failure upon initial start and at high speeds.

4. **Capacity** is built into condenser and is determined by area of metallic elements, and the insulating and impregnating materials. Incorrect capacity will result in point pitting.

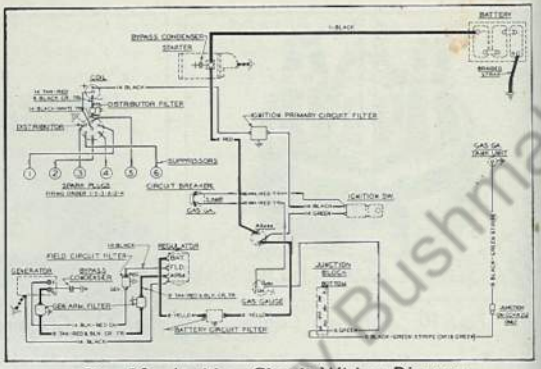

Fig. 13 Ignition Circuit Wiring Diagram

8. SPARK PLUGS

The spark plug is the medium by which high tension voltage is converted into a spark to combustion chamber of engine. These plugs are subjected to severe service during the functioning of ignition system. They require the same degree of careful inspection and care as do the other units of system.

A. Inspection—At periodic intervals, spark plugs should be inspected for cracked porcelains, burnt points, and point gap. Also check for missing gaskets, and loose terminals. Replace plugs which have excessively burnt points or cracked porcelains. Setting of gaps is explained in Paragraph 3.

B. Replacement—Always use a new gasket when a spark plug is replaced. Use special spark plug wrench when removing or installing spark plugs. Use of ordinary wrenches may crack or otherwise damage plugs.

Plugs should be screwed down until they "bottom," then turned one-quarter to one-half turn until firm.

9. LOW AND HIGH TENSION WIRE

Ignition system wiring diagram is illustrated in Fig. 13. This illustration shows relative position of ignition units, and size and tracing color of wires. Complete wiring diagram is shown in Group 06W.

Low and high tension wires and connections of ignition system should be inspected at regular intervals. Loose connections, frayed or broken wires, and oil soaked or wet wires will definitely affect performance of ignition system.

TABULATED DATA

10. SPECIFICATIONS

Ignition Switch	
Make	Delco-Remy
Model	1997754 or 1997760
Ignition Coil	
Make	Delco-Remy
Model	1115149
Condenser	
Make	Delco-Remy
Model	
Min. Insulation Resistance	500 Megohms
Capacity	.20-.25 MFD
Flash Test	750 Volts DC
Distributor	
Make	Delco-Remy
Model	1110135
Rotation-Viewed Drive End	CCW
Advance	Full Automatic
Type of Advance	Centrifugal
Cam Angle	35°
Breaker Point Gap	.018"-.024"
Breaker Arm Tension—Oz.	17-21
Firing Order	1-5-3-6-2-4
Centrifugal Advance—Engine R.P.M.	
Starts—400 R.P.M.	2°
Intermediate—800 R.P.M.	10°
Maximum—3400 R.P.M.	32°
Initial Timing	
Line up Pointer on Flywheel Mark (Steel Ball)	5° B.U.D.C.
Spark Plug	
Make	AC
Type	44
Size	14MM
Gap (set with round gauge)	.025"

11. TOOL EQUIPMENT

The following special tools, or their equivalent, are recommended for use when servicing DISTRIBUTOR.

Tool No.	Name	Supplier Code
E-13 or E-23	Timing Light	AE
E-137	Syncrograph	AE
E-191	Condenser Tester	AE
E-192	Volt-Amp Tester	AE
E-193	Coil Tester	AE
G-16	Contact Tension Gauge	AE

TOOL SUPPLIER

Supplier Code	Name	Address
AE	Allen Electric and Equip. Co.	Kalamazoo, Mich.

Group O6L — Lighting System

GENERAL — Paragraph
- Description and Operation 1
- Trouble Shooting and General Solutions 2

UNIT OPERATION, TEST AND REPAIR
- Main Light Switch 3
- Miscellaneous Switches 4
- Service Head Lamp 5
- Black-out Head Lamp 6
- Black-out Driving Lamp 7
- Tail and Stop Lamp 8
- Trailer Socket 9
- Wiring 10

TABULATED DATA
- Specifications 11

GENERAL

1. DESCRIPTION AND OPERATION

Lighting system comprises service head lamps, black-out head lamps, left-hand black-out driving light, service and black-out tail and stop lamps, instrument panel lights, and trailer light socket connection.

Operation of each unit in this group is explained in their respective unit paragraphs.

2. TROUBLE SHOOTING AND GENERAL SOLUTIONS

For point-to-point inspection of wiring circuits in connection with trouble shooting lighting system difficulties, refer to Wiring group 06W.

06

UNIT OPERATION, TEST AND REPAIR

3. MAIN LIGHT SWITCH

All lights are controlled by action of main light switch. Instrument panel lights, black-out driving lights, and stop lights are controlled by action of individual switches, after circuits are energized by main light switch. Main light switch (Fig. 1) is a four-position push-pull switch located on instrument panel. This switch energizes all lights, depending upon position of control button.

A. Operation—Switch operates in following manner:

1. OFF POSITION—When control button is pushed completely in, **all** lights (service and black-out) are turned off. Black-out and service stop lights cannot be operated with switch in this position on either truck or trailer.

2. BLACK-OUT POSITION—When switch button is pulled out to first stage or black-out position, following lights are energized. (Switch is locked in this position.)
   (a) Right and Left Front Black-out Head Lights.
   (b) Black-out Stop and Tail Lights.
   (c) Left-hand Black-out Driving Light (Note: B. O. driving light can be turned on and off with individual light switch.)

3. SERVICE POSITION — Switch buttons can be pulled to second stage or service position when lock button is depressed. When switch is in "service" position, following lights are energized:
   (a) Service Head Lamps.
   (b) Service Stop and Tail Lamps.
   (c) Instrument Lamps. (Note: Instrument panel lights can be turned on and off with individual switch after main light switch is in this position.)
   (d) Trailer socket.

4. SERVICE STOP LIGHT POSITION—When switch button is pulled completely out, service stop lights can be operated for daylight operation on either truck or trailer. Only the service stop-lights can be energized with switch in this position.

B. Fuse—Thermal type fuse (Fig. 2) is incorporated in main switch to protect entire lighting system circuit. Heat due to shorts will open circuit at predetermined amperage. Circuit is restored when thermal unit cools. In the event circuit is broken by action of thermal fuse, light switch should be immediately turned off, and cause of short in system be determined and corrected.

C. Removing and Replacing—Main switch illustration Fig. 1, and wiring diagram Fig. 9, show all connections to main switch terminals. Make certain that correct wires are connected to switch terminals.

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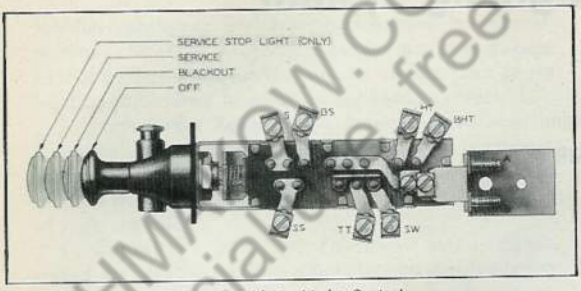


Fig. 1 Main Light Switch

TERM.	CIRCUIT	WIRE SIZE & COLOR
"A"	Auxiliary	Not Used
"B"	Sw. to Ammeter	10-Yellow
"BHT"	Sw. to No. 1—Top Jct. (Feeds Black-Out Headlamp, Tail lamp and Black-Out Driving Lamp)	16-White
"BS"	Sw. to No. 6 Bottom Jct. (R. H. Black-Out Stop)	16-Black, Red Tr.
"HT"	Sw. to No. 5—Top Jct. (Service Tail)	16-Black, Green Tr.
	Sw. to "Bat" on Dim Sw.	12-Blk., Green Tr.
	Sw. to Inst. Lamp Sw.	16-Blk., Green Tr.
"S"	Sw. No. 2 Bottom Jct. (Service Stop)	16-Red, Black Tr.
"SS"	Sw. to No. 5 Bottom Jct. (Trailer Stop)	16-Blk. & Red Check
"TT"	Sw. to No. 1 Bottom Jct. (Trailer Tail)	16-Green & Blk. Check
"SW"	Sw. to No. 3 Bottom Jct. (Stop Sw.)	16-Red

4. MISCELLANEOUS SWITCHES

A. Black-out Driving Light Switch—Individual black-out driving light switch, located at instrument panel, controls left-hand black-out driving light after main light switch is in black-out position as previously explained.

B. Instrument Panel Light Switch—Instrument panel lamps are controlled by action of push-pull type switch at instrument panel, after main light switch is in service position as previously explained.

C. Stop Light Switch—Stop light switch, at hydraulic master cylinder, is hydraulically operated and controls black-out stop lights (with main switch in black-out position), and service stop lights (with main switch in service or service stop light position). If stop lights do not illuminate upon application of brakes, make sure that bulbs are good before testing the switch. Test switch in following manner:

1. Connect one lead of a voltmeter to each terminal of switch.
2. With brakes off, voltmeter should read battery voltage.
3. With brakes applied, reading should be "0."
4. If switch does not check correctly in either test, replace with new unit.

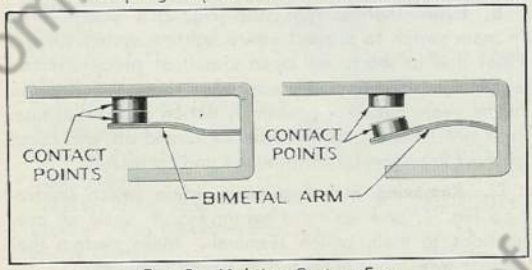


Fig. 2 Lighting System Fuse

D. Dimmer Switch—Dimmer switch, accessible to driver's left foot, controls high and low beam in service head lamps. Dimmer switch is not operative unless main light switch is in service position. If switch becomes inoperative, replace unit with new part. Make certain that correct wires are connected to switch terminals.

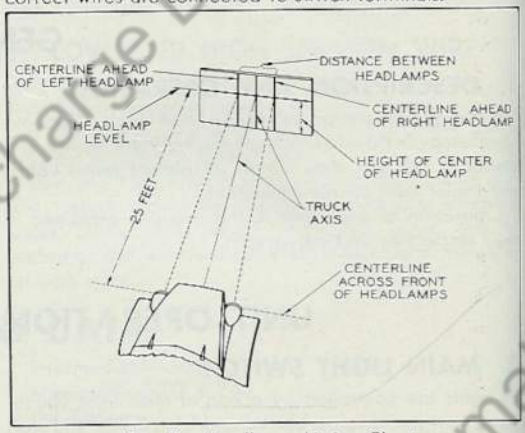


Fig. 3 Headlamp Aiming Chart

5. SERVICE HEAD LAMPS

Service head lamps, mounted on left and right-hand fenders, are double filament "sealed beam" type. These lamps are illuminated when main light switch is in service position. Action of dimmer switch controls upper and lower beam.

A. Use of Head Lamps—Service head lamps are designed to provide adequate highway lighting for vehicle operation under all operating conditions requiring full service lights. The head lamps will provide safe lighting, providing they are aimed correctly, equipped with proper lens and bulb elements, lens is clean, and upper and lower beams are used correctly.

1. UPPER BEAM—Upper beam should only be used on highway when no approaching vehicles are near. The upper beam illuminates highway considerably farther than low beam; however, it also casts the light beam higher, which interferes with an approaching driver's vision.

LIGHTING SYSTEM

2. LOWER BEAM—Lower or depressed beam should always be used when approaching another vehicle and when driving on well-lighted highways. The depressed beam will furnish adequate light to permit safe passing of approaching vehicle. In fact, tests have proven that the depressed beam provides safer road visibility than upper beam under passing conditions, providing both vehicles use the depressed beam.

B. Maintenance—Head lamps require periodic inspection and maintenance as follows:

1. HEAD LAMP LENS—Dirty lenses absorb a large amount of light and, therefore, decrease light output and add to night driving hazards. Lenses are easily cleaned with water and a good glass cleaner. Inside of head lamp lens cannot be cleaned since it is sealed to reflector and forms a complete unit.

2. HEAD LAMP REFLECTOR—Head lamp reflector is a sealed unit with lens and bulb; therefore, it cannot be disassembled for cleaning. A sprung or bent reflector will distort the head light beam, making it impossible to correctly adjust the head lamps. The only remedy is to replace with a new sealed unit.

3. HEAD LAMP BULBS—Proper voltage must be maintained at the head lamp bulb in order to get the maximum illumination output. Such items as a low battery, poor electrical contact in the wiring system, and poor ground through the head lamp body and its brackets and loose connections in generator to battery circuit, all contribute to a loss in voltage. Illumination service demands that all of the head lamp electrical circuits be checked.

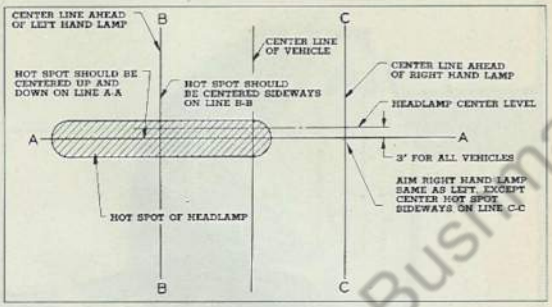


Fig. 4 Headlamp Aiming Pattern

C. Aiming Adjustment—Aiming adjustment operations must be done accurately, as the difference of a very few degrees will mean the difference between safe head lights and dangerous head lights.

When aiming head lamps it may sometimes be noted that the head light beam is distorted. This condition is usually caused by a sprung reflector. Reflectors may become sprung due to careless handling.

Adjustment of head lamps can be accomplished quickly and accurately with head lamp tester. However,

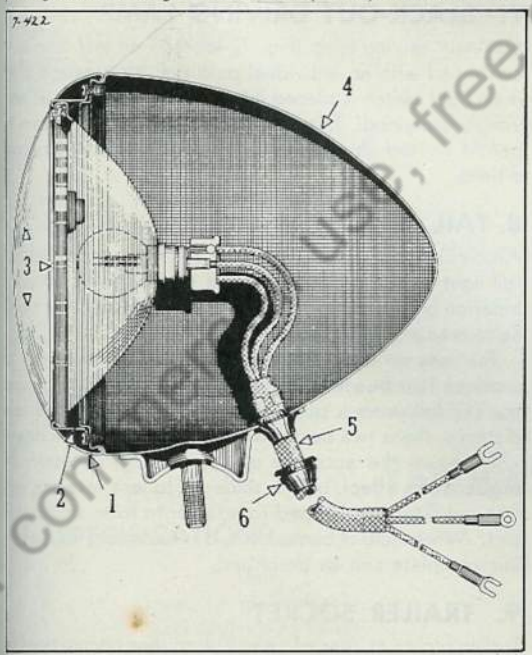


Fig. 5 Headlamp

1. Moulding
2. Retaining Ring
3. Seal
4. Body
5. Wiring Assembly
6. Grommet

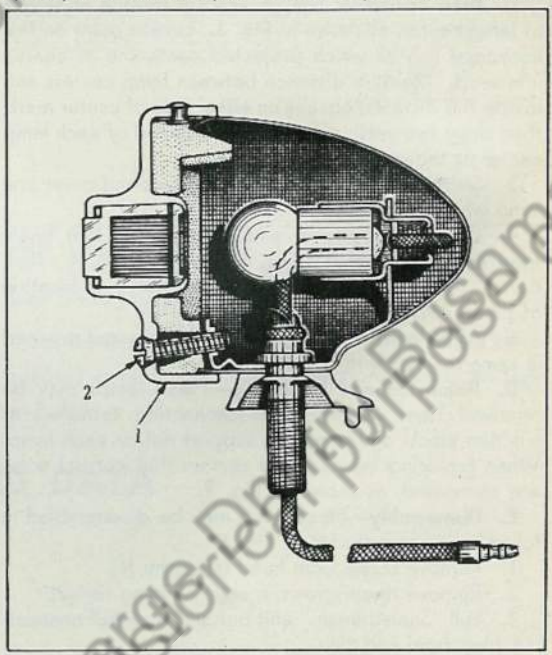


Fig. 6 Black-Out Headlamp

1. Door Assembly (Includes Lense)
2. Door Screw

LIGHTING SYSTEM

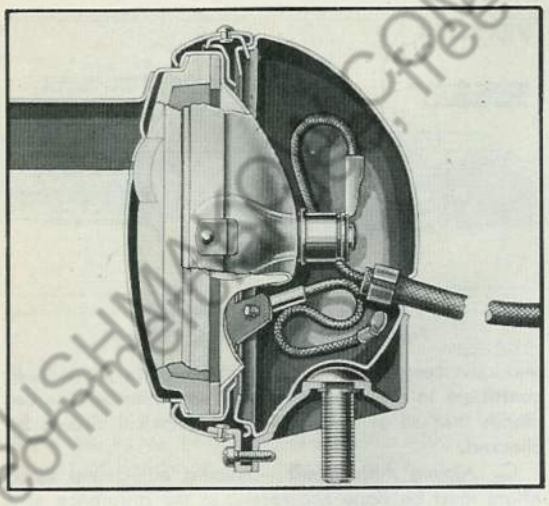


Fig. 7 Black-Out Driving Lamp

if this equipment is not available, adjustment can be made as follows:

1. Place truck on level floor so that head lamps are 25 feet from a smooth vertical surface such as wall or door, preferably of light color. Centerline of truck should be perpendicular to this vertical surface.

2. Draw horizontal line on vertical surface at height of lamp center, as shown in Fig. 3. Locate point on this horizontal line at which projected centerline of chassis intersects. Measure distance between lamp centers and divide this distance equally on either side of center mark, then draw two vertical lines directly ahead of each lamp center as shown.

3. Switch on high beams in head lamps and cover one lamp while adjusting other.

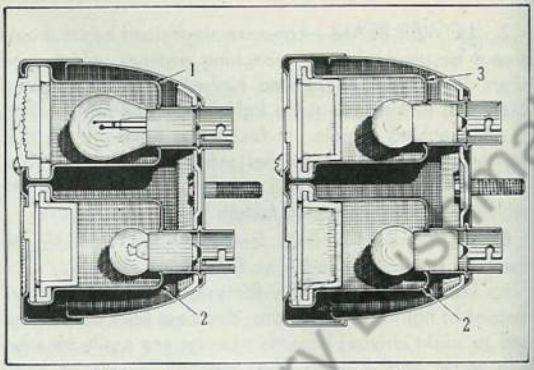
4. Loosen support nut and aim lamp so that beam registers with horizontal line, as shown in Fig. 4. Then tighten nut securely, taking care not to change location of beam pattern on vertical surface.

5. After lamp is aligned, cover its beam and proceed in same manner with opposite lamp.

D. Removing and Replacing—Head lamps may be removed from vehicle by disconnecting terminals at junction blocks and removing support nut on each lamp. When replacing lamps, make certain that correct wires are connected, as shown in Fig. 9.

E. Disassembly—Head lamp may be disassembled in following manner (Refer to Fig. 5):

1. Remove screw from head lamp rim (1).
2. Remove three screws in unit retaining rim (2).
3. Pull "Sealed Beam" unit out and then pull connecting plug from unit (5).
4. Remove wire rubber grommets (6).
5. Pull wiring assembly and connector (5) through head lamp body.
6. Lamp may be assembled in reverse order.



L. H. Rear Lamp *R. H. Rear Lamp*

Fig. 8 Rear Service and Black-Out Lights

1. Service Lamp Unit Assembly
2. Black-Out Driving Lamp Unit Assembly
3. Black-Out Stop Lamp Unit Assembly

6. BLACK-OUT HEAD LAMPS

Black-out head lamps are mounted on fenders at side of each head lamp, and are illuminated only when main light switch is in intermediate position. Lamps are equipped with a colored filter. Fig. 6.

7. BLACK-OUT DRIVING LAMP

Black-out driving lamp (Fig. 7), located on left fender, is controlled with an individual push-pull type switch after main light switch is placed into black-out position as previously explained. This light furnishes a diffused beam to permit limited illumination under black-out driving conditions.

8. TAIL AND STOP LAMP

A combination service stop and tail light and black-out tail light is mounted at left-hand rear of truck. A combination black-out stop and tail light is mounted at right-hand rear of truck. (See Fig. 8.)

The lens on each black-out tail lamp is designed to produce two beams. This design is such that when one truck is following a preceding truck at a specified safe distance, these two beams will merge into a single beam.

To insure the accuracy of construction necessary to produce this effect, bulb is soldered to lens retainer, and lens and filter are crimped to retainer to form a complete unit. When bulb is burned out, it is necessary to replace this complete unit as described.

9. TRAILER SOCKET

Trailer socket at rear of vehicle furnishes connections to trailer tail and stop lights. Trailer tail light connections are energized when main light switch is in service position. Trailer stop connections are energized when main light switch is in service or service stop light position.

LIGHTING SYSTEM

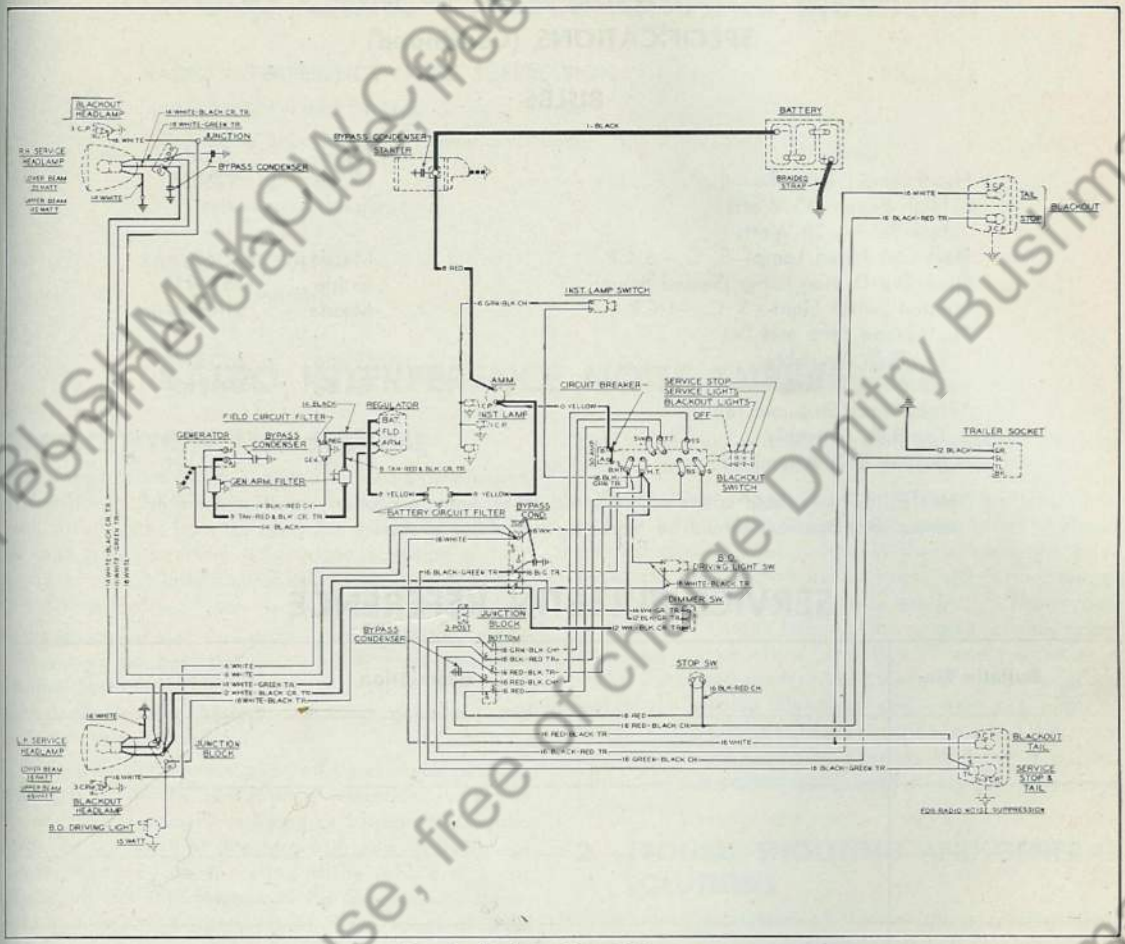


Fig. 9 Lighting Circuit Diagram

10. WIRING

General wiring diagram illustrating all lighting systems is shown in Fig. 9. This diagram lists all connections to various lighting system units. Reference should be made to Group 06W for locations of junctions, wire sizes, and wire tracing colors.

All terminals at lighting equipment units should be inspected periodically. The connections should be tight and clean.

TABULATED DATA

11. SPECIFICATIONS

Unit	Make	Model
Head Lamp (Service)	Guide	1004A
Black-Out Head Lamp	Guide	5503E
Black-Out Driving Lamp	Guide	1023D
Left-Hand Stop and Tail	Guide	3012A
Right-Hand Stop and Tail	Guide	3012B

LIGHTING SYSTEM

SPECIFICATIONS (Continued)

BULBS

Unit	Make	Model
Head Lamp (Sealed Beam)	Guide	925000
High Beam—45 Watts		
Low Beam—35 Watts		
Black-Out Head Lamp—S. C.—3 CP	Mazda	63
Black-Out Driving Lamp (Sealed Beam)	Guide	5934473
Ignition Switch Light—S. C.—1 CP	Mazda	51(G3-1/2)
*Left-Hand Stop and Tail		
Top Bulb Assembly	Guide	5933078
Bottom Bulb Assembly	Guide	5933104
*Right-Hand Stop and Tail		
Top Bulb Assembly	Guide	5933078
Bottom Bulb Assembly	Guide	5933121

*NOTE: Bulbs in these lamps are soldered to retainer to properly position them in lamps. Replacement should be made by assemblies as shown.

SERVICE BULLETIN REFERENCE

Bulletin No.	Description

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Group O6M—Miscellaneous Electrical

RADIO INTERFERENCE NOISE SUPPRESSION	Paragraph
Description and Purpose	1
Trouble Shooting and General Solutions	2
Inspection and Test	3
Removal and Installation	4
TABULATED DATA	
Specifications	5

RADIO INTERFERENCE NOISE SUPPRESSION

1. DESCRIPTION AND PURPOSE

Radio Interference Noise Suppression (radio suppression) as applied to GMC army trucks is the suppression of noise disturbances from the electrical system of the vehicle which would interfere with proper reception of radio signals, or permit detection of vehicle location, by highly sensitive receivers.

The sources of electrical noise interference on a motor vehicle may be basically divided into three groups—**Ignition System,** including coil, distributor and spark plugs — **Generating System,** including generator and regulator—and **Wiring.**

Radio frequency waves given off by elements of these three groups during operation of electrical system of the vehicle are actually radiated or broadcast as radio waves, or signals, that interfere with any receiving apparatus that may be operating in the vehicle or in its vicinity. Radio Interference Noise Suppression, therefore, involves the suppressing of these waves **at their sources**—or confining them within an area where they cannot be picked up by the antenna of a radio equipped vehicle.

The mechanical installation of "radio-suppression" consists of one or more of several types of units permanently installed in the electrical system of the vehicle as follows:

A. Suppressors—Seven suppressors are used, one at each spark plug and one at center terminal of distributor. A suppressor is a high resistance element inclosed in an insulated housing.

B. Filters—Six filters are used in the suppression system, two in the generator armature circuit, one in the generator field circuit, one in the battery circuit and two in the ignition primary circuit. The filter is a unit consisting of a winding and one or more condensers connected internally in a metal housing. Its purpose is to eliminate, or suppress, and prevent the escape of radio frequencies.

C. By-pass Condensers—Six condensers are used at various points of wiring system. These condensers by-pass surges and undesirable radio frequencies. They do not interfere with regular flow of current.

D. Bonding—Application of the foregoing three methods results in a reduction of interference noises to a very marked degree. But to obtain the ultimate low level necessary for effective use of radio, still further means of "radio suppression" must be used. It is known that if the sheet metal forming the engine compartment could be joined into a solid box, it would serve as a metal shield and prevent the escape of radio frequency waves. To provide this effect, every individual piece of metal forming the enclosure must be in good electrical contact with each adjoining piece—and this is accomplished by the proper use of bond straps and shakeproof lockwashers.

2. TROUBLE SHOOTING AND GENERAL SOLUTIONS

If the electrical system of the vehicle is causing interference to radio equipment located in the vehicle, or an adjacent vehicle, the suppression system is not functioning properly. Likewise, if the suppression units are interfering with the normal operation of the electrical circuit in which they are installed, they are defective and must be replaced with **identical new parts—even bolts and nuts MUST be cadmium plated, NEVER substitute with plain or Parkerized parts! Be sure to destroy defective parts.**

There are two phases of trouble shooting in connection with radio noise suppression—(A) To determine the efficiency of the system for noise suppression—(B) To discover the effect of suppression units on the vehicle's electrical systems.

A. Suppression System — In order to determine whether radio suppression system is efficient and vehicle is "quiet," it is necessary to listen to its effects on an actual radio receiver.

B. Radio Suppression Units—In order to determine whether any radio suppression unit is interfering with the

(Continued on Page 6)

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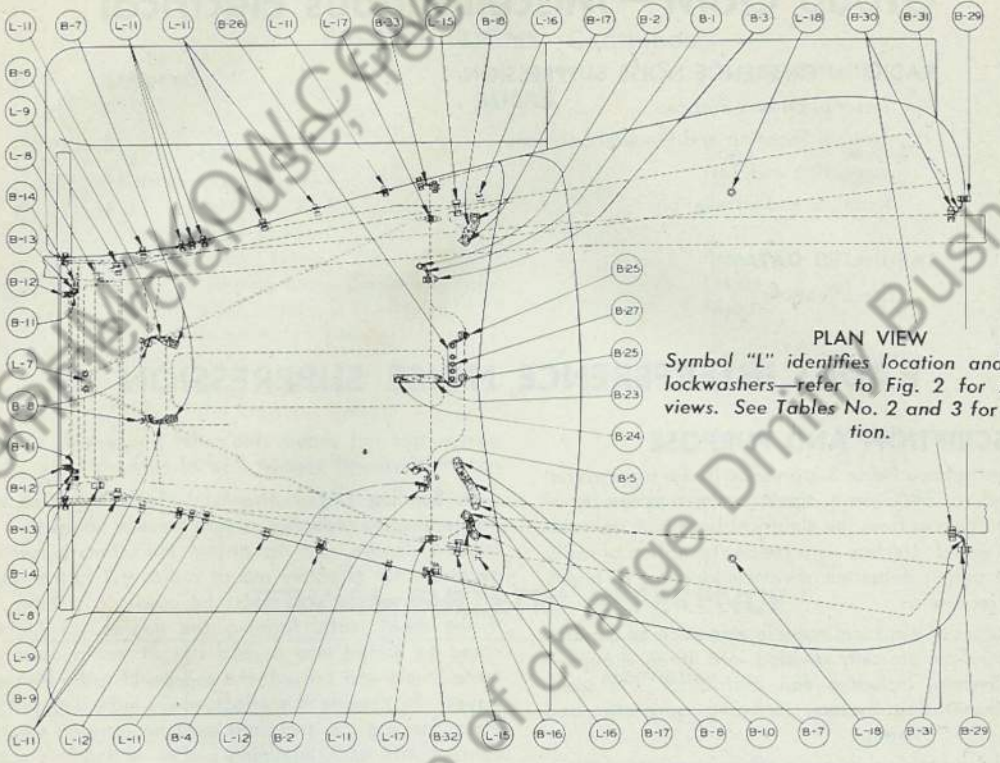
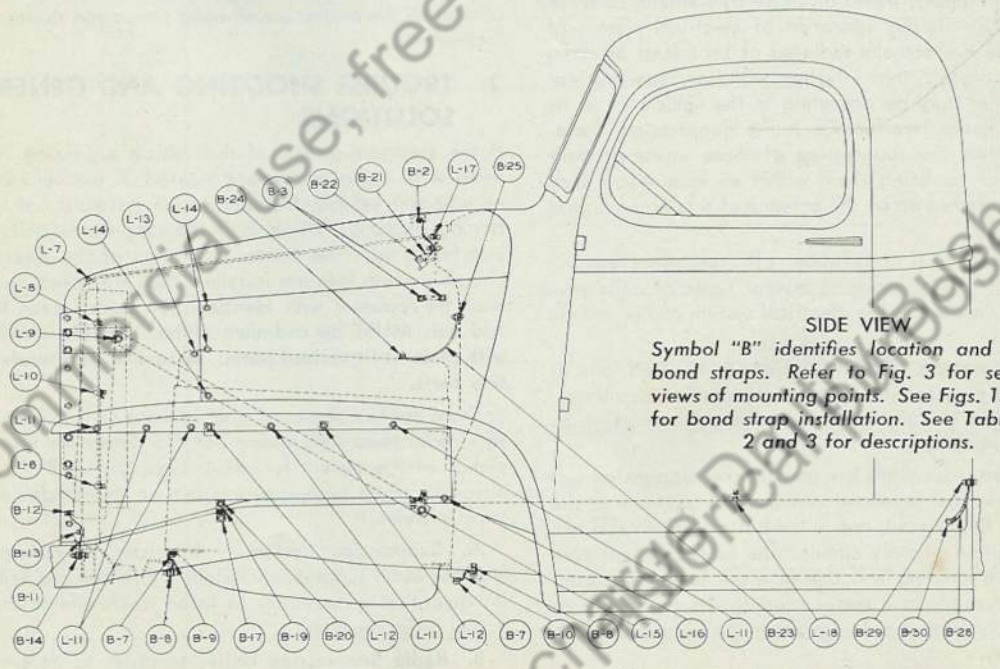


PLAN VIEW

Symbol "L" identifies location and use of lockwashers—refer to Fig. 2 for sectional views. See Tables No. 2 and 3 for description.



SIDE VIEW

Symbol "B" identifies location and use of bond straps. Refer to Fig. 3 for sectional views of mounting points. See Figs. 15 to 22 for bond strap installation. See Tables No. 2 and 3 for descriptions.

Fig. 1 Layout Showing Bond Strap and Lockwasher Locations
— See Notes Above —

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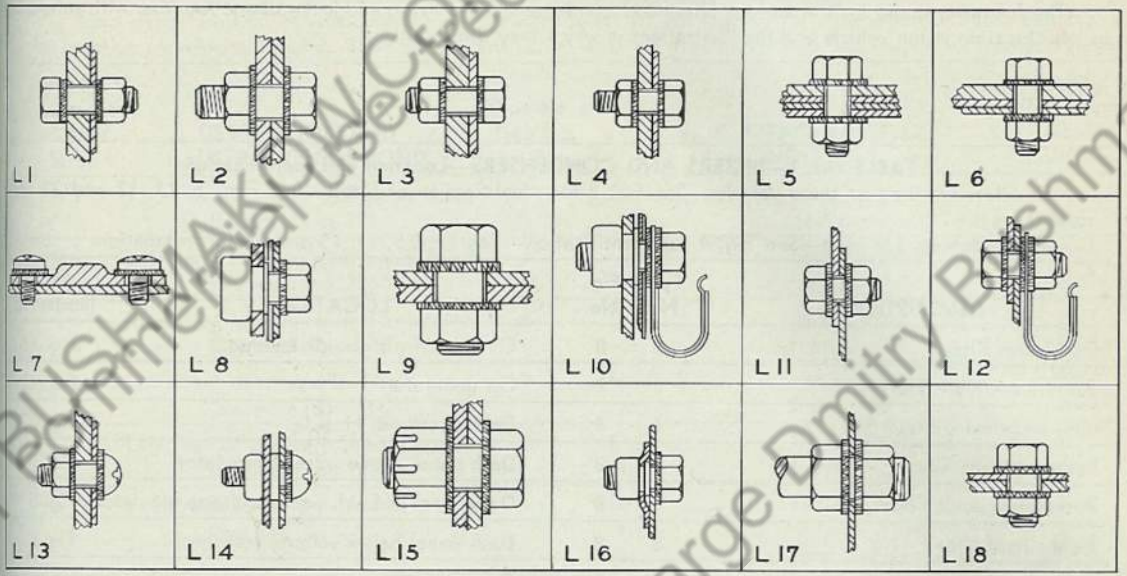

Fig. 2 Sections of All Shakeproof Lockwasher Mountings
(See Fig. 1 for Locations on Vehicle)
(See Table No. 2, Page 4, for Descriptions)

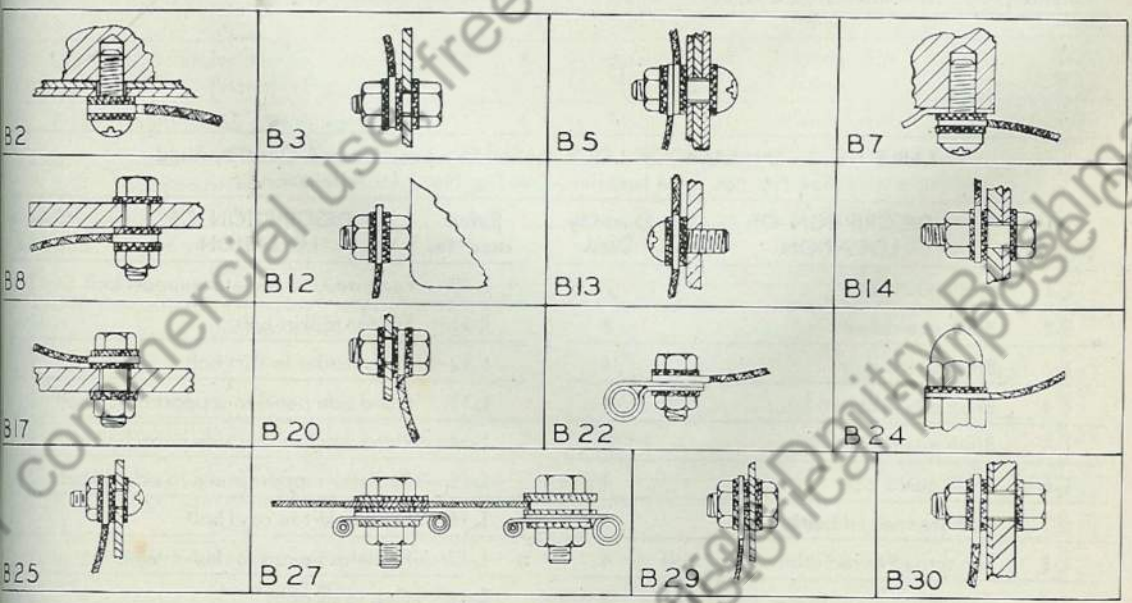

Fig. 3 Sections of All Bond Strap Mountings
(See Fig. 1 for Locations on Vehicle)
(See Table No. 3, Page 5, for Descriptions)

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The following tables list the various filters and condensers, bond straps and lockwashers, together with reference to their location in the vehicle and the illustrations in which they are shown.

TABLE No. 1—FILTERS AND CONDENSERS—Location and Identification

Six filters are used on these vehicles. See Fig. 8 for identification of filters—See Figs. 5, 11, 12 and 22 for installation.

Six condensers are used—See Fig. 9 for identification—See Figs. 5, 11, 13 and 14 for installation.

DESCRIPTION	Type No.	Fig. No.	LOCATION	Illustrated
Distributor filter	6	8	On side of distributor housing	Fig. 12
Armature circuit filter	3	8	On generator	Fig. 11
Ignition primary circuit filter	4	8	Dash panel—R. H. side	Fig. 22
Battery circuit filter	1	8	Dash panel above voltage regulator	Fig. 5
Armature circuit filter	2	8	Dash panel on L. H. side of voltage regulator	Fig. 5
Field circuit filter	5	8	Dash panel below voltage regulator	Fig. 5
Generator by-pass condenser	1	9	On generator	Fig. 11
Starting motor condenser	3	9	On starting motor switch	Fig. 13
Junction block condensers (2 used)	2	9	On dash panel at junction block	Fig. 5
Headlamp by-pass condenser (high beam)	2	9	On R. H. fender skirt	Fig. 14
Headlamp by-pass condenser (low beam)	2	9	On R. H. fender skirt	Fig. 14

TABLE No. 2—SHAKEPROOF LOCKWASHERS—Location and Quantity Used

See Fig. No. 1 for Location—See Fig. No. 2 for Installation

Reference No.	DESCRIPTION OF LOCATION	Quantity Used
L-1	Brush guard bolt	2
L-2	Brush guard bolt	8
L-3	Brush guard bolt	4
L-4	Brush guard bolt	4
L-5	Brush guard bolt	2
L-6	Brush guard bolt	4
L-7	Radiator tie rod bolts	2
L-8	Fan shroud to radiator support bolt	4
L-9	Radiator support brace bolt	2

(Continued in next column)

Reference No.	DESCRIPTION OF LOCATION	Quantity Used
L-10	Fan shroud to radiator support bolt	2
L-11	Fender to skirt bolt	12
L-12	L. H. fender to skirt bolt	2
L-13	Hood side panel to support brace bolt	2
L-14	Hood front to rear side panel bolt	6
L-15	Radiator support brace to side sill bolt	2
L-16	Fender skirt to cowl bolt	2
L-17	Radiator tie rod to dash mounting	2
L-18	Cab to sill bolts	2

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TABLE No. 3—BOND STRAPS Location and Mounting

Bond straps used on vehicle comprise six different lengths. See Fig. 10 for dimension of straps. See Fig. 1 for location on vehicle. See Fig. 3 for detail construction of bond strap mountings. See page 8 for localized views.

(See Fig. 1) for Location of Bond Strap	DESCRIPTION AND ILLUSTRATION OF BOND	Type No. (See Fig. 10)	FOR ATTACHMENT OF BOND STRAP	See Fig. 3 (For attachment of bond strap)
B-1	Right hand hood to dash panel bond (Shown in Fig. 22)	3	from hood top panel to dash panel	B-2 B-3
B-4	Left hand hood to dash panel bond (Shown in Fig. 22)	3	from hood top panel to dash panel	B-2 B-5
B-6	Right front of engine to frame bond (See Fig. 15)	3	from engine block to frame	B-7 B-8
B-9	Left front of engine to frame bond (Shown in Fig. 15)	3	from engine block to frame	B-7 B-8
B-10	Left rear of engine to frame bond (Shown in Fig. 16)	3	from flywheel bell housing to frame	B-7 B-8
B-11	L. H. radiator support to frame bond (See Fig. 20)	5	from radiator tank to radiator support ass'y to lower radiator support	B-12 B-13 B-14
B-15	R. H. radiator support to frame bond (Shown in Fig. 20)	5	from radiator tank to radiator support ass'y to lower radiator support	B-12 B-13 B-14
B-16	L. H. sill to frame bond (Shown in Fig. 18)	6	from sill to frame	B-17 B-17
B-18	R. H. sill to frame bond (See Fig. 18)	6	from sill to frame	B-17 B-17
B-19	Left fender skirt to frame bond (Shown in Fig. 19)	6	from fender skirt to frame	B-20 B-17
B-19	Right fender skirt to frame bond (See Fig. 19)	6	from fender skirt to frame	B-20 B-17
B-21	Speedometer cable to dash panel bond (Shown in Fig. 22)	6	from speedometer cable to dash panel	B-22 B-5
B-23	Valve cover bolt to dash panel bond (Shown in Fig. 22)	1	from valve cover bolt to dash panel	B-24 B-25
B-26	Cables to dash panel bond (Shown in Fig. 22)	4	from dash panel to throttle cable to choke cable to temperature gauge tube to oil gauge pipe	B-25 B-27 B-27 B-27 B-27
B-28	Left rear of cab to step-hanger bond (Shown in Fig. 17)	2	from cab to frame and step-hanger	B-29 B-30
B-31	Right rear of cab to step-hanger bond (See Fig. 17)	2	from cab to frame and step-hanger	B-29 B-30
B-32	Left hood side panel to dash bond (Shown in Fig. 21)	6	from dash panel to dash side panel	B-3 B-3
B-33	Right hood side panel to dash bond (See Fig. 21)	6	from dash panel to dash side panel	B-3 B-3

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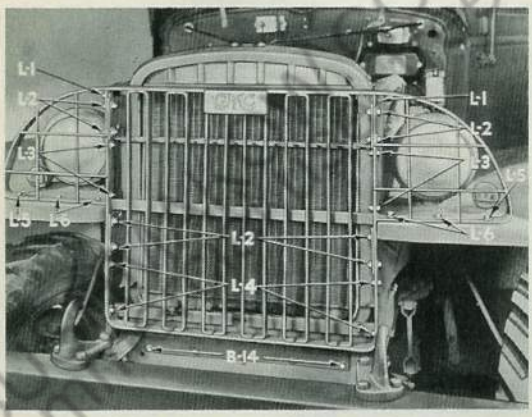

Fig. 4 Radiator Brush Guard Showing Shakeproof Lockwasher Locations (See Fig. 2 for Section Mountings)

proper operation of the electrical circuit in which it is installed, it is essential that each unit be considered.

1. SPARK PLUG SUPPRESSORS—Contrary to possible opinion, the use of suppressors in the ignition system does not reduce the efficiency of the engine in any way. Refer to Inspection and Test in Paragraph 3.

2. IGNITION CIRCUIT FILTER—To quickly localize trouble which may be caused by defective filters in the ignition circuit, the following method is the most practical:

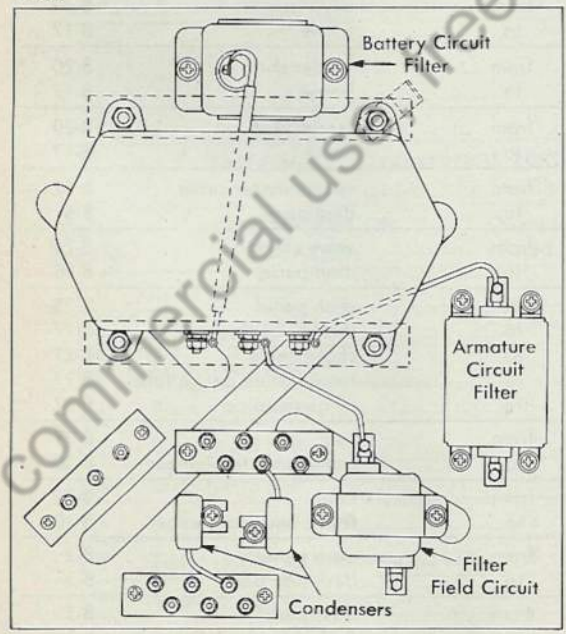

Fig. 5 Filter and Condenser Connections on Dash Panel at Regulator

(a) Disconnect ignition wire from both sides of the filter.

(b) Join the two wires together and note action of ammeter and engine. If ignition circuit now functions properly, filter is at fault and a new part should be installed.

(c) Complete instructions for testing filter are given in Paragraph 3 under "Inspection and Test."

3. GENERATING CIRCUIT FILTERS—To localize trouble in the generating circuit of the electrical system, the following method is suggested. Test one filter at a time in the following manner:

(a) Operate engine at a sufficient speed so that a slight charge would show on ammeter under normal conditions.

(b) Disconnect wires from both terminals of the filter being tested.

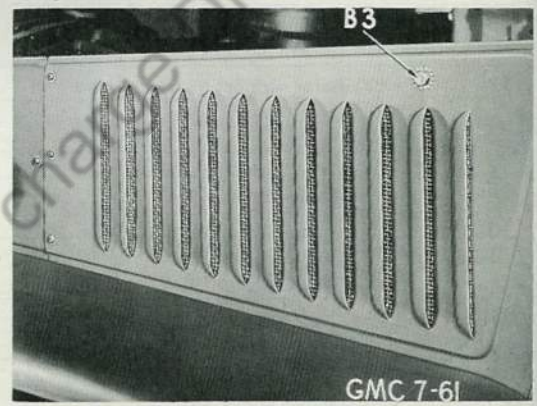

Fig. 6 Hood Side Panel Screen at Louvres. Refer to Table No. 2 for Lockwasher Identification

(c) Connect the two wires (removed from the filter) together.

(d) Note action of ammeter and see if normal operation has been obtained.

(e) if generating system does not function properly after this procedure has been tried, the trouble is probably in either the generator or regulator and the maintenance instructions for these units should then be followed.

4. BY-PASS CONDENSER—If a condenser is shorted, it will permit a high current drain from the particular circuit in which it is installed and, therefore, it is essential that condensers be periodically tested for short circuit as explained in paragraph 3. To localize condenser trouble, simply disconnect condenser from its particular terminal and see if current drain has been eliminated. If so, condenser is at fault and a new one should be installed.

3. INSPECTION AND TEST

All units used in the suppression system as well as all wiring connections, bond straps and lockwashers should

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be inspected periodically to see that they are properly installed. Filters should be tested to be sure that they provide a continuous circuit from terminal to terminal and to see that they are free from shorts or grounds within the unit. Condensers should be tested for shorts and faulty condenser element. Instructions for making these tests follow:

A. To Inspect and Test Filters—

1. Inspect the placement of filters throughout the electrical system and check the quantity used. See that none are missing.

2. Refer to Specifications section for the type and number of each filter used. **Caution:** This is very important as the filters may be alike in appearance but there is a difference in internal construction and rating.

3. Observe filter installations and see that mounting screws are drawn up tight and that connecting wires are tight and in good condition.

The three filters on dash at regulator are shown in Fig. 5; the ignition primary circuit filter is shown in Fig. 22, while the generator filter appears in Fig. 11, the distributor filter in Fig. 12.

4. Filter test for continuous circuit consists of connecting test unit to each terminal of filter. If current does not pass through filter, an "open circuit" is indicated and filter should be discarded and an identical new part installed.

5. Filter test for short consists of disconnecting wiring from filter and connecting test unit from either terminal to filter body. Passage of current between terminal and body indicates a "short" within filter and unit should be replaced.

B. To Inspect and Test Condensers—

1. Inspect condenser mounting and terminal connections to see that they are clean and tight.

2. Test the condenser for short. A suitable condenser tester should be used or if such equipment is not available, condenser may be tested for a short by connecting one lead of test meter to condenser terminal and other lead to condenser body. Passage of current between terminal and body indicates a short circuit within the condenser and unit should be replaced with an identical new part.

C. To Inspect and Test Spark Plug Suppressors—

1. Inspect each spark plug suppressor for cracked or broken housing and make certain that none are missing. Refer to Fig. 7.

2. See that suppressors are properly screwed into wires in cables. Make sure that the screw in each suppressor enters the strands of the cable wire.

3. Snap-on terminals must be free from corrosion and dirt and must be tight in order to make a good contact with the spark plug.

4. Each spark plug suppressor should be tested with a good ohmmeter to make certain that the nominal rated value (10,000 to 15,000 ohms) is within the specified limit



Fig. 7 Suppressors on Spark Plug Cables and on Coil to Distributor Cable

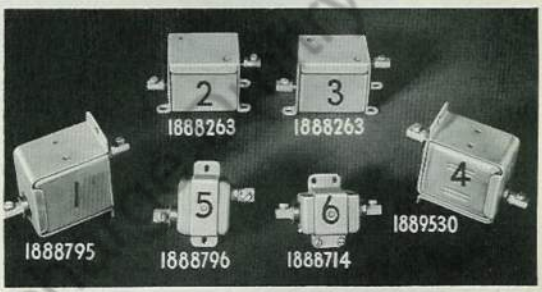

Fig. 8 Filters. See Table No. 1, on Page 4, for Description and Identification of Type Numbers Shown Above; Also for Location of Filters on Chassis

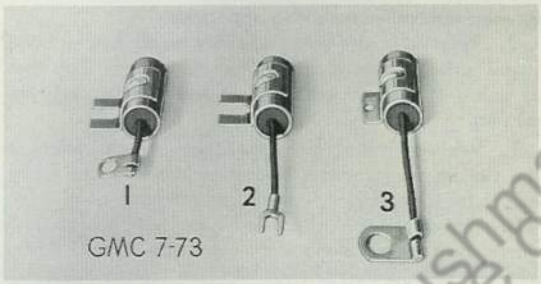

Fig. 9 Condensers. See Table No. 1, on Page 4, for Description and Identification of Type Numbers Shown Above; Also for Location of Condensers on Vehicle.

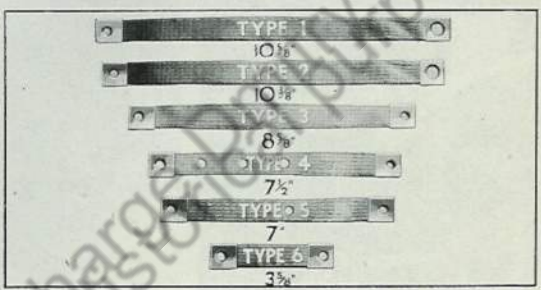

Fig. 10 Bond Straps. See Table No. 3, on Page 4, for Description and Identification of Type Numbers Shown Above; Also for Location and Mounting on Chassis

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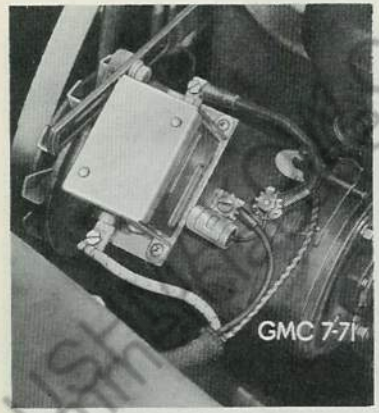

Fig. 11 Filter and Condenser on Generator

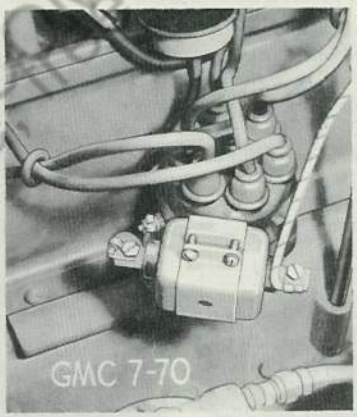

Fig. 12 Filter on Distributor



Fig. 13 Condenser on Starter

of 8,500 to 17,500 ohms (which is the plus or minus tolerance of nominal rated value).

D. Bonding—

1. Inspect all points of bond strap attachment to be sure that bond strap materials are clean and that mounting bolts are drawn up tight. **Caution: All points of bonding are extremely important and tests show that if any one single ground is damaged, broken or otherwise defective, it will result in faulty radio reception or interference with other receiving apparatus.**

2. Refer to illustrations and check location of all bond straps and shakeproof lockwashers on vehicle. See that all points of attachment **are tight and that no parts are missing.**

E. Wiring—It is essential that the electrical system of the vehicle be in proper operating condition to insure successful suppression of radio interference noise. The following conditions affect efficient suppression and should be checked along with inspection of the "Radio Suppression" equipment.

1. See that distributor cap is clean and shows no evidence of carbonized paths.
2. Inspect spark plugs. Gaps should be set to the correct dimensions.
3. Burned or pitted breaker contact points in distributor should be cleaned up or new points installed.
4. Any broken or oil-soaked wires should be replaced.
5. Tighten all loose electrical connections.
6. Clean and tighten all battery cable connections.
7. Refer to wiring diagram shown in "Wiring" group 06W for proper wiring connections. See that all wiring is routed in its proper location on the vehicle.

4. REMOVAL AND INSTALLATION

In addition to illustrations in this group which show installation of the various units and parts used in the suppression system the following instructions apply:

A. Bonds and Shakeproof Lockwashers—

1. Special care should be taken to replace bond straps and shakeproof lockwashers exactly as they were



Fig. 14 Headlamp High and Low Beam Condensers

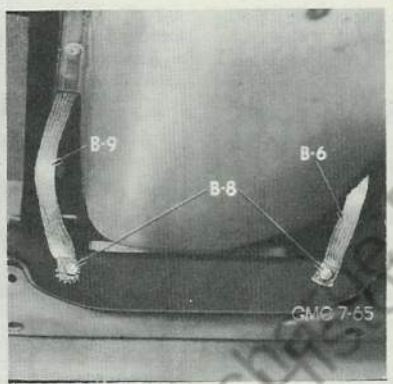

Fig. 15 Front of Engine to Frame Bond (As Viewed Beneath Vehicle)

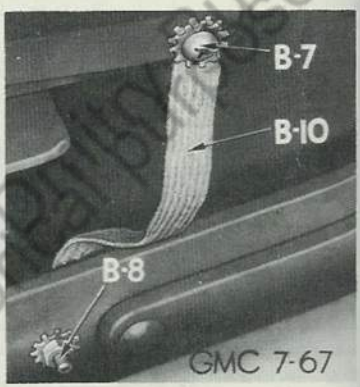

Fig. 16 Rear of Engine to Frame Bond. (As Viewed Beneath Vehicle)

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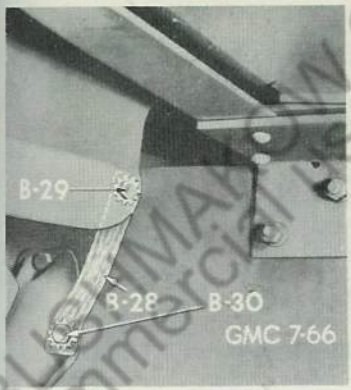

Fig. 17 Rear of Cab to Step-Hanger Bond. L. H. Shown

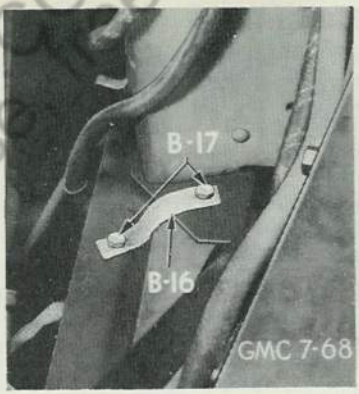

Fig. 18 Sill to Frame Bond. L. H. Shown

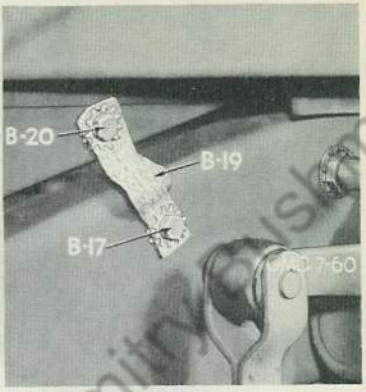

Fig. 19 Fender Skirt to Frame Bond. L. H. Shown

originally installed. In this connection it should be noted that a shakeproof lockwasher is used under head of bolt and under nut, in place of the regular lockwasher under nut. At points where bond straps are used, three shakeproof lockwashers are used—the added one being placed between strap and metal surfaces. All shakeproof lockwashers must be carefully placed in their original sequence. Refer to Figs. 1, 2 and 3. **Bolts and nuts MUST be cadmium plated, NEVER substitute with plain or Parkerized parts.**

2. All bonding points must be given a thorough mechanical tightening. Refer to illustrations for proper assembly methods.

B. Filters and Condensers—

1. Tinned surfaces on dash panel must be retained at points where filter mounting brackets and condensers are attached. Function of the filters and the condensers is absolutely dependent upon their having the best possible ground. **Caution:** Vigorous sanding will remove the tinning from the metal surfaces, later resulting in rust and corrosion.

2. Filter and condenser mounting bolts must be drawn up tight to insure good ground connections.

3. Care should be exercised in installing field circuit filter to make certain that connection from regulator to filter is connected to terminal marked "Reg" and that field wire from generator is connected to terminal marked "Gen." These markings may be found stamped on outer case of filter.

4. Care should also be exercised when installing distributor filter to make certain that the low tension wire from distributor to filter is connected to terminal marked "Dist," and that low tension wire from coil to filter is connected to terminal marked "Coil." These markings may be found stamped on respective ends of filter.

5. Filters are also identified by the part number of the filter which is stamped on mounting bracket. Refer to Fig. 8 and to Table No. 1 on page 4.



Fig. 20 Radiator to Frame Bond. R. H. Shown

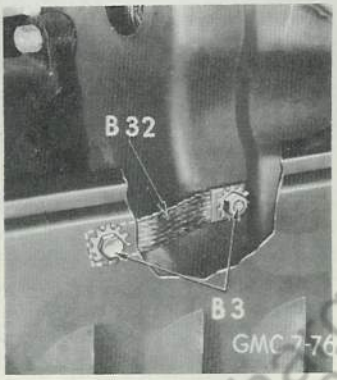

Fig. 21 Hood Side Panel to Dash Bond. L. H. Shown

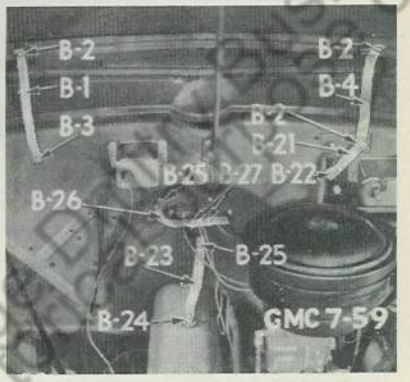

Fig. 22 Bond Straps Mounted on Dash Panel. Ignition Circuit Filter Appears at Center of Dash

MISCELLANEOUS ELECTRICAL

5. SPECIFICATIONS

A. Identification of Filters	Part No.
1. Battery circuit filter (55 amp.)	1888795
2. Armature circuit filter—At Reg. (55 amp.)	1888263
3. Armature circuit filter—At Reg. (55 amp.)	1888263
4. Ignition primary circuit filter (10 amp.)	1889530
5. Field circuit filter (10 amp.)	1888796
6. Distributor filter (10 amp.)	1888714

B. Identification of Condensers
See Fig. 9.

C. Identification of Bond Straps
See Fig. 10 for Lengths.

SERVICE BULLETIN REFERENCE

Bulletin No.	Description

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Historical purpose of

MISCELLANEOUS ELECTRICAL

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Trouble Shooting and General Solutions	7
HORN	
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Trouble Shooting and General Solutions	9
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FUEL GAUGE SYSTEM

6. DESCRIPTION AND OPERATION

Fuel gauge system consists of two units, the registering unit, mounted on instrument panel, and tank unit, which is mounted in fuel tank. As shown on general wiring diagram in Group 06W of this book, circuit for this system passes through ignition switch. Gauge will not register unless ignition switch is turned on. Various positions of tank unit float arm will cut in resistance, permitting current to flow to a calibrated gauge, thereby registering quantity of fuel in tank.

7. TROUBLE SHOOTING AND GENERAL SOLUTIONS

A gas gauge tester (see "Tabulated Data") may be used to localize trouble in either unit. Use gauge tester in following manner:

A. Gauge Test—

1. Turn ignition switch "off." Disconnect "TANK" wire from dash gauge unit.

2. Attach tester wire (red) to dash gauge "TANK" terminal, and tester block wire to a ground on vehicle.

Caution: If connections are not correct, as above, a short will occur and burn out tester.

3. Turn ignition switch "On." Move tester arm up and down. Dash unit should register "full" and "empty." If gauge registers correctly, turn ignition switch off, and reconnect "TANK" wire to gauge terminal.

4. If dash gauge does not register, replace with new unit. Before replacing gauge, make certain it is getting current from ignition switch. Test by connecting a 6 volt lamp from "IGN" terminal on gauge to a ground.

5. Turn ignition switch "On." Move tester arm up and down. Dash gauge should move from "empty" to "full" if wiring is in good condition.

6. If dash gauge reads "empty" at all times or reading is noticeably lower than during check at dash gauge, check for shorts or leaks in wiring between dash and tank. If dash gauge reads above "full" at all times or if it reads higher at "empty" and "full" than readings obtained when checking at dash, check for poor connections or break in wiring. Make sure contacts in connections are clean and making good contacts.

B. Tank Unit Test—If gauge and wiring checks, check tank unit in following manner:

1. Clean all dirt that has collected around tank unit terminal, as road dirt, particularly calcium chloride, causes an electrical leak that will cause an error in reading.

2. After cleaning tank unit, connect the unit to wire leading to dash, ground unit with a short piece of wire from outer edge to vehicle. Turn ignition switch "On" and move float arm up and down. Dash gauge should give corresponding "empty" and "full" readings.

3. If tank unit does not operate correctly, replace with new unit. Always check new unit as previously described. Check movement of float arm by raising it to various positions, observing that it will fall to "empty" position in every instance.

HORN SYSTEM

8. DESCRIPTION AND OPERATION

The electrically operated horn used in this vehicle is a vibrating type unit that operates on a magnetic principle to produce warning signals. Current from battery flows through windings within horn power plant when circuit is completed at horn push-button switch. Refer to Wiring Diagram in Group 0 for horn circuit connections.

9. TROUBLE SHOOTING AND GENERAL SOLUTIONS

Following conditions affect performance of horn and should be checked before attempting to make any adjustments to instrument.

1. If horn produces a weak signal, voltage at horn should be noted. Connect a voltmeter across horn terminals. The voltage reading should not be less than 5.25 volts. A lower reading would indicate either a low battery or a high resistance in horn circuit.

2. Check condition of battery, and if low, recharge.

3. Loose or corroded connections in horn circuit should be corrected. Check for defective wiring by connecting separate test leads from horn to battery.

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4. A loose connection or poor contact at horn push-button switch may cause horn to operate intermittently. Shunt around horn button to determine whether there is poor contact at push-button. Whenever wiring is replaced in horn circuit, size of wire as indicated on Wiring Diagram (Group 06W) should be used.

5. Horns usually have a rasping sound when vital parts are broken or loose. A loose backshell may affect tone. Tighten all collar screws, mounting nuts, and studs, and replace all damaged parts.

6. The horn will not function properly if field windings within horn are open circuited, short circuited, or grounded. Connect an ammeter in horn circuit at horn terminal. If there is no indication of current flowing when contact points are closed, windings are open circuited. The ammeter will indicate an excessive flow of current if windings re short circuited or grounded.

7. Windings may also be checked for grounded circuit by use of test points and test lamp. Disconnect horn leads and touch one test point to one of horn terminals. If lamp lights, the field windings are grounded.

8. Excessive arcing at contact point may be caused by improper current adjustment. An open circuit in condenser will cause excessive arcing at points and in some cases contacts will be held together.

10. ADJUSTMENTS

If tone is not satisfactory after checking preceding conditions, adjust horn in following manner:

1. Remove backshell from horn.

2. Connect ammeter in circuit at horn and adjust current consumption by varying position of adjusting nut. (See "Tabulated Data" for current consumption.)

3. Loosen adjusting locknut and turn adjusting nut to left to increase current, to right to decrease current.

4. Too much current will cause horn to have a sputtering sound. This adjustment is very sensitive. Move nut 1/10 turn at a time and lock in position each time before trying. If ammeter is not available, adjust according to sound.

5. Correct air gap between armature and core is important for proper tone. The gap must be uniform across entire surface of armature. Width of gap may be determined by using a feeler. Adjustments are made by use of air gap adjusting nuts.

11. SPECIFICATIONS

A. Fuel Gage

Tank Unit Make	AC
Model (164" W.B.)	1515435
(144" W.B.)	1515472
Dash Unit—Make	AC
Model	1566366

B. Horn

Make	Delco-Remy
Model	1999809
Current Draw	7-9 Amperes
Air Gap	.027"–.033"

Circuit Breakers

Make	Klixon
Number—Horn	C.A. 15 Amp.
Number—Gas Gauge	C.A. 5 Amp.

12. TOOL EQUIPMENT

Instruments Manufactured by Kent-Moore Organization, Detroit, Michigan or its equivalent is recommended.

Instrument No.	Description
KMO-204	Gas Gauge Tester

Note: Refer to Generator 06G section for volt-amp tester number.

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Group 07 — Transmission

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GENERAL

1. DESCRIPTION AND OPERATION

Transmission provides five speeds forward and one reverse. Power is transferred directly through transmission in fourth speed providing a 1 to 1 ratio; whereas, in fifth speed and all other speeds including reverse, the power is directed through gears of various sizes to provide the desired gear ratio.

Transmission gears are shifted manually by conventional gear shift lever to obtain the correct gear ratio for all operating conditions. Shifting lever positions and instructions for transmission operation are outlined in "Driver's Instructions" group.

2. TROUBLE SHOOTING AND GENERAL SOLUTIONS

A. Hard Shifting—

1. Clutch does not release—
   Adjust pedal correctly and replace worn clutch parts.
2. Gear shift lever bends in transmission cover—
   Remove clutch cover from top of transmission and lubricate the lever ball.
3. Shifter shafts scored—
   Install new parts.

B. Transmission Slipping Out of Gear—

1. Weakened shift shaft poppet springs—
   Install new springs in cover.
2. Gears are partially engaged—
   Remove transmission cover, check position of shafts and forks.
3. Excessively worn gears—
   Install new parts.
4. Shifting fork bent—
   Replace fork.
5. If transmission slips out of high gear when vehicle is accelerated or decelerated, it may be caused by misalignment of transmission in clutch housing, also by excessive looseness of the strut rod.
   Inspect, tighten and adjust these parts.

C. Transmission Noises—Noises which seem to come from the transmission may actually originate in some other part of the chassis; therefore, before any mechanical work is performed on transmission a thorough check should be made, by riding with driver if possible, to determine actual source of noise. **Note:** Noise may actually be in drive line—due to worn needle bearings, universal joints loose, out of alignment or out of balance.

1. Insufficient lubricant—
   Add lubricant as required.
2. Lubricant of incorrect viscosity—
   Change or refill.
3. Excessive worn gears in shaft—
   Install new parts.
4. Gears loose on shaft—
   Disassemble, inspect and install new parts.
5. Worn bearings—
   Install new parts.
6. Transmission out of alignment with clutch housing—
   Remove, inspect and repair or install new parts.
7. Main drive gear clutch shaft worn or out of alignment—
   (Worn clutch pilot bearing may be responsible for this condition)—
   Install new parts.

D. Loss of Transmission Lubricant—

1. Excessive lubricant—
   Remove filler plug and drain to level of this plug.
2. Loose bearing caps or defective gaskets—
   Tighten cap or install new gasket.
3. Worn or damaged oil seal—
   Install new seal.
4. Worn or scored propeller shaft yoke—
   Replace yoke and seal.

TRANSMISSION

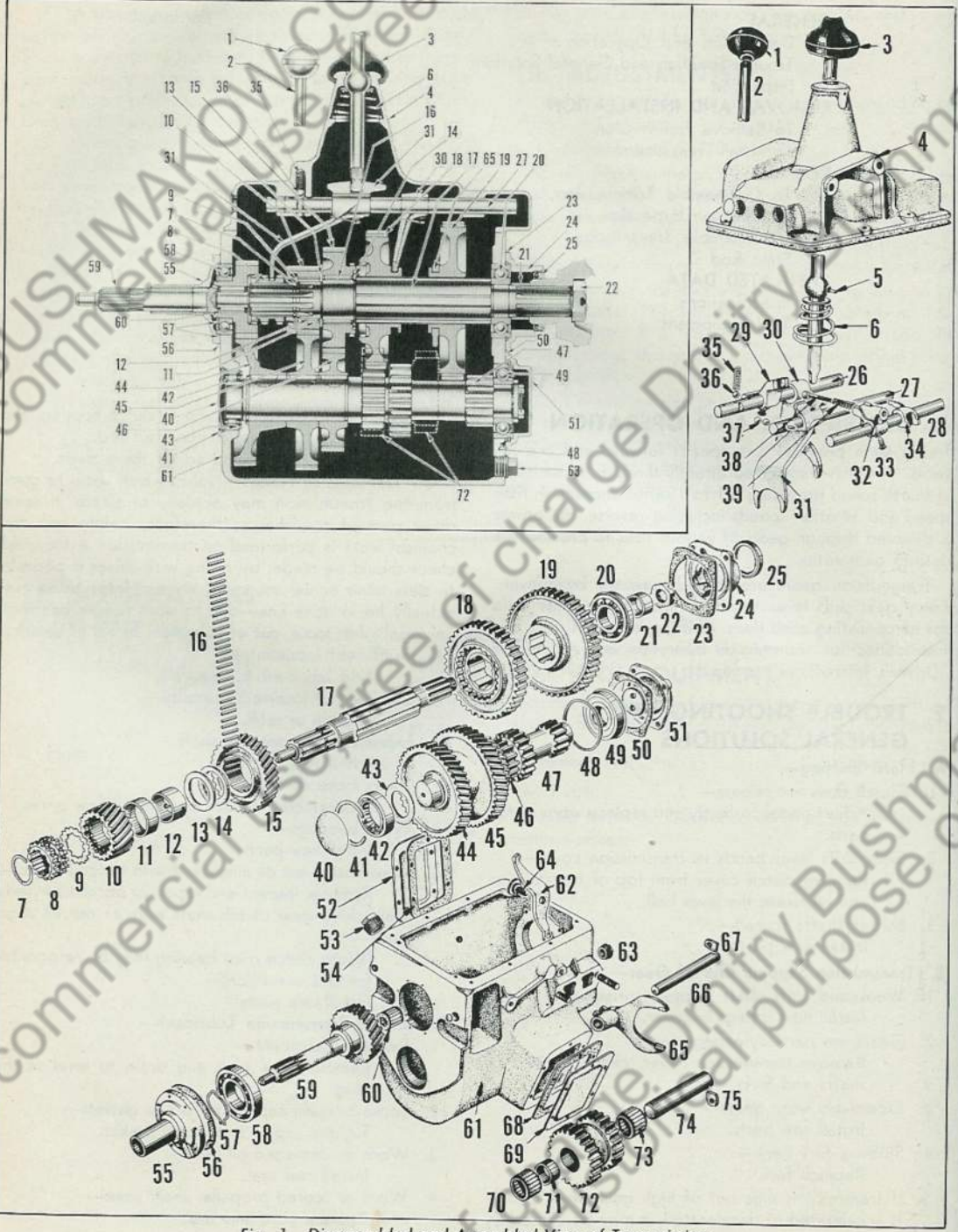

Fig. 1 Disassembled and Assembled View of Transmission

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TRANSMISSION

Captions for Figure 1

1. Gear Shift Lever Ball.
2. Gear Shift Lever.
3. Gear Shift Lever Dust Cover.
4. Control Cover.
5. Gear Shift Lever Pivot Pin.
6. Gear Shift Lever Support Spring.
7. Mainshaft 5th Speed Gear Snap Ring.
8. Mainshaft 4th and 5th Sliding Clutch Gear.
9. Mainshaft 5th Speed Gear Retaining Washer.
10. Mainshaft 5th Speed Gear.
11. Mainshaft 5th Speed Gear Bushing.
12. Mainshaft 5th Speed Gear Sleeve.
13. Mainshaft 3rd Speed Gear Washer.
14. Mainshaft 3rd Speed Gear Washer.
15. Mainshaft 3rd Speed Gear.
16. Mainshaft 3rd Speed Gear Rollers.
17. Mainshaft.
18. 2nd and 3rd Speed Sliding Gear.
19. 1st and Reverse Speed Sliding Gear.
20. Mainshaft Rear Bearing.
21. Mainshaft Flange Spacer.
22. Mainshaft Nut.
23. Mainshaft Rear Bearing Cap Gasket.
24. Mainshaft Rear Bearing Cap.
25. Mainshaft Rear Bearing Cap Oil Seal.
26. 2nd and 3rd Shift Rod.
27. 4th and 5th Shift Rod.
28. 1st and Reverse Shift Rod.
29. 2nd and 3rd Shift Lug.
30. 2nd and 3rd Shift Fork.
31. 4th and 5th Shift Fork.
32. 1st and Reverse Shift Lug.
33. 1st and Reverse Rocker Arm Screw.
34. 1st and Reverse Rocker Lug.
35. Poppet Spring.
36. Poppet Ball.
37. Interlock Balls.
38. 1st and Reverse Latch Spring Plunger.
39. First and Reverse Latch Spring.
40. Expansion Plug.
41. Countershaft Front Bearing Snap Ring.
42. Countershaft Front Bearing.
43. Countershaft Front Bearing Washer.
44. Countershaft Drive Gear.
45. Countershaft 5th Speed Gear.
46. Countershaft 3rd Speed Gear.
47. Countershaft (1st, 2nd and Reverse).
48. Countershaft Rear Bearing Spacer Ring.
49. Countershaft Rear Bearing.
50. Countershaft Rear Bearing Cap Gasket.
51. Countershaft Rear Bearing Cap.
52. Power Take-Off Cover.
53. Plug.
54. Power Take-Off Cover Gasket.
55. Main Drive Gear Bearing Cap.
56. Main Drive Gear Bearing Cap Gasket.
57. Main Drive Gear Bearing Snap Ring.
58. Main Drive Gear Bearing.
59. Main Drive Gear.
60. Mainshaft Pilot Bearing.
61. Case.
62. 1st and Reverse Rocker Arm.
63. Plug.
64. 1st and Reverse Rocker Arm Pivot.
65. 1st and Reverse Shift Fork.
66. 1st and Reverse Shift Fork Bar.
67. 1st and Reverse Shift Fork Bar Lock.
68. Power Take-Off Cover Gasket.
69. Power Take-Off Cover. (Not used on Vehicles equipped with Winch.)
70. Reverse Idler Gear Bearing.
71. Reverse Idler Gear Bearing Spacer.
72. Reverse Idler Gear.
73. Reverse Idler Gear Bearing.
74. Reverse Idler Shaft.
75. Reverse Idler Shaft Lock.

3. INSPECTION

A. Transmission Lubrication—The quality and quantity of lubricant in transmission should be inspected at regular intervals. Evidence of thickening of the transmission lubricant is the signal for immediate cleaning and this can be accomplished most satisfactorily when unit is removed and disassembled.

B. Operation—Try the movement of the shift lever in each of the shifting positions. This test is more readily made when vehicle is in motion as it will reveal any tendency of gears to slip out of mesh. If hard shifting is encountered, the need for corrective service is indicated. Action of transmission and engine under power application may also indicate the need for strut rod adjustment.

REMOVAL AND INSTALLATION

4. TO REMOVE TRANSMISSION

1. Remove front universal joint and drop front of shaft, allowing front propeller shaft to swing clear of transmission.
2. Remove floor boards and toe-boards.
3. Unhook clutch pedal pull rod from pedal.
4. Remove cap screw holding pedal shaft bracket to transmission case.
5. Remove hand brake lever mounting from side of transmission. Also disconnect transfer case control rods and remove control cross shaft from transmission case.
6. Disconnect strut brace rod at transmission by removing pin between rod and bracket at side of transmission. On vehicles equipped with winch it will be necessary to disconnect power take-off drive shaft or remove power take-off from transmission.

TRANSMISSION

7. Remove lower clutch housing. Remove cap screws attaching transmission to clutch housing and pull transmission straight back until shaft is clear of clutch hub. **Do not let weight of transmission rest on clutch disc or disc may be sprung or distorted, seriously affecting clutch operation.**

5. TO INSTALL TRANSMISSION

1. Replace transmission in reverse order in which it was removed, being particularly careful not to permit assembly to get out of alignment with clutch drive disc hub. Rear end of transmission must be supported until mounting bolts are installed.

2. Reinstall hand brake lever mounting, transfer case control cross shaft, pedal mounting bracket, transfer case control rods and clutch pedal pull rod.

3. It is especially important that transmission strut rod be carefully adjusted so that forward movement of power plant will not be excessive. Two nuts used at rear end of rod, should be **adjusted so that rod exerts very slight pull toward rear.** Always be sure that forward locking nut is tight after necessary adjustment has been made at rear nut.

4. Make sure that the proper quantity of lubricant is added to transmission and that filler and drain plugs are securely installed. Refer to Lubrication group for lubrication specifications.

5. Reinstall radio bond straps between lower clutch housing and frame, making certain that strap is in good condition and that connections are clean and tight.

REPAIR

6. TO DISASSEMBLE TRANSMISSION

Procedures for disassembling and assembling transmission as outlined in succeeding paragraphs should be followed carefully. In addition to the tools, designed to assist in the servicing of units, receptacles for cleaning parts and air pressure for blowing out particles of dirt should be available. Parts should be thoroughly cleaned, particularly for the purpose of inspection and assembling.

A. To Remove and Disassemble Cover—(Refer to Fig. 1)

1. Drain transmission by removing plug at rear of case.

2. Remove transmission control cover (4, Fig. 1) and gear shift lever (2, Fig. 1) assembly.

3. If it should be necessary to disassemble shifting mechanism in transmission cover, drive out expansion plugs in cover (4) at front of shift rods, also at side of cover.

4. Remove shift fork set screws and push shift rods (26, 27 and 28) out toward front, holding hand over poppet holes in forward rod support to prevent loss of poppet balls and springs (35 and 36). All rods must be in neutral position at start of this operation.



Fig. 2 Removing Mainshaft and Bearing from Case



Fig. 3 Removing Rear Bearing from Mainshaft

5. Tap cover on side to remove interlock balls from side of cover.

6. Disassemble low and reverse latch spring plunger (38).

7. If necessary to remove gear shift lever (2), retaining spring (6) can be taken out.

B. To Remove First and Reverse Shift Fork—(Refer to Fig. 1)

1. Remove first and reverse rocker arm pivot (64) and remove rocker arm (62).

2. Remove first and reverse shift fork bar, lock screw with lock (67) and withdraw bar (66) from rear of case, removing fork (65).

C. To Remove Mainshaft and Gears—(Refer to Fig. 1)

1. Lock mainshaft (17) by moving two gears into mesh at same time which will simplify removal of mainshaft flange nut and flange.

2. Remove mainshaft rear bearing cap (24) and oil seal (25) assembly and flange spacer (21).

3. Install puller (J-1868) on end of mainshaft as illustrated in Fig. 2 and pull mainshaft towards rear far enough to permit removal of rear bearing (20). Rear bearing can be removed from mainshaft with same tool in manner illustrated in Fig. 3.

4. Continue to move mainshaft assembly backward until front end clears main drive gear (59), then tilt front end upward and lift complete assembly out of case.

D. To Disassemble Mainshaft—(Refer to Fig. 1)

1. Remove sliding gears (18 & 19) from mainshaft (17).

2. Hold splines in soft jaws of vise and spread snap ring (7), holding fifth speed gear (10) so that it can move over splines at front end of shaft, as illustrated in Fig. 6.

3. Turn fifth speed gear retaining washer (9) to align internal splines of washer with spline way on shaft and remove from shaft.

4. Lift off fifth speed gear (10). Sleeve (12) between gear and mainshaft may also be removed at this time.

TRANSMISSION

5. Remove third speed gear (15) with front and rear thrust washers (13 and 14) and roller bearings (16). Be careful that roller bearings are not lost. There are 34 roller bearings used in this gear.

E. To Remove Main Drive Gear—(Refer to Fig. 1)

1. Remove main drive gear bearing cap (55) at front of transmission case.

2. Remove main drive gear bearing to case retaining ring.

Note: Countershaft must be dropped out of front bearing to allow main drive gear bearing to pass gear on countershaft.

3. Main drive gear and bearing assembly can now be removed from inside of transmission case.

4. Bearing may be removed from gear, if necessary, in arbor press.

F. To Remove Reverse Gear—(Refer to Fig. 1)

1. Remove reverse idler shaft lockscrew with lock plate (75).

2. Remove idler shaft (74) from rear of case in following manner:

(a) Start idler shaft with pinch bar inserted in lock plate groove, prying against case, as illustrated in Fig. 4.

(b) Insert brass rod or drift approximately 3/8" through clutch housing stud hole, approximately in line with idler shaft, and drive shaft out of case by tapping drift lightly with hammer as illustrated in Fig. 5. **Do not pry idler shaft all way out as lip is liable to be broken off shaft.**

3. Lift out reverse gear and bearings through top of case.

G. To Remove and Disassemble Countershaft—(Refer to Fig. 1)

1. Remove countershaft rear bearing cap (51) and take out bearing retaining screws and retaining washer.

2. Install puller (J-1868) on end of countershaft as illustrated in Fig. 7 and pull countershaft towards rear far enough to permit removal of rear bearing. Rear bearing may be removed from mainshaft with puller J-1868 in same manner as mainshaft rear bearing. (See Fig. 3.) Countershaft can now be removed by tilting forward end upwards in same manner as mainshaft.

3. If front countershaft bearing (42) remains in case, when countershaft is removed, snap ring (41) and plug (40) can be removed from front of case to facilitate removal.

4. Helical cut gears on countershaft are keyed to shaft and can be removed in arbor press after retaining ring is taken out of groove at forward end of shaft.

7. TRANSMISSION INSPECTION

1. Clean all parts carefully in gasoline or kerosene and blow dry with compressed air.

2. All bearings should be given more than a cursory cleaning. After bearing assemblies have been soaked in gasoline, tap them sharply on a block of wood to dislodge any solid particles. Slush them again in gasoline and blow dry with air. Do not spin the bearings with air—revolve them slowly in races with fingers as air is directed at right angles to the balls or rollers. Examine races and bearings for pits and scores, then oil each assembly thoroughly with clean engine oil.

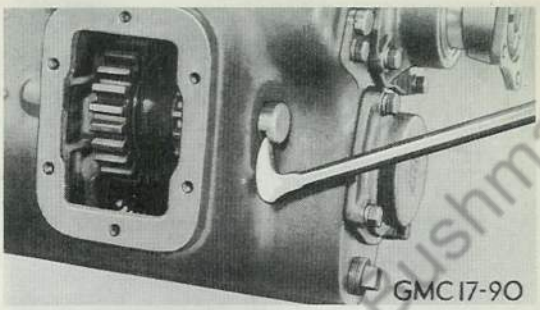

Fig. 4 Start Removal of Reverse Idler Shaft with Pinch Bar as Shown

3. Individual roller bearings (16) which were removed from mainshaft gear should be thoroughly washed and inspected. Replace those bearings which show signs of scores or pits.

4. Examine teeth on all gears carefully for nicks and "gald" spots. Do not take chances with gears which are appreciably nicked or scored. Small nicks may be carefully removed with a "slip-stone" or hone.

5. Inspect faces of gear teeth. Cracked or chipped teeth or spots where case hardening is worn through render gears unfit for use. Any such gears should be replaced with new ones.

6. Inspect splines on mainshaft (17) and on drive gear shaft (59) for scores or evidence of twisting. Place sliding gears on mainshaft and check clearance along splines. If this clearance exceeds limits given in "Specifications" at end of this section, or if shaft is badly scored or twisted, new parts should be installed.

7. Inspect all thrust washers and retaining rings. If these are damaged, they must be replaced. After parts are cleaned and helical gears, thrust washers, etc., are reassembled on mainshaft, measure end play in gears and if in excess of amount shown in "Specifications" group, it will be necessary to install shims or replace worn parts.

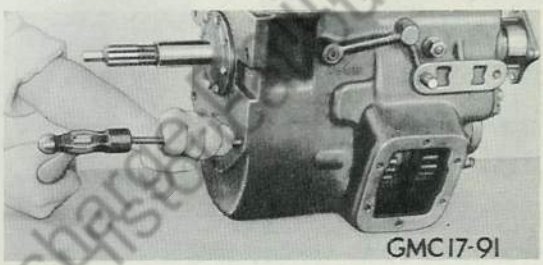

Fig. 5 Continue to Remove Reverse Idler Shaft with Brass Drift as shown

TRANSMISSION

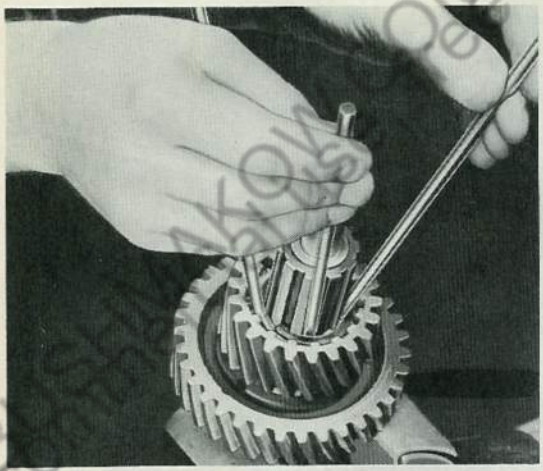

Fig. 6 Removing Snap Rings from Fifth Speed Gear

8. Third speed roller bearings (16) worn beyond limits given in "Specifications" at end of this section, will cause noisy operation and possibly serious damage to transmission.

9. Check clearance betweeen sliding clutch gear (8) and forward splines in same manner, also insert main drive gear shaft (59) into clutch driven disc to check clearances betweeen splines and disc hub. Excessive clearances at these points can only be corrected by installing new parts.

10. Check reverse idler gear bearings (70 and 73) by inserting shaft in normal position. If excessive wear is evident, new parts should be installed. Also replace shaft, if found to be cut or scored.

11. Clean reverse latch spring plunger (38) thoroughly, see that spring (39) is not weakened. Replace parts if necessary.

8. TO ASSEMBLE TRANSMISSION

All bearings, thrust washers and bushings should be lubricated with light gear oil before assembling to prevent scoring when transmission is put back into service.

A. To Install Countershaft—(Refer to Fig. 1)

1. Install countershaft front bearing (42), plug (40) and snap ring (41).

Note: Main drive gear must be installed before installing countershaft in front bearing.

2. With all gears assembled to countershaft (47) and with snap ring and bearing washer in position, install countershaft assembly in reverse of manner in which it was removed. After rear bearing (49) is installed, be sure retainer plate is in place and cap screws drawn up tight.

3. Countershaft rear bearing snap ring can be installed in bearing groove after washer has been installed around bearing. This washer is used between rear of case and bearing snap ring. Countershaft assembly can now be moved forward to its proper location and rear cap (51) installed. It is always advisable to use new lockwashers under all bolt heads.

B. To Install Reverse Gear—(Refer to Fig. 1)

1. Place reverse idler gears (72) in position with smaller gear toward rear of case and install idler shaft (74). With lock (75) in position engaging slot in end of shaft, draw cap screw up tight.

C. To Install Main Drive Gear—(Refer to Fig. 1)

1. In the event bearing (58) has been removed from main drive gear (59) it can be replaced in arbor press, and snap ring (57) installed.

2. Install main drive gear and bearing assembly from inside of transmission, making sure mainshaft pilot bearing (60) is in place and well lubricated.

3. Install bearing to case retaining ring and make sure case is free from burrs which might prevent bearing cap (55) from drawing retaining ring up tightly against case.

4. Install front bearing cap (55) with oil return hole at bottom to line up with hole in case. Oil return passage in cap and case must be open and clear.

D. To Assemble and Install Mainshaft—(Refer to Fig. 1)—

1. Clamp mainshaft in soft jaws of vise with front end up and put third speed gear rear thrust washer in position.

2. Place third speed gear (15) over mainshaft (17). Apply heavy grease to roller bearings (16) to hold them in position and insert rollers between gear and race. There are 34 rollers used in this bearing.

3. Install intermediate thrust washer and fifth gear sleeve (12), making sure pin engages spline way in shaft. Install fifth speed gear (10) and bronze bushing (11), seeing that bushing is well lubricated and that all oil holes in gear and bushing are open.

4. Drop retaining washer (9) over splines, pushing it way down so that snap ring (7) can be installed. Use of new snap ring is recommended if old ring shows any evidence of distortion. Check end play of gear and install shims as necessary. Remove assembly from vise.

5. Apply gear oil to splines and install sliding gears (18 and 19) at rear of shaft with larger gear towards rear. Shifting fork collars must be towards each other when these gears are installed. Install sliding clutch gear (8) on front end of shaft in same manner. Be sure that straight edge of gear is toward rear and that edge with extended hub is at front.

6. Place mainshaft in position in reverse manner of removal. Install rear bearing (20), making sure snap ring is in place before installing bearing cap (24) and oil seal (25) assembly. Replacement of oil seal is recommended at overhaul period as replacement at this time is more economical than premature replacement at a later date.

7. Install spacer (21) between bearing and propeller shaft yoke on rear of mainshaft.

8. Lock mainshaft by putting two gears in mesh at

TRANSMISSION

same time and replace propeller shaft yoke at rear of mainshaft. Draw up yoke nut tightly and lock with new cotter pin.

E. To Install First and Reverse Shift Fork—(Refer to Fig. 1)—

1. Install first and reverse shift fork bar (66) from rear of case, installing fork (65) with offset towards rear as bar is moved forward.

2. Install lock screw and lock (67), making sure screw is drawn up tight. Install lock wire.

3. Assemble first and reverse rocker arm (62) to case with pivot (64) and tighten pivot securely.

F. To Assemble Cover—(Refer to Fig. 1)—

1. Clamp transmission cover in vise by right-hand flange when installing shifter rails.

2. Lubricate all poppet springs, balls, and interlock plungers before installation.

3. Install poppet spring (35) and ball (36) in bottom hole and hold ball in far enough so that second and third speed shift rod (26) can be inserted. **This rod has three unevenly spaced poppet notches at one end and should be installed with these notches toward front end in line with balls.**

4. Place shift lug (29) on rod first, then second and third speed shift fork (30) as rod is pushed into place, making sure fork offset is toward front of case. Shift rod must be pushed in until poppet ball engages middle notch.

5. Install set screw in lug and fork, making sure points engage holes in rail.

6. Drop two interlock balls (37) into hole in side of cover and push them down so as to engage second and third shift rod. Install lock wire.

7. Install poppet spring and ball in middle hole and install fourth and fifth speed rod (27) **(with three notches close together)**, passing it through shift fork (31) having long offset, with offset toward front of case. Before pushing rod all the way in, insert short plain interlock pin in hole aligned with center notch in rod, then push rod in until poppet ball engages center notch in rod. Install set screw in fork.

8. Reassemble first and reverse latch plunger (38) and spring (39) into shift lug (32), turning adjusting nut so that plunger extends slightly but does not interfere with fourth and fifth speed lug.

9. Drop two remaining interlock balls into hole, pushing them down so as to permit installation of low and reverse speed shift rod (28).

10. With poppet spring and ball in uppermost hole, insert first and reverse speed shift rod (28) **(three notches more widely and evenly spaced)**, putting shift lug (32) in place before installing rocker lug (34). Wire all set screws securely.

11. Always use new expansion plugs at ends of shift rods and at interlock hole.

12. Try operation of gearshift lever (2) to be sure poppets and interlocks operate satisfactorily. Check particularly to see that reverse latch plunger is properly installed and adjusted to clear fourth and fifth gear lug and shift lever.

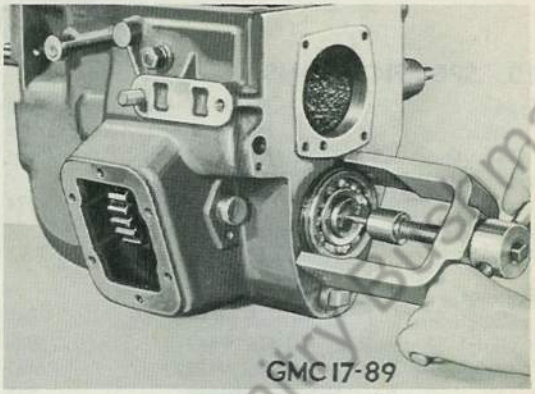

Fig. 7 Pulling Countershaft from Case

13. Always use new gasket under cover if old one is damaged in any way. When installing cover, see that sliding gears are in neutral, making sure shaft can be turned after each shift.

9. STRUT ROD

Strut rod is connected from transmission to frame cross member to limit forward and rearward movement of power plant. Strut rod must be maintained in proper adjustment at all times and readjustment as necessary whenever transmission or strut rod is removed. The following adjustment instructions apply:

1. Thread inner adjusting nut onto rod.

2. Insert threaded end of rod through hole in frame bracket.

3. Attach rod to transmission with clevis pin and cotter pin.

4. Thread outer (or rear) adjusting nut onto rod and tighten until rod exerts a slight rearward pull on power plant.

5. Tighten inner nut securely against bracket.

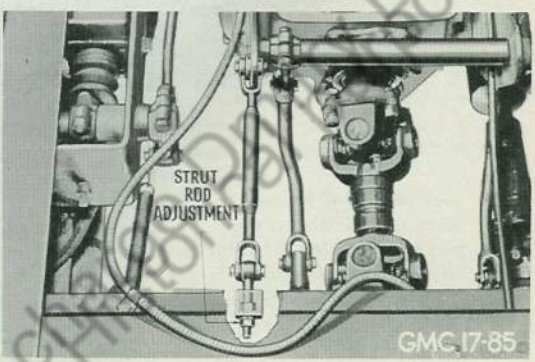

Fig. 8 Strut Rod Adjustment

TRANSMISSION

TABULATED DATA

10. SPECIFICATIONS

Type	Overdrive—Selective Sliding
Speeds	Five Forward—One Reverse
Mounting	Unit Power Plant
When Clark Transmission Is Used	
Model	204V0-274
When Warner Transmission Is Used	
Model	AS-3-T-93

Bearings

Clutch Shaft—In Crankshaft ND-907109	Ball
Clutch Shaft—Rear ND No. 954219	Ball
Mainshaft—Front Hyatt No. 94322	Roller
Mainshaft—Rear ND No. 954164	Ball
Countershaft—Front Hyatt No. 1207-TS	Roller
Countershaft—Rear ND No. 954129	Ball
Mainshaft—Third Speed Gear	34 Needles
Reverse Gear—Hyatt No. 94622	Roller
Third Speed Gear Roller Bearing Diameter	.1873"–.1876"
Fifth Speed Gear Bushing—Grind	2.0287"–2.0297"

Gear Ratio

First Speed	6.06 to 1
Second Speed	3.50 to 1
Third Speed	1.80 to 1
Fourth Speed	Direct
Fifth Speed—Overdrive	.799 to 1
Reverse Speed	6.00 to 1

Mainshaft and Gears

Third and Fifth Speed Gear Thrust Washer Thickness	.119"–.121"
Third and Fifth Speed Mainshaft Gear Shim—Thickness	.003"–.005"
Mainshaft—Out of True—Not Over	.002"
Gear Backlash	.005"–.008"
Clearance Between	
Mainshaft and Sliding Gears	.005"–.0015"
Shifting Fork and Sliding Gears	.010"–.025"
Fifth Speed Gear Bushing and Sleeve	.002"–.0035"
End Play in Helical Gears	
New Limits	.001"–.0035"

Shifting

Shift Rail Poppet Spring	
Free Length	$1\frac{7}{16}$"
Lbs. Pressure @ $\frac{15}{16}$"	45–50
Reverse Latch Spring	
Free Length	$1\frac{9}{16}$"
Lbs. Pressure @ 1"	30–35

Countershaft

Front Bearing Thrust Washer Thickness	.095"

Reverse Gear

Reverse Gear End Thrust	.002"–.013"

11. TOOL EQUIPMENT

The following special tools, or their equivalent, are recommended for use when servicing TRANSMISSION.

Tool No.	Name	Supplier Code
CS-1204	Snap Ring Pry Set	CS
CS-1279	Repair Stand	CS
J-1732	Bearing Replacer	KM
J-1868	Shaft Puller	KM

TOOL SUPPLIER

Supplier Code	Name	Address
CS	Curtiss and Smith Manufacturing Corp.	Pottstown, Penn.
KM	Kent-Moore Organization	Detroit, Mich.

Group O8B — Transfer Case

(Used on vehicles equipped with "Banjo" type axles)

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Trouble Shooting and General Solutions	2
Inspection and Adjustment	3
REMOVAL AND INSTALLATION	
To Remove Transfer Case	4
To Install Transfer Case	5
REPAIR	
Oil Seals	6
To Disassemble Transfer Case	7
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To Assemble Transfer Case	9
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Tool Equipment	12

GENERAL

There are two types of transfer cases in use on these trucks. This group (08B) contains service information on transfer cases used in vehicles equipped with "banjo" type axles; where, group 08S describes transfer cases used on trucks having "split" type axles.

1. DESCRIPTION AND OPERATION

Transfer case used in these vehicles is essentially a two-speed auxiliary unit. It consists of a case, gears and output shafts for transfer of power to each of the three driving axles. This unit is located between frame side rails behind main transmission, and is driven by transmission through propeller shaft connecting these two units.

Shifting of transfer case gears is accomplished by hand, through levers and rods (see Fig. 1) to transfer case shift shafts to which are attached shift forks for actual gear engagement. (Refer to Figs. 4 and 5 for following reference numbers.)

High speed gear ratio is obtained when sliding gear (31) is engaged with mainshaft drive gear (29). Low speed gear ratio is obtained when sliding gear (31) is engaged with low speed gear (78).

Front axle is engaged when low sliding gear (12) engages gear (14). Disengagement of gear (12) from gear (14) disengages front axle drive.

Instructions for control of transfer case during vehicle operation are provided in "Driver's Instructions" group.

2. TROUBLE SHOOTING AND GENERAL SOLUTIONS

Following are the symptoms, cause and probable remedy for difficulties which may occur.

A. Hard Shifting

1. Poor driving practices—
   Follow recommended procedure.
2. Levers seized on shaft—
   Inspect, clean and lubricate.

B. Slips Out of Gear

1. Shift shaft ball spring weak or broken—
   Replace spring.
2. Gears not fully engaged—
   Adjust control linkage.

C. Loss of Lubricant

1. Worn or damaged oil seals—
   Replace seals and install according to instructions.
2. Damaged gaskets—
   Install new gaskets.

3. INSPECTION AND ADJUSTMENT

A. Transfer Case Lubrication—Frequent inspection of quantity and condition of lubricant is essential.

1. Remove level plug at right side of transfer case and check level of oil.
2. When draining lubricant from case, inspect condition of oil removed.

If tarry, semi-solids come from drain hole following the regular draining operation, it will be necessary to completely disassemble unit and clean all parts thoroughly; including bearings, cored passages, etc. Drain plug is located at bottom of case; be sure it is cleaned, installed and tightened after drainage.

3. Fill transfer case to level of level plug hole. Add lubricant slowly and, before replacing filler plug, make sure that lubricant has settled to level of level plug hole.
4. Breather at top of main drive gear bearing cap should be thoroughly cleaned. First wipe dirt off outside of breather; then remove it and clean thoroughly.

B. Transfer Case Controls—Control rod connections at levers should be inspected regularly. See that levers

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TRANSFER CASE—BANJO TYPE AXLES

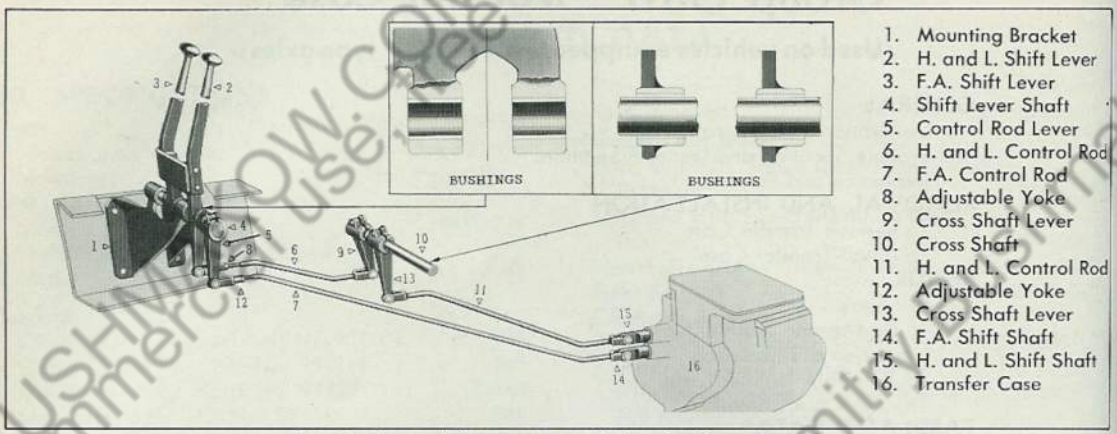

Fig. 1 General Arrangement of Transfer Case Controls

and linkage are free, reasonably clean and well lubricated. Action of control levers should be tested and this can be accomplished more readily if vehicle is in motion.

Adjustments—Control lever adjustment must be maintained to provide proper gear engagement in transfer case. Following instructions provide for adjustment of Front Axle Control Lever and for High and Low Speed Control Lever.

A. Front Axle Control Lever Adjustment—Adjustment of front axle control lever is necessary when shift shaft poppet ball (46, Fig. 4) does not seat in shift shafts (48, Fig. 4) at shaft support. Following are instructions for making linkage adjustment (refer to Fig. 1):

1. Disconnect control rod (7) between control rod lever (5) and shifter shaft (14).

2. Move shifter shaft (14) at transfer case to be sure that poppet ball is seating. Movement of shaft will indicate when poppet ball is seated. Leave shaft "out," in the disengaged position.

3. Note position of hand control lever (3), as it should be slightly forward of an upright or vertical position. When control lever is in this position, clevis pin at front of control rod (7) should line up with hole in control rod lever (5).

4. When clevis pin does not line up with hole in adjustable yoke (12) and hole in control rod lever (when shift lever is in approximately vertical position as explained above), it indicates that adjustment is necessary.

5. Lock nut behind adjustable yoke (12) can be loosened and yoke turned as necessary to line up holes in yoke (12) and control rod lever (5).

6. Replace clevis pin and cotter pin. Be sure yoke lock nut is again tightened.

B. High and Low Control Lever Adjustment (Refer to Fig. 1)—Need for adjustment of speed control lever is indicated when shift shaft poppet ball does not seat in shift shaft at transfer case, or when clearance between control lever and bracket on front axle control is excessive.

1. Disconnect control rod (6) between cross shaft lever (9) and shifting lever (2) at adjustable yoke end.

2. Move shifter shaft (15) at transfer case in and out to be sure that poppet ball is seating in shifter shaft. Movement of shaft will indicate when poppet ball is seated. Leave shaft in neutral position, this is between high and low, and proceed with adjustment.

3. With front axle shifting lever (3) in disengaged position, set high and low speed shifting lever (2) so that 1/8" clearance exists between lever (2) and bracket on front axle shifting lever (3).

4. With high and low speed shifting lever (2) in position as explained above, clevis pin holes in adjustable yoke (8) and shifting lever (2) should line up.

5. When clevis pin holes do not line up, need of adjustment is indicated. Loosen adjustable yoke lock nut and turn yoke (8) as necessary to line up holes.

6. Replace clevis pin and cotter pin. Be sure yoke lock nut is again tightened.

REMOVAL AND INSTALLATION

4. TO REMOVE TRANSFER CASE

If it should be necessary to remove transfer case for overhaul or replacement, procedure is as follows. Refer to Fig. 2 for reference numbers; unless otherwise indicated:

1. Place suitable container under transfer case, remove the drain and filler plugs to allow lubricant to drain from transfer case. After draining, replace plugs.

2. Disconnect propeller shafts between yokes as directed in "Propeller Shaft" group of this book. Also see "Brake" group for removal of hand brake band and controls.

3. Remove cotter pin and clevis pin attaching front

TRANSFER CASE—BANJO TYPE AXLES

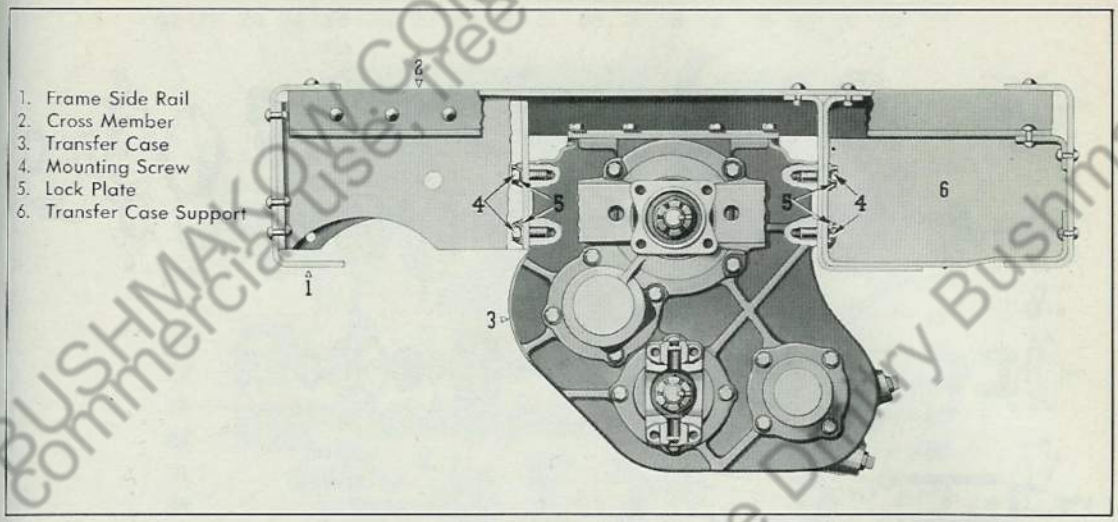

Fig. 2 Transfer Case Mounting

axle control rod (7, Fig. 1) to transfer case.

4. Remove speedometer cable at transfer case idler shaft front cap by loosening knurled nut with pliers. Remove cable from drive gear shaft.

5. Remove two cotter pins and clevis pins at each end of high and low speed control rod (11, Fig. 4).

6. Place suitable support under transfer case assembly before loosening eight mounting screws. Support should be adjustable for height.

7. Bend down lips of mounting screw locking plate (5). Remove four lower screws (4) (two each side) so that case is suspended only by four upper screws (two each side). Loosen upper screws (4) alternately and evenly until screws can be removed. Lower transfer case to completely remove from vehicle.

5. TO INSTALL TRANSFER CASE

When installing new or overhauled transfer case, proceed as follows. Refer to Fig. 2 for reference numbers unless otherwise indicated:

1. With brake support toward rear, raise transfer case into position, using lift jack or other suitable hoist.

2. Reinstall eight mounting screws (4) attaching case assembly to supports. Two upper screws on each side should be installed first. Before installing screws, be sure that locking plates (5) are used under heads of screws.

3. Tighten bolts securely and evenly, locking them in place with locking plate which should be turned up against flat of screw head.

4. Attach high and low control rod (11, Fig. 1) to shifting shaft (15) and lever (13) with clevis pin, using new cotter pins.

5. Replace speedometer cable to transfer case idler shaft front cap. When replacing cable, be sure that tongue on end of cable meshes with driven gear shaft.

6. Replace front axle control rod (7, Fig. 1) to shifting shaft (14) and attach with clevis pin and cotter pin.

7. Reinstall propeller shafts as directed in "Propeller Shaft" group of this book.

8. Reinstall and adjust hand brake as directed in "Brake" group of this book.

9. When transfer case has been completely installed, it should be filled to level plug with recommended lubricant.

10. Adjust controls, as directed under "Adjustment" in this section, before vehicle is placed in service.



Fig. 3 Oil Seals Are Installed in Caps with Replacer Tool As Shown

TRANSFER CASE—BANJO TYPE AXLES

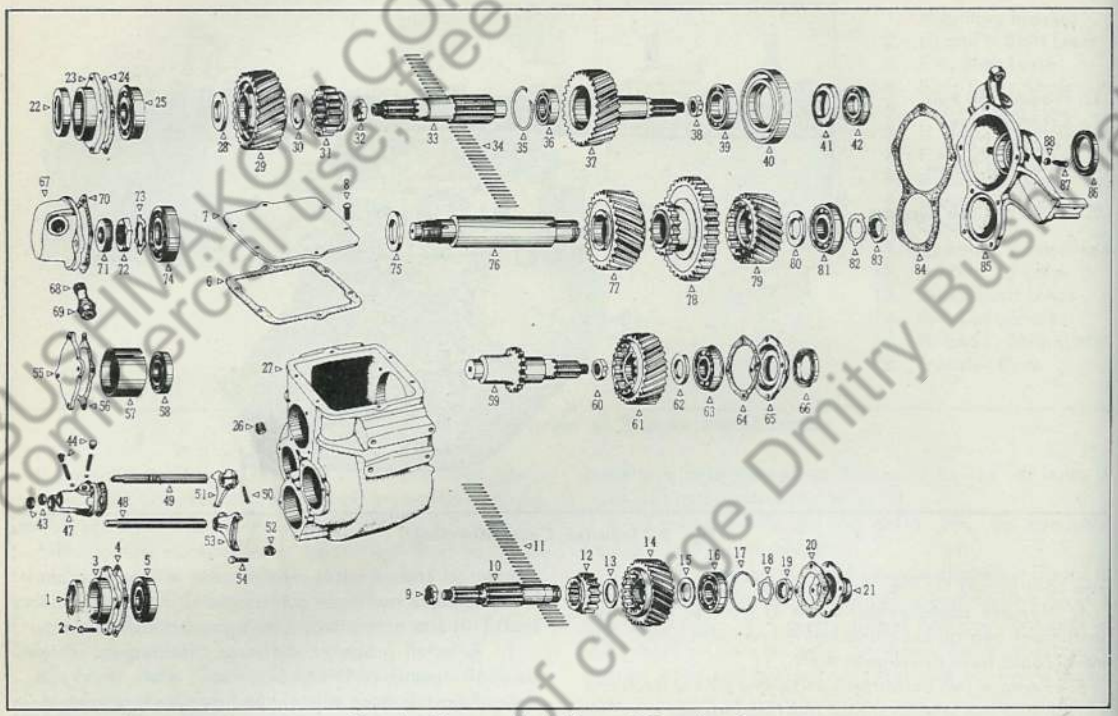

Fig. 4 Disassembled View of Transfer Case

1. Drive Shaft Oil Seal
2. Bearing Cap Screw
3. Drive Shaft Bearing Cap
4. Bearing Cap Gasket
5. Bearing—Front
6. Case Cover Gasket
7. Case Cover
8. Case Cover Cup Screw
9. Drive Shaft Nut
10. Front Axle Drive Shaft
11. Gear Roller Bearings
12. Drive Shaft Sliding Gear
13. Gear Spacer—Thin
14. Drive Shaft Gear
15. Gear Spacer—Thick
16. Drive Shaft Bearing
17. Bearing Snap Ring
18. Bearing Nut Locking Plate
19. Bearing Lock Nut
20. Bearing Cap Gasket
21. Drive Shaft Bearing Cap
22. Bearing Cap Oil Seal
23. Mainshaft Bearing Cap
24. Bearing Cap Gasket
25. Mainshaft Bearing
26. Filler Plug
27. Case
28. Gear Spacer—Thick
29. Mainshaft Gear
30. Gear Spacer—Thin
31. Mainshaft Sliding Gear
32. Mainshaft Nut
33. Mainshaft
34. Gear Roller Bearings
35. Bearing Snap Ring
36. Mainshaft Bearing
37. Rear Axle Drive Gear
38. Drive Gear Nut
39. Drive Gear Bearing
40. Bearing Retainer
41. Bearing Sleeve
42. Drive Gear Bearing
43. Support Oil Seal
44. Poppet Spring Retainer
45. Poppet Spring
46. Poppet Ball
47. Shifter Shaft Support
48. Shifter Shaft
49. Shifter Shaft
50. Shifter Fork Screw
51. Shifter Fork
52. Drain Plug
53. Shifter Fork
54. Shifter Fork Screw
55. Drive Shaft Cover
56. Cover Gasket
57. Bearing Spacer
58. Drive Shaft Bearing
59. Rear Axle Drive Shaft
60. Drive Shaft Nut
61. Drive Shaft Gear
62. Gear Spacer—Thick
63. Drive Shaft Bearing
64. Bearing Cap Gasket
65. Drive Shaft Bearing Cap
66. Bearing Cap Oil Seal
67. Idler Shaft Cap—Front
68. Speedometer Driven Gear
69. Gear Retainer
70. Idler Shaft Cap Gasket
71. Speedometer Drive Gear
72. Idler Shaft Nut
73. Idler Shaft Nut Lock
74. Idler Shaft Bearing
75. Spacer—Thick
76. Idler Shaft
77. Idler Shaft Gear
78. Idler Shaft Gear—Center
79. Idler Shaft Gear—Rear
80. Spacer—With Dowel
81. Idler Shaft Bearing
82. Idler Shaft Nut Lock
83. Idler Shaft Nut
84. Bearing Cap Gasket
85. Rear Bearing Cap
86. Bearing Cap Oil Seal
87. Sleeve Lock Screw
88. Lock Screw Nut

TRANSFER CASE—BANJO TYPE AXLES

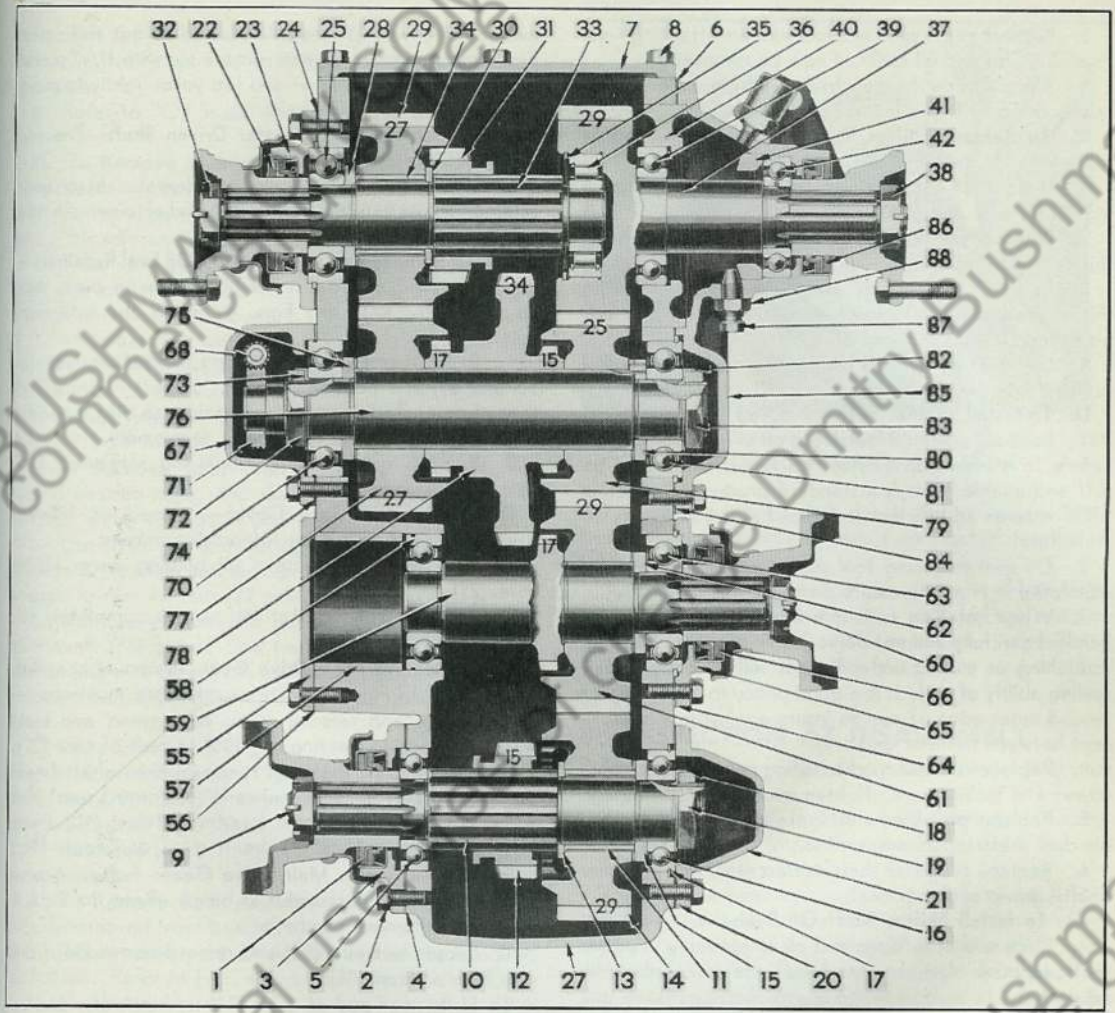

Fig. 5 Assembled View of Transfer Case

6. OIL SEALS

Spring loaded leather type oil seals are used at front of mainshaft, rear of main drive gear, driven shaft and front axle output shaft. Seals used at shifting shafts are felt type, held in place by retainers.

A. Inspection—Seals should be inspected at regular intervals, while vehicle is in service, for evidence of leaks. When transfer case is disassembled seals should be carefully inspected for evidence of wear or other failure.

Propeller shaft yokes must also be handled carefully during storage as well as during disassembling and assembling procedure. **Any nicks, grooves or scores on sealing surface of yoke will not allow a good seal and lubricant will be lost soon after unit is placed in service.** Small nicks may be removed from yokes with a suitable stone. In the event sealing surface of yoke is grooved or scored, surface may be turned down not more than .020". **This must be done carefully with dependable equipment** as yoke will be ruined if sealing surface is out of round. In the event grooves are deeper than .020", installation of a new part will be necessary.

B. To Remove Leather Seals—It is not necessary to completely disassemble transfer case in order to replace seals. Proceed as follows:

1. Disconnect propeller shaft from yoke at transfer case in manner described in "Propeller Shaft" group of this book.

2. Remove propeller shaft yokes in manner described under heading "To Remove Propeller Shaft Yokes" in this section.

TRANSFER CASE—BANJO TYPE AXLES

3. Remove cap screws and lockwashers attaching caps to case. Cap and oil seal can now be removed.

4. Seal can now be punched out from inside of retainer, using drift pin and hammer.

C. To Remove Shifter Shaft Oil Seals—Proceed as follows:

1. Disconnect control rods at shifter shafts by removing cotter pins and clevis pins.

2. Remove poppet spring retainers and springs in shifter shaft support.

3. Remove cap screws and lockwashers attaching shifter shaft support to front of case. Support can now be pulled straight out and off shafts.

4. Use drift punch and hammer to drive seals out of support from inside.

D. To Install Leather Seals—Proceed as follows:

1. Soak oil seal in "Neatsfoot" oil or warm engine oil before it is installed. Leather portion of seal must be soft and pliable. This is a standard production practice which assures an efficient leak-proof seal and assists installation.

2. Oil seal replacing tool should be used in manner illustrated in Fig. 3 to assure proper installation of seals.

3. **When installing seals it is important that they be handled carefully and not damaged in any way. Cutting, scratching or curling under leather will seriously impair sealing ability of seal.** It is a good policy to use Permatex around outer edge of seal to insure against loss of lubricant between radiator and seal.

4. Replace retainer to case, using new gasket. Install screws and lockwashers. Tighten evenly and alternately.

5. Replace propeller shaft yoke described under individual shaft replacement.

6. Replace propeller shaft as described in "Propeller Shaft" group of this book.

E. To Install Shifter Shaft Oil Seals—

1. Place seal in retainer and place assembly in shifter shaft support. Use tool to seat retainer securely in support.

2. Replace support to case, using new gasket. Install screws and new lockwashers; tighten securely.

3. Replace poppet balls, springs and retainers.

4. Attach shift rods to shifter shafts, using clevis pins and new cotter pins.

7. TO DISASSEMBLE TRANSFER CASE

When transfer case is being disassembled, it is necessary to remove each train of gears, shafts and bearings in their proper order (top to bottom) in order to effect proper removal and replacement of individual parts.

It is a good policy to tag gears, spacers and bearings as they are removed so that they may be reassembled in same positions as before disassembly.

A. To Remove Propeller Shaft Yokes—Proceed as follows. Refer to Figs. 4 and 5 for reference numbers:

1. Propeller shaft yokes at mainshaft (33), rear axle drive shafts (59 and 37), and front axle drive shaft (10) must be removed. Yokes are retained by nut and cotter pin. Remove cotter pin and remove nut with $1\frac{1}{2}$" socket wrench. Use lead hammer and tap yokes lightly to move them outward and off shafts.

B. To Remove Speedometer Driven Shaft—Proceed as follows. Refer to Fig. 4:

1. Use $\frac{7}{8}$" wrench to loosen speedometer driven gear retainer (69) at cap (67). Gear (68) and retainer can now be completely removed.

C. To Remove Bearing Caps and Oil Seal Retainers—Before starting major disassembly, following parts may be removed. Refer to Figs. 4 and 5 for reference numbers:

1. Remove cap screws attaching oil seal retainers (3, 23 and 65) and bearing caps (21, 55, 67) to front and rear of case. Tag each oil seal retainer so that it can be replaced to its proper location at reassembly.

2. Remove gaskets under caps and retainers. Use new parts at reassembly.

D. To Remove Case Cover—Proceed as follows. Refer to Figs. 4 and 5 for reference numbers:

1. Remove six cap screws (8) holding cover (7) to case (27).

2. Cover (7) and gasket (6) can be completely removed.

E. To Remove Main Drive Gear—Removal is as follows. Refer to Figs. 4 and 5 for reference numbers:

1. Loosen and remove seven cap screws and lockwashers attaching bearing cap (85) to rear of case (27).

2. Take hold of rearward rear axle drive shaft (main drive gear) (37) and pull outward, or toward rear; this will remove shaft (37), inner bearing retainer (40), inner bearing (39), drive shaft rear bearing (42) and sleeve (41).

F. To Disassemble Main Drive Gear—Following procedure should be performed at bench. Refer to Figs. 4 and 5 for reference numbers.

1. Loosen lock nuts (88) and remove screws (87) from rear bearing cap (85).

2. Strike rear end of shaft (37) on block of wood to remove shaft, bearings, sleeve and retainer from cap.

3. Use sharp pointed tool to remove snap ring (35) from inside of main drive gear (37). Strike gear on block of solid wood to remove bearing (36).

G. To Remove Shifter Support, Shafts and Forks—It is not necessary to entirely remove shafts and support to disassemble case. Refer to Figs. 4 and 5 for reference numbers.

1. Reach through main drive gear opening in case and remove cap screws (50 and 54), holding forks (51 and 53) to shafts (48 and 49).

2. Remove cap screws attaching shift shaft support (47) to case and remove support and shift shafts as an assembly. This will allow shift forks (51 and 53) to be removed from case.

3. Remove two lock plugs (44) in support (47) so that poppet balls (46) and springs (45) can be removed. Re-

TRANSFER CASE—BANJO TYPE AXLES

move shift shafts (48 and 49) from support (47), pulling them out from case side so that notches will not damage seals.

4. Refer to "Oil Seals" for removal of oil seals from support.

H. To Remove Mainshaft—Propeller shaft yoke and oil seal retainer having been previously removed, mainshaft can now be removed as follows. Refer to Figs. 4 and 5 for reference numbers:

1. Place solid block of wood against rear end of mainshaft (33) and strike wood sharply to move shaft forward enough to remove front bearing (25) from case and shaft.

2. Mainshaft (33) with gears (29 and 31), needle bearings (34) and thrust washers (28 and 30) can now be lifted out of case through cover opening.

3. Gears, washers and needle bearings can now be stripped from mainshaft.

I. To Remove Idler Shaft—Having previously removed bearing caps, idler shaft can now be removed as follows. Refer to Figs. 4 and 5 for reference numbers:

1. Use chisel and hammer to raise tangs of lock plates (73 and 82) holding nuts to idler shaft (76). Use 2" socket wrench to remove nuts (72 and 83).

2. Use heavy brass drift punch and hammer to drive idler shaft (76) out of case (rear to front). Rear thrust washer (80) with dowel pin and gears (77, 78, 79) can be stripped from shaft as shaft is removed through front of case.

3. Place idler shaft in press, if necessary, to remove speedometer drive gear (71).

4. Nut (72), lock (73), bearing (74) and spacer (75) can now be slipped from shaft.

5. Rear bearing (81), which is slip fit in case, can now be removed.

J. To Remove Rear Axle Drive Shaft—Having previously removed front bearing cover, rear oil seal retainer and propeller shaft yoke, drive shaft can now be removed as follows. Refer to Figs. 4 and 5 for reference numbers:

1. Use heavy brass drift punch and hammer to drive forward rear axle drive shaft (59) from case (rear to front) until shaft clears rear spring (63).

2. Gear (61) and spacer (62) can now be stripped from shaft as it is removed through front of case. Spacer (57) is also removed from case during this operation.

3. Front bearing (58), which was removed from case with shaft, can now be slipped off shaft.

4. Rear bearing (63), which is slip fit in case, can now be removed.

K. To Remove Front Axle Drive Shaft—Having previously removed rear bearing cap, front oil seal retainer and propeller shaft yoke, front axle drive shaft can be removed as follows. Refer to Figs. 4 and 5 for reference numbers:

1. Use chisel and hammer to raise prongs of lock plate (18) holding nut (19) to shaft. Use 2" socket wrench to remove nut (19).

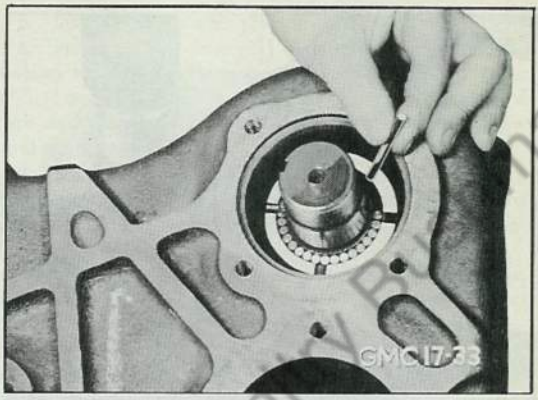

Fig. 6 Roller Bearings Are Installed In Front Axle Drive Gear Through Case As Shown

2. Use heavy brass drift punch and hammer to drive front axle drive shaft (10) from case (rear to front) until shaft clears rear bearing.

3. Sliding gear (12), helical gear (14) with needle bearings (11) and thrust washers (13 and 15) can now be stripped from shaft (10) as it is removed.

4. Rear bearing (16), which is slip fit in case, can now be removed.

8. INSPECTION AT DISASSEMBLY

Following inspections should be made while transfer case is disassembled.

A. Cleaning and Inspection of Bearings—Bearings which do not pass inspection should be discarded and replaced with new parts:

1. Place all bearings in clean gasoline or other suitable cleaning fluid. Allow bearings to remain in cleaning fluid long enough to loosen old grease and lubricant. After thorough soaking, bearing should be slushed up and down and spun slowly below surface of liquid to remove as much of old grease as possible.

2. Remove bearing from cleaning fluid and strike lightly against wooden block to loosen heavier and harder particles of lubricant. Repeat immersion and striking operation until it is evident that bearings are clean.

3. Blow out bearings with compressed air, being careful to direct air pressure across bearing so that it does not spin.

4. Carefully inspect balls for chipping, cracks or worn spots to determine fitness of bearing for further use.

5. After inspection, dip bearings in engine oil and wrap in clean cloth or paper to protect them until they are needed at reassembly.

B. Cleaning and Inspection of Gears, Shafts, Case, Etc.—Parts which are worn excessively or damaged should be replaced with new parts.

1. Case, cover and caps should be thoroughly cleaned in gasoline or other cleaning fluid.

TRANSFER CASE—BANJO TYPE AXLES

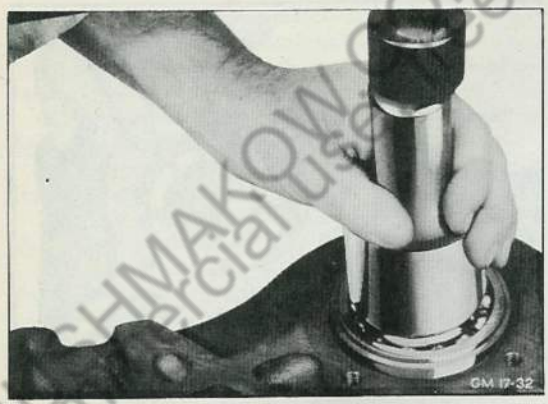

Fig. 7 Drive Shaft Bearings Are Installed with Replacer As Shown

2. Clean magnetic drain plug to remove any metallic particles which may have been attracted by magnet.

3. Carefully examine teeth on all gears for nicks and "gald" spots. Do not take chances with gears which are badly nicked or scored. Small nicks may be removed with a "slip-stone" or hone.

4. Inspect splines on shafts and sliding gears for scores or evidence of twisting. Place sliding gears on respective shafts and check clearance along splines with dimension given in "Specifications" at end of this group. If clearance is excessive, or if shaft is scored or twisted, new parts should be installed.

5. Inspect gears and shafts, using needle bearings at point where needle bearings contact gears and shaft. If any evidence of excessive wear is noted, these parts should be replaced. See "Specifications" at end of this group.

6. Inspect thrust washers for wear and check thickness with dimensions given in "Specifications" at end of this group. Washers that are worn appreciably should be replaced with new parts.

7. Remove breather from drive gear bearing cap and clean thoroughly in gasoline to remove any lubricant or dirt accumulation. Blow dry with compressed air.

9. TO ASSEMBLE TRANSFER CASE

When reassembling, care should be taken to pre-lubricate all parts to prevent possibility of scoring bearing surfaces before regular lubricant reaches these parts.

Note: R. H. and L. H. helical gears, referred to in this text, are identified in following manner: Place gears on bench, either side up. Look straight at gear teeth. If upper end of teeth are to left of lower end, this is a L. H. helix angle. When teeth point to right, this is a R. H. helix angle.

A. To Install Front Axle Drive Shaft—Procedure for assembling and installing front axle drive shaft is as follows. Refer to Figs. 4 and 5 for reference numbers:

1. Replace front bearing (5) (H. D. 41208-XS-7) on shaft (10) if it has been removed, using arbor press if necessary.

2. Insert shaft through opening in front of case. Slip sliding gear (12) in place over shaft splines with shifter fork groove toward front of case. Install thin spacer (13) on shaft.

3. Coat inner surface of constant mesh gear (14) (R. H. helix and 29 teeth) with cup grease and install gear over shaft as shaft is pushed into place, until front bearing is in case opening. Internal gear teeth must be toward front.

4. Install the 32 roller bearings (11) between gear (14) and shaft (10) as illustrated in Fig. 6. Install thick spacer (15) on shaft through opening in rear of case.

5. Support front or splined end of shaft on block of wood as rear bearing (16) (N. D. 41208-XS-7), with snap ring (17) toward rear, is installed. Replace lock (18) and nut (19) on shaft and tighten nut finger-tight.

6. Install front bearing cap (3) and oil seal, using new gasket (4) under cap. Install and tighten cap screws using new lockwashers under head of screws.

7. Replace propeller shaft yoke on splined shaft, with cotter pin holes at right angles to yoke bearing seats. Replace yoke retaining nut (9) on shaft.

8. Use 1½" socket wrench at yoke nut and 2" socket wrench at rear bearing retaining nut. Tighten both nuts securely.

9. Bend tang of rear lock plate (18) over flat of nut (19).

10. Replace cotter pin through shaft hole and nut slot at front of shaft, bending ends of pin over flat of nut.

B. To Install Rear Axle Drive Shaft—Procedure for assembling and installing front rear axle drive shaft is as follows. Refer to Figs. 4 and 5 for reference numbers:

1. Replace front bearing (58) (N. D. 41308-XS-7) on shaft, if it has been removed, using arbor press if necessary.

2. Insert shaft through opening in front of case as constant mesh gear (61) (L. H. helix with 29 external and 17 internal teeth) is slipped over shaft (59), as shaft is pushed into place. Mesh internal gear teeth with external shaft teeth.

3. Install thick spacer (62) on shaft, through opening in rear of case.

4. Support front end of shaft on block of wood as rear bearing (63) (N. D. 41308-XS-7) is installed, with snap ring toward rear.

5. Install rear cap (65) and oil seal, using new gasket (64) under cap. **Note:** Forward rear axle drive shaft rear bearing cap (65) and mainshaft front bearing cap (23) are very similar in design but ARE NOT interchangeable. Forward rear axle drive shaft rear bearing cap (65) is machined to provide clearance for installation of rear bearing cap (85). Be sure these parts are installed in proper places.

TRANSFER CASE—BANJO TYPE AXLES

6. Replace propeller shaft yoke on splined shaft, with cotter pin holes at right angles to yoke bearing seats. Replace yoke retaining nut (60) and tighten securely, using cotter pin to lock nut to shaft.

7. Replace large spacer or sleeve (57) through front opening in case. Install front cap (55), using new gasket (56) between cap and case. Install and tighten cap screws, using new lockwashers under head of screws.

C. To Install Idler Shaft—Procedure for assembling and installing idler shaft is as follows. Refer to Figs. 4 and 5 for reference numbers:

1. Replace thick spacer (75) and front bearing (74) (N.D. 41308-CS-7) on shaft (76), if they have been removed, using arbor press if necessary. Replace locking plate (73) and nut (72) holding bearing to shaft and tighten nut securely. Bend tang of locking plate (73) over flat of nut.

2. Replace speedometer gear (71) on front end of idler shaft (76), using arbor press.

3. Insert idler shaft (76) through opening in front of case and assemble constant mesh gear (77) (R. H. helix with 27 external and 17 internal teeth), low speed gear (78) and rear helical gear (79) (R. H. helix with 25 external and 15 internal teeth) as shaft is pushed to rear until front bearing (74) is located in case.

4. Replace spacer and dowel pin (80) through opening in rear of case. Dowel pin must enter slot in shaft (76) and notch in gear (79).

5. Support front end of shaft on block of wood as rear bearing (81) (N.D. 51308-XS-7), with snap ring toward rear, is driven into case with bearing replacing tool in manner illustrated in Fig. 7.

6. Replace locking plate (82) and nut (83) on rear of shaft, tighten nut securely, using 2" socket wrench. Bend tang of lock plate (82) over flat of nut.

7. Install front cap (67), using new gasket (70) under cap. Install and tighten cap screws, using new lockwashers under head of screws.

8. Replace speedometer driven gear (68) and retainer (69) in cap (67). Teeth of speedometer gear should be lubricated before installing. Tighten driven gear retainer (69) in cap, using 7/8" open wrench.

D. To Install Mainshaft—Procedure for assembling and installing mainshaft is as follows. Refer to Figs. 4 and 5 for reference numbers:

1. Replace inner race of straight roller bearing (36) on rear end of shaft (33), using arbor press if necessary.

2. Install thin spacer (30) over forward end of mainshaft, placing spacer against shoulder of splines.

3. Coat inner surface of helical gear (29) (L. H. helix with 27 external and 15 internal teeth) with cup grease, and install on mainshaft with internal teeth of gear (29) towards rear of case.

4. Install 32 roller bearings (34) between gear (29) and mainshaft (33).

5. Install thick spacer (28) on mainshaft.

6. Install sliding gear (31) over splines of mainshaft, making sure shift fork groove is towards rear of case.

7. Lower mainshaft assembly through top opening of case and insert splined end of mainshaft through front bearing opening in case.

8. Support rear of shaft on block of wood as front bearing (25) (N.D. 41308-XS-7) with snap ring toward front is installed, using bearing replacing tool as illustrated in Fig. 7.

9. Install front bearing cap (23) with oil seal, using new gasket (24) under cap. Install and tighten cap screws, using new lockwashers under head of screws.

10. Replace propeller shaft yoke on splined shaft, with cotter pin holes at right angles to yoke bearing seats. Replace yoke retaining nut on shaft.

11. Use 1 1/2" socket wrench on yoke nut to tighten nut securely. Replace cotter pin and bend over flat of nut.

E. To Install Shifter Support, Shafts and Forks—Procedure for assembling and installing is as follows. Refer to Figs. 4 and 5 for reference numbers:

1. Install shifter shafts (48 and 49) in support (47) from case side to prevent grooves damaging oil seals. Shaft (49) with three poppet ball grooves must be at top of support. Top of support can be identified by edge which is cut off, to permit clearance at case.

2. Replace shift shaft poppet balls (46), springs (45) and retainers (44) in shifter shaft support (47).

3. Install support and shafts assembly to case, using new gasket. Replace and tighten cap screws, using new lockwashers under head of screws.

4. Replace shift fork (53) in front axle sliding gear (12) groove, with ribbed side of fork towards gear teeth. Slide shaft (48) to rear and through fork with shaft slot and hole in fork lined up. Replace cap screw and new lockwasher. Tighten screw securely.

5. Replace shift fork (51) in mainshaft sliding gear (31) groove, with ribbed side of fork towards gear teeth. Slide shaft (49) to rear and through fork, with shaft slot and hole in fork lined up. Replace cap screw and new lockwasher. Tighten screw securely.

F. To Assemble Main Drive Gear—Procedure following should be performed at bench before installing assembly. Refer to Figs. 4 and 5 for reference numbers.

1. Replace mainshaft rear bearing outer race (36) in drive gear pocket, if it has been removed. Replace snap ring (35) in groove to hold bearing outer race.

2. Replace ball bearing (39) (N.D. 1210) on shaft (37) behind gear with bearing replacer tool or arbor press. Replace bearing retainer (40) over bearing.

3. Install bearing (42) (N.D. 3208) into rear bearing cap (85). Replace tapered bearing sleeve (41) into bearing cap (85) with tapered side toward front.

4. Temporarily install two tapered screws (87) into bearing cap to hold sleeve in place.

TRANSFER CASE—BANJO TYPE AXLES

5. Insert gear assembly into bearing cap (85) with splined end of gear shaft through bearing (42), as retainer (40) is seated at front of bearing cap (85).

6. Temporarily install propeller shaft flange and replace nut to hold assembly together until installed on case.

7. Clean and install breather in rear bearing cap.

G. To Install Main Drive Gear—This assembly has been assembled at bench in manner previously described. Refer to Figs. 4 and 5 for reference numbers.

1. Place gasket (84) on main drive gear bearing cap, previously assembled, and attach complete assembly to rear of case, using cap screws and new lockwashers. Tighten screws evenly and alternately.

2. Use 1 1/2" socket wrench to tighten propeller shaft yoke nut. Install new cotter pin and bend over flat of nut.

H. To Install Case Cover—Procedure is as follows:

1. Replace gasket (6) on top of case, being sure cap screw holes line up.

2. Replace cover (7) to case, with large cap screw hole lined up with similar large hole in case.

3. Replace cap screws (8), using new lockwashers. Tighten screws evenly and alternately.

10. TRANSFER CASE CONTROLS

Shifting of transfer case into high or low, also engagement and disengagement of front axle is accomplished by shifting levers, located in cab, and connected to transfer case by control rods.

A. Operation—Shifting of transfer case into high or low, also front axle control is described in "Driver's Instruction" group of this book.

B. To Remove Shifting Levers—Removal of levers and mounting shaft is as follows:

1. Remove floor board as directed in "Body" group of this book.

2. Remove bolts, nuts and lockwashers used to attach shift lever handle to lower lever.

3. Remove high and low, also front axle, control rods by taking out cotter pins and clevis pins.

4. Lift transmission cover assembly as directed in "Transmission" group of this book.

5. Loosen clamp bolt in front axle control lever at end of cross shaft. Lever can now be removed.

6. Loosen clamp bolt in front axle shift lower lever. Cross shaft can now be moved inward and completely removed from frame bracket. Strip levers from shaft as it is removed from bracket.

C. To Remove Cross Shaft and Brackets—

1. Remove floor board as directed in "Body" group of this book.

2. Remove high and low control rods by taking out cotter pins and clevis pins.

3. Remove special hair pin lock at left end of cross shaft.

4. Remove stud nuts attaching R. H. support bracket to transmission case.

5. Cross shaft and R. H. bracket can now be lifted from vehicle as an assembly.

6. Levers can be removed from right-hand support after clamp bolts are removed from levers.

7. If necessary to remove left-hand support bracket, this can be accomplished after stud nuts are removed.

D. Inspection—

1. Carefully check bushings in control lever mounting bracket, also in right and left-hand cross shaft brackets. If wear is apparent, they should be replaced with new parts.

2. Check clevis pins for wear and discard those that are not full size.

E. To Install Shifting Levers—

1. Start shift lever shaft through frame bracket inner bushing, with keyway end toward center of vehicle.

2. Place front axle lower control lever over shaft with stop pad toward left side of vehicle.

3. Tap Woodruff key into keyway near center of shaft and push shaft into its approximate location as lower lever and shaft key are matched.

4. Place high and low speed lower shift lever over end of shaft.

5. Tap Woodruff key into keyway near end of shaft. Replace front axle control rod lever over end of shaft, install and tighten lever clamp bolt, when lever and inner end of shaft are even.

6. When shaft is properly located in frame bracket with both lower shifting levers free, tighten clamp bolts securely.

7. If length of control rods have been disturbed, make necessary adjustments as directed under "Adjustments" in this group.

8. Replace transmission cover and floor boards as directed in their respective groups of this book.

F. To Install Cross Shaft and Brackets—

1. Replace left-hand brackets, using stud nuts. Tighten nuts securely so that bracket is tight.

2. Place cross shaft through right-hand bracket with keyway end toward right side of vehicle.

3. Replace Woodruff keys in shaft and install levers on shaft over keys. Tighten lever clamp bolts.

4. Replace cross shaft and bracket assembly with left end of cross shaft through left-hand bracket. Attach right-hand bracket to transmission case studs, tighten stud nuts securely. Replace hair pin lock in groove at left end of cross shaft.

5. Attach control rods to cross shaft levers, using clevis pins and cotter pins. If new parts have been installed, or if length of control rods has been changed, readjust as directed under "Adjustments" in this group.

6. Replace floor boards as directed in "Body" group of this book.

TRANSFER CASE—BANJO TYPE AXLES

TABULATED DATA

11. SPECIFICATIONS

Make	Chevrolet
Model	3659994
Type	Two Speed with Front Axle Declutching

Gear Ratio

High	1.16 to 1
Low	2.63 to 1

Mainshaft and Gears

Front Bearing	Ball
Make	New Departure
Number	954262
Rear Bearing	Straight Roller
Make	Hyatt
Number	A-1307-TS
Bearing Adjustment	Non-Adjustable
Shaft Dia. at Needle Bearing Race	1.7305"–1.7300"
Helical Gear Inside Dia.—Hone	2.106"–2.107"
Needle Bearing	
Quantity	32
Diameter	.1875"–1873"
Spacing Washer Thickness	
Front	.279"–.283"
Rear	.189"–.185"
Clearance Between	
Mainshaft and Sliding Gear	.075"–.095"
Sliding Gear and Shift Fork	.009"–.018"

Rearward Rear Axle Shaft and Gears

Bearings	Ball
Make	New Departure
Number—Front	901210
Number—Rear	903208
Bearing Adjustment	Non-Adjustable

Idler Shaft and Gears

Bearings	Ball
Make	New Departure
Number	954262
Bearing Adjustment	Non-Adjustable
Spacing Washer Thickness	.279"–.283"
Clearance Between	
Gears and Shaft	.0003"–.0018"

Forward Rear Axle Shaft and Gears

Bearings	Ball
Make	New Departure
Number	954262
Bearing Adjustment	Non-Adjustable
Spacing Washer Thickness	.279"–.283"

Front Axle Drive Shaft and Gears

Bearings	Ball
Make	New Departure
Number	954260
Bearing Adjustment	Non-Adjustable
Shaft Dia. at Needle Bearing Race	1.7305"–1.7300"
Helical Gear Inside Dia.—Hone	2.106"–2.107"
Needle Bearing	
Quantity	32
Diameter	.1875"–.1873"
Spacing Washer Thickness	
Front	.189"–.185"
Rear	.279"–.283"
Clearance Between	
Mainshaft and Sliding Gear	.075"–.095"
Sliding Gear and Shift Fork	.009"–.018"

Shifter Shaft Poppet Spring and Ball

Spring	
Free Length	2"
Lbs. Pressure @ 1 3/8"	30–34
Poppet Ball	
Diameter	.376"–.374"

Control Shaft Bushing Size

I. D. of Shift Lever Brkt. Bush.	.749"–.752"
I. D. of Idler Lever Brkt. Bush.	.880"

12. TOOL EQUIPMENT

The following special tools, or their equivalent, are recommended for use when servicing TRANSFER CASE USED WITH BANJO TYPE AXLES.

Tool No.	Name	Supplier Code
CS-1279	Repair Stand	CS
HS-22-2	Socket for "U" Joint Yoke Nut	GG
J-1666	Bearing Replacing Tool	KM
J-1722	Drive Shaft Oil Seal Replacer	KM
J-1854	Speedometer Gear Puller	KM

TOOL SUPPLIER

Supplier Code	Name	Address
CS	Curtiss and Smith Manufacturing Corp.	Pottstown, Penn.
GG	G and G Sales Company	Detroit, Mich.
KM	Kent-Moore Organization	Detroit, Mich.

TRANSFER CASE—BANJO TYPE AXLES

SERVICE BULLETIN REFERENCE

Bulletin No.	Description

BUSHMAKOV.COM Use, free of charge Dmitry Bushmakov commercial use, free of charge Dmitry Bushmakov

Group O8S—Transfer Case

(Used on Vehicles with Split Type Axles)

	Paragraph
GENERAL	
Description and Operation	1
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Inspection and Adjustment	3
REMOVAL AND INSTALLATION	
To Remove Transfer Case	4
To Install Transfer Case	5
REPAIR	
Oil Seals	6
To Disassemble Transfer Case	7
Inspection and Repair	8
To Assemble Transfer Case	9
Transfer Case Controls	10
TABULATED DATA	
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Tool Equipment	12

GENERAL

There are two types of transfer cases in use on these trucks. This group (08S) contains service information on transfer cases used in vehicles equipped with "Split" type axles, whereas transfer case used on trucks equipped with "Banjo" type axles is described in group 08B.

1. DESCRIPTION AND OPERATION

Transfer case used in these vehicles is essentially a two-speed auxiliary unit. It consists of a two-piece case with gears and output shafts for transfer of power to each of the three driving axles. This unit is located between frame side rails behind main transmission, and is driven by transmission through propeller shaft connecting these two units.

Shifting of transfer case gears is accomplished by hand through levers and rods to transfer case shift shaft to which is attached the shift fork for actual gear engagement. High speed gear ratio is obtained when sliding gear (81, Fig. 3) is engaged with mainshaft drive gear (76). Low speed gear ratio is obtained when sliding gear is engaged with low speed gear (62). Front axle is engaged when sliding clutch (22) connects driven shaft to declutch shaft. Instructions for control of transfer case during vehicle operation are provided in "Driver's Instruction" group.

2. TROUBLE SHOOTING

Following are the symptom, cause and probable remedy for difficulties which may occur.

A. Hard Shifting

1. Poor Driving Practices—
   Follow recommended procedure.
2. Levers Seized on Shaft
   Inspect, clean and lubricate.

B. Slips Out of Gear

1. Shift Lock Spring Weak or Broken—
   Replace spring.
2. Gears Not Fully Engaged—
   Adjust control linkage.

C. Loss of Lubricant

1. Worn or Damaged Oil Seals—
   Replace seals and install according to instructions.
2. Damaged Gaskets—
   Install new gaskets.

3. INSPECTION AND ADJUSTMENT

Periodic inspection of lubrication and controls are required for transfer case operation. The intervals at which these operations should be performed should be governed by the conditions of and severity of operation.

A. Transfer Case Lubrication—Frequent inspection of quantity and condition of lubricant is essential.

1. Remove filler plug at rear of transfer case near idler shaft cover and check level of oil. Plug is located in correct relation to case to provide proper level.

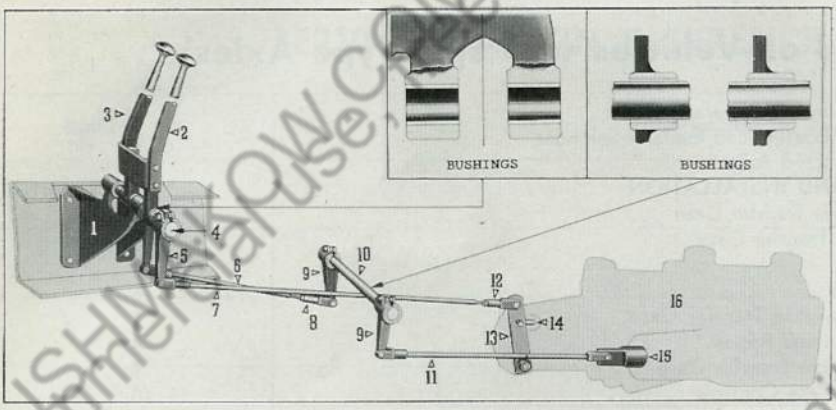
2. When draining lubricant from case, inspect condition of oil removed from unit. If lubrication has been neglected and black, tarry semi-solids come from drain hole following the regular draining operation, it will be necessary to completely disassemble unit and clean all parts thoroughly, including bearings, cored passages, etc. Drain plug is located at bottom of case; be sure it is installed and tightened after drainage.

3. Fill transfer case to level of filler plug hole. Add lubricant slowly and, before replacing filler plug, make sure that lubricant has settled to level of filler plug hole.

4. Breather at top of main drive gear bearing cage should be thoroughly cleaned. First wipe dirt off outside of breather; then remove it and clean out the cap and pipe. Be sure cotter pin is reinstalled and bent properly.

B. Transfer Case Controls—Control rod connections at levers should be inspected regularly. See that levers

TRANSFER CASE—SPLIT TYPE AXLES



1. Mounting Bracket
2. H. and L. Shift Lever
3. F.A. Shift Lever
4. Shift Lever Shaft
5. Control Rod Lever
6. H. and L. Control Rod
7. F.A. Control Rod
8. Adjustable Yoke
9. Cross Shaft Lever
10. Cross Shaft
11. H. and L. Control Rod
12. Adjustable Yoke
13. Cross Shaft Lever
14. F. A. Shift Shaft
15. H. and L. Shift Shaft
16. Transfer Case

Fig. 1 General Arrangement of Transfer Case Control

and linkage are free, clean and well lubricated. Action of control levers should be tested and this can be accomplished more readily if vehicle is in motion. Control lever adjustment must be maintained to provide proper gear engagement in transfer case. Following instructions provide for adjustment of Front Axle Control Lever and for High and Low speed control lever.

1. Front Axle Control Lever Adjustment—Adjustment of front axle control lever is necessary when shift shaft poppet ball does not seat in shift shaft at declutching carrier. Following are instructions for making linkage adjustment. (Refer to Fig. 1):

(a) Disconnect control rod (7) between declutching lever (13) and shaft lever (5) at adjustable yoke end.

(b) Move declutching lever (13) at transfer case to be sure that poppet ball is seating in shift shaft (14). Movement of shaft will indicate when poppet ball is seated. Leave shaft "out," in the disengaged position.

(c) Note position of hand control lever (3), as it should be slightly forward of an upright or vertical position. When control lever is in this position, clevis pin at rear of control rod (7) should line up hole in declutching lever (13).

(d) When clevis pin does not line up with hole in adjustable yoke (12) and hole in declutching lever (when shift lever is in approximately vertical position as explained above), it indicates that adjustment is necessary.

(e) Locknut behind adjustable yoke (12) can be loosened and yoke turned as necessary to line up holes in yoke (12) and declutching lever (13).

(f) Replace clevis pin and cotter pin. Be sure yoke locknut is again tightened.

2. High and Low Control Lever Adjustment (Refer to Fig. 1)—Adjustment of speed control lever is indicated when shift shaft poppet ball does not seat in shift shaft at transfer case, or when clearance between control lever and bracket on front axle control lever is excessive.

(a) Disconnect control rod (6) between cross shaft lever (9) and shifting lever (2) at adjustable yoke end.

(b) Move shifter shaft at transfer case in and out to be sure that poppet ball is seating in shifter shaft. Movement of shaft will indicate when poppet ball is seated. Leave shaft in neutral position (between high and low) and proceed with adjustment.

(c) With front axle shifting lever (3) in disengaged position, set high and low speed shifting lever so that 1/8" clearance exists between lever and bracket on front axle shifting lever (3).

(d) With high and low speed shifting lever (3) in position as explained above, clevis pin holes in adjustable yoke (8) and cross shaft lever (9) should line up.

(e) When clevis pin holes do not line up, need of adjustment is indicated. Loosen adjustable yoke locknut and turn yoke (8) as necessary to line up holes.

(f) Replace clevis pin and cotter pin. Be sure yoke locknut is again tightened.

REMOVAL AND INSTALLATION

4. TO REMOVE TRANSFER CASE

1. Place suitable container under transfer case, remove drain and filler plugs to allow lubricant to drain from transfer case. After draining, replace plugs.

2. Disconnect propeller shafts between yokes as directed in "Propeller Shaft" section of this book. Also see "Brake" section for removal of hand brake band and controls.

3. Remove cotter pin and clevis pin attaching front axle control rod (7, Fig. 1) to transfer case.

4. Remove speedometer cable at transfer case idler shaft front cap by loosening knurled nut with pair of pliers so that nut is free and cable can be removed from drive gear shaft.

5. Remove two cotter pins and clevis pins at each end of high and low speed control rear rod so that rod can be completely removed.

TRANSFER CASE—SPLIT TYPE AXLES

1. Mounting Screw
2. Locking Plate
3. Spacer
4. Frame Cross Member
5. Support
6. Frame Side Rail
7. Mounting Screw
8. Locking Plate
9. Brake Support
10. Transfer Case

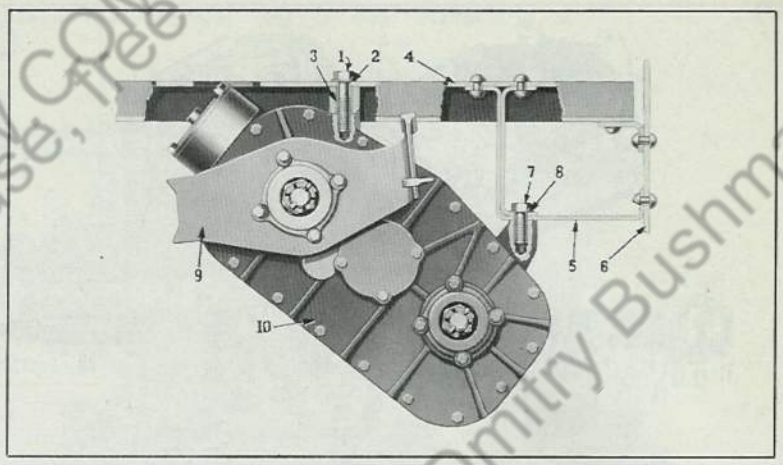


Fig. 2 Transfer Case Mounting

6. Place suitable support under transfer case assembly. Support should be adjustable for height if possible.

7. Upper or center mounting screws (1, Fig. 2) are accessible through removable plate on cab floor under seat cushion. Bend down lips of mounting screw locking plate (2 and 8, Fig. 2) before loosening screws.

8. Loosen four screws alternately and evenly until screws can be removed. Lower transfer case to completely remove from vehicle.

5. TO INSTALL TRANSFER CASE

1. Raise transfer case into position, using lift jack, if more suitable means are not available.

2. Reinstall four bolts attaching case assembly to cross member and special support. Before installing bolts, be sure that spacing sleeve (3, Fig. 2) is used under cross member at top mounting.

3. Tighten bolts securely and evenly, locking them in place with locking plate which should be turned up against flat of bolt head.

4. Attach high and low control rod (11, Fig. 1) to gear shift shaft and cross shaft lever with clevis pins, using new cotter pins.

5. Replace speedometer cable to transfer case idler shaft front cap. When declutching cable, be sure that tongue on end of cable meshes with driven gear shaft.

6. Replace front axle declutching control rod to declutching shift lever and attach with clevis pin and cotter pin.

7. Reinstall propeller shaft.

8. Reinstall and adjust hand brake as directed in "Brake" section of this book.

9. When transfer case has been completely installed, it should be lubricated as instructed in Paragraph 3 under "Inspection, Lubrication and Adjustment."

10. Adjust controls as directed under "Transfer Case Controls" before vehicle is placed in service.

REPAIR

6. OIL SEALS

Spring loaded leather type oil seals are used at front of mainshaft, rear of main drive gear, driven shaft and front axle output shaft. These seals should be carefully inspected for evidence of failure. Replacement of oil seals may be accomplished without disassembling transfer case. The following procedure is suggested.

1. Disconnect propeller shaft universal joints and remove yokes from transfer case shafts.

2. Remove bearing caps. Use great care to note exact quantity of shims under bearing caps and to provide for exact replacement of shims in original positions.

3. Remove and discard used oil seals.

4. Soak new oil seal in "Neatsfoot" oil or warm engine oil before it is installed. Leather portion of seal must be soft and pliable. This is a standard production practice which assures an efficient leak-proof seal and assists installation.

5. Oil seal replacing tool (J-1722) should be used as illustrated in Fig. 14 to assure proper installation of seals.

6. **When installing seals it is important that they are handled carefully and not damaged in any way. Cutting, scratching or curling under of leather will seriously impair sealing ability of seal.** It is a good policy to use permatex around outer edge of oil seal to further insure against loss of lubricant.

7. Propeller shaft yokes must also be handled carefully during storage as well as during disassembling and assembling procedure. **Any nicks, grooves or scores on sealing surface of yoke will not allow a good seal and**

TRANSFER CASE—SPLIT TYPE AXLES

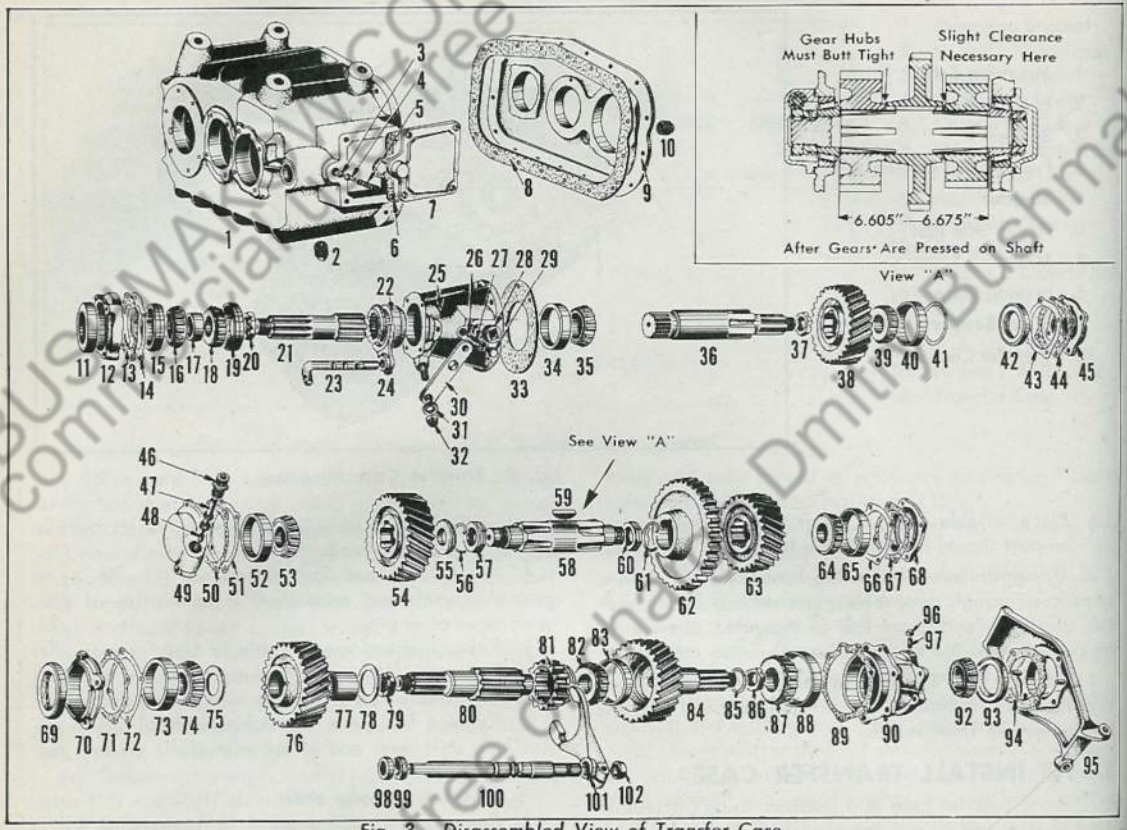


Fig. 3 Disassembled View of Transfer Case

1. Transfer Case
2. Plug
3. Gear Shift Shaft Lock Ball
4. Gear Shift Shaft Lock Plunger
5. Gear Shift Shaft Lock Spring
6. Gear Shift Cover Gasket
7. Gear Shift Cover
8. Case and Cover Gasket
9. Case Cover
10. Plug
11. Declutch Shaft Oil Seal
12. Declutch Carrier Cap
13. Declutch Shaft Carrier Cap Gasket
14. Declutch Shaft Carrier Cap Shim
15. Declutch Shaft Bearing Cup
16. Declutch Shaft Bearing
17. Declutch Shaft Bearing Spacer
18. Declutch Shaft Bearing
19. Declutch Shaft Bearing Cup
20. Declutch Shaft Nut
21. Declutch Shaft
22. Declutch Sliding Clutch
23. Declutch Shift Shaft
24. Declutch Shift Fork
25. Declutch Carrier
26. Declutch Shift Shaft Lock Ball
27. Declutch Shift Shaft Lock Spring
28. Plug
29. Declutch Shift Shaft Lock Spring Screw
30. Declutch Shift Lever
31. Declutch Shift Lever Stud Washer
32. Declutch Shift Lever Stud Nut
33. Declutch Shaft Carrier Gasket
34. Driven Shaft Bearing Cup
35. Driven Shaft Front Bearing
36. Driven Shaft
37. Driven Shaft Nut
38. Driven Shaft Gear
39. Driven Shaft Rear Bearing
40. Driven Shaft Bearing Cup
41. Not Used on this Model Transfer Case
42. Driven Shaft Oil Seal
43. Driven Shaft Rear Cap Shim
44. Driven Shaft Rear Cap Gasket
45. Driven Shaft Rear Cap
46. Speedometer Shaft Fitting
47. Speedometer Driven Gear
48. Speedometer Drive Gear Key
49. Idler Shaft Front Cap
50. Idler Shaft Front Cap Gasket
51. Idler Shaft Front Cap Shim

TRANSFER CASE—SPLIT TYPE AXLES

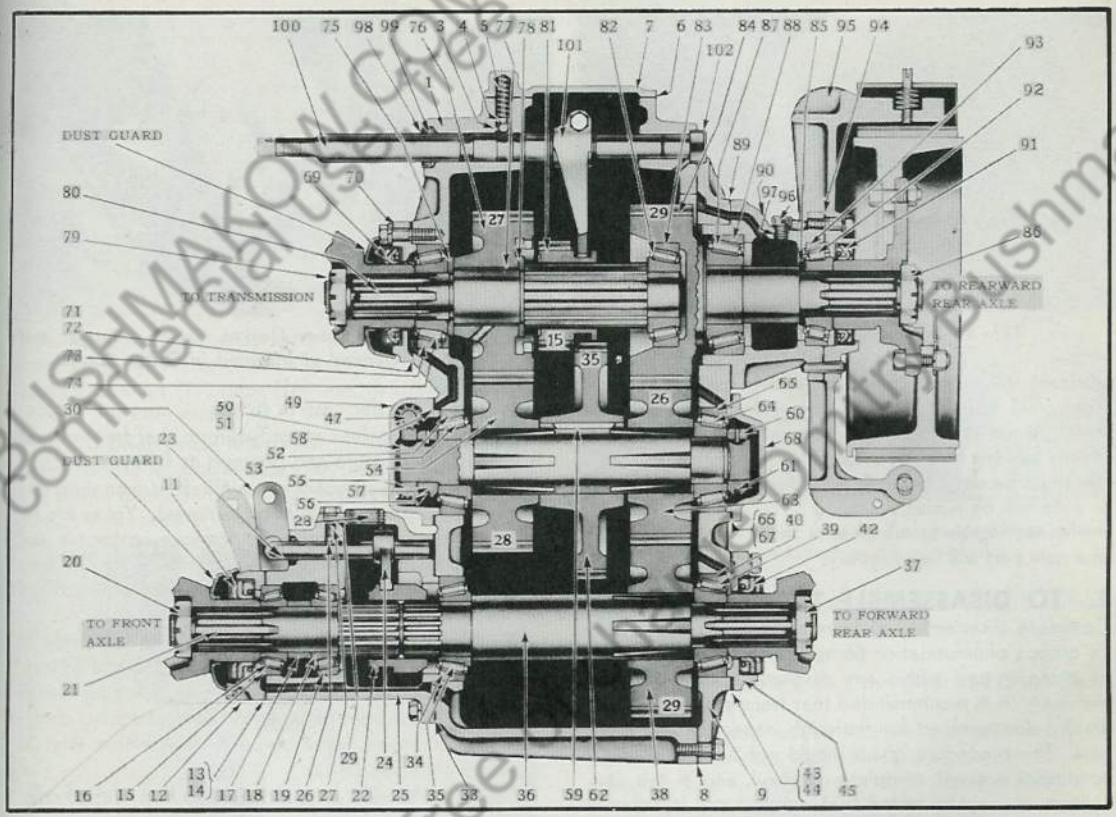


Fig. 4 Assembled View of Transfer Case

52. Idler Shaft Bearing Cup
53. Idler Shaft Bearing
54. Idler Shaft Front Gear
55. Speedometer Drive Gear
56. Idler Shaft Bearing Nut Snap Ring
57. Idler Shaft Bearing Nut
58. Idler Shaft
59. Low Speed Gear Key
60. Idler Shaft Bearing Nut
61. Idler Shaft Bearing Nut Snap Ring
62. Low Speed Gear
63. Idler Shaft Rear Gear
64. Idler Shaft Rear Bearing
65. Idler Shaft Bearing Cup
66. Idler Shaft Rear Cap Shim
67. Idler Shaft Rear Cap Gasket
68. Idler Shaft Rear Cap
69. Main Shaft Oil Seal
70. Mainshaft Front Cap
71. Main Shaft Front Cap Gasket
72. Main Shaft Front Cap Shim
73. Main Shaft Bearing Cup
74. Main Shaft Bearing
75. Main Shaft Drive Gear Outer Washer
76. Main Shaft Drive Gear
77. Main Shaft Drive Gear Bushing
78. Main Shaft Drive Gear Inner Washer
79. Main Shaft Nut
80. Main Shaft
81. Main Shaft Sliding Gear
82. Main Shaft Bearing
83. Main Shaft Bearing Cup
84. Main Drive Gear
85. Main Drive Gear Outer Bearing Shim
86. Main Drive Gear Nut
87. Main Drive Gear Inner Bearing
88. Main Drive Gear Inner Bearing Cup
89. Main Drive Gear Bearing Cage Gasket
90. Main Drive Gear Bearing Cage
91. Main Drive Gear Oil Seal
92. Main Drive Gear Outer Bearing
93. Main Drive Gear Outer Bearing Cup
94. Brake Support Bracket Gasket
95. Brake Support Bracket
96. Breather Cap
97. Breather
98. Gear Shift Shaft Packing Retainer
99. Gear Shift Shaft Packing
100. Gear Shift Shaft
101. Gear Shift Fork
102. Gear Shift Shaft End Cover

TRANSFER CASE—SPLIT TYPE AXLES

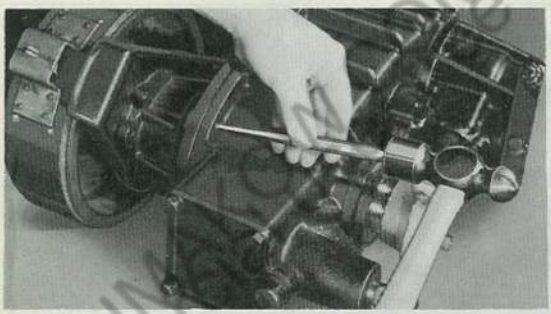


Fig. 5 Removing Cover Dowel Pins

lubricant will be lost soon after unit is put into service. Small nicks may be removed from yokes with a suitable stone. In the event sealing surface of yoke is grooved or scored, surface may be turned down not more than .020". **This must be done carefully with dependable equipment** as yoke will be ruined if sealing surface is out of round. In the even grooves are deeper than .020", installation of a new part will be necessary.

7. TO DISASSEMBLE TRANSFER CASE

Complete disassembly of transfer case is divided into six groups of information (A to F). When replacement of a major part within any of these groups becomes necessary, it is recommended that transfer case be completely disassembled for thorough inspection and overhaul. The procedure given should not be varied unless conditions prevent complete overhaul, and in this connection, it may be noted that removal and installation of the declutching cage and of the various oil seals may be accomplished without necessitating disassembly of the complete unit.

A. To Disassemble Transfer Case and Cover (Refer to Fig. 3)—A suitable fixture should be provided in which to mount transfer case during disassembly. Fixture should permit rotation of unit into four positions, each of which can be locked to hold assembly rigid during service operations.

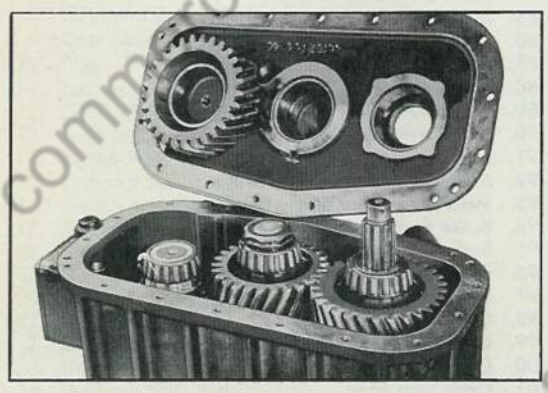


Fig. 6 Transfer Case with Cover Removed

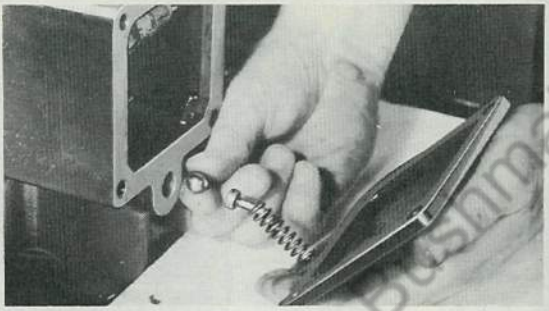


Fig. 7 Gear Shift Cover Gasket, Spring, Plunger and Ball Are Removed or Installed in Order Shown

1. Install transfer case in fixture.

2. Rotate transfer case in fixture so that front of case is upward, lock fixture and proceed as follows:

3. Propeller shaft yokes at mainshaft, driven shaft and front axle output shaft must be removed. Yokes are retained by nut and cotter pins. Remove cotter pin and loosen nut with 1 1/2" socket wrench (HS-22-2). Use lead hammer and tap yokes lightly to move them outward and off shafts.

4. Remove speedometer driven gear (47) at front of idler shaft bearing cap (49), using 7/8" open end wrench.

5. Remove cap screws attaching declutching carrier assembly (25) to front of case. When declutching carrier has been removed, lay aside, and disassemble later as directed on these pages.

6. Rotate transfer case in fixture so that rear of case, or cover side, is upward.

7. Rear cover (9) is held to case by 17 cap screws and two tapered dowel pins. Tapered dowels should be driven toward rear to remove from cover and case, using drift pin, as illustrated in Fig. 5. Remove cap screws and lockwashers, using 9/16" wrench.

8. When cap screws have been removed, as previously directed, cover assembly, with main drive gear and cage, can be completely removed from case, as illustrated in Fig. 6.

9. Remove four cap screws attaching gear shift cover (7) to top of case. Removal of cover also permits removal of poppet spring, plunger and ball, as illustrated in Fig. 7.

10. Remove cotter pin and loosen gear shift fork clamp bolt nut so that bolt is loose.

11. High and low shifter shaft is threaded into yoke. Turn shaft out of yoke (Fig. 8) and remove shaft and yoke from case.

12. Main shaft (80) with gears and bearings, idler shaft (58) with gears and bearings, also driven shaft (36) with gear and bearings, can now be lifted out of case.

13. When case assembly has been disassembled as directed above, bearings and gears can be inspected to determine if further disassembly is necessary to replace any parts.

TRANSFER CASE—SPLIT TYPE AXLES

B. To Disassemble Mainshaft (Refer to Fig. 3)—

1. Place mainshaft in vise, using soft plates over jaws so that shaft splines will not be damaged.

2. Use suitable bearing puller as illustrated in Fig. 9, to remove mainshaft rear bearings (82).

3. Remove sliding gear (81) from shaft splines. This is an opportune time to check clearance between sliding gear and mainshaft. Clearance between these parts should be as given in "Specifications" at end of this section.

4. Remove shaft and drive gear from vise and place in vise with front end up.

5. Use gear puller as explained above to remove front bearing (74) or place assembly in arbor press to remove bearing (74) gear (76) and two thrust washers (75 and 78) from mainshaft.

C. To Disassemble Idler Shaft (Refer to Fig. 3)—It is not necessary to disassemble idler shaft and gear assembly unless gears and bearings must be replaced. Disassembly procedure is as follows:

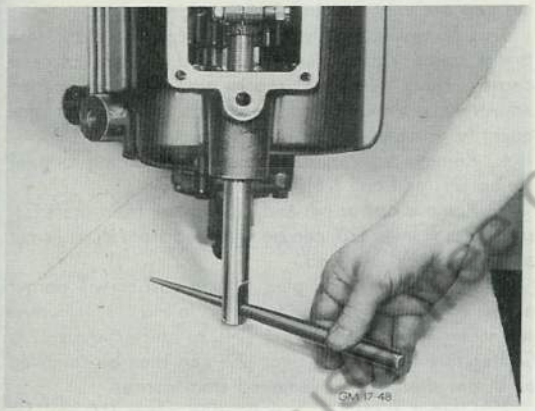


Fig. 8 High and Low Speed Shifter Shaft Is Threaded into Shift Fork as Shown

1. Place shaft assembly in vise with speedometer gear up. Soft plates should be used on jaws of vise to prevent damage to gears.

2. Use gear puller (J-1737) as illustrated in Fig. 10, to pull gear (55) from shaft. Woodruff key is used to prevent gear turning on shaft.

3. Remove lock wire (56 and 61) from bearing retainer nut (57 and 60), using sharp pointed tool, as illustrated in Fig. 11. Nuts can now be removed from shaft with socket wrench.

4. Use bearing puller in manner illustrated in Fig. 9, to remove bearings (53 and 64) from shaft.

5. Remove constant mesh gears (54 and 63) also low speed gear (62) from idler shaft (58) in arbor press.

6. Low speed gear (62) is keyed to shaft and must be removed by pressing in arbor press.

D. To Disassemble Driven Shaft (Refer to Fig. 3)—

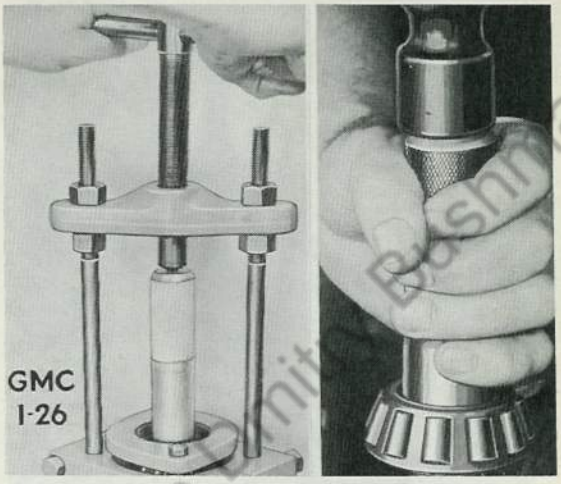


Fig. 9 Tapered Roller Bearing Cones Are Removed and Installed as Shown

1. Remove bearing cones (35 and 39) with suitable puller.

2. Press gear (38) off shaft in arbor press.

E. To Disassemble Main Drive Gear and Cage (Refer to Fig. 3)—

1. Remove cap screws holding rear cap and brake support (95) to cage (90). Remove tapered dowel pins attaching cap to cage, using drift pin in manner illustrated in Fig. 5. Brake support (95) and gasket (94) can now be removed from cage.

2. Place rear cover and cage, with main drive gear and bearings assembly in arbor press. Fig. 12. Support inner side of cover (9) on bed of press and apply pressure to splined end of shaft. Gear (84) with inner bearing cone (87) can now be pressed out of cage. Note that a

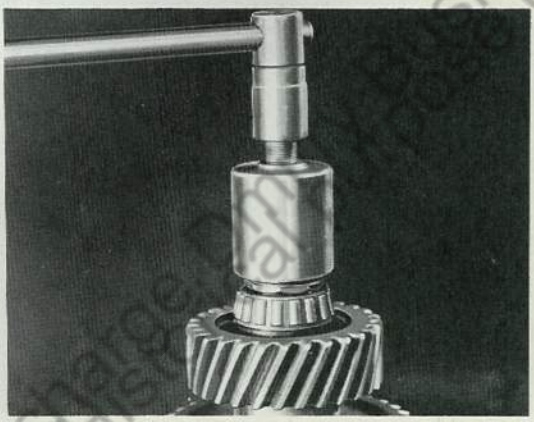


Fig. 10 Removing Speedometer Gear from Idler Shaft with Puller

TRANSFER CASE—SPLIT TYPE AXLES



Fig. 11 Idler Shaft Bearing Nut Is Held with Lock Wire, Remove as Shown

quantity of shims (85) are used inside of rear bearing cone (92). These shims are used to obtain proper bearing adjustment. Shims should be wired to shaft so that same quantity will be used at reassembly.

3. If inspection reveals that bearing cup (83) inside of main drive gear (84) should be replaced, it can be removed with special puller tool (J-1708) developed for this operation.

4. Main drive gear front bearing cone (87) need not be removed, unless inspection indicates need of replacing. When necessary, bearing is removed with puller (CS-1047) in manner illustrated in Fig. 9.

5. Bearing cups (88 and 93) can be removed from cage (90) with brass drift pin and hammer. Place cage on bench and tap cup around edge until it is removed. Do not allow cup to become cocked or crooked.

F. To Disassemble Declutching Carrier—After declutching carrier with shaft, bearings, shift rod and yoke have been removed from case, as previously instructed, further disassembly may be accomplished as follows: Refer to Fig. 3.



Fig. 12 Main Drive Gear Is Removed from Cage with Arbor Press as Shown

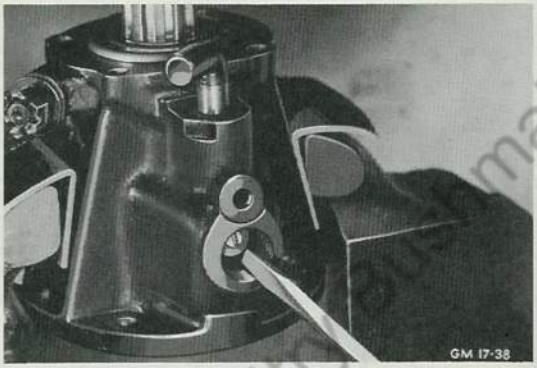


Fig. 13 Front Axle Shift Fork Is Held to Shifter Shaft by Set Screw as Shown

1. Place complete unit in vise. Use soft plates on jaws to protect cage from any injury. (See Fig. 13.)

2. Use $\frac{9}{16}$" wrench to remove four cap screws attaching cap and oil seal assembly to cage.

3. Lift cap assembly (12) from carrier (25). Note that a quantity of shims (14) are used between cap and carrier. These shims are used to obtain proper bearing adjustment. Shims should be tied to cap so that same quantity will be used at reassembly.

4. Remove special cap screw (29) holding poppet spring (27) and ball (26) in carrier (25).

5. Remove cotter pin and flat washer from shaft (23) so that shift lever (30) can be removed from shaft as nut at pivot end is loosened.

6. Removal of pipe plug (28) in carrier will permit access of screwdriver, as illustrated in Fig. 13, to loosen set screw holding shift fork (24) to shifter shaft (23). Shifter fork and sliding gear (22) can then be removed as shifter shaft (23) is removed from carrier.

7. Output shaft (21) two bearing cones (16 and 18) and spacer (17) also outer bearing cup (15) can now be removed through front of carrier.

8. If inspection indicates that inner bearing cup (19) should be replaced, it can be driven from carrier (25) with brass drift pin and hammer. Place carrier on bench with front end down and tap cup around edge until it is removed from carrier. During removal do not allow cup to become "cocked" in carrier.

8. INSPECTION AND REPAIR

A. Cleaning and Inspection of Bearings—

1. Put all bearing cones and cages into gasoline or other suitable cleaning liquid, allowing them to remain long enough to loosen old grease and lubricant. After thorough soaking, bearing should be alternately slushed up and down and spun slowly below surface of liquid to remove as much of old grease as possible.

2. Then remove bearing and strike larger open side of bearing flat against wooden block to jar loose heavier and harder particles of lubricant.

TRANSFER CASE—SPLIT TYPE AXLES

3. Repeat immersion and striking operations until it is evident that bearings are clean.

4. Blow out bearings, being careful to direct air pressure across bearings to remove last traces of old lubricant without spinning bearings.

5. Carefully inspect rollers and cones for chipping, cracks or worn spots to determine fitness of bearing for further use.

6. After inspection, dip bearings in engine oil and wrap in clean cloth or paper to protect them until they are needed.

B. Cleaning and Inspection of Gears, Shafts, etc.—1. Case, cover, bearings, and cages should be thoroughly cleaned. **Special attention should be given to oil passages in case, cages, caps, and mainshaft gear.**

2. Oil seals should be carefully inspected for any evidence of excessive wear or oil leaks. Any seals showing slightest evidence of failure should be replaced.

3. Breather cap at main drive gear cage should be removed and thoroughly cleaned in gasoline or other cleaning fluid.

4. Carefully examine teeth on all gears for nicks and "gald" spots. Do not take chances with gears which are appreciably nicked or scored. Small nicks may be removed with a "slip-stone" or hone.

5. Inspect faces of gear teeth. Gears which are cracked or have chipped teeth, or spots where case hardening is worn through, should be replaced with new parts.

6. Inspect splines on mainshaft, driven shaft, front axle output shaft, for scores or evidence of twisting. Place sliding gears on respective shafts and check clearance along splines with dimensions given in "Specifications" at end of this section. If clearance is excessive, or if shaft is badly scored or twisted, new parts should be installed.

7. Inspect case and cover for evidence of idler shaft gears rubbing. If condition of this nature is found, it indicates that shaft is not properly located in case. Removal or addition of shims under bearing caps to move shaft in proper direction will eliminate condition of this kind.

8. Bushing is used between main drive gear and mainshaft; thrust washers are used at each side of gear. Bushing and washers should be checked against dimensions given in "Specifications." If these parts are scored or worn appreciably, they should be replaced with new parts.

9. TO ASSEMBLE TRANSFER CASE

The following instructions include operations necessary to completely reassemble transfer case. Strict attention must be given to the sequence of procedure given in subjects A to L. This procedure must be followed—step by step—to assemble transfer case satisfactorily.

A. To Assemble and Adjust and Install Declutching Carrier—Carrier is assembled and bearings adjusted on a clean bench. (Refer to Fig. 3.)



Fig. 14 Oil Seals at Drive Shafts Are Installed with Replacer as Shown

1. When inner bearing cup (19) has been removed from declutching carrier, it is important that it be replaced so that it seats against shoulder in carrier. If cup does not seat fully or is cocked, it will be impossible to obtain proper bearing adjustment. Bearing cup replacing tool (J-1719) should be used for this operation.

2. Reinstall inner bearing cone (18) on shaft (21) with large end of tapered roller toward front end of shaft. Replace spacing sleeve (17) over shaft. Reinstall outer

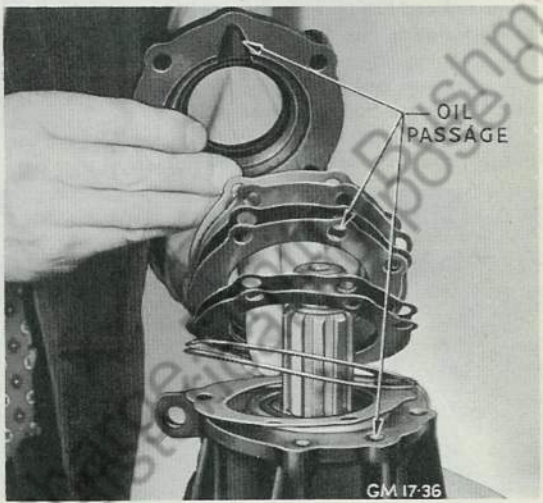


Fig. 15 Oil Passages in Declutching Carrier Shims, Gasket and Cap Must Line Up as Shown

TRANSFER CASE—SPLIT TYPE AXLES

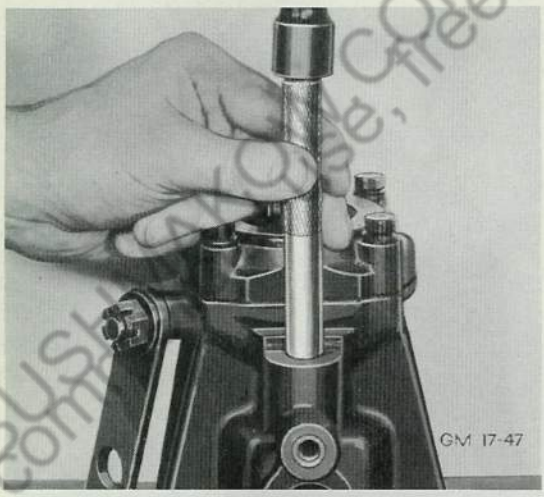


Fig. 16 Declutching Carrier Oil Seal at Shifter Shaft Is Installed with Tool as Shown

bearing cone (16) on shaft (21) with large end of tapered roller toward rear of shaft. Bearing cone replacing tool (J-1718, Fig. 9) should be used when installing bearings to prevent damage to cone and also to insure proper seat against shoulder on shaft.

3. Replace shaft and bearing assembly through front of carrier (25) and install outer bearing cup (15) in carrier. Be sure rollers are oiled with engine oil.

4. Replace outer bearing cap (12) with new oil seal assembly, using new gasket (13) and same shims (14) as were removed at disassembly.

Important: Be sure that oil passage holes in gasket, shims and cap line up with passage at bottom of carrier, as illustrated in Fig. 15.

5. Tighten up cap screws, attaching cap to carrier.

6. Bearings are now ready for adjustment, which is accomplished in following manner:

(a) Remove bearing cap (12) and gasket (13) from carrier (25) and increase or decrease thickness of shim pack (14) enough to cause shaft (21) to **drag slightly when turned by hand.**

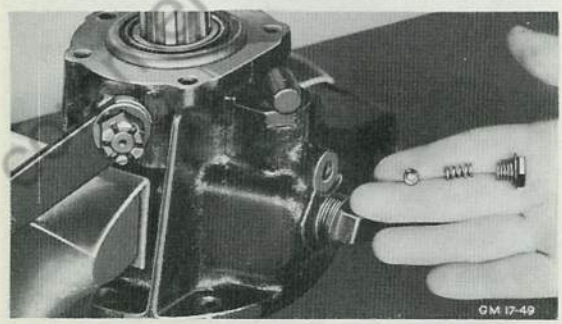


Fig. 17 Poppet Ball, Spring, Washer and Screw Are Installed as Shown

(b) Reassemble cap (12) and gasket (13) and **tighten cap screws securely.**

Tap shaft back and forth with soft hammer to make sure bearing cups are seated against shoulders.

(c) Turn shaft by hand to make sure correct amount of shims have been removed or added. If this test indicates further adjustment necessary, repeat operations (a) and (b) until shaft (21) does **drag slightly** when turned by hand.

(d) Reassemble cap (12) and gasket (13) and **tighten cap screws securely, using new lockwashers.**

7. When it has been found necessary to replace shifter shaft oil seal, replacing tool (J-1717) should be used as shown in Fig. 16 to assure proper installation.

8. Replace shift shaft (23) in carrier (25) as fork (24) is replaced on shift shaft (23) and sliding gear (22) is slipped over splines of shaft (21). When installing fork (24) on shaft (23) be sure that long part of hub is toward front, also, shift fork slot in gear (22) is toward front.

(9) Line up set screw in fork (24) with hole in shaft (23), then tighten set screw securely, using screwdriver, as illustrated in Fig. 13. When screw has been tightened, prick punch fork beside screw to prevent loosening. Replace pipe plug (28) in carrier.

10. Install poppet ball (26) and spring (27), using special plug (29) to hold them in place. Order in which these parts are installed is illustrated in Fig. 17.

11. Attach shift lever (30) to shift shaft (23), using flat washer and cotter pin to hold lever to shaft. Tighten lever pilot stud nut and secure with cotter pin.

12. Install front axle declutching carrier assembly to case, using gasket (33) between carrier and case. **Important: Be sure that oil passage hole at bottom of case lines up with similar passage in carrier, also, that gasket does not obstruct oil passage in either carrier or case. See Fig. 18.**

B. To Assemble Driven Shaft (Bench Operation) (Refer to Fig. 3)—

1. Press constant mesh gear (38) over tapered splines of driven shaft (36) with arbor press until hub of gear is within $\frac{1}{8}$" to $\frac{1}{16}$" of shoulder on shaft.

2. Replace bearing cones (35 and 39) on driven shaft, with large ends of bearings towards each other, using suitable bearing driver or arbor press. Be sure bearing cones are firmly seated.

3. Place assembly where it will be kept clean for bearing adjustment later.

C. To Assemble Idler Shaft (Bench Operation) (Refer to Fig. 3)—

1. Install larger constant mesh gear (54) over tapered splines at front of idler shaft (58).

2. Place shaft and gear in arbor press and press constant mesh gear (54) tight on idler shaft (58) until hub of gear is within $\frac{1}{8}$" to $\frac{1}{16}$" of shoulder on shaft.

3. Install front bearing cone (53) on idler shaft, using

TRANSFER CASE—SPLIT TYPE AXLES

arbor press or suitable bearing driver, tight against gear hub.

4. Replace retaining nut (57) and tighten securely. Lock nut with lockwire (56).

5. Tap low speed gear key (59) in place in idler shaft (58). Place low speed gear (62) over idler shaft, with long shoulder of hub towards front end of shaft, and press tight against constant mesh gear (54).

6. Install smaller constant mesh gear (63) over tapered splines at rear of idler shaft (58).

7. With assembly again in arbor press, press constant mesh gear (63) onto idler shaft (58) until over hub dimension of gears is 6.605"–6.675". See view "A" in Fig. 3. This will require from 10 to 15 tons pressure. **Note:** Hub of low speed gear (62) must butt tight against forward gear (54) and clearance must exist between hub of low speed gear (62) and rearward gear (63). See view "A" Fig. 3. In the event these conditions do not exist, new parts must be selected and installed.

8. Replace rear bearing cone (64), pressing it tight against constant mesh gear (63).

9. Tighten retaining nut (60) and lock with lock wire (61).

10. Replace speedometer gear Woodruff key in idler shaft and press speedometer gear (55) on shaft. Gear must be tight against nut and must not project beyond end of shaft.

11. Place assembly where it will be kept clean for bearing adjustment later.

D. To Assemble Mainshaft (Bench Operation) (Refer to Fig. 3)—

1. Replace thrust washer (78) used between mainshaft gear (76) and shoulder on mainshaft (80). If washer is scored or worn, it is recommended that new part be installed.

2. Install mainshaft gear (76) and bushing (77) assembly over front of shaft (80) with internal teeth toward rear.

3. Replace thrust washer (75) used between mainshaft gear (76) and mainshaft front bearing (74). If washer is scored or worn, it should be replaced with new part.

4. Replace front bearing (74) on shaft (80) with large end toward rear of shaft, tight against washer (75). Bearing cone replacement tool (J-1718) should be used to replace bearing cone, as illustrated in Fig. 9. Gear (76) should turn freely without excessive end play.

5. Replace sliding gear (81) over shaft splines, with shifting fork groove toward rear of shaft.

6. Replace rear bearing cone (82) to mainshaft, using cone replacing tool (J-1718) in manner illustrated in Fig. 9.

E. To Adjust Driven Shaft Bearings (in case)—In order to adjust driven shaft bearings it is necessary to install shaft in case and temporarily install cover. Do not install idler shaft or mainshaft at this time as their installation will interfere with bearing adjustment.



Fig. 18 When Installing Declutching Carrier and Gasket, Be Sure Oil Passage Is Not Obstructed

1. Replace driven shaft bearing cups in case and cover if they have been removed for any reason.

2. Place driven shaft (36) and gear (38) assembly in position in case. Splined end of shaft (36) must be down or toward front.

3. Place rear cover (9) and gasket (8) in position.

4. Temporarily install two tapered dowel pins to line up cover with case. Install cap screws attaching cover to case and draw up tightly.

5. Replace rear cap (45), gasket (44) and shim (43), as illustrated in Fig. 19. **Be sure that oil passage is clean and not obstructed.** Use same shim pack thickness under cap as was used at disassembly.

6. Driven shaft is now ready for bearing adjustment. Be sure rollers are oiled with engine oil.

7. Adjust bearings in following manner:

(a) Remove bearing cap (45) and gasket (44) from cover (9) and increase or decrease thickness of shim pack (43) enough to cause shaft (36) to **drag slightly when turned by hand.**

(b) Reassemble cap (45) and gasket (44) and force shaft back and forth to seat cups.

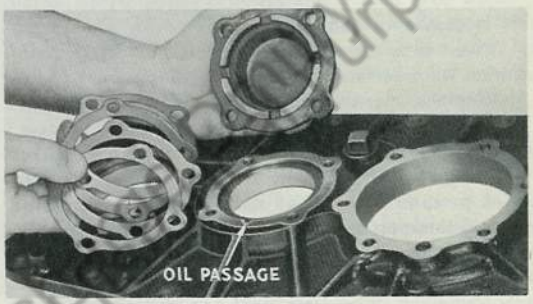


Fig. 19 When Installing Bearing Caps, Gaskets and Shims, Be Sure Oil Passages Are Not Obstructed

TRANSFER CASE—SPLIT TYPE AXLES

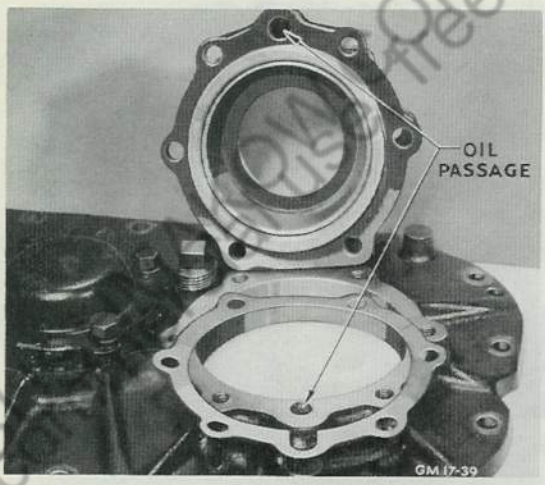


Fig. 20 Oil Passages in Main Drive Gear Cage, Gasket and Rear Cover Must Line Up as Shown.

(c) Turn shaft (36) by hand to make sure correct amount of shims have been removed or added. If this test indicates further adjustment necessary, repeat operations (a) and (b) until shaft (36) does **drag slightly** when turned by hand. Then remove cap (45) and gasket (44) and **add a .005" shim.** This will give correct bearing adjustment.

(d) Reassemble cap (45) and gasket (44) and **tighten cap screws securely.**

(e) After .005" shim has been added, it is again **necessary** to force shaft (36) **outward** to firmly seat bearing cup (40) against bearing cap (45). This may be accomplished by installing yoke and nut, rapping yoke sharply with soft hammer.

8. When it has been determined that driven shaft bearings are properly adjusted, rear cover and driven shaft assembly should be completely removed. Leave driven shaft rear cap attached to cover so that bearing adjustment will be maintained.

F. To Adjust Idler Shaft Bearings (in case)—In order to adjust idler shaft bearings it is necessary to install shaft in case and temporarily install cover. Do not install driven shaft or mainshaft at this time as their installation will interfere with bearing adjustment.

1. Replace idler shaft bearing cups in case and cover if they have been removed for any reason.

2. Install idler shaft front bearing cap (49), gasket (50) and shims (51), as illustrated in Fig. 19. **Be sure that oil passage is clean and not obstructed. Use same shim pack thickness under cap as was used at disassembly. These shims are used for two purposes—first of which is to provide means of making bearing adjustments; secondly, removing shims from front cap and adding, same thickness under rear cap, or vice versa, provides means of properly locating idler shaft in relation to main drive gear.**

3. Place idler shaft assembly in position in case. Speedometer drive gear end must be down or toward front of case.

4. Place cover (9) and gasket (8) in position on case. Temporarily install two tapered dowel pins to line up cover with case. Install cap screws, attaching cover to case, and draw up screws tightly.

5. Replace rear cap (68), gasket (67) and shims (66), as illustrated in Fig. 19. **Be sure that oil passage is clean and not obstructed.** Draw up screws tightly and evenly. When replacing shims, be sure that shim pack thickness is same thickness as was removed at disassembly.

6. Idler shaft is now ready for bearing adjustment. Be sure rollers are oiled with engine oil.

7. Bearings may be adjusted in following manner:

(a) Remove front bearing cap (49) gasket (50) and shim pack (51).

(b) Rap end of idler shaft with soft hammer to make sure rear bearing cup (65) seats firmly against bearing cap (68).

(c) Reinstall front bearing cap (49) gasket (50) and shim pack (51), tightening cap screws securely.

(d) Remove rear bearing cap (68), gasket (67) and shim pack (66).

(e) Rap end of idler shaft with soft hammer to make sure front bearing cup (52) seats firmly against bearing cap (49).

(f) Increase or decrease thickness of shim pack (66) enough to cause idler shaft (58) to **drag slightly when turned by hand.**

(g) Reassemble cap (68) and gasket (67) and **tighten cap screws securely.**

(h) Turn shaft by hand to make sure correct amount of shims have been removed or added. If this test indicates further adjustment necessary, repeat operations (f) and (g) until shaft does **drag slightly** when turned by hand. **In the event shims are added, it is necessary to remove front cap and rap shaft with soft hammer each time this operation is performed.**

(i) Remove rear bearing cap (68) and gasket (67) and **add a .005" shim.** This will give correct bearing adjustment.

(j) Reassemble cap (68) and gasket (67) and **tighten cap screws securely, using new lockwashers.**

(k) Again it is necessary to remove front bearing cap (49) and rap end of idler shaft with soft hammer to seat rear bearing cup (65) firmly against bearing cap (68). Note if speedometer gear (57) is rubbing against cap (49). In such case select deeper cap to eliminate this condition. Reassemble front bearing cap (49) and **tighten cap screws securely, using new lockwashers.**

8. When it has been determined that idler shaft bearings are properly adjusted, rear cover and idler shaft assembly should be completely removed. Leave idler shaft caps attached to cover and case so that bearing adjustment will be maintained.

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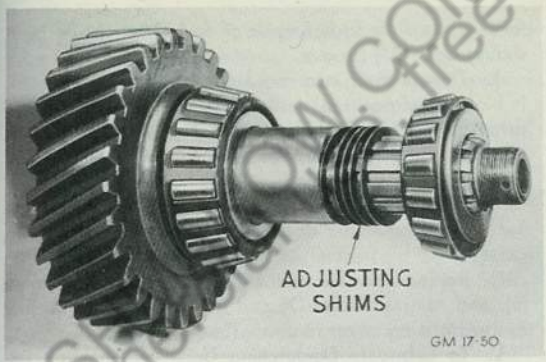

Fig. 21 Main Drive Gear Bearings Are Adjusted With Shims Located as Shown.

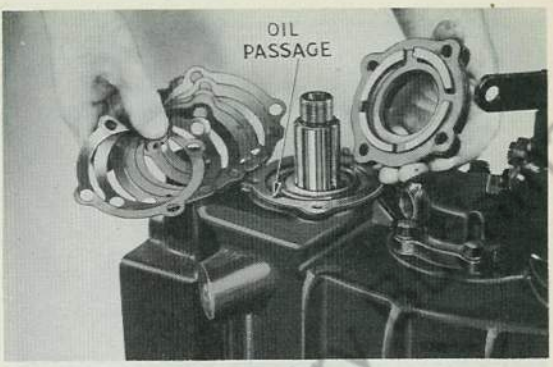

Fig. 22 Installing Mainshaft Bearing Cap, Gasket and Shims. Be Sure Oil Passage Is Not Obstructed.

G. To Assemble and Adjust Main Drive Gear, Cage, and Cover—(Bench Operation) (Refer to Fig. 3)—

1. When cage has been removed from cover, it is important that cage be replaced to cover so that oil passage in cage (90) and gasket (89) are not obstructed and are lined up to permit passage of lubricant through cover. See Fig. 20.

2. When bearing cups (88 and 93) have been removed from main drive gear cage (90) it is important that they be replaced so that each cup seats against shoulder in cage. If cups do not seat fully and are cocked in cage, it is impossible to obtain proper bearing adjustment. Bearing cup replacing tool (J-1715) should be used for this operation.

3. Reinstall inner bearing cone (87) on main drive gear (84), using replacing tool (J-1721) as illustrated in Fig. 9. **Be sure that bearing is fully seated against shoulder on shaft.**

4. Place drive gear and inner bearing assembly into cage through front of cage.

5. Replace original shim pack (85) on shaft (84), Fig. 21, and slide outer bearing cone (92) on shaft from rear. Be sure rollers are oiled with engine oil.

6. Replace rear cap and brake support (95), using new gasket (94) between cap and cage. Install tapered dowels and tap in place. Replace cap screws and tighten screws securely.

7. Replace propeller shaft yoke on shaft and draw up yoke retaining nut tightly to compress shim pack and seat bearings.

Turn main drive gear (84) by hand to test bearing adjustment. Gear should drag slightly.

If further bearing adjustment is necessary it may be accomplished in following manner:

(a) Remove nut, yoke, rear cap (95) and bearing cone (92) and rearrange shim pack (85) to increase or decrease thickness enough to cause main drive gear (84) to **drag slightly when turned by hand.**

(b) Reassemble bearing cone (92), rear cap (95) and yoke, **tightening yoke nut securely.**

(c) Turn main drive gear (84) by hand to make sure correct amount of shims have been removed or added. If this test indicates further adjustment necessary, repeat operations (a) and (b) until main drive gear (84) does **drag slightly** when turned by hand. **Note: Micrometer should be used when selecting shims.**

(d) Lock yoke nut with new cotter pin.

H. To Install Gears and Shafts In Case—This is the final and complete assembly. Idler shaft and driven shaft bearing adjustment having been made, also front axle declutching carrier, and main drive gear cage and cover having been previously assembled and adjusted, complete unit is now ready for reassembly. (Refer to Fig. 3)

1. Replace driven shaft assembly, idler shaft assembly and mainshaft assembly in case.

2. Replace rear cover (9) and gasket (8) with main drive gear assembly, idler shaft and driven shaft caps attached. Install all cover cap screws temporarily, but do not tighten. Install two tapered dowel pins to properly locate cover, then tighten cap screws evenly and alternately.

3. Turn case over so that front side is up and replace speedometer driven gear (47) and fitting (46) in idler shaft front bearing cap (49).

4. Install mainshaft front bearing cap (70), gasket (71) and shims (72), as illustrated in Fig. 22. **Be sure that oil passage is clean and not obstructed.** Use same shim pack thickness under cap as was used at disassembly. Tighten cap screws securely. Mainshaft is now ready for bearing adjustment.

I. To Adjust Mainshaft Bearings (After Case Is Final Assembled) (Refer to Fig. 3)—

1. Move sliding gear (81) into neutral position.

2. Turn mainshaft by hand to test for correct bearing adjustment. Shaft should **drag slightly when turned by hand.** If further bearing adjustment is necessary it may be accomplished in following manner:

(a) Remove cap (70) and gasket (71) from case (1) and increase or decrease thickness of shim pack (72) enough

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Fig. 23 High and Low Speed Shifter Shaft Oil Seal Is Installed with Tool as Shown.

to cause mainshaft (80) to **drag slightly when turned by hand.**

(b) Reassemble cap (70) and gasket (71), and **tighten cap screws securely.** Force shaft back and forth to make sure bearing cups are seated against shoulders.

(c) Turn mainshaft (80) by hand to make sure correct amount of shims have been removed or added. If this test indicates further adjustment necessary, repeat operations (a) and (b) until mainshaft (80) does **drag slightly** when turned by hand. Then remove cap (70) and gasket (71) and **add a .005" shim.** This will give correct bearing adjustment.

(d) Reassemble cap (70) and gasket (71) and **tighten cap screws securely.**

(e) After .005" shim has been added, it is again **necessary** to force mainshaft **outward** to firmly seat bearing **cup** (73) against bearing cap (70). This may be accomplished by installing yoke and nut and rapping yoke sharply with soft hammer.

J. To Check Alignment of Gears—Check alignment of idler rear gear and main drive gear as follows: (Refer to Fig. 3).

1. Look through gear shift cover opening and, with a flash light, see if idler rear gear (63) is flush with main drive gear (84). If not, remove sufficient shims from under idler shaft cap on low side and add same thickness of shims to cap on high side. Rap shaft to high side to seat bearing cup.

K. To Install and Adjust Speed Shifter Yoke (Refer to Fig. 3)—

1. When it is necessary to replace shifter shaft oil seal (99), replacing tool (J-1723) should be used as shown in Fig. 23 to assure proper installation.

2. Replace shifter shaft (100) in case, threaded end first. As shaft is pushed into approximate position, thread into shift fork, fingers of fork (101) should be in sliding gear (81) groove.

3. Thread shaft into fork (101) with sliding gear (81) in high speed position, until sliding gear bottoms in main drive gear (76). Turn shaft out of yoke approximately two full turns or until poppet ball groove in shaft lines up with poppet ball opening.

4. With flats of shaft in vertical position clamp bolt nut in fork should be drawn up tightly and locked with cotter pin.

5. Replace poppet ball (3), plunger (4), and spring (5), and reinstall cover (7) and gasket (6). Tighten four bolts attaching cover to case. (See Fig. 7.)

L. To Lubricate Declutching Unit—Whenever transfer case has been disassembled or if declutching unit has been removed and replaced, it should be lubricated before vehicle is placed in service.

Remove pipe plug in top of declutching cage and put in one pint of lubricant. This should not be done until complete unit is on its proper position in vehicle. It is not necessary to lubricate declutching unit at lubrication intervals as this unit is not completely drained when case is drained.

10. TRANSFER CASE CONTROLS

Shifting of transfer case into high or low, also engagement and disengagement of front axle is accomplished by shifting levers, located in cab, and connected to transfer case by control rods.

A. Operation—Shifting of transfer case into high or low, also front axle control is described in "Driver's Instruction" group of this book.

B. To Remove Shifting Levers—Removal of levers and mounting shaft is as follows:

1. Remove floor board as directed in "Body" group of this book.

2. Remove bolts, nuts and lockwashers used to attach shift lever handle to lower lever.

3. Remove high and low, also front axle, control rods by taking out cotter pins and clevis pins.

4. Lift transmission cover assembly as directed in "Transmission" group of this book.

5. Loosen clamp bolt in front axle control lever at end of cross shaft. Lever can now be removed.

6. Loosen clamp bolt in front axle shift lower lever. Cross shaft can now be moved inward and completely removed from frame bracket. Strip levers from shaft as it is removed from bracket.

C. To Remove Cross Shaft and Brackets—

1. Remove floor board as directed in "Body" section of this book.

2. Remove high and low control rods by taking out cotter pins and clevis pins.

3. Remove special hair pin lock at left end of cross shaft.

4. Remove stud nuts attaching R.H. support bracket to transmission case.

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5. Cross shaft and R.H. bracket can now be lifted from vehicle as an assembly.

6. Levers can be removed from right hand support after clamp bolts are removed from levers.

7. If necessary to remove left hand support bracket, this can be accomplished after stud nuts are removed.

D. Inspection—

1. Carefully check bushings in control lever mounting bracket, also in right and left hand cross shaft brackets. If wear is apparent, they should be replaced with new parts, and ream to dimensions given in "Specifications."

2. Check clevis pins for wear and discard those that are not full size.

E. To Install Shifting Levers—

1. Start shift lever shaft through frame bracket inner bushing, with keyway end toward center of vehicle.

2. Place front axle lower control lever over shaft with stop pad toward left side of vehicle.

3. Tap Woodruff key into keyway near center of shaft and push shaft into its approximate location as lower lever and shaft key are matched.

4. Place high and low speed lower shift lever over end of shaft.

5. Tap Woodruff key into keyway near end of shaft. Replace front axle control rod lever over end of shaft, install and tighten lever clamp bolt, when lever and inner end of shaft are even.

6. When shaft is properly located in frame bracket, with both lower shifting levers free, tighten clamp bolts securely.

7. If length of control rods have been disturbed, make necessary adjustments as directed under "Adjustments" in this group.

8. Replace transmission cover and floor boards as directed in their respective groups of this book.

F. To Install Cross Shaft and Brackets—

1. Tighten left hand brackets using stud nuts. Tighten nuts securely so that bracket is tight.

2. Place cross shaft through right hand bracket with keyway end toward right side of vehicle.

3. Replace Woodruff keys in shaft and install levers on shaft over keys. Tighten lever clamp bolts.

4. Replace cross shaft and bracket assembly with left end of cross shaft through left hand bracket. Attach right hand bracket to transmission case studs, tighten stud nuts securely. Replace hair pin lock in groove at left end of cross shaft.

5. Attach control rods to cross shaft lever using clevis pins and cotter pins. If new parts have been installed or if length of control rods have been changed, readjust as directed under "Adjustments" in this group.

6. Replace floor boards as directed in "Body" group of this book.

TABULATED DATA

11. SPECIFICATIONS

Make	Wisconsin
Model	T-79 and T-79-6
Type	Two Speed With Front Axle Declutching
Mounting	Amidship of Frame
Gear Ratio	
High Speed	1.155 to 1
Low Speed	2.602 to 1
Gear Backlash	
Helical	.005"-.008"
Spur	.005"-.008"
Mainshaft	
Bearings	Timken Tapered Roller
Number	26883 Cone 26824 Cup
Bearing Adjustment Method	Shims
Shim Location	Under Front Cap
Shim Thickness	.003"-.005"-.010"
Adjustment	.003" Loose
Mainshaft Gear	
Bushing Ream	1.6256"-1.6264"
Thrust Washer Thickness	.185"-.187"
Clearance Between	
Mainshaft and Gear Bushing	.0006"-.0019"
Mainshaft and Sliding Gear	.001"-.004"
Sliding Gear and Shift Fork	.003"-.017"
Shifter Shaft Poppet Spring	
Free Length	2"
Lbs. Pressure @ 1"	50-60
Main Drive Gear	
Bearings	Timken Tapered Roller
Number—Inner	3776 Cone 3720 Cup
Number—Outer	339 Cone 332 Cup
Bearing Adjustment Method	Shims
Shim Location	Front of Rear Bearing
Shim Thickness	.020"-.026"-.030"-.034"
Adjustment	.002" Preloaded

(Specifications continued on next page)

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TRANSFER CASE—SPLIT TYPE AXLES

Idler Shaft

Bearings	Timken Tapered Roller
Number	26883 Cone 26824 Cup
Bearing Adjustment Method	Shims
Shim Location	Under Front and Rear Caps
Shim Thickness	.003"-.005"-.010"
Adjustment	.003" Loose

Driven Shaft

Bearings	Timken Tapered Roller
Number—Front	26884 Cone 26824 Cup
Number—Rear	26883 Cone 26824 Cup
Bearing Adjustment Method	Shims
Shim Location	Under Rear Cap
Shim Thickness	.003"-.005"-.010"
Adjustment	.003" Loose

Front Axle Declutching Unit

Bearings	Timken Tapered Roller
Number	14137 Cone 14274 Cup
Bearing Adjustment Method	Shims
Shim Location	Under Front Cap
Shim Thickness	.003"-.005"-.010"
Adjustment	.002" Preloaded
Clearance Between	
Sliding Gear and Shaft	.001"-.005"
Sliding Gear and Fork	.031"-.043"
Shift Shaft Poppet Spring	
Free Length	$1\frac{7}{32}$"
Lbs. Pressure @ $1\frac{1}{32}$"	25-30

Control Shaft Bushing Size

Shift Lever Brkt. Bushing I.D.	.749"-.752"
Idler Lever Brkt. Bushing I.D.	.880"

12. TOOL EQUIPMENT

The following special tools, or their equivalent, are recommended for use when servicing TRANSFER CASE USED WITH SPLIT TYPE AXLES.

Tool No.	Name	Supplier Code
CS-1047	Bearing Cone Puller	CS
CS-1279	Repair Stand	CS
HS-22-2	Socket for "U" Joint Yoke Nut	GG
J-1708	Bearing Cup Puller	KM
J-1715	Bearing Cup Replacer	KM
J-1717	Declutching Carrier Shifter Shaft Oil Seal Replacer	KM
J-1718	Bearing Cone Replacer	KM
J-1719	Bearing Cup Replacer	KM
J-1721	Bearing Cone Replacer	KM
J-1722	Drive Shaft Oil Seal Replacer	KM
J-1723	Speed Shifter Shaft Oil Seal Replacer	KM
J-1737	Speedometer Gear Puller	KM

TOOL SUPPLIER

Supplier Code	Name	Address
CS	Curtiss and Smith Manufacturing Corp.	Pottstown, Penn.
GG	G and G Sales Company	Detroit, Mich.
KM	Kent-Moore Organization	Detroit, Mich.

SERVICE BULLETIN REFERENCE

Bulletin No.	Description

Dmitry Bushmakov.com Historical purpose only, free of charge, commercial use

Group 09 — Propeller Shaft and Universal Joint

	Paragraph
GENERAL	
Description	1
Trouble Shooting and General Solutions	2
Inspection and Adjustments	3
REMOVAL AND INSTALLATION	
To Remove Propeller Shaft	4
To Install Propeller Shaft	5
REPAIR	
Propeller Shaft	6
Universal Joints	7
Pillow Block Assembly	8
TABULATED DATA	
Specifications	9

GENERAL

1. DESCRIPTION

Propeller shafts are arranged as shown in Fig. 1. Three types of shafts are used as illustrated. Each shaft has a universal joint at each end and a slip joint at forward end except front axle propeller shaft which has slip joint at rear end (toward transfer case).

Male and female members of slip joint are marked at time of manufacture, so that splines can be reassembled in original position with yokes of universal joints in same plane to prevent shaft vibrations. If arrows marking alignment of these parts are not clear, mark shaft and sleeve carefully with punch to facilitate proper assembly. Before marking, check to see that yokes on each end of propeller shaft are in same plane.

All propeller shafts except transmission to transfer case shaft are tubular type. Because of short length of this shaft, it is solid type.

2. TROUBLE SHOOTING AND GENERAL SOLUTIONS

The majority of propeller shaft troubles will cause an excessive amount of noise in the drive line. Any mechanical movement has vibration periods, which do not result in noise until they tune in with some other part or unit. In this connection, loose or broken fenders, running boards, body, cab hold down bolts, etc., should be checked as source of noise if the following remedies do not correct the condition.

EXCESSIVE NOISE IN DRIVE LINE

Caused by:

1. Propeller Shaft Universal Joint Not Parallel— Inspect shafts equipped with slip joints to see that arrow marks on slip joint and shaft coincide. If arrows are not legible, see that yokes on each end of shaft are in same plane.
2. Joints Worn Excessively or Lacking Lubrication— Replace joints and lubricate.
3. Universal Joint Companion Flanges Loose— Replace flanges.
4. Propeller Shaft Sprung— Replace shaft.
5. Pillow Block Attaching Bolts Loose— Tighten bolts.
6. Pillow Block Bearing Improperly Adjusted— Adjust as directed under "Pillow Block."

3. INSPECTION

Propeller shaft flange bolts and U bolts in universal joints should be inspected and tightened at regular intervals. Check to see that universal joint shields are installed at points shown in Fig. 1. Remove any accumulation of dirt or foreign material around joints to prevent this material from working into the bearings.

REMOVAL AND INSTALLATION

4. TO REMOVE PROPELLER SHAFT

Dropping propeller shaft permits removal of transmission, transfer case, or front and rear axle without disturbing unit at other end of shaft.

Propeller shafts are attached to transfer case, front and rear axles, and pillow block by two "U" bolts and four nuts with lockwashers.

1. To remove shaft from unit to which it is coupled, remove "U" bolt nuts and drive out "U" bolts.

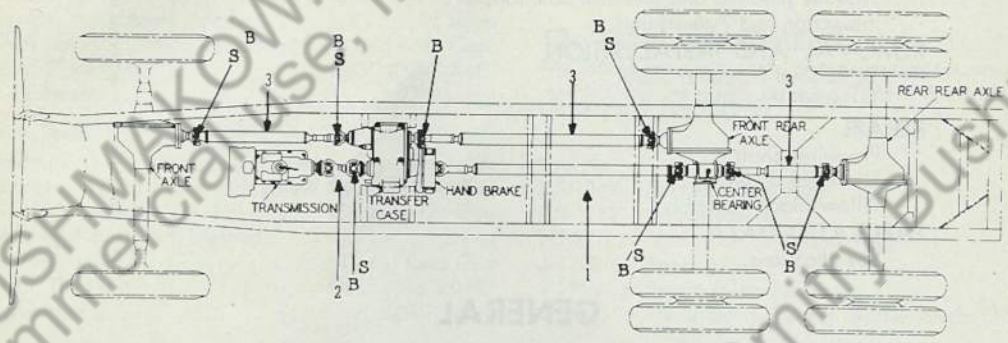
2. Propeller shaft used between transmission and transfer case has flanged type joints as well as front end of transfer case to pillow block shaft, as shown in Fig. 1. When breaking the shaft at these joints, simply remove nuts from bolts holding the flanges.

A. To Disassemble Slip Joint—Before disassembling slip joint, look for arrow marks on shaft and sleeve.

1. If these marks are not readily discernible, punch mark both members so that they can be reassembled in exactly same relative position.

2. Unscrew dust cap from sleeve or female member and withdraw shaft.

PROPELLER SHAFT AND UNIVERSAL JOINT



DUST SHIELDS

Dust shields are provided at points marked "B" and "S." Points marked "B" designate shields used on vehicles equipped with Banjo Axle housing. Points marked "S" designate shields used on vehicles equipped with split type axle housings.

Shaft No. 1

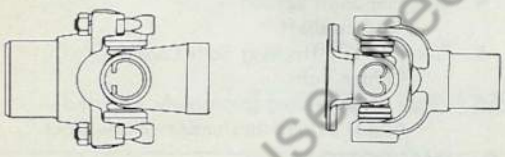
Tubular Shaft Using Snap Rings at Flanged Yoke at Transfer Case and "U" Bolts and Snap Rings at Propeller Shaft Center Bearing Flange.

Shaft No. 2

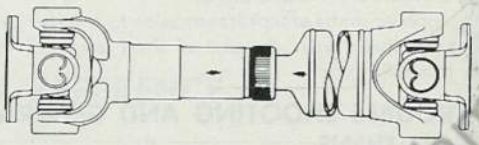
Solid Shaft Using Snap Rings at Flanged Yokes on Both Joints.

Shaft No. 3

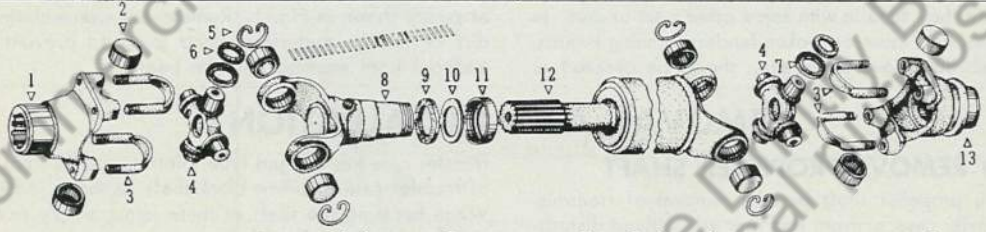
Tubular Shaft Using Snap Rings and "U" Bolts on Both Joints.



Snap Rings and "U" Bolts *Snap Rings*



Arrows on Propeller Shaft Should Be Opposite Each Other for Proper Alignment



Disassembled View of No. 3 Propeller Shaft and Joints

1. Flange
2. Trunnion Bearing Assembly
3. "U" Bolt
4. Journal
5. Bearing Snap Lock Ring
6. Gasket
7. Gasket Retainer
8. Sleeve Yoke
9. Dust Seal
10. Split Washer
11. Dust Cap
12. Shaft and Yoke
13. Flange

Fig. 1 Propeller Shaft and Universal Joints

PROPELLER SHAFT AND UNIVERSAL JOINT

5. TO INSTALL PROPELLER SHAFT

Before installing propeller shaft, inspect slip joint to see that it is properly assembled.

A. To Assemble Slip Joint—All shafts are equipped with slip joints.

1. Assemble slip joint, making sure splines are lubricated and that marks on shaft and sleeve are in line. See Fig. 1. This is particularly important so that yokes on universal joints will be in same planes.

2. Oil seal on slip joint should be renewed if necessary before screwing dustcap onto sleeve.

B. To Install Tubular Propeller Shafts—All shafts are installed with slip joint toward front of vehicle except shaft between front axle and transfer case which has slip joint toward the rear of vehicle.

1. Place bearings over trunnions and put shaft in position in yoke.

2. Assemble "U" bolts around bearing and through yoke, then put on lockwashers and nuts. Tighten "U" bolt nuts alternately and evenly until tight.

C. To Install Propeller Shaft Between Transmission and Transfer Case—This shaft is a solid shaft equipped with flanged joints.

1. Insert shaft in position between transmission and transfer case with slip joint toward front (slip joint grease fitting toward front) and attach shaft to transfer case first.

2. When shaft has been attached to transfer case opposite end can be bolted to transmission flange.

REPAIR

6. PROPELLER SHAFT

New shaft should always be installed in case of breakage. Welding of broken shaft is not recommended, as this operation requires special facilities which are not always available.

7. UNIVERSAL JOINTS

Universal joints are used at both ends of each propeller shaft.

Each universal joint consists of two yokes, a journal or cross, four needle bearings and caps. Bearings are held in place as shown in Fig. 1, either by snap rings or "U" bolts.

A. To Disassemble Universal Joints—

1. Pinch ends of snap rings together and remove rings, or remove "U" type bolts and nuts.

2. Strike sharply on hub of yoke in line with bearing. This will force bearing assembly out far enough to permit withdrawal without damage.

3. Remove journal by moving it sideways as far as possible, then tilt to clear side of yoke.

B. To Clean and Inspect Universal Joint—

1. Clean all parts, using gasoline or other suitable cleaning liquid. Allow needle bearings to remain in cleaner for some time to loosen up any particles of hard grease.

2. Trunnion bearing assemblies having retainer to hold needle bearings in place should not be disassembled. Clean with short stiff brush (tooth brush can be used to advantage) and blow out with compressed air. Work small quantity of lubricant into roller assembly and turn bearing on trunnion to check wear. If side movement of bearing assembly on trunnion is excessive, worn parts should be discarded.

3. Oil seals and retainers at inner ends of needle bearings should be inspected for evidence of failure; if slightest evidence of wear is apparent, these parts should be replaced by new ones.

C. To Assemble Universal Joint—

1. Make sure universal joint bearings are well lubricated before assembly.

2. Inspect journals and yokes carefully and hone out any burrs or rough spots on bearing surfaces and ends of journal pins.

3. Insert one trunnion of journal into yoke as far as possible from inside and tilt until opposite trunnion clears yoke and drops into position.

4. Always use new cork seals between bearing assemblies and journal. With seals in place, insert bearings from outside of yoke, tapping them into place with rawhide mallet. Never use steel hammer for this purpose.

5. It is not advisable to use original snap rings over again; therefore, use of new rings is always recommended.

8. PILLOW BLOCK ASSEMBLY

Pillow block assembly, shown in Fig. 2, supports adjoining ends of rearward rear axle propeller shaft. Pillow block has separate shaft mounted on tapered roller bearings and entire assembly is held in an oil tight housing. Oil seals are provided at each end.

Adjustment of end play in tapered bearings is taken by threaded nut and locknut. Correct adjustment provides for a barely perceptible amount of end play.

A. To Disassemble Pillow Block (Refer to Fig. 2)—

1. Disconnect propeller shafts from pillow block flanges.

2. Mark pillow block so front end may be determined after it is removed from vehicle.

3. Remove four bolts which attach pillow block to support bracket on axle housing.

4. Place pillow block in vise and remove cotter pin and nut (20) from each end of bearing shaft (17).

5. Remove driving flanges.

6. Remove six cap screws from each end of block (12) and remove spacers (1-23) cover and oil seal (2-22). Oil seals (21-4) are pressed into covers (2-22) and staked

PROPELLER SHAFT AND UNIVERSAL JOINT

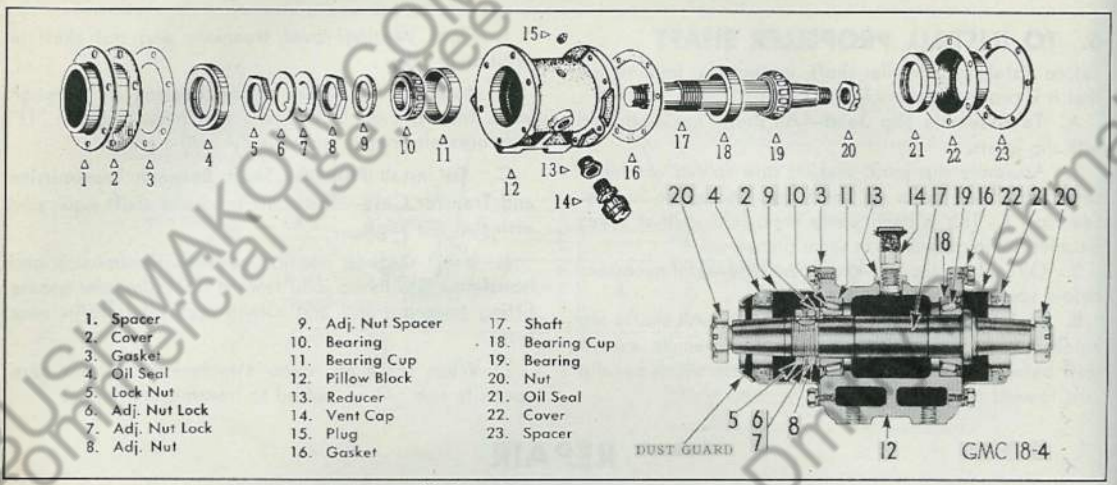


Fig. 2 Assembled and Disassembled View of Pillow Block

with prick punch. Seals (21-4) may be removed from covers (2-22) for service replacement.

7. Bend tang of lock (6) away from lock nut (5) and remove nut.

8. Remove nut lockwashers (6-7), adjusting nut (8) and nut spacer (9).

9. Pillow block shaft (17) may be removed (12) by tapping front end of shaft (17) with a soft faced hammer.

10. Bearing cups (11-18) are a press fit in block (12). Cups should not be removed from block unless inspections show score or wear. To remove cups (11-18) use brass drift and tap on opposite sides alternately so cup will come out straight. If cup is "cocked" badly during removing operation, block may become distorted so that new bearing cups will not fit properly.

11. Bearing (19) is a press fit on shaft (17) and can be removed for inspection or replacement with a suitable puller or press plates.

B. To Assemble Pillow Block (Refer to Fig. 2)—

1. Dip center bearings (10-19) in lubricant, turning roller and cage assembly to be sure bearing is thoroughly lubricated. Assemble bearings (10-19) and shaft (17) to block (12). Install shaft (17) so end onto which adjusting nut is threaded extends out of front of block.

2. Install spacer (9) and adjusting nut (8), drawing nut up tight to be sure all bearing surfaces are seated. Then back off adjusting nut enough to permit shaft to spin—not enough to permit any perceptible end play. Install new lockwashers (6-7) with inner prong seated in shaft slot. Draw up lock nut (5) securely. Check adjustment to be sure it has not been changed during locking operations.

3. When certain that bearings are in satisfactory adjustment, bend edges of lockwasher well over flats on inner and outer nuts to hold them securely.

4. Place driving flange keys in keyways at each end of shaft (17). Apply a suitable sealing compound in keyways from end of key to end of shaft and press new cork oil seals into keyways. Then cover corks with sealing compound.

5. Use new gaskets and install cover and seal assemblies (2-22) and spacers (1-23) to end of block.

6. Replace flanges to shaft (17). Tighten nuts securely and install a new cotter pin full size of hole in shaft.

7. Check condition of vent assembly. A damaged vent assembly will not give satisfactory service. It must be removed and replaced with a new one.

8. Refill pillow block with lubricant as specified in "Lubrication" section of this manual.

9. Connect propeller shafts as described in paragraph 5.

TABULATED DATA

9. SPECIFICATIONS

Shafts

Quantity Used	4
Universal Joints	8
Shaft Diameter	3"
Make	Spicer
Needles Per Bearing	27

Type of Joint

Slip Joint End	Series 1411
Solid Joint End	Series 1418
Clearance Between Shaft Splines and Yoke Splines	.001"–.006"

Pillow Block Assembly

Location	Top of Forward Rear Axle
Bearings	
Make	Timken Tapered Roller
Number	16150 Cone 16284 Cup
Adjustment	Shaft End Play Should be Barely Perceptible. Bearings Must Be Tight Without Drag, Yet Loose Enough to Turn Freely.

Group 10 — Front Axle

	Paragraph
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Front Wheel Alignment	4
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To Install Front Axle Assembly	6
REPAIR	
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Differential Carrier Assembly—Banjo Type Axle Only	13
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GENERAL

1. DESCRIPTION AND OPERATION

Two types of front axles are described in this group. Each is a driving type unit consisting of housing, conventional differential assembly, axle shafts with special universal joints, and specially designed steering knuckle assemblies. The two types of axles are similar in operation but differ in construction as shown in Figs. 1 and 2. The type shown in Fig. 1 is termed the "split" or "two-piece" type since the housing is made in two pieces, bolted together at the differential carrier. The type shown in Fig. 2 is termed the "banjo" or "one-piece" type since the housing is in one-piece.

In both types of axle the differential assembly is the same as the rear axle differential. Both types of axles are full-floating units.

Power is transmitted from transfer case to front axle by a conventional propeller shaft. Differential housing is set off-center in axle housing to permit propeller shaft to pass along right side of engine oil pan, thus maintaining road clearance without excessive height at front end of vehicle.

Front axle is a driving unit and a shift lever in cab is provided to permit engagement or disengagement of drive line from transfer case to front axle. The front axle should be used as a driving unit only for off the road operation, operation on steep grades or in hard pulling operation. On dry, hard surfaced roads the front axle should be disengaged. See "Driver's Instructions" for information on axle drive engagement and disengagement.

2. TROUBLE SHOOTING AND GENERAL SOLUTIONS

In most cases, an unusual noise is the first indication of improper functioning of axle driving units. Since the differential and pinion assemblies are the same in both front and rear axles the information on these parts given under "Trouble Shooting" in rear axle groups applies equally to the front axle.

Front axle alignment, condition of housing, and condition of steering knuckle assemblies have major effects on steering and on front tire wear. The most common difficulties, their cause, and the probable remedies are as follows:

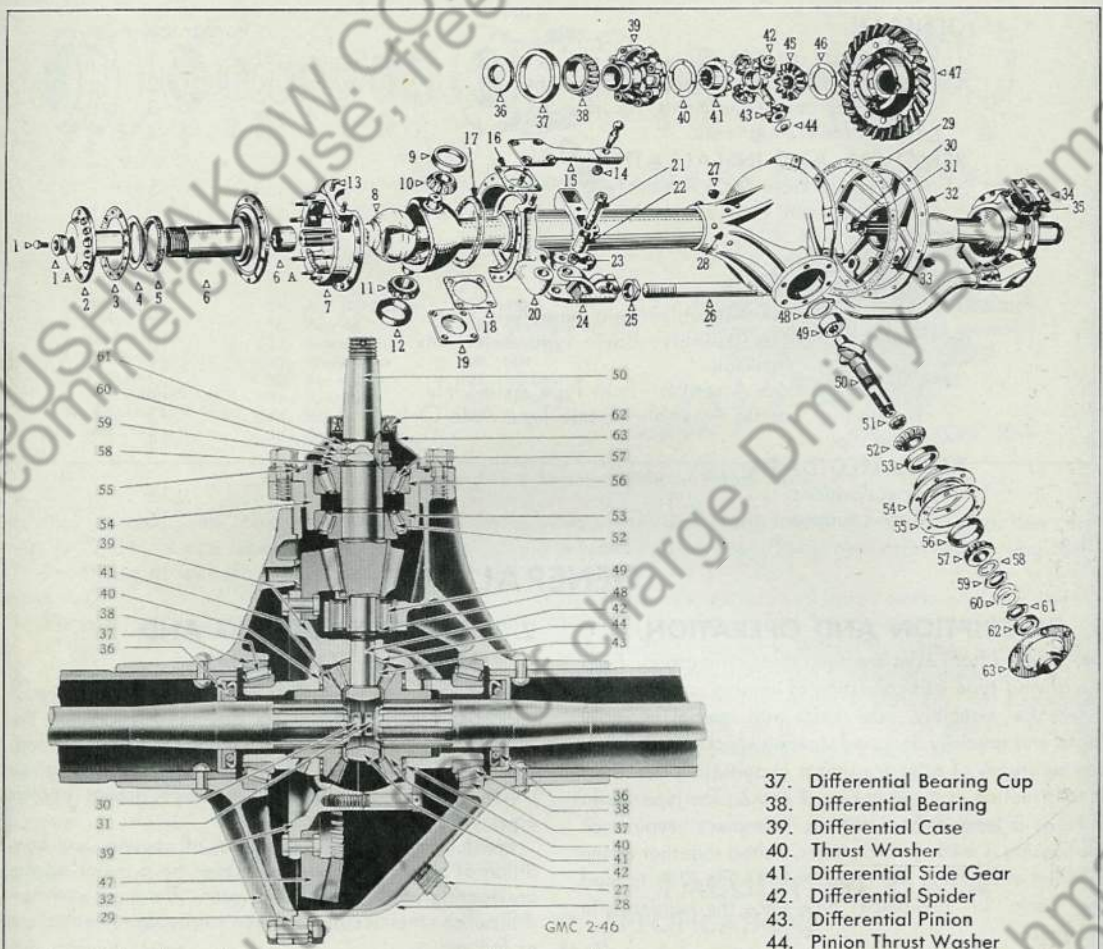
A. Wandering—

1. Steering gear or linkage adjustment incorrect—
   See group 14, "Steering Gear."
2. Spring mounting incorrect or spring broken—
   Inspect and correct faulty spring condition.
3. Axle housing twisted or bent causing unequal or insufficient caster—
   Check axle housing and all wheel adjustment factors.
4. Front wheel bearings out of alignment—
   Inspect and adjust.

B. Vehicle Pulls to One Side—

1. Tires inflated incorrectly or worn unevenly—
   Inflate tires according to tire manufacturer's specifications and check diameters of tires. Diameters of both tires should be the same.
2. Caster or camber angles unequal—
   Check all wheel alignment factors as instructed in this group.

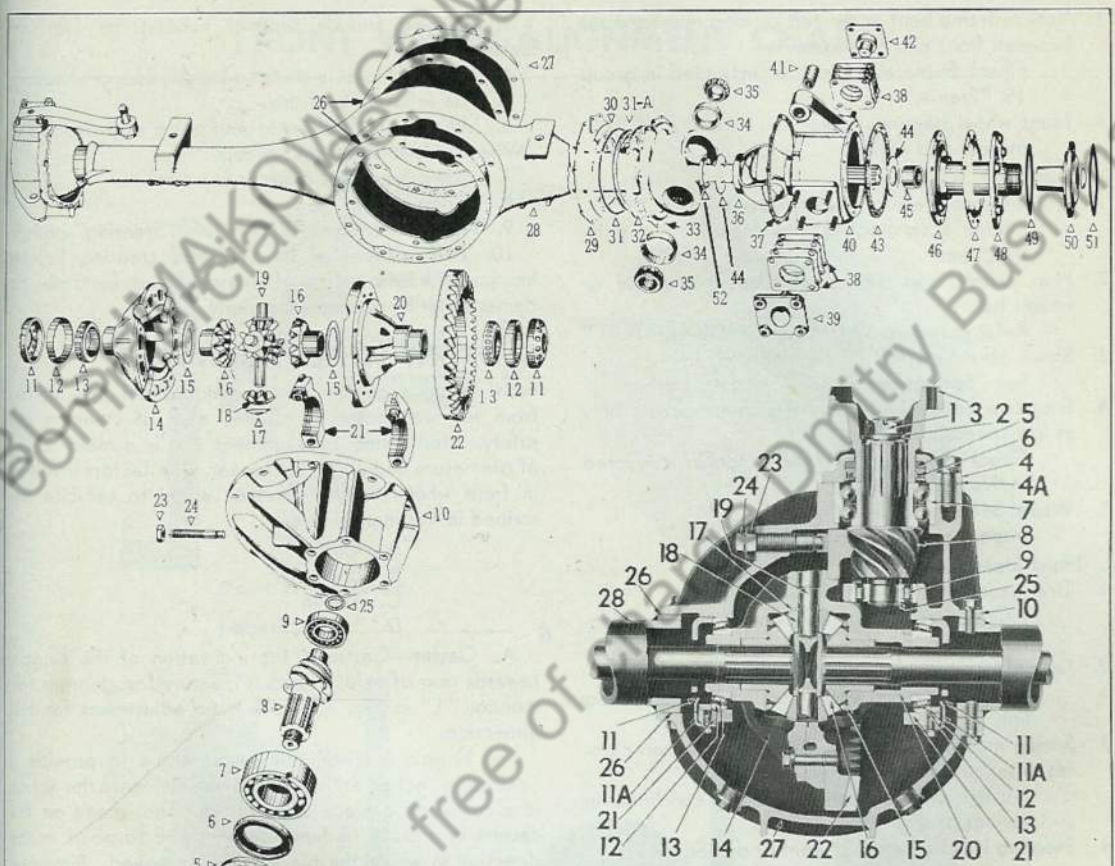
FRONT AXLE



1. Driving Flange Screw
1A. Driving Flange Cap
2. Driving Flange
3. Driving Flange Gasket
4. Hub Felt Retainer
5. Hub Felt
6. Steering Knuckle
6A. Knuckle Bushing
7. Outer Flange
8. Shaft Universal Joint
9. Upper Bearing Cup
10. Upper Bearing
11. Lower Bearing
12. Lower Bearing Cup
13. Steering Arm Stud
14. Stud Nut
15. Steering Arm
16. Knuckle Upper Shim
17. Universal Joint Felt
18. Knuckle Lower Shim
19. Lower Bearing Cover
20. Inner Flange
21. Tie-Rod Bolt
22. Bushing
23. Tie-Rod Bolt Nut
24. Tie-Rod End
25. Tie-Rod Lock Nut
26. Tie-Rod
27. Plug
28. Axle Housing
29. Axle Housing Gasket
30. Shaft Thrust Button
31. Shaft Thrust Shims
32. Axle Housing
33. Thrust Block
34. Knuckle Cap
35. Knuckle Shim
36. Axle Shaft Inner Seal
37. Differential Bearing Cup
38. Differential Bearing
39. Differential Case
40. Thrust Washer
41. Differential Side Gear
42. Differential Spider
43. Differential Pinion
44. Pinion Thrust Washer
45. Differential Side Gear
46. Thrust Washer
47. Case and Ring Gear
48. Inner Bearing Retainer
49. Pinion Inner Bearing
50. Pinion
51. Pinion Nut
52. Pinion Outer Bearing
53. Outer Bearing Cup
54. Pinion Bearing Cage
55. Pinion Cage Gasket
56. Outer Bearing Cup
57. Outer Bearing
58. Adjusting Nut Washer
59. Adjusting Nut
60. Nut Lock—2 Required
61. Pinion Lock Nut
62. Pinion Outer Seal
63. Outer Seal Retainer

Fig. 1 Front Axle—"Split" or Two-Piece Type

FRONT AXLE



1. Pinion Flange Nut
2. Pinion Flange Washer
3. Pinion Flange
4. Oil Seal & Brg. Retainer
4A. Retainer Gasket
5. Bearing Retainer Packing
6. Oil Seal Assembly
7. Pinion Outer Bearing
8. Hypoid Drive Pinion
9. Inner Bearing
10. Differential Carrier
11. Adjusting Nut
11A. Adjusting Nut Lock
12. Outer Race
13. Inner Race Assembly
14. Differential Case Cover
15. Side Gear Thrust Washer
16. Differential Side Gear
17. Pinion Thrust Washer
18. Differential Pinion
19. Differential Spider
20. Differential Case
21. Carrier Bearing Cap
22. Hypoid Drive Gear
23. Check Nut $^{7}/_{8}$–14
24. Drive Gear Thrust Pad
25. Inner Bearing Lock
26. Carrier Gasket
27. Housing Cover
28. Housing Assembly
29. Seal Inner Retainer
30. Inner Seal Retainer
31. Inner Seal Spring
31A. Inner Seal
32. Housing Outer End Seal
33. Seal Outer Retainer
34. Outer Race
35. Bearing Cone
36. Shaft and Universal Joint
37. Seal Retainer Gasket
38. Knuckle Bearing Shim
39. Lower Trunnion
40. Knuckle Support
41. Bushing
42. Upper Trunnion
43. Support Gasket
44. Washer
45. Bushing
46. Knuckle Spindle
47. Oil Deflector
48. Anchor Plate Spacer
49. Drive Flange Gasket
50. Axle Drive Flange
51. Shaft Screw Lock Ring
52. Oil Seal

Fig. 2 Front Axle—"Banjo" or One-Piece Type

3. Vehicle frame bent or twisted causing misalignment between front and rear axles—
   Check frame alignment as instructed in group 15, "Frame."
4. Front wheel bearings loose—
   Inspect and adjust.

C. Shimmy—

1. Tire inflation pressure low or uneven—
   Inflate according to tire manufacturer's instructions.
2. Hub, wheel and tire assemblies unbalanced or wheels bent—
   Refer to group 13, "Wheels, Hubs and Tires."
3. Shock absorbers not functioning properly—
   See "Springs and Shock Absorbers" group.
4. Excessive caster (especially if shimmy occurs only at low speeds).
   Check all wheel alignment factors as instructed in this group.
5. Wheel bearings loose or worn—
   Inspect and adjust or replace.

D. Hard Steering—

1. Tires under-inflated—
   Inflate tires in accordance with tire manufacturer's specifications.
2. Lack of lubrication—
   Lubricate tie-rod ends, steering gear and drag link.
3. Spring mounting bolts loose or spring broken causing misalignment of front wheels—
   Inspect and correct any faulty condition in springs or spring mounting.
4. Steering knuckle bearings worn or damaged—
   Inspect and replace or adjust and lubricate as necessary.
5. Wheel alignment incorrect—
   Check all wheel alignment factors as instructed in this group.
6. Steering gear adjustment incorrect—
   See "Trouble Shooting" in group 14, "Steering Gear."

E. Uneven Tire Wear—

Improper adjustment of any of the wheel alignment factors may cause uneven tire wear—
Check all wheel alignment factors.

3. INSPECTION AND ADJUSTMENTS

Regular inspection is essential to obtain maximum service from axle units. All adjustment instructions are given in Paragraph 4 under "Front Wheel Alignment"; also refer to respective axle section for adjustments in connection with differential parts of axle. Check the following items regularly:

1. Axle housing for leakage of lubricant at pinion and differential housing flanges or cover.
2. Lubricant level in differential housing.
3. Steering knuckle support housing for lubricant leakage.
4. Lubricant level in steering knuckle support housing.
5. Tire inflation pressure.
6. Wheel nuts, both inner and outer as instructed in "Wheels, Hubs and Tires" group.
7. Axle drive flange studs or cap screws.
8. Spring U-bolts.
9. Play in steering mechanism (see **"Steering"** group).
10. Feel differential housing and steering knuckle housing with bare hands. If excessively hot, units may be damaged or lubricated improperly.

4. FRONT WHEEL ALIGNMENT

Front wheel alignment has a major effect on steering from the standpoint of control, ease of steering and safety. Front wheel misalignment also is a major cause of premature and uneven tire wear. The factors involved in front wheel alignment, which apply to vehicles described in this manual, are—

A. Caster
B. Camber
C. Toe-In
D. Turning Angle

A. Caster—Caster is the inclination of the kingpin towards rear of vehicle, and is measured in degrees (dimension "L" in Fig. 3. **There is no adjustment for this dimension.**

The kingpin is given this caster angle to provide a "castering" action at the front wheels similar to the action in a caster on a piece of furniture. The wheels on the casters in a piece of furniture will tend to point in the direction in which the piece is being moved. Similarly, when front wheels on a motor vehicle have proper caster they will tend to point straight ahead as long as vehicle is in motion.

Caster angle is affected by a twisted axle housing, loose spring U-bolts or sagging springs. Special instruments, designed for the purpose, should be used to measure caster angle (see Fig. 4). Insufficient caster will permit front wheels to wander. Too much caster will cause hard steering on turns.

B. Camber—Camber is the sidewise inclination of the front wheels. Positive camber is outward inclination of wheels as viewed from front of vehicle, that is, the wheels are farther apart at the top than at the bottom, (dimensions "H" minus "G" in Fig. 3). **There is no adjustment for camber.**

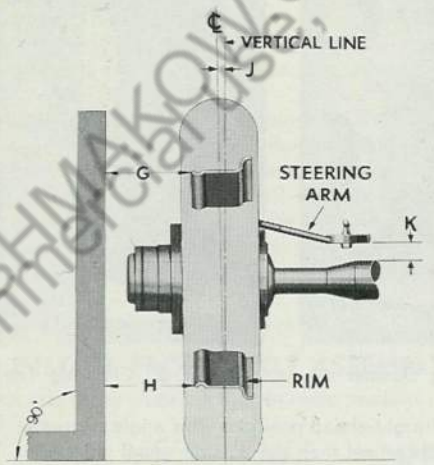
A bent axle housing, bent steering knuckle, loose kingpin bearings or loose wheel bearings will affect camber.

Incorrect camber will cause excessive tire wear and hard steering. Unequal camber will cause vehicle to pull towards side having most camber.

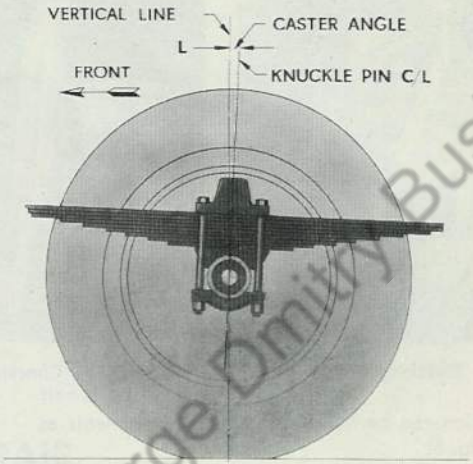
Wheel camber is given in "Specifications" for the straight ahead position only. It may be measured with a square and rule as shown in Fig. 3, but a more accurate

FRONT AXLE

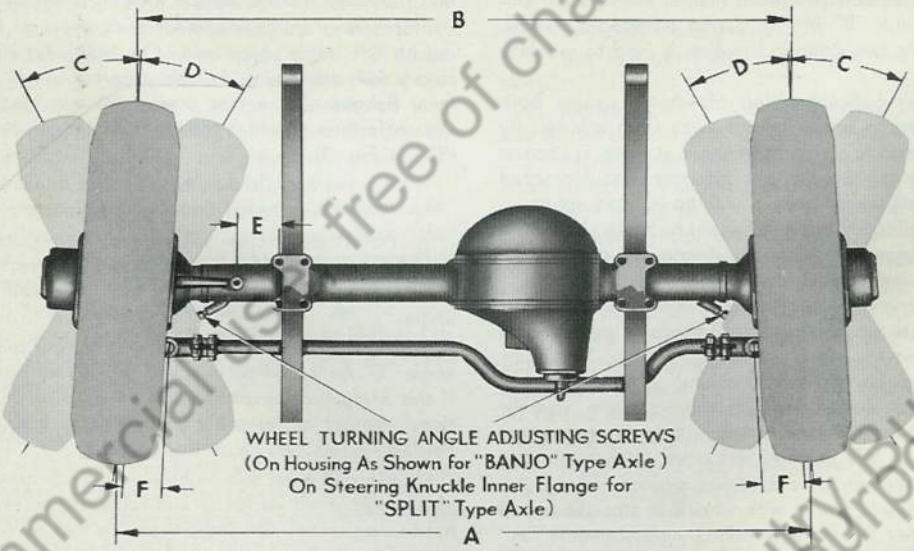
FRONT WHEEL ALIGNMENT CHART



Front Wheel Camber



Front Axle Caster



"A" Minus "B"	Toe-In	"F"	Backing Plate to Center Line of Tie-Rod Yoke Bolt
"C"	Turning Angle (Inside)	"H" Minus "G"	Wheel Camber (Inches)
"D"	Turning Angle (Outside)	"J"	Wheel Camber (Degrees)
"E"	Center Line of Steering Arm Ball to Outside of Spring	"K"	Bottom of Steering Arm to Top of Axle Housing
		"L"	Caster Angle (Degrees)

Refer to Specifications for Dimensions

Fig. 3 Front Wheel Alignment Chart

FRONT AXLE



Fig. 4 Checking Caster Angle

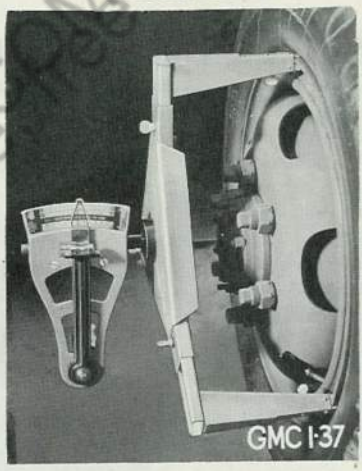


Fig. 5 Checking Camber

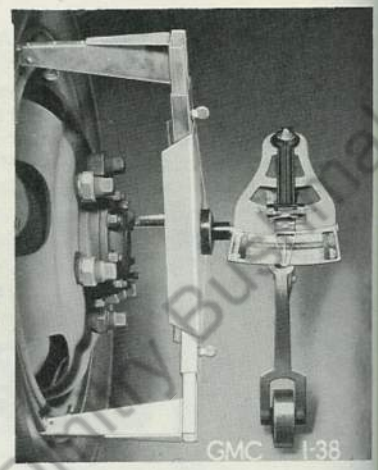


Fig. 6 Checking Toe-In

determination can be made with special instruments as shown in Fig. 5.

C. Toe-In—Toe-in is the amount by which front wheels are closer together at the front than at the rear (dimensions "A" minus "B" in Fig. 3). An adjustable tie-rod, connecting the two steering knuckles, is used to regulate toe-in.

Camber, or outward tilting of wheels, causes both wheels to tend to turn outwards away from vehicle. By adjusting tie-rod to give proper toe-in as given in "Specifications" the tendency to run outwards is counteracted and wheels roll straight ahead with no scuffing action.

Toe-in is affected by loose wheel bearings, bent axle housing, damaged wheels, bent steering knuckle spindle or a bent or improperly adjusted tie-rod.

Improper toe-in causes excessive tire wear or "scuffing." Unequal toe-in may cause vehicle to pull towards side having least toe-in.

Toe-in as given in "Specifications" is straight-ahead position only. As wheels are turned from straight ahead to either right or left, toe-in changes until, at extreme right or left position, they are further apart in front than at the rear. This condition is termed "Toe-out."

Always measure toe-in with wheels in straight ahead position, either by actually taking measurements "A" and "B" as shown in Fig. 3, or, for more accurate work, use special instruments as shown in Fig. 6.

D. Turning Angle—The turning angle is the maximum angle through which wheel may be turned from the straight-ahead position. This angle is greater for the inside wheel than the outside wheel on a turn. The angle for the inside wheel is shown as dimension "C" in Fig. 3 and the angle for the outside wheel is dimension "D."

Stop screws are provided for each wheel on the housing of the "banjo" type axle. On "split" type axles the stop screws are mounted on the steering knuckle support inner flanges. These stop screws are provided to limit the angle through which the inside wheel can turn (angle "C" in Fig. 3).

The turning angle should be adjusted as follows:

1. Turn wheels to extreme left position.
2. Adjust stop screw until angle "C" is correct for left wheel in accordance with "Specifications." Use an accurate turning angle instrument to obtain correct angle.
3. With wheels in position giving correct reading for angle "C" on left wheel check angle "D" for right wheel. If this angle is different than figure given in "Specifications" toe-out on turns will be incorrect. Bent, loose or twisted tie-rod may cause this condition.
4. On split type axle tighten adjusting screw locknut after angle is set correctly and tack-weld or braze locknut to stop screw. On banjo type axle tack-weld or braze stop screw to housing when angle is set correctly.
5. Adjust angle "C" for right-hand wheel by turning wheels to extreme right and repeating operations given for left-hand turning angle.

REMOVAL AND INSTALLATION

5. TO REMOVE FRONT AXLE ASSEMBLY

1. Place vehicle on level spot and apply hand brake or block rear wheels.
2. Jack up front end until tires are about 3" from ground. By raising front end 3" axle may be rolled from chassis without any underneath interference.
3. Place a suitable jack stand on each side of frame just behind front spring rear hanger bracket. Lower front

FRONT AXLE

end until weight rests on jack stands.

4. Disconnect both front shock absorber links at upper spring clip plates.

5. Disconnect hydraulic brake hoses at frame connection. See Group 12 "Brakes."

6. Disconnect steering drag link at steering arm on top of knuckle housing on left side of axle. (See "Steering" group.)

7. Remove nuts from U-bolts on propeller shaft universal joint at axle driving flange. After removing nuts, remove U-bolts and tape bearing assemblies to trunnion to prevent bearings from dropping off and being damaged or becoming filled with dirt. Tie propeller shaft up to keep parts clean and prevent damage.

8. Remove nuts from spring clip U-bolts and remove U-bolts.

9. Roll axle assembly from underneath chassis.

6. TO INSTALL FRONT AXLE ASSEMBLY

1. Place axle under chassis in approximate position.

2. Raise axle up and make sure spring center bolt heads enter holes in axle spring seats.

3. Place spring U-bolts in position and draw up nuts evenly.

4. Connect shock absorber links to upper spring plates.

5. Connect hydraulic brake hoses at frame connection. Bleed both front brakes as instructed in "Brake" section.

6. Connect steering drag link to steering arm and make sure cotter key is installed.

7. Connect propeller shaft to axle driving flange making sure bearing assemblies are in proper position. Tighten nuts alternately to eliminate possibility of distortion or uneven alignment.

8. Check front end for wheel alignment as described in paragraph 4, "Front Wheel Alignment."

9. Check axle lubrication level and refer to lubrication chart for type of lubricant.

REPAIR

Information on axle repair is divided into separate paragraphs to provide a complete procedure for each of the major sub-assemblies of the complete axle. The sub-assemblies are discussed in the order in which they should be removed when an axle is to be disassembled completely. Procedure for removal, installation, disassembly, inspection, repair, assembly, and adjustment is given for each of the sub-assemblies where applicable.

The information given is applicable to both the "split" type and the "banjo" type front axle except where noted otherwise. The differential and drive pinion assemblies are identical for front and rear axles. Reference is made to Group 11B, **"Rear Axle—Banjo Type"** for the banjo type front axle differential assembly and to Group 11S, **"Rear Axle—Split Type"** for the split type front axle drive pinion and differential assemblies.

7. TIE-ROD

Tie-rod is a solid rod threaded at each end and has a double offset to clear differential and pinion housing. Threads on left end of rod have a fine pitch to permit accurate adjustment. Yokes are screwed onto each end of rod and are attached to knuckle steering arms by pins (Fig. 7). Steering arms are forged integrally with steering knuckle supports and are bushed. Threaded portion of yokes are split and held tightly to rods by clamp bolts. On "split type" axle a locknut on rod is used to secure left end yoke in addition to clamp bolts. On the "banjo type" axle tie-rod a key is used in rod at both yokes to keep rod in correct relative position to propeller shafts.

A. To Remove Tie-Rod (see Fig. 7)—

1. Remove cotter pin and nut and remove tie-rod pins from steering knuckle arms, thus disconnecting tie-rod.

2. Slide both yokes off steering knuckle arms.

B. To Install Tie-Rod—

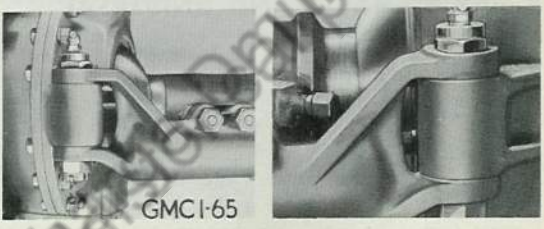
1. Use new parts in place of any that are worn or bent.

2. Replace yoke with coarse threads on right hand end of rod and connect to steering knuckle arm with pin.

3. Replace yoke with fine threads on left end of rod and connect to steering knuckle arm with pin.

4. Turn wheels to extreme left and right positions to be sure there is clearance between tie-rod and differential carrier at all times. On banjo type axles there should be a minimum of 1/8" clearance between tie-rod and lower rib on left side of differential on full left turn.

5. Adjust tie-rod for proper toe-in as given in "Specifications" with wheels in straight-ahead position. This adjustment is made by screwing tie-rod yokes in or out on tie-rod as required. Make final adjustment with left hand yoke because this end has finer threads and permits closer adjustment. See Figs. 3 and 6 for methods of checking toe-in dimensions.



Split Type Axle *Banjo Type Axle*

Fig. 7 Tie-Rod Ends

FRONT AXLE

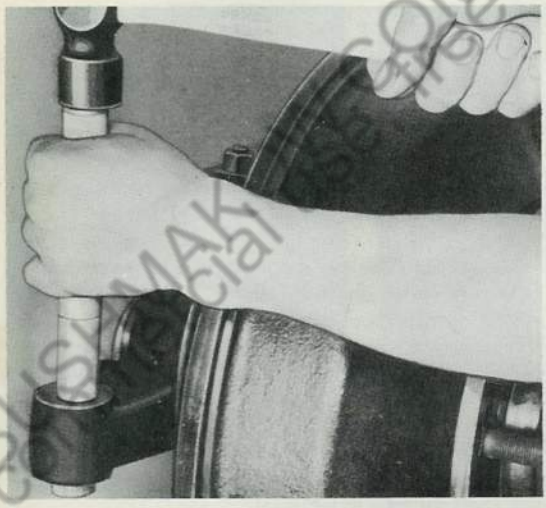


Fig. 8 Typical Method of Removing or Installing Tie-Rod Bushing

6. When toe-in is adjusted properly on split-type axle tighten locknut on left end of rod and tighten clamping bolts at both ends. On banjo-type axle insert key in keyway at each end of tie-rod and align hole in key with one clamp bolt hole. Replace clamp bolts and tighten.

7. Tighten nuts on steering knuckle arm pins snug and then back off ⅓ to ½ a turn and lock with cotter pins.

C. To Disassemble Tie-Rod—

1. Loosen clamp bolts on yokes.

2. On split type axles loosen locknut at left hand yoke. On banjo type axles remove clamp bolts and key.

3. Screw tie-rod yokes off rods.

D. To Inspect Tie-Rods—

1. Examine rods for any indication of bending.

2. Examine threads on rod ends and in yokes.

3. Examine yokes for wear in steering knuckle arm pin holes.

4. Examine bushings in steering knuckle arm and replace if worn (see Fig. 8). Use driver J-1665 to remove old, and to install new bushings, then ream bushing with reamer KMO-347.

8. AXLE SHAFTS AND UNIVERSAL JOINTS

Axle shafts are full floating type carried in differential side gear splines on inner end and in a splined driving flange at outer end. Driving flange is attached to wheel hub. Each axle shaft has a universal joint at the steering knuckle. Two types of joints are used in vehicles covered by this manual: Bendix-Weiss (Figs. 11 and 12) and Rzeppa (Fig. 17). Bendix-Weiss joints are furnished in both banjo and split type axles, whereas Rzeppa joints are used with split type axles only. The two types of joints are interchangeable in split type axles; however, both right and left universal joint and axle shaft assemblies must be of same type. Removal and installation procedures for the three combinations are handled separately.

A. To Remove Axle Shafts and Universal Joints—Split Type Axles with Bendix-Weiss Joints (Refer to Fig. 1)

1. Remove hubs and drums as explained in "Wheels, Hubs and Tires" group.

2. Remove nuts and lockwashers from studs holding brake backing plate, oil shield and steering knuckle spindle (6) to outer knuckle flange (7). Unless brake mechanism is to be disassembled, backing plate may be removed and laid aside without disconnecting hydraulic line.

3. Knuckle spindle (6) can be loosened from knuckle flanges (7) by tapping on side of spindle with brass hammer and using wedge blocks between these two parts.

4. Withdraw axle shaft (8) and universal joint assembly. (See Fig. 9.)

B. To Install Axle Shaft and Universal Joint Assembly in Split Type Axles with Bendix-Weiss Joints (See Fig. 1)

Note: In "split" type front axles the shafts are located lengthwise by a screw (1) which holds the driving flange (2) against a shoulder on the splined portion of the outer half of the axle shaft, and by thrust buttons and shims on inner ends of shafts (at differential) which limit lengthwise movement of inner halves of shafts. See Fig. 11. It is important to install shafts as instructed here to assure proper location of shaft universal joints in housing at steering knuckles. Adjustment of shaft end play is necessary whenever either or both shafts, steering knuckles, or an axle housing are replaced.

1. Install long shaft (L.H.) in axle housing with inner end in side gear splines. Be sure the permanent thrust button is in place on end of shaft before installing. Be careful not to strike oil seal (52) in housing near differential (see Fig. 1).

2. Apply coat of lubricant to bushing (6A) in steering knuckle spindle (6). Slide knuckle spindle over end of outer axle shaft and attach knuckle spindle, with oil shield and backing plate, to outer knuckle flange (7).

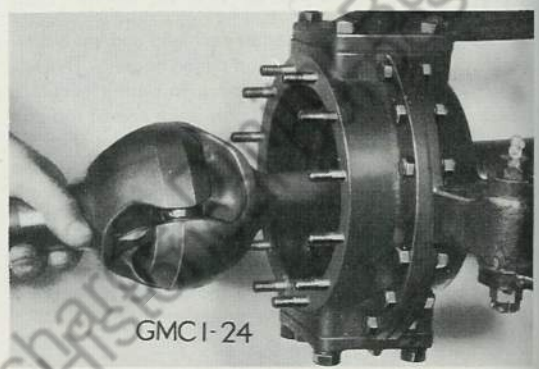


Fig. 9 Removing Axle Shaft and Bendix-Weiss Universal Joint Assembly—"Split" Type Axle

FRONT AXLE

3. Install left hand hub and drum assembly and adjust bearings (see "Wheels, Hubs and Tires" group).

4. Install drive flange (2) with new gasket (3) and cap (1A).

5. Screw driving flange screw into place in end of axle shaft and tighten flange studs to hub.

6. Select a thrust button (30) having a light tap fit in inner end of short shaft (R.H.) and insert in shaft, leaving about $\frac{1}{2}$" between end of shaft and face of button head.

7. Repeat operations 1 to 3 as given for left-hand shaft. Slide driving flange over outer end of drive shaft, omitting gasket (3) between hub and flange. **During this operation be very careful not to push shaft inward.** With driving flange screw (1), draw the shaft outward as far as it will go as this will bottom the driving flange on shoulder of spline portion of shaft. The drive flange which has been guided during this operation by the driving studs should now be drawn up tight with two nuts, one on each side of flange. **Preliminary tightening of short shaft (right-hand) should always be made by flange screw in end of shaft. Final tightening should be made by flange to hub stud nuts.** During this operation, thrust button has been pushed into the end of the right-hand shaft.

8. Remove R.H. drive flange, knuckle spindle and hub. Then remove axle and universal joint assembly. **Be very careful not to push shaft in or to move button on end of shaft.**

9. Measure distance between shaft and button head. Then select a shim pack $\frac{1}{32}$" less than this distance.

10. Remove button and select one having a press fit in shaft end.

11. Install the new button and shim pack, pressing button in solidly to compress shim pack.

12. Replace shaft and universal joint assembly as previously described, this time using a new gasket between drive flange and hub. The $\frac{1}{32}$" allowed at the button plus the thickness of the gasket provides proper clearance at shaft ends.

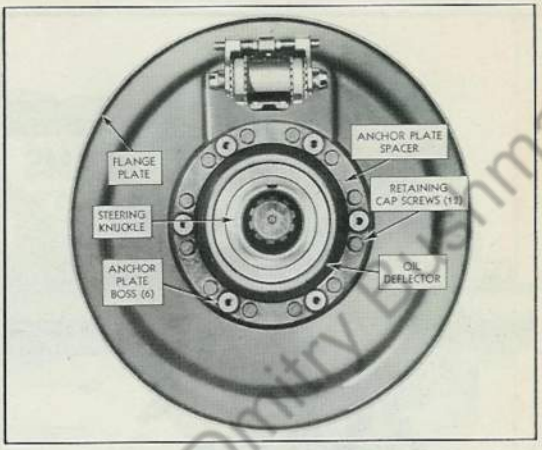


Fig. 10 Flange Plate Assembly—"Banjo" Type Axle

13. After axle is completely assembled, the following checking procedure is recommended to be sure that proper end clearance has been obtained.

(a) Back screw (1) out about $\frac{1}{8}$" at each end of axle.

(b) Use a lead hammer and tap screw (1) on one side of axle inward as far as it will go.

(c) At opposite end of axle, measure distance from top of screw head (1) to outer surface of driving flange cap (1-A). Then tap this screw inward as far as it will go.

(d) After this screw has been tapped inward as far as it will go, again measure the distance from top of screw to cap (as in item c). Difference between these two

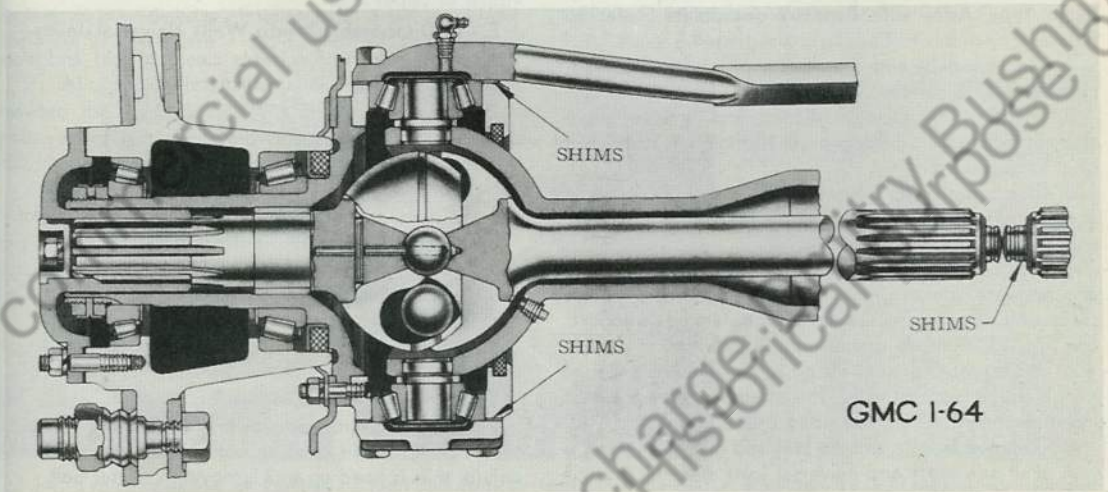


Fig. 11 Steering Knuckle and Bendix-Weiss Universal Joint Assembly—"Split" Type Axle

FRONT AXLE

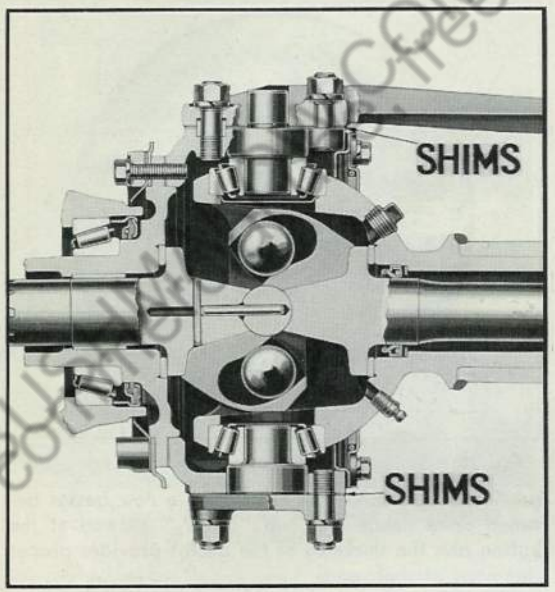


Fig. 12 Steering Knuckle and Bendix-Weiss Universal Joint Assembly—"Banjo" Type Axle

measurements is the total end play in the axle shaft and universal joint assemblies. This dimension should be between $\frac{1}{32}$" and $\frac{1}{16}$". Readjust shim pack (31) if necessary to obtain this dimension.

14. Remove plug in lower half of universal joint housing and apply lubricant through grease fitting at top of steering knuckle until it is visible at lower plug hole. (See **"Lubrication"** group.)

C. To Remove Axle Shafts and Universal Joints—Banjo Type Axles with Bendix-Weiss Joints (Refer to Fig. 2)

1. Remove hubs and drums as explained in "Wheels, Hubs and Tires" group.
2. Install wheel cylinder clamp, and remove brake shoe retracting spring, using brake spring pliers KMO-142 (see "Brakes" group).
3. Remove six cap screws which attach brake shoe anchor plate to anchor plate spacer (48) and remove anchor plate and shoe assembly.
4. Remove 12 cap screws which attach brake shoe anchor plate spacer, inner oil deflector, brake flange plate and knuckle spindle to steering knuckle support. See Fig. 10. Remove spacer and oil deflector.
5. Slide brake flange plate off knuckle spindle and support it with a piece of wire. This procedure saves removing brake line hose and bleeding brakes.
6. Remove knuckle spindle (46) and gasket (43).
7. Pull axle shaft and universal joint assembly out of housing.

D. To Install Axle Shaft and Universal Joint Assembly in Banjo Type Axles with Bendix-Weiss Joints—(Refer to Fig. 2)

Note: In "banjo" type axles the axle shafts are located lengthwise by ground shoulders on each side of each universal joint which are held between thrust rings, one in knuckle spindle flange and one in axle housing itself. Inspect thrust rings (44) and oil seal (52) and replace if worn excessively. (See paragraph 10C.)

1. Lubricate each shaft assembly at points where shaft contacts knuckle spindle bushing and thrust washers in knuckle spindle and end of axle housing. Install long shaft and joint assembly in left hand housing, guiding splined inner shaft into differential side gear. Install short shaft assembly in right side in same manner.
2. Place knuckle spindle (46) on knuckle support (40), using a new gasket between support and spindle.
3. Using 12 cap screws, attach brake flange plate, inner oil deflector (47) and brake shoe anchor plate spacer (48), to knuckle spindle and knuckle support.
4. Replace brake anchor plate and shoe assembly on anchor plate spacer (48), using new lockwashers under screw heads. See Fig. 2.
5. Replace drum and hub assembly on steering knuckle (46) and adjust wheel bearings. See "Wheels, Hubs and Tires" group.
6. Install drive flange, using new metal gasket.
7. Install cap screws through lock plate and tighten them securely. These cap screws should be tightened to 95 to 115 foot pounds torque.
8. Bend tangs of lock plate against capscrew heads.
9. Fill universal joint housing with lubricant as specified in **"Lubrication"** section. In this joint remove plug from upper part of axle housing at joint and apply through fitting in lower part of housing until lubricant is visible at upper hole.

E. To Disassemble Bendix-Weiss Universal Joints—

1. Wash joint with suitable cleaning fluid and place in a vise having soft jaws as illustrated in Fig. 14.
2. Inspect joint for any play or backlash between drive balls and races. Play may be eliminated by using larger drive balls as explained under "To Assemble Universal Joints."
3. With a punch, drive out retainer pin as shown.
4. Hold shaft in an upright position with both hands and strike wheel end on wooden block. By striking once or twice on block, center ball pin will drop into drilled passageway in wheel end of shaft.
5. With center ball pin in drilled passage, bend shaft sharply at joint.
6. Using thumb and index finger, rotate center ball (A, Fig. 15) until grooved side lines up with ball raceway. When center ball is lined up with raceway, remove outer ball (B) that is lined up with groove on center ball.
7. Bend shaft sharply in opposite direction and remaining balls will be released.

FRONT AXLE

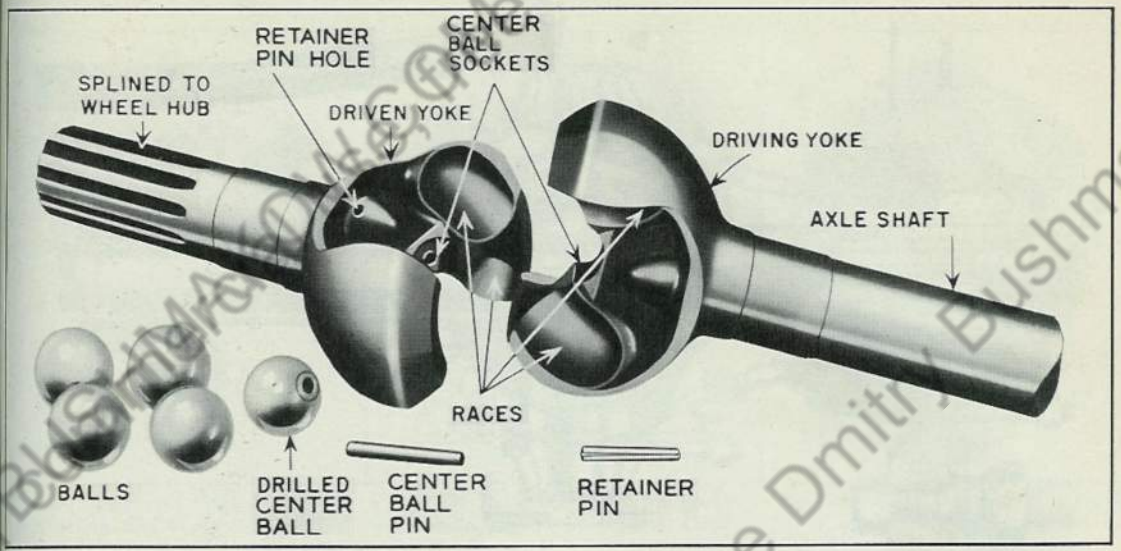


Fig. 13 Typical Bendix-Weiss Universal Joint—Disassembled

F. To Inspect Bendix-Weiss Universal Joints—(Refer to Fig. 13)

1. Wash balls and races thoroughly.

2. Inspect races and, if they are worn excessively, grooved, scratched or pitted, replace with complete new joint.

3. Inspect center ball, center ball pin and the four driving balls. If balls are pitted, scratched or have flat spots, replace with new balls of same diameter as those being removed. Selective sizes are not required when installing a new center ball or center ball pin.

G. To Assemble Bendix-Weiss Universal Joints—Important: If play develops from wear in a universal joint where the ball races are in good condition, the difficulty may be remedied through the installation of larger drive balls. Measure the diameter of the original drive balls with a micrometer to determine the size of each ball. Select one or two new balls .001" larger than the smallest ball originally used in the assembly. It is desirable to keep the drive balls within .001" of the same size and the variation should not exceed .002". As the joint is being assembled, the two largest balls should be placed diagonally across from each other.

Note: If play has not been removed by the use of balls larger than the original size, install still larger balls and repeat the foregoing procedure.

1. Insert center ball pin in drilled passage in wheel half of shaft as shown in Fig. 16.

2. Place differential end of shaft in vise, being careful



Fig. 14 Typical Method of Removing Retainer Pin

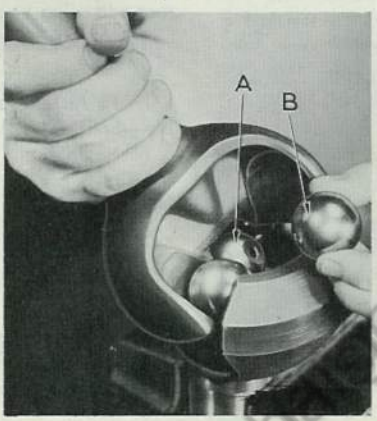


Fig. 15 Typical Method of Removing or Installing Universal Joint Drive Ball



Fig. 16 Typical Method of Inserting Center Ball Pin

FRONT AXLE

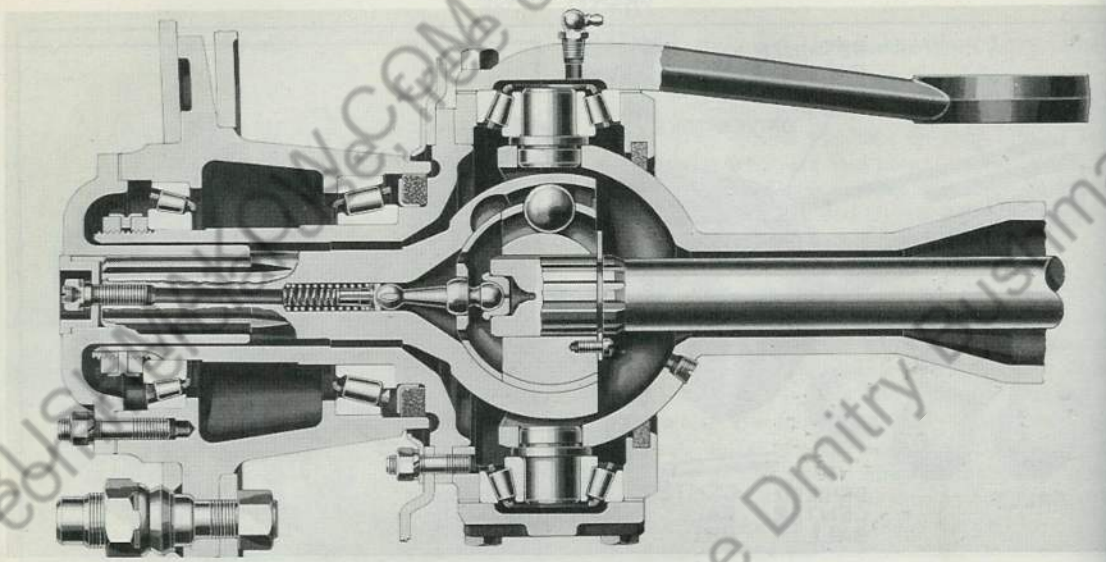


Fig. 17 Steering Knuckle and Rzeppa Universal Joint Assembly—"Split" Type Axle

not to grip on a ground surface.

3. Set the center ball (one with hole drilled in it) in the seat in center of yoke.

4. Place the wheel end of joint over differential half, bend shaft as sharply as possible at joint and install

Note: Drive balls are available in seven sizes, varying from .003" under to .003" over standard size. See "Specifications." Any ball to be replaced should be measured with micrometers and a new ball of same size should be used in its place except when larger balls are required to eliminate excess play in joint.

5. Bend shaft at joint in opposite direction to give clearance to install fourth ball.

6. Rotate center ball to line up grooved side with ground raceway for the remaining ball as shown in Fig. 15. Slip ball into raceway and straighten up joint.

7. Reach in with fingers and turn center ball until center ball pin drops into drilled hole in ball.

8. Install the retainer pin into hole in wheel half of shaft and stake its ends to securely lock it. Always use new retainer pin.

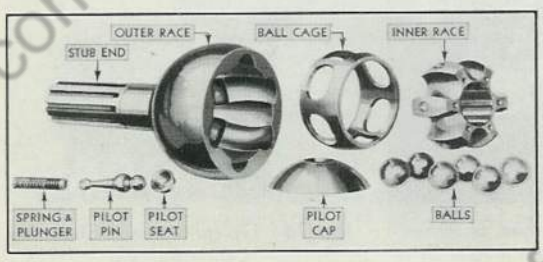


Fig. 18 Rzeppa Universal Joint—Disassembled

9. Lubricate joint before replacing in vehicle. Flex joint in all directions to be certain all parts are properly lubricated (See **"Lubrication"** group).

H. To Remove Axle Shafts and Universal Joints—Split Type Axle with Rzeppa Joints (Refer to Fig. 1)

1. Remove hubs and drums as explained in "Wheels, Hubs and Tires" group.

2. Remove nuts and lockwashers from studs holding brake backing plate, oil shield and steering knuckle spindle (6) to outer knuckle flange (7). Unless brake mechanism is to be disassembled, backing plate may be removed and laid aside without disconnecting hydraulic line.

3. Knuckle spindle (6) can be loosened from knuckle flanges (7) by tapping on side of spindle with brass hammer and using wedge blocks between these two parts.

4. Withdraw axle shaft (8) and universal joint assembly.

I. To Install Axle Shaft and Universal Joint Assembly—Split Type Axle with Rzeppa Joints (See Fig. 1)

Note: In "split" type front axles with Rzeppa joints the shafts are located lengthwise by a screw (1) which holds the driving flange (2) against a shoulder on the outer half of the axle shaft, and a retaining ring bolted to inner race with three cap screws lockwired together.

1. Install long shaft in axle housing with inner end in side gear splines. Be careful not to strike oil seal (52) in housing near differential.

2. Attach knuckle spindle (6), with oil shield and backing plate, to outer knuckle flange (7).

3. Install hub and drum assembly and adjust bearings as described in "Wheels, Hubs and Tires" group.

4. Install drive flange (2) with new gasket (3) and cap (1A).

FRONT AXLE

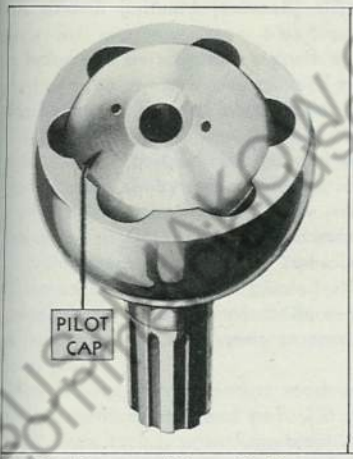


Fig. 19 Race and Cage Position—Inserting and Removing Bolts

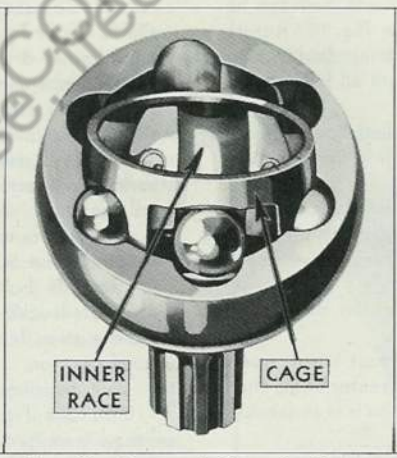


Fig. 20 Race and Cage Position—Inserting and Removing Pilot Cap



Fig. 21 Cage Openings Should Be in Line with Race Teeth

5. Screw driving flange screw into place in end of axle shaft and tighten flange studs to hub.

6. Remove plug in lower half of universal joint bushing and plug in end of driving flange center bolt (1) and apply lubricant through bolt until lubricant is visible at oil level hole in lower half of universal joint housing. See Lubrication group.

J. To Disassemble Rzeppa Universal Joints—

1. Wash joint with suitable cleaning fluid and place in a vise having soft jaws.

2. Take out axle shaft retainer screws and remove shaft, see Figs. 17 and 18.

3. Withdraw pilot pin.

4. Tilt inner race of universal joints, as illustrated in Fig. 19, until one ball can be lifted out. Then roll inner race so that next ball can be removed, and so on until all balls are out.

5. Roll cage upside down and remove pilot cap. See Fig. 20.

6. Turn ball cage at right angles with outer race and with rectangular openings in line with opposite teeth in outer race, as shown in Fig. 21, lift out cage and inner race.

7. Turn inner race until tooth of inner race projects through one rectangular opening in ball cage and roll race out of cage. See Fig. 22.

8. Remove springs and plunger from bore of universal joint stub shaft.

K. To Inspect Rzeppa Universal Joints—

1. Wash all parts thoroughly.

2. Inspect for chipped or broken balls. If balls are pitted, scratched or have flat spots, replace with new balls.

3. Inspect races, and if they are worn excessively, grooved, scratched or pitted, replace with complete new joint.

4. Check plunger spring to see that it conforms to specifications listed in Paragraph 15.

L. To Assemble Rzeppa Universal Joint—

1. Lubricate all parts to facilitate assembly.

2. Mount outer race in vise with opening upward and place springs and plunger in bore of universal joint stub shaft.

3. Put inner race into cage by inserting one race tooth into rectangular opening in cage and rolling it into place. See Fig. 22. Try for a free fit.

4. Hold cage and inner race so that rectangular openings of cage are in line with two opposite teeth in outer race, as shown in Fig. 21. Drop cage into place and turn it into position, making sure parts turn freely.

5. Turn cage and inner race with drilled holes in race downward and install pilot cap. See Fig. 20. Turn race back again until grooves and openings in cage are lined up.

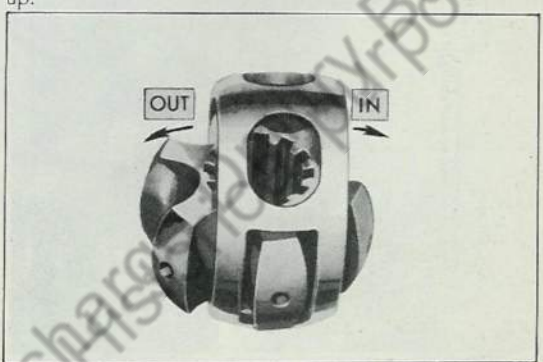


Fig. 22 Pass Inner Race Tooth Through Opening in Cage and Roll Race Out of Cage

FRONT AXLE

6. Tilt inner race and cage so that one ball can be inserted through cage into groove. See Fig. 19. Rotate inner race enough to permit ball to be installed in next groove adjacent to first and so on until all balls are in place.

7. Turn inner race so side with drilled holes is flush with edges of outer race and insert pin in upright position.

8. Be certain pilot seat is pressed into axle shaft as far as possible, and shaft retainer is in place on shaft.

9. Insert splined end of shaft into inner race vertically so that pilot pin will enter seat.

10. Install shaft retainer screws, drawing down tight and locking with wire.

11. Test for free movement throughout entire operating range. Do not force sleeve into greater angle than that at which joint is operated when vehicle is in service.

9. STEERING KNUCKLE ASSEMBLY—SPLIT TYPE AXLE ONLY

—See Figs. 1 and 11.

Note: See Paragraph 10 for "Banjo" type axle steering knuckle assembly.

The steering knuckle on the split type axle is shown in section in Fig. 11. Numbers in parenthesis refer to Fig. 1. Knuckles are mounted on tapered roller bearings on trunnions in the outer ends of the axle housing. The knuckle support flanges (7 and 20) and the trunnions are serviced with the axle housings as complete assemblies and are not serviced separately.

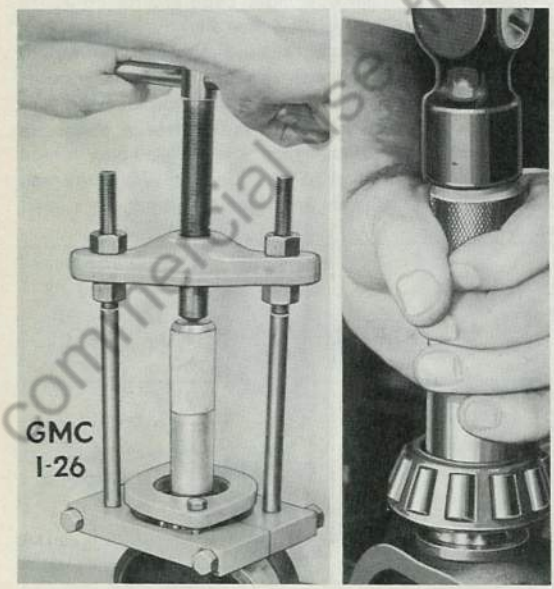


Fig. 23 Removing and Installing Knuckle Bearing from "Split" Type Axle

A. To Disassemble (Remove) Steering Knuckle Assemblies—Split Type Axle

1. Remove drive flange and hubs as instructed in "Wheels, Hubs and Tires" group.

2. Remove steering knuckle spindle, oil shield and brake backing plate.

3. Remove steering knuckle bearing cover plates (steering arm forms upper bearing cover plate on left hand knuckle).

4. Tag and remove bearing cover plate shims (16 and 18) so the same thickness may be used at assembly.

5. Remove bolts holding inner (20) and outer (7) flanges of knuckle support and remove outer flange. Mark the two flanges so they will be reassembled in original position.

6. Pull bearings from trunnions with special puller CS-1047. See Fig. 23. Tag bearings so they may be replaced in original locations.

7. Inspect oil seal (4 and 5), on steering knuckle spindle (6). Replace if not in perfect condition.

B. To Inspect Steering Knuckle Assembly—Split Type Axle

1. Inspect oil seal (17) between inner flange and axle housing. If damaged or worn, even slightly, use a new seal.

2. Clean and inspect bearings as follows:

(a) Soak in suitable cleaning fluid.

(b) Remove from fluid and strike larger side of bearing flat against a wood block to knock out heavier particles of dirt.

(c) Blow bearings clean and dry with compressed air, directing air across bearings. Be careful not to spin bearings.

(d) Rotate bearing slowly by hand, and inspect rollers and race for defects and excessive wear. Never spin bearings while dry.

(e) After inspection dip bearings in engine oil and wrap in clean cloth.

3. Inspect bushing (6A) in steering knuckle spindle (6). If worn, remove old and install new bushing with tool J-1738A. Ream to size given in "Specifications."

C. To Assemble (Install) and Adjust Steering Knuckle Assembly—Split Type Axle

1. Drive bearings onto trunnions using J-1706 driver.

2. Install new oil seal (17) if necessary.

3. Assemble the two flanges (7 and 20) of knuckle support, aligning marks made when disassembling. Then bolt together, using new lockwashers and tightening nuts evenly. Be sure seal is located properly and all nuts are tight.

4. Install bearing cups, shims and cover plates in same locations from which they were removed. Be sure same thickness of shims is used at top and bottom caps.

5. When both upper and lower bearing cover plates have been seated properly and nuts tightened in place the knuckle should have no end play but should be free to oscillate freely by hand.

FRONT AXLE

6. When this condition is attained, remove cover plates and reduce thickness of each shim pack .005" at both top and bottom trunnions. Same thickness of shims must be used at top and bottom to locate knuckle properly relative to shaft universal joint.

7. Place a torque wrench on one of the cover plate nuts, as illustrated in Fig. 24, and measure torque required to turn steering knuckle with axle shaft removed and tie rod disconnected. Torque wrench scale reading should be 15 to 20 foot-pounds while knuckle is in motion. If more or less than 15 to 20 foot-pounds is required to keep knuckle in motion, change shim thickness until proper adjustment is attained. **Be certain the total shim thickness is always the same at top as at bottom bearing cover plates.**

8. Check both left and right steering knuckles separately and then reconnect tie rod at both knuckles.

9. Place torque wrench on one nut of bearing cover plate as illustrated in Fig. 24 and check torque required to turn the assembly. Reading on wrench dial should be 70 to 80 ft. lbs. while knuckles are in motion.

10. Replace axle shafts as explained in previous paragraphs.

11. Lubricate bushing (6A) and replace knuckle spindle (6) and bushing assembly, brake backing plate and oil deflector on outer flange (7) of steering knuckle support.

12. Install hub and axle shaft drive flange as instructed in group 13, "Wheels, Hubs and Tires."

10. STEERING KNUCKLE ASSEMBLY—"BANJO" TYPE AXLES ONLY

—See Figs. 2 and 12

Note: See Paragraph 9 for "split" type axle steering knuckle assembly.

The assembly consists of a one-piece support (40) which carries upper and lower trunnions (39 and 42) and a steering knuckle spindle (46). The knuckle assembly is carried by the trunnions on tapered roller bearings in the outer ends of the axle housing. (Numbers in parenthesis refer to Fig. 2.)

A. To Disassemble and Remove Steering Knuckle Assembly—Banjo Type Axle—

1. Remove axle shaft drive flange and hubs as instructed in "Wheels, Hubs, and Tires" group.

2. Remove brake shoe anchor plate, spacer, oil deflector, flange plate, steering knuckle spindle and gasket and axle shaft. (See "To Remove Axle Shafts" in this group.)

3. Remove 12 cap screws which attach outer end seal inner retainer plates (29) to steering knuckle support (40). Remove plates (29) and seal retainer (30). (See "A," Fig. 25 and refer to Fig. 2, for the names and location of the above parts.

4. Remove nuts from front axle trunnions (top and bottom) shown at "B," Fig. 25. Remove trunnions and shims. Then remove steering knuckle support and bearings from the axle ends. Tag trunnions and shims so they may be replaced in their original positions.

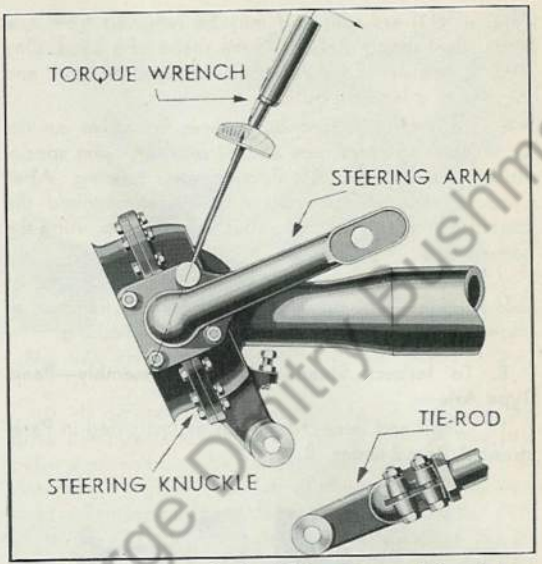


Fig. 24 Typical Method of Using Torque Wrench to Check Steering Knuckle Bearing Adjustment

5. With support (40) removed, separate inner seal (31A) and spring (31) and slide seal and spring over end of axle. Inner seal (32) and housing outer end seal outer

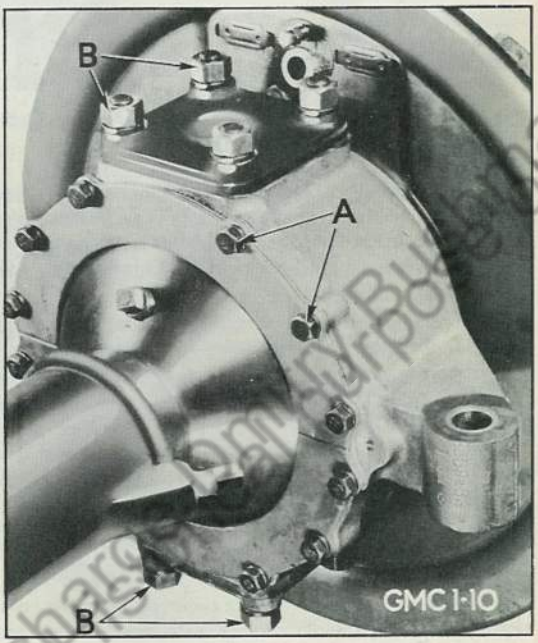


Fig. 25 Outer End Seal Construction—"Banjo" Type Axle

FRONT AXLE

retainer (33) are split and may be removed from axle ends. Seal spring is coiled in the shape of a band. One end is smaller and is inserted in opposite end and twisted to a locked position.

6. To remove bearing outer races first drive out the upper bearing outer race and oil retainer, using special driver (J-1660-2, Fig. 26) through lower bearing. After upper bearing and oil retainer have been removed, the lower bearing may be driven out from the top, using the same driver.

7. Insert oil seal puller J-943 behind seal in end of axle housing. Tapping center of tool with a hammer, as shown in Fig. 27, will remove seal from the housing.

B. To Inspect Steering Knuckle Assembly—Banjo Type Axle—

1. Clean and inspect bearings as instructed in Paragraph 9 (item 2 under "B").

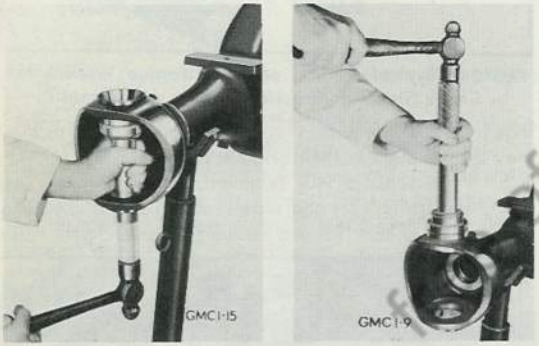


Fig. 26 Removing and Installing Knuckle Bearing Outer Race—"Banjo" Type Axle

2. Inspect bushing (45) in steering knuckle spindle (46). If worn or damaged remove and install new bushing using tool J-1738 for both operations. After installing bushing ream to size given in "Specifications." Then apply coat of lubricant to bushing.

3. Examine thrust washers (44) in axle housing and spindle. Replace if worn or scored badly.

4. Examine axle shaft oil seal removed from end of housing. This is a spring-loaded leather seal and should be replaced with a new part if there is any indication of wear or roughness of the leather. If a new seal is to be installed soak in oil until leather is soft and pliable before installing.

C. To Assemble, Install and Adjust Steering Knuckle Assembly—Banjo Type Axle—

1. If thrust washers (44) were removed from axle housing and knuckle spindle replace with new washers and stake in place. Be sure washer is flat and fully seated. Washer must not be distorted in staking operation.

seal is in good condition and that it has been thoroughly soaked in oil so leather is soft and pliable. Place seal on J-1661 seal replacer with free end of leather towards end of tool. Drive seal in end of housing as illustrated in Fig. 28. In making this installation thrust washer (44) must be in place and seal must be driven in until shoulder on driver strikes on thrust washer. By driving seal in with J-1661 seal replacer in this manner seal will be located with proper clearance ($\frac{1}{32}$"-$\frac{3}{32}$") between inner side of seal and washer in housing.

3. Install oil retainer and then bearing outer race (34) in upper end of axle housing using driver J-1660-2 as shown in Fig. 26.

4. Install bearing outer race in lower end, using same tool. No oil retainer is used at lower end.

5. Place seal inner retainer (30), inner seal (31A) with spring (31) in place on (31A), housing outer end seal (32), housing outer end seal outer retainer (33), and gasket (37) over end of axle housing. It is advisable to use a new gasket. Beveled side of seal (31A) must be towards outer end of axle.

6. Lubricate roller bearings (35) and install in outer races.

7. Place steering knuckle support over end of axle housing.

8. Replace shims over trunnion studs on knuckle support, using one each of following sizes—.002", .005", .010" and .030". The same total shim thickness must be used at both top and bottom.

9. Install trunnions (39) and (42), seating shims and trunnions solidly. Then replace new lockwashers and stud nuts, tightening securely.

10. Install a torque wrench on one of trunnion stud nuts in same position as illustrated in Fig. 24, and measure torque required to turn knuckle. Torque wrench scale reading should be 10 to 12 foot-pounds while knuckle is in motion. This test must be made with axle snaft removed, with oil seal at inner side of support removed, and with tie-rod disconnected. Add or remove shims to obtain correct adjustment but be sure that the total shim thickness is the same at both top and bottom trunnions. Adjust each steering knuckle separately.

11. After knuckle bearings are adjusted properly put gasket (37) and outer seal outer retainer (33) in place on knuckle support. Place retainer joint at top.

12. Place outer seal (32) in retainer with felt side out and with joint horizontal.

13. Put spring loaded seal (31A) with spring (30) in position with beveled side of seal towards outer end of axle.

14. Put inner seal retainer (30) in position with joint at top and install lower half of housing outer end seal inner retainer (29). Use new lockwashers and tighten cap screws finger tight.

15. Adjust retainer (30) so that its outer edges will just fit inside of outer retainer. This adjustment is important to prevent retainer from scoring housing ball.

16. Install upper half of retainer (29) in the same manner and tighten all screws, drawing them up evenly.

17. Replace axle shaft and universal joint assembly, knuckle spindle (46), oil deflector (47), spacer plate (48), anchor plate and shoe assembly, hubs and drum assembly, and shaft drive flange (50) as instructed in preceding paragraphs under "To Install Axle Shafts—Banjo Type Axle Only."

18. Connect tie-rod ends and adjust for toe-in as instructed under "Tie-Rod."

19. Check front wheel alignment (See "Front Wheel Alignment" in this group.)

11. DRIVE PINION ASSEMBLY

For drive pinion assembly removal, installation, disassembly, inspection and assembly, see "Drive Pinion Assembly" in respective Rear Axle group.

12. DIFFERENTIAL CASE ASSEMBLY—SPLIT TYPE AXLE ONLY

The differential case assembly used in the split type front axle is identical to the assembly used in the split type rear axle except that the removal and installation procedures differ. See "Differential Case Assembly" in group 11S, Rear Axle—"Split" Type, for disassembly, inspection and assembly operations. Procedure for removal and installation of the case assembly is given here.

A. To Remove Differential Case Assembly—It is necessary to disconnect the two halves of the axle housing at differential and to remove right hand half of axle from vehicle.

1. Drain lubricant from differential while disconnecting, preparatory to removal.
2. Apply hand brake or block rear wheels.
3. Jack up front end and place a wheel dolly (a drip pan may also be used) under right front tire. Then lower jack so tire just rests on dolly (or pan) so right hand half of axle assembly can be pulled out to side of vehicle when disconnected.
4. Place stand jacks under each frame side rail just back of front spring rear bracket and lower jack until all weight is supported by stand jacks.
5. Place a suitable jack or blocks under left hand half of housing near center to support it when right hand half is removed. Left hand half of housing, drag link, steering knuckles and axle shafts need not be removed to remove differential case assembly.
6. Remove tie-rod as explained under "Tie-Rod."
7. Disconnect right hand brake hose at frame connection.
8. Disconnect right hand shock absorber link at upper spring clip plate.
9. Remove spring U-bolts at right hand spring.

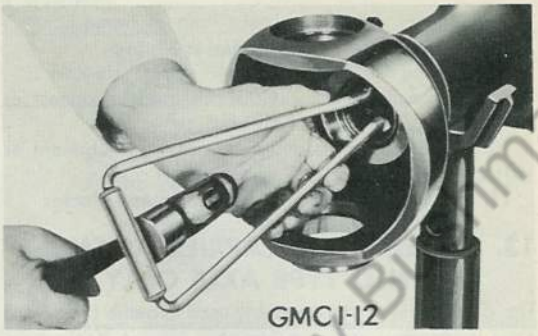


Fig. 27 Removing Axle Shaft Oil Seal "Banjo" Type Axle

10. If differential case alone is to be removed, the drive pinion assembly may remain in position and propeller shaft need not be disconnected. See "Drive Pinion Assembly," in group 11S, if drive pinion is to be removed.
11. Remove bolts at axle housing center and pull right hand half out to right side of vehicle, sliding tire on wheel dolly (or drip pan). Be careful that differential case does not fall out of housing and become damaged.
12. Remove differential case assembly from axle housing.
13. Be careful not to damage or move thrust buttons on ends of axle shafts.

B. To Install Differential Case Assembly—Split Axle Only—

1. Drive pinion and cage assembly must be in place before installing differential case assembly. Also, be sure ring gear thrust block is in place.
2. Replace differential case in left hand housing, slipping side gear over splined end of left hand shaft and pushing solidly into position.
3. Install a new gasket between housing flanges and slide right hand half of housing into position against left hand half, directing shaft into side gear.
4. Bolt housing halves together, using new lockwashers and tightening bolts evenly.
5. Replace right hand spring U-bolts and tighten (See "Springs" group).
6. Connect right hand shock absorber.



Fig. 28 Installing Axle Shaft Oil Seal—"Banjo" Type Axle

7. Connect right hand brake hose at frame connection and bleed brakes. See "Brakes" group.

8. Replace tie-rod as instructed under "Tie-Rod."

9. If propeller shaft was disconnected, reconnect as instructed in "Propeller Shaft" group.

10. Refill differential housing with fresh lubricant as instructed in "Lubrication" section.

11. Remove wheel dolly, stand jacks and blocks.

13. DIFFERENTIAL CARRIER ASSEMBLY —BANJO TYPE AXLE ONLY

The differential carrier assembly used in banjo type front axles is identical with the assembly used in banjo type rear axles. See "Differential Carrier Assembly," "Differential Case Assembly" and "Drive Pinion Assembly" in group 11B, "Rear Axle—Banjo Type."

14. AXLE HOUSING

In the two-piece or "split" type housing, flanges, differential side bearing surfaces, and drive pinion supports are machined to such close limits that no provisions are made for adjusting differential bearings or gear tooth contact. For this reason housing flanges or bearing surfaces must never be machined to true up because both gear and bearing adjustments will be destroyed by such operations.

As mentioned under "Wheel Alignment" and "Trouble Shooting" a bent or twisted axle housing will change camber and caster angles. In the event a housing is found to be bent or twisted it should be replaced. If housing is heated to facilitate straightening the effect of heat treatment will be destroyed. Cold bending may cause a fracture in the steel.

A. To Remove Axle Housing—

1. Remove complete axle assembly as instructed under "To Remove Front Axle."

2. Remove axle shafts, steering knuckle assemblies, drive pinion and differential assembly as instructed in previous paragraphs in this group.

B. To Install Axle Housing—

1. Assemble axle completely as instructed in previous paragraphs.

2. Replace axle assembly in vehicle as instructed under "To Install Complete Front Axle Assembly."

3. Check wheel alignment.

C. To Inspect Axle Housing—Split Type Axle Only—

1. Clean both halves of housing thoroughly.

2. Inspect shaft oil seals in housing just back of bearing cups. These seals are spring loaded leather type and should be replaced at overhaul periods. Use tool J-943 to remove seals and replacer J-2434 to install new ones. Seals should be soaked in oil so leather is soft and pliable before installing. Install with free end of leather towards differential carrier and drive in carefully until seated against shoulder in housing tube.

3. Inspect differential side bearing cups. If necessary, remove using remover J-1708. Note that oil seals must be removed before bearing cups can be removed. Use driver J-1707 to replace bearing cups. Oil seals may be installed either before or after cups are installed.

D. To Inspect Axle Housing—Banjo Type Axle Only—

1. Inspect universal joint thrust washers in outer ends of housing and, if necessary, replace. When installing new washers be sure they are flat and seated solidly in housing. Stake in place but be careful not to distort washers in staking operation.

2. Inspect shaft oil seals in housing just back of universal joint thrust washers. It is good practice to replace these seals at overhaul period. Remove with J-943 remover and install with seal replacer J-1661. Be sure thrust washer is installed **before** installing oil seal.

TABULATED DATA

15. SPECIFICATIONS

FRONT END ALIGNMENT DATA

(Refer to Fig. 3)

	Dimension on Fig. 3	"Split" Type Axle	"Banjo" Type Axle
Toe-In (measured at center of tire tread)	"A" Minus "B"	1/16" to 3/16"	0" to 1/4"
Turning Angle—Inside Wheel	"C"	28° to 29°	28° to 29°
Turning Angle—Outside Wheel	"D"	24°15′ to 25°6′	24°15′ to 25°6′
Center-Line of Steering Arm Ball to Outside Edge of Spring	"E"	4 9/16"	3"
Backing Plate to Center-Line of Tie-Rod Yoke Bolt	"F"	3 3/8"	3 5/16"
Wheel Camber	"H" Minus "G"	17/64"	11/64" to 11/32"
Wheel Camber Angle (Positive)	"J"	0° to 3/4°	1/2° to 1°
Bottom of Steering Arm to Top of Axle Housing	"K"	2 5/8"	2 19/32"
Axle Caster Angle	"L"	2°	1° 30′ to 2° 0′

FRONT AXLE

AXLE SPECIFICATIONS

GENERAL	"SPLIT" TYPE AXLE	"BANJO" TYPE AXLE
Make	Timken	Chevrolet
Model (With "High-Traction" Differential Gears)	F-30-B-28-H-X-26	3663017
Model (With "Standard" Differential Gears)	F-30-B-28-H-X-28	3665635
Housing Type	Split	Banjo
Drive	Thru Springs	Thru Springs
Gear Ratio	6.6 to 1	6.6 to 1
Steering Knuckle Bearings		
Type	Timken Tapered Roller	Timken Tapered Roller
Cone Number	41125	41125
Cup Number	41286	41286
Adjustment (See Text)	Shims	Shims
Shim Thicknesses	.005"-.010"-.030"	.002"-.005"-.010"-.032"
Steering Knuckle Spindle Bushing		
Diameter (Ream in Place)	1.890"-1.895"	1.7025"-1.7045"
Clearance—Bushing to Axle Shaft	.015"-.0205"	.018"-.024"
Tie Rod End Bushing		
Diameter—Ream in Place	.7495"-.7505"	.7495"-.7505"
Clearance—Bolt to Bushing	.0005"-.0025"	.0005"-.0025"

UNIVERSAL JOINTS	"SPLIT" TYPE AXLE		"BANJO" TYPE AXLE
Make	Rzeppa	Bendix-Weiss	Bendix-Weiss
Model—			
Right Hand	——	60122	3659588
Left Hand	——	60121	3659587
Inner Shaft			
Diameter at Splines—Differential End	1.597"-1.602"	1.597"-1.602"	1.6305"-1.6385"
Splines—Differential End	10	10	10
Splines—Universal Joint End	12	——	——
Clearance Between Splines at Universal Joint End	.0015"-.005"	——	——
Outer Shaft			
Diameter at Splines—Hub End	1.623"-1.625"	1.623"-1.625"	1.6435"-1.6445"
Splines	10	10	10
Plunger Springs (Rzeppa)			
Inner Spring Free Length	.920"-.940"	——	——
Inner Spring Outside Diameter	.365"-.380"	——	——
Outer Spring Free Length	2.250"	——	——
Outer Spring Inside Diameter	.392"-.397"	——	——
Center Ball Diameter	——	1.2495"-1.2505"	1.2495"-1.2505"
Drive Ball Diameter	1.0625"	1.375"	1.375"

Note: Drive Balls for Bendix-Weiss Joints are available from .003" undersize to .003" oversize in steps of .001".

Differential (See Group 11S for "Split" Type or Group 11B for "Banjo" Type Front Axle Differential Specifications)

Pinion (See Group 11S for "Split" Type or Group 11B for "Banjo" Type Pinion and Pinion Bearing Specifications)

FRONT AXLE

16. TOOL EQUIPMENT

The following special tools, or their equivalent, are recommended for use when servicing FRONT AXLE.

Tool No.	Name	Supplier Code
CS-1047	Bearing Cone Remover (Split Type Axle)	CS
J-943	Axle Shaft Oil Seal Remover	KM
J-1660-2	Steering Knuckle Bearing Outer Race Tool (Banjo Type Axle)	KM
J-1661	Axle Shaft Oil Seal and Thrust Washer Replacer (Banjo Type Axle)	KM
J-1665	Tie Rod Bushing Tool	KM
J-1706	Steering Knuckle Bearing Cone Replacer (Split Type Axle)	KM
J-1738	Knuckle Spindle Bushing Tool (Banjo Type Axle)	KM
J-1738-A	Knuckle Spindle Bushing Tool (Split Type Axle)	KM
J-2434	Axle Shaft Oil Seal Replacer (Split Type Axle)	KM
KMO-347	Tie Rod Bushing Reamer	KM
TA-1000	Micro-Liner Set	TA

TOOL SUPPLIER

Supplier Code	Name	Address
CS	Curtiss and Smith Manufacturing Corp.	Pottstown, Penn.
KM	Kent-Moore Organization	Detroit, Mich.
TA	Testing Apparatus Co.	Los Angeles, Cal.

SERVICE BULLETIN REFERENCE

Bulletin No.	Description

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Group 11B—Rear Axle (Banjo Type)

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Trouble Shooting and General Solutions	2
Inspection and Adjustment	3
REMOVAL AND INSTALLATION	
To Remove Rear Axle Front Unit	4
To Install Rear Axle Front Unit	5
To Remove Rear Axle Rear Unit	6
To Install Rear Axle Rear Unit	7
(For Complete Carrier Assembly Removal and Installation See Paragraph 9)	
REPAIR	
Axle Shafts	8
Differential Carrier Assembly	9
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GENERAL

1. DESCRIPTION AND OPERATION

Axles described in this group are full floating, spiral bevel hypoid type with one-piece, "banjo" type housings. Component parts of a complete axle assembly are shown in their relative positions in Fig. 1, together with a sectional view of the differential and pinion assembly.

There are two driving rear axles, similar in design and construction. The major difference between the two is that the forward rear axle housing differential carrier bowl is off-center and also, this housing carries a pillow block for the propeller shaft which drives the rearward rear axle.

Power is transmitted from transfer case by two propeller shafts, one to each of the rear axles. Driving force is transmitted from axle to chassis frame by six torque rods attached to the spring trunnion cross-shaft brackets which, in turn, are attached to vehicle frame. Three of the torque rods are attached to each axle and take all driving and braking load at rear axles.

2. TROUBLE SHOOTING AND GENERAL SOLUTIONS

An unusual noise is usually the first evidence of improper functioning of driving axle parts. Occasionally noises which seem to come from the rear axle may be caused by some other unit such as transfer case or transmission. Also, improper tire inflation or uneven tire wear may be the cause of a noise which seems to come from the axle. Common symptoms of axle difficulties and probable remedies are:

A. Continuous Axle Noise, Both on Drive and Coast—

1. Tires may be causing the noise.

Check inflation pressures and condition of tread. Drive vehicle on soft, unfinished road surface and, if this stops noise, it is being caused by tires and not axle.

2. Pinion too deep in ring gear.

Pinion outer bearing (double row ball type) installed backwards.

Remove and replace in correct position.

3. Ring and pinion gears adjusted too tight.

Readjust in accordance with instructions.

4. Pinion or differential bearings worn or damaged.

Inspect and replace worn or damaged parts.

5. Wheel bearings loose or worn.

Inspect and adjust or replace as required. (See "Wheels, Hubs and Tires" group.)

6. Gears damaged or worn excessively.

Inspect and replace defective parts.

B. Axle Noise on Drive Only—

1. Ring gear and pinion adjustment too tight.

Readjust in accordance with instructions.

2. Pinion outer bearing worn or damaged.

Inspect and replace if necessary. Readjust pinion and gear backlash if bearing is replaced.

3. Pinion or gear, rough or worn.

Inspect and replace with new parts.

C. Axle Noise on Coast Only—

1. Excessive lash between pinion and ring gear.

Inspect and readjust in accordance with instructions.

2. Pinion outer bearing worn or damaged.

Inspect and replace if necessary. Readjust backlash if bearing is replaced.

D. Excessive Backlash—

1. Axle shaft flange loose.

Install new shaft flange gasket, retighten cap screws, and lock in place.

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REAR AXLE (Banjo Type)

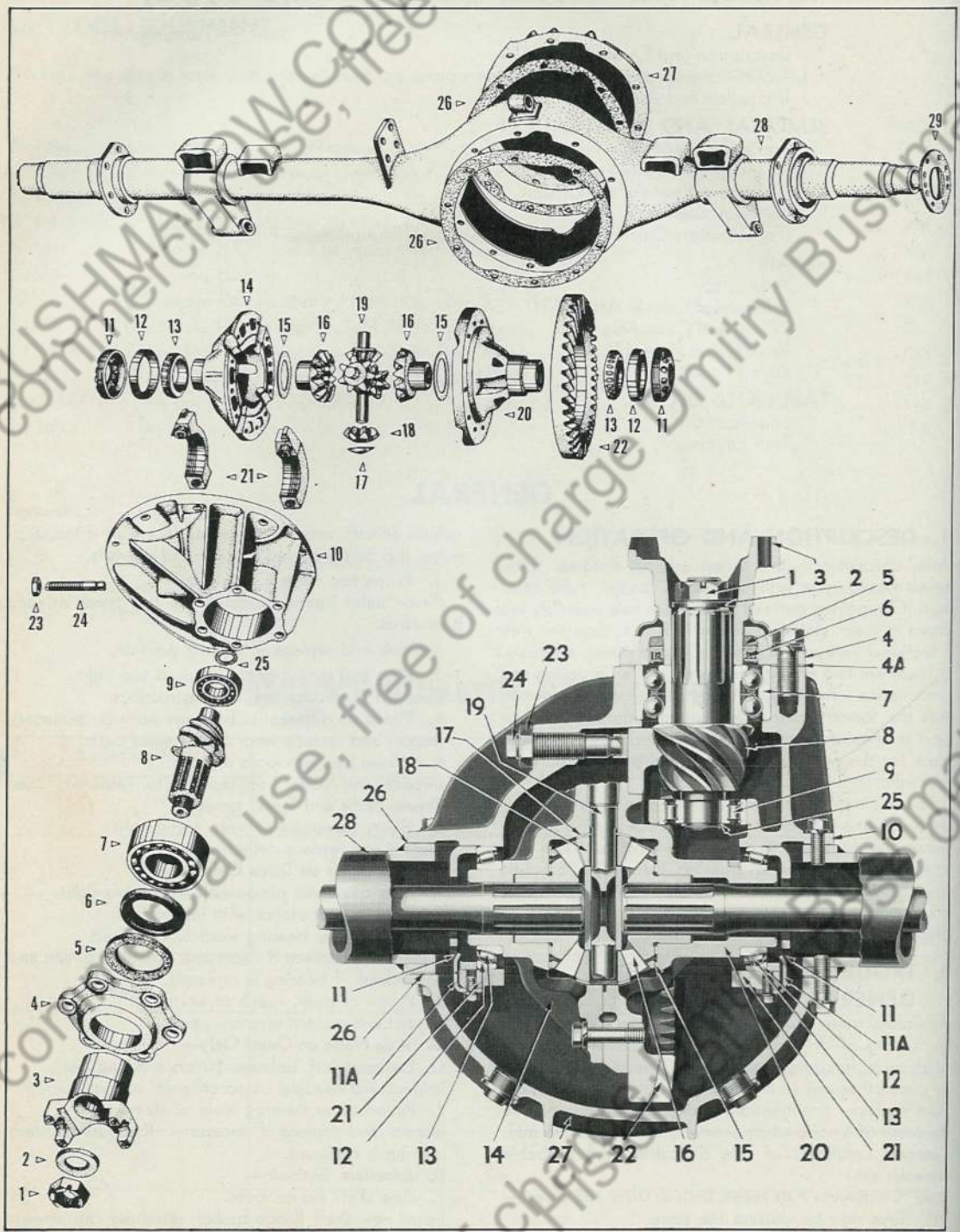


Fig. 1 Assembled and Disassembled View of Rear Axle (Banjo Type)

REAR AXLE (Banjo Type)

Captions for Fig. 1

1. Pinion Flange Nut
2. Pinion Flange Washer
3. Pinion Flange
4. Pinion Oil Seal and Bearing Retainer
4A. Retainer Gasket
5. Pinion Bearing Retainer Packing
6. Pinion Flange Oil Seal Assembly
7. Pinion Outer Bearing
8. Hypoid Drive Pinion
9. Pinion Inner Bearing
10. Differential Carrier
11. Differential Adjusting Nut
11A. Adjusting Nut Lock
12. Outer Race
13. Inner Race Assembly
14. Differential Case Cover
15. Differential Side Gear Thrust Washer (Used with "High-Traction" Differential Gears Only)
16. Differential Side Gear
17. Differential Pinion Thrust Washer (Used with "High-Traction" Differential Gears Only)
18. Differential Pinion
19. Pinion Spider
20. Differential Case
21. Differential Carrier Bearing Cap
22. Hypoid Drive Gear
23. Check Nut $^{7}/_{8}$–14
24. Drive Gear Thrust Pad Assembly
25. Inner Bearing Lock
26. Differential Carrier Gasket
27. Axle Housing Cover
28. Housing Assembly
29. Axle Shaft

2. Differential or side gear thrust washers worn or differential case or side gear hubs may be worn in those axles using "Standard" type differential gears.

Inspect and replace worn parts.

3. Universal joints worn.

Inspect and replace.

3. INSPECTION AND ADJUSTMENT

Regular inspection is essential to obtain maximum trouble-free service from axle units. Instructions on adjustment of differential carrier bearings are given in Paragraph 10 under "To Adjust and Install Differential Case Assembly." Check the following items regularly:

1. Axle housing for leakage of lubricant at pinion and cover.
2. Lubricant level in differential housing.
3. Tire inflation pressure.
4. Wheel nuts, both inner and outer.
5. Axle shaft flange screws.
6. Torque arm stud nuts.

REMOVAL AND INSTALLATION

4. TO REMOVE REAR AXLE—FRONT UNIT

1. Remove differential housing cover and allow lubricant to drain while disconnecting axle.
2. Jack up rear end, using jacks under spring cross-shaft torque rod brackets, as shown in Fig. 2. Be sure jacks are raised high enough so that there will be no load on spring ends after wheels are removed.
3. Place dolly or suitable jack under forward rear axle to support axle and to permit withdrawing from under chassis after disconnecting.
4. Remove wheels. (See "Wheels, Hubs and Tires" group.)
5. Disconnect brake lines at frame connections as explained under "Brakes."
6. Remove four bolts at pillow block bracket on housing and tie pillow block up to keep it from dropping when axle is removed.
7. Mark flanges of forward axle propeller shaft to pinion joint, so they may be replaced in same position at reassembly, and disconnect as explained in "Propeller Shaft" group.
8. Remove nuts from the three torque rods at brackets on axle and force torque rod pins out of brackets.



Fig. 2 Method Used in Jacking Up Rear End

REAR AXLE (Banjo Type)



Fig. 3 Disconnecting Torque Rods From Axle

To start pin, insert a claw bar between bracket and hub of torque arm at axle. Strike bottom of bracket sharply with a heavy hammer while prying with claw bar. See Fig. 3. Do not pry too hard or rubber bushing in torque rod will be damaged.

9. With axle resting on dolly, move forward until springs are out of guide brackets on axle.

10. Draw axle out from under chassis.

5. TO INSTALL REAR AXLE—FRONT UNIT

1. Place axle on dolly and place in approximate position under chassis.

2. Move axle towards rear, sliding spring ends into guide brackets on axle and lining up torque rod holes so rods can be connected.

3. Clean all grease or oil from torque rod pins and see that rubber bushings are clean and free from oil, grease or dirt.

4. Insert torque rod studs in axle brackets. The two lower rods should be put in place before the top rod is installed.

5. Force torque rod studs in solidly, using a heavy hammer and a block of wood. Then install lockwashers and nuts. Tighten securely.

6. Connect propeller shaft to pinion flange with flanges aligned in accordance with marking made at removal. (See "Propeller Shaft" group 9.)

7. Attach pillow block to bracket on housing and tighten the four bolts.

8. Connect brake lines and bleed rear cylinders. (See "Brakes" group 12.)

9. Replace wheels. (See "Wheels, Hubs and Tires" group 13.)

10. Remove dolly and jacks.

11. Refill differential with new lubricant and tighten cover in place. (See "Lubrication" group.)

6. TO REMOVE REAR AXLE—REAR UNIT

Follow procedure given in Paragraph 4, "To Remove Rear Axle—Front Unit," omitting operation No. 6 and moving axle to rear to remove spring ends from brackets on axle housing.

7. TO INSTALL REAR AXLE—REAR UNIT

Follow procedure given in Paragraph 5, "To Install Rear Axle Front Unit," with the exceptions that axle is moved forward to slide springs into seats on housing, and operation No. 7 is omitted.

REPAIR

Discussion of axle repair is broken down to provide a complete procedure for each of the major sub-assemblies of which the complete axle unit is composed. The sub-assemblies are discussed in the order in which they should be removed when an axle is to be disassembled completely. Procedure for removal, installation, disassembly, inspection, repair, reassembly, and adjustment is given for each of the sub-assemblies where applicable.

The information given applies to both rear axle units. Also, the procedures given under "Differential Carrier Assembly," "Differential Case Assembly," and "Drive Pinion Assembly" applies to the corresponding units in the "Banjo" type front axle assembly as well as to the rear axles.

8. AXLE SHAFTS

Axle shafts are full-floating type with flanges forged at outer ends and are attached to hubs by cap screws. Inner ends of shafts are splined and are carried in differential side gears.

A. To Remove Axle Shafts—

1. Bend tangs of lock plate away from cap screws at shaft flange and remove the eight cap screws and lock plate.

2. Install $\frac{7}{16}$" cap screws in the two threaded holes in shaft flange. Turn screws alternately, pulling shaft out of differential side gear. Then draw shaft out of housing completely. (See Fig. 4.)

3. Remove metal gasket at shaft flange.

REAR AXLE (Banjo Type)

4. See "Wheels, Hubs and Tires" group 13 for hub removal instructions if hubs are to be removed.

B. Axle Shaft Inspection—

1. Clean each shaft thoroughly.
2. Inspect very carefully for any indication of twisting along shaft or at splines.
3. Inspect flange screw holes.
4. Mount shaft between lathe centers.
5. Mount a dial indicator in tool carriage with indicator shaft parallel to axle shaft.
6. Rotate shaft slowly and take indicator reading with end of indicator shaft against machined surface on inner side of shaft flange. Discard shaft if total indicator reading exceeds .003".
7. With indicator shaft at right angles to axle shaft, turn axle shaft slowly and take indicator readings near center of shaft. Replace shaft if total indicator reading exceeds $\frac{1}{16}$".

C. To Install Axle Shafts

1. If hubs, bearings and oil seals have been removed, replace as instructed in "Wheels, Hubs and Tires" group.
2. If differential carrier assembly has been removed, it must be installed before replacing axle shafts. (See instructions in Paragraph 9 under "Differential Carrier Assembly.")
3. Be sure shaft and hub surfaces are clean, then place a new aluminum gasket at shaft flange.
4. Push shaft into housing and into differential side gear.
5. Insert the eight cap screws in shaft flange, using a new lock plate.
6. Draw cap screws up alternately until they are all tight. Then bend tangs of lock plate against cap screw heads.
7. If wheels were removed, replace as instructed in "Wheels, Hubs and Tires" group.

9. DIFFERENTIAL CARRIER ASSEMBLY

Complete carrier assembly, consisting of carrier, differential case assembly and pinion assembly, may be removed without disturbing the axle housing, wheels or hubs. The following procedures apply to the "banjo" or "one-piece" type front axle as well as to the rear axles. (Refer to Fig. 1.)

A. To Remove Differential Carrier Assembly—

1. Remove differential housing cover (27) and allow lubricant to drain.
2. Remove axle shafts as described under "Axle Shafts." (For front axle see group 10—Front Axle.)
3. Disconnect propeller shaft universal joint at pinion flange (3). Move propeller shaft away from pinion by sliding at slip joint. (See "Propeller Shaft" group.)
4. Remove cap screws and lockwashers which attach carrier to axle housing.
5. Withdraw carrier assembly from housing.

B. To Install Differential Carrier Assembly—

1. Differential case and pinion must be assembled to carrier and all bearing and gear adjustments completed before carrier assembly is installed. See "Differential Case Assembly" and "Drive Pinion Assembly" for description of these operations.
2. Clean axle housing and cover thoroughly. Be sure mating surfaces of carrier and housing are clean and free from scratches and nicks.
3. Install carrier assembly in housing, using new gasket.
4. Install cap screws and draw up alternately until tight. **Note:** Use cap screws with "H" stamped on head.
5. Replace housing cover and gasket and tighten cap screws. Cover used on front and rear axles is the same. When used at rear, be sure filler hole marked **"Rear** oil level" is below axle center line, or installed so that lettering is upright. When used at front axle, the hole marked **"Front** oil level" should be below the center line so words will be upright. See Fig. 5.
6. Replace axle shafts as instructed under "AXLE SHAFTS" in this group for rear axle or in "Front Axle" group for front axle.

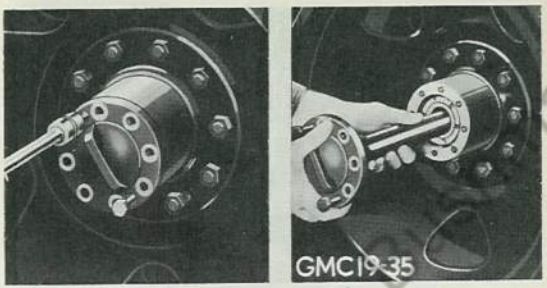


Fig. 4 Loosening and Removing Axle Shafts

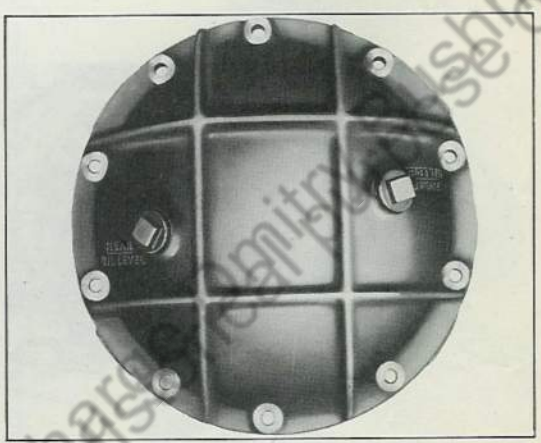


Fig. 5 Install Cover in Position Shown for Rear Axle; Rotate 180 Degrees for Front Axle

REAR AXLE (Banjo Type)

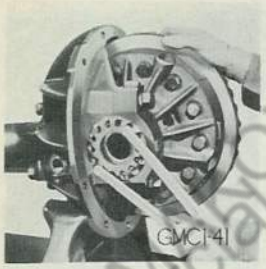


Fig. 6 Adjusting Ring Gear and Pinion Backlash



Fig. 7 Checking Backlash Between Pinion and Ring Gear with Dial Indicator

7. Fill differential housing with new lubricant as instructed in "LUBRICATION" group "L."

8. Connect propeller shaft as instructed in "PROPELLER SHAFT" group 9.

C. Differential Carrier Adjustment—

Instructions for adjustment of differential carrier bearings are given in Paragraph 10 under "To Adjust and Install Differential Case Assembly."

10. DIFFERENTIAL CASE ASSEMBLY

A. To Remove Case Assembly from Carrier (Refer to Fig. 1)—

1. Remove complete carrier assembly from axle as described under "DIFFERENTIAL CARRIER ASSEMBLY."

2. Mount carrier in vise.

3. Remove ring gear thrust pad (24).

4. Remove differential adjusting nut locks from differential bearing caps (21).

5. Remove bearing caps. Do not damage or loose the dowel sleeves.

6. Remove differential case and ring gear assembly from carrier.

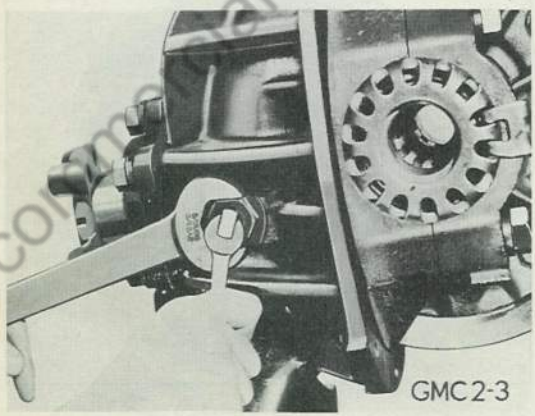


Fig. 8 Adjusting Ring Gear Thrust Pad

B. To Adjust and Install Differential Case Assembly—

1. If pinion assembly has been removed from carrier, it must be replaced before installing the case assembly. See Paragraph 11, "DRIVE PINION ASSEMBLY," for this operation.

2. Mount differential carrier (10) in vise.

3. Place differential assembly in carrier.

4. Put differential side bearing outer races (12) in place.

5. Replace bearing caps (21), being careful that dowel sleeves are in place and that marks on caps and carrier are aligned.

6. Tighten cap screws until lockwashers just flatten out.

7. Screw adjusting nuts (11) into carrier. If nuts do not turn freely, check bearing cap alignment with marks on carrier.

8. Tighten nuts with Tool J-972 (Fig. 6) to straighten bearing outer races (12). In this operation turn nuts on each side of case alternately so that both will be screwed into cap and carrier assembly the same amount when tightened.

9. Back off adjusting nut on side of case which carries ring gear and tighten the other nut, making each change in small steps, until all backlash between pinion and ring gear is removed.

10. Then back off nut on side opposite ring gear approximately two notches, stopping with nut in position to permit lock to engage slots in nut.

11. Tighten adjusting nut solidly on side of case which carries ring gear. The purpose of this operation is to seat bearings. Nut must be drawn up solid to assure proper seating of bearings.

12. Now back off this same nut free of bearing and then tighten it again. This time, however, bring it up just tight enough to eliminate all play in bearings.

13. After nut has been brought up just to the point where all play has been removed from bearings, tighten it one to two more notches to preload bearing, stopping at position where lock will engage notches in nut.

14. Backlash between pinion and ring gear should be .005" to .008". Check with dial indicator as shown in Fig. 7. If backlash is not within these limits, adjust as follows:

(a) To decrease backlash, loosen adjusting nut on side of case which carries ring gear one notch and tighten other nut one notch. Check backlash and repeat if necessary.

(b) To increase backlash, loosen adjusting nut on side of case opposite ring gear one notch and tighten the other nut one notch. Check backlash and repeat if necessary.

15. Tighten differential carrier cap screws and recheck backlash.

16. Install adjusting nut locks and tighten in place.

17. Install ring gear thrust pad (24).

18. Rotate ring gear slowly and tighten thrust pad

REAR AXLE (Banjo Type)

screw until bronze tip contacts back of ring gear lightly. Then back off screw one-twelfth (1/12) of a turn and tighten lock nut (23) as shown in Fig. 8. Be sure screw does not turn during locking process.

19. Replace complete carrier assembly as instructed in Paragraph 9, "To Install Differential Carrier Assembly."

C. To Disassemble Differential Case—

1. Remove differential adjusting nuts (11) and side bearing outer races (12).

2. Remove bearing inner races (13). These bearings are pressed on each side of case and must be removed with a special puller, as shown in Fig. 9, or bearings will be damaged.

3. Before separating the two halves of the case be sure it is marked as shown in Fig. 10 so that the two halves may be replaced in original position.

4. Remove the twelve cap screws and lock washers and separate case.

5. Remove side gears, trunnion and pinions. Two types of differential gears ("high traction" type and "standard" type) are used in these axles in production. The difference between the two types is in the shape of the gear teeth, the "high traction" type having deeper, thicker teeth than the "standard" type, as shown in Fig. 11. These two types are interchangeable as complete sets, consisting of two side gears and four pinions. **However, thrust washers are used between case and pinion, and case and side gears, only when the "high traction" differential gears are used.** No thrust washers are used with the "standard" type, either at pinions or at side gears.

6. Remove ring gear from case by tapping with soft hammer.

D. To Inspect Differential Case Assembly—

1. Clean and inspect bearings as follows:

(a) Soak in suitable cleaning fluid such as clean gasoline.

(b) Remove from fluid and strike larger side of bearing flat against a wood block to knock out heavier particles of dirt.

(c) Blow bearings clean and dry with compressed air, directing air across bearings. Be careful not to spin bearings.

(d) Rotate each bearing slowly by hand, and inspect rollers and race for defects and excessive wear. Never spin bearings while dry.

(e) After inspection, dip bearings in engine oil and wrap in clean cloth.

2. Wash all other parts thoroughly in clean gasoline.

3. Inspect side bearings for worn or chipped rollers. Lubricate and rotate by hand to check for any roughness.

4. Inspect ring gear teeth.

5. Inspect side gear teeth, fit of hubs in case, and condition of splines.

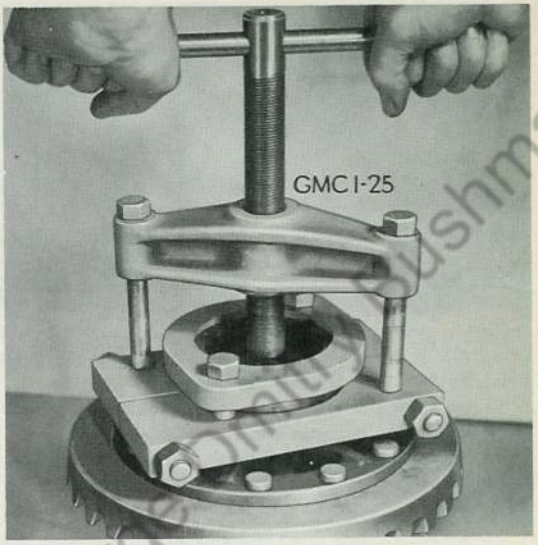


Fig. 9 Typical Method of Removing Differential Side Bearings with CS-1047 Bearing Puller

6. Inspect pinion teeth and fit of pinions on trunnion arms.

7. If the differential gears are out of the "high traction" type (see Fig. 11), examine the six thrust washers for wear. No thrust washers are used in the "standard" type differential.

8. Inspect both halves of case at pinion and side gear bearing surfaces.

9. Inspect bronze tip of ring gear thrust pad and replace with new part if worn.

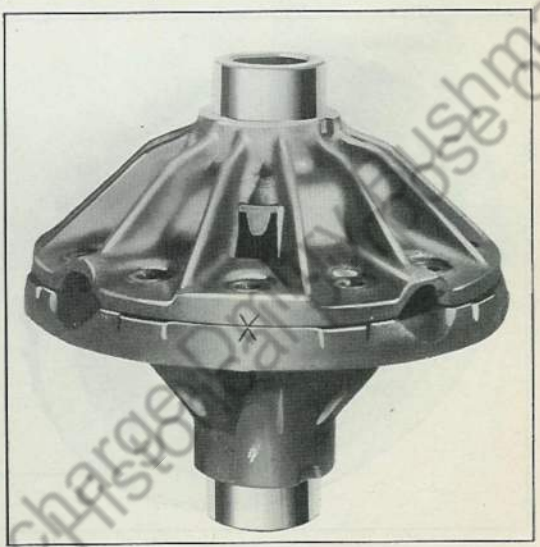
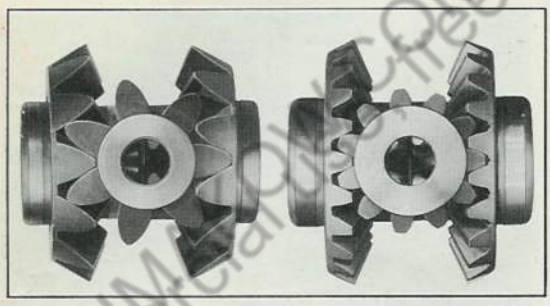


Fig. 10 Mark Differential Case Before Disassembling

REAR AXLE (Banjo Type)



High Traction *Standard*

Fig. 11 Types of Differential Gears

E. To Assemble Differential Case—

1. Use new parts in place of any that show indications of damage or excessive wear.
2. Be sure that all parts are cleaned thoroughly.
3. Replace ring gear (22) on differential case (20). Be sure mating surfaces are clean and free from burrs. This replacement operation can be performed best if two guide pins are made from differential case screws and installed in gear, as shown in Fig. 12. Taper ends of guide pins slightly and make screw driver slots in ends to facilitate removal. Slip ring gear over pilot shoulder on case (20).
4. Lubricate pinions (18), side gears (16) and trunnion (19) and install in case (20). If any one of these gears is damaged, always replace with a complete new set, consisting of two side gears (16) and four pinions (18).

Important: Determine whether differential gears are of the "high-traction" or "standard" type (Fig. 11). If "high-traction" type gears are being installed, be sure to install thrust washers between both the side gear and case and the pinions and case. Do not use thrust washers with "standard" type gears.

5. Place differential case cover (14) on case (20) over guide pins, being certain that marks on case and cover are aligned, as shown in Fig. 10.
6. Install ten differential case cap screws with new lockwashers. Tighten alternate screws one turn at a time until ring gear is flush against case flange.
7. Remove guide pins and install the two remaining cap screws and washers. Then draw all twelve screws up tight.
8. Replace side bearing inner races (13) on each side of case, using special driver J-1488.

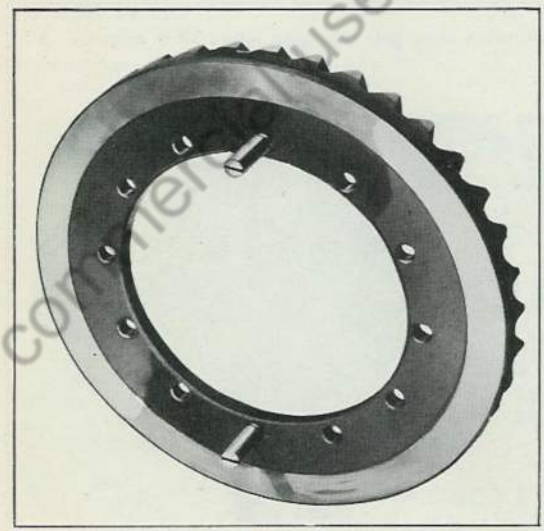


Fig. 12 Ring Gear Guide Pins

11. DRIVE PINION ASSEMBLY

A. To Remove Pinion Assembly—

1. Carrier assembly must be removed from axle housing as explained under "Differential Carrier Assembly."
2. Differential case assembly must be removed as explained under "Differential Case Assembly."
3. With carrier mounted in vise, remove bolts from pinion oil seal and bearing retainer (4).
4. Remove complete pinion and bearing assembly from carrier.

B. To Install Drive Pinion Assembly in Carrier—

1. Use a new gasket between retainer (4) and carrier (10).
2. Replace drive pinion assembly in carrier, attaching securely with cap screws and new lockwashers.
3. For ring gear and pinion adjustment see "To Install and Adjust Differential Case Assembly."
4. To replace carrier in axle housing, see "To Replace Differential Carrier Assembly."

C. To Disassemble Drive Pinion Assembly—

1. Clamp universal joint yoke (3) in vise.
2. Remove cotter pin, nut (1) and washer from end of pinion shaft.
3. Remove yoke, oil seal and bearing retainer (4), packing (5), and seal (6) from shaft.
4. Remove lock ring (25) from inner end of pinion shaft.
5. Place pinion in an arbor press, using special press plate J-1453A, and press pinion shaft (8) out of inner bearing (9), as shown in Fig. 13. Be sure plate is installed with recessed side towards pinion so that the pressure is applied to inner race.
6. Place special press plate J-1439 over pinion and press shaft out of double row bearing, as shown in Fig. 14.

D. To Inspect Drive Pinion Assembly—

1. Clean and inspect bearings as explained in Paragraph 10, "To Inspect Differential Case Assembly."
2. Clean all other parts thoroughly in clean gasoline.
3. Inspect pinion for worn or chipped teeth.
4. Inspect pinion shaft and splines for indications of

REAR AXLE (Banjo Type)

twisting or damage.

5. Check fit of both bearings in carrier. They should be a close push fit by hand.

6. Inspect oil seal and felt packing.

E. To Assemble Drive Pinion Assembly—

1. Use new parts in place of any that are worn or damaged. Drive pinion and ring gear should always be used as matched sets. If pinion is replaced, the ring gear should be replaced also.

2. Press double row bearing (7) on pinion shaft (8). **The extended portion of bearing inner race must be towards the gear and seated against heel of gear.**

3. Press roller bearing (9) on inner end of shaft with chamfered side of inner race toward pinion.

4. Install lock ring (25) on inner end of shaft, using lock ring installer J-1364, as shown in Fig. 15.

5. Replace felt (5) in retainer (4), seating felt evenly.

6. Install oil seal assembly (6) in retainer with open end of leather out. Use oil seal replacing tool J-1658, as shown in Fig. 16. Press seal against felt.

7. Place retainer and seal assembly on universal joint yoke (3).

8. Replace yoke on splined pinion shaft.

9. Place flat washer (2) and nut (1) on shaft.

10. Tighten nut with torque wrench set to 160-280 lbs.-ft. and install cotter pin.

12. AXLE HOUSING

A. To Remove Axle Housing—

1. Remove complete axle from vehicle as explained in Paragraph 4 or Paragraph 6.

2. Remove axle shafts and carrier assembly as explained in Paragraphs 8 and 9, respectively.

3. Remove wheels, hubs and drums as explained in "Wheels, Hubs and Tires" group.

B. To Install Axle Housing—

Replace carrier assembly, hubs and shafts and replace unit in vehicle as described in previous paragraphs in this group.

C. To Inspect Axle Housing—

1. Clean housing thoroughly.

2. Clean, inspect and install hubs temporarily, as explained in "Wheels, Hubs and Tires" group, except that bearing adjusting nuts must be drawn up tight so hubs will just turn on bearings.

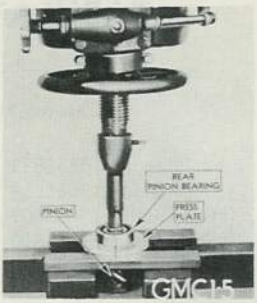


Fig. 13 Removing Pinion Inner Bearing (Single Row Type)

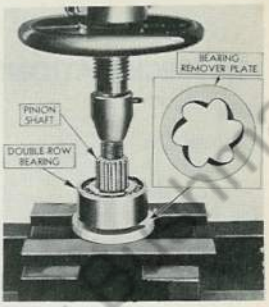


Fig. 14 Removing Pinion Outer Bearing (Double Row Type)

3. Be sure axle shafts are straight and flanges are square with shaft, as explained under "Axle Shafts."

4. Install axle shafts and draw cap screws up tight.

5. Attach a dial indicator to housing center to measure shaft run-out in housing.

6. Rotate shaft slowly (do not spin) and take indicator readings on finished surface of each shaft near back of splines. If run-out of either shaft exceeds $\frac{1}{32}$" total indicator reading, and shafts were found to be straight when checked in lathe, the hub bearing adjustment or shaft connection at hub are incorrect.

7. When both shafts are installed properly so run-out does not exceed $\frac{1}{32}$", lay a straight edge on shafts. If the two shafts are out of alignment by more than $\frac{1}{32}$", the housing is bent and should be replaced.



Fig. 15 Installing Inner Bearing Lock Ring



Fig. 16 Installing Pinion Oil Seal in Retainer

REAR AXLE (Banjo Type)

TABULATED DATA

13. SPECIFICATIONS

Make ..... Chevrolet
- Model
  - Front Unit ..... (Standard) 3665633
  - Rear Unit ..... (Standard) 3665634
  - Front Unit ..... (High Traction) 3665609
  - Rear Unit ..... (High Traction) 3665610
- Housing ..... Banjo
- Drive ..... Torque Rods
- Gear Ratio ..... 6.6 to 1

Differential
- Drive ..... Hypoid
- Bearings ..... Hyatt Barrel
- Number KA-11820-2

Pinion Shaft Bearings
- Inner ..... Hyatt Roller
- Number U-1306-TAM
- Outer ..... New Departure
- Number 954237

Axle Shaft
- Diameter—Differential End 1.6445–1.6345
- Number of Splines 10

Differential
- Bearing Adjustment ..... Adjusting Rings
- Gear to Pinion Backlash ..... .005″–.008″
- Gear Run-Out—Not Over ..... .002″
- Case Run-Out—Not Over ..... .002″

Clearance Between
- Pinion and Spider ..... .004″–.008″
- Side Gear and Case ..... .002″–.006″

Differential Gear Thrust Washers
- New Limits ..... .062″–.058″

Note: Thrust washers are used at pinions and side gears when "High-Traction" differential gears are used. No washers used with "Standard" type gears. (See Fig. 9.)

Pinion Shaft Adjustment
- Bearing Adjustment ..... Bearing Must Turn with no Perceptible End Play—Tighten Nut to 160-280 ft.-lbs. Torque

Drive Gear Thrust Block
- Clearance—Block to Gear ..... .005″–.007″
- Block Thickness ..... .1865″–.1885″

Axle Shaft
- Shaft Flange Run-Out—Not Over ..... .003″
- Shaft Run-Out at Center—Not Over ..... $\frac{1}{16}$″

(See "To Inspect Axle Shafts" in this Group)

Housing Inspection
- Shaft Inner Ends to Be Aligned in Housing Within ..... $\frac{1}{32}$″

(See "To Inspect Axle Housings" in this Group)

14. TOOL EQUIPMENT

The following special tools, or their equivalent, are recommended for use when servicing REAR AXLE (BANJO TYPE).

Tool No.	Name	Supplier Code
CS-1047	Bearing Cone Remover	CS
HS-22-2	Socket for "U" Joint Yoke Nut	GG
J-870-G	Wheel Bearing Nut Wrench	KM
J-972	Differential Side Bearing Adjusting Wrench	KM
J-1364	Pinion Bearing Lock Ring Installer	KM
J-1439	Pinion Outer Bearing Remover	KM
J-1453-A	Pinion Inner Bearing Press Plate	KM
J-1488	Differential Side Bearing Replacer	KM
J-1658	Pinion Bearing Oil Seal Replacer	KM
T-20-22-R-3	Holder for J-1453-A Press Plate	KM

TOOL SUPPLIER

Supplier Code	Name	Address
CS	Curtiss and Smith Manufacturing Corp.	Pottstown, Penn.
GG	G and G Sales Company	Detroit, Mich.
KM	Kent-Moore Organization	Detroit, Mich.

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Group 11S—Rear Axle ("Split" Type)

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To Remove Rear Axle Rear Unit	6
To Install Rear Axle Rear Unit	7
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GENERAL

1. DESCRIPTION AND OPERATION

Axles described in this group are full-floating, spiral bevel type with two-piece or "split" type housings. Component parts of a complete axle assembly are shown in their relative positions in Fig. 1, along with a sectional view of the differential and pinion assembly.

There are two driving rear axles, similar in design and construction. The major difference between the two is that the differential carrier is off-center in the forward rear axle, and also, the forward housing supports a pillow block for the propeller shaft which drives the rearward rear axle.

Power to rear axles is transmitted from transfer case by two propeller shafts, one to each of the axles. Driving force is transmitted from axle to chassis frame by six torque rods (Fig. 2) attached to spring trunnion brackets at one end and to brackets on axle housing at other end. Three of these rods are connected to each rear axle and take all their driving and braking load.

2. TROUBLE SHOOTING AND GENERAL SOLUTIONS

An unusual noise is usually the first evidence of improper functioning of driving axle parts. Occasionally, noises which seem to come from the axles may be caused by some other unit in the drive line such as transfer case or transmission. Also, improper tire inflation or uneven tire wear may be the cause of a noise which seems to come from the axle. Common symptoms of axle difficulties and probable remedies are:

A. Continuous Axle Noises, Both on Drive and Coast

1. Tires may be causing the noise—
   Check inflation pressures and condition of tread. Drive vehicle on soft, unfinished road surface and, if this eliminates the noise, it is being caused by tires and not by axle.
2. Wheel bearings are loose or worn—
   Inspect and adjust as explained in "Wheels, Hubs and Tires" group 13.
3. Drive pinion meshed too deep—
   Check backlash of pinion and ring gear. If lash is appreciably less than amount given in "Specifications," install a .003"–.005" shim between axle housing and pinion bearing cage.
4. Drive pinion bearings or differential side bearings worn or damaged—
   Inspect bearings and replace if necessary.
5. Drive pinion and ring gear teeth worn or damaged—
   Inspect teeth and replace gears if necessary. Always replace both pinion and gear as a matched set.

B. Axle Noise on Drive Only

1. Drive pinion bearings loose or worn—
   Inspect and replace if necessary.
2. Drive pinion meshed too deep in ring gear—
   Inspect and, if backlash is appreciably less than amount given in "Specifications," install a .003" shim between axle housing and pinion bearing cage.
3. Pinion or gear rough or worn excessively—
   Inspect and replace if necessary. Always replace both pinion and gear as a matched set.

C. Axle Noise on Coast Only

1. Drive pinion bearings loose or worn—
   Inspect and adjust or replace as necessary.
2. Drive pinion or ring gear teeth worn or damaged—
   Inspect and replace gears as a matched set.

3. INSPECTION

Regular inspection is essential to obtain maximum trouble-free service from axle units. Check the following items regularly:

REAR AXLE ("Split" Type)

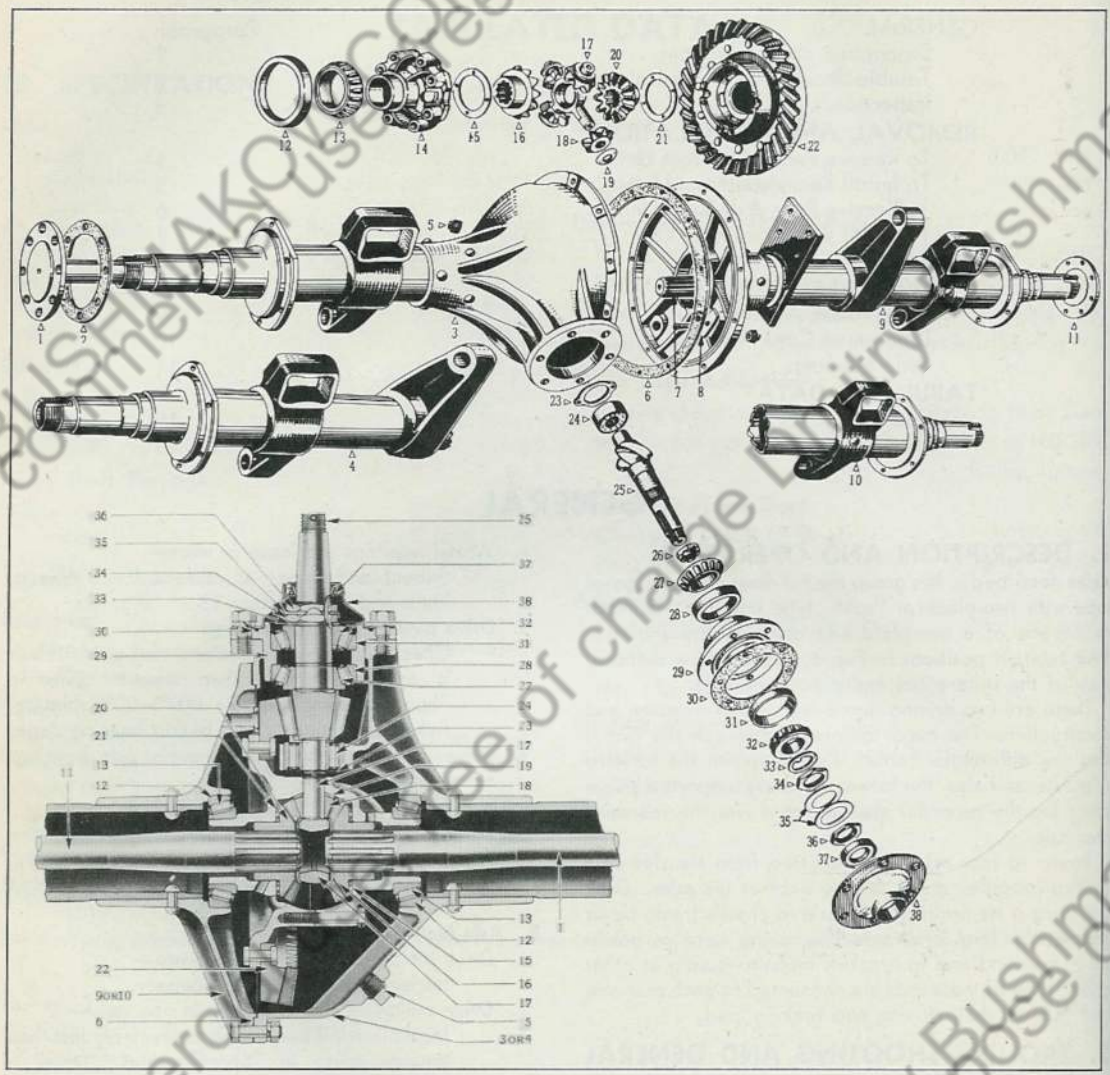

Fig. 1 Rear Axle—"Split" Type

1. Axle Shaft
2. Shaft Flange Gasket
3. Axle Housing, Forward, R.H.
4. Axle Housing, Rear, R.H.
5. Plug
6. Axle Housing Gasket
7. Axle Shaft
8. Thrust Block
9. Axle Housing, Forward, L.H.
10. Axle Housing, Rear, L.H.
11. Axle Shaft
12. Differential Bearing Cup
13. Differential Bearing
14. Differential Case
15. Side Gear Thrust Washer
16. Differential Side Gear
17. Differential Spider
18. Differential Pinion
19. Pinion Thrust Washer
20. Differential Side Gear
21. Side Gear Thrust Washer
22. Diff. Case and Ring Gear
23. Inner Bearing Retainer
24. Pinion Inner Bearing
25. Drive Pinion
26. Pinion Nut
27. Pinion Outer Bearing
28. Pinion Outer Bearing Cup
29. Pinion Bearing Cage
30. Pinion Cage Gasket
31. Pinion Outer Bearing Cup
32. Pinion Outer Bearing
33. Adjusting Nut Washer
34. Pinion Adjusting Nut
35. Pinion Nut Lock—2 Required
36. Pinion Lock Nut
37. Pinion Outer Seal
38. Outer Seal Retainer

REAR AXLE ("Split" Type)

1. Axle housing for leakage of lubricant at pinion and at housing flange.
2. Lubricant level in differential housing.
3. Tire inflation pressure.
4. Wheel nuts, both inner and outer as instructed in "Wheels, Hubs and Tires" group 13.
5. Axle shaft flange stud nuts.
6. Torque arm stud nuts.

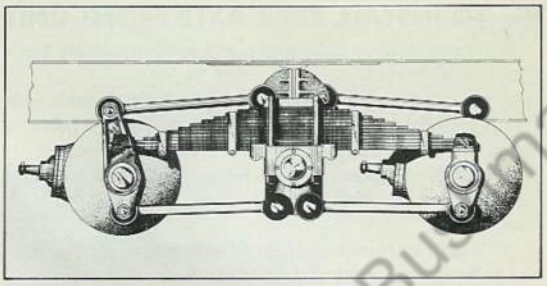

Fig. 2 Typical Arrangement of Torque Rods

REMOVAL AND INSTALLATION

4. TO REMOVE REAR AXLE FRONT UNIT

1. Remove plug and allow differential lubricant to drain while disconnecting axle preparatory to removal.
2. Jack up rear end, using jacks under spring cross-shaft torque rod brackets as shown in Fig. 3. Be sure jacks are raised high enough so that there will be no weight on spring ends after wheels are removed.
3. Remove wheels. (See "Wheels, Hubs and Tires" group 13.)
4. Place dolly or suitable jack under forward rear axle to support axle.
5. Disconnect brake lines at frame connections as explained in "Brakes" group 12.
6. Remove four bolts at pillow block bracket on housing and tie pillow block up to keep it from dropping when axle is removed.
7. Mark flanges of forward axle propeller shaft to pinion joint, so they may be replaced in same position at reassembly, and disconnect as explained in "Propeller Shaft" group 09.
8. Remove nuts from the three torque rods at brackets on axle and force torque rod pins out of brackets. To start pin, insert a claw bar between bracket and hub of torque arm to axle. Strike bottom of bracket sharply with a heavy hammer while prying with claw bar. Do not pry too hard or rubber bushing in torque rod will be damaged. (See Fig. 4.)
9. With axle resting on dolly, move forward until springs are out of guide brackets on axle.
10. Draw axle out from under chassis.



Fig. 3 Method Used in Jacking Up Rear Axle



Fig. 4 Disconnect Torque Rods From Axle

REAR AXLE ("Split" Type)

5. TO INSTALL REAR AXLE FRONT UNIT

1. Place axle on dolly and place in approximate position under chassis.
2. Move axle towards rear, sliding spring ends into guide brackets on axle and lining up torque rod holes so rods can be connected.
3. Clean all grease or oil from torque rod pins and see that rubber bushings are clean and free from oil and grease.
4. Insert torque rod studs in axle brackets. The two lower rods should be put in place before the top rod.
5. Force torque rod studs in solidly, using a heavy hammer and a block of wood. Then install lockwashers and nuts. Tighten securely.
6. Connect propeller shaft to pinion flange with flanges aligned in accordance with marking made at removal. (See "Propeller Shaft" group 09.)
7. Attach pillow block to bracket on housing and tighten the four bolts.
8. Connect brake lines and bleed rear cylinders. (See "Brakes" group 12.)
9. Replace wheels. (See "Wheels, Hubs and Tires" group 13.)
10. Remove dolly and jacks.
11. Refill differential with new lubricant and replace plug in filler hole. (See "Lubrication" group "L.")

6. TO REMOVE REAR AXLE REAR UNIT

Follow procedure given in Paragraph 4, "To Remove Rear Axle Front Unit," omitting operation No. 6 and moving axle to rear to remove spring ends from brackets on axle housing.

7. TO INSTALL REAR AXLE REAR UNIT

Follow procedure given in Paragraph 5, "To Install Rear Axle Front Unit," with the exceptions that axle is moved forward to slide springs into seats on housing, and operation No. 7 is omitted.

REPAIR

Discussion of axle repair is broken down to provide a complete procedure for each of the major sub-assemblies of which the complete axle unit is composed. The sub-assemblies are discussed in the order in which they should be removed when an axle is to be disassembled completely. Procedure for removal and installation, disassembly, inspection, repair, reassembly, and adjustment is given for each of the sub-assemblies where applicable.

The information given applies to both the forward and rearward rear axle units. Also the procedures given under "Drive Pinion Assembly" and "Differential Case Assembly" applies to the corresponding units in the "Split" type front axle assembly as well as to the rear axles of this type.

8. AXLE SHAFTS

Axle shafts are full-floating type with flanges forged at outer ends. Flanges are attached to hubs by studs, nuts and tapered dowels. Inner ends of shafts are splined and are carried in differential side gears.

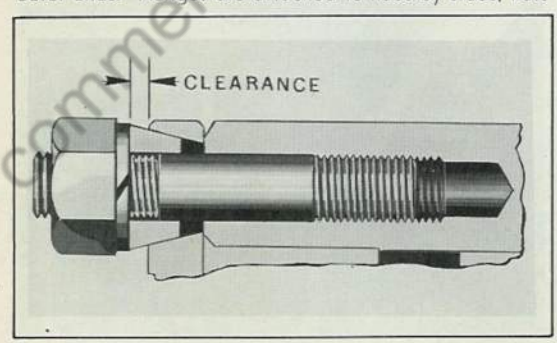

Fig. 5 There Must Be Clearance Between Lockwasher and Driving Flange When Nuts Are Tight

A. To Remove Axle Shafts—

1. Remove nuts and lockwashers from flange studs.
2. Use puller screws in threaded holes in flange to draw shafts out of side gears. Turn screws alternately.
3. Withdraw shafts from housing.

B. To Install Axle Shafts—

1. If hubs, bearings and oil seals have been removed, inspect and replace as instructed in "Wheels, Hubs and Tires" group.
2. If differential case assembly has been removed, replace and assemble housing as instructed in Paragraph 10, "To Install Differential Assembly."
3. Use new gaskets between shaft flange and hub and install axle in housing, sliding splined end into side gear hubs.
4. Install split tapered dowels on all studs, install new lockwashers and tighten stud nuts alternately. **Note:** Tapered dowels are split so they will compress around stud without bottoming against hub when studs are tightened. There should be a slight clearance between lockwasher and axle flange (Fig. 5) after nuts are tightened. If there is no clearance, studs, dowels or dowel holes in shaft flange are worn excessively and new parts should be used.

C. Axle Shaft Inspection—

1. Clean each shaft thoroughly.
2. Inspect very carefully for any indication of twisting along shaft or at splines.
3. Inspect tapered dowel holes in flanges.
4. Mount shaft between lathe centers.

REAR AXLE ("Split" Type)

5. Mount a dial indicator in tool carriage with indicator shaft parallel to axle shaft.

6. Rotate shaft slowly and take indicator reading with end of indicator shaft against machined surface on inner side of shaft flange. Install new shaft if total indicator reading exceeds .005".

7. With indicator shaft at right angles to axle shaft, turn axle shaft slowly and take indicator readings near center of shaft. Install new shaft if total indicator reading exceeds $\frac{1}{32}$".

9. DRIVE PINION ASSEMBLY

Drive pinion is straddle mounted with two opposed tapered roller bearings at outer side and one straight roller bearing at inner end. The pinion assembly, including the two outer bearings and oil seal, may be removed without disassembling any other parts of the axle unit. Removal of inner bearing (straight roller) requires separating the two halves of the axle housing. This is discussed in Paragraph 10, "Differential Case Assembly."

Following operations apply to either of the two rear axles and also to the front axle ("Split Type"):

A. To Remove Drive Pinion Assembly—

1. Remove propeller shaft flange nut from end of pinion shaft, using a socket wrench.

2. Remove propeller shaft flange from pinion shaft with puller J-1714, as shown in Fig. 6.

3. Remove cap screws which hold pinion bearing cage to axle housing.

4. Pull drive pinion, seal, cage and outer bearings out of housing with puller J-1701, as shown in Fig. 7.

B. To Install and Adjust Drive Pinion Assembly—

1. With drive pinion and bearing cage assembled, install in housing. Be certain mating surfaces of pinion bearing cage flange and axle housing are smooth and clean. Housing and cage are machined to very close limits during manufacture so no adjustment will be required to obtain proper pinion and ring gear backlash and tooth contact. However, in some instances, machining variations may be such as to require the use of a shim between bearing cage and axle housing to secure proper backlash. In cases where such a shim is required, it is installed in production. However, if an axle has a continuous hum, both on drive and coast, it may be the result of insufficient backlash. In such a case, a .003" shim may be installed between pinion bearing cage and housing, as mentioned in "Trouble Shooting."

2. Install a new gasket and a new oil seal and cover assembly on pinion shaft. New seal and cover assembly should be soaked in Neatsfoot or engine oil until leather is soft and pliable before being assembled to shaft. Be very careful that this seal is not damaged.

3. Install and tighten cap screws fastening pinion, cage and seal assembly to housing. Use new lockwashers.

C. To Disassemble Drive Pinion Assembly—

1. Clamp pinion between two blocks of wood in a vise.



Fig. 6 Removing Pinion Flange



Fig. 7 Removing Pinion Cage

2. Remove oil seal and cover assembly.

3. Straighten lips of lockwashers and remove locknut, lockwashers and adjusting nut. Use KMO-351 wrench, as shown in Fig. 8.

4. Push shaft out of cage and tapered roller bearings, using J-1704 press plate and holder assembly in an arbor press, as shown in Fig. 9.

5. Remove bearing cones from cage.

6. Inspect bearing cups and, if damaged or worn excessively, remove from cage with a puller. If puller is not available, cups may be driven out with a brass drift but, when this method is used, great care must be taken to prevent cups from becoming cocked and damaging the cage.

D. To Inspect Drive Pinion Assembly—

Refer to Fig. 1 for caption numbers in parenthesis.

1. Clean and inspect bearings as follows:

(a) Soak in suitable cleaning fluid such as clean gasoline.

(b) Remove from fluid and strike larger side of bearing flat against a wood block to knock out heavier particles of dirt.

(c) Blow bearings clean and dry with compressed air, directing air across bearings. Be careful not to spin bearings.



Fig. 8 Removing Pinion Shaft Nut



Fig. 9 Removing Outer Bearing and Cage From Pinion Shaft

REAR AXLE ("Split" Type)



Fig. 10 Installing Pinion Bearing Cups in Cage

(d) Rotate bearings slowly by hand, and inspect rollers and races for defects and excessive wear.

(e) After inspection, dip bearing in engine oil and wrap in clean cloth.

2. Clean and inspect oil seal assembly but **do not attempt to remove seal (37) from retainer (38).** It is advisable to use a new seal and cover assembly at overhaul periods. Before installing, soak seal in Neatsfoot or warm engine oil until leather is soft and pliable.

3. Examine pinion shaft at surface where oil seal bears. This surface must be smooth, round and free from nicks or oil seal will not be effective.

4. Clean and inspect pinion shaft and teeth. If teeth are worn or damaged, both the ring gear and pinion must be replaced. If pinion is to be replaced, the differential ring gear must be replaced also. **These parts should always be replaced as a matched set, consisting of drive pinion, ring gear, and the two matched halves of differential case.**

5. Clean and inspect bearing cage.

E. To Assemble Drive Pinion Assembly—

Refer to Fig. 1 for caption numbers in parenthesis.

1. Dip tapered roller bearings in differential lubricant, turning roller and cage assembly to be sure all surfaces are lubricated.

2. If bearing cups were removed from cage, install carefully, using tool J-1705, as shown in Fig. 10. Be very careful cups do not become cocked or cage will be sprung out of shape. Force both cups solidly against shoulder in cage.

3. Install one tapered roller bearing cone on pinion shaft, driving it down carefully against shoulder on pinion with tool J-1713.

4. Install cage (29) and bearing cup assembly on pinion shaft.

5. Install washer (33).

6. Install adjusting nut (34) on shaft and tighten solidly to be certain all bearings are seated properly. Then back off adjusting nut until cage can be turned but will not spin on shaft.

7. Install two new lockwashers (35) with inner prongs in slot in shaft.

8. Install locknut (36) and tighten securely, being careful not to turn adjusting nut.

9. After locknut is tightened, check bearing adjustment again.

10. Bend tangs of inner lockwasher over adjusting nut and tangs of outer washer over locknut when bearing adjustment is correct.

10. DIFFERENTIAL CASE ASSEMBLY

Differential is four-pinion type. Case is two-piece type, machined as a unit and serviced only as a complete assembly consisting of the two halves. Ring gear is riveted to one half of the case. If either the case or ring gear is to be replaced, it is recommended that a complete assembly consisting of drive pinion and differential case with ring gear attached be used. Tapered roller bearings support case assembly in axle housing. Axle housing flanges and bearing supports are machined to such close limits that no adjustment is required for differential side bearings.

Two types of gears, "high-traction" and "standard" are used in these differentials. Either type is interchangeable with the other but, in any case, differential gears must always be installed as a complete set, consisting of four pinions and two side gears. The "high-traction" type has specially shaped teeth, designed to distribute driving force unequally between the driving wheels of the axle in the event one of the wheels loses its traction. With a "high-traction" differential the wheel having traction will always receive driving force, even though the other wheel is slipping.

A. To Remove Differential Case Assembly—It is necessary to disconnect the two halves of the axle housing at differential and to remove one half from vehicle to remove the differential case assembly.

If the differential is to be removed from the forward rear axle unit, remove the right-hand half of that housing. If the differential is to be removed from the rearward rear axle, remove the left-hand half of the housing. Operations given here apply to either of the two rear axles unless stated otherwise.

1. Drain lubricant from axle while disconnecting preparatory to removal of differential.

2. Install jack under spring cross-shaft bracket on side from which housing half is to be removed. (See Fig. 3.)

3. Raise jack until wheels clear ground and place a wheel dolly or a drip pan under wheels. Then lower jack

REAR AXLE ("Split" Type)

until wheels rest on pan or dolly but leave jack high enough so there is no load on spring end.

4. Install a stand jack or blocks under inner portion of the housing half that is to remain in vehicle so inner end will remain in position when the other half of axle is removed.

5. Disconnect brake cylinder flexible hose at frame connection (on side to be removed only).

6. On forward rear axle, disconnect propeller shaft at pinion yoke (item 7 in paragraph 4 under "To Remove Rear Axle Front Unit). This is not necessary on the back axle unless drive pinion is to be removed.

7. Disconnect torque rod from the half of the housing to be removed (see Paragraph 4, "To Remove Rear Axle Front Unit").

8. Remove axle shaft from the housing half to be removed.

9. Remove bolts connecting the two halves of the housing.

10. Rotate housing until brackets on housing clear spring ends.

11. Draw the disconnected half of the housing out from chassis so differential case may be removed. **Note:** Be very careful that differential assembly does not drop out.

12. Remove differential assembly from housing.

B. To Install Differential Case Assembly—

1. Drive pinion and cage assembly must be in place before installing differential case (see Paragraph 9, "To Install Drive Pinion Assembly"). Also be sure ring gear thrust block is in place.

2. Install differential assembly in housing half which was not removed from vehicle, slipping side gear over splines on axle shaft.

3. Slide other half of housing into position against housing half still in vehicle. Be sure mating surfaces are clean and smooth and use a new gasket.

4. Rotate housing so spring end is in position in bracket on housing.

5. Bolt housing together, using new lockwashers, and tighten bolts evenly.

6. Connect torque rod as explained under "To Install Rear Axle Front Unit."

7. Replace axle shaft as instructed under "To Install Axle Shafts."

8. If propeller shaft was disconnected, reconnect (see "To Install Rear Axle Front Unit").

9. Connect wheel cylinder brake hose and bleed wheel cylinder (see "Brakes" group 12).

10. Refill differential housing with fresh lubricant as instructed in "Lubrication" group "L."

11. Remove stand jack or blocks from center of housing also jack from under spring cross-shaft bracket.

C. To Disassemble Differential Case—

Note: Following operations apply to split type front axle also.



Fig. 11 Removing Differential Side Bearing

1. Remove side bearings with puller CS-1047, as shown in Fig. 11.

2. Mark the two halves of differential case so it may be reassembled in original position (see Fig. 12).

3. Cut lockwire and remove bolts attaching the two halves of the case.

4. Separate case and remove gears, spider and thrust washers.



Fig. 12 Differential Case Assembly

1. *Mark Each Half*
2. *Side Gear*
3. *Side Gear Thrust Washer*
4. *Pinion Gear Thrust Washer*

REAR AXLE ("Split" Type)

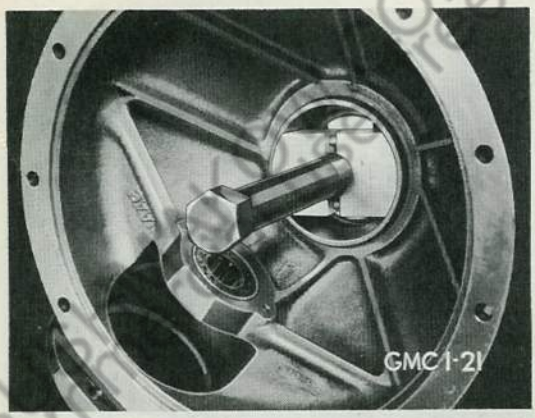

Fig. 13 Removing Diff. Side Bearing Cups

5. Inspect side bearing cups in housing and, if necessary, remove with Tool No. J-1708, as shown in Fig. 13. **Note:** Axle shafts must be removed to remove bearing cups. See "To Remove Axle Shafts." Also see "To Inspect Axle Housing" in Front Axle group for inspection, removal and installation of bearing cups and shaft oil seals in split type front axles.

6. If drive pinion is to be removed (see "To Remove Drive Pinion"), the pinion shaft inner bearing (24, Fig. 1) may be removed at this time. First drive rivets out of bearing retainer plate, then drive bearing out of housing, using Tool No. J-1702, as shown in Fig. 14.

D. To Inspect Differential Case Assembly—

Note: Following inspection instructions apply to split type front axle also.

1. Clean and inspect bearings as described in item 1 under "To Inspect Drive Pinion Assembly."
2. Clean all other parts thoroughly.
3. Inspect ring gear teeth.



Fig. 14 Removing Pinion Inner Bearing

4. Inspect side gear teeth, fit of hubs in case, and condition of splines.
5. Inspect pinion teeth and fit of pinions on spider arms.
6. Inspect thrust washers.
7. Inspect both sides of case at trunnion and side gear bearing surfaces.
8. Inspect ring gear side thrust block ("8" in Fig. 1) in axle housing. If there is any indication of wear, block should be replaced. Drive thrust block pin from outside of housing to remove block.

E. To Assemble Differential Case Assembly—

Note: Following operations apply to split type front axle also.

1. Use new parts in place of any that are damaged or worn excessively.
2. Be sure that all parts are cleaned thoroughly and that bearings, gears, thrust washers and spider are lubricated before installing.
3. If side bearing cups were removed from housing, replace using Tool J-1707 and replace axle shafts. See "To Install Axle Shafts."
4. Place pinions and thrust washers on spider and install side gears and spider assembly in one half of case.
5. Assemble the case temporarily, tightening cap screws up evenly.
6. Check clearance between case and thrust washers. If clearance is greater than limits given in "Specifications," the worn parts should be replaced. If new gears are required, be sure to install a complete matched set consisting of two side gears, four pinions and the thrust washers.
7. When clearances are correct, tighten case cap screws and install lock-wire, threading it through screw heads so that wire will become tighter if screws start to loosen.
8. Dip differential side bearings in gear oil, turning rollers so all surfaces are lubricated before installing.
9. Install side bearings on each side of case, using Tool J-1703, as illustrated in Fig. 15. Be sure bearings are seated solidly.
10. If ring gear thrust block was removed from housing, install, driving thrust block pin from inside of housing. Be sure pin fits snugly.
11. If drive pinion inner bearing (straight roller) was removed, replace in housing, using Tool J-1702. Then install new retainer plate and rivet in place.

11. AXLE HOUSING

Housing is of the two-piece or "split" type. Housing flanges, differential side bearing surfaces, and drive pinion supports are machined to such close limits that no provisions are made for adjusting differential bearings or gear tooth contact. For this reason housing flanges or bearing surfaces must never be machined to true up because both gear and bearing adjustment will be destroyed by such operations.

REAR AXLE ("Split" Type)

A. To Remove Axle Housing—

1. Remove axle assembly from vehicle as instructed under "To Remove Rear Axle Front Unit" or "To Remove Rear Axle Rear Unit."
2. Remove axle shafts, drive pinion assembly and differential assembly as instructed in previous paragraphs in this group.
3. Remove hubs and drums as instructed in "Wheels, Hubs and Tires" group 13.

B. To Install Axle Housing—

1. Install hubs and drums as instructed in "Wheels, Hubs and Tires" group.
2. Install pinion and cage assembly as instructed previously.
3. Install axle shaft in larger belled half of housing.
4. Install differential case assembly and bolt the two halves of housing together, using new gasket and new lockwashers.
5. Replace axle assembly in vehicle following complete instructions given under "To Install Rear Axle Front Unit (or Rear Unit)."
6. Be sure differential is refilled with correct lubricant (see "Lubrication" group "L").

C. Axle Housing Inspection—

1. Clean both halves of housing thoroughly.
2. Clean, inspect and install hubs temporarily as explained in "Wheels, Hubs and Tires" group, except that bearing adjusting nuts must be drawn up tight so hubs will just turn.
3. Be sure axle shafts are straight and that flanges are square with shaft, as explained in Paragraph 8 under "Axle Shaft Inspection."
4. Install axle shafts in each housing, using tapered dowels at each stud, and tighten nuts.
5. Measure from one fixed point on shoulder of housing flange to four points, 90 degrees apart on splined portion of axle shaft. Rotate shaft slowly. Do not spin. If run-out exceeds $\frac{1}{32}$", and shafts have been found to be straight when inspected in lathe, the hub bearing adjustment or shaft connection at hub are not correct.
6. When both shafts are installed properly so run-out does not exceed $\frac{1}{32}$", attach a dial indicator or a stiff wire to shaft so measurement may be made from shaft to shoulder on housing flange.
7. Rotate shaft and take measurement at four points 90 degrees apart on housing flange. If difference between any two measurements is greater than $\frac{1}{32}$", the housing is bent and must be replaced.



Fig. 15 Installing Differential Side Bearings

REAR AXLE ("Split" Type)

TABULATED DATA

12. SPECIFICATIONS

Make	Timken
Model	
Front Unit	(Standard)—53661-N-X-5
Rear Unit	(Standard)—53662-N-X-5
Front Unit	(High Traction)—53661-N-X-4
Rear Unit	(High Traction)—53662-N-X-4
Housing	Split Type
Drive	Torque Rods
Gear Ratio	6.6 to 1
Differential	
Drive	Spiral Bevel
Bearings	Timken Tapered Roller
Number	
Cone	3982
Cup	3920
Pinion Shaft Bearings	
Inner	Bower Straight Roller
Number	S5305-W
Outer	Timken Tapered Roller
Number	
Cone	44150
Cup	44348
Axle Shaft	
Diameter—Differential End	1.615"–1.620"
Number of Splines	16
Differential	
Bearing Adjustment	Non-Adjustable
Gear to Pinion Backlash	.008"–.012"
Gear Run-Out—Not Over	.002"
Case Run-Out—Not Over	.002"
Clearance Between	
Pinion and Spider	.003"–.007"
Side Gear and Case	.005"–.009"
Differential Gear Thrust Washers	
Thickness	.062"–.058"
Pinion Shaft	
Bearing Adjustment	Bearing Must Turn with no Perceptible End Play
Pinion Backlash Adjustment (See Text)	Shim
Shim Thickness	.003"
Drive Gear Thrust Block	
Clearance—Block to Gear	.015"–.023"
Block Thickness	.210"–.214"
Axle Shaft	
Shaft Flange Run-Out Not Over	.005"
Shaft Run-Out at Center Not Over (See "To Inspect Axle Shafts" in this Group)	$\frac{1}{32}$"
Housing Inspection	
Axle Shaft Run-Out Not Over (See "To Inspect Axle Housings" in this Group)	$\frac{1}{32}$"

13. TOOL EQUIPMENT

The following special tools, or their equivalent, are recommended for use when servicing REAR AXLE (SPLIT TYPE).

Tool No.	Name	Supplier Code
CS-1047	Bearing Cone Remover	CS
J-1660-1	Handle for J-1707 Replacer	KM
J-1701	Pinion Cage Assembly Puller	KM
J-1702	Pinion Inner Bearing Remover and Replacer	KM
J-1703	Differential Side Bearing Replacer	KM
J-1704	Pinion Outer Bearings Press Plate and Holder	KM
J-1705	Pinion Inner and Outer Cup Replacer	KM
J-1707	Differential Side Bearing Cup Replacer	KM
J-1708	Differential Side Bearing Cup Remover	KM
J-1713	Pinion Outer Bearing Cone Replacer	KM
J-1714	Pinion Driving Flange Puller	KM
KMO-351	Pinion Bearing Lock Nut Wrench	KM

TOOL SUPPLIER

Supplier Code	Name	Address
CS	Curtiss and Smith Manufacturing Corp.	Pottstown, Penn.
KM	Kent-Moore Organization	Detroit, Mich.

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Group 12 — Brakes

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GENERAL

1. DESCRIPTION AND OPERATION

Two brake systems are used on these vehicles. Service Brake, which is hydraulic—and Hand Brake which is mechanical.

Service Brake—This brake is applied at foot pedal and is hydraulic type, operating two shoes at each wheel. In addition to hydraulic system, a Hydrovac unit utilizes atmospheric pressure and engine manifold vacuum to assist driver in application of brakes.

Application or operation of service brakes is dependent upon the function of two systems—hydraulic and vacuum. These two systems are inter-connected in such a manner that hydraulic pressure actuates relay valve, which controls vacuum and atmosphere in power cylinder. Movement of power cylinder pistons, controlled by vacuum and atmosphere, forces fluid from hydraulic slave cylinder into brake lines and subsequently to each wheel cylinder.

Hand Brake—Hand brake lever, located within easy reach of driver, operates brake located at rear of transfer case. Hand lever and brake are connected by rods and linkage.

A. Hydraulic System—The actual brake operating system consists of a master cylinder, one wheel cylinder at each wheel and connecting hydraulic hose or lines. Master cylinder is operated through brake pedal and connecting linkage. Briefly, the hydraulic system employs the principle of pressing a column of fluid with which the wheel cylinder pistons are operated to force brake shoes against brake drums.

B. Vacuum System—The secondary, or assisting system, consists of a Hydrovac unit (relay valve, power cylinder and hydraulic cylinder), check valve and interconnecting tubing and lines. This system utilizes engine manifold vacuum and atmosphere to operate power cylinder, which assists driver in building up sufficient hydraulic pressure necessary to apply brakes.

2. TROUBLE SHOOTING AND GENERAL SOLUTIONS

Following are the most common symptoms, causes and remedies for difficulties which may occur in brake system.

Excessive Pedal Pressure and Poor Stop—

1. Brake Shoes Improperly Adjusted—
   Readjust.
2. Vacuum System Not Functioning—
   (a) Relay valve not functioning.
   (b) Power cylinder not functioning.
   (c) Leak in vacuum lines.
3. Brake Linkage Improperly Adjusted—
   Readjust.
4. Improper Linings—
   Use only Genuine GMC Parts.
5. Grease Soaked Linings—
   Remove and replace with Genuine GMC Parts.
6. Partial Lining to Drum Contact—
   (a) Shoe twisted or sprung.
   (b) Shoe anchor twisted or sprung.
7. Improper Brake Fluid—
   Use only Genuine Hydraulic Brake Fluid.
8. Obstructed Brake Line—
   Remove and replace faulty parts.

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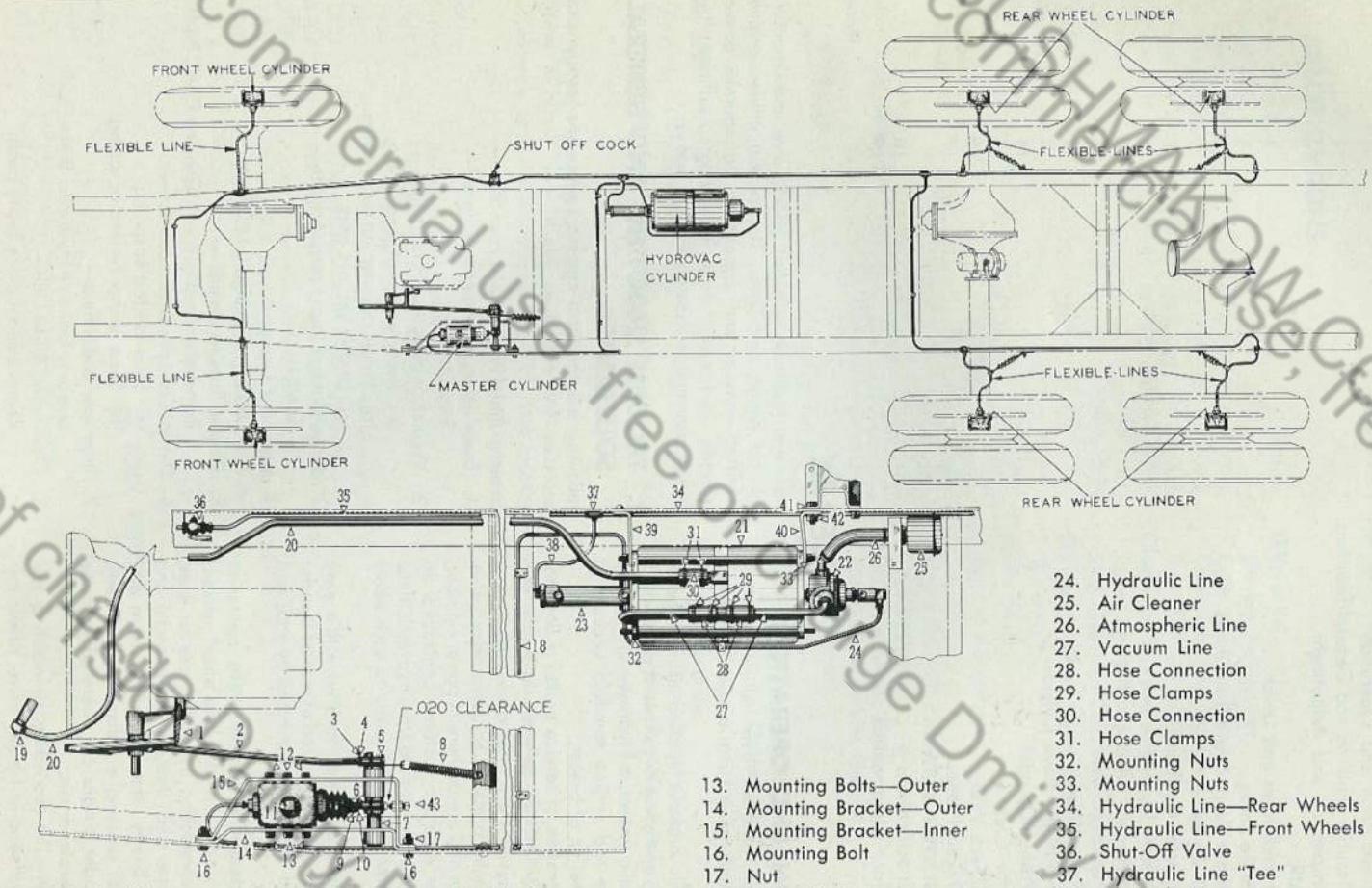

1. Brake Pedal
2. Pedal Pull Rod
3. Adjustable Yoke
4. Yoke Lock Nut
5. Operating Lever—Inner
6. Operating Lever—Outer
7. Operating Shaft
8. Return Spring
9. Push Rod
10. Lock Nut
11. Master Cylinder
12. Mounting Bolts—Inner
13. Mounting Bolts—Outer
14. Mounting Bracket—Outer
15. Mounting Bracket—Inner
16. Mounting Bolt
17. Nut
18. Hydraulic Line
19. Check Valve
20. Vacuum Line
21. Hydrovac Unit
22. Relay Valve
23. Hydraulic Slave Cylinder
24. Hydraulic Line
25. Air Cleaner
26. Atmospheric Line
27. Vacuum Line
28. Hose Connection
29. Hose Clamps
30. Hose Connection
31. Hose Clamps
32. Mounting Nuts
33. Mounting Nuts
34. Hydraulic Line—Rear Wheels
35. Hydraulic Line—Front Wheels
36. Shut-Off Valve
37. Hydraulic Line "Tee"
38. Hydraulic Line
39. Mounting Bracket
40. Mounting Bracket
41. Mounting Bracket Bolt
42. Nut
43. Stop Screw

Fig. 1 General Arrangement of Brake Units, Controls, Hydraulic and Vacuum Lines

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BRAKES

Pedal Goes to Floor Board—

1. Normal Wear of Linings—
   (a) Readjust.
   (b) Worn excessively. Replace brake lining.
2. Low Fluid Level in Master Cylinder—
   Refill.
3. Air Trapped in Hydraulic System—
   Bleed system and refill.
4. Leak in System—
   (a) Inspect complete brake system for evidence of leaks. Tighten connections and replace defective parts where necessary.
   (b) Remove, disassemble and inspect wheel cylinders, master cylinder and hydraulic slave cylinder as directed under their respective headings.
5. Brake Shoes Improperly Adjusted—
   Readjust.

Noisy Brakes—

1. Bent or Distorted Anchor Plate—
   Replace.
2. Bent or Distorted Brake Shoes—
   Replace.
3. Dirty Linings—
   Replace.
4. Loose Lining Rivets—
   Remove and replace.
5. Drums Distorted—
   Regrind or replace.
6. Improper Lining—
   Use Genuine GMC Parts. See Parts Catalogue.

Springy, Spongy Pedal Action—

1. Air Trapped in Hydraulic System—
   Bleed system.
2. Improper Brake Fluid—
   Use only Genuine hydraulic brake fluid.
3. Brake Shoes Improperly Adjusted—
   Readjust.

Truck Pulls to One Side—

1. Grease Soaked Linings—
   Remove and replace with Genuine GMC Parts.
2. Brake Shoes Improperly Adjusted—
   Readjust.
3. Loose Anchor Plate—
   Keep tight. See "Brake Support and Dust Shield."
4. Wheel Bearings Improperly Adjusted—
   Readjust.
5. Tires Not Properly Inflated—
   Inflate all tires to same pressure.
6. Loose Spring Clips—
   Keep tight.
7. Improper Linings—
   Use Genuine GMC Parts. See Parts Catalogue.
8. Axle Shifted to One Side—
   Relocate and tighten spring clips as directed in "Spring" section. See "Frame" section for method of checking alignment.

One Brake Drags—

1. Weak or Broken Brake Shoe Return Spring—
   Replace.
2. Brake Anchor Pins Tight—
   Remove, inspect and replace if faulty.
3. Brake Shoes Improperly Adjusted—
   Readjust.
4. Wheel Bearings Improperly Adjusted—
   Readjust.
5. Distorted or Swollen Piston Cups—
   Remove and replace faulty parts.
6. Obstructed Brake Line or Hose—
   Remove and replace faulty parts.
7. Grease Soaked Linings—
   Remove, and replace with Genuine GMC Parts.

All Brakes Drag—

1. Brake Linkage Improperly Adjusted—
   Readjust.
2. Weak Brake Pedal, or Hydraulic Cylinder Return Springs—
   Replace.
3. Mineral Oil in System—
   Use only Genuine hydraulic brake fluid.
4. Distorted or Swollen Master Cylinder or Hydraulic Cylinder Cups—
   Replace faulty parts.

Severe Brake With Light Pedal Pressure—

1. Brake Shoes Improperly Adjusted—
   Readjust.
2. Brake Linkage Improperly Adjusted—
   Readjust.
3. Loose Brake Anchor Plate—
   Keep tight.
4. Improper Linings—
   Use Genuine GMC Parts. See Parts Catalogue.
5. Grease Soaked Linings—
   Remove and replace with Genuine GMC Parts.

3. INSPECTION AND ADJUSTMENT

INSPECTION:

A. Vacuum Leaks—It is important that all vacuum lines and connections be tight to prevent entrance of atmosphere, otherwise the efficiency of the complete braking system is seriously affected.

Tests for leaks are made as described under "Vacuum Lines," "Power Cylinder" and "Relay Valve" in this section. Leaks are sometimes audible and can be detected by ear.

It should be borne in mind when making these tests that at no place in the system can any greater vacuum be obtained than exists in the intake manifold. Therefore, it is important that the test first be made at this point in order to determine the actual manifold vacuum. When taking a reading at the vacuum gauge after engine has stopped, a vacuum drop of not more than 1" every 15 seconds may be considered satisfactory.

B. Hydraulic Fluid Leaks—Brake lines and flexible hose should be carefully inspected for any evidence of

BRAKES

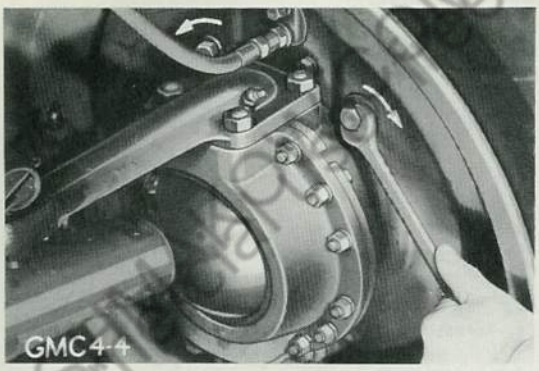

Fig. 2 Front Brake Shoe Minor Adjustment ("Split" Type Axle Housing)

hydraulic fluid leakage. Leaks can usually be detected visually if adjacent parts appear to be oily. However, continued low level of hydraulic fluid in master cylinder is usually an indication that system is leaking at some point where it is not visible, possibly at the wheel cylinders.

C. Overheating—Whenever brake shoes are not properly adjusted, excessive heat is generated at brake drums. All drums should be approximately same temperature. However, an abnormally cool drum usually indicates that the brakes on that particular wheel are not functioning properly and may not be adjusted evenly with the other wheels. **Note:** If an overheated condition is found, this should not be confused with the possibility that the wheel bearing may be adjusted too tightly. Refer to "Wheel" group of this book for corrective measures.

Important: Brakes on all wheels must be properly adjusted to avoid stress on axles, propeller shafts, transfer case, etc.

ADJUSTMENT:

Proper brake shoe adjustment cannot be obtained unless bearings are correctly adjusted. Refer to "Wheel" group of this book for instructions.

Note: Two types of front brake shoes and wheel cylinders are used on vehicles covered by this brake group. These two types can be easily identified by the fact that one type is used on vehicles having "Banjo" type axle housing while other type is used with "Split" type or two-piece housings. Refer to Front or Rear axle groups of this book for identifying illustrations of both type axles.

A. Front Brake Minor Adjustment—Following adjustment method is used only on vehicles having "Split" type or two-piece axle housings.

1. Jack up wheel and adjust one shoe at a time by turning adjusting cam pin in direction indicated by arrows in Fig. 2, until brake drags slightly when wheel is turned by hand. Back off adjusting cam pin until wheel turns freely. Both adjustments at each wheel should be as near alike as possible. Unequal adjustment at one shoe may result in any one or more of the conditions mentioned under "Trouble Shooting."

2. Repeat this operation at both adjusting cam pins on each front wheel. Friction springs hold adjusting cams in position.



Fig. 3 Using Feeler Gauge to Check Lining to Drum Clearance

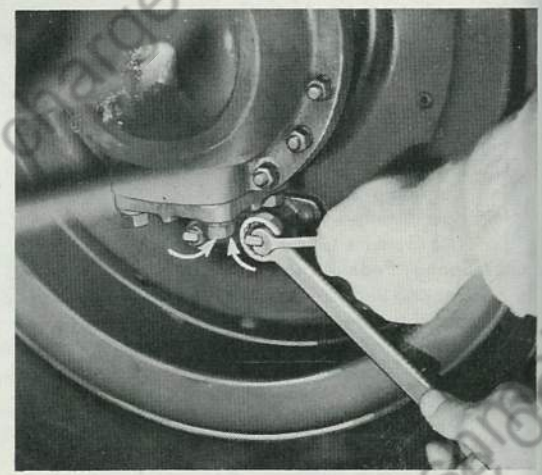

Fig. 4 Front Brake Shoe Major Adjustment ("Split" Type Axle Housing)

3. In rare instances, minor adjustments outlined above may not give entirely satisfactory results. In such cases, major adjustments described in next paragraph should be made.

B. Front Brake Major Adjustment—Following adjustment method is used only on vehicles having "Split" type or two-piece axle housing. Major adjustments are not ordinarily necessary, except after relining brakes, grinding drums or in case eccentric anchor pins have been tampered with. Major adjustment may also be required in rare instances when minor adjustments previously described do not give satisfactory results.

1. Remove inspection cover on brake drum at point where feeler gauge is shown by taking out retaining screw in Fig. 3.

2. Back off lock nuts on eccentric anchor pins using

BRAKES

two wrenches, one on nut and other on anchor pin as shown in Fig. 4.

3. Adjust one shoe at a time, turning anchor pin (Fig. 4) and adjusting cam pin (Fig. 2) slightly in direction of arrows in successive stages, backing off on one or other as necessary until clearance of .010" is secured at lower end, or heel, of shoe and .020" at upper end, or toe. Check clearance at about 1½" from end of lining in each case. Feeler gauge used as shown in Fig. 3 will assist in securing proper and equal adjustment at each brake shoe.

4. When proper drum to lining clearance has been obtained, hold anchor pin securely to prevent pins turning while lock nuts are tightened. Final check of brake shoe to drum clearance should be made when nut has been tightened.

5. Repeat operations 3 and 4 at both shoes on each front wheel. Keep in mind that all shoes should be adjusted as near alike as possible.

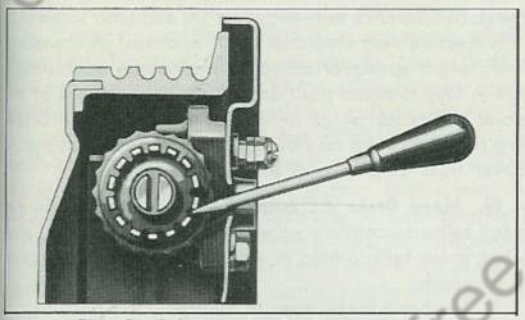

Fig. 5 Front Brake Shoe Adjustment ("Banjo" Type Axle Housing)

C. Front Brake Adjustment—Following adjustment method is used only on vehicles having "Banjo" type or one-piece axle housing:

1. Jack up wheel so that it can be turned by hand while adjustment is being made.

2. Remove adjusting hole covers on backing plate at each side of hydraulic line connection.

3. Insert screw driver or special adjusting tool through adjusting hole in manner shown in Fig. 5. End of screw driver or adjusting tool must firmly engage notches in wheel cylinder adjusting cap.

4. Turn adjusting cover in clockwise direction, as when looking at end of cylinder, until shoe causes a slight drag on drum, as wheel is turned by hand. Back off adjusting cap four notches to provide proper clearance between lining and drum. Backing off cap specified notches will be indicated by click as adjusting cap lock spring seats in notches of cap.

5. When making adjustment be sure that each shoe is adjusted as near like other shoes as possible. Uneven adjustment may cause greater braking effort at one wheel than other resulting in uneven brakes and excessive lining wear.

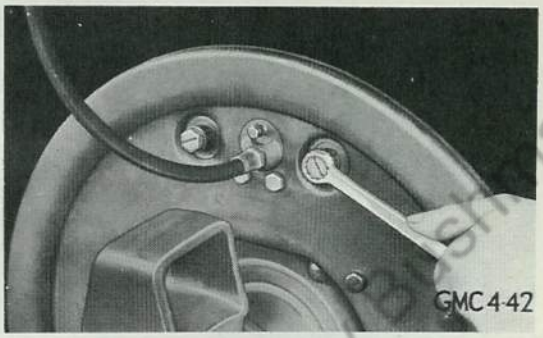

Fig. 6 Rear Brake Shoe Adjustment

6. When adjustment has been completed, be sure that adjusting hole cover is replaced.

D. Rear Brake Adjustment—Following adjustment is used on all vehicles, regardless of type of axle.

1. Jack up wheel so that it can be turned by hand while adjustment is being made.

2. Use ⅝" wrench on hex head adjusting pinion shaft as shown in Fig. 6. Turn adjusters in clockwise direction, as indicated by arrows, until shoe causes a slight drag on drum as wheel is turned by hand.

3. Turn adjuster back ¾ of a turn to provide proper running clearance. There are two adjusters at each wheel. When making adjustment, be sure that each shoe is adjusted as near like others as possible. Uneven adjustment may cause greater braking effort at one wheel or shoe than at others, resulting in uneven brakes and excessive lining wear.

4. When adjustment has been completed, wheel should be lowered and jack removed.

E. Pedal Adjustment—Pedal linkage should be adjusted to permit ½" to 1" clearance between toe board and pedal. Refer to Figs. 1 and 7 and proceed as follows:

1. Remove cotter pin and clevis pin attaching adjustable yoke (3) to operating shaft inner lever (5).

2. Loosen lock nut (4) at adjustable yoke (3) and turn

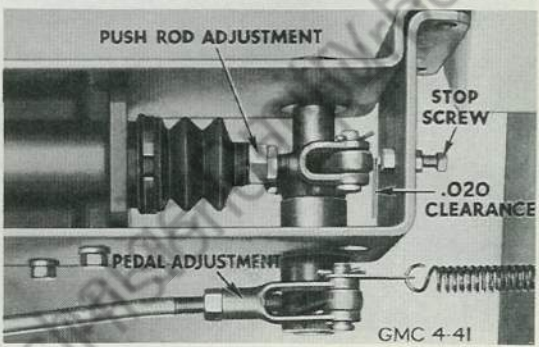

Fig. 7 Master Cylinder Linkage and Mounting Bracket, Viewed from Under Vehicle, Showing Adjustments

BRAKES

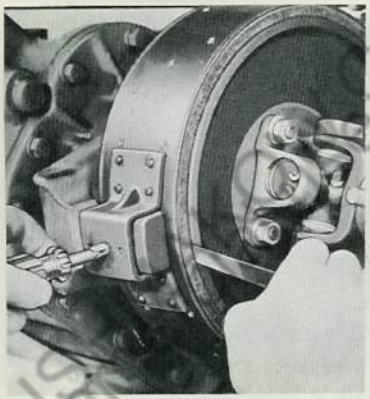

Fig. 8 Hand Brake Lining to Drum Adjustment at Anchor

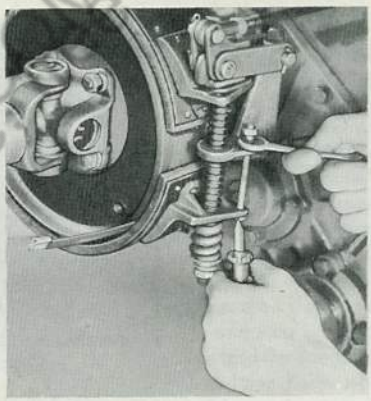

Fig. 9 Hand Brake Lining to Drum Clearance at Bottom is Adjusted as Shown

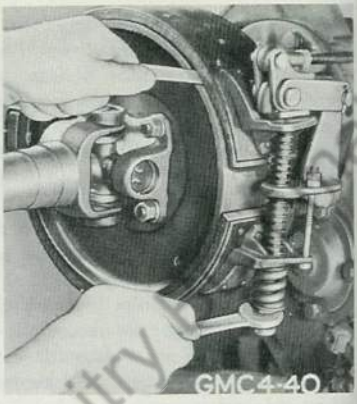

Fig. 10 Hand Brake to Drum Clearance at Top is Adjusted as Shown

yoke (3) to obtain proper pedal to toe board clearance.

3. Replace clevis pin and secure with cotter pin. Always be sure that lock nut (4) is tightened when adjustment has been completed.

F. Master Cylinder Adjustment—Master cylinder piston and push rod must return to full released position when brakes are released. If push rod does not return fully, fluid by-pass port in master cylinder will be covered by piston cup; thereby preventing fluid from entering master cylinder barrel. Refer to Figs. 1 and 7 and proceed as follows:

1. Loosen lock nut (10) at push rod (9), using one wrench on push rod and other on nut, and turn rod until piston touches stop plate in end of master cylinder. Tighten lock nut.

2. When push rod adjustment has been completed, measure clearance between lever (6) and stop screw (43). This measurement should be .020" and must be measured with return spring attached so that pedal and controls are in fully released position. Excessive clearance at this point will cause piston to strike stop plate when brakes are released, while no clearance will cause piston cup to cover fluid by-pass port in master cylinder.

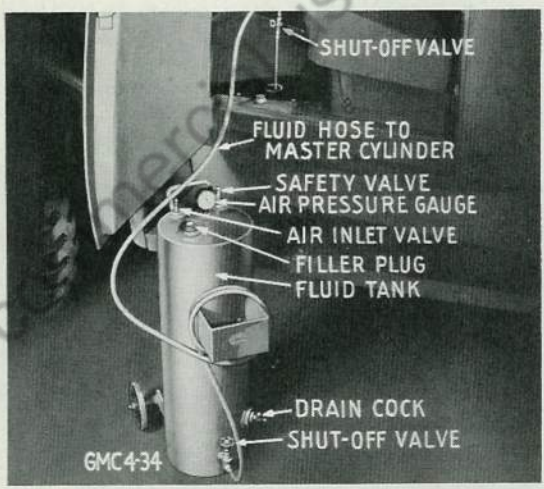

Fig. 11 Use of Pressure Tank Facilitates Bleeding Hydraulic System

G. Hand Brake Adjustment—After hand brake has been relined complete adjustment must be made, also; when brake fails to hold or when hand brake lever travel is excessive.

1. Set hand brake lever in fully released position.

2. Refer to Fig. 8 and turn anchor adjusting screw until there is .010"-.015" clearance between lining and drum opposite anchor.

3. Loosen lock nut and draw up locating screw until there is .020" clearance between lower end of band and brake drum. Clearance should be measured about 1½" from end of lining. Tighten lock nut when adjustment is completed. Refer to Fig. 9 for adjustment method.

4. Refer to Fig. 10 and loosen lock nut and draw up adjuster bolt nut until there is .020" clearance between upper end of band and brake drum. Clearance should be measured about 1½" from end of lining. When adjustment is completed tighten locknut.

5. When brake band adjustments have been completed loosen pull rod adjustable yoke lock nut and turn yoke until clevis pin can be easily inserted through cams and yoke eye. During this adjustment hand brake lever should be one notch toward applied position.

H. Bleeding Hydraulic System—There are two methods of bleeding the hydraulic system—pressure and manual. **Important:** Hydrovac unit is equipped with three bleeder screws, which must be bled **Before** bleeding wheel cylinders. It is especially important that screws be bled in order "A," "B" and "C" as illustrated in Fig. 33. If bleeding is done in any other sequence, air

may remain in lines and prevent satisfactory brake performance.

1. **Pressure Bleeding** equipment is typically illustrated in Fig. 11. When using pressure tank, make sure fluid level is up to pet cock above outlet and that tank has 10 to 20 lbs. air pressure before starting bleeding operation.

2. Connect bleeding tank hose to master cylinder at filler cap opening, using proper size fittings. Master cylinder filler cap is accessible through opening in floor board under mat on driver's side of vehicle. Lift floor mat and remove screws holding cover over opening in floor.

3. Remove cap screws from backing plate as shown in Fig. 12 and connect bleeder hose. Place other end in suitable container which should have sufficient fluid placed in it to cover end of hose.

4. Open bleeder valve by turning ¾ turn in counterclockwise direction and watch flow at end of bleeder hose. Close bleeder valve tightly again as soon as air bubbles stop and fluid comes out in solid stream. Remove bleeder hose and reinstall cap screw in bleeder valve.

5. Repeat operations 3 and 4 at remaining wheels. **Important:** Hydrovac unit must also be bled. Perform bleeding operation at each of the three bleeder screws in Hydrovac unit. These screws are indicated in Fig. 33.

6. **Manual Bleeding** requires filling master cylinder reservoir and "pumping" brake pedal to force fluid through lines to expell air from system. Engine must not be running during manual bleeding as fluid by-pass in Hydrovac slave cylinder will be closed, thus preventing proper flow of fluid. Operations 3 and 4 are same for both methods. However, it is advisable to refill reservoir after bleeding each point, as air may be taken into system at master cylinder and entire operation would have to be repeated.

I. Brake Fluid—When necessary to add brake fluid, only Delco Super No. 9 or Wagner Lockheed 21 hydraulic fluid should be used.

Never use gasoline, kerosene or other liquids of mineral base when cleaning cylinders and cups of master cylinder and wheel cylinders. **Only Denatured Alcohol Should Be Used When Cleaning Rubber Parts, As Mineral Fluids Will Cause Rubber Parts to Swell and Otherwise Deteriorate, Necessitating Premature Replacement.**

4. HAND BRAKE AND LEVER

Hand brake lever is located within easy reach of driver and is connected by rod and linkage to brake mounted on the transfer case.

Brake drum is bolted between two flanges—one on transfer case drive shaft and other on propeller shaft universal joint. Band is supported by brake spider which is integral with transfer case rear bearing cap. Ends of band float on adjustable rod which passes through hole in brake support. Clevis pin passes through a yoke in adjustable rod, also through two cams which apply the brake through adjustable pull rod extending to the hand brake lever.

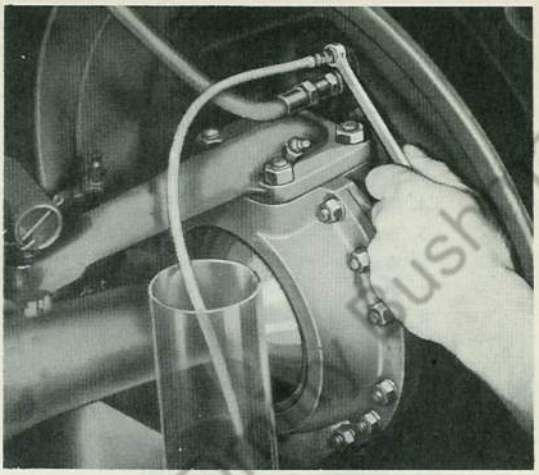

Fig. 12 Bleeding Wheel Cylinder (Front Shown)

A. To Remove Brake Band—Brake band can be removed from vehicle for relining or other service work without disturbing the hand brake lever or brake drum. Refer to Fig. 13 for reference numbers.

1. Remove lock wire and loosen anchor screw (35) sufficiently to remove screw from anchor.

2. Remove cotter pin and clevis pin attaching pull rod adjustable yoke (19) to operating cams (22).

3. Remove adjusting nuts (32), washers (30 and 31), and spring (29) from bottom of pull rod (24).

4. Pull rod can now be lifted straight up through opening in cab floor. Opening in cab floor can be reached after seat cushion is removed.

5. Remove adjusting nuts (28) which will permit removal of locating screw (27).

6. Brake band and lining assembly can now be slipped off brake support. In doing so, anchor screw spring (36) can be removed from anchor.

Inspection: While brake band and drum are removed they should be carefully inspected for the following conditions:

1. Surface of brake drum should be smooth, and free of scoring caused by rivet heads.

2. Inspect brake lining and if worn excessively, replace. Rivet heads are countersunk on new linings and therefore should be below contact surface of lining.

3. Inspect retracting springs to be sure coils are not broken or have not lost tension.

4. Hand brake lever sector as well as pawl teeth should be inspected for excessive wear. Teeth that are worn may cause lever to slip when in applied position. Replace worn parts.

B. To Install Brake Band—Refer to Fig. 13 and install as follows:

1. Place anchor spring (36) in depression of support and compress spring as band anchor bracket is placed over support.

BRAKES

1. Grip
2. Lever Assembly
3. Bolt
4. Nut
5. Pawl
6. Sector
7. Bolt
8. Washer
9. Bolt
10. Bracket
11. Bolt
12. Nut
13. Washer
14. Spacer
15. Washer
16. Nut
17. Bolt
18. Rod
19. Adjusting End
20. Pin
21. Spacer Link
22. Cam Lever
23. Pin
24. Adjusting Bolt
25. Shoe
26. Spring
27. Locating Screw
28. Nut
29. Spring
30. Washer
31. Washer
32. Nut
33. Drum
34. Band
35. Screw
36. Spring
37. Lining

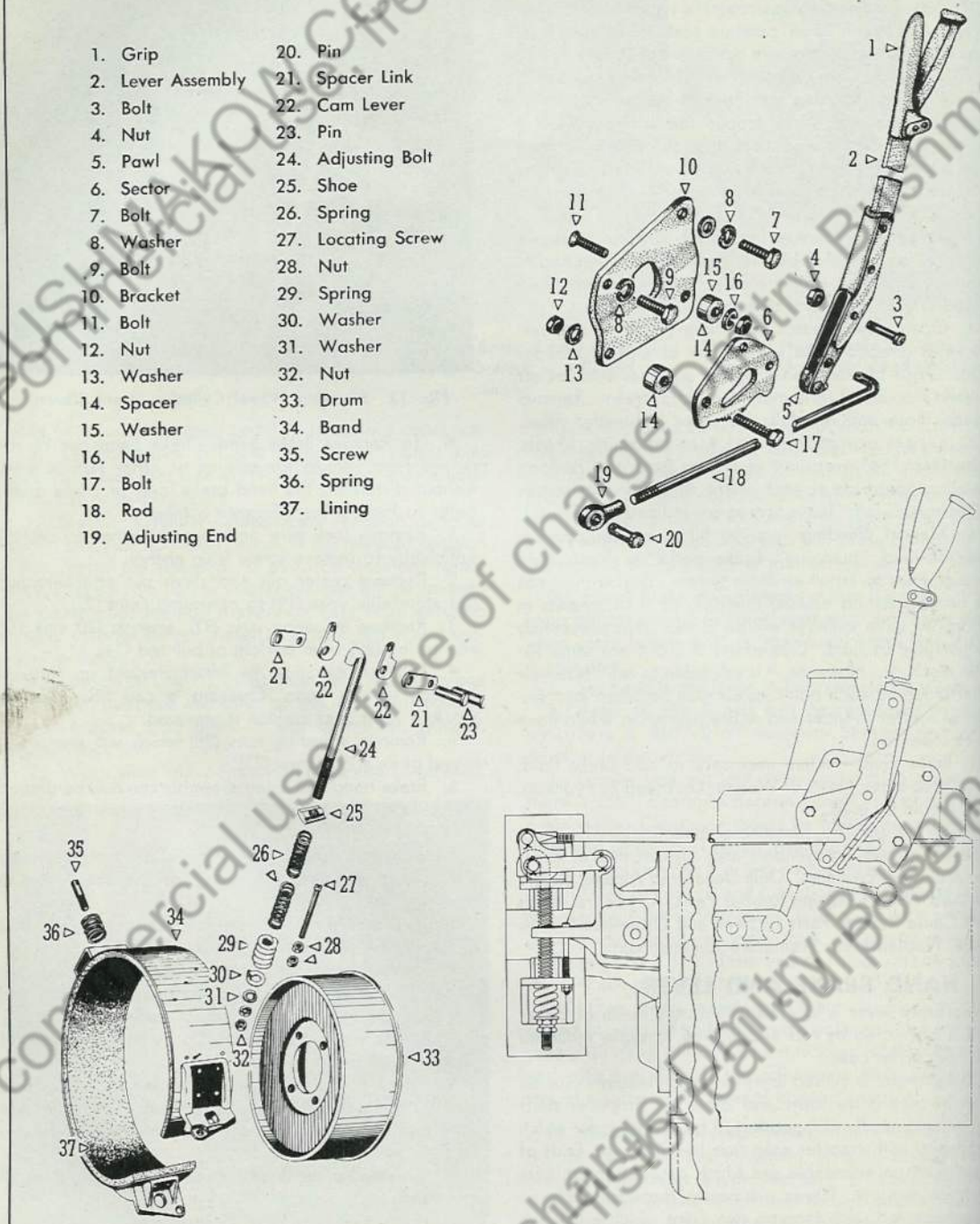

Fig. 13 Hand Brake Band and Lever Installation, also Disassembled Views

BRAKES

2. Temporarily install anchor adjusting screw (35) through band anchor and into support.

3. Place locating screw (27) through band lower bracket and hole in support and install nuts (28).

4. Replace clevis pin (23) through links (21) and cams (22) so that two cams are between two links. Use new cotter pin in clevis pin.

5. Replace adjusting bolt (24) through opening in cab floor under seat cushion. End of bolt must pass between two cams (22), cam shoe (25), upper band bracket, spring (26), support, spring (26) and lower band bracket. Replace spring (29) over end of bolt and install flat washer (30), lockwasher (31) and nuts (32).

6. Adjust band lining to drum clearance as described under "Adjustments" in this group.

7. When adjustments have been completed attach pull rod (18) to operating cams (22) using clevis pin (20). It may be necessary to adjust length of rod which can be accomplished at yoke at rear of rod.

C. To Reline Brake Band—Lining only need be replaced when inspection reveals excessive wear. Only Genuine GMC lining, cut and formed to fit contour of band, should be used.

1. Place lining around inside of band and mark location of one rivet hole near each end of lining. When locating lining it should not extend over $\frac{1}{16}$" past end of band.

2. Drill hole in lining same size of rivet and countersink so that rivet head is not less than one-half the thickness of lining below contact surface.

3. Rivet outer ends of lining to band using brake relining machine. With lining thus located on band, balance of rivets can be installed after drilling and countersinking. Rivets should be installed from each end alternately, working toward center of band.

D. To Remove Brake Drum—Drum can be removed without removing brake band.

1. Remove four nuts and lock washers from bolts attaching yoke at rear of transfer case to universal joint yoke. Drum is held between these two yokes.

2. Slide propeller shaft universal joint towards rear sufficiently to remove the yoke from the bolts, lower end of shaft to the ground. Suitable wooden block or support can be placed underneath shaft to prevent dirt getting on this part.

3. Drum can now be pulled towards rear to complete removal.

E. To Install Brake Drum—Before installing drum it should be thoroughly cleaned of any grease, which may come in contact with lining. Remove any burrs or rough spots at points where drum is held between universal joint yokes.

1. Place drum over four bolts in yoke at rear of transfer case.

2. Raise propeller shaft and move forward so that four bolts can be inserted into universal joint yoke.

3. Install nuts and new lockwashers on bolts and tighten securely. Inspect both inside and outer surface of drum at point where it contacts yokes to be sure that drum and yokes are seated firmly against each other.

F. To Remove Hand Brake Lever—Ordinarily it should not be necessary to remove lever except when removing transmission or replacing pawl and sector. To remove however, refer to Fig. 13 and proceed as follows:

1. Remove cotter pin attaching pull rod (18) to lever so that rod can be moved toward rear.

2. Remove nuts and lockwashers from bolts attaching sector (6) to support bracket (10). Lever and sector assembly can now be completely removed. During removal see that two spacers (14) between sector (6) and support bracket (10) are not mislaid or lost.

3. Sector can be removed from lever by taking cotter pin and nut from bolt which acts as pivot for lever.

G. To Install Hand Brake lever—Refer to Fig. 13 and proceed as follows:

1. Place sector (6) between forks at lower end of lever and insert bolt through lever and sector. Replace nut on bolt, tighten and lock with cotter pin.

2. Attach pull rod (18) to lever (2) before attaching lever to transmission. Rod is secured to lever by cotter pin.

3. Attach sector and lever assembly to transmission by using bolts in bracket. Be sure that spacers (14) are placed over bolts between bracket and sector. Install lockwashers and nuts on bolts and tighten securely.

5. BRAKE SHOES

Front brake shoes differ on vehicles having "Split" type axles from those equipped with "Banjo" type axles—

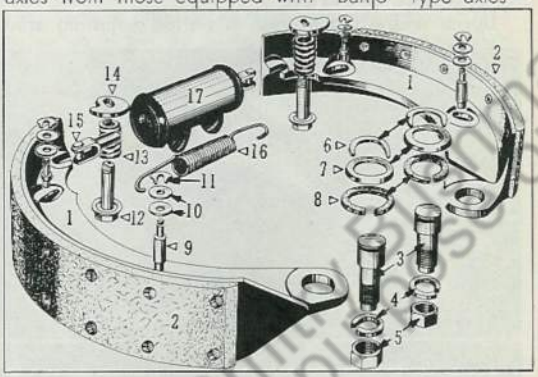

Fig. 14 Disassembled View of Front Brake Shoe Parts ("Split" Type Axle Housing)

1. Brake Shoe
2. Brake Lining
3. Anchor Pin
4. Pin Lockwasher
5. Anchor Pin Nut
6. Pin "C" Washer
7. Felt Retainer
8. Felt Washer
9. Guide Pin
10. Plain Washer
11. "C" Washer
12. Adjusting Pin
13. Pin Spring
14. Adjusting Pin Cam
15. Yoke
16. Return Spring
17. Wheel Cylinder

BRAKES

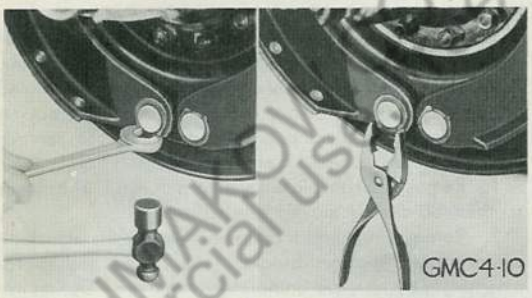

Fig. 15 Method of Removing and Installing Brake Shoe Anchor Pin "C" Washers. (Front "Split" Type Axle Housing)

rear brakes, however, are alike for both type axles.

A. Front Brake Shoe—("Split" type axle housing). Shoes are anchored to backing plate by adjustable eccentric pins at lower end of shoes. Refer to Fig. 14.

Adjusting cams, located near upper end of shoes, bear against brake shoe itself. Guide pins, two in each shoe, are riveted to backing plate. Special washers, used over pins, are on each side of shoe and these are held in place by "C" shaped washers fitting in grooves at outer end of pin. "C" shaped washers are also used to hold brake shoes in place on anchor pins.

B. Brake Shoe (Except Front With "Split" Axle Housing)—Shoes are connected to anchor plate through articulating links and anchor pins. Guide plates near upper ends of shoes hold brake shoe in alignment at all times. Refer to Figs. 18 and 19.

Upper end of shoes rest in slotted adjusting studs threaded into wheel cylinder caps. These caps can be adjusted as previously described under "Adjustments" to obtain proper lining to drum clearance.

C. To Remove Front Brake Shoe ("Split" Type Axle Housing)—Removal of brake shoe is accomplished as described below. Refer to Fig. 14 for reference numbers.

1. Apply hand brake and jack up axle to remove front wheel and hub as directed in "Wheel" section of this book.
2. Remove "C" washers (6) using 3/4" open end wrench and hammer in manner illustrated in Fig. 15.
3. Remove guide pin "C" washers (11) with pair of pliers as shown in Fig. 16.
4. Before attempting to remove brake shoes, place clamp in position on wheel cylinder as shown in Fig. 17, to keep wheel cylinder together and prevent leakage of brake fluid while servicing brake shoes.
5. Remove brake shoe return spring (16), using special pliers in manner illustrated in Fig. 17.
6. Mark shoes so that they can be replaced to their original position.
7. Note position of punch marks on heads of eccentric anchor pins so that they may be reinstalled in their original position. This is not necessary when relining shoes, as complete major adjustment will then be necessary.
8. Pull shoe straight out to remove from anchor pins (3) at bottom of shoe and guide pins (9) midway on shoes.
9. Refer to "Brake Support and Dust Shield," for instructions regarding removal of anchor pins.

D. To Replace Front Brake Shoe—("Split" Type Axle Housing)—Replacement of brake shoe is accomplished as described below. Refer to Fig. 14, for reference numbers in following text.

1. If anchor pins (3) have been removed they should be replaced as described under "Brake Support and

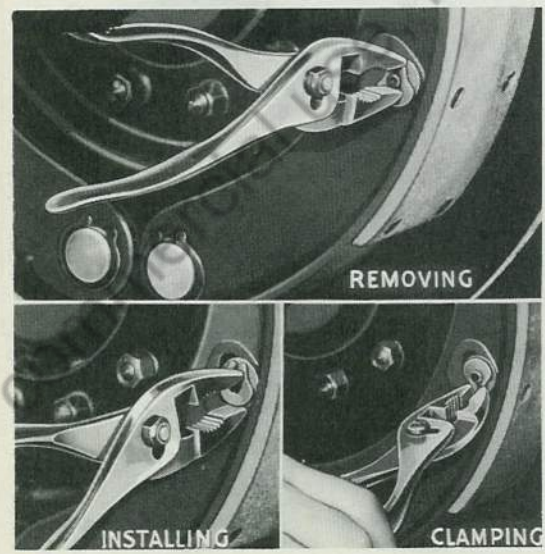

Fig. 16 Method of Removing and Installing Brake Shoe Guide Pin "C" Washers. (Front "Split" Type Axle Housing)

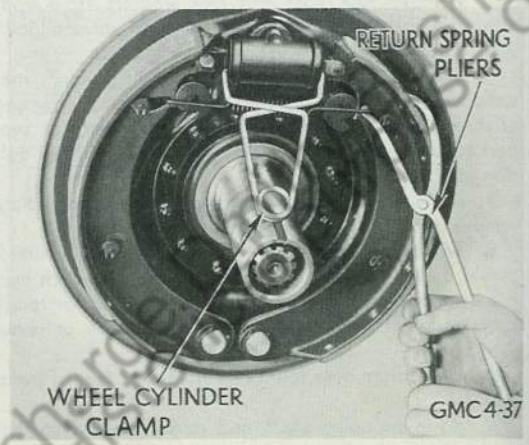

Fig. 17 Installation of Wheel Cylinder Clamp and Use of Return Spring Pliers

BRAKES

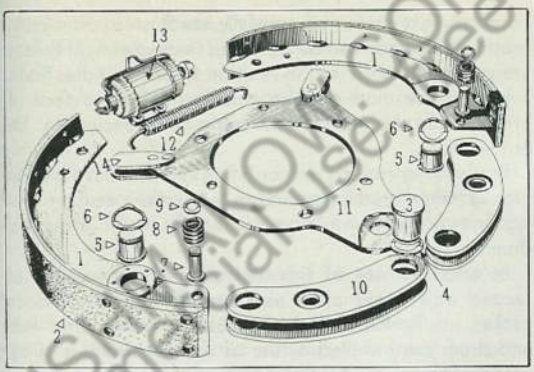

Fig. 18 Disassembled View of Front Brake Shoe Parts ("Banjo" Type Axle Housing)

1. Brake Shoe
2. Brake Lining
3. Anchor Pin
4. Anchor Pin Lock
5. Link Pin
6. Link Pin Lock
7. Friction Spring Pin
8. Friction Spring
9. Friction Spring Pin Lock
10. Articulating Link
11. Anchor Plate
12. Return Spring
13. Wheel Cylinder
14. Guide Plate

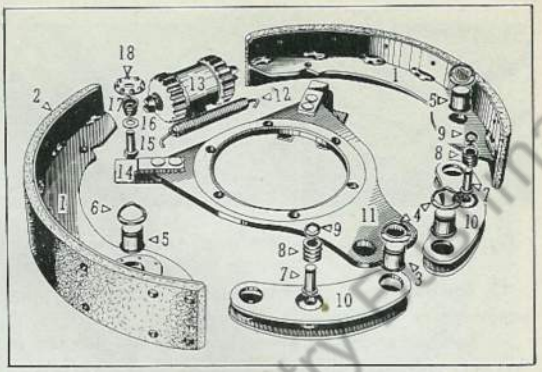

Fig. 19 Disassembled View of Rear Brake Shoe Parts (All Vehicles)

1. Brake Shoe
2. Brake Lining
3. Anchor Pin
4. Anchor Pin Lock
5. Link Pin
6. Link Pin Lock
7. Friction Spring Pin
8. Friction Spring
9. Friction Spring Pin Lock
10. Articulating Link
11. Anchor Plate
12. Return Spring
13. Wheel Cylinder
14. Guide Plate
15. Pinion Shaft
16. Pinion Shaft Washer
17. Pinion Shaft Spring
18. Adjusting Pinion

Dust Shield." Turn pins so that dots are toward each other as indicated in Fig. 25, if brakes have been relined or if original position of pins has been changed.

2. Replace shoe (1) on anchor pin (3), as shoe is pushed on anchor pin it should be guided over guide pins (9). Upper end of shoe rests against yoke in end of cylinder.

3. Reinstall brake shoe return spring (16) using special pliers in manner illustrated in Fig. 17. Remove wheel cylinder clamp, installed at disassembly.

4. Replace anchor pin "C" washers (6), using new part. Tap washer into anchor pin groove being sure washer seats fully. Use pliers as illustrated in Fig. 15, to clamp ends of washer together.

5. Replace "C" washer (11) on guide pins using flat washers (10) on each side of shoe. Clamp ends together using pliers as shown in Fig. 16.

6. Replace wheel and hub as directed in "Wheel" section of this book. Adjust wheel bearings as also directed in that section.

7. Adjust each brake shoe as directed under "Adjustments." Keep in mind that two adjustments are provided —one at anchor pins and other at cams near top of shoe.

E. To Remove Brake Shoes—(Except Front With "Split" Axle Housing)—Removal of brake shoe is described below. Refer to Figs. 18 and 19 for reference numbers in following text.

1. Jack up axle and remove wheel and hub as directed in "Wheel" section of this book.

2. Install wheel cylinder clamp as shown in Fig. 17 to keep wheel cylinder together and prevent leakage of brake fluid while servicing brake shoes.

3. Mark shoes so that they can be replaced to their original position. This will not be necessary if new shoes are going to be used. Shoes are interchangeable, however it is a good policy that they be replaced to their original position.

4. Remove brake shoes retracting spring (12) in manner shown in Fig. 17, using special brake spring pliers.

5. Remove articulating link anchor pin lock (4), using screwdriver in manner illustrated in Fig. 20.

6. Brake shoes with links can now be removed by swinging them clear of guide plates.

7. If necessary to remove articulating links (10) from shoe this can be accomplished by removing locks (6 and 9) in same manner as at anchor pins and illustrated in Fig. 20.

F. To Replace Brake Shoes—(Except Front With "Split" Axle Housing)—Replacement of brake shoe is accomplished as described below. Refer to Figs. 18 and 19 for reference numbers in following text.

1. Reassemble articulating links (10), pins (5 and 7), friction springs (8) and locks (6 and 9) to brake shoes (1) before installing shoe.

2. Install both shoes to anchor plate (11), using new anchor pin (3) if old part is worn. Replace locking washer (4) in anchor pin groove (3). Be sure that it seats fully in groove and locks securely. **Note:** Front brakes use only one anchor pin (3) (Fig. 18), while two are used on rear brakes (Fig. 19).

3. Install brake shoe retracting spring (12) using pliers as shown in Fig. 17.

BRAKES

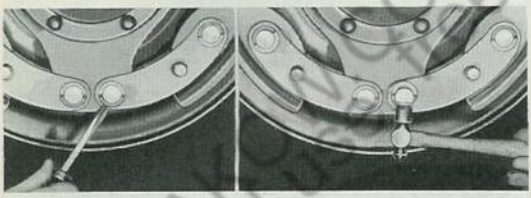

Fig. 20 Removing and Installing Anchor Pin Locks

4. Remove wheel cylinder clamp, installed at disassembly.

5. Replace hub and wheel assembly as directed in "Wheel" section of this book. Adjust wheel bearings as also directed in that section.

6. Adjust each brake shoe as previously directed under "Adjustments." There are two adjustments at each wheel, one for each shoe. Before and during adjustment, brakes should be applied severely several times to allow articulating links to become centralized.

G. To Replace Brake Lining—As previously stated only genuine GMC brake lining should be used. Linings are supplied in replacement sets of four linings and sufficient rivets of correct specifications.

1. Remove lining rivets, using deliner punches in a brake shoe relining machine.

2. Wash shoes in gasoline or other cleaning fluid then buff them on a wire buffer.

3. Install new lining in place on shoe. Brake shoe lining clamp should be used to assure lining fitting contour of shoe. See Fig. 21.

4. Align lining and shoe holes and install rivets at ends of lining. Fig. 22.

5. Remove shoe clamp and install remaining rivets.

Whenever brake linings have been renewed or when brake drums have been machined it is of utmost importance that brakes be carefully readjusted. Maximum braking efficiency can be obtained immediately if linings are properly centralized in relation to axle spindle. Brake lining surface must also be true in relation to face of brake drum before 100% brake efficiency can be obtained.

Brake lining trueing unit or lining grinder illustrated in Fig. 23, when used according to instructions accompanying unit, provides maximum contact between lining and drum.

In addition, use of this unit eliminates necessity of second adjustment after new brake linings have been broken in. Further; need of adjusting brakes after hub and drum are installed or use of dummy drum, is eliminated as linings can be trued to exact brake drum dimensions by measuring drum with micrometer as shown in Fig. 24.

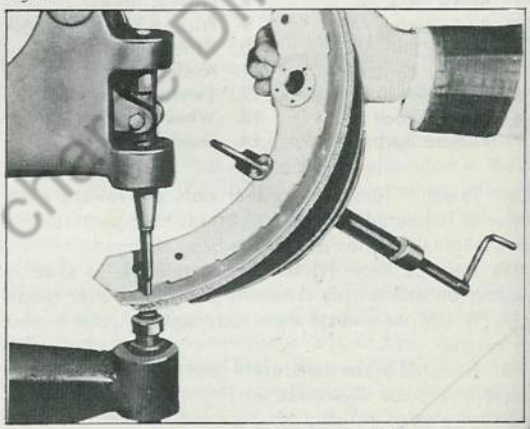

Fig. 22 Riveting Lining to Shoes

H. To Remove Brake Drums—Ordinarily, it is only necessary to remove drum from hub when inspection reveals that replacement is necessary.

1. Jack up axle. Remove front wheel and hub as directed in "Wheel" group of this book.

2. At front hub on vehicles equipped with "Split" type axle housings studs are held by nut. At all others, studs are held in hubs by serrations under head of bolt.

3. Nuts, when used, are spot welded to stud. This weld must be removed. Use wrench to remove nut from stud.

4. Use arbor press to remove studs or bolts, which will permit removal of drum from hub.

I. Inspection—Drums that are cracked or warped should be replaced with new parts. Those that are found to be scored, rough or out-of-round can sometimes be cleaned up by re-machining. Brake drums can be machined up to .125" on diameter; whenever it is necessary to go beyond these limits new drums should be installed.

When drums have been machined, shim stock, equal to amount removed, should be used between shoe and lining to maintain lining to drum contour.

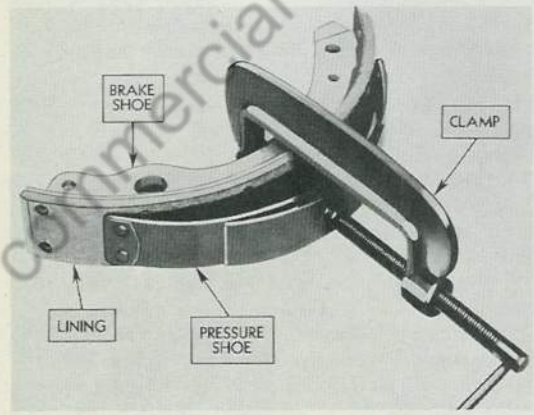

Fig. 21 Installing Brake Lining Clamp

BRAKES

J. To Replace Brake Drums—Before new drums are installed it is important that they be thoroughly cleaned. If grease is allowed to remain on drums it may find its way to linings which would necessitate their replacement.

1. Place hub in arbor press and locate drum in its correct position on hub.
2. Select studs or bolts to be used, being careful to use only those that are in good condition when installing used parts. Note that these parts have right and left hand threads.
3. Start studs by tapping with hammer and complete installation by use of press.
4. Studs used in front hub on vehicles having "Split" type axle housings are held with nut which must be spot welded in place to prevent loosening.
5. Studs used in hubs on vehicles having "Banjo" type axle housings are swaged with special tool after installation to prevent loosening. Refer to "Wheel" group of this book.

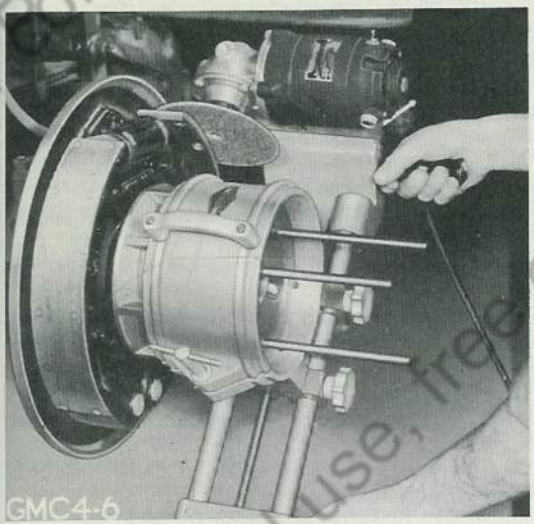

Fig. 23 Application of Lining Grinder

6. BRAKE SUPPORT AND DUST SHIELD

Brake dust shield used at front on vehicles equipped with "Split" type axle housings also serves as brake support. On all other vehicles, regardless of axle housing type, brake support and dust shield are separate parts, at both front and rear.

A. To Remove Brake Support and Dust Shield—Instructions necessary for the removal of these parts are listed below under paragraph heads for each axle type. Prior to actual removal it is necessary to perform the following operations which are common to all vehicles.

1. Remove wheel and hub. See "Wheel" section.
2. Disconnect hydraulic flexible hose. See "Hydraulic Lines" in this section

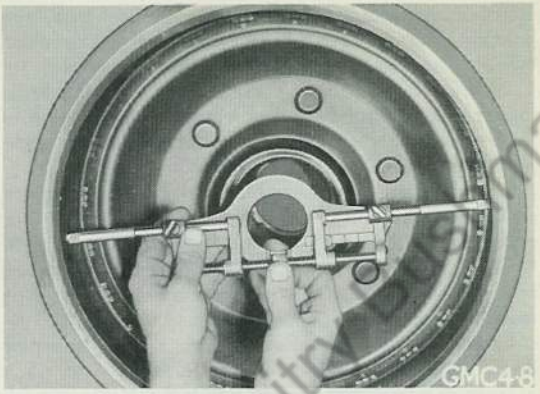

Fig. 24 Use of Micrometer to Measure Brake Drum Diameter

3. Remove brake shoe assemblies. See "Brake Shoes" in this section.
4. Remove wheel cylinder assembly. See "To Remove Wheel Cylinder" in this section.

B. Front ("Split" Type Axle Housing)—On these vehicles this part is a combination dust shield and brake support. Actual removal operations are as follows:

1. Loosen and remove stud nuts and lockwashers attaching shield to knuckle.
2. Shield can now be pulled straight out to remove from knuckle studs.

C. Front ("Banjo" Type Axle Housing)—On these vehicles dust shield is separate from the anchor plate. Actual removal of these parts is as follows:

1. Remove six cap screws and lockwashers attaching anchor plate to spacer. Anchor plate can now be completely removed.
2. Remove twelve cap screws and lockwashers holding spacer, oil deflector and dust shield to knuckle. Spacer, oil deflector and dust shield can now be completely removed.

D. Rear (Both Type Axles)—On these vehicles dust shield is separate from anchor plate. Actual removal of these parts is as follows:

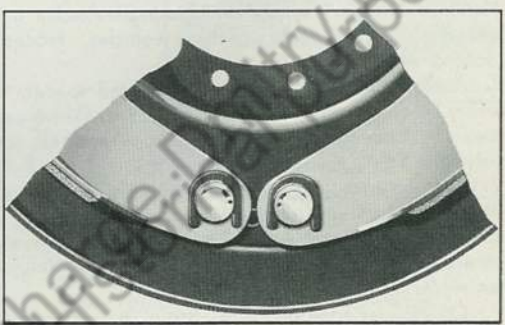

Fig. 25 Front Brake Anchor Pins are Marked as Shown ("Split" Type Axle Housings)

BRAKES

1. On vehicles equipped with "Banjo" type axle housings, loosen and remove bolt nuts and lockwashers. Anchor and shield can now be completely removed.

2. On vehicles equipped with "Split" type axle housings these parts are riveted to housing flange, therefore it is recommended that they be removed only when damaged, by cutting heads off rivets.

E. Inspection—If anchor plates and dust shields are removed they should be carefully inspected before replacing.

Carefully examine these parts for evidence of bending or twisting. Check anchor pin holes and if worn out of round anchor should be replaced.

Check condition of adjusting cams, springs, and pins and if defective replace with new parts.

Examine anchor pins, springs, and locks. Replace those showing evidence of excessive wear.

Guide pins and adjusting pins requiring replacement must be securely riveted and straight. When riveting these parts use extreme caution that anchor or shield are not bent during riveting operation.

F. To Install Brake Support and Dust Shield—When support and shield have been replaced, as described in following paragraphs, it is necessary that certain operations also be performed to complete the reassembly:

1. Replace wheel cylinder assembly. See "To Install Wheel Cylinder" in this section.

2. Attach flexible hose. See "Hydraulic Lines" in this section.

3. Replace brake shoes. See "To Install Brake Shoes" in this section

4. Replace hubs and wheels. See "Wheel" section of this book.

5. Bleed brake system. See "Bleeding Hydraulic System" in this section

6. Adjust brakes. See "Adjustments" in this section.

G. Front ("Split" Type Axle Housing)—Combination dust shield and brake anchor is used on these vehicles. Proceed as follows when replacing:

1. Place shield over studs in steering knuckle and replace lockwashers and nuts. Tighten nuts alternately and evenly until tight.

H. Front ("Banjo" Type Axle Housing)—Anchor and shield are separate parts on these vehicles. Proceed as follows when replacing:

1. Replace dust shield, oil deflector and spacer, to steering knuckle flange, in order given, using twelve cap screws and lockwashers. Tighten screws alternately and evenly until tight.

2. Replace anchor to spacer using six cap screws and lockwashers. Tighten screws alternately and evenly.

I. Rear (Both Type Axles)—Anchor and shield are separate parts on these vehicles. Proceed as follows when replacing:

1. On vehicles equipped with "Banjo" type axle housings these parts are bolted to housing flange. Replace shield and anchor to flange and install bolts, lockwashers and nuts. Tighten nuts alternately and evenly.

2. On vehicles equipped with "Split" type axle housings these parts are riveted to housing flange. When replacing be sure that rivets are correct diameter and are tight.

7. BRAKE PEDAL

Brake pedal is mounted to power plant by pedal shaft and bracket in same manner as clutch pedal and is used only to apply or release service brakes.

As brake pedal is depressed this physical effort is transmitted to master cylinder through pull rod. Master cylinder transfers this effort into hydraulic pressure to apply brakes as described under "Master Cylinder." Also see "Hydrovac Unit." When pedal is released, hydraulic fluid pressure, built up at application, returns to normal and brakes are released.

Avoid driving with foot on brake pedal as this will cause brakes to be partially applied. A smooth and even application of brakes is good driving practice.

A. To Remove Brake Pedal—Ordinarily brake pedal need not be removed except when power plant is being removed or for pedal bushing replacement.

1. Remove floor boards and toe boards as directed in "Body" section of this book.

2. Disconnect clutch pedal linkage as described in "Clutch" section of this book.

3. Disconnect pedal pull rod by removing cotter pin and clevis pin at pedal.

4. Remove three bolts attaching pedal shaft bracket to clutch housing and transmission case. Pedals and bracket can now be removed as a complete assembly.

5. Remove taper pin attaching collar to pedal shaft. Collar, clutch pedal and brake pedal can now be slipped off shaft.

B. Inspection—Before assembly of pedal, following inspections should be made:

1. Inspect brake pedal bushing for wear and fit on pedal shaft. Bushing should be replaced if worn excessively. Remove and replace by use of arbor press or other suitable tools.

2. Inspect condition of pedal shaft and if scored or worn, replace. Shaft is held in bracket with pin which can be driven out. Replace shaft in bracket with holes lined up and drive in new pin.

C. To Install Brake Pedal—

1. Replace brake pedal, then clutch pedal on shaft. Slip collar over outer end of shaft and line up pin holes. Install pin and drive securely into place.

2. Replace bracket and pedal assembly to clutch housing and transmission case, using three cap screws and lockwashers.

3. Attach pull rod to brake pedal, using clevis pin and cotter pin.

4. Reconnect clutch pedal linkage and make necessary adjustments as directed in "Clutch" section of this book.

5. Install toe and floor boards as directed in "Body" section of this book.

6. Adjust brake pedal linkage and check master cylinder stop screw clearance as directed under "Adjustments" in this section.

8. MASTER CYLINDER

Purpose of the master cylinder is to displace fluid under pressure from a central source into lines and build up hydraulic pressure to operate hydrovac relay valve.

Depressing brake pedal, connected to master cylinder through linkage, results in master cylinder piston movement and in turn displacement of hydraulic fluid as described.

When pedal is released, pressure built up is relieved; therefore, pistons in master cylinder and wheel cylinders return to released position, also; atmospheric and vacuum valves in relay valve return to their release position.

Check valve used in closed end of master cylinder is held in place by piston cup return spring. Fluid passing through valve on pressure stroke can return to master cylinder by raising entire valve from its seat when pedal pressure is released. As pressure of returning fluid drops below 6 to 8 lbs., spring pressure seats check valve and system is held under a slight hydraulic pressure. This pressure is not enough to cause application or drag of brakes.

A. To Remove Master Cylinder—Sequence of operations necessary to completely remove master cylinder are covered in following text. Refer to Fig. 1 for reference numbers, also see Fig. 7.

1. Disconnect hydraulic fluid line (18) at front of master cylinder.

2. Disconnect brake linkage return spring (8) at frame cross member.

3. Remove cotter pin and clevis pin attaching pedal pull rod (2) to inner operating lever (5).

4. Remove mounting bolts (16) and nuts (17) attaching mounting brackets (14 and 15) to frame side rail. At this time master cylinder, mounting brackets and linkage may be completely removed from vehicle and further disassembled at bench.

5. Remove cotter pin and clevis pin attaching adjustable yoke to operating lever (6).

6. Loosen clamp bolts in levers (5 and 6) and drive operating shaft (7) out of levers and mounting brackets.

7. Remove cap screws (12 and 13) and lockwashers attaching master cylinder (11) between brackets (14 and 15).

8. Master cylinder can now be completely removed and disassembled for inspection, or other service operations.

B. To Install Master Cylinder—Master cylinder and mounting brackets are replaced in vehicle as described in following text. Refer to Fig. 1 for reference numbers.

1. Attach outer mounting bracket (14) to left side of master cylinder, using cap screws (13) and lockwashers. Also attach inner bracket (15) to right side of cylinder, using cap screws (12) and lockwashers. Be sure that screws are tight as any looseness of cylinder may seriously affect their operation.

2. Push operating shaft (7) through inner bracket (15) and slide operating lever (6) over shaft, as shaft is pushed into inner bracket (14).

3. Tap Woodruff keys into slots in shaft and locate levers (5 and 6) over keys. Tighten lever clamp bolts securely.

4. Place master cylinder and bracket assembly inside of frame side rail and install mounting bolts (16), nuts (17) and lockwashers. Draw up nuts tightly so that brackets are rigidly attached to frame rail.

5. When replacing master cylinder brackets it is suggested that complete bracket assembly be used as shaft supports are line reamed to eliminate binding of operating shaft.

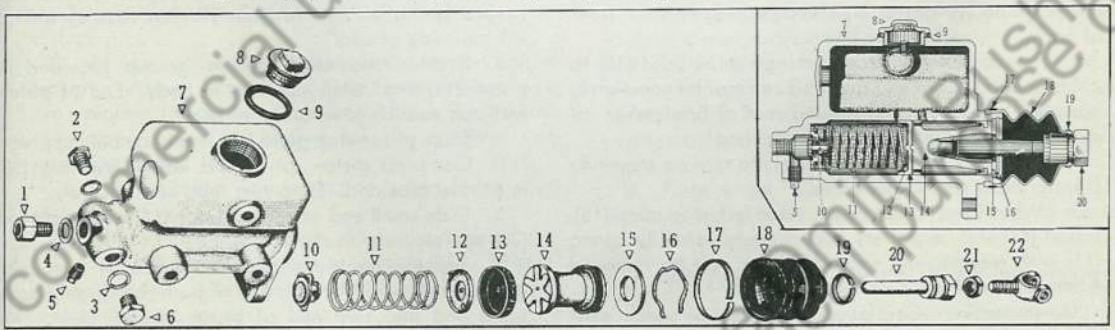

Fig. 26 Disassembled and Sectional View of Brake Master Cylinder

1. Outlet Fitting
2. Outlet Plug
3. Gasket
4. Gasket
5. Plug
6. Outlet Plug
7. Cylinder Only
8. Filler Cap
9. Gasket
10. Valve Assembly
11. Spring
12. Retainer
13. Cup—Piston
14. Piston Assembly
15. Stop Plate
16. Lockwire
17. Strap—Large
18. Boot
19. Strap—Small
20. Push Rod
21. Nut
22. Yoke

BRAKES

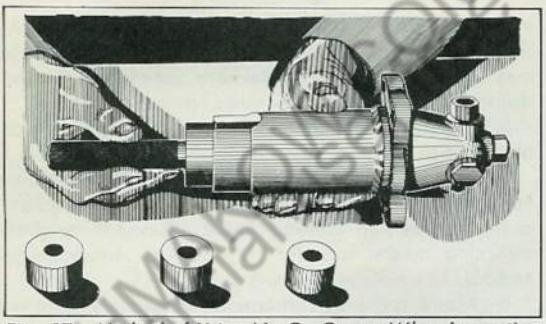

Fig. 27 Method of Using No-Go Gauge When Inspecting Master and Wheel Cylinders

6. Thread adjustable yoke into push rod and attach yoke to operating lever, using clevis pin and cotter pin. (See Fig. 7.)

7. Adjust master cylinder push rod and stop screw as previously directed under "Adjustments".

8. Attach pedal pull rod (2) to operating lever (5), using clevis pin and cotter pin. Adjust brake pedal to toe board clearance at adjustable yoke (3) as previously directed under "Adjustments".

9. Replace hydraulic line (18) to front of brake master cylinder, being sure that fitting is tight to prevent loss of hydraulic fluid at this point.

10. Complete brake system must now be bled as directed under "Adjustments".

C. To Disassemble Master Cylinder—Following instructions cover the actual disassembly of master cylinder. If it should only be necessary to replace parts within cylinder body this can be accomplished without removing cylinder from vehicle. Refer to Fig. 26 for reference numbers.

1. Remove filler cap (8) and gasket (9) from master cylinder body.

2. Remove outlet plugs (2 and 6) and gaskets (3), also outlet fitting (1), gasket (4) and pipe plug (5) from front of body.

3. Remove clamp (17) attaching rubber boot (18) to cylinder body. Boot and push rod can now be completely removed and clamp (19) around rear of boot taken off so that rod (20) can be removed from boot.

4. Use pair of pointed end pliers to remove snap ring (16) from rear of cylinder body.

5. When snap ring has been taken out, stop plate (15), piston (14) with secondary cup, primary cup (13), spring (11) with retainer and valve (10) can now be removed from cylinder body.

D. Inspection—Careful examination of each part should be made and those which show any evidence of wear should be replaced with new parts.

1. Examine cylinder walls and if found to be scored or rusted, they must be reconditioned by honing.

2. Hone of proper size should be placed in chuck of electric drill clamped in vise. Slide cylinder back and forth over revolving hone a few times and inspect cylinder walls to see if walls are cleaned up. Do not hone away any more than is required to remove scores and smooth up cylinder.

3. Try No-Go gauge as shown in Fig. 27, using collar of correct diameter for cylinder. No-Go gauge is slightly larger than maximum allowable diameter at which cups will operate satisfactorily. Therefore, if gauge will enter bore, cylinder must be discarded and new part installed.

4. Make sure two by-pass ports in cylinder barrel are clean and that all sediment is cleaned from cylinder. Clean entire unit in denatured alcohol after reconditioning to remove all abrasive matter. Use compressed air to dry cylinder and remove any particles of foreign material that may affect operation of cylinder.

5. Inspect check valve seats; if pitted or swollen, entire valve assembly should be replaced with new part.

6. Check piston fit in cylinder bore. Clearance between piston and cylinder wall should be within limits specified in "Specifications" at end of this section. If piston is scratched or defaced in any way it should be replaced by new part.

7. Always use new rubber parts when reconditioning cylinder. Rubber parts which are swollen or are otherwise damaged, will seriously impair proper function of cylinder.

E. To Assemble Master Cylinder—During reassembling, it is extremely important that all parts be clean and free of any abrasive; also that each part be coated with hydraulic brake fluid. Refer to Fig. 26, for reference numbers.

1. Replace valve assembly (10) over open end of piston spring (11). Hold spring in vertical position, with valve end up, and slide body down over spring and valve assembly. Retainer (12) is held to rear of spring by two clips which are bent over spring coil. These two parts are serviced only as an assembly.

2. Replace piston cup (13) in body with edge of cup toward spring so that retainer (12) on rear of spring will be inside of cup.

3. Replace secondary cup in groove provided in piston (14) and install assembly in body. End of piston with cup must be toward rear of body.

4. Place piston stop plate (15) into body behind piston (14). Compress piston spring and install snap ring (16) in groove provided. Snap ring must seat securely.

5. Slide small end of rubber boot (18) over push rod (20) and secure with clamp (19).

6. Replace boot and push rod assembly over rear end of body, with forward end of push rod through stop plate and into rear end of piston. Install clamp (17) attaching boot to body.

7. Replace outlet plugs (2 and 6) using gasket (3) under head of plug, also replace pipe plug (5). Replace outlet fitting (1) in forward end of body using gasket (4).

8. Replace filler cap (8) using gasket (9) between cap and cylinder body.

BRAKES

9. WHEEL CYLINDER

One wheel cylinder is used at each wheel. Vehicles using "Banjo" type front axle uses a different type wheel cylinder than is used on vehicles equipped with "Split" type axle housing. Rear wheel cylinder is same on both types of axles. Wheel cylinders are illustrated in Fig. 28.

Purpose of wheel cylinder is to transfer hydraulic pressure to brake shoes. Hydraulic pressure forces pistons outward, thus brake shoes are also forced outward against brake drums. When pressure at master cylinder is relieved, fluid in wheel cylinders is also relieved, cylinder pistons and brake shoes are returned to released position by brake shoe return springs.

A. To Remove Wheel Cylinders—Wheel cylinders are attached to inside of brake dust shields. Procedure for removing is as follows:

1. Jack up axle and remove hub and wheel as directed in "Wheel" section of this book.

2. Install wheel cylinder clamp over ends of wheel cylinder to keep wheel cylinder together. Piston spring will force end cups and pistons out, if clamp is not used. Refer to Fig. 17, for method of using clamp.

3. Remove brake shoe retracting spring as shown in Fig. 17, using special pliers.

4. Before removing cylinder, disconnect flexible hose at frame fitting and wheel cylinder as directed in "Hydraulic Lines". **Do not attempt to remove from cylinder first as this necessitates twisting hose which will result in damage to fabric.**

5. Remove cap screws and lockwashers attaching cylinder to backing plate. Cylinder with clamps can now be lifted from backing plate.

B. To Install Wheel Cylinder—Procedure for installing wheel cylinder to backing plate is as follows:

1. Install cylinder to backing plate, using cap screws and lockwashers. Be sure screws are drawn up tightly and evenly. Cylinder must be installed with bleeder screw at top.

2. Attach flexible hose to wheel cylinder and tighten securely. Attach opposite end to frame fitting, using two wrenches to tighten. One wrench holds flexible hose while other is used at coupling nut. **Do not twist hose when tightening.**

3. Reinstall brake shoe retracting spring, using pliers as shown in Fig. 17.

4. Remove clamp over ends of wheel cylinder.

5. Replace wheel and hub as directed in "Wheel" section of this book; also adjust wheel bearings as directed in that section.

6. Complete brake system must now be bled as directed under "Adjustments".

7. Make brake shoe adjustment as previously instructed under "Adjustments" in this section.

C. To Disassemble Wheel Cylinder—Disassembly of wheel cylinders is as follows. Refer to Fig. 28 for reference numbers.

1. Remove wheel cylinder clamp used to hold cylinder.

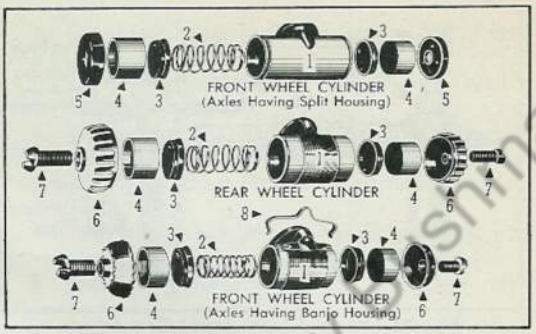

Fig. 28 Wheel Cylinders Disassembled

1. Wheel Cylinder
2. Piston Return Spring
3. Cylinder Cup
4. Cylinder Piston
5. Cylinder End Boot
6. Cylinder End Cover
7. Adjusting Screw
8. End Cover Lock Spring

2. Remove wheel cylinder end caps (6) or boots (5) from ends of cylinder housing. Pistons (4), cups (3) and spring (2) can now also be removed from housing.

3. Remove bleeder valve screw and lockwasher from housing also flexible hose fitting.

Careful examination of each part should be made and those which show any evidence of wear should be replaced with new parts. Examine the following:

1. Cylinder walls; if found to be scored or rusted, they must be reconditioned by honing in same manner as described for master cylinder.

2. Always use new rubber parts when reconditioning cylinder. Rubber parts which have swollen, or are otherwise damaged, will seriously impair function of cylinder.

D. To Assemble Wheel Cylinder—During reassembly it is extremely important that all parts be clean and free of any abrasive; also, that each part be coated with hydraulic brake fluid. Refer to Fig. 28 for reference numbers.

1. Reassemble flexible hose fitting to cylinder and replace bleeder screw and lockwasher.

2. Install piston return spring (2), piston cups (3), pistons (4), and end caps (6) or boot (5) in order illustrated in Fig. 28. Piston cups are installed with edge of cup toward spring. Flat surface of piston must be toward cups.

3. Place wheel cylinder clamp over ends of cylinder as shown in Fig. 17, to hold parts together until cylinder is installed.

10. HYDRAULIC LINES AND FITTINGS

Relative location of hydraulic lines used between master cylinder, Hydrovac unit and wheel cylinders are shown in Fig. 1.

Flexible hose, constructed to withstand high pressure is used between each wheel cylinder and frame fitting. Special metal tubing is used between flexible hose frame fittings, master cylinder and hydraulic slave cylinder.

A. Front Wheel Shut-Off Cock—Shut-off cock is provided in hydraulic line leading to front wheels, as shown

BRAKES

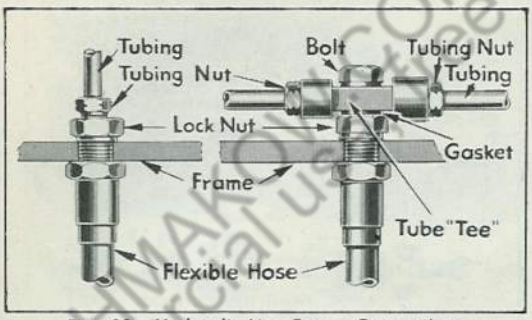

Fig. 29 Hydraulic Line Frame Connections

in Fig. 1. This part provides means of closing off fluid pressure to front wheel cylinders, if flexible hose or line should become broken. When shut-off cock is closed, front brakes are inoperative and all braking effort is at rear wheels.

B. Flexible Hose—Hydraulic hose, used between wheel cylinders and frame connections, is special flexible type; made especially for this purpose. Whenever it is necessary to renew this part it is important that only genuine GMC parts be used.

C. To Remove Flexible Hose—Procedure for removal of flexible hose is as follows: Connections are illustrated in Fig. 29.

1. Before flexible hose at right front wheel and forward rear wheels can be removed it is necessary to first remove bolt attaching "Tee" to hose, shown in Fig. 29.
2. At other wheels, remove tubing flared nut shown in Fig. 29.
3. Remove lock nut and shake proof lockwasher attaching hose to frame, using two wrenches, one at hose fitting and other at lock nut. Use of two wrenches eliminates possibility of twisting hose.
4. Flexible hose can now be removed at wheel cylinder with wrench.

D. To Replace Flexible Hose—It is important that all connections be tight to prevent loss of hydraulic fluid. Excessive fluid loss will cause brakes to become ineffective.

1. Attach flexible hose to wheel cylinder, using new gasket, being especially careful that hose is tightened securely to prevent leaks.
2. Attach opposite end to frame side rail and replace shake proof lockwasher and lock nut at inside of side rail. Do not twist hose while tightening nut. Use two wrenches, in manner previously described for removal of hose, to eliminate possibility of twisting.
3. On right front wheel and at forward rear wheels always use new gasket on both sides of "Tee". Attach "Tee" to flexible hose using special bolt. Be sure that connection is tight else hydraulic fluid may be lost through leakage.
4. At other wheels attach tubing nut directly to flexible hose fitting. Flared fitting nut must be drawn up tightly; also be sure that tubing is not twisted during tightening.

E. Tubing—Tubing used is of Special Metal, made especially for this purpose and must withstand high pressures. Ordinary copper tubing is not satisfactory and must not be used.

F. Tube Flaring—It is important when flaring hydraulic tube that the ends be properly flared to fit couplings. Tubing that is not properly flared will leak and cause brakes to be ineffective.

1. Cut the tubing to the desired length, using a special tube cutter to prevent flattening. Square off the end with a fine-cut mill file, then ream the sharp edges with reamer blade provided on the tube cutter.
2. Place new compression coupling nuts on tubing. Dip end of tubing to be flared in Hydraulic Brake Fluid. This lubrication results in a better formation of the flare. Loosen clamping nuts on flaring tool, and insert finished end of tubing in channel of the die until it bears against the stop pin. Fig. 30.
3. Tighten clamping nuts by hand and place fixture in a bench vise. Then tighten down clamping nuts firmly with a wrench and remove stop pin from the die. The tubing is now firmly gripped in die and ready for the first flare-forming operation.
4. Using the flare-forming tool having the concave die, insert forming tool in die and strike firm blows, with a hammer, until shoulder of the tool contacts top of the die. Fig. 31.
5. Next, use flare-forming tool having 45 degree die of its lower end. Insert tool in die and strike firm blows, with a hammer, until shoulder of tool contacts top of the die. Fig. 32.

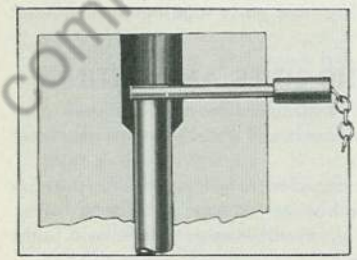

Fig. 30 Install Tubing to Proper Depth

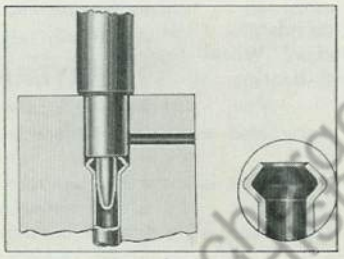

Fig. 31 First Flaring Operation

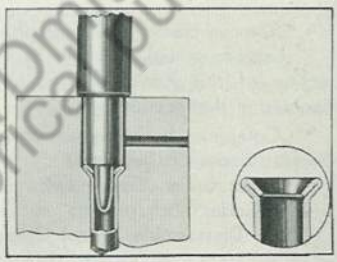

Fig. 32 Finish Flaring Operation

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11. HYDROVAC UNIT

Hydrovac unit consists of a power cylinder, relay valve, and hydraulic cylinder. Refer to subject paragraphs for individual description of three units.

A. Description—Individual units are assembled into a single unit to form an assisting system to aid hydraulic system in applying brakes.

Complete unit is connected in hydraulic line behind master cylinder. Installation of Hydrovac unit showing hydraulic lines, vacuum lines and master cylinder is illustrated in Fig. 1, while Figs. 33 and 34, illustrate unit sectionally and disassembled.

B. Operation—Physical pressure applied to brake pedal is transmitted to master cylinder through pull rod. Hydraulic fluid in master cylinder is then displaced in same manner as in a straight hydraulic system. Hydraulic fluid, displaced by master cylinder, builds up pressure in hydraulic lines, until pressure reaches a point which causes relay valve to function.

As relay valve functions, vacuum valve is closed and atmospheric valve is opened. (See Fig. 36.) As vacuum valve closes, vacuum to one side of power cylinder pistons is blocked off and atmosphere is admitted to power cylinder through atmospheric valve.

Atmosphere admitted to power cylinder through atmospheric valve in relay causes power cylinder pistons to move toward hydraulic cylinder. Push rod, attached to power cylinder piston rod, closes check valve in hydraulic cylinder; therefore, pressure is applied to fluid in hydraulic cylinder, hydraulic lines, and wheel cylinders to apply brakes as in conventional hydraulic system.

C. Testing Power Brake Equipment—Before testing brake equipment, make sure that no leaks exist in the vacuum system:

1. If engine is running, it should be stopped and brakes applied a few times so that supply of vacuum in lines and power cylinder is exhausted.
2. Make a light brake pedal application with left foot and hold the pedal in this position.
3. Turn on ignition switch and start engine.
4. As engine is started, pressure necessary to hold the pedal will be partially relieved if vacuum system is functioning. If there is no release of pedal pressure after engine has been started, this indicates that the Hydrovac power cylinder is not functioning. Refer to "Vacuum Lines", "Relay Valve" and "Power Cylinder" for further tests.

D. To Remove Hydrovac Unit—Hydrovac unit can be removed from vehicle in following manner. Refer to Fig. 1 for reference numbers:

1. Remove vacuum line hose clamp (31) at top of power cylinder.
2. Disconnect air cleaner hose (26) by removing clamp at relay valve.
3. Disconnect hydraulic fluid line (18) between master cylinder and hydraulic cylinder.
4. Disconnect hydraulic fluid outlet line (38) at front end of hydraulic cylinder.
5. Remove two nuts (32) attaching Hydrovac unit to front support bracket (39).
6. Remove nuts (42) and cap screws (41) attaching rear support bracket (40) to frame side rail and remove two nuts (33) attaching Hydrovac unit to rear support bracket (40).
7. Rear support bracket can now be moved slightly to rear to permit complete removal of Hydrovac unit.

E. To Install Hydrovac Unit—Refer to Fig. 1 for reference numbers.

1. Replace Hydrovac unit in approximately correct position with two through studs in front bracket (39).
2. Install rear bracket (40) over rear ends of studs and move bracket forward until holes line up with frame side rail. Install bolts (41) and nuts (42) attaching rear bracket to frame side rail.
3. Reconnect hydraulic lines (18 and 38) to cylinder. Line at front end of hydraulic cylinder leads to "Tee" inside frame side rail, while line at rear of hydraulic cylinder leads to brake master cylinder. It is extremely important that there should not be any leaks in hydraulic line fittings, therefore always tighten line nuts securely.
4. Reconnect atmospheric (26) and vacuum (20) lines at power cylinder and tighten hose clamps securely so that no leaks exist at these points.
5. When unit is replaced, and hydraulic lines are reconnected it is necessary that complete brake system be bled as previously instructed.

12. RELAY VALVE

This unit is attached to rear of power cylinder as illustrated in Fig. 33. Refer to Fig. 1 for Hydrovac unit installation, also hydraulic and vacuum lines connections. Purpose of relay valve is to regulate and control vacuum and atmosphere pressure on both sides of power cylinder pistons.

When brake pedal is depressed hydraulic fluid displaced by master cylinder builds up sufficient pressure to cause diaphragm linkage to open and close vacuum and atmospheric valves in accordance with requirements.

Detailed description of the four functions of relay valve are given below:

1. **Released Position**—When brakes are not being used, relay valve is in released position, as shown in Fig. 35. In the released position atmospheric valve "A" is closed, and vacuum valve "B" is open: therefore, both sides of diaphragm are connected to vacuum intake through a drilled port in the valve body and diaphragm chamber "D2" is open to power cylinder through cored opening in valve housing. Diaphragm is held in released position by a return spring. As long as valve "A" remains closed, and valve "B" is open, engine manifold vacuum exists on both sides of power cylinder pistons.
2. **Applied Position**—When hydraulic pressure at relay valve is sufficient to cause piston to move diaphragm,

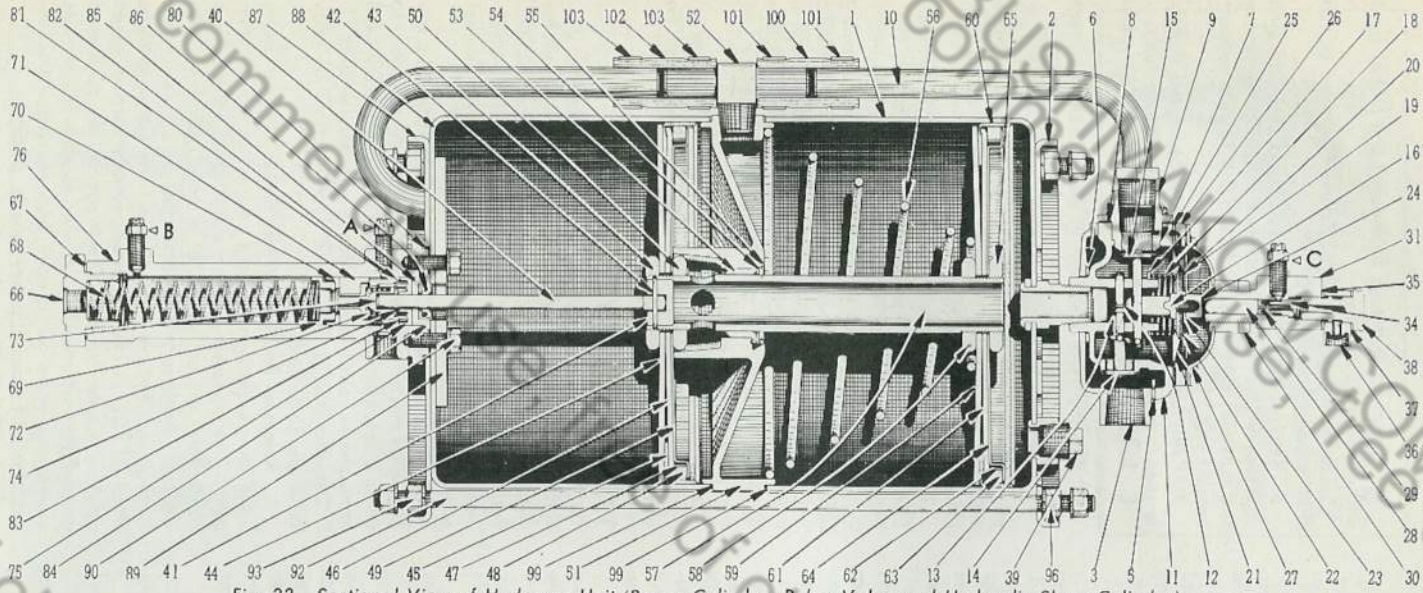

Fig. 33 Sectional View of Hydrovac Unit (Power Cylinder, Relay Valve and Hydraulic Slave Cylinder)

1. Shell—Rear
2. Stud Plate
3. Valve Body Cover
4. Elbow (Fig. 34)
5. Cover Gasket
6. Cover Gasket
7. Valve Seat Gasket
8. Valve Body Gasket
9. Vacuum Valve Seat
10. Vacuum Tube
11. Relay Valve Body
12. Valve Spring Washer
13. Valve Spring
14. Atmospheric Valve
15. Vacuum Valve
16. Valve Link
17. Spring Washer
18. Release Spring
19. Washer
20. Diaphragm Washer
21. Diaphragm
22. Diaphragm Washer
23. Washer
24. Support Plate Nut
25. Valve Cover Gasket
26. Valve Cover Spacer
27. Relay Valve Cover
28. Hydraulic Piston
29. Piston Cup
30. Adapter Body Nut
31. Adapter Body
31A. Bleeder Valve (Fig. 34)
32. Lockwasher (Fig. 34)
33. Bleeder Screw (Fig. 34)
34. Piston Stop
35. Fitting Gasket
36. Fitting
37. Fitting Gasket
38. Fitting Bolt
39. Pipe Plug
40. Push Rod
41. Thrust Cup
42. Push Rod Pin
43. Piston Rod Nut
44. Piston Plate
45. Piston Packing
46. Piston Plate
47. Packing Spring
48. Piston Felt
49. Felt Retainer
50. Piston Rod Nut
51. Center Plate
52. Hose "Tee"
53. Piston Rod Seal
54. Seal Washer
55. Washer Retainer
56. Return Spring
57. Piston Rod
58. Piston Rod Nut
59. Piston Plate
60. Piston Packing
61. Piston Plate
62. Packing Spring
63. Piston Felt
64. Felt Retainer
65. Piston Rod Nut
66. Cylinder Plug
67. Plug Gasket
68. Return Spring
69. Spring Retainer
70. Piston Cup
71. Cylinder Piston
72. Piston Spring
73. Piston Valve
74. Valve Stop Ring
75. Piston Seat Cup
76. Cylinder Body
77. Bleeder Valve (Fig. 34)
78. Lockwasher (Fig. 34)
79. Bleeder Screw (Fig. 34)
80. Guide Gasket
81. Washer Snap Ring
82. Seal Washer
83. Cylinder Seal
84. Body Gasket
85. Push Rod Guide
86. Push Rod Seal
87. Stud Plate
88. Shell—Front
89. Face Plate
90. Cap Screw
91. Lockwasher (Fig. 34)
92. Stud
93. Stud Nut
94. Lockwasher (Fig. 34)
95. Lockwasher (Fig. 34)
96. Stud Nut
97. Hydraulic Tube (Fig. 34)
98. Tube Clip (Fig. 34)
99. Gasket
100. Vacuum Hose
101. Hose Clamp
102. Vacuum Hose
103. Hose Clamp

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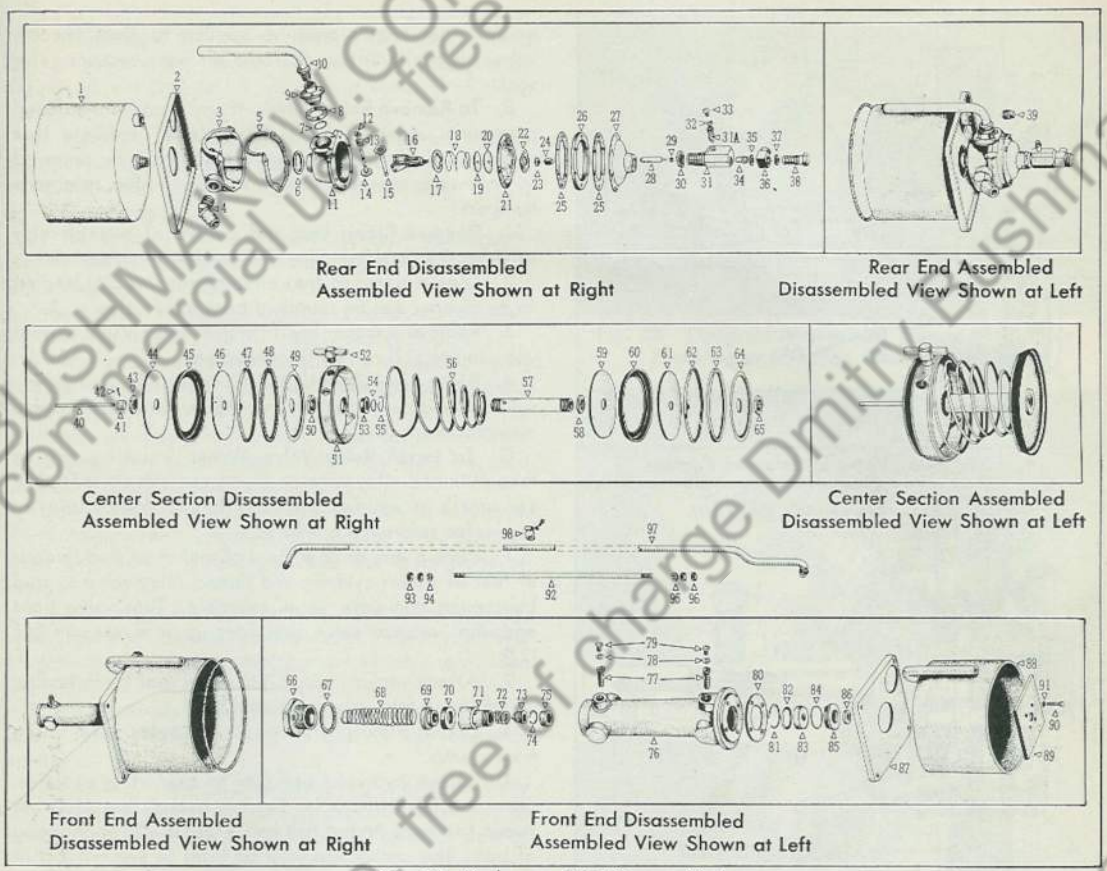

Fig. 34 Hydrovac Unit Disassembled

triangular shaped linkage operates to close vacuum valve "B" and open atmospheric valve "A" as shown in Fig. 36. This permits atmosphere to pass through relay valve and to one side of power cylinder position. This pressure of air causes pistons to commence their power stroke and force push rod against hydraulic cylinder piston.

3. **Holding Position**—Atmospheric pressure in diaphragm chamber "D2" creates an opposing force in the relay valve which tends to move diaphragm toward released position and close atmospheric valve "A". Movement of diaphragm, combined with action of triangular linkage, closes atmospheric valve "A" and (with valve "B" also closed) to hold brakes in partially applied position. This relay valve position is shown in Fig. 37. Relay valve remains in this position, with both atmospheric (A) and vacuum (B) valves closed and power cylinder pistons do not move in either direction, until; hydraulic pressure at relay valve is changed to open one of the valves. This action provides complete control of the power cylinder operation and prevents cylinder applying more brake action than is desired.

4. **Releasing**—When foot pedal is released, hydraulic pressure at relay valve drops, atmospheric valve "A" closes, shutting off atmospheric pressure in power cylinder, and valve "B" opens so that both sides of power cylinder pistons are again connected to intake manifold. Atmosphere in power cylinder is drawn into intake manifold through vacuum lines. Vacuum on both sides of power cylinder pistons is thus equalized and brakes are released instantly by their retracting springs.

A. Testing Relay Valve

To determine whether relay valve is functioning properly, the following procedure may be used:

1. Disconnect atmosphere line from relay valve inlet and vacuum line from power cylinder center plate "Tee". Light air pressure **(not more than 10 lbs.)** should be applied through atmosphere inlet. If air pressure is retained for a reasonable length of time it indicates that valve is seating satisfactorily. If leak is apparent or audible it may be around one of the gaskets, instead of at atmospheric valve.

2. Vacuum valve may also be tested at this time;

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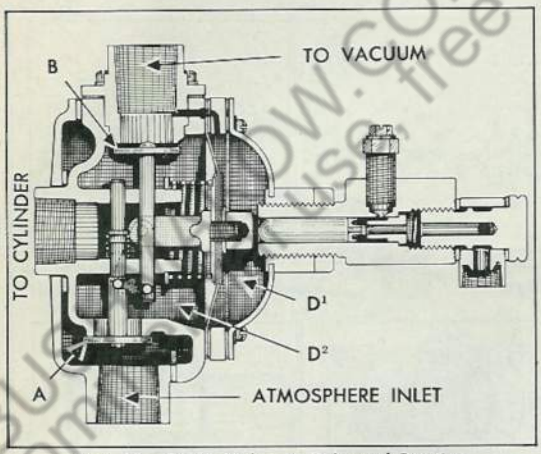

Fig. 35 Relay Valve in Released Position

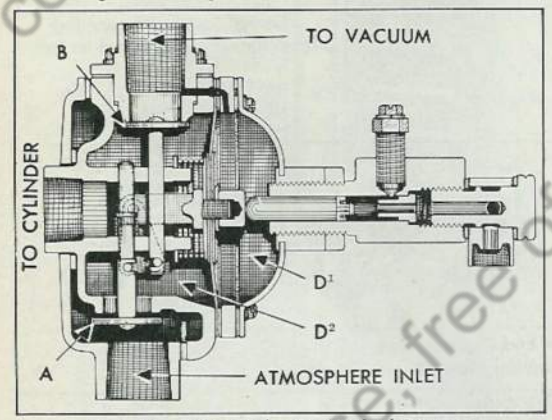

Fig. 36 Relay Valve in Applied Position

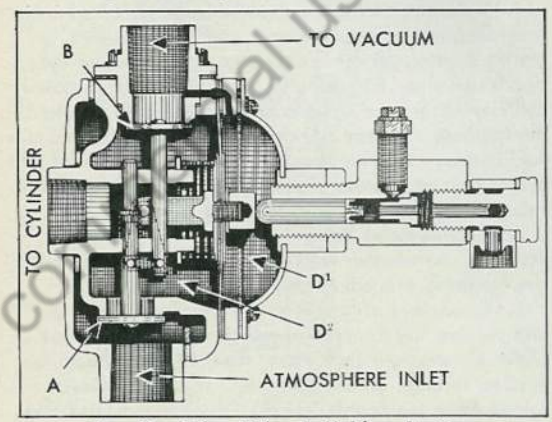

Fig. 37 Relay Valve in Holding Position

A. Atmospheric Valve
B. Vacuum Valve
D1. Vacuum Chamber
D2. Vacuum and Atmospheric Chamber

except, that brakes must be applied to close vacuum valve while attempting to force air past vacuum valve seat.

B. To Remove Relay Valve—If any conditions outlined previously under "Testing Relay Valve" indicate that relay valve is not functioning properly it can be removed in following manner. Refer to Fig. 1 for reference numbers:

1. Remove fitting bolt and gaskets at rear of relay valve so that hydraulic line (24) can be disconnected.
2. Loosen clamp so that atmospheric line (26) leading to air cleaner can be removed from relay valve.
3. Remove vacuum line fitting at relay valve so that vacuum line (27) can be disconnected.
4. Relay valve is threaded to stud at rear of power cylinder and can now be removed by turning complete assembly from stud.

C. To Install Relay Valve—When installing new or reconditioned relay valve to Hydrovac unit while Hydrovac unit is in vehicle, procedure is as follows. Refer to Fig. 1 for reference numbers:

1. Place a very small amount of shellac on stud threads at rear of power cylinder and thread relay valve to stud by turning complete valve assembly. Turn valve tight and until vacuum valve seat lines up with vacuum line (27).
2. Attach vacuum line (27) to valve seat by threading coupling nut into valve seat until tight.
3. Attach atmospheric line (26) at relay valve, using hose clamp.
4. Attach hydraulic line (24) to rear of relay valve, using special fitting bolt. Be sure gaskets are used between fitting at end of line and adapter also under head of bolt. This connection must be tight to prevent loss of hydraulic fluid at this point.
5. It is now necessary to bleed entire brake system as instructed under "Bleeding Brake System".

D. To Disassemble Relay Valve—Whenever it is found necessary to disassemble relay valve it should be removed from power cylinder. Refer to Figs. 33 and 34 for reference numbers.

1. Remove six screws holding cover (27) and spacer (26) to valve body and remove cover, gaskets (25) and spacer.
2. Remove four screws holding vacuum valve seat (9) to body of valve and remove vacuum valve.
3. Removal of six screws will permit two halves (3 and 11) of valve body being taken apart.
4. Press down on diaphragm nut (24) as vacuum valve (15) is moved outward to disconnect valve stem from linkage.
5. Remove diaphragm assembly (21) and linkage (16) from body as an assembly.
6. Hold atmospheric valve spring (13) out of position with a screw driver, and remove horse shoe lockwasher (12) from valve stem. Valve and spring can now be removed from valve body. (Refer to Fig. 38.)

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7. Diaphragm (21) fabric spacers (20 and 22) and washers (19 and 23) can be removed from yoke (16) by taking off nut (24), which will permit removal of these parts.

8. Hydraulic adapter body (31) can be completely disassembled when fitting (36) and bolt (38) have been removed, which permits removing of piston (28), cup (29) and piston stop (34).

E. Inspection—Place all parts, except diaphragm, fabric washers, gaskets and rubber parts in gasoline, or other suitable cleaning fluid. After cleaning, compressed air may be used to remove any foreign deposits loosened by cleaning fluid, and to thoroughly dry each part.

Special attention should be given to vacuum by-pass holes in vacuum valve seat, body and spacer. If these holes are restricted, valve cannot function properly.

Diaphragm should be carefully inspected for evidence of failure. It is recommended that new part be used unless old one is in perfect condition.

Hydraulic piston is fitted in adapter body to very close limits. Whenever it is necessary to replace either adapter body or piston it is recommended that both parts be new.

Clean atmospheric and vacuum valve seats carefully, using steel wool. Do not remove metal, since any removal of metal may necessitate replacement of valve seat. (See Fig. 39.)

F. To Assemble Relay Valve—Reassembly procedure is as follows. Refer to Figs. 33 and 34 for reference numbers:

1. Replace hydraulic piston stop (34) in adapter body (31) and install fitting (36) and fitting bolt (38) at end of adapter, using new gaskets (35 and 37) on each side of fitting.

2. Reassemble diaphragm and washers to yoke and link assembly (16) in following order:

A. Large Washer	(19)	D. Fabric Spacer	(22)
B. Fabric Spacer	(20)	E. Small Washer	(23)
C. Diaphragm	(21)	F. Nut	(24)

When installing nut, place small amount of shellac on threads to prevent loosening.

3. Install atmospheric valve (14) in body (11) with spring (13) over valve stem. Compress spring and install horseshoe lock washer (12) in manner illustrated in Fig. 38.

4. Place release spring (18) and washer (17) over diaphragm link (16) in manner illustrated in Fig. 40.

5. Install vacuum valve (15) part way into valve body. Install complete diaphragm assembly in valve body, as shown in Fig. 41, and fasten link pins into slots of vacuum and atmospheric valves.

Important: When installing diaphragm be sure that vacuum by-pass hole in diaphragm indexes with similar passage in valve body.

6. Install hydraulic piston (28) and cup (29) in hydraulic adapter (31) attached to valve cover. Rounded end of piston must be toward diaphragm nut; cup is at opposite

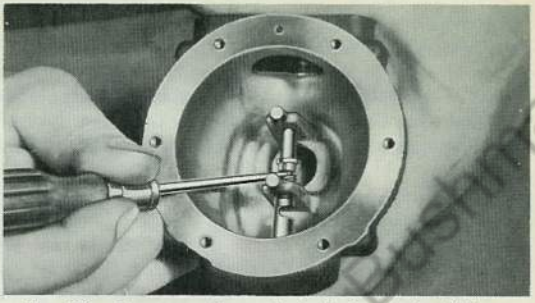

Fig. 38 Compress Atmospheric Valve Spring When Removing or Installing Retaining Washer



Fig. 39 Use Steel Wool Lightly to Clean Valve Seats



Fig. 40 Installing Release Spring and Washer Over Diaphragm Link

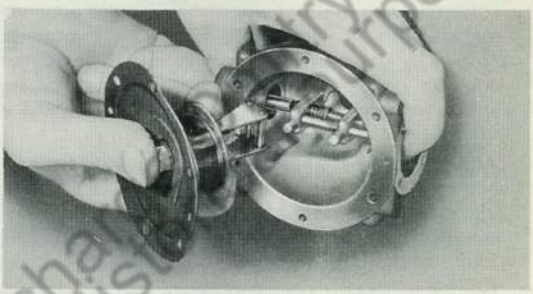

Fig. 41 Installing Diaphragm Assembly in Relay Valve Body

end of piston. Place gasket (25) and spacer (26) to cover and attach to valve body (11).

Important: Be sure that by-pass holes in spacer (26) and gasket (25) index with similar passages in diaphragm (21) and valve body (11). Screws attaching cover, spacer and diaphragm to body should be tightened alternately and evenly.

7. Replace vacuum valve seat (9), using new gaskets (7 and 8) between seat and body.

Important: Be sure vacuum by-pass hole in seat (9) indexes with similar passage in valve body (11).

8. Replace lower (or inner) half of valve body (4) to opposite part of valve body (11), using new gasket (5 and 6) between two halves. Tighten retaining screws evenly and alternately.

13. HYDRAULIC SLAVE CYLINDER

This unit is attached to front of power cylinder as illustrated in Fig. 33. Refer to Fig. 1 for Hydrovac unit installation, also hydraulic lines connections. Slave cylinder is a hydraulic cylinder, from which a column of hydraulic fluid is forced into lines and wheel cylinders to apply brakes.

Hydraulic fluid displaced by master cylinder passes through by-pass valve to build up initial pressure in hydraulic cylinder, hydraulic lines and wheel cylinders, before relay valve functions to bring power cylinder into action.

As sufficient hydraulic pressure is attained to cause relay valve to function, as previously explained, power cylinder push rod movement closes by-pass valve within hydraulic cylinder. Closing of by-pass valve prevents fluid escaping to rear and from hydraulic cylinder. Movement of power cylinder pistons and push rod also moves hydraulic cylinder piston, thereby displacing fluid within hydraulic cylinder to build up sufficient hydraulic pressure in lines and wheel cylinders to apply brakes.

When relay valve comes to holding position, as previously explained, movement of power cylinder piston push rod and hydraulic cylinder piston stops, and brakes are held in that position until released or applied still further.

Upon releasing brakes, by-pass valve is quickly opened to permit hydraulic fluid to return to normal pressure as controlled by master cylinder check valve. Power cylinder pistons and push rod, also hydraulic cylinder piston are returned to released position by return springs, and is then ready for next brake application.

A. To Remove and Disassemble Hydraulic Cylinder—Complete removal can only be accomplished after Hydrovac unit is removed from vehicle and power cylinder is partially disassembled, as bolts attaching slave cylinder are inside of front end of power cylinder.

Complete disassembly is accomplished as follows. Refer to Figs. 33 and 34 for reference numbers:

1. Remove hose clamps on vacuum line leading from front cover to "Tee" (52) at center plate of power cylinder.

2. Disconnect hydraulic line, extending to relay valve, at hydraulic cylinders.

3. Remove four nuts and lockwashers at front end of power cylinder studs, which will permit removal of power cylinder front shell and hydraulic cylinder assembly.

4. Remove plug (66) and gasket (67) at outer end of cylinder, which will permit removal of return spring (68) and spring retainer (69).

5. Remove cap screws (90) and lockwashers in side of power cylinder attaching hydraulic cylinder to power cylinder face plate.

6. Pushrod guide (85) and seal (86) assembly, also seal (83), washer (82) and snap ring (81) can now be removed from inner end of cylinder body. If washer (82) and snap ring (81) are not removed, piston assembly (71) and cup (70) can be removed through front end of cylinder.

7. Removal of piston seat cup (75) and valve stop ring (74) from inside of piston (71) permits removal of piston valve (73) and spring (72).

B. Inspection—Place all metal parts in cleaning fluid and allow to remain sufficient length of time to loosen any accumulation of foreign deposits. Rubber parts and gaskets should be cleaned in alcohol; never use gasoline. Compressed air may be used to remove any foreign deposits loosened by cleaning fluid, and to thoroughly dry each part.

Piston cups or seals that show any evidence of failure or deterioration should be replaced with new parts. Valve seat, inside piston and valve, must be carefully inspected. If there is any indication that these parts are not seating they should be replaced with a new assembly.

Slave cylinder body should be given same attention as master cylinder and wheel cylinders, previously covered in this section.

C. To Assemble and Install Hydraulic Cylinder—While power cylinder is partially disassembled, this is an opportune time to inspect seals and pistons before reassembly.

At reassembly all parts should be thoroughly coated with hydraulic brake fluid. Assembly procedure is as follows. Refer to Figs. 33 and 34 for reference numbers:

1. Place piston valve spring (72) and valve (73) inside of piston (71) and install snap ring (74), so as to hold spring and valve in place. Be sure that snap ring is seated securely in groove, then install piston seat cup (75) over rear of piston.

2. Install piston and valve (71) assembly through front of cylinder body with flat side of piston toward front. Replace seal snap ring (81), washer (82) and seal (83) and valve rod guide (85) and seal assembly. Use small gasket (84) between guide flange and cylinder body.

3. Replace partially assembled cylinder body to power cylinder shell (88), using gasket (80) between these parts. With outer stud plate (87) in place, use cap screws (90) through face plate (89) to hold cylinder in place. Tighten cap screws alternately and evenly.

4. Install cylinder piston cup (70), retainer (69) and return spring (68) through outer end of cylinder body. Replace end plug (66) and gasket (67) to hold spring in place in body.

5. Install bleeder screws in cylinder body.

6. Replace cylinder and front shell assembly to balance of power cylinder, using gasket between center plate and edge of shell.

7. Line up vacuum tube and attach hose, using clamps, being sure that clamps are drawn up tightly. Replace studs (92) through stud plates (2 and 87), install nuts and lockwashers, tighten nuts alternately and evenly.

8. Replace hydraulic line (97) between relay valve and hydraulic cylinder. Be sure that connections are tight so that there will be no loss of hydraulic fluid when unit is placed in service.

14. POWER CYLINDER

This unit is a double piston type, each of which is mounted on a single piston rod so that they travel simultaneously as brakes are applied and released. Refer to Fig. 1 for unit installation, also vacuum line connections.

Power cylinder is connected into brake system in such a manner that it utilizes engine manifold vacuum and atmospheric pressure to assist in building up necessary hydraulic pressure to apply brakes. When brakes are released, vacuum is present on both sides of power cylinder pistons. Vacuum is controlled as previously explained under "Released Position" of relay valve.

As brake pedal is depressed, atmosphere is admitted to rear side of power cylinder pistons. Atmosphere is controlled as previously explained under "Applied Position" of relay valve. Atmosphere thus admitted forces pistons forward, also; piston rod and push rod move in same relation as pistons. Push rod contacts hydraulic cylinder piston to force hydraulic fluid into lines and wheel cylinders.

Release of brake pedal shuts off atmosphere to power cylinder and again opens both sides of pistons to vacuum as previously explained under "Releasing Brakes".

A. Testing Power Cylinder for Leaks—Power cylinder may be tested in following manner when it has been determined that check valve and vacuum lines are satisfactory as outlined under "Vacuum Lines" in this section.

1. Remove pipe plug at rear of Hydrovac power cylinder and attach vacuum gauge in pipe plug hole.

2. Start engine and note reading on vacuum gauge; it should be same as at intake manifold.

3. Stop engine and note rate of vacuum drop. If gauge shows a drop in excess of 1" every 15 seconds, this is an indication that a leak exists, probably between two halves of the power cylinder shell, or that relay atmospheric valve is not seating properly.

B. To Disassemble Power Cylinder—It is necessary to remove Hydrovac unit, as previously explained, in order to disassemble power cylinder. This operation does not necessarily require removal of hydraulic slave cylinder or relay valve. Refer to Fig. 33 and 34 for reference numbers.

1. Remove hose clamps attaching vacuum lines to "Tee" (52) at center plate (51) of power cylinder.

2. Remove hydraulic line (97) between hydraulic cylinder and relay valve.

3. Remove four stud nuts (93 and 96) at end of power cylinder so that studs (92) can be removed.

4. Front and rear outer shell assemblies (1 and 88) of power cylinder can now be completely removed, which exposes power cylinder pistons. Hydraulic slave cylinder is attached to front shell (88) while relay valve is attached to rear shell (1).

5. Remove nut (65) at rear of piston rod (57) which will allow removal of felt retainer (64), felt (63), packing ring (62), packing plate (61), packing (60), packing plate (59), return spring (56) and inner nut (58).

6. Front piston assembly and piston rod can now be removed from center plate (51).

7. Remove nut (43) at front of piston rod (57) which permits removal of push rod pin (42), push rod (40), packing plate (44), packing (45), packing plate (46), felt (47), packing ring (48), felt retainer (49) and inner nut (50).

8. Piston rod seal (53) and washer (54) can be removed from center plate (51) when spring (55) has been removed.

C. Inspection—While power cylinder is disassembled following inspections should be made to assure proper function of unit after reassembly.

1. Clean all metal parts in gasoline or other suitable cleaning fluid, then dry thoroughly so that all cleaning fluid is removed.

2. Leather seals should be cleaned with denatured alcohol. Seals showing slightest evidence of failure or wear should be replaced with new parts.

3. Inspect shells for any evidence of damage such as corroded or rust spots; also dents due to external objects striking outer shell.

D. To Assemble Power Cylinder—Before reassembly, inside of shell should be coated lightly with recommended lubricant; also leather seals should be soaked in warm oil to assure pliability and softness of leather. Refer to Figs. 33 and 34 for reference numbers.

1. Replace piston rod seal (53) in center plate (51), install washer (54) and spring (55).

2. Replace nut (50) on piston rod (57) and install piston felt retainer (49). Place piston packing spring (47) inside felt (48) and install these two parts in felt retainer.

3. Install curved piston plate (46) on piston rod (57) and install piston packing (45) and flat piston plate (44) in manner shown in Fig. 33.

BRAKES

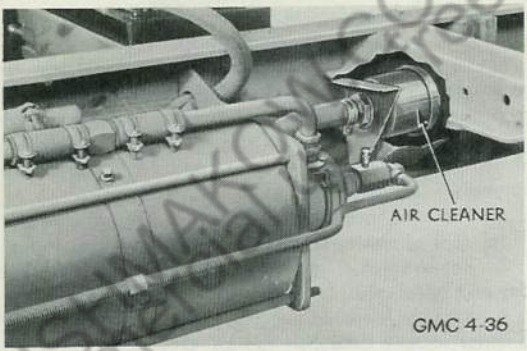

Fig. 42 Air Cleaner Is Mounted as Shown

4. Install thrust cup (41) in end of piston rod and replace push rod pin (42) through piston rod (57), thrust cup (41) and push rod (40). Replace outer nut (43) over piston rod and thread onto piston rod.

5. When packing (45) is centered and felt (48) is in place, tighten nut (43).

6. Install piston assembly in vacuum cylinder front shell (88). As piston assembly is installed in shell, push rod (40) must be directed into hydraulic cylinder.

7. With gasket in place, install center plate (51) over piston rod (57), being careful that seal (53) is not damaged during this operation.

8. Install piston return spring (56) with large end of spring against center plate (51); also replace center plate to shell gasket at this time.

9. Replace inner nut (58) on piston rod (57) and install flat piston plate (59). Replace piston packing (60) and curved piston plate (61).

10. Place piston packing spring (62) inside felt (63) and install these two parts in felt retainer (64).

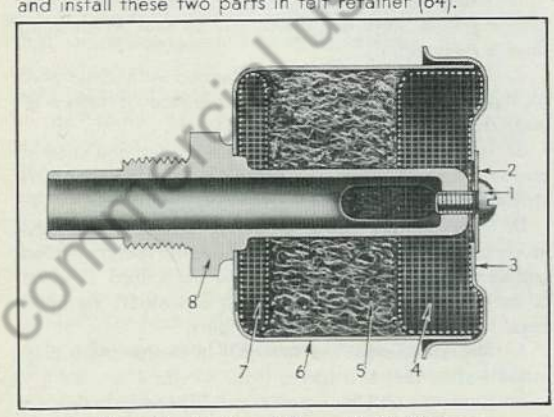

Fig. 43 Sectional View of Air Cleaner

1. Screw
2. Washer
3. Cover
4. Outer Screen
5. Curled Hair
6. Shell
7. Inner Screen
8. Center Stem

11. Install felt retainer assembly on piston rod (57) and replace nut (65). When packing (60) and felt (63) are properly centered tighten nut (65) securely.

12. Place shell assembly (1) over rear piston assembly, being sure that packing (60) is over felt (63) as shown in Fig. 33.

13. Install studs (92) through holes in stud plates (2 and 87), replace and tighten nuts (93 and 96) so that shells (1 and 88) form a tight seal at center plate (51).

14. Replace vacuum line hose and install hose clamps, being sure that clamps are drawn up tightly, so that no atmosphere will enter vacuum lines at this point.

15. Replace hydraulic line (97) between relay valve and hydraulic cylinder. Hydraulic line connections must be tight to prevent loss of any hydraulic fluid. Clips (98), used to attach hydraulic line to power cylinder center plate, should be reinstalled and tightened securely to prevent failure of line due to vibration.

15. AIR CLEANER

Air cleaner, mounted as illustrated in Figs. 1 and 42, is used to filter air used in operation of power cylinder. Cleaner is attached to under side of frame cross member near frame side rail, where it is protected from air stream.

Air entering power cylinder through relay valve, is filtered by curled hair within air cleaner. Air entering cleaner must pass through hair, which is oiled; therefore, practically all particles of dirt in air are trapped and prevented from reaching relay valve and power cylinder.

A. To Remove Air Cleaner

1. Remove clamps attaching hose to relay valve and air cleaner so that hose can be removed.

2. Remove nuts and lockwashers on bolts attaching air cleaner mounting bracket to frame cross member.

3. Bracket and cleaner can now be completely removed from vehicle.

4. Ordinarily it will not be necessary to remove cleaner from bracket, unless unit is being replaced. If this is necessary, remove lock nut which holds cleaner to bracket, which will permit these two parts being removed from each other.

B. To Install Air Cleaner—Before installing, area of frame side rail and cross member near air cleaner should be cleaned of any foreign deposits.

1. If air cleaner has been removed from mounting bracket it should be reattached, using lock nut.

2. Replace cleaner and bracket assembly in its proper location and attach bracket to cross member using bolts, nuts and lockwashers.

3. Attach rubber hose and clamps to air cleaner and relay valve. Tighten hose clamps securely.

C. To Disassemble Air Cleaner—Procedure for disassembly is as follows. Refer to Fig. 43.

1. Use screw driver to remove screw and washer holding cover to shell.

2. Cover, screen, curled hair and shell of cleaner can now be completely disassembled.

Cleaning—Place all parts in gasoline or other cleaning fluid to loosen accumulated dirt. Blow all parts dry with compressed air, after deposits of dirt have been removed. Saturate curled hair in light engine oil and allow surplus oil to drain off. Oil catches particles of dirt which otherwise would pass through cleaner.

D. To Assemble Air Cleaner—When air cleaner has been cleaned it should be assembled in following manner. Refer to Fig. 43.

1. Place shell over center stem and install wire screen in bottom of shell.
2. Place oiled, curled hair element inside of shell.
3. Place screen inside shell, with edge of screen toward top of cover.
4. Replace cover and secure in place with flat washer and screw.

16. CHECK VALVE

Check valve is mounted at engine manifold and consists of a disc type valve contained between two housings. Purpose of check valve is to seal vacuum in power cylinder and lines if engine should stop suddenly, thus assuring sufficient vacuum to provide at least one maximum power brake application after engine has stalled.

When engine is not running, valve drops down and prevents atmosphere entering lines and power cylinder at this point. While engine is running, manifold vacuum raises valve; therefore, vacuum is present in lines and power cylinder when needed.

A. To Remove Check Valve—If any indication is apparent that check valve is not operating satisfactorily it may be removed, inspected and repaired or entirely replaced with new part.

1. Use wrench to loosen and disconnect vacuum line compression nut from elbow at bottom of check valve.
2. Use wrench to remove check valve assembly from street elbow connecting valve with manifold.

B. To Install Check Valve

1. Thread upper body (short) to street elbow. Use wrench and tighten securely.
2. Attach elbow to bottom body (long) and tighten securely.
3. Thread vacuum line compression nut to elbow in lower body and tighten securely.
4. Importance of tightening fittings cannot be overstressed as any leaks at these points will seriously affect operation of brakes.

C. To Disassemble Check Valve—Valve is easily disassembled for inspection, without removing from vehicle. Refer to Fig. 44.

1. Use screw driver to remove screws (1) and lockwashers holding upper (3) and lower (6) halves of body together.
2. Lift valve stem assembly (4) from lower body (6). Remove body gasket (5).

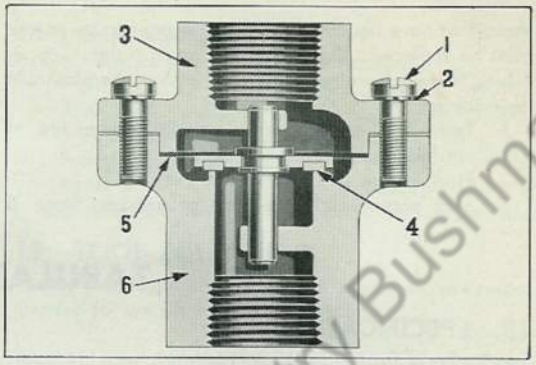

Fig. 44 Sectional View of Check Valve

1. Screw
2. Lockwasher
3. Upper Body
4. Valve Assembly
5. Gasket
6. Lower Body

Inspection—If check valve does not function properly operation of brakes may become sluggish and ineffective, particularly when engine is pulling and manifold vacuum is low.

1. Inspect valve seat in lower body for any evidence of pitting or corrosion that may cause an imperfect seat, or would permit atmosphere to enter lines at this point. Slight imperfections may be removed with steel wool; if not, replace with new part.
2. Inspect rubber seal at valve stem and replace with new stem assembly if deterioration or other failure is evident.
3. Inspect stems of valve, also guides in upper and lower halves of body. Stem must be free so as not to bind in guides.

D. To Assemble Check Valve—Procedure for reassembly of valve is as follows. Refer to Fig. 44 for reference numbers:

1. Place valve stem assembly (4) in lower half of valve body (6) with long half of stem through guide.
2. Place gasket (5) on flange of lower body (6).
3. Place upper half of body (3) over lower half of body (6) with short valve stem through guide in upper body.
4. Replace four lockwashers and screws (1), attaching upper and lower halves of body together. Tighten screws evenly and alternately.

17. VACUUM LINES

Vacuum lines used between check valve at manifold, power cylinder and relay valve are illustrated in Fig. 1. Purpose of these lines is to exhaust atmosphere in power cylinder, thereby permitting power cylinder pistons to travel when atmosphere is admitted to one side of pistons, as described under "Relay Valve".

A. Inspection—At frequent intervals, lines, hose connections and clamps should be carefully inspected. Particular attention should be given to hose connections;

those that have become cracked or appear to be porous must be replaced. Keep all hose clamps tight. Copper tubing that has become mashed or has sharp bends should be replaced.

B. Test—1. Connect test gauge in vacuum line at "Tee" on Hydrovac power cylinder.

2. Start engine and note gauge reading.

3. Stop engine and note rate of vacuum drop. If gauge shows a drop in excess of 1" every 15 seconds, this is an indication that a leak exists between the gauge and engine manifold. Leak must be localized and corrected before proceeding with further tests. Foregoing test indicates that leak may be in vacuum line connections or at check valve seat.

4. If foregoing test is satisfactory refer to "Testing Relay Valve" in this group.

TABULATED DATA

18. SPECIFICATIONS

Service Brake Type—Six Wheel Hydraulic with Hydrovac Unit

Hand Brake Type—Band Type at Rear of Transfer Case

Master Cylinder

Mounting	Frame Side Rail
Make	Wagner
Model	FF-1266
Size	1 3/4"
Piston Clearance	.001"–.005"
Fluid Level	Check Every 1,000 Miles
Brake Fluid	Use Delco Super # 9 or Wagner Lockheed #21
Piston Return Spring—Lbs. Pressure @ 4 13/32"	8–9
Operating Lever Return Spring	
Free Length	6 5/16"
Lbs. Pull @ 7 5/16"	45–55

Front Wheel Cylinder (On Axles With Split Housings)

Make	Wagner
Their Model	FD–4402
Size	1 3/8"
Piston Clearance	.001"–.005"
Piston Return Spring	
Free Length	2 5/8"
Lbs. Pressure @ 1 3/4"	1 to 1 1/4"

Front Wheel Clyinder (On Axles With "Banjo" Housings)

Make	Delco
Their Model	5450619
Size	1 1/4"
Piston Clearance	.003"
Piston Return Spring	
Free Length	2 13/64"
Lbs. Pressure @ 1 3/4"	3/4 to 1 1/4"

Rear Wheel Cylinder (On Axles with "Split" Housings)

Make	Delco
Their Model	5300885
Size	1 1/2"
Piston Clearance	.003"–.006"
Piston Return Spring	
Free Length	2 7/8"
Lbs. Pressure @ 1 3/4"	1 to 1 1/4"

Rear Wheel Cylinder (On Axles With "Banjo" Housings)

Make	Delco
Their Model	5450553
Size	1 1/2"
Piston Clearance	.003"–.006"
Piston Return Spring	
Free Length	2 7/8"
Lbs. Pressure @ 1 3/4"	1 to 1 1/4"

Hydrovac Unit

Make	BK
Model	H–76–4
Relay Valve Number	372440
Slave Cylinder Number	371827

Front Brake Shoe and Lining (On Vehicles with "Split" Housing)

Size	15" x 2 1/4"
Lining	
Area—(Sq. In. Per Axle)	138
Length—Forward	16 1/2"
Length—Reverse	14"
Width	2 1/4"
Thickness	1/4"
Adjustment	
Cam (Top of Shoe)	.020"
Eccentric (Bottom of Shoe)	.010"
Brake Shoe Return Spring	
Lbs. Pressure @ 8 3/16"	75–85

Front Brake Shoe and Lining (On Vehicles with "Banjo" Housing)

Size	14" x 2"
Lining	
Area (Sq. In. Per Axle)	118
Length	14 3/4"
Width	2"
Thickness	1/4"
Adjustment	At Wheel Cylinders
Brake Shoe Return Spring	
Lbs. Pressure @ 8 3/4"	115–135

BRAKES

Rear Brake Shoe and Lining

Size	16" x 3"
Lining	
Area (Sq. In. Per Axle)	218
Length	$18\frac{5}{32}$"
Width	3"
Thickness	$\frac{1}{4}$"
Adjustment	Back off $\frac{3}{4}$ Turn From Slight Drag on Adjusting Screws at Ends of Wheel Cylinders
Brake Shoe Return Spring	
Lbs. Pull @ $8\frac{3}{4}$"	115–135

Pedal Adjustment

Pedal to Toe Board Clearance	1" to 2"
Free Travel Before Power Stroke Begins in Master Cylinder	$\frac{1}{2}$"
Pedal Return Spring	
Free Length	$6\frac{5}{16}$"
Lbs. Pull @ $8\frac{5}{16}$"	45–55

Hand Brake Shoe and Lining

Size	$9\frac{1}{2}$" x 3"
Lining	
Area (Sq. In.)	$88\frac{1}{2}$
Length	$29\frac{1}{2}$"
Width	3"
Thickness	$\frac{5}{16}$"
Adjustment	See Instructions
Clearance—Band to Drum	
At Anchor	.010"
At Ends of Lining	.020"
Hand Brake Release Spring	
Free Length	$2\frac{11}{16}$"
Lbs. Pressure @ $1\frac{15}{32}$"	25-35
Hand Brake Operating Bolt Spring	
Free Length	$1\frac{3}{8}$"
Lbs. Pressure @ $1\frac{1}{4}$"	750–850

Brake Drum—Diameter

(On Vehicles with "Split" Axle Housing)	
Front	14.990"–15.010"
Rear	16.005"–15.995"
(On Vehicles with "Banjo" Axle Housing)	
Front	14.0075"–13.9975"
Rear	16.0075"–15.9975"
Regrinding Limits	.125" on Diameter

19. TOOL EQUIPMENT

The following special tools, or their equivalent, are recommended for use when servicing BRAKES.

Tool No.	Name	Supplier Code
B-120	Brake Lining Grinder	B
B-131	Brake Lining Clamp	B
CS-1032	Bleeder Pressure Tank	CS
CS-1033	Brake Cylinder Gauge	CS
CS-1038	Wheel Cylinder Clamp	CS
FC-131	Brake Bleeder Hose (Split Type Front Axle)	WE
J-747	Brake Bleeder Hose (Split Type Rear Axle and Banjo Type Axles)	KM
J-1885	Double Lap Flaring Tool Set	KM
KMO-3	Brake Tubing Cutter	KM
KMO-142	Brake Spring Pliers	KM

TOOL SUPPLIER

Supplier Code	Name	Address
B	Barrett Equipment Co.	St. Louis, Mo.
CS	Curtiss and Smith Manufacturing Corp.	Pottstown, Penn.
KM	Kent-Moore Organization	Detroit, Mich.
WE	Wagner Electric Corp.	St. Louis, Mo.

BRAKES

SERVICE BULLETIN REFERENCE

Bulletin No.	Description

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Group 13 — Wheels, Hubs and Tires

GENERAL — Paragraph

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Trouble Shooting 2
Inspection and Adjustments 3
Tire Maintenance 4

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To Install Wheel and Tire 6
To Remove Tires 7
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GENERAL

1. DESCRIPTION

There are two types of front and rear hubs, drums and bearings used on these vehicles. These can be distinguished by type of axle housings with which they are used. The visual difference between the Split and Banjo types of axle housings are clearly illustrated in "Front" or "Rear" axle groups of this book.

Spoke steel wheels used on these vehicles are the same, regardless of type of axle used, and are interchangeable front and rear. Dual wheels may be installed on front hubs as well as rear without alterations.

2. TROUBLE SHOOTING

The chart which follows lists the most common failures that may arise in this group and offers a probable remedy for each failure.

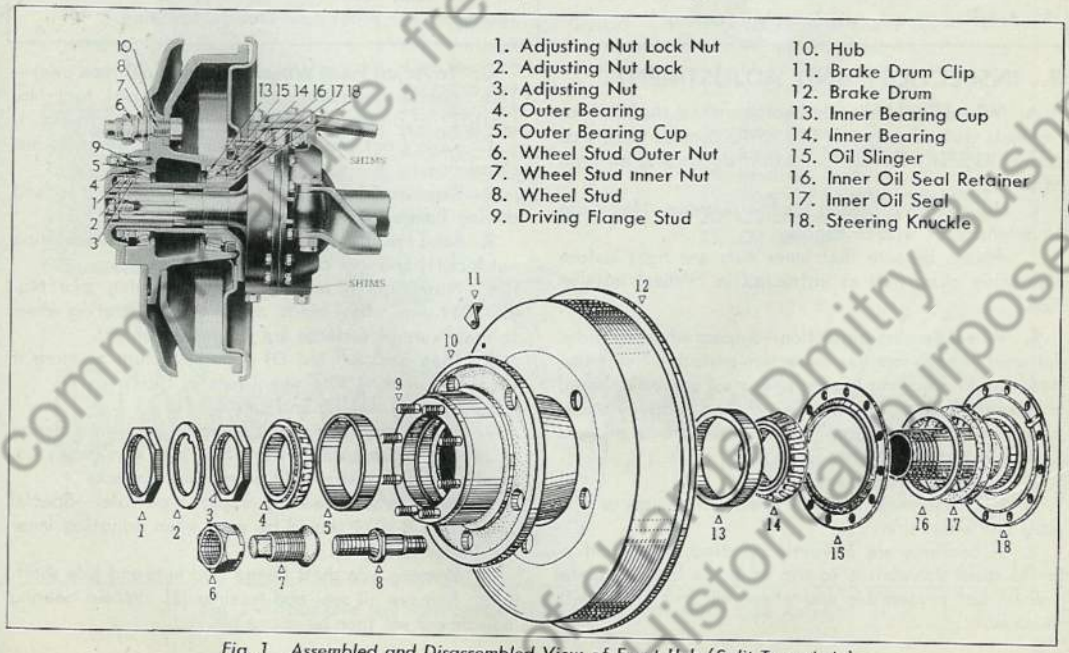


Fig. 1 Assembled and Disassembled View of Front Hub (Split Type Axle)

WHEELS, HUBS AND TIRES

WHEELS POUNDING

Caused by:

1. Loose front wheel bearings—
   Adjust bearings as described in this group.
2. Wheel assembly out of balance—
   a. Deflate tire and mount properly.
   b. Remove hub and wheel assembly and check dynamic balance if balancer is available.

EXCESSIVE OR UNEVEN TIRE WEAR

Caused by:

1. Improperly inflated tires—
   Inflate to recommended pressure.
2. Wheel assembly out of balance—
   a. Deflate tire and align valve stem and tire balance mark.
   b. Remove hub and wheel assembly and check dynamic balance if balancer is available.
3. Rim or wheel bent or not mounted true on hub—
   Straighten or replace and mount correctly.
4. Grabbing brakes—
   Refer to "Brake" group.
5. Excessive brake application—
   a. Permit engine to act as brake when bringing vehicle to a stop.
   b. Do not apply brakes suddenly except in case of emergency.
6. Vehicle overloaded—
   Load vehicle to rated capacity.
7. Refer to "Front Axle Trouble Shooting."

HARD STEERING

Caused by:

1. Tires under-inflated.
   Inflate to recommended pressure.
2. Refer to "Steering Gear Trouble Shooting."

VEHICLE PULLS TO ONE SIDE

Caused by:

1. Uneven tire pressure—
   Inflate to recommended pressure.
2. Wheel bearing too tight—
   Adjust as described in this group.
3. Frame out of alignment—
   Check alignment as directed in "Frame" group.
4. Brakes improperly adjusted—
   Adjust as instructed in "Brake" group.

SHIMMY

Caused by:

1. Rim or wheel bent or not mounted true on hub—
   Straighten or replace and mount correctly.
2. Wheel assembly out of balance—
   a. Deflate tire and align valve stem and tire balance mark.
   b. Remove wheel and hub assembly and check dynamic balance is balancer is available.
3. Loose front wheel bearings—
   Adjust bearings as described in this group.
4. Tires worn unevenly or improperly inflated—
   Match tires and inflate to recommended pressure.
5. Refer to "Front Axle Trouble Shooting."

3. INSPECTION AND ADJUSTMENT

A. Wheel Stud Nuts—Inspect the wheel stud nuts for tightness daily during first 500 to 1000 miles of service and at regular intervals thereafter, depending on type of service.

1. Use wrench provided for this purpose. Never use an extension on wrench handle.

2. Always be sure that inner nuts are tight before tightening outer nuts as instructed in "Wheel Installation."

B. Wheel Bearing Inspection—Inspect wheel bearings for wear at each monthly inspection period to determine necessity of adjusting bearings. It must be remembered that wheel bearings cannot be checked properly unless brakes are free from dragging on brake drums, and are in fully released position.

1. Jack up wheels, one at a time.

2. Check sidewise shake of wheel with hands or with long bar under tire.

3. If bearings are correctly adjusted, movement of brake drum (in relation to top of brake backing plate) will be just perceptible and wheel will turn freely with no drag.

C. To Adjust Front Wheel Bearings (Split type axle)—This operation requires the use of special tool No. CS-1079 to properly adjust inner nut. (Refer to Fig. 1)

1. Raise front end of truck with jack so that tire just clears floor.

2. Remove driving flange stud nuts, center cap and driving flange.

3. Bend lips of adjusting nut lock (2) so that adjusting nut lock (1) and lock can be removed.

4. Now tighten adjusting nut (3), using tool No. CS-1079 until wheel binds, at same time rotating wheel to make sure all surfaces are in proper contact.

5. Then back off nut (3) about 1/6 turn or more if necessary, making sure wheel rotates freely.

6. Replace lock (2) and lock nut (1).

7. Check adjustment and reassemble driving flange in reverse order. When front hubs are completely assembled, again test wheel before lowering jack.

D. Rear Wheel Bearings (Split type axle)—Special tool No. CS-1074 should be used when adjusting inner nut (Refer to Fig. 3).

1. Remove axle shaft flange stud nuts and axle shaft.

2. Remove oil seal and retainer (2). Wheel bearing adjustment will then be accessible.

WHEELS, HUBS AND TIRES

3. Raise lips of lock nut lock (5) and remove adjusting lock nut (4) and nut lock (5).

4. Raise lips of inner adjusting nut lock (7).

5. Tighten inner adjusting nut (6) until wheel binds, at same time rotate wheel to make sure all surfaces are seating properly. Use tool CS-1074 as shown in Fig. 2.

6. Now back off adjusting nut 1/6 turn, or more if necessary, to permit tangs of adjusting nut lock to engage flats of nut. Bend the tangs down over nut.

7. Replace lock nut (4) and lock (5) and test adjustment. Then install oil seal with retainer and axle shaft and again check wheel to determine that adjustment is correct before leaving axle off of jack.

E. Front Wheel Bearings (Banjo type axle)—This operation requires use of special wrench J-1663, illustrated in Fig. 5, to properly tighten adjusting nut (Refer to Fig. 4).

1. With vehicle on jack, remove wheel.

2. With cold chisel and hammer, bend tangs of lock plate away from bolt heads.

3. Remove bolts which attach drive flange to front wheel hub.

4. Remove drive flange—if tight, it may be removed by installing two $\frac{7}{16}$"-14 cap screws in tapped holes in flange. By turning these cap screws alternately, drive flange may be easily removed.

5. Raise tang (2) which locks outer lock nut and remove nut (1), using special wrench J-1663. Then remove nut lock (2).

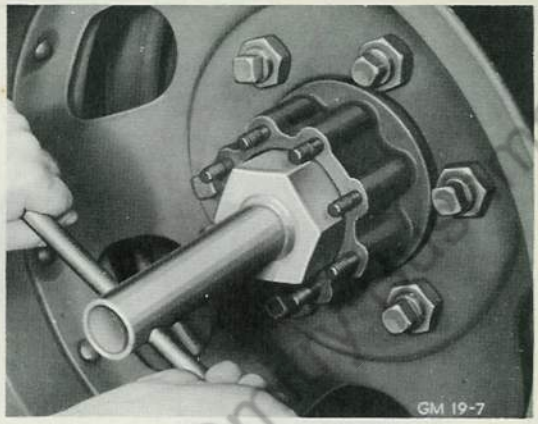


Fig. 2 Installing Rear Wheel Bearing Adj. Nut

6. Using wrench, having "T" handle 12 inches long each side, pull inner lock nut (3) up wrench tight, then back nut (3) off 45 degrees minimum to align nearest slot in nut with short tang on lock (2).

7. Install lock (2) and outer lock nut (1). Then tighten nut (1) securely and bend down long tang on lock (2) into slot in nut (1).

8. Place a new metal gasket on drive flange and install flange.

9. Install cap screws through lock plate and tighten

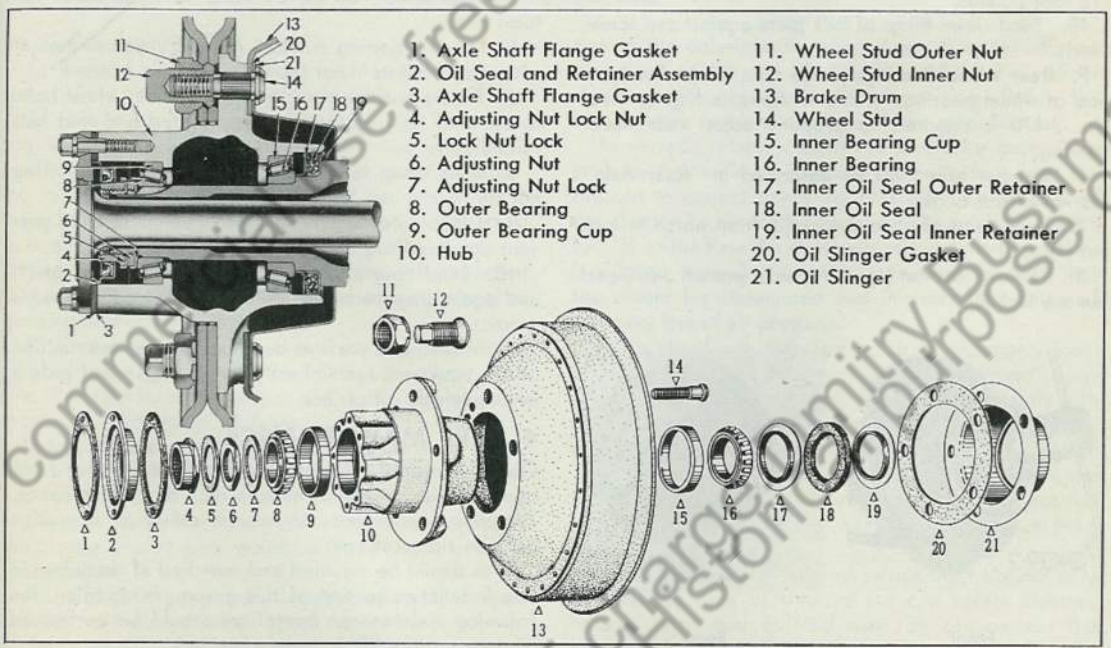


Fig. 3 Assembled and Disassembled View of Rear Hub (Split Type Axle)

WHEELS, HUBS AND TIRES

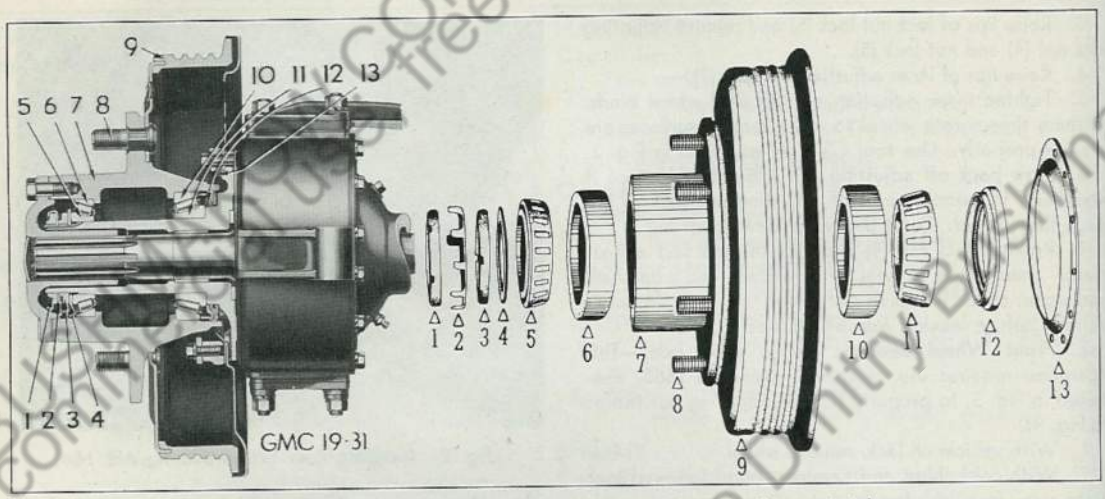


Fig. 4 Assembled and Disassembled View of Front Hub (Banjo Axle)

1. Bearing Outer Lock Nut
2. Lock Nut Lock
3. Bearing Inner Lock Nut
4. Bearing Spacer Washer
5. Outer Bearing and Cone Assembly
6. Outer Bearing Outer Race
7. Hub
8. Wheel Stud
9. Brake Drum
10. Inner Bearing Outer Race
11. Inner Bearing and Cone Assembly
12. Inner Bearing Seal
13. Oil Deflector

them securely. Where tension wrenches are available, cap screws should be tightened to torque load of 95 to 115 foot pounds.

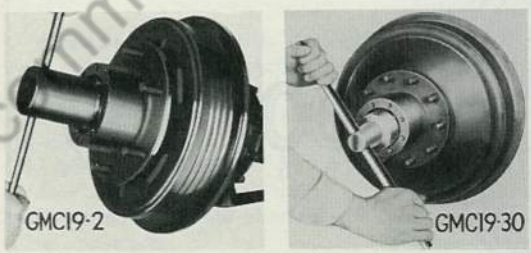
10. Bend down tangs of lock plate against cap screw heads.

F. Rear Wheel Bearings (Banjo type axle)—The position of wheel bearings in hub is shown in Fig. 6. Tool No. J-870 is required to properly adjust rear wheel bearing.

1. Remove axle shaft as described in "Rear Axle" section of this book.

2. Raise tang of special lock (2) from notch in lock nut (1).

3. Remove lock nut (1) with special wrench J-870 and remove lock (2).



Front *Rear*

Fig. 5 Installing Wheel Bearing Adj. Nuts

4. Using special wrench J-870, tighten adjusting nut (3) tight, then back nut off 45 degrees.

5. Turn wheel hub (8) by hand to make sure hub turns freely.

6. Install adjusting nut lock (2) and check alignment of tangs with slots in nut (1).

7. Rotate hub by hand, grasping hub at wheel bolts to see that bearings are properly seated and that hub turns freely.

8. Bend down tang on lock (2) in notch of adjusting nut (3).

9. Install outer lock nut (1) and pull up tight to prevent any loosening of adjusting nut (3).

10. Bend tang of lock (2) into notch of lock nut (1) and again check wheel to determine that adjustment is correct.

11. Install axle shaft as described in rear axle section of this book and again check bearing adjustment before letting vehicle off of jack.

4. TIRE MAINTENANCE

One of the most important factors of safe motor truck operation is systematic and correct tire maintenance. Tire maintenance not only affects safety of operation but also tire economy.

Tires should be mounted and matched as described in Tire Installation section of this group. In addition, the following maintenance operations should be performed if maximum tire life is to be obtained.

A. Visual Inspection—Inspect tires daily, performing

WHEELS, HUBS AND TIRES

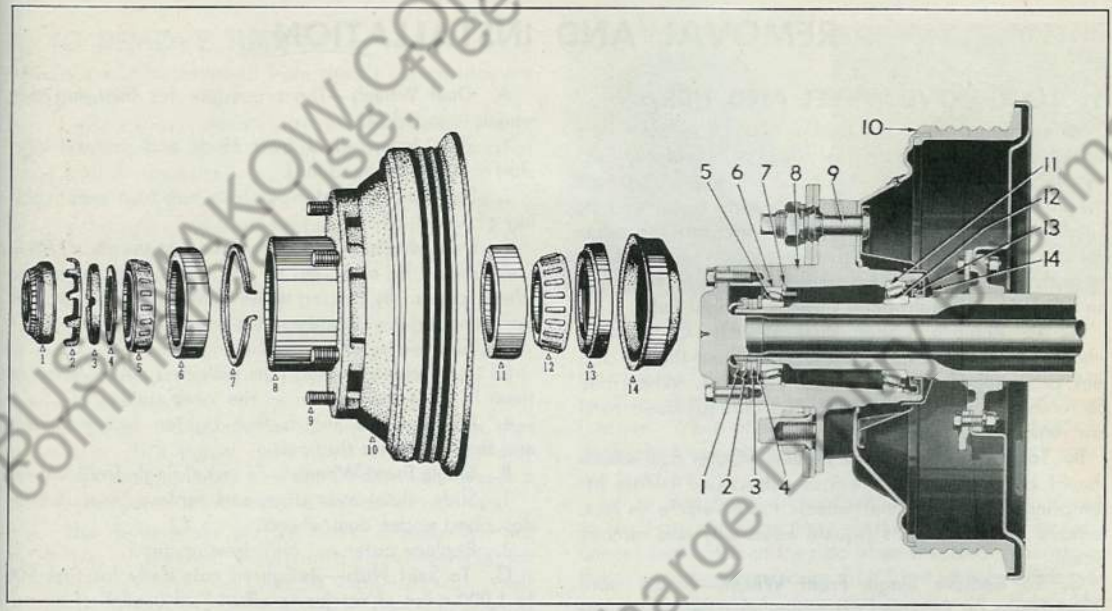


Fig. 6 Assembled and Disassembled View of Rear Hub (Banjo Axle)

1. Bearing Lock Nut and Seal
2. Lock Nut Lock
3. Bearing Adjusting Nut
4. Thrust Washer
5. Outer Bearing Inner Race and Rollers
6. Outer Bearing Outer Race
7. Snap Ring
8. Hub
9. Wheel Stud
10. Brake Drum
11. Inner Bearing Outer Race
12. Inner Bearing Inner Race and Rollers
13. Inner Bearing Oil Seal
14. Oil Deflector

the operations as listed.

1. Remove all foreign matter, such as nails, glass, or stones, from tires or from between duals.

2. Replace any missing valve caps. The valve cap, with its inside sealing washer, is the medium which positively seals air in the tube. The valve core is the operating valve which permits inflating and gauging of air in tube; but the core, without cap, is exposed to dirt, moisture and other foreign material which may render it inoperative as a definite seal. **Therefore, it is important that positive sealing caps be replaced on the stems after gauging and inflating operations.**

B. Gauging Tires—Tires should be gauged with a reliable gauge to determine the inflation pressure in each tire. Pressure recommendation of the tire manufacturer should be followed at all times.

Every tire is designed and built to operate on a predetermined inflation pressure. This operating air pressure, recommended by the tire manufacturers, is as essential to the safe, economical operation of the tire as the proper amount of oil would be to the engine or other chassis units.

An under-inflated tire runs sluggishly and quickly wears out with too much flexing. On the other hand, over-inflating a weakened tire may cause a blow-out. In addition to the deteriorating effect over- or under-inflation may have on the tire life, these conditions will affect steering, riding comfort, and safe driving. **Follow the tire pressure recommendations of the manufacturer.**

At periodic intervals, each tire should be gauged for **pressure loss** with an accurate gauge before tires are brought to correct operating pressure. The purpose of this check is to determine the exact pressure loss in each tire. **If, at the time this check is made, a definite pressure loss (above normal) is noted in any one of the tires, that tire should be dismounted and inspected for cause of excessive loss of air pressure.**

This method will definitely establish a danger signal on condition of the tires and will minimize road delay. The pressure loss check should be made consistently with same gauge, so that any element of inaccuracy in the gauge shall be the same for all the tires.

C. Balanced Inflation—The whole efficiency of the vehicle will be upset if air pressures in the tires are out of balance. This means that **all** tires on the vehicle must be the same pressure.

A five pound under-inflation in one front tire not only can destroy ease of steering but can create steering hazards. An under-inflated rear tire can destroy the value of the most efficient brakes.

WHEELS, HUBS AND TIRES

REMOVAL AND INSTALLATION

5. TO REMOVE WHEEL AND TIRE

Inner and outer wheels are held on hubs by separate nuts as shown in Fig. 7. Inner dual wheel is individually held by the sleeve-shaped inner nut. Outer wheel slips over the inner nut and is held independently by outer nut. Single front wheels are held by the inner nut and outer nut is furnished in case dual wheels are required. **Left-hand threads are used on both inner and outer stud nuts on left hubs and right-hand threads on right hubs.**

A. To Remove Outer Dual Wheels—Outer dual wheels may be removed or replaced without the use of a jack, providing inner tire is properly inflated. Wheel may be removed after outer wheel stud nuts (six-sided nuts) are removed.

B. To Remove Inner Dual Wheels—Outer dual wheels should be removed as previously described before attempting to remove inner wheel. Place vehicle on jack, remove inner stud nuts (square head nut) and remove wheel.

C. To Remove Single Front Wheels—Single front wheels may be removed by removing inner and outer stud nut together. This is accomplished by applying the wrench to the inner (square head) nut and removing the nut.

6. TO INSTALL WHEEL AND TIRE

Refer to Paragraph 8 describing mounting of tires to insure correct installation of wheel equipped with "Directional" tires. Before installing wheels to hubs, remove dirt, grease or excess paint from mating surfaces. See that stud nuts are free from grease or oil and that conical seat portion of nut is not scored or grooved.

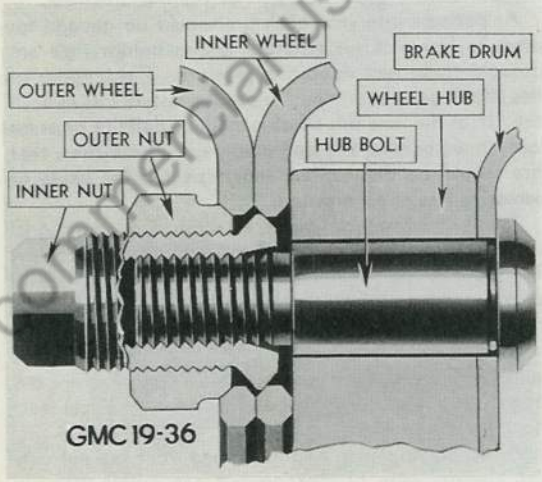


Fig. 7 Cross Section of Wheel Retaining Nuts

A. Dual Wheels—The procedure for installing dual wheels is as follows:

1. Slide inner wheel over studs and replace inner stud nuts (square head nut).
2. Successively tighten opposite nuts to prevent cocking of wheel on studs.
3. Dual wheels should be mounted as shown in Fig. 8. Care should be exercised in positioning tire valves and wheel spokes. By placing spoke openings as shown, both inner and outer valves are more accessible.
   (a) Slide outer wheel over inner nuts.
   (b) Replace outer stud nuts (six-sided nut), tightening them in the same manner as the inner stud nuts.
4. Remove jack and further tighten first the inner and then the outer stud nuts.

B. Single Front Wheels—To install single front wheels:

1. Slide wheel over studs and replace inner nuts as described under dual wheels.
2. Replace outer nut and draw up tight.

C. To Seat Nuts—Retighten nuts daily for first 500 to 1,000 miles of service to offset "setting in" of clamping surfaces—Use wrench provided for the purpose. Do not use an extension on wrench handle or jump on same. Perform retightening operation as follows:

1. Loosen outer wheel stud nuts (six-sided nut).
2. Tighten opposite inner wheel stud nuts (square head) to prevent cocking of wheel on pilot and studs.
3. Tighten outer wheel stud nuts in the same manner as the inner stud nuts.

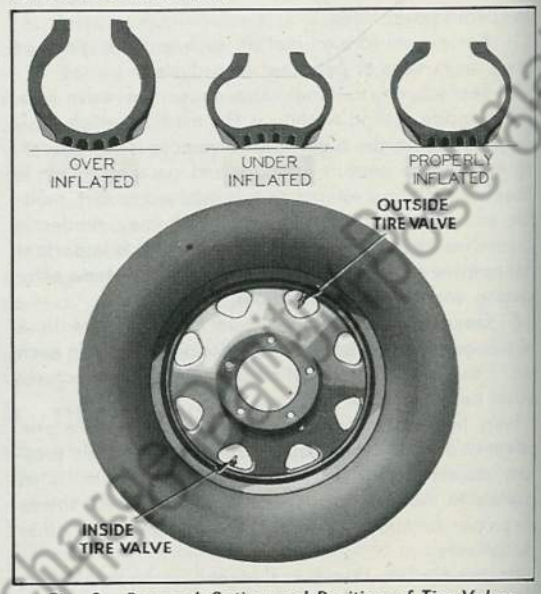


Fig. 8 Proper Inflation and Position of Tire Valves With Dual Tire Mounting

WHEELS, HUBS AND TIRES

7. TO REMOVE TIRES

Wheels should be removed from chassis before tires are dismounted.

1. Deflate tires completely by removing valve core.
2. Force one side of clamp ring toward center of wheel until it drops into groove in wheel.
3. Insert heavy screwdriver into recess in clamp ring and pry this side of ring out over edge of wheel.
4. Work ring off with tire irons and remove tire.

8. TO INSTALL TIRES

It is extremely important that proper selection of tires be made before installing or replacing tires on two or three axle drive vehicles which are not equipped with inter-axle differentials.

Replacement tire should be same make as other tires on vehicle. Tire should have same outside diameter within 1/4" as other tires and, if "Directional" tires are used, be mounted with proper direction of rotation.

A. Use Same Make of Tire on All Wheels—Do not install tires of different makes on the same vehicle, for differences in design and tread, in some instances, result in unequal tire rolling radiuses. Use of tires with unequal radiuses will result in excessive wear on tire with smaller radius. All wheels are driven at the same speed and tire with smaller radius will be partially dragged as it will not travel as far per revolution as larger tires.

In addition, excessive differential gear wear will be experienced if tires on one side of vehicle have a smaller rolling radius than those on the other side. This gear wear is due to constant differential action brought about by tires on the low side revolving faster.

B. Use Tires with Same Outside Diameter (Within 1/4")—If tires do not have same outside diameter (within 1/4"), excessive tread scuffing will result. This outside diameter may be measured with a pair of calipers, if such tool is available. Another simple method of selecting tires of equal diameter is shown in Fig. 9. By adjusting tire measuring gauge (Tool No. J-1867) so that it will just slip over the outside diameter of a selected tire, nine more tires, or whatever number of additional tires are needed to have a complete set, may be selected from the tire stores by comparing diameters as illustrated.

C. Mount Tires with Correct Tread Rotation—The various tread patterns on these vehicles can be classified into two general types: Non-directional and Directional.

Tires with "non-directional" tread designs are those where the cross bars or other tread patterns are approximately the same on each side of center line of tread (see Fig. 10). These tires can be run in either direction on any wheel.

Tread patterns of "Directional" type have bars on tread patterns in the general form of a "V" (see sketch). Directional tread tires should be mounted on ALL rear wheels so the point of the "V" is in direction of wheel rotation and meets the ground first. In this mounting position, the tread is self-cleaning and offers maximum traction. When point of "V" touches last, mud tends to pack into tread, forming a smoother surface which gives less traction.

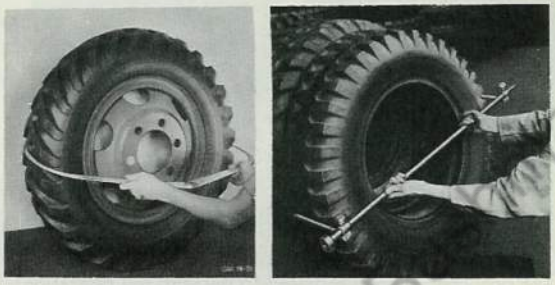


Fig. 9 Measuring Outside Diameter of Tires

When directional tread tires are mounted on wheels of front-driving axles, they wear more rapidly in their normal position than they do when reversed. Therefore, they should be reversed on ALL front wheels, driving or non-driving (so that open part of the "V" meets the ground first), except when driving conditions make it necessary to get the greatest possible traction.

D. To Mount Tires on Wheel—After tire has been properly selected as described above, mount on wheel as follows:

1. Install inner tube in tire so that valve stem is at red dot on side of tire.
2. Inflate tube sufficiently to prevent tube falling out of tire or being pinched during mounting operation.
3. Place wheel flat on floor or ground and drop tire down over wheel, carefully inserting valve stem in hole in rim.
4. Place one edge clamp ring over edge of rim and force entire ring over rim using a heavy brass hammer.
5. Be sure clamp ring is seated against rim of wheel throughout its whole circumference and inflate tire to recommended pressure.

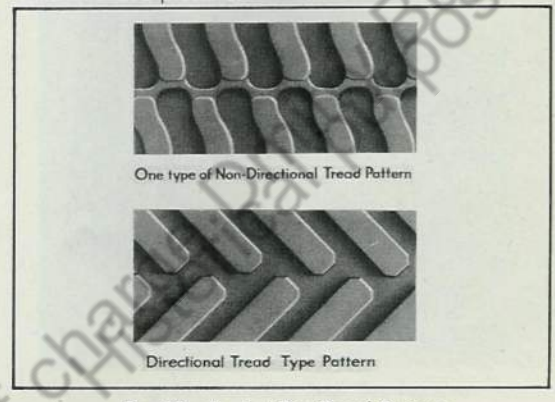


Fig. 10 Typical Tire Tread Patterns

WHEELS, HUBS AND TIRES

REPAIR

9. FRONT HUB, DRUM AND BEARING ASSEMBLY (Split Type Axle)

Front wheels are carried on two opposed tapered bearings as illustrated in Fig. 1. Under normal operating conditions bearings should be removed from hubs and lubricated every 5,000 miles.

A. To Remove and Disassemble Hub and Drum—The only special tools required to perform this operation are a puller for removing bearings and adjusting nut wrench CS-1079.

1. Raise front end of truck until tire just clears floor.
2. Remove wheel stud nuts (7).
3. Remove wheel and tire.
4. Remove driving flange stud nuts, center cap and driving flange.
5. Remove adjusting nut lock nut (1), lock (2) and adjusting nut (3).
6. Lift off hub and brake drum assembly.
7. Then remove inner oil seal (17) and retainer (16) from spindle.
8. Hub bearing cups (5 and 13) may be removed with suitable puller or press. Likewise, inner bearing (14) should be pulled off steering knuckle (18) with a puller.

B. To Remove Drum from Hub—Brake drums are secured to hubs with studs that are also used for mounting wheels to hub. Front brake drums may be removed from hubs by removing stud inner nut and driving out studs.



Fig. 11 Bearing Lubricator

C. To Clean and Inspect Bearings—Normally, wheel bearings require cleaning and inspection only at 5000 mile lubrication periods.

1. First soak parts in gasoline (or other cleaning fluid) and use clean stiff brush to loosen all particles of old lubricant.
2. Remove from fluid and strike larger side of bearing flat against a wood block to knock out heavier particles of dirt.
3. Blow bearings clean and dry with compressed air, directing air across bearings. Be careful not to spin bearings.
4. Rotate bearing slowly by hand, and inspect rollers or balls and race for defects and excessive wear. **Never spin bearings while dry.**
5. After inspection lubricate bearings as described below and wrap in clean cloth.

D. To Lubricate Bearings—In order that front and rear wheel bearings may be properly lubricated, it is necessary to remove hubs. Bearings and hubs should be thoroughly cleaned as previously outlined. Bearings should be hand packed or lubricated with special lubricator. **Hubs should not be packed with lubricant.**

For lubricant specifications and periods, refer to "Lubrication" chart.

Grease should not be forced into bearings and hubs through pipe plugs.

Operation of lubricator illustrated in Fig. 11 is as follows:

1. Lubricant is stored in cylinder on base of mechanism.
2. Remove dust cap and place bearing on lubricator as shown in illustration.
3. By pushing handle down, lubricant is forced into bearing.
4. When bearing is thoroughly packed, remove it and replace dust cap.

Caution: Lubricant placed in this vehicle is provided with correct viscosity according to season of year in which vehicles are delivered. If vehicle is delivered in one season and not used until another, lubricant should be changed to agree with climatic conditions as described in Lubrication section of this book.

E. To Assemble and Install Hub Assembly—This operation requires the use of special tools to install bearings, cups and seal. (Refer to Fig. 1.)

1. Assemble brake drum and hub by replacing studs and inner stud nuts. Make sure studs are driven in until shoulders of studs are tight against hub.
2. Install wheel inner bearing cup (13) in hub, using J-1660-3 bearing cup driver with J-1660-1 handle as illustrated in Fig. 12.

3. Install wheel outer bearing cup (5) in hub, using same tools as used in step 2, except that opposite side of driver is used.

4. Install new inner oil seal (17) on steering knuckle (18), using Oil Seal Replacer J-1664. Start oil seal (16) on knuckle, insert oil seal retainer in tool, place tool over oil seal and drive into place by tapping outer edge of tool with hammer.

5. Install inner bearing cone (14) on spindle, using Tool No. J-1712 shown in Fig. 13.

6. Replace hub and drum and insert outer bearing (4).

7. Replace adjusting nut (3), lock (2) and lock nut (1).

8. Adjust bearings as described under "Adjustments."

10. REAR HUB, DRUM AND BEARING ASSEMBLY (Split Type Axle)

A. To Remove and Disassemble Hub and Drum—The procedure for removing rear hub and drum assembly is as follows: (Refer to Fig. 3)

1. Raise wheel on which repair is to be made by placing jack under proper axle housing.

2. Remove wheel stud nuts (11 and 12).

3. Remove both wheels and tires.

4. Remove axle shaft as described in "Rear Axle" section of this book.

5. Remove outer oil seal and retainer (2).

6. Remove adjusting lock nut (4), lock (5) and adjusting nut (6) and lock (7).

7. Remove hub and brake drum assembly (10 and 13).

8. Remove hub bearing cups (9 and 15) from hub (10) with suitable puller or press.

9. Remove inner bearing (16) from axle housing with suitable puller.

10. Remove inner oil seal (18).

B. To Remove Drum from Hub—Rear brake drum may be removed from hubs by driving studs out from outer or hub side.

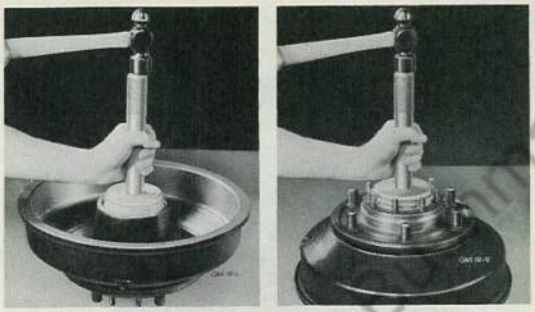
C. To Clean and Inspect Bearings—Rear wheel bearings are similar to those used in the front hubs and the cleaning and inspection procedures listed in Paragraph 9 under Front Hubs apply to the rear bearings as well.

D. To Assemble and Install Hub Assembly—Installation of bearings requires the use of Tool No. J-1709 bearing cup driver with J-1660-1 handle to replace cups, J-1712 for driving inner bearing, and J-1664 to install inner oil seal (refer to Fig. 3).

1. Assemble brake drum and hub by replacing studs. Drive studs in until shoulders of studs are tight against drum.

2. Install inner and outer wheel bearing cups (6 and 10), using J-1709 bearing cup driver with J-1660-1 handle. One side of drum is used for inner cup and other side is used with outer cup.

3. Install new inner oil seal (18), using Tool J-1664 in manner similar to that followed for front hub. It should be noted that a retainer is used at each side of the seal. Both retainers are installed with shoulder portion extending towards outer end of hub.



Inner Bearing *Outer Bearing*

Fig. 12 Installing Front Wheel Bearing Cups

4. Lubricate inner and outer bearings as described under "To Lubricate Bearings."

5. Replace inner bearing cone (16) on axle housing, using Tool No. J-1712 in a manner similar to that shown in Fig. 13.

6. Install hub and drum on axle and insert outer bearing (8).

7. Replace adjusting nut lock (7), adjusting nut (6), and adjusting nut lock nut (5), and adjust bearings as described under "Adjustments."

11. FRONT HUB, DRUM AND BEARING ASSEMBLY (Banjo Axle)

General construction of hubs on Banjo axle is similar to those on the split type axle but different tools are required when disassembling the unit.



Fig. 13 Installing Inner Bearing Cone

WHEELS, HUBS AND TIRES



Fig. 14 Peening Hub and Drum Bolts

A. To Remove and Disassemble Hub Assembly—This operation requires use of special tools, J-1663 for removing adjusting nut and J-1660-3 wheel bearing cup driver (refer to Fig. 4).

1. Remove front wheel drive flange and bearing lock nuts according to instructions given under "Front Wheel Bearing Adjustment."
2. Remove spacer washer (4) and roller bearing cone assembly (5).
3. Remove wheel hub (7).



Fig. 15 Replacing Outer Bearing Outer Race

4. Inspect inner bearing seal (12). This seal is a light drive fit in wheel hub and should not be removed if in good condition because it cannot be removed without damage.
5. If hub is to be completely disassembled, remove oil seal (12) with hook or screw driver and take out inner roller bearing cone assembly (11).
6. Remove inner bearing outer race (10) from wheel hub (7), using drift through opposite side of hub. Inside of hub has openings to permit drift to engage back of race.
7. Remove outer bearing outer race (6) in same manner.

B. To Remove Drum from Hub—Brake drums are attached to wheel hubs by serrated bolts. Drum may be removed from hub by driving out these serrated bolts.

C. To Clean and Inspect Bearings—Clean and inspect wheel bearings in same manner as described in Paragraph 9 for split type axle.

D. To Assemble Drum and Hub—From a safety standpoint, it is very important to adhere to the following instructions:

1. Coat gasket between inside of brake drum and oil deflector with heavy shellac or paint on both sides to prevent oil from leaking onto braking surface of drum.
2. Be sure small hole in gasket and channel in oil deflector is lined up with oil relief hole in drum.
3. Insert six new bolts through oil deflector, brake drum and hub flange; then place assembly on riveting fixture with threaded end of bolt passing into hole in one of the supports. Drive bolts into place, solidly.
4. Place assembly on fixture, as shown in Fig. 14, and peen shoulder of bolt into chamfer in hub flange, using Tool No. J-554-G.

E. To Assemble and Install Hub Assembly—This operation requires the use of special drivers, J-1660-3 and J-1672, to install bearing cups and seal (refer to Fig. 4).

1. Install inner and outer bearing races (6 and 10) in hub (7) with wide side of race toward inside, using driver J-1660-3 to either press or drive race into place (Fig. 15).
2. Lubricate wheel bearings as described under "To Lubricate Bearings."
3. Place inner bearing cone (11) in hub and install new oil seal (12). Soak seal in Neatsfoot or warm engine oil until leather in seal is soft and pliable, then drive seal into hub, using Tool No. J-1672.
4. Install hub and drum on spindle and insert outer bearing cone (5).
5. Replace bearing spacer washer (4), inner lock nut (3) and lock nut lock (2) and bearing outer lock nut (1).
6. Adjust bearings as described under "Adjustments."

12. REAR HUB, DRUM AND BEARING ASSEMBLY (Banjo Axle)

Rear hub assembly and exploded view is shown in Fig. 6.

WHEELS, HUBS AND TIRES

A. To Remove and Disassemble Hub Assembly—

1. Jack up rear axle and remove wheel. **Note:** Removal of wheel is important; it prevents damage to oil seal and permits more accurate adjustments of bearings.

2. Remove axle shafts as described in "Rear Axle" section of this book.

3. Raise tang of special lock (2) from notch in lock nut (1). Remove lock nut (1) with special wrench J-870, and remove lock (2), adjusting nut (3) and thrust washer (4).

4. Remove hub and drum assembly (8 and 10).

5. Install brake wheel cylinder clamp to prevent brake fluid from leaking should brake pedal be accidentally depressed.

6. Outer bearing cone (5) may be lifted out of hub.

7. Remove inner bearing cone and race (11 and 12) and oil seal (13) from hub, using a drift against race (12). Care must be taken to engage edge of race and not damage bearing seat in housing. Race must be driven out evenly.

8. Remove outer bearing race (6) by turning drum over and using drift in same manner as described for inner race. Be sure drift is used on edge of race and not on snap ring.

B. To Remove Drum from Hub—Brake drums are attached to wheel hubs by serrated bolts. To remove drum, drive out these bolts from outer or hub side.

C. To Clean and Inspect Bearings—Rear wheel bearings should be cleaned in same manner as described in cleaning procedure for front hubs of split type axle.

D. To Assemble and Install Hub Assembly—This operation requires use of special tools J-872-1, J-872-2 and J-872-4 to properly install bearings and seal (refer to Fig. 6).

1. If drum has been removed, replace as described in paragraph 11, "To Assemble Drum and Hub."

2. Check fit of inner cones on housing. These cones should be free to turn but not loose.

3. Lubricate bearings, using lubricator T-300 as previously described.

4. Install outer race (6) in hub, using Tool No. J-872-1 to seat race against snap ring (7).

5. Press inner bearing outer race (11) in hub, using driver J-872-4.

6. Place inner race and roller assembly (12) in hub and install new oil seal. Soak seal in Neatsfoot or warm engine oil until leather is soft and pliable, then drive seal into place with Tool No. J-872-2. Lock seal in place by prick punching at three equally spaced places.

7. Wheel bearing lock nut (1) incorporates a leather seal which bears against inner surface of axle shaft flange as shown in Fig. 16. This seal should be examined and if any damage is indicated seal should be replaced.

8. Inspect oil deflector (14). This deflector should be tight on axle housing and not have any defects. If it is damaged in any way, it must be replaced by a new one.

A special tool is necessary for this operation. Oil Deflector Replacer, J-973, shown in Fig. 17, is designed so it will pilot on axle housing and drive the deflector into proper position so it will mate with oil deflector in wheel hub.

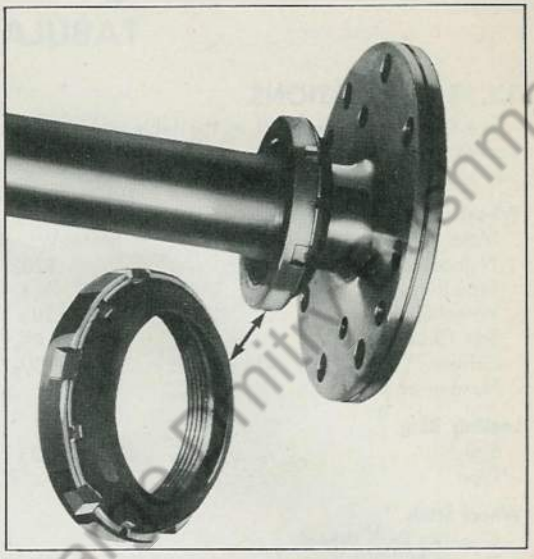


Fig. 16 Outer Bearing Oil Seal

9. Install hub and drum assembly, rotating hub to properly line up inner bearing.

10. Place inner race and roller assembly (5) in hub and install thrust washer (4), adjusting nut (3), lock (2) and lock nut (1).

11. Adjust bearings as described under "Adjustments."

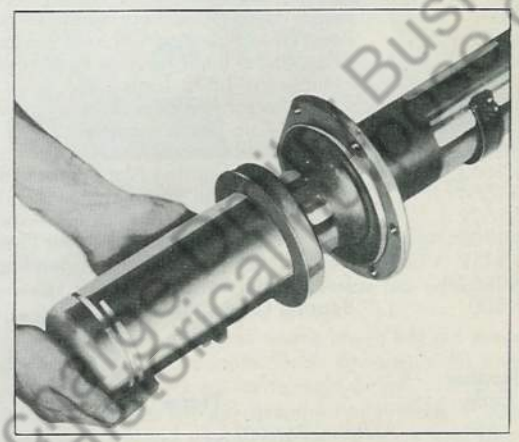


Fig. 17 Replacing Oil Deflector

WHEELS, HUBS AND TIRES

TABULATED DATA

13. SPECIFICATIONS

Information and data listed in the table which follows applies to vehicles having either "banjo" or "split" type axle housings except as noted.

Wheel

Make	Motor Wheel
Number	82023
Type Rim	RH
Wheel Size	20 x 7
Bolt Circle	8¾"
Offset	5⅛"
Number of Studs	6

Locking Ring

Size	20 x 7
Type	RI

Wheel Studs

Quantity Each Wheel	6
Thread Size	¾"-16
Tighten Every 500 to 1,000 Miles	

Tires

Minimum Tire Pressure—Use Manufacturer's Recommendations

Bearings

Front Wheel Hub	
Make	Timken Tapered
Number	
Inner Cone	33275
Inner Cup	33472
Outer Cone	399A
Outer Cup	394A
Rear Wheel Hub (Split Type Axle)	
Make	Timken Tapered
Number	
Inner Cone	395
Inner Cup	394A
Outer Cone	387
Outer Cup	382
Rear Wheel Hub (Banjo Type Axle)	
Make	Hyatt Barrel Roller
Number	
Inner Cone	KD12051
Inner Cup	12051Z
Outer Cone	KB11786
Outer Cup	11786Y

Bearing Adjustment—Wheel Must Turn Freely with no Bearing Drag

14. TOOL EQUIPMENT

The following special tools, or their equivalent, are recommended for use when servicing WHEELS AND HUBS.

Tool No.	Name	Supplier Code
CS-1074	Rear Wheel Bearing Adjusting Nut Wrench (Split Type Axles)	CS
CS-1079	Front Wheel Bearing Adjusting Nut Wrench (Split Type Axles)	CS
J-554-G	Brake Drum Anvil and Hub Bolt Peening Tool (Banjo Type Axles)	KM
J-870	Rear Wheel Bearing Nut Wrench (Banjo Type Axles)	KM
J-872-1	Rear Wheel Outer Bearing Race Tool (Banjo Type Axles)	KM
J-872-2	Rear Wheel Bearing Oil Seal Replacer (Banjo Type Axles)	KM
J-872-4	Rear Wheel Inner Bearing Race Replacer (Banjo Types Axles)	KM
J-872-5	Handle for J-872 Tools	KM
J-973	Oil Deflector Replacer (Banjo Type Axles)	KM
J-1660-1	Bearing Cup Driver Handle	KM
J-1660-3	Front Wheel Bearing Cup Driver	KM
J-1663	Front Wheel Bearing Nut Wrench (Banjo Type Axles)	KM
J-1664	Wheel Inner Oil Seal Replacer (Split Type Axles)	KM
J-1672	Oil Seal Replacer (Banjo Type Axle)	KM
J-1709	Rear Wheel Bearing Cup Driver (Split Type Axles)	KM
J-1712	Front Wheel Inner Bearing Cone Replacer (Split Type Axles)	KM
J-1867	Tire Measuring Gauge	KM
T-300	Bearing Lubricator	AB

TOOL SUPPLIER

Supplier Code	Name	Address
AB	Ahlberg Bearing Co.	Detroit, Mich.
CS	Curtiss and Smith Manufacturing Corp.	Pottstown, Penn.
KM	Kent-Moore Organization	Detroit, Mich.

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Group 14 — Steering Gear

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GENERAL

1. DESCRIPTION AND OPERATION

The steering system includes the steering gear and wheel, steering drag link between gear and axle arm, and axle tie-rod. The axle tie-rod is described in "Front Axle," group 10. Front end alignment and steering geometry, which directly affect steering are also included in the "Front Axle" group. Steering gear is recirculating ball type. This description refers to balls which serve as contact between worm and worm nut, Fig. 1. Drag link is ball and socket type and is adjustable for wear.

When steering wheel is turned, movement is transmitted to pitman arm through worm, worm nut and sector shaft inside steering gear. Drag link connected between pitman arm and axle steering arm transfers movement to front wheels through front axle tie-rod and steering arms.

A. Worm, Wormshaft and Nut—The worm, welded to tubular wormshaft, is mounted in gear housing between barrel type roller bearings. Worm nut is bored to fit over worm and both are threaded with corresponding helical grooves, Fig. 1. Two circuits in nut contain steel balls. Balls roll between nut and worm within their circuits, and are the only contact between worm and nut. When wormshaft is turned, nut moves on worm as with an ordinary screw thread. However, movement of nut is accomplished by balls rolling between worm and nut instead of by sliding contact between parts.

B. Sector Gear and Shaft—Sector gear and shaft (an integral unit) is mounted in bushings in housing and side cover. Pitman arm fits on serrated end of shaft and is held on with nut and lockwasher. Rack teeth in worm nut mesh with sector gear. Gear tooth design provides proper gear action with worm nut positioned at a slight angle. This characteristic permits simple lash adjustment by shifting sector shaft along its axis.

With no back lash when wheels are in straight-ahead position, sector gear tooth design provides slight back lash with wheels turned far to right or left. This characteristic permits lash adjustment for wear of sector gear teeth in much used straight-ahead position without causing "binding" in less used portion of sector gear (extreme right or left turn position).

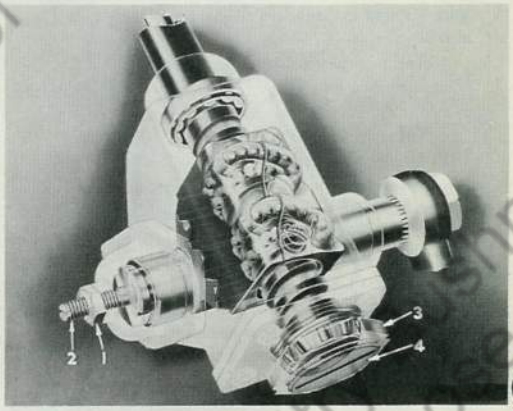

Fig. 1 Phantom Sectional View of Steering Gear

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STEERING GEAR

2. TROUBLE SHOOTING AND GENERAL SOLUTIONS

Proper operation of steering system is closely related to other units in vehicle. Hence, whenever diagnosing steering difficulties other relative factors must also be checked. A symptom indicating steering trouble may also be evidence of difficulty in other units; i.e., front axle alignment, front axle suspension, tire inflation, wheel and tire mounting, frame alignment and brakes. Symptoms which indicate possible trouble in steering system are listed below with probable cause, probable remedy and references to other functional groups covering related units.

Hard Steering—

1. Worm Bearings or Sector Gear Lash Too Tight—
   Check and adjust worm bearings and sector gear lash.
2. Drag Link Ends Adjusted Too Tight—
   Check and adjust correctly.
3. Misalignment in Steering Gear Mountings Causing Binding—
   Adjust mountings.
4. Bent Drag Link or Pitman Arm Causing Binding—
   Straighten part, if practical, or replace.
5. Lack of Lubrication at Drag Link Ends or in Gear Housing—
   Lubricate as directed in Lubrication group.
6. Worn Parts in Steering Gear and Drag Link Causing Binding—
   Replace worn parts.
7. Misalignment of Front End, Front Axle Parts Worn, or Front Axle Parts Adjusted Too Tight—
   Refer to "Front Axle," group 10.
8. Tires Under-inflated—
   Refer to "Hubs and Tires," group 13.

Wander or Lack of Steering Control—

1. Worm Bearings or Sector Gear Lash Too Loose—
   Check and adjust worm bearings and sector gear lash.
2. Drag Link Ends Worn or Adjusted Too Loose—
   Adjust if possible or replace.
3. Steering Gear Mountings Loose—
   Adjust and tighten mountings.
4. Worn Parts in Steering Gear—Play in Gear After Adjusted—
   Remove gear and replace worn parts.
5. Pitman Arm Loose on Sector Shaft—
   Tighten pitman arm lock nut.
6. Steering Linkage Adjusted Too Tight Causing Driver to Over-steer—
   Adjust worm bearings, sector gear lash or drag link ends as necessary.
7. Misalignment of Front End, Front Axle Parts Worn, or Front Axle Parts Adjusted Incorrectly—
   Refer to "Front Axle," group 10.

Road Shock Transmitted to Steering Wheel—

1. Steering Drag Link Ends Adjusted Too Tight—
   Check and adjust correctly.
2. Worm Bearings or Sector Gear Too Tight—
   Check and adjust worm bearings and sector gear lash.
3. Looseness and Misalignment of Front End Parts—
   Refer to "Front Axle," group 10 for adjustments.
4. Pounding Caused by Loose Wheel Bearings or Tires Unbalanced—
   Refer to group 13.

Unequal Turning Radius to Right and Left—

1. Pitman Arm Not Positioned Properly on Sector Shaft—
   Pitman arm position must be such that with gear in center of travel and wheels in straight-ahead position, drag link can be easily connected without changing position of gear or wheels.
2. Drag Link Bent—
   Straighten part, if practical, or replace.
3. Steering Knuckle Stop Screws Broken, Worn, or Improperly Adjusted—
   Refer to "Front Axle," group 10.

Shimmy—

Steering units are not the cause of front end shimmy; the front end shimmy is transmitted to the steering wheel through the steering system. This condition is caused by looseness and misalignment of front end parts—

Refer to group 10 and group 13.

Tendency to Pull to Right or Left—

Steering units are not the cause of vehicle pulling to right or left. The pull caused by an improper condition in other units is evidenced by difficulty in holding vehicle on a straight-ahead position—

Refer to following groups for remedies: Front Axle," group 10; "Brakes," group 12; "Hubs, Wheels and Tires," group 13; "Frame," group 15; and "Springs," group 16.

3. INSPECTION

Steering gear and related parts which affect steering should be inspected regularly. Front end alignment, tire inflation, wheel bearing adjustment, brakes adjustment, etc., should always be considered when checking steering gear operation. For inspections pertaining to these items, refer to proper group covering the unit. Inspection items for steering mechanism only, are listed below:

1. Disconnect drag link at pitman arm and check adjustment of worm thrust bearings and sector gear lash. Refer to "Adjustment," Paragraph 4.

2. Turn steering wheel slowly and carefully with drag link disconnected to determine if gear action is rough or lumpy. **Caution: Do not turn wheel hard against stops or worm nut may be damaged when it bottoms in gear housing.** Rough or lumpy gear action indicates worn or damaged bearings which require removal and repair of steering gear assembly.

STEERING GEAR

1. Steering Wheel
2. Steering Wheel Nut
3. Upper Bearing Spring
4. Upper Bearing Spring Seat
5. Bearing Race—Upper
6. Bearing Balls
7. Bearing Race—Lower
8. Upper Bearing Packing
9. Upper Bearing Washer
10. Retainer
11. Wormshaft Jacket
12. Horn Terminal Plate
13. Housing Filler Plug
14. Steering Gear Housing
15. Worm Bearing Cup—Upper
16. Worm Bearing—Upper
17. Worm Nut
18. Recirculating Ball Guide
19. Guide Clamp
20. Recirculating Balls
21. Wormshaft (worm integral)
22. Worm Bearing—Lower
23. End Cover Gasket
24. End Cover
25. Adjusting Screw
26. Adjusting Screw Lock Nut
27. Lash Adjuster Lock Nut
28. Side Cover
29. Side Cover Gasket
30. Sector Shaft Bushing
31. Sector Gear and Shaft
31A. Sector Gear Lash Adjuster
31B. Lash Adjuster Shim
32. Sector Shaft Bushing
33. Sector Shaft Bushing
34. Oil Seal Packing
35. Packing Retainer
36. Pitman Arm
37. Lockwasher
38. Pitman Arm Nut

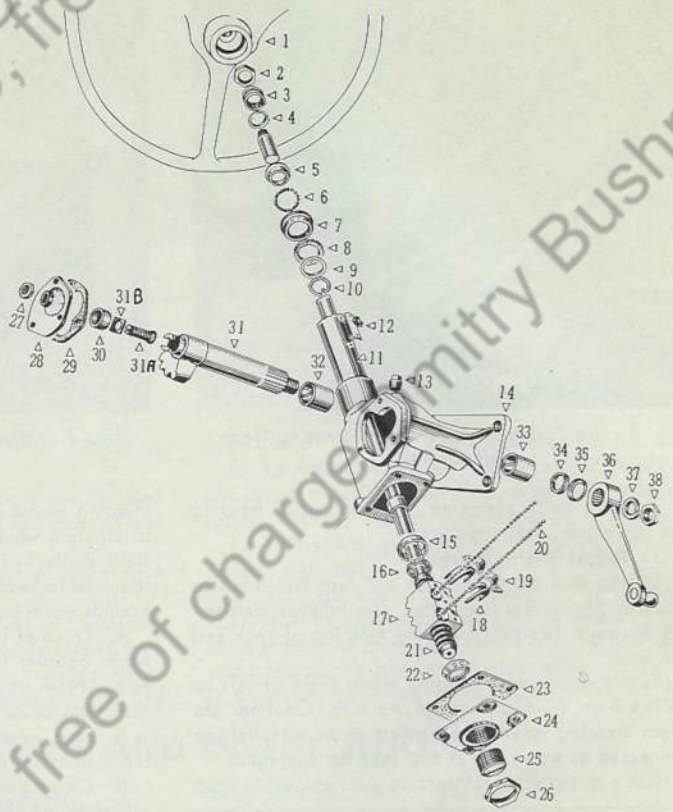

Fig. 2 Steering Gear Disassembled

3. Inspect steering gear mountings. Loosen steering column bracket bolts at instrument panel and notice if column springs away from dash. If it does, mounting misalignment is indicated, and mounting should be adjusted as described under "Adjustment," Paragraph 4.

4. Check position of pitman arm on sector shaft, and be sure nut is tight. With gear in center of travel and wheels in straight-ahead position, pitman arm should be assembled on sector shaft so drag link can be easily connected without changing position of either gear or wheels.

5. Inspect drag link for end socket wear. Adjust as outlined under "Adjustment," Paragraph 4, if end sockets are loose.

6. Check drag link for bends or distortion.

7. Check lubricant level in steering gear housing. Inspect for evidence of leakage at sector shaft oil seal or side and end cover gaskets.

8. Be sure drag link ends have been lubricated.

9. Check action of horn button and inspect horn wiring. Check wiring connections at horn wire terminal on steering column.

4. ADJUSTMENTS

It is important that steering gear, steering gear mountings and drag link be correctly adjusted to assure satisfactory steering and prevent excessive wear of parts. Necessary procedures for various adjustments are given below.

A. Preliminary Operations—Before adjusting worm bearings and sector gear lash following preliminary operations are necessary:

1. Disconnect steering drag link from pitman arm. Note relative positions of parts. Link should remain disconnected until all adjustments are completed.

2. Loosen steering column bracket at instrument panel to be certain there is no binding due to misalignment.

STEERING GEAR



Fig. 3 Use Spring Scale to Check Steering Gear Adjustments

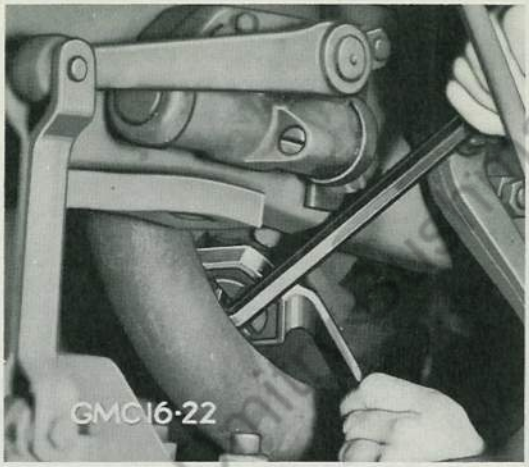

Fig. 4 Adjusting Worm Bearings—Steering Gear Installed

3. Tighten bolts clamping steering gear housing flange to vehicle understructure.

B. To Adjust Worm Bearings—

1. Loosen lock nut (1, Fig. 1) and turn lash adjuster (2) counter-clockwise a few turns. This relieves load imposed on worm bearings by close meshing of rack and sector teeth.

2. Turn steering wheel gently either right or left as far as it will go, then back about one turn. **Caution: Do not turn steering gear hard against stops with linkage disconnected as worm nut in unit may be damaged.**

3. Use a spring scale to measure pull required to keep steering wheel in motion. Scale should be used at rim of steering wheel with a line through length of scale at right angle to spoke of wheel. Refer to Fig. 3. If pull required to keep wheel moving is not between 1 and 1½ pounds worm bearing adjustment is required.

4. Proceed by loosening locknut (3, Fig. 1) and turn worm bearing thrust screw (4) counter-clockwise a few turns. Now, end cover screws can be tightened without distorting cover flange.

5. Turn worm bearing thrust screw clockwise until there is no perceptible end play in worm shaft, Fig. 4.

6. Check the pull at steering wheel as in item 3. Readjust thrust screw if necessary to obtain proper pull. Then tighten locknut and check pull again to be sure adjustment has not changed.

7. If adjustment is correct and gear feels lumpy when turning, bearings are damaged and gear must be removed and disassembled.

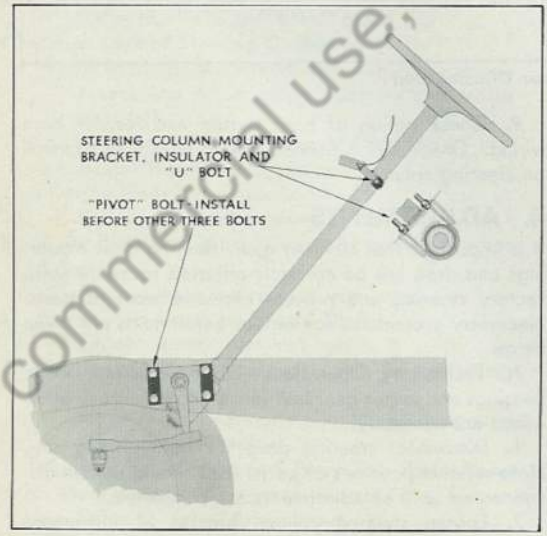

Fig. 5 Steering Gear Mountings at Frame and Instrument Panel

C. To Adjust Sector Gear Lash—

1. Be sure worm bearing adjustment is completed.

2. Center steering gear by turning steering wheel from right to left extreme, carefully counting number of turns. Then rotate wheel back exactly half way. Mark wheel at top or bottom center with a piece of tape.

3. Tighten side cover screws. Then turn lash adjuster (2, Fig. 1) clockwise until there is no shaft end play or tooth lash.

4. Check pull with spring scale at steering wheel rim as before, except measure greatest pull as wheel is pulled through center position. Readjust lash adjuster if necessary to obtain pull of 2 to 2½ pounds.

5. Tighten locknut and check pull again to be sure adjustment has not changed.

D. To Adjust Steering Gear Mounting—If proper procedure is followed when tightening gear mountings

STEERING GEAR

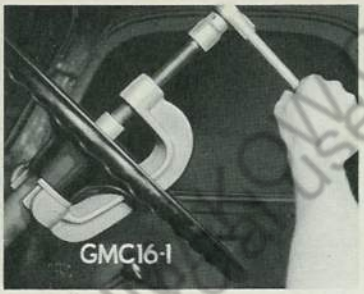

Fig. 6 Using Steering Wheel Puller



Fig. 7 Pitman Arm and Shaft Alignment Marks



Fig. 8 Using Pitman Arm Puller

there will be no misalignment and resultant binding. **Always adjust gear mountings after making worm bearing and sector gear lash adjustments.** Refer to Fig. 5.

1. Before starting mounting adjustments be sure all cab structural and mounting bolts are tight. Refer to "Cab and Body," group 18.

2. Be sure gear housing to frame bolts are installed correctly with clamp plates in position but bolts should not be tightened.

3. Connect steering column bracket to instrument panel and tighten bolt nuts securely.

4. Tighten bolts mounting gear housing to frame side rail. Upper front or pivot bolt should be tightened last.

5. Check pull at steering wheel with spring scale as described under "To Adjust Worm Bearings" and "To Adjust Sector Gear Lash" above after all mounting bolts are tight. If pull exceeds limits, cause must be located and corrected.

6. Assemble steering drag link to pitman arm as outlined under "To Install Drag Link," Paragraph 8.

E. To Adjust Drag Link—Socket at each end of drag link incorporates a screw plug which adjusts tension of spring, Fig. 22. Adjust drag link ends as follows:

1. With cotter pin removed turn screw plug in tight against ball stud.

2. Back off screw plug one-half to one turn. Ball joints must be tight enough to prevent end play, and yet loose enough to allow free movement. Be sure drag link end is thoroughly lubricated before adjustment.

3. Install cotter pin to lock screw plug.

REMOVAL AND INSTALLATION

5. TO REMOVE STEERING GEAR

Steering gear housing has an integral flange which is attached directly to frame left side rail with four bolts and two clamp plates, Fig. 5. Steering column is fitted with a bracket which bolts directly to instrument panel. Steering gear can be removed from vehicle as follows:

1. Remove horn button and spring.

2. Remove steering wheel retaining nut (2, Fig. 2).

3. Assemble steering wheel puller on steering column as shown in Fig. 6. Turning puller screw will remove steering wheel. Remove wheel key and upper bearing tension spring.

4. Disconnect steering column bracket from instrument panel.

5. Remove floor mat, floor boards, and toe boards.

6. Disconnect brake pedal rod at brake pedal. Pedal may then be pulled back to allow clearance.

7. Remove horn wire terminal plate (12, Fig. 2).

8. Disconnect steering drag link from pitman arm (36, Fig. 2) as described under "To Remove Drag Link," Paragraph 7.

9. Mark pitman arm and shaft so that correct position of arm will be known when reinstalling, Fig. 7.

10. Remove pitman arm nut and then pitman arm, using puller as shown in Fig. 8.

11. Remove the four bolts and clamp plates which attach steering gear flange to frame.

12. Assembly may be pulled up and withdrawn through cab left door.

6. TO INSTALL STEERING GEAR

1. Lift steering gear through cab left door into position against frame side rail.

2. Install upper front mounting bolt through clamp plate, housing flange and frame side rail. This bolt serves as pivot and should not be tightened at this time.

3. Install other mounting bolts and clamp plate but do not tighten.

4. Connect steering column bracket to instrument panel and tighten bolt nuts securely, Fig. 5.

5. Tighten bolts mounting steering gear housing to frame side rail. Upper front or pivot bolt should be tightened last, Fig. 5.

6. Install pitman arm on serrated end of sector shaft. Be sure pitman arm is positioned so locating marks, Fig. 7, are aligned. Draw pitman arm tight on sector shaft with nut and lockwasher, using a wrench with sufficient leverage to fully tighten nut.

STEERING GEAR



Fig. 9 Removing or Installing Side Cover and Sector Shaft Assembly



Fig. 10 Removing or Installing End Cover and Lower Worm Bearing

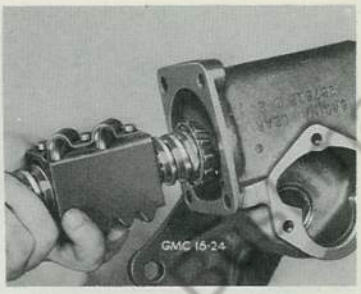

Fig. 11 Removing or Installing Worm Nut, Wormshaft and Balls Assembly

7. Install horn wire terminal plate, upper bearing tension spring, steering wheel with key and nut, horn button and spring, and reconnect brake rod to brake pedal.

8. Be sure steering gear housing is filled to correct level with proper lubricant.

9. Test and adjust as described under "Adjustment," Paragraph 4. Checking front end alignment also at this time is recommended.

10. Install floor and toe boards and floor mat.

11. Assemble steering drag link to pitman arm as outlined under "To Install Drag Link," Paragraph 8.

7. TO REMOVE DRAG LINK

Drag link can be removed as a unit without disturbing pitman arm or axle steering arm with which link connects. When removing steering gear, it is only necessary to disconnect drag link from pitman arm. Procedure is as follows: Refer to Fig. 22.

1. Remove cotter pin from pitman arm end of drag link and loosen screw plug as far as possible without completely removing it from link.

2. Pull end of drag link off pitman arm ball stud as an assistant inside cab turns steering wheel to loosen stud in link. If link does not slip off stud easily, ball seats (1, 2, Fig. 22) may have turned in link so ground slot is out of position. Check, and if this has occurred, insert a screw driver or similar tool at ball and re-position ground slot.

3. If drag link is to be disconnected at axle steering arm, remove cotter pin in end of link and loosen screw plug as far as possible without removing it.

4. Then pull end of drag link off axle steering arm ball stud. Slot in each ball seat must be in proper position before link can be removed.

8. TO INSTALL DRAG LINK

With pitman arm properly positioned on sector shaft, steering gear in center position of movement, and wheels in straight-ahead position; drag link should fit over ball studs in pitman arm and axle steering arm without changing position of pitman arm or front wheels. Install pitman arm as follows:

1. Connect end of drag link, with hole for ball stud located closest to end of link, Fig. 22, to axle steering arm.

2. Be sure drag link end is thoroughly lubricated. Then adjust as described under "Adjustment," Paragraph 4. Ground slot in ball seats (1, 2, Fig. 22) must fit around ball stud above ball. Check this by looking at parts as adjustment is made.

3. Locate center of steering gear movement by turning steering wheel carefully **(do not turn wheel hard against stops)** from right extreme to left extreme, counting the number of turns. Then back up exactly half way. Locate front wheels in straight-ahead position.

4. Slip end socket of drag link over ball stud in pitman arm and adjust as described under "Adjustment," Paragraph 4. Slot in each ball seat must be in proper position as adjustment is made. Be sure drag link end is thoroughly lubricated before adjusting.

REPAIR

9. TO DISASSEMBLE STEERING GEAR

Before starting disassembly be sure steering gear, bench and tools are clean. Steering gear parts must be kept free of dirt. Disassembly is accomplished as follows: Refer to Fig. 2.

A. Steering Gear—

1. Loosen lock nut (27) on lash adjuster (31A) and turn lash adjuster a few turns counter-clockwise.

2. Place a pan under assembly to catch lubricant, and remove screws attaching side cover (28) to housing (14).

3. After lubricant is drained, pull side cover (28) with lash adjuster (31A) and sector shaft (31) from housing (14), Fig. 9. If sector does not clear opening in housing easily, turn wormshaft by hand until sector will pass through opening.

4. Loosen lock nut (26) on worm bearing thrust screw

STEERING GEAR

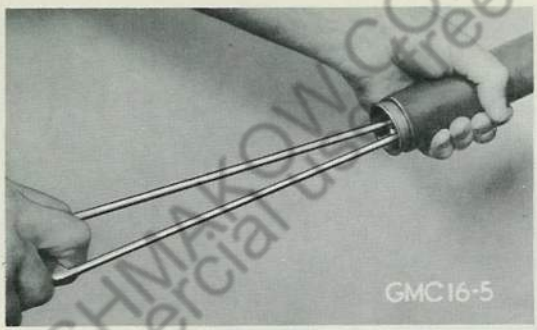

Fig. 12 Steering Column Jacket Bearing Removal

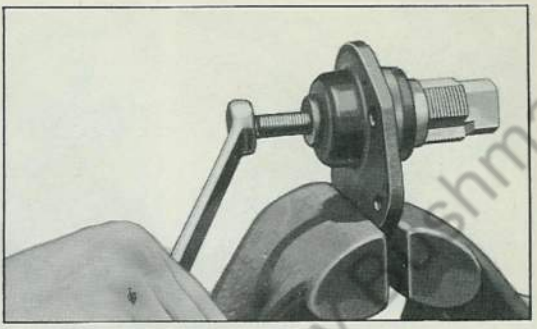

Fig. 13 Side Cover Bushing Removal

(25) and turn thrust screw counter-clockwise a few turns.

5. Place housing (14) in a bench vise with steering column horizontal. Do not clamp too tightly. Remove lower end cover screws, end cover (24) including thrust screw (25) and lock nut (26), lower bearings and cage (22) and gasket (23), Fig. 10.

6. Remove bearings and cage (22) from adjusting screw (25) and then turn adjusting screw out of end cover (24). Lock nut (26) can be turned off screw (25).

7. Withdraw worm nut, wormshaft and ball assembly from steering gear housing (14), Fig. 11. Grasp nut and shaft as shown in illustration to prevent nut rotating on worm. Lay assembly flat on bench.

Important: If shaft is held in a vertical position with nut (17) free to rotate on worm, nut will travel by its own weight to end of worm. If nut strikes either end of worm sharply, ball guides (18) will be damaged.

8. Upper worm barrel rollers and cage (16) come out with wormshaft (21). Use puller to remove bearing cup (15).

9. Remove wormshaft top bearing assembly from steering column jacket, using tool as illustrated in Fig. 12.

10. Take lock nut (27) off lash adjuster (31A) and unscrew lash adjuster from side cover (28). Slide lash adjuster with shim (31B) out of slot in end of sector shaft (31).

11. Remove bushing (30) from side cover (28), using tool as shown in Fig. 13.

12. Press bushings (32 and 33) and seal (34 and 35) from housing (14) in an arbor press or use suitable driver, Fig. 14.

B. Worm Nut, Wormshaft and Balls—If worm nut rotates freely on worm with no evidence of binding or roughness it is not necessary to disassemble parts. However, if movement is rough or parts bind disassemble as follows:

1. Remove screws and clamp (19) which retain ball guides (18) in nut (17). Draw guides out of nut. Refer to Fig. 15.

2. Turn nut upside down and rotate wormshaft (21) back and forth until all balls (20) have dropped out of nut into clean pan. With balls removed, pull nut endwise off worm.

10. TO INSPECT STEERING GEAR PARTS

It is very important to keep all steering gear parts clean while disassembling, inspecting and assembling. Inspect parts as follows: Refer to Fig. 2.

1. First give all steering gear parts a general inspection for wear, distortion, pitting, etc.

2. Inspect sector gear teeth and mating worm nut rack teeth for wear, pitting, chipping, or nicks. Replace defective parts as necessary.

3. Check sector shaft bushings in housing and side cover for wear. If clearance between bushings and sector shaft exceeds limits in "Specifications," Paragraph 15, replace bushings.

4. Carefully examine sector shaft (31). Shaft should not be worn or twisted and serrations for pitman arm should be in good condition.

5. Check oil seal (34 and 35) and replace if seal is worn or damaged.

6. If wormshaft bearings (16 and 22), cup (15) or bearing surface in adjusting screw (25) are worn, pitted, clipped or nicked, replace worn parts. Since bearing

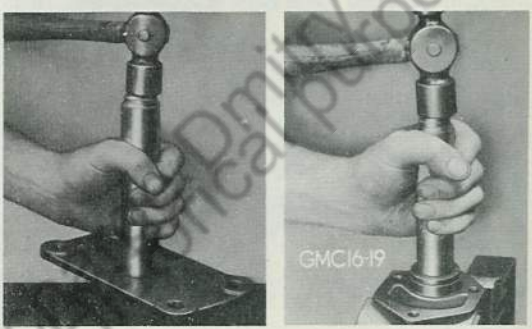

Fig. 14 Housing and Side Cover Bushing Drivers

STEERING GEAR



Fig. 15 Removing and Assembling Ball Guides

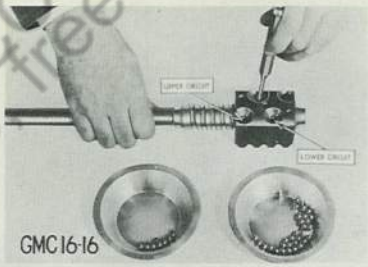

Fig. 16 Filling Ball Circuits in Nut



Fig. 17 Filling Ball Guides

cones are an integral part of wormshaft (21), install new wormshaft assembly if cones need replacement. Lubricate bearings thoroughly.

7. Carefully examine wormshaft (21), worm nut (17), balls (20) and guides (18)—all parts of wormshaft and nut assembly. Use new guides if worn or bent. Inspect each ball individually (preferably with a magnifying glass) for roughness, cracking or flaking. Balls must be equal in size within .0001". Check helical cut grooves of wormshaft and worm nut for roughness. Grooves must be smooth.

8. Clean, inspect and lubricate wormshaft upper bearing which disassembles easily into component parts (4, 5, 6, 7, 8, 9 and 10). Use correct number of balls and new packing when reassembling.

11. TO ASSEMBLE STEERING GEAR

Cleanliness when assembling steering gear parts cannot be over-emphasized. Parts must be kept clean, any dirt which gets inside housing is harmful. Any bits of abrasive material may quickly ruin gear. Grease used should be free from dirt or other contamination. Proceed with assembly as follows: Refer to Fig. 2.

A. Worm Nut, Wormshaft and Balls—

1. Apply light coating of lubricant to grooves in worm and bore of worm nut.

2. Place wormshaft (21) flat on bench and slip nut (17) over worm with ball guide holes in upper surface. Align grooves in worm and nut by sighting through bottom of ball guide holes.

3. Divide total number of balls into two clean pans. Refer to "Specifications," paragraph 15, for proper quantity of balls. Apply light coating of lubricant to all balls before installing in worm nut. Drop balls from one pan into guide holes of one circuit in worm nut. Turn worm away from hole gradually while putting in balls. Continue until ball circuit is full from bottom of one guide hole to bottom of other—or until stopped by reaching end of worm.

4. If balls are stopped by end of worm, hold down those balls already in nut with blunt end of a clean punch or rod, Fig. 16. Then turn worm in reverse direction a few turns. More balls can then be dropped into circuit. If necessary, work worm back and forth, holding balls down first in one hole, then the other. This closes spaces between balls, filling circuit completely and solidly.

5. Lay one half of a guide (18), groove "UP" on bench and place remaining balls from the pan in it, Fig. 17. Put second half of guide in place over balls and plug open ends with heavy grease to hold balls in.

6. Push guide, with balls, into guide holes of nut (17) as shown in Fig. 15. Tap guide lightly with screw driver handle to seat guide if necessary. This completes one ball circuit.

7. Fill second ball circuit in same manner as first.

8. Assemble ball guide clamp (19) to nut (17). Use lockwashers under clamp screws and set screws up tight.

9. Check assembly by rotating nut on worm to see that it moves freely. **Do not rotate nut to end of worm threads and thereby damage ball guides.** If motion of nut is not free, cause of condition must be located and corrected. Ball guides may have been bent in assembly so they restrict ball circuit.

10. Lay wormshaft (21) and nut (17) assembly flat on bench to be sure nut does not run to end of worm.

11. Brush wormshaft horn wire terminal contact ring and horn button contact at upper end of wormshaft with petrolatum.

B. Steering Gear—

1. Install bushings (32 and 33) and oil seal (34 and

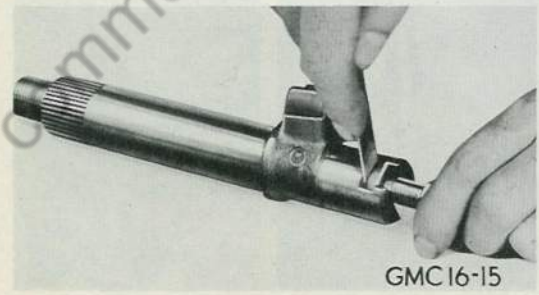

Fig. 18 Checking Lash Adjuster Clearance

STEERING GEAR

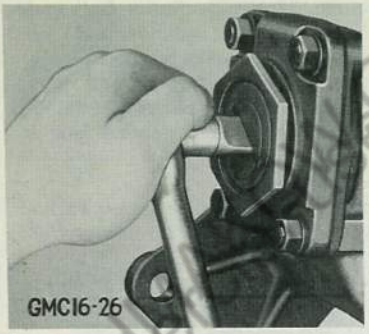

Fig. 19 Adjusting Worm Bearings on Bench



Fig. 20 Use Spring Scale to Check Bench Adjustments



Fig. 21 Adjusting Sector Gear Lash on Bench

35) in housing (14), using arbor press or suitable driver, Fig. 14.

2. Insert upper worm bearing cup (15) in housing (14). Be sure bearing seat is clean and cup bottoms squarely.

3. Place upper worm bearing (16) over end of shaft (21) and slide into position against worm. Be sure bearing has been lubricated.

4. Clamp housing (14) in bench vise lightly with steering column in horizontal position. Grasp worm nut (17) and shaft (21) so nut cannot run to end of worm and damage ball guides (18). Then guide upper end of shaft into housing, Fig. 11, until bearing (16) seats against cup (15).

5. Turn worm bearing thrust screw (25) into end cover (24) a few turns to assemble parts. Put lower worm bearing (22) in thrust screw (25). Grease bearing thoroughly. Assemble cover to housing (14), Fig. 10, using new gasket (23) and tighten cover screws securely. Then adjust thrust screw (25) so there is no end play in wormshaft (21). This is only a temporary adjustment.

6. Place shim (31B) on lash adjusting screw (31A) and insert screw head and shim into slot in end of sector shaft (31). Check clearance between screw head and shaft, Fig. 18. If over .002", use thicker shim to reduce clearance. See "Specifications," paragraph 15, for shim sizes.

7. Press bushing (30) into side cover (28) or use driver, Fig. 14. If new bushing is used, it will be necessary to ream bushing after it is pressed into side cover and after cover is attached to steering gear housing. Use special tool for this operation and ream to diameter given in "Specifications," paragraph 15.

8. Start sector shaft end into bushing (30). Insert screw driver in hole in side cover (28) to engage slot in lash adjuster screw (31A). Turn screw counter-clockwise to thread it into cover and also pull sector shaft end into bushing (30) in side cover (28) as far as it will go.

9. Rotate wormshaft (21) by hand until worm nut is about in center of travel on worm. This is to make sure that teeth of worm nut and sector gear will engage properly—center tooth of sector gear entering center tooth space of nut.

10. Push sector shaft (31), assembled to side cover (28), into housing (14), Fig. 9. Be careful when pushing end of shaft through bushings (32 and 33) and oil seal (34 and 35). Use new gasket between housing (14) and side cover (28). After making sure there is sufficient lash between teeth of worm nut and sector gear, install and tighten side cover screws. Then insert lockwire to keep cover screws from loosening.

11. Install wormshaft top bearing assembly over upper end of shaft (21). Tap bearing outer race to seat it in upper end of wormshaft jacket (11). Bearing assembly is made up of items 4, 5, 6, 7, 8, 9 and 10 in Fig. 2, and is easily assembled.

12. Do not install pitman arm (36) until steering gear is mounted in vehicle.

12. TO ADJUST STEERING GEAR ON BENCH

Steering gear is adjusted easily on bench before installation in vehicle. If properly adjusted at this time,

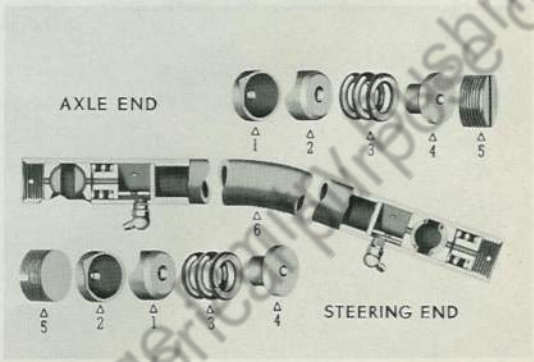

Fig. 22 Steering Gear Drag Link

1. Ball Seat Inner
2. Ball Seat Outer
3. Spring
4. Safety Plug
5. Screw Plug
6. Connecting Rod

STEERING GEAR

it should only be necessary to check adjustment after installation in vehicle. Proceed as follows:

1. Clamp steering gear assembly carefully in bench vise in same position as installed in vehicle. Then fill assembly with proper lubricant to level of filler plug hole and install filler plug.

2. Be sure sector gear lash adjustment is loose. Then tighten worm bearing thrust screw until all wormshaft end-play has been removed, Fig. 19, and tighten lock nut.

3. Install steering wheel on wormshaft temporarily. Carefully turn steering wheel all way in one direction and then back about one turn.

4. Using suitable spring scale, at right angle to one spoke at wheel rim, measure the pull required to keep wheel in motion, Fig. 20. This should be between 1 and 1½ pounds. If necessary, readjust worm thrust screw until proper pull is obtained.

5. Turn steering wheel from one stop all way to other, counting number of turns. Then turn wheel back exactly half number of turns to center position and mark wheel at top or bottom with a piece of tape.

6. Turn sector lash adjuster screw clockwise to remove all lash between rack and sector teeth. Tighten lock nut, Fig. 21. Be sure adjustment is not changed while tightening lock nut.

7. Check pull at rim of steering wheel. Take the highest reading on scale as wheel is pulled through center position. This should be between 2 and 2½ pounds.

8. If necessary, readjust lash adjuster screw to obtain proper pull. Tighten lock nut and again check for proper pull.

9. With lubricant in gear housing and proper adjustment completed, steering gear assembly is ready for installation in vehicle.

13. TO DISASSEMBLE DRAG LINK

Drag link is one piece tubular type. Only the drag link ends can be disassembled. Ball seats, springs, spring plug and screw plug, Fig. 22, are identical in both ends of link but relative location of parts is different. At axle end, spring and spring plug fit between bottom of socket and ball seat. At steering gear end, spring and spring plug fit between ball seat and screw plug. This method of assembly relieves road shock from steering gear in both directions.

A. Steering Gear End—

1. Cotter pin locking screw plug was removed and plug partially removed when drag link was removed from vehicle.

2. Remove screw plug and hold drag link on end so end parts will drop out. These in order are: Spring plug, spring, outer ball seat, and inner ball seat, Fig. 22.

3. Discard parts worn excessively and check spring load to limits given in "Specifications," paragraph 15.

B. Axle End—Procedure for disassembly of axle end of drag link is same as for steering gear end except order in which parts drop out of link end after screw plug is removed. Order of parts is: Outer ball seat, inner ball seat, spring and spring plug.

14. TO ASSEMBLE DRAG LINK

Before starting to assemble drag link ends, study Fig. 22 to assure assembling parts in correct relative positions.

A. Steering Gear End—

1. Slide inner ball seat, outer ball seat, spring, spring plug into link end in order.

2. Start screw plug into end of link.

3. Cotter pin to lock screw plug cannot be installed until after link is installed on vehicle and adjusted.

4. Lubricate link end thoroughly with proper lubricant.

B. Axle End—Procedure for assembling axle end of drag link is same as for steering gear end except order in which parts are put into link. Order of parts is: spring plug, spring, inner ball seat, outer ball seat and finally the screw plug.

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STEERING GEAR

TABULATED DATA

15. SPECIFICATIONS

Steering Gear

Type	Recirculating Ball
Gear Ratio	23.6 to 1
Make	Saginaw
Model	548-D1

Bearings

Worm	Barrel Roller
Bearing Cup Make	Hyatt
Bearing Cup Number	Hyatt 10983-Z
Bearing Cone Make	Hyatt
Bearing Cone Number	Hyatt 10983-R
Worm Nut	Ball
Ball Diameter (Nominal)	$\frac{9}{32}$"
Quantity of Balls	106

Sector Shaft Bushings

Cover Bushing Inside Diameter	1.1255"–1.1260"
Housing Bushing Inside Diameter	1.2495"–1.250"

Clearance Between

Sector Shaft and Bushing	
In Cover	.0015"–.0025"
In Housing	.0035"–.0045"
Sector Shaft and Adjusting Screw	
Not to Exceed	.002"
Shims Available	.063"–.065" .067"–".069"

Adjustments—Screw Type

Worm Shaft Bearings	No Perceptible End Play
Sector Shaft End Play	.002"–.003"

Steering Wheel

Make	Inland
Diameter	20"

Steering Drag Link

Type	Ball and Socket—Spring Loaded
Make	Saginaw
Adjustment (See Text)	Threaded Plug
Spring (Lbs. Pressure at 55/64")	250–300

16. TOOL EQUIPMENT

The following special tools, or their equivalent, are recommended for use when servicing STEERING GEAR.

Tool No.	Name	Supplier Code
J-452-G	Steering Wheel Puller	KM
J-489	Jacket Bearing Remover	KM
J-544-A	Tension Scale	KM
J-1376-G	Pitman Arm Puller	KM
J-1728	Housing Bearing Tool	KM
J-1729	Side Cover Bushing Remover	KM
J-1730	Side Cover Bushing Driver	KM
J-1734	Worm Adjusting Wrench	KM
KMO-353	Side Cover Bushing Reamer	KM

TOOL SUPPLIER

Supplier Code	Name	Address
KM	Kent-Moore Organization	Detroit, Mich.

STEERING GEAR

SERVICE BULLETIN REFERENCE

Bulletin No.	Description

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Group 15 — Frame

	Paragraph
GENERAL	
Description	1
REPLACEMENT AND REPAIR	
Frame	2
Towing Attachment	3
Pintle Hook	4
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GENERAL

1. DESCRIPTION

Frame side rails, shown in Fig. 1, are pressed steel channel section, designed to provide maximum strength with light weight. Cross members are of various types riveted to side rails with gussets to insure rigidity. The 145" and 164" wheelbase frames are of similar construction, differing only to provide additional length required in longer wheelbase models. The greater length, on longer model, is added to the rear of third cross member, thereby not disturbing motor, transmission, or transfer case installation. An additional cross member is used ahead of rear axle to provide the extra stiffness needed due to this greater length.

REPLACEMENT AND REPAIR

2. FRAME

Due to the exceptionally rugged design of frame used in this vehicle, very little service attention is required. However, vehicles which have been in a collision, upset, or accident of any nature which might result in "swayed" or sprung frame, should always be checked carefully for proper frame alignment in addition to steering geometry and axle alignment.

A. To Check Frame Alignment—Most convenient way to check frame alignment, particularly on trucks equipped with a body, is by marking on floor all points from which measurements are to be taken. This can be done by tacking or cementing pieces of paper securely to floor under each point of measurement "M," indicated on frame drawing Fig. 1, and dropping a "plumb bob" from each point. Satisfactory checking is dependent upon accuracy of marks with relation to frame.

After each point shown has been marked carefully and vehicle moved away from layout on floor, proceed as directed in following paragraphs:

1. Check frame width at front and rear ends, using corresponding marks on floor. If widths correspond to specifications given, draw center line full length of vehicle halfway between marks indicating front and rear widths. If frame width is not correct, layout center line as directed in item 4.

2. With center line properly laid out, measure distance from it to opposite points marked over entire length of chassis. If frame is in proper alignment, measurements should not vary more than 1/8" at any point.

3. To locate point at which frame is sprung, measure diagonals marked A, B, and C. If diagonals in each pair are within 1/8", that part of frame included between points of measurement may be considered in alignment, and these diagonals should intersect within 1/8" of center line. Variations of more than 1/8" indicate misalignment.

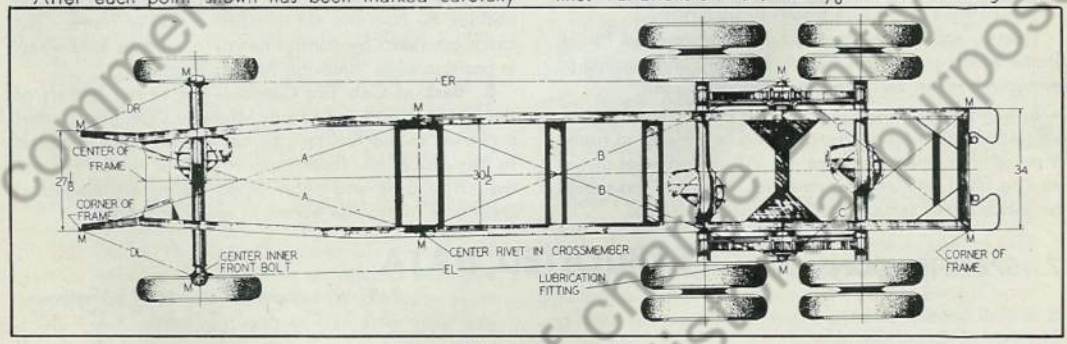

Fig. 1 Checking Frame Alignment

15

FRAME

4. If center line cannot be laid out from center points of ends of frame, it can be drawn through intersection of any one pair of equal diagonals and center points of one end of frame or through points of intersection of any two pairs of equal diagonals. If extreme front end, or horn of frame, is damaged, center of front end of frame can be located from point exactly midway between radiator support bolts.

5. After it has been determined that frame is properly aligned, front axle alignment with frame can be checked as directed below. Refer to Fig. 1.

(a) Front axle is square with frame if ER equals EL, and DR equals DL.

(b) Front axle has shifted sideways if ER is less than EL, and DR less than DL, or vice versa.

(c) Front axle is bent, twisted or one end shifted if ER is less than EL and DR is greater than DL, or vice versa.

B. To Straighten Frame—Use of heat is not recommended when straightening frames. Heat weakens structural characteristics of frame members and all straightening should be done cold. Frame members which are bent or buckled sufficiently to show strain or cracks after straightening, should be replaced.

C. To Reinforce Frame—Reinforcements can be made with flat, channel or angle stock. Because of difficulties encountered when inserting channel reinforcements into frame side rails, use of angle reinforcements is recommended. Wherever possible, reinforcement should extend entire length of side rail or at least 18" beyond cab cross member. This procedure, of course, is impractical in many instances because of position of attached units and existing cross members. Reinforcement stock thickness should not exceed that of side rail to be reinforced.

Wherever possible, parts should be securely riveted together. Hot rivets are recommended, as they can be properly driven with hand tools. Cold rivets are not recommended unless heavy power press equipment to obtain secure fastening is available.

Diameter of reinforcement rivets depends upon spacing and number of rivets used. Generally, rivets are 50% to 100% as thick as plates to be riveted.

Electric arc-welding method is recommended for all frame welding. Heat of weld is localized and burning of material is minimized when this method is used.

In addition to thoroughly welding cut in side rail, outside edges of reinforcements should be welded to frame after reinforcements are riveted. All unused holes should also be filled with welding material. Welding rod should be substantially same material as used in frame.

3. TOWING ATTACHMENTS

Towing attachment on these vehicles consists of two tow hooks mounted on the front bumper. These tow hooks may be replaced by removing three bolts which attach hooks to bumper and frame side rail.

4. PINTLE HOOK

Pintle hook furnished on these vehicles is held in place between rear frame cross member and an additional support brace by means of two heavy steel bushings. Machined collars on bushings bear against a strong coil spring, providing a means of absorbing starting shock.

When installing pintle hook, first place one of the steel bushings with shorter length from the collar into opening in rear cross member. Install other bushing with longer length from collar, through opening in the pintle support. Install coil spring over two bushings and thread shaft of hook through bushings, spring and support. Attach flat washer and nut to end of shaft and tighten until spring compresses far enough so that bolt holes in pintle support line up with those in frame. Bolt support securely to frame and then back off retaining nut sufficiently to just leave coil spring under slight tension to eliminate rattles. Install new cotter pin.

The pintle hook may be extended 1¾" further back from rear cross member by reversing both bushings.

5. SPRING BRACKETS

Front spring brackets are riveted to frame and should not require servicing. However, if brackets are to be replaced, be sure that rivets of proper size are used. Front spring shackle brackets on vehicles having split type axles are equipped with bushings which are replaceable. Replacement procedure for these bushings and complete details of front and rear spring brackets is covered in "Springs and Shock Absorbers" group in this manual.

6. SPARE WHEEL CARRIER

There are two types of spare wheel carriers. A single wheel under body type is used on 164" wheelbase vehicles, and a dual wheel back of cab type is used on shorter vehicles.

A. Under Body Tire Carrier—This carrier is riveted to lower frame flange. Wheel supporting plate is held in position by bolt and nut installed in side of frame. The catch operated by control handle is used to hold wheel in position while removing retaining nut.

B. Back of Cab Tire Carrier—This carrier is part of the fuel tank and tire carrier assembly. The tire support is riveted to the fuel tank carrier which in turn is bolted to frame side rail. Inner support arms of tire carrier are riveted to base and outer support arms are hinged at lower end to provide access to wheel and tire.

7. SPECIFICATIONS

TABULATED DATA

	145" Wheelbase	164" Wheelbase
Side Rail Section (Max.)	$8\frac{3}{16}$" x 3" x $\frac{5}{16}$	$8\frac{3}{16}$" x 3" x $\frac{5}{16}$"
Number of Crossmembers	5	6

Group 16 — Springs and Shock Absorbers

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GENERAL

1. DESCRIPTION

Front and rear springs discussed in this section include shackles, brackets, bolts, mountings, rebound clips, torque rod mounting parts for rear springs, shock absorbers and attachments.

Front and rear springs are semi-elliptic type. Leaves are held together by four rebound clips and properly located on spring seat by means of a center bolt.

A. Front Spring—Top leaf of front springs has an eye formed at each end into which a bronze bushing is pressed. Second leaf is wrapped around eye. Front end of spring is mounted in shackle, while rear end is supported in stationary bracket. Front springs, in addition to supporting weight of front of vehicle, also transmit the driving thrust to the frame.

Shackles are provided to permit spring to lengthen and shorten under load compression and rebound action.

There are three types of shackle used:

1. THE "U" TYPE SHACKLE shown at "A" in Fig. 1 is used on left front spring on vehicles equipped with split type axle and winch. This type shackle has left-hand lower bolt threaded into shackle. Lower bolt nut has been omitted to provide clearance for the winch propeller shaft. Bolt lock under head of this bolt prevents it from turning.

2. THE "U" TYPE SHACKLE shown at "B" in Fig. 1 is used on right-hand front spring on vehicles equipped with **split type front axle, with winch;** and also on right and left front springs on vehicles with **split type axle and without winch.**

This type shackle is practically the same in design as that shown at "A" in Fig. 1, except that nuts are provided for all shackle bolts.

3. THE "Y" TYPE OF SHACKLE shown in Fig. 2 is used on vehicles equipped with banjo type front axles.

This type shackle is attached to bracket and spring by means of pins. Outside end of pins are grooved to permit installation of clamping bolts.

B. Rear Springs—Rear springs are inverted semi-elliptic type with center of spring held to spring seat by two U bolts. Spring seat is carried on trunnion cross shaft by tapered roller bearings. These bearings should be in proper adjustment as entire weight of rear of vehicle is supported at this point. Ends of spring ride on axle housing and are free to slide forward and backward to permit spring to lengthen and shorten under load compression and rebound action. Drive from rear axles is through torque rods.

C. Shock Absorbers—Shock absorber used in this vehicle, at front springs only, is heavy duty double acting type interconnecting frame and axle through links, as shown in Fig. 1.

These hydraulic absorbers operate on the principle of a piston forcing fluid through a small orifice or hole, thereby building up necessary resistance to control vehicle body movement. When pressure is built up to a predetermined point, spring loaded relief valve will open and hold this constant pressure until completion of piston stroke.

SPRINGS AND SHOCK ABSORBERS

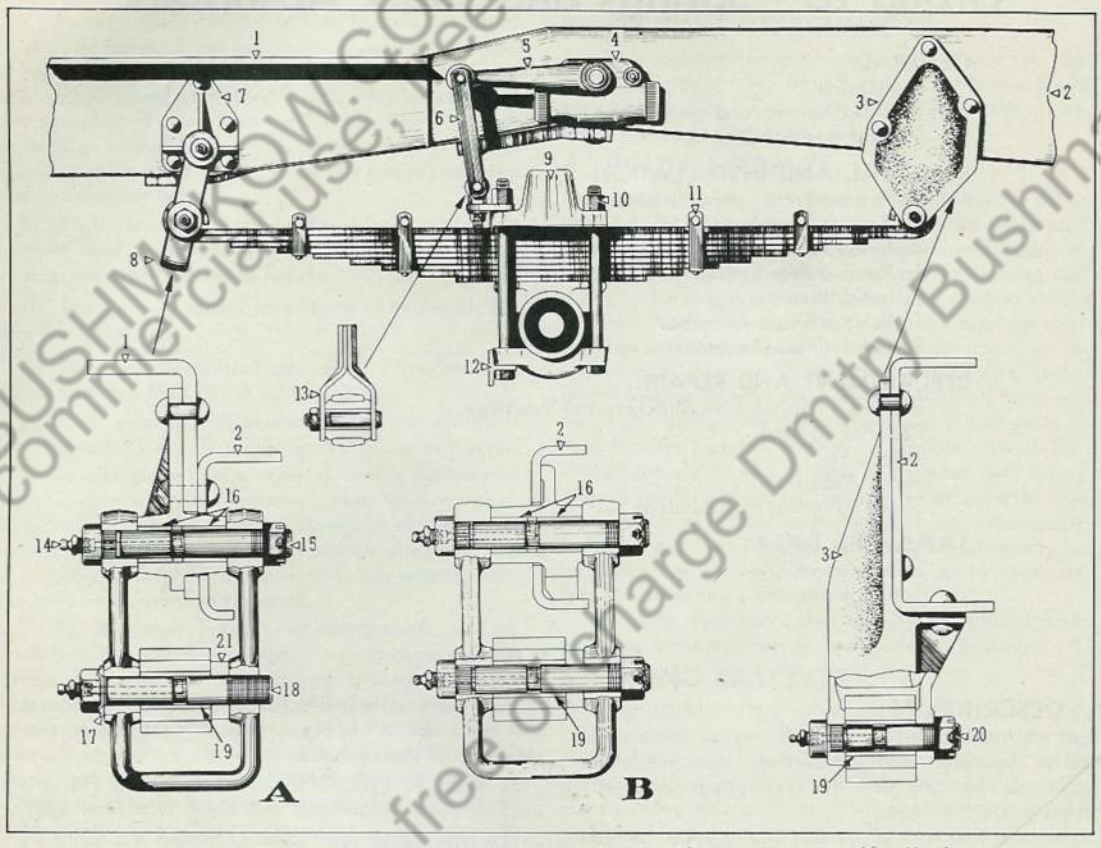


Fig. 1 Front Spring and Shock Absorber Installation Showing Front Shackles Used on Vehicles Equipped with Split Type Axles and Winch.

1. Frame Extension
2. Frame
3. Front Spring Rear Bracket
4. Shock Absorber
5. Shock Absorber Arm
6. Shock Absorber Link
7. Shackle Bracket
8. "U" Shackle
9. Mounting Bolt Spacer
10. Mounting Bolt Nut
11. Rebound Clip
12. Guard
13. Shock Absorber Link End
14. Lubrication Fitting
15. Shackle Bolt and Nut
16. Shackle Bracket Bushing
17. Eye Bolt Lock Nut
18. Spring Front Eye Bolt
19. Spring Eye Bushing
20. Spring Rear Eye Bolt and Nut
21. Bracket Spacer

2. TROUBLE SHOOTING AND GENERAL SOLUTIONS

The chart which follows lists the most common failures that may arise in this group and offers a probable remedy for each failure.

HARD RIDING

Caused by:

1. Insufficient lubrication—
   Lubricate front spring shackle and bracket bolts.
2. Bolts in shackle or bracket froze—
   (a) Remove and clean.
   (b) Replace bushings if scored.
3. Vehicle overloaded.
4. Uneven load distribution.

OVER FLEXIBLE

Caused by:

1. Over lubrication—
   (a) Lubricate only at mileage intervals specified in Lubrication section.
   (b) Do not lubricate spring leaves.
2. Lack of fluid in shock absorber—
   Refill to proper level.
3. Shock absorber not operating—
   Remove and inspect for worn or broken parts.
4. Rebound clips loose or not in place—
   Tighten and place in proper position.

SPRINGS AND SHOCK ADSORBERS

EXCESSIVE NOISE
Caused by:

1. Worn bolts and bushings in shackles or brackets—
   Replace with new parts.
2. Loose spring mounting bolts, causing misalignment of axle and springs—
   Tighten mounting bolt nuts.
3. Rear spring seat bearings not tight, causing end play of seat on cross shaft—
   Readjust bearings as described under "Spring Seat Bearing Adjustment."

SPRING LEAF FAILURES
Caused by:

1. Vehicle overloaded.
2. Rebound clips loose or not in place.
3. Shackle or spring pins frozen or shackles adjusted too tightly.
4. Grabbing clutch or brake.

3. INSPECTION AND ADJUSTMENT

Following inspection and maintenance items covering springs and mounting parts are essential to satisfactory spring performance:

1. Front spring shackles should be drawn up tight enough to take up all play caused by wear, but not too tight to prevent free action of shackle bolt or pin. Draw nuts up as tightly as possible, then back off one-half turn to prevent binding. Always use new cotter pins full size of hole.

2. Center bolts should be kept tight at all times.

3. Mounting bolts holding front springs to axle and rear spring clips or "U" bolts should be kept tight with vehicle under normal load.

4. Rebound clips also should be drawn up tight enough to hold leaves in alignment without restricting free movement of leaves.

5. Lubrication of spring shackles and brackets should be performed periodically, or whenever necessary under abnormal conditions, in accordance with recommendations as given in "Lubrication" chart.

6. Rear spring bearings used at spring seat should be cleaned, lubricated and adjusted as outlined in Paragraph 12.

7. When springs have lost some of their resilience or elastic properties, it is advisable to replace them by new ones, rather than attempt to restore spring camber by heating, bending and tempering.

8. Rubber bushings at end of torque rods should be kept clean and free from oils and greases.

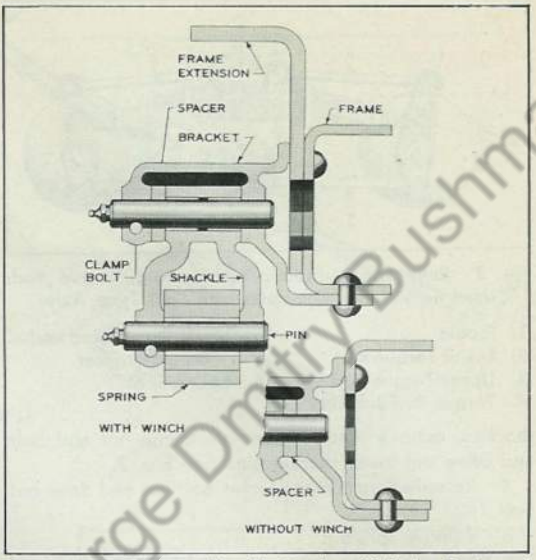


Fig. 2 Front Spring Shackle Used on Vehicles Equipped with Banjo Type Axles

REMOVAL AND INSTALLATION

4. TO REMOVE FRONT SPRING SHACKLE

1. Jack up front end of vehicle frame until spring tension is completely relieved.

2. Shackles shown at "B," Fig. 1. Remove upper and lower shackle bolt nuts and drive out bolts, using lead hammer.

3. Shackles shown at "A," Fig. 1. Front spring left-hand shackle lower bolt should be unscrewed, not driven out.

4. Shackle shown in Fig. 2. Remove shackle pin clamp nuts and bolts and drive out shackle pins. Frame is provided with hole to facilitate driving out upper shackle pin.

5. TO REMOVE FRONT SPRING

Front spring removal procedure for vehicles equipped with either type of axle is the same except that lower shackle bolt or pin is retained in a different manner. To remove front spring:

1. Remove four spring seat nuts and bolts. This operation will remove spacer plate holding spring to seat and disconnect shock absorber link.

2. Jack up front end of truck frame until tension is completely relieved.

3. (a) Remove "U" shackle lower bolt nut on vehicles, using split type axle and not equipped with winch, and drive out bolt, using lead hammer. See "B," Fig. 1.

(b) On vehicles equipped with split type axle and winch, front spring left-hand "U" shackle lower bolt is threaded into shackle. Remove lock and unscrew bolt. See "A," Fig. 1.

(c) On vehicles using banjo type axle and "Y" type

SPRINGS AND SHOCK ABSORBERS

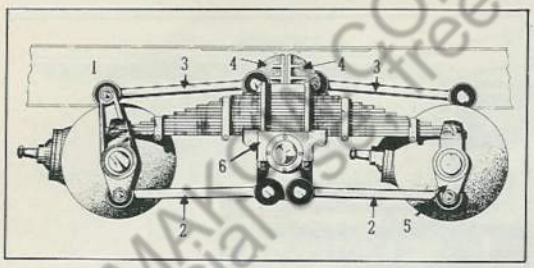


Fig. 3 Rear Spring Installation Showing Torque Rods Used on Vehicles Equipped with Split Type Axles

1. Frame
2. Lower Torque Rod
3. Upper Torque Rod
4. Torque Rod Bracket
5. Lower Torque Rod and Spring Bracket
6. Spring Seat

shackles, remove shackle lower pin clamp nut and bolt and drive out lower shackle pin. See Fig. 2.

4. Remove spring rear bracket bolt nut and drive out bolt.

5. Remove spring.

6. Spring may be disassembled after center bolt and spring clips are removed.

6. TO INSTALL FRONT SPRING

Installation operations are the reverse of removal operations. (Refer to Fig. 1.)

1. Check fit of bolt or pin in shackle and spring eye bushing and if bushings require replacement, replace as instructed under Paragraph 11, "To Replace Spring Eye Bushings."

2. Place spring in position and replace rear bracket bolt and nut.

3. Replace lower shackle bolt on vehicles using split type axle or shackle pin on vehicles equipped with banjo axle. Be sure to use new bolt lock when front spring left-hand "U" shackle is replaced on vehicles equipped with split type axle and winch.

4. Replace four spring seat bolts and nuts, making sure that guard (12) is installed on left-hand front bolt used on vehicles with split type axle.

7. TO REMOVE REAR SPRING

Rear spring and cross shaft assembly should be periodically inspected and adjusted. To do this properly, springs must be removed from chassis, and cross shaft ends must be disassembled.

Rear springs may be removed as follows:

1. Place jack under cross shaft to frame bracket and raise to relieve spring tension.

2. Remove spring "U" bolts and spacer. Loosen spring seat clamping bolts.

3. Slide spring back in its seat until front end can be lifted out of bracket on forward rear axle.

4. Pull spring forward until rear end clears bracket on rearward rear axle and lift spring assembly from chassis.

8. TO INSTALL REAR SPRING

Installation of rear spring may usually be accomplished without changing the position of rear axles. (Refer to Fig. 3.)

1. Place end of spring in bracket on forward rear axle and slide spring in its seat until rear of spring will clear bracket on rearward rear axle.

2. Slide spring toward rear until center bolt drops into recess in spring seat.

3. Place spacer on top leaf of spring.

4. Replace "U" bolts and nuts and tighten securely.

5. Tighten spring seat clamping bolts.

9. TO REMOVE SHOCK ABSORBER

Shock absorbers should be removed and overhauled or replaced if shock absorber body is broken or leaks; if arm is broken or stuck; or if (after checking to see that unit is full of fluid) there is no resistance in shock absorber when arm is moved up and down. To remove shock absorber from vehicle:

1. Disconnect link from shock absorber arm.

2. Remove bolts which hold shock absorber to frame and remove shock absorber.

10. TO INSTALL SHOCK ABSORBER

Before installing shock absorber, inspect grommet and bushings at both ends of link and replace if necessary, as described in Paragraph 15, "Shock Absorber Link Bushings."

1. Bolt shock absorber to frame and connect link between shock absorber and spring seat.

2. When installation is complete, check all screws and nuts. Be sure they are tight. If necessary, paint absorbers and fittings.

3. Check tire pressure. To secure most satisfactory performance, keep spring pins well lubricated, and spring bolts and shackles free.

REPLACEMENT AND REPAIR

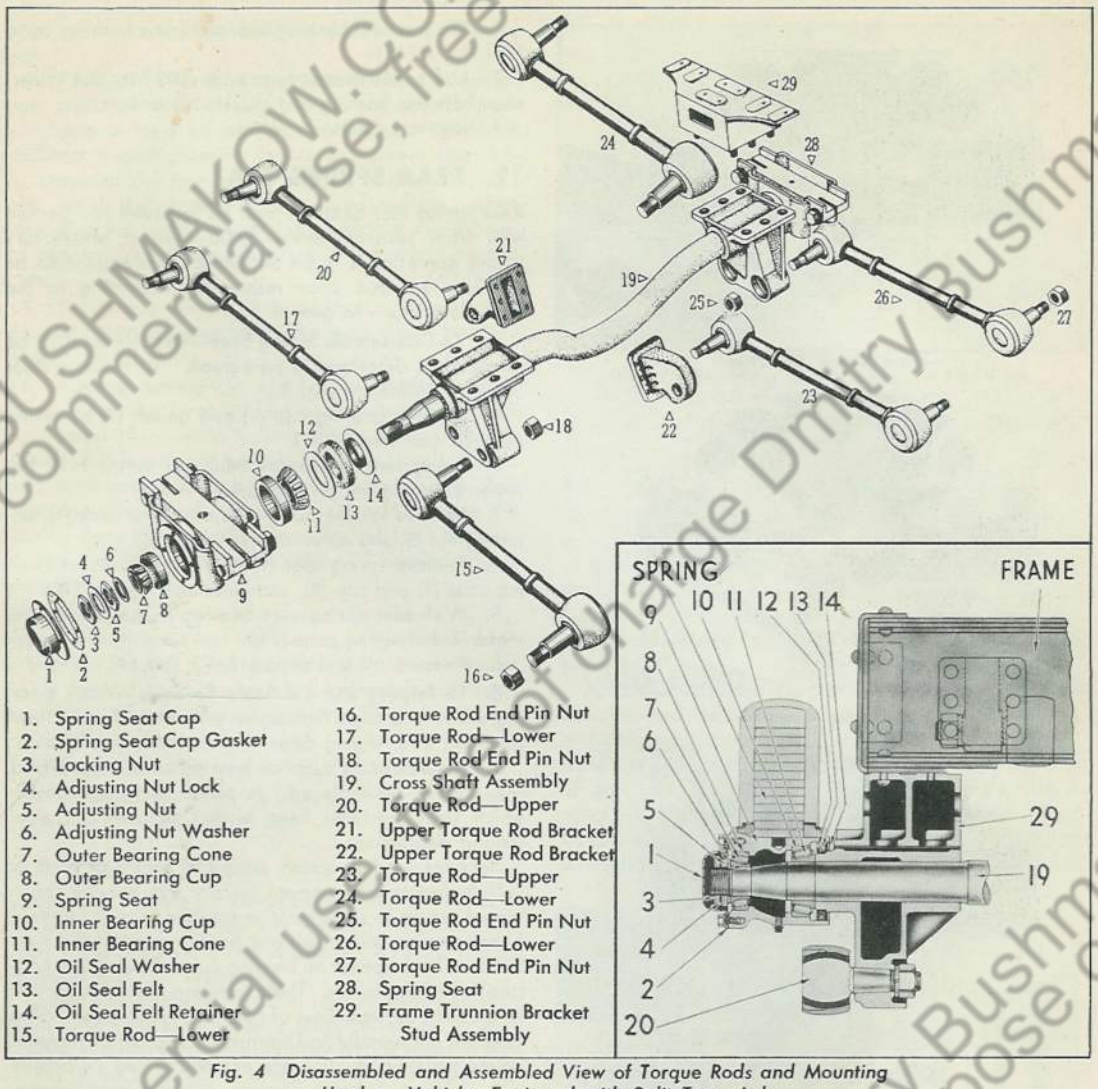
11. BUSHINGS IN SPRING EYES, BRACKETS, AND SHACKLES

Replaceable bushings are used in both front and rear eyes of front springs. Replaceable bushings are also used in front spring front brackets on vehicles having split type axles and on vehicles equipped with banjo type axles, at front spring front shackle.

A. To Replace Spring Eye Bushings—Replacement of bushings requires use of Tool No. J-2402 to remove and install bushing.

1. Remove front spring as instructed in paragraph, "To Remove Front Spring."

SPRINGS AND SHOCK ABSORBERS



1. Spring Seat Cap
2. Spring Seat Cap Gasket
3. Locking Nut
4. Adjusting Nut Lock
5. Adjusting Nut
6. Adjusting Nut Washer
7. Outer Bearing Cone
8. Outer Bearing Cup
9. Spring Seat
10. Inner Bearing Cup
11. Inner Bearing Cone
12. Oil Seal Washer
13. Oil Seal Felt
14. Oil Seal Felt Retainer
15. Torque Rod—Lower
16. Torque Rod End Pin Nut
17. Torque Rod—Lower
18. Torque Rod End Pin Nut
19. Cross Shaft Assembly
20. Torque Rod—Upper
21. Upper Torque Rod Bracket
22. Upper Torque Rod Bracket
23. Torque Rod—Upper
24. Torque Rod—Lower
25. Torque Rod End Pin Nut
26. Torque Rod—Lower
27. Torque Rod End Pin Nut
28. Spring Seat
29. Frame Trunnion Bracket Stud Assembly

Fig. 4 Disassembled and Assembled View of Torque Rods and Mounting Used on Vehicles Equipped with Split Type Axle

2. Press out old bushing, using driver No. J-2402.

3. Install new bushing, using same tool, and ream to size shown in specifications with .750 reamer.

4. Install spring in chassis.

B. To Replace Bracket or Shackle Bushings—Bushings used in front bracket of vehicles equipped with split type axle and front shackle of vehicles having banjo type axles are the same size. Tool No. J-2401 should be used when replacing bushings.

1. Remove front spring shackle as instructed in paragraph, "To Remove Front Spring Shackle."

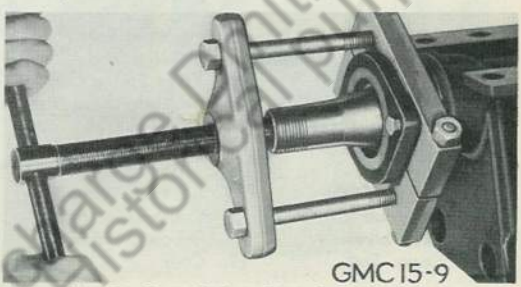
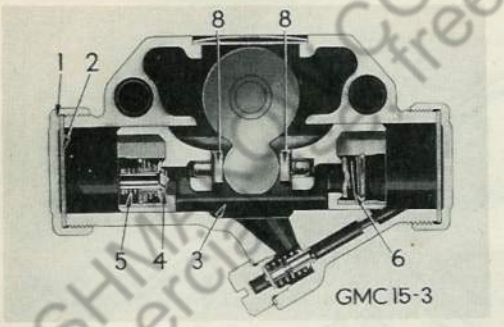
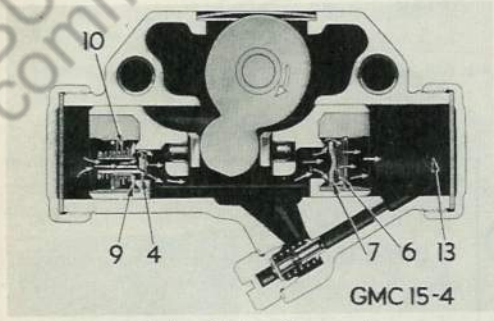


Fig. 5 Rear Spring Seat Bearing Puller

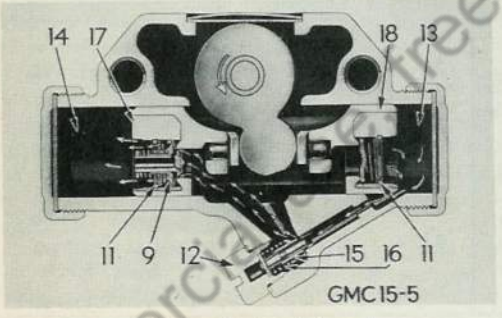
SPRINGS AND SHOCK ABSORBERS



Front Shock Absorber



During Spring Compression



During Spring Rebound

1. End Cap
2. Steel Spacer
3. Fluid Reservoir
4. Comp. Valve Spring
6. Intake Valve Spring Rebound End
7. Intake Valve—Rebound Clip
8. Cam Button
9. Intake Valve—Comp. End.
10. Int. Valve Sprg. Comp. End.
11. Valve Spring Clip
12. Rebound Valve Nut
13. Rebound End
14. Compression End
15. Rebound Valve
16. Rebound Valve Sprg.
17. Compression Piston
18. Rebound Piston
19. Cam

Fig. 6 Shock Absorber Sections Showing Action

2. Press out old bushing and install new bushing, using Tool No. J-2401.
3. Use a .765 reamer to provide .002" to .004" clearance between bushing and shackle pin or bolt.
4. Replace shackle in vehicle.

12. REAR SPRING SEAT

Rear spring seat bearings must be removed and packed with fresh lubricant every 6,000 miles if satisfactory spring operation is to be obtained. Bearings should be carefully adjusted upon reassembly according to the procedure which follows:

A. To Disassemble Spring Seat—Rear spring must be removed as described in paragraph, "To Remove Rear Springs." (Refer to Fig. 4.)

1. Remove bearing cap (1) and gasket (2) by taking out four cap screws.
2. Straighten tongues of adjusting nut lock (4) between adjusting nut (5) and locking nut (3).
3. Remove locking nut (3), adjusting nut lock (4), adjusting nut (5) and adjusting nut washer (6).
4. Remove spring seat (9) together with outer bearing cone (7) and cup (8), and inner bearing cup (10).
5. With rear spring seat bearing puller (Fig. 5), remove inner bearing cone (11).
6. Remove oil seal parts (12, 13 and 14).

B. To Inspect and Lubricate Bearings—Wash bearing cones and cups thoroughly with kerosene or Diesel fuel, and after wiping clean, inspect them carefully.

1. If surfaces of cups or bearing rollers are pitted, they should be replaced. A pitted surface is one in which small particles have broken out, leaving small jagged depressions.

Bearings used in spring seats roll back and forth as vehicle passes over uneven terrain, but bearing rollers always return to same relative position in cups. In fact, bearing rollers rest in this one position most of the time. Polished lines appear on bearing cups, showing "resting" position of the rollers. These lines are spaced according to distance between lines of contact of each roller. These lines are not harmful and bearings should not be replaced unless surfaces of cups are actually pitted or broken.

2. Inspect seals for damage resulting from handling during assembling or disassembling and for sand or mud inside of seal. Replace seals when these conditions exist. Soak bearings in engine oil, shake off excess and pack by squeezing chassis grease in behind the rollers and smoothing the grease even with the surfaces of the rollers. Apply a small amount of grease to the shaft between the bearings so as to form a dam should the grease in the bearings soften enough to flow.

C. To Assemble Spring Seat and Adjust Bearings—The adjustment of these bearings should be performed as indicated in following procedure if satisfactory spring operation is to be obtained.

1. Install spring seat on cross shaft end.

SPRINGS AND SHOCK ABSORBERS

2. Insert bearing cup and cone in outer end of spring seat.

3. Place washer and adjusting nut (inner) over end of cross shaft and with suitable wrench, pull adjusting nut up to approximate adjustment. Spring seat should be oscillated while tightening to prevent grease from being squeezed out from under bearing rollers.

4. Install dummy bearing cap (prepared by brazing a standard nut of convenient size on face of spare bearing cap) on face of spring seat with two attaching cap screws.

5. Put torque wrench on brazed nut and test effort required to move spring seat. This force should be 20 to 25 foot pounds.

6. Remove dummy cap and tighten or loosen adjust nut to obtain the 20 to 25 foot pounds testing effort at the tightest place while rocking spring seat. If torque wrench and dummy cap are not available, an alternative method of testing bearing adjustment can be used. Bolt a two-foot bar to face of spring seat and measure the bearing drag with spring scale at end of bar. Reading of scale should be from 10 to 12 lbs. if bearing adjustment is correct.

7. When adjusting nut has been tightened properly, replace adjusting nut lock and locking nut (outer). Tighten locking nut securely. Test adjustment once more to see that it has not been changed and correct if necessary. Bend tangs of adjusting nut lock over flats of adjusting nut and locking nut.

8. Replace bearing cap and four cap screws.

9. Install springs on spring seats as instructed in paragraph, "To Install Rear Springs."

13. TORQUE RODS

Torque rods, three each side, interconnect forward rear axle and rearward rear axle with trunnion brackets. Figs. 3 and 4 illustrate torque rod installation used on vehicles equipped with split type axle.

Torque rod installation used on vehicles equipped with banjo type axles differs mainly from the above, in that forward and rearward ends of upper torque rods (20 and 23, Fig. 4) are attached to bracket welded to upper half of axle housing bowl, also upper rear torque rod (23, Fig. 4) is installed in vehicle in same position as torque rod (15, Fig. 4) to provide sufficient clearance for installation at rearward axle. Torque rods used on vehicles with "split" type axles are 1½" longer than those used on Banjo axles—**do not interchange.**

Both ends of rods are rubber bushed to ball pin which has tapered mounting stud. Tapered studs must be kept tight at all times as any looseness at these points may result in axle becoming out of line, and will also result in excessive wear of studs and mountings.

Rubber bushing in ends of rods (Figs. 3 and 4) require no special attention, except that they should be sprayed with rubber preserving fluid to prevent cracking or deterioration of rubber. Satisfactory fluids are listed in "Lubrication" section.

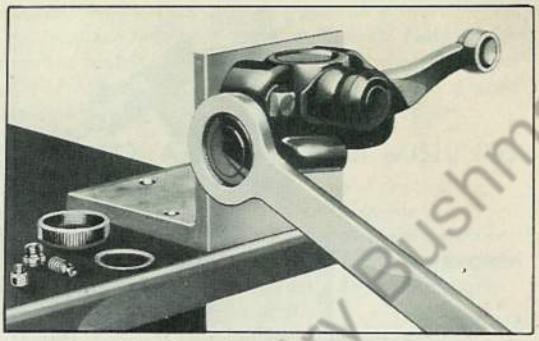


Fig. 7 Removing Shock Absorber End Cap

14. SHOCK ABSORBERS

Shock absorbers provide a smoother ride by dampening spring vibrations as vehicle runs over obstructions in road or goes into hole or rut. Absorber units do not require special attention, except periodically inspecting and tightening links and to check fluid level in housings. Use only genuine Delco-Lovejoy fluid, and check level at least every 5,000 miles.

A. Shock Absorber Operation—Delco-Lovejoy shock absorber and fluid flow in action during spring rebound and compression are shown in Fig. 6. As arm moves upward (compression stroke), piston moves toward arm end of unit, compressing fluid in compression end of shock absorber. With very slight or slow axle movements, fluid flows only through orifice of compression valve (4) and into fluid reservoir (3).

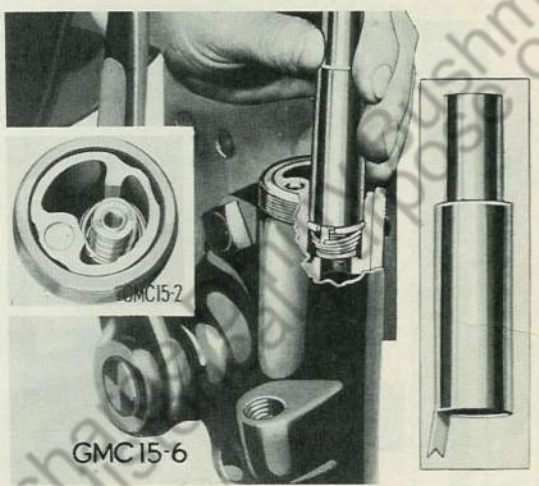


Fig. 8 Installing Compression Valve

SPRINGS AND SHOCK ABSORBERS

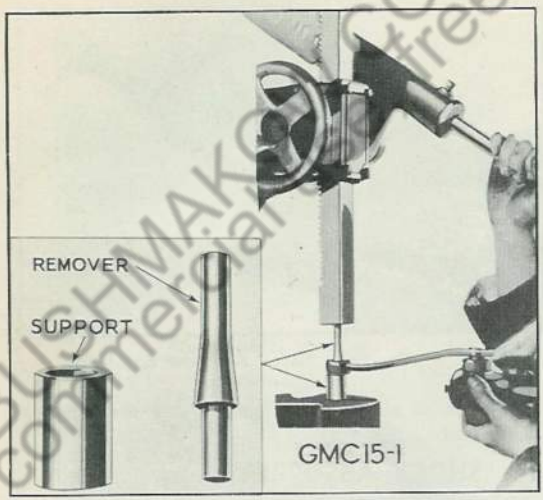


Fig. 9 Removing Link Bushing

In rapid movements, pressure lifts valve (4) from seat, allowing greater volume of fluid into reservoir, as shown by arrows at compression end in Fig. 6. At the same time, intake valve (7) in rebound end of piston opens, allowing fluid to flow from reservoir into rebound end of cylinder (13).

During rebound stroke, or when arm moves downward, direction of flow is reversed. Piston moves away from arm end of shock absorber, compressing fluid in rebound end (13) of absorber. In slow action, fluid flows only through orifice of rebound valve (15, Fig. 6) into reservoir. During rapid action, rebound valve (15) is lifted from its seat and fluid passes in larger volume into reservoir. At the same time, intake valve (9) at compression end of piston opens, allowing fluid to pass from reservoir into compression end of cylinder (14, Fig. 6).

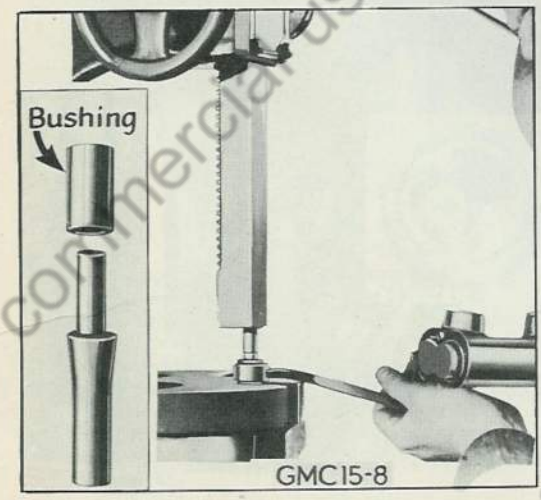


Fig. 10 Installing Link Bushing

B. To Inspect and Fill Shock Absorber—Before proceeding with any repair operation on shock absorber, lubricate vehicle spring pins and shackles and see that tire pressure does not exceed pressure as recommended by the tire manufacturer. Smooth operation is obtained only when shackles operate freely and tires are not overinflated.

1. Disconnect link from axle and pull shock absorber arm down. If arm drops easily partway and then stops and continues moving down slowly the rest of the way, there is not enough fluid in shock absorber.

2. Clean shock absorber thoroughly and remove filler plug. Then fill with shock absorber insulating fluid to a level with filler plug hole. Use fluid gun KMO-1026.

3. Replace filler plug and move shock absorber arm up and down several times to work oil into piston cylinder. Then inject additional fluid to fill reservoir. To provide necessary air space in shock absorber, allow fluid to escape down to bottom edge of filler plug hole before replacing plug. Use new filler plug gasket if necessary. If end caps, valve plug or filler plug leak, install new end cap fibre gaskets, or valve and filler plug lead gaskets.

4. Shock absorber packing washers which have been operating with fluid below proper level may become worn and cause leaks around shaft. Leaks of this nature can only be corrected by replacing shock absorbers.

5. Need of major overhaul service may be readily determined by following conditions:

(a) Shock absorber body or arm broken.
(b) Shock absorber leaks at arm.
(c) Arm stuck or "frozen."
(d) No resistance in shock absorber when arm is moved up and down, after checking to see if it is full of fluid.

If any of above conditions exist, remove absorber from vehicle, replace with new unit or overhaul in following manner:

C. To Disassemble Shock Absorber—This operation requires the use of special holding fixture J-895 and knurled end cap wrench J-766. (Refer to Fig. 6.)

1. Remove dirt, grease and loose paint from exterior of shock absorber.

2. Place absorber in special assembly fixture, as shown in Fig. 7. **Do not clamp in a vise.**

3. Remove filler plug, drain fluid completely by working arm back and forth, and remove end caps, using end cap wrench, J-766. Refer to Fig. 7.

4. Remove rebound valve nut (12), rebound valve (15) and piston valves (4 and 7). To remove piston valves, first remove valve spring retainer clip with a screw driver; then lift valves out.

5. Remove plugs over piston screws by piercing with a sharp tool and lifting out.

6. Disassemble piston (17) by removing piston screws.

SPRINGS AND SHOCK ABSORBERS

7. Wash shock absorber and all parts in kerosene and inspect for wear or defects. Blow out valve orifices with compressed air. Be sure valves are clean.

8. Check camshaft for wear in housing by moving shock arm sideways. If shaft is worn, replace complete shock absorber.

D. To Assemble Shock Absorber—The following assembly procedure should be followed with care. Use Tool No. J-896 to install compression valve. (Refer to Fig. 6.)

1. Assemble piston. Try both sizes of piston in cylinder. Use size which allows some clearance. Too tight a fit will cause a bind and result in noise.

Small diameter piston has a green paint mark.

Large diameter piston has a blue paint mark.

Assemble piston with cam clearance up, and also with high arch or anti-rotation spring up.

2. Assemble piston screws down tightly and than back off about one turn to prevent binding between cam (19) and cam buttons (8).

3. Install new plugs over piston screws. Expand in place.

4. Replace piston valves and valve spring retainer clip, using valve installing tool, J-896, Fig. 8. Be sure compression valve is placed in compression end of piston. See Fig. 9 for correct position of compression valve.

5. Replace rebound valve (15) and valve nut (12), using new gasket.

6. Replace one end cap (using new gasket) and rotate fixture until open end of absorber is up. Fill shock absorber to capacity with new Delco Shock Absorber Fluid. While filling, move shock arm through complete strokes to expel air from fluid.

7. Replace other end cap and rotate fixture until shock absorber is in same position as when mounted on vehicle.

8. Remove filler plug and allow fluid to drain down to filler plug hole level. This allows air space at top of shock absorber reservoir for natural expansion of fluid.

9. Replace filler plug, using new gasket. **Note:** Shock absorber body, arm, packing gland, camshaft and cam are not replaceable due to special fixtures and presses required to assemble and disassemble these parts.

15. SHOCK ABSORBER LINK BUSHINGS

Unsatisfactory shock absorber action and shock absorber noise might be due to worn links, link bushings and grommets. To determine if one or more of these conditions exists, disconnect link from axle and check for lost motion at both ends. If wear has occurred, replace grommets and bushings at both ends.

A. To Replace Link Bushings and Grommets—This operation requires use of special Tools J-899, J-901 and J-902 to properly remove and install bushings.

1. Remove shock absorber from vehicle and disconnect link.

2. Press worn bushings and grommet from shock absorber arm, using bushing remover and support in an arbor press, as shown in Fig. 9.

3. Coat a new rubber grommet with liquid soap, for easy installation, and press it into shock absorber arm, using tool J-901 to insure proper seating of grommet.

4. Place new bronze bushing on bushing replacer pilot and press bushing into grommet, Fig. 10. Replacing tool, J-899, expands grommet and should be used for this operation to prevent damaging grommet.

5. Insert knurled end of pin in large hole of link and press pin into link, using tool J-902. This tool limits the depth that pin can be pressed through link, thus preventing damage to link holes.

6. After pin is installed, strike link against press plate of arbor press. A sharp blow on head of pin will properly seat large hole on pin shoulder.

7. Assemble cotter pins to link pins and install shock absorber on vehicle.

TABULATED DATA

16. SPECIFICATIONS

Front Springs	
Center to Center of Eye	40″
Center of Eye to Seat Center	20″
Width	2″
Rebound Clips	4
Leaves—With Winch	
Quantity	9
Thickness	4 @ .360″—5 @ .323″
Total Thickness	3.055″
Leaves—Without Winch	
Quantity	9
Thickness	2 @ .360″—2 @ .323″—5 @ .291″
Total Thickness	2.821″
Spring Clips	Keep Tight
Front Spring Bushing	
Inside Diameter	.754″–.749″
Front Bracket Pin Bushings	
Inside Diameter (Split Axle Type)	.752″–.749″
Spring Pins	
Diameter	.7475″–.7465″
Rear Springs	
Length	51½″
End to Seat Center—Each End	25¾″
Width	2½″
Rebound Clips	4
Leaves	
Quantity	13
Thickness	6 @ 7/16″—7 @ ⅜″
Total Thickness	5¼″

SPRINGS AND SHOCK ABSORBERS

Rear Spring Seat

Bearing Adjustment ..... See Instructions

Torque Rods

Adjustment ..... None

Keep Tapered Pins Tight. Brush Hydraulic Brake Fluid on Rubber Bushings at Regular Lubrication Periods

Shock Absorbers

Make ..... Delco Products
Type ..... Double Acting
Model Number
Right 1731-G-2JG2
Left 1731-H-2JG2

Use only Genuine Delco-Lovejoy Shock Absorber Fluid. Brush Hydraulic Brake Fluid on Rubber Bushings at Regular Lubrication Periods.

17. TOOL EQUIPMENT

The following special tools, or their equivalent, are recommended for use when servicing SPRINGS AND SHOCK ABSORBERS.

Tool No.	Name	Supplier Code
CS-1047	Bearing Cone Remover	CS
CS-1057	Cross Shaft Bearing Adjusting Nut Wrench	CS
J-766	End Cap Wrench—Knurled	KM
J-895	Holding Fixture	KM
J-896-A	Valve Installing Tool	KM
J-899	Link Bushing Driver	KM
J-901	Rubber Bushing Depth Spacer	KM
J-902	Link Pin Setting Tool	KM
J-903	Link Bushing Support	KM
J-1733	Cross Shaft Bearing Cone Replacer	KM
J-2401	Shackle Bushing Remover	KM
J-2402	Spring Eye Bushing Remover and Replacer	KM
KMO-1026	Fluid Gun	KM
MT-1000	Torque Wrench	S

TOOL SUPPLIER

Supplier Code	Name	Address
CS	Curtiss and Smith Manufacturing Corp.	Pottstown, Penn.
KM	Kent-Moore Organization	Detroit, Mich.
S	Sturtevant Tool Co.	Addison, Ill.

SERVICE BULLETIN REFERENCE

Bulletin No.	Description

Group 18 — Cab and Body

	Paragraph
GENERAL	
Description	1
Trouble-Shooting, and General Solutions	2
Inspection and Adjustment	3
REMOVAL AND INSTALLATION	
To Remove Driver's Cab	4
To Install Driver's Cab	5
To Remove Cargo or Tank Body	6
To Install Cargo or Tank Body	7
To Remove Sheet Metal (Hoods, Fenders, Running Boards, etc.)	8
To Install Sheet Metal (Hoods, Fenders, Running Boards, etc.)	9
REPAIR	
Windshield Glass and Frame	10
Windshield Wipers	11
Door Alignment	12
Door Window Glass and Frame	13
Window Regulator, Door Latch and Remote Control	14
Rear Glass and Guard	15
Floor Boards and Mats	16
Exterior and Interior Panels	17
Seats and Upholstery	18
Cowl Ventilator	19
Exterior and Interior Finish	20
TABULATED DATA	
Special Tools	21

GENERAL

1. DESCRIPTION

Driver's cab is all-steel, drop skirt design with "helmet" type top. Construction is a composite of welding and bolting sub-assemblies into an integral unit. Outer panels are welded to cab structural posts and side rails.

Two types of bodies are used on vehicles described in this manual—"Cargo" and "Tank." mounting is similar for both body types. Longitudinal sills integral with body are clamped and bolted to chassis frame side rails.

2. TROUBLE-SHOOTING AND GENERAL SOLUTIONS

Symptoms which indicate trouble with various units of driver's cab and cargo or tank body, are listed below with probable cause, probable remedy and references.

A. Looseness or Rattles in Driver's Cab—Panels, Mountings and Structural Bolts—

1. Cab panels loose due to excessive distortion of cab—
   Weld or bolt panels to cab posts and sills. Tighten cab mounting bolts. Refer to Fig. 1.
2. Structural bolts in cab loose—
   Tighten bolts. Refer to "Inspection and Adjustment," Paragraph 3.

B. Sheet Metal Rattling or Cracked—Hoods, Fenders, etc.—

1. Assembly or attaching bolts loose—
   Tighten bolts. Refer to Figs. 6 and 7.

C. Doors Rattle—

1. Structural bolts in cab loose—
   Tighten bolts. Refer to "Inspection and Adjustment," Paragraph 3.
2. Hinges loose or pins worn—
   Tighten hinge screws or replace pins.
3. Striker plate worn or needs adjustment—
   Adjust striker plate or replace as necessary.
4. Rubber door bumpers worn—
   Install new bumpers.

D. Doors Do Not Close and Latch Properly—

1. Hinges loose or pins worn—
   Tighten hinge screws or replace pins.
2. Striker plate needs adjustment—
   Adjust striker plate.
3. Structural bolts in cab loose—
   Tighten bolts. Refer to "Inspection and Adjustment," Paragraph 3.
4. Hinges sprung—
   Be sure check strap is in good condition, then adjust door alignment as described under "Door Alignment," Paragraph 12.
5. Door sprung or distorted—
   Align door. Refer to "Door Alignment," Paragraph 12.

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CAB AND BODY

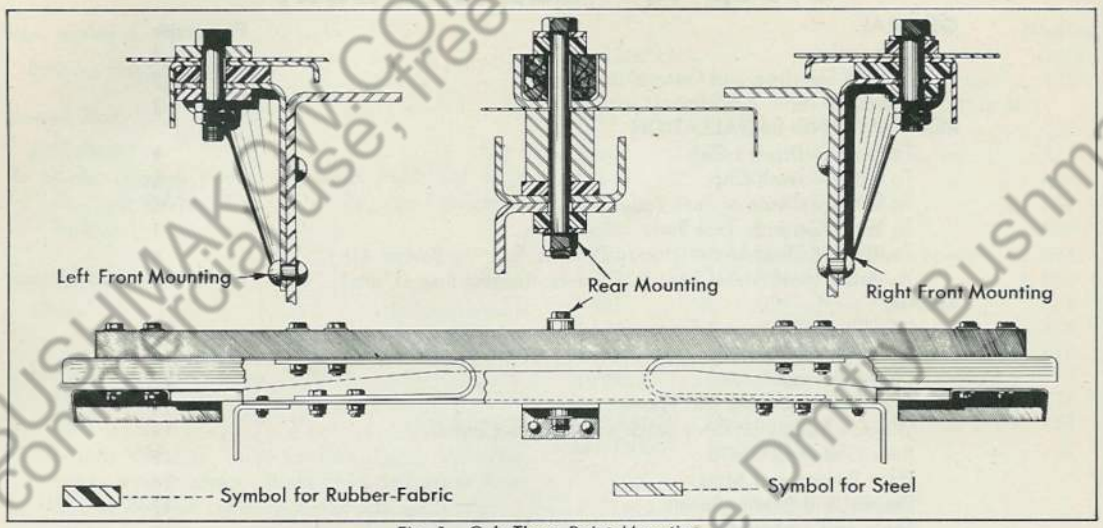


Fig. 1 Cab Three Point Mounting

6. Door latch inoperative—
   Install new door latch.

E. Windshield Leaks—

1. Rubber weatherstrip deteriorated—
   Install new weatherstrip.
2. Rubber channel between glass and frame poorly fitted—
   Replace with heavier channel or if small leak apply sealing compound.
3. Hinges loose or pins worn—
   Tighten hinge screws or replace pins.

F. Windshield Wipers Inoperative—

1. Leak in vacuum line—
   Check vacuum line for leaks and tighten all connections.
2. Hose kinked or tubing or fittings plugged—
   Replace hose and clean tubing and fittings.
3. Broken or worn parts in wiper motor—
   Refer to "Inspection and Adjustment," Paragraph 3.

G. Leak at Cowl Ventilator—

1. Seal strip in cowl needs replacement—
   Install new seal strip.

H. Binding in Steering Mechanism—

1. Cab mountings and structural bolts loose—
   Tighten mounting and structural bolts. Refer to "Inspection and Adjustment," Paragraph 3 and Figs. 1 and 2.
2. Refer to "Steering Gear," group 14—

I. Body Shifting on Chassis—

1. Mounting bolts loose—
   Check and tighten all mounting bolts.

3. INSPECTION AND ADJUSTMENT

Items listed below should be inspected at regular intervals and adjustments or repairs made as required.

A. Cab and Body Mountings—Cab mounting bolts, Fig. 1, should be inspected and tightened to prevent breaking cab panels loose due to excessive distortion. Loose body mountings permit body to shift on frame. Check all body mounting bolts at regular intervals to be sure they are tight.

B. Cab Structural Bolts—Structural bolts used in door posts and to attach floor platform to cab sills should be kept tight. Nuts of bolts joining floor platform to cab side sills are accessible between chassis frame side rail and cab skirt above running board.

Two screws in each windshield corner post which serve to join roof structure to cowl are accessible when cover plates are removed. Refer to Fig. 2. Check and tighten these screws regularly.

It is important that all structural bolts be kept tight to prevent sagging of doors, inability to close and latch doors properly, binding in steering mechanism due to improper alignment of steering column and to maintain a tight, rattle-free cab.

C. Sheet Metal (Hoods, Fenders, Running Boards, etc.)—All of the sheet metal parts are bolted together and to the chassis frame, radiator support and brush guard. Refer to Fig. 7 for a view of disassembled parts. Assembly bolts should be inspected and tightened at regular intervals. This will prevent rattles and cracking or breaking of parts due to vibration.

Tightening all assembly bolts regularly is especially important on vehicles constructed to incorporate "radio interference suppression." Double shakeproof lock washers assure a proper electrical ground between sheet

CAB AND BODY

metal parts if bolts are kept tight. Bolts attaching flexible metal bond straps should be kept tight also. Detailed information on installation of all parts used with radio suppression is given in the "Miscellaneous Electrical" group 06M.

D. Doors—Proper functioning of each door is dependent upon a number of relative parts and conditions. These parts and conditions with operations pertaining to each are listed below:

1. Door Hinges—Door hinges are attached to door pillars and doors with screws. Inspect and tighten screws as necessary to prevent doors sagging. Also inspect hinge pins occasionally and replace if worn. Keep door hinges properly lubricated.

2. Door Metal Check Strap—Check strap, which limits width door can open and prevents damage to hinges, is a metal spring strap type. Strap is designed to hold door in extreme open position until pulled closed by hand. Strap should be kept in working order and properly lubricated.

3. Door Latch Striker Plate—Door rattles can usually be traced to worn door bumpers and striker plate. Striker plate adjustment is provided to compensate for wear and to eliminate door rattles resulting from this cause.

Loosen screws attaching plate to door pillar sufficiently to slide striker plate toward inner edge of pillar. Amount to move plate depends on looseness of door when latched. Tighten screws, latch door and try door to determine if looseness or rattling has been corrected. If striker plate has been moved inward as far as possible then it will be necessary to replace worn parts or check the fit of door contour against door opening in cab.

4. Weatherstrip—Weatherstrip around doors effectively seals doors to prevent drafts. Weatherstrip is held in place under metal moulding strips attached by screws to door pillars. If weatherstrip is undamaged but fails to seal door satisfactorily with door in proper alignment, condition is easily corrected by two methods.

(a) Loosen metal moulding screws enough to permit pulling weatherstrip toward outside of cab and retighten screws clamping weatherstrip in new position. Weatherstrip flange is a rubber coated screen and is clamped by moulding. Screen permits screw holes to be elongated to allow moving weatherstrip into new position.

(b) Using a hammer handle or similar rounded stick with ends held in hands, rub along bead of weatherstrip in such manner as to bend bead into better position to seal door.

5. Door to Cab Alignment—Inspect doors for proper alignment to cab. Refer to "Door Alignment," Paragraph 12 for conditions which indicate improper alignment and methods of correction.

E. Windshield Seals—Windshield glass is mounted in a rubber channel and held securely in windshield frame. Windshield frame is sealed when in closed position by tension between special rubber weatherstrip and cab

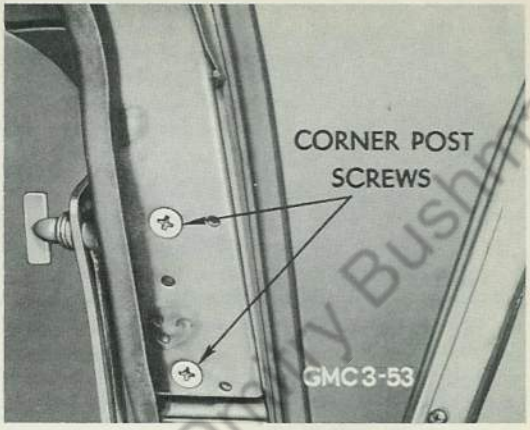


Fig. 2 Windshield Post Screws

panel. Refer to Fig. 3.

Inspect or test windshield for leaks by spraying water with medium pressure on front of the closed windshield, directing a heavy stream along windshield frame and seal. At the same time an assistant may observe from inside cab and mark points where leakage occurs. Leakage may occur at one of two locations which are listed below with method of correction of each.

1. Leak Between Rubber Weatherstrip and Cab—A leak of this type is usually due to deterioration of weatherstrip which results in cracking, splitting or buckling of the rubber. The condition can be corrected easily by installing a new weatherstrip as outlined under Paragraph 10, "Windshield Glass and Frame."

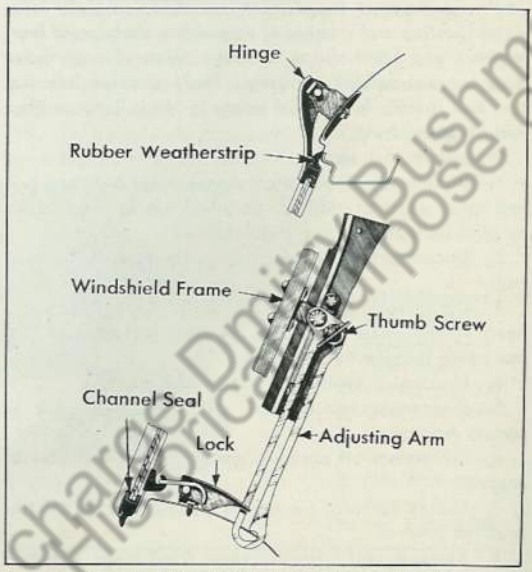


Fig. 3 Windshield, Regulator and Seals

CAB AND BODY

2. Leak Between Glass and Windshield Frame—A leak of this type usually requires removal and disassembly of windshield and installation of a heavier rubber channel seal which is available. Or if only a slight leak, apply rubber cement carefully at point of leak. Refer to Paragraph 10, "Windshield Glass and Frame" for removal and disassembly procedure.

F. Windshield Wipers—Wiper motors require no special maintenance and should not be disturbed until they fail to function. Then proceed as follows:

1. Check vacuum line for leaks, kinked hose or tubing, plugging of line or fittings and tighten all connections before checking wiper motor.

2. With small access panel removed and wiper motor exposed, Fig. 9, remove small metal cover from rear of motor and check for broken valve mechanism parts such as valve, kicker, yoke or spring.

3. If valve parts are broken or if valve mechanism is in good condition and motor still does not operate, remove motor for repair.

G. Windshield Regulator—Windshield is adjusted or regulated manually, Fig. 3. A spring clamp on instrument panel at center of windshield locks windshield in closed position. After clamp is opened windshield can be swung outward by loosening adjusting arm thumb screws at end of windshield. Location of hinges on front crown panel of cab, together with length of adjusting arms, permits windshield to be opened and held open in a nearly horizontal position.

Inspect and tighten all hinge screws and screws attaching adjusting arms to windshield frame at regular intervals. Occasionally check hinge pins for wear. In time, rubber washers used between thumb screws and adjusting arms may become hardened. When this condition exists install new washers.

REMOVAL AND INSTALLATION

4. TO REMOVE DRIVER'S CAB

"Three point" type mounting as shown in Fig. 1 is used to attach cab to frame. Both front corners of cab are flexibly mounted with insulating spacers between cab sill and mounting bracket. Rear mounting consists of a single through bolt at rear center of cab which fastens cab sill to frame cross-member. Rubberized fabric insulators absorb shock. A heavy cushioning spring is placed between cab sill and frame cross-member each side of center mounting bolt to prevent excessive rocking movement at rear of cab.

When removing and installing cab on vehicles having radio interference suppression installed, carefully note exact location and manner of assembling shakeproof lockwashers and bond straps so these points of suppression may be reassembled correctly. Study detailed information and specific location of points in "Miscellaneous Electrical," group 06M.

Proceed as follows:

1. Disconnect all electrical connections between cab and other parts of vehicle. Junction blocks are located on cowl beneath voltage regulator.

2. Disconnect accelerator, throttle and choke controls.

3. Disconnect speedometer cable at speedometer head in instrument panel, loosen grommet in cowl and pull cable through hole in cowl.

4. Disconnect windshield wiper tube at cowl.

5. Disconnect temperature gauge thermal plug at engine fitting.

6. Disconnect oil pressure gauge line at left side of engine.

7. Loosen radiator tie rod at both points of attachment to cowl.

8. Remove seat cushion—raise front edge and pull forward.

9. Unscrew starter button from starter rod.

10. Remove floor mat and take out floor and toe boards after removing hold-down screws.

11. Disconnect steering column mounting bracket at instrument panel.

12. Remove bolts connecting front end sheet metal to cowl and remove hood after taking out hinge pins, and disconnecting hood support.

13. Unscrew nuts from all three cab mounting bolts, Fig. 1, and remove bolts, spacers and washers.

14. Remove bolts attaching each cushioning spring (between cab rear sill and frame cross-member) to the cross-member.

15. Raise cab straight up from frame, using a suitable overhead hoist. Be careful to clear steering wheel when raising cab.

5. TO MOUNT DRIVER'S CAB

When installing cab on chassis, items above apply in a reverse sequence as reassembly operations. In addition, items below also apply.

1. Be sure to install rubberized fabric insulators at cab mounting bolts exactly as shown in Fig. 1.

2. Use drift pin to align holes in cab sills with holes in chassis when lowering cab on frame to simplify installation of mounting bolts.

3. Do not forget to install bolts in both cushion springs under cab rear sill.

4. Be sure radiator tie rod is attached to cowl to allow clearance between radiator and fan.

5. Before attaching steering column to instrument panel, loosen steering gear housing to frame mounting bolts. Then attach steering column bracket to dash and tighten securely. Last, tighten gear housing to frame bolts, tightening upper front or pivot bolt last. This method prevents misalignment and resultant binding in steering gear.

CAB AND BODY

6. TO REMOVE CARGO OR TANK BODY

Following operations are necessary whenever vehicle body is to be removed.

1. Disconnect wiring to stop and tail lights and to trailer wiring socket.

2. If body is "Cargo" type, Fig. 4, remove tarpaulin, bows, rear safety belt, front rack and side rack and seat assemblies to simplify hoisting body.

3. Disconnect exhaust tail pipe from rear wheel splash guard. Then take out bolts attaching splash guards and remove guards.

4. If body uses front corner flexible mountings, Fig. 5, remove hold-down bolts, nuts and springs.

5. Remove nuts located at under side of frame side rails at rear end and remove hold-down bolts. Bolts extend down through body sills and rear end of chassis frame rails.

6. Remove all nuts, lockwashers and clip plates from "U" bolts attaching body sills to frame side rails. Then remove "U" bolts.

7. Raise body straight up from frame, using a suitable overhead hoist.

8. Wood spacer blocks and strips can be removed easily when body is off chassis.

7. TO INSTALL CARGO OR TANK BODY

When installing body on chassis, items above apply in reverse sequence as reassembly operations. Instructions below should also be followed:

1. Be sure to install wood spacer blocks and strips in the proper positions.

2. Use drift pin to align holes in body with holes in chassis when lowering body on frame to simplify installation of hold-down bolts.

3. "U" bolts should be installed in the proper locations and nuts tightened evenly.

4. If body uses front corner flexible mountings be careful to assemble bolts and springs according to Fig. 5 and tighten nut till spring is well compressed.

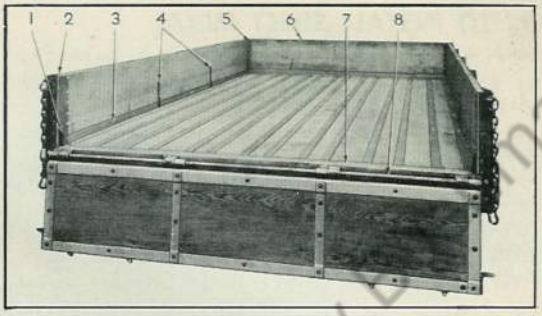
5. Be sure to reconnect wiring.

8. TO REMOVE SHEET METAL

(Hoods, Fenders, Running Boards, etc.)—

Sheet metal parts including fenders, running boards and engine closure parts can be taken off as separate pieces or as sub-assemblies. The latter method is recommended and is outlined below. Figure 6 shows fender sub-assemblies. Fig. 7 shows front end sheet metal disassembled.

When removing and installing sheet metal on vehicles having radio interference suppression installed, carefully note exact location and manner of assembling shakeproof lockwashers and bond straps so these points of suppression may be reassembled correctly. Study detailed information and specific location of points in "Miscellaneous Electrical," group 06M.



1. Rear Corner Stake Pocket Hook Bolt Assembly
2. Rear Corner Stake Pocket
3. Side Corner Skid Strip
4. Side Panel Strap Bolt
5. Front Corner Reinforcement
6. Front End Panel Ass'y
7. Rear End Scuff Plate
8. Tail Gate Hinge Rod

Fig. 4 Cargo Type Body Without Bows or Tarpaulin

Proceed as follows:

1. Raise engine hood, disconnect support, remove hinge pins and take off hood.

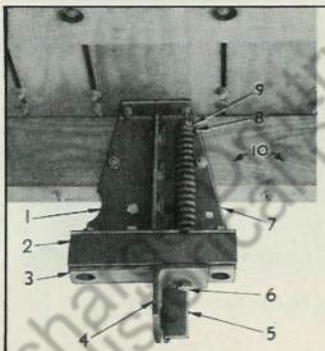
2. Disconnect headlamp and black-out lamp wiring at junction blocks mounted on inner side of fender skirts.

3. Remove each fender in an assembly with its respective fender skirt, running board, hood side panel, panel extension, head lamp and black-out lamp. Bolts in following locations must be removed.

(a) Running board to support hangers.
(b) Fender flange to cowl and cowl bracket.
(c) Fender skirt rear lower corner to frame.
(d) Hood side panel to cowl.
(e) Hood side panel extension to brush guard.
(f) Fender skirt to brush guard.
(g) Fender to brush guard.

4. Move fender sub-assembly to the rear and raise it to clear supports and remove from vehicle.

5. To completely disassemble component parts, remove the bolts which fasten the various parts together.



1. Front Support
2. Filler Block Reinforcement
3. Filler Block
4. Anchor Bracket
5. Guide Bracket
6. Hold Down Bolt
7. Tension Spring
8. Flat Washer
9. Slotted Nut
10. No. 1 Cross Sill

Fig. 5 Body Front Corner Flexible Mounting

CAB AND BODY

9. TO INSTALL SHEET METAL

Sheet metal is installed on vehicle easiest by building up as a sub-assembly, Fig. 6, and then installing sub-assembly.

1. Reassemble sheet metal sub-assemblies, each consisting of fender, fender skirt, running board, hood side panel, panel extension, head lamp and black-out lamp. Be sure to install anti-squeak and lockwashers in proper locations and tighten all nuts securely. Following steps apply:

(a) Attach running board to fender, using anti-squeak between.

(b) Assemble black-out lamp in small hole in front of fender. Put loom on wire. Then thread wire through fender reinforcement.

(c) Assemble head lamp to fender and bracket with plate, washers and nut on under side of fender.

(d) Bolt fender skirt to fender along fender flange.

(e) Assemble hood side panel extension to fender flange.

(f) Attach hood side panel to side panel extension after fitting lower edge between the fender and clips on the upper edge of fender skirt.

2. Put fender sub-assembly in place on chassis. Be sure fender skirt is in proper position at frame clip.

3. Install all bolts as listed under "To Remove and Disassemble Sheet Metal," operation 3. Replace all lockwashers and tighten bolts and nuts securely. Be sure to install anti-squeak between fender flange and cowl and wooden spacer between running board and front support hanger.

4. Connect wiring to head lamps and black-out lamps at junction panels on fender skirts. Adjust head-lamps and black-out lamps as directed in "Electrical—Lighting System," group 06L.

5. Install engine hood by putting in hinge pins and connecting hood support.

REPAIR

10. WINDSHIELD GLASS AND FRAME

Windshield is a unit assembly consisting of two glass sections, a center divider, frame, seals and regulator parts. Windshield is hinged at top edge to roof crown panels and swings outward at the bottom. Adjustment or regulation is manual, Fig. 3.

Replacement of broken windshield glass can be performed easily as outlined below. Refer to Fig. 8. However, it is important that cause of breakage if due to distortion of cab structure be located and corrected before new glass is installed.

1. Release center lock and remove adjusting arm adjusting screws.

2. Remove two screws and sleeve nuts attaching each windshield hinge to windshield frame. Then remove windshield glass and frame assembly.

3. Remove one piece rubber weatherstrip from groove around outside of windshield frame. Use a putty knife to simplify this operation.

4. Take off top and bottom frame reinforcing plates and center lock bracket by removing screws. Then remove screws from center divider cover plate and remove cover plate and seal strip.

5. Remove screws which attach top and bottom frame channels to reinforcements at each end of center divider. Then pull two halves of windshield apart at center.

6. Remove rubber channel seal and broken glass from windshield frame and clean frame channels thoroughly. Brush inside of channel with soap solution or rub with paraffin to facilitate glass installation.

7. To install glass, place strip of rubber filler channel on edge of new glass and slide "U" shaped frame channel in place on rubber channel and glass.

8. Join windshield frame sections by installing joint reinforcements and screws. Tighten screws securely.

9. Coat center divider seal strip with sealing compound. With outer part of center divider in position between glass sections, install rubber seal strip, inner cover plate and screws, tightening screws securely.

10. Assemble top and bottom reinforcing plates and center lock bracket installing screws and tightening securely.

11. Reinstall one piece rubber weatherstrip in groove around outside of frame, using a putty knife to force bead of weatherstrip into frame groove. Be careful not to stretch rubber as it is being inserted or weatherstrip will buckle and permit leakage around windshield. Brushing frame groove with soap solution or rubbing with paraffin will facilitate assembly.

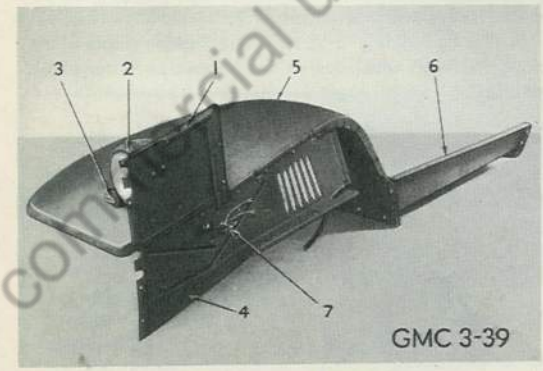


Fig. 6 Front Fender Sub-Assembly

1. Hood Extension
2. Head Lamp
3. Black-out Lamp
4. Fender Skirt
5. Fender
6. Running Board
7. Head Lamp Wiring Harness

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1. Fender—R.H.
2. Hood Panel Extension
3. Fender Reinforcement
4. Hood Side Panel
5. Running Board—R.H.
6. Fender Skirt—R.H.
7. Hood Assembly
8. Radiator Tie-Rod
9. Front Bumper
10. Brush Guard
11. Running Board—L. H.
12. Fender Skirt—L.H.
13. Fender Reinforcement
14. Hood Panel Extension
15. Hood Side Panel
16. Fender—L.H.
17. Anti-Squeak
18. Anti-Squeak

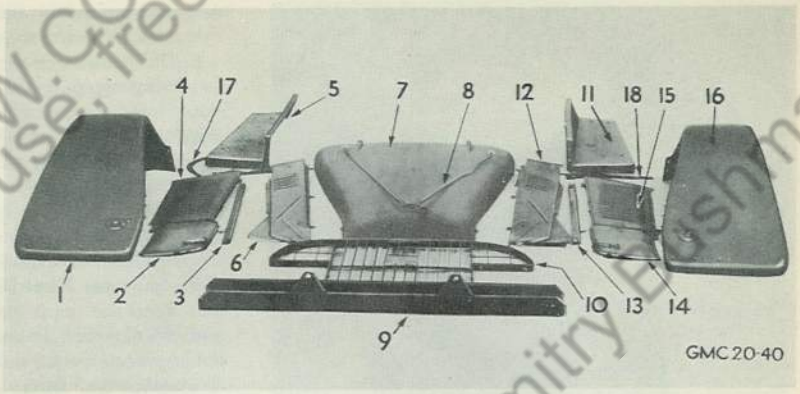

Fig. 7 Front End Sheet Metal Disassembled

12. Install windshield in cab opening. Replace hinge screws and adjusting arm screws. Be sure to install rubber washers correctly under adjusting arm screws.

11. WINDSHIELD WIPERS

Wipers are vacuum type. Vacuum is furnished by engine intake manifold through tubing between manifold fitting and wiper motors. Wiper motors, Fig. 9, are mounted in roof crown panel above right and left sections of windshield. Access to motors is by removing small trim panels attached to interior header panel by screws.

Controls consist of individual push-pull buttons at wiper motors above windshield. Wiper speed is not adjustable.

Wiper motors are easily removed from vehicle but repair of units requires special tools as well as the proper kit of repair parts. The Trico Products Corp., Buffalo, N. Y., manufacture wipers used in vehicles covered in this manual. Their "Tool Assortment Box," Sp. No. 1031-1-A contains all necessary tools, gauges and fixtures as well as detailed instruction sheets for proper repair of wipers. Trico "Wiper Motor Repair Kit" Sp. No. 1065-2-A contains all parts usually required when disassembling and repairing inoperative motors.

A. To Remove Wiper Motors—

1. From inside cab, take out screws and remove access panel covering wiper motor, Fig. 9.
2. Disconnect vacuum line so motor can be removed.
3. From outside vehicle, unscrew nut on motor shaft which attaches wiper arm and remove arm.
4. From outside vehicle, remove retainer nut, washer and spacer from motor shaft. Then pull motor shaft out of hole in crown panel from inside vehicle.

B. To Repair Wiper Motors—

1. If inspection prior to removal disclosed broken valve parts, replace broken parts, clean remaining parts and lubricate sliding valve with special oil included in special tool kit.
2. Attach wiper to a suction line, turn on and check action. Check pull of paddle piston in each direction by holding motor shaft against the pull. Listen for leakage. If leak occurs during stroke in both directions, trouble is still in valve mechanism.
3. After valve is disassembled, cleaned, reassembled and operation checked and further loss of power still exists in motor, paddle piston must be at fault.
4. Disassemble motor, removing cover, paddle and all valve mechanism parts as well as gaskets.
5. Repair operations from this point should closely follow instructions included with "Special Tool Kit" as described above.

C. To Install Wiper Motors—

After necessary new parts are installed, motor assembled and operation checked, installation in vehicle is easily made by reversing procedure outlined in steps 1 through 4 above under "To Remove Wiper Motors."

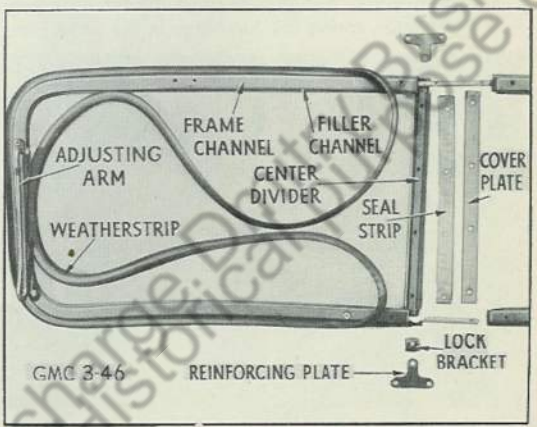

Fig. 8 Windshield Partially Disassembled

CAB AND BODY



Fig. 9 Windshield Wiper Access Cover Removed

12. DOOR ALIGNMENT

Two conditions of door misalignment must be considered: First, the fit of the door in the cab opening; and second, the fit of the door panel flange against the cab.

A. Improper Fit of Door in Cab Opening—This condition is evidenced when wedge plate on door fails to center in door bumpers as door is closed. A practical use of procedure below should correct condition:

1. Be sure that a sprung or warped condition of door has not been mistaken for poor fit of door in cab opening.
2. Run the door window all the way down to prevent glass breakage before making any adjustment.
3. To move door wedge plate **up** to center properly in door bumper, place a tool handle or small wood block between the halves of the bottom hinge and close door enough to slightly spring the hinge. Refer to Fig. 10.
4. Try closing the door without the block and repeat process if necessary.
5. To move door wedge plate **down** to center properly in door bumper, spring the top hinge in the same manner. This procedure also moves latch edge of door and cab latch pillar closer together.
6. If necessary to move door closer to cab hinge pillar at bottom put a "C" clamp on bottom hinge with door closed, Fig. 10. Open door enough to spring hinge slightly. Use "C" clamp on top hinge in same manner to move top of door closer to cab hinge pillar.
7. Remove the clamp and try opening and closing the door. Repeat operations as necessary.
8. Tighten hinge screws and try the door several times to be sure operation is satisfactory.

B. Improper Fit of Door Panel Flange Against Cab—This condition must be corrected by use of a door straightener tool. Improper fit can be determined by holding door handle down, closing door gently and observing how well flange around edge of door fits against cab. A door contour "bowed" excessively will be difficult to latch. A door contour not "bowed" enough will cause a gap between door flange and cab at top or bottom, or both.

A special door straightener tool should be obtained and used by a competent body repair man whenever it is necessary to straighten a sprung or warped door.

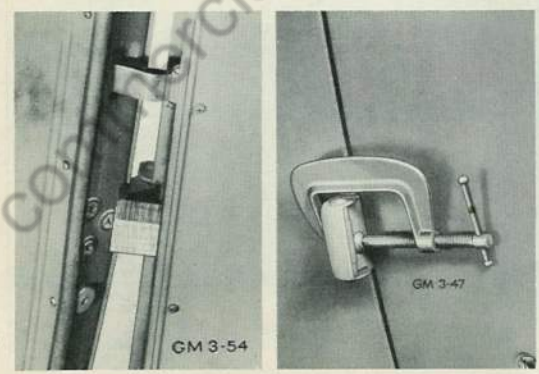

Fig. 10 Use of Wood Block and "C" Clamp to Align Door

13. DOOR WINDOW GLASS

Door window glass is raised or lowered by a crank operated gear and sector regulator, Fig. 11. Glass is set in a metal frame which provides support and freedom from looseness and rattles. A rubber filler strip is fitted between glass and frame. Frame lower channel is attached to "U" shaped section of frame with sleeve nuts and screws. Lugs on bar of regulator fit into lower channel groove and connect glass to regulator. Refer to Fig. 12.

A. To Remove Glass From Door—

1. Take out attaching screws and pry off regulator crank and door latch handle.
2. Remove screws and lift off door inside trim panel.
3. Replace regulator handle on shaft and lower window glass part way.
4. Remove garnish moulding at top rear corner of door after removing screws and clip at top center.
5. Pry metal tongues which clamp lower ends of run channel outward to free ends of channel. Screws spaced at intervals around opening and located in groove of run channel should be removed next.
6. Pull run channel away from door at top and upward to slide it out between door and glass.
7. After run channel is removed, raise glass as top is tipped away from door to disengage lugs of regulator bar from glass lower channel, Fig. 13. Then pull glass and frame out of door.

B. To Install Door Glass—

1. Disconnect lower channel of glass frame from "U" shaped section of frame by removing screw and sleeve nut from each end.
2. Pull sections of frame apart, remove rubber filler strip and broken glass and clean frame channels thor-

oughly. Brush inside of channels with soap solution or rub with paraffin to facilitate glass installation.

3. Install new glass in lower frame channel first. Lay glass on flat surface of bench with top edge against suitable stops and lower edge of glass protruding beyond edge of bench. Place rubber filler strip on edge of glass and press lower channel squarely on glass with rubber between. Trim off surplus rubber filler flush with channel. Do not press glass into channel—always press channel on glass.

4. Place frame rubber channel over top and side edges of glass and make sure it is well seated, particularly at corners.

5. Install "U" shaped section of metal frame over glass and rubber channel, pressing it on with the hands, and driving it into position, using light, firm taps with hard rubber hammer.

6. With metal frame properly installed, holes in frame will line up with holes in lower channel and screws and sleeve nuts can be inserted and tightened securely.

7. Install completed assembly in window opening, tilting into position to engage regulator bar lugs.

8. Lower glass part way, slide run channel back in between door and glass frame, install run channel screws and bend metal tongues against ends of run channel.

9. Install top corner garnish moulding and joint clip.

10. Install door inside trim panel, regulator crank and door latch handle. This completes installation. Try raising and lowering glass to be sure it operates freely.

14. WINDOW REGULATOR, DOOR LATCH AND REMOTE CONTROL

Crank operated gear and sector door window regulator, door latch and door latch remote control units are all attached to latch rail or panel under door trim panel. Rail is attached to door with screws at each end. Refer to Figs. 11 and 12. Latch rail can be removed and units attached to it replaced as follows:

1. Remove attaching screws and pry off regulator crank and door latch handle after lowering glass.

2. Remove screws and lift off door inside trim panel.

3. Remove screw from inner end of door latch outside handle and pull handle out of door and latch.

4. Take out screws at each end of latch rail and remove latch rail complete with window regulator, door latch and remote control.

5. Remove screws attaching regulator and latch to rail, disconnect remote control link and remove units.

6. Remote control unit is assembled to rail by peening over a metal flange. To replace unit it is first necessary to cut away peened flange to remove old control.

7. To install new remote control unit place in position in latch rail, support unit on suitable metal support and peen flange, using special driver (CS-1190), Fig. 14.

8. Install new regulator unit in position shown in Fig. 11 by attaching with screws.

9. Connect remote control link and install door latch

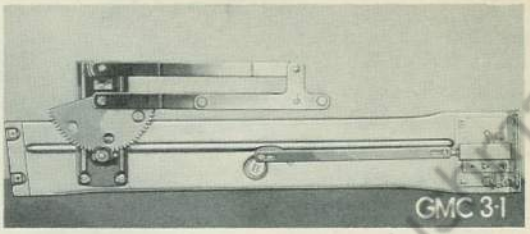

Fig. 11 Window Regulator, Remote Control and Door Latch on Latch Rail

on end of latch rail as shown in Fig. 11 by attaching screws.

10. Install rail assembly on door. Be sure to engage regulator lugs in glass lower channel before installing and tightening screws.

11. Assemble door latch outer handle, inner trim panel, regulator crank and door latch inner handle.

12. Try regulator and door latch to be sure they operate properly.

15. REAR GLASS AND GUARD

A heavy wire mesh guard is installed outside cab over rear glass to protect it from breakage. Rear glass is installed, using a special "insert" type rubber seal.

A. To Remove Rear Glass—

1. Remove guard and rubber spacers (between guard clips and cab) after removing attaching screws.

2. Raise one end of insert out of retainer seal groove with pointed tool. Then pull insert out by hand.

3. Push glass outward from inside vehicle. An assistant outside vehicle should prevent glass falling and breaking.

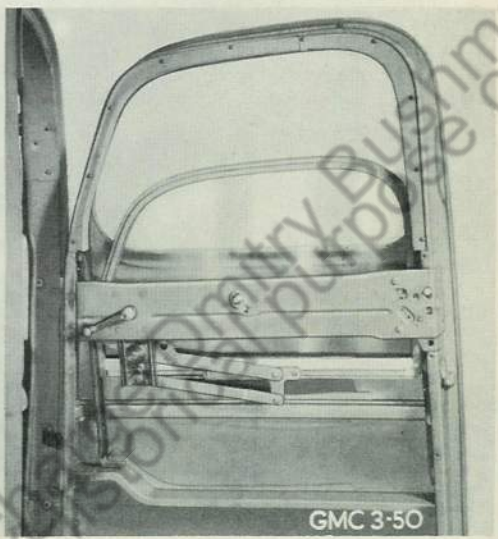

Fig. 12 Latch Rail Installed on Door

CAB AND BODY



Fig. 13 Removing Glass and Frame From Door

4. Retainer seal will remain on panel as glass is removed. Pull seal off by hand.

B. To Install Rear Glass—

1. Cut new glass to provide $\frac{3}{32}$" clearance between glass and panel cutout on all sides. Use template to assure cutting glass to correct size. Old glass, if not too badly shattered, may be used as a template.

2. Straighten panel flange around opening to assure a good fit in retainer seal groove.

3. Install retainer seal over edge of panel. Push into position in corners. Ends of seal should come together at side of opening near top.

4. Cut off retainer seal ends, allowing sufficient overlap to secure a tight joint. Rubber cement ends and carefully butt into position.

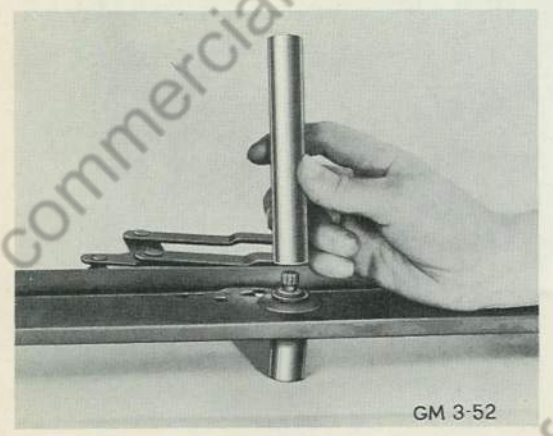

Fig. 14 Peening Door Latch Remote Control

5. Brush retainer seal, particularly groove into which glass fits, with soap solution to facilitate glass installation.

6. Install glass in retainer seal, using special handle and hook (CS-1154-E). Rubber insert is not yet installed in retainer seal. Apply tool end in seal groove and move tool along edge of glass, Fig. 15. Outer lip of seal will be forced over glass.

7. Insert end of required length of rubber insert through special handle and loop (CS-1154-A). At point opposite retainer seal joint, push tool loop and end of insert into seal groove. Use hitching motion to spread seal groove and feed rubber insert into groove, Fig. 15, proceeding all the way around retainer seal. This method prevents excessive elongation of insert as it is fed into seal groove.

8. Cut off insert allowing overlap and butt ends tightly into groove.

9. Install guard, using rubber spacers under clips and tighten attaching screws.

16. FLOOR BOARDS AND MATS

Floor mat is one-piece rubber with jute pad backing. Mat is held in position on floor by fasteners which are attached to floor and fit through holes in mat. The floor board consists of four parts: flat section next to seat; toe board in two sections, to fit around steering column and pedals; and seal plate which clamps felt seal at pedal and steering column. All parts are held in place with screws, Fig. 16.

A. To Remove Floor Mat and Boards—

1. Pull floor mat loose from all fasteners and lift off over pedals, shift levers, etc. Be careful not to tear mat.

2. Remove all screws holding down floor boards and remove sections one at a time. Seal plate should be the first section removed.

B. To Install Floor Boards and Mat—

1. Position sections of floor board in floor platform and install attaching screws.

2. Install seal plate to clamp felt seal at pedals and attach with screws.

3. Insert control pedals through proper slits in floor mat and spread mat squarely and smoothly over floor boards. Then push mat down over fasteners which hold it in place.

17. EXTERIOR AND INTERIOR PANELS

Exterior panels are of steel as are most of the interior trim panels. Interior panels are removable in convenient sections.

A. Exterior Panels—As exterior panels are welded to cab structural members, replacement or repair should be attempted only by competent craftsmen with proper tools and equipment. To maintain structural strength, damaged posts and sills should be replaced with new parts.

CAB AND BODY

B. Interior Panels—Interior panels are of steel and fibre board. Panels are attached with metal moulding strips, put on with self-tapping screws or attached with self-tapping screws and suitable retaining washers. Damaged panels are easily removed and replaced in convenient sections.

C. Self-Tapping Screws—To avoid stripping threads, do not over-tighten self-tapping screws. If threads are stripped, use existing holes and employ next larger size self-tapping screw.

18. SEATS AND UPHOLSTERY

Two-piece cab seat consists of a seat cushion and a seat back. Seat cushion is adjustable by raising front edge and sliding backward or forward. Holes on underside of cushion fit down over pins in seat support to locate cushion in different positions. Upholstery is olive drab whip cord. Any reputable fabric cleaner used according to manufacturer's directions should be satisfactory for cleaning upholstery.

A. To Remove Seat—

1. Raise front edge of seat cushion, slide forward and then lift endwise through cab door.
2. Remove bolts at bottom edge near each end of seat back which attach back to cab.
3. Raise seat back from the bottom to disengage tongue supports at top edge of seat back.
4. Lift seat back out through cab door.

B. To Install Seat—

1. Put seat back in cab through door and hang by tongue supports. Tongue clips on seat back frame must fit into slots in brackets mounted on cab.
2. Install bolts at bottom of seat back near each end.
3. Put seat cushion in cab and position on seat support. Be sure pins in seat support engage correct holes in underside of seat cushion to provide proper adjustment.

19. COWL VENTILATOR

A door type ventilator opening upward is provided in cowl ahead of windshield. Regulation is by a hand lever beneath instrument panel in cab.

Ventilator is easily removed by taking out installation bolts and screws accessible behind instrument panel. Unit requires no maintenance. If water leakage should occur around ventilator door in closed position, a new rubber seal strip can be installed. Open ventilator, pull out old seal strip, clean groove and cement a new seal strip in groove.

20. EXTERIOR AND INTERIOR FINISH

Bodies should be washed regularly to remove road film of dirt and grime which accumulates and, in time, may result in damage to the surface. The finish can be protected against action of the elements for longer periods of time by applying a coating of lusterless wax or some other suitable protective coating.

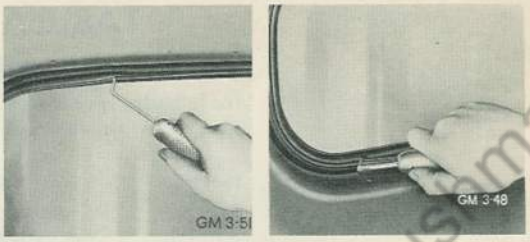

Fig. 15 Installing Rear Glass and Seal Insert Using Special Tools

A. Repainting—When more than one coat is necessary there are two methods recommended for applying.

First and quicker method is to apply second coat about five minutes after first coat. There should be no appreciable interval for air drying in this method.

Second method requires more time, but is more satisfactory. When using this method, first coat should be allowed to air-dry for four hours before applying second coat. Second coat should be dried overnight.

B. Effect of Anti-Freeze—Alcohol or anti-freeze solutions spilled on exterior finish, should be washed off immediately or flushed off with plenty of water, or it may cause dullness or stains which cannot be removed.

C. Paint Color—Available standard color and specifications as follows:

1. Color—Olive Drab, Flat.
2. Specification—Dupont No. 1071-050.



Fig. 16 Floor Boards Installed

CAB AND BODY

TABULATED DATA

21. TOOL EQUIPMENT

The following special tools, or their equivalent, are recommended for use when servicing CAB AND BODY.

Tool No.	Name	Supplier Code
1031-I-A	Windshield Wiper Tool Kit	TP
CS-1190	Door Latch Remote Control Peening Tool	CS
CS-1154-A	Rear Window Seal Handle and Loop	CS
CS-1154-E	Rear Window Seal Handle and Hook	CS

TOOL SUPPLIER

Supplier Code	Name	Address
CS	Curtiss and Smith Manufacturing Corp.	Pottstown, Penn.
TP	Trico Products	Buffalo, N. Y.

SERVICE BULLETIN REFERENCE

Bulletin No.	Description

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Group 19—Winch

	Paragraph
GENERAL	
Description and Operation	1
Trouble Shooting and General Solutions	2
Inspection	3
Adjustment	4
REMOVAL AND INSTALLATION	
To Remove Winch From Truck	5
To Install Winch on Truck	6
REPAIR	
To Disassemble Winch	7
Inspection at Disassembly	8
To Assemble Winch	9
Propeller Shaft	10
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To Assemble and Disassemble Universal Joints	13
Winch and Propeller Shaft Lubrication	14
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GENERAL

1. DESCRIPTION and OPERATION

Winch is jaw type and is mounted at front end of vehicle ahead of radiator. Power operation is provided through power take-off unit mounted on left hand side of transmission and is connected to winch with propeller shaft, as shown in Fig. 1.

Winch is operated by power take-off control lever located in driver's cab—specific instructions for operating the winch are given in Driver's Instructions group of this booklet. **Caution** worth repeating here however should always be observed—keep winch control lever **locked** at all times except when in use. A hasp lock on floor of cab is provided for this purpose which prevents kicking or jarring winch into gear accidentally.

The major parts of the winch and how they operate, are:

A. Worm Shaft (Refer to Fig. 2)—Worm shaft (1) operates worm gear (2) keyed to drum shaft (3). Worm shaft is supported at each end by single row ball bearing. Bearings are held in place in gear case (4) by bearing caps which are also fitted with oil seals. Front end of worm shaft also supports automatic brake disc (5).

B. Worm Gear and Drum Shaft (Refer to Fig. 2)—Worm gear (2) is keyed to drum shaft (3) with two keys and is driven by worm shaft (1). Drum shaft is supported at three points by two bushings, between gear case cover (6) and gear case (4), and one in end frame (7).

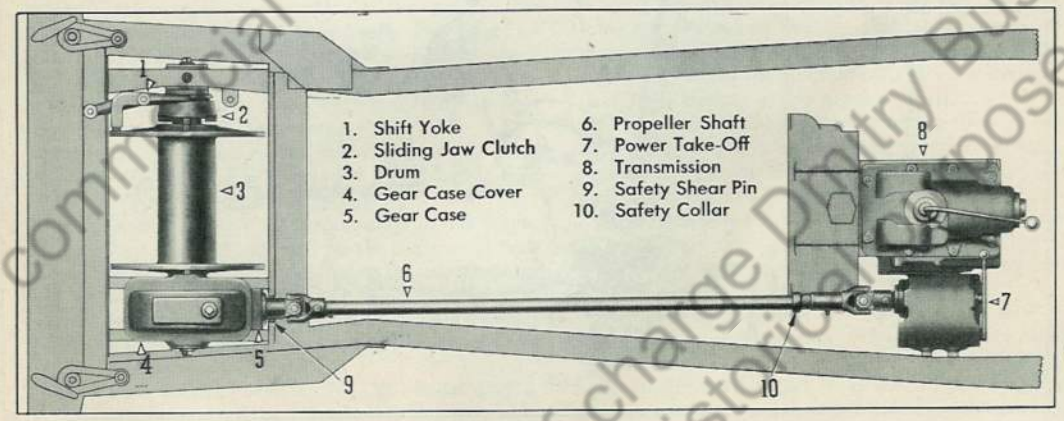

Fig. 1 Winch and Power Take-off Installation

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WINCH

1. Worm Shaft
2. Worm Gear
3. Drum Shaft
4. Gear Case
5. Automatic Brake Disc
6. Gear Case Cover
7. End Frame
8. Drum
9. Sliding Clutch
10. Automatic Brake Cover
11. Roller Shaft
12. Roller
13. Front Base Angle
14. Rear Base Angle
15. Drum Shaft End Washer
16. Drum Shaft End Washer Shims
17. Shift Yoke Pin
18. Drag Brake
19. Shift Yoke
20. Thrust Ring
21. Automatic Brake Band
22. Front Bearing Cap
23. Rear Bearing Cap
24. Front Bearing Cap Oil Seal
25. Rear Bearing Cap Oil Seal
26. Worm Shaft Front Bearing
27. Worm Shaft Rear Bearing
28. Drum Shaft Outer Bushing
29. End Frame Sleeve
30. Sliding Clutch to Drum Shaft Key
31. Cable Guard
32. Cable
33. Cable Pulley
34. Chain
35. Drum Shaft Inner Bushing
36. Worm Gear Key
37. Drum Bushing
38. Roller Bushing
39. Roller Shaft Nut
40. Automatic Brake Band Adj. Spring
41. Spring Ferrule
42. Adjusting Nut
43. Brake Disc Retaining Washer
44. Front Bearing Cap Gasket
45. Worm Shaft to Brake Disc Key
46. Rear Bearing Cap Gasket
47. Gear Case Gasket
48. Gear Case Filler Plug
49. Gear Case Drain Plug
50. Propeller Shaft Universal Joint
51. Propeller Shaft Key
52. Propeller Shaft
53. Propeller Shaft Yoke
54. Propeller Shaft Journal
55. Power Take-Off Yoke
56. Journal Bearings
57. Journal Bearing Snap Ring
58. Shift Yoke Handle
59. End Frame to Base Angle Bolt
60. Drum Shaft End Screw
61. Shift Handle Poppet
62. Shift Handle Poppet Spring
63. Drag Brake Tension Bolt
64. Drag Brake Tension Spring
65. Drag Brake Tension Washers
66. Drag Brake Tension Lock Nut
67. Cable Guard to Base Angle Bolt
68. Brake Disc to Worm Shaft Bolt
69. Front Bearing Cap Bolt
70. Rear Bearing Cap Bolt
71. Gear Case Bolt
72. Universal Joint to Worm Shaft Shear Pin
73. Propeller Shaft Safety Collar
74. Thrust Washer

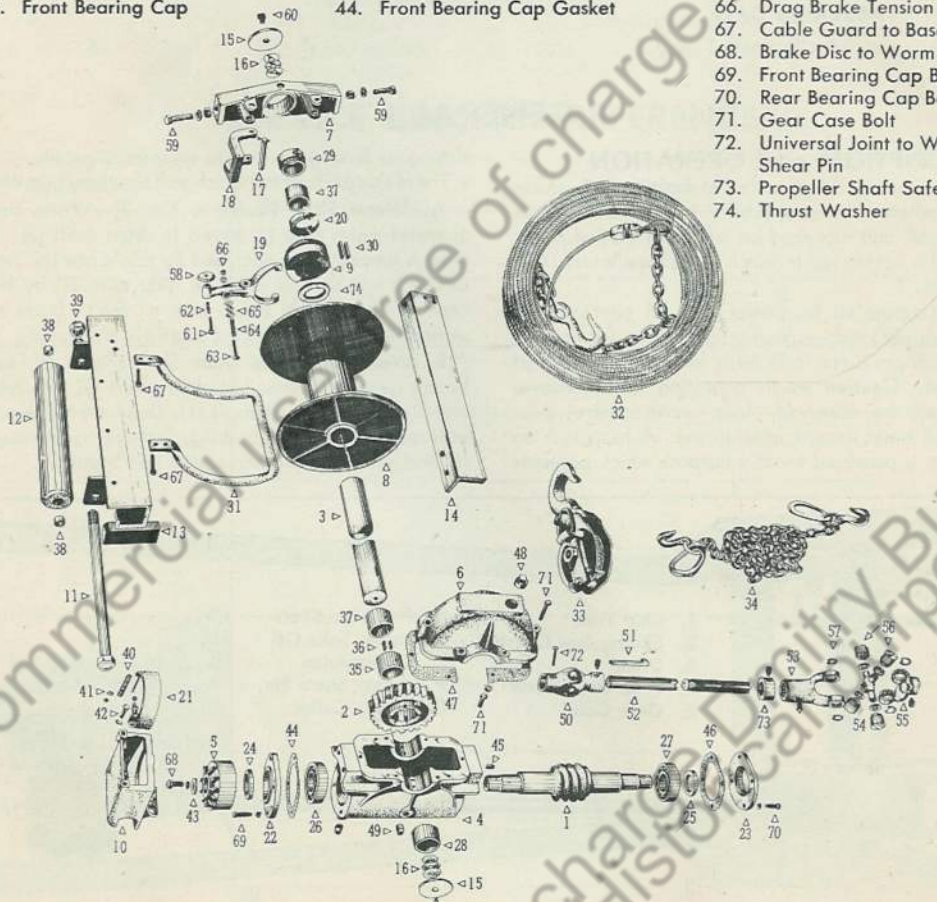

Fig. 2 Disassembled View of Winch

WINCH

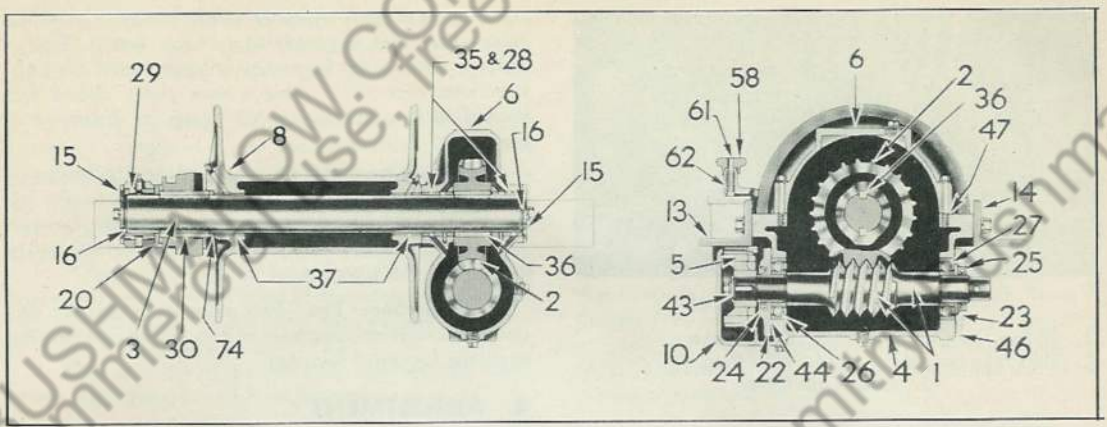

Fig. 3—Sectional View of Drum and Driving Worm

C. Drum (Refer to Fig. 2)—Drum (8) is supported by drum shaft (3) and is fitted with bronze bushings at each end where shaft supports drum. Drum is driven through shaft (3) to which is keyed a hand operated sliding clutch (9). Whenever clutch engages drum, power is transmitted through sliding clutch to drum. Disengagement of clutch allows drum to turn freely on shaft.

D. Sliding Jaw Clutch—Connection between drum shaft and cable winding drum is by means of a sliding jaw clutch sliding on feather keys on drum shaft and meshing with fixed jaws on drum hub.

Jaw clutch should be engaged at all times (except when pulling cable off drum by hand) to prevent cable and chain sagging and eventually falling to ground where it may cause serious damage.

E. Drag Brake on Drum Flange—The object of this brake (18, Fig. 2) is to keep drum from spinning or "overrunning" when cable is being pulled from drum by hand, and is in use only when jaw clutch is **Disengaged.** For proper adjustment see paragraph 4 in this group.

F. Automatic Brake on Worm Shaft—The object of this brake is to prevent load from overhauling worm gearing or in other words, to hold load at any position that winch has placed it, when winch is shifted into neutral or after safety pin has sheared.

Brake consists essentially of brake band (21, Fig. 2) around brake disc (5, Fig. 2) keyed to worm shaft (1, Fig. 2) and operates entirely automatically.

For proper adjustment see paragraph 4 in this group.

Brake lining used in automatic brake is a special type developed especially for this purpose. **Do not substitute non genuine brake lining: Genuine lining has been designed especially for winch operation. When relining brake be sure ends are on same side of brake cover as before disassembly.**

G. Cable Roller (Refer to Fig. 2)—Roller (12) is mounted in winch front base angle (13) to keep cable from rubbing on bumper when winch is pulling. Cable should always run **under** roller, and not over top of bumper. Running cable over top of bumper will quickly wear or cut cable and render it unfit for further use. Frayed cables are extremely dangerous and should be replaced immediately.

2. TROUBLE SHOOTING AND GENERAL SOLUTIONS

A. Winch Fails to Operate—If, upon following the instructions on use of winch as given in "Driver's Instructions" group, winch fails to operate, check for:

1. Shear pin sheared off. Spare shear pins are carried in package compartment. Install new pin and secure in position with new cotter pin.

2. Winch clutch in disengaged position. Engage clutch fork with winch drum as described and illustrated in "Driver's Instructions" group.

B. Winch Fails to Hold Load—The automatic brake in winch housing is designed to hold load when power take-off is in neutral position or in event shear pin is sheared off. Should winch fail to hold load under these conditions, adjust the automatic brake as described under "Adjustments" in this group.

C. Excessive Heat at Worm Housing—This is usually caused by automatic brake being adjusted too tight or use of improper brake lining. Follow instructions given under "Adjustments" in this group.

D. Winch Drum Spins—In event winch drum revolves too fast when cable is being pulled off, drag brake requires adjustment. Follow the instructions given under "Adjustment" in this group.

E. Noisy Operation—

1. Insufficient lubrication. Fill worm housing to level plug on side of housing.

2. Insufficient lubrication at winch shaft and drum. Lubricate through pressure fittings—one fitting at drum shaft and one at each side of winch drum.

WINCH

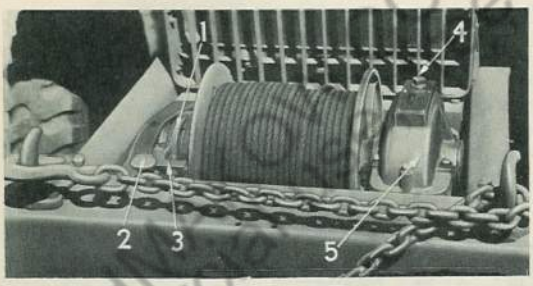

Fig. 4—General View of Winch

1. Sliding Jaw Clutch
2. Shift Yoke Handle
3. Drag Brake
4. Filler Plug
5. Gear Case Cover

3. INSPECTION

The design and rugged construction of this winch are such that only reasonable care is required to keep it in first class working condition at all times. To obtain best results, lubricate this unit at regular intervals and perform the following inspections periodically.

A. Oil in Gear Case—Observe quantity and condition of oil in gear case following severe operation. Keep filled to level of plug in side of case. If oil shows any evidence of failure, drain and refill with new oil.

B. Winch Cable—Should be kept in best of condition—inspect for:

1. Frayed Cable—This is definitely a serious safety hazard. A frayed cable should be immediately replaced with a new one, or one in good condition.

2. Rusted Cable—The application of engine oil on cable will prevent it from rusting—use sparingly.

3. Wind Cable Evenly on Drum—Cable should not be wound on drum in a manner permitting it to wedge. Wind on drum evenly from side to side with same drag or tension on cable as described in Driver's Instruction group of this book.

4. Cable Chain—Another safety hazard is a winch cable chain that is permitted to hang freely. Serious damage could result from chain snagging onto road obstructions, rocks, etc. Always have chain looped and hooked to tow hooks when not in use, as illustrated in Fig. 4.

C. Automatic Brake—This brake is in gear case and holds load in required position. When using winch, observe action of brake to be sure it does not become overheated. Usually, overheating is indication that new brake lining should be installed.

D. Safety Shear Pins—Two spare shear pins are carried in package compartment of cab. Make sure they are available for use if required.

4. ADJUSTMENT

These adjustment instructions have to do with operating the winch—not mechanical adjustments required when overhauling or making repairs and replacements. Only two operation adjustments are necessary and these are made as follows:

A. Drum Adjustment—This adjustment is provided in order to regulate speed at which drum revolves and is to prevent spinning or over-running when cable is being pulled from drum by hand—much in the same manner fishing reels are adjusted to prevent back-lash. The adjustment point is illustrated in Fig. 5 and is made as follows:

1. Move shift yoke handle as far to the right as it will go, thus completely freeing drag brake from side of drum flange.

2. Use screw driver or similar wedge between drag brake and head of tension bolt and pry bolt away from brake—this will move bolt sufficiently to get wrenches on the lock nut and adjusting nut at other end of bolt.

3. While holding adjusting nut with wrench, back off lock nut. Turn up adjusting nut one full turn, remove



Fig. 5 Winch Drum Adjustment

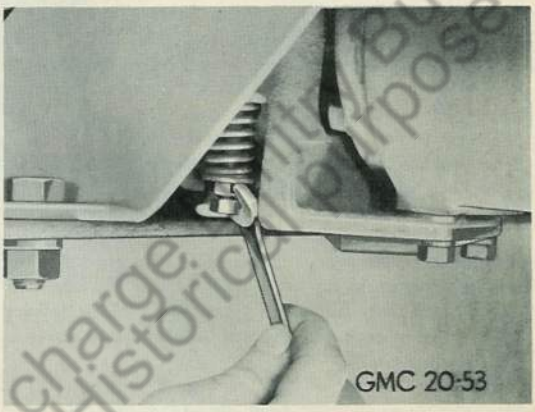

Fig. 6 Winch Automatic Brake Adjustment

wedge and determine if sufficient brake has been obtained; if it has not, repeat the process. Complete the adjustment by turning lock nut up tight against adjusting nut.

B. Automatic Brake Adjustment—The object of this brake is to hold load in any desired position when winch is shifted into neutral—also, to hold load in event safety pin is sheared. This brake is inclosed in a cover at end of winch gear case and is adjusted as shown in Fig. 6 and in the following manner:

1. Adjusting bolt is accessible from the under side of brake cover near lower flange of front bumper. Back off lock nut, then tighten adjusting nut one-half turn, then set lock nut up tight to adjusting nut.

2. One method of determining whether this brake needs adjustment or not is as follows:

Place a winch-equipped truck at the top of a steep grade. Fasten winch cable to another truck at bottom of grade and start pulling truck up grade, using winch only. After a short haul depress engine clutch pedal. Winch will stop pulling and truck being pulled should not roll backward. In the event brake does not hold, tighten adjusting nut as described above. SET CHECK NUT UP TIGHT and repeat test and adjustment until brake is properly adjusted. **Caution:** Brake may heat up even though it is properly adjusted; however, if hand cannot be held on brake cover on account of heat, this indicates that brake is too tight and should be loosened. Brake is designed to hold load while shifting and, if properly adjusted, will not become hot. If above procedure will not give desired results, it is evident that brake should be relined or replaced.

REMOVAL AND INSTALLATION

5. TO REMOVE WINCH FROM TRUCK

1. Disconnect winch propeller shaft but do not remove it. At forward end, merely remove shear pin as indicated in Fig. 7. At opposite end, safety collar, which is illustrated in Fig. 8, is held in position with a set screw—loosen this screw and slide lock ring away from slip joint. Now, both ends of shaft are free—entire propeller shaft should be shoved back toward power take-off until yoke on forward end clears winch worm shaft—front end of propeller shaft should be temporarily supported rather than allowed to hang down.

2. With propeller shaft disconnected, block up or use chain fall to support winch. Remove front tow hooks and then remove front bumper mounting bolts and take off bumper.

3. Disconnect and remove bolts which mount winch to frame side rails—winch is then entirely free and may be moved forward and out of vehicle.

6. TO INSTALL WINCH IN TRUCK

1. Locate winch in proper position for mounting and install mounting bolts and nuts and use new lockwashers. Tighten securely to provide rigid installation.

2. Reinstall front bumper and tow hooks.

3. Reconnect propeller shaft by discarding wire or whatever was used to temporarily support it. Slide entire propeller shaft forward, being careful to line up hole in yoke with hole in winch worm shaft. Install new shear pin at this point and use new cotter pin to secure it—thus completing the hook-up at forward end of shaft.

4. Now, at rear, or power take-off end of shaft, only one operation is necessary, but MUST be performed properly, and that is positioning the safety collar. This collar must be located correctly—proper measurement between edge of collar and slip joint is shown in Fig. 8. Measure carefully, then turn down set screw in collar.

5. The mechanics of installing winch are given completely in foregoing instructions. However, installation should not be considered complete until the two adjustments to winch are made as called for under the heading "Adjustment," as well as to see that lubricant is to proper level in winch worm housing.

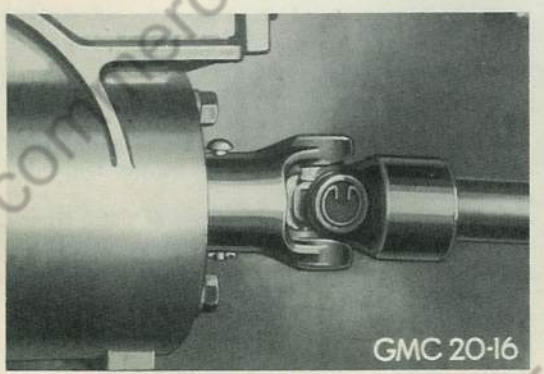

Fig. 7 Winch Shear Pin

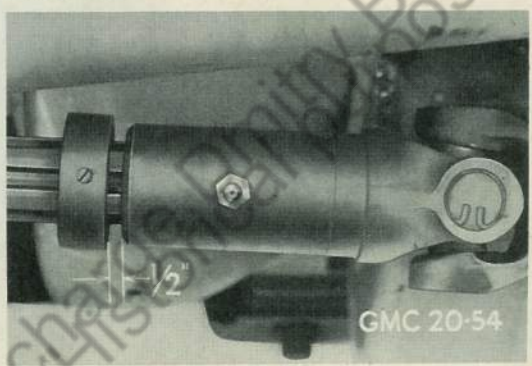

Fig. 8 Winch Safety Collar

WINCH

REPAIR

7. TO DISASSEMBLE WINCH

No special tools or fixtures are required. Refer to Fig. 2 and follow these instructions:

1. Remove cotter pin and nut from end of roller shaft (11)—withdraw roller shaft and remove roller (12).
2. Remove cap screws which mount base angles (13 and 14) and remove these parts.
3. Remove screws at each end of drum shaft (3) as well as end washers (15) and shims (16).
4. Remove cotter pin from clutch yoke pin (17) and drive out pin. End frame (7), drag brake (18), thrust ring (20), shift yoke (19) and clutch (9) can now be removed from drum shaft.
5. With chisel, remove keys (30) on which sliding clutch bears, then pull drum (8) off shaft.
6. Drum shaft (3) with worm gear (2) can now be lifted from gear case.
7. Remove gear case bolts (71) and lift off gear case cover (6).
8. Remove worm gear (2) from drum shaft (3), if necessary, in arbor press.
9. Remove brake cover (10) with automatic brake band (21) from front end of gear case (4).
10. Remove adjusting nuts and anchor nut from brake band (21) and remove brake band from cover (10).
11. Remove cap screw and washer from end of worm shaft (1) and remove brake disc (5) with suitable puller.
12. Remove bearing cap (22 and 23) and oil seal (24 and 25) assemblies from each end of worm shaft (1).
13. Pull worm shaft towards front to remove from gear case (4) which also removes front bearing (26).
14. Rear bearing (27) can be slipped off worm shaft after removal.

8. INSPECTION AT DISASSEMBLY

When winch is disassembled, all parts should be carefully inspected for wear and replacements made where necessary. Clean all parts carefully in gasoline or other cleaning fluid and blow dry with compressed air. Points to observe are:

1. Bearings should be given more than a cursory cleaning. After bearings have been soaked in gasoline, tap them lightly against wooden block to dislodge any solid particles. Slush them again in clean gasoline and blow dry with compressed air. Do not spin bearings with air, revolve them slowly in races with fingers as air is directed at right angles to bearing. Examine races and balls for pits or flat spots, then oil each bearing assembly with clean engine oil.
2. Lubricant grooves and passages in bushings should be thoroughly cleaned and bushings inspected for evidence of excessive wear.
3. Drilled lubricant passages in gear case cover and gear case, also in each end of drum and end frame, should be cleaned thoroughly and inspected to be sure that passage in bushing indexes with lubrication fitting passages.
4. Inspect worm and worm gear for evidence of cracked or chipped teeth, or spots where case hardening is worn through, rendering gears unfit for further use.
5. Oil seals, at each end of worm shaft, should be carefully inspected and replaced if slightest evidence of wear is apparent.

9. TO ASSEMBLE WINCH

Refer to Fig. 2 and proceed as follows:

1. Replace worm shaft front bearing (26) on worm shaft (1) and place shaft through front of gear case (4) installing gear bearing (27) as shaft is pushed into place. Bearings require no adjustments.
2. Replace oil seals (24 and 25) in front and rear bearing caps (22 and 23) and install caps.

Caution: Use great care in replacing caps with oil seals as oil seals may be easily damaged if improperly pushed over shoulders of worm shaft.

3. Replace brake disc (5) at front of worm shaft (1) and install retaining washer, lockwasher and cap screws.
4. Replace brake band (21) in cover (10), leaving adjustment as loose as possible.
5. Replace cover and brake band assembly at front of gear case (4).
6. Replace gear (2) on drum shaft (3), if removed, using suitable press.
7. Replace inner bushing (35) on left-hand end of drum shaft (3), making sure lubricant holes index with those in cover (6) and gear case (4), also inspect dowel in gear case to make sure it has not been damaged.
8. Replace drum shaft outer bushing (28), using same precautions as given under item 7.
9. Replace drum shaft (3) and bushing assembly in gear case (4), making sure bushings fit on dowels and that lubricant holes index with those in gear case.
10. Replace gear case cover (6), using new gaskets.
11. Slide drum (8) into place on shaft (3) with clutch jaws towards right-hand side of vehicle.
12. Install clutch keys (30) in shaft, making sure keys are properly in place and in full depth.
13. Slide clutch (9) over keys in drum shaft, making certain clutch slides freely on keys. Replace thrust ring (20) on outer side of clutch.
14. Insert shift yoke (19) in groove of clutch (9) and slide end frame (7) with sleeve (29) installed, into place on drum shaft (3).
15. As support is moved into place, install drag brake (18) and shift yoke pin (17), using new cotter pins at each end of pin.
16. Replace drag brake tension bolt (63) spring (64) washers (65), and nuts (66).

17. Replace drum shaft washer shims (16), using same number of shims as removed at disassembly and drum shaft washers (15), tightening screws securely.

18. Replace front and rear base angles (13 and 14). Angles are secured to end frame and gear case by cap screws and bolts which should be drawn up tightly, using new lockwashers.

19. Install roller (12) and roller shaft (11) on front base angle (13), drawing nut up tight, using new cotter pin.

20. Lubricate, install and adjust according to instructions given elsewhere in this group.

10. PROPELLER SHAFT

Is solid type, having a fixed joint at winch end, and slip joint at power take-off end.

Fixed joint is held in place on winch worm shaft by use of a shear pin as illustrated in Fig. 7. Slip joint is held in position on power take-off shaft with key and set-screw.

This propeller shaft incorporates two very valuable safety features, each having a definite relation to the other. Feature No. 1 is the shear pin at forward end of shaft as shown in Fig. 7. Feature No. 2 is safety collar at opposite end of shaft as shown in Fig. 8.

1. SAFETY SHEAR PIN—Purpose of shear pin is to shear off in event of sudden jerks or over-loading of winch, thus preventing more serious damage occurring to winch or other parts. Two spare shear pins are provided with these vehicles and are placed in package compartment. **Caution:** Never use a substitute shear pin. The substitute may result in expensive replacement of parts.

(a) To Replace Shear Pin—Loosen set-screw in safety collar at other end of shaft and slide collar on shaft toward front of truck (see Fig. 8)—this will allow entire propeller shaft to be shoved back far enough to permit front yoke to come free and clear of winch worm shaft after shear pin is removed.

(b) Use drift to drive out old shear pin from worm shaft. Obtain new shear pin from spare carried in package compartment of cab. Coat inner diameter of yoke and outer surface of end of worm shaft with chassis grease to prevent yoke seizing to worm shaft Install by pulling propeller shaft forward, lining up hole in yoke with hole in worm shaft. Insert new shear pin and secure in place, using new cotter pin (see Fig. 7).

(c) Position safety collar ahead of slip joint properly (see Fig. 8), and secure in position by turning down set-screw.

(d) Order a new shear pin and place this spare in package compartment for use when needed.

2. SAFETY COLLAR—Purpose of safety collar is to prevent propeller shaft from sliding back into slip joint and causing front end of shaft to drop down when and if, shear pin is sheared off. This safety collar is held in position with a set-screw—proper position is between collar and slip joint yoke as shown in Fig. 8.

11. TO REMOVE PROPELLER SHAFT

Propeller shaft should be disconnected as described under "To Remove Winch From Truck"—except that shaft should be removed from vehicle rather than temporarily supported at front.

12. TO INSTALL PROPELLER SHAFT

1. If rear universal joint assembly has been removed, it should be the first replaced. Insert key in power take-off shaft. Position universal joint yoke so as to line up with key and press yoke onto shaft—then turn down set-screw in yoke firmly.

2. With safety collar slipped onto splined end of propeller shaft, slide shaft into slip joint Remaining instructions are same as given under "To Replace Shear Pin."

13. TO ASSEMBLE AND DISASSEMBLE UNIVERSAL JOINTS

Snap ring type universal joints used with winch propeller shaft ate the same type but smaller in size than the regular universal joints used to drive axles. Refer to Propeller Shaft group for instructions.

14. WINCH AND PROPELLER SHAFT LUBRICATION

The lubrication group of this book gives full information on the proper lubricants to use with these units—as well as telling where and how often it should be applied.

Winch gear case is provided with a filler plug, a level plug and a drain plug. Gear oil should be kept up to level plug at all times. For the other points on winch where pressure gun lubricant is required, a special adapter to facilitate lubricating is provided with each vehicle.

The propeller shaft has three pressure type lubrication fittings—one at each universal joint and one for the slip joint.

WINCH

TABULATED DATA

15. SPECIFICATIONS

Winch

When Gar Wood Is Used

Model	24-512
Number	22Y6225

When Heil Is Used

Model	125-G
Number	A-157-E3
Location	Front of Truck
Drive	From Power Take-off at Transmission

Propeller Shaft

When Gar Wood Is Used

Model	2U-512
Number	6Y-2105

When Heil Is Used

Model	125-G
Number	E-238-B

SERVICE BULLETIN REFERENCE

Bulletin No.	Description

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Group 20—Power Take-Off

	Paragraph
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Description and Operation	1
Trouble Shooting and General Solutions	2
Inspection and Adjustments	3
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GENERAL

1. DESCRIPTION AND OPERATION

Power take-off unit, illustrated in Fig. 1, is mounted on left-hand side of transmission and drives winch at front of truck through propeller shaft.

Power take-off is driven by transmission reverse idler gear. Shift lever is located on inside of cab within easy reach of driver and is fitted with a hasp lock as a protection against accidentally kicking or jarring into engagement. Power take-off has three engaged positions—low, reverse and high; also, two neutral positions are provided, one between low and reverse, other between reverse and high. Shift lever positions are shown in "Driver's Instructions"; also, on plate over cab windshield.

Referring again to Fig. 1, power take-off is driven by transmission; drive gear (7) is in constant mesh with transmission reverse idler gear, small end of high speed gear (13), and low speed gear (14). Power take-off drive shaft (27) is engaged whenever sliding gear (28) is meshed with gears on idler shaft (16) or drive gear (7).

When power take-off is engaged, sliding gear (28) supported by drive shaft (27) meshes with low speed gear (14) when in low forward position and with large end of high speed gear (13) when in high forward position. Reverse is accomplished by engaging sliding gear (28) with large end of drive gear (7).

2. TROUBLE SHOOTING AND GENERAL SOLUTIONS

Any operating difficulty occurring with power take-off would most likely be confined to noisy operation and shifting difficulties. Cause and remedy would be as follows:

A. Power Take-Off Noise—

1. Lubricant not of proper viscosity—or insufficient—
   Check quality and quantity of gear oil in transmission.
2. Water entering unit through rear oil seal when underside of vehicle is cleaned with high pressure hose—
   Replace oil seal.
3. Power take-off mounting nuts loose—
   Tighten.
4. Gears having excessive lash (wear)—
   Replace.

B. Hard to Shift Gears—

1. Lubricant too heavy—
   Drain transmission; fill with correct grade.
2. Clash ends of gear teeth burred—
   Replace.
3. Paint on shift rail—
   Remove paint.

3. INSPECTION AND ADJUSTMENTS

Power take-off construction is such that no adjustments are necessary. Stud nuts which hold power take-off to transmission should be inspected and tightened at regular intervals to insure proper meshing of drive gear and to prevent loss of lubricant. If there is any evidence of lubricant loss after nuts are tightened, gasket between transmission and power take-off should be replaced.

REMOVAL AND INSTALLATION

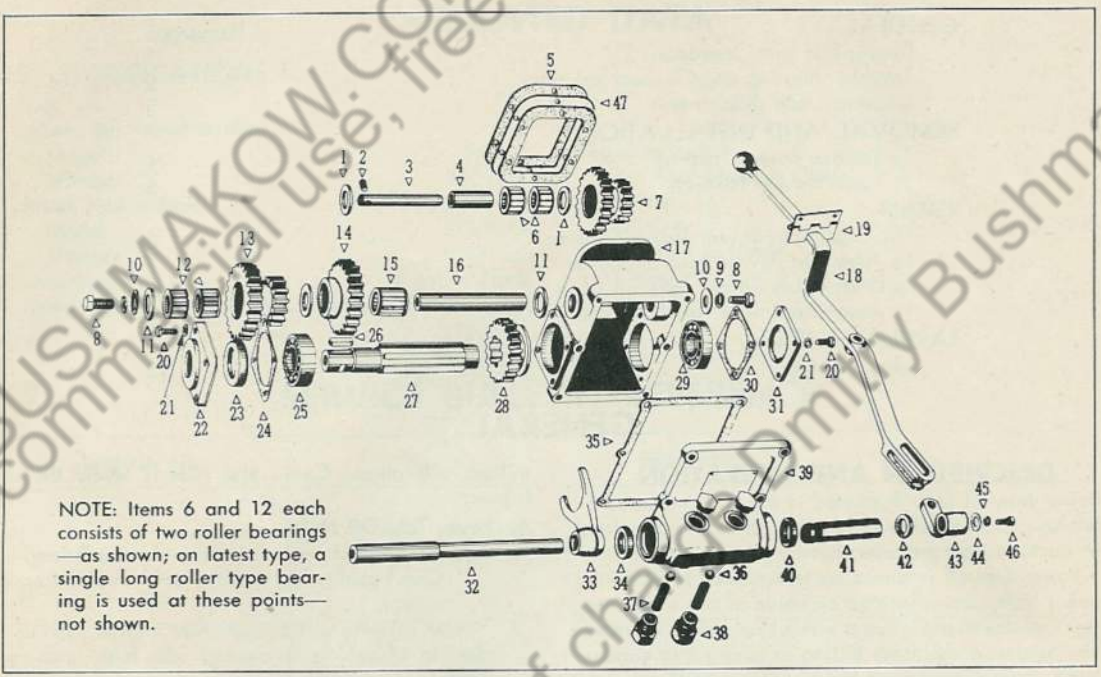
4. TO REMOVE POWER TAKE-OFF

When necessary to perform service work or disassemble power take-off, unit should be removed from transmission in following manner:

1. Use suitable support under power take-off unit so that it will not be damaged in event of accidental dropping during removal.

2. Remove drain plug from transmission and allow lubricant to drain while performing the succeeding operations.

POWER TAKE-OFF



NOTE: Items 6 and 12 each consists of two roller bearings —as shown; on latest type, a single long roller type bearing is used at these points—not shown.

Fig. 1 Disassembled View of Power Take-Off

1. Drive Gear Thrust Washer
2. Headless Set Screw
3. Drive Gear Shaft
4. Drive Gear Bearing Sleeve
5. Gasket
6. Drive Gear Roller Bearing
7. Drive Gear
8. Idler Shaft Cap Screw
9. Cap Screw Lockwasher
10. Retaining Washer
11. Low and High Speed Gear Thrust Washer
12. High Speed Gear Bearing
13. High Speed Gear
14. Low Speed Gear
15. Low Speed Gear Bearing
16. Idler Shaft
17. Case
18. Control Lever
19. Control Lever Latch
20. Bearing Cap Screw
21. Bearing Cap Screw Lockwasher
22. Drive Shaft Front Brg. Cap
23. Drive Shaft Oil Seal
24. Front Bearing Cap Gasket
25. Drive Shaft Front Bearing
26. Drive Shaft Key
27. Drive Shaft
28. Sliding Gear
29. Drive Shaft Rear Bearing
30. Rear Bearing Cap Gasket
31. Drive Shaft Rear Brg. Cap
32. Shift Rail
33. Shift Fork
34. Shift Rail Oil Seal
35. Cover to Case Gasket
36. Poppet Ball
37. Poppet Spring
38. Poppet Spring Retainer
39. Cover and Shift Rail Assy.
40. Shift Rail Oil Seal
41. Shift Rail Sleeve
42. Spacing Washer
43. Control Linkage
44. Retaining Washer
45. Cap Screw Lockwasher
46. Cap Screw
47. Spacer

3. Loosen winch propeller shaft slip joint safety collar.

4. Remove shear pin from "U" joint assembly and slide joint towards rear until it clears winch, then pull propeller shaft out of slip joint.

5. Remove cotter pin and clevis pin attaching control lever to linkage.

6. Remove cap screws attaching power take-off support to transmission, then remove stud nuts attaching power take-off to transmission and remove power take-off.

7. The number of gaskets used between power take-off and transmission should be noted as the same number should be used during the replacement operations.

8. Place cover or cloth over transmission opening to prevent entering of dirt during time power take-off unit is being overhauled.

5. TO INSTALL POWER TAKE-OFF

Before installing power take-off unit, inspect transmission to see that no dirt or foreign material has entered while power take-off was removed.

1. Attach power take-off to transmission, making sure that at least one new gasket is used on each side of spacer (47) and that total number of gaskets removed are replaced. Draw up stud nuts evenly and tightly.

2. Replace power take-off support cap screws and

nuts which hold power take-off to transmission.

3. Reinstall control lever at shift rail and make sure that gears engage and disengage fully.

4. Insert propeller shaft in slip joint.

5. Connect from "U" joint to winch and install new shear pin, securing it into position, using new cotter pin.

6. Refill transmission to proper level with correct lubricant.

REPAIR

6. TO DISASSEMBLE POWER TAKE-OFF COVER

Power take-off unit should be removed from vehicle before its cover is removed.

A. To Disassemble Cover—The reference numbers used in the following procedure are taken from Fig. 1.

1. Removal of cover (39) and shift rail assembly from case (17) can be accomplished after cap screws attaching cover to case are removed.

2. Remove two poppet spring and ball retainers (38) as cover is turned upside down to permit springs (37) and balls (36) dropping out.

3. Remove cap screw (46) at rear of shift rail (32) which retains control linkage (43), spacing washer (42), sleeve (41) and shift fork (33) to rail. Pull rail to front, stripping linkage, washer, sleeve and fork off of rail. During this operation be careful that oil seal is not damaged.

B. To Inspect Cover—Cover and relative parts should be thoroughly cleaned in gasoline or other suitable cleaning fluid.

1. Oil seals (23, 34 and 40) should be carefully inspected and, if slightest evidence of wear is noticeable, they should be replaced with new parts.

2. Inspect shift rail to see that it is not scored or grooved and that it slides freely in cover. Portion of rail that extends out of cover should not be painted as paint will hinder free movement of rail in cover.

7. TO ASSEMBLE POWER TAKE-OFF COVER

Particular care should be exercised when installing cover to see that power take-off unit is clean as presence of foreign material in unit may result in damage to gears in both power take-off and transmission. Refer to Fig. 1 and proceed as follows:

1. Replace oil seals (34 and 40) in ends of cover if they show the slightest evidence of wear. Before installing new seal, soak seal in "Neatsfoot" oil or warm engine oil until leather is soft and pliable.

2. Slide shift rail (32) into cover from front end, being careful that oil seal is not damaged. As rail is being pushed into place, slide shift fork (33) over rear end of shaft. Push rail still further until in approximately correct location.

3. Slide sleeve (41) over rear end of shaft, exercising care that oil seal is not damaged. Install spacing washer (42), control linkage (43), washers (44 and 45) and cap screw (46) at rear end of shaft and draw screw up tight so that shift fork is forced against shoulder on rail by sleeve.

4. Place poppet springs (37) and balls (36) into retainers (38) and install in top of cover (39). Cover may be turned upside down for this operation.

5. Install the cover assembly to case, using a new gasket, and secure with cap screws. When installing the cover, be sure that shift fork is engaging the sliding gear fork groove.

8. TO DISASSEMBLE POWER TAKE-OFF CASE

Disassembly is accomplished as follows:

A. To Remove Drive Gear and Shaft (Refer to Fig. 1)

1. Take out special headless set screw (2) at front end of shaft (3), holding shaft in case.

2. Push shaft out of case, which will permit removal of gear (7), bearings (6) and thrust washers (1). This gear should be suitably marked or tagged so that it will not be confused with high speed idler shaft gear (13).

B. To Remove Idler Shaft (Refer to Fig. 1)—

1. Remove cap screws, lockwashers and retaining washers at each end of shaft (16).

2. Push shaft out of case, which will permit removal of gears (13 and 14), bearings (12) and thrust washers (11). High speed gear (13) should be suitably marked or tagged so that it will not be confused with drive gear (7).

3. Remove bearing assemblies (12 and 15) from gears (13 and 14).

4. Clean and inspect all parts as directed under "To Clean and Inspect Drive Gear Assembly."

C. To Remove Drive Shaft and Sliding Gear (Refer to Fig. 1)—

1. Take out cap screws holding front and rear bearing caps (22 and 31) to case. Remove caps and gaskets.

2. Move shaft (27) toward rear far enough so that rear bearing (29) can be removed from shaft. With rear bearing removed, shaft and front bearing (25) can be removed through front of case as sliding gear (28) is stripped off rear end of shaft.

3. Clean and inspect parts as directed under "To Clean and Inspect Drive Gear Assembly."

D. To Clean and Inspect Drive Gear Assembly—All parts of the assembly should be cleaned in gasoline or other suitable cleaning fluid.

1. Clean and inspect bearings as follows:

(a) Soak in suitable cleaning fluid long enough to loosen old grease and lubricant.

POWER TAKE-OFF

(b) After thorough soaking, bearing should be slushed up and down and spun slowly below surface of liquid.

(c) Remove from fluid and strike bearing against a wood block to knock out heavier particles of dirt.

(d) Blow bearings clean and dry with compressed air, directing air across bearings. Do not spin **bearings.**

(e) Rotate bearing slowly by hand, and inspect for defects and excessive wear. Never spin dry bearing while dry.

(f) After inspection, dip bearings in engine oil and wrap in clean cloth until ready for use.

2. Inspect gear for evidence of wear. If teeth are worn, broken or chipped, the gear should be replaced.

3. Inspect surfaces of thrust washers. Replace if they are scored or show evidence of excessive wear.

9. TO ASSEMBLE POWER TAKE-OFF CASE

A. To Install Drive Shaft and Sliding Gear (Refer to Fig. 1)—

1. Put double row ball bearing (25) on front end of shaft (27). Slide bearing and shaft assembly in place through front of case (17), at same time sliding gear (28) should be slipped over end of shaft. Shift fork groove side of gear must be toward rear when installing gear on shaft.

2. Push shaft far enough through rear of case so that bearing (29) can be installed on rear end of shaft.

3. Install rear bearing cap (31), using new gasket between cap and case.

4. Install front bearing cap and oil seal assembly (22), using new gasket between case and cap. If oil seal in cap shows any indication of wear, it should be replaced with a new part.

B. To Install Idler Shaft and Gears (Refer to Fig. 1)—

1. Insert shaft (16) into case (17) from rear side and push in until shaft extends through inside about 1".

2. Place thrust washer (11) over end of shaft with oil grooves toward case.

3. Insert bearing (15) into low speed gear (14) and slide gear and bearing assembly over end of shaft.

4. Assemble bearing (12) into high speed gear (13); also, assemble thrust washers (11) to each side of gear. Oil groove in front thrust washer must be toward outside, while grooves in thrust washer between gears must be toward high speed gear bearings (12).

5. Place gear (13), bearings (12), and thrust washers (11) in place and push shaft into place.

C. To Install Drive Gear and Shaft (Refer to Fig. 1)—

1. Place bearing assemblies (6) and sleeve (4) in side of gear (7). Install thrust washers (1) over ends of sleeve at each side of gear. Washers must be installed with oil grooves on outside or toward case when in running position.

2. Place gear and bearing assembly in case (17) with large gear toward front. Insert shaft (3) from rear of case. Push shaft through bearing sleeve and into front of case.

3. Screw driver slot in rear end of shaft may be used to turn shaft until set screw hole in shaft lines up with hole in case. Insert screw (2) and draw up tight.

TABULATED DATA

10. SPECIFICATIONS

Power take-off units furnished in these vehicles are manufactured by two different companies. Both units are identical in construction and differ only in the model number.

Make & Model ..... Gar Wood, 64-Y-600-LG Rev.
Make & Model ..... Heil, B-360
Speeds
Lifting ..... Two
Lowering ..... One
Drive ..... From Transmission
Control ..... Shift Lever in Cab
Drive Gear Bearing
Type & No. ..... Roller, Hyatt No. 94532
High Speed Gear Bearing
Type & No. ..... Roller, Hyatt No. 94532
Low Speed Gear Bearing
Type & No. ..... Roller, Hyatt No. 94526
Drive Shaft Front Bearing
Type & No. ..... Double Row Ball, ND No. E-207
Drive Shaft Rear Bearing
Type & No. ..... Single Row Ball, ND No. 1207

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Group 22 — Instruments and Accessories

GENERAL

	Paragraph
Description	1
Instruments	2
Speedometer and Drive	3
Fire Extinguisher	4
Outside Rear View Mirror	5
Standard Tools	6

1. DESCRIPTION

This group describes the accessibility of units listed above and outlines replacement procedures. The description and function of instruments is described in "Driver's Instructions" group.

2. INSTRUMENTS

Instruments are mounted in a cluster assembly in instrument panel which in turn is attached to cowl of cab. Instruments may be removed separately or as a cluster assembly. Figs. 1 and 2 indicate units and installations.

Procedures for instrument removal and installation in vehicles equipped for "radio noise suppression" are no different than for vehicles without such equipment. Full information relative to radio suppression is given in "Miscellaneous Electrical" group 06M.

A. To Remove Instrument Cluster Assembly from Panel—

1. Remove battery cover and disconnect cable from one of two battery terminal posts.
2. Disconnect wiring to electrical instruments, tubing to oil gauge and temperature gauge and speedometer cable at back of instruments.
3. Remove speedometer clamp plate upper wing nut and pull wiring harness clip loose from screw.
4. Unscrew temperature gauge thermal plug at engine and remove closure seal around capillary tube at cowl. Then pull thermal unit through cowl.
5. Remove nuts and screws on back side at each end of instrument cluster panel. Then push on face side of cluster assembly to remove from instrument panel.
6. Separate instruments are easily disassembled from

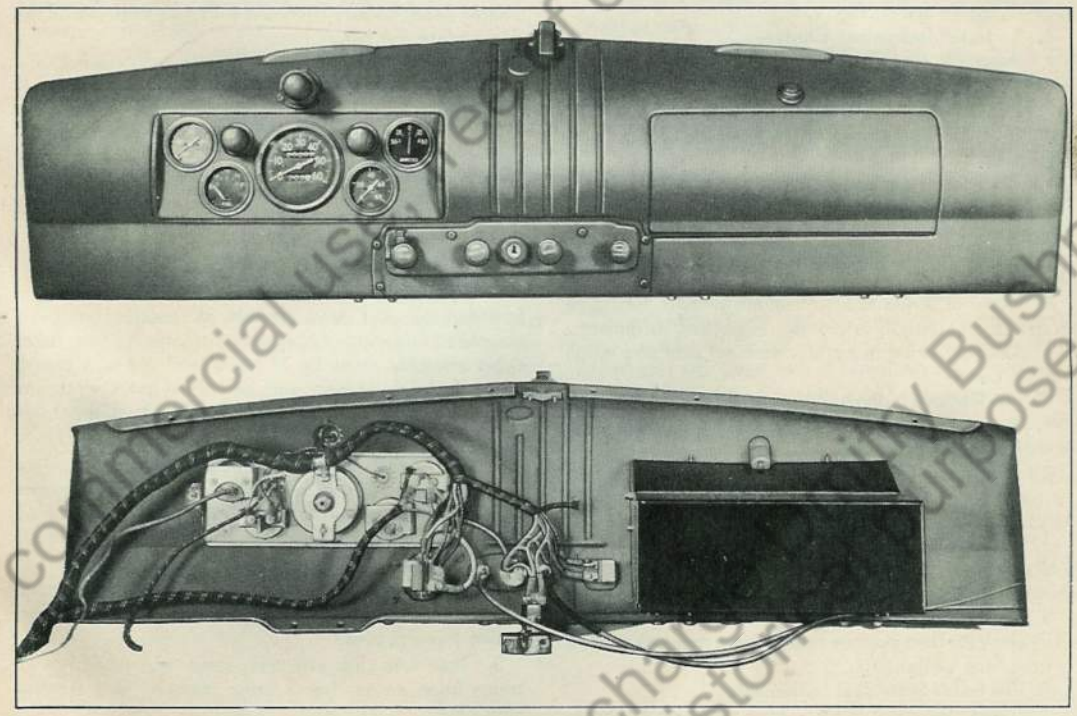
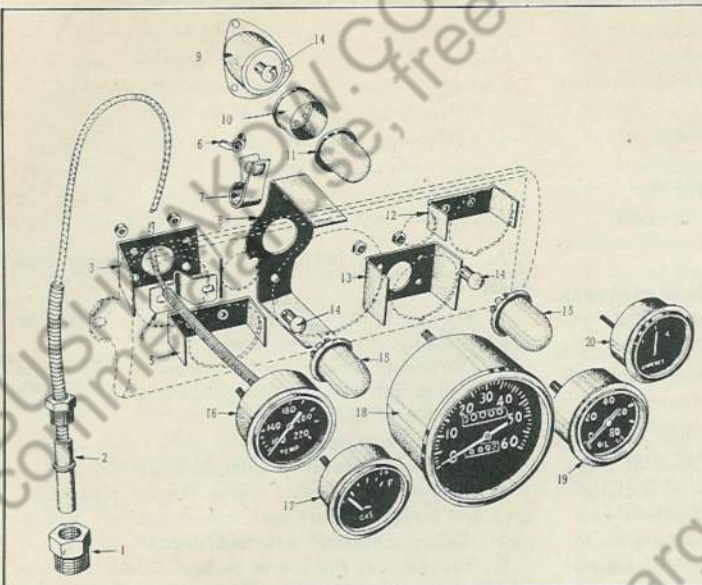


Fig. 1 Front and Rear Views of Instrument Panel

INSTRUMENTS AND ACCESSORIES



1. *Temperature Gauge Engine Fitting*
2. *Temperature Gauge Thermal Plug*
3. *Temperature Gauge Clamp Plate*
4. *Fuel Gauge*
5. *Fuel Gauge Clamp Plate*
6. *Speedometer Mounting Nut*
7. *Wiring Harness Clip*
8. *Speedometer Clamp Plate*
9. *Instrument Light Unit*
10. *Light Shield Extension*
11. *Light Shield*
12. *Ammeter Clamp Plate*
13. *Oil Gauge Clamp Plate*
14. *Instrument Light Bulb*
15. *Light Shield*
16. *Temperature Gauge Unit*
17. *Fuel Gauge Unit*
18. *Speedometer Head Unit*
19. *Oil Gauge Unit*
20. *Ammeter*

Fig. 2 Disassembled View of Instrument Cluster

cluster by removing nuts and clamp plate holding instrument in cluster panel, Fig. 2.

B. To Install Instrument Cluster—

1. Assemble separate instruments in cluster panel and install all clamp plates and nuts.

2. Place instrument cluster assembly in instrument panel from back side and install attaching screws and nuts at each end.

3. Place temperature gauge thermal unit through cowl and screw into engine fitting. Then fasten closure seal around capillary tube at cowl.

4. Install wiring harness clip under speedometer clamp plate upper wing nut.

5. Connect wiring to electrical instruments, tubing to oil gauge, and speedometer cable at back of instruments.

6. Connect cable to battery terminal post and install battery cover.

C. To Remove Individual Instruments—

1. Remove battery cover and disconnect cable from one of two battery terminal posts.

2. Disconnect wiring, tubing, drive cable at back of instrument or thermal plug at engine, depending on which instrument is being removed.

3. If removing temperature gauge, remove closure seal around capillary tube at cowl and pull thermal unit through cowl.

4. Remove nuts and clamp plate at rear of instrument, Fig. 2. Then push on rear of instrument to remove it from face of panel.

D. To Install Individual Instruments—

1. Place instrument in place from face side of cluster panel.

2. Install clamp plate and nuts. If installing speedometer head, be sure to mount wiring harness clip under clamp plate top nut.

3. If installing temperature gauge, place thermal unit through cowl and screw into engine fitting. Then fasten closure seal around capillary tube at cowl.

4. Connect wiring, tubing, or drive cable at back of instrument, depending on which instrument is being installed.

5. Connect cable to battery terminal post and install battery cover.

3. SPEEDOMETER AND DRIVE

Speedometer and drive consists of speedometer head mounted in instrument cluster in instrument panel, drive cable assembly made up of cable enclosed in a casing with swivel nuts at each end, and drive gears which are installed in the transfer case. Installation diagram is shown in Fig. 3.

A. To Remove Speedometer and Drive—

1. To remove speedometer head from instrument panel, unscrew swivel nut connecting cable to back of head, remove wing nuts and clamp plate, pull wiring harness clip free and push unit out of panel.

2. To remove drive cable assembly, raise engine hood, loosen grommet around casing in cowl and pull cable and casing through cowl.

3. Then free clips attaching cable assembly to cowl, transmission cover, frame cross member and transfer case cover.

4. Unscrew swivel nut attaching cable assembly to

INSTRUMENTS AND ACCESSORIES

speedometer gear in transfer case and pull assembly free from vehicle.

B. To Install Speedometer and Drive—

1. Thread cable assembly into position in vehicle with end having smaller swivel nut through cowl to instrument panel. Fit rubber grommet around casing into hole in cowl.
2. Insert end of drive cable into end of drive gear in transfer case and tighten swivel nut securely.
3. Install speedometer head, if removed, in place in instrument panel, attach with clamp plate and nuts with wiring harness clip under top nut.
4. Insert end of drive cable into place in rear of speedometer head and fasten securely with swivel nut.
5. Install clips attaching cable assembly to cowl, transmission cover, frame cross member, and transfer case cover.

C. To Disassemble Speedometer Drive Shaft—if drive cable is broken inside casing, it can be disassembled simply by pulling section of cable out of each end of casing. If drive cable is to be replaced because either of end tips has twisted or broken off, proceed as follows:

1. Slide swivel nut at transfer case end of cable (larger of two nuts) back over casing.
2. Clamp end of cable with pliers and, with casing held against a suitable block, pull end of cable until "C" washer is exposed.
3. Remove "C" washer with fingers.
4. Then pull cable out of casing, pulling from opposite or speedometer head end.

D. To Assemble Speedometer Drive Shaft—

1. Apply a coating of graphite grease to new cable.
2. Insert end of cable with driving lug into casing end having small swivel nut. Then push cable through casing.
3. Place end of casing with larger swivel nut against suitable block and pull cable out this end of casing until groove into which "C" washer seats is exposed.
4. Use fingers to slip "C" washer into groove in end of cable. Then ease pull on cable, letting it fit back into end of casing.

4. FIRE EXTINGUISHER

All necessary information relative to mounting, removal and use of fire extinguisher is given in the "Driver's Instructions" group of this manual.

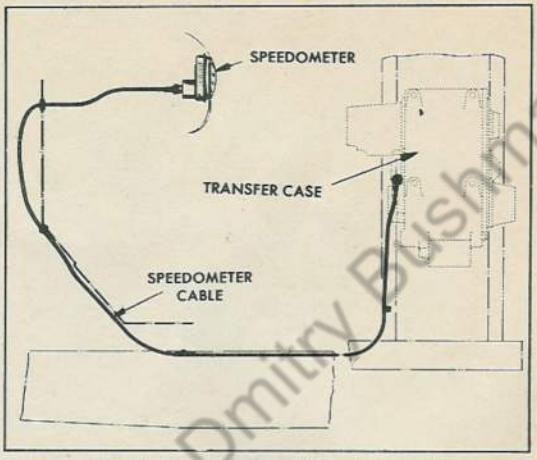


Fig. 3 Speedometer Drive Installation

5. OUTSIDE REAR VIEW MIRROR

This mirror is serviced only as an assembly with attaching parts separate. Mirror is adjustable at both mirror pivot stud and at extension arm bracket at door hinge pillar. Simply loosen nuts and position mirror as desired, then tighten nuts.

Mirror proper can be removed by unscrewing pivot stud nut and pulling mirror and stud out of extension arm.

To remove mirror and extension arm complete, remove nuts from bolts inside cab which attach extension arm bracket to door hinge pillar. Then remove bolts, mirror assembly complete and spacers used between flanges of door hinge pillar.

6. STANDARD TOOLS

A kit of standard tools, consisting of items shown in "Driver's Instructions" group, is furnished with each vehicle. Tool kit is placed in tool box at rear end of body in vehicles equipped with "Cargo" bodies. Tool kits are put in compartment under cab seat cushion in other vehicles.

All tools and equipment required to properly inspect vehicle in field, make adjustments and effect repairs of a minor nature are included in this kit.

SERVICE BULLETIN REFERENCE

Bulletin No.	Description