



INDUSTRIAL TRUCK DIVISION



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**OPERATORS  
MAINTENANCE  
PARTS  
MANUAL  
FOR  
CY-60**

CODE GOV'T 0-201

**CLARK EQUIPMENT COMPANY**

PUBLISHED BY

TECHNICAL SERVICE DEPARTMENT,  
BATTLE, CREEK, MICHIGAN, U.S.A.



INDUSTRIAL TRUCK DIVISION



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## **SAFETY INSTRUCTIONS** FOR MAINTAINING INDUSTRIAL TRUCKS

Powered industrial trucks may become hazardous if adequate maintenance is neglected. Therefore, adequate maintenance facilities, personnel and procedures should be provided.

Maintenance and inspection of all powered industrial trucks should be performed in conformance with the recommendations in this Manual and the following practices:

1. Only qualified and authorized personnel should be permitted to maintain, repair, adjust, and inspect industrial trucks, and a scheduled preventive maintenance, lubrication, and inspection system should be followed.
2. When truck is to be parked for maintenance: Turn off engine, lower lifting mechanism, place directional controls in neutral, (clutch type trucks may be left in gear) apply parking brake and chock wheels.
3. Before working on truck raise wheels free of floor or disconnect power source. Use chocks or other positive truck positioning devices and block carriage, innermast(s), or chassis before working under them. Before working on engine fuel system of: (a) Gasoline powered trucks with gravity feed fuel systems, be sure fuel shutoff is closed; (b) LP gas powered trucks, close LP-gas cylinder valve and run engine until fuel in system is depleted and engine dies.
4. When starting engine place shift levers in neutral and depress clutch (or brake pedal on automatic transmissions).
5. Avoid fire hazards and have fire protection equipment present. Do not use an open flame to check level, or for leakage, of fuel, electrolyte or coolant. Do not use open pans of fuel or flammable cleaning fluids for cleaning parts.
6. Properly ventilate work area, vent exhaust fumes and keep shop clean and floor dry.
7. Use hoisting equipment for heavy lifts.
8. Handle LP Gas cylinders with care. Do not drop, dent, or damage in any way.
9. Brakes, steering mechanisms, control mechanisms, warning devices, lights governors, lift overload devices, safety guards and safety devices should be inspected regularly and maintained in a safe operating condition.
10. All parts of lift and tilt mechanisms and frame members should be carefully and regularly inspected and maintained in a safe operating condition.
11. Special trucks or devices designed and approved for hazardous area operation should receive special attention to ensure that maintenance preserves the original approved safe operating features.

*(Continued)*

## **SAFETY INSTRUCTIONS** FOR MAINTAINING INDUSTRIAL TRUCKS

12. Fuel systems should be checked for leaks and condition of parts. Extra special consideration should be given in the case of a leak in the fuel system. Action should be taken to prevent the use of the truck until the leak has been corrected.
13. All hydraulic systems should be regularly inspected and maintained in conformance with good practices. Tilt cylinders, valves, and other similar parts should be checked to assure that "drift" has not developed to the extent that it would create a hazard.
14. Capacity rating, operation and maintenance instruction plates, tags, or decals should be maintained in legible condition.
15. Batteries, motors, controllers, limit switches, protective devices, electrical conductors and connections should be inspected and maintained in conformance with good practices. Special attention should be paid to the condition of electrical insulation.
16. Industrial trucks should be kept in a clean condition to minimize fire hazards and facilitate detection of loose or defective parts.
17. Modifications and additions which affect capacity rating and safe operation should not be performed by the user without manufacturer's approval.
18. Care should be taken to assure that all replacement parts are interchangeable with the original parts and of a quality equal to that provided in the original equipment.



# INDUSTRIAL TRUCK DIVISION



## P L E A S E   N O T E

### I N S T R U C T I O N S   O N   U S E   O F   M A N U A L

This Operator's Manual is published as a service reference guide and includes Specifications, Operating Instructions, Lubrication and Preventive Maintenance Instructions, and Trouble Shooting Guide.

The TABLE OF CONTENTS for this manual is printed on green paper and is placed at the front for easy reference. A separate INDEX (also printed on green paper) is placed in front of the Lubrication and Preventive Maintenance Section.

Lubrication and Preventive Maintenance Instructions are listed under the TIME INTERVALS that they should be performed.

The TIME INTERVAL is part of the page number and code number.

Example: 8H 002-0; 8H is the TIME INTERVAL (8 operating hours), 002 is the PAGE NUMBER, and -0 is a CODE NUMBER that you as a customer should disregard. The dash number or code number is for the benefit of the publisher only.

The INDEX is set up under the TIME INTERVALS that the Lubrication and Preventive Maintenance should be performed.

Example: (8 Hours)	Time Interval (H=Hours)	&	Page Number (000-)
Hydraulic Sump Tank, level check...	8H		503
Brake Pedal Free Travel, check.....	8H		303

The above states to check the sump tank fluid level every 8 operating hours and refer to page 503 for fluid recommendations etc. Also, to check brake pedal free travel at this interval and turn to page 303 for instructions.

Turn to the eight (8) hour section (8H) and then to the page listed — 503 or 303 etc. The instructions covered therein will pertain only to the checks or adjustments that should be performed at this TIME INTERVAL.

If, for instance, the Brake Pedal Free Travel is incorrect, you would then refer to the INDEX for "Brake Pedal Free Travel, adjust" which would be listed in the TIME INTERVALS following the 8 hour section.

Example: (100 Hours)	Time Interval (H=Hours)	&	Page Number (000-)
Brake Pedal Free Travel, adjust....	100H		302

Turn to the one hundred hour section (100H) and then to





# INDUSTRIAL TRUCK DIVISION



(continued)

## INSTRUCTIONS ON USE OF MANUAL

page 302. Complete instructions as to the importance of pedal free travel, the method to check and adjust for correct free travel with illustrations are included therein.

### NOTE

YOU WILL NOTE THAT AT THE BEGINNING OF EVERY SECTION A LUBRICATION AND PREVENTIVE MAINTENANCE ILLUSTRATION IS SHOWN GIVING THE LOCATION OF THE COMPONENTS TO BE SERVICED.

It is impossible to cover all types of machine operations in one manual. Operating conditions should determine the lubrication and maintenance intervals. Common sense and a close observance can best determine the frequency with which you should service your machine.

The care you give your machine will greatly determine the satisfaction and service life that you will obtain from it. A definite maintenance program should be set up and followed. Haphazard maintenance will only lead to faulty performance and short life.



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## TABLE OF CONTENTS

<u>Page</u>	<u>Description</u>
A001	Instructions on use of manual
A002	Instructions on use of manual
A003	Table of contents
A004	Table of contents
1077-Z	Serial number location
B002	Specifications
B003	Specifications
B005	Specifications
B006	Specifications
B007	Specifications
B008	Specifications
B031	New machine 50 hour inspection

### OPERATIONS

C002	Overall Controls
C003	Instrument indicators
C004	Instrument indicators
C103	Starting instructions
C303	Safety precautions

### LUBRICATION AND PREVENTIVE MAINTENANCE

<u>Time Interval (H=Hours)</u>	<u>Page Number (0000)</u>	<u>Description</u>
H	001	Index
8H	000	<u>8 Hour Lubrication and Preventive Maintenance Illustration</u>
8H	001	Location of Fuses and Fuel Tank Check
8H	002	Engine crankcase check
8H	103	Engine cooling system check
8H	203	Instrument indicators check
8H	204	Instrument indicators check
8H	303	Brake pedal free travel, parking brake check
8H	403	Air Cleaner check
8H	503	Hydraulic sump and control levers check
8H	602	Tire and rim maintenance
8H	603	Tire and rim maintenance
8H	703	Power Steering pump
100H	000	<u>100 Hour Lubrication and Preventive Maintenance Illustration</u>
100H	001	Converter, Transmission and Axle Adapter
100H	002	Engine crankcase and oil filter check
100H	103	Cooling System check
100H	203	Fan and Generator drive belt check
100H	302	Brake System check, Brake pedal free travel check
100H	303	Master cylinder check
100H	403	Lifting mechanisms check
100H	503	Hydraulic sump tank breather
100H	603	Steering gear and battery check
100H	604	Battery check
100H	703	Lubrication check



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### LUBRICATION AND PREVENTIVE MAINTENANCE

Time Interval (H=Hours)	Page Number (0000)	Description
500H	000	<u>Lubrication and preventive maintenance illustration</u>
500H	001	Fuel Pump Filter Check
500H	002	Transmission oil filter, screen, and level check
500H	004	Axle adapter & transmission drain plugs
500H	103	Hydraulic sump tank and filter check
500H	202	Steering gear adjust
500H	203	Steering gear adjust
500H	302	Steering axle and linkage adjustments
500H	303	Steering axle and linkage adjustments
500H	403	Manifolds check
1000H	000	<u>Lubrication and Preventive Maintenance Illustration</u>
1000H	001	Engine Tune up
1000H	002	Cylinder head, manifolds, crankcase, and valves adjustments
1000H	003	Valve adjustment
1000H	103	Compression test
1000H	203	Distributor Adjustments
1000H	204	Distributor adjustments
1000H	303	Distributor adjustments and timing
1000H	304	Timing
1000H	403	Vacuum Test
1000H	503	Governor adjustment
1000H	504	Governor adjustment
1000H	603	Starting motor
1000H	604	Starting motor
1000H	703	Generator adjustment
1000H	704	Generator adjustment
1000H	803	Steer wheel bearings lubrication
1000H	805	Axle ends lubrication
1000H	912	Brake bleeding procedure
1000H	913	Brake Bleeding procedure
1000H	1003	Brakes service
1000H	1103	Hand Brake adjustment
1000H	1202	Cooling System inspect and clean
1000H	1203	Cooling System inspect and clean
1000H	1503	Hydraulic system check
1000H	1504	Hydraulic system check
1000H	1505	Hydraulic system check
1000H	1507	Hydraulic system check
1000H	1703	Transmission stall and pressure checks
1000H	1704	Transmission stall and pressure checks
1000H	1705	Battery check
1000H	1793	Neutral starting switch
1000H	1803	Lift and upright adjustments
1000H	1806	Roller adjustments
1000H	1807	Upright roller adjustments
1000H	1808	Upright roller adjustments
1000H	1811	Lift carriage roller adjustments
1000H	1815	Upright roller lubrication

### TROUBLE SHOOTING GUIDE

Page	Description	Page	Description
TS 001	Engine	TS 483	Drive Axle
TS 251	Fuel System	TS 251	Steering Axle
TS 321	Cooling System	TS 531	Steering
TS 341	Ignition System	TS 541	Brakes
TS 361	Starting Motor	TS 653	Hydraulic System
TS 381	Generator troubles	TS 963	Transmission, Converter and Axle
TS 401	Battery, Lights and Horn		Adapter (Hydrator Drive)



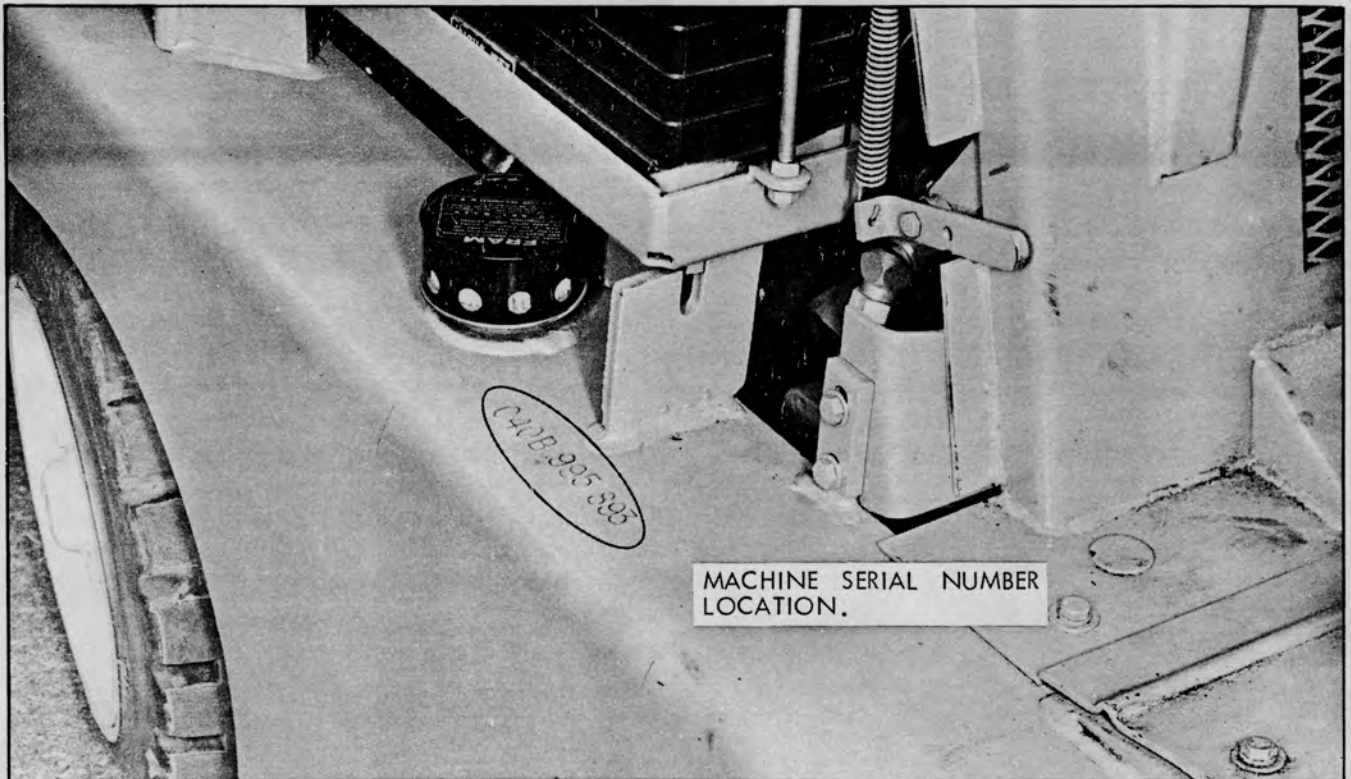


Plate 9474. Machine Serial No. Location

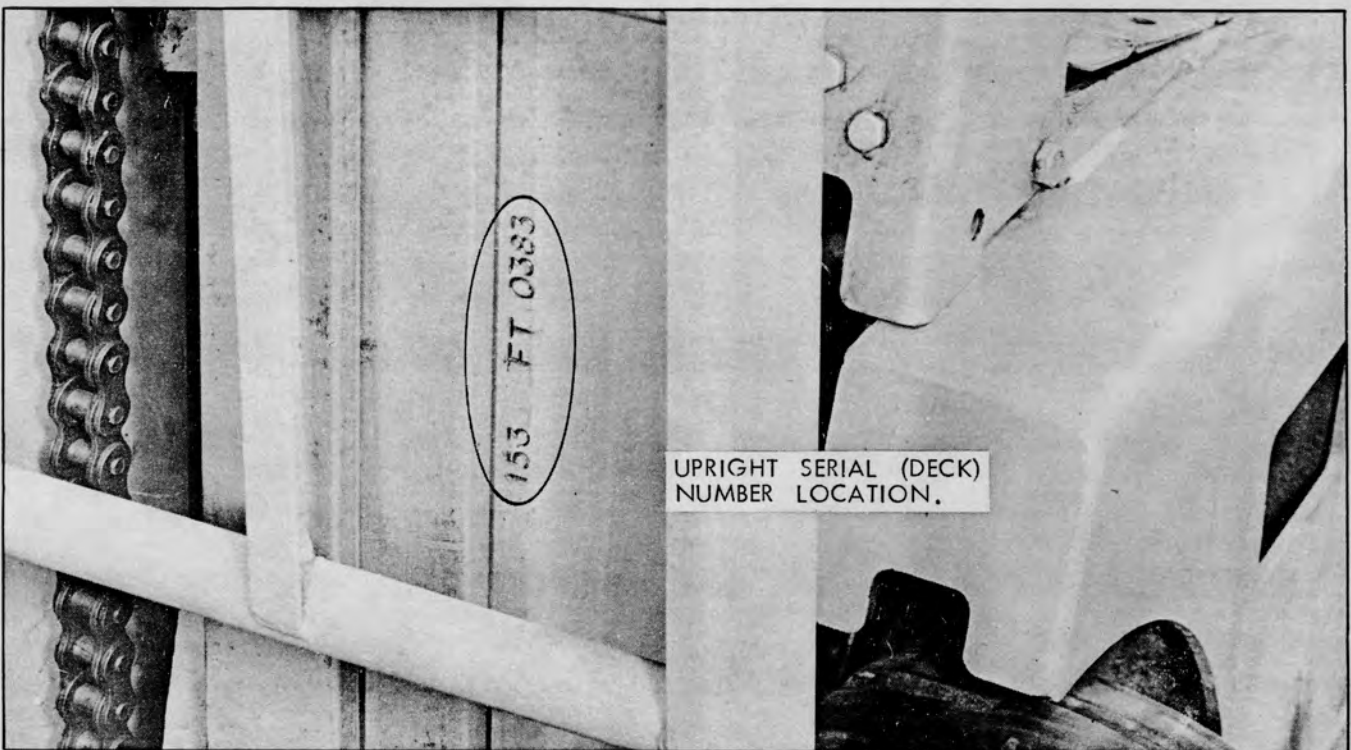


Plate 9475. Upright Serial (Deck) No. Location



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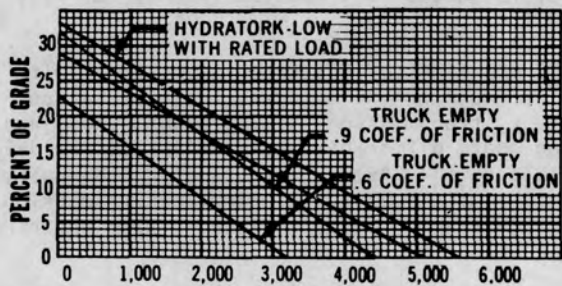
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**DIMENSIONAL SPECIFICATIONS**

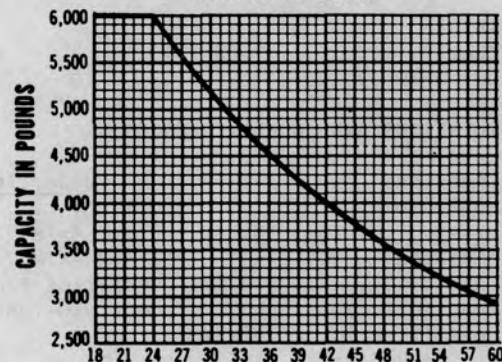
**CLARKLIFT®  
CY-60**



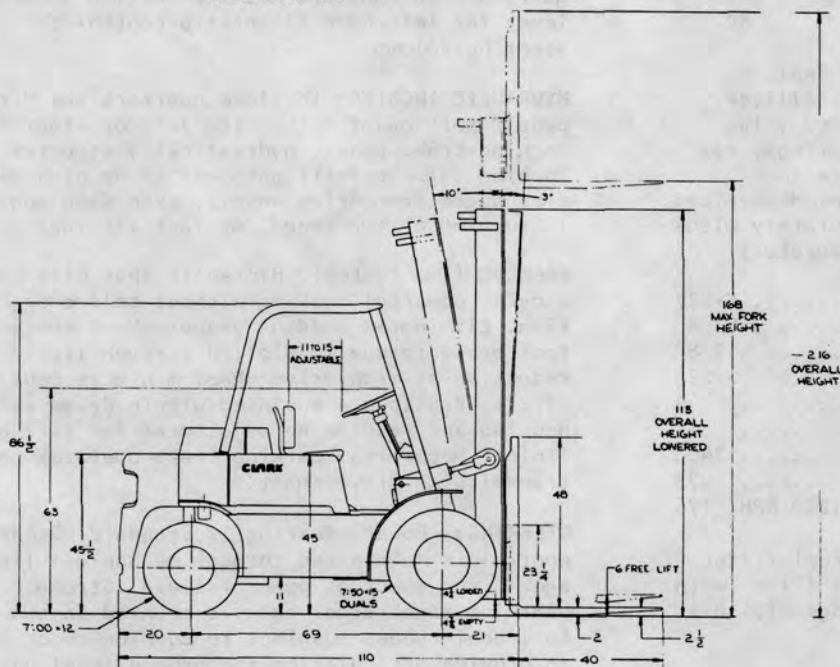
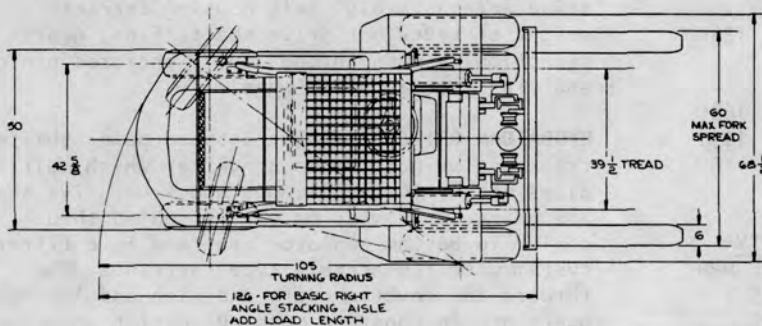
**AVAILABLE DRAWBAR PULL IN POUNDS**

With towing coupler 12" from floor. Empty truck grades are with either transmission.

**CAPACITY CHART**



Load center in inches from front face of forks. Capacities shown above are computed with uprights in vertical position. Specific capacity is shown on truck nameplate.





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## D I M E N S I O N A L   S P E C I F I C A T I O N S

MODEL: CY 60 Weight..... 10,375 Lbs. Standard

### WEIGHT DISTRIBUTION AND CAPACITY:

Percent on drive wheels, truck empty:.....48%  
Rated Capacity....6,000 Lbs. at 24" load center  
Alternate ratings.4,550 Lbs. at 36" load center  
3,610 Lbs. at 48" load center  
(See capacity chart for other ratings)

### TIRES:

Steer..... 7.00 X 15     12     100 Lbs.  
Dual Drive..... 7.50 X 15     10     95 Lbs.

### DIMENSIONS AND UNDERCLEARANCES:

Dimensions	Underclearances
Length (to face of forks)..... 108"	Upright ..... 5"
Wheelbase..... 69"	Drive Axle..... 8"
Width..... 68 1/2"	Steer Axle....8 1/4"
Tread (Drive).... 60"	Center of Frame..11"
Tread (Steer).... 42 5/8"	Counterweight.8 1/4"
Turning Radius).. 105"	

Basic aisle for right angle stacking.....  
(add load length)..... 126"

### UPRIGHT DIMENSIONAL TABLE

Max. Fork height..... 168"  
Over-all Height lowered..... 115"  
Free Lift ..... 6"

### SPEEDS AND GRADES

Travel speeds:	LOADED	EMPTY
	12.5 MPH	13.8 MPH
Gradeability with rated load	32.7	29.2
Lift Speed	72	82
Lowering speed	60	80

**ENGINE:** Industrial Continental Red Seal, 6 Cylinder, "L" head, equipped with stellite-faced valves and seats; also positive valve rotators. Connecting rods, main bearings, cam shaft, and timing gears are pressure lubricated by submerged gear-type pump. Mechanical governor controls engine speed accurately without choking off power. Updraft carburetor.

Model..... F-227  
Bore..... 3 5/16"  
Stroke..... 4 3/8"  
Displacement, Cu. Inches..... 226  
Crankcase Capacity, quarts..... 5  
Fuel Tank Capacity, gallons..... 12  
Governor RPM with no load..... 2400  
SAE rated horsepower at 2400 RPM..... 73  
Max. SAE Rated Torque, Lb Foot at 1200 RPM. 176

**ENGINE FILTERS:** Three Types - (1) Fuel filter in metallic bowl. (2) One-quart oil filter with automotive type replaceable cartridge. (3) Oil bath air cleaner.

**ELECTRICAL SYSTEM:** 12-volt, 60-amp-hour battery; 25 amp low cut-in generator charges at idle.

Enclosed electric starter motor has positive engagement, electrical cut-c t. Weather-shielded keyless starting switch; dust-proof distributor electric horn; and multiple disconnect plug to instrument panel.

**INSTRUMENTS:** Direct reading engine hour meter; ammeter, engine oil pressure, fuel, and temperature gauges, all mounted in cowl for easy reading.

**AXLE AND FINAL DRIVE:** Integral assembly with 3-point mounting including engine, torque converter, transmission, spiral bevel pinion and ring gear, differential and full-floating drive axle assembly. Axle housing, not drive shaft, carries weight of truck. Final gear reduction is made through fully enclosed pinion and ring gear at drive wheels.

**DRIVE AXLE AND TRANSMISSION:** Integral assembly with 3-point mounting including engine, torque converter, transmission, spiral bevel pinion and ring gear, differential and full floating drive axle assembly. Axle housing carries weight of truck not drive shaft. Final gear reduction is made through fully enclosed pinion and ring gear at drive wheels.

**HYDRATORK DRIVE-STANDARD:** 2-speed power shifted transmission has torque converter which multiplies engine torque without shock on drive shaft and gears. Transmission oil is cooled thru cooler in bottom radiator tank and is a filtered system with replaceable type cartridge. The forward and reverse gears and high and low range gears are in constant mesh. Direction selector lever for left-hand finger-tip control on steering column.

**HYDRAULIC INCHING:** In close quarters the "free pedal" portion of either the left or right foot inching-brake pedal, hydraulically actuates inching valve permitting power to be gradually disengaged from drive wheels, even when engine is running at top speed for fast lifting.

**BRAKES:** (Two system). Hydraulic spot disc brakes provide powerful braking without self-energization. Eliminates sudden "grabbing" of the brakes. Foot brake torque multiplied through final reduction at each drive wheel minimize pedal effort. Brakes are enclosed within drive axle housing and require no adjustment for life of lining. Mechanical parking brake operates on transmission drive shaft.

**STEERING:** Power steering is standard. Steering control is maintained through mechanical linkage in the event of power failure. Strong vanadium steel steer axle is mounted on two torsional rubber bushings to cushion shock and to provide articulation for ground level variations up to 6". Positive stops for lateral stability. Inclined king pins minimize road



**STEERING (CONTINUED)**

shocks. Recirculated ball type steering gear with 18" diameter handwheel. Tie rods are automotive type.

**UPRIGHT:** Nested telescopic roller types. "I" beam inner section of SAE 1045 steel is nested within outer channel of SAE 1045 steel for greater safety and visibility. Side loading on upright rails is taken on upright rollers. Upright and carriage rollers are adjustable for wear to maintain new truck tolerances. Carriage also has 4 adjustable side thrust rollers to prevent binding. Carriage has additional lateral thrust rollers to prevent upright spread, insuring maximum free-rolling movement.

**HYDRAULIC SYSTEM:** Full feathering balanced spool type valves for gentle starts and stops. Built-in pressure relief valve protects system against overloads; will open fully within 100 p.s.i. cracking pressure. SAE straight threads and O-ring seals used throughout pressure system. Vane-type pump is driven by hardened gears. Hydraulic sump, built into frame of 3/8" thick plate has 12.5 gal. capacity. Flexible rubber hydraulic hose lines are steel braid reinforced. System is protected from dirt by (1) a 5 micron pleated replacement filler cap breather, (2) a 25-micron full flow filter in sump.

**FORK CARRIAGE AND FORKS:** All-welded construction, 1045 steel fork carriage to withstand impacts. Lateral fork adjustments from 0" to 60" with or without optional load rack. Convenient snap action latch assures positive fork positioning. Heat treated and upset forged forks to provide full section strength at heel.

**SEATING:** Rubber mounted extra wide seat and back rest are Polyether, covered with vinyl plastic. Curved back rest tilts to provide additional driver comfort. An automotive type latch releases the seat for horizontal adjustment up to 4"/

**MAINTENANCE:** Split swing-out hood offers easy access for servicing. Check-points such as water and hydraulic sump filler caps, oil dipstick and filler readily accessible. Battery swings out. Quickly detachable counterweight is hook mounted, secured with one large bolt.

**GENERAL:** Protectoseal gas tank filler cap. 12" height recessed pin-type coupler. Bolts and screws are zinc or cadmium plated. Multi-pass muffler. All exposed surfaces are shot-blasted and prime painted with weather resistant paint.



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## SPECIFICATIONS



Air Cleaner ..... 3/4 pints  
 Cooling System Capacity ..... 15 quarts  
 Fan Belt Deflection (long span)..... 3/4"  
 Brake Pedal Free Travel... 3/16 to 5/16 inch  
 Torque Converter..... diameter 11 inches  
 ..... Torque multiplication 2 to 1  
 Transmission Hydratork  
 Speeds: 2  
 Capacity: 13 quarts

### STEERING AXLE

Toe in ..... 0 degrees  
 Camber ..... 1 degree  
 Caster ..... 0 degrees  
 Left hand turning radius angle:  
 Left wheel ..... 75 degrees  
 Right wheel ..... 52 degrees  
 Right hand turning radius angle:  
 Left wheel ..... 52 degrees  
 Right wheel ..... 75 degrees

### DRIVE AXLE

Ratio-Bevel Gear ..... 5.286 to 1  
 Wheel Reduction ..... 4.09 to 1  
 Axle end (grease)  
 capacity ..... 1 1/4 pounds

### MAIN HYDRAULIC PUMP

Type ..... Vane  
 Capacity..... 17 GPM @ 2250 engine RPM

### STEERING PUMP

Type ..... Vane  
 Capacity:.....  
 .... regulated to 2 GPM by flow control

### HYDRAULIC VALVE

Pressure Relief Valve Setting .....  
 ..... 2000 PSI @ 2250 engine RPM

### ELECTRICAL SYSTEM

Starting Motor  
 Brush tension (min) ..... 35 oz.  
 Rotation viewing D.E. .... C  
 Spec. No. .... 2441  
 No load test:  
 Volts ..... 10.6  
 Min. amps ..... 49\*  
 Max. amps ..... 76\*  
 Min RPM ..... 6200  
 Max. RPM ..... 9400

Resistance test:  
 Volts ..... 4.3  
 Min amps ..... 270  
 Max amps ..... 310

### Distributor

Rotation viewing D.E. .... C  
 Point opening (in) ..... 021  
 Cam angle (deg) ..... 31-34  
 Spec. No.....70  
 Centrifugal advance:  
 Start  
 RPM ..... 300  
 Deg ..... 5-2.5  
 Intermediate  
 RPM ..... 400  
 Deg ..... 3-5  
 Intermediate  
 RPM ..... 800  
 Deg ..... 5.5-7.5  
 Maximum  
 RPM ..... 1100  
 Deg..... 7.5-9.5

### Generator

Rotation ..... C  
 Circuit ..... A  
 Brush spring tension..... 28  
 Field Current  
 Amps ..... 1.69-1.79  
 Volts ..... 12.0  
 Volt output  
 Amps ..... 25.0  
 Volts ..... 14.0  
 RPM ..... 1970

### Voltage regulator

Circuit ..... A  
 Polarity ..... N  
 Spec. No. .... 2146  
 Cutout Relay  
 Air gap (in) ..... 020  
 Point opening ..... 020  
 Closing voltage range.11.8013.5  
 Voltage regulator  
 Air gap (in) ..... 075  
 Volt setting range .....  
 .....14.2-15.2 at 85 degrees  
 Current regulator  
 Air gap (in) ..... 075  
 Current setting range.....  
 ..... 24.5-29 at 85 degrees

Ignition timing ..... 2 degrees BTDC

### SPARK PLUGS

..... Resistor .035

### BATTERY (12 Volt)

20 hr. rate @ 61 amp. hr.  
 300 amp. @ 1.6 min. @ 0 deg F  
 300 amp. @ 10 sec. @ 7.7 volts  
 ..... @ 0 deg F  
 6 cell, 66 plates  
 Group number SAE 25 MD.



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## SPECIFICATIONS



### WHEEL NUT TORQUE

Steering wheels 290-300 lb. ft.  
 Drive wheels ..... 490-500 lb. ft.

\* Includes solenoid.

### ENGINE LIMITS AND CLEARANCE DATA

No. of Cylinders ..... 6  
 Bore & Stroke ..... 3 5/16 X 4 3/8  
 Displacement Cu. In. .... 226  
 Compression Ratio ..... 7.28  
 Max. Oil Pressure ..... 20-30  
 Min. Oil Pressure ..... 7  
 Firing Order ..... 1-5-3-6-2-4  
 Main Brg.- Front ..... 2 3/8 X 1 1/16  
 Main Brg. - Int. .... (2) 2 3/8 X 1 5/16  
 Main Brg. - Rear ..... 2 3/8 X 1 23/64  
 Conn. Rod Brg:  
 Dia. & Length ..... 2 1/16 X 1 1/8  
 Oil Capacity  
 Crankcase ..... 5  
 Filter ..... 1/2  
 Total ..... 5 1/2  
 Water Capacity (Given in quarts - add  
 approximately 1 quart for hoses)  
 Engine ..... 6 1/2  
 Radiator ..... 10 1/2  
 Total ..... 17  
 Weight - Bare Engine..... 555

Valve Clearance  
 Intake (Hot) ..... .014  
 Intake (Cold) ..... .012  
 Exhaust (Hot) ..... .014  
 Exhaust (Cold) ..... .020

Valve Guide:  
 Length: ..... 2 5/16  
 Outside Diameter..... .6575/.6565  
 Stem Hole Diameter ..... .3432/.3422  
 Wear Limits - Max. Dia ..... .3447  
 Distance, Cyl. Block Contact .....  
 ..... Face to Guide. 1 13/32

Dimensions of Standard Inserts and  
 Counterbores:  
 Outside Dia. of Inserts (A).... 1.442-1.441  
 Inside Dia of Counterbore (B).. 1.438-1.437  
 Press Fit ..... .003-.005

Valves, Intake  
 Stem Dia ..... .3414/.3406  
 Wear Limits, Min. Dia ..... .3386  
 Seat Angle ..... 30°  
 Stem Clearance Limits ..... .0026/.0008  
 Wear Limits-Max. Clearance ..... .0046  
 Sesired Stem Clearance ..... .0015

Valves, Exhaust  
 Stem Dia ..... .3385/.3357  
 Wear Limits - Min, Dia. .... .3357  
 Seat Angle ..... 45°  
 Stem Clearance-Limits..... .0055/.0037  
 Wear Limits, Max. Clearance ..... .0075  
 Desired Stem Clearance ..... .45

Valve Springs  
 Outside Dia. .... 31/32  
 Length-Valve Closed ..... 45/64  
 Wear Limits-Min. Wgt ..... 42#  
 Length-Valve Open ..... 1 27/64  
 Load-Valve Open ..... 961-104#  
 Wear Limits-Min. Wgt. .... 86#



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## SPECIFICATIONS

### ENGINE LIMITS AND CLEARANCE DATA

#### Tappets

O. D. Tappet ..... .9990  
 Bore in Block ..... 1.0000  
 Total Max. Wear Limits ..... .005

#### Camshaft

Brg. Journal Dia. #1 .....1.8725/1.8715  
 #2 .....1.8095/1.8085  
 #3 .....1.7465/1.7457  
 #4 .....1.2475/1.2465

Wear Limits-Min. Dia. (.001 UNDER MIN.....  
 (NEW SHAFT DIAMETER).....

Bushing-Inside Dia. #1 ..... 1.8755/1.8745  
 #2 ..... 1.8125/1.8115  
 #3 ..... 1.7502/1.7495  
 #4 ..... 1.2505/1.2495

Bushing-Clearance Limits ..... .004/.002  
 End Play ..... .009/.005

#### Connecting Rods

Bush. Hose Dia ..... .914/913  
 Brg. Hole Dia. .... .1870/2.1865  
 Brg. Thickness ..... 16/.0613  
 Wear Limits-Min. Thk. .... .0608  
 Dia. - Crank Pin ..... 2.0619/2.0627  
 Wear Limits-Min. Dia. .... 2.0609  
 Clearance Limits ..... .0006/.0022  
 Desired Clearance ..... .0015  
 Wear Limits-Max Clearance ..... .0032  
 Side Play ..... .010/.006  
 Desired Side Play ..... .006

#### Main Bearings

Dia. of Brg. Bore  
 in Block ..... 2.5615-2.5622  
 Brg. Shell Thickness ..... .09250/.0928  
 Wear Limits Min. Thk. .... .0920  
 Dia. of Main Brg. Jr. .... 2.3744/2.3752  
 Wear Limits-Min. Dia ..... 2.3734  
 Clearance Limits..... .0007/.0028  
 Desired Clearance ..... .0015  
 C/S End Play ..... .002/.006

#### Crankshaft Fillet Radii

C/S Fillet Radii - 3/32" + or - 1/64" R on  
 all crankpins and mains except rear.  
 C/S Fillet Radii 1/8" + or - 1/64" R on  
 rear main.

#### Piston Pin

Length ..... 2.868/2.878  
 Diameter ..... .8593/.8591  
 Wear Limits-Min Dia ..... .8588  
 Desired Fit..... Light Push  
 Bush. Hole Dia. - Fin ..... .8597/.8595  
 Wear Limits-Max. Dia ..... .8 07  
 Pin Cl. in Bushing ..... .0006/.0002  
 Desired Pin Fit ..... .0004

#### Pistons

Cylinder Dia. .... 3.3145/3.3125  
 Wear Limits-Cyl. Bore ..... .008  
 Piston Pin Hole Dia. .... .8595/.8595

Ring Groove Width #1 ..... .1290/.1270  
 Max. Wear Limits ..... .1310  
 Ring Groove Width-#2-3..... .1285/.1275  
 Max Wear Limit ..... .1305  
 Ring Groove Width-#4 ..... .2535/.2520  
 Max. Wear Limit ..... .2555  
 Ring Groove Width-#5 ..... None  
 Max. Wear Limit ..... —  
 Piston Fit-Feeler Gauge ..... .003  
 Lbs. Pull ..... 5-10#

#### Piston Rings

Ring Width-#1 ..... .124/.123  
 Wear Limits-Min. Width ..... .121  
 Ring Width-#2 & #3 ..... .124/.123  
 Wear Limits-Min. Width ..... .121  
 Ring Width-#4 ..... .249/.2485  
 Wear Limits-Min. Width..... .2465  
 Ring Width-#5 ..... None  
 Wear Limits-Min Width ..... —  
 Ring Gap Clearance-#1..... .020/.010  
 Ring Gap Clearance-#2 & 3..... .020/.010  
 Ring Gap Clearance-#4 ..... .015/.055  
 Ring Gap Clearance-#5 ..... None  
 Ring Side Clearance-#1 ..... .004/.0025  
 Ring Side Clearance-#2 & 3 .... .0055/.0035  
 Ring Side Clearance-#4 ..... .005/.003  
 Ring Side Clearance-#5 ..... None



INDUSTRIAL TRUCK DIVISION



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BATTLE CREEK, MICHIGAN, U.S.A.





# INDUSTRIAL TRUCK DIVISION



NEW MODEL SECTION SPECIFICATIONS

## ENGINE TORQUE SPECIFICATIONS

Engines have many studs, bolts, and cap screws of special material and sizes and it is very important that care be exercised to torque all studs and bolts correctly.

The torque specifications; foot pounds, listed below MUST be followed in order to have the engine conform to the original specifications.

Size - Diameter	5/16"	3/8"	7/16"	1/2"	9/16"	5/8"
Cylinder Heads	-----	35-40	70-85	100-110	130-140	145-155
Manifolds	15-20	25-30	40-50	50-60	50-50	60-70
Gear Covers, Water Pumps, Front and Rear End Plates	15-20	25-30	50-55	80-90	-----	-----
Oil Pans	12-16	12-16	-----	-----	-----	-----



# INDUSTRIAL TRUCK DIVISION



NEW MACHINE 50 HOUR SERVICE AND INSPECTION

Air Cleaner, Service .....	8H 403
Battery Test and Level Check.....	100H 603
Brake Master Cylinder Level Check.....	100H 303
Brake Pedal, Adjust.....	100H 302
Cooling System, Inspect.....	100H 103
Cylinder Head, Tighten.....	1000H 002
Engine Crankcase, Drain and Refill.....	100H 002
Engine Oil Filter, Change.....	100H 002
Fan Belt, Adjust.....	100H 203
Fuel Pump Strainer, Clean or Replace.....	500H 002
Hand Brake, Adjust.....	1000H 1103
Hydraulic Oil Filter, Change.....	500H 103
Intake and Exhaust Manifold, Tighten.....	500H 403
Lift Chains, Adjust.....	100H 403
Lubricate Machine.....	100H 703
Nuts, Bolts and Capscrews, Tighten.....	500H 403
Power Steering Reservoir Level Check.....	8H 703
Pressure Check Main Hydraulic System.....	1000H 1503
Steering Gear Level Check.....	100H 603
Transmission, Converter and Axle Adapter Level Check.....	100H 002
Transmission, Converter and Axle Adapter Change Filter.....	500H 002

### N O T E

PERFORM THIS SERVICE AND INSPECTION AFTER  
 THE FIRST 50 HOURS OF OPERATION ON NEW  
 MACHINES.





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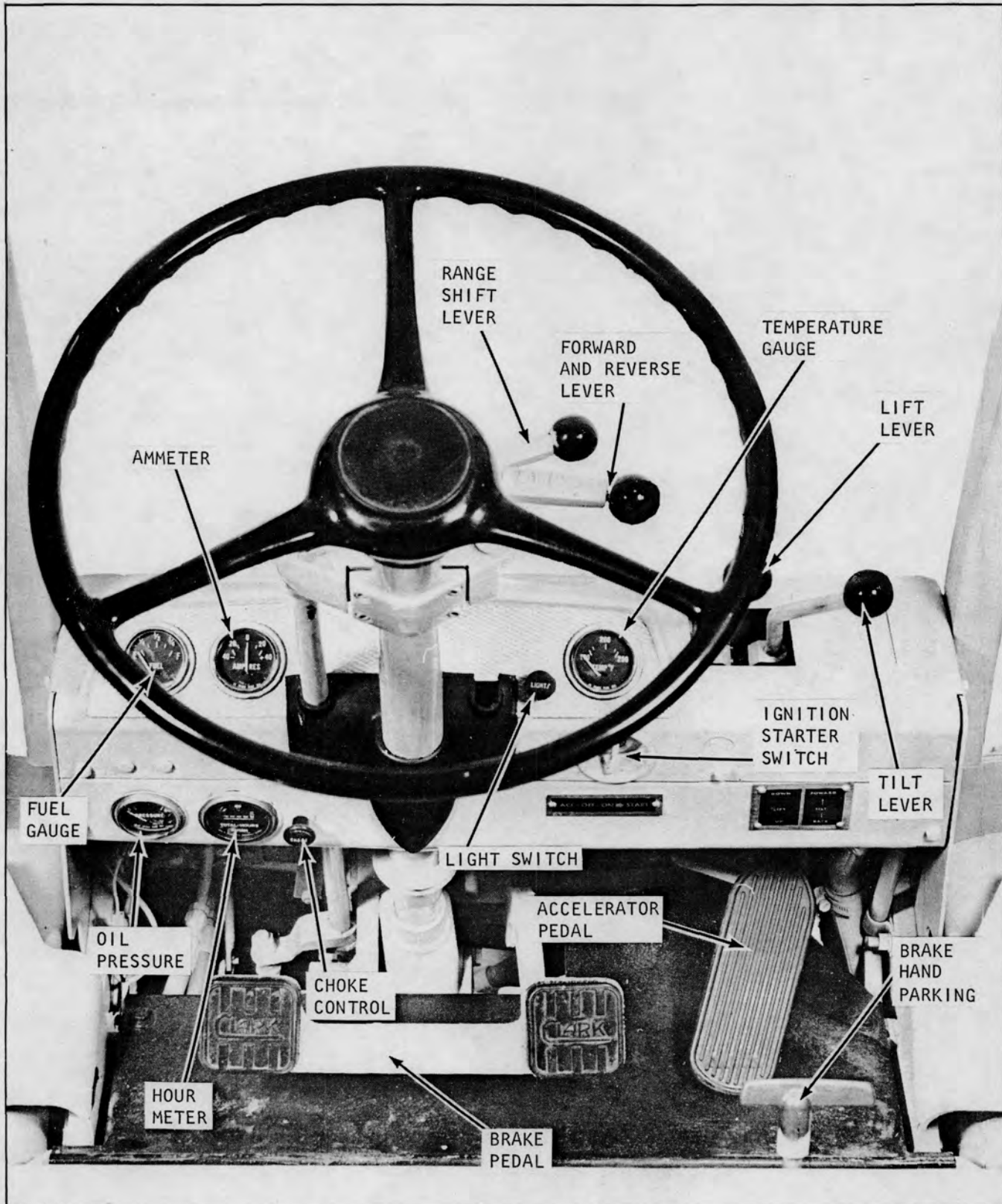


Plate 9478. Overall Controls



Plate 8606. Oil Pressure Indicator

If the oil pressure is erratic or falls below the above limit, stop the engine immediately and find the cause of the trouble. Refer to trouble shooting section for this information. On new machines, after starting machine, run it at idle for five minutes, then stop engine and recheck oil level in crankcase. Bring oil level to high mark, if necessary.

**NOTE**

Before placing machine in operation, run engine a few minutes to warm oil especially in cold operating conditions.

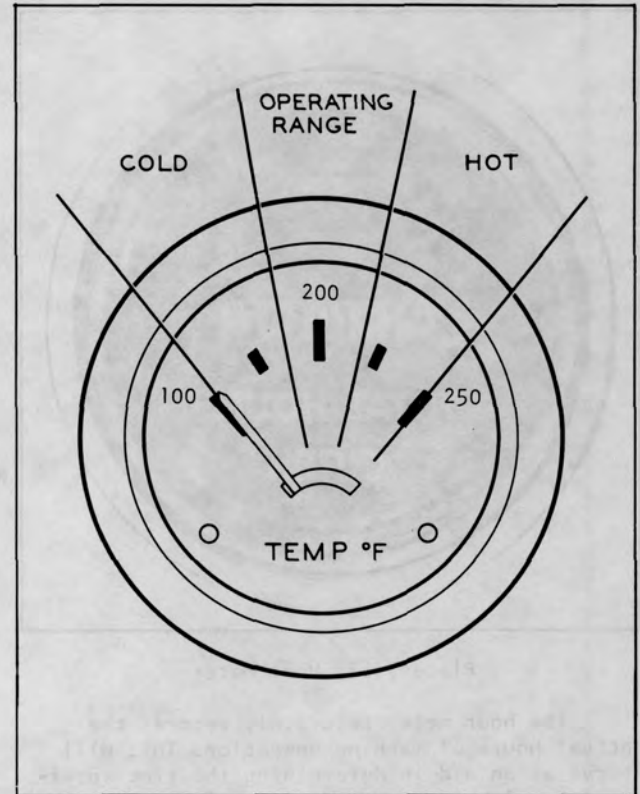


Plate 9479. Engine Coolant Temperature Indicator

**NOTE**

The coolant temperature should register in the operating range after the first few minutes of operation. Low operating temperatures wastes fuel and increases engine wear.

**CAUTION**

DO NOT IDLE THE ENGINE FOR LONG PERIODS AS IT IS NOT ONLY DETRIMENTAL TO THE ENGINE BUT ALSO INCREASES OPERATING COSTS AS YOU ARE USING FUEL WITHOUT BENEFIT.



Plate 7162. Hour Meter

The hour meter accurately records the actual hours of machine operation. This will serve as an aid in determining the time intervals for lubrication and preventive maintenance services.

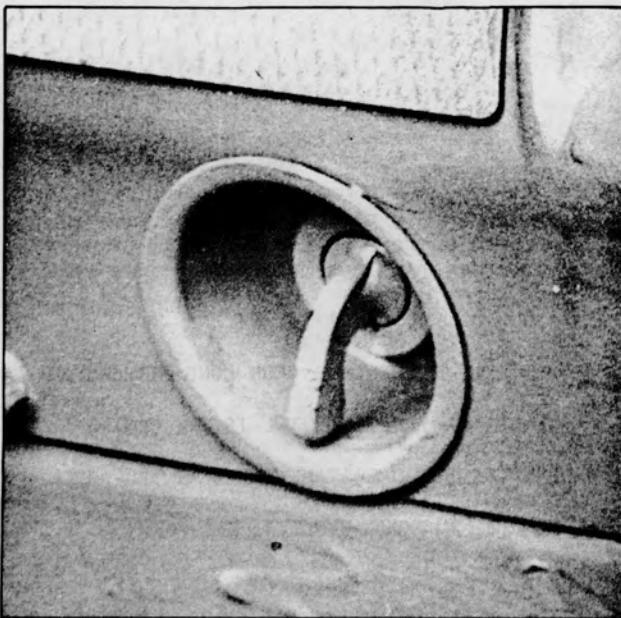
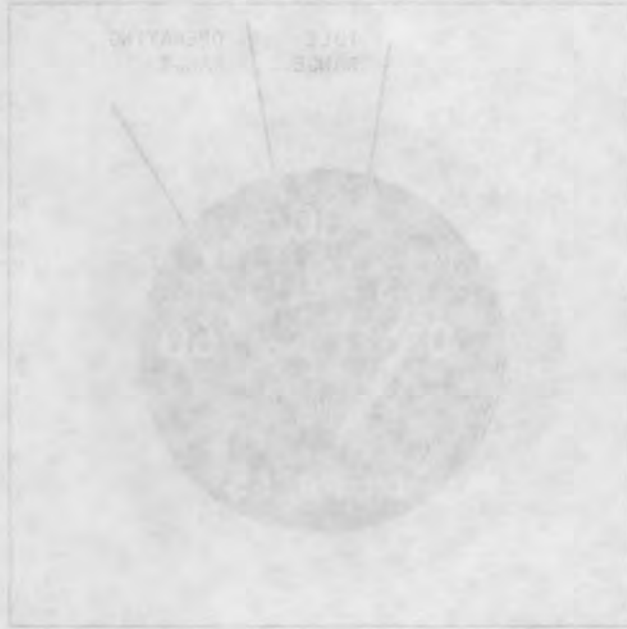


Plate 7018. Ignition Switch



Faint, illegible text, possibly a description or technical notes related to the components shown in the adjacent images.





# INDUSTRIAL TRUCK DIVISION



## OPERATIONS

### STARTING

Place all transmission control levers in neutral position. Pull out on choke and engage the starter by actuating the ignition switch in the start position.

### CAUTION

DO NOT ENGAGE THE STARTER LONGER THAN 15 SECONDS WITHOUT A MINUTE OR SO INTERVAL BETWEEN TRIALS.

If the engine becomes overchoked or flooded; push choke button in, depress accelerator pedal fully and engage starter. If all necessary equipment is in correct working order, the engine will start.

After engine has started, check instrument panel making certain the engine oil pressure indicator shows adequate pressure. If no oil pressure is indicated, stop engine and correct the difficulty.

### NOTE

RUN ENGINE A FEW MINUTES TO WARM OIL, BEFORE PUTTING MACHINE TO WORK ESPECIALLY IN COLD OPERATING CONDITIONS.

### TO OPERATE MACHINE

1. Place transmission control levers in neutral position and start engine.
2. Move Hi and Lo range lever for desired speed.
3. Now move forward and reverse lever out of neutral and into position for desired direction. Accelerate as required.
4. Inching Operation: To inch the machine into a load, the brake pedal should be depressed in its free travel range and the accelerator pedal actuated as required. The initial brake movement is used to regulate the inching control valve which allows a decrease in pressure on the transmission selector pack discs. This permits controlled slippage of the discs allowing the machine to inch - - after the brake pedal travel has actuated the inching valve mechanism the brake become applied and all pressure by-pass the selector discs.

### CAUTION

TO PROLONG MACHINE LIFE IT IS BEST TO COME TO A COMPLETE STOP BEFORE SHIFTING TO THE OPPOSITE DIRECTION.

ALLOW FOOT TO REST ON BRAKE PEDAL ONLY WHEN INCHING IS DESIRED. DO NOT ALLOW FOOT TO REST ON BRAKE PEDAL WHILE DRIVING MACHINE FROM POINT TO POINT. RIDING THE BRAKE PEDAL WILL CAUSE CONTINUED SLIPPAGE OF THE TRANSMISSION SELECTOR PACKS RESULTING IN OVERHEATING AND UNNECESSARY WEAR OR DAMAGE TO TRANSMISSION COMPONENTS.

### TO STOP MACHINE

Remove foot from accelerator pedal and depress brake pedal. If machine is to be parked, place transmission control levers in neutral position, apply hand brake and shut engine off.

### CAUTION

IF THE ENGINE HAS BEEN OPERATING AT OR NEAR FULL LOAD, IT SHOULD BE ALLOWED TO RUN AT FAST IDLE (600 to 800 R.P.M.) FOR ONE OR TWO MINUTES AFTER LOAD IS REMOVED BEFORE BEING STOPPED. THIS ALLOWS INTERNAL ENGINE TEMPERATURES TO EQUALIZE.



# INDUSTRIAL TRUCK DIVISION



## OPERATIONS

### TO MOVE A LOAD

The forks should be adjusted sideways on fork bars to obtain maximum balance in proportion to width of load. Raise or lower forks to proper level and center the load as nearly as possible on the forks. Tilt upright assembly slightly backward to prevent the load from falling, accelerating engine slightly at the same time. Back away from stack.

Adjust the forks with load so they are close to the floor or ground but high enough to avoid hitting obstructions. The operator should have clear vision ahead when moving in a forward direction. When this is not possible, the operator should drive in reverse and sufficiently turn in his seat to obtain clear vision backward.

When the load is to be deposited, enter the area squarely, especially when placing one load on top of another, in order that all piles will be square and secure. Place load directly over desired area and slowly lower to the floor.

### IMPORTANT

EVERY 8 OPERATING HOURS (OR EVERY SHIFT) ELEVATE UPRIGHT TO THE UPPER LIMIT. THIS WILL PROVIDE LUBRICATION TO THE TOP PORTION OF THE LIFT CYLINDER.

### SAFETY AND OPERATION SUGGESTIONS

The use of industrial powered trucks is subject to certain hazards that cannot be overcome by purely mechanical means. The exercise of intelligence, care and common sense by the truck operator is necessary to eliminate the hazards of overloading, slipping and falling of the load; obstructions in the path of travel, or the use of equipment for a purpose for which it is not intended or designed.

The following are a few suggestions that should be followed in the operation of this machine.

1. Operate machine with forks close to floor, loaded or empty, but high enough to avoid hitting obstructions.
2. If vision is obstructed by the load, operate machine in reverse and sufficiently turn in the seat to obtain clear vision.

3. Avoid sudden stops or starts. When backing, be sure to look for fellow workmen before moving machine.
4. Drive carefully at all times. Exercise caution at cross aisles. Sound horn for safety.
5. Be sure loads are safe to move. Have loads properly centered on machine. Refer to the Capacity Chart in Specifications for various load center ratings.
6. An operator should be assigned to a specific machine.
7. The operator should be qualified and drive in accordance with established safety rules.
8. If the machine does not respond immediately, report to designated individual in charge. A minor adjustment now may save a major repair later.
9. Do not allow riders or hitchhikers.
10. Operate the machine at a safe distance behind other vehicles.
11. Do not operate machine with wet or greasy hands.
12. Observe highway traffic laws in the operation of the vehicle in the plant.
13. Drive carefully on wet or slippery floors.
14. Keep feet within running line of truck.
15. Avoid overloading the truck -- this is a safety measure against possible injury to the driver and fellow workmen. Overloading shortens the life of the truck and increases maintenance.
16. Do not operate machine for prolonged periods in an unventilated area. All engines produce poisonous carbon monoxide gas as a by-product of combustion and can be dangerous if allowed to accumulate in a closed area.
17. Be sure the brakes are in proper working condition. Be sure all mechanical and electrical components are working correctly.





# INDUSTRIAL TRUCK DIVISION



## LUBRICATION AND PREVENTIVE MAINTENANCE INDEX

### (8 Hours)

	Time Interval & Number (H=Hours)	Page (0000)
Air cleaner check.....	8H.....	403
Brake Pedal free travel & parking brake check.....	8H.....	303
Engine crankcase check.....	8H.....	002
Engine cooling system check.....	8H.....	103
Hydraulic sump and control levers check.....	8H.....	503
Instrument indicators check.....	8H.....	203
Instrument indicators check.....	8H.....	204
Power steering pump.....	8H.....	703
Tire and rim maintenance.....	8H.....	602
Tire and rim maintenance.....	8H.....	603

### (100 Hours)

Brake pedal free travel check.....	100H.....	302
Brake system check.....	100H.....	303
Battery check.....	100H.....	603
Cooling system check.....	100H.....	103
Converter, Transmission and Axle Adapter.....	100H.....	001
Engine crankcase and oil filter check.....	100H.....	002
Fan and generator drive belt check.....	100H.....	203
Hydraulic sump tank breather..	100H.....	503
Lifting mechanisms check.....	100H.....	403
Lubrication chart.....	100H.....	703
Steering Gear Check.....	100H.....	603

### (500 Hours)

Axle adapter and transmission drain plugs.....	500H.....	004
Fuel pump filter check.....	500H.....	001
Hydraulic sump tank and filter check.....	500H.....	103
Manifolds check.....	500H.....	403
Steering gear adjust.....	500H.....	202
Steering gear adjust.....	500H.....	203
Steering axle and linkage adjustments.....	500H.....	302
Steering axle and linkage adjustments.....	500H.....	303
Transmission oil filter, screen, and level check.....	500H.....	002

### (1000H)

Axle ends lubrication.....	1000H.....	805
Brake bleeding procedure.....	1000H.....	912
Brake bleeding procedure.....	1000H.....	913
Brake service.....	1000H.....	1003
Battery check.....	1000H.....	1705
Cylinder head, manifolds, crankcase, and valves adjust,..	1000H.....	002
Compression test.....	1000H.....	103
Cooling system inspect and clean.....	1000H.....	1202
Distributor adjustments.....	1000H.....	203

### (1000 Hours)

	Time Interval & Number (H=Hours)	Page (0000)
Distributor adjustments.....	1000H.....	203
Distributor adjustments and timing.....	1000H.....	303
Engine Tune-up.....	1000H.....	001
Governor adjustment.....	1000H.....	503
Governor adjustment.....	1000H.....	504
Generator adjustment.....	1000H.....	703
Generator adjustment.....	1000H.....	704
Hand brake adjustment.....	1000H.....	1103
Hydraulic system check.....	1000H.....	1503
Hydraulic system check.....	1000H.....	1504
Hydraulic system check.....	1000H.....	1505
Hydraulic system check.....	1000H.....	1507
Lift and upright adjustments..	1000H.....	1803
Lift carriage roller adjust....	1000H.....	1811
Neutral starting switch.....	1000H.....	1793
Roller adjustments.....	1000H.....	1806
Starting motor.....	1000H.....	603
Starting motor.....	1000H.....	604
Steer wheel bearings Lubrication.....	1000H.....	803
Timing.....	1000H.....	304
Transmission stall and pressure chekcs.....	1000H.....	1703
Transmission stall and pressure checks.....	1000H.....	1705
Upright roller adjustments....	1000H.....	1807
Upright roller lubrication....	1000H.....	1815
Valve adjustments.....	1000H.....	002
Vacuum test.....	1000H.....	403

### N O T E

Lubrication and Preventive Maintenance Illustrations at the beginning of each time interval section. When performing the 100, 500 or 1000 hour lubrication and preventive maintenance, always include the previous lubrication and preventive maintenance schedules.



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LUBRICATION AND PREVENTIVE MAINTENANCE

8 HOURS

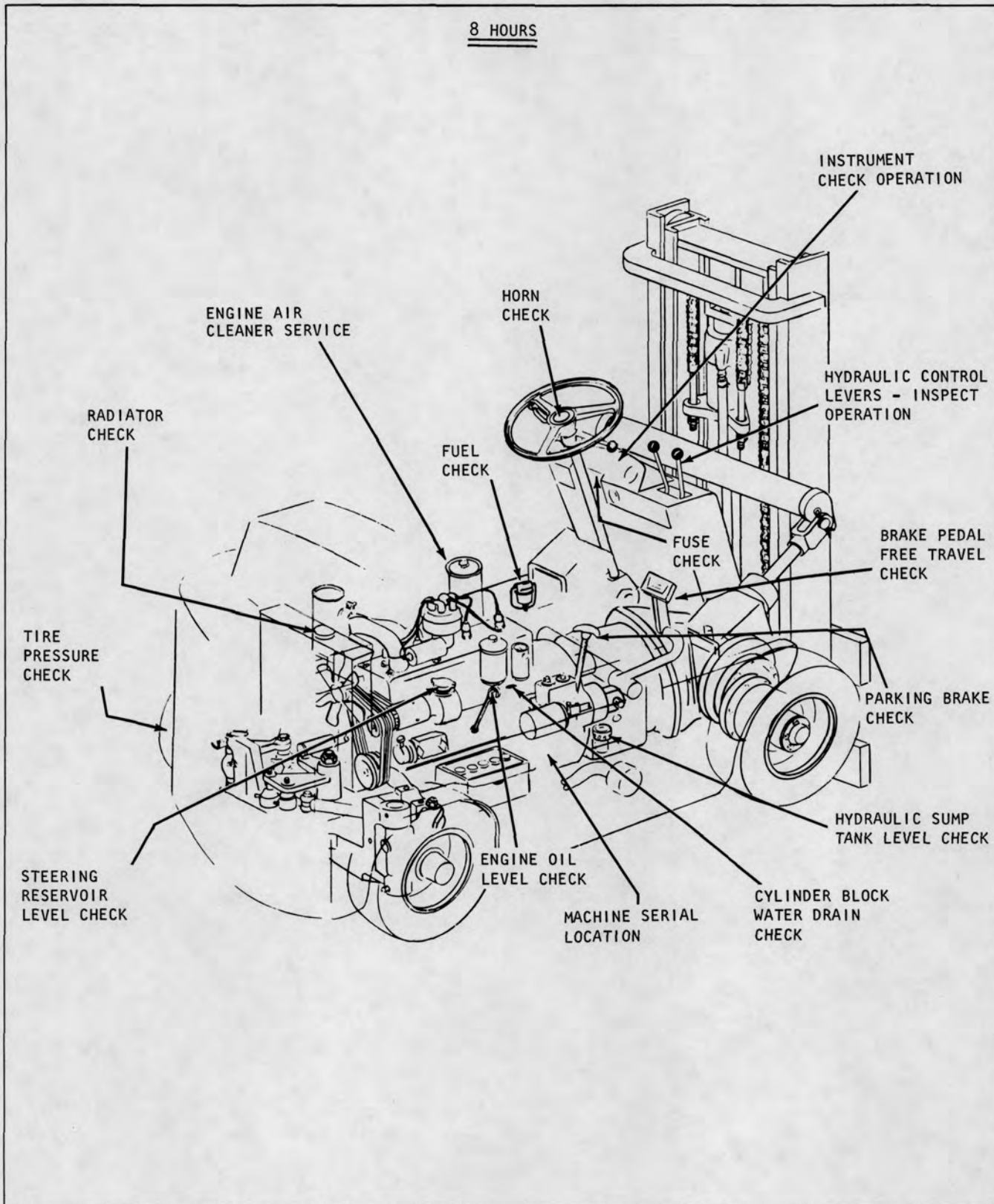


Plate 9480. Lubrication & Preventive Maintenance Illustration



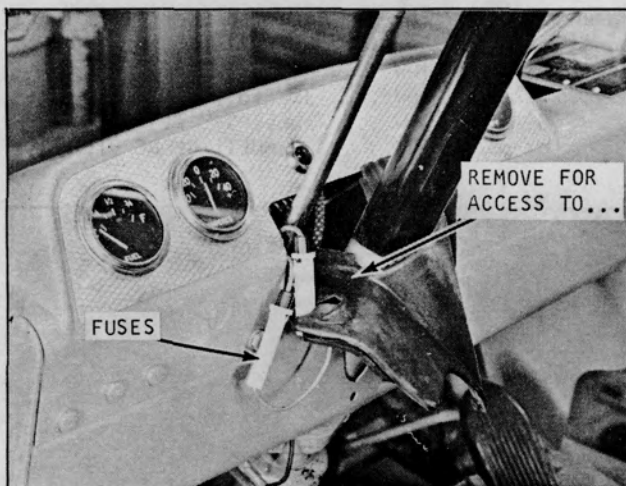


Plate 9473. Electrical System Fuse

**HORN**

Check to be sure the horn is working properly. The horn and ignition fuse is located beneath the dash near the steering column. Fuses are accessible by removing steering column grommet.

**FUEL TANK**

Check fuel supply and fill if necessary. Use a good grade of fuel.

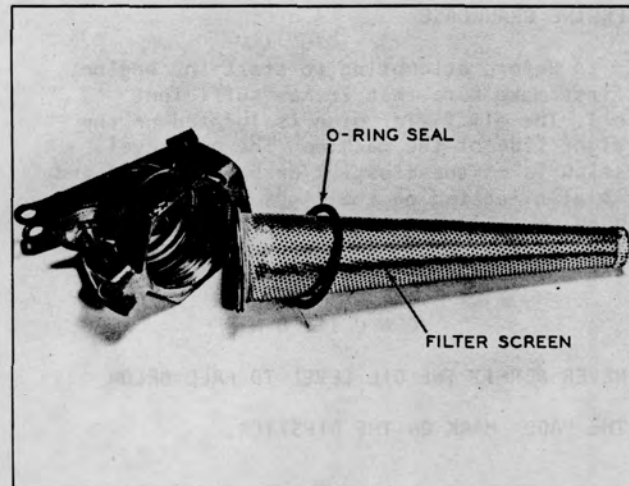


Plate 6627. Fuel Tank Filler Cap & Screen

Before filling fuel tank, make certain the filler cap screen and "O" ring are in place and not damaged.

**CAUTION**

**DO NOT REMOVE THE SCREEN WHILE FILLING TANK.**



**ENGINE CRANKCASE**

Before attempting to start the engine, first make sure that it has sufficient oil. The oil filler pipe is located on the right side of the machine. The oil level stick is of the dipstick or bayonet type and is also located on the right side of the machine. Fill the crankcase reservoir through the filler pipe to the proper level as indicated on the dipstick.

**CAUTION**

NEVER PERMIT THE OIL LEVEL TO FALL BELOW THE "ADD" MARK ON THE DIPSTICK.

DO NOT OVERFILL THE CRANKCASE, AS TOO MUCH OIL WILL BRING THE LEVEL HIGH ENOUGH FOR THE CONNECTING RODS TO DIP, THUS CAUSING EXCESSIVE QUANTITIES OF OIL TO BE THROWN TO THE CYLINDER WALLS RESULTING IN OIL CONSUMPTION, SMOKING, EXCESSIVE CARBON DEPOSITS AND FOULED SPARK PLUGS.

Crankcase Capacity — Refer to Specifications

		Service "MS" Oils
S.A.E.	10W ....	0° to 32° F.
S.A.E.	20W ....	32° to 75° F.
S.A.E.	30W ....	above 75° F.
or use	10W ....	30 MULTI-GRADE OIL

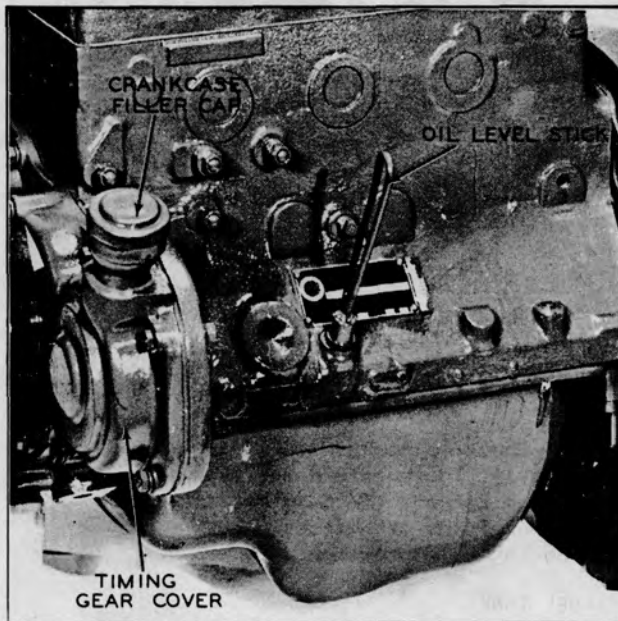


Plate 6629. Engine Crankcase Fill

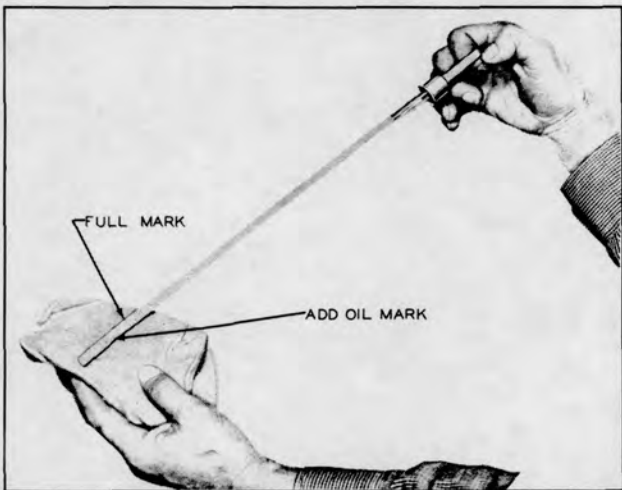


Plate 3145. Crankcase Oil Check

**ENGINE COOLING**

Make sure that the radiator drain cock and the water drain in the cylinder block are closed. Check radiator coolant level and fill to within 1 inch of the top with clean water; or if operation is in cold weather, use a suitable anti-freeze solution.

It is recommended that a soluble oil in the proportion of 1 ounce per gallon of water be added to the Cooling System.

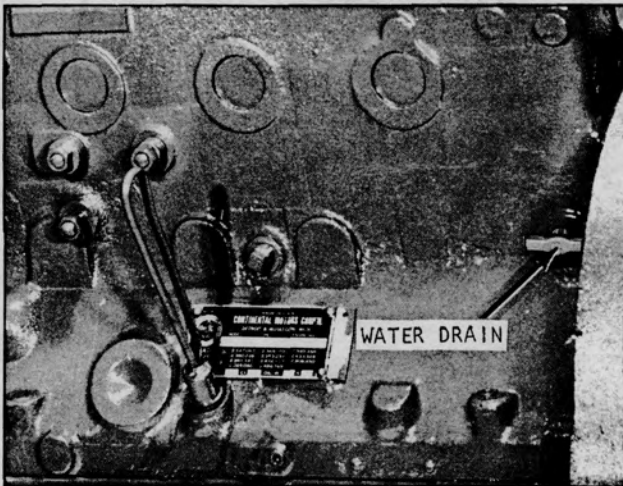


Plate 7008. Typical Cylinder Block Water Drain

**CAUTION**

NEVER POUR COLD WATER OR COLD ANTI-FREEZE INTO THE RADIATOR OF AN OVERHEATED ENGINE. ALLOW THE ENGINE TO COOL AND AVOID THE DANGER OF CRACKING THE CYLINDER HEAD OR BLOCK. KEEP ENGINE RUNNING WHILE ADDING WATER OR ANTI-FREEZE. WHEN PERMANENT ANTI-FREEZE OF THE ETHYLENE GLYCOL TYPE IS USED, THE COOLANT SOLUTION MUST CONTAIN AT LEAST 40% WATER.



# INDUSTRIAL TRUCK DIVISION



LUBRICATION AND PREVENTIVE MAINTENANCE

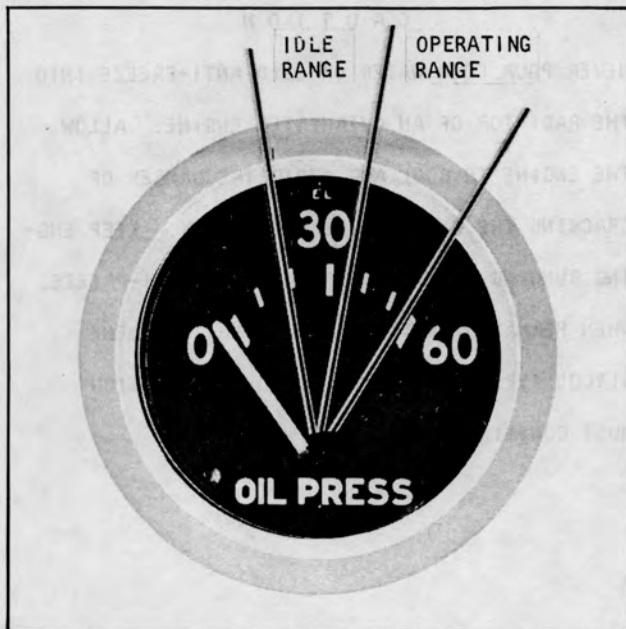


Plate 8606. Oil Pressure Indicator

If the oil pressure is erratic or falls below the above limit, stop the engine immediately and find the cause of the trouble. Refer to trouble shooting section for this information. On new machines, after starting machine, run it at idle for five minutes, then stop engine and recheck oil level in crankcase. Bring oil level to high mark, if necessary.

### NOTE

Before placing machine in operation, run engine a few minutes to warm oil especially in cold operating conditions.

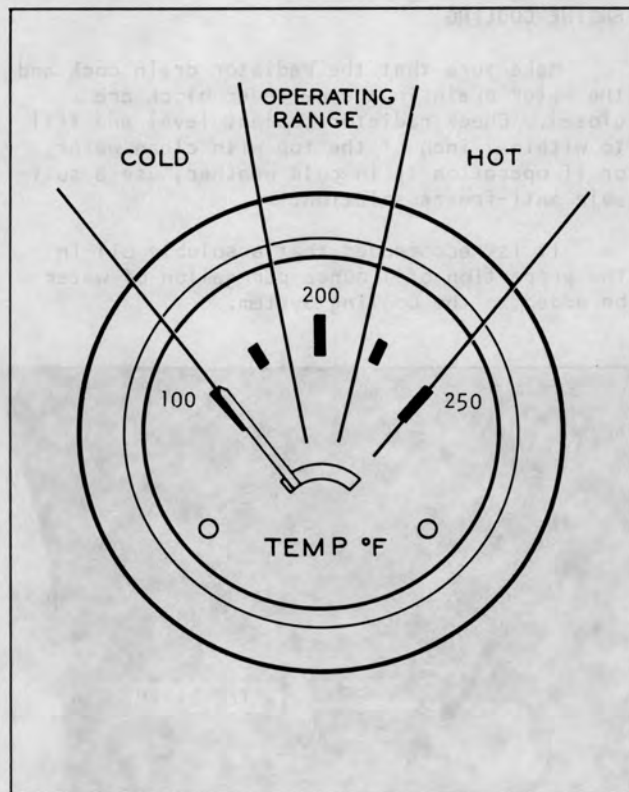


Plate 9479. Engine Coolant Temperature Indicator

### NOTE

The coolant temperature should register in the operating range after the first few minutes of operation. Low operating temperatures wastes fuel and increases engine wear.

### CAUTION

DO NOT IDLE THE ENGINE FOR LONG PERIODS AS IT IS NOT ONLY DETRIMENTAL TO THE ENGINE BUT ALSO INCREASES OPERATING COSTS AS YOU ARE USING FUEL WITHOUT BENEFIT.





Plate 7162. Hour Meter

The hour meter accurately records the actual hours of machine operation. This will serve as an aid in determining the time intervals for lubrication and preventive maintenance services.

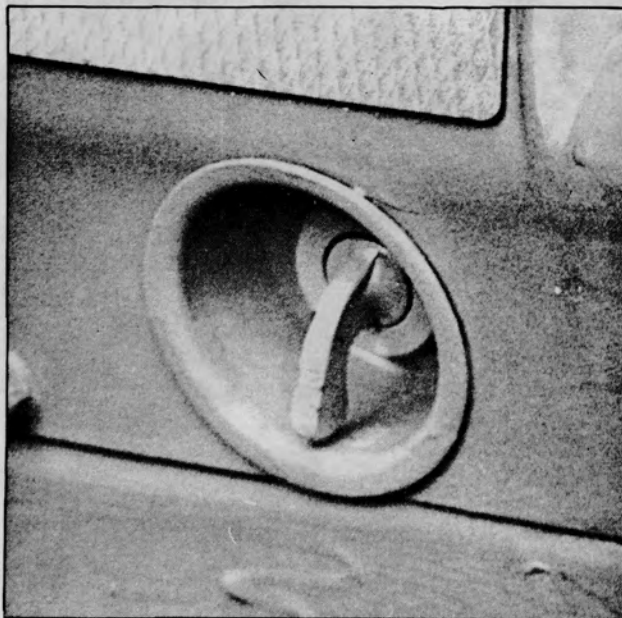
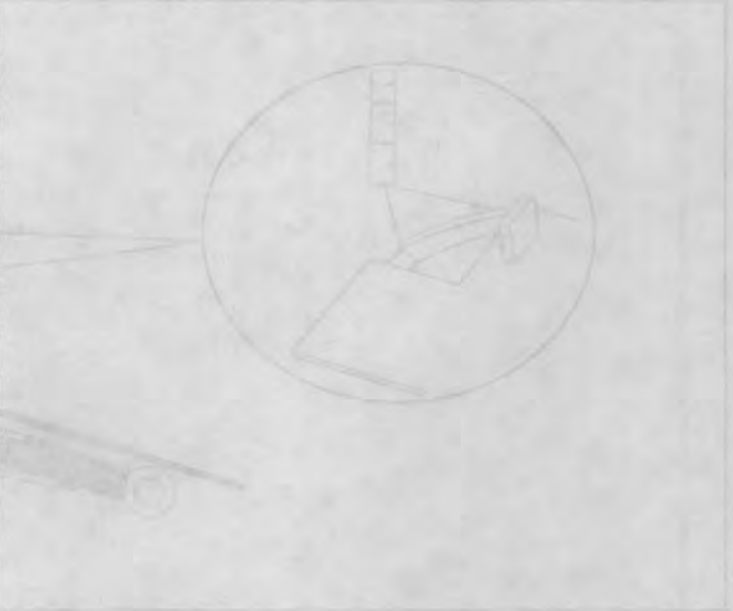


Plate 7018. Ignition Switch



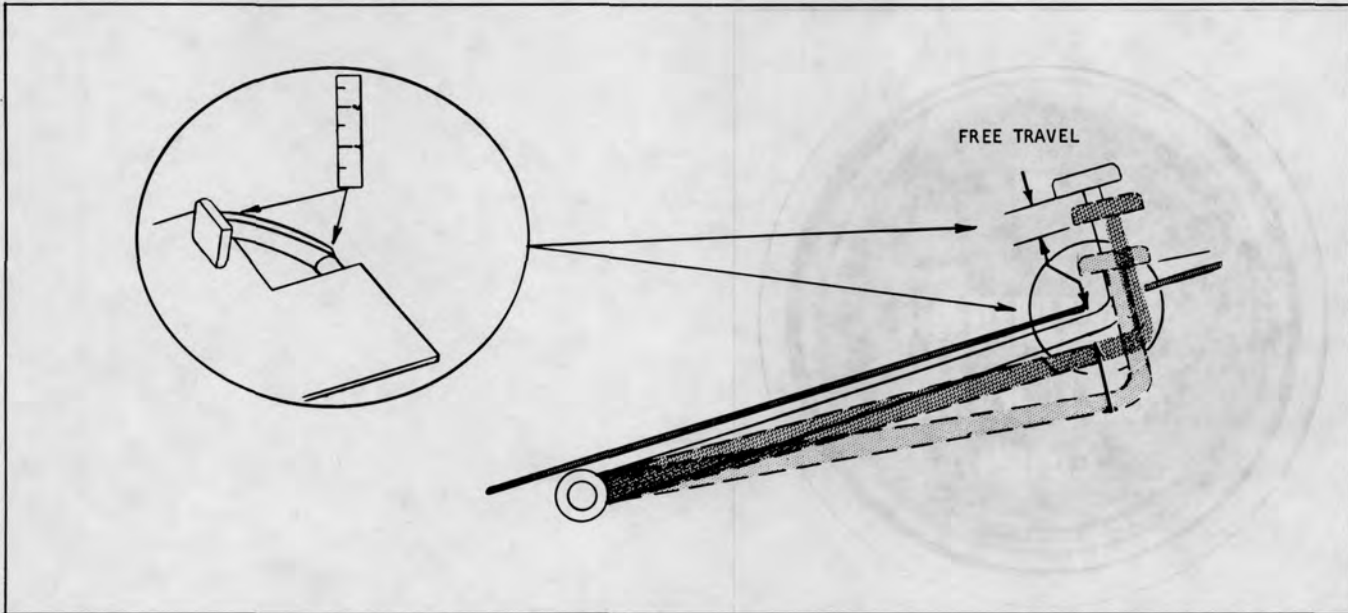


Plate 9592. Brake Pedal Free Travel

**BRAKE PEDAL**

1. Depress brake pedal by hand. When pedal meets resistance from the master cylinder, the distance traveled should be  $\frac{3}{16}$ " to  $\frac{5}{16}$ ". If free travel is incorrect an adjustment should be made at the master cylinder linkage adjuster.

2. Depress foot pedal and hold for at least 10 seconds. Pedal must be solid, must not be spongy or drift under foot pressure

**PARKING BRAKE**

The parking brake linkage should be adjusted so that the brake handle will have 2 inches of upward free travel, before resistance is noticed and the brake becomes applied.

The parking brake must be capable of holding the truck, with full rated load, on a 15% grade. This should be tested while occupying the driver's seat with the parking brake applied and truck out of gear.

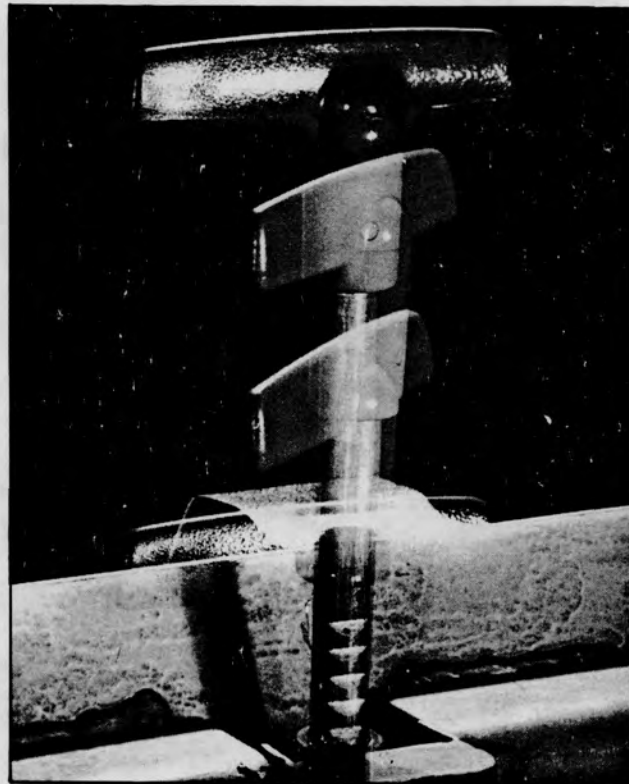


Plate 7482. Parking Brake



Plate 5985. Air Cleaner  
Fill to oil level only.

**AIR CLEANER (OIL BATH TYPE)**

The air cleaner is of the oil bath type. The main function of the air cleaner is to prevent dirt and grit from getting into the engine. All engines, when operating, consume several thousand cubic feet of air per hour. Since dusty air is full of abrasive matter, the engine will soon wear excessively if the air cleaner does not remove the dust before entering the cylinders.

Operating conditions determine the air cleaner service periods. As the dirt is strained from the air flowing through the cleaner, it thickens the oil in the cup and raises the level. If the level is too high, agitation of the oil on the screen is affected and gritty oil is carried over into the air stream, through the carburetor and into the engine cylinders. This would actually introduce a grinding compound with resulting very rapid wear.

Air cleaner maintenance may seem trivial, but it can mean longer engine life, less engine up keep and better economy providing proper maintenance is exercised. Common sense with a close observance can best determine the frequency of air cleaner maintenance.



Plate 7663. Air Cleaner Screen and Oil Cup.

**RECOMMENDED MAINTENANCE**

The air cleaner should be checked every 8 operating hours and cleaned if needed. This may be necessary twice daily under extreme dirty conditions.

Remove air cleaner oil cup and wash in a Stoddard type cleaning solvent. Wipe dry and refill with new engine oil. Replace oil cup on air cleaner being sure it is properly positioned.

Check all hose connections to be sure they are tight. Periodically remove hose connections and check interior of hose for dirty or dust. If found, this indicates that additional cleaning intervals are necessary.

**CAUTION**

**ALWAYS CHECK AIR CLEANER ASSEMBLY WITH THE ENGINE TURNED OFF. NEVER CHECK OR REFILL THE OIL CUP WITH THE ENGINE IN OPERATION.**

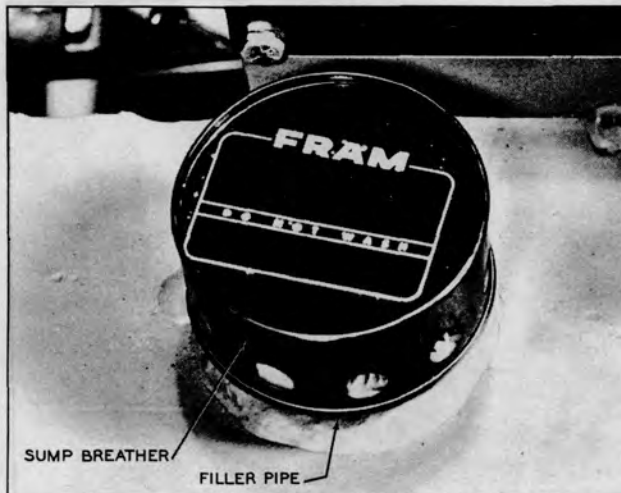


Plate 6626. Hydraulic Sump Tank and Sump Breather

**HYDRAULIC SUMP TANK**

Check hydraulic sump tank fluid level in the following manner:

1. Lower upright.
2. Turn switch key to off position
3. Remove sump breather. Fluid level should be up to bottom of filler pipe.

If necessary, fill sump tank using MS 68 Hydraulic fluid. Move valve control levers with hydraulic pump operating to allow any air in the lines to escape, then recheck sump tank fluid level and fill as required before putting machine in operation.

**HYDRAULIC CONTROL LEVERS**

**I M P O R T A N T**

EVERY 8 OPERATING HOURS (OR EVERY SHIFT)

ELEVATE UPRIGHT TO THE UPPER LIMIT. THIS WILL PROVIDE LUBRICATION TO THE TOP PORTION OF THE LIFT CYLINDER.

Check lift and tilt operation. The lift and tilt cylinders should actuate when lift or tilt levers are moved either way from neutral position.

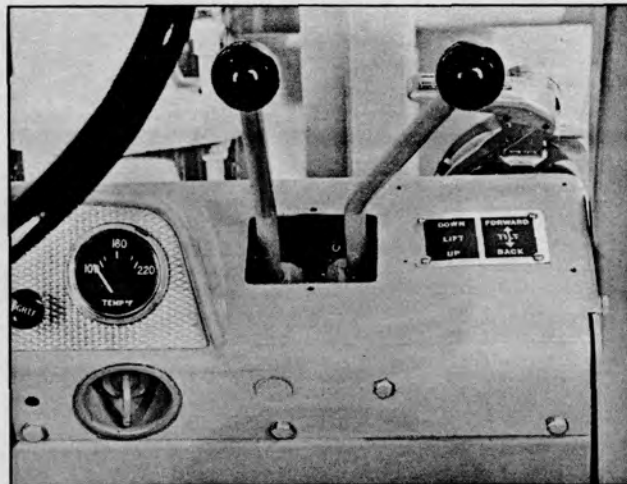


Plate 9535. Lift and Tilt Lever

When load is elevated and control lever returned to neutral position, load should remain in elevated position, with no noticeable downward drift. If load drifts downward excessively, this may indicate lift cylinder U-Cup or seal damage.

With tilt lever in neutral position, upright should remain steady with no noticeable backward or forward drift. If upright drifts excessively either way, this may indicate tilt cylinder seal or U-Cup damage.

**C A U T I O N**

NEVER ALLOW LOADED OR UNLOADED LIFT CARRIAGE TO REMAIN IN AN ELEVATED POSITION FOR ANY PROLONGED PERIODS. LIFT CARRIAGE SHOULD BE LOWERED WHEN NOT IN USE.

DO NOT HOLD CONTROL LEVERS IN EXTREME POSITIONS AFTER A LOAD HAS REACHED ITS LIMITS. TO DO SO WILL RESULT IN HIGH OIL PRESSURE THAT MAY RESULT IN OVERHEATING OF THE HYDRAULIC OIL.



## TIRE AND RIM MAINTENANCE

x  
x  
x W A R N I N G x  
x AN INFLATED TIRE AND RIM CAN BE VERY x  
x DANGEROUS, MANY ACCIDENTS, SOME FATAL, x  
x HAVE RESULTED FROM IMPROPER HANDLING AND x  
x OPERATION OF VEHICLE RIMS TIRES AND WHEELS. x  
x IT IS, THEREFORE, OF THE UTMOST IMPORTANCE x  
x THAT THE FOLLOWING PRECAUTIONS BE NOTED BY x  
x ALL PERSONS CONCERNED TO AVOID PERSONAL x  
x INJURY AND COSTLY DAMAGE. x  
x  
x x

1. After raising the vehicle and prior to removal of wheels, place blocking under the frame so the vehicle cannot become lowered by accident. Blocking must be of adequate strength to support the weight of the vehicle.



Plate 7613. Wheel with Inner and Outer Halves

2. Some vehicles use a rim that has an inner half and an outer half. The two halves are held together by bolts and by the wheel attaching bolts. See Plate 7613. In all cases the air should be removed from the tire by removing the valve core before attempting to remove the wheel from the vehicle. The tire should not be inflated while it is "off" the vehicle. Check for security of all rim retainment bolts and

and wheel attaching bolts before inflating tire. A clip-on type air chuck should be used so the operator can stand to one side during tire inflation.

3. In all cases, when removing wheels equipped with the lock ring type rim from the vehicle for repair or periodic rotation, completely deflate tires. This is best accomplished by removing the valve core.

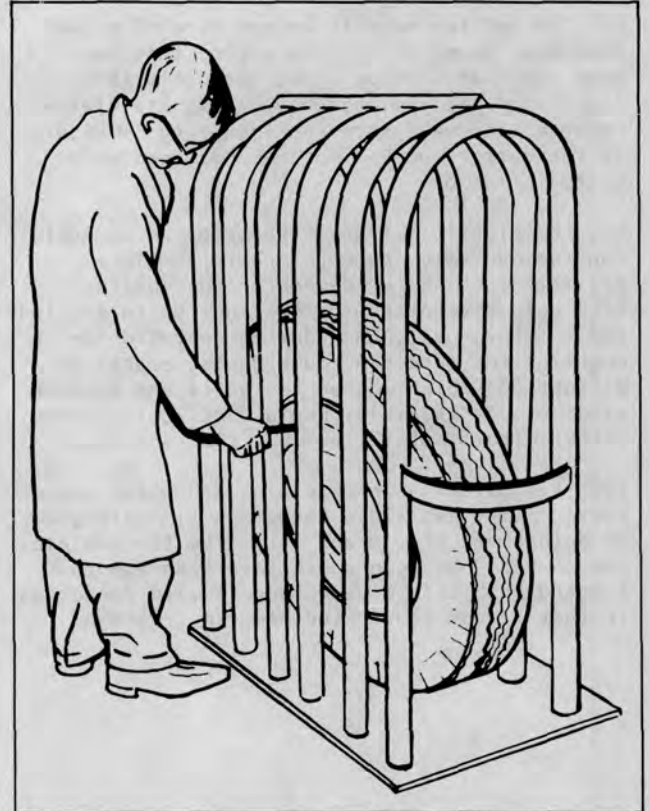


Plate 7614. Safety Cage

4. Tires used on the lock ring type rim should be inflated in a safety cage. See Plate 7614. Insure that rings are properly seated prior to inflation. An inflated tire contains potentially explosive energy that can blow rings loose. A clip-on type air chuck should also be used, so the operator can stand to one side during tire inflation.

5. Use properly matched parts only. Rim base and rings must be matched according to manufacturer, size and type. This information is stamped on each part.

6. Remove rust and other foreign matter. Accumulation of such material in the rim gutter can prevent the proper fitting of rings. Parts that are excessively corroded are weakened and should be replaced. Use of

a rust preventative compound (not containing water) during mounting will minimize rusting.

7. Do not use over-size or over-inflated tires. Use only preferred or alternate size rims for tires and do not exceed recommended air pressures. It is also important to maintain uniform inflation in both tires of a dual assembly so that weight is equally sustained.

8. Do not run vehicle on one tire of a dual assembly. Never re-inflate a tire that has been run flat without first thoroughly inspecting it and the rim assembly. It is especially important to make sure the lock ring is secure in the gutter and has not been damaged prior to re-inflation.

9. Completely deflate tire prior to demounting. Remove valve core to insure complete deflation. Check for damage or worn parts. Mark defective parts for destruction to preclude their future use. Abuse during operation or in mounting the tire can cause dents, cracks or distortions which weaken the parts and prevent safe, proper assembly. Replace defective parts with new parts of the correct size and type.

10. Periodically check clamps and wheel nuts. Loose clamps can cause dangerous rim slippage or detachment of rim and tire from the vehicle. Loose wheel nuts can cause severe damage to rim and hub. Excessive torque is also dangerous in that it can cause stud and rim breakage.

11. Even with the best of maintenance practices, cuts will still be a source of tire trouble. The correct procedure for handling and repairing tires should be given careful attention. Close inspection of all tires should be made at the time of inflation check, and all tires having cuts that penetrate into the cord body should be taken off for proper repair.

*Failure to make regular inspections and repairs, when needed, will result in further deterioration of the cord body and eventually a blowout. Small rocks and dirt will get into shallow cuts in the tread and if neglected will gradually be pounded through the cord body.*

One simple method to forestall this action is to clean out the cut with an Awl or similar tool to remove any stones or other matter which may be lodged in the cut. Use a sharp, narrow-bladed knife and cut away the rubber around the cut to form a cone-shaped cavity extending to the bottom of the injury. The sides of the cavity should be slanted enough to prevent stones from wedging into it. Tires with cuts treated in this manner may be continued in service without danger of further growth of these injuries. If a tire has at least one deep cut that requires a repair, then all smaller cuts may be quickly and economically repaired and vulcanized by the steam kettle method.

**N O T E**

**IT IS NOT RECOMMENDED THAT TIRES WITH BREAKS BE USED AGAIN.**

If uneven tire wear is evident, wheel alignment should be checked.

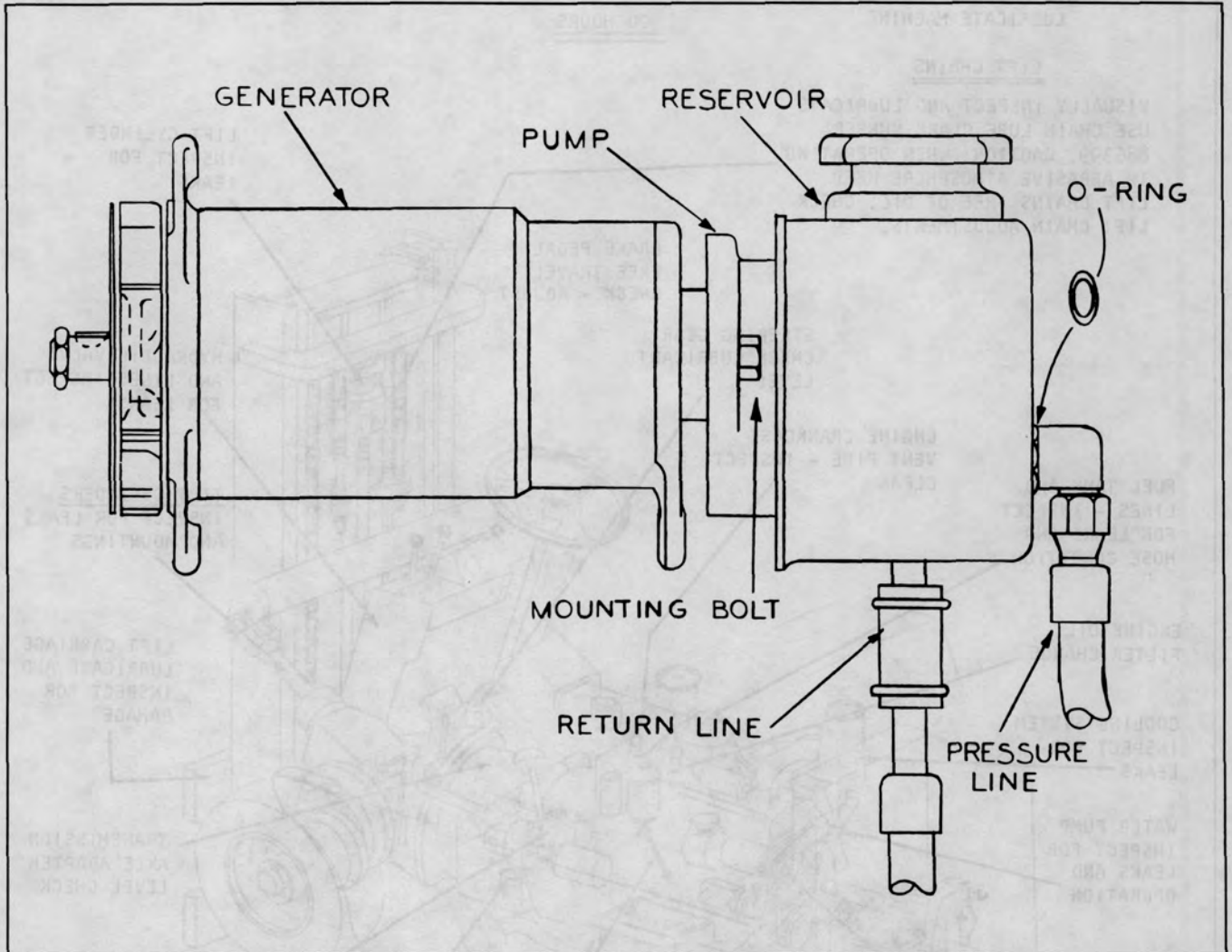


Plate 5940.

Power Steering Pump

**POWER STEERING PUMP**

Check reservoir fluid level each 8 operating hours. Fill (if necessary) with type "A" suffix "A" automatic transmission fluid, CLARK part number 879803. (Fluid containers must display a qualification number prefixed by AQ-ATF.) When fluid in reservoir becomes contaminated it should be drained by removing the return line hose at the bottom of the reservoir. After draining refill to the proper level with the above mentioned fluid. Operate engine for a few minutes and recheck fluid level. Fill to the proper level if necessary.

**CAUTION**

DO NOT OPERATE ENGINE WHILE RESERVOIR IS EMPTY AS THE STEERING PUMP WILL NOT BE LUBRICATED AND SERIOUS DAMAGE WILL OCCUR.



LUBRICATE MACHINE

100 HOURS

LIFT CHAINS

VISUALLY INSPECT AND LUBRICATE  
USE CHAIN LUBE CLARK NUMBER  
886399. CAUTION: WHEN OPERATING  
IN ABRASIVE ATMOSPHERE KEEP  
LIFT CHAINS FREE OF OIL. CHECK  
LIFT CHAIN ADJUSTMENTS.

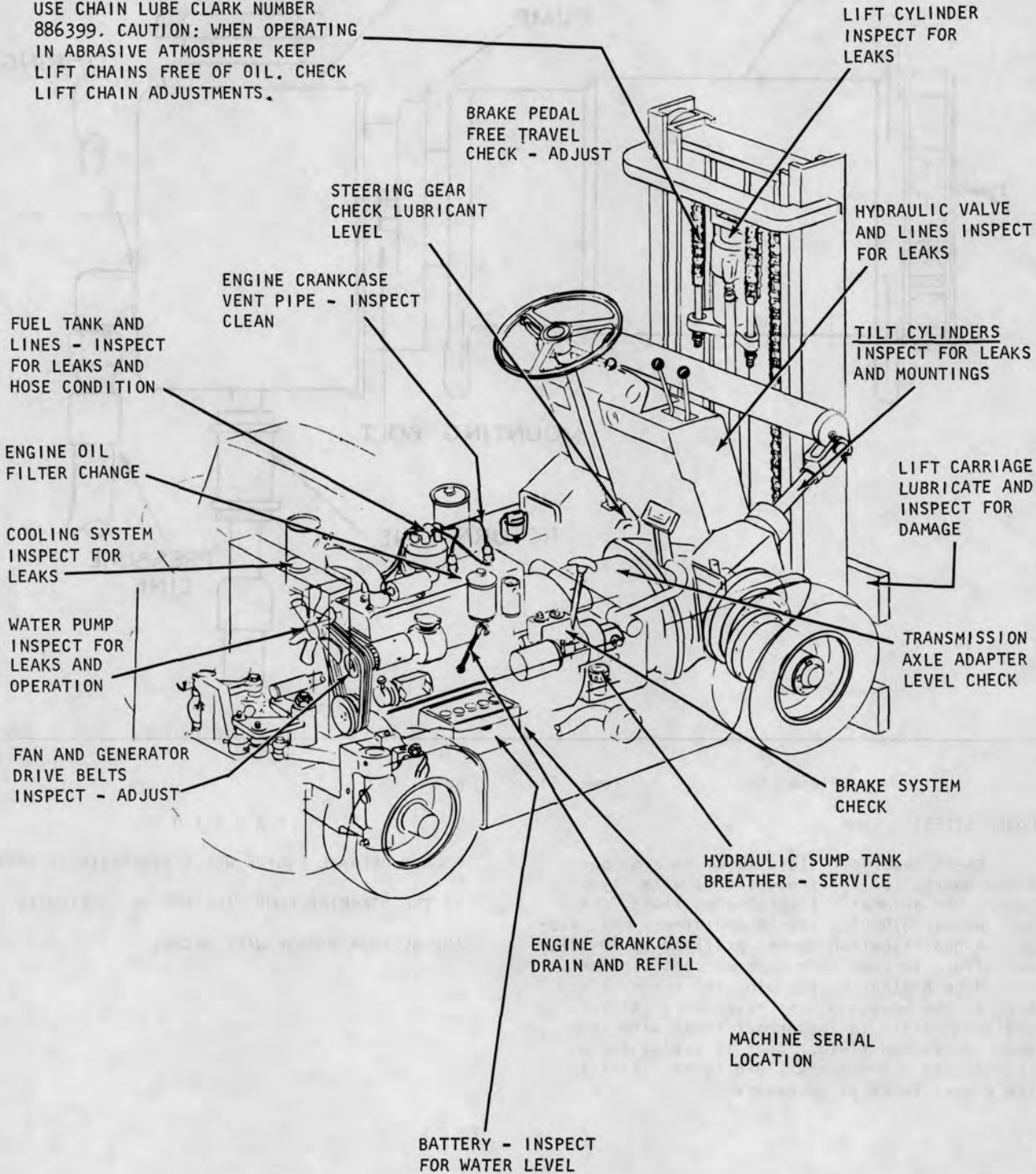


Plate 9481. 100 Hour Lubrication & Preventive Maintenance Illustration Index





Plste 6458. Radiator Pressure Cap

x  
x  
x                    W A R N I N G                    x  
x                    x                    x  
x USE EXTREME CARE IN REMOVING THE RADIATOR x  
x PRESSURE CAP. IN PRESSURE SYSTEM, THE        x  
x SUDDEN RELEASE OF PRESSURE CAN CAUSE A        x  
x STEAM FLASH AND THE FLASH, OR THE LOOSENED    x  
x CAP CAN CAUSE SERIOUS PERSONAL INJURY.        x  
x LOOSEN CAP SLOWLY AND ALLOW STEAM TO            x  
x ESCAPE. THIS MACHINE IS EQUIPPED WITH            x  
x A 7 LB. PRESSURE CAP.                                x  
x x

### COOLING SYSTEM

Check radiator, hoses and water pump for leaks.

Add proper amount of water or antifreeze solution to cooling system. If antifreeze is not available and machine is to be at rest for an appreciable length of time; drain system when temperature is likely to be 32° F, or lower. If water is added to radiator containing antifreeze solution, always test solution in radiator with a hydrometer to determine the degree of protection. For proper amount of antifreeze solution required to protect the cooling system, refer to instructions on antifreeze container.

### N O T E

COOLING SYSTEM CAPACITY - REFER TO SPECIFICATIONS.

Accumulated foreign material should be blown from radiator fins with compressed air. Direct air stream through radiator fins towards engine to make this process effective.

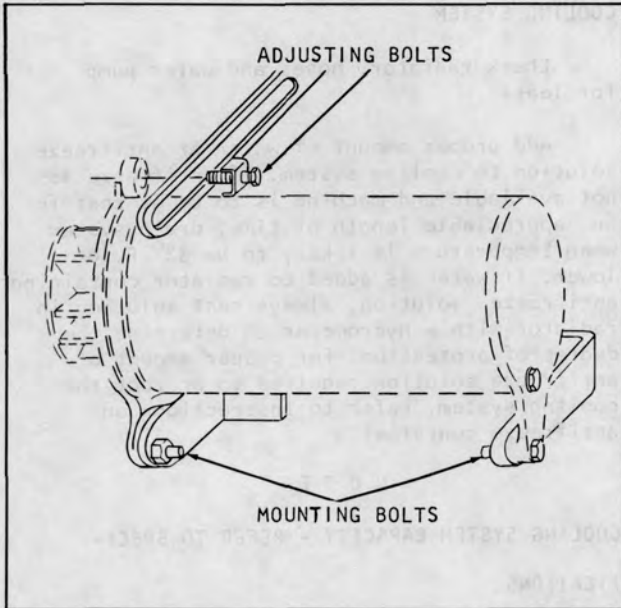


Plate 6631. Generator Drive Belt Adjustment

**FAN AND GENERATOR DRIVE BELTS**

The drive belts should have finger pressure deflection of  $3/4$  to 1 inch midway on long span. If belts require adjustment, use following procedure.

1. Loosen generator brace adjusting bolt and two lower mounting bolts, See Plate 6631.
2. Move generator toward cylinder block to loosen Generator Drive Belts and away from cylinder block to tighten belts. Tighten bolts when correct finger deflection is obtained.

**C A U T I O N**

EXERCISE CAUTION WHEN ADJUSTING BELTS. BELTS ADJUSTED TOO TIGHT WILL VERY LIKELY CAUSE

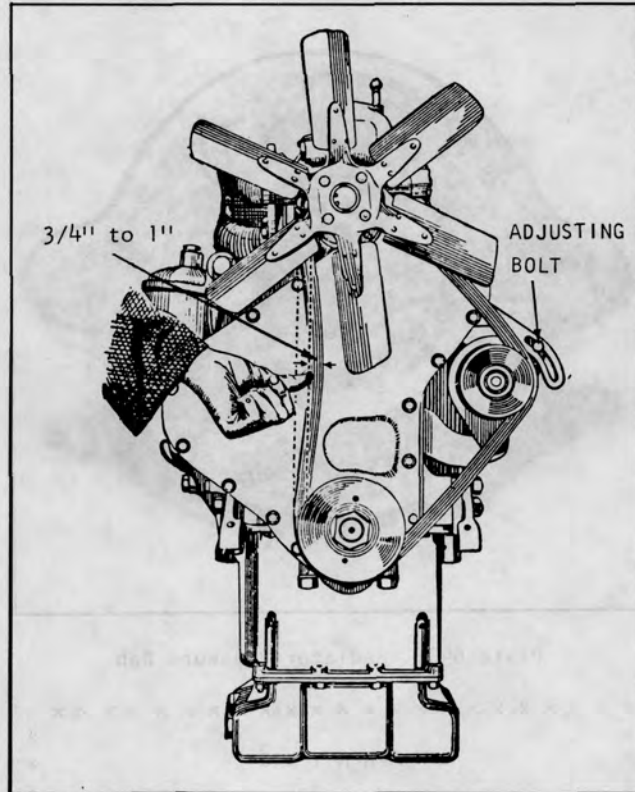


Plate 6632. Belt Deflection Check

BEARING DAMAGE. CONVERSELY, BELTS ADJUSTED TOO LOOSE WILL RESULT IN BELT WEAR AND HIGH ENGINE TEMPERATURE DUE TO BELT SLIPPAGE.

**N O T E**

UPON REPLACEMENT OF DRIVE BELTS, IT WILL BE NECESSARY TO USE A MATCHED SET OF BELTS.

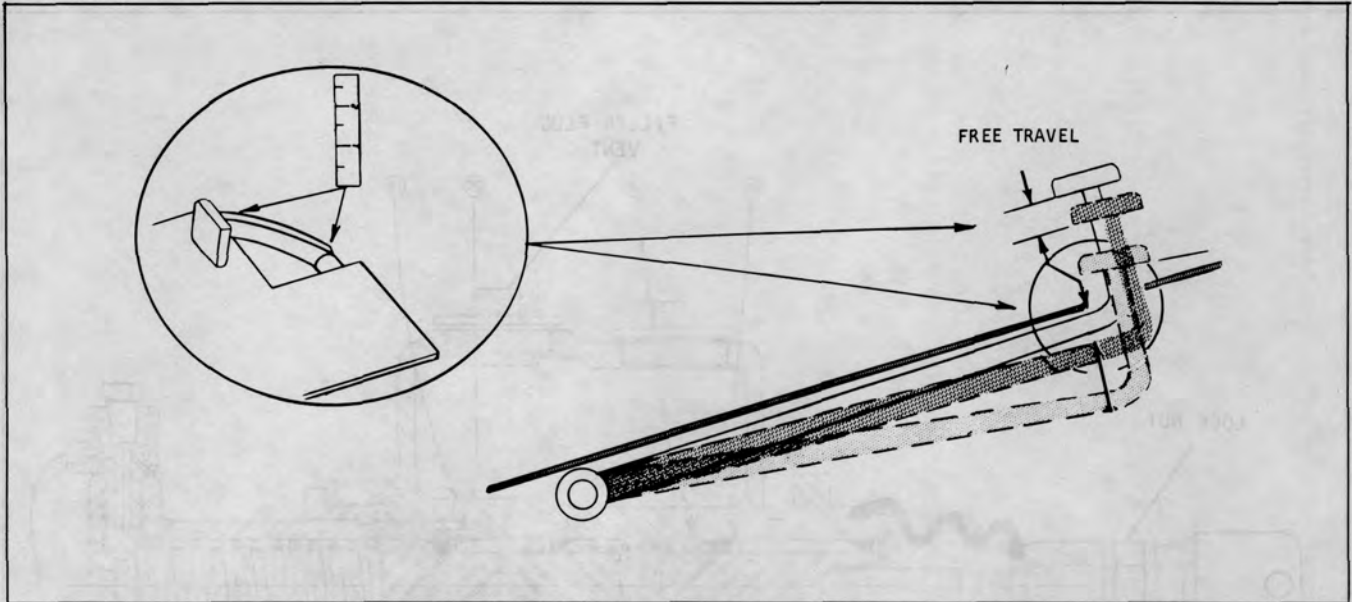


Plate 9592. Brake Pedal Free Travel

**BRAKE PEDAL**

1. Depress brake pedal by hand. When pedal meets resistance from the master cylinder, the distance traveled should be 3/16" to 5/16". If free travel is incorrect an adjustment should be made at the master cylinder linkage adjuster.

2. Depress foot pedal and hold for at least 10 seconds. Pedal must be solid, must not be spongy or drift under foot pressure.

**BRAKE SYSTEM**

Check brake fluid level in the master cylinder. Brake fluid should be within 1/4 inch of the top. Fill with SAE 70 Re Heavy Duty Brake Fluid. Clark Part Number 1800200.

Master Cylinder Filler Cap Vent Hole:

Check cap vent hole for obstruction. Vent hole must be open at all times. Clean if necessary, see Plate 6987.

Brake Pedal Adjustment

1. Loosen locknut, See plate 6987.
2. Rotate adjuster in the direction necessary to obtain specified free travel.
3. Tighten locknut to secure adjustment.

**ACTUATION STROKE**

If nearly full pedal travel is necessary to apply the brakes, there is an indication of either lack of fluid in the master cylinder; air in system, leakage at the cylinders, or the brake linings require adjustment or replacement.

**W A R N I N G**

**CORRECT BRAKE PEDAL FREE TRAVEL IS IMPORTANT FOR SAFE OPERATING BRAKES.**

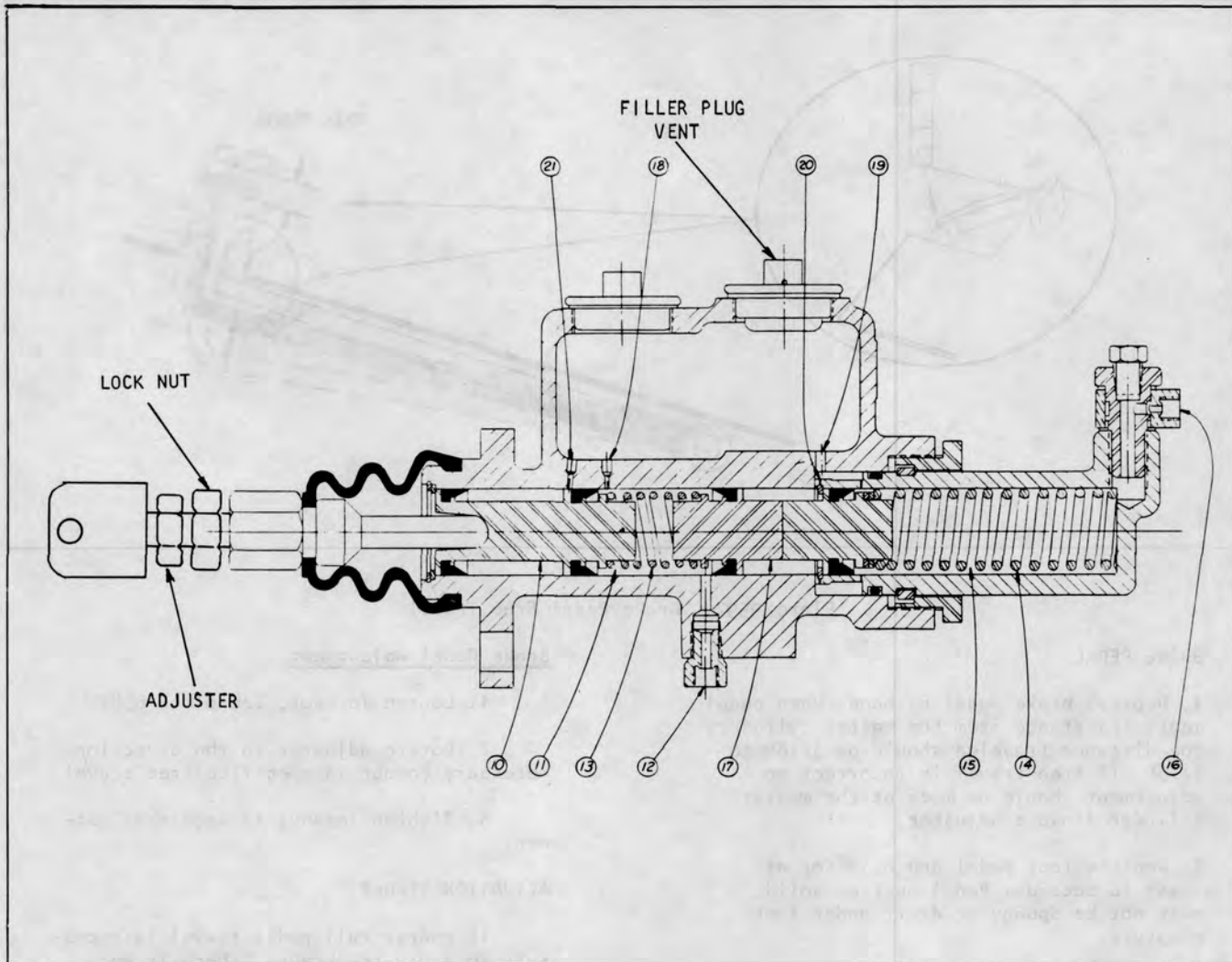


Plate 6987. Master Cylinder

The piston (10) is moved in conventional manner by linkage from the brake pedal. As this is done, oil from the cavity (11) is moved out thru port (12) to the inching control. Since spring (13) is lighter and more readily compressed than spring (14) the oil from cavity (11) will flow thru port (12) more readily and in greater volume than oil from cavity (15) thru port (16) the latter supplying the brake system.

As further motion is imparted to piston (10) from the brake pedal the pressure in (11) builds up to the pressure required for positive brake application. At this time piston (17) is caused to move further into cavity (15) thus forcing high pressure oil out of port (16) and into the brake system.

Thus it is seen that this unit provides initially, low pressure oil to actuate the inching mechanism and to partially actuate the brake mechanism, making brakes ready for immediate application, and finally, high pressure oil for complete brake actuation. In the reverse operation when brake pedal effort is released, the braking effort is removed first, and the inching effort second upon return of the brake to its normal position.

Hydraulic oil is provided to the system thru ports (18) and (19) from a conventional reservoir. Port (20) serves to vent any build up of oil pressure between the two sections of the piston (17). Port (21) serves to vent any build up of oil pressure between the two seals on piston (10).



LUBRICATION AND PREVENTIVE MAINTENANCE

LIFT AND TILT CYLINDERS

Check for drift, leakage at packings, damage and security of mountings (Anchor Pivot Pins, Flanges and Mounting Rings).

LIFT CHAINS

The lift chains are mounted to the chain anchors on the lift carriage and at the chain anchor rods near the lift cylinder piston head.

If it becomes necessary to adjust the lift chains place a capacity load on forks (or device if used) and adjust chains so center line of lower carriage roller is at least 1/2" above the bottom end of the innerslide channel. It is important that the chain adjustment be made with a capacity load. In this manner you will allow for chain stretch.

W A R N I N G

KEEP CLEAR OF LOAD DURING ADJUSTMENT TO AVOID INJURY IF ANY MALFUNCTION SHOULD OCCUR AND CAUSE LOAD TO FALL.

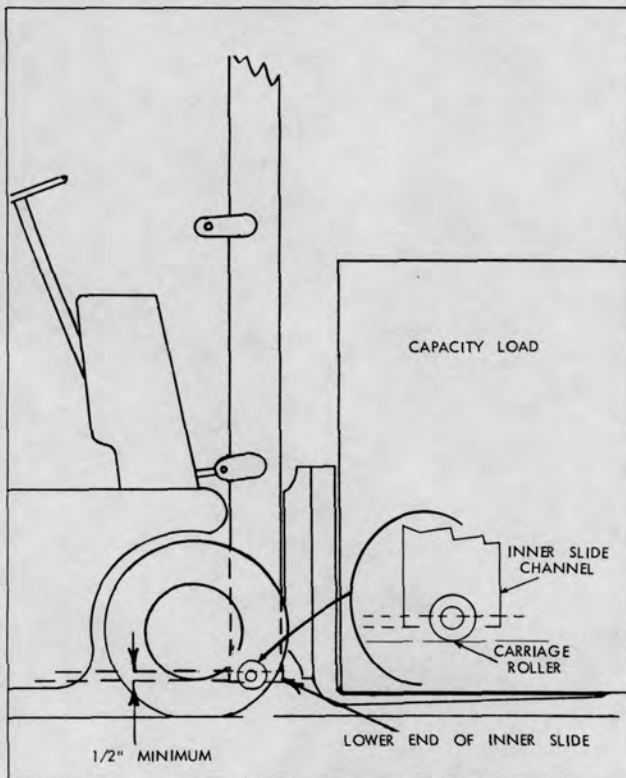


Plate 6884. Lift Chain Adjustment  
(Place Maximum Load On Forks)

LUBRICATE MACHINE

CAUTION

WHEN LUBRICATING THE TRUCK, MAKE A VISUAL INSPECTION OF ALL HYDRAULIC LINES, FITTINGS AND ALL ELECTRICAL WIRING. LUBRICATE ALL MISCELLANEOUS LINKAGE WITH S.A.E. NUMBER 20 OIL.

HYDRAULIC CONTROL VALVE AND LINES

Inspect for damage, leakage and security of mounting.

LIFT BRACKET

Inspect for damage, bent forks etc.

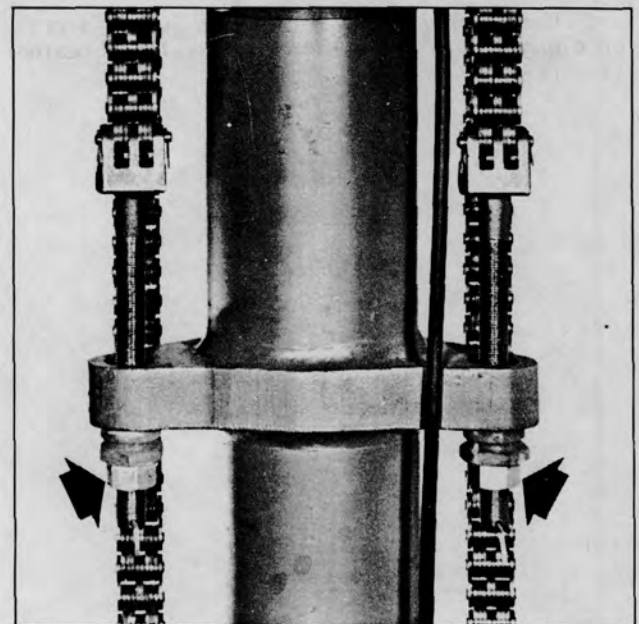


Plate 6634. Lift Chain Adjustment  
(Chain Anchor Rods)

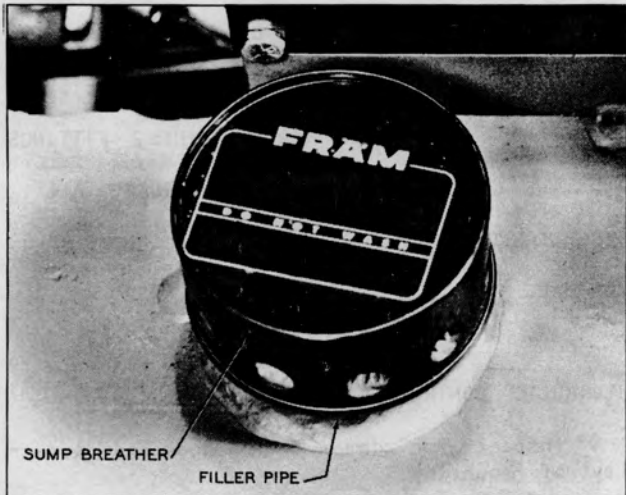


Plate 6626. Hydraulic Sump Tank

### HYDRAULIC SUMP TANK BREATHER

Check breather to be sure it is not dirty or clogged with foreign matter. Replace breather if dirty.

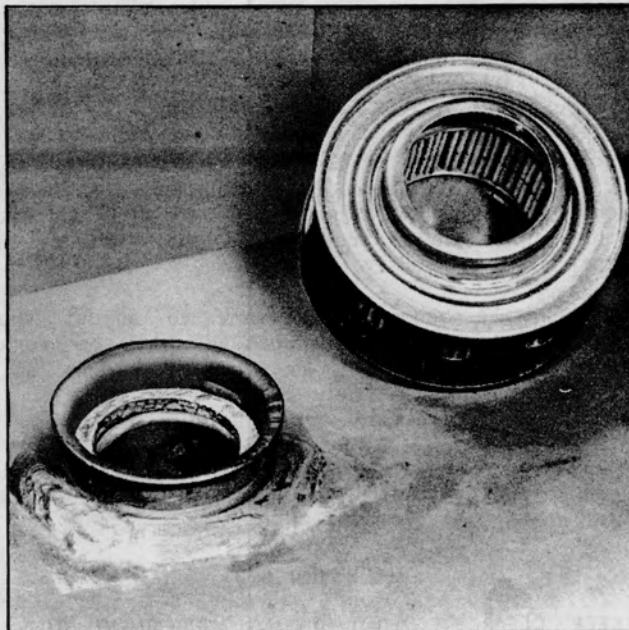
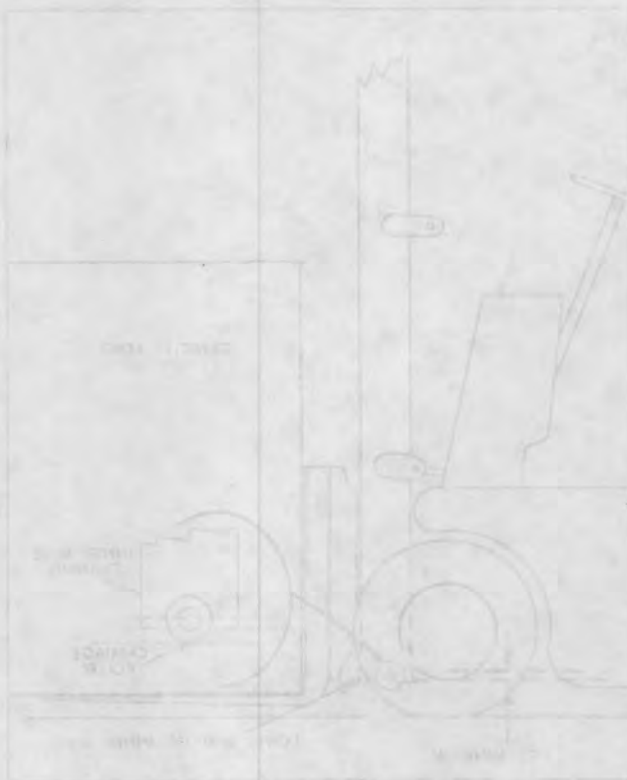


Plate 6682. Hydraulic Sump Tank & Sump Breather



**STEERING GEAR**

Verify lubricant level, fill if necessary with AMOCO Lithium Multipurpose Grease or its equivalent.

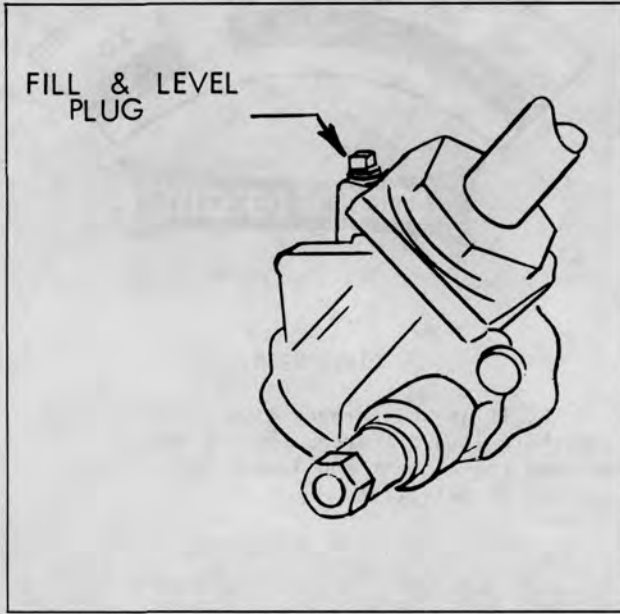


Plate 6429. Steering Gear

not encountered, the full charge specific gravity reading may be lowered from 1.375 to 1.225 by diluting the electrolyte with distilled water.

**NOTE**

Add distilled water before charging. Do not add distilled water immediately after a charge.

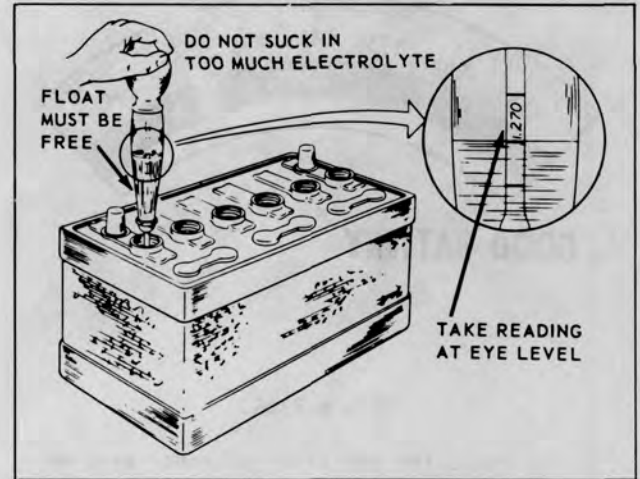


Plate 6271. Checking Specific Gravity of Battery

**BATTERY INSPECTION**

Remove all caps and check fluid level. Keep the fluid in each battery cell above the plates or up to the level ring in the bottom of the filler well. Use only pure distilled water. If the machine is exposed to freezing temperatures, operate the engine for a period of time to make sure the added water mixes thoroughly with the battery electrolyte solution. Otherwise, the water may freeze and damage the battery.

x  
 x  
 x                      W A R N I N G                      x  
 x  
 x    NEVER ALLOW FLAME OR SPARKS NEAR THE                      x  
 x  
 x    BATTERY FILLER HOLES BECAUSE EXPLOSIVE                      x  
 x  
 x    HYDROGEN GAS MAY BE PRESENT                      x  
 x  
 x

Take hydrometer reading of electrolyte to determine state of charge. Charge battery if reading is below 1.225 at 24° C (75° F), or below 1.265, if machine is exposed to freezing temperatures. If machine is operating in tropical areas in which freezing weather is

Make sure that all connections are tight at battery, starter, generator voltage regulator, distributor and spark plugs. Corrosion can be removed from the battery cables and terminals with a solution of baking soda or ammonia and water. After cleaning, flush the top of the battery with clean water, and coat the parts with grease to retard further corrosion.

**BATTERY TEST PROCEDURE**

A defective battery or a discharged battery may be found by performing the following "Light Load Test"

1. Place an electrical load on the battery by cranking the engine for three seconds. If it starts, turn the ignition off immediately.
2. Place a 10 ampere load across the battery terminals for one minute. This will condition the battery so an accurate voltage comparison test can be made between cells. (Turning two headlights on low beam will equal the 10 ampere load - this method may be used in place of the load placed across the terminals)

3. After one minute, and with the 10 ampere load still on the battery, check the individual cells with an expanded scale voltmeter.

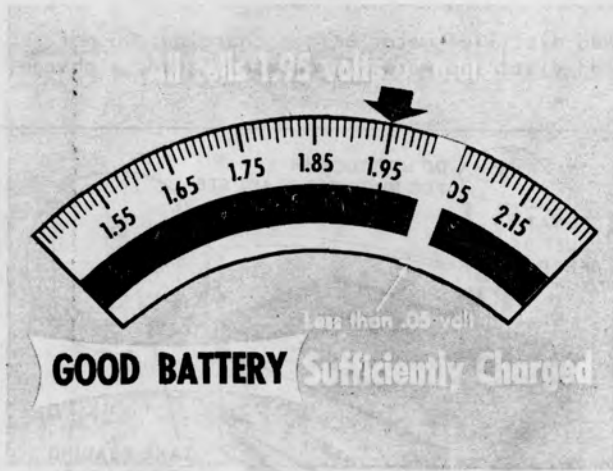


Plate 8306.

4. Place the positive voltmeter prod on the positive side of the cell and the other prod on the negative side. A good battery, sufficiently charged will read 1.95 volts or more on each cell with a difference of less than .05 volt between highest and lowest cell.

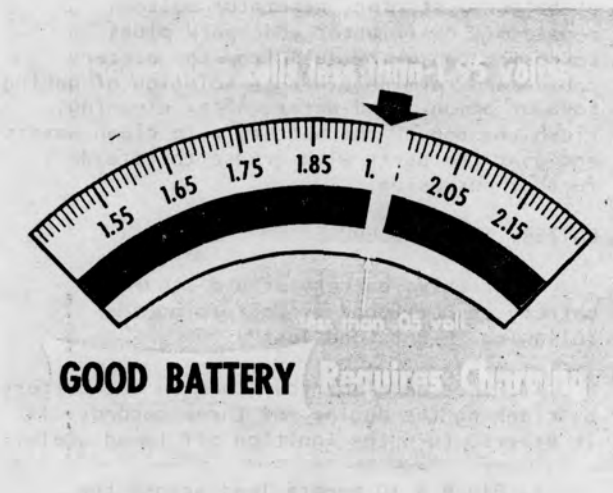


Plate 8307.

5. If cells read both above and below 1.95 volts and the difference between highest and lowest cell is less than .05 volt, battery is good but requires charging.

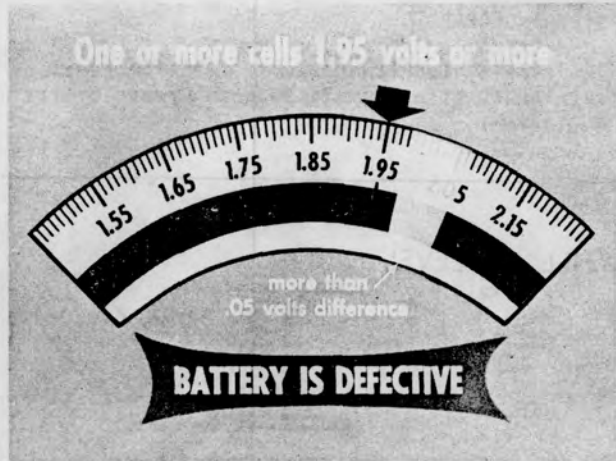


Plate 8308.

6. If any cell reads 1.95 volts or more and there is a difference of .05 volt or more between the highest and lowest cell, the battery is defective.

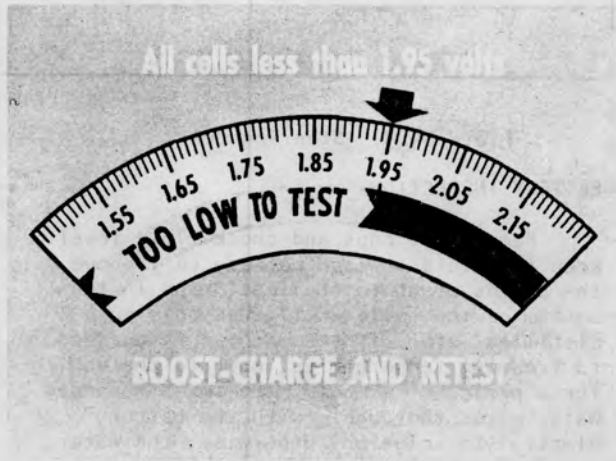
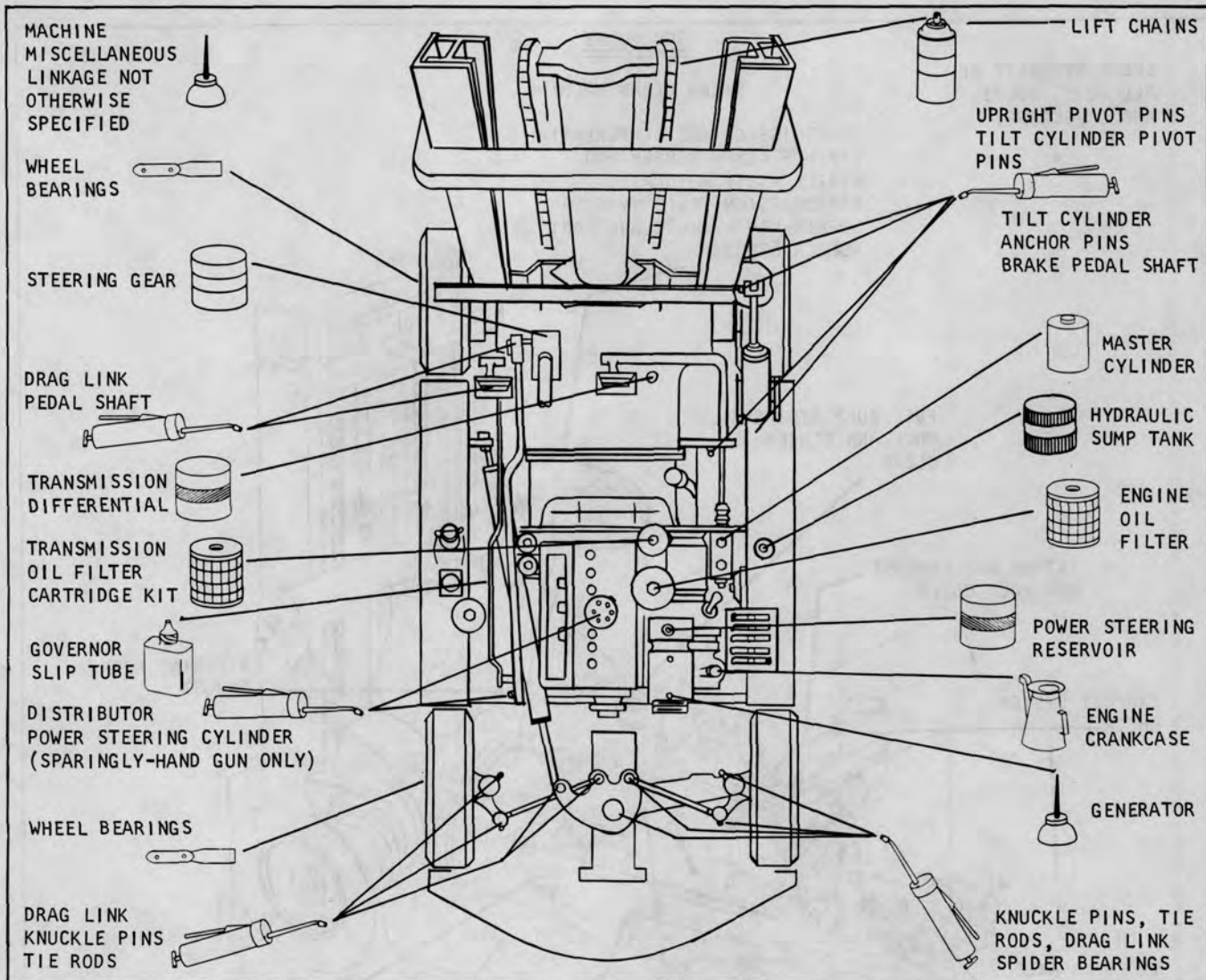













Plate 8309.

7. If all cells read less than 1.95 volts, battery is too low to test accurately. Boost-charge and repeat light load test.



LUBRICATION AND PREVENTIVE MAINTENANCE



- CHASSIS GREASE 
- ENGINE OIL: S.A.E. 20 
- GEAR LUBE: S.A.E. 90 
- OIL FILTER CARTRIDGE KIT 
- 1800200 HYDRAULIC BRAKE FLUID HEAVY DUTY S.A.E. 70R3 
- 879803 AUTOMATIC TRANSMISSION FLUID TYPE "A", SUFFIX "A" (CAN MUST HAVE NUMBER PREFIXED BY "AQ-ATF") 
- HYDRAULIC FLUID - CLARK SPECIFICATION MS-68 885385 
- ENGINE OIL--S.A.E. 10W 0 deg-32 deg F S.A.E. 20W 32 deg-75 d F. "Service MS" S.A.E. 30 above 75 deg F. Or use 10W-30 MULTI-GRADE OIL. 
- GRAPHITE GREASE 
- 886399 CHAIN LUBE 
- WHEEL BEARING GREASE SPEC. MS 9C GREASE AXLE ENDS-#1 EP LITHIUM SOAP GREASE 

LUBRICATION AND PREVENTIVE MAINTENANCE

500 HOURS

CHECK SECURITY OF ALL NUTS, BOLTS, AND CAPSCREWS.

STEAM CLEAN MACHINE

TRANSMISSION AND DIFFERENTIAL DRAIN - CLEAN SCREEN AND REFILL - USE AUTOMATIC TRANSMISSION FLUID TYPE "A" SUFFIX "A" ----- CLARK PART NUMBER 879803

FUEL PUMP SEDIMENT BOWL AND SCREEN CLEAN

INTAKE AND EXHAUST MANIFOLD CHECK

EXHAUST SYSTEM CHECK

STEERING AXLE AND LINKAGE CHECK - ADJUST

STEERING GEAR ADJUST

HYDRAULIC SUMP TANK DRAIN - REFILL

MACHINE SERIAL LOCATION

TRANSMISSION OIL FILTER CHANGE

SUMP TANK FILTER CHANGE

Plate 9482. Lubrication and Preventive Maintenance Illustration

**FUEL PUMP STRAINER**

The fuel filter and sediment bowl should be cleaned every 500 operating hours. Remove and clean sediment bowl. If fuel strainer is dirty, install a new strainer assembly and gasket. Do not reuse old gasket.

**FUEL PUMP**

To determine if the fuel pump is defective, remove the fuel tank supply line at the pump and blow out line with compressed air to remove any possible obstructions. Reconnect fuel tank line and disconnect pump to carburetor line. Install a fuel pressure gauge, by placing a "T" in the line, and run engine at 1800 R.P.M. with all lines connected. Fuel pump pressure should be between 1 1/2 and 2 1/4 lbs. If the fuel pump pressure is not within this range the pump should be removed for repair or replacement.

**CAUTION**

TO MINIMIZE ANY POSSIBLE FIRE HAZARD,

DO NOT SPILL GASOLINE.

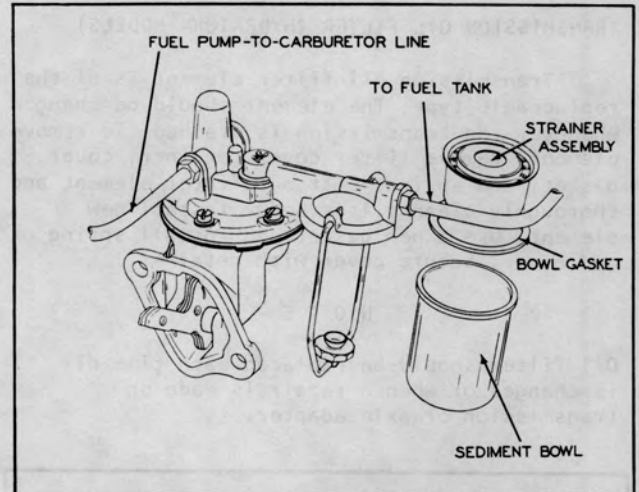
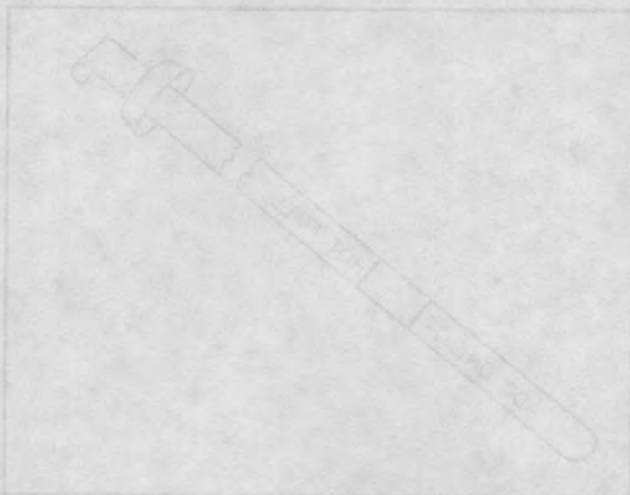
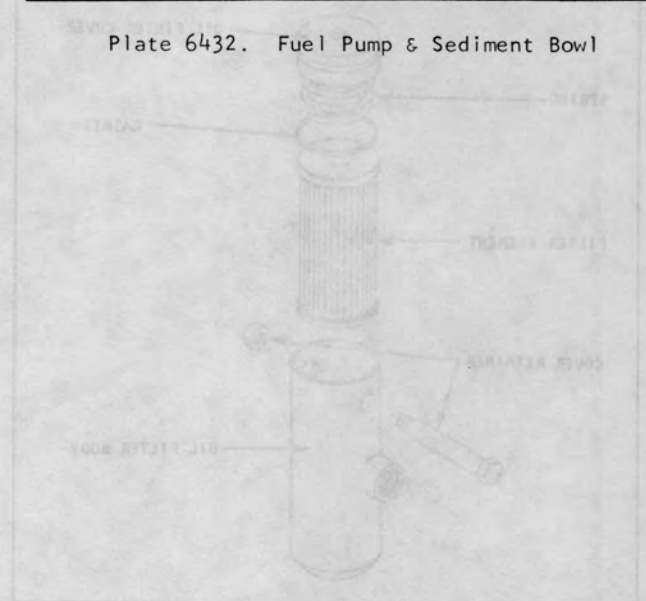


Plate 6432. Fuel Pump & Sediment Bowl





**TRANSMISSION OIL FILTER (HYDRATORK MODELS)**

Transmission oil filter element is of the replaceable type. The element should be changed whenever the transmission is drained. To remove element, remove filter cover retainer, cover, gasket, and spring. Lift out filter element and thoroughly clean filter body. Install new element. Use a new gasket and install spring and cover. Secure cover with retainer.

**NOTE**

Oil filter should be replaced each time oil is changed or when a repair is made on transmission or axle adapter.

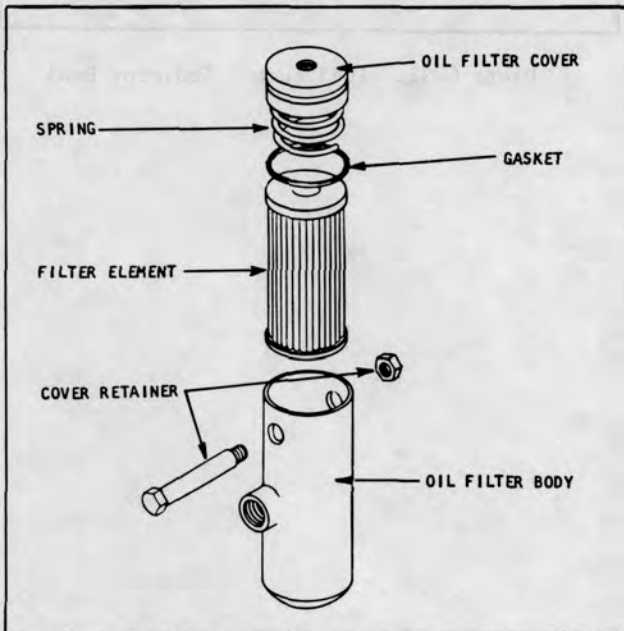


Plate 7234. Transmission Oil Filter

**CONVERTER, AXLE ADAPTER AND TRANSMISSION SUMP SCREEN.**

1. Drain transmission and axle adapter at operating temperatures. See Plate 7301 on following page for location of drain plugs.

**CAUTION**

DO NOT USE FLUSHING OIL OR COMPOUND TO FLUSH SYSTEM.

2. Remove and clean transmission sump screen in a Stoddard type solvent. Dry with filtered compressed air - directing air thru neck of screen.



Plate 7235. Transmission Sump Screen

3. It is recommended that a new "O" ring be used when installing the sump screen.

4. Refill transmission and axle adapter to the full mark as indicated on the dipstick. Use Automatic Transmission Fluid Type "A", Suffix "A". Clark part number 879803. Fluid containers must display a qualification number prefixed by "AQ-ATF".

5. Operate engine for a short period of time to completely charge the converter and plumbing with fluid; then recheck fluid level. To accurately check the fluid level the transmission should be at normal operating temperature, engine running at low idle, and transmission in neutral.

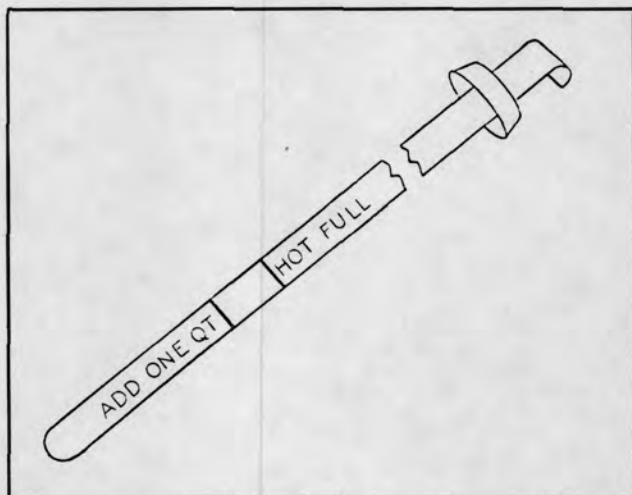


Plate 8281. Transmission Dipstick



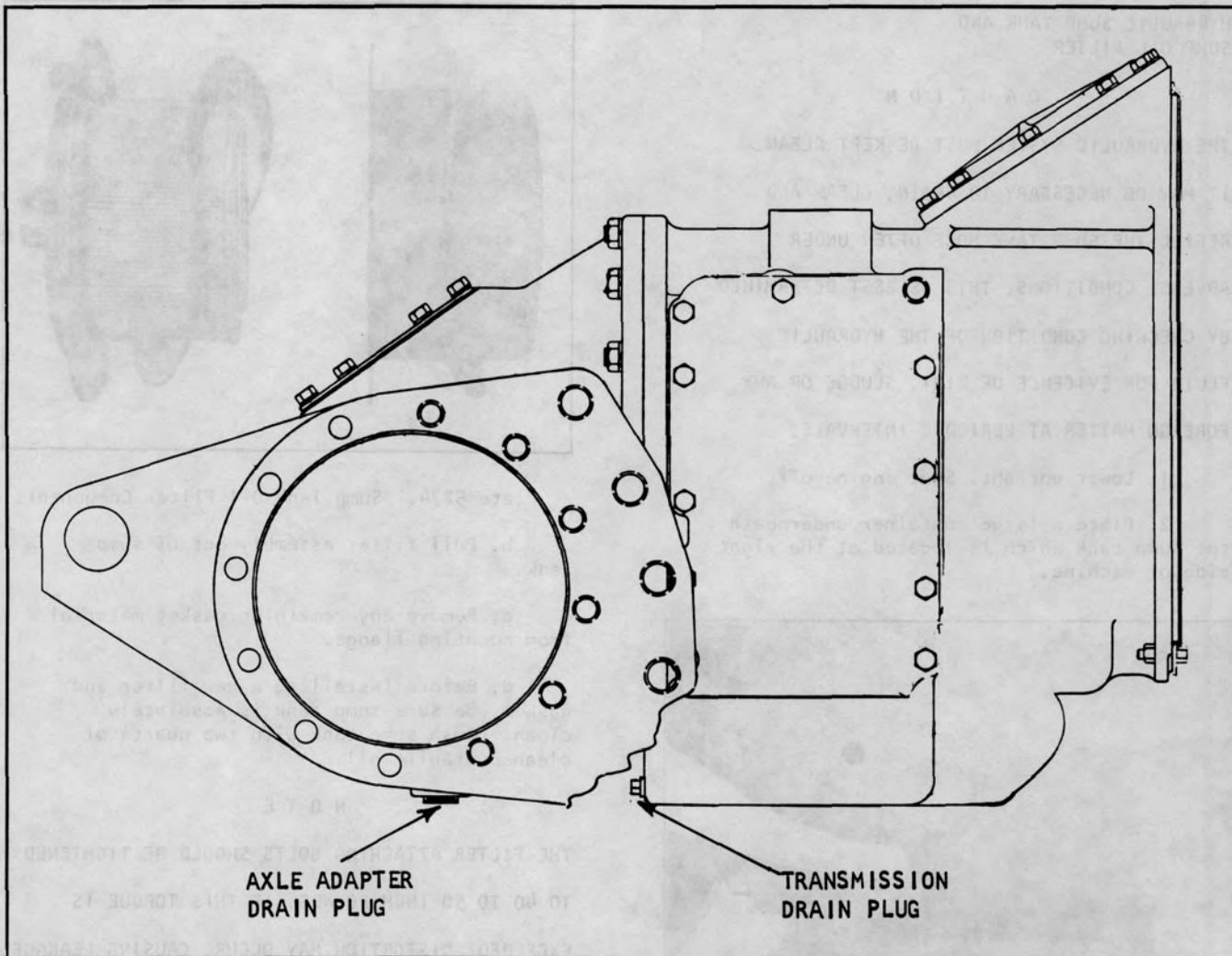


Plate 7301. Axle Adapter and Transmission Drain Plugs

HYDRAULIC SUMP TANK AND  
SUMP OIL FILTER

C A U T I O N

THE HYDRAULIC SYSTEM MUST BE KEPT CLEAN. IT MAY BE NECESSARY TO DRAIN, CLEAN AND REFILL THE SUMP TANK MORE OFTEN UNDER ADVERSE CONDITIONS. THIS IS BEST DETERMINED BY CHECKING CONDITION OF THE HYDRAULIC FLUID FOR EVIDENCE OF DIRT, SLUDGE OR ANY FOREIGN MATTER AT PERIODIC INTERVALS.

1. Lower upright. Shut engine off.
2. Place a large container underneath the sump tank which is located at the right side of machine.

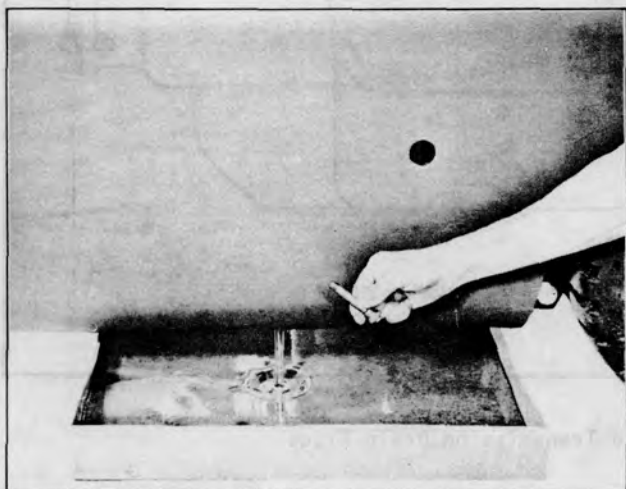


Plate 5359. Draining Sump Tank

3. Remove sump tank drain plug, located at bottom of tank, and allow the fluid to drain. Replace drain plug.

C A U T I O N

DO NOT START ENGINE WHILE SUMP TANK IS EMPTY AS DAMAGE TO THE HYDRAULIC PUMP WILL RESULT.

4. Remove Filter and Clean Sump Tank:
  - a. Disconnect hose and remove filter retainer bolts.

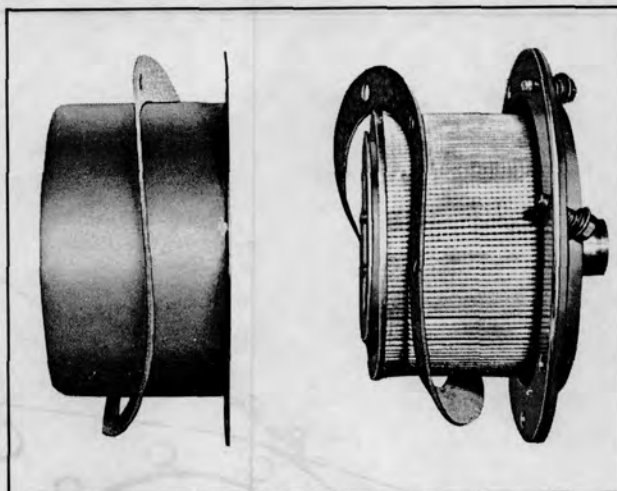


Plate 5274. Sump Tank Oil Filter Components

- b. Pull filter assembly out of sump tank.
- c. Remove any remaining gasket material from mounting flange.
- d. Before installing a new filter and gasket, be sure sump tank is absolutely clean. Flush sump tank with two quarts of clean hydraulic oil.

N O T E

THE FILTER ATTACHING BOLTS SHOULD BE TIGHTENED TO 40 TO 50 INCH POUNDS. IF THIS TORQUE IS EXCEEDED, DISTORTION MAY OCCUR, CAUSING LEAKAGE.

- e. Install hose and tighten hose connections.
5. Fill sump tank with MS 68 Hydraulic fluid until level reaches the bottom of the fill pipe.

C A U T I O N

START ENGINE AND OPERATE HYDRAULIC CONTROL LEVERS SEVERAL TIMES. CHECK OIL FILTER FOR LEAKS, RECHECK OIL LEVEL AND FILL TO BOTTOM OF FILL PIPE IF NECESSARY.

**STEERING GEAR**

Steering gear adjustments must be made in the following manner (see Plates 6636 and 6637).

Always check worm bearing thrust adjustment, and adjust if necessary, before making sector gear lash adjustment.

Before making above adjustments, the following preliminary operations are necessary.

1. Disconnect steering drag link from pitman arm. Note relative position of drag link parts when disconnecting link so the parts may be re-assembled correctly.

2. Check lubricant level in steering gear housing. If low, add enough lubricant to bring level up to filler plug hole. (Use AMOCO Lithium Multipurpose Grease or its equivalent.)

3. Tighten steering gear housing to frame side member bolts, see Plate 6636.

4. Determine straight-ahead position of steering mechanism by turning steering wheel to extreme right.

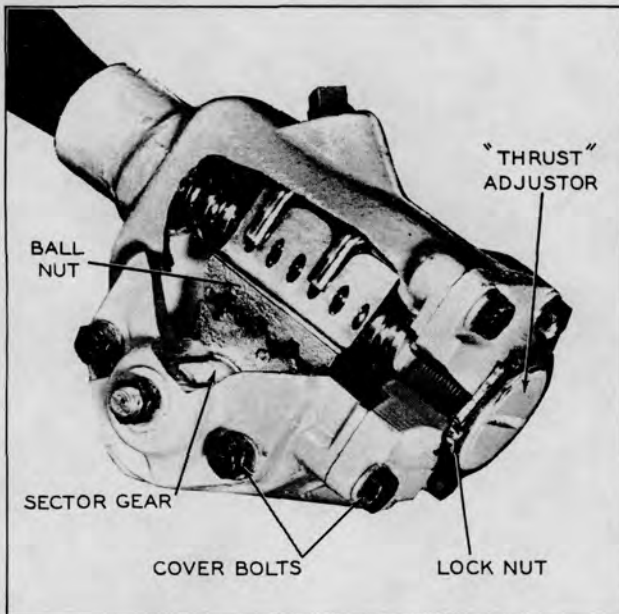


Plate 6636. Steering Gear Thrust Adjustment (Worm Bearings)

**CAUTION**  
APPROACH EXTREME ENDS CAUTIOUSLY; WORM BALL NUT MUST NOT STRIKE ENDS WITH ANY DEGREE OF FORCE.

Then turn to extreme left, counting the exact number of turns from right to left end. Turn wheel back one-half number of wheel turns. Mark wheel with respect to steering column so center position may readily be found during adjustment procedures.

Worm Bearing THRUST Adjustment: Refer to Plate 6636 and proceed as follows:

1. Check tightness of cover bolts, see Plate 6636. Loosen lock nut and turn lash adjuster screw (Plate 6637) counterclockwise a few turns to provide clearance between sector gear and worm ball nut.

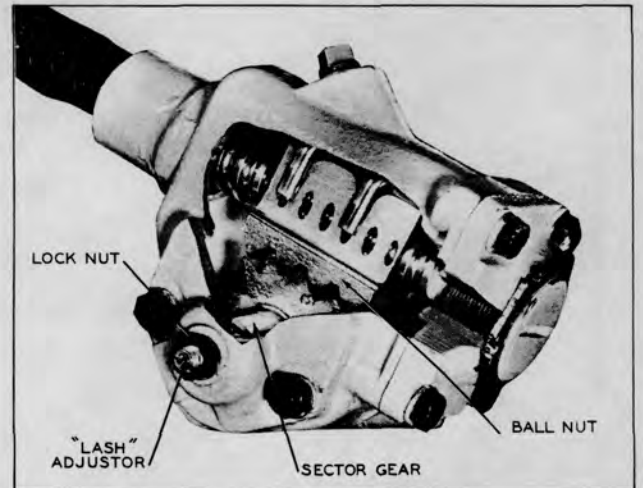


Plate 6637. Steering Gear Lash Adjustment (Sector Gear)

2. Turn steering wheel GENTLY to one extreme end. Turn wheel back one full turn. With spring scale on spoke of wheel, measure pull required to KEEP WHEEL MOVING. Pull on scale should be made at right angles to wheel spoke. If pull is within 1 1/2 to 2 pounds, proceed to lash adjustment in the following paragraphs. If pull is not within 1 1/2 to 2 pounds, adjust worm bearings. The pitman shaft adjustment must be made if worm bearing check is accomplished, or if the worm bearings are adjusted.

3. If it is necessary to adjust the worm bearings, loosen lock nut and then turn worm bearing adjuster nut clockwise until all end play is removed, see Plate 6636. Using spring scale, as directed in Step 2, check pull and readjust as necessary; then tighten lock nut securely.





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**Sector Gear Lash Adjustment:** Refer to Plate 6637 and proceed as follows:

1. Steering Gear Mechanism must be in straight ahead position as previously explained.

2. Turn lash adjuster screw clockwise to remove all lash between gear teeth. Tighten adjuster screw lock nut. Position spring scale on steering wheel so pull may be made at right angles to wheel spoke.

3. Measure pull while wheel is TURNED THROUGH CENTER POSITION. Readjust if reading is not within 2 1/2 to 3 pounds.

4. Tighten adjuster screw lock nut, check pull again.

5. After adjustments are made, install drag link on pitman arm.

### NOTE

IF STEERING LINKAGE ADJUSTMENT IS NECESSARY

DO NOT INSTALL DRAG LINK TO PITMAN ARM.

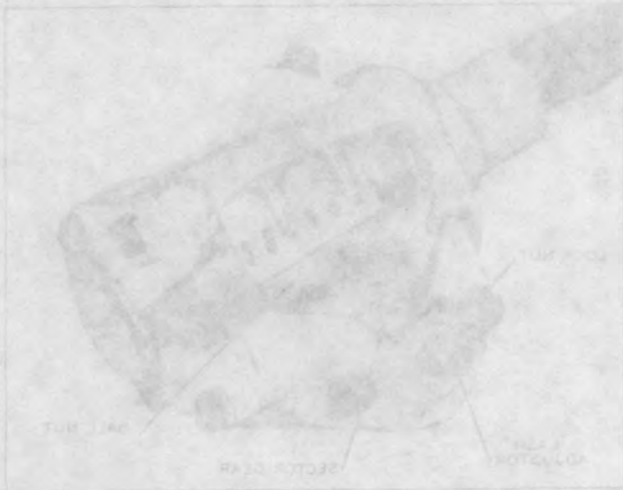


Fig. 6637 (Sector Gear) - Steering Gear Lash Adjustment

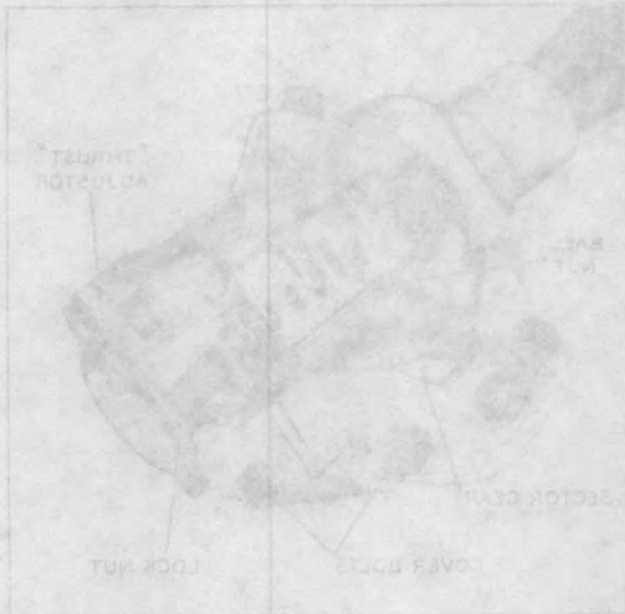


Fig. 6638 (Thrust Adjuster) - Steering Gear Thrust Adjustment

3. Turn steering wheel GENTLY to one extreme and turn wheel back one full turn. With spring scale on spoke of wheel, measure pull. Adjuster to KEEP WHEEL MOVING. All on scale should be made at right angles to wheel spoke. If pull is within 1 1/2 to 2 pounds, proceed in last adjustment. In the following paragraphs, if pull is not within 1 1/2 to 2 pounds, adjust worm bearing. The pinion shaft adjustment must be made if worm bearing check is accomplished, or if the worm bearing is adjusted.

3. If it is necessary to adjust the worm bearing, loosen lock nut and then turn worm bearing adjuster out clockwise until all play is removed, see Plate 6638. Using spring scale as directed in step 2, check pull and readjust as necessary. Then tighten lock nut securely.

APPROACH EXTREME ENDS CAUTIOUSLY; WORM BALLS MUST NOT STRIKE ENDS WITH ANY DEGREE OF FORCE.



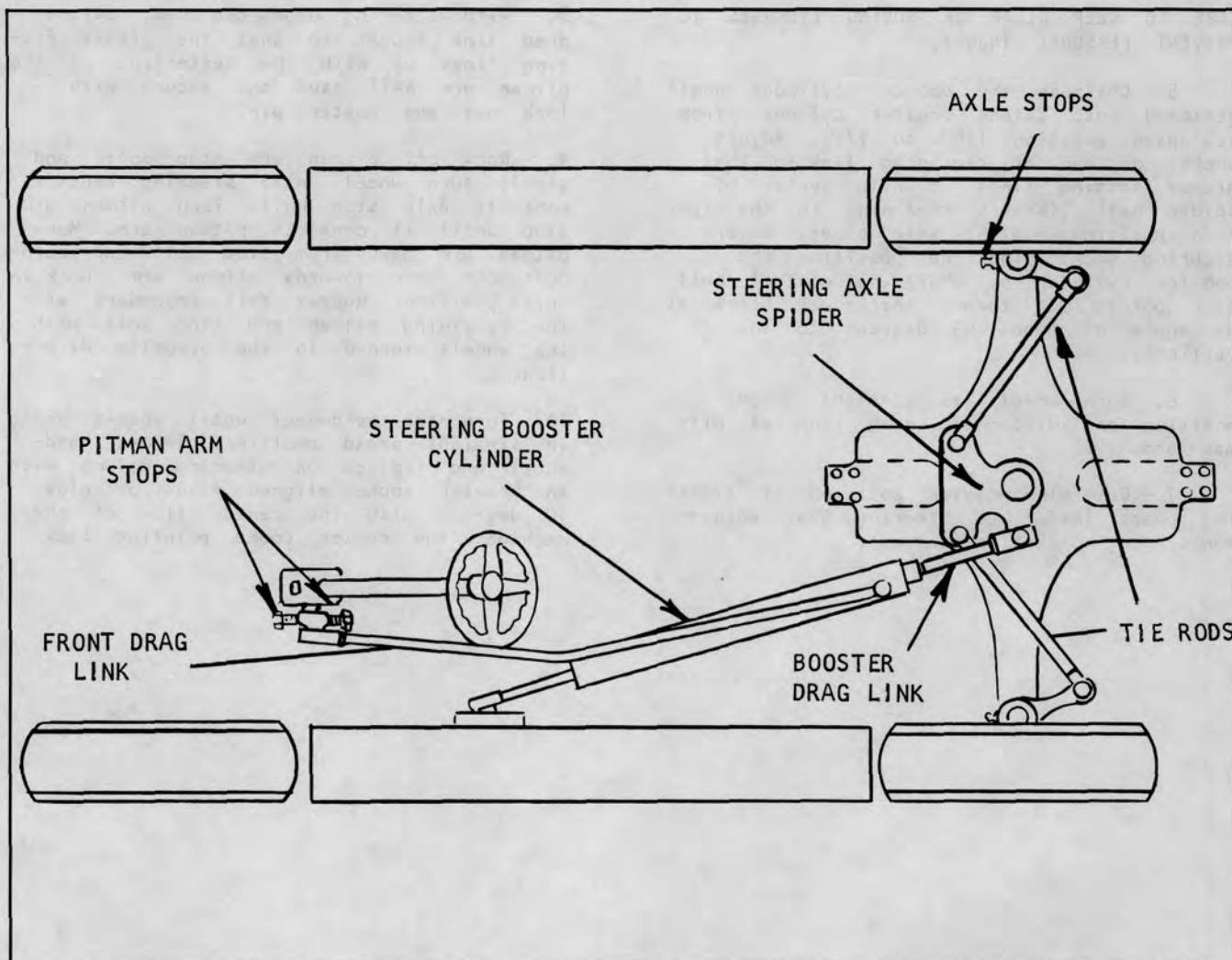


Plate 7340. Steering Linkage

**STEERING AXLE AND LINKAGE ADJUSTMENTS**

1. Raise the steering wheels far enough to clear the floor and place heavy blocking under the machine frame so it cannot accidentally become lowered during adjustments.

2. The steering wheels should track square with the drive wheels with no toe-in or toe-out. If adjustment is necessary loosen the lock nuts at the tie rod ends and turn each tie rod in a manner so they will be the same length when the correct adjustment is obtained. Tighten tie rod lock nuts to secure this adjustment.

3. Disconnect the steering booster socket from the steering axle spider noting the relative position of the socket parts so they may be re-installed correctly

after checking wheels for correct turning geometry.

4. Check wheels for correct turning geometry by turning the wheels all the way for a left turn - this should allow the left wheel to attain an angle of 75 degrees to the frame on pneumatic tire machines and 78 degrees on solid tire machines. If an adjustment is necessary, the axle stop on the left side should be turned in or out whichever is necessary to achieve the correct angle. Repeat this procedure in a right turn with the opposite wheel and adjust the right axle stop as required.

**WARNING**

IF THE STEERING BOOSTER CYLINDER IS TO BE ACTUATED UNDER POWER DO SO ONLY WITH THE ENGINE RUNNING AT IDLE SPEED, USING EXTREME

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CARE TO KEEP CLEAR OF MOVING LINKAGES TO PREVENT PERSONAL INJURY.

5. Collapse the booster cylinder until bottomed out. Extend booster cylinder from collapsed position 1/4" to 1/2". Adjust socket on end of rear drag link so that grease fitting lines up with center of spider ball. (Wheels remaining in the right turn position against axle stop). Before securing socket lock nut position the booster cylinder so that the control ball stud points out toward the truck frame at an angle of about 45 degrees to the vertical.

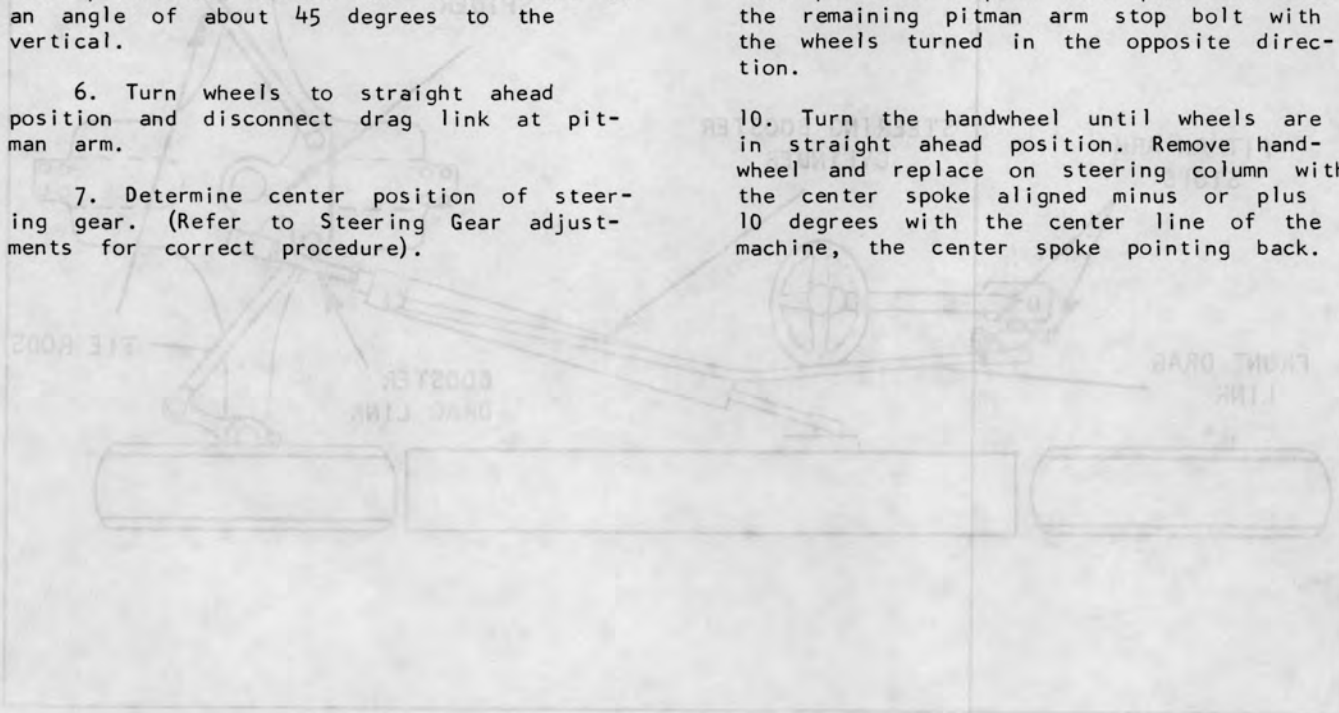
6. Turn wheels to straight ahead position and disconnect drag link at pitman arm.

7. Determine center position of steering gear. (Refer to Steering Gear adjustments for correct procedure).

8. With Steering Gear centered; adjust drag link socket so that the grease fitting lines up with the centerline of the pitman arm ball stud and secure with lock nut and cotter pin.

9. Back off pitman arm stop bolts and slowly turn wheel until steering knuckle contacts axle stop bolt. Turn pitman arm stop until it contacts pitman arm. Move pitman arm away from stop bolt and turn bolt one turn towards pitman arm. Lock in this position. Repeat this procedure with the remaining pitman arm stop bolt with the wheels turned in the opposite direction.

10. Turn the handwheel until wheels are in straight ahead position. Remove handwheel and replace on steering column with the center spoke aligned minus or plus 10 degrees with the center line of the machine, the center spoke pointing back.



STEERING WHEEL AND LINKAGE ADJUSTMENTS

1. After the steering wheel has been brought to level top, front and back heavy loadings, the machine frame will be level. The steering wheel should be adjusted so that the steering wheel is level.

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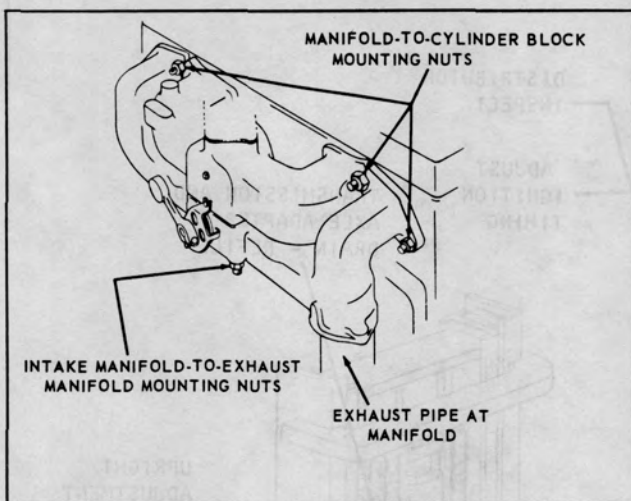
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**INTAKE AND EXHAUST MANIFOLDS**

1. Inspect gaskets for leaks and inspect security of manifold nuts.
2. Inspect exhaust pipe and muffler for damage, leakage and security of mountings.

**NUTS, BOLTS AND CAP SCREWS.** Check security of mounting, tighten as required.

Plate 6269. Intake and Exhaust Manifolds

## LUBRICATION AND PREVENTIVE MAINTENANCE

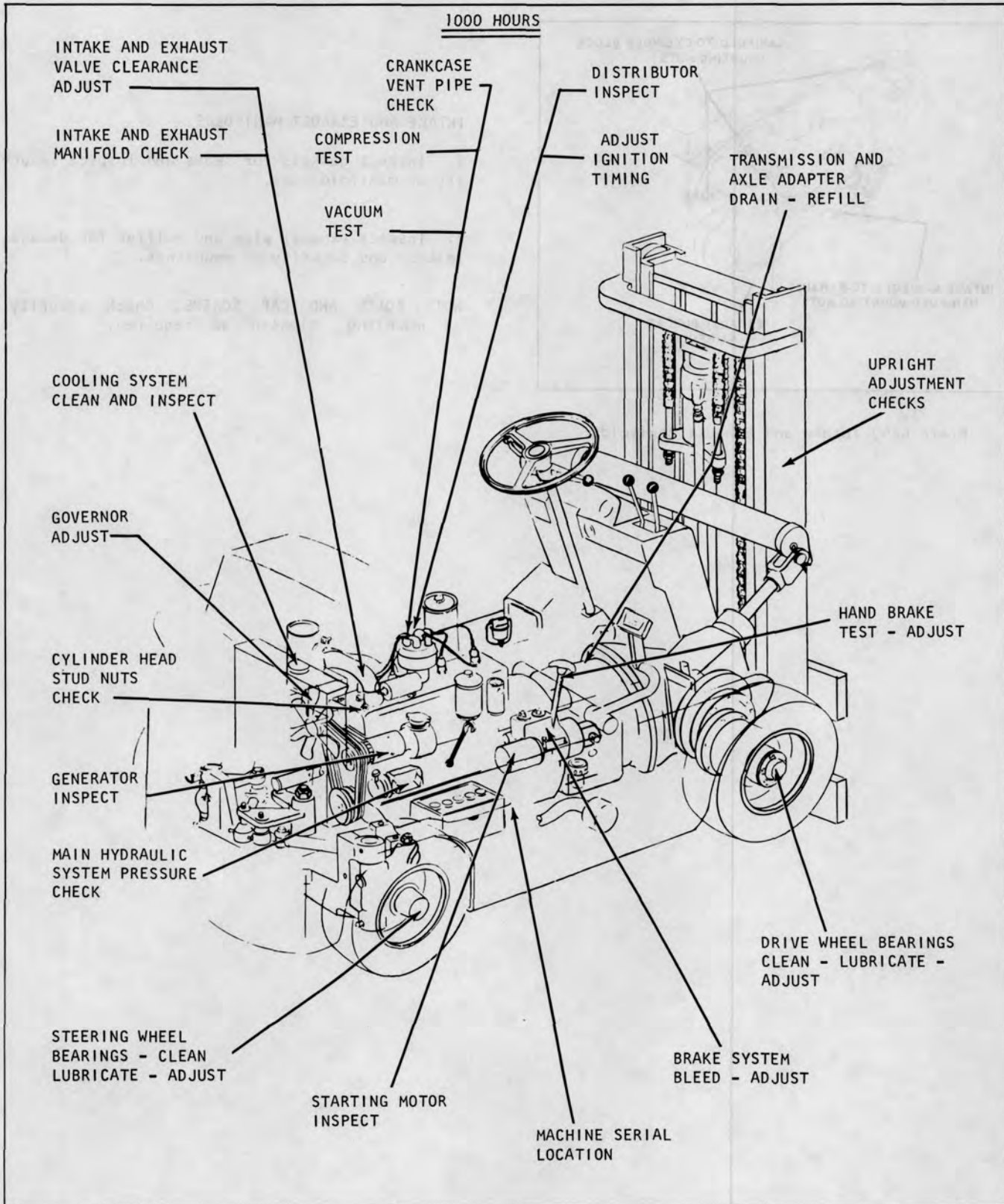


Plate 9484. Lubrication and Preventive Maintenance Illustration



**ENGINE TUNE-UP**

Engine tune-up is the orderly and systematic process of checking the engine and accessory equipment to maintain or restore satisfactory engine performance. Engine tune-up must be accomplished semi-annually and more frequently if engine performance indicates the need for these services. Perform engine tune-up as follows:

**1. AIR CLEANER.** Be sure air cleaner has received proper service. Air cleaner must be installed before making engine tune-up.

**2. FUEL PUMP.** Be sure the fuel pump bowl and strainer has been properly serviced and the fuel pump is operating satisfactorily.

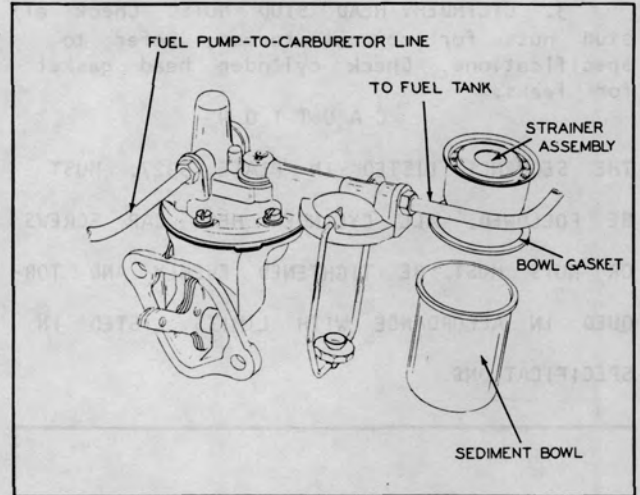
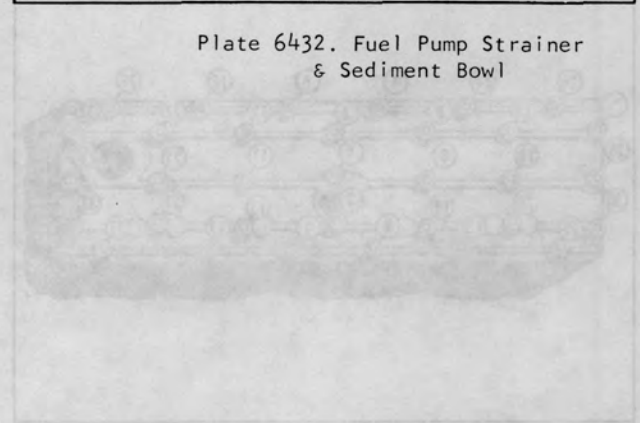


Plate 6432. Fuel Pump Strainer & Sediment Bowl



3. CYLINDER HEAD STUD NUTS. Check all stud nuts for correct torque, refer to specifications. Check cylinder head gasket for leaks.

**CAUTION**

THE SEQUENCE LISTED IN PLATE 5927. MUST BE FOLLOWED. ALL CYLINDER HEAD CAP SCREWS OR NUTS MUST BE TIGHTENED EVENLY AND TORQUED IN ACCORDANCE WITH LIMITS LISTED IN SPECIFICATIONS.

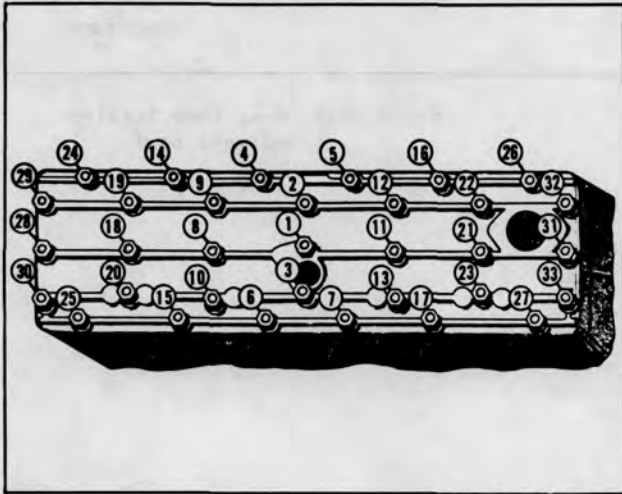


Plate 5927. Cylinder Head Stud Nut Tightening Sequence

4. INTAKE AND EXHAUST MANIFOLDS. Inspect for gasket leaks and security of mounting.

5. CRANKCASE VENTILATION METERING VALVE. The metering valve connected between the intake manifold and valve cover regulates the amount of air which will flow through the crankcase and is controlled by the engine vacuum.

Remove metering valve and disassemble and wash in a Stoddard type cleaning solvent. Before assembling, put a small quantity of very light oil on the metering pin to prevent sticking until its own lubrication is established. The ventilation tube and valve cover should also be cleaned at the same time, particularly if any noticeable amount of sludge accumulation is found.

After installing the metering valve on the engine be sure hose is in good condition and all connections are properly

sealed to prevent unfiltered air from entering the engine.

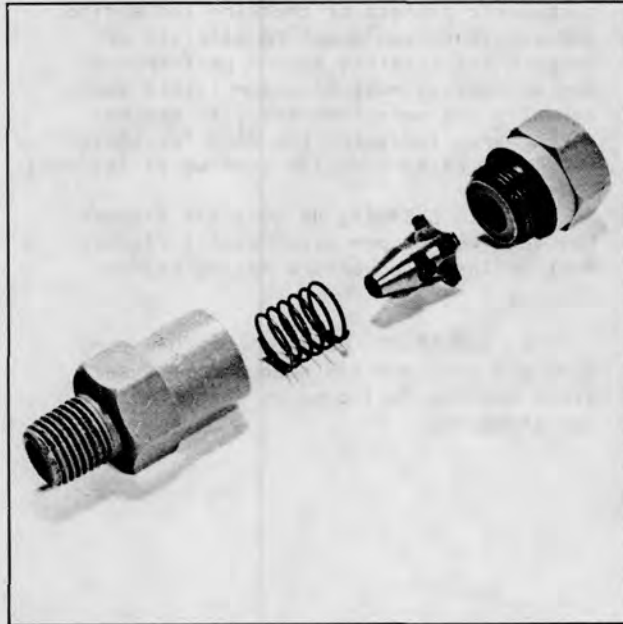


Plate 7034. Crankcase Ventilation Metering Valve

6. INTAKE AND EXHAUST VALVE CLEARANCE ADJUSTMENTS.

a. Remove valve chamber cover mounting screws, and the valve chamber cover gasket.

b. With engine running at idling speed and at normal operating temperature, adjust intake valves as follows:

c. Check for proper 0.014 inch clearance by alternately passing a 0.013 inch and a 0.015 inch flat feeler gauge between head of adjusting screw and valve stem, see Plate 3223 on following page.

d. If a 0.013 inch feeler gauge moves freely back and forth in gap when valve is not being lifted and a 0.015 inch feeler gauge binds, at all times, clearance requires no adjustment.

e. If a 0.013 inch feeler gauge is gripped at all times, the clearance is insufficient.

f. Hold valve lifter with an open end wrench while using a second wrench to turn adjusting screw 1/4 to 1/2 turn clockwise. Repeat clearance check and adjustment, until proper clearance is obtained. The adjustable type valve lifters

have self-locking adjusting screws that require no lock nuts.

g. If 0.015 inch feeler moves freely when valve is not being lifted, the clearance is too great. Hold valve lifter with an open end wrench while using a second wrench to turn valve lifter adjusting screw counterclockwise 1/4 to 1/2 turn. Repeat clearance check and adjustment until proper clearance is obtained.

h. Repeat clearance check and adjustment on remaining intake valves.

i. With engine running at idling speed and at normal operating temperature, adjust exhaust valve as follows:

j. Check for proper 0.014 inch clearance by alternately passing a 0.013 inch and a 0.015 inch flat feeler gauge between head of adjusting screw and valve stem cap, See Plate 3223.

k. Follow procedure outlined in paragraphs (d) thru (h).

m. Install valve chamber cover using new valve chamber cover gasket and replace cover mounting screws.

**N O T E**

DO NOT REUSE OLD GASKETS. THEY DO NOT

AFFORD A POSITIVE SEAL.

n. Check valve chamber cover gasket for leaks.

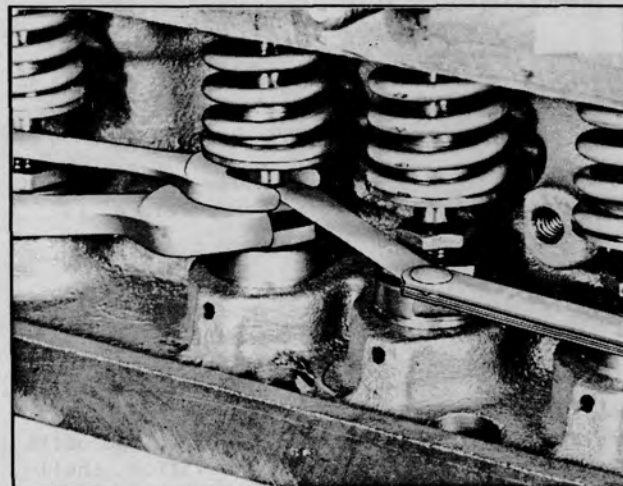


Plate 3223. Adjusting Valve Clearance

**6A. COLD SETTING. (ALTERNATE METHOD)**

To adjust valve clearance when engine is at room temperature and not running, proceed in the following manner:

a. Remove distributor cap.

b. Crank engine until distributor rotor points to No. 1 cylinder position with the breaker points open. In this position the No. 1 piston is at the top of its compression stroke with both lifters on the base circle of the cam and both valves can be adjusted.

c. Adjust the valve clearance to 0.012 inch on the intake and 0.020 inch on the exhaust. The exhaust (e) and intake (I) valve arrangement on the six cylinder engine is: E-I-I-E-E-I-I-E-E-I-I-E.

d. The other valves may be adjusted by setting the engine with the distributor rotor pointing to the rest of the cylinder positions in the sequence of the firing order which is 1-5-3-6-2-4.







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### 7. COMPRESSION TEST

a. Test battery for full charge (specific gravity 1.280 temperature of 24°C (75° F)). If battery is not fully charged, replace with fully charged battery.

b. Start engine and allow it to warm up until normal operating temperature is reached.

c. Turn off ignition.

d. Remove spark plug cables from spark plugs and remove spark plugs from cylinder head. Examine spark plugs for carbon deposits, defective insulation and general serviceability. All carbon or lead deposits must be removed from the insulation shell and electrodes. This can be done on a sand blast cleaner. Carbon deposits should be removed from the plug threads with a stiff brush. After cleaning, inspect plugs carefully for cracked or broken insulator, badly pitted electrodes or other signs of failure.

e. With all plugs removed, install compression gauge in front spark plug port. Operate starting motor until maximum reading on gauge is obtained, see Plate 3486., Record gauge reading. Repeat this operation on each remaining cylinder.

f. If readings are reasonably high (110 to 120) pounds and the readings do not vary more than about 10 pounds between cylinders, compression may be considered normal. Excessively low readings or readings that vary more than 10 pounds between cylinders indicate internal trouble to be corrected after further examination and testing.

g. Set the spark plug gap as specified, by bending side electrode only. The gap should be checked with a wire feeler gauge rather than a flat type gauge as it is better suited for this purpose.

h. Spark Plug Specifications:

Resistor Type - .035" Gap

i. Replace spark plugs using new gaskets. Always replace spark plug gasket whenever a spark plug is removed from the engine. Before installing plugs, be sure that the spark plug seat in the cylinder head is clean and free from obstructions. The spark plug should be screwed into cylinder head (using a socket of proper size) sufficiently tight to fully compress the gasket. This is most important as a large percentage of troubles due to overheated spark plugs are caused by plugs being too loose in the cylinder head. Conversely, excessive tightening may change the gap between the electrodes or crack the insulator.

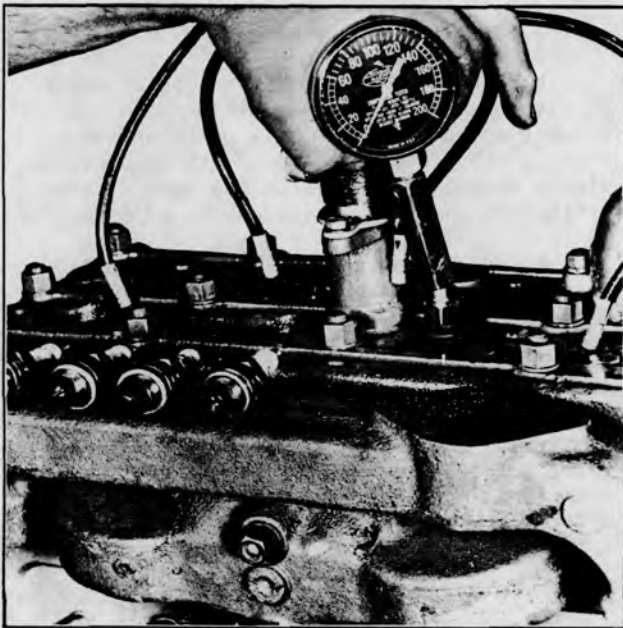


Plate 3486. Compression Test



Plate 3278. Check Spark Plug Gap



8. DISTRIBUTOR

Inspection: Remove distributor cap (without removing wires). Wipe cap with a clean cloth. Examine rotor and cap for chips, cracks, corroded terminals, carbon runners (paths which will allow high-tension leakage to ground) or if the vertical faces of the inserts are burned -- install a new cap and rotor, as this is due to the rotor being too short.

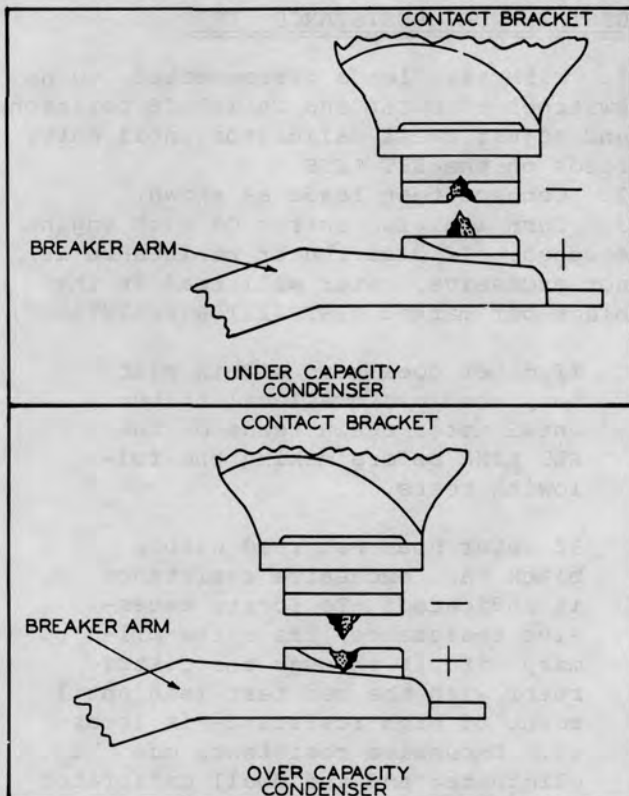


Plate 5933. Breaker Points

Check the centrifugal advance mechanism for "freeness" by turning the breaker cam in the direction of rotation and then releasing it. The advance springs should return the cam to its original position without sticking.

Inspect breaker points. If points are pitted, burned or worn to an unserviceable condition, install a new set of points.

The normal color of contact points should be a light gray. If the contact point surfaces are black, it is usually caused by oil vapor, or grease from the cam. If they are blue, the cause is usually excessive heating due to improper

alignment, high resistance or open condenser circuit.

Badly pitted points may be caused by a defective or improper condenser capacity.

If the condenser capacity is too high, the crater (depression) will form in the positive contact. If the condenser capacity is too low, the crater will form in the negative contact, see Plate 5933.

For a temporary repair, dress the contact points with a few EVEN strokes using a clean fine-cut contact file. DO NOT ATTEMPT TO REMOVE ALL ROUGHNESS OR DRESS THE POINT SURFACES DOWN SMOOTH. See Plate 7475.

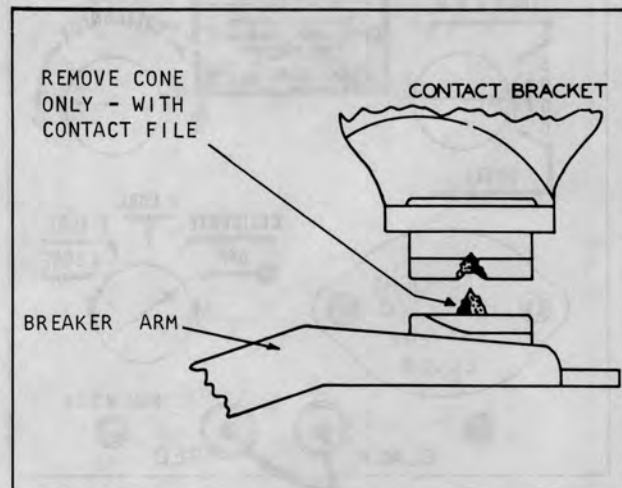
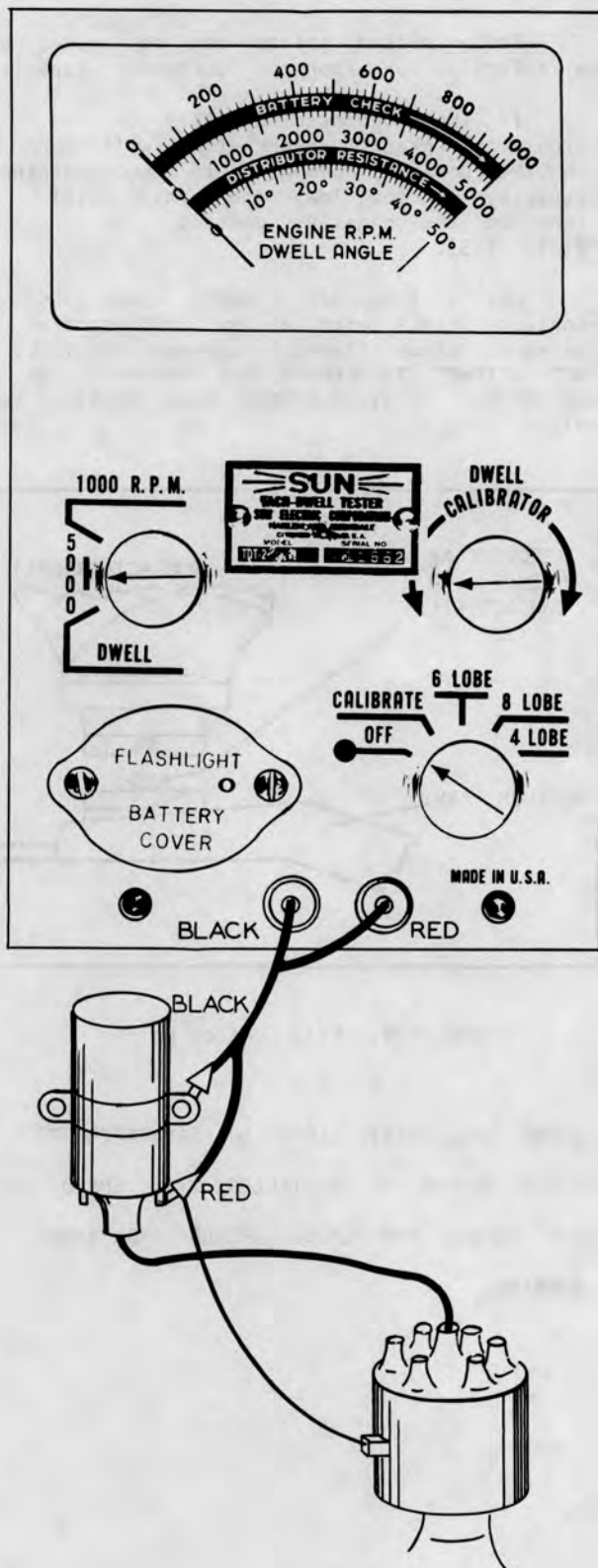


Plate 7475. File Contact Points

CAUTION

NEVER USE EMERY CLOTH OR SANDPAPER TO CLEAN POINTS AS PARTICLES WILL EMBED IN THE POINTS AND CAUSE ARCING AND RAPID BURNING.



MEASURING ENGINE SPEED

1. Connect the test leads as shown.
2. Turn switch to the LOBE position corresponding to the number of cylinders.
3. Turn the other switch to the 1000 rpm position for all idle and low speed testing. Use the 5000 rpm position for all speeds over 1000 rpm.

DISTRIBUTOR RESISTANCE TEST

1. With test leads disconnected, turn switches to DWELL and CALIBRATE positions and adjust dwell calibrator until meter reads on the SET LINE.
2. Connect test leads as shown.
3. Turn ignition switch ON with engine stopped. If distributor resistance is not excessive, meter will read in the black bar marked DISTRIBUTOR RESISTANCE.

If meter does read within black bar, readjust dwell calibrator until meter again reads on the SET LINE before making the following tests.

If meter does not read within black bar, excessive resistance is indicated. To locate excessive resistance, trace the primary circuit through the distributor with the red test lead until point of high resistance is located. Excessive resistance must be eliminated and the dwell calibrator adjusted until the meter again reads on the SET LINE before proceeding with the following tests.

DWELL AND DWELL VARIATION TESTS

1. Turn switch to the proper LOBE position.
2. Operate engine at idle speed and note reading on dwell scale of meter. Refer to specifications for proper dwell.
3. Turn tachometer switch to the 5000 rpm position and increase speed to 1500 rpm.
4. Turn switch back to the DWELL position and again note dwell reading. Slowly reduce speed to idle while watching meter. Dwell should not change more than 3 degrees in either case.

Plate 6887 Tach Dwell Meter

**Contact Point Adjustment:** The point opening of new points can be checked with a wire feeler gauge, but the use of a feeler gauge on older, rough points is not recommended, since accurate gauging cannot be done on such points. The gauge measures between high spots on the points instead of the true point opening. Point opening of used points can be checked with a Dwell Angle Meter. A meter of this type indicates the cam or contact angle. This angle is the number of degrees that the breaker cam rotates from the time the points close until they open again. The cam angle increases as the point opening decreases and it is reduced as the point opening is increased. Manufacturers of this type equipment furnish complete instructions as to their use.

**NOTE**

REFER TO SPECIFICATIONS FOR DWELL ANGLE AND CONTACT POINT OPENING.

To check point opening with a feeler gauge, insert a wire feeler gauge of proper size between the contact points. MAKE CERTAIN THAT THE BUMPER BLOCK ON THE MOVABLE CONTACT IS AT THE HIGH POINT ON THE CAM. If adjustment is necessary, loosen the lock screw, and insert a screwdriver of the proper size in the adjustment slot and move the stationary arm until the correct clearance is obtained. Tighten locking screw and recheck point gap. See Plate 7457.

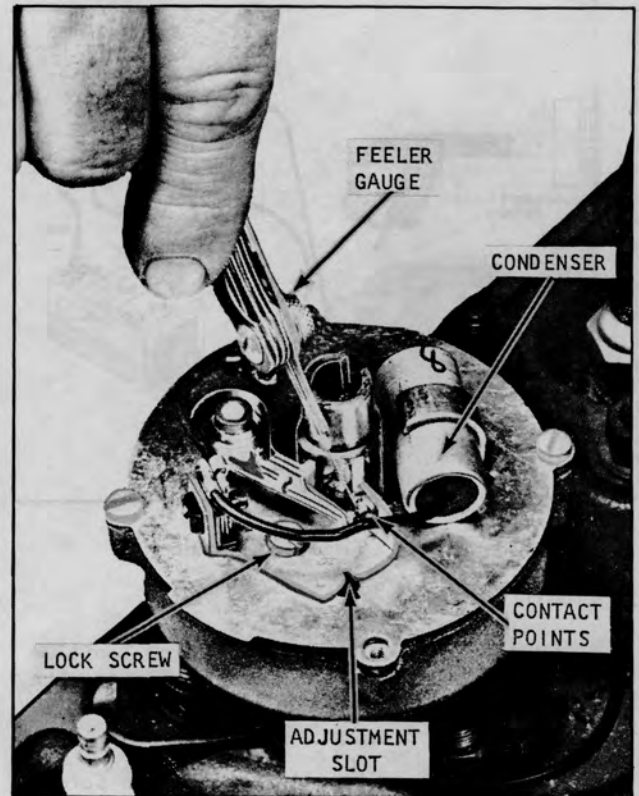


Plate 7457. Contact Point Adjustment



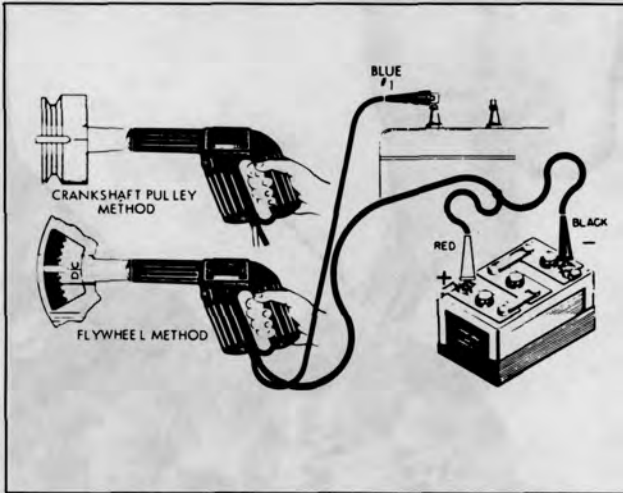


Plate 7818. Timing Light Hookup

9. IGNITION TIMING

There are two methods of checking ignition timing --- with or without a timing light. The PREFERRED METHOD is to use a timing light in following sequence:

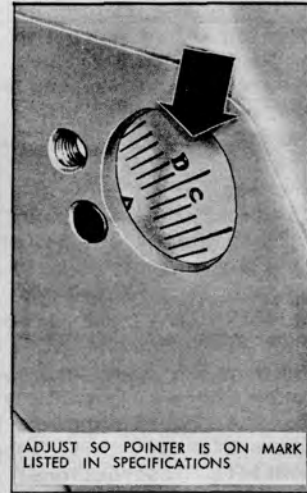
Paint a line on the flywheel (or in some cases, on the front pulley) so the correct timing mark will be more legible under the timing light.

- a. Clip blue secondary lead of light to the #1 spark plug -- leave spark plug wire on plug.
- b. Connect primary positive lead (red) to positive terminal of battery.
- c. Connect primary negative lead (black) to negative battery terminal.
- d. Start engine and run a 400 RPM or below so the automatic advance of the distributor is completely retarded. THIS IS VERY IMPORTANT TO OBTAIN CORRECT TIMING.

**NOTE**

The initial advance RPM range is 430-580. Distributor advance at 600 engine RPM should be 1° to 5°.

- e. Direct timing light on the pulley (or flywheel through opening in bell housing) and note timing marks as light flashes. The light should flash on the timing mark that is listed in specifications.
- f. To advance timing, turn distributor body clockwise. To retard timing, turn distributor body counterclockwise.



ADJUST SO POINTER IS ON MARK LISTED IN SPECIFICATIONS

Plate 7861. Ignition Timing

- g. When timing is correct, tighten distributor clamp screw securely. Then recheck timing again with light.

ALTERNATE TIMING METHOD

- a. Remove #1 Spark Plug -- put your thumb over the spark plug hole and crank engine by hand until air is exhausting.
- b. Continue to slowly crank engine until the mark listed in specifications lines up with the pointer in bell housing.
- c. Loosen the distributor clamp bolt and rotate the distributor body until the contact points just start to open. (This may be more accurately checked by means of a test lamp connected between the distributor primary lead and the negative terminal of the battery -- when the points are closed the light will be ON and as soon as the points break the light will go OFF.)
- d. Tighten distributor mounting bolts.



10. VACUUM TEST

Before making vacuum test, make certain cylinder head is securely tightened and that cylinder head gasket is not leaking. Air cleaner must be installed and must be clean to perform vacuum test. Manifold stud nuts must be tight and there must not be any leakage at gasket.

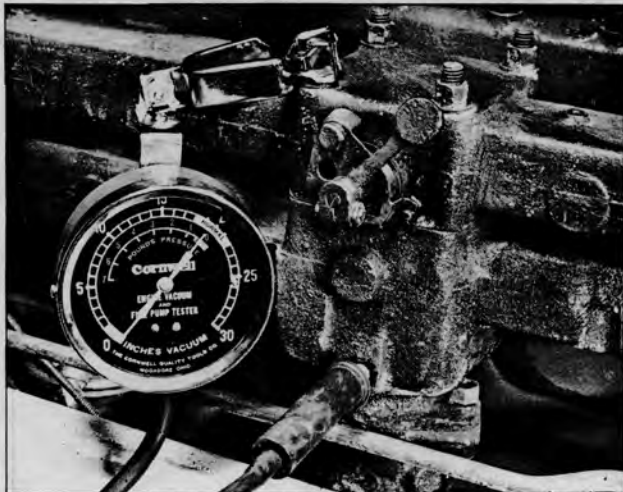


Plate 6643. Vacuum Test

(a) Remove plug at intake manifold and install vacuum gauge, see Plate 6443. Using the tachometer, set the engine idle speed at 450 to 500 RPM.

Idle Speed Adjustment: A stop screw controls action of the throttle valve. Turn screw clockwise for faster idle speed, or counterclockwise for slower idle speed. This adjustment should be made with a tachometer. Idling speed should be set for 450 to 500 revolutions per minute. Reset idle mixture screw if necessary, after throttle adjustment has been made, see Plate 6889.

(b) Check the vacuum gauge. A steady reading from 18" to 22" of mercury is a normal reading, indicating that valve and spark timing, valve seating, and piston ring sealing are all satisfactory.

(c) A steady but below normal reading indicates a condition common to all cylinders such as a leak at the carburetor gasket, late ignition or valve timing, or uniform piston ring and bore wear.

(d) A slowly fluctuating or drifting reading indicates that the fuel idle mixture is incorrect. Look for the cause in the fuel system.

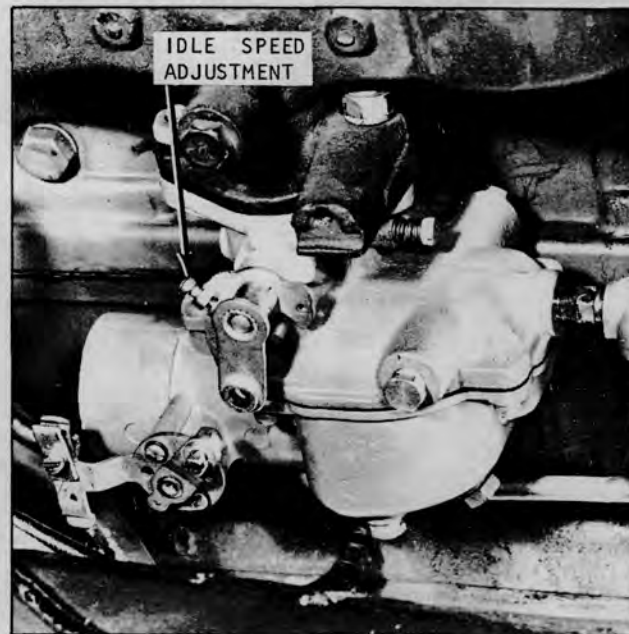


Plate 6889. Idle Speed Adjustment

(e) A rhythmic pulsating reading is caused by a condition affecting one or more cylinders, but not all, and indicates leaky valve, gasket blow-by, restricted intake port, or an electrical miss.

(f) An intermittent pulsating reading is caused by an occasional malfunction, such as a sticking valve (all valves may be erratic in operation if the valve springs are weak), electrical miss caused by insufficient distributor point tension or low coil voltage coupled with inconsistent spark plug gaps or fouled plugs, or dirt in the fuel system finding its way into passages of critical size or valve seats in the carburetor.

(g) A normal reading that quickly falls off (with engine running at approx. 1860 RPM) indicates exhaust back pressure caused by a restriction in the exhaust system.

(h) Make indicated corrections to bring vacuum to 18" to 22" of mercury normal reading.

Idle Fuel Adjustment: The carburetor is controlled by the idle adjustment screw that regulates the fuel-air mixture, see Plate 6889. Turning the screw clockwise, towards the seat, cuts off air increasing the suction on the idle jet and making the mixture richer. Turning the idle adjusting screw counterclockwise, or away from seat, allows more air to be mixed with the fuel making a leaner mixture for idling.

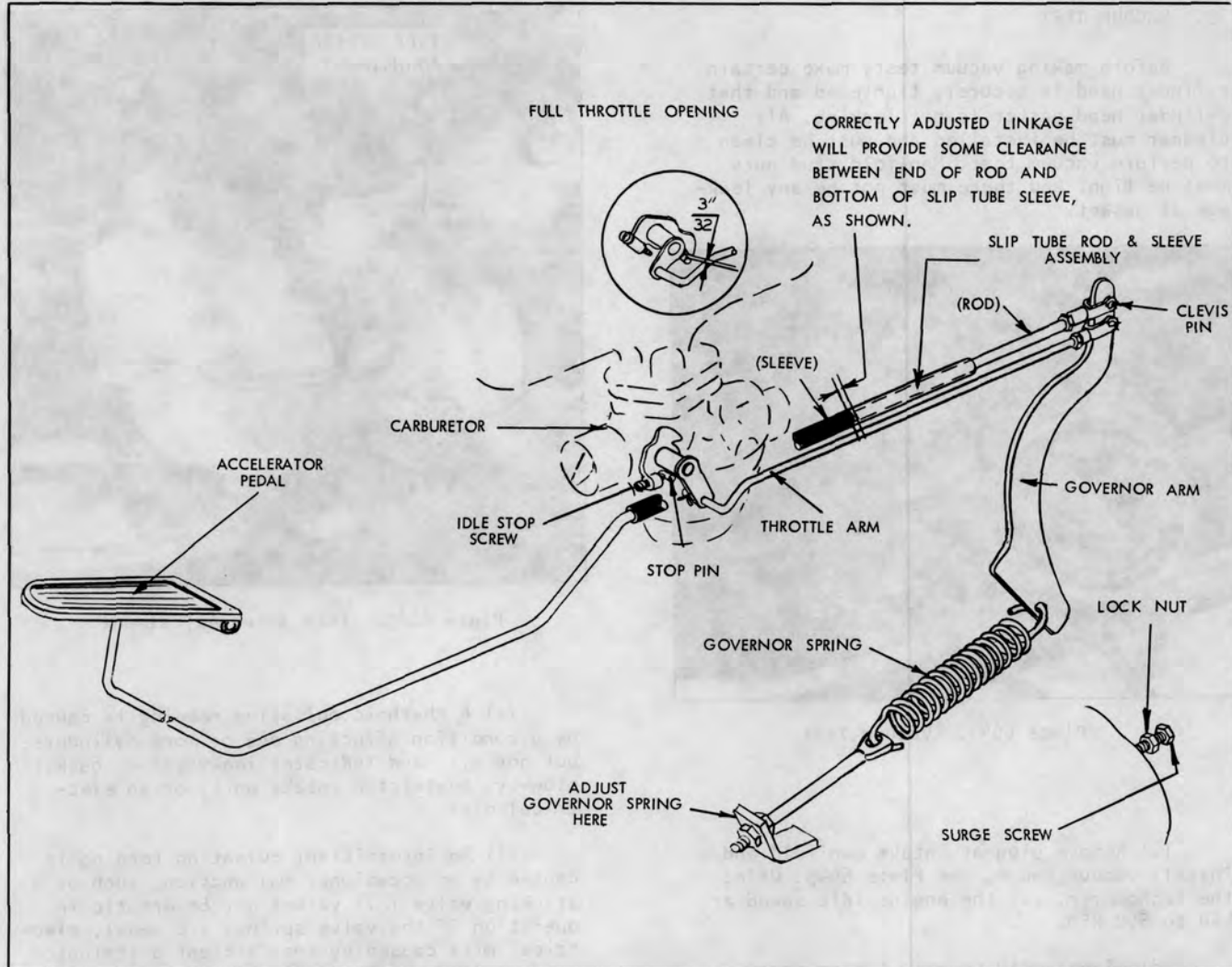


plate 6660. Governor Adjustment

**11. GOVERNOR ADJUSTMENT**

With timing set on top dead center, and the carburetor properly adjusted to idle at 500 R.P.M., proceed with the following:

A. Loosen Governor Surge Screw Jam Nut and back Surge Screw out.

B. Disconnect Slip Tube Rod from Governor Arm by removing Clevis Pin.

**NOTE**

REMOVE CLEVIS PIN --- DO NOT LOOSEN CLEVIS JAM NUT.

C. Pull rod from Slip Tube Sleeve and thoroughly clean rod and sleeve. Lubricate rod with Graphite Grease after cleaning.

**NOTE**

THE SLIP TUBE ROD AND SLEEVE ASSEMBLY CANNOT FUNCTION PROPERLY IF IT IS BINDING, THEREFORE, THE ASSEMBLY MUST BE CLEAN AND PROPERLY LUBRICATED TO CORRECTLY ADJUST THE GOVERNOR.

D. With the Slip Tube and Sleeve Assembly disconnected, the Governor Arm will move forward. Check the Carburetor Throttle Opening. There should be 3/32 inch clearance between the Full Throttle Opening Stop and Stop Pin on the carburetor.

If adjustment is necessary, adjust the Throttle Rod between carburetor and



# INDUSTRIAL TRUCK DIVISION



## LUBRICATION AND PREVENTIVE MAINTENANCE

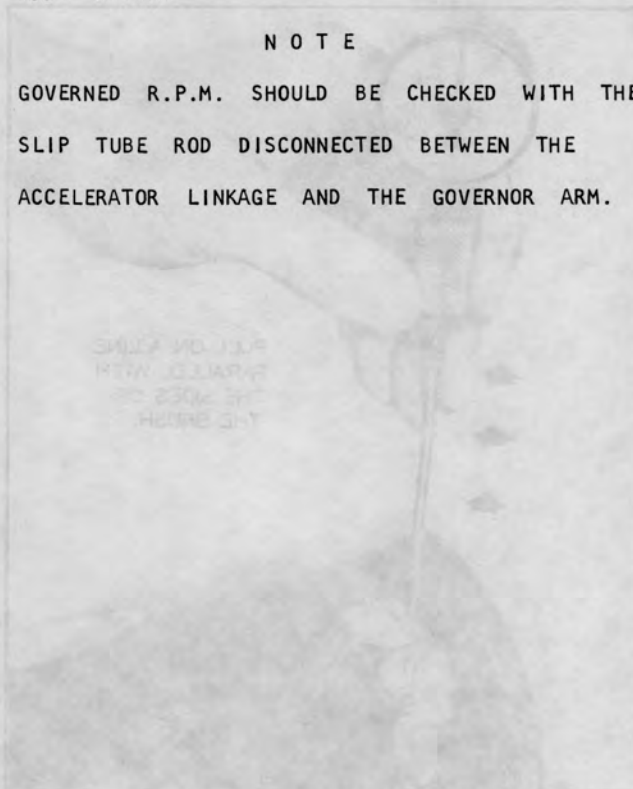
governor arm until the specified clearance (3/32 inch between STOP and STOP PIN) is obtained.

E. Push the Governor Arm toward rear of machine until the Idle Stop Screw contacts Stop Pin on the carburetor. Rotate the Governor Surge Screw inwards until screw comes in contact with the Governor Shaft Lever (when holding the Governor Arm rearward) ---- Do Not Rotate Screw So Far That The Idle Stop Screw Moves Away From Stop Pin. When correct surge screw adjustment is obtained, tighten jam nut.

F. With the use of an Electric Tachometer, start engine (Warm up to normal temperature) and check for NO -- LOAD 2350 R.P.M.

### NOTE

GOVERNED R.P.M. SHOULD BE CHECKED WITH THE SLIP TUBE ROD DISCONNECTED BETWEEN THE ACCELERATOR LINKAGE AND THE GOVERNOR ARM.



If adjustment is necessary, adjust the Governor Spring, see Plate 6660.

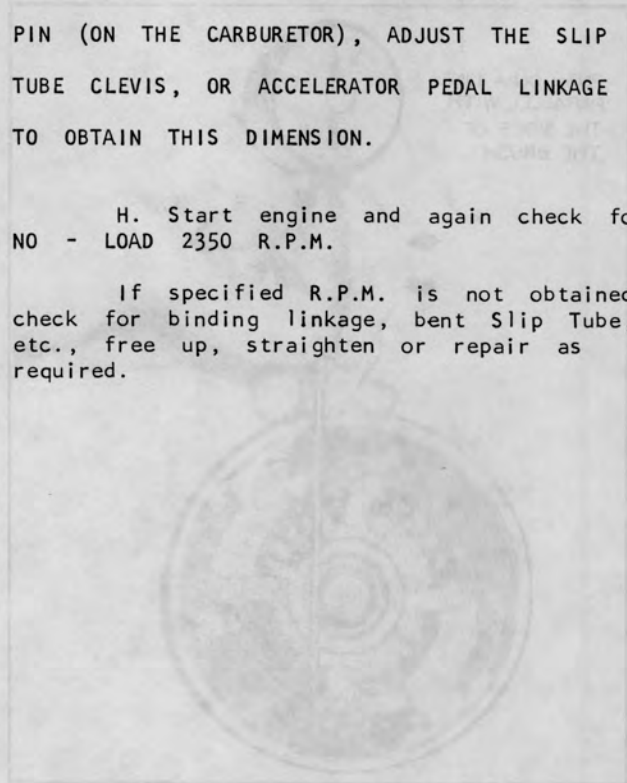
G. Install Slip Tube over rod. Attach Rod Clevis to Governor Arm with Clevis Pin.

### IMPORTANT

WITH IGNITION OFF, DEPRESS ACCELERATOR PEDAL AND CHECK THROTTLE OPENING. IF THERE IS MORE THAN 3/32 INCH CLEARANCE BETWEEN THE FULL THROTTLE OPENING STOP AND STOP PIN (ON THE CARBURETOR), ADJUST THE SLIP TUBE CLEVIS, OR ACCELERATOR PEDAL LINKAGE TO OBTAIN THIS DIMENSION.

H. Start engine and again check for NO - LOAD 2350 R.P.M.

If specified R.P.M. is not obtained, check for binding linkage, bent Slip Tube, etc., free up, straighten or repair as required.





**STARTING MOTOR**

1. Remove end plate (or Brush Cover) from starter. Use a wire hook to lift a brush spring and remove brush from holder. Compare brush size with that of a new brush. If brush is worn beyond half the original size, or if brushes are jammed, chipped, or broken they must be replaced.

**CAUTION**

NEVER ALLOW SPRING TO SNAP DOWN ON BRUSHES.



Plate 6449 Checking Brush Spring Tension

2. Check for Brush Spring Tension, refer to Specifications. Refer to the following procedures for checking spring tension.

Measuring Brush Spring Tension - Reaction Type Brushes. Hook the scale under the brush spring near the end and push or pull on a line parallel to the sides of the brush. To assist in telling the exact instant that the pressure is relieved, a small strip of paper can be placed under the brush. Pull slightly on the paper and the paper will slip out at the correct instant for reading the spring scale.

Measuring Spring Tension - Swinging Type Brushes: Hook the spring scale under the brush screw tight

against the brush and push or pull on a line parallel to the sides of the brush. Take the reading just as the brush leaves the commutator. Pulling slightly on a strip of paper which has been placed under the brush will indicate when the brush leaves the commutator and the correct instant for reading the spring scale.

3. If commutator is glazed or dirty, clean with a strip of No. 00 sandpaper. Blow out all dirt and grit with compressed air.

**CAUTION**

DO NOT USE EMERY CLOTH TO CLEAN COMMUTATOR.

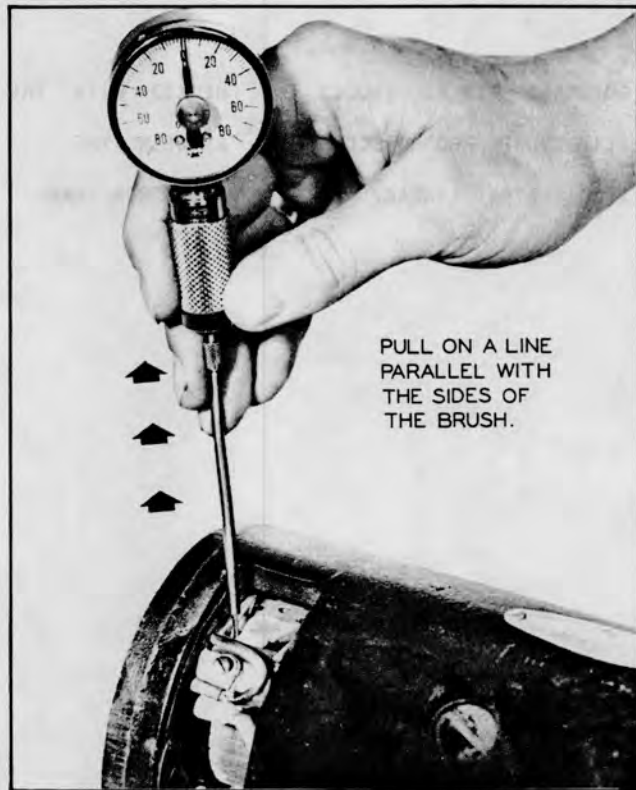


Plate 6450. Checking Brush Spring Tension

Condition Test: Use one of the two following methods to determine whether the starting motor should be removed from the engine for inspection, service or replacement.

1. First Method: Operate the starting motor by disconnecting the battery cable from the solenoid switch and holding the cable terminal firmly against the starting motor terminal, using a battery known to be fully charged and in good condition. To do this it will be necessary to remove the solenoid switch.



2. If the motor reacts correctly, and the drive mechanism engages and disengages each time the starting motor is operated, the starting motor is in good condition.

3. If motor does not react properly, it must be removed for inspection or replacement.

4. Second Method: Using a voltmeter and a battery (fully charged) that is in good condition, connect positive lead of test voltmeter to positive terminal of battery and negative lead of voltmeter to negative (grounded) terminal of battery. Record voltmeter reading. Now pull high-tension wire from ignition coil so engine will not start when starter is engaged. Connect positive lead of test voltmeter to ground and negative lead of test voltmeter to starter switch terminal. Turn ignition switch to start position and note voltmeter reading. Compare this reading with the previously recorded reading. If the voltage drop is more than 4 volts, or if the second reading is below 8 volts, the starting motor should be removed from the engine for further testing and repair, or replacement.

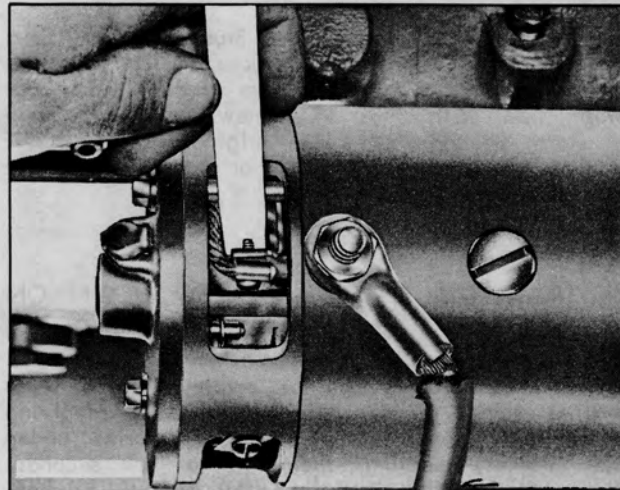


Plate 3436. Seating Brushes

**NOTE**

**BLOW OUT ABRASIVE PARTICLES AFTER SEATING BRUSHES.**



**GENERATOR**

1. Remove end plate (or Brush Cover) from generator. Use a wire hook to lift a brush spring and remove brush from holder. Compare brush size with that of a new brush. If brush is worn beyond half the original size, or if brushes are jammed, chipped, or broken they must be replaced.

**CAUTION**

**NEVER ALLOW SPRING TO SNAP DOWN ON BRUSHES.**

New brushes can be seated with a brush seating stone. When held against the revolving commutator, the abrasive material carries under the brushes, seating them in a few seconds. Blow out abrasive particles after seating brushes. See Plate 3436.

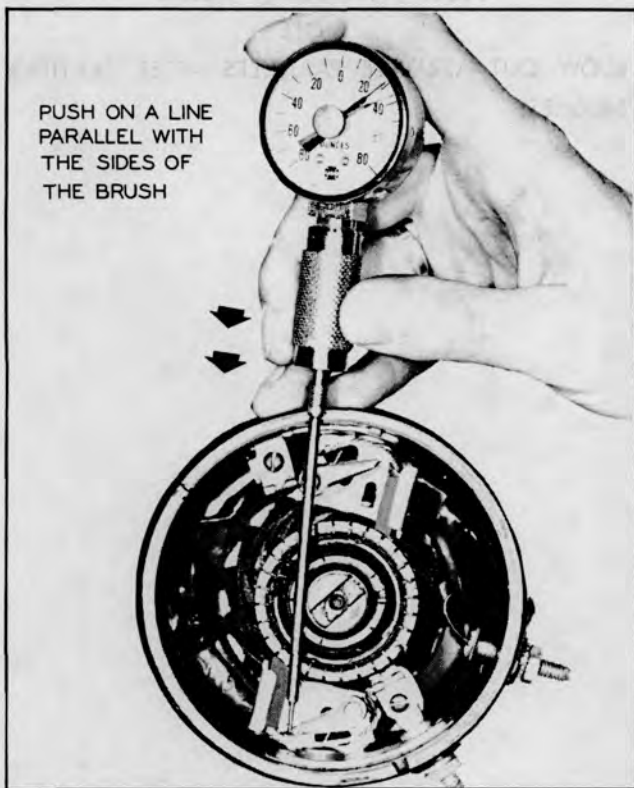


Plate 6451. Checking Brush Spring Tension

Using a spring scale, check for proper brush spring tension. Refer to Specifications. Refer to the following procedures for checking spring tension.

Measuring Brush Spring Tension - Reaction Type Brushes. Hook the scale under the brush spring near the end and push or pull on a line parallel to the sides of the brush.

allel to the sides of the brush. To assist in telling the exact instant that the pressure is relieved, a small strip of paper can be placed under the brush. Pull slightly on the paper and the paper will slip out at the correct instant for reading the spring scale.

Measuring Spring Tension - Swinging Type Brushes:

Hook the spring scale under the brush screw tight against the brush and push or pull on a line parallel to the sides of the brush. Take the reading just as the brush leaves the commutator. Pulling slightly on a strip of paper which has been placed under the brush will indicate when the brush leaves the commutator and the correct instant for reading the spring scale.

3. If commutator is glazed or dirty, clean with a strip of No. 00 sandpaper. Blow out all dirt and grit with compressed air.

**CAUTION**

**DO NOT USE EMERY CLOTH TO CLEAN COMMUTATOR.**

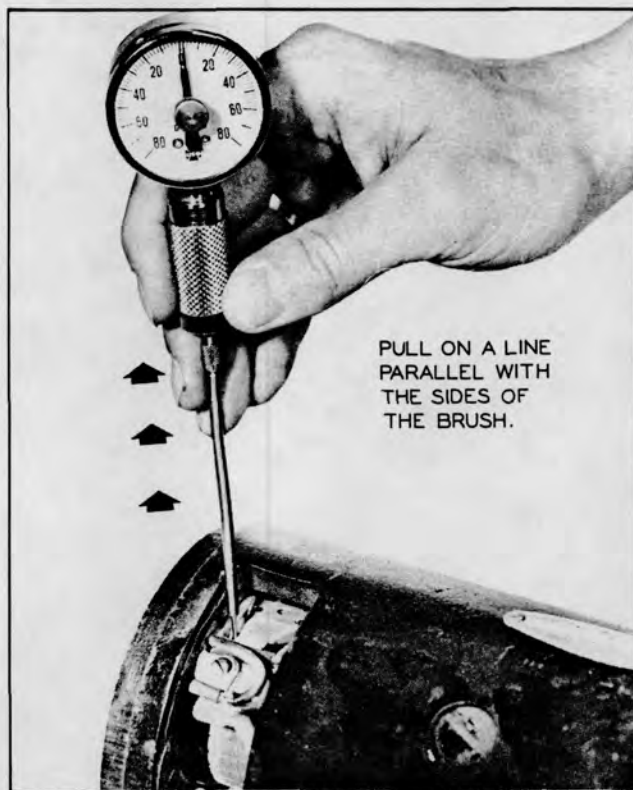


Plate 6450. Checking Brush Spring Tension

## LUBRICATION AND PREVENTIVE MAINTENANCE

### NOTE

BLOW OUT ABRASIVE PARTICLES AFTER SEATING BRUSHES.

### REGULATOR

Inspect regulator leads for frayed or worn condition. Check to make certain that leads are tight and securely mounted.

### WIRING

Check all wires for loose or corroded connections and for fraying. Replace defective wires.

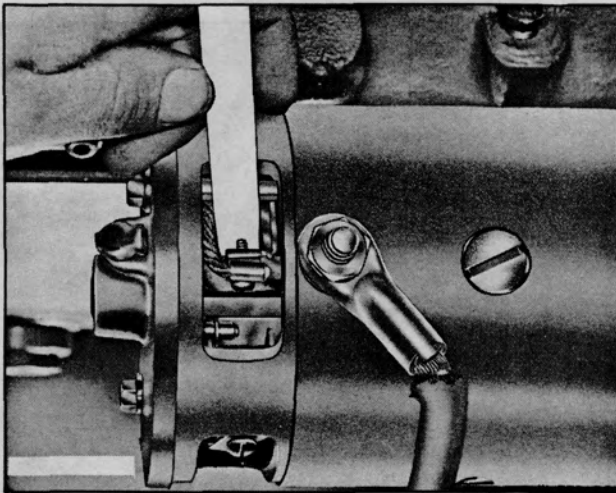


Plate 3436. Seating Brushes





Plate 6640. Typical Wheel Bearings

**STEERING WHEEL BEARINGS**

Adjustment:

1. Raise rear of machine so that tires clear floor.

**W A R N I N G**

AFTER RAISING MACHINE AND BEFORE MAKING ANY ADJUSTMENTS OR ADJUSTMENT CHECKS, PLACE ADEQUATE (HEAVY) BLOCKING (SUFFICIENT TO SUPPORT THE WEIGHT OF THE MACHINE) UNDER THE FRAME TO PREVENT ACCIDENTAL LOWERING OR FALLING OF THE VEHICLE, THUS PREVENTING PERSONAL INJURY TO MECHANIC OR BYSTANDERS.

2. Inspect adjustment of bearings by gripping top and bottom of tire, chuck tire 'in' and 'out' to determine looseness or wobble.

**N O T E**

BEFORE MAKING WHEEL BEARING ADJUSTMENTS, BE SURE PLAY (LOOSENESS OR WOBBLE) IS IN THE WHEEL BEARINGS AND NOT IN THE KING PINS.

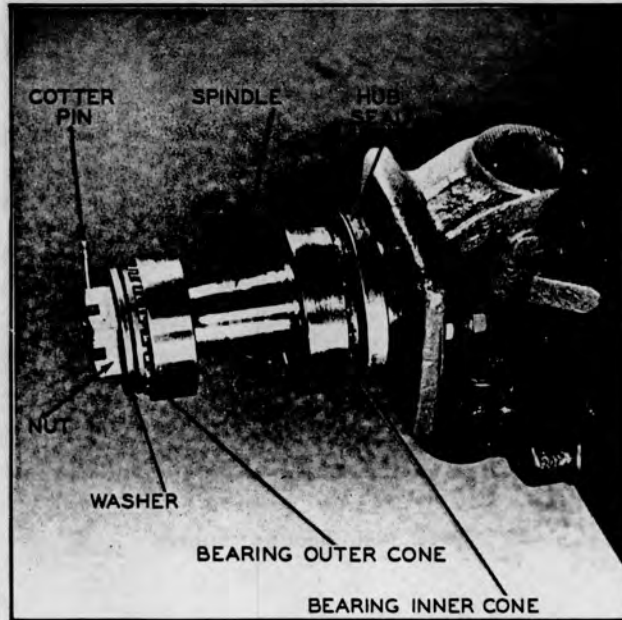


Plate 6703. Typical Wheel Bearings

**N O T E**

IF WHEEL BEARINGS NEED ADJUSTING, CLEAN AND REPACK BEARINGS BEFORE MAKING ADJUSTMENTS. REFER TO LUBRICATION PARAGRAPH. BEFORE REPACKING WHEEL BEARINGS, CHECK FOR ANY INDICATION OF LEAKAGE AROUND HUB SEALS. IF SUCH A CONDITION EXISTS, REPORT TO DESIGNATED PERSON IN AUTHORITY.

3. If looseness or wobble is in the wheel bearings, remove hub cap and spindle cotter pin, see (Plate 6640). Tighten nut with a 12" wrench, and at the same time rotate the wheel in one direction and then in the other until there is a slight bind to be sure all bearing surfaces are in contact. Then back off the nut 1/6 to 1/4 turn allowing the wheel to rotate freely. Secure nut at this position with a new cotter pin and replace hub cap.

Lubrication:

1. Remove wheels after 1000 hours or every six months of operation. Clean bearings and repack with medium bodied high temperature wheel bearing grease, Clark Specification MS9C.
2. Install wheels and adjust wheel bearings as previously described.



**CLEAN AND REPACK AXLE ENDS**

Every 1000 operating hours remove and repack the axle ends.

1. Tilt upright back. Place solid heavy blocks under each upright rail. Tilt upright forward until vertical to the floor. This should allow the drive wheels to clear the floor. Remove drive wheels.

**WARNING**

ON PNEUMATIC TIRE MACHINES DEFLATE TIRES

BEFORE REMOVING WHEELS.

2. Remove hub cap, outer spindle nut, lockwasher, inner spindle nut and washer. Pull hub assembly from spindle.

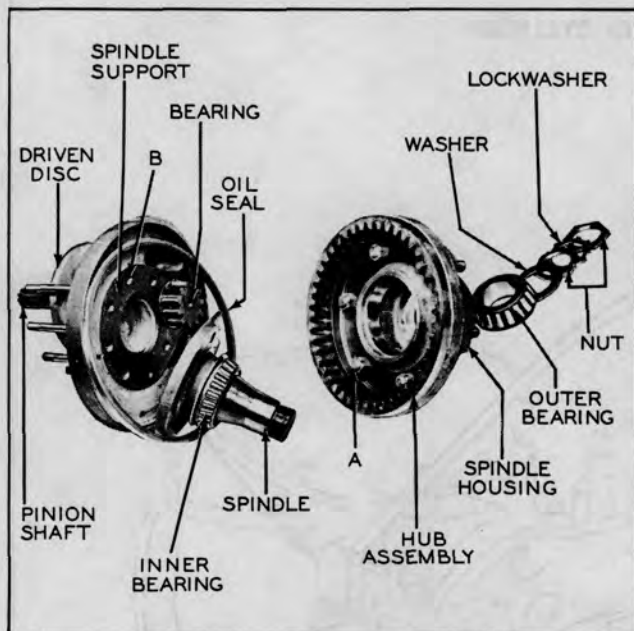


Plate 5694. Axle End Assembly

3. Remove bearings and clean in a Stoddard type cleaning solvent. Slop bearings up and down in solvent. Remove and tap large side of bearing against a block of wood to dislodge solidified particles of lubricant. Repeat operation until bearings are thoroughly clean. Blow bearings dry with compressed air. Direct air stream across bearing to avoid spinning. Slowly rotate bearing by hand to facilitate drying. Dip bearings in gear oil and wrap in paper until they are to be reinstalled.

4. Pack all bearings with NLGI #1 (Amolith grease EP #1 or its equivalent) before final assembly. Also pack the hub cavity between the

bearings 1/2 full. (As an alternate grease No. 1 E.P. lithium soap grease may be used).

5. Clean ring gear, pinion drive shaft, hub assembly, spindle and spindle support.

6. Inspect seals for cuts, scratches and nicks. It is necessary to replace seal if such a condition is found. Check the axle end vent for obstruction, vent must be open. See Plate 6893.

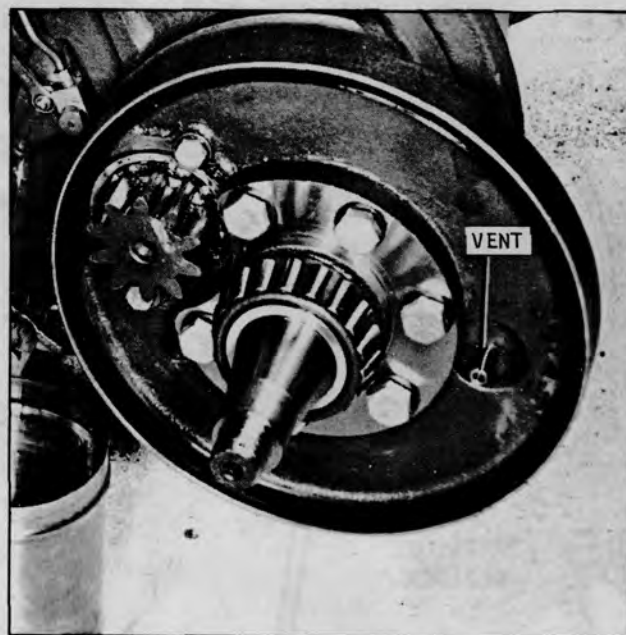


Plate 6893. Typical Axle End Vent

7. Pack the spaces between the teeth of the ring gear and pinion, level full for the entire circumference with NLGI #1 (Amolith grease EP #1 or its equivalent). The approximate amount of grease in this area is to be 1 1/4 pounds.

8. Install bearings, seal and hub assembly on spindle. Tighten inner bearing adjusting nut until bearings bind slightly during rotation. Back off adjusting nut approximately 1/8 turn and lock with outer nut. Secure this adjustment by bending the tangs on the lock washer. Install the hub cap.

9. Replace drive wheels and tires. Inflate tires if they are of the pneumatic type. Tilt upright back and remove blocking.

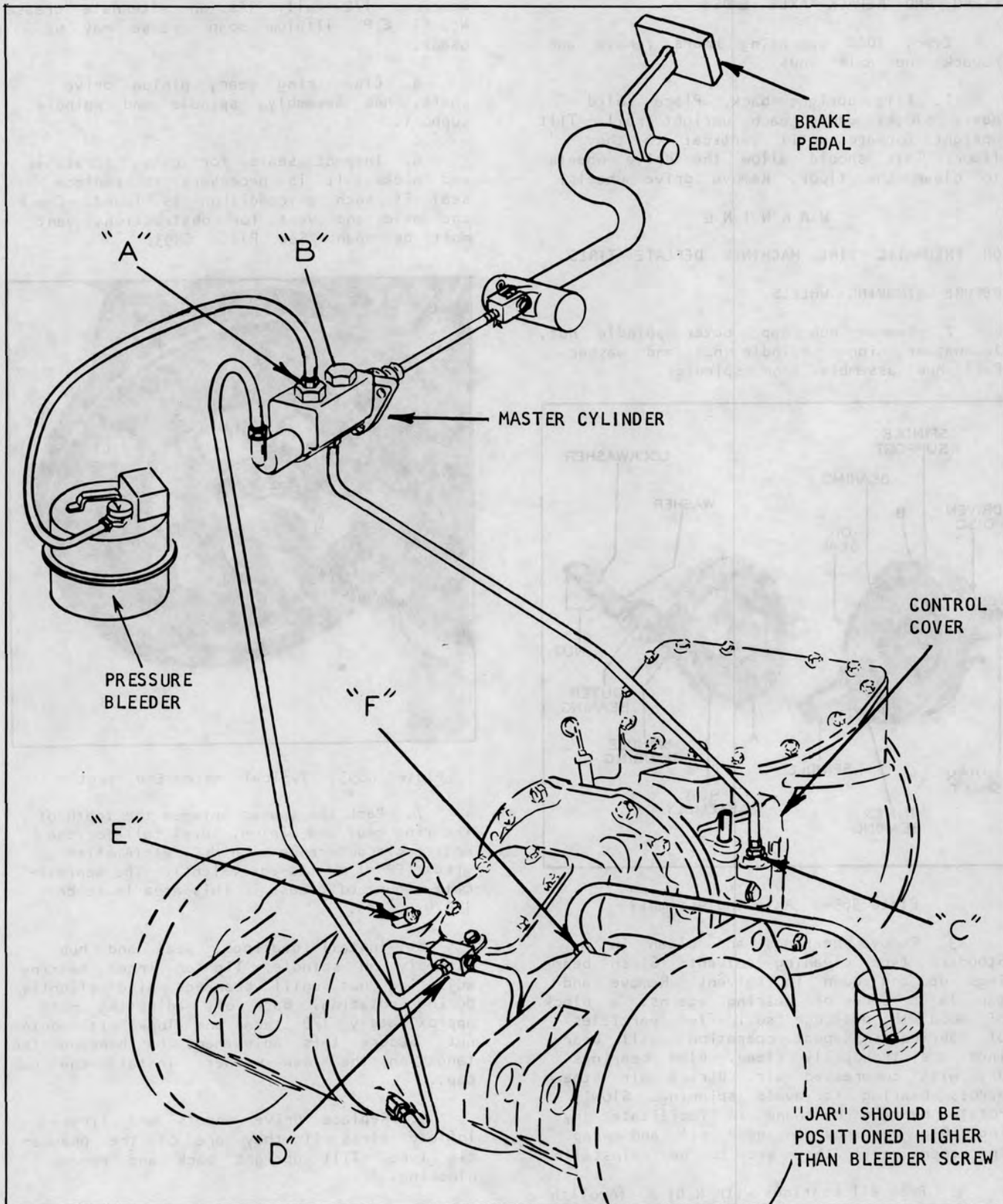


Plate 7302. Bleeding Brakes



# INDUSTRIAL TRUCK DIVISION



## LUBRICATION AND PREVENTIVE MAINTENANCE

### BRAKE BLEEDING PROCEDURE

Proper operation of the hydraulic brake system requires a solid column of fluid without air bubbles at all points in the pressure system. Under certain conditions it becomes necessary to bleed fluid from the system in order to expel air bubbles which have become mixed with the fluid. The necessity of bleeding is indicated by a soft or spongy pedal, or at any time a brake line is removed (or broken) the system must be bled.

Step 1. Tilt upright back. Place solid heavy blocks under each upright rail. Tilt upright forward until vertical to the floor. This should allow the drive wheels to clear the floor.

#### NOTE

IF DRIVE WHEELS ARE REMOVED FROM MACHINES EQUIPPED WITH PNEUMATIC TIRES, DEFLATE TIRES BEFORE REMOVING.

Step 2. Check the brake pedal free travel (see specifications). Clean dirt from around the filler cap of the master cylinder reservoir. Brake fluid should be within 1/4" of the top. With filler cap off the master cylinder, depress and release brake pedal. A small displacement of fluid should be noticed in the cylinder reservoir. If this happens, the brake pedal (upon being released) is returning the master cylinder piston to its normal position to open a master cylinder port. This port must be open. If fluid does not return to the reservoir (when releasing brake pedal), this indicates improper pedal free travel and a pedal adjustment is required.

#### NOTE

THE KEY LETTERS IN PARENTHESES ARE SHOWN ON OPPOSITE PAGE EXCEPT WHERE OTHERWISE INDICATED.

Step 3. To properly bleed the system it is recommended that a pressure bleeder filled with about two quarts of S.A.E. 70-R-3 heavy duty brake fluid be connected to the master cylinder reservoir. Pressure bleeder should then be pressurized to 10-20 P.S.I.

Step 4. Remove vented filler plug and attach pressure bleeder.

Step 5. Loosen plug (B) to permit air to escape from reservoir. Tighten plug after fluid appears around plug.

Step 6. Loosen tube nut (C) and allow all air to escape. Tighten tube nut.

Step 7. Loosen tube nut (D) and allow air to escape. Tighten tube nut.

Step 8. Install a bleeder hose on bleeder screw (E) and submerge the unattached end of the hose in a clean transparent jar containing several inches of brake fluid. NOTE: DURING BLEEDING THE JAR SHOULD BE ELEVATED TO A POSITION HIGHER THAN THE BLEEDER SCREWS MAKING SURE THAT THE END OF THE HOSE REMAINS SUBMERGED IN THE FLUID AT ALL TIMES. Allow fluid to flow until all traces of air are gone. Tighten bleeder screw. Repeat this operation on opposite bleeder screw (F).

Step 9. After all bleeding has been completed close the pressure bleeder shut-off cock and loosen hose connection at master cylinder to allow pressure to escape. Replace master cylinder cap.

Step 10. If wheels were removed replace them. (Inflate tires if they are of the pneumatic type). Tilt upright back and remove blocking from under each upright rail.

If a pressure bleeder is unavailable the system may be bled manually by following steps six thru eight. It must be remembered that the brake pedal should be depressed slowly and held to the floor-board until the line connections or bleeder screws are securely tightened. This prevents the possibility of air being drawn into the system during the bleeding operation. Check master cylinder reservoir level periodically during manual bleeding and fill to within 1/4 inch of the top as required.



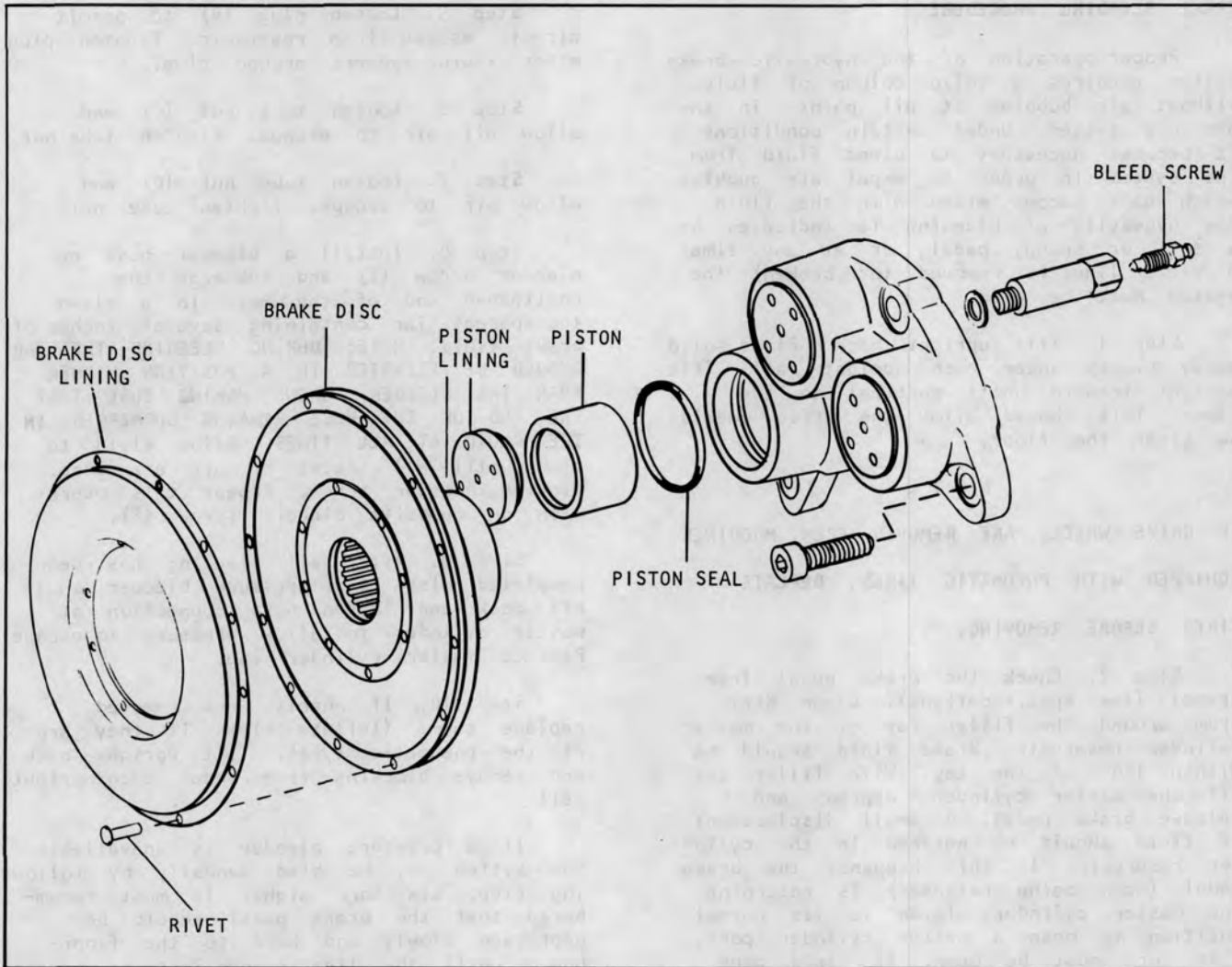


Plate 8261. Wheel Brake Assembly

**DESCRIPTION**

When depressing the brake pedal, hydraulic pressure is applied to the brakes, the pistons move out and their linings force the brake disc and its lining against a member of the axle end producing braking action by friction.

**INSPECTION**

Operating conditions determine the inspection and service periods for the brake linings. If it is found that the brake effectiveness has dropped to a noticeable degree (and the system has been properly bled and pedal free travel is correctly adjusted) the axle ends should be removed so that linings may be inspected to determine their further serviceability.

The original thickness of the brake disc lining is 0.221 inch. The disc lining is effective until it is worn to 1/16 inch thickness. If after inspection it is found that the lining is worn to the extent that it will not be effective until the next inspection period, it should be replaced. The brake piston lining when new is 0.649 inch thick to the step on the lining. This lining should also be replaced if it is determined that it will be worn to within 1/16 of step before the next inspection period.

Before replacing axle ends, check the cylinders for leakage. The actual presence of fluid, other than mere dampness, indicates a fluid leak. Correct leaks as necessary by replacing the piston seals after cleaning the pistons and seal grooves thoroughly.



**PARKING BRAKE ADJUSTMENT**

The mechanical "V" block type parking brake operates on the transmission drive shaft brake drum. The only adjustment necessary during the useful life of the brake lining is a periodic adjustment of the linkage.

To adjust the linkage, remove the floor plates, and adjust the clevis on the linkage, so that the brake handle has 2 inches of upward travel, before resistance is noticed and the brake becomes applied.

The parking brake must be capable of holding the truck, with full rated load, on a 15% grade. This should be tested with the drivers seat occupied, parking brake applied and the truck out of gear.

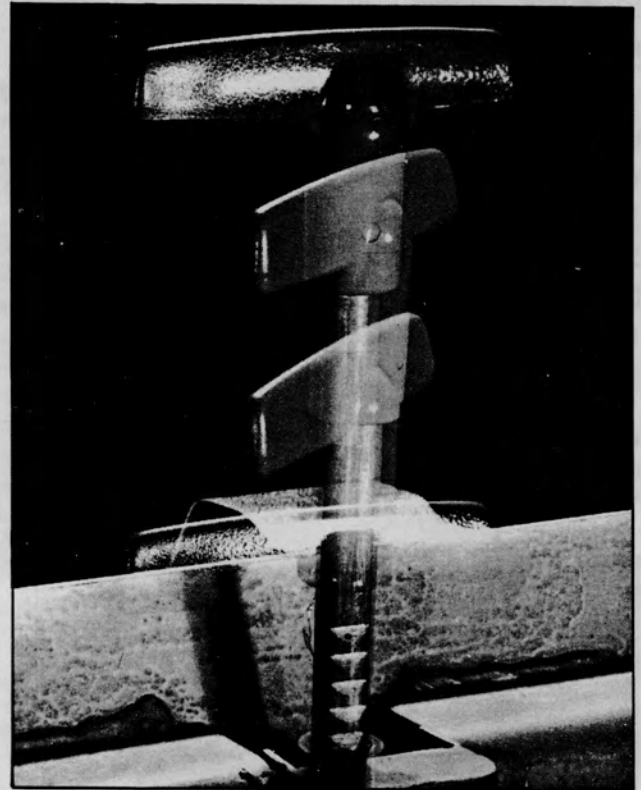


Plate 7482. Parking Brake



**COOLING SYSTEM**

Radiator Pressure Caps:

**WARNING**

USE EXTREME CARE IN REMOVING THE RADIATOR PRESSURE CAP. IN PRESSURE SYSTEMS, THE SUDDEN RELEASE OF PRESSURE CAN CAUSE A STEAM FLASH AND THE FLASH, OR THE LOOSENED CAP CAN CAUSE SERIOUS PERSONAL INJURY. LOOSEN CAP SLOWLY AND ALLOW STEAM TO ESCAPE.

1. Inspect pressure cap gasket and radiator filler neck to be sure they are providing a proper seal. If the rubber face of the valve is defective, a new cap should be installed.



Plate 6458. Radiator Pressure Cap

2. Inspect pressure cap for freedom of operation.

Pressure caps employ a spring loaded, rubber-faced valve which presses against a seat in the radiator top tank. Pressure caps employ either a vacuum valve held against its seat under spring pressure, or a weighted vacuum valve which hangs open until forced closed by a surge of vapor or coolant. Check to be sure components are free to operate.

**NOTE**

IF A NEW CAP IS REQUIRED, ALWAYS INSTALL A CAP OF THE SAME TYPE AND PRESSURE RATING. PRESSURE RATING 7 LB.

3. Inspect for dented or clogged overflow pipe. To remove clogged material, run a flexible wire through pipe until obstruction is removed.

When a pressure cap opens the sudden surge of vapor or liquid must pass thru the overflow pipe. If the pipe is dented or clogged, the pressure developed by the obstruction may cause damage to radiator or hoses.

Inspect and Clean Cooling System:

Check hose connections for coolant leaks as well as air leakage. Air leakage around hose connections allows oxygen into the system which is a major factor in corrosion.

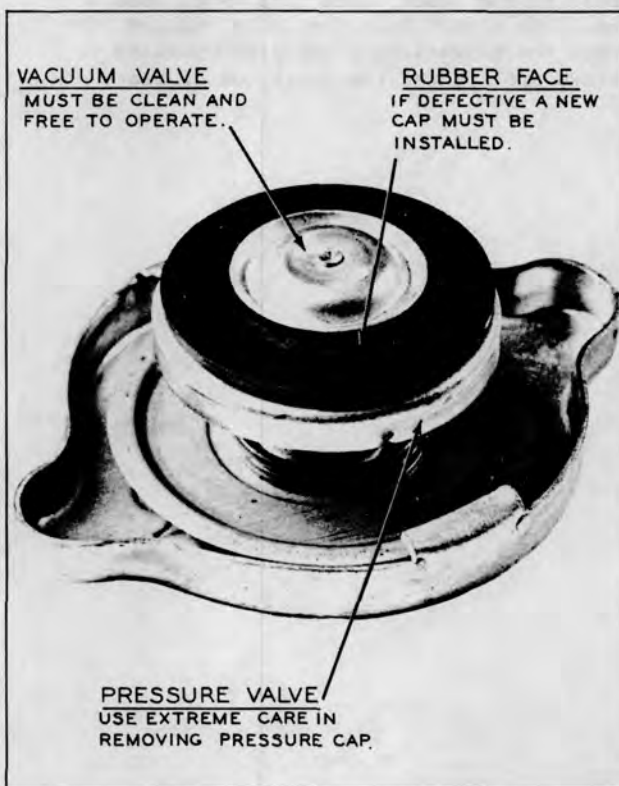


Plate 6459. Pressure Cap Gasket, Valve and Valve Gasket

**NOTE**

EXHAUST GAS LEAKAGE BETWEEN CYLINDER HEAD AND GASKET ALSO RESULTS IN CORROSION. IF EXHAUST GAS DISCHARGES INTO COOLANT, THE COOLANT AND THE GAS COMBINE TO FORM A VARIETY OF ACIDS. IT IS THEREFORE IMPORTANT THAT CYLINDER HEAD STUD NUTS BE DRAWN DOWN TO SPECIFICATIONS AS INSTRUCTED IN "ENGINE TUNE-UP".

## LUBRICATION AND PREVENTIVE MAINTENANCE

Using a washing soda solution, flush cooling system in the following manner:

1. Drain system.
2. Replace half of volume with fresh water. Refer to Specifications for capacity.
3. Boil other half of volume and add washing soda until no more will dissolve.
4. Add hot soda solution to cooling system (fill up).
5. Operate engine normally for 24 hours.
6. Drain, flush, refill with clean water to which a soluble oil has been added in a proportion of 1 ounce per gallon of water.

Maintaining the cooling system efficiency is important, as engine temperatures must be brought up to and maintained within satisfactory range

for efficient operation; however, must be kept from overheating, in order to prevent damage to valves, pistons and bearings. Continued overheating may cause internal damage, while continuously low operating temperature wastes fuel, increases engine wear and causes oil sludge and corrosion of engine parts.

Overcooling may be caused by operating conditions such as excessive idling, low speeds and light loads during cold weather. Overheating may be caused by faulty thermostat, clogged radiator or an improperly adjusted fan belt.

**CAUTION**

NEVER POUR COLD WATER OR COLD ANTI-FREEZE INTO THE RADIATOR OF AN OVERHEATED ENGINE. ALLOW THE ENGINE TO COOL AND AVOID THE DANGER OF CRACKING THE CYLINDER HEAD OR BLOCK. KEEP ENGINE RUNNING WHILE ADDING WATER.

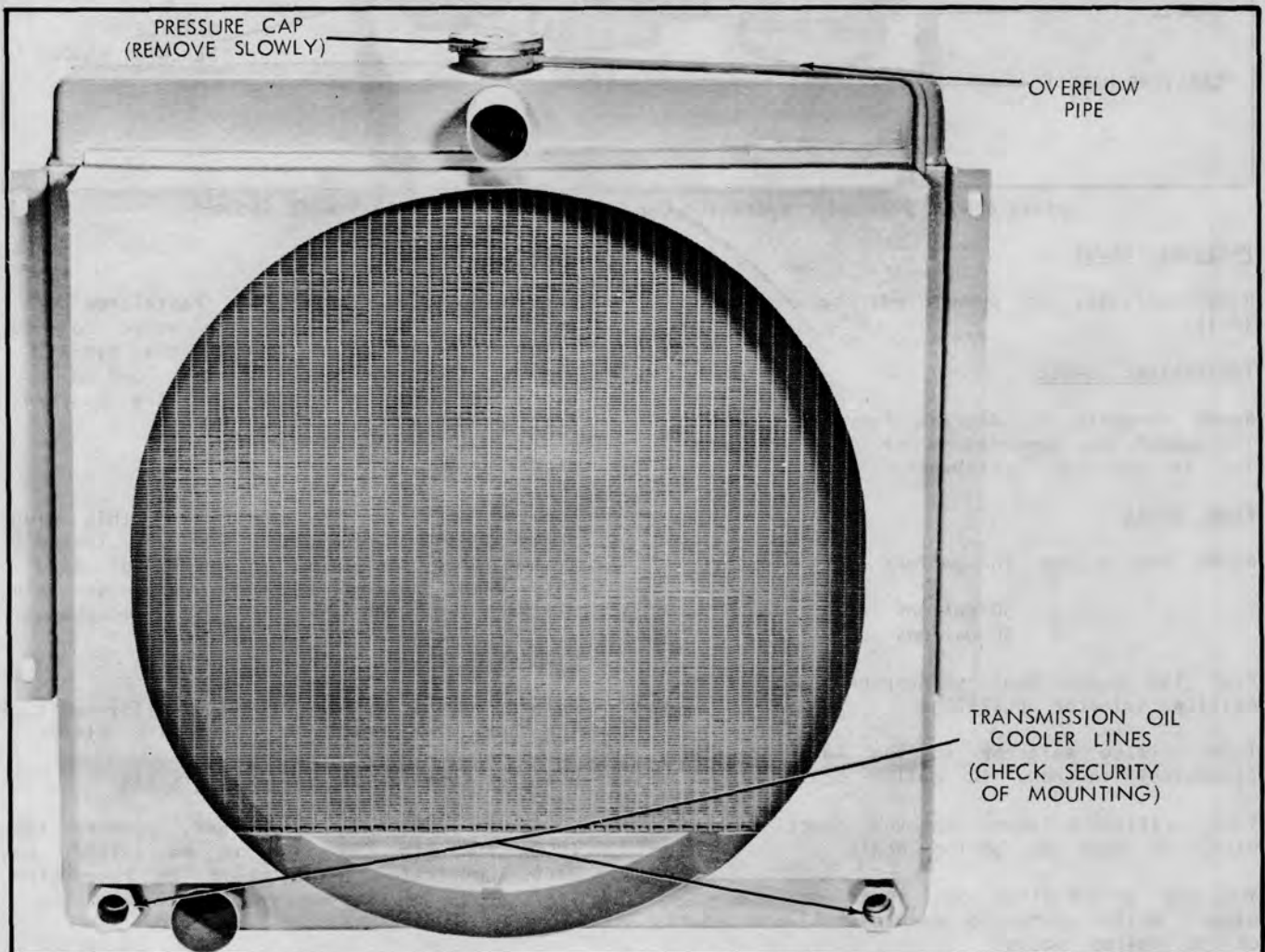


Plate 6460. Typical Radiator



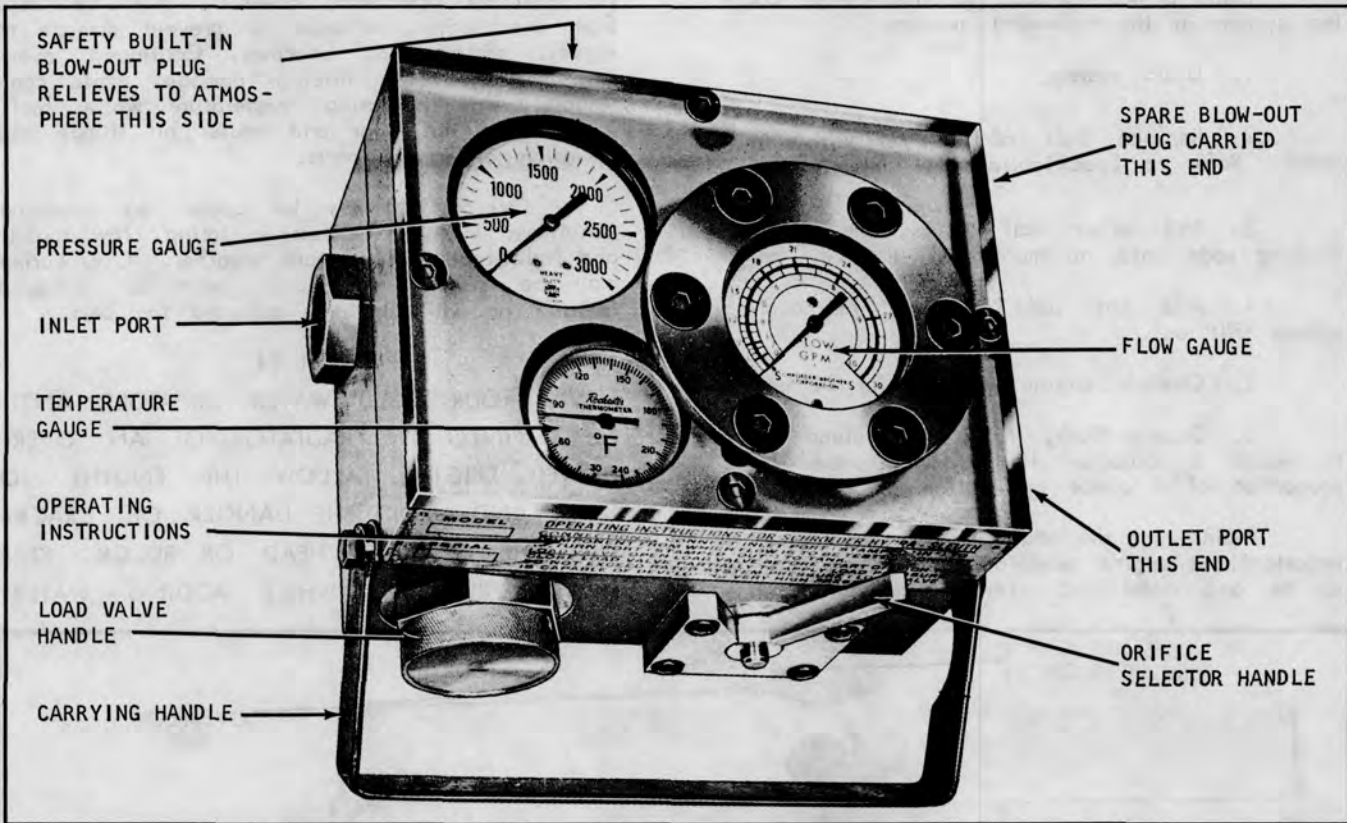


Plate 6747. Schroeder Hydraulic Circuit Tester CLARK PART NUMBER 1800060

PRESSURE GAUGE

Reads directly in pounds per square inch (PSI).

TEMPERATURE GAUGE

Reads directly in degrees Fahrenheit and indicates the temperature of the oil passing through the instrument.

FLOW GAUGE

Reads two scales in gallons per minute.

- 0 - 30 gallons
- 9 - 30 gallons

Read the scale that corresponds with the orifice selector position.

Turn orifice selector to the left (counter-clockwise) to read 10 gallon scale.

Turn orifice selector to the right (clockwise) to read 30 gallon scale.

You may switch from one scale to the other, while operating machine. Always start on 30 gallon scale.

LOAD VALVE

The load valve is a flow restrictor or shut off valve. Turning the valve to the right throttles flow through the Hydra-Sleuth, thus the operator may load a hydraulic pump or circuit to the desired test pressure, simulating work.

SAFETY PLUG

Located opposite the load valve this plug protects the Hydra-Sleuth and the tested system from pressures in excess of 3200 PSI. When pressure becomes higher the plug will rupture and dump oil to atmosphere.

HYDRAULIC FLUID

Unless marked to the contrary, the unit is for use with petroleum, hydraulic fluids.

HOW TO CONNECT THE PORTABLE TESTER

Using a 1/2" hose or larger, connect tester INLET PORT to the flow to be tested. Connect the tester outlet port to reservoir fill port, or system return line.



LUBRICATION AND PREVENTIVE MAINTENANCE

HYDRA-SLEUTH ADJUSTMENTS BEFORE OPERATION

A. Depending on flow (GPM) to be checked choose proper orifice. (It is good practice to start always on 30 gallon scale.)

B. Fully open load valve by turning all the way to the left.

HYDRA-SLEUTH ADJUSTMENTS DURING OPERATION

1. Turn load valve to right to develop test pressures.

**CAUTION**

LOAD VALVE IS CAPABLE OF VERY HIGH PRESSURES.

A. Always start test with load valve fully open.

B. Do not exceed design pressure of system under test.

C. Keep load pressures within range of the Hydra-Sleuth pressure gauge.

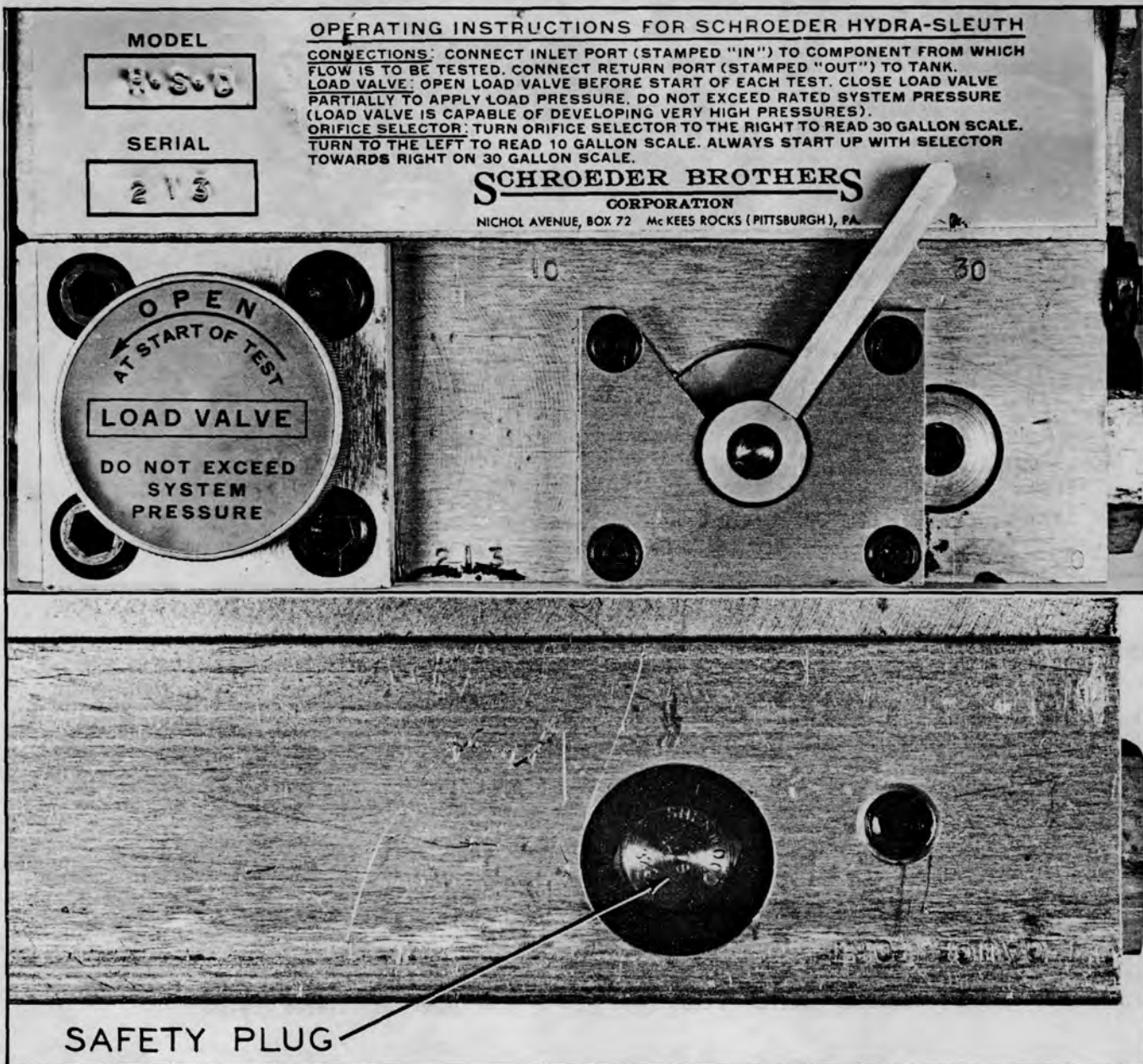


Plate 6748. Schroeder Hydraulic Circuit Tester

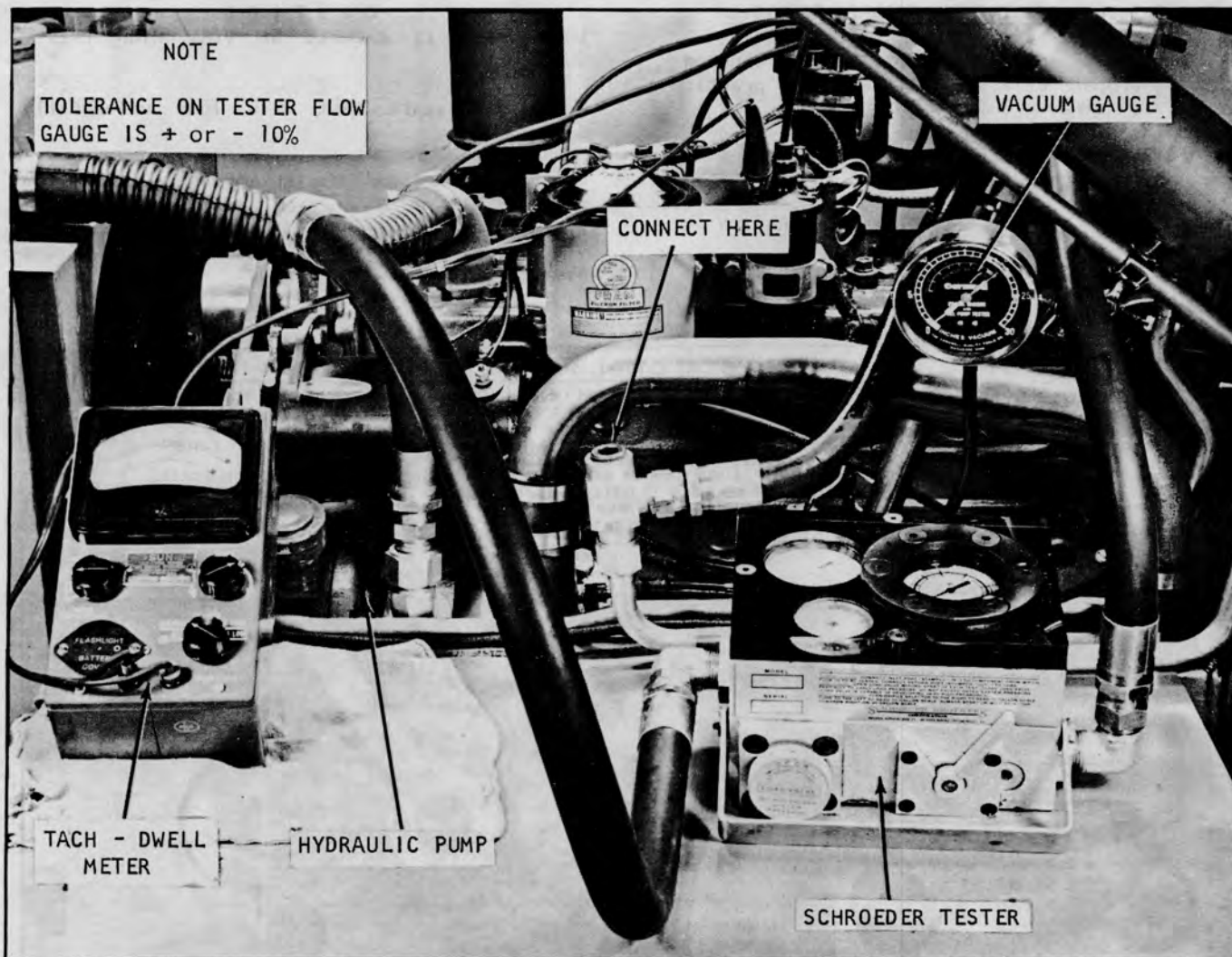


Plate 6749. Flowmeter Hookup

**HOOK UP FLOWMETER**

Install the high pressure hose onto the pump as shown, see Plate 6749. Attach the return line hose as shown in Plate 6749.

**TESTING PUMP OUTPUT**

1. Start the Tractor engine, and set speed to the exact R.P.M. stated in the chart below.

2. To heat up oil, apply the load valve until pressure reaches 1000 P.S.I. CAUTION: APPLY PRESSURE GRADUALLY. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN "BLOWING-OUT" THE FLOWMETER RELIEF PLUG.

3. After the oil has come up to test temperature (120°F.) and the flow gauge needle is stabilized, apply the load valve GRADUALLY until desired pressure is achieved. Then stabilize the pressure needle. NOTE: IT WILL BE NECESSARY TO INCREASE TRACTOR SPEED SLIGHTLY AS PUMP MUST BE TESTED UNDER LOAD (AT SPECIFIED R.P.M.)

CAUTION: LIMIT TIME THE LOAD VALVE IS SET FOR A READING OF 2000 P.S.I. TO 30 SECONDS EXTENDED PERIOD OF TIME WITH MAXIMUM READING COULD CAUSE DAMAGE.

4. Read the flow gauge. It should read reasonably close to the specifications for a new pump as listed below.

ENGINE R.P.M.	P.S.I.	G.P.M.
2250	2000	17



INDUSTRIAL TRUCK DIVISION



OPERATORS

MAINTENANCE

PARTS

MANUAL

FOR

CY-60

FORM NO. 1-60

CLARK EQUIPMENT COMPANY

PUBLISHED BY

TECHNICAL SERVICE DEPARTMENT  
BATTLE CREEK, MICHIGAN, U.S.A.



# INDUSTRIAL TRUCK DIVISION



LUBRICATION AND PREVENTIVE MAINTENANCE

## TRANSMISSION STALL AND PRESSURE CHECKS

### Minimum Tools Required

- 1 - Pressure Gauge 0-250 PSI
- 1 - Tachometer

Before making transmission checks the machine should be steam cleaned. It is important that the radiator be clean externally and internally so that it is capable of maintaining proper cooling for the engine and transmission.

1. Operate engine 3 to 4 minutes to fully charge the transmission plumbing and the torque converter. With the engine operating at idle and the transmission in "Neutral" check the fluid level on the dipstick. Fill if necessary to the "Cold Full" mark or the "Hot Full" mark, depending upon the temperature of the transmission. Use Type "A", Suffix "A" Automatic Transmission Fluid, Clark Part #879803. Container must be imprinted AQ-ATF.

### 2. Check brake pedal free travel.

The hydraulic inching (brake) pedal should contact the floorboard when in the released (up) position. Refer to page 100H-302 for explanatory illustrations on Pedal Free Travel.

3. With a tachometer, check engine for governed speed at full throttle. The unloaded engine RPM should be set at 2400.

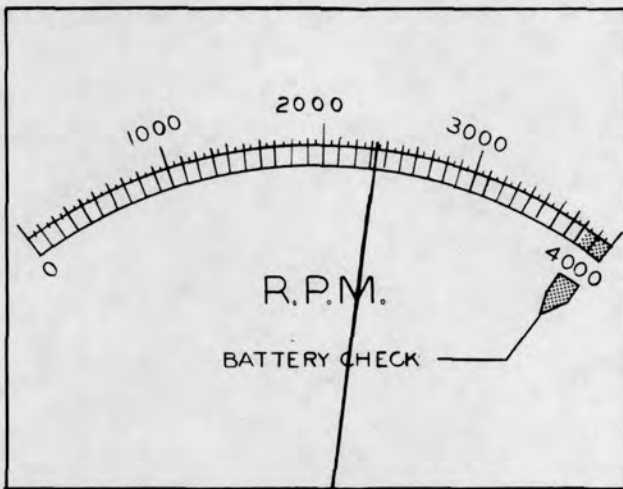


Plate 6683. Engine RPM (no load)

4. Check governed engine speed with partial load. With engine at full throttle and upright in full backward tilt, momentarily hold the tilt lever back to load the engine. With the engine loaded in this manner the approximate engine RPM should be 2200.

## NOTE

Engine must be properly tuned before making transmission stall checks.

## CAUTION

PROLONGED STALLING OF THE CONVERTER CAN CAUSE INTERNAL DAMAGE TO THE CONVERTER. STALL CONVERTER ONLY LONG ENOUGH TO ATTAIN THE PEAK RPM READING, (MAXIMUM 30 SECONDS).

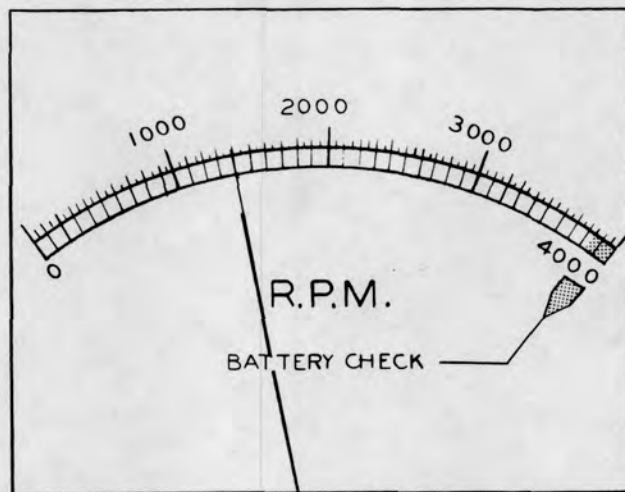


Plate 6684. Normal Engine Stall

5. With a capacity load on the forks, check for normal stall RPM by positioning machine against an immovable object. Place the machine in gear and accelerate engine to full throttle.

Normal Stall for F-227 Engine.....  
 ..... 1300 to 1400 RPM



WHEN APPLYING BRAKE HYDRAULIC PRESSURE  
92# ± 5 TO INCHING VALVE "F" AND "R"  
CHECKED INDIVIDUALLY MUST DROP OFF TO  
3# ± 2 P.S.I. MAX. WITH INCHING BREAK  
OFF POINT OF 55# ± 5

IMMERSE IN UCON-1145 FLUID BEFORE ASSEM.

UNLESS OTHERWISE SPECIFIED

IMMERSE ALL OIL SEALS IN TYPE "A"  
TRANSMISSION FLUID BEFORE ASSEMBLY

OIL ALL "O" RINGS BEFORE ASSEMBLY

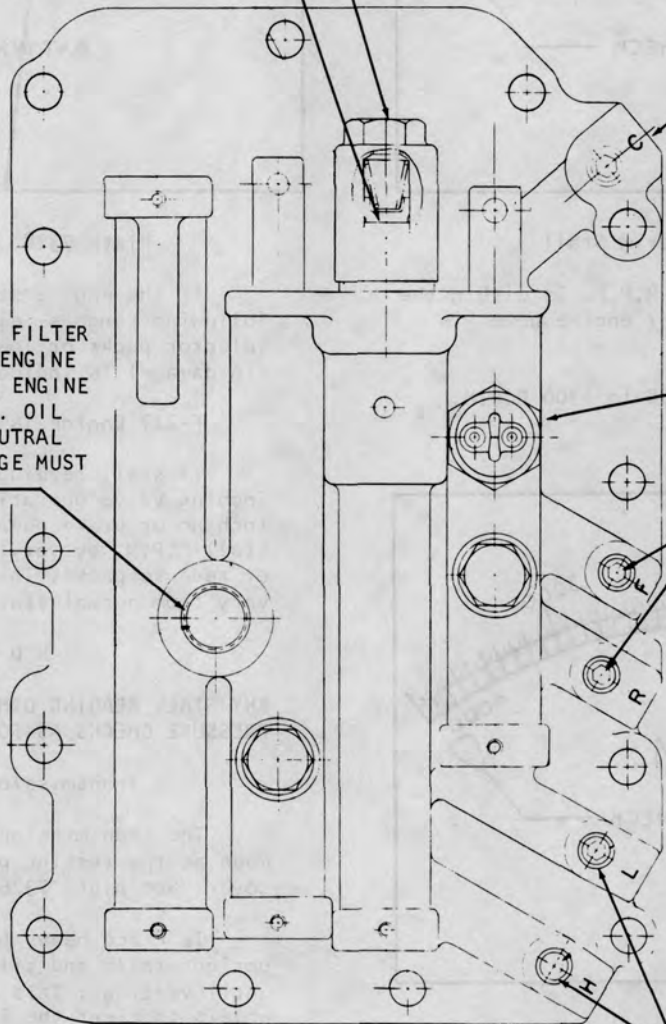
TIGHTEN ALL CAP SCREWS 20-25 FT. LBS. TORQUE

CONV. PRESS. 60 PSI AT  
1300 RPM. NOT TO EXCEED  
75 PSI AT 2200 RPM  
ENGINE.

NEUTRAL SWITCH (12 VOLTS)  
NEUTRAL-SWITCH CLOSED  
FOR. & REV.-SWITCH OPEN  
NEUTRAL START SWITCH TEST  
SEE NOTE

OIL FLOW TO CONTROL FROM FILTER  
5-7 GALLONS AT 1300 RPM ENGINE  
8-11 GALLONS AT 2000 RPM ENGINE  
TO BE TESTED WITH 200° F. OIL  
LEAKAGE-WITH F & R IN NEUTRAL  
& H OR L ENGAGED. LEAKAGE MUST  
NOT EXCEED .2 GAL.,

OIL PRESSURE CHECK  
AT 1300 RPM ENGINE  
120 LBS MIN-135 LBS MAX



**NOTE**

NEUTRAL START SWITCH TEST  
1-WIRE SWITCH INTO TEST STAND LIGHT CIRCUIT  
2-WITH ENGINE RUNNING & TRANSMISSION IN LOW  
FOR., NUDGE CONTROL FOR. & REV. SPOOL  
SLOWLY TOWARD NEUTRAL. IF SWITCH DOES NOT  
MAKE CONTACT REPEAT STARTING IN LOW REV.  
IF IN EITHER TEST CONTACT IS MADE WHEN NOT  
IN DEAD NEUTRAL, SWITCH IS TO BE SHIMED,  
TILL TEST SHOWS PROPER FUNCTION.

OIL PRESSURE CHECK  
AT 1300 RPM ENGINE-150 LBS. MIN.  
AT 2200 RPM ENGINE-165 LBS. MAX.

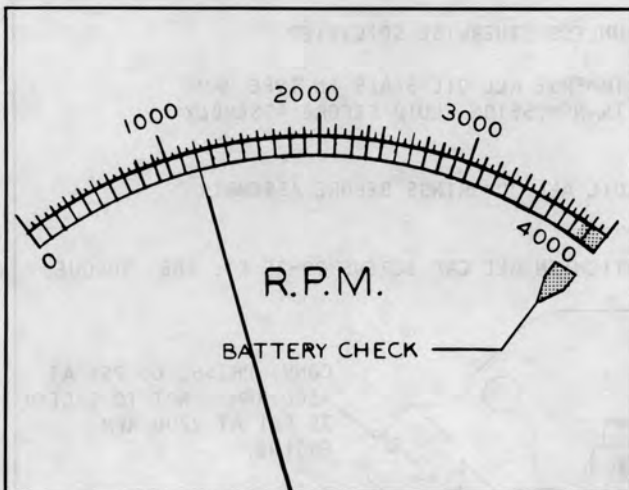


Plate 7327. Interim Stall

If the engine stall R.P.M. is within the following range -- loss of engine power is indicated.

F-227 Engine 1000 to 1300 R.P.M.

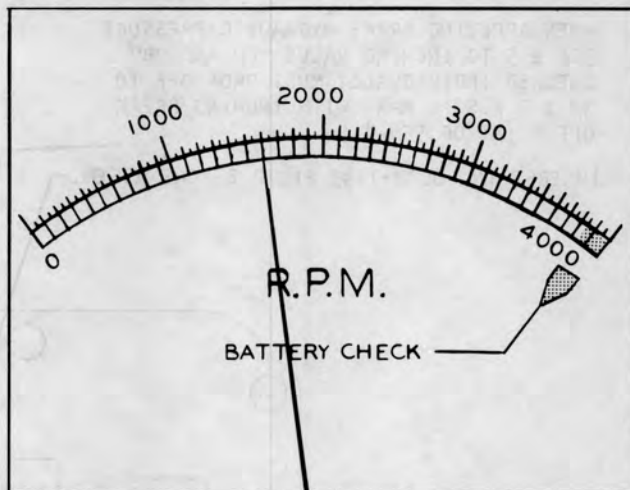


Plate 7328. High Engine Stall

If the engine stall R.P.M. is within the following range -- either slippage of the selector packs or low oil pressure (converter fin damage) is indicated.

F-227 Engine 1450 R.P.M. and above.

If stall readings are normal, check inching valve operation by operating the inching or brake pedal. This will vary stall R.P.M. by varying pressure on forward or reverse packs. This reading should vary from normal stall speed to high R.P.M.

**N O T E**

ANY STALL READING OTHER THAN NORMAL, MAKE PRESSURE CHECKS AS FOLLOWS.

**Transmission Pressure Checks**

The transmission pressure checks are made at the testing ports of the control cover. See plate 7326.

1. Place heavy blocking under the upright rails and tilt upright forward until vertical. This will allow the drive wheels to clear the floor.

2. Install a 250 P.S.I. pressure gauge at one of the testing ports (whichever direction or range of speed being tested.) With shift lever in related position the pressure should be within the range as specified on Plate 7326.

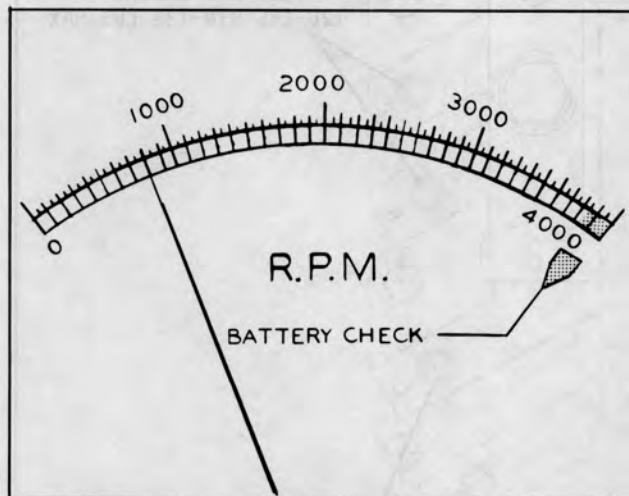


Plate 6686. Low Engine Stall

If the engine stall R.P.M. is within the following range -- converter malfunction or a faulty stator support shaft is indicated.

F-227 Engine 650 to 900 R.P.M.

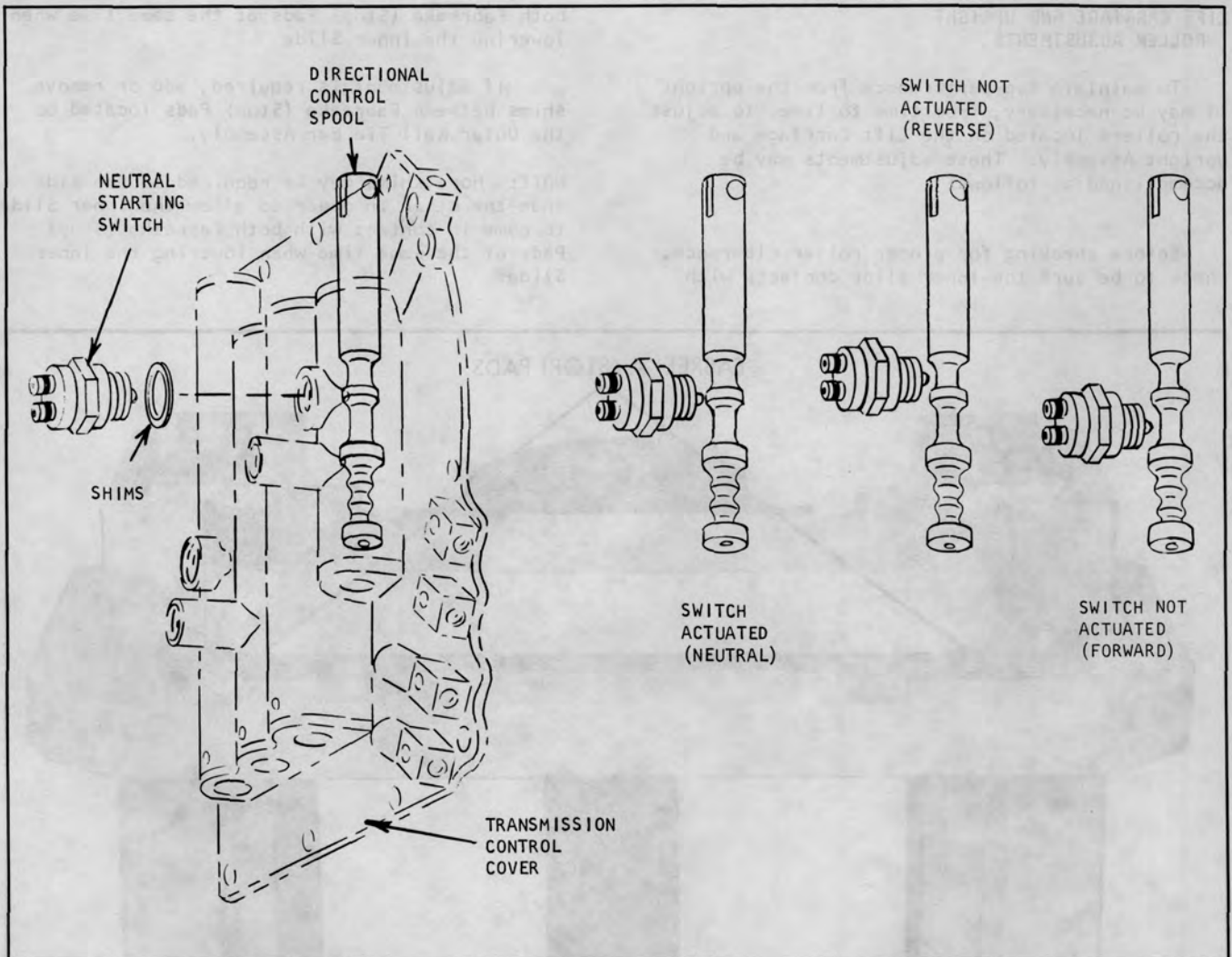


Plate 7300. Neutral Starting Switch

**NEUTRAL STARTING SWITCH**

The neutral starting switch should be adjusted so that machine will not start except when the transmission control is in the (dead) neutral position.

**ADJUSTMENT CHECK**

1. With driver's seat occupied and transmission in gear hold starting switch in actuated position and gently move shift lever towards neutral position.

2. If engine does not start, repeat adjustment operation in opposite direction.

3. If engine starts, coming from either direction on the shift lever prior to reaching neutral, switch should be adjusted by means of shims underneath the switch until engine will not start unless it is in (dead) neutral; that is, vehicle will not move regardless of shift lever position during the starting cycle.

## LUBRICATION AND PREVENTIVE MAINTENANCE

LIFT CARRIAGE AND UPRIGHT  
ROLLER ADJUSTMENTS

To maintain top performance from the upright it may be necessary, from time to time, to adjust the rollers located on the Lift Carriage and Upright Assembly. These adjustments may be accomplished as follows:

Before checking for proper roller clearance, check to be sure the Inner Slide contacts with

both Fabreeka (Stop) Pads at the same time when lowering the Inner Slide.

If adjustment is required, add or remove shims between Fabreeka (Stop) Pads located on the Outer Rail Tie Bar Assembly.

NOTE: More shims may be required on one side than the other in order to allow the Inner Slide to come in contact with both Fabreeka (Stop) Pads at the same time when lowering the Inner Slide.

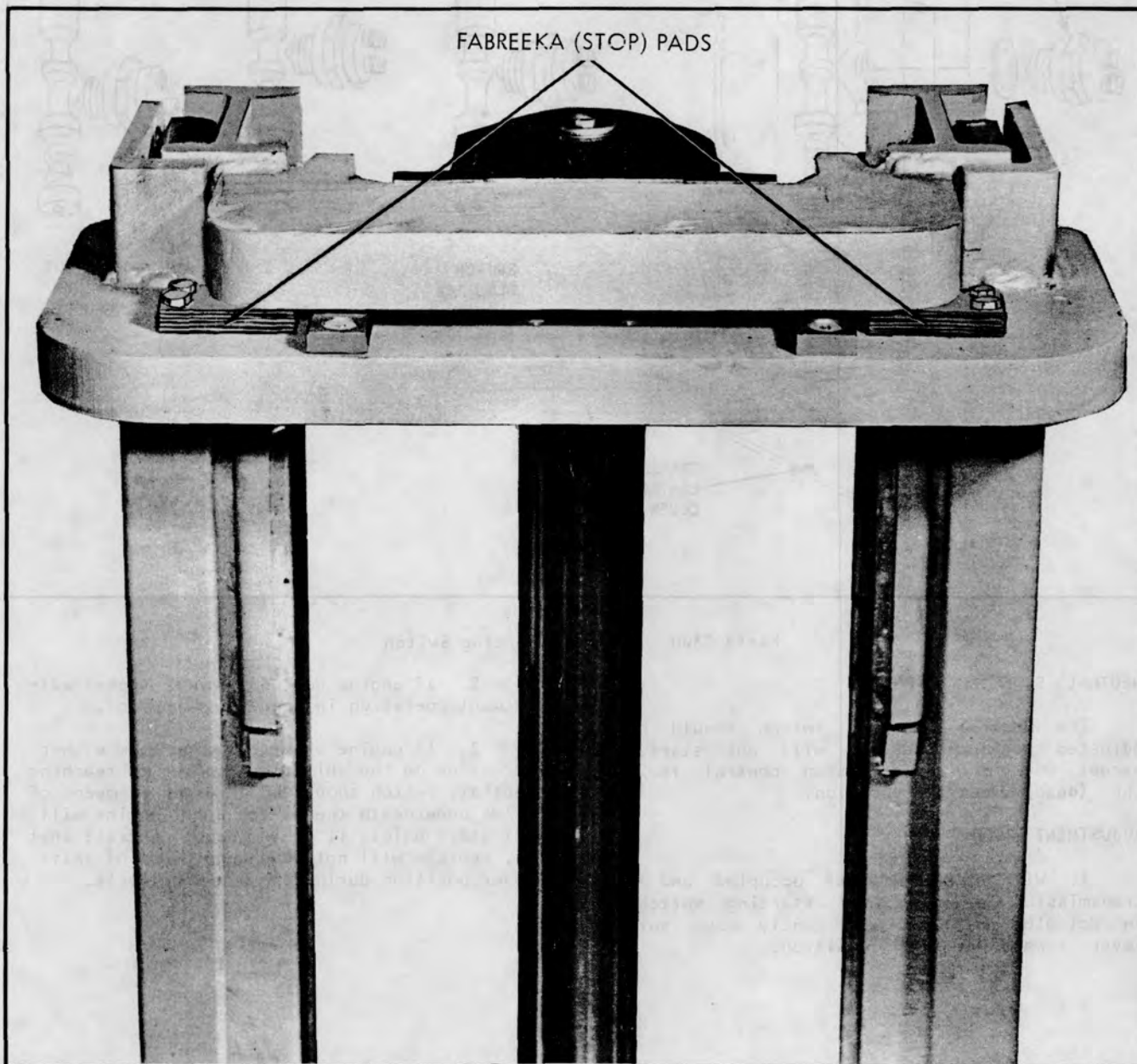


Plate 6619. inner Slide Must Contact Both Fabreeka (Stop) Pads  
At The Same Time When Lowering Inner Slide



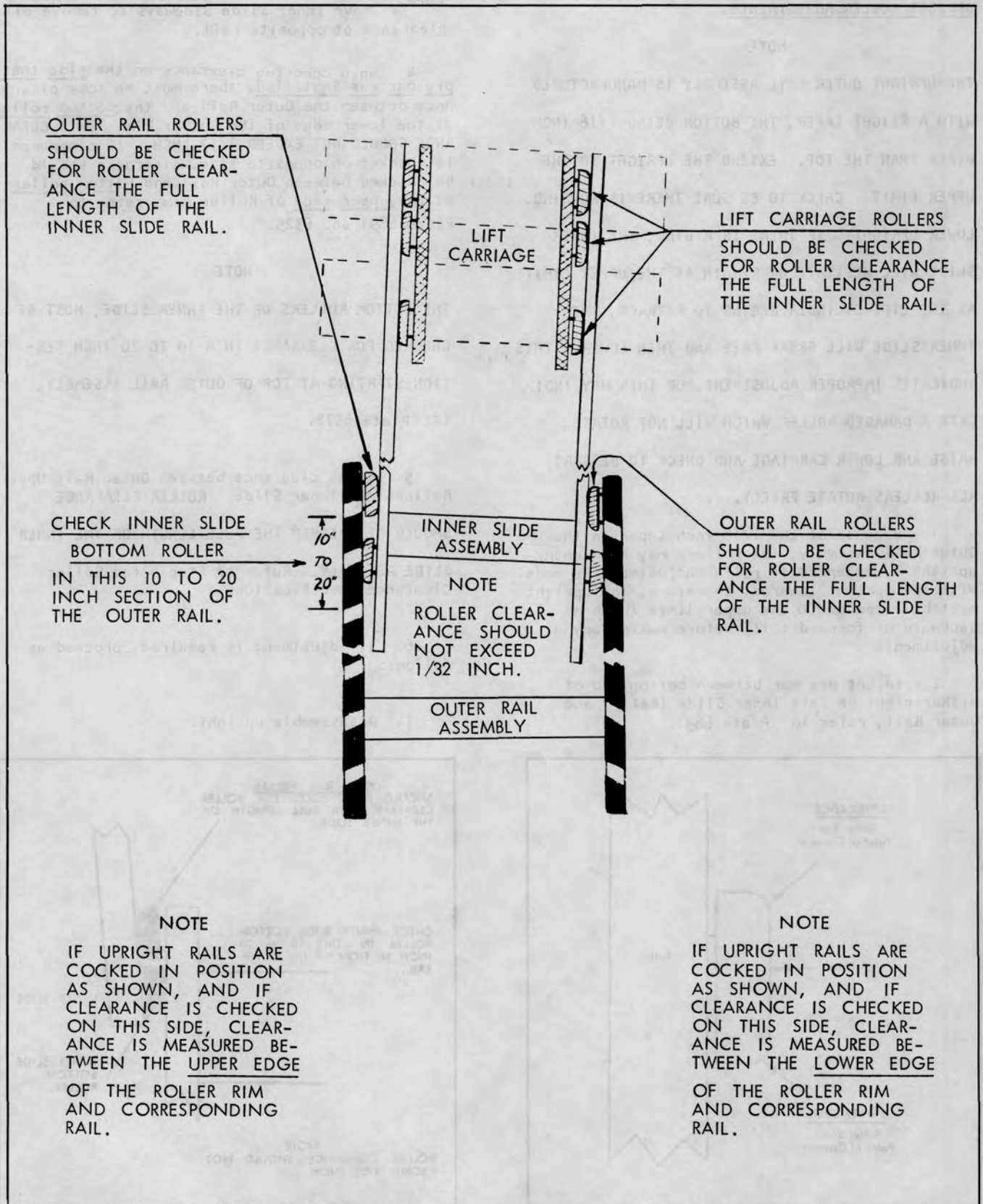


Plate 6891. Roller Adjustments



# INDUSTRIAL TRUCK DIVISION



## LUBRICATION AND PREVENTIVE MAINTENANCE

### UPRIGHT ROLLER ADJUSTMENTS.

#### NOTE

THE UPRIGHT OUTER RAIL ASSEMBLY IS MANUFACTURED WITH A SLIGHT TAPER, THE BOTTOM BEING 1/16 INCH WIDER THAN THE TOP. EXTEND THE UPRIGHT TO THE UPPER LIMIT. CHECK TO BE SURE THERE IS NO BIND. LOWER UPRIGHT. IF THERE IS A BIND, THE INNER SLIDE WILL HESITATE OR REMAIN AT THE UPPER LIMIT. AS THE LIFT CYLINDER BEGINS TO RETRACT, THE INNER SLIDE WILL BREAK FREE AND THEN LOWER. THIS INDICATES IMPROPER ADJUSTMENT, OR THIS MAY INDICATE A DAMAGED ROLLER WHICH WILL NOT ROTATE. RAISE AND LOWER CARRIAGE AND CHECK TO BE SURE ALL ROLLERS ROTATE FREELY.

1. Because of the 1/16 inch taper in the Outer Rail Assembly, the rollers may bind when upright is extended if roller adjustment is made with the upright lowered; therefore, the upright must be extended to the upper limit (with no backward or forward tilt) before making any adjustments.

2. Insert pry bar between bottom end of either right or left Inner Slide (Rail), and Outer Rail, refer to Plate 6891.

3. Move Inner Slide sideways to remove all clearance at opposite rail.

4. When checking clearance on the side that pry bar was installed, there must be some clearance between the Outer Rail and the bottom roller at the lower edge of the Roller Rim. THIS CLEARANCE SHOULD NOT EXCEED 1/32 INCH. If clearance is checked on opposite side, clearance should be checked between Outer Rail and bottom roller at the upper edge of Roller Rim, refer to Plate 6891 and 6325.

#### NOTE

THE BOTTOM ROLLERS OF THE INNER SLIDE, MUST BE CHECKED FOR CLEARANCE IN A 10 TO 20 INCH SECTION STARTING AT TOP OF OUTER RAIL ASSEMBLY, SEE Plate 6572.

5. Check clearance between Outer Rail Upper Rollers and Inner Slide. ROLLER CLEARANCE SHOULD BE CHECKED THE FULL LENGTH OF THE INNER SLIDE ASSEMBLY. Refer to Step 4 for Roller Clearance Specifications.

6. If adjustment is required, proceed as follows:

7. Disassemble upright.

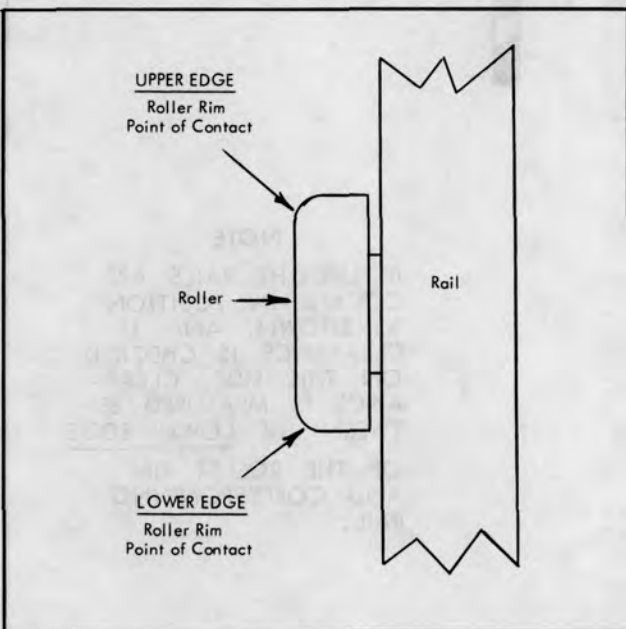


Plate 6325. Upright Roller

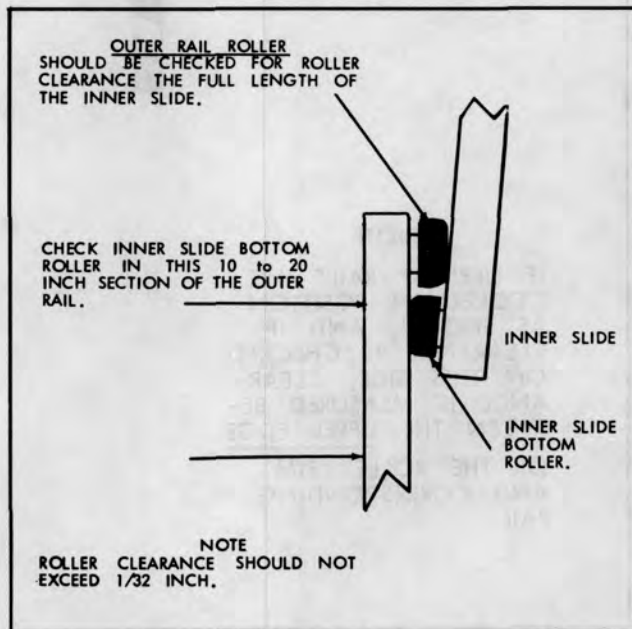


Plate 6572. Outer Rail Roller Clearance Check

## LUBRICATION AND PREVENTIVE MAINTENANCE

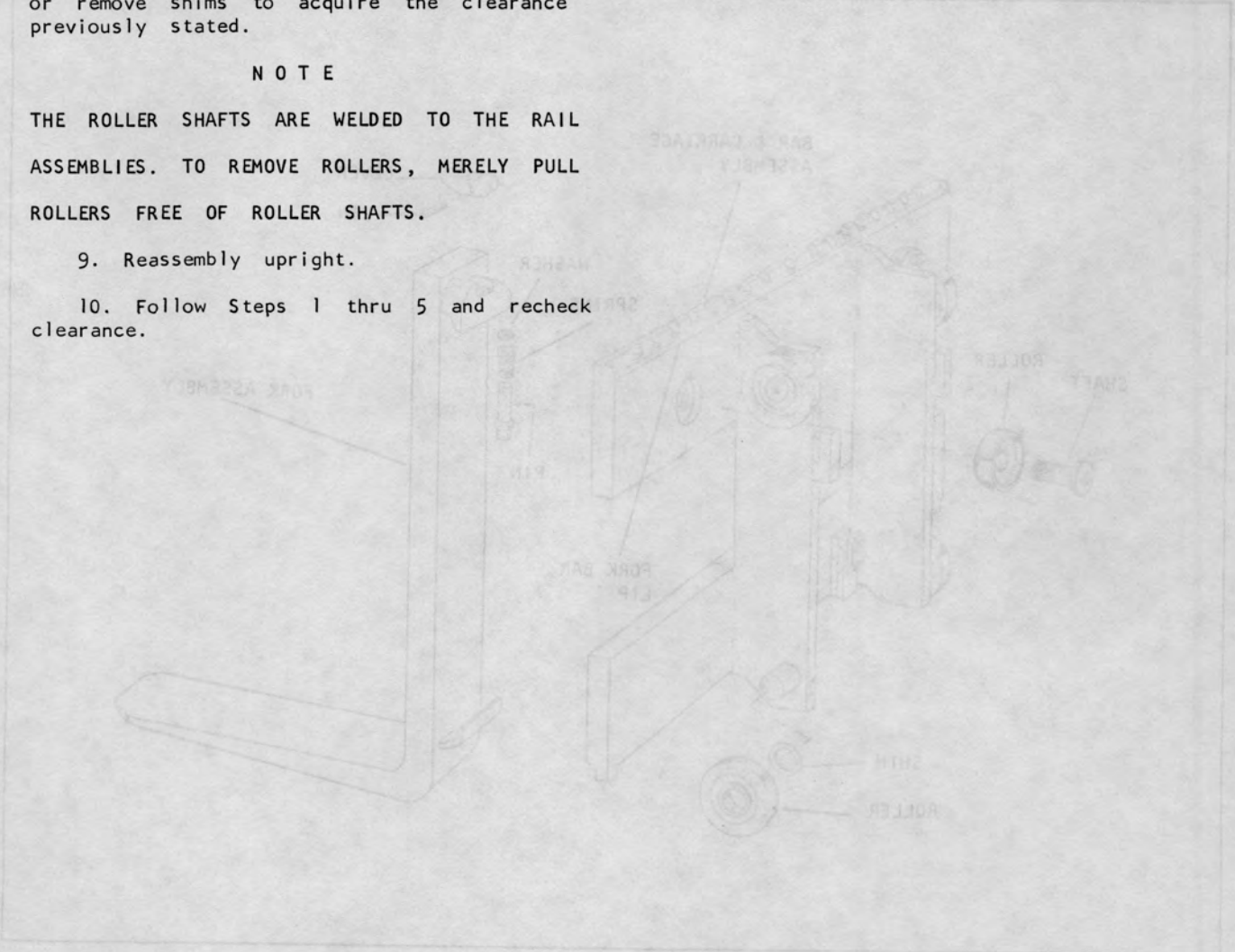
8. Remove rollers from shafts and add or remove shims to acquire the clearance previously stated.

### NOTE

THE ROLLER SHAFTS ARE WELDED TO THE RAIL ASSEMBLIES. TO REMOVE ROLLERS, MERELY PULL ROLLERS FREE OF ROLLER SHAFTS.

9. Reassembly upright.

10. Follow Steps 1 thru 5 and recheck clearance.



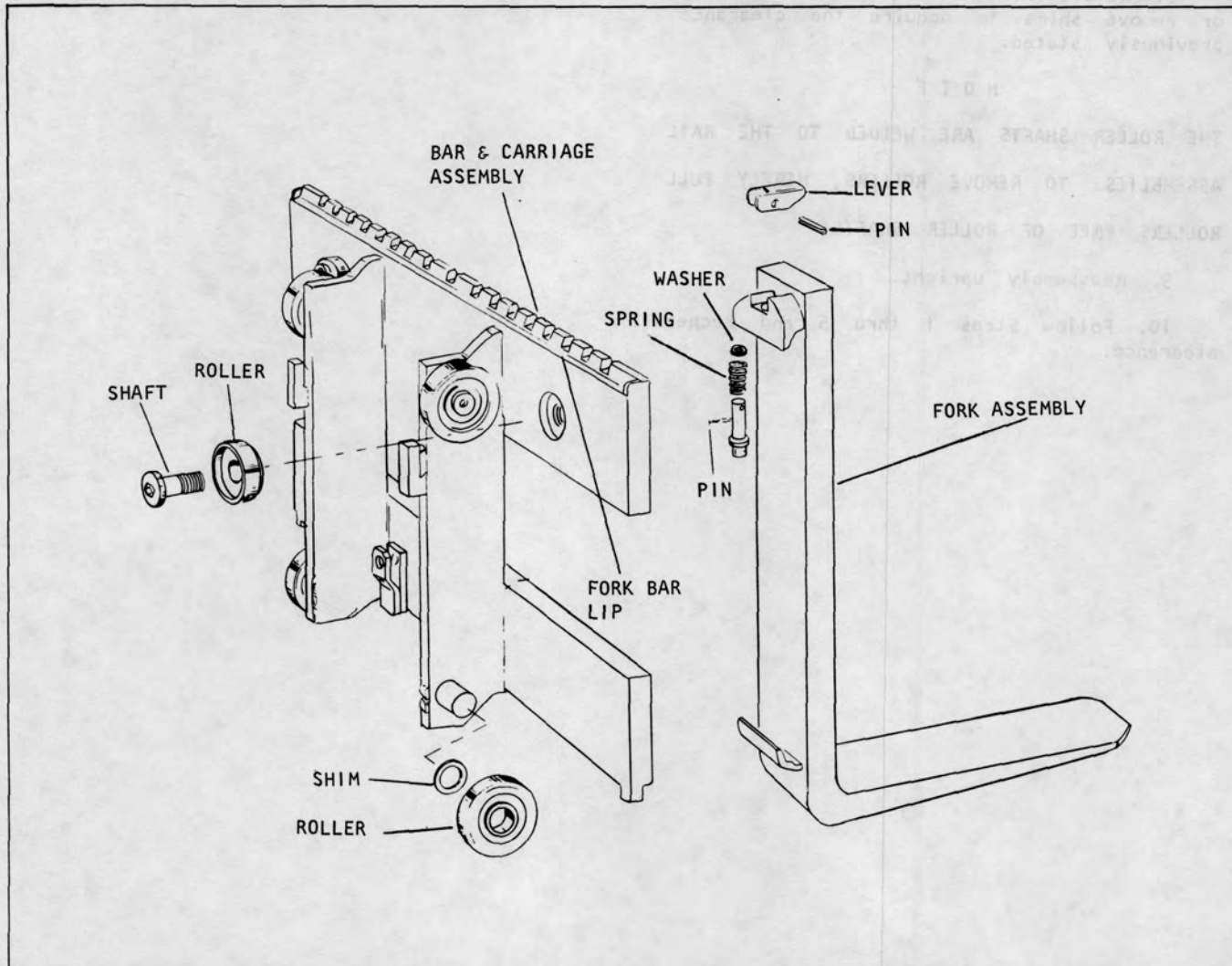


Plate 9483. Lift Carriage

LIFT CARRIAGE ROLLER ADJUSTMENTS

CARRIAGE MUST BE ADJUSTED SO IT IS HORIZONTAL AND CENTERED IN THE UPRIGHT FRAME. ROLLER CLEARANCE SHOULD BE CHECKED THE FULL LENGTH OF THE RAILS. ROLLERS SHOULD HAVE CLEARANCE OF NOT MORE THAN 1/32 INCH AT EACH SIDE.

LIFT CHAINS MUST BE ADJUSTED SO THAT UPPER FORK BAR LIP IS 22 7/8" FROM FLOOR.





# INDUSTRIAL TRUCK DIVISION



## TROUBLE SHOOTING GUIDE

### ENGINE

TROUBLE	PROBABLE CAUSE	REMEDY
Starting motor will not crank engine.	Battery discharged	Recharge or replace battery.
	Battery cable terminals loose or corroded. Ignition Fuse blown.	Remove and clean, reinstall and tighten cables. Replace fuse.
	Starting motor drive gear jammed in flywheel teeth.	Loosen starting motor and free-up gear.
	Improper oil.	Change oil to proper grade.
	Battery cable terminal broken.	Replace cable.
	Poor starting switch contacts.	Replace switch.
	Faulty Neutral Starting Switch.	Replace Switch
Starting motor operates, but fails to crank engine when switch is engaged.	Starting motor gear does not engage flywheel.	Remove starting motor, and clean drive mechanism.
	Starting motor or drive gear defective.	Replace starting motor.
<u>Engine will not start.</u> No spark. Ammeter shows no discharge (Zero reading) with ignition switch "on".	Ignition switch partly "on".	Turn switch "on" fully.
	Ignition switch defective.	Replace switch.
	Ignition primary wires or starting motor cables broken or connections loose.	Repair, or replace and tighten.
	Ignition coil primary winding open.	Replace coil.
	Distributor points dirty.	Clean and adjust points.
	Distributor points not closing.	Adjust or replace points.
	Loose or corroded ground, or battery cable connections.	Remove and clean, reinstall and tighten cables.
<u>Engine will not start.</u> Ammeter showing abnormal discharge with ignition switch "on".	Defective condenser.	Replace condenser
	Short-circuited or burned distributor cap or rotor.	Replace parts.
	Short-circuited wire between ammeter and ignition switch.	Repair or replace wire.
	Short-circuited primary winding in ignition coil.	Replace coil.
	Distributor points not opening.	Clean or replace, and adjust points.
	Distributor points pitted or burned.	Clean or replace, and adjust points.
	Distributor condenser weak. Ignition coil weak.	Replace condenser. Replace coil.

TRUBLE SHOOTING GUIDE

ENGINE (CONTINUED)

TROUBLE	PROBABLE CAUSE	REMEDY
<p><u>Engine will not start.</u> <u>Weak spark (continued)</u></p>	<p>Primary wire connections loose.</p> <p>High-tension, spark plug wires, or distributor cap wet.</p> <p>High-tension, spark plug wires, or distributor cap damaged.</p> <p>Distributor cap or rotor burned or broken.</p> <p>Spark plug gap incorrect.</p> <p>Short-circuited secondary circuit in coil.</p>	<p>Tighten.</p> <p>Dry thoroughly.</p> <p>Replace defective parts.</p> <p>Replace defective parts.</p> <p>Reset Gaps.</p> <p>Replace coil.</p>
<p>Good spark.</p>	<p>Fuel tank empty.</p> <p>Dirt or water in carburetor, or float stuck.</p> <p>Carburetor and engine flooded by excessive use of choke.</p> <p>Fuel does not reach carburetor.</p> <p>Dirt in fuel lines or tank.</p> <p>Fuel line pinched.</p> <p>Ignition wires incorrectly installed in distributor cap.</p> <p>Ignition timing incorrect.</p> <p>Fuel Strainer Clogged.</p> <p>Fuel pump does not pump.</p> <p>Lack of engine compression.</p>	<p>Refill tank.</p> <p>Drain and clean carburetor</p> <p>Depress accelerator pedal fully, crank engine with starting motor when engine starts, reset throttle and leave choke control "in".</p> <p>Inspect for damaged or leaky lines or air leak into line between tank and fuel pump.</p> <p>Disconnect lines, drain tank, and blow out lines.</p> <p>Repair or replace line.</p> <p>Install wires correctly.</p> <p>Reset timing.</p> <p>Remove and clean strainer.</p> <p>Clean screen, replace pump if defective.</p> <p>Replace head gasket, Grind valves, replace valve spring, replace bad valve.</p>
<p>Backfiring.</p>	<p>Ignition out of time.</p> <p>Spark plug wires incorrectly installed distributor cap or at spark plugs.</p> <p>Distributor cap cracked or shorted</p> <p>Valve holding open.</p>	<p>Reset timing.</p> <p>Install wires correctly.</p> <p>Replace cap.</p> <p>Reset timing. replace valve springs. Adjust tappets.</p>



# INDUSTRIAL TRUCK DIVISION



## TROUBLE SHOOTING GUIDE

### ENGINE (CONTINUED)

TROUBLE	PROBABLE CAUSE	REMEDY
Engine operates, but backfires and spits.	Improper ignition timing.	Reset timing.
	Spark plug wires incorrectly installed in distributor cap.	Install wires correctly.
	Dirt or water in carburetor.	Drain and clean carburetor.
	Carburetor improperly adjusted.	Clean and adjust carburetor.
	Carburetor float level low.	Reset Float Level
	Valve sticking or not seating properly, burned or pitted.	Regrind Valves
	Excessive carbon in cylinders.	Remove carbon from cylinders.
	Valve springs weak.	Replace Valve Springs
	Heat control valve not operating.	Free-up, and adjust valve.
	Fuel pump pressure low.	Clean screen; replace pump, if defective.
Engine stalls on idle.	Fuel strainer clogged.	Remove and clean strainer.
	Partly clogged or pinched fuel lines.	Clean and repair lines.
	Intake manifold leak.	Inspect gaskets and tighten manifold stud nuts.
Engine stalls on idle.	Distributor cap cracked or shorted.	Replace cap.
	Carburetor throttle valve closes too far, or idle mixture incorrect.	Adjust carburetor.
	Carburetor choke valve remains closed.	Free-up and lubricate valve.
	Dirt or water in idler passages of Carburetor.	Clean or replace carburetor.
	Air leak at intake manifold.	Inspect gaskets and tighten manifold stud nut.
	Heat control valve defective.	Free-up and adjust valve.
	Spark plugs defective, gaps incorrect.	Clean or replace spark plugs, set gap clearance.
	Ignition timing early.	Reset timing.
	Low compression.	Tighten intake manifold. Adjust valve.
	Water leak in cylinder head or head gasket.	Replace gasket.



# INDUSTRIAL TRUCK DIVISION



## TROUBLE SHOOTING GUIDE

### ENGINE (CONTINUED)

TROUBLE	PROBABLE CAUSE	REMEDY
Engine misfires on one or more cylinders.	Dirty spark plugs. Spark plug gap incorrect. Cracked spark plug porcelain. Spark plug wires grounded. Spark plug wires incorrectly installed in cap or at spark plugs. Distributor cap or rotor burned or broken. Valve tappet holding valve open. Low engine compression. Leaky cylinder head gasket. Cracked cylinder block, broken valve tappet or tappet screw.	Clean, adjust, or replace plugs. Reset gap. Replace spark plug. Replace wires. Install wires incorrectly. Replace defective parts. Adjust tappets Adjust tappets, Retime engine, Replace rings. Replace gasket. Replace defective or broken parts.
Engine does not idle properly.	Ignition timing. Dirty spark plugs, or gaps too close.	Reset timing. Clean and adjust spark plugs.
Engine misses at high speeds.	Ignition coil or condenser weak. Distributor points sticking, dirty or improperly adjusted. Distributor rotor or cap cracked or burned. Leaky cylinder head gaskets. Uneven cylinder compression. High-tension or spark plug wires leaky, cracked insulation. Carburetor choke not adjusted. Carburetor accelerating pump system defective, dirt in metering jets or float level incorrect. Fuel pump defective, causing lack of fuel. Air cleaner dirty. Heat control valve defective	Replace defective parts. Clean, adjust, or replace points. Replace defective parts. Replace gaskets. Adjust tappets or timing. Replace defective parts. Adjust choke. Replace defective parts, Clean carburetor, reset float level. Clean screen, replace defective pump. Clean complete air cleaner and refill oil cup. Free-up and adjust.





# INDUSTRIAL TRUCK DIVISION



## TROUBLE SHOOTING GUIDE

### ENGINE (CONTINUED)

TROUBLE	PROBABLE CAUSE	REMEDY
Engine misses at high speeds. (Continued)	Valves sticking, weak or broken valve springs.	Free up valves, replace valve springs.
	Fuel strainer clogged.	Remove and clean strainer.
	Weak distributor bracket arm spring.	Replace point set.
	Excessive play in distributor shaft bearing.	Replace distributor.
Engine pings (Spark Knock.)	Spark plugs defective, dirty or gap incorrectly set.	Clean, adjust or replace spark plugs.
	Ignition timing early.	Reset timing.
	Distributor automatic spark advance stuck in advance position, or spring broken.	Replace distributor.
	Excessive carbon deposits in cylinders.	Remove cylinder head and clean.
Engine lacks power.	Incorrect fuel.	Drain, use correct fuel.
	Ignition timing late.	Reset timing.
	Incorrect fuel.	Use correct fuel.
	Leaky cylinder head gasket.	Replace gasket.
	Excessive carbon formation.	Remove cylinder head, and clean cylinder head, piston heads, cylinder block, and valves.
	Engine runs cold.	Test thermostat; in cold weather, cover radiator.
	Insufficient oil, or improper grade oil.	Lubricate in accordance with lubrication section.
	Oil system failure.	Fill crankcase to prescribed level, check oil pressure.
	Air Cleaner dirty.	Clean complete air cleaner, change oil in cup.
	Spark plug gaps to wide.	Reset gaps.
	Choke valve partially closed, or throttle does not open fully.	Adjust valve or throttle.
	Manifold heat control inoperative.	Free-up and adjust control.
Exhaust pipe, muffler or tail pipe obstructed.	Service or replace obstructed parts.	
Low compression, broken valve spring, sticking valves.	Replace valves or springs, Free up valves.	



# INDUSTRIAL TRUCK DIVISION



## TROUBLE SHOOTING GUIDE

### ENGINE (CONTINUED)

TROUBLE	PROBABLE CAUSE	REMEDY
Engine lacks power. (Continued)	Improper tappet adjustment.  Lack of fuel.	Adjust Tappets.  Clean filter, inspect fuel pump, inspect carburetor for water or dirt and clean if necessary.
Engine overheats.	Cooling system deficient. Water low, air flow through radiator core restricted.  Clogged radiator core (Clogged internally).  Cylinder head gasket leaking.  Radiator or water pump leaking.  Damaged or deteriorated hose or fan belt.  Loose fan belt.  Cylinder block or head leaking.  Ignition timing incorrect.  Damaged muffler, bent or clogged exhaust pipe.  Excessive carbon in cylinders.  Insufficient oil, or improper grade.  Air Cleaner restricted.  Inoperative thermostat.  Water pump impeller broken.  Poor compression.  Valve timing incorrect.	Clean radiator core from engine side with compressed air or water, or fill radiator to proper level.  Clean by flushing radiator.  Tighten cylinder head stud nuts and/or replace gasket.  Repair or replace defective parts.  Replace defective parts.  Adjust fan tension.  Replace block or head.  Reset timing.  Service or replace defective parts.  Remove cylinder head, and clean cylinder head, piston heads cylinder block, and valves.  Refer to lubrication instructions.  Clean complete change oil in cup.  Replace thermostat and gasket  Replace pump.  Check ignition timing.  Reset timing.
High fuel consumption.	High engine speeds (Excessive driving in lower gear range).  Air cleaner clogged.  Carburetor float level too high, accelerating pump not properly adjusted.  Fuel line leaks.	Correct driving practice.  Clean complete air cleaner and change oil in cup.  Reset float level, overhaul carburetor pump.  Correct leaks, replace lines.

TROUBLE SHOOTING GUIDE

ENGINE (CONTINUED)

TROUBLE	PROBABLE CAUSE	REMEDY
High fuel consumption. (Continued)	Overheated engine. Carburetor parts worn or broken. Fuel pump pressure too high, or leaky diaphragm. Engine running cold. Ignition incorrectly timed. Spark advance stuck. Leaking fuel pump bowl gasket. Low compression. Carburetor controls sticking. Engine idles too fast. Spark plugs dirty. Weak coil or condenser. Clogged muffler, or bent exhaust pipe. Loose engine mounts, permitting engine to shake and raise fuel level in carburetor.	See "Engine overheats". Replace fuel carburetor. Replace fuel pump. Inspect thermostat, cover radiator in winter. Reset timing. Replace distributor. Replace gasket. Check timing, Rebuild Engine. Free-up and lubricate controls. Adjust carburetor throttle stop screw. Clean or replace spark plugs. Replace coil or condenser. Service or replace defective parts. Tighten; if damaged, replace defective mounts.
High oil consumption	High engine speeds, or excessive driving in low gear range. Oil leaks. Improper grade oil, or diluted oil. Overheating of engine causing thinning of oil. Oil filter clogged. Defective piston or rings, excessive side clearance of intake valves in guides, cylinder bores worn (scored, out-of-round, tapered); excessive bearing clearance, misaligned connecting rods.	Correct driving practice. Replace leaking gaskets. Use new oil of proper grade. See "Engine overheats". Clean filter case thoroughly and replace element. Replace worn parts.



# INDUSTRIAL TRUCK DIVISION



## TROUBLE SHOOTING GUIDE

### ENGINE (CONTINUED)

TROUBLE	PROBABLE CAUSE	REMEDY
Low oil pressure.	<p>Insufficient oil supply.</p> <p>Improper grade of oil, or diluted oil foaming at high speed.</p> <p>Oil too heavy (Funneling in cold weather).</p> <p>Oil pump screen clogged.</p> <p>Oil leaks.</p> <p>Faulty oil pump, pressure regulator valve stuck or improperly adjusted, or spring broken.</p>	<p>Fill crankcase to prescribed level.</p> <p>Change oil, inspect crankcase ventilator inspect for water in oil.</p> <p>Change to proper grade oil. (Refer to Lubrication Instructions.</p> <p>Remove oil pan and clean pump screen.</p> <p>Replace gaskets or seals.</p> <p>Replace worn parts.</p>
Defective valves.	<p>Incorrect tappet adjustment.</p>	<p>Adjust tappets.</p>
Abnormal engine noises.	<p>Loose fan, fan pulley or belt, heat control valve.</p> <p>Leaking intake or exhaust manifold or gaskets, cylinder head gasket, or spark plugs.</p> <p>Overheated engine, clogged exhaust system</p>	<p>Tighten or correct conditions as required.</p> <p>Tighten loose components or replace defective gaskets.</p> <p>Remove obstruction from exhaust system. Inspect for further serviceability.</p>
Poor compression.	<p>Incorrect tappet adjustment.</p> <p>Leaking, sticking, or burned valves; sticking tappets; valve spring weak or broken; valve stems and guides worn; piston ring grooves worn or rings worn, broken, or stuck; cylinder bores scored or worn.</p>	<p>Adjust tappets.</p> <p>Replace worn, Broken, or Defective parts.</p>





# INDUSTRIAL TRUCK DIVISION



## TROUBLE SHOOTING GUIDE

### FUEL SYSTEM

TROUBLE	PROBABLE CAUSE	REMEDY
Fuel does not reach carburetor	No fuel in Fuel tank.	Fill fuel tank.
	Fuel pump inoperative.	Replace pump.
	Fuel line air leak between tank and fuel pump.	Repair or replace line.
	Fuel line clogged.	Disconnect and blow out lines.
	Fuel tank cap vent clogged.	Clean vent.
Fuel reaches carburetor, but does not reach cylinders.	Choke does not close.	Free-up and lubricate, inspect for proper operation.
	Fuel passage in carburetor clogged.	Clean or replace carburetor.
	Carburetor float valve stuck closed.	Clean or replace carburetor.
High fuel consumption	Lubricant in power train too heavy.	Use correct lubricant.
	Incorrect adjustment of carburetor.	Adjust carburetor.
	Vehicle overloaded.	Reduce loads to specified maximum capacity.
	Tires improperly inflated.	Inflate tires properly.
	Tight brakes.	Adjust brakes.
Low Fuel Pressure.	Air leak in fuel lines.	Tighten connections, repair lines if damaged.
	Fuel pump defective, diaphragm broken; valve leaking, linkage worn.	Replace fuel pump
	Fuel lines clogged.	Clean or replace lines.
Engine idles too fast.	Improper carburetor throttle stop adjustment.	Adjust throttle stop screw.
	Carburetor control sticking.	Free-up and lubricate control.
	Control return spring weak.	Replace spring.
Fuel gauge does not register.	Loose wire connection at instrmnt panel or tank unit.	Tighten connections.
	Instrument panel unit or tank unit inoperative.	Replace unit.



# INDUSTRIAL TRUCK DIVISION



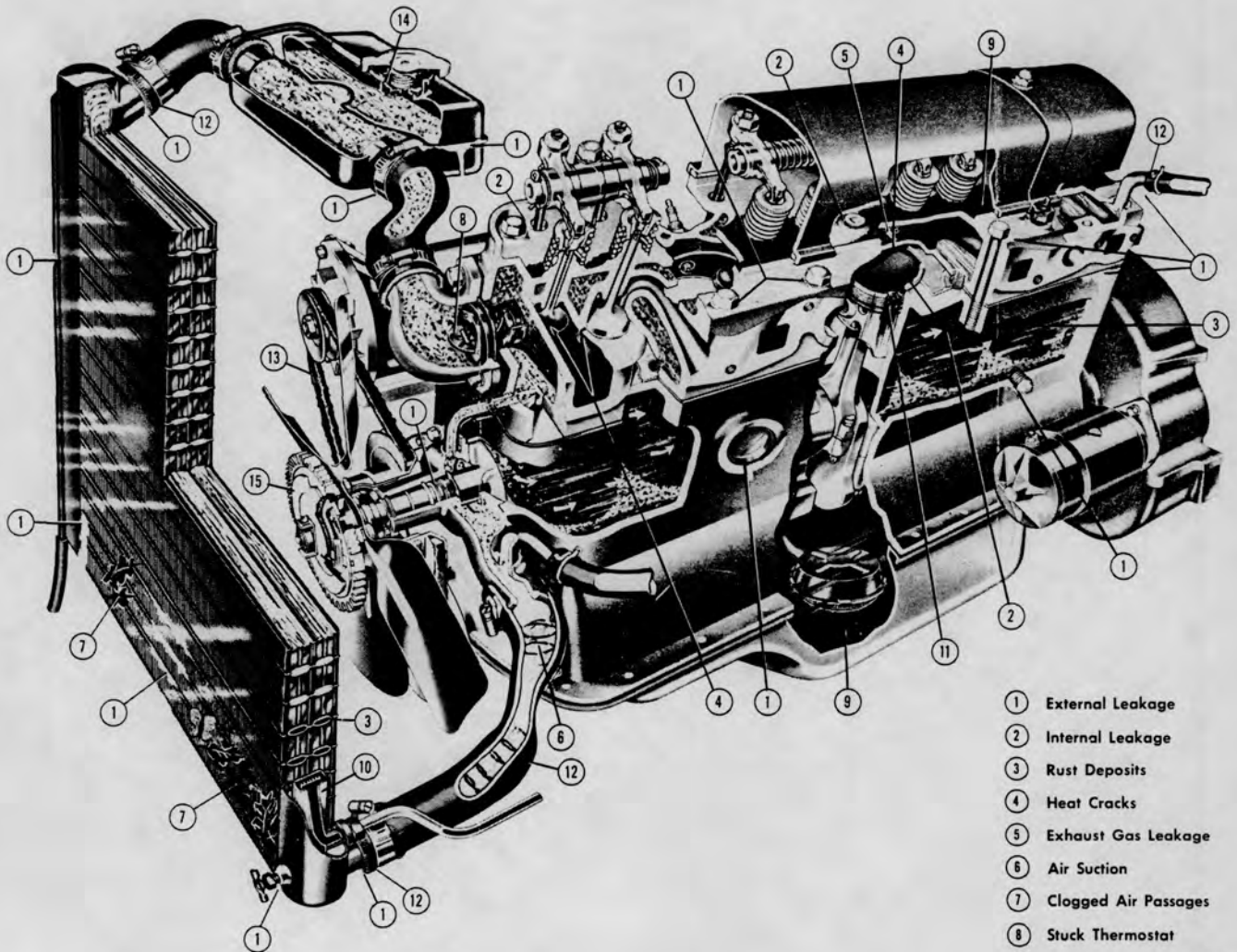
## TROUBLE SHOOTING GUIDE

### COOLING SYSTEM

TROUBLE	PROBABLE CAUSE	REMEDY
Overheating.	Unusual operating conditions of high temperature.	Inspect. (Refer to "Engine overheats".)
Loss of cooling solution.	Loose hose connections. Damaged or deteriorated hose. Leaking radiator.	Tighten hose connections. Replace hoses. Repair or replace radiator.
Engine operates too cool.	Thermostat sticking. Low air temperature.	Replace thermostat and gasket. Cover radiator.
Noises.	Frayed or loose fan belt. Water pump defective.	Replace or adjust belt. Replace pump.

# THE ENGINE COOLING SYSTEM

Trouble spots resulting from service neglect



- ① External Leakage
- ② Internal Leakage
- ③ Rust Deposits
- ④ Heat Cracks
- ⑤ Exhaust Gas Leakage
- ⑥ Air Suction
- ⑦ Clogged Air Passages
- ⑧ Stuck Thermostat
- ⑨ Sludge Formation in Oil
- ⑩ Transmission Oil Cooler
- ⑪ Heat Damage
- ⑫ Hose Failure
- ⑬ Worn Fan Belt
- ⑭ Pressure Cap Leakage
- ⑮ Temperature Control Fan Drive

The cooling system depicted here does not represent that of any particular make of car; it incorporates features used by many different manufacturers.

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## Cooling System Care Pays!

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UNION CARBIDE Division of Union Carbide Corporation



INDUSTRIAL TRUCK DIVISION



OPERATORS

MAINTENANCE

PARTS

MANUAL

FOR

CY-60

FORM NO. 1-60

CLARK EQUIPMENT COMPANY

PUBLISHED BY

TECHNICAL SERVICE DEPARTMENT  
BATTLE CREEK, MICHIGAN, U.S.A.





# INDUSTRIAL TRUCK DIVISION



## TRUBLE SHOOTING GUIDE

### IGNITION SYSTEM

TROUBLE	PROBABLE CAUSE	REMEDY
Ignition System troubles.	<p>Weak spark.</p> <p>Timing incorrect.</p> <p>Moisture on distributor wires, coil, or spark plugs.</p> <p>Ignition switch inoperative</p> <p>Primary or secondary wiring loose, broken, or grounded.</p> <p>Coil defective</p> <p>Distributor defective.</p> <p>Spark plug defective.</p>	<p>Refer to "Engine will not Start."</p> <p>Retime ignition.</p> <p>Clean and dry thoroughly</p> <p>Replace switch</p> <p>Service.</p> <p>Refer to "Ignition coil troubles," below.</p> <p>Refer to "Distributor troubles", below.</p> <p>Refer to spark plug troubles below.</p>
Ignition coil.	<p>Connections loose; dirty or broken external wire, wet.</p> <p>Coil defective.</p>	<p>Clean and tighten, or repair, dry thoroughly.</p> <p>Replace coil.</p>
Distributor troubles.	<p>Distributor breaker points dirty or pitted, point gaps incorrect.</p> <p>Distributor breaker point arm spring weak.</p> <p>Distributor breaker points sticking.</p> <p>Distributor automatic advance defective.</p> <p>Distributor cap or rotor shorted, cracked or broken.</p> <p>Distributor rotor does not turn.</p> <p>Condenser defective.</p>	<p>Clean, adjust or replace breaker points.</p> <p>Replace breaker point arm.</p> <p>Free-up breaker points.</p> <p>Lubricate and free-up. If seized, replace distributor.</p> <p>Replace defective parts.</p> <p>Replace broken shaft, rotor, or gear.</p> <p>Replace condenser.</p>
Spark plug troubles.	<p>Cracked, broken, leaking, or improper type.</p> <p>Spark plug wires incorrectly installed on plugs or in distributor cap.</p> <p>Spark plugs dirty; gap incorrect.</p> <p>Spark plug porcelain cracked or broken.</p>	<p>Replace spark plug.</p> <p>Install wires correctly.</p> <p>Clean, set gaps, or replace plugs.</p> <p>Replace plug.</p>



# INDUSTRIAL TRUCK DIVISION



## TROUBLE SHOOTING GUIDE

### STARTING MOTOR

TROUBLE	PROBABLE CAUSE	REMEDY
Starting motor cranks engine slowly.	<p>Engine oil too heavy.</p> <p>Battery charge low.</p> <p>Battery cell shorted.</p> <p>Battery connections corroded, broken, or loose.</p> <p>Dirty commutator.</p> <p>Insufficient brush surface contact.</p> <p>Defective starting motor.</p> <p>Starting switch defective.</p>	<p>Change to proper grade oil.</p> <p>Recharge or replace battery.</p> <p>Replace battery.</p> <p>Clean and tighten, or replace cables.</p> <p>Clean commutator.</p> <p>Free-up or replace brush.</p> <p>Replace starting motor.</p> <p>Replace switch.</p>
Starting motor does not crank engine.	<p>Engine oil too heavy.</p> <p>Starting motor, Solenoid, or cables defective; loose connections.</p> <p>Starting motor pinion gear jammed in flywheel drive gear.</p> <p>Dirty drive mechanism.</p> <p>Faulty Relay Switch.</p> <p>Ignition Fuse Blown.</p> <p>Faulty Ignition Switch.</p> <p>Faulty Neutral Starting Switch.</p>	<p>Change to proper grade oil.</p> <p>Replace or tighten loose connections.</p> <p>Remove starting motor and reinstall. Replace defective driving gear.</p> <p>Clean and lubricate drive mechanism.</p> <p>Replace Relay Switch.</p> <p>Replace Fuse.</p> <p>Replace Switch.</p> <p>Replace Switch. NOTE: The INDEX of this manual will list an ADJUSTABLE Neutral Starting Switch if your machine is so equipped.</p>



# INDUSTRIAL TRUCK DIVISION



## TROUBLE SHOOTING GUIDE

### GENERATOR TROUBLES

TROUBLE	PROBABLE CAUSE	REMEDY
No output.	Regulator defective.	Replace regulator.
Low or fluctuating output.	Loose fan belt. Insufficient brush surface contact. Weak brush springs. Worn commutator. Broken or loose connections. Dirty commutator. Regulator defective. Loose or dirty connections in charging circuit.	Adjust belt. Free-up or replace brush. Replace spring. Turn commutator and undercut. Repair, tighten or replace Clean commutator. Replace regulator. Clean and tighten connections.
Excessive output.	Short circuit between field coil and armature leads. Regulator defective.	Replace generator Replace regulator.
Noisy.	Loose pulley or generator mounting. Defective bearings, or armature rubbing on field poles. Improperly seated brushes.	Tighten. Replace generator. Seat Brushes.
Generator regulator trouble.	Loose connections or mountings. Defective regulator.	Clean and tighten. Replace regulator.



# INDUSTRIAL TRUCK DIVISION



## TROUBLE SHOOTING GUIDE

### BATTERY, LIGHTS AND HORN

TROUBLE	PROBABLE CAUSE	REMEDY
Battery discharged.	<p>Battery solution level low.</p> <p>Short in battery cell.</p> <p>Generator not charging.</p> <p>Loose or dirty connections; broken cables.</p> <p>Excessive use of starting motor.</p> <p>Idle battery, or excessive use of lights with engine at idle.</p> <p>Short circuits.</p>	<p>Add distilled water to bring level above plates; inspect for cracked case.</p> <p>Replace battery.</p> <p>Inspect generator, fan belt, and regulator.</p> <p>Clean and tighten connections; replace cables.</p> <p>Tune up engine; charge battery.</p> <p>Recharge or replace battery. Use lights sparingly.</p> <p>Replace defective wiring.</p>
Battery (other troubles)	<p>Overheated battery.</p> <p>Case bulged (or out of shape).</p>	<p>Inspect for short circuit or excessive generator charge.</p> <p>Inspect for overcharging and over-tightening of hold-down screws.</p>
Light switch.	<p>Loose or dirty connections; broken wire.</p> <p>Defective switch.</p>	<p>Clean and tighten; replace broken wire.</p> <p>Replace switch.</p>
Wiring.	<p>Loose or dirty connections; broken wire or terminal.</p>	<p>Clean, tighten, repair or replace. Wire or terminal.</p>
Lights do not light.	<p>Switch not fully "on".</p> <p>Loose or dirty connections; broken wire.</p> <p>Wiring circuit short-circuited, or open.</p> <p>Light burned out.</p>	<p>Turn switch "on" fully.</p> <p>Clean and tighten; replace or repair wire or terminal.</p> <p>Correct short circuit or replace defective parts.</p> <p>Replace light.</p>
Lights dim.	<p>Loose or dirty connection.</p> <p>Wiring short-circuited.</p> <p>Defective switch.</p>	<p>Clean and tighten connections.</p> <p>Correct short circuit or replace defective parts.</p> <p>Replace switch.</p>





# INDUSTRIAL TRUCK DIVISION



## TROUBLE SHOOTING GUIDE

### BATTERY, LIGHTS AND HORN (Continued)

TROUBLE	PROBABLE CAUSE	REMEDY
Horn troubles.	Loose or dirty wiring connections.	Clean and tighten connections.
Horn sounds continuously.	Short-circuit in wiring between horn and horn button.	Replace wire.
Improper tone.	Loose or dirty wiring connections. Cover or bracket screws loose. Points adjusted improperly.	Clean and tighten connections. Tighten. Adjust points.
Horn will not operate.	Horn Fuse Blown. Open Circuit. Faulty Horn Relay.	Replace Fuse. Trace, repair or replace as required. Replace relay.



# INDUSTRIAL TRUCK DIVISION



## TROUBLE SHOOTING GUIDE

### DRIVE AXLE

TROUBLE	PROBABLE CAUSE	REMEDY
Continuous Axle Noise.	<p>Badly worn parts.</p> <p>Unevenly worn tires.</p> <p>Improperly adjusted wheel bearing.</p> <p>Lack of lubricant.</p>	<p>Replace worn parts with new.</p> <p>Replace tires.</p> <p>Adjust correctly.</p> <p>Add sufficient lubricant of correct grade.</p>
Axle Noise on Drive or on Coast Only.	Differential pinion gear and ring gear out of adjustment or worn excessively.	Adjust, repair or replace entire unit if conditions warrants.
Excessive Backlash in Axle Driving.	<p>Loose axle shaft drive flange cap screws.</p> <p>Flange loose on axle shaft.</p> <p>Worn splines on axle shaft at differential end.</p> <p>Differential drive pinion gear and ring gear out of adjustment or worn excessively.</p>	<p>Tighten cap screws.</p> <p>Reweld flange to shaft.</p> <p>Replace drive flange and shaft assembly.</p> <p>Adjust or replace as condition warrants.</p>
Complete Failure to Function.	<p>Broken axle shaft.</p> <p>Broken teeth on ring gear or pinion gear.</p>	<p>Replace axle shaft.</p> <p>Replace ring gear and pinion and other parts of differential necessary. Adjust ring gear and pinion gear correctly.</p>



# INDUSTRIAL TRUCK DIVISION



## TROUBLE SHOOTING GUIDE

### STEERING AXLE

TROUBLE	PROBABLE CAUSE	REMEDY
Trouble.	Damaged axle.	Replace axle.
	Lubrication leaks.	Replace oil seals.
	Incorrect caster or camber.	Adjust and Replace worn parts.
	Uneven tire wear.	Inflate tires properly. Check wheel alignment.



# INDUSTRIAL TRUCK DIVISION



## 201 TROUBLE SHOOTING GUIDE

### STEERING

TROUBLE	PROBABLE CAUSE	REMEDY
Steering difficult.	Lack of lubrication Tight steering system connections. Tight steering gear; misaligned wheels. Bent steering connecting linkage or arm. Misaligned steering gear mounting.	Lubricate. Lubricate and adjust linkage. Adjust steering gear bearings, realign wheels. Straighten or replace linkage. Adjust mounting.
Wander or weaving	Improper toe in camber or caster (axle twisted). Steering system connections or king pin bearings not properly lubricated. Loose wheel bearings. Steering gear worn or maladjusted. Steering gear mountings loose.	Replace worn parts. Adjust for proper camber and caster. Lubricate. Adjust wheel bearings. Replace worn parts and adjust bearings. Tighten mounting bolts.
Low speed shimmy or wobble.	Loose steering connections. Steering gear worn, or adjustment too loose.	Adjust and tighten linkage. Tighten mounting bolts.
Low speed shimmy or wobble.	Loose steering connections. Steering gear worn, or adjustment too loose. Loose wheel bearings.	Adjust and tighten linkage. Replace worn parts; adjust worn thrust bearings and lash adjustment. Adjust wheel bearings.
Vehicle pulls to one side.	Odd size, or new and old tires on opposite wheels. Bent steering arm or connection.	Match tires. Straighten or replace bent linkage.





# INDUSTRIAL TRUCK DIVISION



## TROUBLE SHOOTING GUIDE

### HYDRAULIC SYSTEM

TROUBLE	PROBABLE CAUSE	REMEDY
Pump not delivering oil.	Wrong direction of rotation.	Must be reversed immediately to prevent seizure and breakage of parts due to lack of oil.
	Tank oil level low.	Add recommended oil.
	Oil intake pipe or suction filter plugged.	Replace filter cartridge, clean strainer if so equipped.
	Air leak in suction line.	Will prevent priming, or cause noise and irregular action of control circuit.
	Oil viscosity too heavy to pick up prime.	Thinner oil should be used, per recommendations for given temperature and service.
Pump not developing pressure.	Broken pump shaft or gear.	Replace broken, worn or defective parts.
	Pump not delivering oil for any of the above reasons.	Check oil circulation by watching oil in tank.
	Relief valve spring broken	Replace relief valve
	Relief valve sticking open.	Dirt under pressure adjustment valve. Clean valve
	Leak in hydraulic control system (cylinders or valves).	Find leak and correct.
Pump making noise.	Partially clogged intake line, intake filter or restricted intake pipe.	Pump must receive intake oil freely or cavitation will take place.
	Small air leak at pump intake piping joints.	Test by pouring oil on joints while listening for change in operation. Tighten as required.
	Air leak at pump shaft packing.	Repair or replace.
	Tank air vent plugged.	Must be open thru breather opening or air filter.
	Too high oil viscosity.	Use recommended oils.
Forks do not lift to maximum height.	Shaft packing worn.	Replace shaft packing per preceding instructions.
	Oil filter dirty.	Replace filter element.
	Hydraulic Oil level low.	Fill sump tank.



# INDUSTRIAL TRUCK DIVISION



## TROUBLE SHOOTING GUIDE

### HYDRAULIC SYSTEM CONTINUED

TROUBLE	PROBABLE CAUSE	REMEDY
Lift or tilt action fails.	Loss of oil pressure.	See "pump not delivering oil"
Oil leak at top of lift cylinder assembly.	Worn or damaged lift piston seal. Scored cylinder wall. Plugged vent line.	Replace seal. Replace Cylinder Clean out vent line. Replace if collapsed.
Oil leak around piston rod at tilt cylinder	Worn seal. Scored piston rod.	Replace seal. Replace rod and eliminate cause of scoring which may be caused by misalignment, worn bearing or foreign matter.
With load centered on lift forks load is lifted unevenly.	Lift chains out of adjustment.	Adjust chains.



# INDUSTRIAL TRUCK DIVISION



## TROUBLE SHOOTING GUIDE

### TRANSMISSION, CONVERTER AND AXLE ADAPTER

TROUBLE	PROBABLE CAUSE	REMEDY
Machine will not move in either direction	<p>Parking brake not released.</p> <p>Control linkage not properly adjusted.</p> <p>Oil level low.</p> <p>No oil pressure.</p>	<p>Release brake.</p> <p>Readjust linkage.</p> <p>Determine cause and correct. Fill to proper level with Type "A" Automatic Transmission Fluid Armour Qualified.</p> <p>Replace Pump.</p>
Machine will move in one direction only.	<p>Control linkage not adjusted.</p> <p>No oil pressure to Directional Selector. Seals and "O" Rings in Directional Selector may be defective.</p> <p>Directional Selector Discs not releasing. Discs defective. Relief hole in D.S. Drum clogged.</p>	<p>Adjust linkage.</p> <p>Replace seals and "O" Rings.</p> <p>Replace Discs and clean all orifices.</p>
Machine moves slowly in both directions at wide open throttle.	<p>Oil level low.</p> <p>Low oil pressure. Faulty Inching Valve, Faulty Relief Valve, Faulty Pump.</p> <p>Brakes dragging.</p> <p>Clogged Sump screen.</p>	<p>Fill to correct level and determine cause for loss of oil.</p> <p>Replace defective parts.</p> <p>Adjust brakes.</p> <p>Clean Screen.</p>
Transmission overheating.	<p>Low oil.</p> <p>Low Directional Selector pressure (check with gauge). Inching valve not functioning properly.</p> <p>Seals in selector defective.</p> <p>Regulating valve sticking open.</p> <p>Brakes Dragging.</p> <p>Clogged Sump Screen.</p>	<p>Check and fill to correct level.</p> <p>Replace worn parts as necessary and clean.</p> <p>Replace seals</p> <p>Clean valve; replace worn or defective parts.</p> <p>Adjust brakes.</p> <p>Clean Screen.</p>



# INDUSTRIAL TRUCK DIVISION



## TROUBLE SHOOTING GUIDE

### TRANSMISSION, CONVERTER AND AXLE ADAPTER

TROUBLE	PROBABLE CAUSE	REMEDY
Transmission Overheating (continued)	Insufficient oil to Torque Converter and Cooler.	Add oil to proper level; check for plugged lines; replace defective parts.
	Cooler clogged internally stopping flow of oil.	Clean Cooler.
	Bushing in Torque Converter Impeller Hub worn, allowing oil to leak out.	Replace worn or defective parts.
	Slipping Stator.	Refer to Transmission Pressure Checks.
Machine has full power and overheats.	Overloading machine.	Check Capacity loads. Never overload.
	Radiator core clogged externally.	Clean Core.
	Pressure Regulator Valve sticking, giving low pressure.	Clean Valve; replace worn or defective parts.





# MASTER MAINTENANCE MANUAL



## MAINTENANCE SECTION ALPHABETICAL INDEX

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INDUSTRIAL TRUCK DIVISION



OPERATORS

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CY-60

FORM NO. 1-60

CLARK EQUIPMENT COMPANY

PUBLISHED BY

TECHNICAL SERVICE DEPARTMENT  
BATTLE CREEK, MICHIGAN, U.S.A.

**TROUBLE SHOOTING**

A preventive maintenance system including inspection, lubrication and adjustment as recommended in our Maintenance Section will prevent the greater portion of gasoline engine troubles.

Failure of a gasoline engine to start is mainly due to two things: ignition trouble or failure in the fuel system.

Operators handling the same engine every day, soon develop a sense of impending trouble when abnormal operation occurs. Immediate attention to these danger signals can prevent major failures, insure dependable operation and increase the life of the engine.

Operators should depend on their well-developed senses of **feeling, hearing, seeing** and **smelling** and replace their sense of taste in this type of work — with a generous amount of “Common-Sense”.

A good rule to follow in locating trouble is to never make more than **one** adjustment at a time — then locate the trouble by a process of elimination. Remember the cause is usually **Simple** — rather than mysterious and complicated.

Following are listed some of the normal complaints encountered in routine operation of all gasoline engines and the probable causes.

**A — STARTING MOTOR — WILL NOT CRANK ENGINE:**

- 1 — Weak or dead battery.
- 2 — Poor ground connection.
- 3 — Faulty starting switch or relay.
- 4 — Defective starting motor.
- 5 — Internal engine seizure — turn engine manually to determine cause.

**B — ENGINE CRANKS — BUT DOES NOT START:**

Disconnect one spark plug wire, turn ignition on with starter cranking engine and free end of wire  $\frac{1}{8}$ " from cylinder head — note spark.

**1 — NO SPARK:**

(A) — **If Ammeter Shows No Discharge** — it indicates an open primary circuit due to:

- 1 — Points not closing.
- 2 — Open primary wires.
- 3 — Defective ignition switch.
- 4 — Faulty coil.

(B) — **Normal Ammeter Reading (2-5 Amps)** — this indicates that primary circuit is OK — trouble may be in secondary circuit due to:

- 1 — Broken or grounded high tension wire from coil to distributor.
- 2 — Wet high tension wires.
- 3 — Faulty distributor cap or rotor.
- 4 — Broken secondary winding of coil.

(C) — **Excessive Ammeter Reading (over 5 Amps)** — indicates a “short” in the primary winding which may be due to:

- 1 — Shorted or grounded primary winding.
- 2 — Distributor or magneto points not opening.
- 3 — Grounded breaker point arm.
- 4 — Defective condenser.

**2 — WEAK SPARK** — may be caused by:

- (A) Loose ignition wiring connections.
- (B) Burned or pitted distributor points.
- (C) Wet spark plug wires.
- (D) Defective condenser.
- (E) Cracked distributor cap.
- (F) Weak ignition coil.

**3 — GOOD SPARK AT EACH PLUG** — indicates that ignition system is OK and trouble is in fuel system — which may be due to:

(A) **No Gas in Carburetor** — which may be due to:

- 1 — No gas in tank.
- 2 — Clogged filter or lines.
- 3 — Faulty fuel pump.
- 4 — Leaky fuel line from tank.
- 5 — Plugged vent in fuel tank cap.

(B) **Gas in Carburetor** — which may be flooded due to:

- 1 — Too much choking — plugs are wet.
- 2 — Wrong float level.
- 3 — Choke not operating correctly.
- 4 — Water in Gas.

**C — ENGINE RUNS WITH CONTINUOUS MIS-FIRING:** Due to:

- 1 — Uneven compression.
- 2 — Wet or deteriorated high tension wires.
- 3 — Cracked distributor cap.
- 4 — Faulty spark plugs—if spark plug porcelain is white when removed, use **Colder** plug — if light brown OK — if Black or oily use **Hotter** plug.

**D — ENGINE RUNS UNEVENLY**

- 1 — **At Idling Speed**—which may be due to:
  - (A) Too wide spark plug gaps.
  - (B) Poor Carburetor idle adjustment.
  - (C) Wrong float level.
  - (D) Carburetor or intake manifold air leaks.
  - (E) Leaky cylinder head gasket.
- 2 — **At High Speed** — which may be due to:
  - (A) Wide breaker points.
  - (B) Weak distributor breaker arm spring
  - (C) Weak valve springs.
  - (D) Spark plug of wrong type or incorrect gap.

**E — ENGINE RUNS IMPROPERLY**

- 1 — **Back-Firing into Manifold** — indicates **Too Rich** a fuel mixture; into carburetor indicates **Too Lean** a mixture—may be due to:
  - (A) Late Ignition Timing.
  - (B) Clogged Air Cleaner.
  - (C) Fuel line restrictions.
  - (D) Clogged carburetor jets.
  - (E) Sticking Valves.
  - (F) Weak or broken valve springs.
- 2 — **Excessive Ping (Detonation)**—Results in damaged pistons and bearings and is caused by pre-ignition or using inferior grade of gas.
- 3 — **Engine Idles Too Fast** — indicates improper throttle adjustment or weak throttle return springs.
- 4 — **Engine Dies When Idling** — which indicates incorrect speed or mixture adjustment; clogged idling circuit in carburetor or wrong choke adjustment, or air leaks in intake manifold.
- 5 — **Engine "Stumbles" on Acceleration** — which may be due to defective accelerator pump or air in fuel lines.

6 — Defective Spark Plugs.

**F — LACK OF POWER** — which may be due to:

- 1 — Poor Compression.
- 2 — Wrong Timing.
- 3 — Throttle control not opening fully.
- 4 — Air leak in fuel system.
- 5 — Restriction in air cleaner — should have vacuum less than 10" water.
- 6 — Exhaust line obstructed — should have back pressure of not more than 20" water.
- 7 — Poor fuel.
- 8 — Piston rings sticking or worn.

**G — POOR COMPRESSION**—check with compression gauge — if irregular, seal the piston with a teaspoonful of engine oil poured through the spark plug hole, and take a second reading; if pressure does not increase this will indicate that poor seating of valves are at fault. Poor compression may be due to:

- 1 — Valves holding open — no tappet clearance.
- 2 — Leaky cylinder head gasket.
- 3 — Broken or weak valve springs.
- 4 — Burned or sticking valves.
- 5 — Badly worn, broken or stuck piston rings.
- 6 — Wrong valve timing.

**H — OVERHEATING**

- 1 — Lack of water in radiator.
- 2 — Fan belts slipping.
- 3 — Thermostat sticking or inoperative.
- 4 — Radiator clogged or leaky.
- 5 — Late ignition timing.
- 6 — Back pressure in exhaust line.
- 7 — Defective water pump.
- 8 — Overloading of engine.

**I — LOW OIL PRESSURE**

- 1 — Low Oil level.
- 2 — Oil pressure gauge or line faulty.
- 3 — Oil too light — diluted.
- 4 — Suction screen plugged.
- 5 — Dirt in relief valve or broken spring.
- 6 — Worn bearings.
- 7 — Worn or damaged oil pump gears.
- 8 — Worn Cam Bushings.



**J — HIGH OIL PRESSURE**—should not exceed recommended pressures except when engine is starting up cold. Abnormally high oil pressure is not desirable because it increases oil consumption — possible causes of high oil pressures are:

- 1 — Engine oil too heavy.
- 2 — Stuck relief valve.
- 3 — Obstruction in distributing line.
- 4 — Faulty oil pressure gauge.

**K — HIGH OIL CONSUMPTION**

- 1 — Oil leaks.
- 2 — Too high oil level.
- 3 — Incorrect grade of oil used.
- 4 — Clogged crankcase breather.
- 5 — Oil pressure too high — stuck relief valve.
- 6 — Piston rings not run-in, due to too smooth cylinder bore finish or glazed condition.
- 7 — Worn, broken or stuck piston rings and clogged oil control rings.
- 8 — Worn pistons and sleeves.
- 9 — Worn bearings.
- 10 — Worn valve guides.

(Manifold may be removed for visual inspection.)

**L — ENGINE KNOCKS AND OTHER NOISES**

1 — Operating Knocks — which may be due to:

- (A) **Pre-Ignition** — Most common cause is due to wrong type plugs which are too hot.
- (B) **Carbon** — noticeable when engine is accelerated while hot — clean head and pistons.
- (C) **Timing**—early timing causes knocks similar to carbon — but may tend to kick back when starting.
- (D) **Fuel** — detonation knock caused by poor gas.
- (E) **Overloads** — particularly at lower operating speeds.

2 — **Mechanical Knocks**—result from wear, abuse or improper adjustments — which may be due to:

- (A) **Crankshaft and Main Bearings:**
  - (1) **Worn or burned-out Main Bearings** — A heavy, dull knock when accelerating under load. Locate by shorting out plugs on both sides of the bad bearing.
  - (2) **Crankshaft End-Play** — excessive end-play is indicated by an intermittent

knock which will come and go when the load is released and engaged.

(B) **Connecting Rod Bearings**

(1) **Worn or Burned-out Bearings** — The worst condition, a light pound or metallic knock, is noted at idling and to about  $\frac{2}{3}$  maximum speed. Bad bearings can be determined by shorting out plugs.

(C) **Pistons and Wrist-Pins**

(1) **Loose Wrist Pins** — noise doubles when the correct plug is shorted out — most noticeable at idling speed.

(2) **Piston Loose in Cylinder** — “Piston-Slap” is noted by metallic knocking at low speed under load; but disappears at high speed — also most noticeable when starting cold — test by shorting out plugs.

(D) **Broken Piston Ring or Pin**

sharp clicking noise that won't short out.

(E) **Valves**

(1) **Burned Valves and Seats** — engine misses, especially at low speeds, or acceleration under load.

(2) **Weak or Broken Valve Springs** — missing at low or high speeds when under load.

(3) **Sticking Valves** — loss of power and popping sound when bad.

(4) **Tappet noise** — excessive clearances cause noise when cold — which diminishes at normal operating temperature.

(F) **Camshaft** — Noise due to loose bearings or end play — usually occurs at half engine speed.

(G) **Timing Gear Noise** — Loose or worn gears rattle or knock — tight gears hum.

3 — **Vibration Originating at Engine** — The most common sources of vibration originating in or on the engine, as distinguished from causes created outside the engine are as follows:

- (A) Misfiring
- (B) Misalignment of engine
- (C) Bent or off-center coupling
- (D) Engine loose on bed and type of mountings.
- (E) Out of balance condition of flywheel and clutch assembly.



INDUSTRIAL TRUCK DIVISION



OPERATORS

MAINTENANCE

PARTS

MANUAL

FOR

CY-60

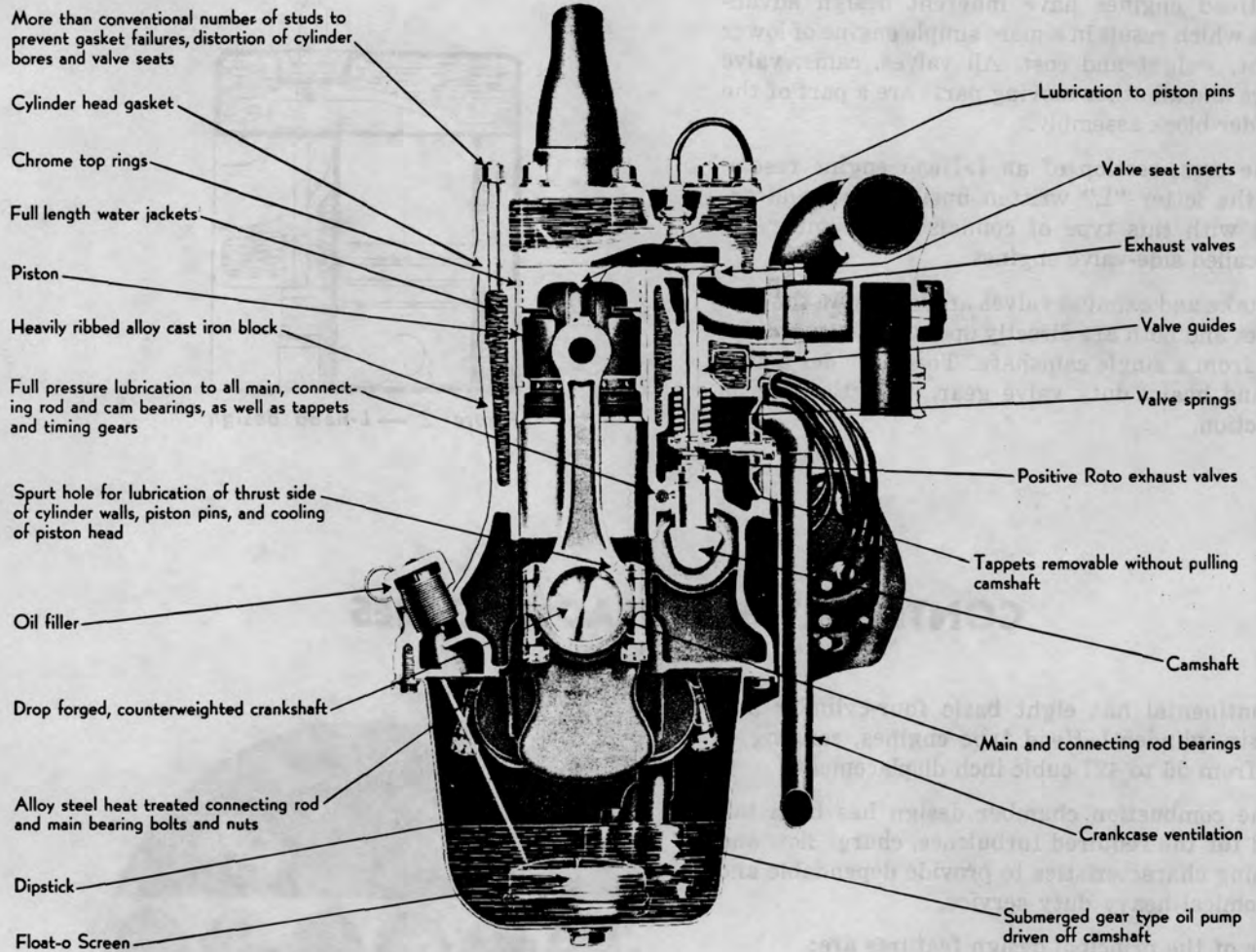
FORM NO. 1-60

CLARK EQUIPMENT COMPANY

PUBLISHED BY

TECHNICAL SERVICE DEPARTMENT  
BATTLE CREEK, MICHIGAN, U.S.A.

GENERAL INFORMATION



**Figure 1 — Cross Section of a Typical Continental "L" Head Engine**

**GENERAL INFORMATION**

L-Head engines have inherent design advantages which result in a more simple engine of lower height, weight and cost. All valves, cams, valve lifters and all other moving parts are a part of the cylinder block assembly.

The cross-section of an L-Head engine resembles the letter "L" written upside down and engines with this type of combustion chamber are also called side-valve engines.

Intake and exhaust valves are located in the side pocket and both are directly operated through tappets from a single camshaft. This provides a simple and heavy duty valve gear, since there is no deflection.

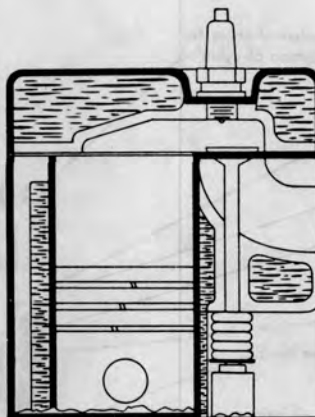


Figure 2 — L-head design

**CONTINENTAL L-HEAD ENGINES**

Continental has eight basic four-cylinder and ten six-cylinder L-Head type engines, ranging in size from 56 to 427 cubic inch displacement.

The combustion chamber design has been tailored for the required turbulence, charge flow and burning characteristics to provide dependable and economical heavy duty service.

Some of the principal design features are:

1. **Individual Porting** — of the intake manifold whereby each cylinder is fed with the fuel-air mixture individually and not influenced by other cylinders of the engine.

This is accomplished by casting the cylinder block with individual intake valve passages for each cylinder and connecting these passages to an intake manifold which also has individualized passages for each cylinder.

This equal distribution results in maximum power, smooth operation, easy starting and longer engine life.

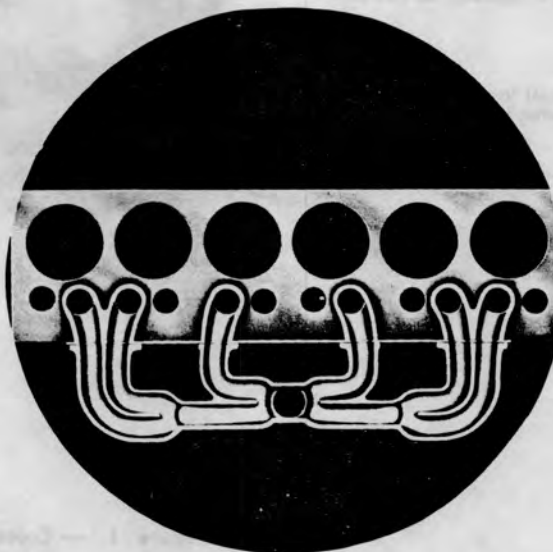


Figure 3 — Individual Porting



2. **Directional Cooling** — is accomplished by regulating the course of the cool water from the water pump so it first comes in contact with exhaust valve seats and then to other points as indicated by their relative temperatures.

This feature promotes uniform cooling throughout the system, prevents hot-spots and prolongs valve life.

This coupled with the by-pass and thermostat included in the engine assembly, insures rapid warm-up and even temperature distribution.

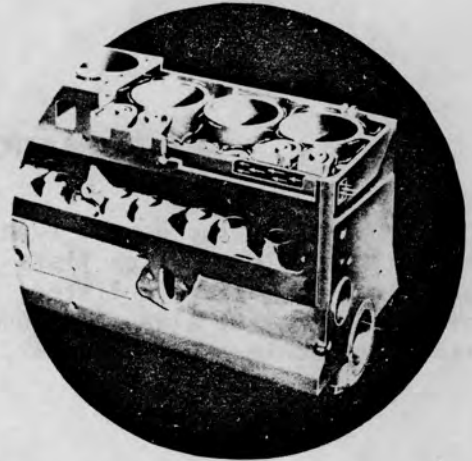


Figure 4 — Directional Cooling in Block

3. **Full Length Water Jackets** — completely surround all cylinder bores the full length of the piston travel.

This insures uniform cooling with minimum bore distortion — which results in lower oil consumption; less blow-by and minimum tendency to sludge.

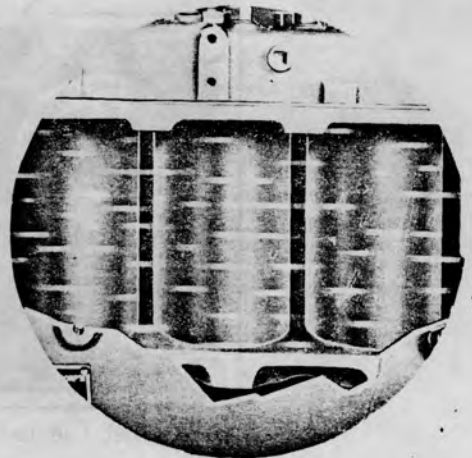


Figure 5 — Full Length Water Jackets

4. **Removable Tappets** — The large, barrel shaped, pressure lubricated tappets are so designed that by removing the adjusting screw — the main body can be lifted out and replaced from above through the valve chamber. This eliminates the costly service operation of dropping the oil pan and pulling the camshaft. Locking of the adjustment is both simple and effective.

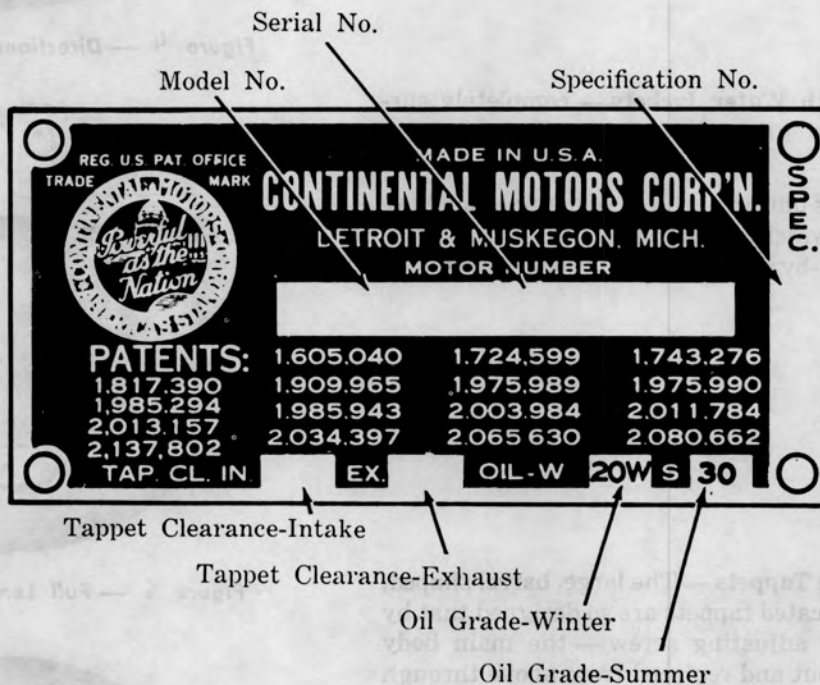


Figure 6 — Removable Tappets

5. **Choice of Fuels** — Gasoline - LPG - Natural Gas - Fuel Oil — Continental L-Head engines have been tailored for heavy-duty operation using gasoline - LPG - natural gas - fuel oil fuels.

**INFORMATION FOR ORDERING PARTS**

When ordering engine parts, refer to the engine name plate attached to side of the cylinder block, which lists the model and serial number. In most cases a specification number is listed. This data is of vital importance in obtaining the correct parts: always include this information on your parts order together with your machine serial number.



**Figure 7 — Nameplate**

**LUBRICATION**

**ENGINE LUBRICATION SYSTEM**

Continental L-Head engines have full pressure lubrication to all main, connecting rod and camshaft bearings as well as tappets and timing gears.

To insure piston pin lubrication and prevent piston scuffing during the warm-up period in cold

weather — the large end of the connecting rods have drilled spurt holes pointing toward the thrust side of the pistons. These line up with the oil hole in the crank pin so that once each revolution, oil is sprayed on the cylinder wall for lubrication.

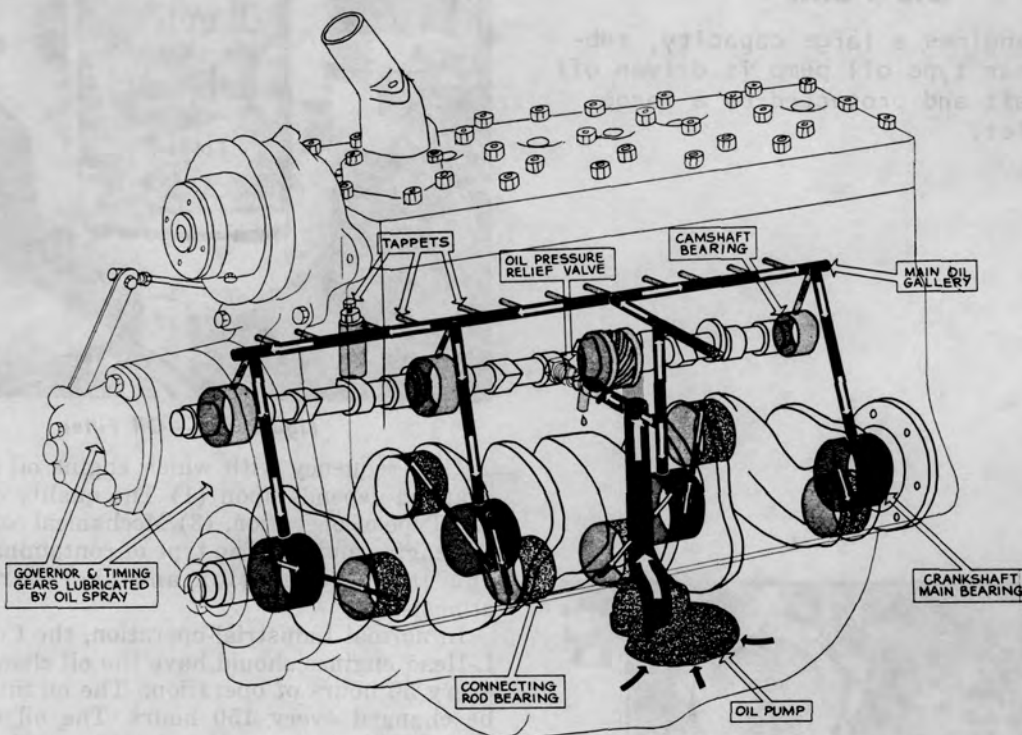


Figure 8—Oiling Diagram



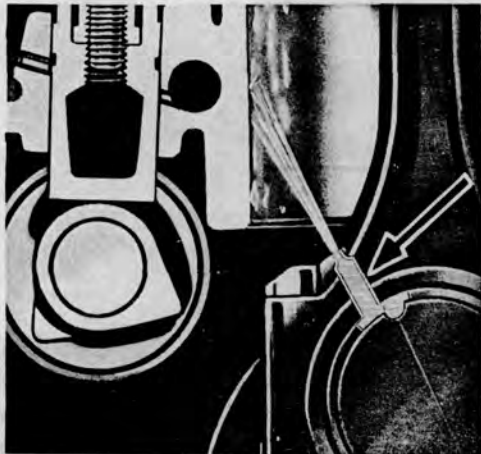


Figure 9 — Connecting Rod Spurt Hole

**OIL PUMP**

On all engines a large capacity, submerged, gear type oil pump is driven off the camshaft and protected by a large screen inlet.

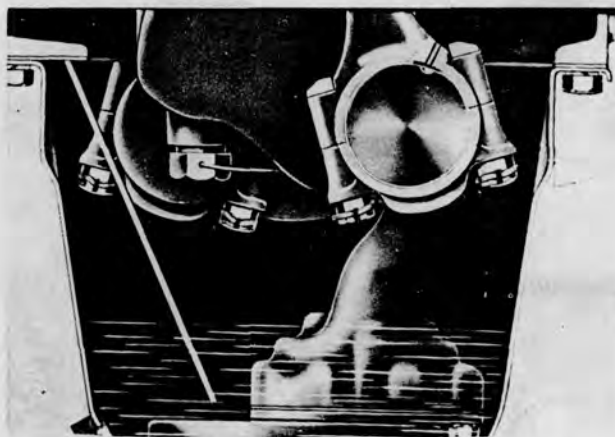


Figure 10 — Oil Pump

\*Other pressures are available, based on customer specifications.

A by-pass type oil filter is normally provided to remove dirt and foreign elements from the oil, a percentage of which is passed through the filter during the operating period. The removal of grit, sludge and foreign particles causes filter elements to clog and become ineffective unless they are normally replaced every 150 hours.

**OIL CHANGE FREQUENCY**

Engine oil does not "wear out". However, the lubricating oil in internal-combustion engines becomes contaminated from the by-products of combustion: dirt, water, unburned fuel entering the crankcase, and the detergents holding the carbon particles in suspension in the crankcase.



Figure 11 — Oil Filter

The frequency with which engine oil should be changed depends upon (1) The quality of the oil, (2) Type of operation, (3) Mechanical condition of the engine and (4) The type of contaminants from the engine operation and the surrounding atmosphere.

In normal Industrial operation, the Continental L-Head engines should have the oil changed after every 50 hours of operation. The oil filter should be changed every 150 hours. The oil should be drained when the engine is at normal operating temperature.

**BREAKING-IN NEW OR RECONDITIONED ENGINES**

New or reconditioned engines have very small clearances. To assure adequate oil distribution to these closely fitted surfaces during the first week or 50 hours of engine operation, the use of a lighter bodied oil is desirable.

When the engine break-in is performed during the warmer months of the year, an SAE 10-W-30 oil should be used. Be sure to allow a several-minutes warm-up period before applying the load.



**DO NOT FLUSH CRANKCASE WITH KEROSENE**

Some operators unwisely put kerosene in the crankcase after draining the engine oil, then turn the engine over with the starter — in the belief they are doing a better job of crankcase cleaning.

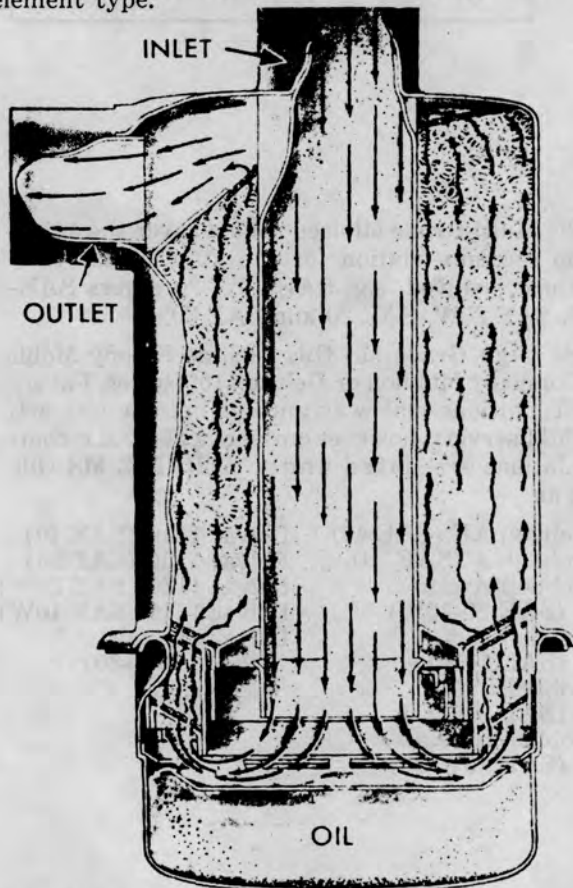
In doing this, kerosene is circulated through the oil pump, the main oil header and the branches leading into the engine bearings — thereby washing away the protective oil film. In addition, some of the kerosene will be trapped and remain to thin out the new oil, reducing its lubricating qualities.

**Do not put kerosene into the crankcase.** The best method is to drain the oil when the engine is thoroughly heated — which will carry off most of the sediment.

**AIR CLEANER**

All engines, when operating, consume several thousand cubic feet of air per hour. Since dusty air is full of abrasive matter, the engine will soon wear excessively if the air cleaner does not remove the dust before entering the cylinders.

Two basic types of air cleaners are normally used — the oil bath type and the dry replaceable element type.



**Figure 12 — Sectional View of Oil Bath Air Cleaner**

Operating conditions determine the air cleaner service periods. In extremely dusty operations, this may be once or twice daily. In dust protected

areas, the air cleaner should be serviced when changing oil.

As the dirt is strained from the air flowing through the cleaner, it thickens the oil in the cup and raises the level. If the level is too high, agitation of the oil on the screen is affected and gritty oil is carried over into the air stream, through the carburetor and into the engine cylinders. This would actually introduce a grinding compound with resulting very rapid wear.

**LUBRICATION RECOMMENDATIONS**

Motor oils used for internal-combustion engine lubrication perform many useful functions including: dissipating heat; sealing piston rings; preventing metal to metal contact wear and reducing power loss through friction.

The lubricating oil recommendation is based upon engine design; type of service and the atmospheric temperature prevailing. High quality oils are required to assure maximum performance, long engine life and minimum cost of operation.

L-Head gasoline engines operate in a wide range of service conditions and seasonal temperatures, so our recommendations are given for various types of service and ambient temperatures.

The American Petroleum Institute (API) has established new service classifications so that the engine operator can properly select the best type of oil.

They have the following three classifications of engine oils relating to the different operating conditions for gasoline or other spark-ignition engines:

**SERVICE ML** — (Former API Designation: Regular)

**Light or Easy Service Conditions** — Such as moderate operating speed at normal engine temperatures — especially where the engine is relatively insensitive to promote deposit formation and bearing corrosion.

**SERVICE MM** — (Former API Designation: Premium)

**Moderate Severe Service Conditions** — Involving higher speeds and operating temperatures; particularly when the higher temperatures tend to promote deposit formation and bearing corrosion.

**SERVICE MS** — (Former API Designation: Heavy-Duty Type)

**Severest Service Conditions** — include:

**Start-Stop Operation** — which leads to emulsion sludge and corrosive wear; involves essentially a low-temperature condition, and one which gets worse in colder weather.

**Severe High Temperature Operation** — Resulting from high loads or overloads or high operating speed which tends to result in carbon, lacquer and sludge deposits.

**S.A.E. OIL BODY GRADES**

The oil body grades available from the lightest (SAE 5W) to the heaviest (SAE 40) are:

5W	10W	20W	20	30	40
← 5W - 20 →					
	← 10W - 30 →				

**MULTI-GRADE OILS** — Such as SAE 5W-20 and SAE 10W-30 have the starting grade characteristics of the lighter oil and after it warms up it has the running characteristic of the heavier grade.

The following SAE grades are general recommendations for Continental L-Head engines during changing seasonal atmospheric temperatures:

SEVERE WINTER BELOW 0°F.	NORMAL WINTER 0° - 32°F.	SPRING-FALL 32° - 75°F.	SUMMER ABOVE 75°F.
10W	10W	SAE20W	SAE30

The Multi-Grade oil used should cover the single grade recommendation for the atmospheric temperature involved, e.g. SAE 10W-30 covers SAE-10W, SAE 20W, SAE 20 and SAE 30.

Use High Grade MS Oils such as Socony Mobil Oil Company Mobiloil or Delvac 1100-series. Favorable conditions may warrant oils listed under ML and MM service; however our above general recommendations are listed under SERVICE MS Oils such as:

- |                               |                             |
|-------------------------------|-----------------------------|
| Mobiloil AF (SAE 40)          | Delvac 1140 (SAE 40)        |
| Mobiloil A (SAE 30)           | Delvac 1130 (SAE 30)        |
| Mobiloil Arctic (SAE 20-20W)  | Delvac 1120 (SAE 20W)       |
| Mobiloil 10W (SAE 10W)        | Delvac 1110 (SAE 10W)       |
| Mobiloil 5W (SAE 5W-20)       | Delvac Special (SAE 10W-30) |
| Mobiloil Special (SAE 10W-30) |                             |

**ENGINE REPAIR AND  
OVERHAUL**

This section includes instructions for repairs and overhaul of the component units of Continental Red Seal L-Head engines.

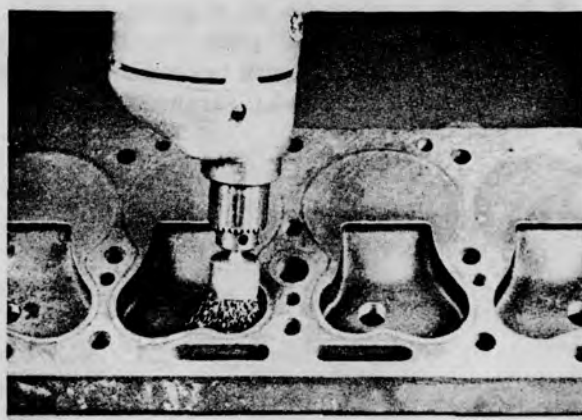
Provide a clean place to work and clean the engine exterior before you start disassembling — dirt causes engine failures. Many shop tools have been developed to save time and assure good workmanship; these should be included in your equipment.

Use only genuine Red Seal parts in Continental engines since years of development and testing have gone into these specifications to assure maximum life and performance.

**CYLINDER HEAD**

The cylinder head is an important part of the engine assembly since it contains the complete combustion chamber and cored passage for water flow. Remove the cylinder head in the following sequence:

1. Drain water from engine and disconnect radiator or heat exchanger outlet hose.
2. Loosen and remove the nuts holding the cylinder head to the block.
3. Lift the cylinder head off the engine and carry to a clean bench for further disassembly.
4. Remove all carbon from combustion areas using a scraper and wire brush.



**Figure 14** — Cleaning carbon from combustion chamber

5. Clean the cylinder head thoroughly with a solvent or degreasing solution and blow it off with air pressure.

6. Make sure that gasket contact surfaces on the head and block are clean, smooth and flat.



**Figure 13** — Checking cylinder head flatness lengthwise.

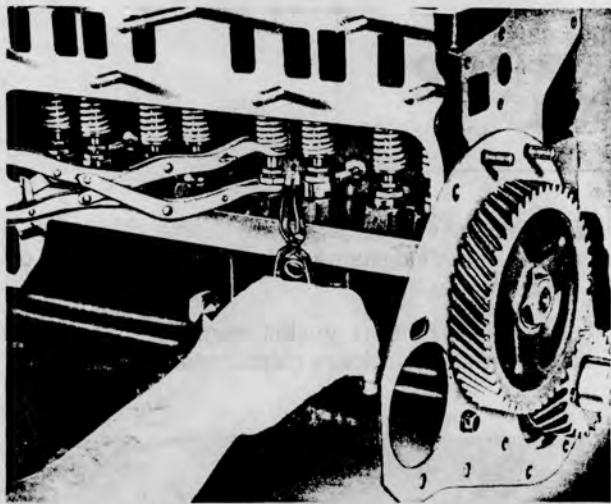
7. Check out-of-flatness with straight edge and feeler gauge: maximum permissible is .00075 inches per inch of width or length. Thus, for a cylinder head 16" long, maximum permissible lengthwise out-of-flatness is .012". Out-of-flatness should vary gradually and uniformly from end to end and side to side. Localized depressions or high spots should not exceed .003.



**Figure 15** — Checking cylinder head flatness crosswise.

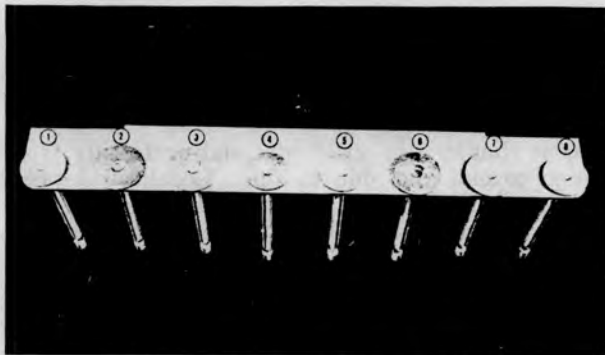


**CYLINDER BLOCK**



**Figure 16 — Valve Removal**

1. With a valve spring lifter, compress the springs and remove the locks or pins from the valve stems which are in a closed position. Close the other valves by rotating the crankshaft and remove the locks (or pins) from these valves in the same manner. Remove all valves and place in order in a rack, with holes numbered for both intake and exhaust valves so they will not be mixed in handling.



**Figure 17 — Valves in rack**

**VALVE GUIDES**

1. Clean the valve stem guides, removing lacquer or other deposits by running a valve guide cleaner or wire brush through the guides.

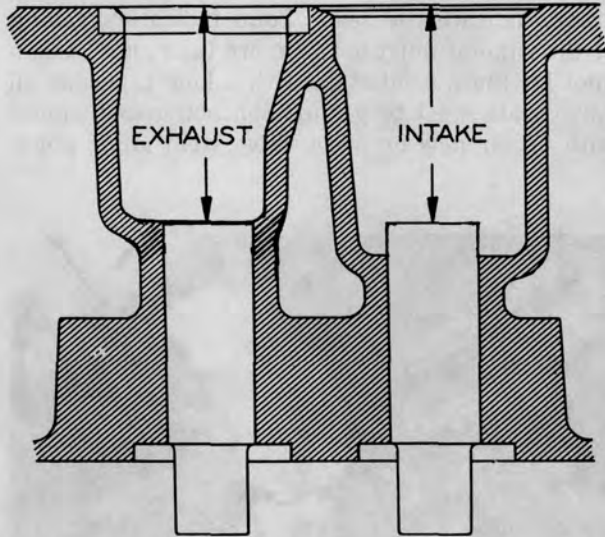
2. Check guides for wear by using "Go and No-Go" plug gage or a telescope gage and 1" micrometer. Replace all guides that are worn bell-mouthed and have increased .0015 in diameter. See Limits and Clearance Section for maximum diameter permissible to determine actual amount the diameter has increased. Remove all valve guides when necessary by using an arbor press and pressing them out from the combustion chamber side with a driver slightly smaller than the O.D. of the valve guide.



**Figure 18 — Removing valve guides**

3. Replace worn guides as required by using a suitable driver and an arbor press from the combustion side to the correct depth below the valve seat as given in the Limits and Clearance Chart.





Engine	Distance from Block Face to Top of Guide	
	Intake	Exhaust

Refer to Limits and Clearance in front of manual.

**CAUTION:** When replacing guides that are ferrox coated do not ream since these are all pre-reamed before being ferrox coated — any further reaming will remove the coating.

**VALVE SEAT INSERTS**

1. The exhaust valve seat insert is held in place by a shrink fit.

Inspect all exhaust valve inserts in the block and replace any that are loose, cracked or otherwise damaged. Use puller for removing faulty insert as shown in illustration.

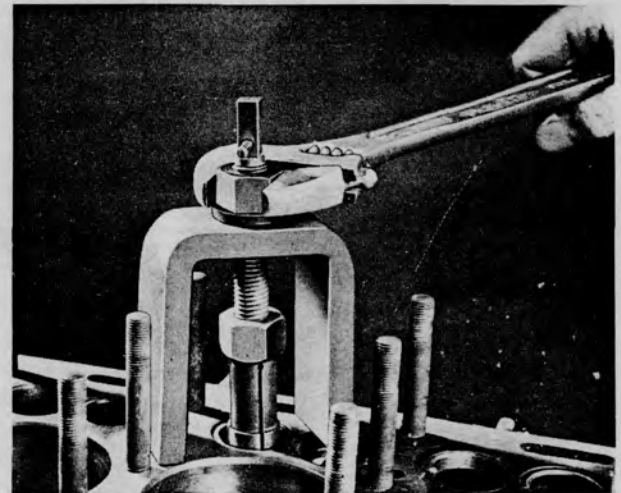


Figure 19 — Removing exhaust valve seat insert

2. When required to replace with new insert, clean and counterbore for .010 larger insert using counterbore tool with correct fitting pilot.

When machining the counterbore, be sure to go deep enough with the tool to clean up the bottom so that the insert will have full contact to carry away the heat.

Continental does not recommend installing new inserts having the same outside diameter as the one removed. The following chart shows the dimensions of Standard Inserts and counterbores:

**DIMENSIONS OF STANDARD INSERTS AND COUNTERBORES**

Engine Model	Outside Dia. of Insert (A)	Inside Dia. of Counterbore (B)

Refer to Limits and Clearance in front of manual.

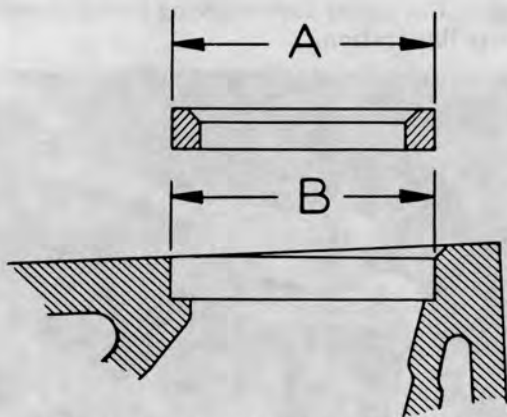


Figure 20-A — Insert and counterbore

When OVERSIZE inserts are used, dimensions of the insert and counterbore increase proportionately (.010, .020 — depending on the oversize).

New insert installation should have a press fit. Chill insert in container with dry ice for 20 minutes before assembling.

Insert may then be installed in the counterbore using a piloted driver, tapping in place with very light hammer blows, without the possibility of shearing the side walls. This assures it being seated firmly on the bottom of the counterbore.



Figure 21 — Installing valve seat insert with an arbor press

3. Grind the intake and exhaust valve seats in the block in accordance with instructions in the limits and clearance chart and before removing the arbor, indicate the seat. Total indicator reading of the run-out must not be more than .002". Use a pilot having a solid stem with a long taper, as all valve seats must be ground concentric and square with either new or worn valve stem guide holes.

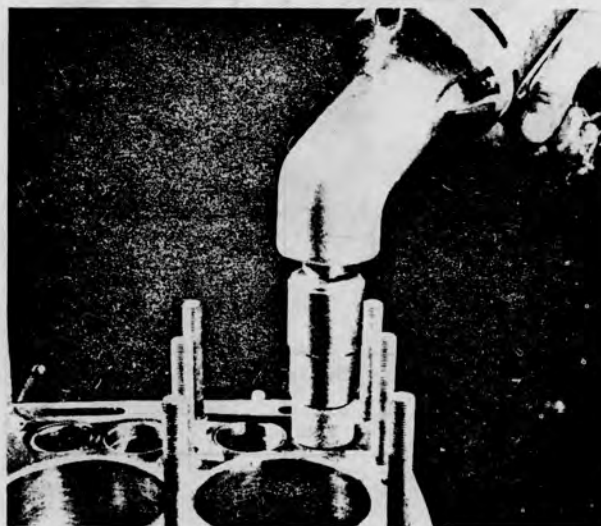


Figure 22 — Grinding Valve Seat

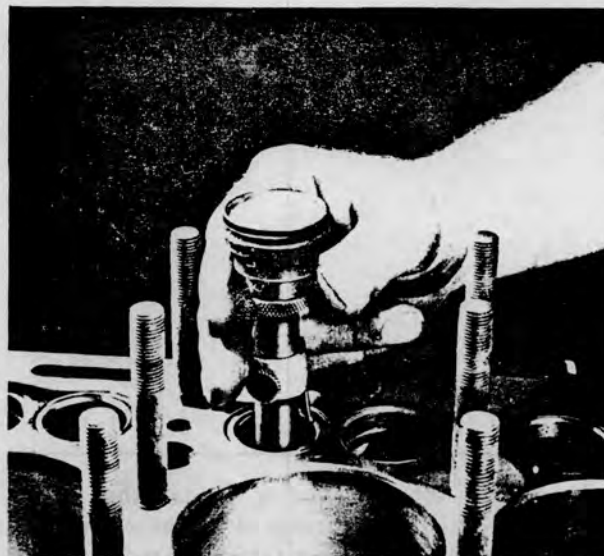
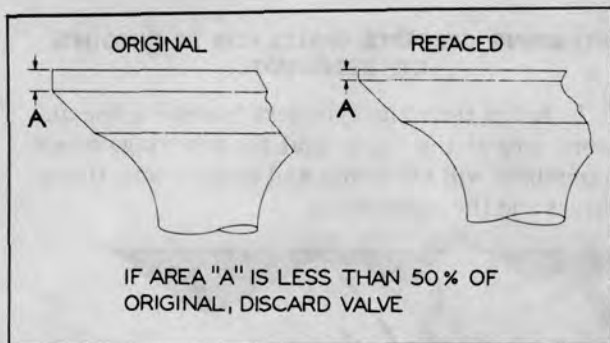


Figure 23 — Indicating Valve Seat

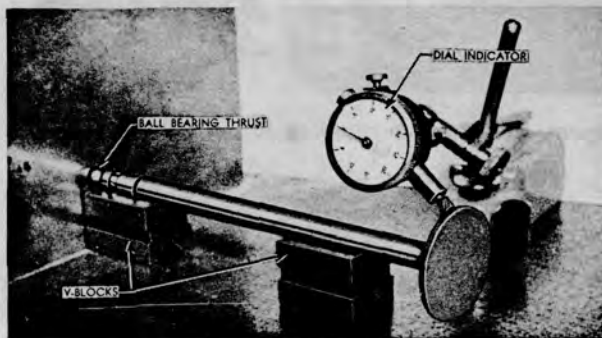
**VALVES**

1. Inspect valves for condition and replace any that are "necked", cracked or burned, also any on which valve stems are bent or worn more than .002 over the maximum allowable limits. Reface or replace all valves.



**Figure 24** — Allowable head thickness of refaced valves

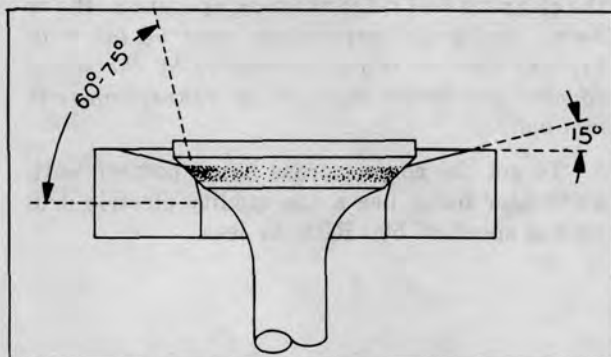
2. All valves having less than 50% margin thickness (outer edge of valve head) after refacing has been completed must be replaced. To check this dimension, compare the refaced valve with a new valve.



**Figure 25** — Checking valve face in "V" blocks

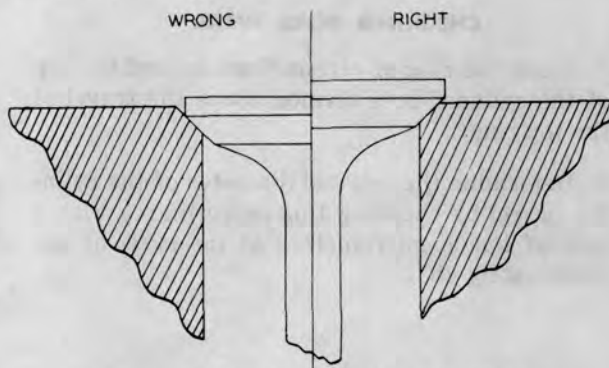
3. Check all refaced or new valves in V-blocks with indicator to determine if the contact face is true with the stem within .002. If not, repeat the refacing operation.

4. After the valves and seats have been refaced and reground, coat the seat lightly with Prussian blue and drop the valve into position, oscillating it slightly to transfer the blue pattern to the valve face. This should show a contact width of  $\frac{1}{16}$ " to  $\frac{3}{32}$ " and should fall well within the width of the valve face, leaving at least  $\frac{1}{64}$ " on either side where



**Figure 26** — Method of narrowing valve seats

the blue does not show. If the contact is over  $\frac{3}{32}$ " wide, the seat in the head may be narrowed by using a 15° stone to reduce the outside diameter or using a 60° or 75° stone to increase the inside diameter.



**Figure 27** — Valve position in block

Never allow valves to set down inside the seat.

After the narrowed-down seat is brought within specifications, the seat should be retouched lightly with the original stone to remove burrs or feathered edge.

**"A poor valve grinding job cannot be corrected by valve lapping."**

5. Coat the valve stem with a light film of engine oil.

**VALVE SPRINGS**

1. Check all valve springs on a spring tester to make sure they meet specifications regarding weight and length. Springs, when compressed to the "valve open" or "valve closed" length, must fall within the specifications shown on the chart when new, and must not show more than 10% loss to re-use.



**Figure 28** — Valve spring tester

2. Reassemble the valves and springs in the block with the retainer and retainer lock.



**CYLINDER BLOCK**

All "L" head engines, except the N56, have cylinder barrels cast in the block.

**CHECKING BORE WEAR**

1. Clean the ring of carbon from around the top of the cylinder bore formed above the travel of the top ring.
2. Determine the original diameter of the cylinder barrel by checking this unworn area with a pair of inside micrometers at intervals of approximately 45°.

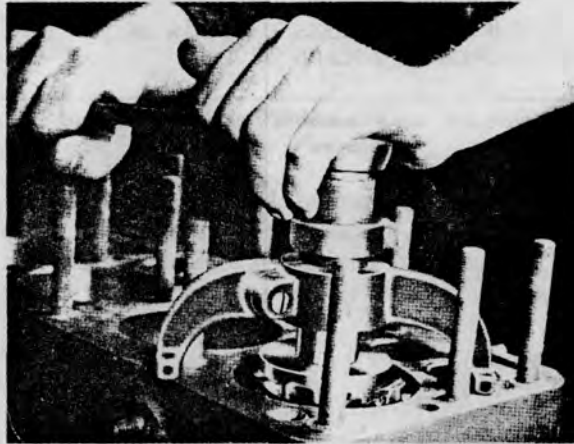


**Figure 29 — Measuring original bore diameter above ring travel**

3. Check in same manner the top of the ring travel area approximately 1/4" below the shoulder.
4. The maximum difference in the above checks, indicates the amount of cylinder bore wear. If less than .008, re-ringing will be suitable and if over .008 re-boring is recommended.

**PREPARING CYLINDER WALLS FOR RE-RINGING OR REBORING**

1. Ridge ream the cylinders to remove the unworn area at the top so that the new rings when assembled will not bump and distort both themselves and the piston lands.



**Figure 30 — Ridge reaming top of cylinder bore**

Several good makes of ridge reamers are available which will ream the top of the bore in direct relation to the worn area so that should the worn area be off center slightly there will be no partial ridge remaining.

2. Drain the crankcase and remove the oil pan.
3. Remove the cap screws holding the connecting rod caps to the rod. *Keep the cap and bolts in numerical order so that when the pistons and rods are removed from the engine, the cap can be reassembled and kept with its mating part.*
4. Push the pistons and connecting rods up through the top of the cylinder, carrying with them all the carbon and metal chips left from the cleaning and ridge reaming operation. *When doing this, every precaution must be taken to prevent damage to cylinder bores by the sharp corners and rough edges of the connecting rods and bolts.*
5. To get the correct cross hatch pattern with a cylinder hone, use a top quality electric drill with a speed of 500 RPM or less.



5. It is important to remove the glaze on the cylinder bores by using a glaze breaker in order to assure quick seating of the new piston rings. If the cylinder glaze is not removed, you will have no assurance as to when the rings will begin to function properly and control the oil; this is especially true when chrome rings are used.

The following step by step procedure is recommended:

a. Cover the entire crankshaft with a clean, slightly oily cloth to prevent abrasives and dirt from getting on the crankshaft.

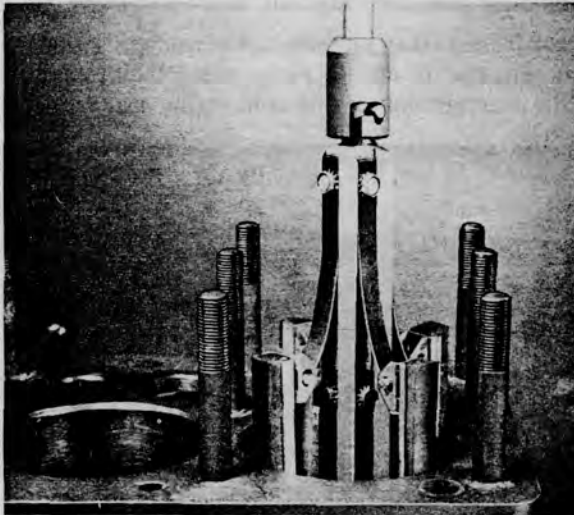


Figure 34— Removing cylinder wall glaze

b. Remove the excess carbon deposits from the top of the cylinder wall before beginning the glaze breaking operation. (This is to prevent loading the stones.)

c. Surface hone each cylinder several times; move the glaze breaker up and down in the cylinder rapidly to produce a 45 degree cross hatch pattern similar to that illustrated.

d. Clean the loose abrasives from the stones by using kerosene and a wire brush. (Do not use thinner to clean the stones because of the ex-

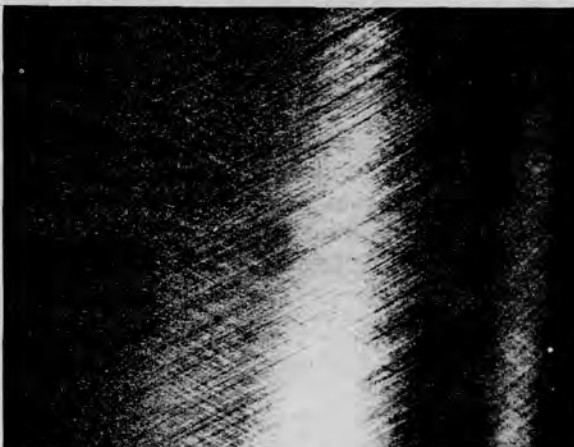


Figure 35— Desirable cross hatch pattern obtained with a glaze breaker

plosion hazard.) Dry the glaze breaker before moving to the next cylinder.

e. The most desirable cylinder finish is 30 — 40 micro inches; with this finish the depressions in the surface tend to keep the supply of lubrication between the mating parts. This finish can be obtained by using 220 grit stones on the glaze breaker.

f. Clean all bores thoroughly with a clean oiled rag to pick up all the small particles of dust that may be embedded in the walls. Follow this with a clean cloth to make certain the walls are CLEAN.

### PISTONS

Check the pistons for excessive ring groove wear, and replace any that exceed the allowable limits in our limits and clearance data.

The cylinder walls and pistons must be perfectly clean and dry when fitting pistons in the cylinder bores. Pistons should be fitted with the block and piston at room temperature (68° - 70° F).

Refer to Limits and Clearance in front of manual.

Check the piston fit in the bore using a half-inch wide strip of feeler stock, of the thickness specified in the Limits and Clearance Chart, the feeler being attached to a small scale of approximately 15 lbs. capacity.

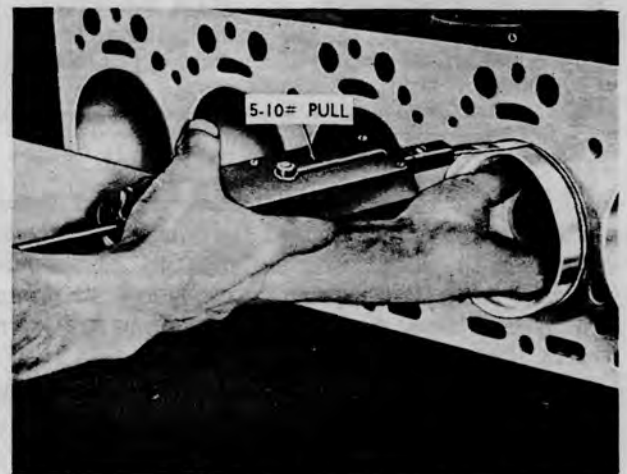


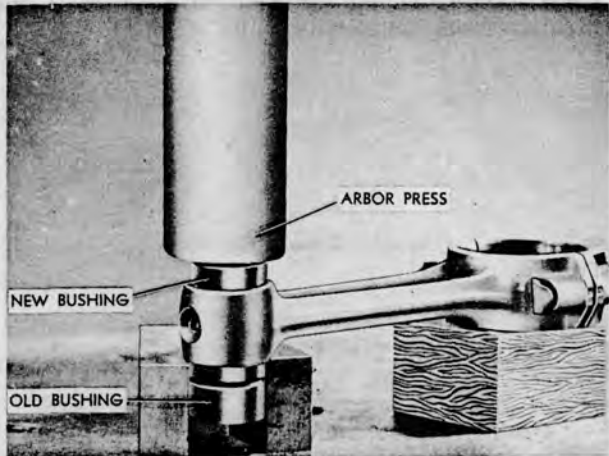
Figure 36— Checking Piston fit in bore

When the correct fit is obtained you must be able to withdraw the feeler with a pull of 5-10 pounds on the scale, with the feeler inserted between the piston and the cylinder midway between the piston pin bosses where the diameter of the piston is the greatest. Check the fit of the piston when it is approximately 2" down in the cylinder bore in an inverted position.

**PISTON PINS**

Check the bushing in the upper end of the connecting rod for wear. If worn and you are using the original pistons with a service set of rings, an over-size piston pin may be obtained in .003 or .005" oversize.

The piston pin hole in the piston and the bushing in the connecting rod may be honed to increase



**Figure 34 — Pressing in Piston Pin Bushing**

their diameter to obtain the desired fit as shown in your Limits and Clearance Chart.

Note that while the chart specifies a light push fit of the pin in the piston, there is a definite clearance of the piston pin in the connecting rod.

**CONNECTING ROD**

Replace the bushing in the connecting rod if new pistons and sleeves are used. Using an arbor press, press out the old bushing and press in the new one — after which the bushing must be honed to obtain the correct fit of the pin in the bushing as shown on Limits and Clearance Chart.

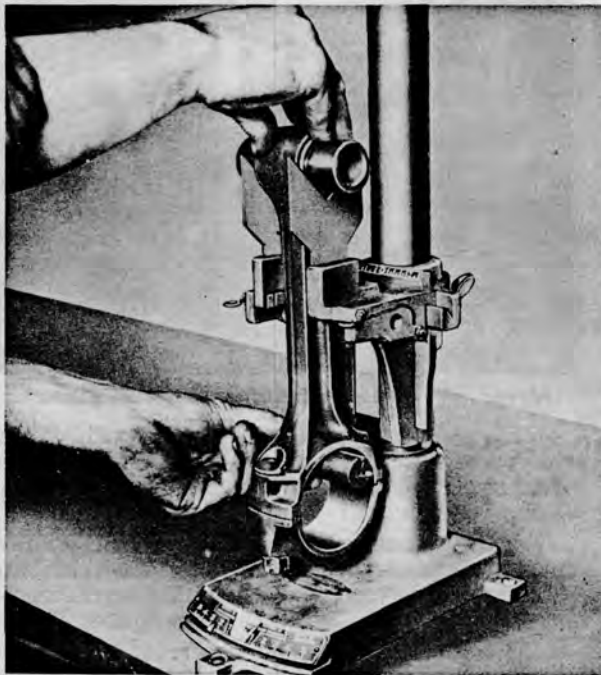
If there is an excess of stock in the piston pin bushing, it may be reamed first, then honed. In any event, the final operation should be done with a hone to obtain the desired fit with better than 75% bearing area on the pin.

**PISTON AND CONNECTING ROD ASSEMBLY**

1. Assemble the pistons on the connecting rod by first heating them in some form of oven or in hot water to a minimum temperature of 160°F. When heated, the piston pin will enter the piston very easily and can be tapped through the connecting rod and into place without distorting the piston.

The snap rings must be assembled in the grooves, making sure they are fully seated in place.

2. The piston pin hole in the connecting rod must be parallel to and in plane with, the large bore in the bearing end of the connecting rod.



**Figure 35 — Checking connecting rod for twist**

This may be checked on a fixture with the piston pin assembled in the rod before assembling the piston; but regardless of this preliminary check, the completed piston and rod assembly must be re-checked and there must not be more than .002" twist or out of squareness checked over a spread of approximately 4 inches. The connecting rod can be bent or twisted to meet this specification.

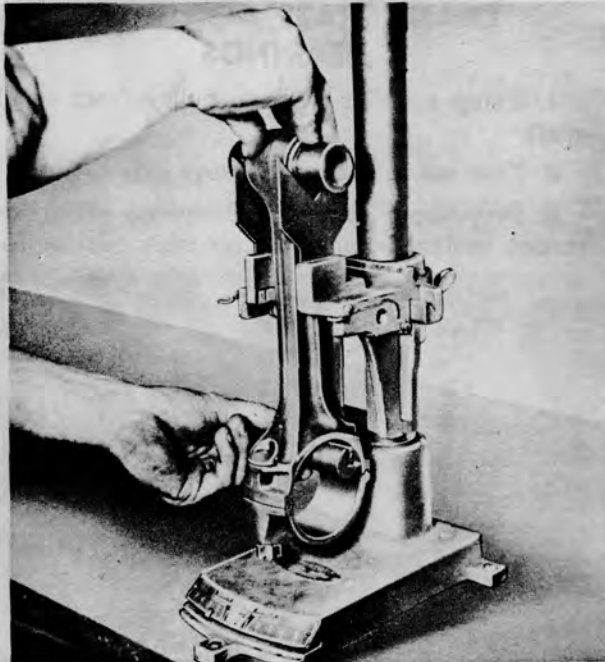


Figure 39. - Checking connecting rod for alignment

Pistons are cam and taper ground, and this must be taken into consideration when checking alignment of the assembly, since the diameter in line with the piston pin would be less at the top of the skirt than at the bottom.

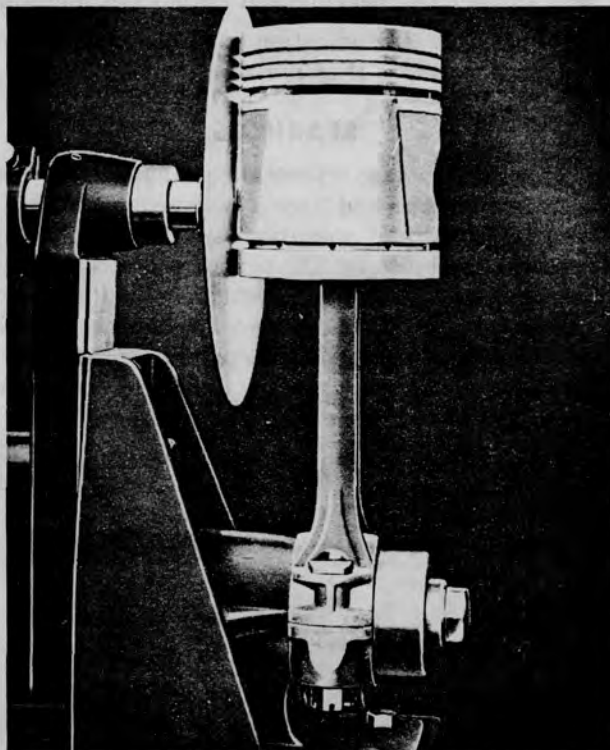


Figure 40 — Checking connecting rod assembly for alignment

**PISTON RINGS**

Check the piston rings in the cylinders for gap.

To do this, insert a piston in the cylinder bore in an inverted position and then insert each ring one at a time about 2" down in the bore and bring the bottom edge of the piston up against the ring to square it up in the cylinder bore.

Check the gap between the ends of the ring with a feeler gauge in accordance with specifications shown in the Limits and Clearance chart. If any of the rings do not have enough gap, they may be filed either in a ring filing fixture or by clamping the file in a vise and holding the two ends against opposite sides of the file.



Figure 41 — Filing piston ring to increase gap

**RECOMMENDED METHOD OF INSTALLING PISTON RINGS**

1. Grip the connecting rod in a vise with lead lined jaws to hold the piston firmly and roll each of the straight side rings in its groove to be sure there are no burrs or other interference with the free action of the ring in the groove.



Figure 42 — Installing Rings with Ring Expander Tool



2. The 3 piece oil ring should be installed first on the piston, from the top side so skirt will not be scratched.

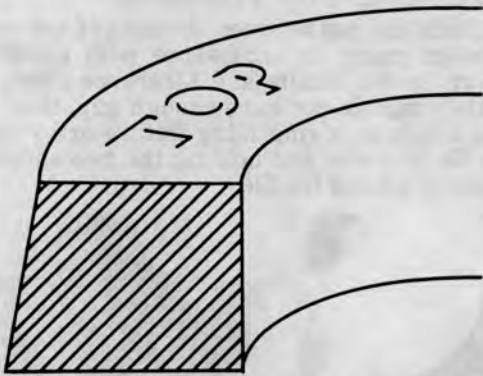


Figure 40 — Install Tapered Rings with "Top" Side Up

3. To install the balance of the rings, use a ring tool with recess side up and place the ring in with the bottom side up. Start with the lowest ring first.

Some piston rings are taper faced. These are clearly marked "TOP" on the side to be up when assembled on piston.

4. Position ring in the tool so the expanding fingers will fully engage both ends.

5. Apply pressure on handles so ring is completely expanded. Pass the expanded ring and tool recessed side down over the piston to the proper groove.

**CAUTION**

If piston is equipped with a steel groove insert, this must be installed on top of the number one ring. (The steel groove insert is not part of the re-ringing kit — this can be re-used when replacing rings.)

6. Check the ring side clearance at various positions with a feeler in accordance with the tolerances shown on the Limits and Clearance Chart.



Figure 41 — Checking Ring Clearance in Groove

**CRANKSHAFT AND MAIN BEARINGS**

1. Using a puller, remove pulley from crankshaft.

2. Take out screws and remove gear cover.

3. Drop the oil pump, by removing nut or cap screws holding pump to center main bearing cap.

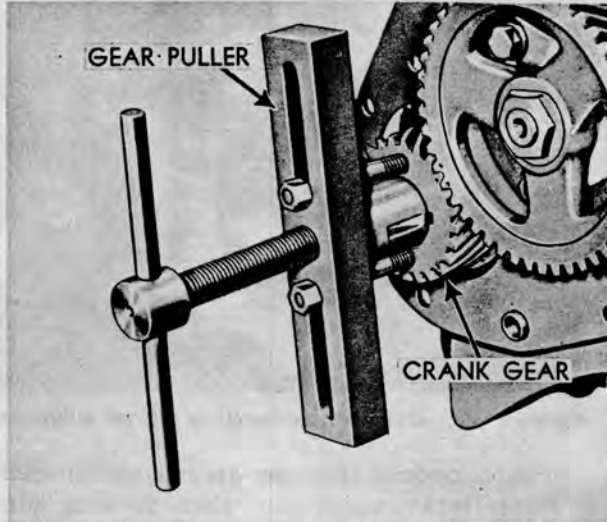


Figure 42 — Removing Crank Gear

4. Remove each main bearing cap, one at a time, and inspect the bearing and crankshaft journals.

If there is any indication of flaking out, scoring or actual wear, — they must be replaced.

**BEARINGS**

Some models use tri-metal bearings which when new are smooth and highly polished. However, a *very few hours of operation will change their appearance completely.* The bearing surface becomes a leaden gray in color and develops minute craters, almost cellular in appearance as indicated in the photograph, which follow the pattern of the matrix. *This appearance is a natural characteristic of this type bearing and in no way indicates failure.*

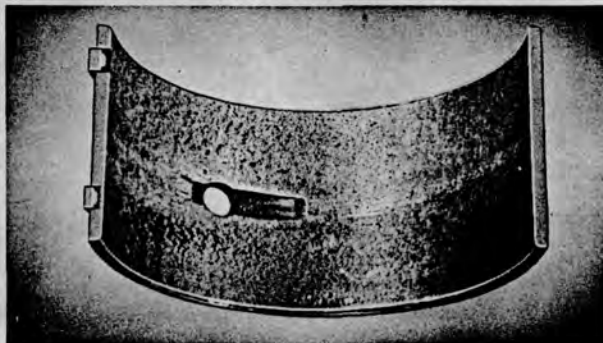


Figure 43 — Appearance of a Good Bearing



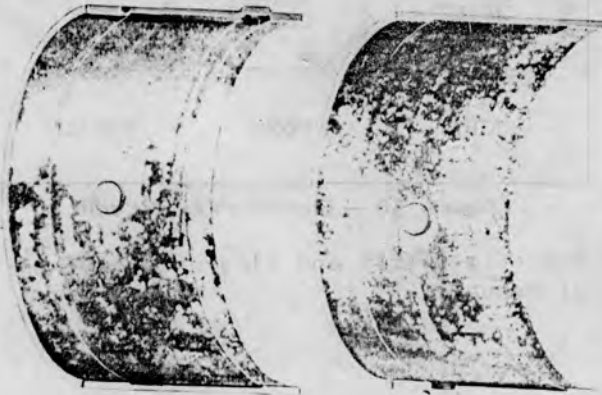


Figure 44 — Bearing Damage Due to Corrosion

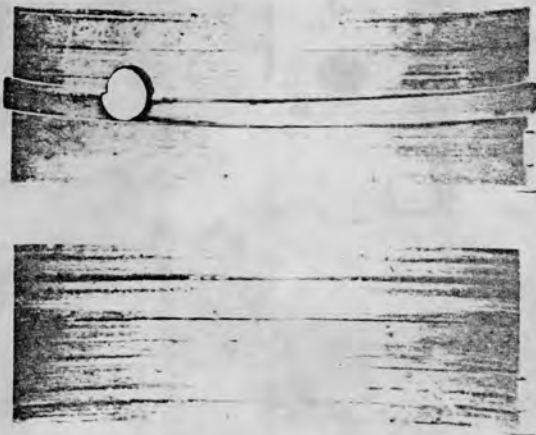


Figure 45 — Scored Bearing Due to Dirt or Lack of Oil

5. If the visual inspection appears satisfactory, they should be removed and checked for thickness using a ball micrometer.



Figure 46 — Removing Main Bearing

To remove the upper half of the bearing shell use a special tool obtainable at most parts houses, which is a pin with an angular head. It may be inserted in the oil hole of the crankshaft and as the crankshaft is turned in a clockwise direction, the head of this pin picks up the bearing shell and forces it out of the bore in the block.



Figure 47 — Measuring Bearing Thickness

The thickness of the bearing shells is given in the Limits and Clearance Chart, and if this thickness has been reduced more than .0005 beyond the maximum allowable tolerance the bearing shell must be replaced.

6. If visual inspection of the crankshaft shows no indication of excessive wear or scoring, the clearance of the feeler should be checked.



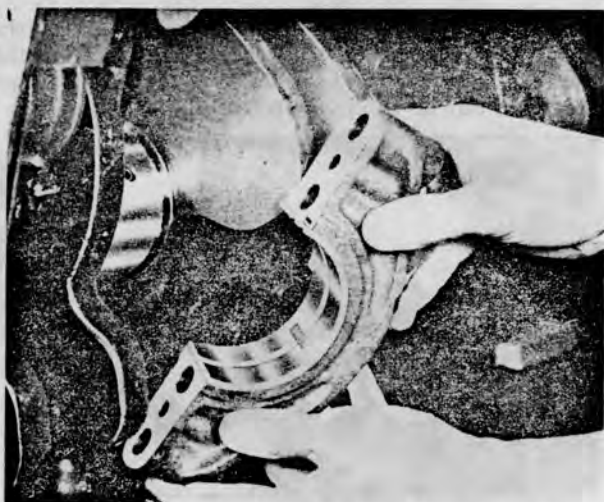
Figure 48 — Checking Bearing Clearance with Plastigauge

7. Check each bearing, one at a time, by using a piece of Plastigage of a diameter specified to check certain clearances.

By placing this Plastigage in the bearing and tightening it in place, the width of the Plastigage after crushing determines the bearing clearance as shown above.

**CAUTION**

When using this method **DO NOT TURN** the crankshaft as that would destroy the Plastigage.



**Figure 49 — Checking Bearing Clearance with Feeler Stock**

An alternative method is to use a piece of 1/2" feeler stock (the thickness of which should be equivalent to the maximum clearance permissible in the bearing) lengthwise, in the bearing shell, on a film of oil. Assemble the bearing cap and tighten the screws, torquing them to the specifications, — then try to turn the crankshaft by hand to determine whether or not you can feel a drag.

If a definite drag is felt and the piece of feeler stock is equivalent to, but no more in thickness than the maximum clearance specified, you may be sure that neither the crankshaft nor bearing are worn excessively as far as clearance is concerned.

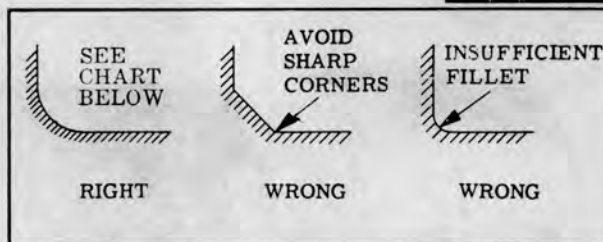
When using new bearings and the crankshaft is not worn, checking with a piece of feeler stock as outlined above should lock up the crankshaft, making it possible to turn only by use of a bar or wrench.

If crankshaft is scored, or worn enough so that new bearings will not fit with the required clearance, it should be removed and reground.

Standard crankshafts may be reground to decrease the diameter a maximum of .040.

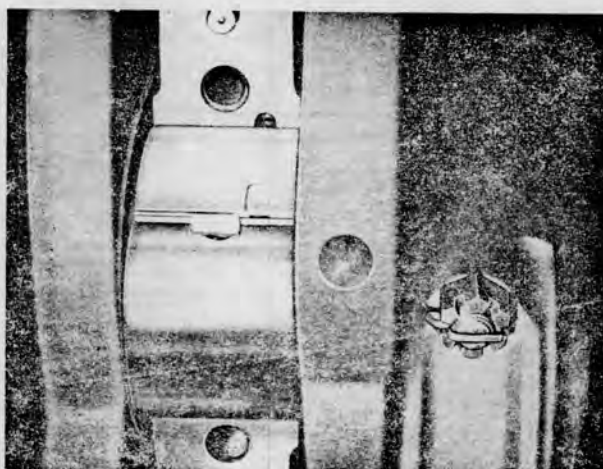
Before shaft is reground, it must be checked for straightness and straightened if necessary to be within .002 indicator reading. When reground, the fillet radii must be within dimensional limits and must be perfectly blended into thrust and bearing surfaces.

8. Connecting rod bearings and crank pins may be checked in the same manner with one exception; instead of trying to turn the crankshaft when the connecting rod bearing is tightened on it with a piece of feeler gauge assembled, try to move the connecting rod from side to side.

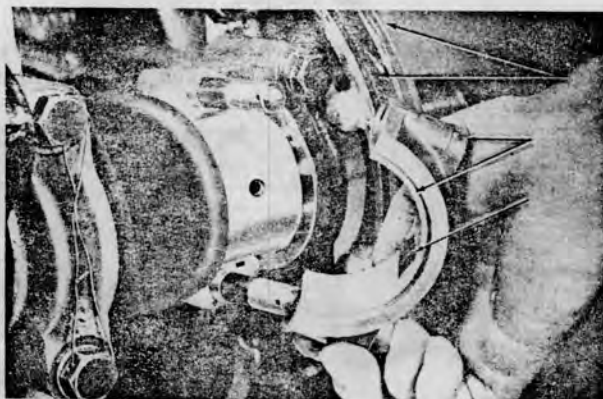


**Figure 50 — Crankshaft Fillet Radii**

Refer to Limits and Clearance in front of manual.



**Figure 51 — Replacing Bearing**



**Figure 52 — Checking Rod Bearing with Feeler Stock**

With new bearing shells and feeler stock equivalent to the specified clearance in thickness, if the crank pin is not worn you will quite probably have to use a hammer tap to move the rod from side to side, indicating that the clearance is well within the specification range.

**CAMSHAFT**

1. Using a puller, remove the cam and crank gears.

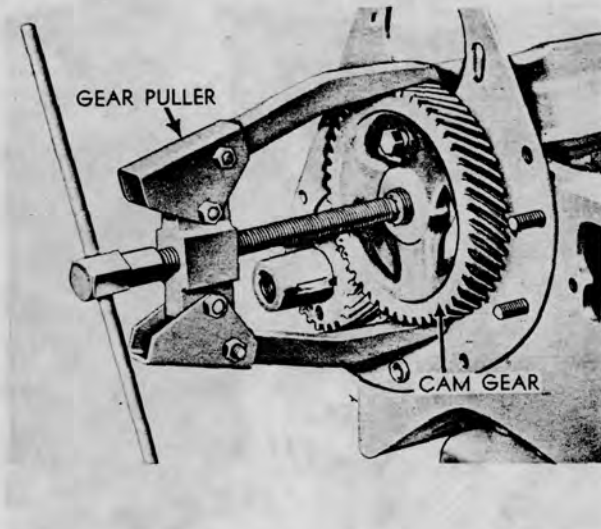


Figure 53 — Removing Cam Gear with Puller

2. Remove the screws holding the camshaft thrust plate to the front of the cylinder block, which makes it possible to pull the camshaft forward out of the bearings.

3. Unless engine is lying on its side, tappets must be removed or lifted before camshaft can be pulled.

4. Remove tappet chamber covers.

5. Tappets can then be lifted out and lined up in sequence, for installation in the same location unless inspection shows that they require replacement.

6. Before pulling the camshaft completely, check the clearance of the bearing journals in the bushing (or block in some models). To do this use strips of feeler stock 1/4" wide with edges dressed with a stone to eliminate any burrs or feathered edges.

7. If clearance is equal to or greater than the amount indicated under wear limits, check the diameter of the camshaft journals to determine the next step. Excess wear at these positions require replacement of the shaft.

If wear is found to be in the bushings instead, these must be replaced using precision service bushings, available for that purpose, which require no reaming, only care in assembly, to line up oil holes, and not to damage the bushings as they are being pressed in.

**TAPPETS**

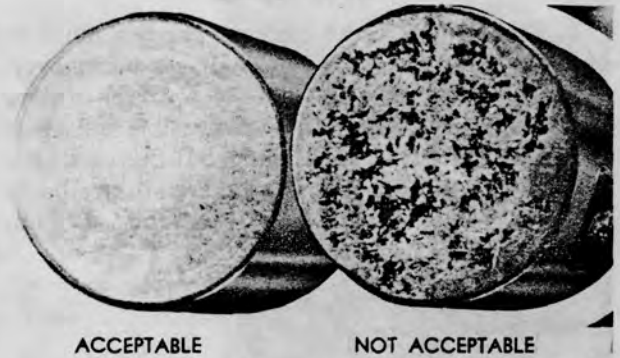


Figure 54 — Valve Tappet Wear Comparison

1. Inspect each tappet carefully. Two or more small pits on the contact face is acceptable; more than that calls for replacement of the tappet on the N, Y, F4, F6 Series.

Oversize tappets are available as required.

2. Check the outside diameter with micrometers to determine if replacement is necessary because of wear.

The tappet bore may be reamed oversize, and oversize tappets installed.

TAPPETS			
ENGINE	O. D. TAPPET	BORE IN BLOCK	TOTAL MAX. WEAR LIMITS

Refer to Limits and Clearance in front of manual.

**CAUTION — WHEN INSTALLING CAMSHAFT USE SPECIAL CARE TO PREVENT CAMSHAFT BUMPING AND LOOSENING EXPANSION PLUG TO CAUSE AN OIL LEAK**



**TIMING GEARS**

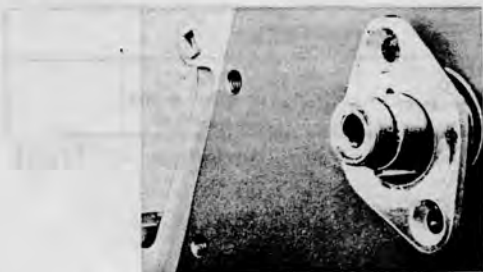
1. Timing gears and timing gear fits must be checked carefully while the engine is being overhauled. To check the fit, use a screw driver to force the mating teeth as far apart as possible and check this clearance with a feeler gauge. If this clearance is .002" or greater, or if the gear teeth are badly scuffed and worn, the gear must be replaced. Timing gears must be replaced in pairs.



**Figure 55 — Checking Timing Gear Backlash**

Gears marked same as the original as far as sizes are concerned should be used as replacements.

2. Examine the camshaft thrust plate carefully for scoring and wear and if any indication of either shows, a new thrust plate should be assembled without question.

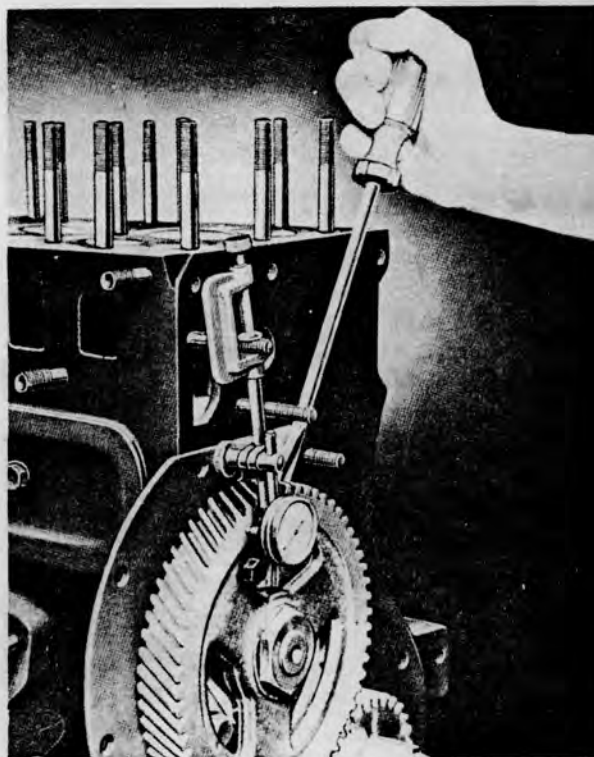


**Figure 56 — Camshaft Thrust Plate**

3. Assemble the cam gear to the camshaft by driving or pressing it on, at the same time holding the camshaft forward with a suitable bar through the fuel pump opening in the block so there is no possibility of the camshaft bumping the expansion plug at the rear end and forcing it out of position, thus causing an oil leak.

Check camshaft end play as shown in illustration. Refer to limits and clearance section for the correct dimension.

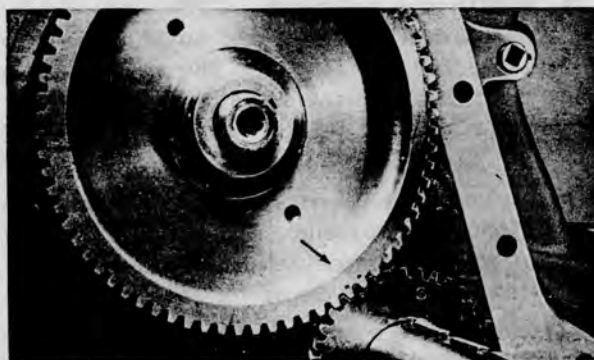
**CAUTION: NEVER USE THE CAMSHAFT NUT TO PULL THE GEAR ONTO THE CAMSHAFT.** This will break the threaded end off cast iron camshafts and damage threads on steel camshafts.



**Figure 57 — Checking Camshaft End Play**

4. Inspect crankshaft thrust washers for wear and scoring. Replace if necessary before reassembling gear.

5. Drive the crank gear on the shaft making sure that the marked teeth on the cam gear straddle the marked tooth on the crank gear, which assures you of the crankshaft and camshaft being in time.



**Figure 58 — Timing Gears Assembled According to Timing Marks**

6. Check for clearance with the above gears assembled in place, since it may be possible that it is not within specifications. Repeat the operation previously outlined. Using a screwdriver pry the teeth as far apart as possible and check the clearance with a feeler gauge. If a .0015" feeler will not enter the gap the clearance is not excessive.



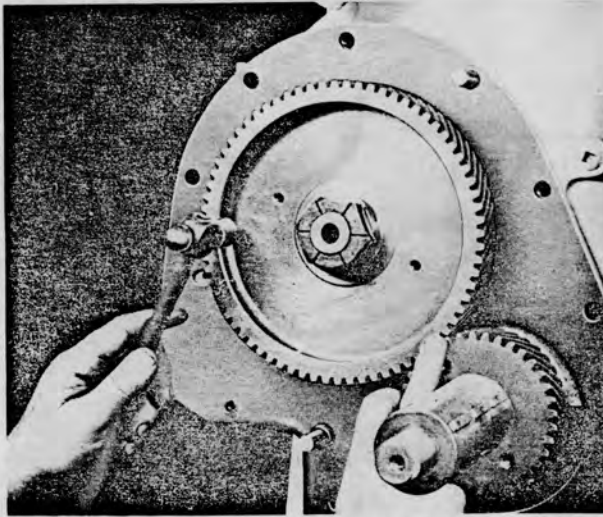


Figure 59 — Checking Gear Fit

To be certain that there is enough clearance, hold your finger at the junction of the two gears and with a light hammer tap the rim of the cam gear and note if there is vibration felt at this point.

If there is vibration and a .0015" feeler gauge will not enter the gap between the two gear teeth, the gear fit is within specifications.

7. Crankshaft gears and camshaft gears are furnished in standard and under and over sizes. Gears marked "S" are standard; if they are marked with figures "1" or "2" in a letter "U" this signifies undersize. If they are marked with figures in the letter "O" this signifies oversize.

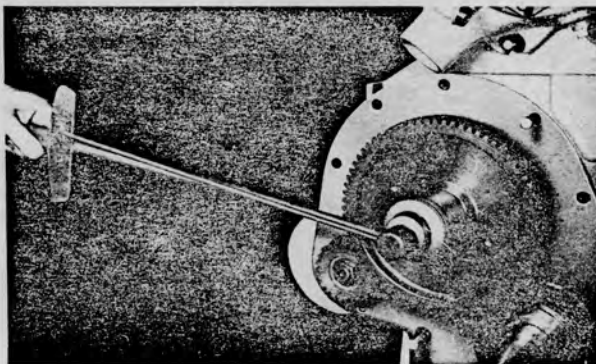


Figure 60 — Torquing Cam Gear Nut

**CRANKSHAFT END PLAY**

1. Check the crankshaft end play before replacing the gear cover. A shim pack containing shims of .002" and .008" thickness is incorporated in the assembly between the front end of the main bearing journal and the crank gear and by removing or adding shims, this end play can be corrected to fall within the specifications.

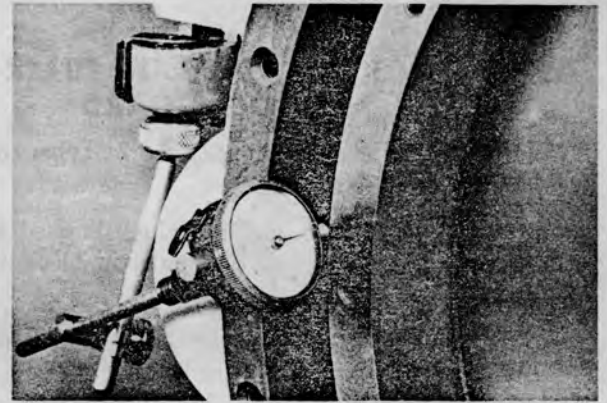


Figure 61 - Checking End Play with Indicator

**ASSEMBLING OIL SEALS IN FILLER BLOCK AND OIL GUARD**

Continental L-head engines have 2 types of crankshaft and oil pan seals.

The first type is jute packing which is used in sealing the filler block and oil guard in block to crankshaft.

The second type is a neoprene seal which is used in sealing the oil pan to the filler block.

**JUTE TYPE OIL SEALS**

First, remove the filler block and oil guard, the latter being the semi-circular die casting which fits in the cylinder block just to the rear of the rear bearing bore. Clean out the grooves thoroughly and clean the outer surface of this oil guard so as to remove all dried cement and grease.

Jute packing for crankshaft seal as it is received is approximately one-third larger in diameter than the width of the groove. To fit the grooves in the filler block, this must be crushed in a vise or flattened with a hammer on a flat surface so the jute packing is narrow enough to fit into the grooves.

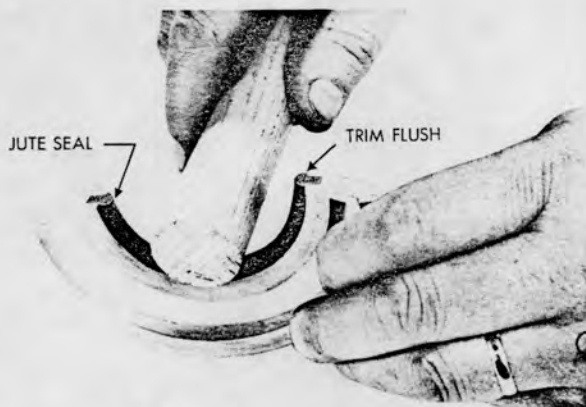


Figure 62 — Top Half of Rear Seal

Next, press it into the grooves of both the filler block and the oil guard. Then, using a piston pin, a smooth hammer handle or some other instrument with a rounded surface, iron this packing into the groove so that it is seated firmly and expanded so that it seizes the sides.

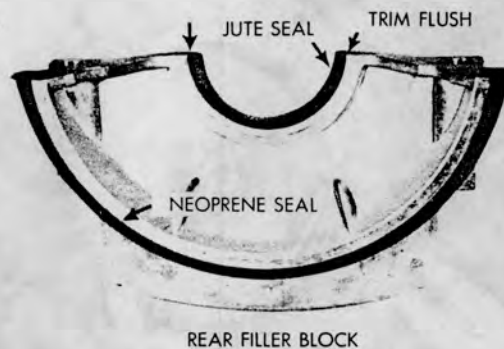


Figure 63 — Lower Half of Rear Seal

*In its present condition the packing will protrude from the grooves at either end in varying amounts. With a sharp knife, or razor blade, cut this off flush, making the cut parallel to the surface of the casting. Then slip it into place, either around the crankshaft, if the engine is still assembled, or directly into the groove if the crankshaft is out.*

**NEOPRENE OIL SEAL**

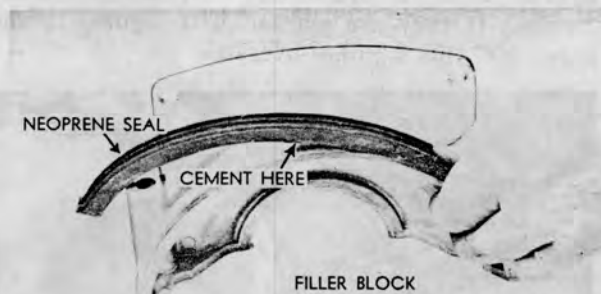
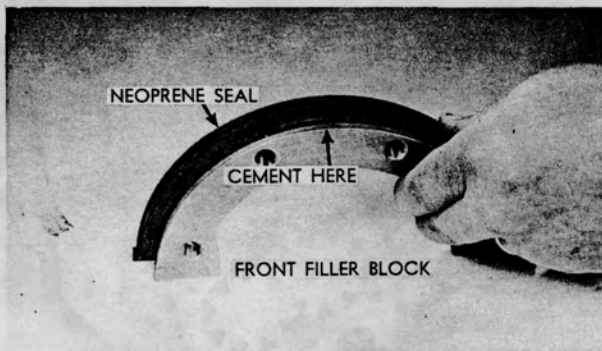


Figure 64 — Installing Neoprene Seal in Rear Filler Block

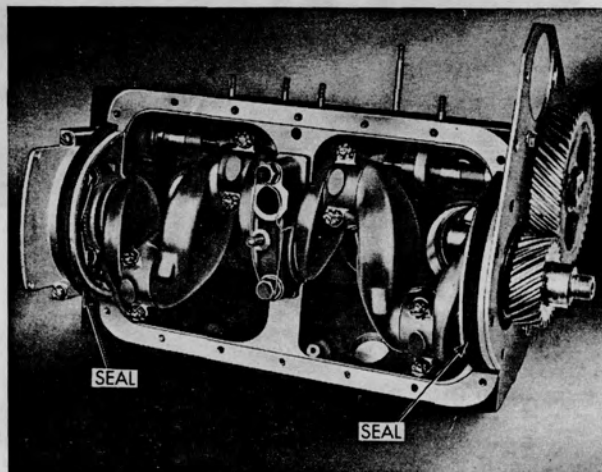
1. To replace neoprene seal, thoroughly clean all cement, dirt, and oil from the contacting surface of the filler block. To hold seal in place for assembly, use **only a small spot** of non-hardening cement in the center of the contacting surface, before inserting seal in groove. **No other cement is required.**



**Figure 65 — Installing Neoprene Seal in Front Filler Block**

2. Neoprene seal on front filler block is installed in the same manner.

When replacing gear cover, cement gasket to gear cover with a quick drying gasket cement and reassemble to engine block.



**Figure 66 — Neoprene Seals in Place**



**OIL PUMPS**

The oil pump is assembled to the center main bearing, held in position vertically against a machined pad by studs.



**Figure 67 — Oil Pump Removal**

The extended portion of the body acts as a pilot, fitting closely in a reamed hole in the main bearing web, maintaining definite relationship between the camshaft and the oil pump drive shaft.

A gear assembled to the upper end of this shaft is driven by a mating gear cut on the camshaft and drives the oil pump gear which is assembled to the lower end of the pump shaft.

The pump shaft is carried in two bronze bushings assembled in the cast iron housing, which is also a part of the oil distributing system, transmitting oil to the drilled passages.

The gear type pump has a capacity well in excess of that required by the engine.

When the pump is removed, examine the drive gear carefully for wear, inspecting the gear on the camshaft at the same time. If scored or worn badly, both the camshaft and the gear on the pump must be replaced.

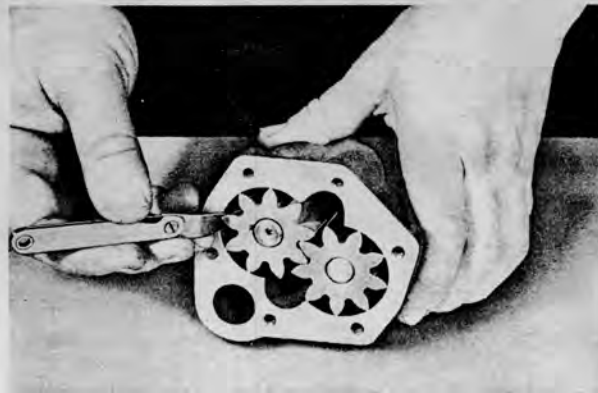
Examine the pick-up screen for clogging or damage.

Remove the cover, being careful not to damage the lead gasket which acts as a spacer as well as a gasket to seal the joint.

Examine the gears and pump body for any sign of wear indicating lack of clearance. The gears should have from .001 to .003 clearance in the chamber and should make no contact with the walls.

Inspect the cover and face of the gears for excessive wear or scoring. With the gasket assembled to the body there should be .0015 - .006 clearance between the gears and the cover.

Worn or scored gears can be replaced, as can a worn cover. If the body shows wear in the chamber, it can be replaced, but in a case like this a new pump would be the most economical.



**Figure 68 — Checking Oil Pump Gear Clearance in Body**

Engine oil pressure must be maintained to specification for satisfactory engine life.



**Figure 69 — Checking Oil Pump End Clearance**

Pressure relief is located externally on the right-hand side, near the oil pan flange at the center.

Pressure is controlled by a plunger and spring, the latter specifically for a certain range. The only adjustment variation is either to change springs or assemble or remove washers from behind the present spring. Up to four washers are permissible.



**Figure 70 — Oil Pressure Relief Valve**



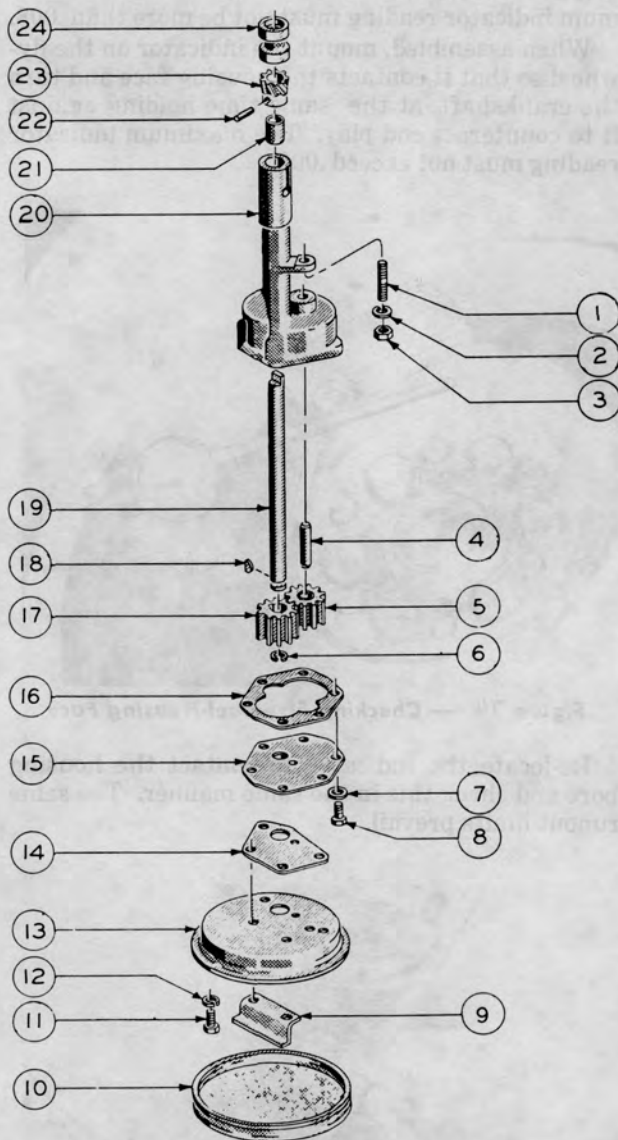


Figure 71 — Typical Oil Pump

- |                 |                      |
|-----------------|----------------------|
| 1. Stud         | 13. Frame — oil pump |
| 2. Washer       | screen               |
| 3. Nut          | 14. Gasket           |
| 4. Stud         | 15. Cover — oil pump |
| 5. Gear — idler | 16. Gasket           |
| 6. Snap ring    | 17. Gear — driver    |
| 7. Washer       | 18. Key              |
| 8. Screw        | 19. Drive shaft      |
| 9. Spacer       | 20. Body assembly    |
| 10. Screen      | 21. Bushing          |
| 11. Screw       | 22. Pin              |
| 12. Washer      | 23. Gear             |
|                 | 24. Bushing          |

**CAUTION**

On several models of our L-Head engines, a 1/8" flat spacer washer is used between the oil pump mounting lug and the center main bearing cap. When reassembling, be **SURE** that this washer is placed on the oil pump mounting stud before the oil pump is installed in place. Failure to do this will cause interference between oil pump and camshaft and will not allow the distributor drive to mesh correctly.

**NOTE**

When replacing oil pump drive gear (Item 23, Fig. 171) it is necessary to line up the hole in the gear with the hole in shaft and drill through the other half of the gear before pinning in place.

**FLYWHEEL AND FLYWHEEL HOUSING**

The flywheel is machined and balanced so that the clutch face and locating counterbore will run true with its axis.

To be sure that the crankshaft flange has not been sprung or otherwise damaged or that the counterbore in the flywheel, which locates it on the crankshaft, is not damaged, mount an indicator on the flywheel housing and check the flywheel for runout. Caution: When checking runout remove spark plugs to allow engine to be turned over freely.

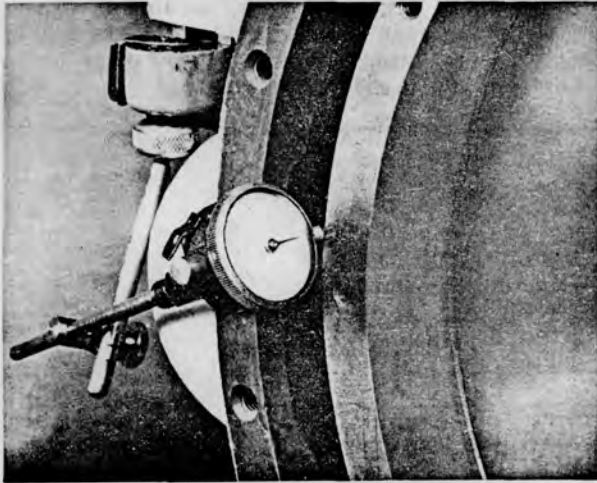


Figure 72 — Checking Flywheel Run-Out

The indicator should be set up so that it contacts the clutch face or the vertical surface of the clutch counterbore, then turn the flywheel at least one full revolution at the same time holding against the crankshaft to offset the possibility of end play.

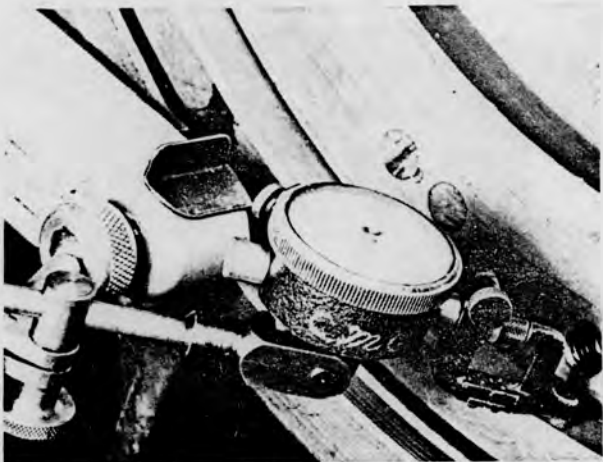


Figure 73 — Checking Flywheel Counterbore

Excessive runout of the flywheel, in either position, is probably caused by dirt in or damage to counterbore locating the flywheel on the crankshaft flange.

Re-locate the indicator to check the inside diameter of the counterbore. In both cases the maximum indicator reading must not be more than .008.

When assembled, mount the indicator on the flywheel so that it contacts the housing face and turn the crankshaft, at the same time holding against it to counteract end play. The maximum indicator reading must not exceed .008.

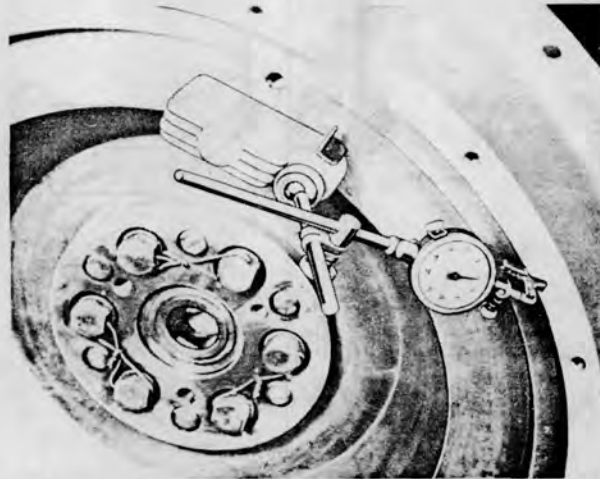


Figure 74 — Checking Flywheel Housing Face

Re-locate the indicator to contact the housing bore and check this in the same manner. The same runout limits prevail.

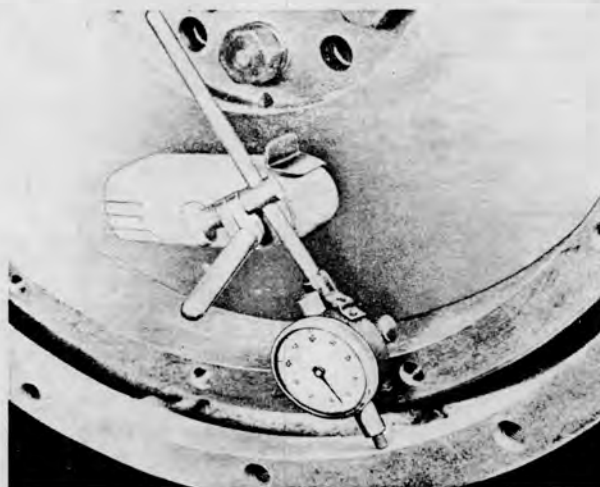


Figure 75 — Checking Housing Bore

If more than one engine is being rebuilt at a time, the housing should be identified with its original cylinder block and should be reassembled to that block in the rebuilding process.

**REASSEMBLING ENGINE**

In the foregoing, we have outlined procedures for checking, repairing or replacing the many wearing parts in the engine.

In most cases, the instructions have covered the reassembly of parts or subassemblies made up of several parts.

When reassembling pistons and connecting rods, use a good ring compressor and oil the bores thoroughly. A hammer handle may be used to bump the pistons out of the ring compressor into the cylinder bore.

Once more, we call attention to care demanded to prevent connecting rods damaging the cylinder bore finish and at the same time as they are assembled over the crank pin, locate them carefully in order to protect the bearing surfaces.

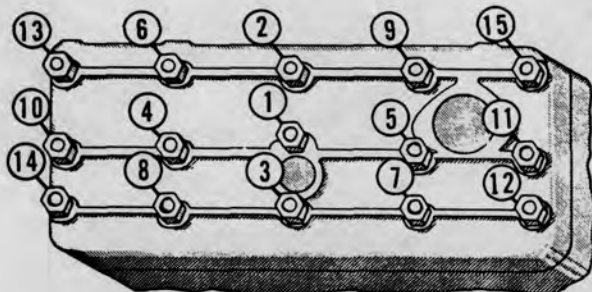
Always lubricate the bearings with clean engine oil when assembling, and tighten them to the torque specified. Use lockwires, cotter pins or lockwashers as required to prevent nuts and screws from loosening.

Clean cylinder head and block surfaces thoroughly before installing gasket. Tighten all cylinder heads or cap screws evenly and torque in following sequence to the recommended torque.

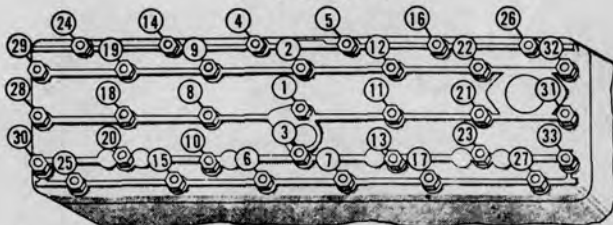
Before assembling the oil pan with new gaskets make certain that gasket surfaces are flat and clean. Tighten screws in accordance with limits prescribed in torque chart — to avoid looseness or overstressing.

**Torque Specifications for Cylinder Head Tightening Sequence in Foot Pounds**

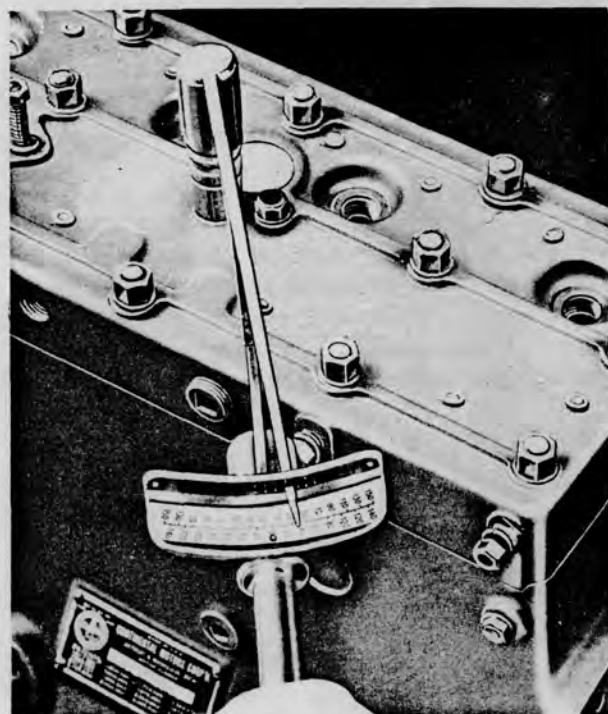
Size - Diameter	$\frac{3}{8}$ "	$\frac{7}{16}$ "	$\frac{1}{2}$ "	$\frac{9}{16}$ "	$\frac{5}{8}$ "
Cylinder Heads	35-40	70-75	100-110	130-140	145-155



**Figure 76 — Cylinder Head Tightening Sequence — Four Cylinder**

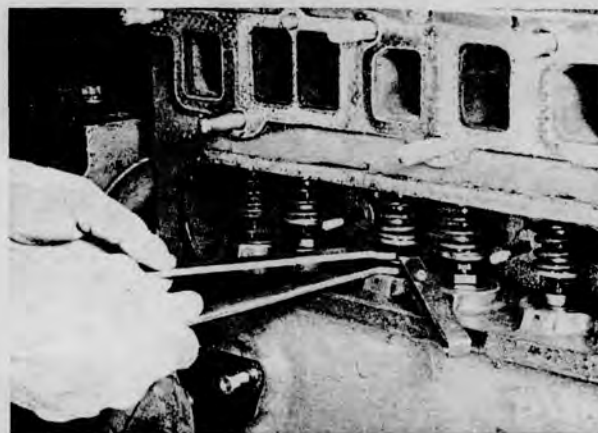


**Figure 77 — Cylinder Head Tightening Sequence — Six Cylinder**



**Figure 78**

When engine is completely assembled and filled with proper oil, (See Lubrication Sec.) set tappets and refer to Engine Limits and Clearance Data.



**Figure 78 — Setting Tappets**



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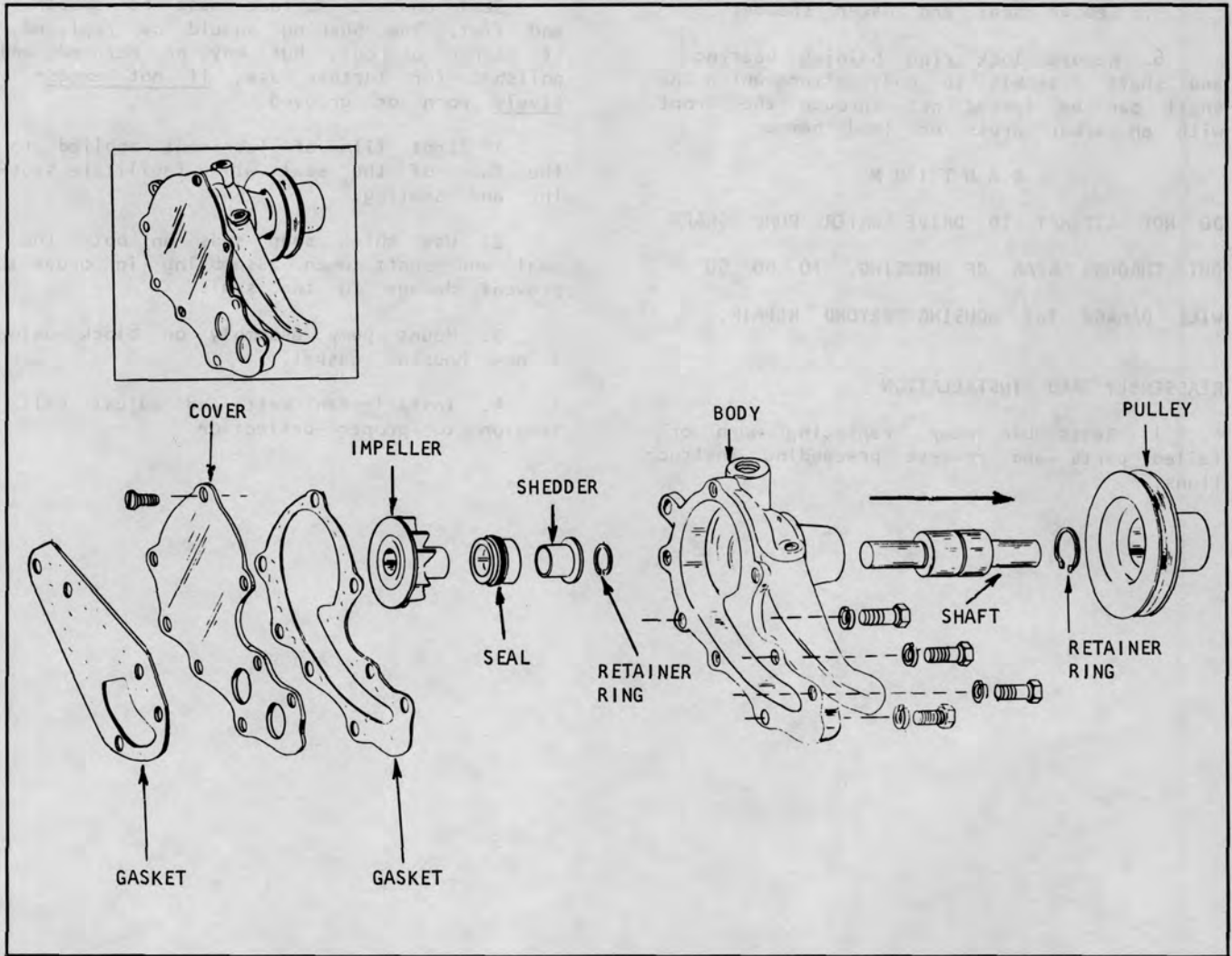


Plate 6992. Water Pump Components

No lubrication of the pump is required as the bearings are of the permanently sealed type and are packed with lubricant for the life of the bearing.

Check bearings for excessive looseness. If a water leak develops, a damaged or badly worn seal needs replacement.

The water pump assembly can be removed from the engine as a unit for service or repair in the following manner:

1. Remove fan by taking out cap screws.
2. Loosen generator and fan belt adjusting bracket, (if so equipped) retainer bolts so that belts can be slacked off enough to slide over pulley.

3. Remove nuts and lockwashers holding the pump body to the front of the block and remove the pump assembly.

**DISASSEMBLY OF WATER PUMP**

Disassembly must be in the following sequence in order to prevent damage to the pump.

1. Before removing pump, use puller to remove pulley from shaft.
2. Remove cap screws attaching pump to engine.
3. Remove countersunk screws holding cover. Remove cover and gasket.
4. Use puller to remove impeller taking precautions to prevent damage to the casting.



**SECTION VII  
FUEL SYSTEM**

**DESCRIPTION**

The fuel system consists of a main fuel tank, fuel filter, air cleaner, fuel lines, carburetor and fuel pump. For fuel tank capacity see machine specifications in the front of this manual.

**CARBURETOR**

The carburetor is a jet, one venturi updraft type. It is mounted to the intake manifold on the left side of the engine. There are five systems that comprise the carburetor operation: the fuel supply system, the idle system, the high speed system, the economizer system and the choke system.

The fuel supply system is made up of the threaded fuel inlet, the fuel valve seat, fuel valve, float and fuel bowl.

The idle system consists of two idle discharge ports, idle air passage, idle adjusting needle, idle jet, fuel passage, and idle air bleed.

The high speed system controls the fuel mixture and part throttle speeds and at wide open throttle. This system consists of a venturi, controlling the maximum volume of air admitted into the engine; the main jet, which regulates the flow of fuel from the float chamber to the main discharge jet; the well vent which maintains uniform mixture ratio under changing suction and engine speeds; and a discharge jet, which delivers the fuel into the air stream.

The economizer system consists of a "milled" slot in the throttle shaft, which acts as a valve to open or close the system; a vacuum passage from the throttle bore to the slot in the throttle shaft; and a vacuum passage from the slot in the throttle shaft to the fuel bowl vent channel.

The choke system consists of a valve mounted on a shaft located in the air entrance and operated externally by a lever mounted on the shaft. The choke valve is used to restrict the air entering the carburetor. This increases the suction on the jets when starting the engine. The choke valve is of a semi-automatic type, having a poppet valve incorporated in its design, which is controlled by a spring.

**CARBURETOR ADJUSTMENT**  
(See Figure 1)

Warm engine to normal operating temperature and let idle at normal idling speed. To make the fuel mixture richer; turn mixture adjusting needle, figure 1, counterclockwise; and to lean mixture, turn in a clockwise direction. To get correct mixture tighten needle screw until engine runs rough, then let off on adjusting needle until engine starts to "Lope", Note the position of the needle, The correct setting will be half way between these two points.

**CARBURETOR REMOVAL**

Remove cotter key from accelerator rod at throttle arm and pull rod from throttle arm hole.

Remove the air cleaner to the carburetor hose.

Disconnect choke control.

Disconnect fuel pump to carburetor line.

Remove two nuts and lockwashers at the manifold to carburetor flange and withdraw carburetor from machine.

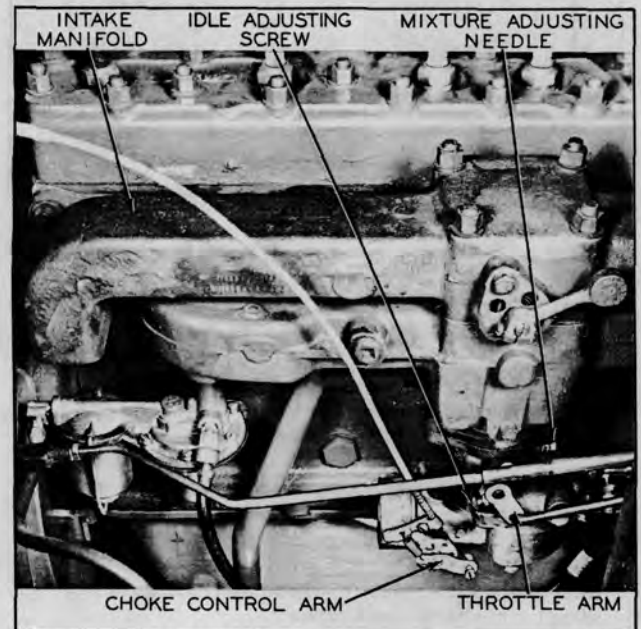


Figure 1. Carburetor

In event of disassembly, refer to an exploded view of the carburetor in the Parts Section of this manual.

**CARBURETOR MAINTENANCE AND INSPECTION**

Clean all metal parts thoroughly with cleaning solution and rinse in solvent.

Blow out all passages in the air intake and fuel bowl assembly and throttle body.

**NOTE**

Be sure all carbon deposits have been removed from throttle bore and idle port.

It is advisable to reverse flow of compressed air in all passages to insure that all dirt has been removed. NEVER use a wire or drill to clean out jets.



Replace float assembly if loaded with gasoline, damaged, or if float axle bearing is worn excessively. Inspect top side of float lever for wear where it contacts fuel valve needle.

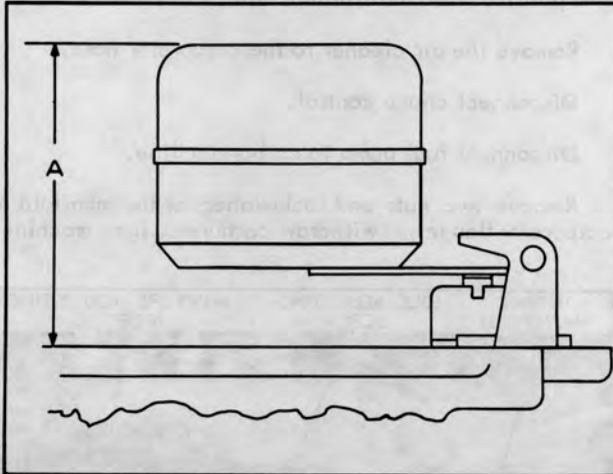


Figure 2. Setting Float Level

Replace the float axle if any wear can be visually detected on the bearing surface.

Always replace fuel valve seat and needle because both parts wear and may cause improper float level.

Idle adjusting needle point must be smooth and free of ridges.

Inspect throttle plate for burrs or damaged edges. Never clean with a buffing wheel or sharp instrument.

Inspect air shutter for bends, butts or damaged edges.

Check air shutter shaft bearing surface for wear - see that shaft is straight.

Replace all gaskets and fibre washers every time carburetor is disassembled.

**N O T E**

Replacement parts must be of the same part number and specifications.

Check float level with throttle body in an inverted position, measure level from machined surface of body to top of float at highest point. The measurement, "A" figure 2, should be  $1\ 5/32'' \pm 1/32''$ . To increase or decrease measurement, bend float close to float body.

**CLEANING PARTS**

Clean all metal parts thoroughly with cleaning solution and rinse in solvent. Blow out all passages in the air intake and fuel bowl casting and throttle body.

**N O T E**

Be sure all carbon deposits have been removed from throttle bore and idle port. It is advisable to reverse flow of compressed air in all passages to insure that all dirt has been removed. Never use a wire or drill to clean out jets.

**DISASSEMBLED VIEW**

Disassembly of the carburetor is not recommended except by experienced mechanics. The disassembled view will identify the various component parts and show their relation to assembly. Use the disassembled view with the identifying part numbers to identify and locate parts when performing the disassembly and reassembly operations.



CARBURETOR  
OPERATION SCHEMATIC

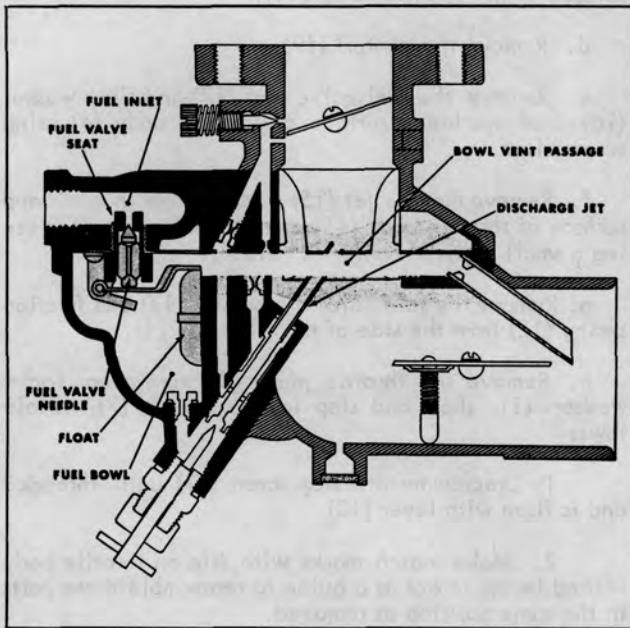


Figure 5. Fuel Supply System

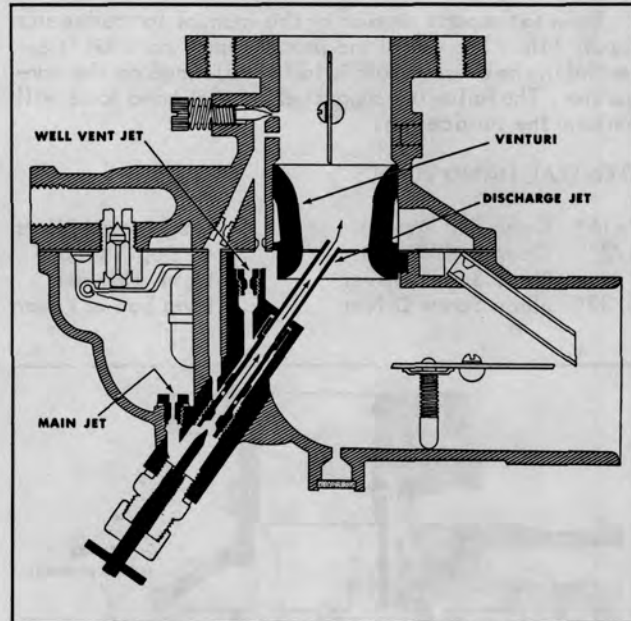


Figure 7. High Speed System

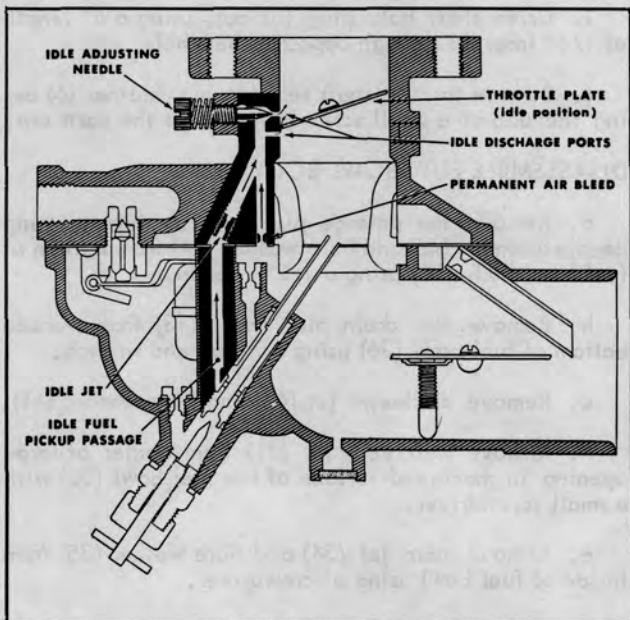


Figure 6. Idle System

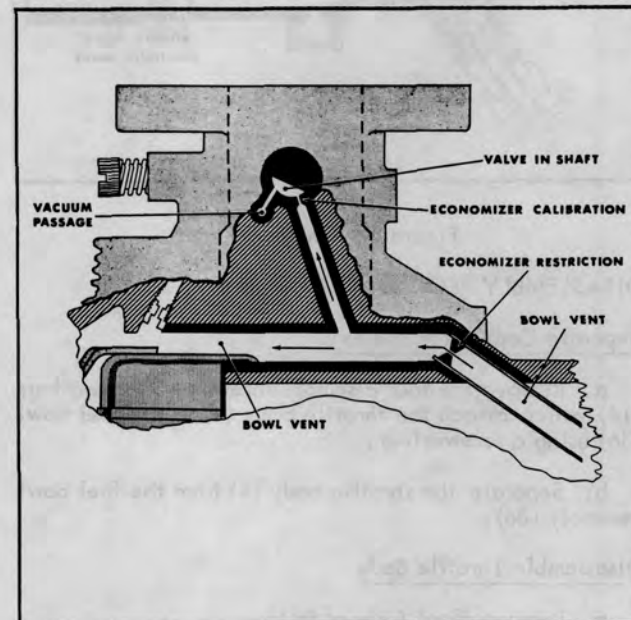


Figure 8. Back Suction Economizer System

cept by experienced mechanics. The disassembled view will identify the various component parts and show their relation to assembly. Use the disassembled view with the identifying part numbers to identify and locate parts when performing the disassembly and reassembly operations.

**REPAIR PARTS**

Refer to the parts section of this manual for carburetor repair kits. The use of the proper repair parts kit is essential in the event repair is to be performed on the carburetor. The following suggested general hand tools will perform the service job.

**GENERAL HAND TOOLS**

- |                          |                   |
|--------------------------|-------------------|
| 7/16" Open End Wrench    | Long Nosed Pliers |
| 1/2" Open End Wrench     | 6" Depth Gauge    |
| 1/4" Blade Screw Driver  | Light Hammer      |
| 5/32" Blade Screw Driver | Long Rod or Punch |

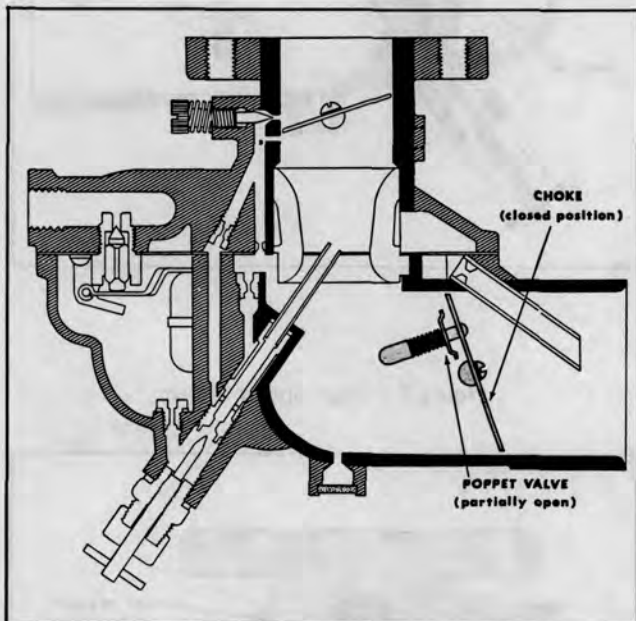


Figure 9. Choke System

**DISASSEMBLY PROCEDURE**

Separate Carburetor Bodies

- a. Remove the four assembly screws and lockwashers (14) which attach the throttle body (4) to the fuel bowl (36) using a screwdriver.
- b. Separate the throttle body (4) from the fuel bowl assembly (36).

Disassemble Throttle Body

a. Remove Float Axle as follows:

1. Press screwdriver against float axle (21) at slotted side of float hinge bracket and force through

hinge bracket.

2. Remove float axle (21) completely with fingers from opposite side and remove float (20).

b. Remove fuel valve needle (17).

- c. Remove the assembly gasket (18) from the machined surface of the throttle body (14).

d. Remove the venturi (19).

- e. Remove the fuel valve seat (17) and fibre washer (16) from machined surface of throttle body (4) using screwdriver.

- f. Remove the idle jet (15) from passage in machined surface of throttle body (4) near fuel valve seat (17) using a small screwdriver (5/32" blade).

- g. Remove the idle adjusting needle (13) and friction spring (12) from the side of throttle body (4).

- h. Remove the throttle plate (2), screws and lockwashers (1), shaft and stop lever assembly (7), as follows:

1. Unscrew throttle stop screw (11) until threaded end is flush with lever (10).

2. Make match marks with file on throttle body (4) and levers to act as a guide to reassemble these parts in the same position as removed.

3. Remove the screws (1) and remove the throttle plate (2).

4. Remove the throttle shaft and stop lever assembly (7) from the throttle body (4).

- i. Drive shaft hole plug (3) out, using a 6" length of 1/4" inserted through opposite shaft hole.

- j. Remove throttle shaft seal (5) and retainer (6) using the end of a small screwdriver to lift the parts out.

**DISASSEMBLE FUEL BOWL BODY**

- a. Remove the passage plug or main jet adjusting needle assembly (45) and fibre washer (44) from bottom of fuel bowl body (36) using a 1/2" wrench.

- b. Remove the drain plug (hex) (43) from outside bottom of fuel bowl (36) using a 7/16" end wrench.

- c. Remove discharge jet (42) and fibre washer (41).

- d. Remove well vent jet (31) from center of large opening in machined surface of the fuel bowl (36) with a small screwdriver.

- e. Remove main jet (34) and fibre washer (35) from inside of fuel bowl using a screwdriver.

f. Disassemble choke as follows:

1. Make match marks with a file or prick punch on choke bracket (28), choke lever (23) and adjacent

shaft boss as an aid to correct reassembly.

2. Remove choke lever spring (22).
3. Remove choke plate screws and lockwashers (37).
4. Remove the choke plate (38) and choke shaft and lever (23).

### NOTE

In some cases it may be necessary to bend the bowl vent tube up a very little to give the choke clearance. (Use a screw driver inserted in the tube.)

5. Remove bracket assembly screws (29), packing washer (33) and choke bracket (28).
6. Remove choke shaft hole plug (39), packing washer (33) and retainer (32) using method suggested in throttle body disassembly section "Disassembly Throttle Body", items "i" and "j".

### REASSEMBLY

#### Fuel Bowl Body

a. Install the choke shaft hole plug (39), packing (33) and retainer (32) in fuel bowl body (36) as follows:

1. Assemble packing (33) and retainer (32) and place completed assembly on bushing driver with packing facing small end of tool.
2. Start retainer (32) into counter bore in body (36) and lightly drive retainer into body until it is flush with machine surface.
3. Install shaft hole plug (39) with hammer.

b. Reassemble choke parts as follows:

1. Refer to match marks for correct position and install choke bracket (28), screws (29) and lockwashers (30).
2. Start the choke plate (38), poppet valve first and stem down, into the air intake.
3. Hold the choke plate up and insert the choke shaft (23) into place with cut-out section facing up.
4. Rotate the shaft to the closed position, place the choke plate in the cut-out section and install the screws (37). (Be sure the plate is properly centered before tightening the screws).
5. Install lever spring (22) to return the choke to the wide open position.

c. Install main jet (34) and fibre washer (35) in the fuel bowl, using a screwdriver.

d. Install well vent jet (31) in fuel bowl (36) and tighten with a small screwdriver.

e. Install discharge jet (42) and fibre washer (41)

in large threaded passage beneath the fuel bowl.

f. Install the drain plug (43) in threaded passage, bottom of fuel bowl, using a 7/16" end wrench.

g. Install main jet adjustment or passage plug (45) and fibre washer (44) using a 1/2" wrench.

#### Throttle Body

a. Install throttle shaft hole plug (3) in the side opposite the stop pin using a light hammer to drive it into place flush with the boss.

b. Install throttle shaft seal (5), open side out, followed by retainer (6), using fingers only.

c. Install the throttle shaft and stop lever assembly (7), throttle (2), screws (1) as follows:

1. Insert the throttle shaft and stop lever assembly in throttle body.

### NOTE

Be sure stop (11) is backed out far enough to permit complete closing of throttle.

2. Rotate throttle shaft to closed position, insert throttle plate in the cut-out section of the shaft, holding the plate in position with fingers.

3. Start throttle plate screws and tighten with small screwdriver, being sure that the throttle plate is properly centered in the throttle body bore.

### NOTE

The screw holes in the throttle plate are off center. Start the side of the throttle plate with the shortest distance between the screw holes and beveled edge into place first. The throttle plates are made with two opposite edges beveled to fit the throttle body bore when the plate is closed. The throttle plate will not close tightly if installed upside down. Pressure on the plate must be maintained with the finger until the screws are tightened. When properly installed, the side of the throttle plate farthest away from the mounting flange will be aligned with the idle port when the plate is closed.

d. Install idle adjusting needle (13) and friction spring (12) in threaded passage on side of throttle body. Seat lightly with screwdriver and back out 1-1/4 full turns as preliminary adjustment.

e. Install idle jet (15) in counter-bored passage in machined surface.

f. Install fuel valve seat (17) and fibre washer (16) using wrench.

g. Place new throttle body to fuel bowl gasket (18) on machined surface of fuel bowl cover.

h. Install fuel valve needle (17) in seat followed by float (20) and float axle (21).

i. Float Level. Check position of float assembly for





# MASTER MAINTENANCE MANUAL



correct measurement to obtain proper float level using a depth gauge. The "A" dimension should be 1-5/32" plus or minus 1/32", see Figure 2.

1. With bowl cover assembly (4) in an inverted position, viewed from free end of float the float bodies must be centered and at right angles to the machined surface. The float setting is measured from the machined surface (no gasket) of cover to top side of float bodies at highest point.

2. Bending Float Lever. To increase or decrease distance between float body and machine surface use long nosed pliers and bend lever close to float body.

### NOTE

REPLACE WITH NEW FLOAT IF POSITION IS OFF

MORE THAN 1/16".

j. Insert venturi (19) in fuel bowl bore, small opening down.

### NOTE

THE FLAT SIDE OF VENTURI MUST BE TOWARD THE

WELL VENT JET (31).

### Assemble Carburetor Bodies

a. Assemble the two completed bodies and four screws and lockwashers (14) and tighten screws evenly and firmly.

b. Hold the throttle lever in a closed position and turn the throttle stop screw (11) in until it just contacts the stop pin, then turn screw in 1-1/2 additional turns as a preliminary adjustment of the idle speed.



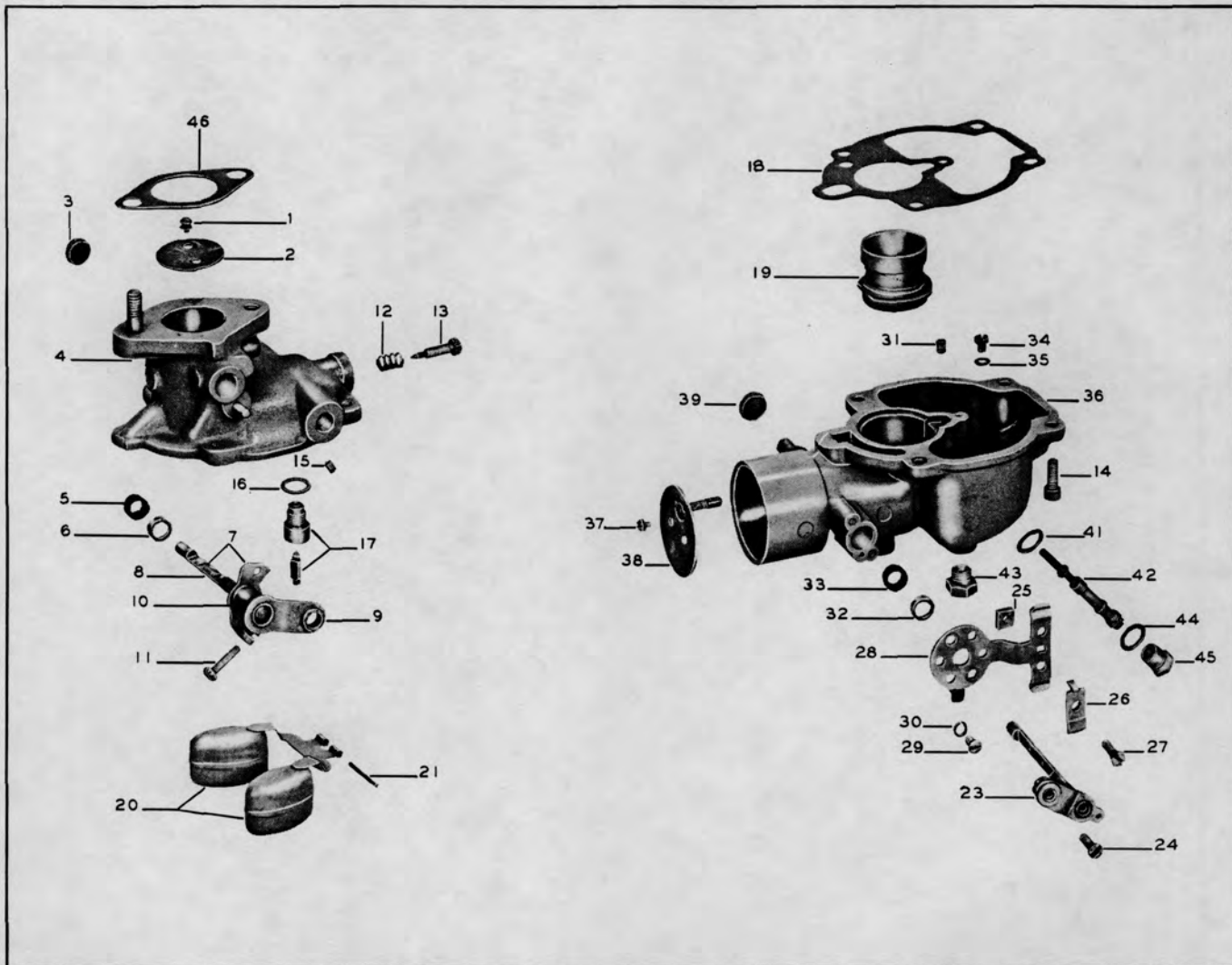


Figure 10. Carburetor

- |   |  |
|---|--|
| 1. Screws and Lockwashers, Throttle Plate | 24. Screw, Swivel                      |
| 2. Throttle Plate                         | 25. Clamp Screw Nut                    |
| 3. Shaft Hole Plug                        | 26. Clamp Cable                        |
| 4. Throttle Body                          | 27. Cable Clamp Screw                  |
| 5. Throttle Shaft Seal                    | 28. Choke Bracket                      |
| 6. Retainer, Throttle Shaft Seal          | 29. Bracket Assembly Screws            |
| 7. Shaft and Stop Lever Assembly          | 30. Lockwashers, Bracket Screw         |
| 8. Throttle Shaft                         | 31. Well Vent Jet                      |
| 9. Lever                                  | 32. Packing Washer Retainer            |
| 10. Lever Pin                             | 33. Packing Washer                     |
| 11. Stop Screw                            | 34. Main Jet                           |
| 12. Friction Spring                       | 35. Fibre Washer                       |
| 13. Idle Adjusting Needle                 | 36. Fuel Bowl                          |
| 14. Assembly Screws & Lockwashers         | 37. Choke Plate Screws & Lockwashers   |
| 15. Idle Jet                              | 38. Choke Plate                        |
| 16. Fibre Washer                          | 39. Choke Shaft Hole Plug              |
| 17. Fuel Valve Needle and Seat            | 40. Plug                               |
| 18. Assemble Gasket                       | 41. Fibre Washer, Discharge Jet        |
| 19. Venturi                               | 42. Discharge Jet                      |
| 20. Float                                 | 43. Drain Plug (Hex)                   |
| 21. Float Axle                            | 44. Fibre Washer, Pressure Plug        |
| 22. Choke Lever Spring (Not Shown)        | 45. Main Jet Adjusting Needle Assembly |
| 23. Choke Lever and Shaft                 | 46. Gasket                             |



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TYPICAL FUEL PUMPS — DIAPHRAGM TYPE

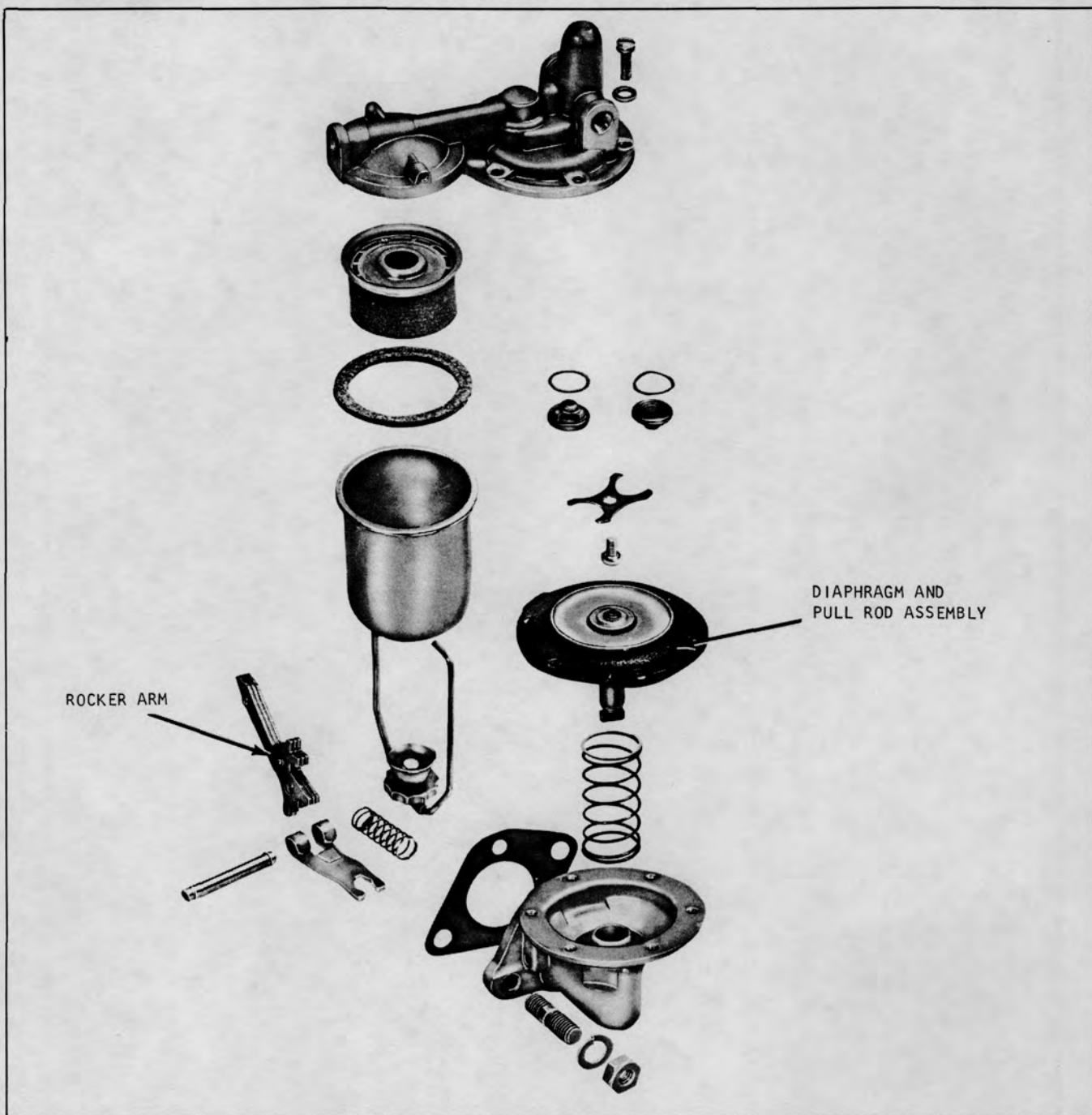


Plate 6978. Fuel Pump

Before disassembling any pump, scribe a mark across the housings in such a manner that they may be reassembled with inlet and outlet fitting holes in correct location.

When disassembled, clean all parts (except diaphragms) in solvent and blow dry with compressed air. Examine the diaphragm for cracks, torn screw holes or

ruptures. If deteriorated, install new diaphragm and pull rod assembly. Check the strainer screen and if found to be corroded or clogged, install a new screen. Check rocker arm for wear or scoring or that portion that contacts the camshaft eccentric. If arm is scored or worn install a new one.

When reassembling a pump, do not use shellac or other adhesive on a diaphragm.



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OVERHAUL OF TRANSMISSION ASSEMBLY

The instructions contained herein cover the disassembly and reassembly of the transmission in a sequence that would normally be followed after the unit has been removed from the machine and is to be completely overhauled.

**CAUTION:** Cleanliness is of extreme importance and an absolute must in the repair and overhaul of this unit. Before attempting any repairs, the exterior of the unit must be thoroughly cleaned to prevent the possibility of dirt and foreign matter entering the mechanism.

DISASSEMBLY OF THE TRANSMISSION

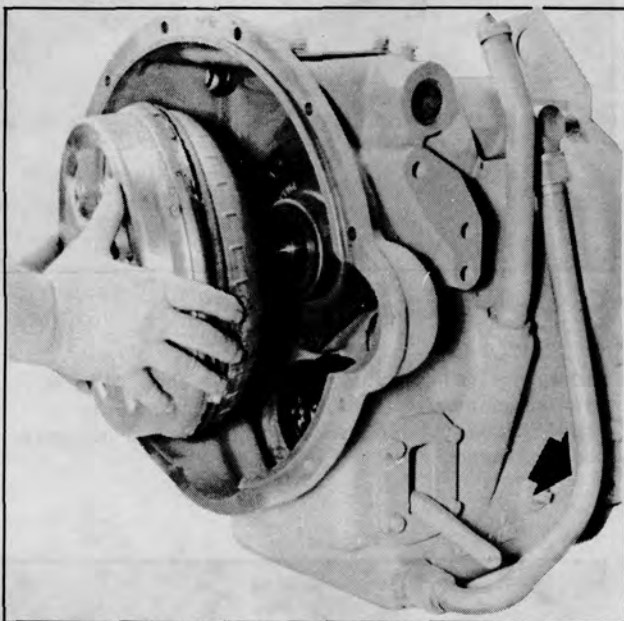


Plate 8010.

Remove inlet line by disconnecting the fittings at the convertor pump and at the sump strainer.

Remove torque convertor from input shaft and stator support. Carefully slide the convertor off the splines keeping it in alignment to prevent damage to the convertor hub bushing.

**NOTE:** Components of the torque convertor (exclusive of the Drive Plate) are not serviced separately. If any of the parts show excessive wear the convertor should be discarded and replaced with a new unit when the transmission is reassembled.

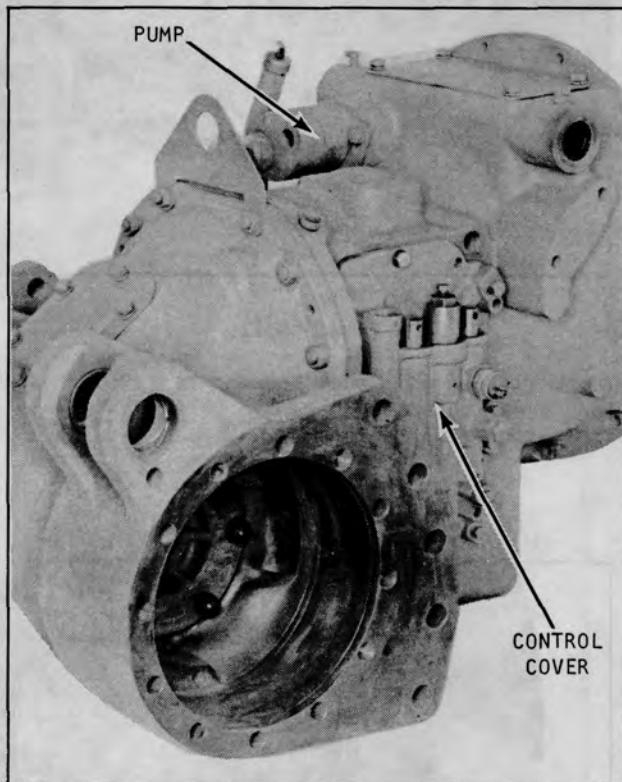


Plate 8011.

Remove control cover retaining capscrews and remove cover, gasket and "O" rings.

Remove the two capscrews and washers from the convertor pump. Remove pump from housing.

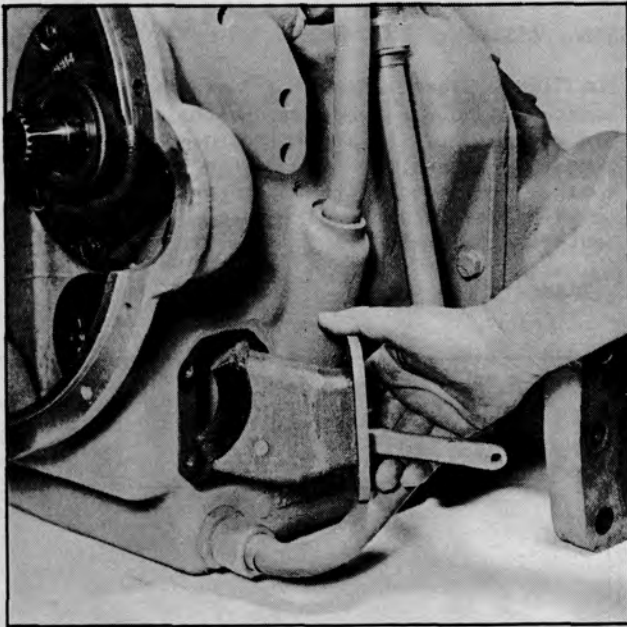


Plate 8012.

Remove cap screws and lock washers from parking brake assembly. Remove brake assembly from converter housing.

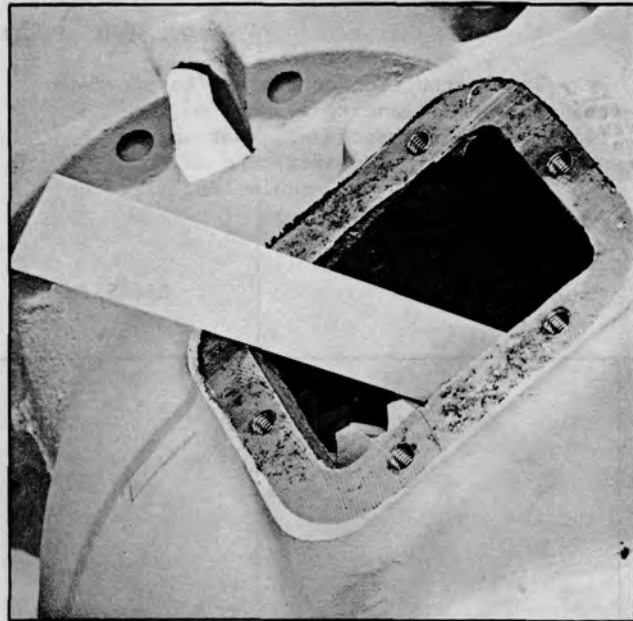


Plate 9594.

Insert a soft brass rod between the ring and pinion gears. This will prevent the output shaft from turning so the brake drum nut may be loosened.

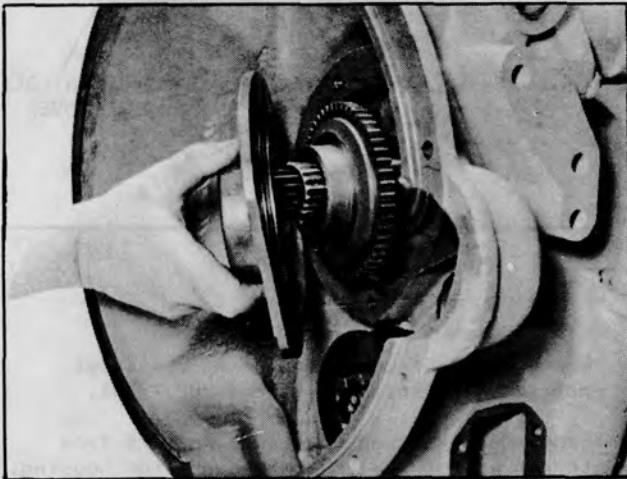


Plate 8013.

Remove cap screws and lock washers from converter pump gear cover. Remove cover and pump gear.

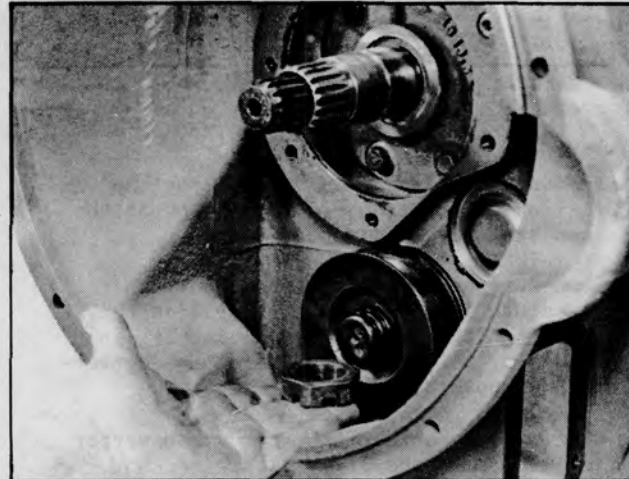


Plate 8015.

Remove brake drum nut and "O" rings. Remove brake drum with a suitable puller.

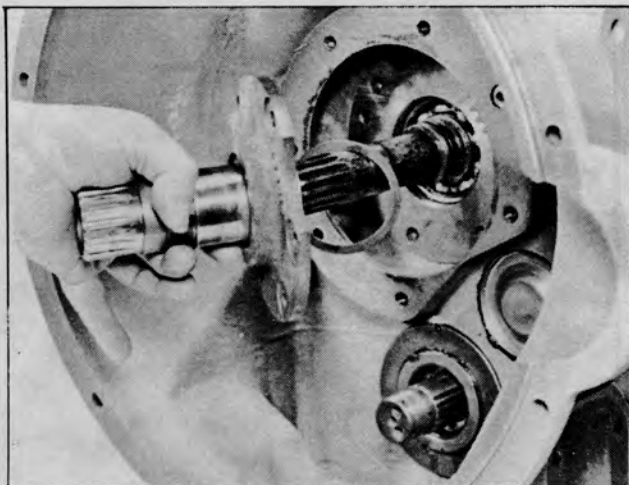


Plate 8016.

Remove capscrews and lockwashers from stator support. Remove stator support and washer.

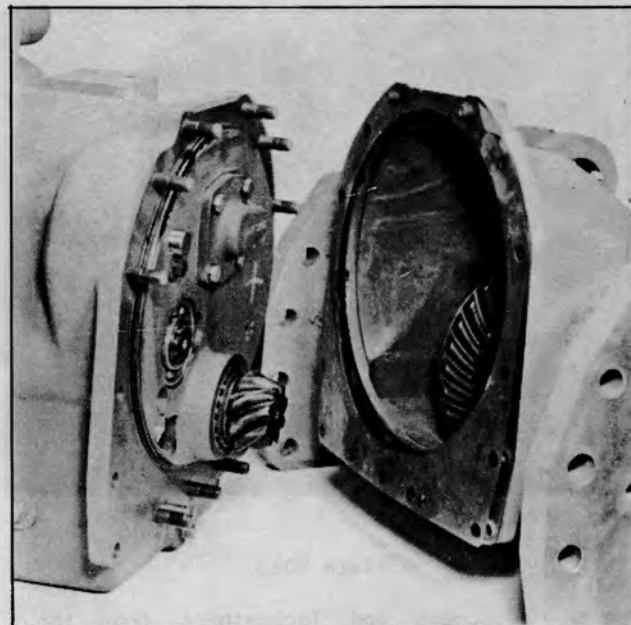


Plate 8018.

Remove all nuts and capscrews retaining the axle adaptor (or auxiliary gear box) to the transmission. Install pusher bolts in the holes provided on the axle adaptor or gear box--turn bolts equally to separate the two housings.

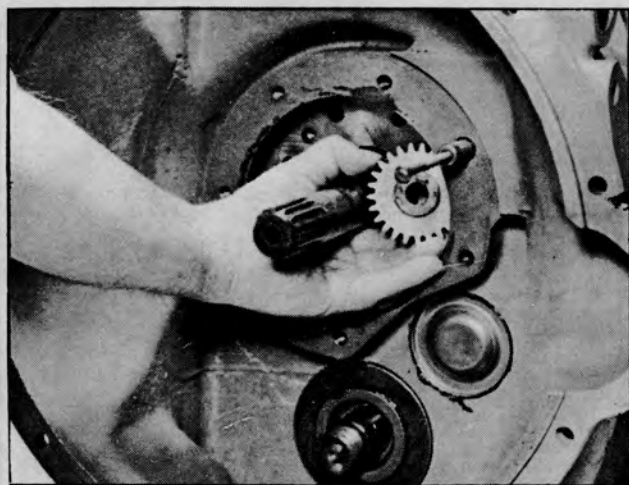


Plate 8017.

Use bolt as shown in Plate 8017 and remove pump idler gear shaft, thrust washers and gear.

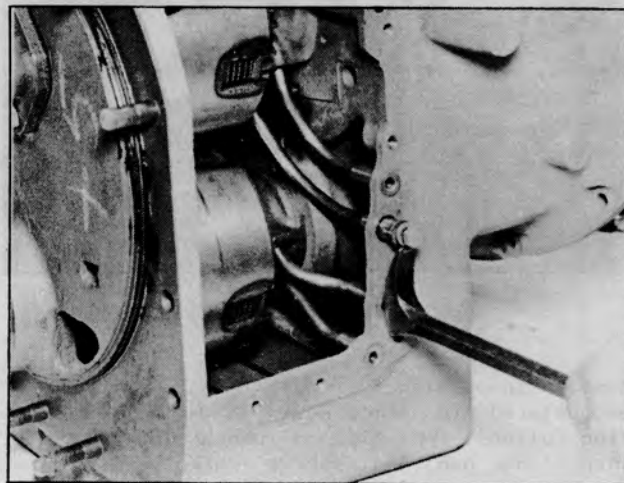


Plate 8019.

Install a bolt in each oil distributor tube sleeve and pull sleeves as shown in Plate 8019. The tubes may now be pulled out of the oil distributors and removed from the housing.



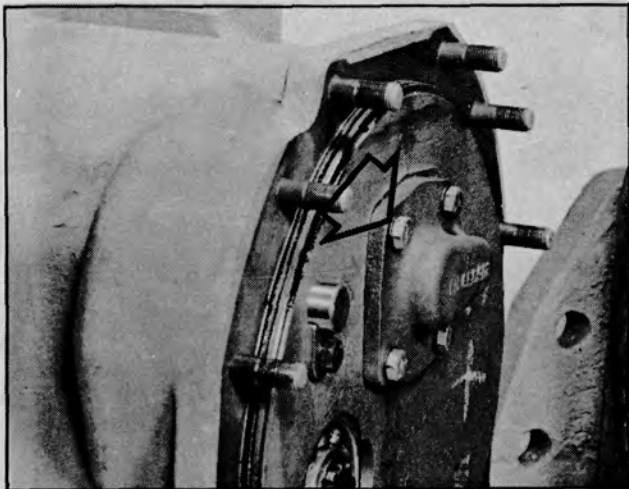


Plate 8020.

Remove capscrews and lockwashers from input shaft cap. Remove cap.

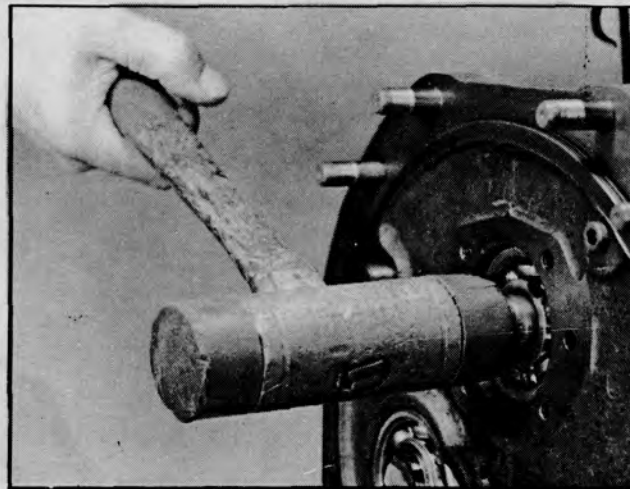


Plate 8022.

Drive input shaft back with a soft mallet.

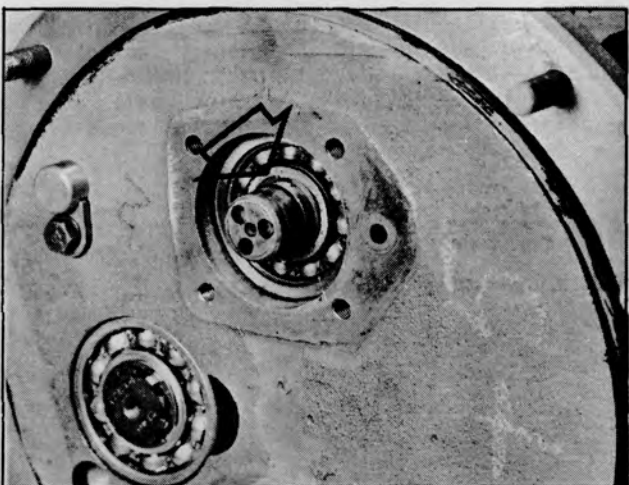


Plate 8021.

Remove snap ring. If difficulty is encountered in removing ring with snap ring pliers, position a punch 180° from snap ring gap and strike sharply, springing the snap ring open. On reassembly of transmission, always use a new snap ring.

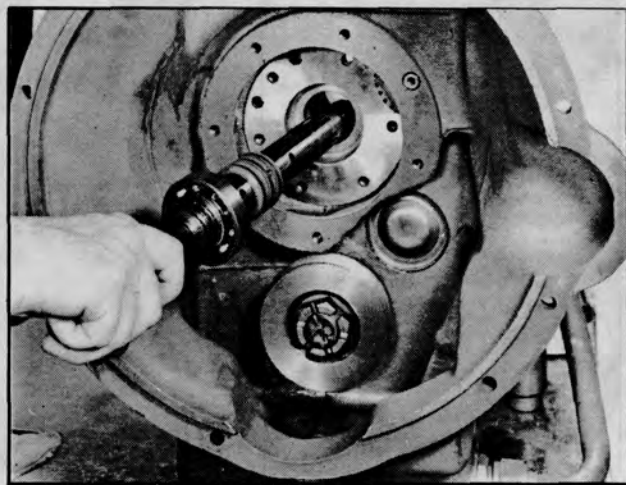


Plate 8023.

Remove input shaft, bearing and oil distributor sleeve from converter housing.



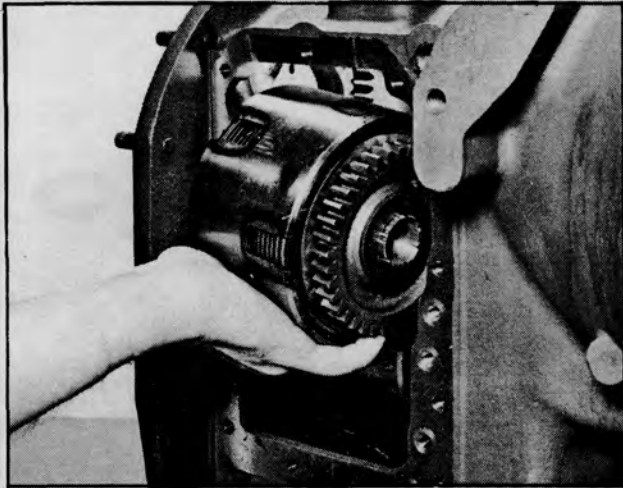


Plate 8024.

Using a hammer handle insert handle between oil distributor and selector pack to move distributor forward, then.....remove forward and reverse selector pack from transmission housing.

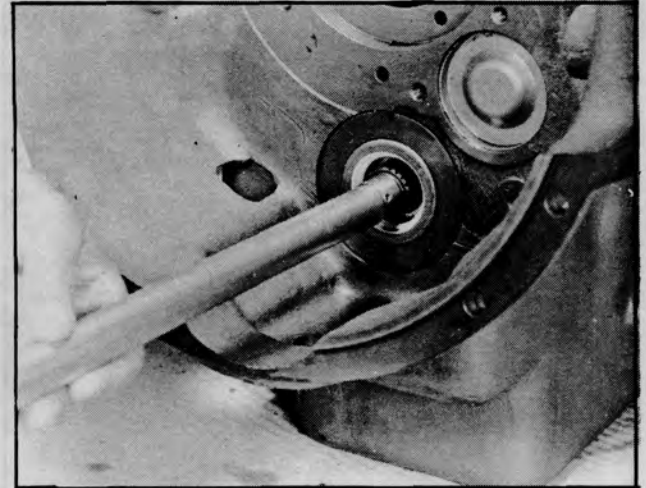


Plate 6221.

With a soft brass rod or mallet tap pinion shaft back.

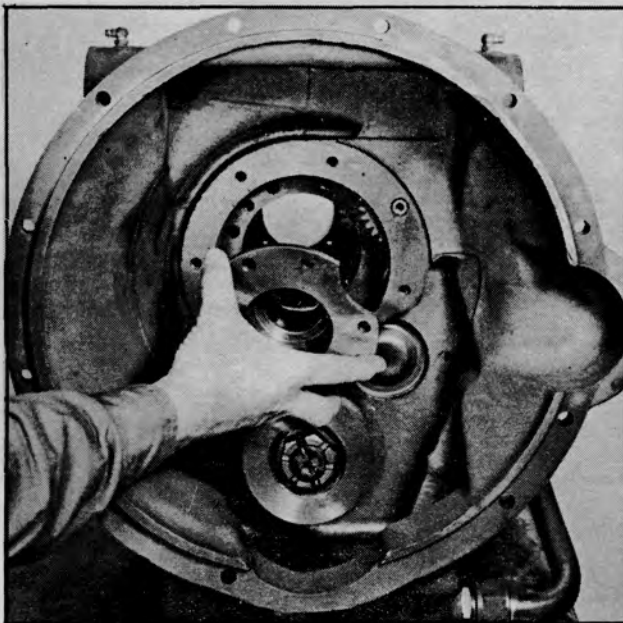


Plate 8025.

Tap oil distributor out of housing with a soft mallet.

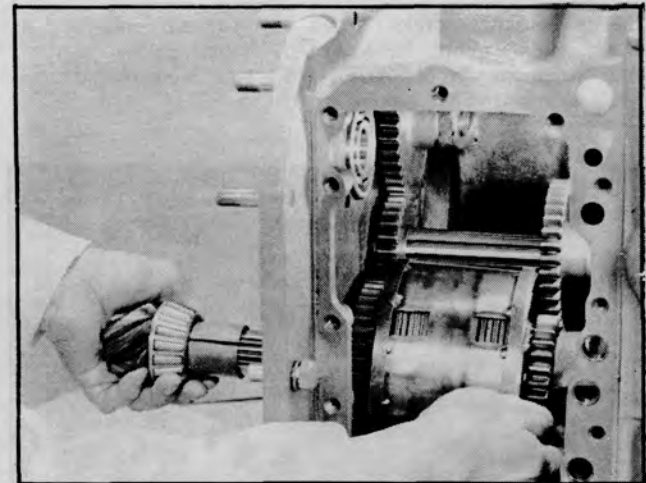


Plate 8026.

Holding speed selector pack, pull pinion shaft, bearing and spacer out of housing. Remove selector pack from transmission.

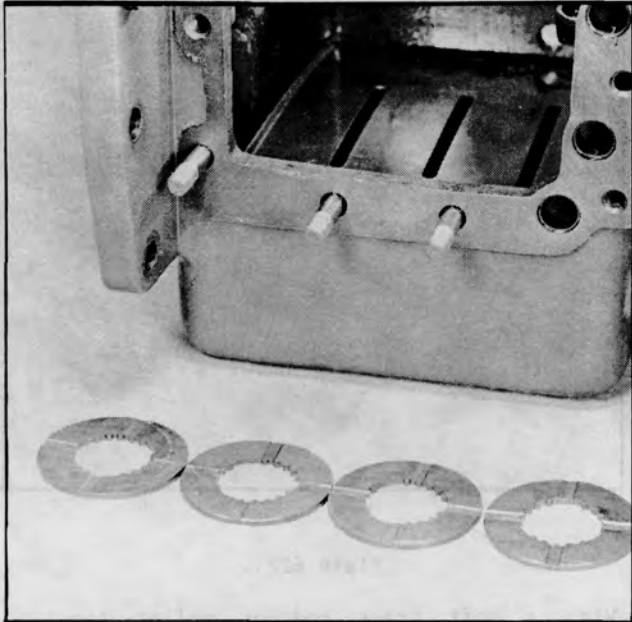


Plate 8027.

The selector packs have a thrust washer at each end. Upon removal of the packs at the bottom of the transmission case.

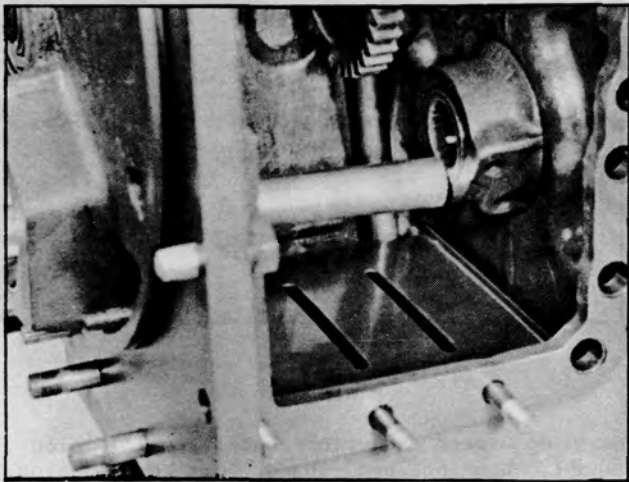


Plate 8028.

With a soft brass rod, tap oil distributor, distributor sleeve, shims, bearing and seal out of housing.



Plate 8029.

The above components are contained within the speed selector pack oil distributor.

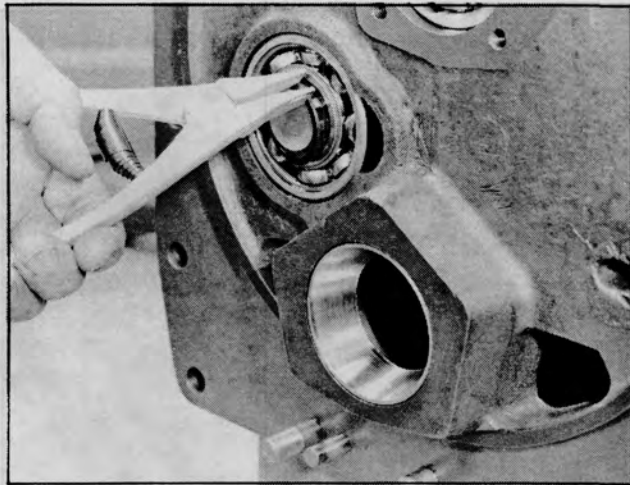


Plate 6219.

Remove snap ring from intermediate shaft. (Axle adaptor end of transmission housing).

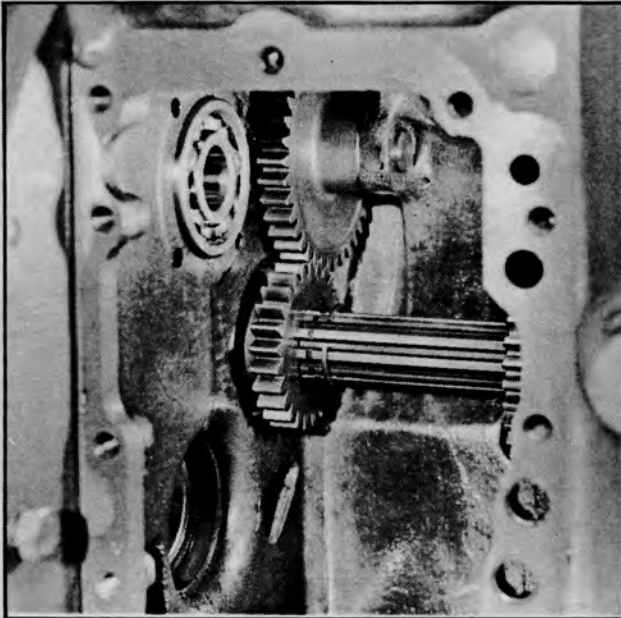


Plate 8031.

Slide snap ring away from "low" gear on intermediate shaft.

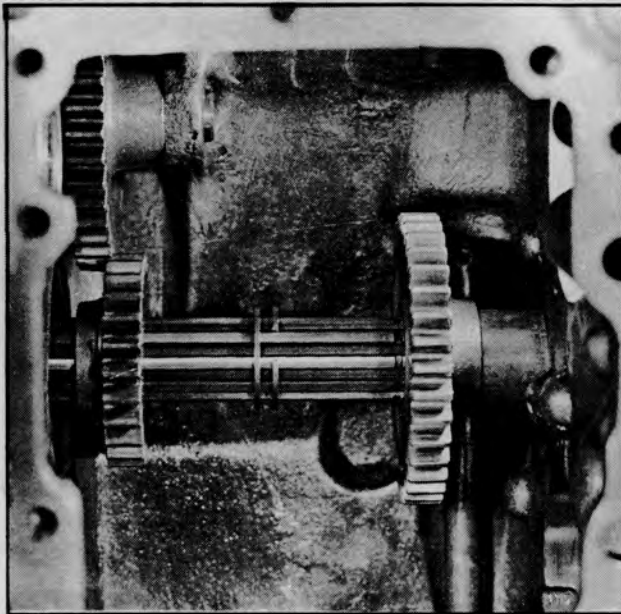


Plate 8032.

Slide snap ring away from "high" gear on intermediate shaft.

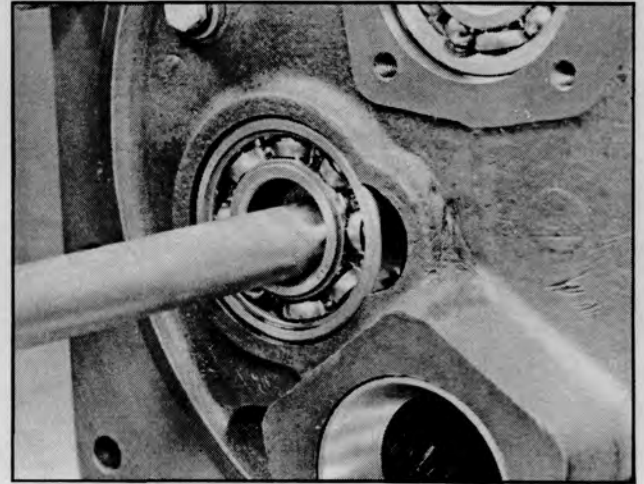


Plate 6217.

Tap intermediate shaft with a soft brass rod until shaft is free of bearing. This will push out plug on opposite end of housing. Note: Exercise caution when shaft is being tapped, so that the "high" gear on intermediate shaft does not damage the dipstick tube.

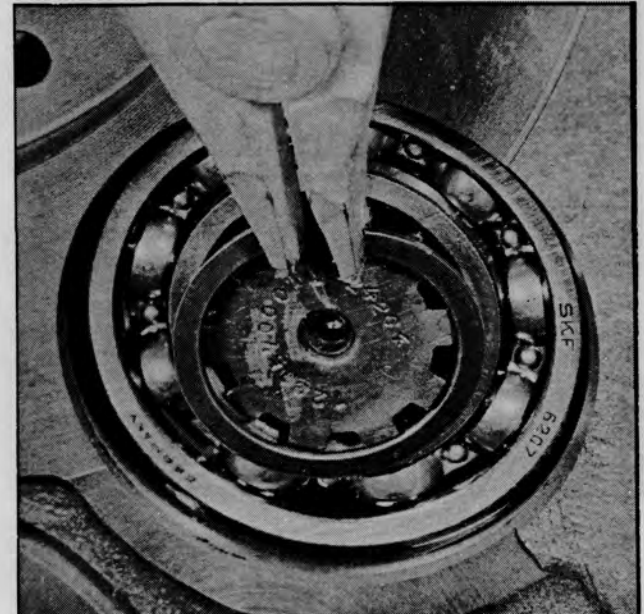


Plate 6220.

After plug has been pushed out of converter end of housing, exposing snap ring, remove ring.



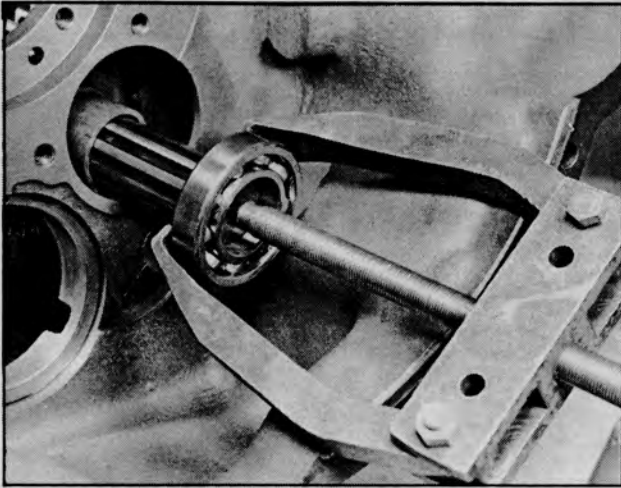


Plate 6222.

Remove bearing from convertor end of intermediate shaft with a suitable puller.

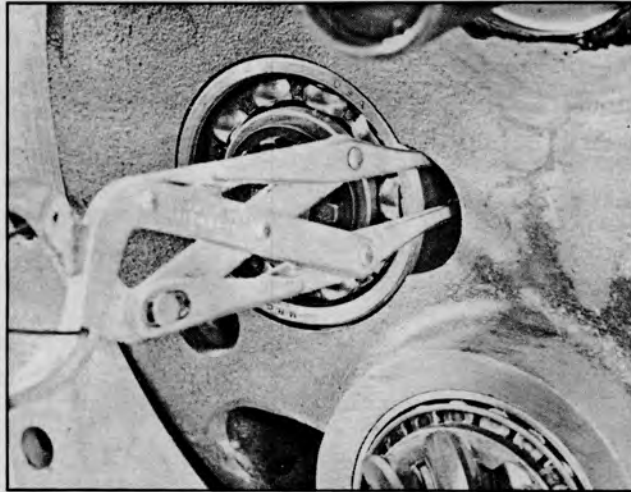


Plate 9595.

Expand retainer ring and lightly tap intermediate shaft bearing from housing, (Tapping from inside of transmission.)

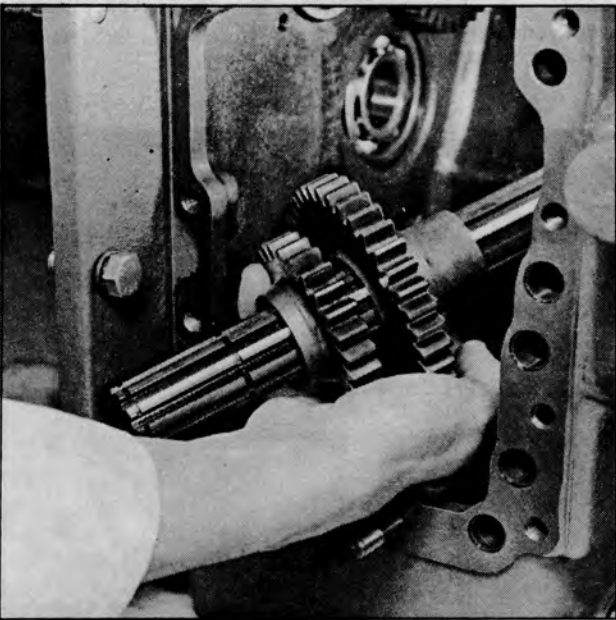


Plate 8033.

Remove intermediate shaft, spacer, "high" and "low" gear from housing.

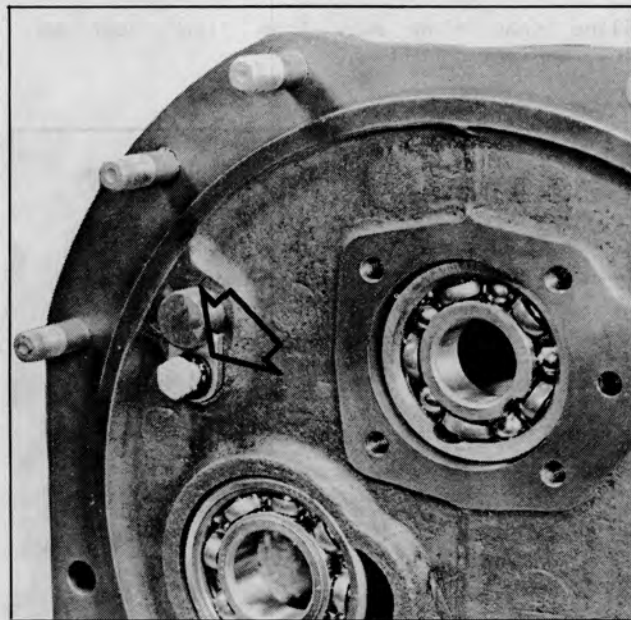


Plate 8034.

Remove idler gear shaft retainer bolt and retainer.



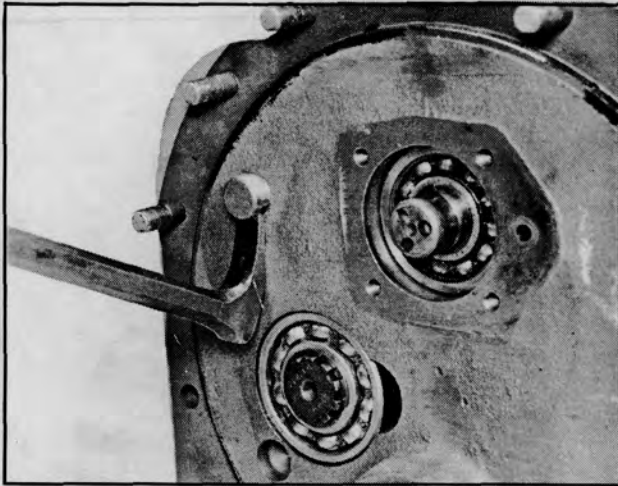


Plate 8035.

Pull out idler gear shaft and remove gear from inside transmission case.

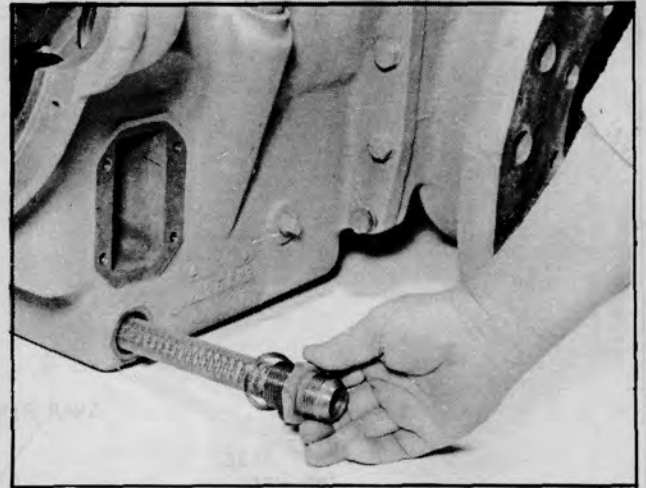


Plate 8037.

Remove sump strainer and "O" ring from transmission sump.

**SELECTOR PACK DISASSEMBLY**

The forward and reverse selector pack and the high and low selector pack are identical.

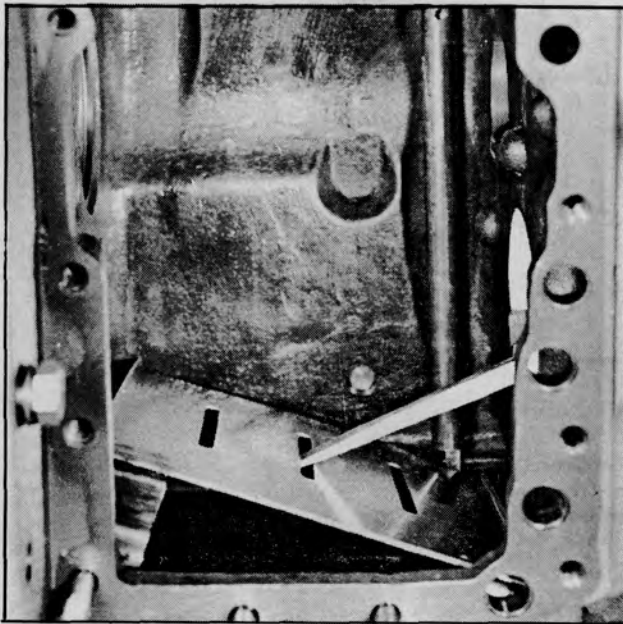


Plate 8036.

Tip up sump baffle with a screwdriver and remove from transmission housing.

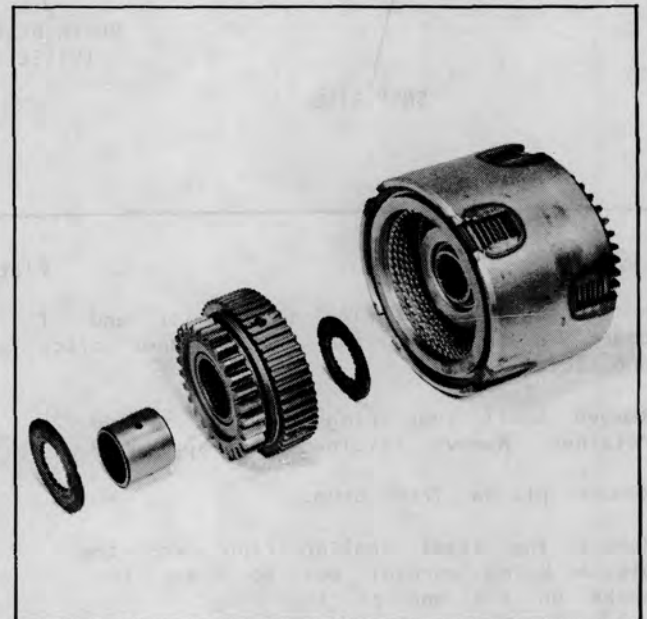


Plate 8038.

Remove the thrust washers, gear and inner bearing race from the pack.

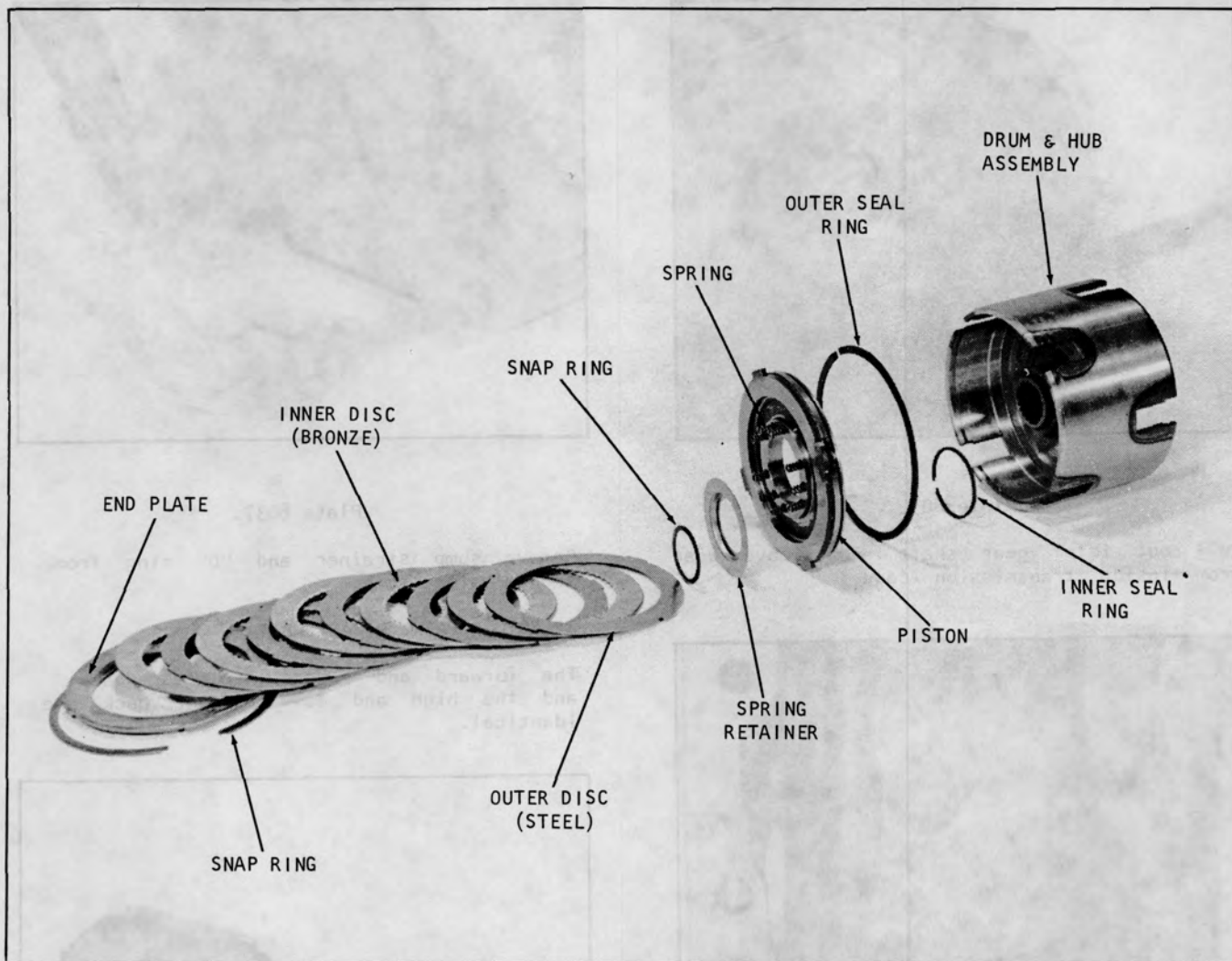


Plate 8039.

Remove large snap ring from outer end of drum and pull out end plate, inner discs and outer discs.

Remove small snap ring securing spring retainer. Remove retainer and springs.

Remove piston from drum.

Remove the steel sealing ring from the piston being careful not to break the hooks on the end of the ring.

Remove the steel sealing ring from the piston guide being careful not to break the hooks on the end of the ring.

NOTE

DISASSEMBLY PROCEDURES ARE IDENTICAL FOR EACH END OF THE TWIN PACK SELECTORS.

CLEANING AND INSPECTION

CLEANING

Clean all parts thoroughly using a Stoddard Type cleaning solvent. It is recommended that parts be immersed in cleaning solvent and gently agitated until all old lubricant and foreign material is removed and parts are thoroughly cleaned.

**BEARINGS:** Remove bearings from cleaning solvent and strike larger side of cone flat against a block of wood to dislodge solidified particles of lubricant. Immerse again in cleaning fluid to flush out particles. Repeat above operation until bearings are thoroughly clean. Dry bearings using moisture-free compressed air. Direct air stream across bearings to avoid spinning. Do not spin bearings when drying. Bearings may be rotated slowly by hand to facilitate drying process.

**HOUSINGS:** Clean interior and exterior of housings, bearing caps, ect., thoroughly. Cast parts may be cleaned in hot solution tanks with mild alkali solutions providing these parts do not have ground or polished surfaces. Parts should remain in solution long enough to be thoroughly cleaned and heated. This will aid the evaporation of the cleaning solution and rinse water. Parts cleaned in solution tanks must be thoroughly rinsed with clean water to remove all traces of alkali. Cast parts may also be cleaned with a steam cleaner.

W A R N I N G

CARE SHOULD BE EXERCISED TO AVOID INHALATION OF VAPORS. DO NOT ALLOW SKIN TO COME IN CONTACT WITH ALKALI CLEANERS.

All parts cleaned must be thoroughly dried immediately by using moisture-free compressed air or soft, lintless absorbent wiping rags free of abrasive materials such as metal filings, contaminated oil or lapping compound.

INSPECTION

The importance of careful and thorough inspection of all parts cannot be overstressed. Any parts showing wear or an indication of stress should be discarded and new parts installed. It is more economical to replace a questionable part at this time than risk the possibility of a premature malfunction, necessitating a teardown of the transmission for replacement of these items.

**OIL SEALS, GASKETS, ETC:** Spring loaded oil seals, "O" rings, metal sealing rings, gaskets and snap rings should be replaced with new parts. Loss of lubricant through a worn seal may result in failure of other more expensive parts of the assembly. Sealing members should be handled carefully, particularly when being installed. Cutting, scratching, or curling under of lip of seal seriously impairs efficiency. Apply a thin coat of Permatex No. 2 on the outer diameter of the oil seal to assure an oil tight fit into the retainer. When assembling new metal type sealing rings, they should be lubricated with coat of chassis grease to stabilize rings in their grooves for ease of assembly of mating members. Lubricate all "O" rings and seals with type "A" Automatic Transmission Fluid before assembly.

**GEARS AND SHAFTS:** If a magna-flux process is available, check all parts using this process, to determine their further serviceability. Examine teeth on all gears carefully, for wear, pitting, chipping, nicks, cracks or scores. If gear teeth show spots where case hardening is worn through or cracked, replace with new gear. Small nicks may be removed with suitable hone. Inspect shafts to make certain they are not sprung, bent, or splines twisted, and that shafts are true.

**HOUSING, COVERS, ETC:** Inspect housings, covers and bearing caps to be certain they are thoroughly cleaned and that mating surfaces, bearing bores, etc., are free from nicks or burrs. Check all parts carefully for evidence of cracks or condition which would cause subsequent oil leaks or failures.



**SELECTOR PACK REASSEMBLY**

(Refer to exploded view, Plate 8039, page 06M010K for sequence of parts).

**NOTE:** Reassembly procedure given in the following will be the same for each selector drum.

Install the inner steel seal ring on the piston guide making sure that the hooks on the end of the ring are engaged.

Install the outer steel seal ring on the piston making sure that the hooks on the end of the ring are engaged.

Place the drum assembly on end. Coat the piston assembly with Automatic Transmission Fluid and insert the piston assembly in the drum. The piston should seat in the drum with finger pressure.

Insert the springs in the holes provided on the piston assembly. Place the spring retainer over the springs and compress the springs sufficiently to allow the installation of the snap ring on the hub assembly.

Install a steel outer disc in the drum and then a bronze inner disc. Alternate with steel and bronze discs until the correct number of discs are installed.

Install the end plate in the selector drum and insert the retaining snap ring being sure it is seated properly.

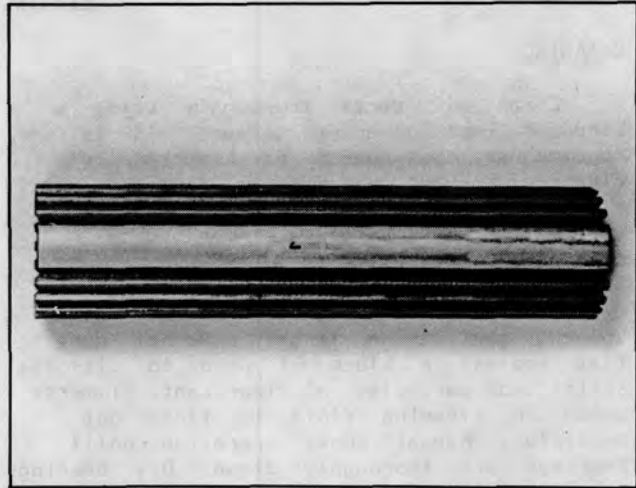


Plate 8041.

The above tool is used for ease of selector pack assembly. Tool number 801435 is available from Central Parts Division. Two of the splines are slightly more shallow than the remaining splines and are used as an index to align oil holes. The shaft will enter the selector hub and inner bearing races in one position only.

**NOTE**

The F & R and the Hi & Lo selector packs are identical and when assembled should have a small gear on one end and a large gear on the opposite end.

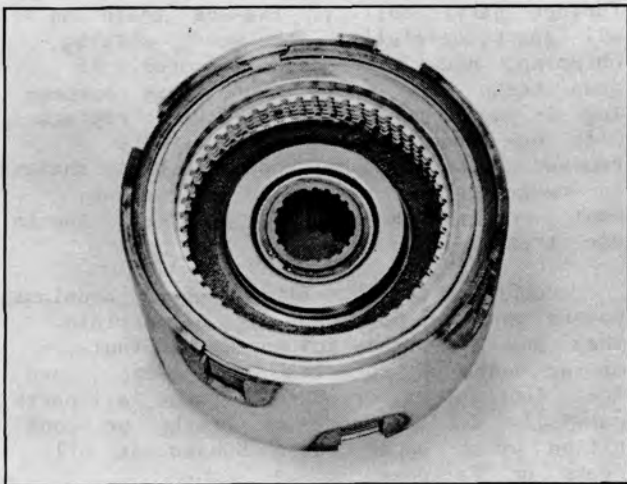


Plate 8040.

Align inner disc teeth so the gear may be more easily installed in a later step.

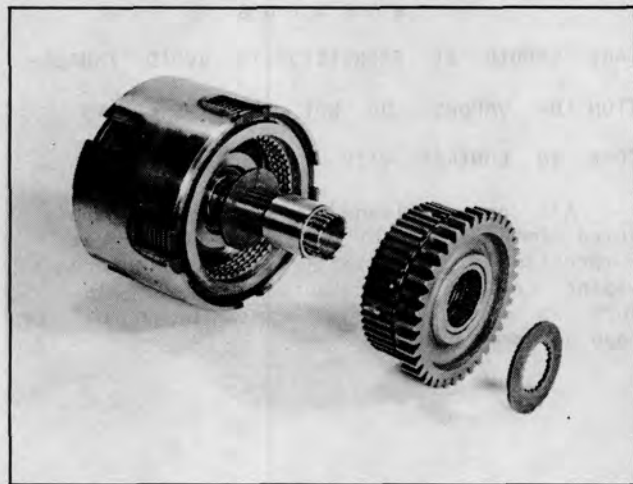


Plate 8042.

Match the index splines on the assembly tool with the splines on the selector hub



and insert tool. Place a thrust washer (lubrication slots facing toward gear) over the shaft. Next place gear over assembly tool and allow it to drop into registry with all of the inner discs. Install the inner bearing race over the shaft and into the gear.

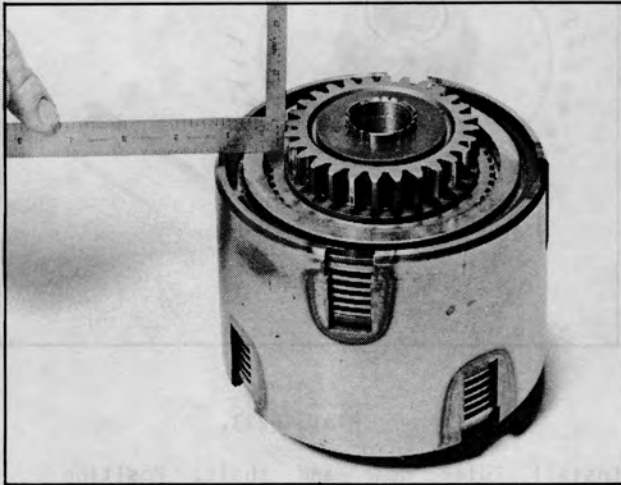


Plate 8043.

Turn the gear and watch the inner discs to determine if they are engaged. When the gear has completely entered the discs it should be 1/4 inch below the top of the end plate. Install a thrust washer over the shaft with the lubrication grooves facing the gear.

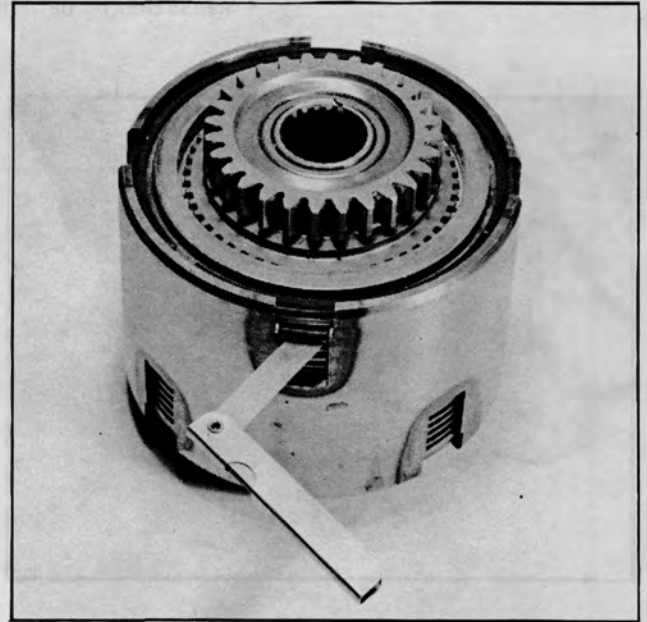


Plate 8045.

Check the total clearance of each set of discs by inserting a feeler gauge between any two discs. If a .050 inch feeler will not enter between the discs the clearance is insufficient and one steel disc should be removed from the outer end of that particular pack. If a .120 feeler will enter, the clearance is too great and a steel disc should be added to the pack. Add or remove a steel disc as necessary to maintain a minimum clearance of .050 inch or a maximum of .120 inch at each pack.

## REASSEMBLY OF THE TRANSMISSION

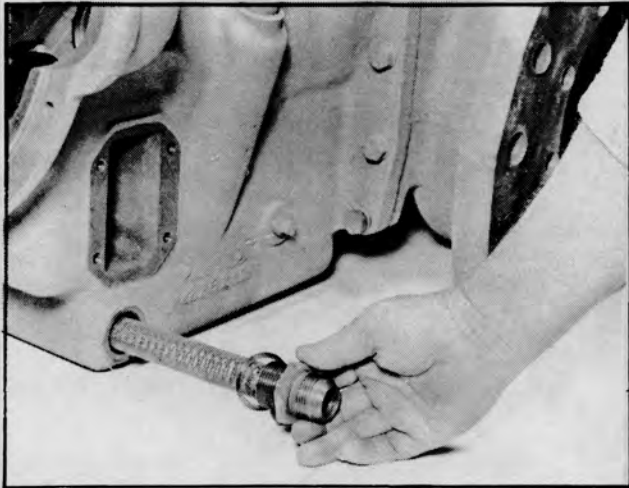


Plate 8037.

Place a new "0" ring on sump strainer and install strainer in transmission sump.

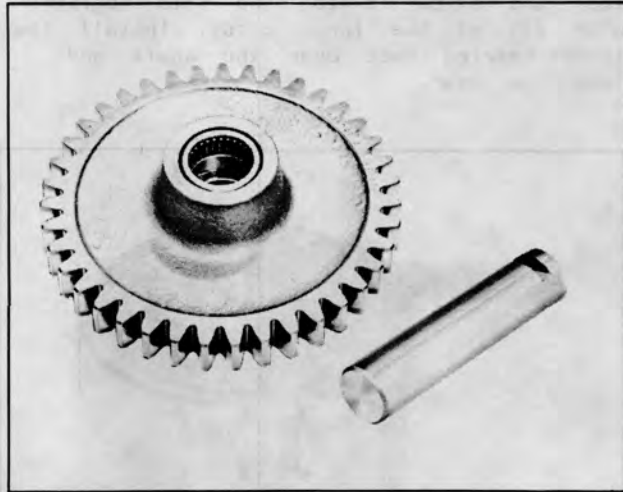


Plate 6223.

Install idler gear and shaft. Position the shaft so that the retainer slot is in alignment to receive the retainer.

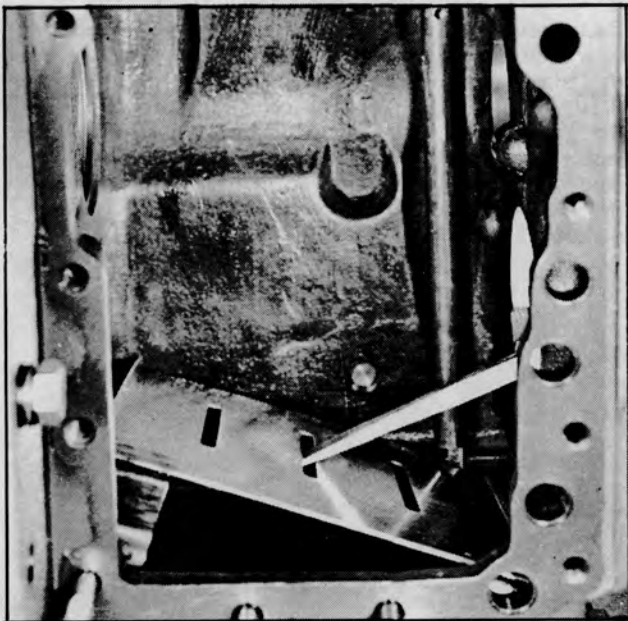


Plate 8036.

Position sump baffle in housing and press into place.

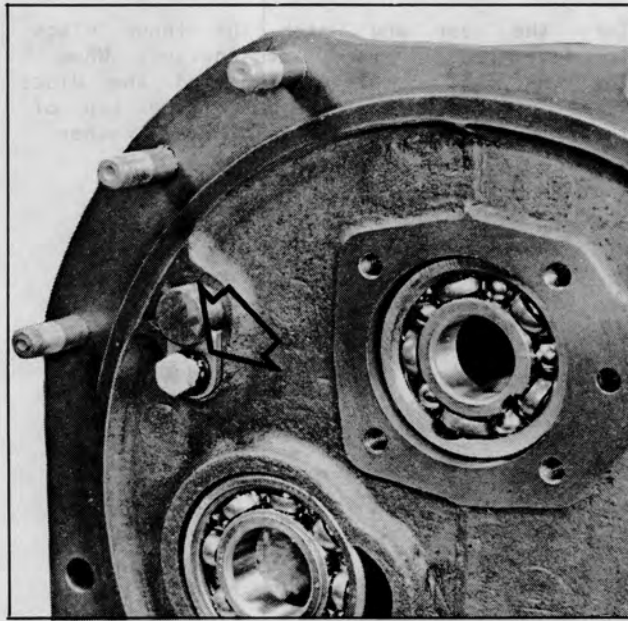


Plate 8034.

Install retainer, lockwasher and retainer cap screw.

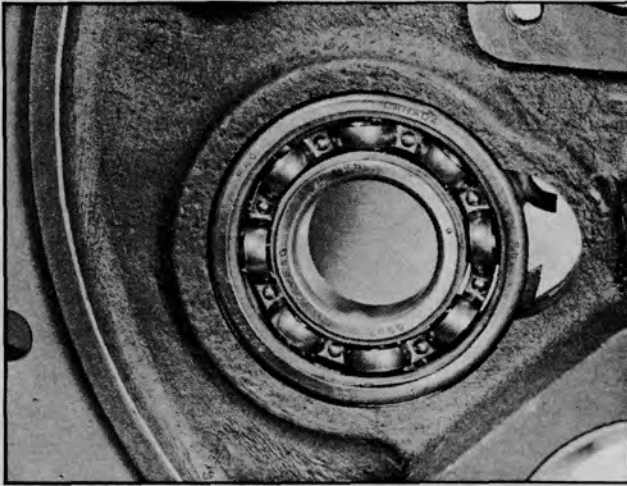


Plate 6218.

Expand retainer ring and install intermediate shaft bearing. Allow ring to seat in the retainer groove provided on the bearing.

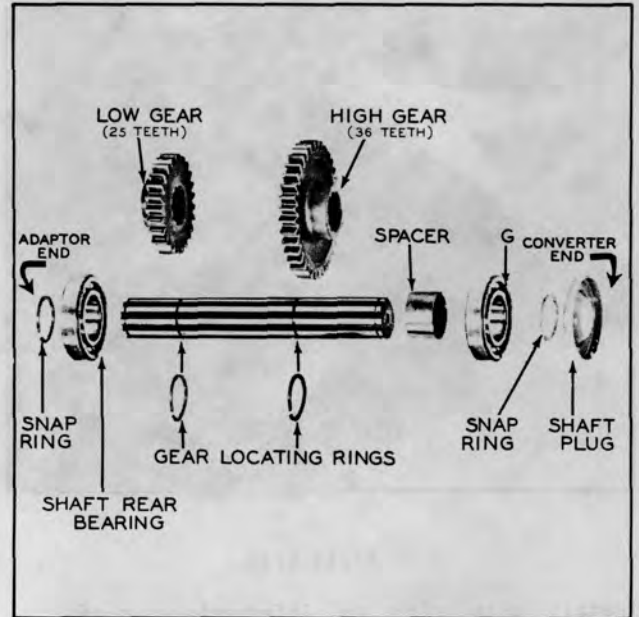


Plate 5680.

Tap on inner race of bearing "G" until snap ring groove on shaft is in position for installation of snap ring.

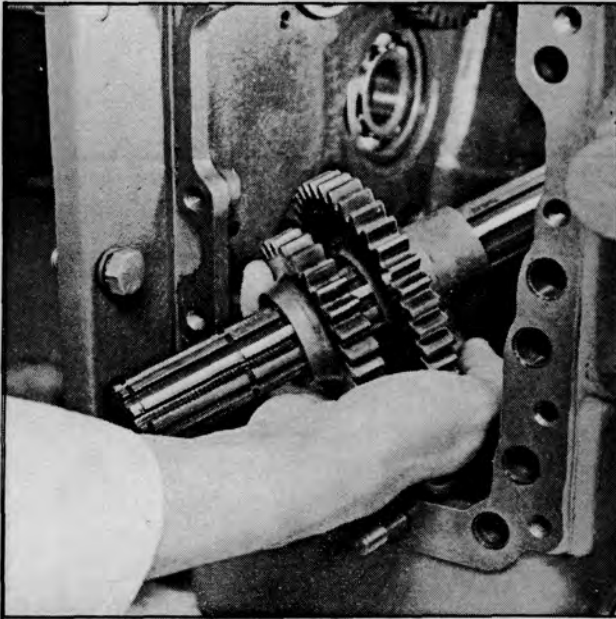


Plate 8033.

Install intermediate shaft, spacer, "high" and "low" gear. Smaller gear should be toward the bearing shown in Plate 6218.

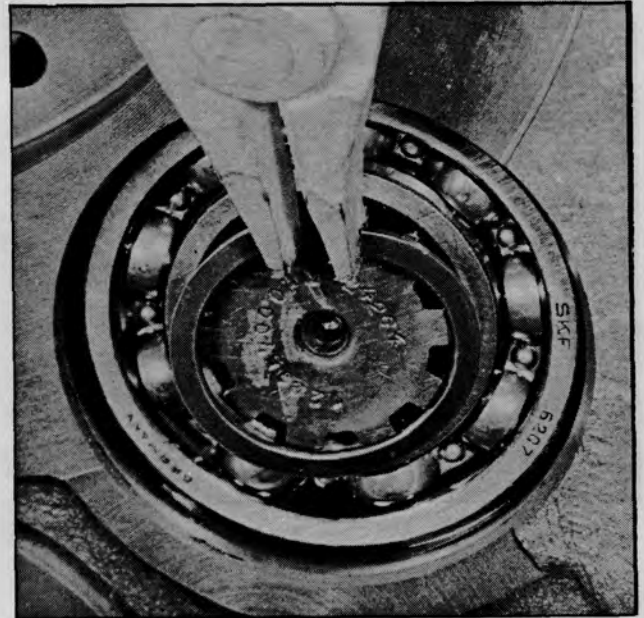


Plate 6220.

Install snap ring on intermediate shaft.



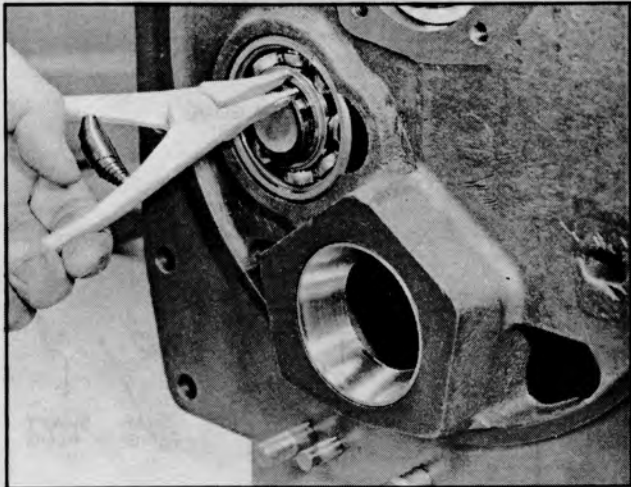


Plate 6219.

Install snap ring on intermediate shaft.  
(Axle adaptor end of transmission housing.)

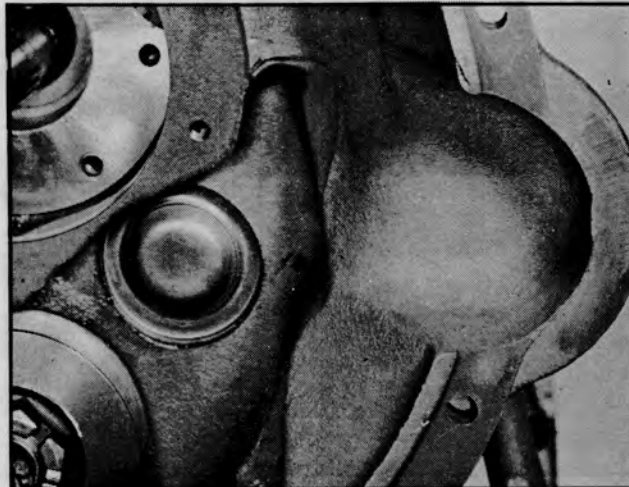


Plate 8030.

Apply a thin coat of #2 Permatex to mating surface of shaft plug and install plug in transmission case using a suitable driver.

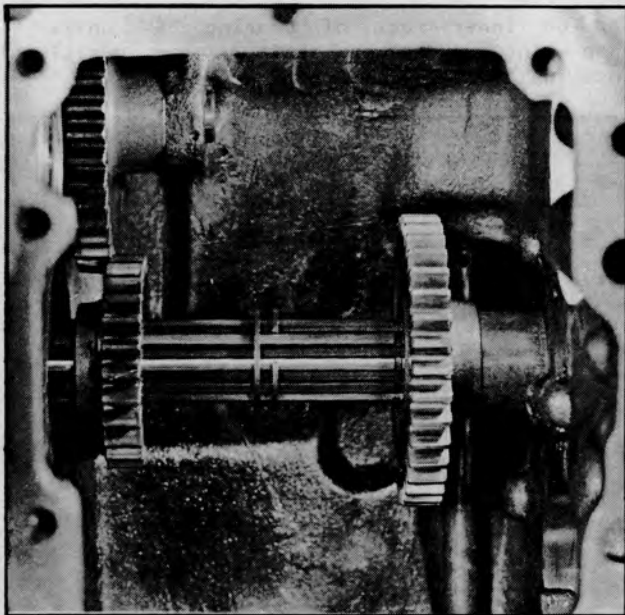


Plate 8032.

Slide each snap ring into its groove against the "Hi" gear and the "Low" gear.

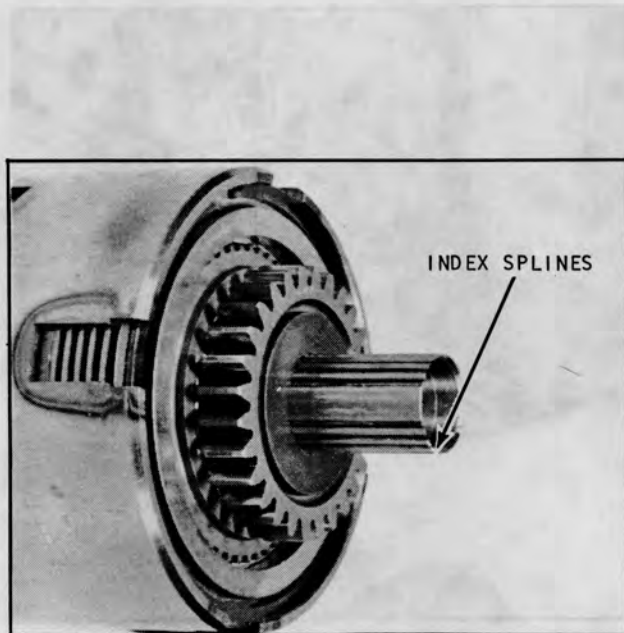


Plate 8044.

Mark the index splines on the installation tool with a piece of chalk so they may be aligned more easily with the index splines of the transmission shaft in a later step.



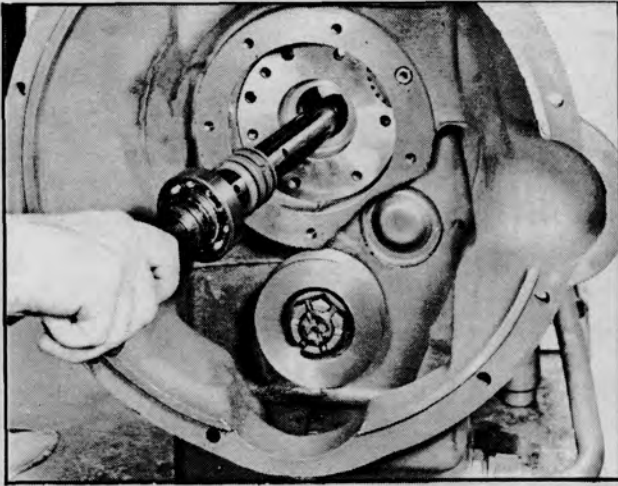


Plate 8023.

Place selector pack assembly in transmission case. Be sure there is a thrust washer on each end of selector - lubrication grooves facing the gears.

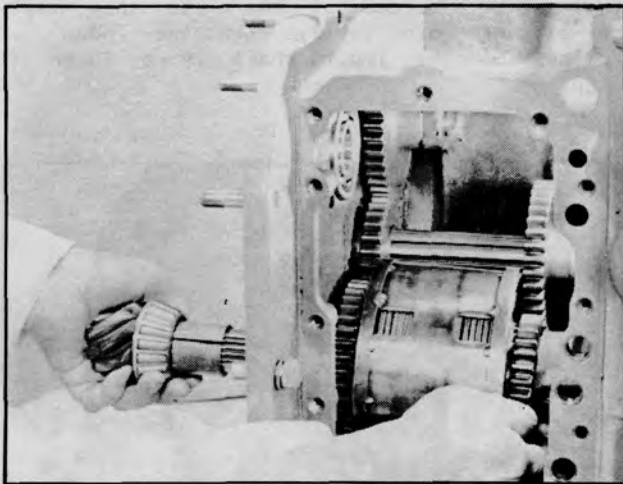


Plate 8026.

Holding speed selector, match index splines on transmission shaft with the index splines on assembly tool and push in the transmission shaft. The tool will drop out the opposite end of selector.

NOTE: It may be desirable to place the transmission on end when installing the transmission shafts.



Plate 8029.

Install a new "O" ring on the pinion shaft oil distributor and push it into the housing. Be sure the locating pin is in alignment and that distributor housing contains the above components. Press the oil seal in the housing until it is 3/32 inch from flush position. This will prevent the seal from contacting the bearing.

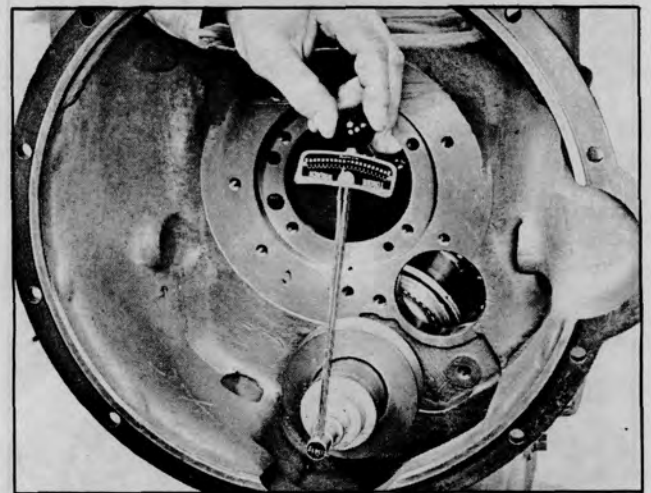


Plate 9663.

Install brake drum, drum "O" rings and nut. Tighten nut and check bearing preload. See specifications for proper bearing preload and drum nut torque. Add or remove shims from behind the drum until correct preload is obtained. Install cotter pin.

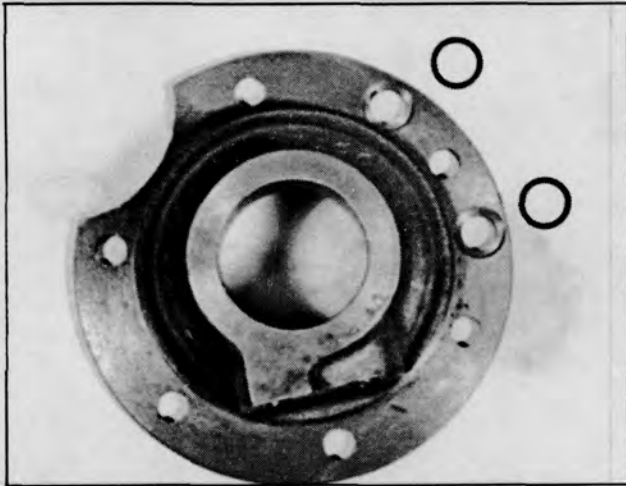


Plate 8046.

Install two new "O" rings in the recesses provided on the input shaft oil distributor. Coat the "O" rings with grease to hold them in place during installation of the oil distributor.

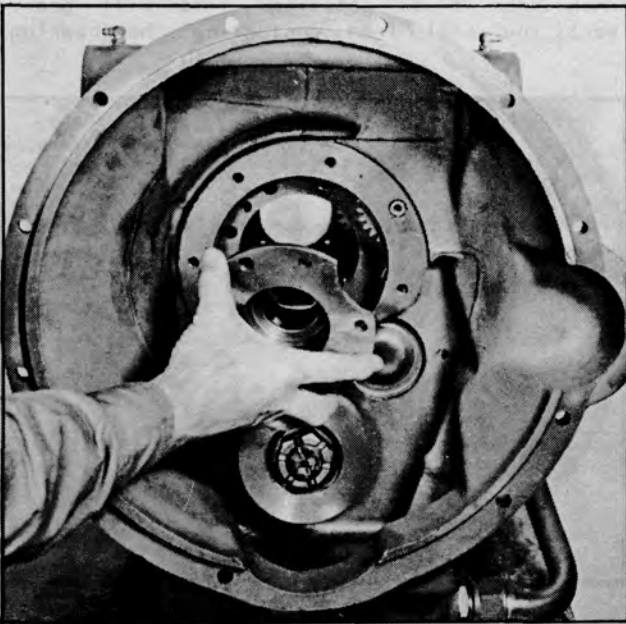


Plate 8025.

Install the oil distributor in the case. A capscrew may be temporarily installed to hold the distributor in position. (Do not push the distributor all the way in to allow more clearance for installation of the selector pack as shown in Plate 8023.)

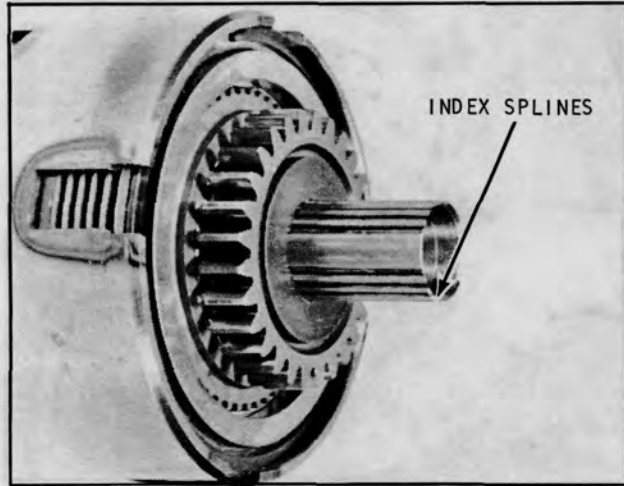


Plate 8044.

Mark the index splines on the installation tool with a piece of chalk so they may be aligned more easily with the index splines of the input shaft in a later step.

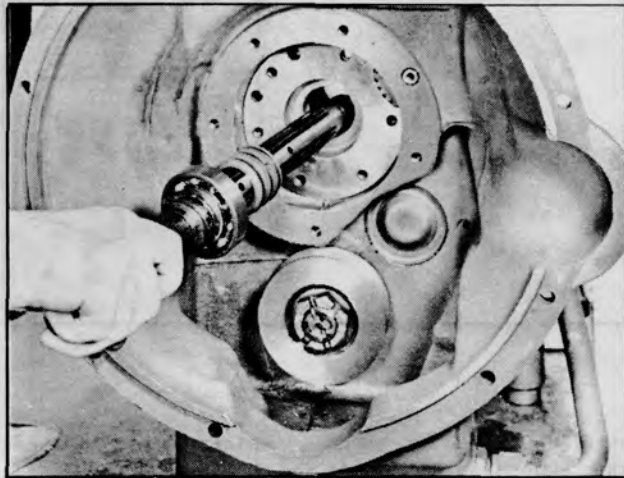


Plate 8023.

Place selector pack assembly in transmission case. Be sure there is a thrust washer on each end of selector - lubrication grooves facing the gear.

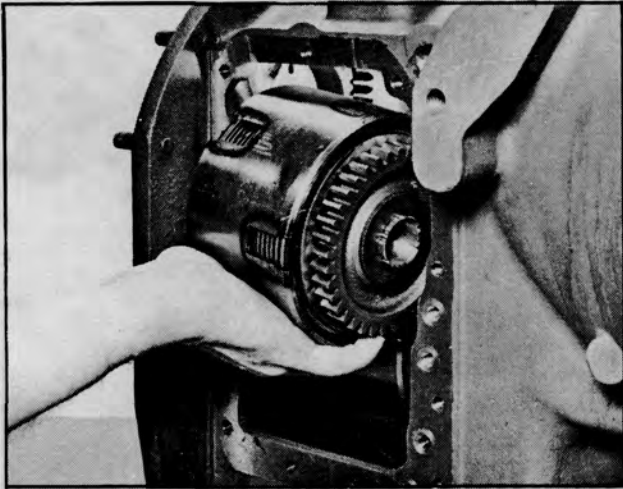


Plate 8024.

Holding forward and reverse selector, match index splines on input shaft with the index splines on assembly tool and push in the input shaft. The tool will drop out the opposite end of selector.

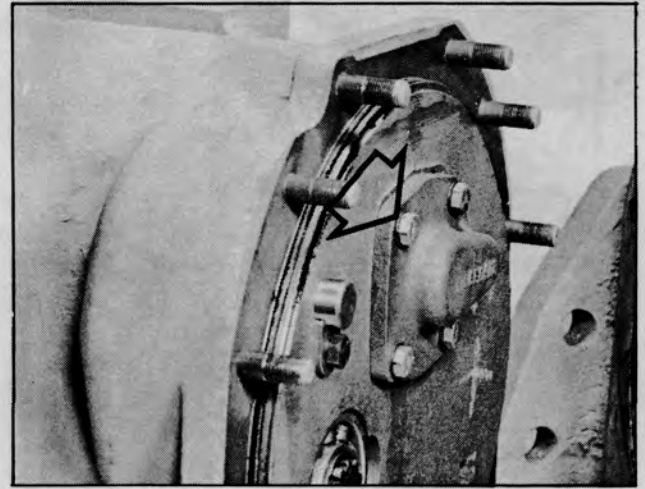


Plate 8020.

Install input shaft cap being sure there is a new "O" ring in the cap. Tighten capscrews.

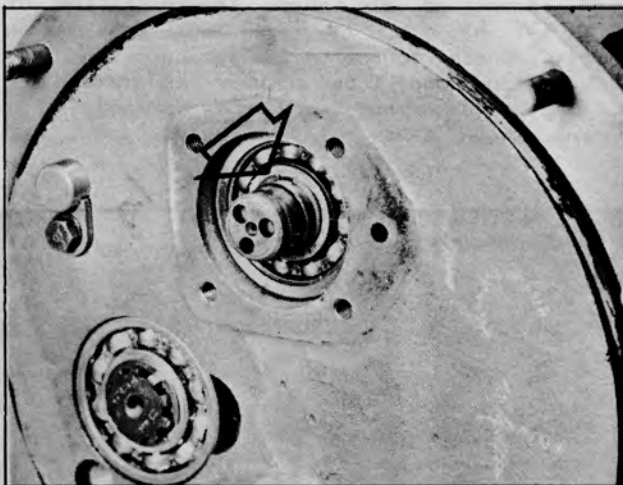


Plate 8021.

Install input shaft bearing by tapping against the inner race only. When bearing is in far enough to expose snap ring groove on shaft, install a new snap ring.

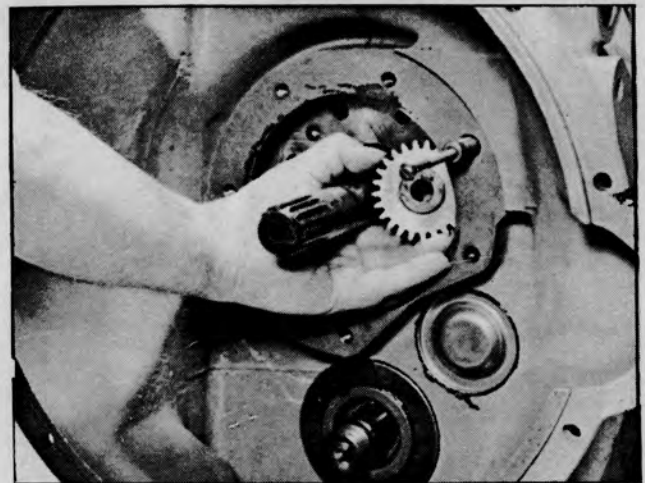


Plate 8017.

Using a bolt as shown, install idler gear shaft and gear. Be sure the gear has a thrust washer on each side and that the shaft has a new "O" ring in its groove.



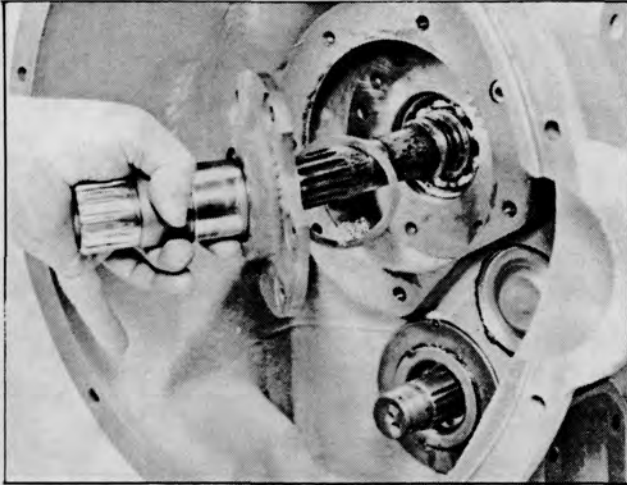


Plate 8016.

Remove the capscrew used to hold the oil distributor in position (if used) and install the washer and stator support. Tighten the capscrews against the lockwashers and stator support.

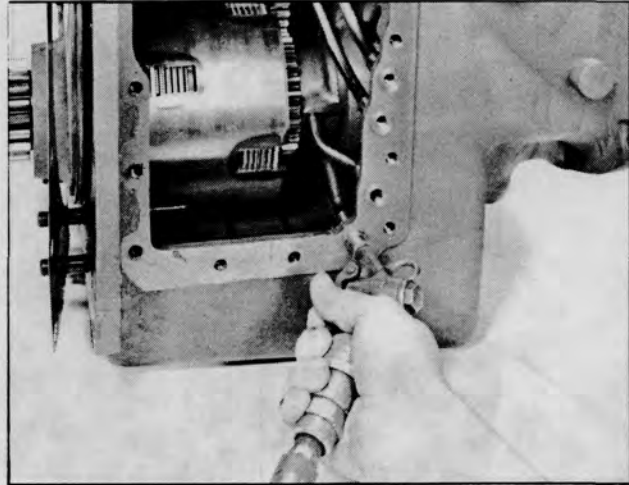


Plate 8047.

Place new "O" rings in the oil distributors and tube nipples. Carefully press the tubes into the distributors to prevent damage to the "O" rings. Press the nipples into the holes provided in the case and onto the tubes. With moisture free compressed air check the operation of each set of discs to see that they move freely. Check for air leakage at the the distributors and tube sleeves to make sure the "O" rings were not damaged during installation of the tubes.

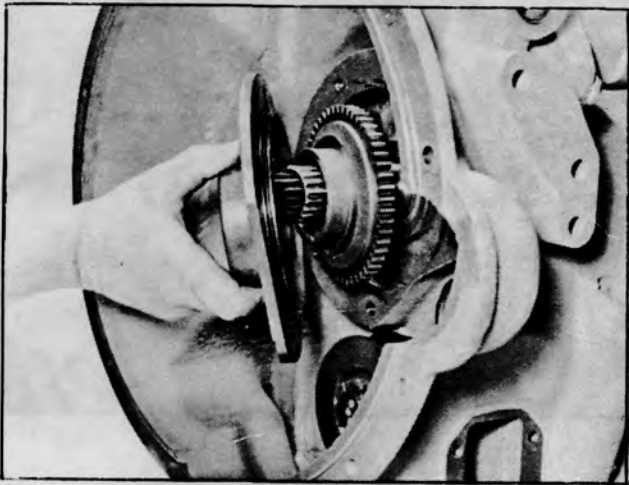


Plate 8013.

Place the pump gear over the stator support and install pump gear cover. Be sure a new "O" ring and oil seal was properly installed on cover. Secure cover with lockwashers and capscrews.

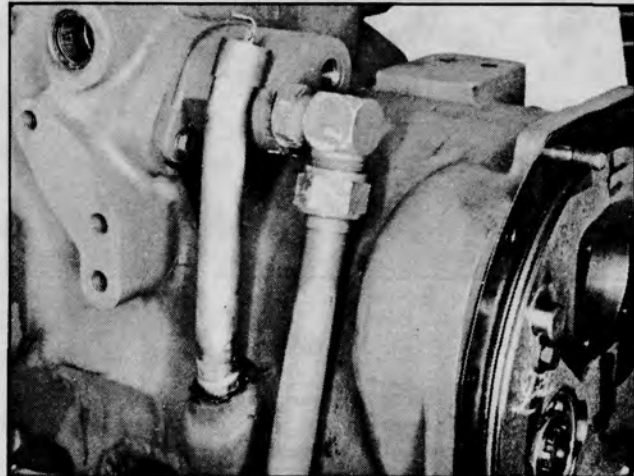


Plate 8048.

Attach convertor pump to the housing and secure with the lockwashers and capscrews. Connect the inlet line at pump and sump strainer.



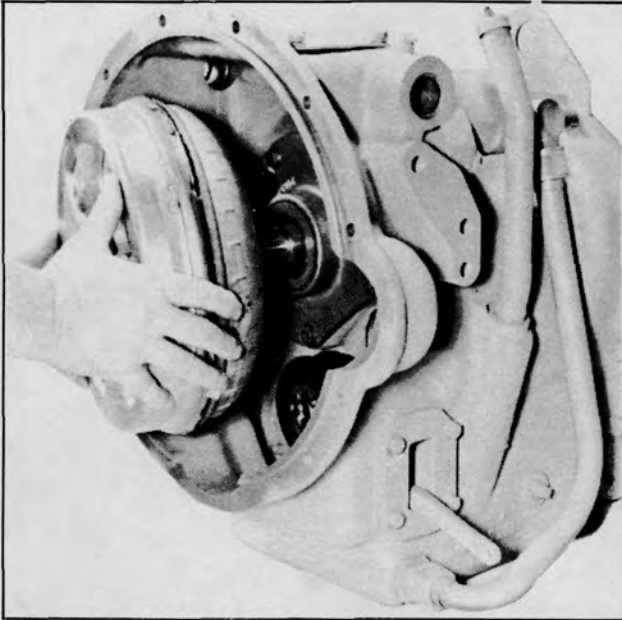


Plate 8010.

Install the torque converter. Exercise caution so as not to damage the torque converter bushing. Be sure the pump driving lugs of the torque converter are fully engaged with the pump gear.

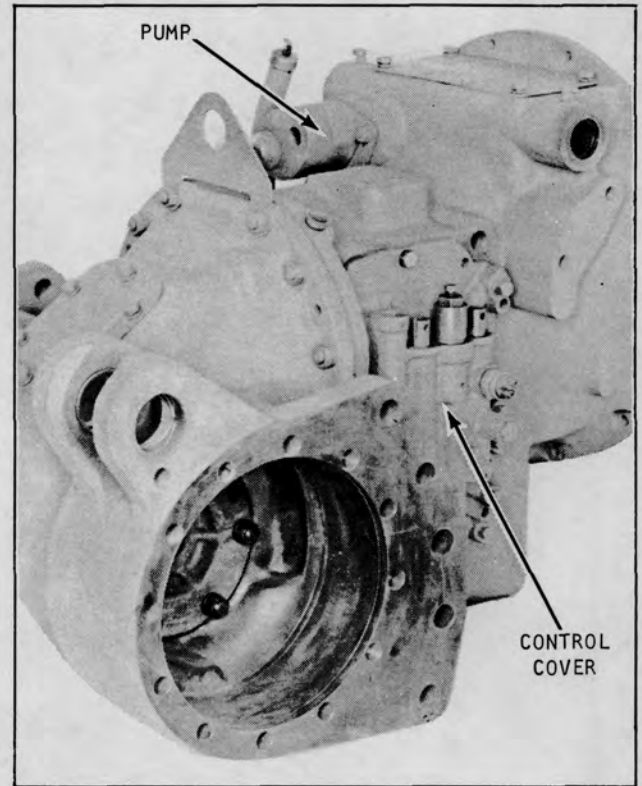


Plate 8011.

Using a new gasket and "O" rings install the control cover. Secure cover with lockwashers and capscrews.

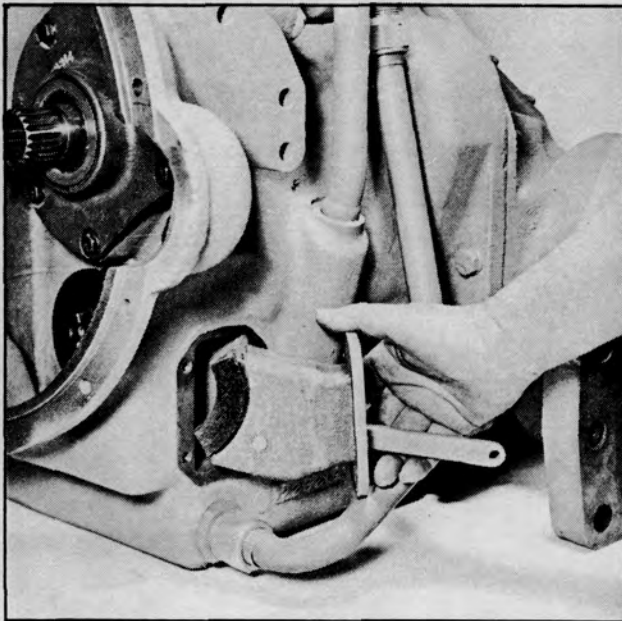


Plate 8012.

Install parking brake assembly. Tighten capscrews.



INDUSTRIAL TRUCK DIVISION



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CLARK EQUIPMENT COMPANY

PUBLISHED BY

TECHNICAL SERVICE DEPARTMENT  
BATTLE CREEK, MICHIGAN, U.S.A.

TEST WITH TRANSMISSION FILLED TO LEVEL  
INDICATED ON DIPSTICK-USE TYPE 'A' AUTOMATIC  
TRANSMISSION FLUID 200° F. to 225° F.

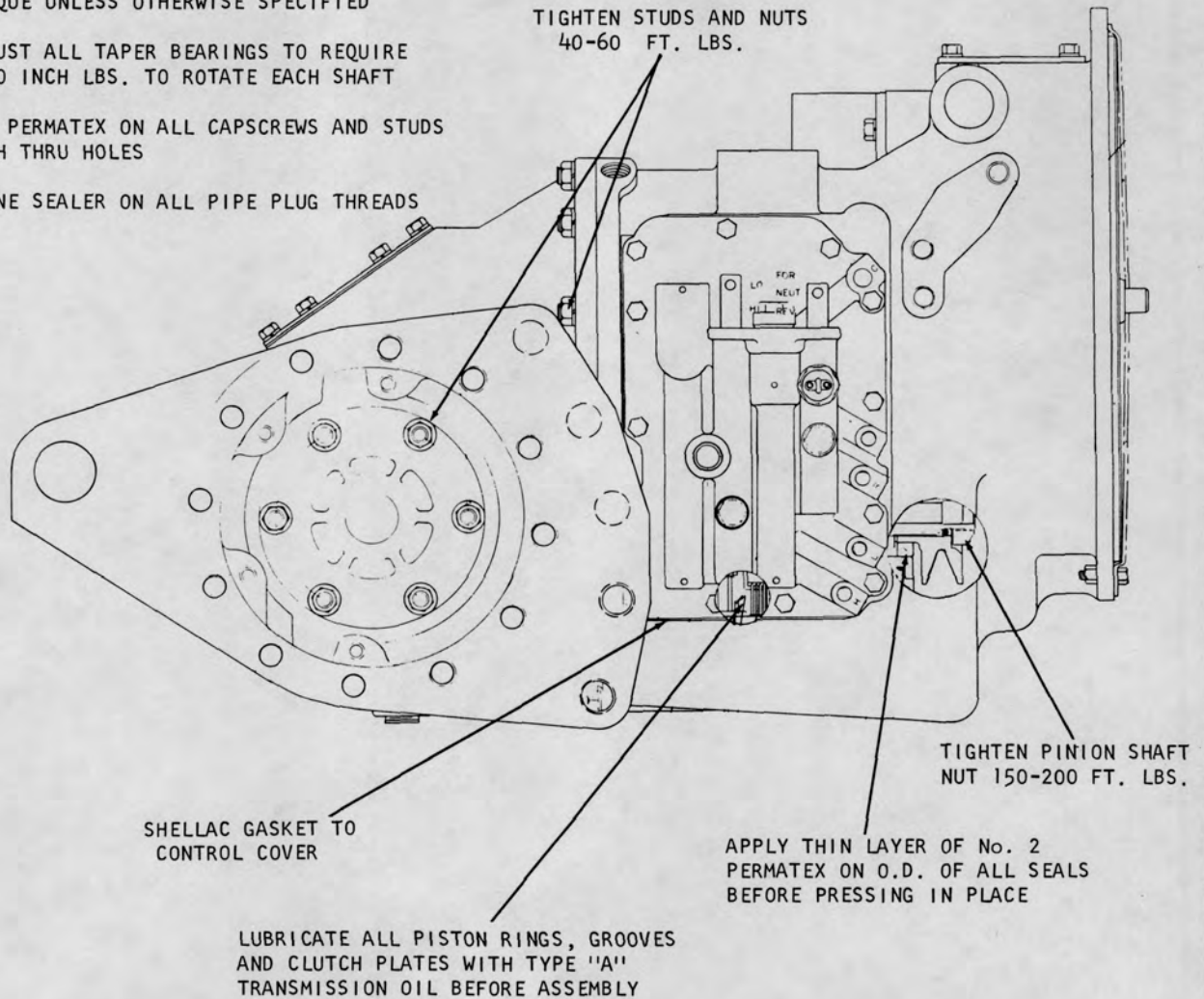
BRUSH TYPE 'A' OIL ON ALL TAPER BEARINGS  
AND BORES OF ALL BUSHINGS

TIGHTEN ALL CAPSCREWS 20-25 FT. LB.  
TORQUE UNLESS OTHERWISE SPECIFIED

ADJUST ALL TAPER BEARINGS TO REQUIRE  
8-10 INCH LBS. TO ROTATE EACH SHAFT

USE PERMATEX ON ALL CAPSCREWS AND STUDS  
WITH THRU HOLES

CRANE SEALER ON ALL PIPE PLUG THREADS





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DISASSEMBLY OF CONTROL VALVE

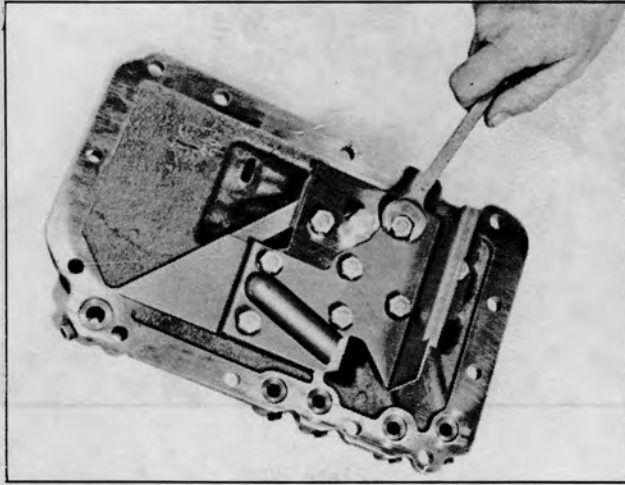


Plate 8003

Remove the cap screws retaining the control cover plate and baffle.

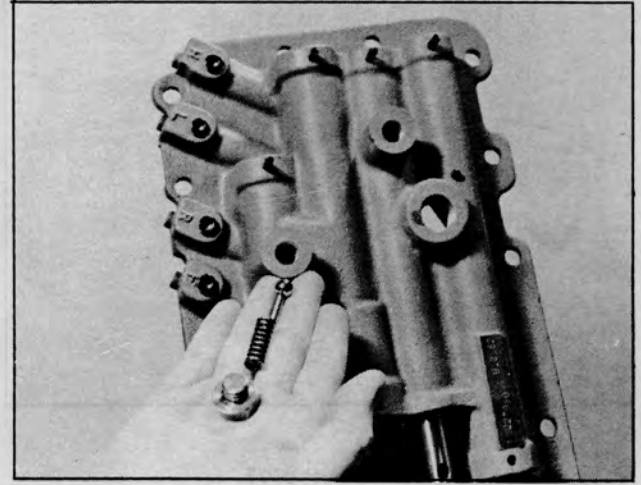


Plate 8005

Remove the plug, washer, spring, stop and ball from both of the control spool locations.

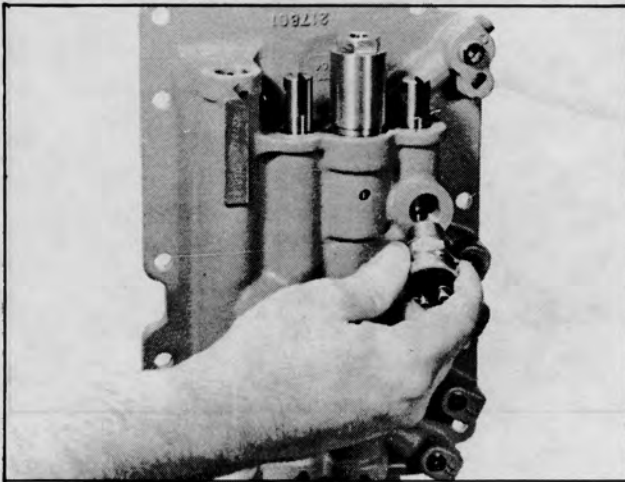


Plate 8004.

Remove the neutral switch and spacer washer from the control cover.

CAUTION

IF THE CONTROL COVER IS CLAMPED IN A VISE FOR DISASSEMBLY - BE SURE THE VISE IS EQUIPPED WITH A SET OF SOFT JAWS - EXERCISE CARE TO AVOID SCRATCHING THE POLISHED SURFACES OF THE COVER.

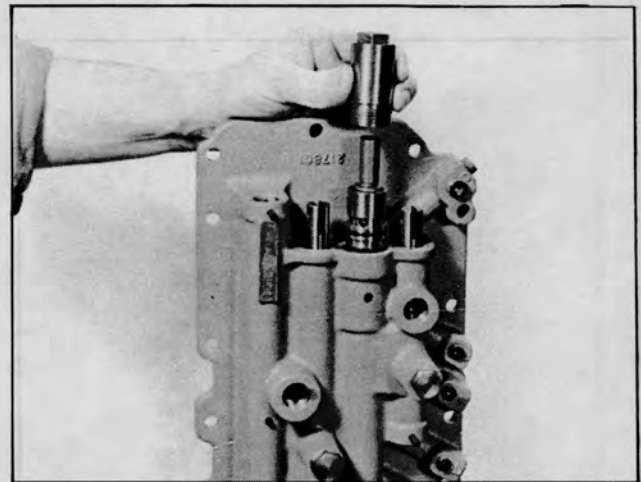


Plate 8006.

Unscrew the inching piston housing and remove inching piston seal housing and its components.

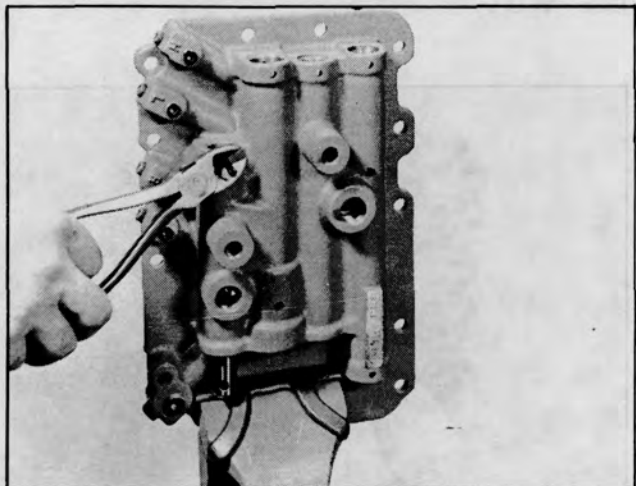


Plate 8007.

Remove roll pins from cover with side cutters. When removing the roll pins from the convertor regulator and pressure regulator bores, wrap a cloth around the end to catch the stop and spring which is held under pressure by the roll pins.

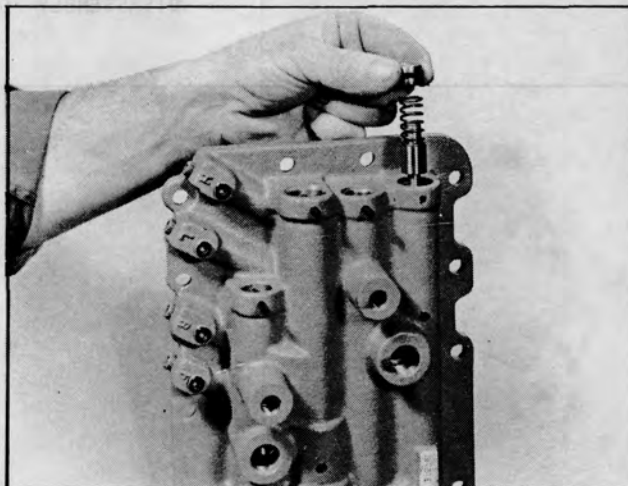


Plate 8009.

Remove the stop, spring and convertor pressure regulating valve from housing.

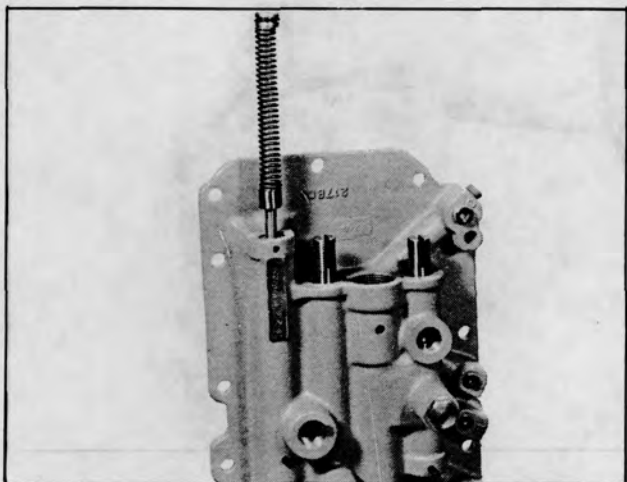


Plate 8008.

Remove the stop, spring and pressure regulating valve from the housing.

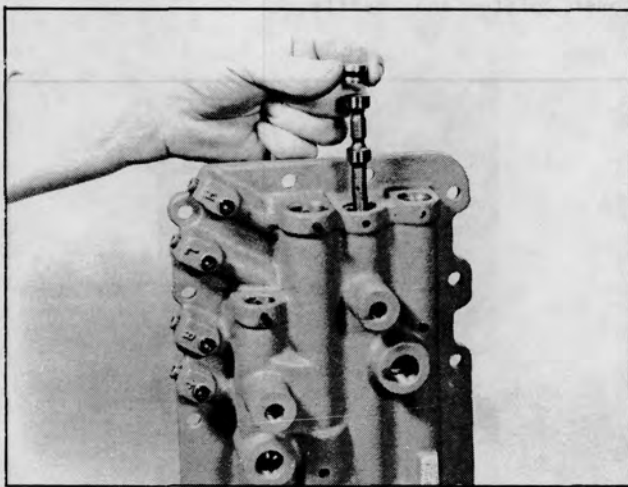


Plate 8070.

Remove stop and high and low selector valve.

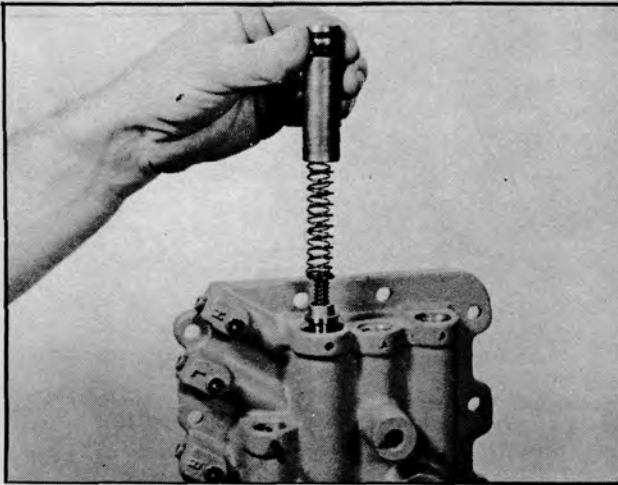


Plate 8071.

Remove inching valve and components shown above.

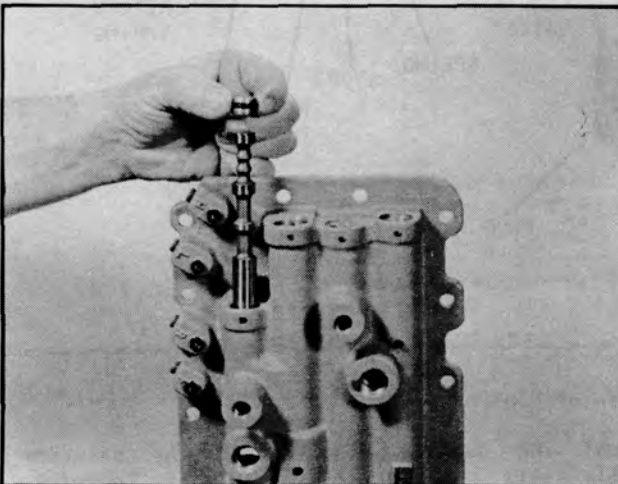


Plate 8072.

Remove the stop and forward and reverse selector spool. Pry the spool oil seals from the cover. Exercise caution so as not to scratch the spool bore during removal of the seals.

**CLEANING AND INSPECTION**

**CLEANING:** Clean all metal parts thoroughly using a Stoddard Type cleaning solvent. It is recommended that parts be immersed in cleaning solvent and gently agitated until all old lubricant and foreign material is removed and parts are thoroughly cleaned. All parts cleaned should be dried by using moisture-free compressed air.

**INSPECTION:** The importance of careful and thorough inspection of all parts cannot be overstressed. Any parts showing wear or an indication of stress should be discarded and new parts installed. It is more economical to replace a questionable part at this time than risk the possibility of a premature malfunction, necessitating a teardown of the assembly for replacement of faulty items.

**Oil Seals, Inching Cup, "O" Rings and Cover Gasket:** These items should be replaced with new parts. Apply a thin coat of Permatex #2 on the outer diameter of the seals to assure an oil tight fit in their retainers. Immerse inching cup in UCON-1145 fluid and lubricate sealing rings and inner diameter of oil seals with Automatic Transmission Fluid before assembly.

**Spools, Valves and Housing:** Inspect housing bores, valves and spools to be certain they are thoroughly cleaned and that mating surfaces are free from nicks or burrs. Minor nicks or burrs may be removed with a pocket type hone.



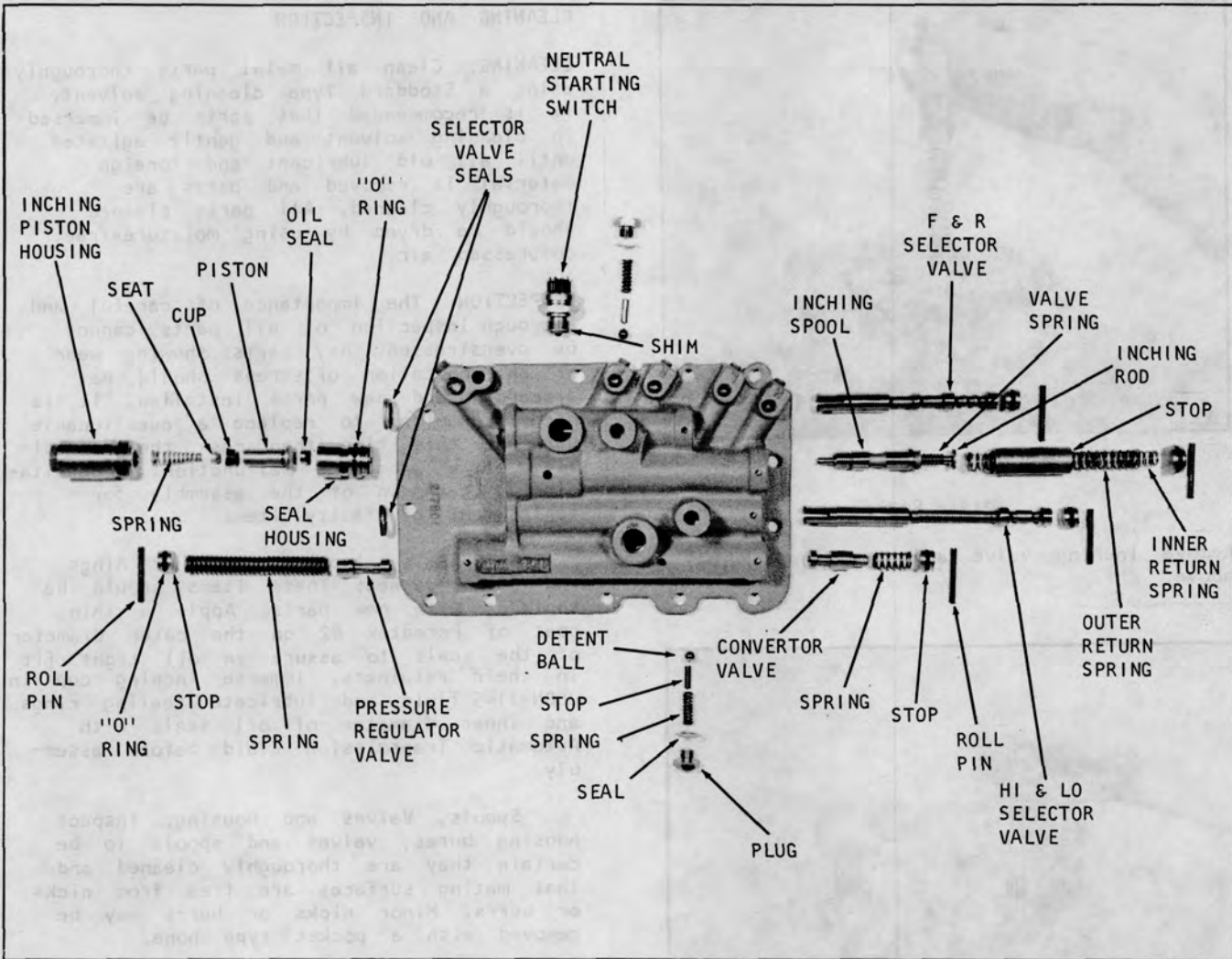


Plate 8002. Disassembled View of Control Cover

**REASSEMBLY OF CONTROL COVER**

See Plate 8002 for sequence of parts and parts identification.

**NOTE**

LUBRICATE ALL VALVES, SPRINGS, 1/10\"/>

Coat the outside diameter of the selector oil seals with a light coat of Permatex number 2 to assure an oil tight fit in the housing.

Using the correct diameter seal driver, press the seals into the housing.



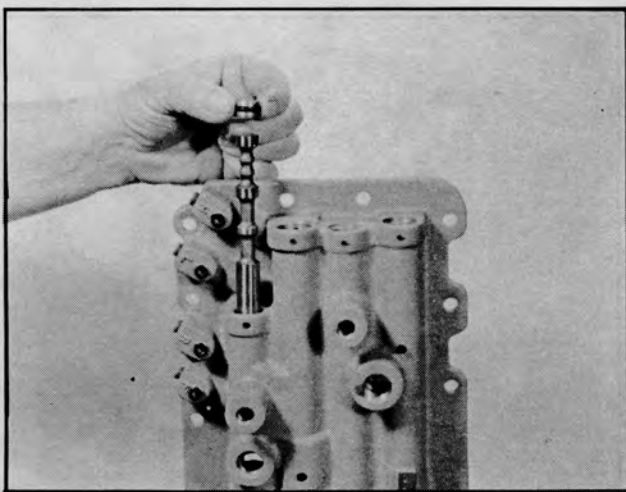


Plate 8072.

Exercise caution to avoid damaging the lip of the oil seal during installation of the selector spool. Place a new "O" ring on the stop and push it into the housing.

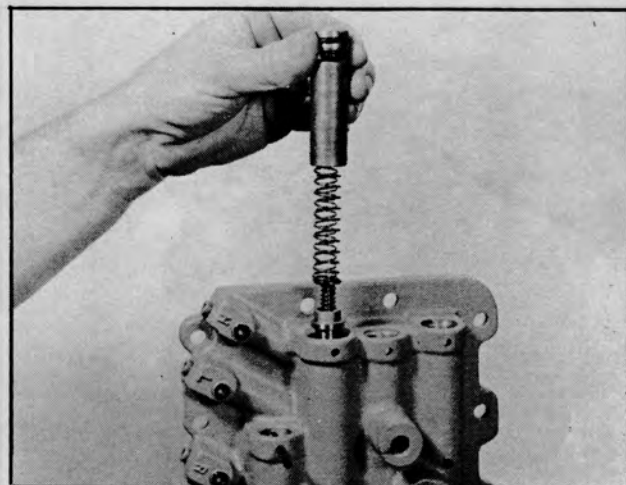


Plate 8071.

Install inching valve and components shown above. Replace roll pin.

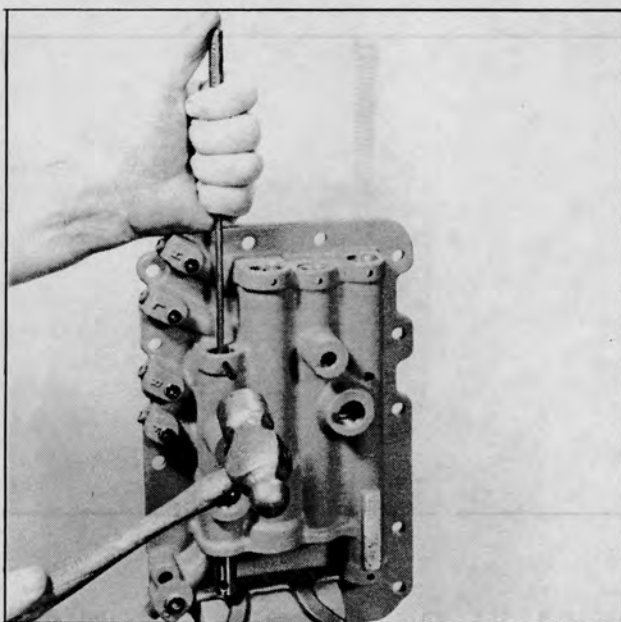


Plate 8073.

Start a roll pin in the housing. Push down stop with a punch and tap roll pin in to retain the stop. This procedure will be repeated at each roll pin after the necessary components are installed in their bores.

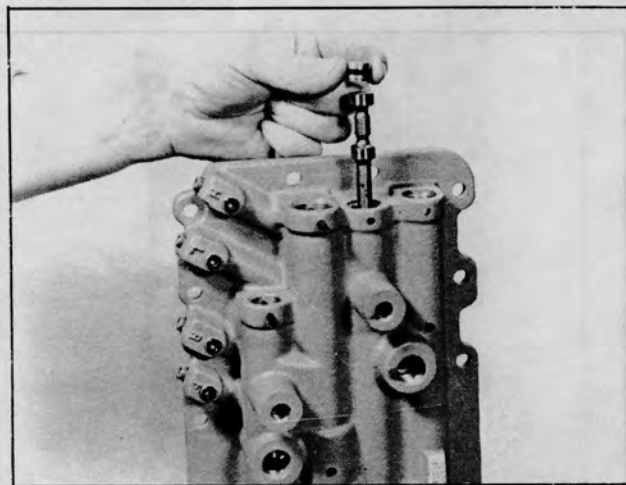


Plate 8070.

Exercise caution to avoid damaging the lip of the oil seal during installation of the high & low selector spool. Place a new "O" ring on the stop and push it into the housing. Install the retaining roll pin.

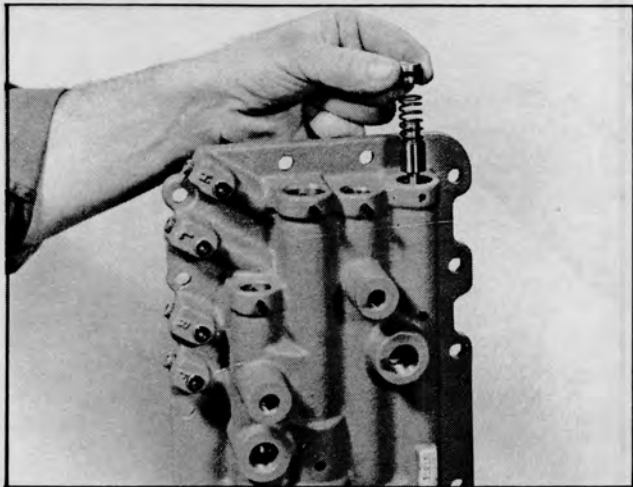


Plate 8009.

Install the converter pressure regulating valve, spring and stop. Replace the retaining roll pin.

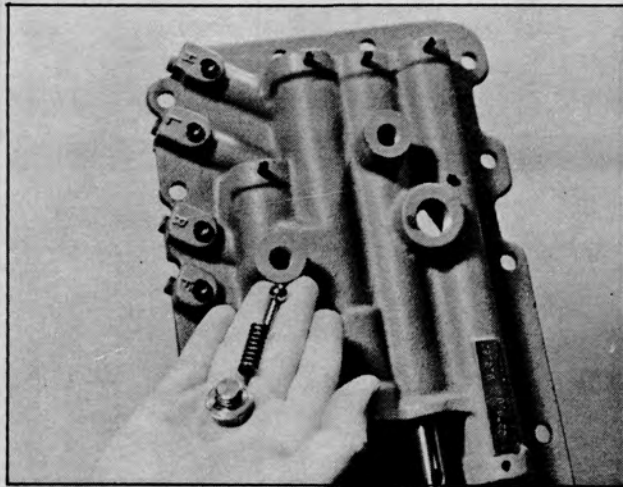


Plate 8005.

Replace the detent ball, stop, spring, seal washer and plug in the hole provided at the forward and reverse selector spool. Replace a set of identical parts at the high and low selector spool.

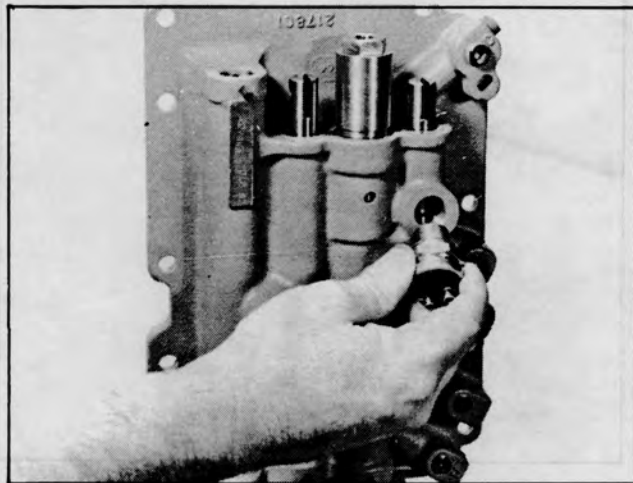


Plate 8008.

Install the pressure regulating valve, spring and stop. Replace retaining roll pin.

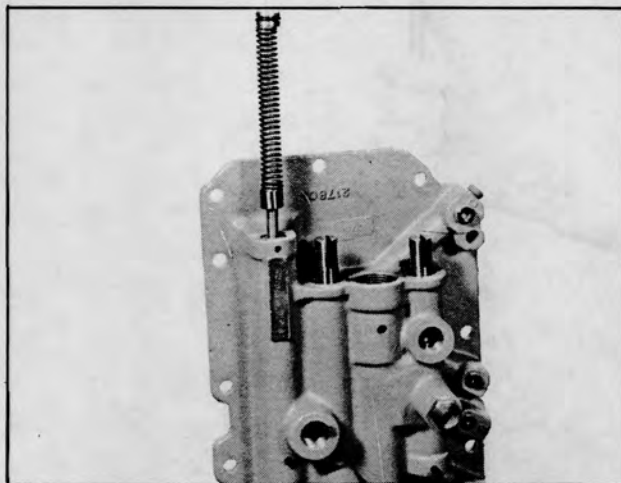


Plate 8004.

Replace the shim and neutral starting switch at the forward and reverse selector spool.

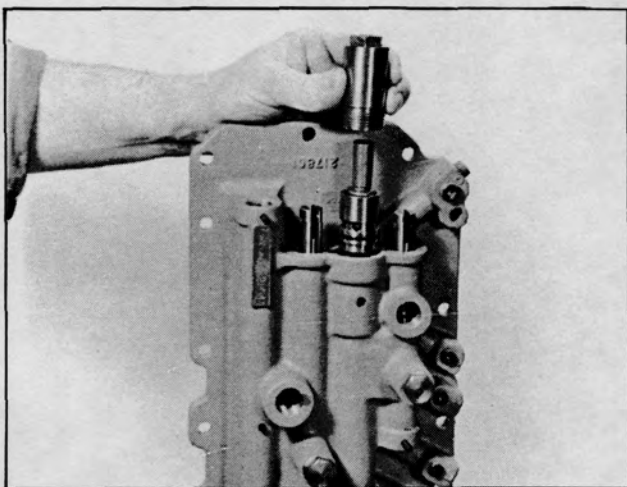


Plate 8006.

Press a new oil seal in the inching piston seal housing. Install a new "O" ring and with finger pressure, push the housing into its seat in the control cover. Next place the inching piston in the seal housing. Install a new cup in the inching piston housing and screw housing into cover. Refer to disassembled view of control cover (Plate 8002) for correct sequence of parts.

N O T E

Immerse inching piston cup in UCON 1145 Fluid before installing it in the housing.

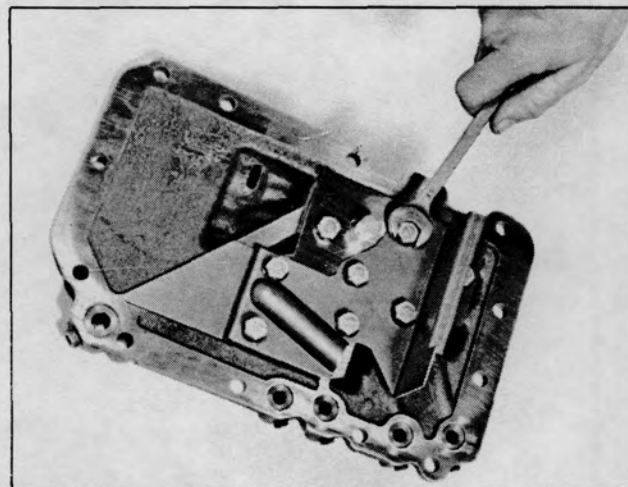


Plate 8003.

Replace the control cover plate and baffle. Secure with the capscrews and lockwashers.



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WHEN APPLYING BRAKE HYDRAULIC PRESSURE  
92# ± 5 TO INCHING VALVE "F" AND "R"  
CHECKED INDIVIDUALLY MUST DROP OFF TO  
3# ± 2 P.S.I. MAX. WITH INCHING BREAK  
OFF POINT OF 55# ± 5

IMMERSE IN UCON-1145 FLUID BEFORE ASSEM.

UNLESS OTHERWISE SPECIFIED

IMMERSE ALL OIL SEALS IN TYPE "A"  
TRANSMISSION FLUID BEFORE ASSEMBLY

OIL ALL "O" RINGS BEFORE ASSEMBLY

TIGHTEN ALL CAP SCREWS 20-25 FT. LBS. TORQUE

OIL FLOW TO CONTROL FROM FILTER  
5-7 GALLONS AT 1300 RPM ENGINE  
8-11 GALLONS AT 2000 RPM ENGINE  
TO BE TESTED WITH 200° F. OIL  
LEAKAGE-WITH F & R IN NEUTRAL  
& H OR L ENGAGED. LEAKAGE MUST  
NOT EXCEED .2 GAL.

CONV. PRESS. 60 PSI AT  
1300 RPM. NOT TO EXCEED  
75 PSI AT 2200 RPM  
ENGINE.

NEUTRAL SWITCH (12 VOLTS)  
NEUTRAL-SWITCH CLOSED  
FOR. & REV.-SWITCH OPEN  
NEUTRAL START SWITCH TEST  
SEE NOTE

OIL PRESSURE CHECK  
AT 1300 RPM ENGINE  
120 LBS MIN-135 LBS MAX

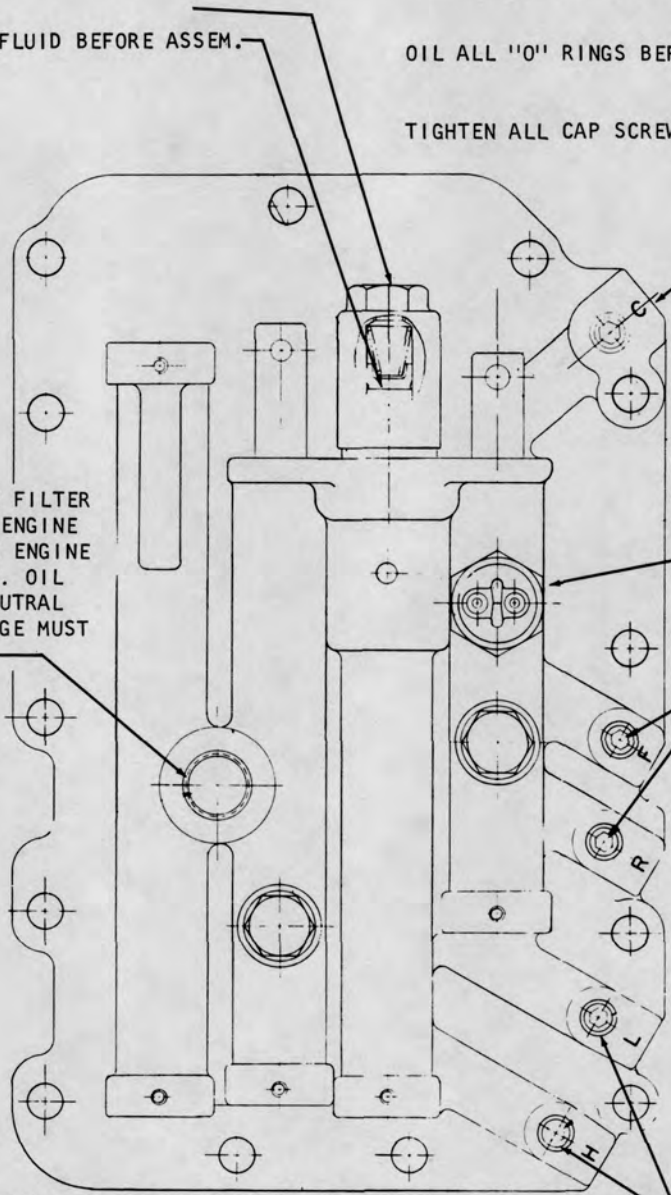
NOTE

NEUTRAL START SWITCH TEST

- 1-WIRE SWITCH INTO TEST STAND LIGHT CIRCUIT
- 2-WITH ENGINE RUNNING & TRANSMISSION IN LOW  
FOR., NUDGE CONTROL FOR. & REV. SPOOL  
SLOWLY TOWARD NEUTRAL. IF SWITCH DOES NOT  
MAKE CONTACT REPEAT STARTING IN LOW REV.  
IF IN EITHER TEST CONTACT IS MADE WHEN NOT  
IN DEAD NEUTRAL, SWITCH IS TO BE SHIMED,  
TILL TEST SHOWS PROPER FUNCTION.

OIL PRESSURE CHECK

- AT 1300 RPM ENGINE-150 LBS. MIN.
- AT 2200 RPM ENGINE-165 LBS. MAX.





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BATTLE CREEK, MICHIGAN, U.S.A.



# MASTER MAINTENANCE MANUAL



## HOW TO USE THIS HANDBOOK

COURTESY OF:  
SUN ELECTRIC CORPORATION

PAGE  
NO.

# INDEX

To fully utilize all of the facilities of your test equipment, and thereby realize its many values and applications in your service operation, it is suggested that you carefully study the sections of this Handbook that pertain to the pieces of test equipment in your possession.

For your convenience, this handbook is designed to provide application and use data pertinent to a number of testers which can be used individually or in many combinations. As you will note, a complete section, detailed as to application, procedure, results and indications, is provided for each test unit. In addition, a complete sequence of tests, combining the facilities of all the testers, is outlined for the more skilled operator under the heading of "Condensed Test Procedure."

Each step in the Condensed Procedure sequence is labeled to indicate what information is to be gained, and is also identified with the particular tester required to perform the test. When the need for more detailed tests of a given area are required, the operator need only refer to the section of the handbook dealing with the specific tester involved.

Whether your shop is equipped with all, or just a few of the testers covered in this publication, it will be to your advantage to review its various sections periodically to make sure you are not overlooking any of the many valuable functions and applications of the test equipment at your disposal.

### TESTER MAINTENANCE

SUN test equipment is the finest available and retains its accuracy and long life with a minimum of care. The test leads can be quickly cleaned with waterless soap or solvent. Do not use gasoline as it will deteriorate the rubber. The metal work can be kept glossy with any good automobile polish. To assure accurate test results, meter pointers must read zero when all tester switches are off. To zero a meter, turn the adjustment button on the face of the meter.

Test Report .....	11TS000B
Condensed Procedure.....	11TS000C - H
Cylinder Leakage Test .....	11TS000J - L
Ignition Primary Circuits .....	11TS000M
Volts - Ignition Tester .....	11TS000N - V
Tach - Dwell Tester .....	11TS000W & X
Electronic Distributor Tester	11TS000Y-AA
Sun Scope .....	11TS000AB - AS
Fuel Pump Tester .....	11TS000AT
Combustion - Efficiency Tester	11TS000AU-Y
Vacuum - Pressure Tester	11TS000AZ - BB
Coil - Circuit Tester .....	11TS000BC - BF
Condenser - Resistance Tester .....	11TS000BG - BH
Generator Field Control .....	11TS000BJ



# MASTER MAINTENANCE MANUAL



## Engine Tune-Up Test Report

ORDER NO. \_\_\_\_\_

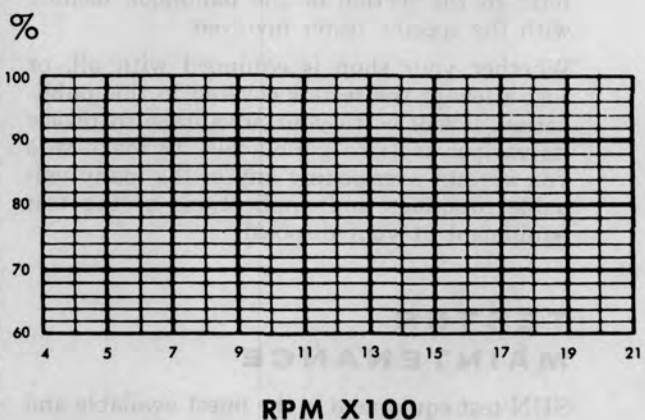
CUSTOMER NAME \_\_\_\_\_ DATE \_\_\_\_\_

ADDRESS \_\_\_\_\_ PHONE \_\_\_\_\_

MAKE \_\_\_\_\_ MODEL \_\_\_\_\_ MILEAGE \_\_\_\_\_ LICENSE NO. \_\_\_\_\_

CUSTOMER COMMENTS: \_\_\_\_\_

TESTS	SPECS.	RESULTS	RECOMMENDATIONS
Cylinder Leakage .....	20% or Less		1 _____ 2 _____ 3 _____ 4 _____ 5 _____ 6 _____ 7 _____ 8 _____
Spark Plug Inspection .....			
Cranking Voltage .....			
Cranking Vacuum .....			
Distributor Resistance .....	Black Bar		
Coil-Output-Cranking .....	+20KV		
Dwell .....			
Dwell Variation .....			
Initial Timing .....			
Timing Advance .....			
Coil Polarity .....			
Plug Firing Voltage .....			
Available Voltage .....			
Secondary Insulation .....			
Secondary Resistance .....			
Spark Plugs Under Load .....			
Point Action .....			
Coil and Condenser .....			
Fuel Pump-Pressure .....			
Volume .....			
Carburetor Tests .....			
Idle .....			
Intake Manifold .....			
Intermediate .....			
High .....			
Accelerating .....			
Air Cleaner .....			
Charging Voltage .....			
Final Idle Adjustment .....			
<b>STARTING SYSTEM</b>			
Battery Capacity .....			
Cables & Switches .....			
Starter Amp. Draw .....			
<b>CHARGING SYSTEM</b>			
Circuit Resistance .....			
Generator Output .....			
Cut-Out Relay .....			
Voltage Regulator .....			
Current Regulator .....			





# CONDENSED TEST PROCEDURE

The Condensed Test Procedure outlined in this section of the Handbook is designed primarily for the operator who has already acquired some degree of skill in using the individual test instruments at his disposal and interpreting the test results obtained. Note that each step in the Condensed Test Procedure is "keyed", indicating which test instrument is being utilized to perform each test. (If your tester is equipped with the Sun Scope, omit steps 8 and 9. However, if your tester is equipped with a Volts Ignition Tester, omit steps 10 through 17.)

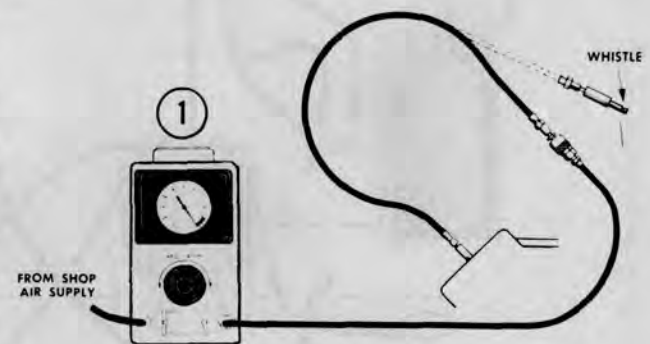
A Condensed Test Procedure is quite valuable for a number of reasons. For the purpose of determining exactly what specific services will be required, prior to writing a work order, it may be used to quickly determine the condition of the five important power plant areas. The Condensed Test Procedure may also be used in conjunction with the actual tune-up operation. In this manner, the test instruments are used to assist in making the various tune-up adjustments and calibrations. In addition, the Condensed Test Procedure, as a whole or in part, may perform a quality control function: the tests being performed prior to vehicle delivery to make sure that all necessary work had been completed, and that the powerplant is now operating at top efficiency.

## 1. Cylinder Leakage Test . . . (Cylinder Leakage Tester)

- a. Remove Spark Plugs.
- b. Remove air cleaner, crank case filler cap and radiator cap. Set throttle valve to wide open position and fill radiator to prescribed level.
- c. Connect shop air line to tester and calibrate tester.
- d. Install adapter in No. 1 spark plug hole and attach whistle.
- e. Use whistle to locate TDC of No. 1 cylinder.
- f. Install TDC indicator and connect indicator light to distributor.
- g. Connect tester hose and note percentage of leakage. Listen for sound of leakage at carburetor, oil filler, tail pipe and check for bubbles at the radiator.
- h. Disconnect tester hose, rotate engine to next marker on TDC indicator.
- i. Install adapter in next cylinder in engine's

It is suggested that all the pertinent specifications and data applicable to the vehicle being tested be first recorded on a Test Report Form, such as the one illustrated on the adjoining page. In this manner, the operator is assured of having all the necessary information readily available for reference during the test sequence. In reviewing the Condensed Test Procedure and the arrangement of the Test Report Form, it is readily apparent that both follow a similar, step-by-step arrangement. The Test Report Form serves an important function in the service operation if the results of each test are recorded on it. The completed report can then be used later as a guide in writing the shop work order, or as a factual reference in discussing service requirements with the vehicle owner.

As you will note, the Cylinder Leakage Test and Spark Plug Visual Inspection are listed as preliminary steps to the Condensed Test Procedure. The final results of any tune-up work performed depend to such a great extent on the condition of the engine itself that it is highly recommended that a Cylinder Leakage Test become a step in every major tune-up or engine service operation. Naturally, when service work is being confined to just one or two areas or systems of a vehicle, only the applicable portions of the Condensed Procedure need be used.



firing order and repeat test.

- j. Repeat test on all cylinders, following sequence of engine's firing order.

## 2. Spark Plug Visual Inspection

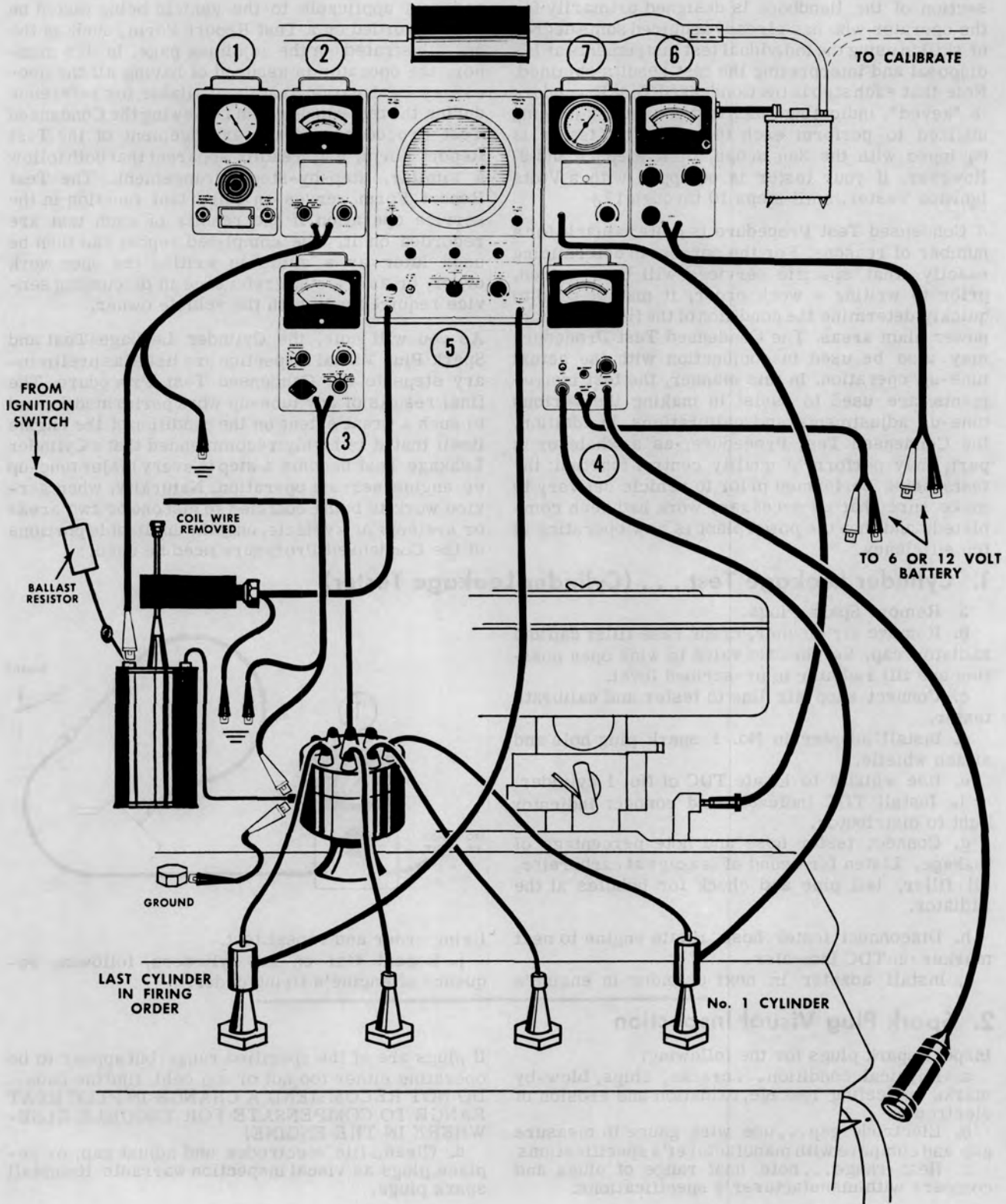
Inspect spark plugs for the following:

- a. Physical condition... cracks, chips, blow-by marks indicating leakage, oxidation and erosion of electrodes.
- b. Electrode gap... use wire gauge to measure gap and compare with manufacturer's specifications.
- c. Heat range... note heat range of plugs and compare with manufacturer's specifications.

If plugs are of the specified range, but appear to be operating either too hot or too cold, find the cause. **DO NOT RECOMMEND A CHANGE IN PLUG HEAT RANGE TO COMPENSATE FOR TROUBLE ELSEWHERE IN THE ENGINE!**

- d. Clean, file electrodes and adjust gap; or replace plugs as visual inspection warrants. Reinstall spark plugs.

Connections to Vehicle



A. Tach-Dwell Tester: . . . Set switches to CALIBRATE and DWELL positions and adjust the dwell calibrator until the meter reads to SET LINE. Connect leads to primary terminal of distributor and to ground, observing proper polarity.

B. Vacuum Gauge: . . . Connect hose to intake manifold.

C. Electronic Distributor Tester: . . . Connect battery leads to car battery, observing proper polarity. Connect pickup to No. 1 spark plug.

D. Jumper Lead: . . . Connect to distributor primary lead and to ground.

E. Volts-Ignition Tester: . . . Set switch to voltage position which corresponds to vehicle voltage. Observing proper polarity, connect leads to battery side of coil and to ground.

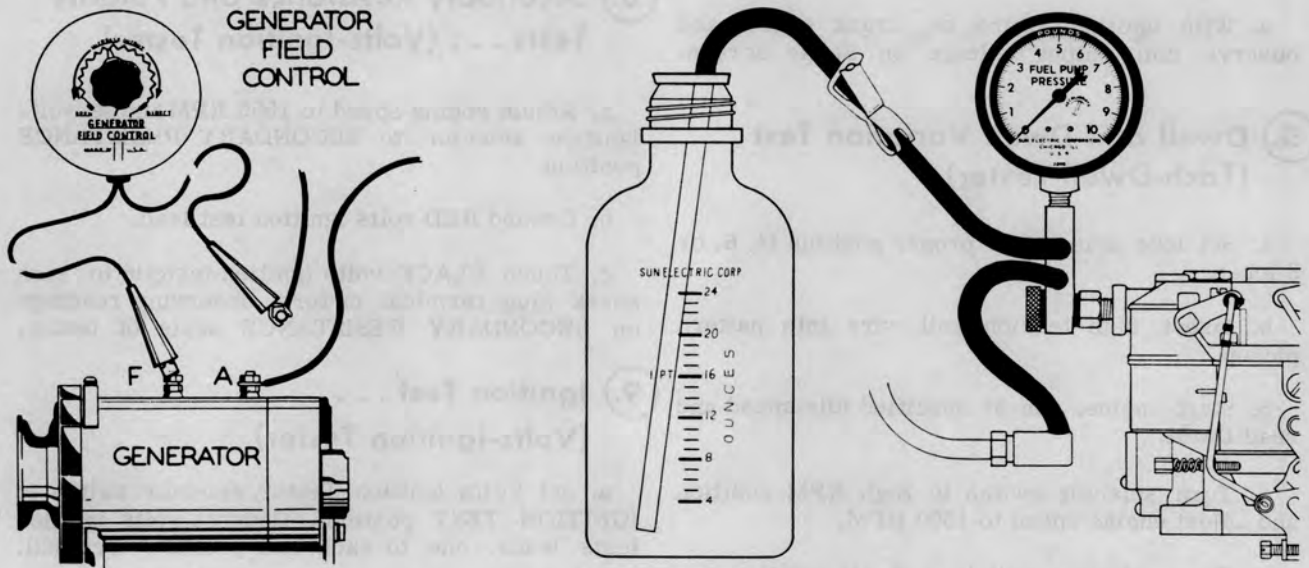
F. Combustion Efficiency Tester: . . . Observing

polarity, connect battery leads to car battery. Connect one end of neoprene hose to exhaust condenser, and the other end to the fitting on the combustion tester.

G. Sun Scope: . . . Plug power cord into proper outlet. Connect scope's trigger pickup into circuit of last spark plug in engine's firing order. Remove high tension wire from coil and leave disconnected. Insert pattern pickup into coil tower and attach ground clip to ground. Set polarity switch to POSITIVE position, turn display selector to SCOPE CHECK position and adjust scope until trace appears on "Zero" line.

H. Generator Field Control: . . . Disconnect generator field wire at either end and attach GFC leads; one to end of field wire, the other to terminal. Set GFC to OPEN position.

I. Fuel Pump Tester: . . . Disconnect main fuel line at carburetor and mount Fuel Pump Tester to carburetor fuel fitting. Connect vehicle's fuel line to fitting on Fuel Pump Tester hose.





**1. Cranking Voltage . . .  
(Volts-Ignition Tester)**

- a. Turn ignition switch ON. (For safety, set parking brake and shift transmission to neutral.)
- b. Crank engine, observe cranking speed and note reading on Voltmeter.

**2. Cranking Vacuum Test . . .  
(Vacuum Pressure Tester)**

- a. Back out throttle stop screw and release automatic choke so that throttle valves can seat tightly.
- b. Crank engine, noting Vacuum Gauge readings.

**3. Distributor Resistance Test . . .  
(Tach-Dwell Tester)**

- a. Remove jumper lead from distributor.
- b. With ignition switch on, Dwellmeter should read in black bar at right end of scale.

**4. Coil Output Voltage at  
Cranking Speed . . . (Sun Scope)**

- a. With ignition switch on, crank engine and observe coil output voltage on Scope screen.

**5. Dwell and Dwell Variation Test . . .  
(Tach-Dwell Tester)**

- a. Set lobe selector to proper position (4, 6, or 8 lobe).
- b. Insert high tension coil wire into pattern pickup.
- c. Start engine, run at specified idle speed and read Dwell.
- d. Turn selector switch to High RPM position and adjust engine speed to 1500 RPM.
- e. Turn selector switch to dwell position and read Dwellmeter.
- f. Observe dwell reading as engine speed is reduced to idle, noting any difference in dwell readings at 1500 RPM and at idle.

**6. Initial Ignition Timing . . .  
(Electronic Distributor Tester)**

- a. Turn Tach-Dwell selector switch to LOW RPM position.
- b. Turn Electronic Distributor Tester ON and set advance control to TIMING position.
- c. Operate engine at specified timing speed, and note timing. Adjust if necessary.

**7. Ignition Timing Advance Test . . .  
(Electronic Distributor Tester)**

- a. Turn Tach-Dwell switch to HIGH RPM position.
- b. Adjust engine speed to 2500 RPM and adjust advance control until timing mark appears in its original position. Read degrees of advance on tester meter.
- c. Turn Electronic Distributor Tester OFF.

**NOTE** For ignition tests with the Sun Scope, follow steps 10 through 17.

**8. Secondary Resistance and Polarity  
Tests . . . (Volts-Ignition Tester)**

- a. Adjust engine speed to 1500 RPM and set volts ignition selector to SECONDARY RESISTANCE position.
- b. Ground RED volts ignition test lead.
- c. Touch BLACK volts ignition testclip to each spark plug terminal in turn, observing readings on SECONDARY RESISTANCE scale of tester.

**9. Ignition Test . . .  
(Volts-Ignition Tester)**

- a. Set Volts Ignition Tester selector switch to IGNITION TEST position. Connect volts ignition tests leads, one to each coil primary terminal.
- b. Set engine speed to 1500 RPM. (To 1000 RPM for Ford V8, Lincoln and Mercury.)
- c. Adjust Ignition Test calibrator to proper SET LINE.



**9. Ignition Test . . .**  
**(Volts-Ignition Tester) (Continued)**

d. Using insulated pliers, lift off any one spark plug wire and note reading on IGNITION TEST scale of meter. Reconnect wire.

**NOTE** To check insulation of all wires and all portions of distributor cap for cracks and carbon tracks, repeat step d at each spark plug.

**IF TESTER IS NOT EQUIPPED WITH THE SUN SCOPE, PROCEED WITH STEP 18**

**10. Coil Polarity Test . . .**  
**(Sun Scope)**

- a. Adjust engine speed to 1200 RPM.
- b. Turn Scope Display Selector to ALL CYLINDERS position, and adjust Pattern Length control until all cylinders appear between the vertical lines on both sides of the screen.
- c. Rotate Pattern Shift control counterclockwise until last pattern on screen appears complete.
- d. Observe patterns, noting whether they are upright or inverted.

**11. Required (Firing) Voltage Test . . .**  
**(Sun Scope)**

- a. Observe height of each firing line and compare firing lines for uniformity of height.

**12. Available Voltage Test . . .**  
**(Sun Scope)**

- a. Use insulated pliers to disconnect a wire from a spark plug and hold the spark plug wire away from any ground.
- b. Observe Scope pattern, noting upward extent of pattern which represents available voltage in kilovolts.

**13. Secondary Insulation Test . . .**  
**(Sun Scope)**

- a. Observe downward extent of pattern of cylinder with spark plug wire removed.
- b. Reconnect wire to spark plug.
- c. Test secondary circuits to other cylinders in the same manner. (Trigger cylinder may be tested in "SCOPE CHECK" position.)

**14. Secondary Resistance Test . . .**  
**(Sun Scope)**

- a. With Display Selector in ALL CYLINDERS position, observe and compare spark line of patterns for height, length, angle and oscillations. (For closer examination, the pattern for any given cylinder may be expanded, viewed individually, or compared with that of another cylinder.)

**15. Spark Plugs Under Load . . .**  
**(Sun Scope)**

- a. With Display Selector set in ALL CYLINDERS position, rotate Pattern Shift control FULL CLOCKWISE.
- b. Momentarily accelerate engine to approximately 2000 RPM, then allow engine speed to return to 1200 RPM.
- c. Observe rise of firing lines during momentary engine acceleration.

**16. Point Condition and Action . . .**  
**(Sun Scope)**

- a. Turn Display Selector to the INDIVIDUAL CYLINDER position.
- b. Observe point CLOSE and point OPEN signal.

**17. Coil and Condenser . . .**  
**(Sun Scope)**

- a. Observe and note the number of oscillations in the intermediate section of the Scope patterns.
- b. Reduce engine speed to idle.

**18. Fuel Pump Pressure and Volume Test . . . (Fuel Pump Tester)**

- a. Adjust engine speed to approximately 500 RPM unless otherwise specified.
- b. Observe pressure gauge and note fuel pump pressure.
- c. Insert Volume Test hose into graduated contained and open clamp.
- d. Observe time required for pump to deliver one pint of fuel.

**19. Idle Mixture Test . . . (Combustion Efficiency Tester)**

- a. Set Combustion Tester switch to BATTERY position and adjust BATTERY CALIBRATOR until meter reads on its SET LINE.
- b. Set Combustion Tester switch to COMBUSTION position and adjust COMBUSTION CALIBRATOR until meter again reads on SET LINE.
- c. Insert metal pickup hose in tail pipe of vehicle.
- d. Adjust engine speed to specified idle RPM.
- e. Observe idle RPM, combustion efficiency, and vacuum readings.

**20. Manifold Leak Test . . . (Combustion Efficiency Tester)**

- a. With engine operating at idle speed, use a squirt can to apply a mixture of engine oil and kerosene to the carburetor flange gasket and intake manifold gaskets.
- b. Observe Combustion Tester meter for any unusual deflections towards the rich side.

**21. Carburetor Mixture Curve . . . (Combustion Efficiency Tester)**

- a. Accelerate engine slowly, pausing at intervals of approximately 200 RPM long enough to permit the Combustion Efficiency Meter to stabilize.
- b. Observe and note combustion efficiency reading at each step in test sequence.

**NOTE** Upon completion of the test sequence, disconnect test leads and hoses. Make sure all electrical, fuel and vacuum connections on vehicle are secure.

**22. Accelerator Pump Test . . . (Combustion Efficiency Tester)**

- a. Set engine speed to 1000 RPM and allow combustion reading to stabilize.
- b. Accelerate quickly to approximately half throttle and immediately drop speed back to 1000 RPM.
- c. Observe combustion meter for the amount of temporary enrichment.

**23. Air Cleaner Test . . . (Combustion Efficiency Tester)**

- a. With engine operating at 2000 RPM, observe combustion meter reading with air cleaner in place on carburetor, and observe combustion meter reading with air cleaner removed from carburetor.
- b. Compare meter readings observed.

**24. Charging Voltage Test . . . (Volts-Ignition Tester)**

- a. Set Generator Field Control to DIRECT position.
- b. Reconnect Volts Ignition test leads to insulated battery post and to ground, observing polarity.
- c. Set Tester selector switch to VOLTAGE position which corresponds to vehicle voltage.
- d. Set engine speed to 1500 RPM.
- e. Wait until voltmeter pointer stops rising, then read charging voltage.

**25. Final Idle Adjustment**

- a. Reduce engine speed to idle.
- b. Observe idle RPM, combustion efficiency, and vacuum readings.
- c. Adjust Vacuum Dampener until gauge responds freely, but does not flutter excessively.
- d. Adjust carburetor idle mixture for highest, steady vacuum. Idle should be smooth with mixture and speed within specifications.

# THE CYLINDER LEAKAGE TESTER

In the modern automotive engine, improved designs and higher compression ratios are providing greater power, performance and economy; but the valves, rings, and cylinder heads are being subjected to greater combustion pressures than ever before. These advances in engine design have increased the need for better and more accurate means of testing cylinder leakage.

The Cylinder Leakage Tester will point out exhaust and intake valve leaks, leaks between cylinders or into the water jacket, or any other causes of compression loss. This tester applies air to the cylinder at controlled volume and pressure and measures the percentage of cylinder leakage. Even

the smallest cylinder leak can easily be detected.

Satisfactory Engine performance depends first of all upon a mechanically sound engine. In many cases, unsatisfactory performance and rough idle is caused by combustion chamber leakage. Experience and research have established that a compression test alone may not show up this fault.

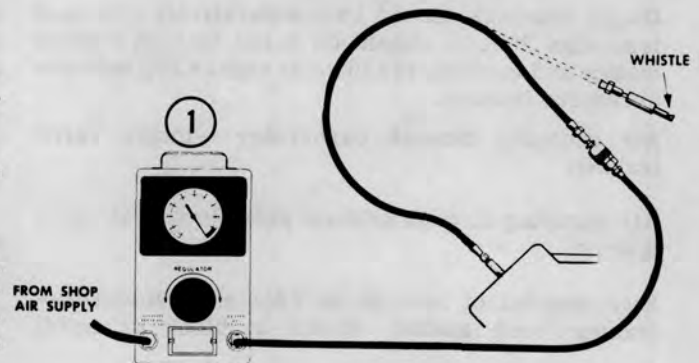
It is normal for a small amount of air to escape past the rings into the crankcase. However, any leak through an intake valve, an exhaust valve, head gasket, head, block, or excessive leakage past the rings indicates trouble which must be corrected before satisfactory engine performance can be expected.

## PREPARATION OF ENGINE

1. Run engine until normal operating temperature is reached.
2. Stop engine, loosen all spark plugs approximately one turn to break free any accumulated carbon adjacent to the spark plugs.
3. Start engine and accelerate to approximately 1000 RPM, to blow out the loosened carbon.
4. Stop engine and remove any foreign matter from around the spark plugs with compressed air.
5. Remove all spark plugs and gaskets or tubes, if used.
6. Remove air cleaner and set carburetor throttle valve to wide open position.
7. Remove crankcase filler cap.
8. Remove radiator filler cap. If coolant level is low, fill to prescribed level.

## TESTER CALIBRATION

1. Turn pressure regulator knob counter-clockwise until it turns freely.
2. Connect shop air supply to tester "air inlet" fitting. (minimum 70, maximum 200 PSI.)
3. Turn pressure regulator knob clockwise until gauge reads ZERO. Momentarily connect then disconnect test adapter. (The pointer on the gauge should return to ZERO. If not, readjust pressure regulator and recheck adjustment.)

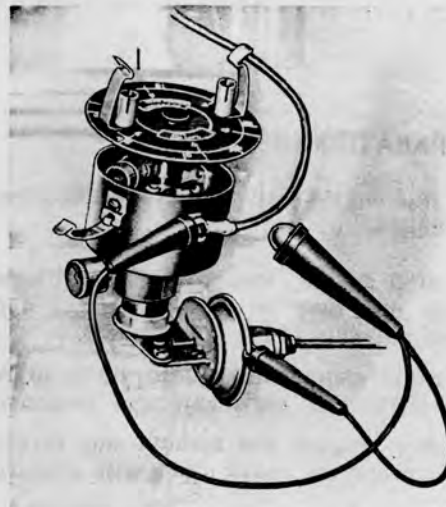




**PROCEDURE**

1. Select the proper adapter and install in the spark plug hole of number one cylinder. Attach whistle to adapter in the cylinder.
2. Rotate engine until whistle sounds. Continue to rotate engine slowly until engine timing mark (TDC) aligns with engine timing pointer. Remove whistle from the adapter.
3. Remove distributor cap from distributor and connect coil secondary lead to ground.
4. Mount "TDC" indicator on distributor shaft or rotor and chalk mark a suitable reference point on an adjacent surface of the engine which aligns with an applicable mark on the "TDC" indicator.
5. Connect the "Indicator Light"; one lead to the distributor primary terminal, other lead to ground. Turn vehicles ignition switch "ON".
6. Connect tester hose to adapter and note the percentage of leakage on the tester gauge. Listen for escaping air through the carburetor, the exhaust or tail pipe, and the crankcase filler pipe. Check for air bubbles in the radiator.
7. Disconnect tester hose from adapter and rotate engine until the next applicable mark on the "TDC" indicator is aligned with the chalk mark on the engine. NOTE: Indicator light will glow when piston is in firing position.
8. Remove the adapter from the cylinder previously tested and install it in the next cylinder in the engine's firing order. (Piston in this cylinder is now at top dead center.)
9. Repeat steps 6, 7, and 8 until all cylinders have been tested.

Typical applications of the  
TOP DEAD CENTER INDICATOR



**Results and Indications**

Gauge readings should be comparatively even and less than 20%. It should be noted that on certain makes and models, readings as high as 20% indicate excessive leakage.

Air escaping through carburetor---intake valve leaking.

Air escaping through exhaust pipe---exhaust valve leaking.

High percent of leakage on adjacent cylinders---leaking head gasket, crack in block or head.

Air escaping through radiator---leaking head gasket, crack in block or head.

High percent of leakage in crank case---worn rings or cylinder walls, stuck or broken rings, cracked piston.

**NOTE** Analysis of ring and cylinder wall condition should be made with consideration to case history and mileage of the engine.

Occasionally, in cases where high percentage of leakage is noted on engines with comparatively low mileage which could be attributed to stuck piston rings, it is advisable to treat the engine with a good grade of tune-up or break-in oil for a period of time and then retest, before recommending that the engine be disassembled for major service.

For testing Cylinder Leakage of diesel engines, a kit of Diesel Adapters is available from Sun Electric Corporation.



model CLT-228

A new concept in Engine Testing. This unique tester pin points the location and extent of compression leaks before engine disassembly. Valves tested for leakage. Piston rings checked for wear and blow-by. No Guess-work. Pin points accurately, burnt valves, worn and broken rings, and scored or tapered cylinders. Tests all internal combustion engines —gasoline, propane, and diesel; either 2 or 4 cycle.

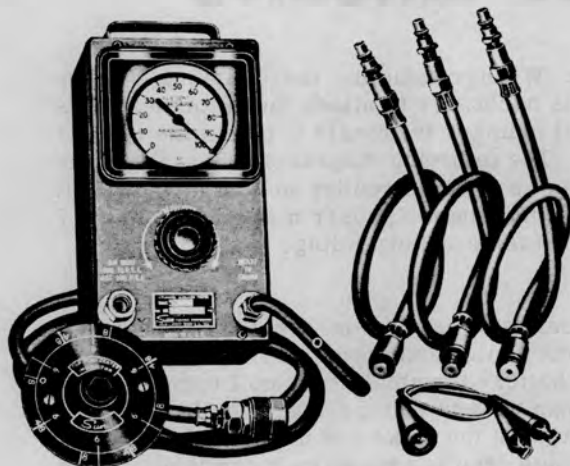
**FEATURES:**

Four inch gauge, graduated from 0 to 100% leakage • Operates from shop air supply • Built-in pressure regulator for stabilized test conditions • Simple time-saving procedure.

**UNIVERSAL DIESEL  
ADAPTER KIT**

Model DAK

For getting the true facts concerning the cylinder, piston ring and valve condition of diesel engines this set of universal adapters may be used with any Sun Cylinder Leakage Tester. Adapters included are compatible to practically all motive type diesel engines. All fittings and adapters are conveniently contained in a sturdy, formed steel case, (Model DAK is not included with CLT-228 above.)



**CYLINDER LEAKAGE  
TESTER**



Here's the equipment to **PIN POINT** those elusive engine troubles—those slight misses - that loss of power - those things that make you scratch your head!



TO SHOP  
AIR SUPPLY

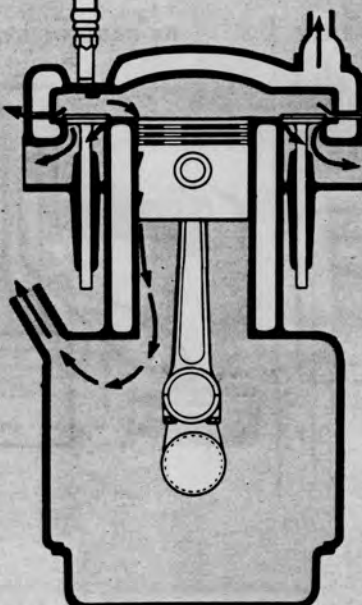


Look outside the block for a gasket leak with the air pressure on. Listen at the radiator, with cap off, for gasket leak to water jacket. High percentage of leakage at two adjacent cylinders points to a blown head gasket.



HERE'S  
HOW  
IT WORKS

Listen at the air intake for the hiss indicating a leak past the intake valve



Put your ear down at the tail pipe and listen for that air leak past the exhaust valve.



Piston ring and blow-by troubles can be heard at the oil filler or breather pipe. This one sure pays off.

# IGNITION PRIMARY CIRCUITS

In the majority of 12 Volt ignition systems, a ballast resistor has been added to the Primary Circuit. On some vehicles the resistor is in the form of a separate component connected in the primary circuit, while on other vehicles a specific ohmic value is built in the lead wire itself. The purpose of a resistance unit is two-fold. First, it limits to a safe maximum the primary current flow through the coil and the distributor contact points, thereby protecting the contact points during slow speed operation when they are closed for a longer period of time. Secondly, the resistor protects against excessive build-up of the primary current when the ignition switch is closed with the engine stopped and the contact points closed.

On certain systems, this resistor is removed from the circuit during cranking and the ignition coil is connected directly to the battery, thus maintaining the ignition voltage as high as possible during

cranking. When conducting the Cranking Voltage Test, it is necessary to attach the voltmeter leads to the coil primary terminals to obtain the correct readings. The following diagrams, which illustrate two types of by-pass circuitry in common use, will aid in determining the proper method of voltmeter connections for cranking voltage tests.

With a ballast resistor in the primary circuit between the switch and the coil, a voltmeter reading from the battery terminal of the coil to ground will be less than battery voltage. The drop in voltage is dependent upon the make and model of vehicle, but if the voltage drop is excessive, it can be attributed to either a defective ignition switch or resistor unit. A faulty ignition switch will give erratic voltmeter readings as the switch is repeatedly turned on and off. The condition of a ballast resistor can be determined by using a SUN ohmmeter.

**NO BY-PASS CIRCUIT**

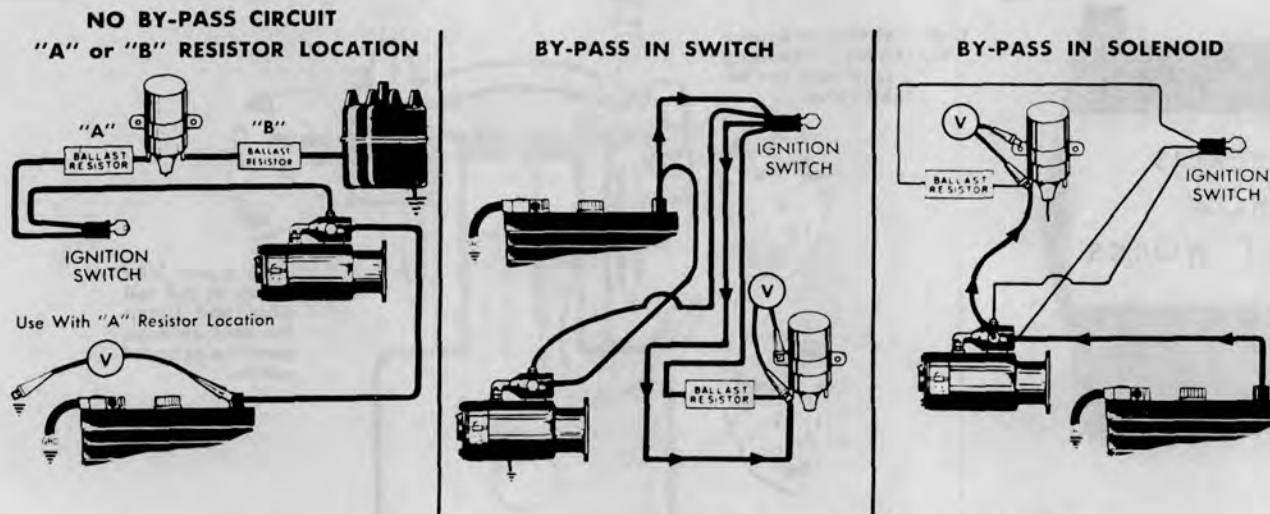
With ballast resistor located at "A", the voltmeter is connected from the insulated battery post to ground. With resistor located at "B", the voltmeter is connected from the battery terminal of the coil to ground.

**BY-PASS IN SWITCH**

Battery voltage is conducted directly from the ignition switch to the coil terminal using a separate lead, thus by-passing the resistor. The voltmeter is connected from the battery terminal of the coil to ground.

**BY-PASS IN SOLENOID**

Battery voltage is conducted directly from the solenoid switch to the coil terminal using a separate lead, thus by-passing the resistor. The voltmeter is connected from the battery terminal of the coil to ground.



## VOLTS-IGNITION TESTER

The Volts-Ignition Tester combines the versatility of a dual range voltmeter with unique facilities for making two over-all ignition system efficiency tests. The tests listed in the following pages outline but a few of the many applications for this fine test instrument. As indicated, when performing

ignition tests, an accurate means of measuring engine speed is required. In addition, the generator is prevented from working, to provide a stable voltage input for the ignition system and assure accurate test results.

### Cranking Voltage Test

This test quickly determines whether or not sufficient voltage is being delivered to the ignition system while the engine is cranking. A normal reading confirms that the general condition of

battery, cables, starting system and circuit to the ignition system is satisfactory. An unsatisfactory reading indicates that further testing is required in this area.

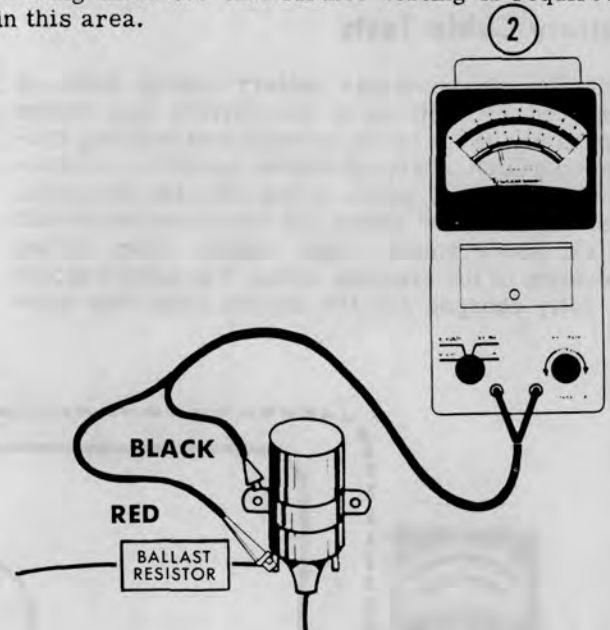
1. Connect tester leads in accordance with type of primary circuit used on vehicle. Observe proper polarity. (Refer to facing page for details on variations in primary circuits.)
2. Turn tester switch to either 8 or the 16 volt position, depending upon vehicle voltage.
3. Connect the jumper lead from the distributor primary terminal to ground.
4. With vehicles ignition switch "ON", crank engine.
5. Observe cranking voltage, cranking speed and evenness of cranking.

### Results and Indications

Meter reads specified voltage or more, cranking speed normal and even---battery, starter, cables, switch and ignition circuit to coil operating satisfactorily.

Meter reads less than specified voltage---weak battery, defective cables, connections, switch or starter; defective bypass circuit or ignition circuit to coil.

Cranking speed below normal---excessive resist-



### CRANKING VOLTAGE TEST

ance in cables, or starting motor, excessive mechanical drag in engine.

Uneven cranking speed---uneven compression, defective starter or starter drive.

### Charging Voltage Test.

The charging voltage test provides a good over-all indication of the voltage available to the vehicle's entire electrical system. The voltage applied to the ignition system is an important factor to be considered in cases of distributor point burning, and when abnormal operating life of other electrical components is encountered.

In cases where abnormal charging voltage readings

are encountered, it is suggested that each component in the charging system be tested utilizing the facilities of a Volts-Ampere Tester to determine exactly where the malfunction lies within the charging system.

1. Set tester switch to 8 or 16 volt position depending on vehicle voltage.



2. Observing polarity, connect the tester leads to the insulated post of the battery and to ground, or to the battery post of the regulator unit and to ground, depending on which is more accessible.

3. With a Tachometer connected, operate engine at a speed of 1500 to 2000 RPM.

4. Note Volt Meter reading after meter pointer stops climbing.

**Results and Indications**

Charging voltage within specified charging voltage range for a vehicle being tested---charging system and voltage regulator operating satisfactorily.

Charging voltage below specified voltage range---defective generator or generator drive, defective or misadjusted voltage regulator, high resistance

in circuits.

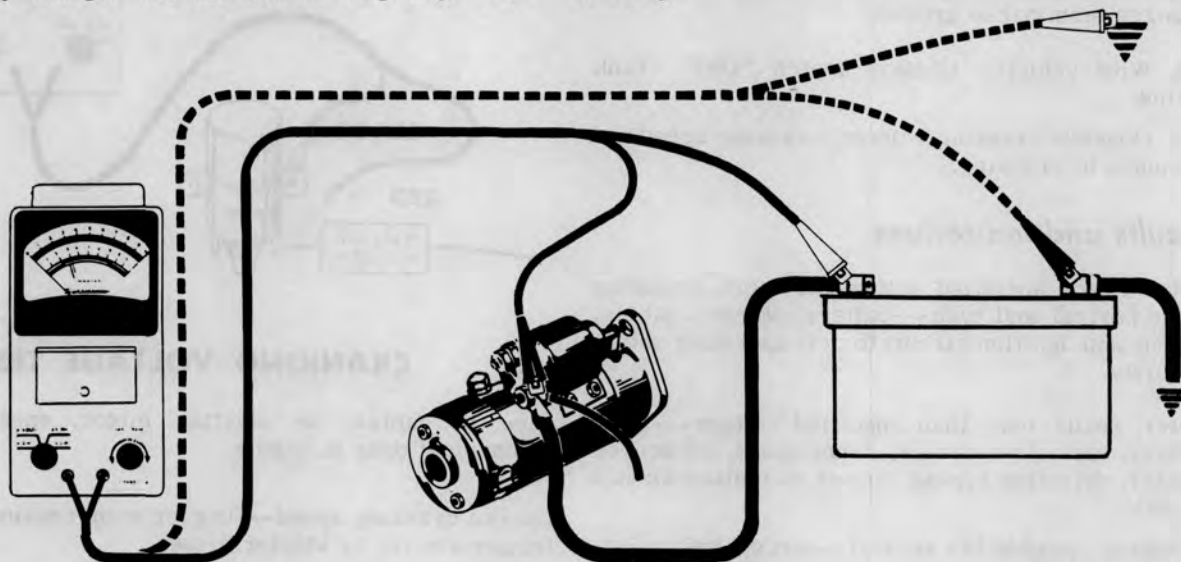
Charging voltage above specified voltage range---defective or misadjusted voltage regulator, high resistance in regulator ground circuit, defective field circuit.

**Battery Cable Tests**

Defective or undersize battery cables, loose or corroded connections or excessively long cables can easily be the cause of inefficient starting system operation, charging system operation, or malfunction in many parts of the vehicle's electrical system. Defective cables and/or connections result in excessive voltage loss (voltage drop) during operation of the cranking motor. The battery should be fully charged and the starter amperage draw

must be within normal limits when conducting battery cable tests. (If any doubt exists concerning the condition of the battery or the starting motor, these components should be tested with a battery starter tester.)

**IMPORTANT**— Ground ignition primary at distributor with a jumper lead, to prevent engine from starting.



**NOTE:**  
GROUND IGNITION PRIMARY  
AT DISTRIBUTOR WITH JUMPER  
LEAD TO PREVENT ENGINE  
FROM STARTING

**INSULATED CABLE TEST**

The entire insulated portion of a cranking circuit may be tested in one operation, or each individual portion of the insulated circuit may be tested separately.

1. Set tester switch to the 8 volt position.



2. Connect one voltmeter clip to the center of the insulated battery post, and the other to the input post of the starting motor, observing proper polarity. (Meter will attempt to read battery voltage until starter switch is closed.)

3. Operate starting motor, and observe voltmeter. Generally, on most vehicles voltmeter reading should not exceed 3/10 of a volt. Refer to specifications.

**GROUND CABLE TEST**

1. Set tester switch to 8 volt position.

2. Connect one voltmeter clip to a ground on engine block, the other to center of the ground post of battery, observing proper polarity.

3. Crank engine while observing voltmeter. Generally on most vehicles voltmeter readings should not exceed 2/10 of a volt.

**Results and Indications**

Voltmeter readings within specified limits--cables, connections, etc., in normal operating condition.

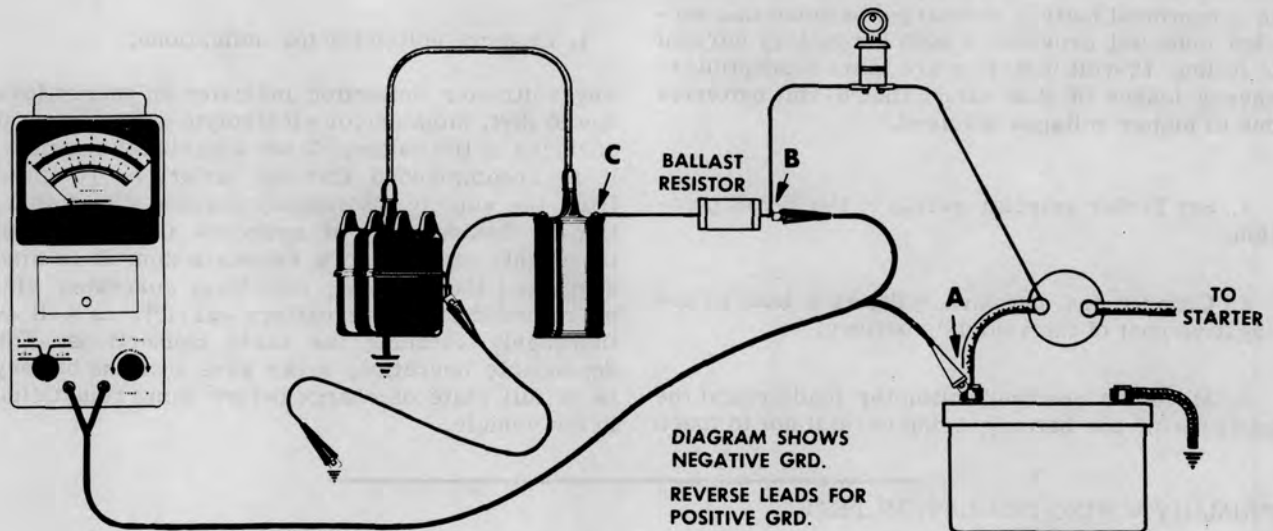
Voltmeter readings exceed specified limits--defective cable, undersized cable, loose or corroded connections, defective switch contacts, possibility of excessive starter draw, etc.

When excessive voltage drop readings are obtained, retest each item and connection within that portion of the circuit to determine exact location of fault. Correct fault by cleaning and tightening connections or replacing cables or components as necessary, then retest.

**Ignition Primary Circuit Resistance Test**

Excessive voltage loss (voltage drop) in the ignition primary circuit between the vehicles battery and the ignition coil can reduce the secondary output of the ignition coil to the extent that hard starting and poor performance can result.

**NOTE** On some vehicles, a special type of resistance wire is built into the wiring harness to serve the purpose of a separate ballast resistor unit.



1. Turn voltmeter selector switch to the 8 volt position.

2. Connect voltmeter leads as follows: (observe proper polarity) from "A" to "B" for coils equipped with an external ballast resistor.

From "A" to "C" for coils not equipped with an external ballast resistor.

3. Use jumper lead to ground primary terminal of distributor as shown. (Grounding the distributor primary terminal with the jumper lead makes it unnecessary to spot the engine so that the breaker points are closed and also eliminates the possibility of false test readings due to reduced current caused

by defective points, wiring and connections in the distributor.)

4. Be sure all lights and accessories are turned off.

5. Turn ignition switch "ON", and observe voltmeter. Voltmeter should not read more than .5 volts.

6. Test ignition switch by turning it "OFF" and "ON" several times. Voltmeter should read the same each time switch is turned on.

7. Test all wires for tightness. Move them about and note any change in meter reading.

### Results and Indications

Voltmeter reading within specified limits---connections, wiring, switch contacts, etc., in satisfactory condition.

Meter readings exceed the specified maximum -- loose or corroded connections, undersized or faulty wiring, damaged or worn ignition switch contacts, etc.

If voltmeter readings exceed the specified maximum, isolate the point of high resistance by placing the test leads across each connection and wire in turn. The reading across a connection should be zero. The reading across any one wire should be proportionate to its length as compared to the length and allowable voltage drop of the entire circuit.

### Primary Circuit Insulation Tests

Defective insulation in the primary system, or at the battery, can result in a constant loss of energy from the battery. Trouble of this nature is usually indicated by the battery becoming discharged in

damp weather or when the vehicle is not in use for a day or two at a time. Usually leakage of this nature is so gradual that it is impossible to detect on the vehicle's charge indicator.

#### BATTERY LEAKAGE TEST

Electrolyte, dirt, moisture or foreign material on the surface of the battery cell covers usually results in a continual battery discharge, because this foreign material provides a path for battery current to follow. 12-volt batteries are more susceptible to energy losses of this nature than 6-volt batteries due to higher voltages involved.

the cell connecting straps or the positive battery post.

4. Observe voltmeter for indications.

1. Set Tester selector switch to the 8-volt position.

2. Connect the negative voltmeter lead to the negative post of the vehicle's battery.

3. Move the positive voltmeter lead around the surfaces of the battery, being careful not to touch

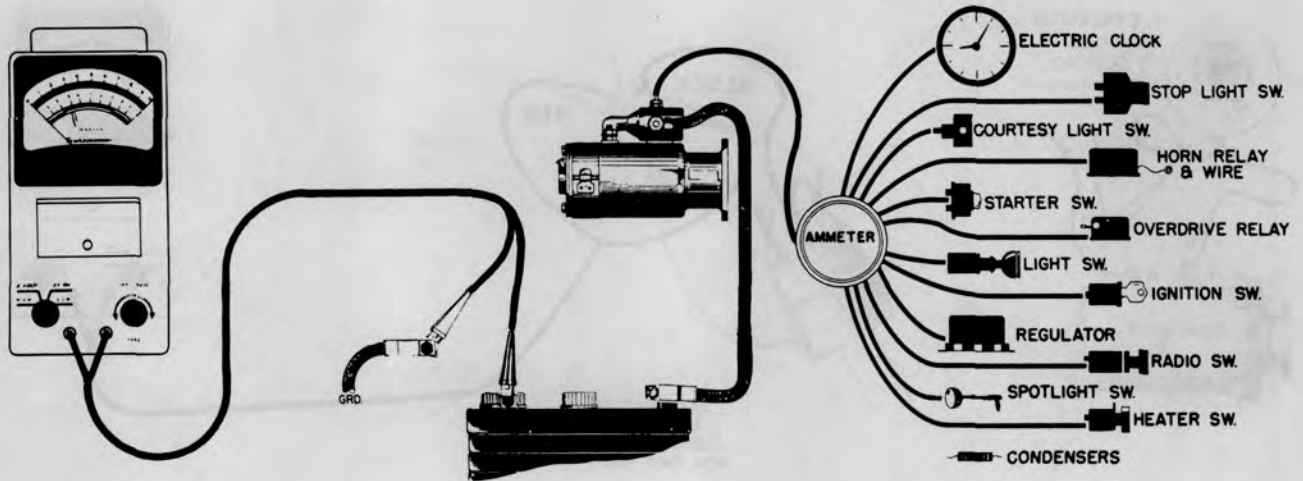
Any voltmeter deflection indicates an energy loss due to dirt, moisture, or electrolyte on the external surfaces of the battery. When this condition exists, it is recommended that the battery be removed from the vehicle, thoroughly cleaned with a solution of baking soda or ammonia and water, and thoroughly dried before reinstallation. It is also suggested that all dirt, moisture, corrosion, etc. be removed from the battery carrier, as well as thoroughly cleaning the cable connections. For dependable operation, make sure that the battery is in full state of charge before being reinstalled in the vehicle.

#### PRIMARY WIRING INSULATION TEST

This test of primary wiring insulation, using a voltmeter, can detect leakage in the insulation too

small to be located with a test ammeter.

**PRIMARY WIRING INSULATION TEST**



1. Disconnect the ground battery cable from the battery post.
2. Turn off all switches, and close all doors to prevent operation of the courtesy lights from the door switches. Disconnect under-hood light if used.
3. Turn tester selector switch to position corresponding to the system voltage of the vehicle.
4. If vehicle is equipped with an electric clock, touch battery cable to battery post just prior to conducting the test to rewind the clock.
5. Observing polarity, connect voltmeter in the circuit: one lead to battery cable, and one lead to battery post as shown.
6. Note voltmeter reading.

**Results and Indications**

Voltmeter reads zero---insulation in vehicle's electrical primary circuits normal, no leakage exists.

Voltmeter reads above zero---insulation leakage exists in one or more of the vehicle's primary electrical circuits.

To locate leakage (a short) in the primary wiring circuits, remove the battery wire from each of the following components in the order in which they are listed. Retest the primary circuit for leaks after disconnecting each item.

- |                         |                  |
|-------------------------|------------------|
| Stop light switch       | Ignition switch  |
| Courtesy light switches | Regulator        |
| Horn relay and wire     | Spotlight switch |
| Starter switch          | Heater switch    |
| Overdrive relay         | Condensers       |
| Light switch            |                  |

**NOTE** Condensers may be located on the light switch, the regulator battery terminal, generator armature terminal, etc.

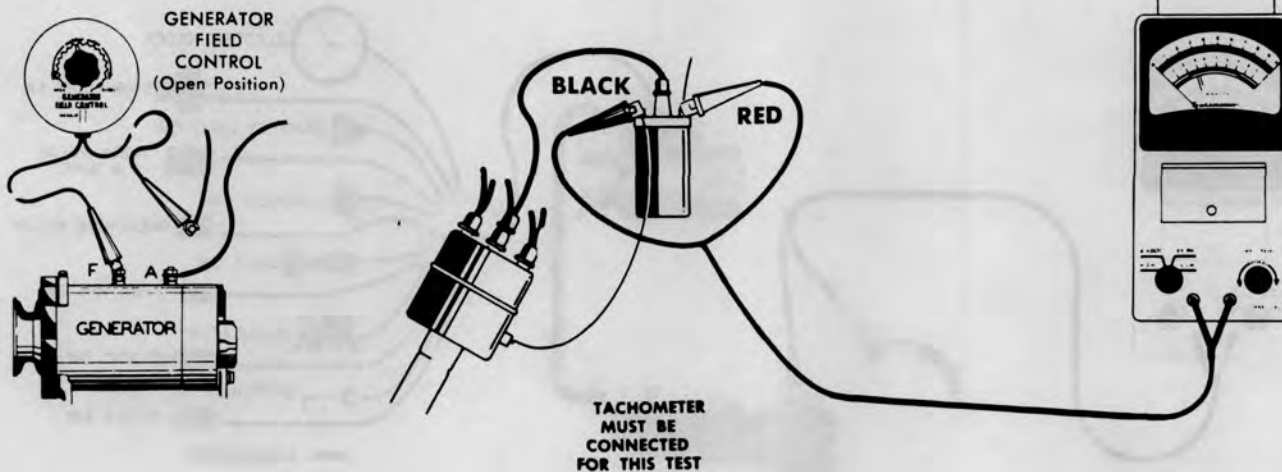
**Ignition Test**

Efficient, dependable ignition system operation can be expected only when sufficient ignition output is available and the secondary insulation is in satisfactory condition. A defector malfunction anywhere in the ignition system will result in lower than normal ignition output. Defective, cracked or deterior-

ated insulation on any component or in any portion of the ignition secondary circuit may permit the high voltage impulses from the coil to leak off to ground and thus result in misfire or an overall reduction in the engine's operating efficiency.



**IGNITION OUTPUT & LEAKAGE TEST**



1. To prevent vehicle's generator from operating during test, connect Generator Field Control in generator field circuit and set control to "open" position. (Refer to Generator Field Control Section of Handbook.)

2. With tachometer connected, start engine and adjust speed to 1500 RPM.

**NOTE** For Ford V-8, Lincoln, and Mercury, set engine speed to 1000 RPM. (Refer to Tach-Dwell Section of Handbook.)

3. Set tester switch to Ignition Test position.

4. Connect Tester leads to each primary terminal of the vehicle's ignition coil.

5. Adjust ignition test calibrator until meter reads on proper SET LINE.

6. Using insulated pliers, remove one spark plug wire from its plug, and observe meter reading. For a complete secondary insulation test, note tester reading as each spark plug wire is removed in turn.

**Results and Indications**

Meter reads in GOOD band when each plug wire is lifted off---both the ignition output and the secondary insulation are satisfactory.

All readings low, or if ignition test calibrator can not be adjusted for set line---high resistance in primary circuit, defective distributor points, defective coil or condenser, coil tower wire, rotor or distributor cap.

Low readings when only certain plug wires are lifted off---defective insulation on those wires, cracks or carbon tracks in the distributor cap.

**NOTE** Errors may be introduced if coil is not at operating temperature, improper engine speed or ignition test set line are used, distributor point setting is not within specified limits.

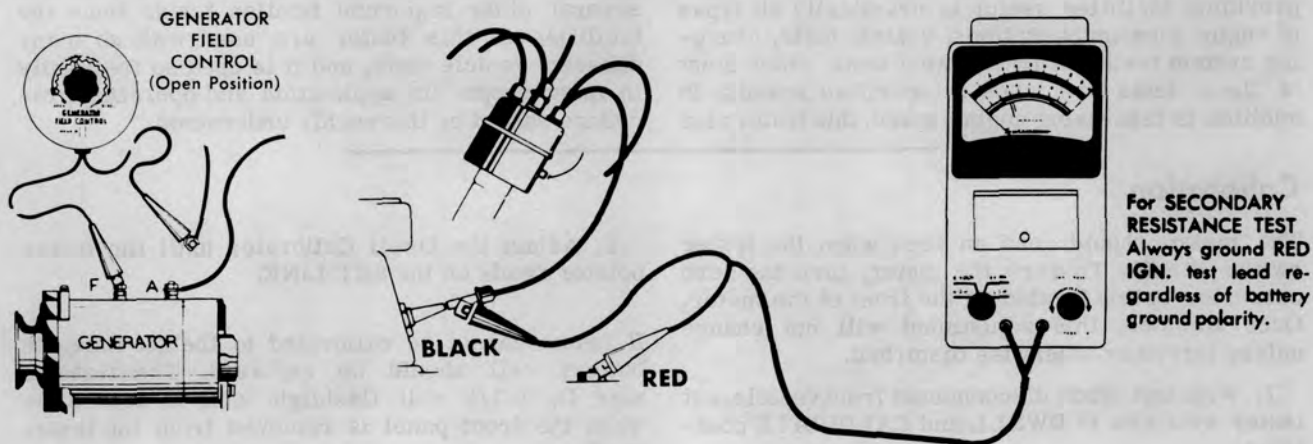
**Secondary Resistance and Polarity Test**

Excessive secondary circuit resistance uses up energy which is needed to maintain good ignition under all conditions, severely reduces ignition system reserve, and consequently results in poor performance under severe operating conditions. In-

correct secondary system polarity, can result in up to 40% more voltage being required to fire the spark plugs causing misfire and erratic engine operation.



**SECONDARY RESISTANCE TEST**



**For SECONDARY RESISTANCE TEST Always ground RED IGN. test lead regardless of battery ground polarity.**

1. To prevent generator from operating during test, connect Generator Field Control into field circuit and set knob to open position. (See Generator Field Control Section in Handbook.)

2. With Tachometer connected start engine and adjust speed to 1500 RPM. (See Tach Dwell Tester Section of Handbook.)

3. Set Tester switch to Secondary Resistance position.

4. Connect RED tester lead to engine ground, and contact BLACK test lead to each spark plug terminal in turn. Observe readings on 0-8 secondary resistance scale of meter.

**Results and Indications**

Readings are average for make and type of circuit being tested---secondary circuit in normal condition.

All readings lower than average for make and type of circuit being tested---corroded coil tower terminal, poorly connected or broken coil wire, center cap electrode burned, burned rotor tip, open secondary in coil.

One or more readings lower than average for make and type of circuit being tested---broken or poorly connected spark plug wires, burned or corroded cap terminals, gouged electrodes inside cap.

Readings higher than average at two or more plugs---crossfire occurring in the distributor cap or between spark plug cables concerned.

Meter reads off scale to left with red test clip grounded---coil secondary polarity reversed; may be due to coil primary wires connected in reverse, wrong coil, or vehicle battery connections reversed.

**NOTE** On vehicles utilizing suppression type ignition cables, readings can be expected to be somewhat uneven with the lowest readings on the longest cables. Although suppression results in lower test readings, normal suppression does not impair ignition efficiency.

# TACH-DWELL TESTER

The Tach-Dwell Tester is a basic test instrument providing facilities useful in practically all types of engine tune-up operations, vehicle tests, charging system tests and fuel system tests, since most of these tests are made at specified speeds. In addition to measuring engine speed, this tester also

provides facilities for measuring point-dwell and several other important ignition tests. Since the facilities of this tester are used with so many different vehicle tests, and it is used so frequently in most shops, its application and operating procedure should be thoroughly understood.

## Calibration

The meter should read on zero when the tester switch is off. To zero the meter, turn the zero corrector button located on the front of the meter. Once adjusted, this adjustment will not change unless jarred or otherwise disturbed.

1. With test leads disconnected from vehicle, set tester switches to DWELL and CALIBRATE positions.

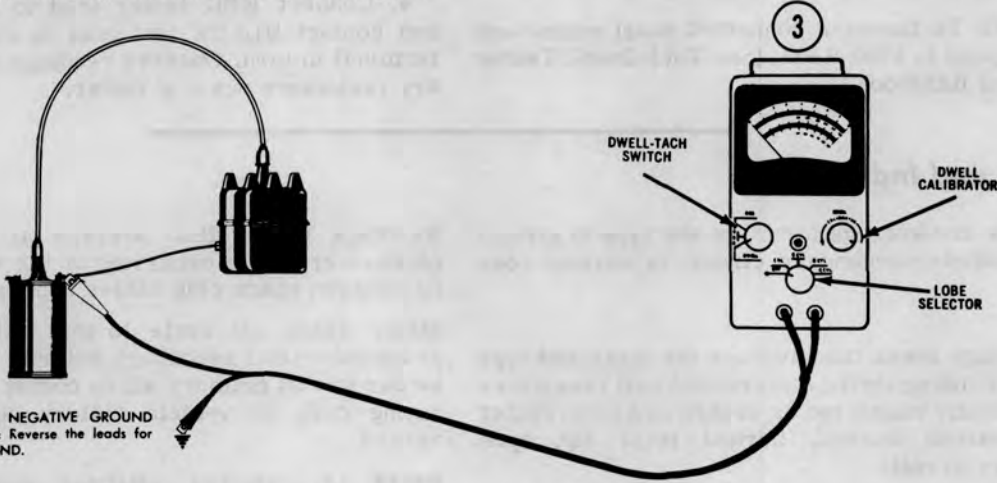
2. Adjust the Dwell Calibrator until the meter pointer reads on the SET LINE.

If tester cannot be calibrated to the Set Line, its battery cell should be replaced. The tester's size D, 1-1/2 volt flashlight cell is accessible when the front panel is removed from the tester case.

## Distributor Resistance

Excessive resistance in the ignition primary circuit from the distributor side of the coil, through the points, and to the distributor ground, will prevent the coil from producing sufficient output for good

over-all ignition. Any resistance in this portion of the ignition system will be indicated on the dwell meter during this test.



1. Observing proper polarity, connect test leads, one to distributor primary lead at coil, and the other lead to ground.

2. Turn vehicle's ignition switch ON.

3. With engine stopped, observe tester meter.

If meter reads zero, crank the engine a fraction of a revolution to close the breaker points.

## Results and Indications

Meter pointer reads within range of black bar--- distributor resistance is within normal tolerances.

Meter pointer not within black bar . . . high resist-

ance at: internal distributor connections, external distributor connections, contact points, distributor mounting.

To locate excessive resistance, trace the primary circuit by moving tester lead step by step through the distributor toward the ground lead. All excessive

resistance must be eliminated before proceeding with Dwell, Dwell Variation and other ignition system tests.

**Dwell**

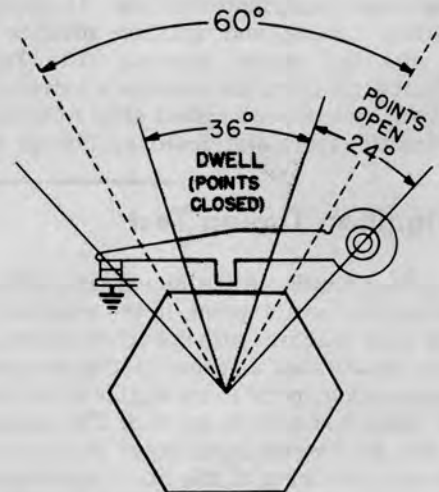
Dwell is the period during which the distributor points remain closed for each ignition cycle. The dwell meter electrically measures this period and registers the average for each cylinder in terms of degrees of distributor cam rotation.

The total number of degrees for each ignition cycle is 360 degrees divided by the number of cylinders. The illustration for 6 cylinder engine shows 60 degrees (between dotted lines) for each cylinder, and 36 degrees (the shaded area) as the dwell. A study of this illustration shows that a wider point setting will result in less dwell and a closer point setting will increase the dwell.

1. Calibrate Tach-Dwell Tester and connect to engine as for Distributor Resistance Test.

2. Turn selector switch to the lobe position corresponding to the number of lobes on the vehicle's distributor cam.

3. With engine operating at idle speed, note reading on dwell meter.



**Results and Indications**

The dwell reading within specified tolerances . . . ignition points are operating normally and are spaced properly.

Dwell reading not within specifications . . . improper point spacing, wrong point assembly, point rubbing block defective, point rubbing block misaligned, distributor cam worn.

**Dwell Variation**

Dwell variation is determined by noting the dwell change as the engine is operating at different speeds. Excessive variation indicates a change in point opening that can result from shaft or bushing wear, or from the distributor plate shifting because of wear or looseness.

1. Measure distributor dwell at idle speed.
2. Set RPM Switch to 8000 RPM position and

increase speed to 1500 RPM.

3. Turn switch to DWELL position and note dwell reading.

4. Slowly reduce speed to idle while observing dwell meter. Dwell reading should not change more than 3 degrees on most vehicles. Refer to vehicle's specifications before condemning distributor.

**Results and Indications**

Dwell variation within manufacturer's specified tolerances . . . distributor in sound mechanical condition.

Dwell variation exceeds manufacturer's maximum specifications . . . Worn distributor shaft, loose distributor shaft, worn bushings, worn breaker plate.

**Measuring Engine Speed**

The ignition and combustion efficiency tests, covered elsewhere in this Handbook, call for specific engine speeds in order to obtain correct indications. Therefore, during these tests, the Tach-Dwell Tester must be connected to the vehicle.

1. Connect Tach-Dwell Tester to vehicle as illustrated.
2. With selector switch in proper lobe position:

- a. Set RPM Switch to 800 RPM position for all idle and low speed testing. Read lower Tach scale.
- b. Set RPM Switch to 8000 RPM position for all testing at speeds above 800 RPM. Read upper Tach scale.
3. Cranking speed may be measured on the 800 RPM scale, providing the ignition switch is "on" and a jumper lead is connected from the coil secondary tower to ground.



# ELECTRONIC DISTRIBUTOR TESTER

The Electronic Distributor Tester is designed to test ignition timing and ignition advance on the vehicle with the engine running. The Tester is powered directly from the vehicle's battery, either 6 or 12 volt, and is used to test either conventional or loadomatic type distributors. Should on-the-

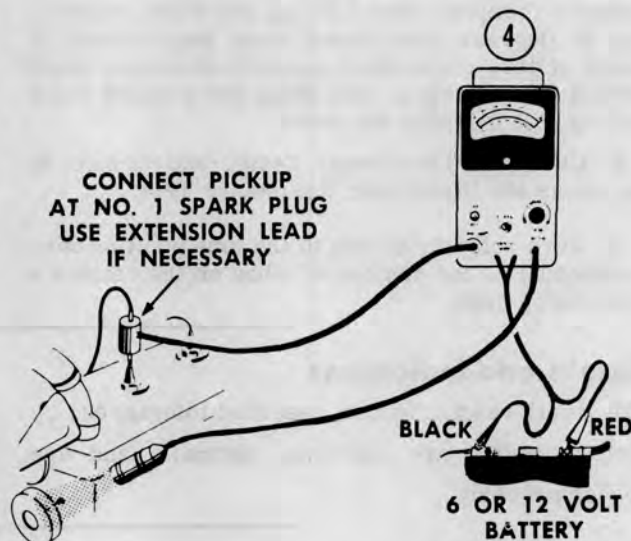
vehicle tests of the distributor indicate malfunction of either the mechanical or the vacuum advance mechanisms, the distributor should be removed from the vehicle for complete, detailed tests utilizing a Sun Distributor Tester, and then serviced as required before reinstallation.

## Initial Ignition Timing Test

Initial ignition timing is the mechanical adjustment establishing the exact point in the engine cycle at which the plug will fire at a specified engine speed. Timing is established and specified by the manufacturer for the exact point in the engine cycle at which the fuel charge should be ignited. The strobe light flash of the Electronic Distributor Tester is simultaneous with the firing of the No. 1 spark plug, and when timing is properly set, the specified mark will appear to be aligned with the pointer when the strobe light flash occurs.

1. Connect Tester's battery leads to the vehicle's battery. (6 or 12 volt)
2. Connect Tester Pickup into circuit of No. 1 spark plug.
3. Connect Tach-Dwell Tester to the engine. (If vehicle is equipped with loadomatic type distributor, connect a manometer into the distributor vacuum line.)
4. Set Toggle Switch to ON position and turn advance control to Timing position.

5. Start engine and adjust speed to RPM specified by manufacturer for initial timing adjustment. (Disconnect distributor vacuum line if specified.)



6. Use light flash to observe the position of the timing mark in relation to the timing pointer. Refer to manufacturer's specifications.

## Results and Indications

Timing mark aligns with pointer at specified speed . . . ignition properly timed.

Timing mark not aligned with pointer at idle per manufacturer's specifications . . . ignition not properly timed.

Position of timing mark not steady . . . pitted or misaligned breaker points, incorrect breaker point spring tension, worn or loose breaker plate, or worn distributor shaft or bushings.

## Distributor Advance Test

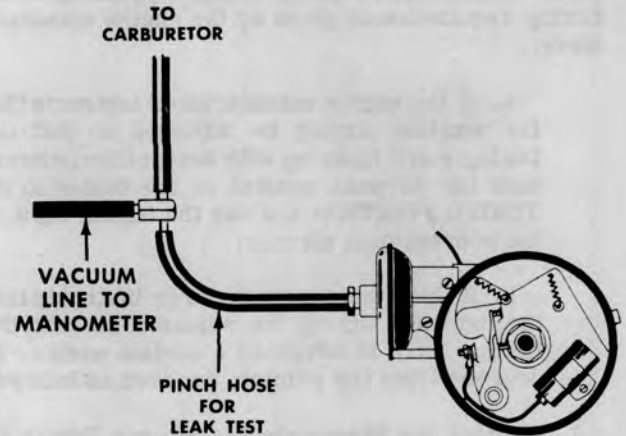
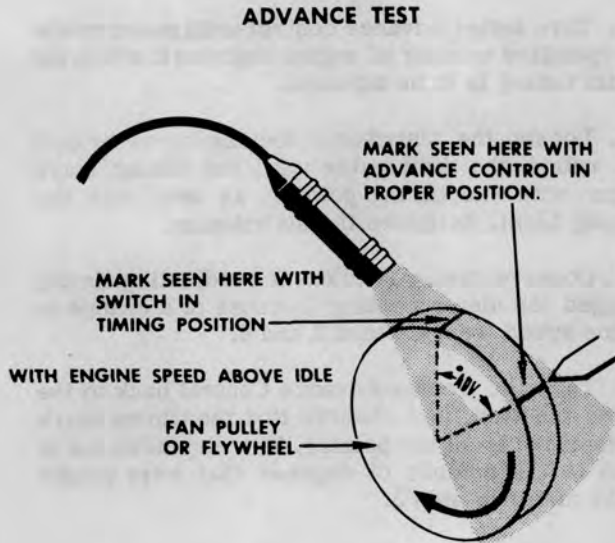
Correct timing under all speed and load conditions is extremely important to performance and economy. As engine speed is increased, the distributor advance mechanism causes the plug to fire earlier in the engine cycle. As a result, the timing mark moves away from the pointer when viewed with a Timing Light. Through the use of the Electronic

Distributor Tester, at a specified test speed, the timing mark can be electronically realigned with the timing pointer. When the timing mark is aligned with the pointer, as shown in the illustration, the meter will indicate the number of degrees the plug is firing ahead of the initial ignition timing.



**DISTRIBUTOR ADVANCE TEST**

**VACUUM LEAK TEST**



1. Reconnect distributor vacuum line, if it has been disconnected, for the initial timing test.
2. Adjust engine speed to 2500 RPM, or until manometer indicates first vacuum specification if vehicle is equipped with a loadomatic type distributor.
3. With Strobe Light directed at Timing Pointer,

rotate tester advance control clockwise until Timing Mark appears in its original position.

Note degrees advance on tester meter, and compare with manufacturer's specifications.

On conventional type distributors, if total advance is incorrect, disconnect distributor vacuum line and repeat test to determine whether vacuum or centrifugal advance mechanism is at fault.

**Results and Indications**

Total advance readings within range at specified RPM or specified Vacuum... mechanical and vacuum advance mechanisms or loadomatic vacuum advance mechanism operating satisfactorily.

Total advance readings not within range at specified RPM or specified vacuum... faulty mechanical or vacuum mechanism, or loadomatic advance mechanism defective.

**Distributor Vacuum Leak Test (Applies only to Loadomatic Distributors)**

1. With Electronic Distributor Tester, a Tach-Dwell Unit and the Manometer connected as for distributor advance test, adjust engine speed to 1500 RPM.
2. Note exact Manometer reading at 1500 RPM.

3. Pinch the hose closed between the distributor vacuum line and the "T" fitting.

4. Observe Manometer reading and compare with reading obtained in Step 2.

**Results and Indications**

Manometer readings in step 2 and step 4 above, alike and within normal range for type and make of vehicle being tested... carburetor and distributor vacuum system airtight.

Manometer reading does not increase when hose is pinched and distributor vacuum is noticeably lower than that obtained on similarly equipped vehicles at comparable speeds... possible air leaks around carburetor gaskets or a faulty carburetor vacuum system.

Manometer reading increases when hose is pinched... defective distributor advance mechanism unit, line or fittings.

**Adjusting Initial Ignition Timing**

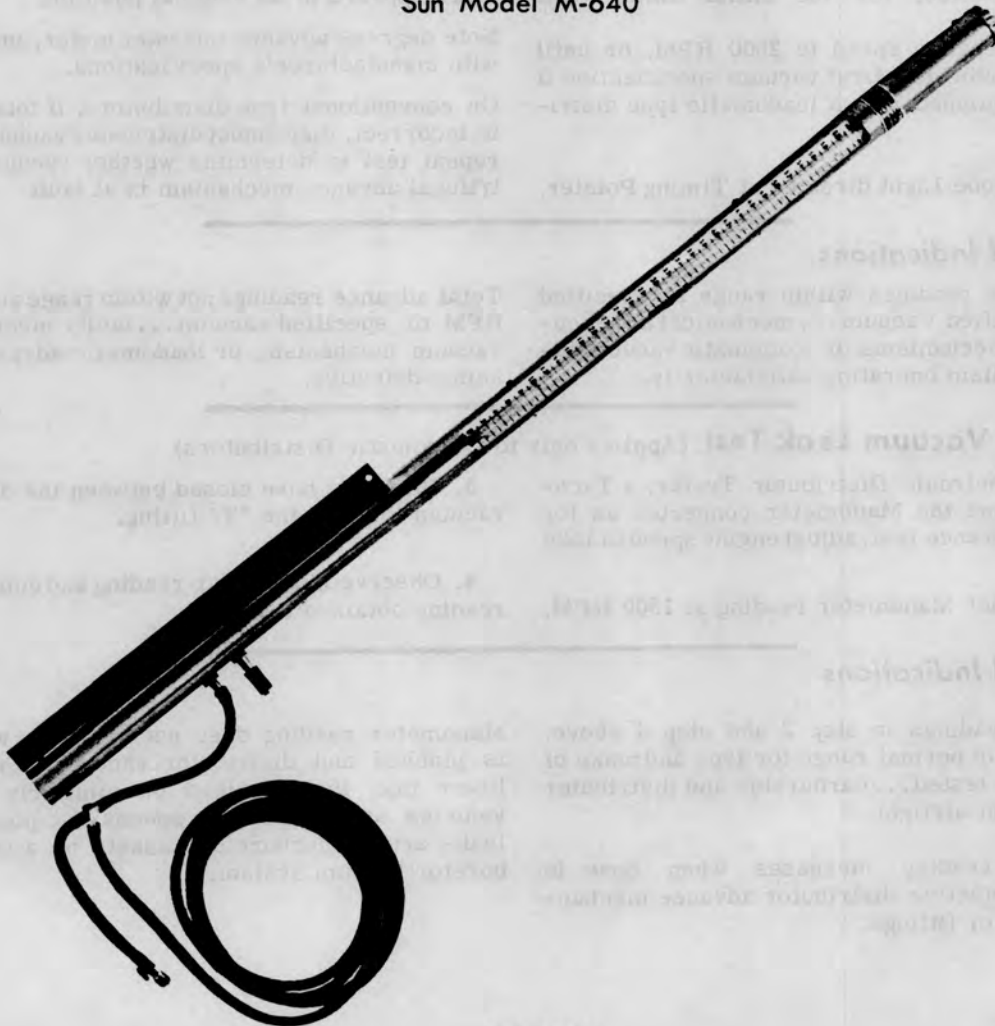
When using the Electronic Distributor Tester, there are two methods of adjusting initial ignition timing on an engine. The method to use depends upon the timing requirements given by the engine manufacturer.

- a. If the engine manufacturer instructs that the ignition timing be adjusted so that the timing mark lines up with the ignition pointer, turn the advance control of the tester to its **TIMING POSITION** and use the timing light in the conventional manner.
- b. If the engine manufacturer instructs that the ignition timing be adjusted so that the timing mark is advanced a certain number of degrees from the pointer, proceed as follows:
  1. Connect the Electronic Distributor Tester as indicated under Initial Ignition Timing.

2. Adjust engine to specified Timing speed.
3. Turn tester advance control until meter reads the specified number of engine degrees to which the initial timing is to be adjusted.
4. Loosen the distributor locking screw or bolt and rotate the distributor until the timing mark aligns with the timing pointer, as seen with the Timing Light. Retighten the distributor.
5. Observe meter reading. If readjusting timing changed the meter reading (because of a change in engine speed) repeat steps 3 and 4.
6. Turn the Tester Advance Control back to the timing position, and observe that the timing mark is displaced from the pointer. The displacement is equal to the number of degrees that were preset on the meter in step 3.

**MANOMETER**

Sun Model M-640



## SUN SCOPE

The Sun Scope provides a convenient means of observing an ignition system's performance by displaying an easily interpreted graph-like picture of all phases of ignition cycle the instant at which these occur on an operating engine. The picture thus displayed permits the observer to actually see in minute detail the results of a multitude of factors effecting the ignition system's operation. The factors which once were assumed in theory only, such as firing voltage requirements, spark duration, coil and condenser action, breaker point action and maximum ignition system voltage output, can now be accurately seen.

Testing with the Sun Scope is comparatively simple. Aside from one or two physical operations involved, actual testing consists of observing the pictures or patterns for irregularity. Since each part of the pattern represents certain events which occur in the various parts of the ignition system, any deviations from the normal appearing patterns will quickly indicate the types of troubles present. The Sun Scope is designed to permit an operator to view the patterns of all cylinders side by side in the engine's firing order, each cylinder's pattern in turn individually, a choice of patterns compared one above the other, or a superimposed display of all cylinders' patterns.

To interpret Sun Scope test results, it is important that the basic Oscilloscope Wave Form Pattern be thoroughly understood. Review and study the following two pages very carefully. Before applying the Sun Scope to an engine, it is suggested that the operator become familiar with each Scope control and its function, and the Scope's connections to the vehicle.

In the interest of speed, ease and over-all ignition testing, a nine-step condensed test procedure is outlined in this section of the Handbook. For a more detailed analysis and to help in pin-pointing ignition troubles, several auxiliary tests are described in the latter portion of this section. To aid in interpreting the variations of the basic wave form pattern, the Scope Test Indication section illustrates and describes the scope patterns representing many of the more commonly encountered ignition troubles.

To quickly associate Scope indications of ignition troubles with a specific cylinder or cylinders of the engine, the operator should be familiar with cylinder numbering arrangements and engine firing orders. The last page of this section illustrates and lists engine cylinder arrangements and firing orders usually encountered on American built passenger cars.

Certain ignition system functions vary with the input voltage available to the ignition coil. Therefore, to be assured of obtaining accurate test results, it is necessary to prevent the generator from operating during the ignition test sequence. A convenient means of preventing the generator from operating, regardless of whether the vehicle is equipped with an AC or a DC system, is to connect a Sun Generator Field Control into the generator's field circuit, and to position the control knob in its "open" position.





**EXPLANATION OF SCOPE PATTERNS**

Before applying the Sun Scope to an engine, it is suggested that the operator become familiar with the Scope controls and their function, and the Scope connections to the engine.

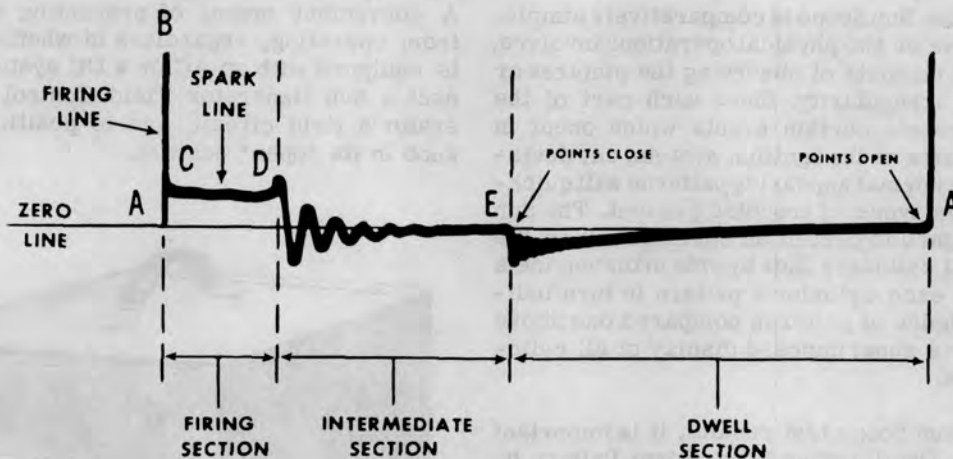
To interpret Scope test results, it is important that the basic oscilloscope waveform or pattern be thoroughly understood. Study the following carefully.

The display (or trace) visible on an oscilloscope screen is usually referred to as a pattern or waveform. In studying oscilloscope patterns, consider them to be graphs of voltage with respect to time. The vertical displacement from the ZERO line (either up or down depending on polarity) represents voltage at any instant along the ZERO line.

The Sun Scope is designed to display either a Second-

ary waveform which is obtained at the coil's high tension tower, or a Primary waveform which is obtained at the distributor primary terminal of the coil. However, because the Secondary waveform is generally the most informative for showing over-all ignition system operation, the screen of the Sun Scope is laid out in kilovolts (KV) to permit accurate voltage measurements of Secondary patterns to be made. Each vertical division of the screen represents 2 kilovolts (2000 volts), providing the Scope's Pattern Height control is positioned at its SET LINE.

Each part of the waveform represents a specific phase of ignition system operation. For the purpose of understanding and analyzing the Scope pattern, it is divided into three sections; The Firing Section, the Intermediate Section and the Dwell Section.



**BASIC PATTERN SECTIONS**

**The Firing Section**

So called, because it is during this period that the actual firing of the spark plug takes place. This section of the pattern is composed of only two lines:

The Firing Line, a vertical line indicating the voltage required to overcome the plug and rotor gaps.

The Spark Line, a horizontal line indicating the voltage required to maintain the spark.

Point "A" in the pattern illustrated represents the

instant at which the breaker points have separated. The resulting high voltage is indicated by the vertical rise from "A" to "B" in the pattern. The height at point "B" shows the voltage required to fire the plug and rotor gap; sometimes referred to as the "firing" or "ionization" voltage.

Once the plug fires there is a noticeable drop in secondary voltage to point "C". As the spark continues to bridge the gap, the spark voltage remains at a fairly constant low value until the spark extinguishes at point "D".



**The Intermediate Section**

This section, which immediately follows the Firing Section, is seen as a series of gradually diminishing oscillations which disappear or nearly disappear by the time the Dwell Section begins. Beginning at point "D", the remaining coil energy dissipates itself

as an oscillating current which gradually dies out as it approaches point "E". The oscillation results from the combined effects of the coil and the condenser in dissipating this energy.

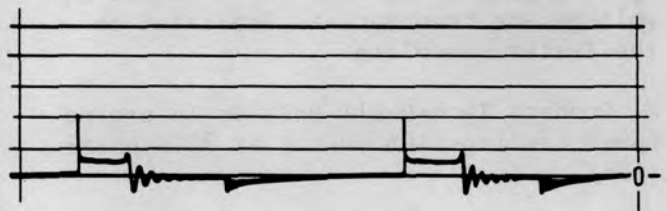
**The Dwell Section**

This section represents the period of time during the ignition cycle in which the breaker points are closed. The Dwell Section begins at point "E" when the breaker points close. Closing the points causes a short down-

ward line followed by a series of small rapidly diminishing oscillations. The Dwell Section continues until the points open at the beginning of the next waveform (the next point "A").



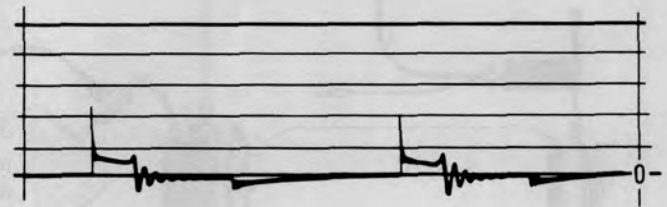
A-1



A-2



A-3



A-4

Figure "A-1" represents an ALL CYLINDER Sun Scope display of an eight cylinder ignition system which contains no suppression and is functioning in a normal manner. Figure "A-2" illustrates the INDIVIDUAL CYLINDER display of the above engine.

The patterns illustrated in Figures "A-3" and "A-4" represent a normally functioning eight cylinder ignition system which incorporates secondary suppression, as they would be observed in the ALL CYLINDER

or INDIVIDUAL CYLINDER Sun Scope display.

To be particularly noted is the slight difference in the length and shape of the sparklines when comparing the above illustrated patterns. It will be observed that the spark lines of the suppressor equipped system begin at a slightly higher voltage than that of the other system and that they slant downward slightly as they approach the Intermediate Section and appear to have slightly more oscillations.

**SUNSCOPE TEST PROCEDURE**

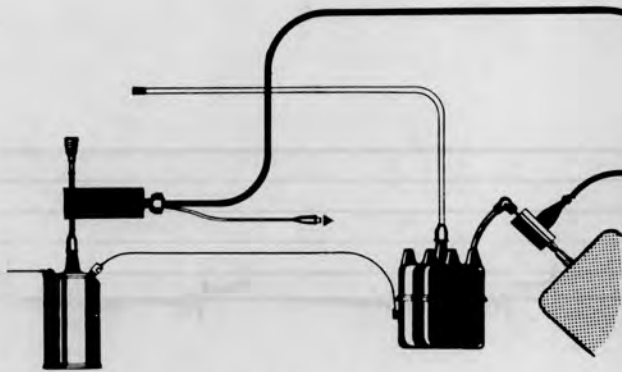
The following test procedures for use of the secondary and primary pattern pick-ups are to serve mainly as a guide, and can be varied in control settings or sequence to best suit the desires of the operator and the particular test problems encountered. An engine speed of 1200 RPM is recommended for performing most tests. However, when an engine does not perform properly at speeds other than 1200 RPM it is recommended that in addition to testing at 1200 RPM, tests should also be performed at the speed or speeds where the performance difficulty is most prominent. To make comparisons of performance, before and

after services have been completed, it will of course be necessary that the tests be made under the same speed and operating conditions.

The pattern illustrations associated with each basic step in the test procedure are representative of the average normal system being tested at an engine speed of 1200 RPM. These normal patterns can be expected to vary slightly because of minor variations in engine and ignition system design, number of cylinders, specified dwell settings and the absence or presence of ignition suppression.

**CONNECTIONS AND CONTROL SETTINGS**

1. Plug power lead into an AC outlet of voltage and frequency as indicated on the Tester nameplate.
2. Connect Tach-Dwell Unit as in engine speed testing (RPM switch at 8000 position).

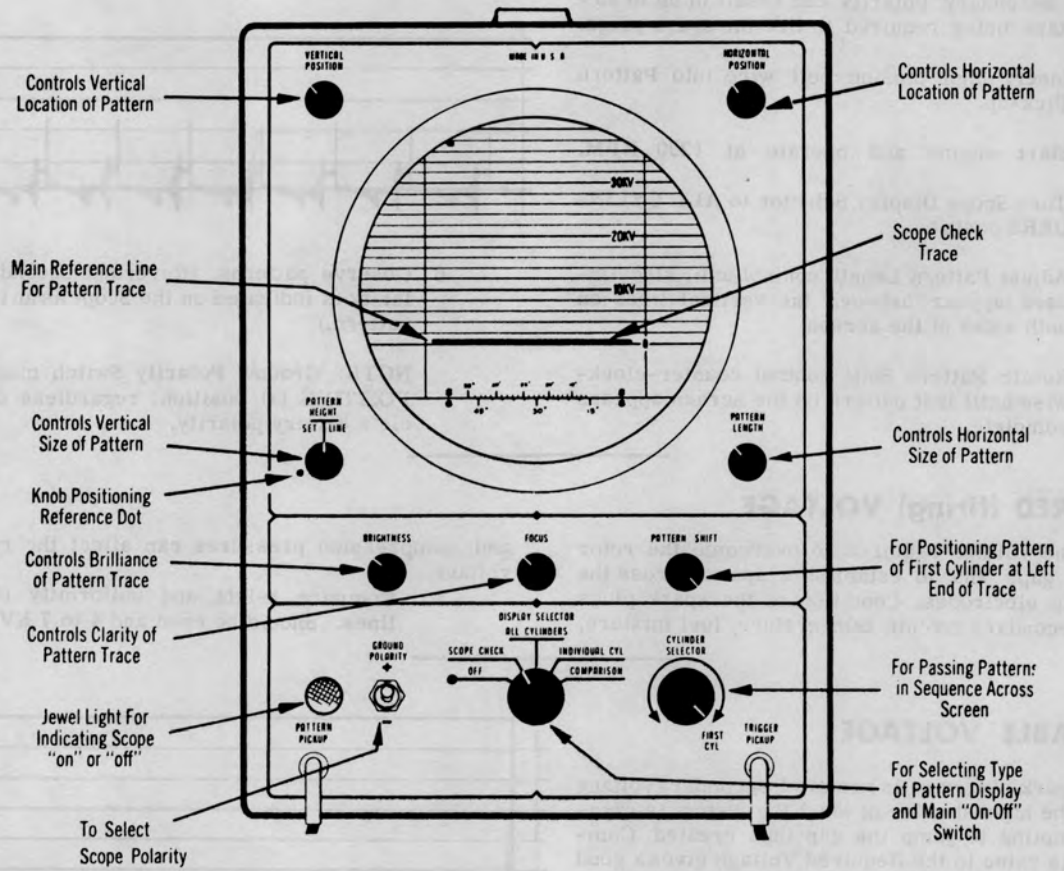


3. Connect Generator Field Control into generator's field circuit, set control to "OPEN" position.
4. Remove high tension wire from coil and leave wire disconnected.
5. Insert Secondary Pattern Pickup into coil tower and attach Ground Clip to a good ground on the engine.
6. Connect Trigger Pickup into the circuit of the last spark plug in the firing order.
7. Turn Display Selector to SCOPE CHECK position, and Ground Polarity Switch to POSITIVE (+) position.

8. With Display Selector in SCOPE CHECK position, a horizontal line (scope trace) will appear on the screen after about 30 seconds warm-up, (if trace does not appear, turn Brightness Control clockwise and rotate Horizontal and Vertical Position controls until trace appears on the screen.)

9. Adjust Horizontal and Vertical Position controls to align left end of trace with vertical line on left of screen at ZERO line.
10. Adjust Brightness and Focus controls to obtain desired brilliance and a sharp clear trace.
11. Rotate Pattern Shift and Cylinder Selector controls to FULL CLOCKWISE position.
12. Adjust Pattern Height control to SET LINE.

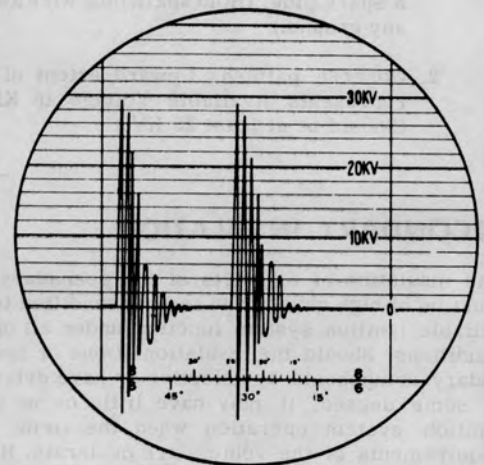
**SCOPE CONTROLS**



**COIL OUTPUT VOLTAGE AT CRANKING SPEED**

This is a Scope measurement of the secondary voltage available to fire the spark plug while the engine is being cranked. In instances of hard starting or starting failure, it may quickly confirm or eliminate the primary circuit and coil as the cause.

1. With ignition switch ON, crank engine and note coil output voltage. Coil output voltage should extend at least 20 KV above ZERO line.

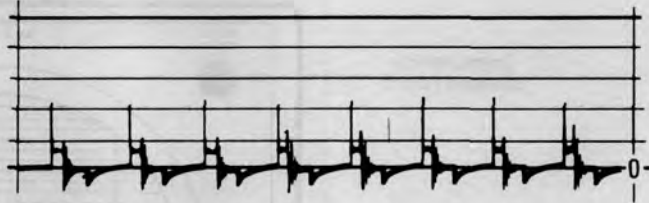




**SECONDARY POLARITY**

Incorrect Secondary Polarity can result in up to 40% more voltage being required to fire the spark plugs.

1. Insert high tension coil wire into Pattern Pick-up.
2. Start engine and operate at 1200 RPM.
3. Turn Scope Display Selector to ALL CYLINDERS position.
4. Adjust Pattern Length control until all cylinders appear between the vertical lines on both sides of the screen.
5. Rotate Pattern Shift control counter-clockwise until last pattern on the screen appears complete.



6. Observe patterns. (Reversed secondary polarity is indicated on the Scope as an inverted pattern.)

NOTE: Ground Polarity Switch must be in POSITIVE (+) position, regardless of vehicle's battery polarity.

**REQUIRED (firing) VOLTAGE**

This is the voltage required to overcome the rotor and plug gaps and to establish a spark across the spark plug electrodes. Condition of the spark plugs and/or secondary circuit, temperature, fuel mixture,

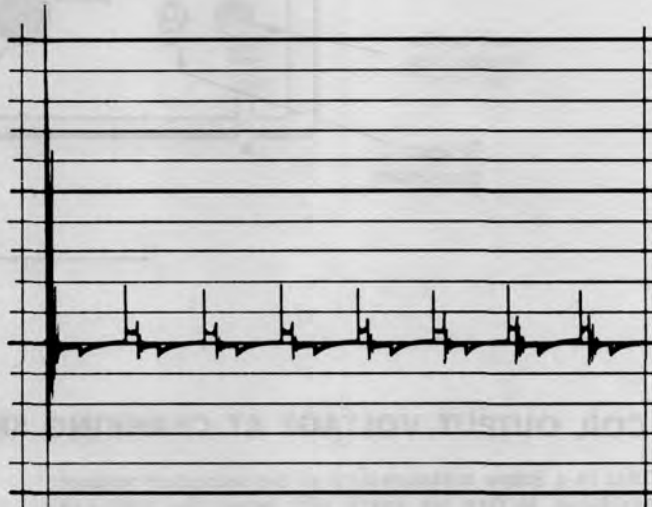
and compression pressures can affect the required voltage.

1. Compare height and uniformity of firing lines. Should be even and 4 to 7 KV.

**AVAILABLE VOLTAGE**

When a spark plug wire is removed, secondary voltage rises to the highest value of which the system is capable, attempting to jump the gap thus created. Comparing this value to the Required Voltage gives a good indication of "Ignition Reserve." If "Ignition Reserve" is insufficient at test speed, ignition failure can occur when subjected to the more severe requirements of various driving conditions.

1. Use insulated pliers to disconnect a wire from a spark plug. (Hold spark plug wire away from any ground.)
2. Observe pattern. Upward extent of pattern represents Available Voltage in Kilovolts. (Should be at least 20 KV.)



**SECONDARY INSULATION**

The insulation of all parts of the secondary circuit must be of high quality and in good condition to insure reliable ignition system function under all operating conditions. Should the insulation of one or more secondary components be defective or have deteriorated to some degree, it may have little or no effect on ignition system operation when the firing voltage requirements of the vehicle are moderate. However, when firing voltage requirements are high, this defective insulation may leak or break down, allowing much of the voltage surge to be lost to ground resulting in misfire of one or more plugs.

1. Observe downward extent of pattern of cylinder with spark plug wire removed. (Note length of downward extent and whether it is consistent or intermittent.) Downward extent should equal at least 1/2 of the upward extent.
2. Reconnect wire to spark plug.
3. Test remaining cylinders in the same manner. (Trigger cylinder must be tested in SCOPE CHECK position.)



**SECONDARY RESISTANCE**

"Spark Line" analysis reveals the condition of the secondary circuit conductors. Excessive resistance uses up energy which is needed to maintain good ignition, and consequently results in poor performance under severe operating conditions.

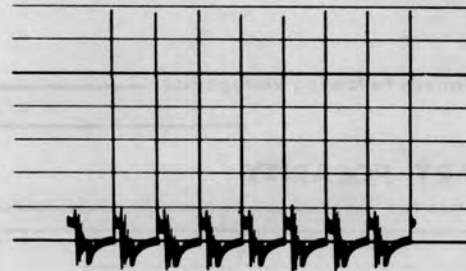
1. With Display Selector in ALL CYLINDERS position, observe and compare spark line of patterns for height, length, angle, and oscillations. For closer examination, the pattern for each cylinder may be expanded, viewed individually, or compared. ( Use Pattern Length, Display Selector, and Cylinder Selector controls.)



**SPARK PLUGS UNDER LOAD**

When a load is applied to an engine the Required Voltage rises. This rise will be slight and uniform if the plugs are in good condition and properly gapped. However, if any unusual firing characteristics are observed while the engine is operating under a load, it generally indicates faulty spark plug condition. To be particularly noted are the individual firing voltages that are considerably higher or lower than the firing requirements of the other cylinders of the engine.

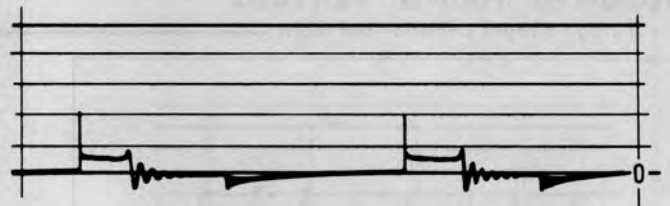
1. With Display Selector set in ALL CYLINDERS position, rotate Pattern Shift control FULL CLOCKWISE.
2. Momentarily accelerate engine (to approximately 2000 RPM) and note rise of the firing lines.
3. Allow engine speed to return to 1200 RPM.



**POINT CONDITION AND ACTION**

The Scope permits direct observation of point action. Since the points are the main switch in the primary circuit, and are required to make and break this circuit for each spark at the plug, it is essential that every phase of their operation be correct. Arcing, bounce, or poor contact can be quickly detected.

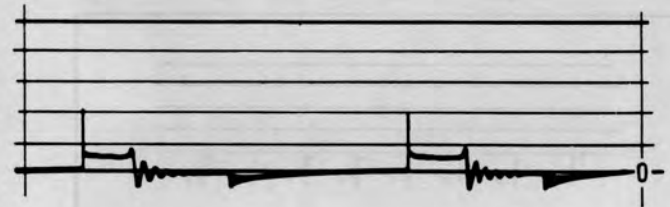
1. Turn Display Selector to the INDIVIDUAL CYLINDER position.
2. Observe POINT CLOSE and POINT OPEN signal for normal operation.



**COIL AND CONDENSER**

If the coil and condenser are functioning normally, energy remaining in the system, after the firing cycle is completed, dissipates in diminishing oscillations. The absence of these oscillations is a clear indication of trouble.

1. Observe and note the number of oscillations in the intermediate section of patterns.



## SCOPE TEST INDICATIONS

The Test Indications section which follows, illustrates only the more frequently encountered patterns which indicate specific types of troubles as displayed at an engine speed of 1200 RPM. It must be realized that many of the troubles and defects which occur, can exist in various degrees of severity which in turn

will determine how prominently the trouble will be disclosed in the Scope display. Another important fact which must be considered is that occasionally two or more troubles may be present at the same time, and in some instances these troubles may have opposite effects on an ignition waveform pattern.

### UNSATISFACTORY TEST RESULTS

### PROBABLE CAUSES

#### COIL OUTPUT VOLTAGE AT CRANKING SPEED

*Low secondary voltage* →

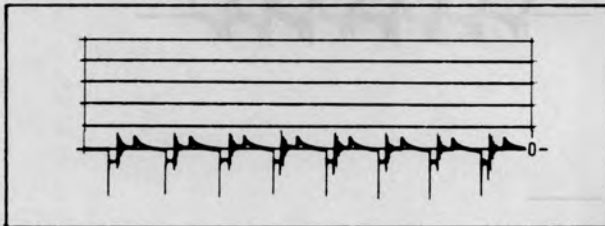
**Battery Low**  
**Defective Ignition Circuit**  
**Failure of Resistor By-Pass Circuit**  
**Insufficient Dwell**  
**Excessive Distributor Resistance**  
**Defective Coil or Condenser**

*No oscillations following voltage rise.* →

**Defective Coil or Condenser**

#### SECONDARY POLARITY

*Pattern inverted* →



**Scope Polarity Switch in Wrong Position**  
**Battery Polarity Reversed**  
**Coil Improperly Connected**  
**Incorrect Coil for the Vehicle**

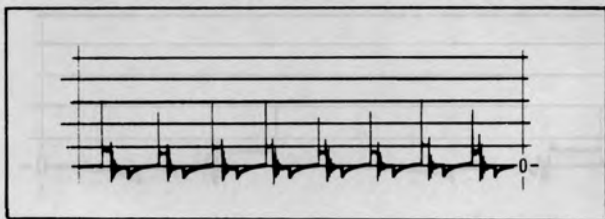
#### REQUIRED (FIRING) VOLTAGE

*Firing voltages uniform—but high* →



**Worn Spark Plug Electrodes**  
**Late Ignition Timing**  
**Lean Fuel Mixture**  
**Too Large Rotor Gap**  
**Break in the Coil Wire**

*Uneven firing voltages* →



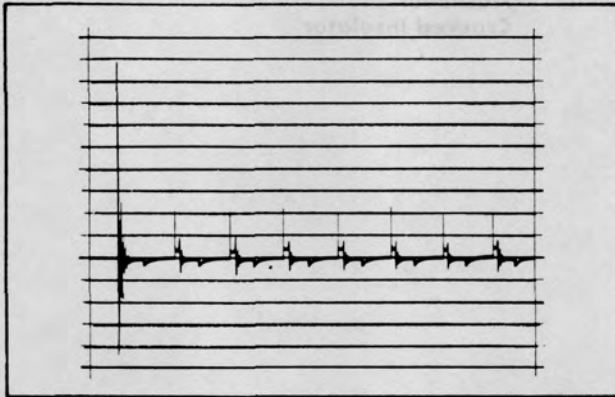
**Worn Spark Plug Electrodes**  
**Unbalanced Fuel Mixture**  
**Breaks in Spark Plug Wires**  
**Cocked or Worn Distributor Cap**

**UNSATISFACTORY TEST RESULTS**

**PROBABLE CAUSES**

**AVAILABLE VOLTAGE**

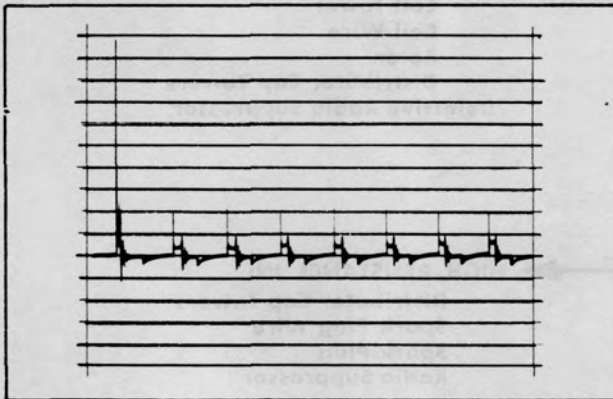
*Insufficient available voltage*



- Excessive Resistance in the Primary Circuit
- Low Primary Input Voltage
- Defective Coil
- Dwell Less than Specified
- Defective Secondary Insulation

**SECONDARY INSULATION**

*Short, intermittent, or absent lower extent*



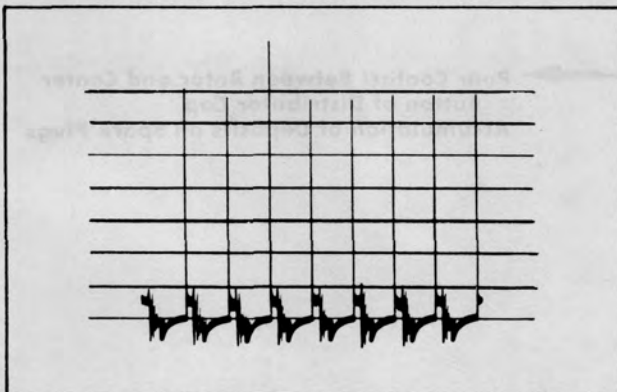
**INSULATION LEAKAGE IN:**

- Coil
- Coil Tower
- Rotor
- Coil Wire
- Distributor Cap
- Spark Plug Wire
- (See Below)

- ON ALL CYLINDERS:**  
Coil Tower, Rotor, Coil Wire, or Distributor Cap
- ON ONE OR MORE CYLINDERS:**  
Distributor Cap or Spark Plug Wires

**SPARK PLUGS UNDER LOAD**

*One or more firing lines higher than others*



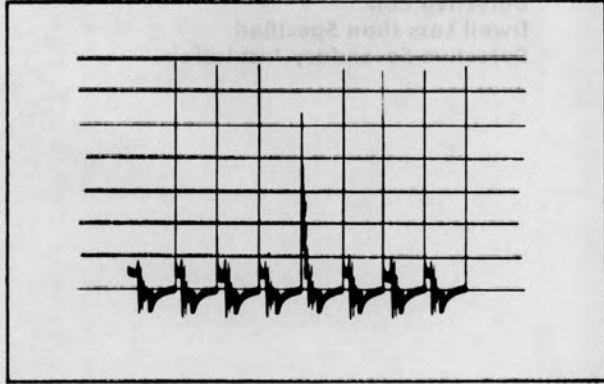
- Wide Plug Gap
- Open Spark Plug Resistor
- Badly Deteriorated Electrodes

**UNSATISFACTORY TEST RESULTS**

**PROBABLE CAUSES**

**SPARK PLUGS UNDER LOAD**

One or more firing lines lower than others



Spark Plug Fouling  
Flashover  
Cracked Insulator

**SECONDARY RESISTANCE**

Affecting all cylinders



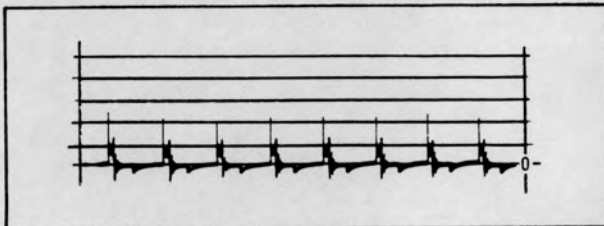
**HIGH RESISTANCE IN:**  
Coil Tower  
Coil Wire  
Rotor  
Distributor Cap Towers  
Defective Radio Suppressor

Affecting one or more cylinders



**HIGH RESISTANCE IN:**  
Distributor Cap Towers  
Spark Plug Wire  
Spark Plug  
Radio Suppressor

Affecting all cylinders



**Poor Contact Between Rotor and Center  
Button of Distributor Cap  
Accumulation of Deposits on Spark Plugs**

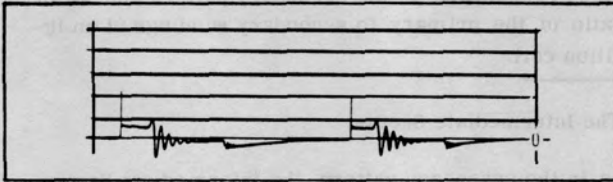


**UNSATISFACTORY TEST RESULTS**

**PROBABLE CAUSES**

**POINT CONDITION AND ACTION**

*Unusual point close signal*



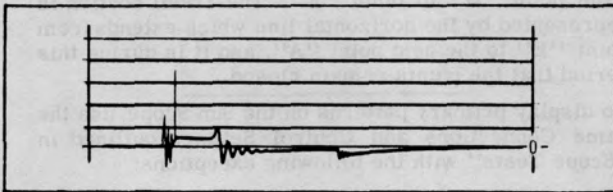
**Poor Point Contact or Point Misalignment**

*Unusual point close signal*

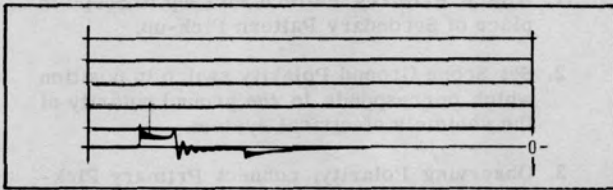


**Point Bounce  
Weak Point Spring Tension**

*Unusual point open signal*

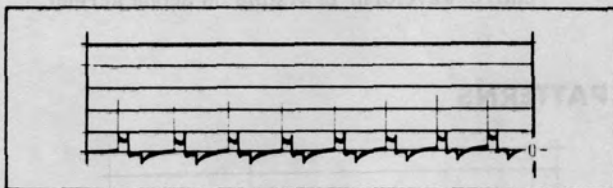


**Dirty Points  
Burned Points  
High Condenser Series Resistance**



**COIL AND CONDENSER**

*Lack of oscillations in Intermediate Section*

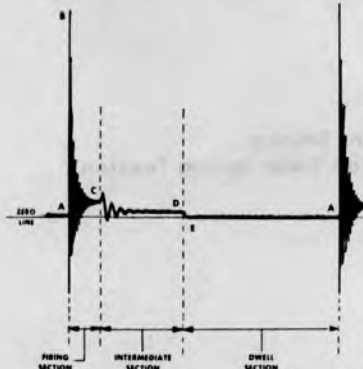


**Short in the Coil  
Leaky Condenser**

**PRIMARY WAVEFORM INTERPRETATION**

Since any voltage variation in the ignition primary circuit will be reflected in the secondary, it is seldom necessary to use a primary pattern for general ignition testing. If desired, a primary waveform can be displayed on the Sun Scope by substituting the Primary Pattern Pick-up for the Secondary Pattern Pick-up.

The KV scale on the scope screen applies only to the



The primary pattern has the same three basic sections as the secondary:

**The Firing Section**

This section displays the series of rapid oscillations that take place in the ignition primary circuit during the period of time in which the sparkplug fires. Point "A" represents the instant at which the breaker points separate.

The vertical rise from "A" to "B" and the diminishing oscillations which follow, represent the initial and repeated charging and discharging of the condenser and the induced voltage surges in the primary circuit while the spark plug is firing. As the spark bridges the gap and energy is being drained from the coil, the amplitude of these oscillations will diminish until the spark is extinguished as indicated at point "C".

display of secondary patterns. Although a resemblance exists between primary and secondary patterns, it should be noted that the voltage values represented in the primary patterns are considerably lower than those represented in the secondary patterns due to the ratio of the primary to secondary windings of an ignition coil.

**The Intermediate Section**

As in the secondary pattern, the Intermediate Section is seen as a series of gradually diminishing oscillations which disappear or nearly disappear by the time the Dwell Section begins. Beginning at point "C", what energy still remains in the coil will dissipate itself as an oscillating current which gradually dies out as it approaches point "D".

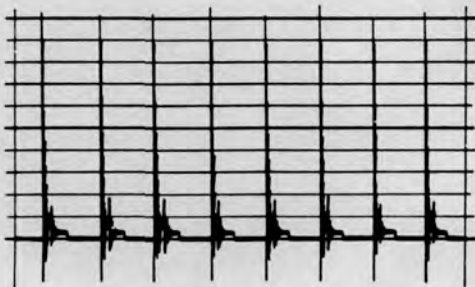
**The Dwell Section**

The Intermediate Section ends and the Dwell Section begins simultaneously when the distributor contacts close, and can be observed as a faint downward line from point "D" to point "E". The Dwell Section is represented by the horizontal line which extends from point "E" to the next point "A", and it is during this period that the points remain closed.

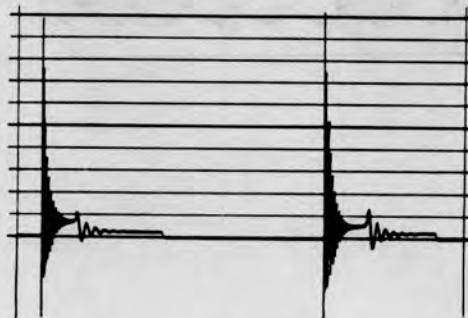
To display primary patterns on the Sun Scope, use the same Connections and Control Settings outlined in "Scope Tests" with the following exceptions:

1. Attach Primary Pattern Pick-up to Scope in place of Secondary Pattern Pick-up.
2. Set Scope Ground Polarity switch in position which corresponds to the ground polarity of the vehicle's electrical system.
3. Observing Polarity, connect Primary Pick-up Leads to distributor primary terminal of coil and to ground.
4. With engine operating at the desired test speed, adjust Pattern Height control until entire waveform is visible on Scope screen.

**TYPICAL PRIMARY PATTERNS**



**ALL CYLINDERS**



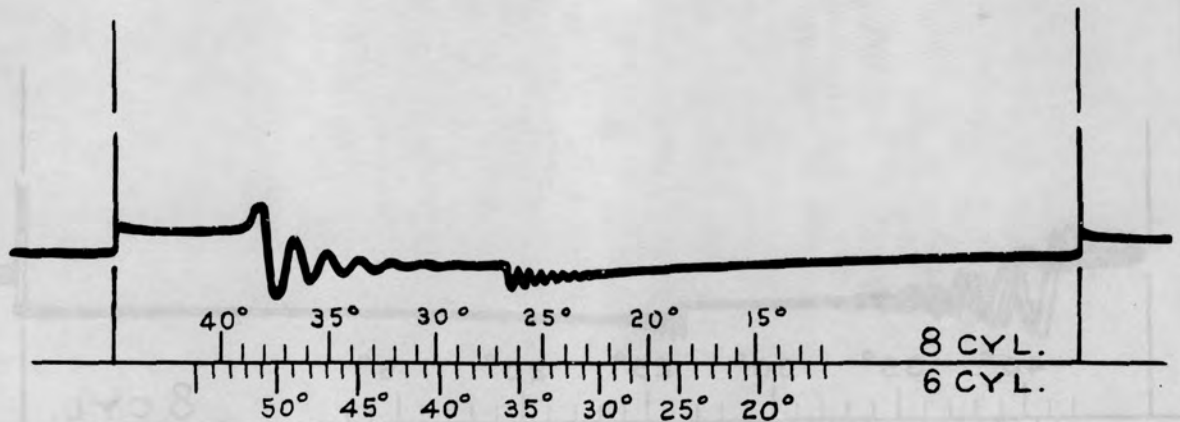
**INDIVIDUAL CYLINDERS**

**SUN SCOPE DWELL TEST**

Facilities are provided in the Sun Scope for measuring distributor point dwell. These facilities may be utilized when displaying either secondary or primary waveform patterns.

Dwell can accurately be measured by expanding the pattern of any one cylinder until it completely fills

the space between the two vertical lines on the screen, then lowering the pattern until it rests on the Dwell Scale. Dwell is measured directly from the scale, which actually consists of two sets of graduations; the upper one for 8 cylinder engines and the lower one for 6 cylinder engines. The dwell of 4 cylinder engines may also be measured by doubling the Dwell reading, obtained from the 8 cylinder scale.



1. With Scope connected and adjusted as outlined in "Scope Tests", set Display Selector to INDIVIDUAL CYLINDER position.
2. Adjust engine speed to 1200 RPM.
3. Set Cylinder Selector to FIRST CYLINDER position.
4. Adjust Horizontal Position control to bring the firing line of the first pattern into alignment with the vertical line at the left of the screen.
5. Adjust Pattern Length control to bring the next firing line into alignment with the vertical line at the right of the screen.
6. Adjust Vertical Position control until the pattern rests on the Dwell Scale near bottom of screen.
7. Measure dwell by noting point on Dwell Scale which is in alignment with the beginning of the pattern's "Dwell Section."

Refer to specifications for proper dwell.

**SUPERIMPOSED SCOPE PATTERNS**

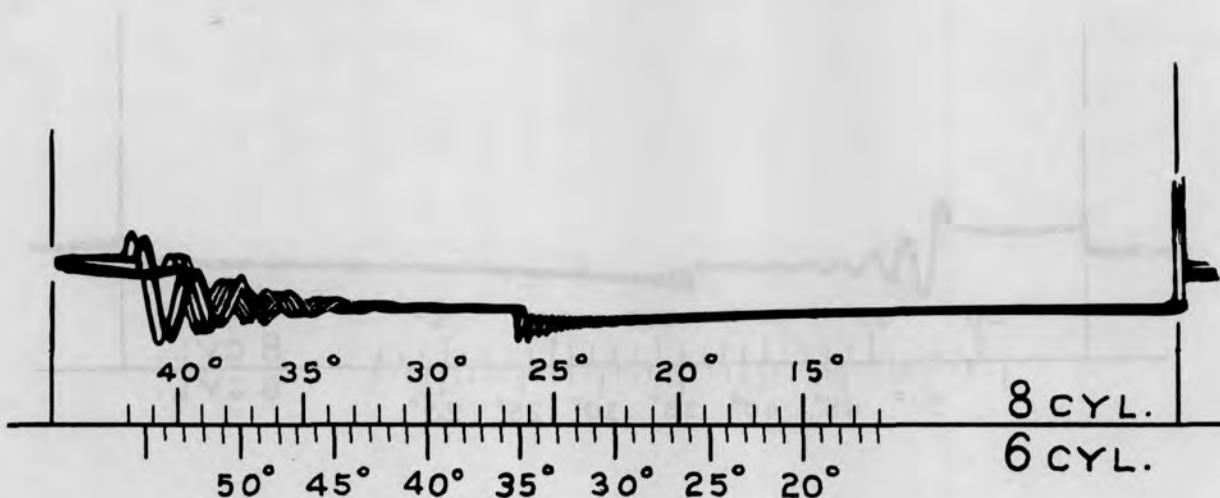
A superimposed pattern is the display obtained by simultaneously placing the patterns of all cylinders one on top of the other. To obtain a superimposed pattern, it is necessary to trigger the Scope each time the ignition points break. This is accomplished by connecting the Trigger Pick-Up into the secondary circuit between the coil and the distributor cap. Using this method, the operator has a choice of superimposing either a secondary or a primary display by selecting the proper Pattern Pick-Up.

Superimposing Scope patterns of all cylinders is advantageous in many instances, because it provides a convenient method of testing the ignition system for over-all uniformity. By expanding the display horizontally to completely fill the space between

the two vertical lines on the screen, any variation in the basic pattern sections can quickly be detected.

Lowering the superimposed display until it rests on the Dwell Scale permits any inaccuracy of the distributor cam to be indicated and measured on the Dwell Scale. The accuracy of the distributor cam determines the ignition timing relationship of all cylinders. Should one or more lobes of the distributor cam become worn, or should the distributor shaft be bent, uneven timing of the cylinders would result.

The display illustrated below shows the superimposed patterns of an eight cylinder engine and indicates a total variation of 1/2 degree at the "Point Close" portion of the pattern.



To display superimposed patterns on the Sun Scope, use the same connections and control settings as outlined in "Scope Tests" with the following exceptions:

1. Using Pick-Up Transformer Adapters, install the Trigger Pick-Up into the secondary circuit between the coil and distributor cap.
2. With Pattern Shift and Cylinder Selector controls in FULL CLOCKWISE position, set Display Selector to ALL CYLINDERS position.
3. Start engine and adjust speed to 1200 RPM.
4. Adjust Horizontal Position control to align

beginning of trace with vertical line at left of screen.

5. Adjust Pattern Length control to align end of trace with vertical line at right of screen.

Observe display for uniformity of patterns.

6. Adjust Vertical Position control to locate display midway between ZERO line and Dwell Scale near bottom of screen. (For easier observation the Pattern Height may be increased by rotating the control CLOCKWISE.)

Observe number of degrees that "Point Close" signals overlap. This should not exceed three degrees.



## COMPARISON TEST

During the process of ignition testing the pattern of one cylinder may appear to look different than the patterns of the other cylinders of that engine. The Sunscope permits displaying one pattern above the others for closer examination of differences in pattern characteristics. Differences in individual cylinder patterns are of great value in evaluating engine problems.

To compare patterns on the Sunscope use the same connections and control settings as outlined in "Scope Tests" with the following additions:

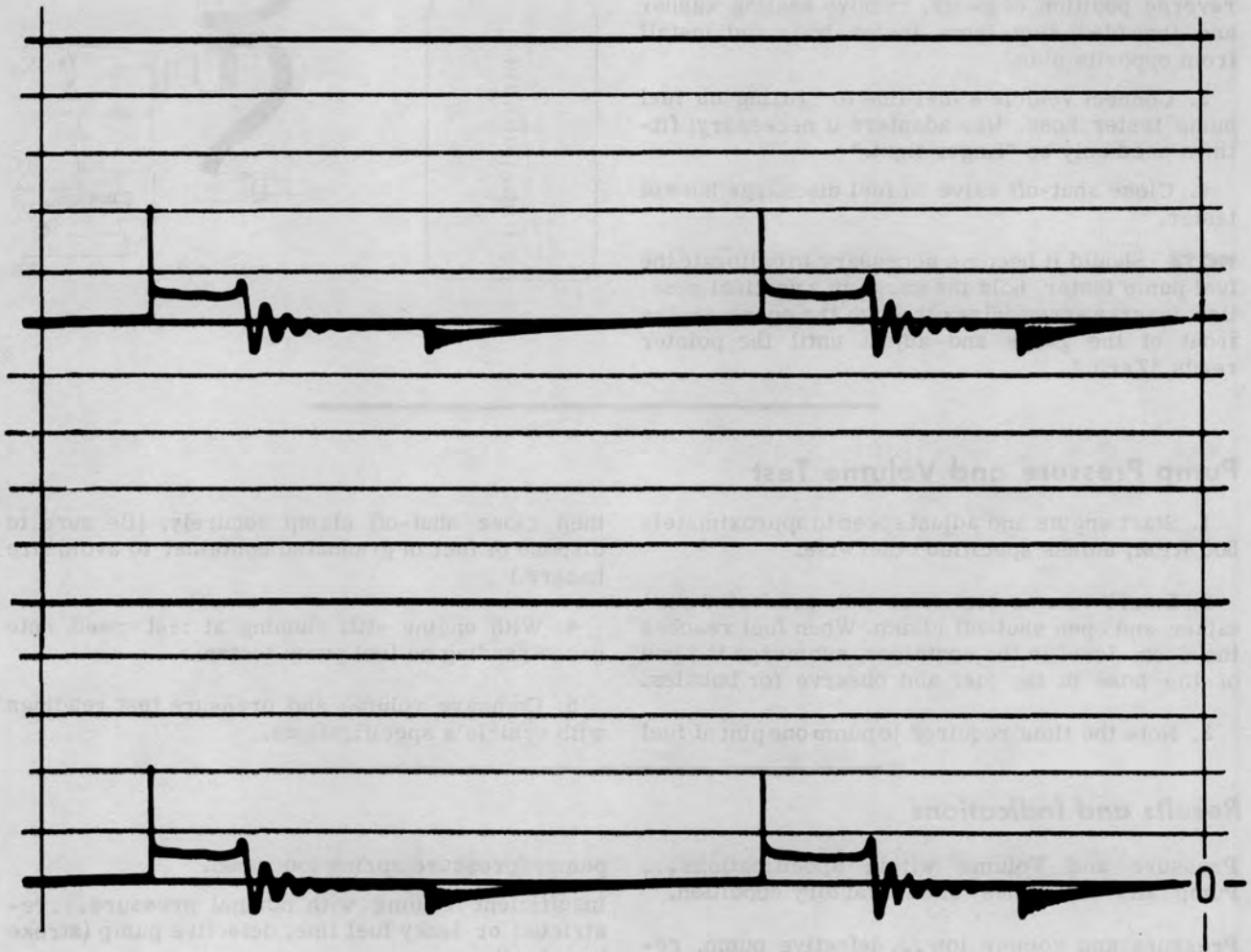
1. After the "Coil and Condenser Test" turn DISPLAY SELECTOR switch to "COMPARISON" position.

2. Turn CYLINDER SELECTOR Control clockwise to first cylinder position.

Both patterns will be of the cylinder in the firing order following the one with the trigger pickup.

3. Rotate Cylinder Selector Counterclockwise and observe bottom Cylinder and compare patterns as they pass in their respective positions in the firing order.

Any Cylinder's pattern can be displayed in the upper position by connecting trigger pickups to the Cylinder preceding it in the firing order.



## FUEL PUMP TESTER

In order to assure an adequate quantity of fuel and a constant fuel level for all driving conditions, it is necessary that both Fuel Pump pressure and volume be within specifications. It has been established that the only reliable pressure test is one

that is made under actual operating conditions (i.e., with pump supplying fuel to the carburetor and gauge located within six inches of and connected to the fuel line).

### Connections to Vehicle

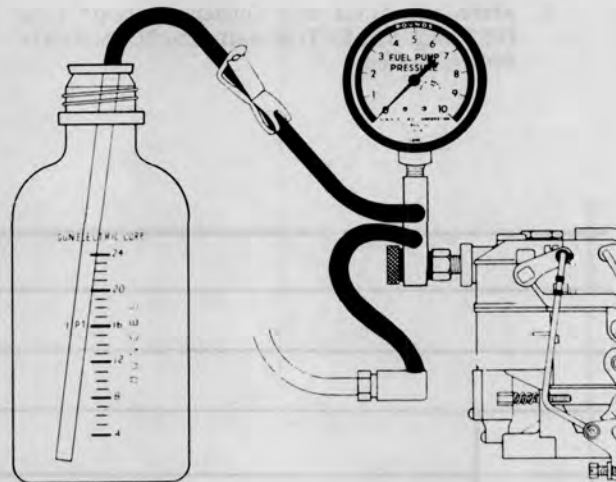
1. Remove vehicle's air cleaner and disconnect main fuel line at carburetor, or at "T" or junction, if vehicle is equipped with more than one carburetor.

2. Mount tester to carburetor inlet with gauge vertical and facing operator. Use adapters if necessary; fittings need only to be "finger tight." (To reverse position of gauge, remove sealing washer and threaded stud from tester body and install from opposite side.)

3. Connect vehicle's fuel line to fitting on fuel pump tester hose. Use adapters if necessary; fittings need only be "finger tight."

4. Close shut-off valve on fuel discharge hose of tester.

**NOTE** Should it become necessary to calibrate the fuel pump tester, hold the gauge in a vertical position, insert a screwdriver through the opening in the front of the gauge and adjust until the pointer reads "Zero."



### Pump Pressure and Volume Test

1. Start engine and adjust speed to approximately 500 RPM, unless specified otherwise.

2. Insert volume test hose into graduated container and open shut-off clamp. When fuel reaches the 4 oz. level in the container, submerge the end of the hose in the fuel and observe for bubbles.

3. Note the time required to pump one pint of fuel

then close shut-off clamp securely. (Be sure to dispose of fuel in graduated container to avoid fire hazard.)

4. With engine still running at test speed, note gauge reading on fuel pump tester.

5. Compare volume and pressure test readings with vehicle's specifications.

### Results and Indications

Pressure and Volume within specifications...  
Pump and fuel lines in satisfactory condition.

Pressure and volume low...defective pump, restricted or leaky line.

Pressure low with correct volume...defective

pump, (pressure spring too weak).

Insufficient volume with normal pressure... restricted or leaky fuel line, defective pump (stroke too short).

Air bubbles on volume test...leaky fuel line, leaky pump.

# COMBUSTION EFFICIENCY TESTER

Combustion efficiency is a very reliable indication of carburetor system operation on a mechanically sound, properly tuned engine with a good ignition system. Combustion efficiency is tested by utilizing exhaust gas samples picked up at the tail pipe to determine the fuel to air ratio, and indicating this information on an electric meter. To obtain accurate test results, the engine must be at operating temperature.

Before testing, determine that both compression and ignition of the engine to be tested are in good condition, and that the exhaust system doesn't leak. While oil smoke from a car does not materially affect the accuracy of a tester during the test, repeated use of a combustion efficiency tester on oil burning engines will eventually decrease its sensitivity because of oil fouling.

## Preparation For Tests

1. Connect a Tachometer to the engine. (Refer to the Tach-Dwell Tester section of this Handbook.)
2. Connect a Vacuum Gauge to the Intake Manifold. (Refer to the Vacuum Pressure Tester section of this Handbook.)
3. Connect the battery leads of the Combustion Tester to either a 6 volt or 12 volt battery as shown. (Red lead to Positive battery post, and Black lead to Negative battery post.) Battery specific gravity must be at least 1.250 to assure accurate test results.

If battery in vehicle is to be used to power tester, it is important that the voltage applied to the tester be maintained at a constant value. Therefore, to prevent the generator varying its input voltage to the tester, it is necessary to connect the generator field control unit into the generator's field circuit. (Refer to the Generator Field Control section of this Handbook.)

4. Connect one end of neoprene hose to Exhaust Condenser and the other end to fitting on Combustion Efficiency Tester.

5. Turn selector switch to BATTERY position and adjust BATTERY CALIBRATOR knob until the meter reads on the SET LINE.

## Idle Mixture

1. Adjust engine speed to specified idle RPM.
2. Note reading on Combustion Efficiency Meter. The most desirable idle mixture on most passenger vehicles is 72% to 76%.

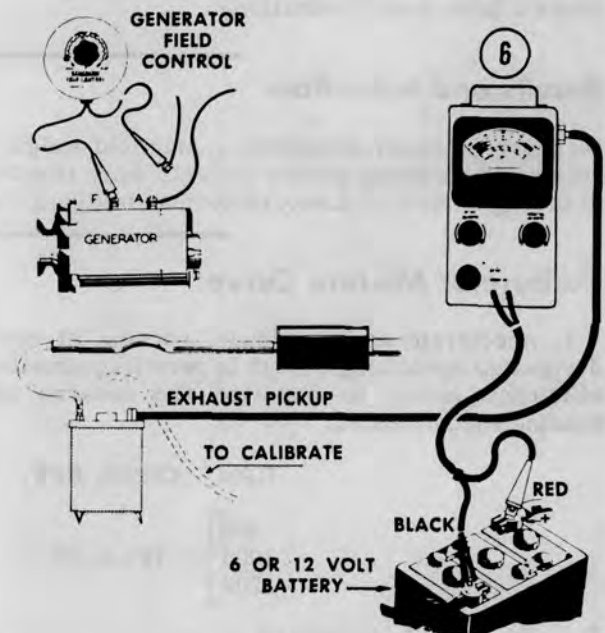
## Results and Indications

Idle mixture reading ranges from 72% to 76%... Idle speed and idle mixture screw settings satisfactory.

6. Turn the selector switch to COMBUSTION position and adjust the COMBUSTION CALIBRATOR knob until the meter reads on the SET LINE.
7. Start engine and insert metal pick-up hose in tail pipe of vehicle. (With dual exhaust, use side opposite Manifold Heat Control Valve.)

3. Make fine adjustments, moving each carburetor idle mixture screw to obtain the desired setting.
4. Note idle speed and reset as necessary to manufacturer's specifications.

Too lean... Incorrect idle mixture adjustments, low float level, plugged idle jets or air leaks.





Too rich...Incorrect idle mixture adjustment, high float level, or plugged air bleeds.

Little or no change in meter reading when idle mixture adjustment is changed...Plugged idle passages or carbon over idle ports.

Meter reading drifts...Worn needle and seat, fuel pull-over from: high speed nozzle, accelerator pump jet, improper float level, or leaky power valve.

**Intake Manifold Leak**

1. Using a squirt can, apply a mixture of engine oil and kerosene to the carburetor flange gasket and intake manifold gaskets. (Do not apply this mixture near the choke heat riser tube as it will cause a false meter indication.)

2. Observe Combustion Tester meter for any unusual deflections towards the rich side.

**CAUTION** Because this mixture is combustible, care should be exercised in its use. Keep the fire extinguisher handy.

**Results and Indications**

No observed meter deflection... Manifold and gaskets airtight. Meter pointer deflects more than 3% to the right (rich) ... Leaky intake manifold gaskets,

cracked or warped intake manifold, loose carburetor, or loose manifold mounting bolts.

**Carburetor Mixture Curve**

1. Accelerate engine slowly, pausing at each designated speed long enough to permit combustion efficiency meter to stabilize and observe for reading recommended:

**NOTE** These readings have been found the most desirable for economy during no-load carburetor testing as pertaining to most passenger cars and light trucks.

RPM	COMB. EFF.	RPM	COMB. EFF.
800	78% to 82%	1500	84% to 88%
1000		1800	
1200		2000	
		2200	

**Results and Indications**

Meter reading within specification for listed engine speeds... Carburetor action satisfactory.

Too rich...High float level, leaky power valve, leaky accelerator pump check valve, incorrect metering rod adjustment, incorrect metering jets, plugged air bleeds or restricted air cleaner.

Too lean...Low float level, incorrect metering rod adjustment or metering jets, plugged high speed passages or jets, manifold or carburetor air leaks.

Meter reading drifts...Worn needle and seat. Fuel pull-over from: high speed nozzle, accelerator pump jet, improper float level, or leaky power valve.

**Accelerator Pump**

1. Set engine speed to 1000 RPM and allow Combustion Reading to stabilize.

tle and immediately drop speed back to 1000 RPM.

2. Accelerate quickly to approximately half throt-

3. Observe Combustion Meter for the amount of temporary enrichment (deflection to the right). Should be a minimum of 8%.

**Results and Indications**

Meter shows a minimum of 8% temporary enrichment... Accelerator Pump action satisfactory.

Too lean. Little or no change in meter reading... Insufficient pump stroke, leaky check valve, worn linkage, worn plunger.



### Air Cleaner Test

1. With engine operating at 2000 RPM;
  - a. Observe Combustion Meter Reading with air cleaner in place on carburetor.
  - b. Observe Combustion Meter Reading with air cleaner removed from carburetor.
2. Compare meter readings observed in previous step.

### Results and Indications

Little or no difference indicated in the two meter readings just observed... Air cleaner not restricting flow of air.

is indicated.

Greater than 5% difference noted in the two meter readings just observed... Air cleaner restriction

**NOTE** Some air cleaners have a built in restriction which will cause considerable leanness of the air-fuel ratio when the air cleaner is removed. Consult manufacturer's data.

### Final Idle Adjustment

1. Reduce engine speed to idle.
2. Observe idle RPM, Combustion Efficiency reading and Vacuum readings.
3. Adjust Carburetor Idle Mixture for highest, smoothest vacuum. Idle should be smooth with mixture and speed within specifications. Vacuum reading should be steady.

**NOTE** Experience is the best guide in determining the normal vacuum for any given engine. Normal manifold vacuum ranges from 15 inches to 22 inches on various engines. On late model engines, lower and less steady vacuum is becoming increasingly common because of greater use of high lift cams and more valve overlap

### Results and Indications

High, steady vacuum. Mixture and speed within specification . . . Proper carburetor adjustment, correct timing.

leaks; uneven compression and improper carburetor action.

Vacuum reading lower than normal but steady... Late ignition timing, late valve timing, low compression, and excessive mechanical drag in engine.

After completing the test series, stop engine before disconnecting test leads, pickups, hoses or accessories required for performing the tests. Be sure all vehicle electric, fuel, and vacuum connections are secure before restarting the engine.

Vacuum reading abnormally unsteady... Improper carburetor idle mixture; distributor points faulty; spark plugs improperly gapped; faulty valve adjustment; fouled or dirty spark plugs; manifold air

**NOTE** Allow combustion tester to operate approximately five minutes after removing hose, to expel any moisture that has accumulated in the unit.

## LOAD TESTING

### Passenger Cars

The Combustion Efficiency Tester will make accurate tests of combustion efficiency in an engine operating under load, on the road or on a dynamometer, up to an air-fuel ratio of 15 to 1. The proper air-fuel ratio for load tests on passenger cars

is best determined by comparison tests and experience with several engines of the same make and model. Consideration must be given to engine conditions, temperatures, grades of fuel, etc.

**Trucks**

Full load, full throttle readings of 82% to 84% combustion efficiency, or 13.5 to 1, to 13.8 to 1 air fuel ratio, are as high as is practical in truck engines. Leaner mixtures result in valve trouble and detonation. It is suggested that the Combustion Efficiency Tester be used to test the combustion efficiency with the vehicle under load in addition to the no-load tests. This is necessary since the full power system is not in operation at 2000 RPM,

no load.

A 14.5 to 1 air-fuel ratio or 87.5% combustion efficiency reading is satisfactory for part throttle operation with the truck under road-load, but it is too lean for sustained open throttle runs. The test equipment operator should be guided by the truck manufacturer's specifications for combustion efficiency under various loadings.

**Dynamometer and Road Testing**

If the Combustion Efficiency Tester is used for road testing, or in conjunction with the Dynamometer to determine combustion efficiency of the engine at various loads, an auxiliary condenser must be used to prevent moisture from entering the tester element. The tester should be placed at a level considerably above the tail pipe to further

guard against water being forced into the tester. When making road or dynamometer tests, it is a good practice to remove the pick-up hose from the tester panel except for periods when actual test data is being recorded. This is a very effective means of keeping moisture out of the tester element.

**L. P. Engine Testing**

When testing engines designed to operate on butane or propane fuels, read the air-fuel ratio on the designated scale of the tester meter.

Specifications for the air-fuel ratio of propane and butane on specified engines may be obtained from the various engine manufacturers as well as propane and butane gas suppliers.

**Multi-Carburetor Installations**

The Combustion Efficiency Tester is ideal for adjusting multi-carburetor installations. With throttle linkage disconnected and the engine operating

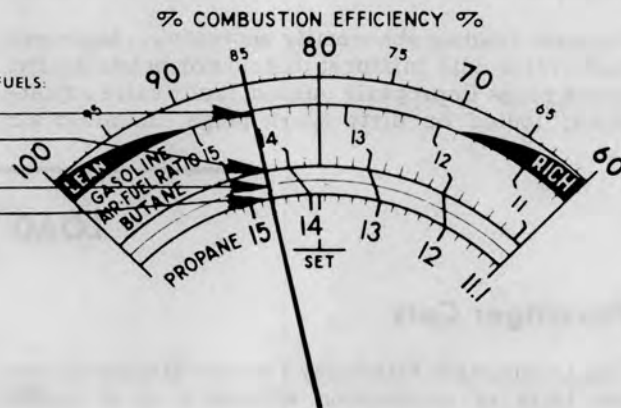
at a fixed speed on each carburetor in turn, the combustion efficiency readings should be consistent.

**HOW TO READ THE COMBUSTION METER**

AIR-FUEL RATIOS INDICATED BY THIS READING FOR THE FOLLOWING FUELS:

- GASOLINE 14 to 1
- BUTANE 14.4 to 1
- 50 50 MIXTURE BUTANE & PROPANE 14.5 to 1
- PROPANE 14.6 to 1

PERCENT OF COMBUSTION EFFICIENCY IS READ ON TOP SCALE.



The "Percent of Combustion Efficiency" scale of the tester is provided as a convenient reference

and is based theoretically, on the complete burning of fuel and at any given ratio of fuel and air.

**Use and Care of The Combustion Tester**

The Combustion Tester is a precision instrument and, like any precision instrument, must receive proper care and usage if long life and accuracy are to be obtained.

Never use the Combustion Tester on an engine while gum solvents or oils are being introduced into the Combustion Chamber through the carburetor or by any other means.

Do not use the Combustion Tester on an engine that is burning oil badly. The oil leakage must be stopped before efficient combustion can be obtained. The oil smoke will eventually decrease the sensitivity of the Combustion Tester.

Check the vehicle for exhaust leaks at manifolding, exhaust gasket, exhaust pipe, muffler or tail pipe. Leaks will allow the exhaust gases to be diluted with outside air, causing meter test readings to be inaccurate. Always insert the pick-up tube as far as possible into the tail pipe of the vehicle.

After completing the Combustion Tests, pull the exhaust hose off the meter panel and allow the booster to continue running for about ten minutes to evaporate any trace of moisture in the instrument.

Drain all water from the hose and the pick-up, and remove the water from the auxiliary condenser if used, and then place the hose in a dry place.

**Meter Indications**

1. Meter will not calibrate to set line with selector switch in battery position. Check for low battery or poor connection.

2. Meter calibration with selector switch in Combustion position very critical or touchy. Rotate the Combustion Calibrator Knob several times, then readjust to SET LINE.

3. Meter constantly floating in Combustion POSITION or showing a fixed reading, indicates moisture in tester. Dry out tester by leaving it in operation with Combustion hose disconnected at tester for ten minutes or more if necessary.

**CAUTION** Under no condition should compressed air be used in an attempt to remove moisture from tester.





# VACUUM PRESSURE TESTER

The Vacuum Pressure Tester is a combination vacuum gauge and 0-7 psi pressure gauge designed for measuring manifold vacuum, fuel pump pres-

sure, the testing of vacuum booster pumps, etc. Adapters are provided for all standard applica-

## Manifold Vacuum Test

1. Connect a tachometer to the engine. (Refer to Tach-Dwell section of this Handbook.)

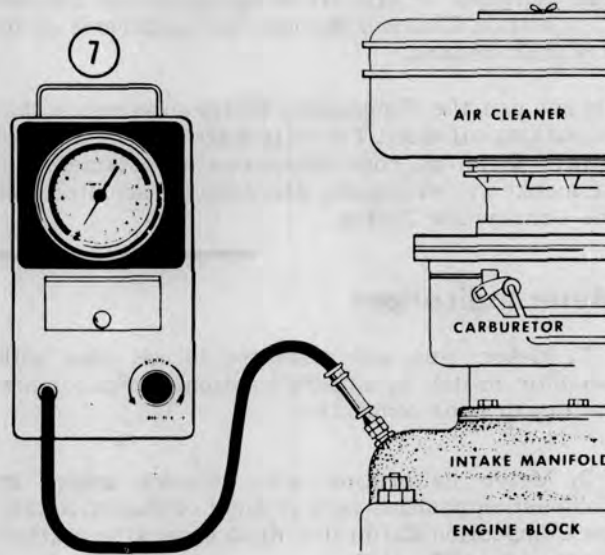
2. Connect Vacuum Pressure Tester hose to the engine's intake manifold, using proper adapter if necessary.

**NOTE** On vehicles with vacuum booster, be sure the tester hose is connected directly to the intake manifold.

3. Start engine and run until normal operating temperature is reached.

4. With engine operating at specified idle speed, note manifold vacuum. If gauge pointer flutters rapidly, adjust damper control until gauge responds freely, but does not flutter excessively.

**NOTE** Experience is the best guide in determining the normal vacuum for any given engine. Normal manifold vacuum ranges from 15 to 22 inches on various engines. On late model engines, lower and less steady manifold vacuum is becoming increasingly common because of the greater use of high lift cams and more valve overlap.



<p>With motor at idling speed vacuum pointer should hold steady between 18 and 21.</p>	<p>With motor at idling speed dropping back of vacuum pointer indicates sticky valves.</p>	<p>With motor at idling speed floating motion right and left of vacuum pointer indicates carburetor too rich or too lean.</p>	<p>With motor at idling speed low reading of vacuum pointer indicates late timing or intake manifold air leak.</p>
--	--	---	--



**Results and Indications**

Engine running smoothly at specified idle RPM. Vacuum reading average and steady---engine, ignition system and fuel system operating normally.

Vacuum reading lower than normal but steady---late ignition or late valve timing, low compression, valves improperly adjusted, excessive mechanical drag in engine.

Vacuum reading abnormally unsteady---improper carburetor idle mixture, distributor point spacing, spark plug gapping, choke adjustment, or valve adjustment. Poor plug or carburetor condition. Manifold air leaks, defective valves, or uneven compression.

**Exhaust Restriction Test**

This test is used to determine whether the exhaust system is restricted, or offers excessive back pressure which could result in reduced engine efficiency.

1. Connect Vacuum Tester and Tach-Dwell Tester to engine as for manifold vacuum test.
2. Gradually accelerate engine from idle to 2000 RPM.

3. Note vacuum gauge reading.

4. Maintain engine speed at 2000 RPM for approximately 10 seconds or longer while observing Vacuum Gauge.

If exhaust system is restricted, vacuum reading will gradually decrease.

**Cranking Vacuum Test**

A high steady vacuum during cranking indicates a mechanically sound engine, properly sealed intake manifold and intake valve guides, and a normal cranking speed. Even though the individual design characteristics of different engines cause the normal cranking vacuum to vary considerably from one type to another, the results of this test have been found to be extremely valuable as a guide in determining compression factor conditions and intake system leakage.

1. Engine should be at normal operating temperature.
2. Connect the jumper lead from the distributor

primary terminal to ground to prevent the engine from starting during this cranking operation.

3. Back out throttle stop screw and release automatic choke so that throttle valves can seat tightly.
4. Crank engine, note vacuum gauge readings and observe cranking speed.

Readings should be average for the make and model of engine being tested. Readings will pulsate slightly but should be even. Cranking speed should be normal and steady.

**Results and Indications**

High, steady vacuum reading---mechanically sound engine, intake manifold gaskets and valve guides in good condition, cranking speed satisfactory.

Uneven pulsating reading---defective valves, rings, pistons, head gasket, uneven cranking speed.

Low even pulsating reading---slow cranking speed, over-all low compression, incorrect valve timing, throttle valves not tightly closed, vacuum leaks at intake valve guides, manifold, or vacuum accessories.

Cranking speed below normal---excessive resistance in battery cables, defective starting motor, excessive mechanical drag in engine.

Uneven cranking speed---uneven compression, defective starter, defective starter drive.

**NOTE** If Cranking vacuum is low or uneven, make cylinder leakage or compression test. Satisfactory engine performance cannot be obtained until any compression or vacuum leaks that exist have been eliminated.

**Fuel Pump Pressure Test**

1. Disconnect fuel line at carburetor and connect vacuum pressure tester hose to this fuel line.
2. Connect the Tach-Dwell Tester to the engine. (Refer to Tach-Dwell section in this Handbook.)
3. Operate engine at 500 RPM and note pressure reading. Refer to manufacturer's specifications.

**NOTE** For most accurate readings, hose should be held approximately level.



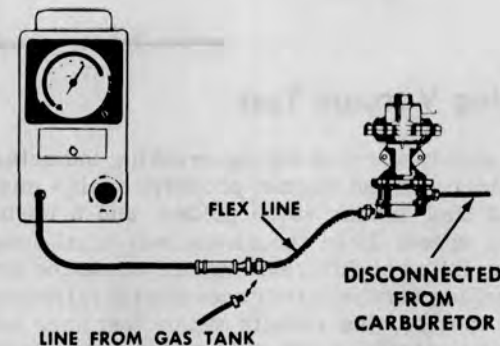
**Fuel Pump Vacuum Test**

The fuel pump vacuum test is an auxiliary test and is necessary only when the pump output does not meet the pressure or volume specifications. The fuel pump vacuum test is made to determine whether the defect is in the pump or in the fuel line.

1. Disconnect fuel pump flexible line from tank fuel delivery line.
2. Install proper adapter fitting in flex line and attach Vacuum Gauge hose.
3. Start engine and operate at idle speed.
4. Run Engine for a period of time sufficient to permit Vacuum Gauge to reach its maximum reading.
5. Stop engine and observe Vacuum Gauge for ten or fifteen seconds.

If maximum vacuum is ten inches or more, and does not fall off when the engine is stopped, the flex line, pump valves, and filter bowl gaskets do not leak.

If maximum reading is less than 10 inches, or vacuum falls off rapidly, remove flex line and couple vacuum gauge directly to the inlet opening of the fuel pump and retest pump.



**NOTE:** The entire line from the fuel tank can be tested for air leaks in a similar manner by connecting the vacuum gauge hose to the fuel line at the tank end of the line, and repeating the test. A rapid fall off of vacuum after the engine is stopped would indicate air leaks into the line somewhere between the tank and the fuel pump.

**Vacuum Booster Pump Test**

The purpose of the Vacuum Booster section of the fuel pump is to operate the windshield wipers during periods of acceleration and at high speeds when manifold vacuum is too low for proper wiper action. A complaint of improper wiper action may be due to

1. Disconnect vacuum line between booster pump and intake manifold.
2. Remove windshield wiper hose from inlet of booster pump and connect vacuum pressure hose to the pump's inlet.
3. Connect the Tach-Dwell Tester to the engine. (Refer to Tach-Dwell section of this Handbook).

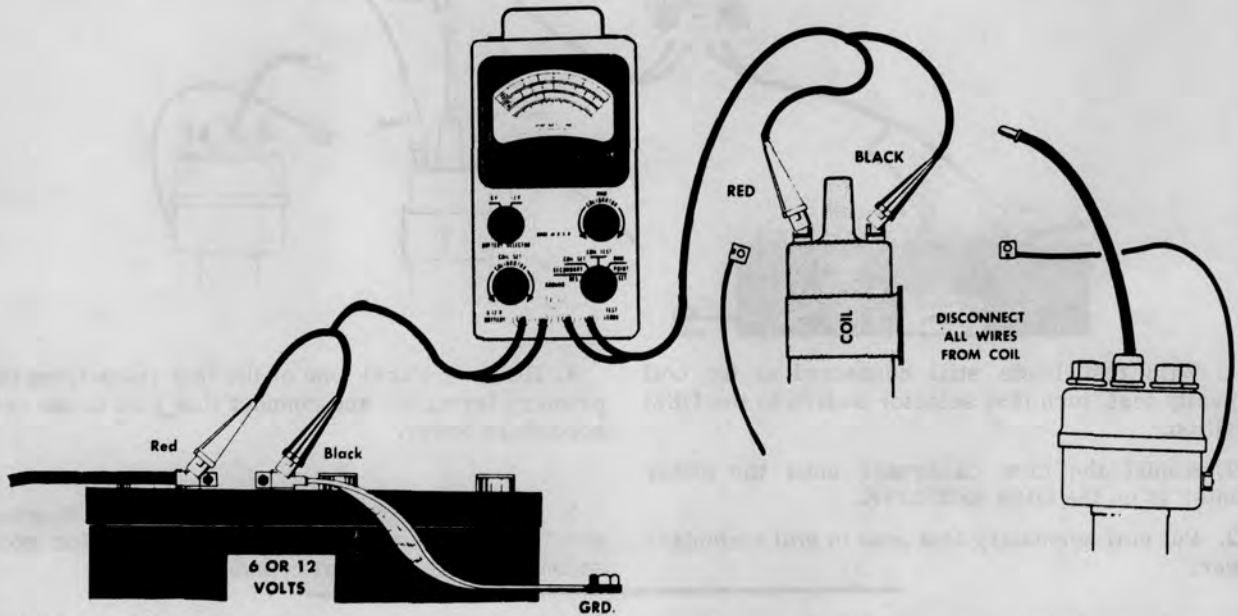
stuck valves or ruptured diaphragm in the booster pump. A ruptured diaphragm can also cause an engine miss (due to a lean air-fuel mixture), fouled plugs, a smoky exhaust, or high oil consumption.

4. Operate engine at 1000 RPM. Vacuum reading generally should be 8-1/2 inches or more if the booster pump is operating satisfactorily.
5. Stop engine and observe Vacuum Gauge for a short period of time. A rapid fall-off of the Vacuum Gauge reading would indicate air leaks in the pump, pump valves, tester connection, etc.

# COIL CIRCUIT TESTER

The coil circuit tester quickly indicates whether an ignition coil is good or bad. It completely tests six or twelve volt coils for opens, shorts, grounds and insulation breakdown. It also provides facilities for making "on-the-vehicle" tests of secondary

circuit resistance, and tests of secondary circuit insulation. Being equipped with a zero to one hundred thousand ohm scale, it provides facilities for testing the condition and continuity of suppressor resistors and other ignition system components.



## Ignition Coil Tests

To determine whether a coil is in satisfactory condition, it is necessary to perform both the coil capacity test and the coil secondary continuity test.

1. Observing polarity, connect the battery leads of the coil tester to a battery. (For testing 12 volt coils, a 12 volt battery should be used. For testing 6 volt coils, either a 6 or a 12 volt battery may be used.)

2. Turn battery selector switch of tester to position corresponding with battery voltage.

3. Disconnect all vehicle wires from the coil terminals.

4. Connect tester's test leads one to each coil primary terminal.

**NOTE** For bench tests, or tests on the vehicle when other than the vehicle battery is used, connect ground lead of tester to the case of the coil.

## Coil Capacity Test

5. Turn test selector switch to COIL SET position.

6. Adjust coil set calibrator until meter pointer indicates the specified reading on the COIL SET scale.

Refer to coil test specification chart in this section of the Handbook.

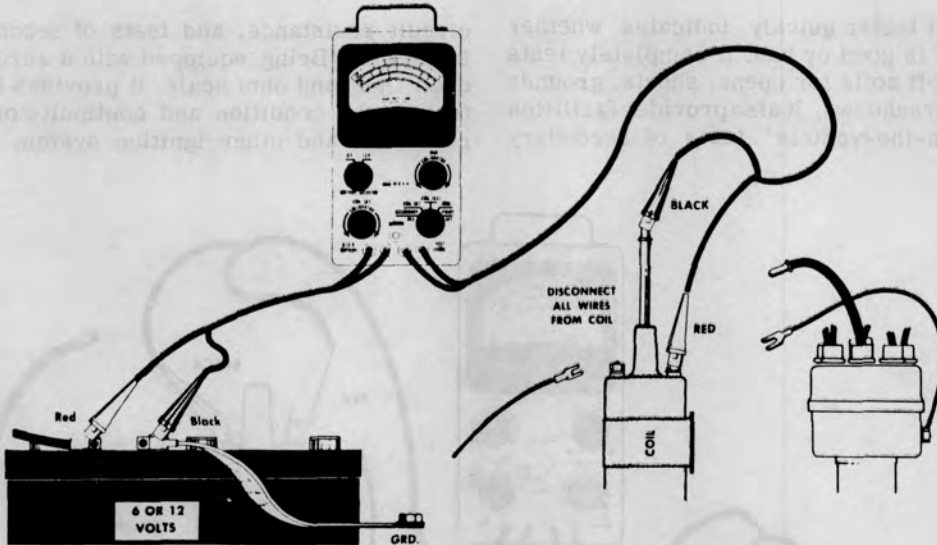
7. Turn test selector switch to COIL TEST position. If coil is good, meter will read steadily in

GOOD band. If coil is defective, meter will read in BAD band, or meter reading will read unsteady in the GOOD band.

**NOTE** If coil capacity shows in the good band, there are no opens, grounds, or shorts in any of the primary or secondary windings. However, it is necessary to test the secondary continuity to be certain that the ends of the secondary windings are securely fastened to their terminals in the coil.



**Secondary Continuity Test**



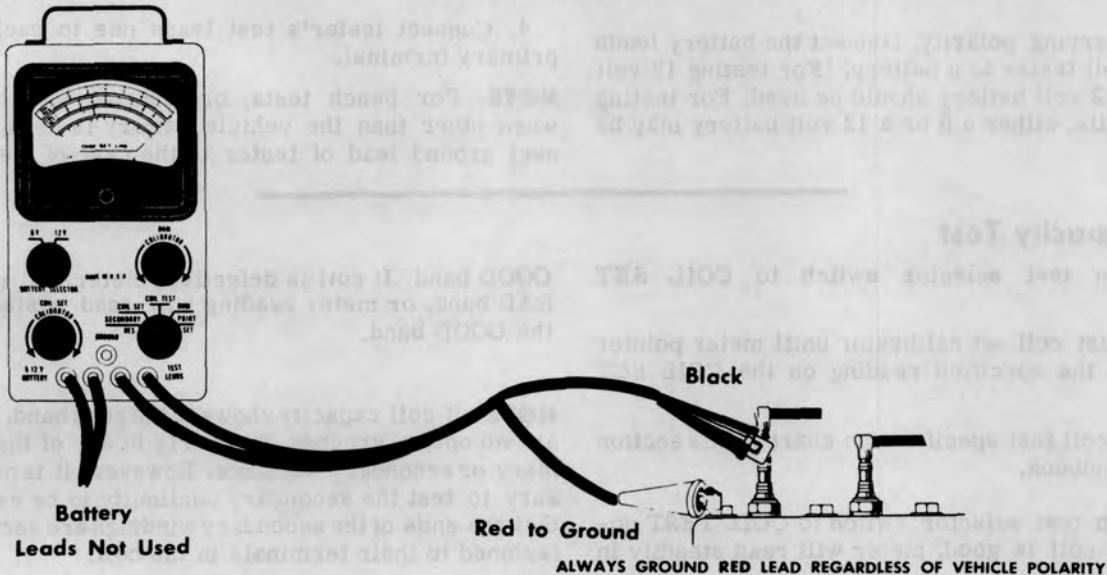
1. With test leads still connected as for coil capacity test, turn test selector switch to the OHM position.
2. Adjust the ohm calibrator until the meter pointer is on the OHM SET LINE.
3. Put coil secondary test lead in coil secondary tower.

4. Remove either one of the test leads from the primary terminal, and connect this lead to the coil secondary tower.
5. Read the ohm scale of the meter. Reading should be less than 20K (20,000) ohms for good secondary coil terminal connections.

**Secondary Resistance and Polarity Test**

Excessive secondary circuit resistance uses up energy which is needed to maintain good ignition under all conditions, severely reduces ignition system reserve, and consequently results in poor

performance under severe operating conditions. Incorrect secondary system polarity can result in 40% more voltage being required to fire the spark plugs, causing misfire and erratic engine operation.





1. To prevent generator from operating during this test, connect Generator Field Control into circuit and set knob to OPEN position. (See Generator Field Control section in Handbook.)

2. With tachometer connected, start engine and adjust speed to 1500 RPM. (See Tach Dwell Tester section in Handbook.)

3. Set tester switch to Secondary Resistance position. (Coil Circuit Tester Battery Leads need not be connected to a battery for this test.)

4. Connect Red tester lead to engine ground and connect Black test lead to each spark plug terminal in turn. Observe readings on Secondary Resistance scale (0 to 8) of meter.

---

### **Results and Indications**

Readings are average for make and type of circuit being tested... secondary circuit in normal condition.

All readings lower than average for make and type of circuit being tested... corroded coil tower terminal, poorly connected or broken coil wire, center cap electrode burned, burned rotor tip, open secondary in coil.

One or more readings lower than average for make and type of circuit being tested... broken or poorly connected spark plug wires, burned or corroded cap terminals, gouged electrodes inside of cap.

Readings higher than average for two or more plugs... Cross fire occurring in the distributor cap or between spark plug cables concerned.

Meter reads off scale to the left with red test clip grounded... Coil secondary polarity reversed; may be due to coil primary wires connected in reverse, wrong coil, or vehicle battery connections reversed.

**NOTE** On vehicles utilizing suppression type ignition cables, readings can be expected to be somewhat uneven with the lowest readings on the longest cables. Although suppression results in lower test readings, normal suppression does not impair ignition efficiency.

---

### **Use of Ohmmeter**

The ohmmeter facilities of the coil circuit tester may be used for measuring resistance values which fall within the range of zero to one hundred thousand ohms. Use the scale of the tester with red numerals, and note that the letter "K" represents one thousand ohms.

1. Turn test selector switch to the OHM position.

2. Attach battery leads of the tester to either a 6 or a 12 volt battery.

3. To calibrate, attach test leads together and adjust the ohm calibrator until the meter pointer reads on the OHM SET LINE.

4. Separate test leads and attach one to each end of resistance to be measured, and read the ohm scale.

---

### **Calibration of Coil Circuit Tester**

To assure accurate tests of ignition coils, the calibration of the Coil Circuit Tester should be checked and/or adjusted periodically. The calibration of the coil circuit tester may vary slightly after long periods of use, due to normal wear of the point rubbing block in the breaker assembly. The calibration should be checked and adjusted as described below.

1. Zero meter pointer to the left end of the scale, using the adjustment on the face of the meter.

2. Connect the tester test lead clips together.

3. Connect the battery leads to a 6 or a 12 volt battery and turn the battery selector to the proper voltage.

4. Turn test selector switch to OHM position, and use the ohm calibrator to adjust the meter pointer to the ohm set line.

5. Turn test selector switch to POINT SET position.

6. Meter now reads the dwell of the coil breaker unit. The pointer should now be on the red 6 of the coil set scale, plus or minus one half division.

If meter does not read within these limits, remove breaker cover located on side of tester. Adjust spacing of tester contacts, with breaker motor running until proper meter reading is obtained. Replace breaker cover, and disconnect test leads. Tester is now properly calibrated for accurate test indications.

**TEST "SET NUMBERS" FOR USE WITH SUN COIL TESTERS**

FOR COIL CAPACITY TEST, FIRST EXAMINE COIL TO DETERMINE PART NUMBER (DELCO-REMY AND FORD) OR PART NUMBER PREFIX LETTERS DENOTING MODEL (AUTO-LITE), THEN REFER TO CHART FOR SET NUMBER.

**COIL TEST SPECIFICATIONS**

COIL MAKE	MODEL OR PART NUMBER	TEST VOLTAGE	SET NUMBER
<b>AUTO-LITE</b>	All CE Models	6	10
	All CF Models	12	5
	All *CO Models	12	5
	All *CP Models	12	4.5
	All CR Models	6	8
	All CM Models	12	4.5
	All CZ Models	12	7
	All IG Models	6	7
	All CAB Models	12	4
	All CAC Models	6	9
	All CAD Models	12	7
	All CAE Models	12	6
	All CAF Models	12	4.5
	All CAG Models	12	4.5
	200565, 200572, 200613, 200636, 200637	12	4.5
	All CAH Models	12	8
	200567, 200571	12	8
	All CAL Models	6	8
All CAM Models	6	8	
<b>CHRYSLER</b>	1688212, 2095223	12	8
<b>DELCO-REMY</b>	1115326, 1115327, 1115328, 1115329, 1115330, 1115331, 1115332, 1115333, 1115334, 1115335, 1115336, 1115337, 1115338, 1115351, 1115376, 1115378, 1115380, 1115385, 1115386, 1115387, 1115388, 1115389, 1115390, 1115391, 1115392, 1115393, 1115394, 1115396, 1115397, 1115401, 1115403, 1115404, 1115481	6	9
	1115226, 1115227, 1115379, 1115381, 1115383, 1115384, 1115395, 1115399, 1115400	6	8
	1115081, 1115082, 1115083, 1115084, 1115085, 1115086, 1115087, 1115088, 1115089, 1115090, 1115091, 1115092, 1115094, 1115095, 1115096, 1115097, 1115098, 1115099, 1115100, 1115104, 1115105, 1115106, 1115107, 1115108, 1115109, 1115110, 1115111, 1115485, 1115061, 1115066, 1115112, 1115114, 1115115, 1115118, 1115119, 1115120, 1115121, 1115122, 1115131, 1115132, 1115133, 1115134, 1115135, 1115136, 1115137, 1115154, 1115156, 1115157	12	8
	1115042, 1115043, 1115044, 1115045, 1115046, 1115047, 1115048, 1115049, 1115050, 1115052, 1115053, 1115054, 1115055, 1115056, 1115057, 1115058, 1115251, 1115252, 1115254, 1115255, 1115257, 1115258, 1115259, 1115276	12	5
	1115256, 1115162	12	6.5
<b>ESSEX</b>	62-160-2	12	8
<b>FORD</b>	8BA-12029A	6	8
	FAB-12029B, FAC-12029A, FAY-12029A	12	7

\*To test Coil Capacity, connect a Jumper Lead from either Primary Terminal to Coil Case. Do not connect Blue Ground Lead when conducting this test with coil off the vehicle. Meter should read "6" or higher during Coil Capacity Test to be a "Good" Coil. (Read "Coil Set" Scale). To test Coil Secondary Winding Continuity, connect leads to Tower Terminal and Coil Case.

**NOTE** A non-standard coil should be tested with the same "SET LINE" as the original factory equipment and should also have the same primary draw and secondary resistance.

**NOTE** SET LINE specifications for standard equipment coils not shown above may be established by making Coil Capacity Tests first, on 3 or more new coils of the same model. While in COIL TEST position, turn COIL SET CALIBRATOR until meter pointer reads in the GOOD BAND, then turn TEST SELECTOR switch to COIL SET position. The average reading shown on the meter will be the proper COIL SET specification.

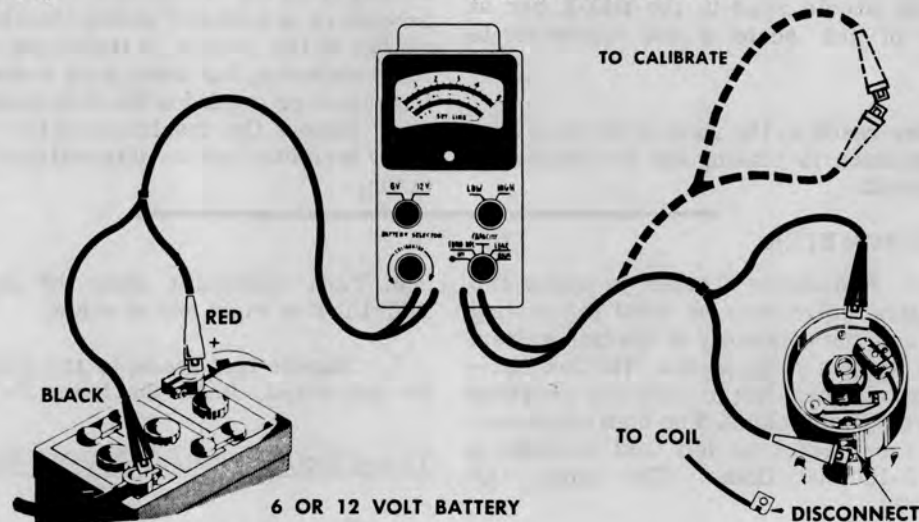
# CONDENSER RESISTANCE TESTER

The purpose of the condenser in the ignition system is to prevent arcing and pitting at the breaker points and to aid in collapsing the magnetic field in the ignition coil. In order to function properly, and to assure good ignition, the condenser must have three important characteristics.

1. Minimum resistance
2. Correct capacity

3. Minimum insulation leakage

These important factors are conveniently tested on the Condenser Resistance Tester. In addition, the Condenser Resistance Tester is equipped with two Ohmmeter ranges, 0-100 Ohms and 0-100,000 Ohms, providing facilities for testing continuity and condition of many automotive components and circuits.



## CALIBRATION

1. Set the Battery Selector Switch to the position which corresponds to the battery voltage, and connect the battery leads of the Condenser Tester to a fully charged 6 or 12 volt battery. If desired, the vehicle's battery may be used.
2. Connect the Condenser TEST leads together.
3. Turn the Tester Selector Switch to Condenser Resistance Position and allow approximately one

minute for the tester to warm up.

4. Adjust the calibrator until the meter pointer reads on SET LINE at the right end of the scale.
5. After adjusting the pointer to SET LINE, separate the condenser Tester Leads and proceed with the Tests of the condenser. Do not change the position of the calibrator knob while making condenser tests.

## CONDENSER TESTS

Ignition condensers may be tested in or out of the vehicle. If they are to be tested in the vehicle, the condenser must be electrically isolated from the balance of the vehicle's ignition system. Disconnect

the wire from the primary terminal of the distributor as shown in the illustration, and block the breaker points open with a piece of fibre between the rubbing block and cam as shown.

## CONDENSER RESISTANCE TEST

1. Connect the condenser test leads, one to the primary terminal of the distributor and the other test lead to ground on the distributor body.

is noted, the pigtail is making poor contact and the condenser should be replaced.

2. With the selector switch in the Condenser Resistance position, the meter should read in the BLUE bar at the right end of the scale.

If reading is in the red bar, marked "Resistance," move the grounded lead of the Condenser Tester to the body of the condenser. If the reading improves, the condenser is not properly grounded to the distributor housing.

Move condenser pigtail. If a deflection of the meter



**CAPACITY TEST (Microfarad)**

1. Turn the selector switch to the CAPACITY position.
2. Read top scale of the meter for the microfarad capacity of the condenser being tested.

3. Refer to manufacturer's specifications for condenser capacity in microfarads.

If tester reading in microfarads does not fall within tolerances specified for condenser being tested, the condenser should be replaced.

**LEAKAGE TEST**

1. Turn selector switch to LEAKAGE position.
2. The meter should read in the BLUE bar at the left end of the scale if the condenser is satisfactory.

If meter pointer reads to the right of the blue bar, condenser insulation is leaking and the condenser should be replaced.

**IMPORTANT** If the condenser does not test good while mounted in the distributor, remove the condenser from the distributor and retest it. The same procedure is followed whether testing condensers in or out of the vehicle. If the condenser tests bad in the distributor, but tests good when removed, there is a short or ground in the distributor primary circuit. Inspect the insulation of the distributor primary terminal and the internal circuit of the distributor.

**USE OF THE OHMMETER**

The Condenser Resistance Tester provides two ohmmeter scales which may be used for testing the condition and the continuity of ignition system and electrical system components. The low ohmmeter scale, reads from left to right and provides a test range from 0-100 ohms. The high ohmmeter scale, reads from right to left and provides a range from 0-100,000 Ohms. (The letter "K" represents 1000.)

1. Connect battery leads to a 6 or 12 volt battery.
2. Turn battery selector switch to the position corresponding to the battery voltage.
3. Turn the selector switch to the OHM position.

**To use the low scale (0-100)**

4. Turn ohmmeter selector switch to LOW position.
5. Do not connect the test leads together.

6. Turn calibrator until the pointer reads on SET LINE at right end of scale.

7. Connect test leads to the resistance unit to be measured. Read the lower 0-100 ohm scale.

**To use the high scale (0-100,000 ohms)**

8. Turn Ohmmeter Selector Switch to HIGH position.
9. Connect the Test Leads together.
10. Turn Calibrator until the pointer reads on SET LINE on right end of scale.
11. Disconnect Test Leads and connect them to the resistance to be measured. Read 0-100,000 scale.

**CAUTION** Do not connect the test leads of an Ohmmeter across any source of voltage.

**SUGGESTED APPLICATIONS FOR THE OHMMETER**

1. Circuit continuity... Low Ohm scale. For locating broken wires or poor connections in such circuits as: horn, overdrive, turn signals, lights, etc. Reference to the wiring diagram for the vehicle being tested aids in making continuity checks.

2. Bench testing of relays, Solenoids, Switches, Etc.,... Low Ohm Scale. This test is primarily for checking continuity of the actuating coils or windings of relays, and components.

3. Generators... On or off the vehicle... Low

Ohm Scale. For checking generator circuit continuity and field coil resistance.

4. Regulators... On or off the vehicle... Low Ohm Scale. For locating open resistors or shunt windings.

5. Car Radios... Antennas... Check for shorts or grounds. Tubes... Check for open filament. Use low Ohm Scale.

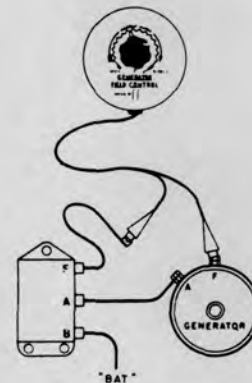
6. Suppressor resistors in rotors, caps, spark plugs, wires, ... etc.... High Ohm Scale.



# GENERATOR FIELD CONTROL

The Generator Field Control provides a convenient means of varying generator output without changing the vehicle's engine speed. It is equally applicable to either D.C. or A.C. systems.

As indicated in other sections of this Handbook, (i.e., Sun Scope, Combustion Efficiency Tester, Volts Ignition Tester, and Coil Circuit Tester) for the purpose of providing stable test conditions, it is necessary to prevent the generator from producing electrical power while certain tests are being performed. By using the Generator Field Control in the prescribed manner, generator output can be reduced to zero without danger of damage to any charging system component. The operator has full control of generator performance at all times.



**NOTE** Engine must be stopped when connecting or disconnecting the Generator Field Control.

1. Disconnect Charging System Field Circuit, either at generator (alternator) or at regulator, whichever connection is more accessible.

2. Connect the leads of the field control, one to the end of the vehicle's field wire, the other to the field terminal. (Refer to illustration.)

3. Set Generator Field Control Knob to its OPEN position. (Generator will now be inoperative.)

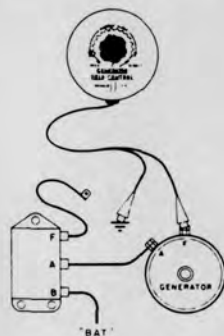
4. Start engine and proceed with tests in their prescribed manner.

5. Should it be desired that the generator operate at regulated voltage, such as for "Charging Voltage Test", gradually rotate the Field Control Knob to its DIRECT position. (Generator voltage will increase until it reaches maximum value permitted by the setting of voltage regulator.)

## Additional Uses

The Generator Field Control, used with a Volts-Ampere Tester, provides a convenient means of

controlling generator operation when performing tests of generator output and cutout relay functions.



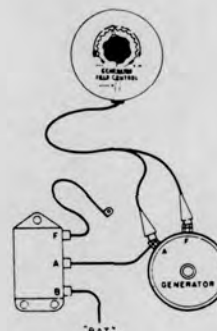
**Fig. A**

1. Connect Generator Field Control as illustrated:-

Illustration A - for systems having field circuit grounded externally.

Illustration B - for systems having field circuit grounded internally.

2. For Generator Output Test - operate engine at specified RPM, set generator field control to its



**Fig. B**

DIRECT position and observe test ammeter for generator output in amperes.

3. For Cutout Relay Tests - operate engine at approximately 1000 RPM, gradually rotate field control from OPEN towards its DIRECT position, while observing test voltmeter for reading of voltage required to close the cutout relay. After closing voltage has been tested, slowly rotate field control from DIRECT towards its OPEN position, while observing test ammeter for reading of reverse current necessary to open cutout.



INDUSTRIAL TRUCK DIVISION



OPERATORS

MAINTENANCE

PARTS

MANUAL

FOR

CY-60

FORM NO. 1-60

CLARK EQUIPMENT COMPANY

PUBLISHED BY

TECHNICAL SERVICE DEPARTMENT  
BATTLE CREEK, MICHIGAN, U.S.A.

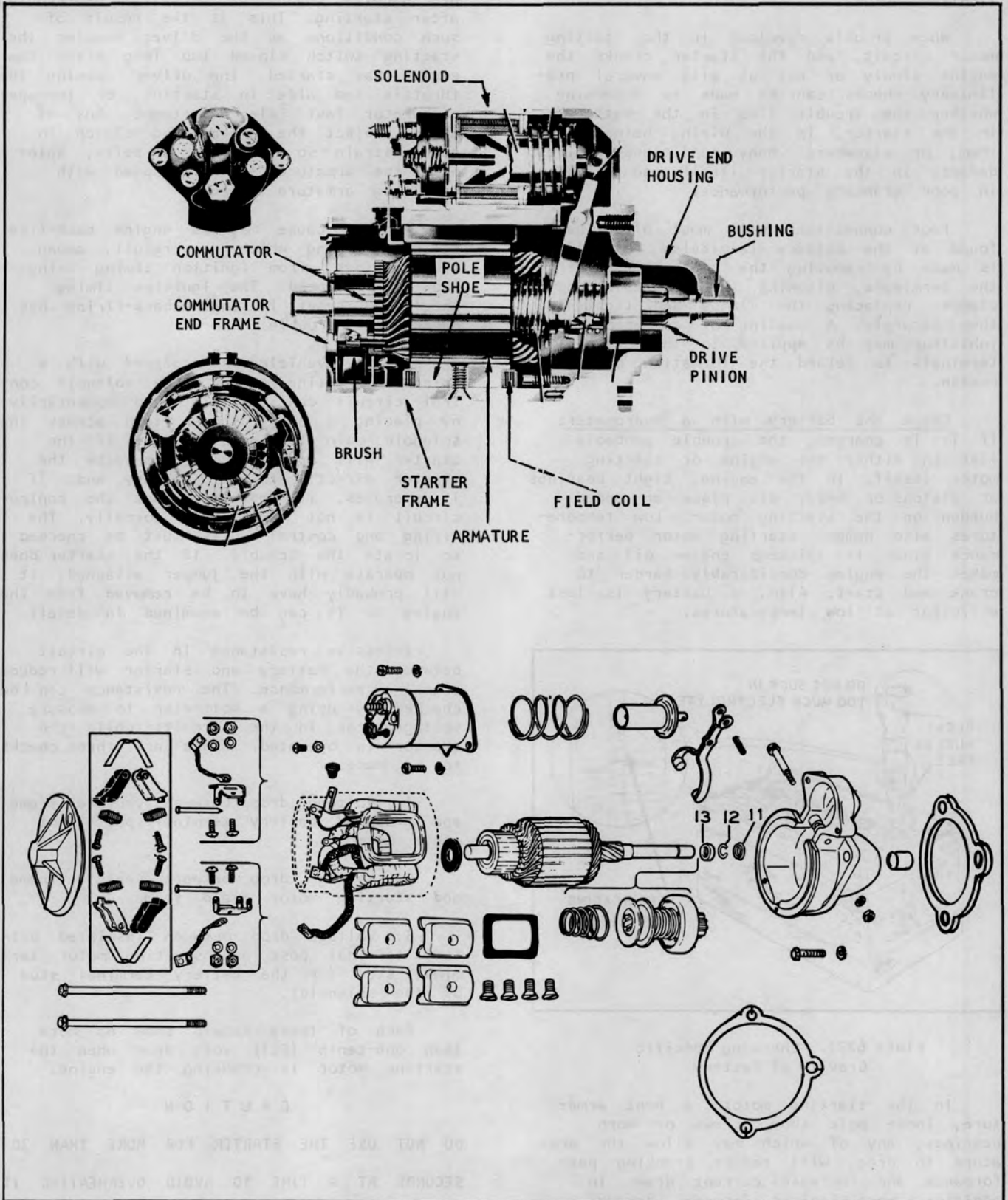


Plate 6997. Starter

**STARTING MOTORS**

When trouble develops in the starting motor circuit, and the starter cranks the engine slowly or not at all, several preliminary checks can be made to determine whether the trouble lies in the battery, in the starter, in the wiring between them, or elsewhere. Many conditions besides defects in the starter itself can result in poor cranking performance.

Poor connections will most often be found at the battery terminals. Correction is made by removing the cable clamps from the terminals, cleaning the terminals and clamps, replacing the clamps and tightening them securely. A coating of corrosion inhibitor may be applied to the clamps and terminals to retard the formation of corrosion.

Check the battery with a hydrometer:

If it is charged, the trouble probably lies in either the engine or starting motor itself. In the engine, tight bearings or pistons or heavy oil place an added burden on the starting motor. Low temperatures also hamper starting motor performance since it thickens engine oil and makes the engine considerably harder to crank and start. Also, a battery is less efficient at low temperatures.

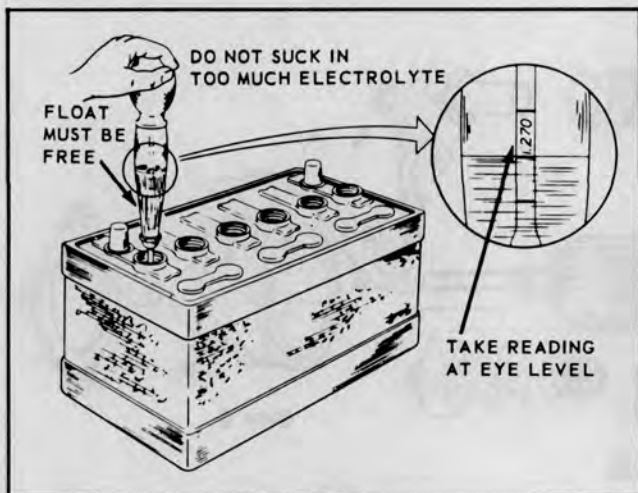


Plate 6271. Checking Specific Gravity of Battery

In the starting motor, a bent armature, loose pole shoe screws or worn bearings, any of which may allow the armature to drag, will reduce cranking performance and increase current draw. In addition, more serious internal damage is sometimes found. Thrown armature windings or commutator bars, which sometimes occur on overrunning clutch drive starting motors,

are usually caused by excessive overrunning after starting. This is the result of such conditions as the driver keeping the starting switch closed too long after the engine has started, the driver opening the throttle too wide in starting, or improper carburetor fast idle adjustment. Any of these subject the overrunning clutch to extra strain so it tends to seize, spinning the armature at high speed with resulting armature damage.

Another cause may be engine back-fire during cranking which may result, among other things, from ignition timing being too far advanced. The ignition timing should be reset if engine back-firing has caused the trouble.

If the vehicle is equipped with a solenoid starting switch, the solenoid control circuit can be eliminated momentarily by placing a heavy jumper lead across the solenoid main terminals to see if the starter will operate. This connects the starter directly to the battery and, if it operates, it indicates that the control circuit is not functioning normally. The wiring and control units must be checked to locate the trouble. If the starter does not operate with the jumper attached, it will probably have to be removed from the engine so it can be examined in detail.

Excessive resistance in the circuit between the battery and starter will reduce cranking performance. The resistance can be checked by using a voltmeter to measure voltage drop in the circuits while the starter is operated. There are three checks to be made:

1. Voltage drop between vehicle frame and grounded battery terminal post (not cable clamp).
2. Voltage drop between vehicle frame and starting motor field frame.
3. Voltage drop between insulated battery terminal post and starting motor terminal stud (or the battery terminal stud of the solenoid).

Each of these should show no more than one-tenth (0.1) volt drop when the starting motor is cranking the engine.

**CAUTION**

**DO NOT USE THE STARTER FOR MORE THAN 30 SECONDS AT A TIME TO AVOID OVERHEATING IT.**

If excessive voltage drop is found in any of these circuits, make correction by disconnecting the cables, cleaning the



connections carefully, and then reconnecting the cables firmly in place.

Starting Motor Service: To obtain full performance data on a starting motor or to determine the cause of abnormal operation, the starting motor should be submitted to a no load and torque test. These tests are best performed on a starter bench tester with the starter mounted on it. From a practical standpoint, however, a simple torque test may be made quickly with the starter in the vehicle. Make sure the battery is fully charged and that the starter circuit wires and terminals are in good condition. Then operate the starter to see if the engine turns over normally. If it does not, the torque developed is below standard and the starter should be removed for further checking.

Removing Starter From Engine: the general procedure for removing a starter from the engine is as follows: Disconnect the leads from the starter. (When the switch is mounted on the motor, the battery lead should be covered with friction tape or a short piece of hose to prevent it from short-circuiting against any metal surface.) Disconnect any linkage directly connected to the starting motor or yoke. Then take out the mounting bolts and lift the starter from the engine.

Disassembly Starting Motor: The disassembly procedure to be followed will vary according to the type and construction of the starting motor. Normally, disassembly should proceed only so far as it is necessary to make repair or replacement of defective parts. For example, the field coils should be checked for opens or grounds and if found to be in normal condition, they should not be removed from the field frame.

1. If the brush holders are of the reaction type, lift the spring with a hook made of stiff wire and take the brushes out of the holders. On swinging type brushes, disconnect the field coil lead from the brush and slightly tighten the screw to keep the brush in place.

2. Before disassembling commutator end heads that are fastened by a number of screws into the end of the field frame, scratch a mark on the frame and head so that they can be reassembled in their original position. This is not necessary on motors using through bolts to hold the heads and having a dowel pin to locate the commutator end head position.

3. Take out the through bolts or commutator end head and drive end housing attaching screws. If necessary, tap the commutator end head slightly with a rubber or plastic hammer and remove the head.

4. Lift off the drive end head (or pinion housing) and the armature. On types having an intermediate bearing, the armature will remain in the pinion housing. On most motors, this bearing assembly is a press fit in the pinion housing and can be forced out with an arbor press bearing on the drive end of the shaft. A few types of motors use a screw or a lock ring to hold the intermediate bearing in place. These must be removed before pressing the armature out of the pinion housing. Gear reduction motors require the removal of the intermediate housing screws to complete their disassembly.

#### Armature Inspection and Service

1. Visually inspect the armature for mechanical defects such as a worn or bent shaft, worn commutator, scored core laminations, and to see that all windings are properly in place in the core slots.

2. Inspect for evidence of excessively high speeds which would throw the windings outward at the ends and may even cause them to leave the core slots.

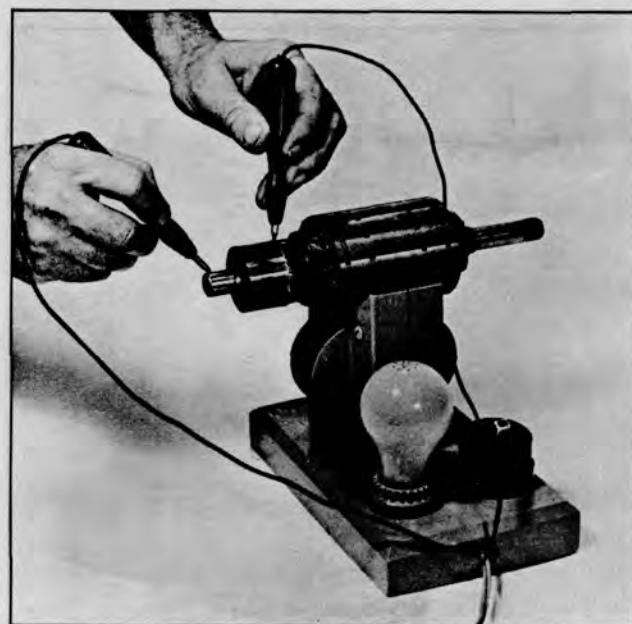


Plate 7222. Testing Armature for Grounds

3. Inspect to see that all windings are properly staked and soldered to the commutator. Resolder if necessary, with rosin core solder, being careful not to short between coils and commutator bars.

4. With test clips or points test the armature for grounds by touching the shaft with one point and the commutator with the other. Do not touch the test points to the bearing or brush surfaces as an arc would burn the smooth finish. If the lamp lights, the armature is grounded and should be replaced.

5. Clean the commutator with 00 sandpaper and remove all dirt from between the bars.

6. Place the armature shaft bearing surfaces on V blocks, and mount a dial indicator against the commutator.

7. Turn the armature slowly and read the total runout as indicated on the dial gauge. If runout exceeds .003", the commutator should be turned down with a lathe to make it concentric.

8. Mount the armature in the lathe by the shaft bearing surfaces (not shaft centers), and take light cuts until the commutator is completely cleaned up. Remove all burrs with 00 sandpaper. This trueing up of the commutator should also be done if it is rough, burned or if the mica

extends above the surface of the copper. Recheck runout after turning the commutator.

9. Undercut the mica  $1/64$ " measured depth. This cut should be exactly centered on the mica and the cutting tool used should be .002" wider than the mica. The undercut should be clean and square.

10. If the burrs on the copper after undercutting are not large they can be left on the commutator to help seat the brushes after assembly. However, be sure to remove the burrs with 00 sandpaper before completing the overhaul.

11. Place the armature on an open core transformer, otherwise known as a growler, and hold a hacksaw blade on the core. Rotate the armature slowly and if the armature is shorted the hacksaw blade will become magnetized and vibrate.

12. If a short is present, inspect the commutator risers and bars for copper chips or solder that may be shorting between the bars. If shorts cannot be found, replace the armature.

**Frame and Field Coil Service**

1. Clean the frame and field with a cloth dampened in cleaning solvent but do not soak insulation or brushes.

2. Inspect for faulty insulation and stripped threads.



Plate 6996. Checking Armature For Short Circuit



Plate 7223. Testing Field Circuit for Ground

3. With a test lamp, check for grounds by touching the terminal stud with one test point and an unpainted spot on the frame with the other test point. Be sure brushes or leads are not in contact with the frame. If the lamp lights, there is a ground in the field circuit.

4. If a ground is present, remove the terminal stud nuts and if the stud is removable, press it out of the frame. Then recheck the field coils for grounds as before.

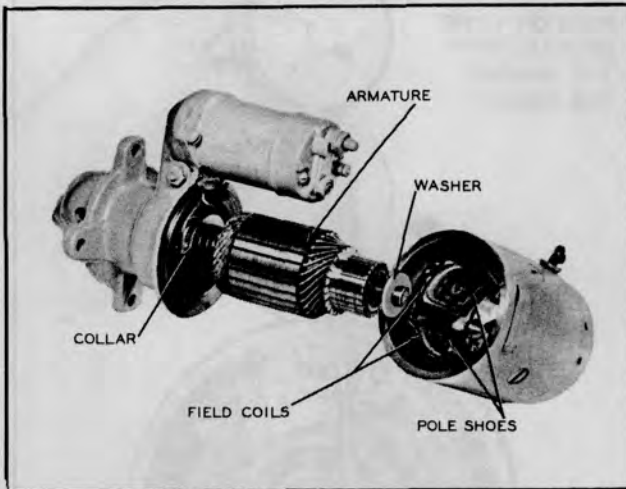


Plate 6237. Armature and Field Coils

5. If the terminal stud is soldered to the field coils or if the field coils are grounded, remove the pole shoe screws and take the coils out of the frame. It is good practice to mark one end of the frame and also the shoes before disassembly so that they can be installed in their original position.

6. Replace any faulty or damaged parts, making sure all connections are tightly clinched and soldered to be sure that no high resistance connections are present.

7. When installing field coils and shoes, a pole shoe spreader and pole shoe screwdriver should be used to insure a tight installation of the coils and shoes.

8. Be sure the pole shoes are installed in the same location and direction as they were originally. On some motors, the shoes are bored after assembly and when they are interchanged they may interfere with the armature. On other motors, the two tips of the shoes are not alike. However, on this type, the long tip is

always the trailing edge.

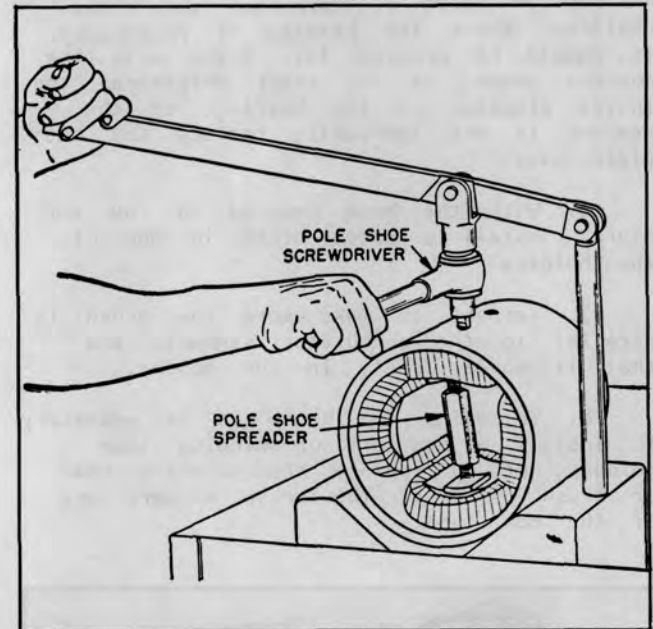


Plate 6994. Field Coil Removal

9. If the brushes are oil soaked or are worn to less than 1/2 their original length they should be replaced.

10. To remove the brushes, unsolder and unclinch the lead from the field coil or connector.

11. Insert the new brush lead to its full dept and insert the equalizer lead (if used).

12. Clinch tightly and solder to make a low resistance connection. Do not use acid for soldering flux as it will damage the insulation. Use a rosin or alcohol solution.

**Commutator End Head Service**

1. Clean the commutator end head, being careful not to soak the brushes in solvent.

2. Inspect for a cracked, bent or distorted head and replace if these conditions are present.

3. Place the armature in a padded vise and install the commutator end head on the end of the armature shaft.

4. Do not clamp the armature tightly as this distorts the laminated core.



5. Feel the fit of the bearing on the shaft. If side play is excessive, the bearing or shaft is worn and should be replaced. Where the bearing is replaceable, it should be pressed into place with the correct arbor, as the arbor determines the inside diameter of the bearing. If the bearing is not removable, replace the complete head.

6. With the head mounted on the armature, install a spare brush in one of the holders.

7. Inspect to make sure the brush is parallel to the commutator segments and that it moves freely in the holder.

8. To align the brush it is necessary to install a new arm on swinging type holders, or to replace the complete head or brush plate if the brush holders are of the box type.

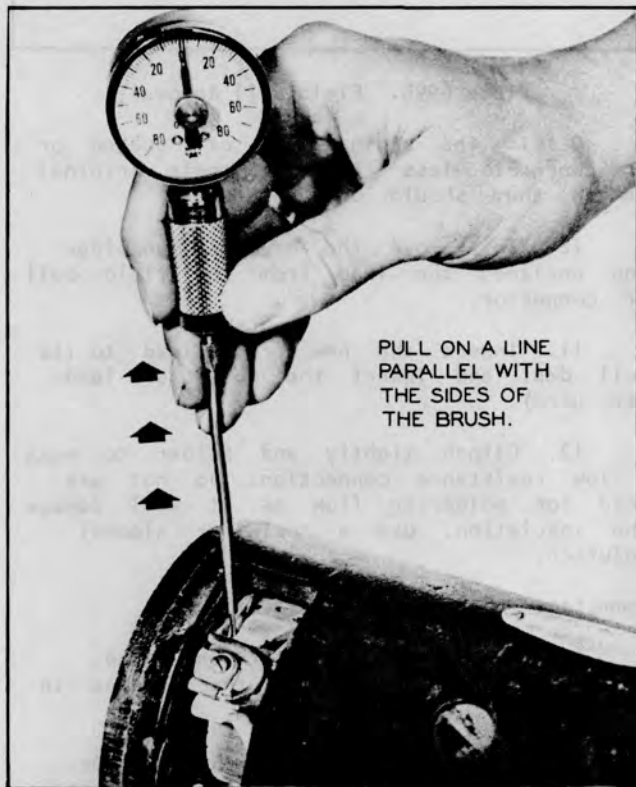


Plate 6450. Checking Brush Spring Tension

9. Measure the brush spring tension with a spring scale hooked under the brush spring, or brush screw, near the end. Pull the scale on a line parallel to the edge of the brush and take the reading just as the spring leaves the brush, or just as the brush leaves the commutator. (Refer to specifications for proper brush spring tension).

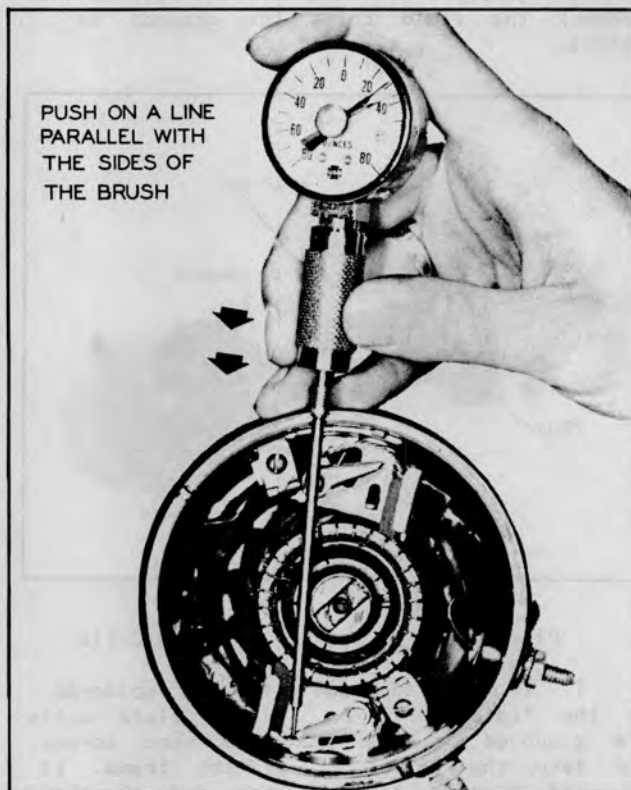


Plate 6451. Checking Brush Spring Tension

10. Adjust the tension by bending the brush spring at the point where it is clamped by the brush holder.

11. Repeat this brush alignment, movement and tension inspection for all brushes.

12. Be sure to remove the brushes from the holders before taking the head off the armature as they may become chipped or cracked if they are allowed to snap off the commutator.

13. If the brush leads are broken or frayed or if the brushes are oil soaked, chipped or cracked, or worn less than 1/2 their original length, the brushes should be replaced.



14. Brushes that are soldered to the field coils or connectors should be replaced as outlined under Frame and Field Coil Service. Brushes that have the ground terminal riveted under the brush holder should have the lead unsoldered and the terminal unclamped.

15. Insert the lead to its full length in the terminal and clamp tightly. Solder it to make a strong and electrically tight connections, using a high temperature solder and a rosin flux. Do not use acid.

**Drive End Head Service**

1. Thoroughly clean the head or pinion housing and inspect for cracks.

2. Try the fit of the armature shaft in the bearing and replace the bearing if the side play is excessive.

3. When installing a new bearing, be sure to support the housing so that it does not twist or damage the bearing.

4. Install a new bearing, using the correct arbor, as it is designed to give the proper inside diameter of the bearing without the necessity of reaming or scraping.

5. Soak the bearing in S.A.E. 10 engine oil and remove the excess oil from the housing or head.

**Starter Drive Service**

Starter drives fall into one or the other of two basic groups, the type that uses the principle of the overrunning clutch, and the Bendix, which uses the spinning nut principle.

Starter drive troubles are easy to diagnose and they usually cannot be confused with ordinary starter difficulties. If the starter does not turn over at all or if it drags, look for trouble in the starter or electrical supply system. Concentrate on the starter drive or ring gear if the starter is noisy, if it turns but does not engage the engine, or if the starter won't disengage after the engine is started. After the starter is removed, the trouble can usually be located with a quick inspection.

Worn or chipped ring gear or starter pinion are the usual causes of noisy operation. Before replacing either or both of these parts try to find out what caused the damage. With the Bendix type drive, incomplete engagement of the pinion with

the ring gear is common cause of tooth damage. The wrong pinion clearance on starter drives of the overrunning clutch type leads to poor meshing of the pinion and ring gear and to rapid tooth wear.

A less common cause of noise with either type of drive is a bent starter armature shaft. When this shaft is bent, the pinion gear alternately binds and then only partly meshes with the ring gear. Most manufacturers specify a maximum of .003" radial run-out on the armature shaft.

**Overrunning Clutch Type Drives:** Seldom become so worn that it fails to engage since it is directly activated by a fork and lever. The only thing that is likely to happen is that, once engaged, it will not turn the engine because the clutch itself is worn out. A much more frequent difficulty and one that rapidly wears ring gear and teeth is partial engagement. Proper meshing of the pinion is controlled by the end clearance between the pinion gear and the starter housing or the pinion stop, if one is used.

Cranking motors having a thrust washer require a clearance of 3/16", whereas those cranking motors having a thrust plug require 1/8" clearance. The difference in the pinion clearance is due to a difference in the thickness of the "nose" housing. The absence of the thrust washer and the use of the plug make this type construction easy to identify. No change is required in the procedure of adjusting pinion clearance.

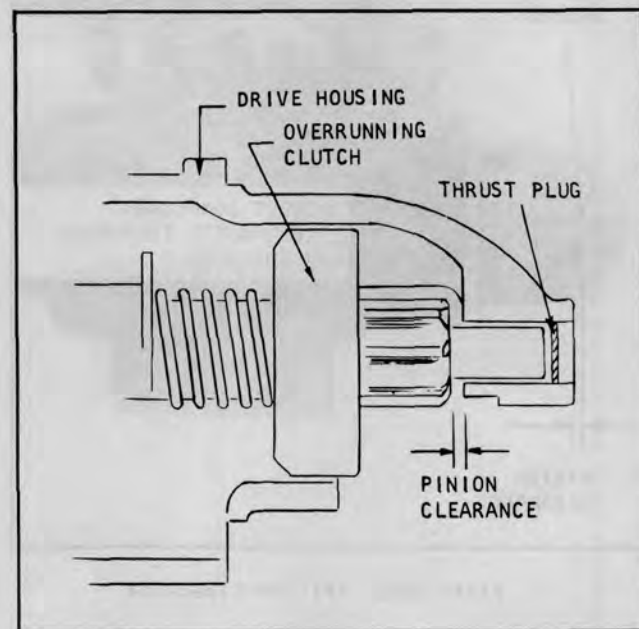


Plate 6998. Pinion Clearance

Clamp the cranking motor in a vise and remove the cable from the "motor" terminal of the solenoid so the cranking motor will not operate. For the type motor having a thrust washer, place a piece of 3/16" bar stock or gauge between the pinion and the housing. If the motor has a thrust plug, place a piece of 1/8" bar stock or gauge between the pinion and the housing. Connect a battery cable of the proper voltage between the "switch" terminal of the solenoid and the solenoid base (ground), and push the solenoid plunger in by hand. Battery current will hold the plunger in the "bottomed" position while the pinion clearance is adjusted. Loosen the solenoid switch mounting screws and pull the solenoid switch away from the shift lever until play is taken out of the lever and clutch mechanism. **DO NOT COMPRESS OVERRUNNING CLUTCH SPRING.** Moving switch toward lever increases clearance, and moving switch away from lever decreases clearance. When correct adjustment is obtained tighten solenoid switch mounting screws and replace connector at "motor" terminal of solenoid.

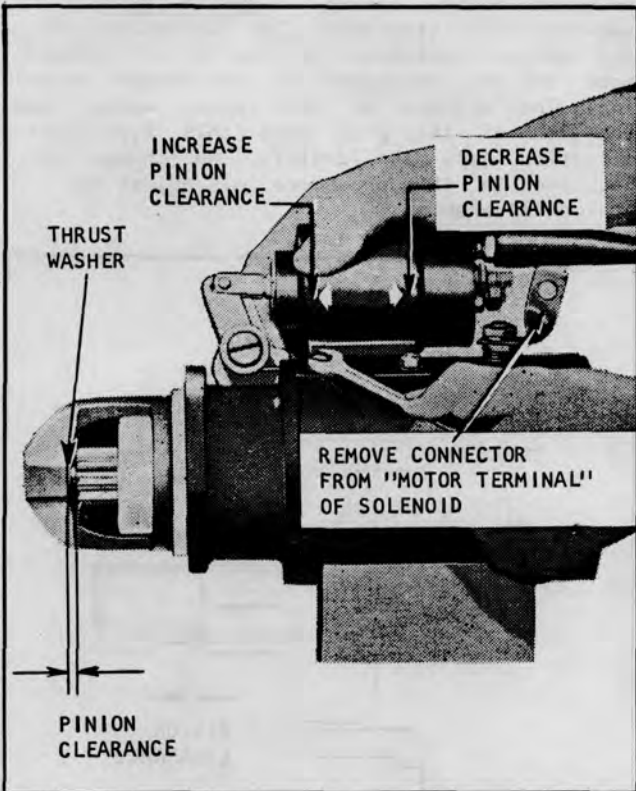


Plate 6999. Pinion Clearance

On some model starters the solenoids are completely enclosed in the starter housing and the pinion clearance is not adjustable. If the clearance is not correct, the starter must be disassembled and checked for excessive wear of solenoid linkage, shift lever mechanism, or improper assembly of parts.

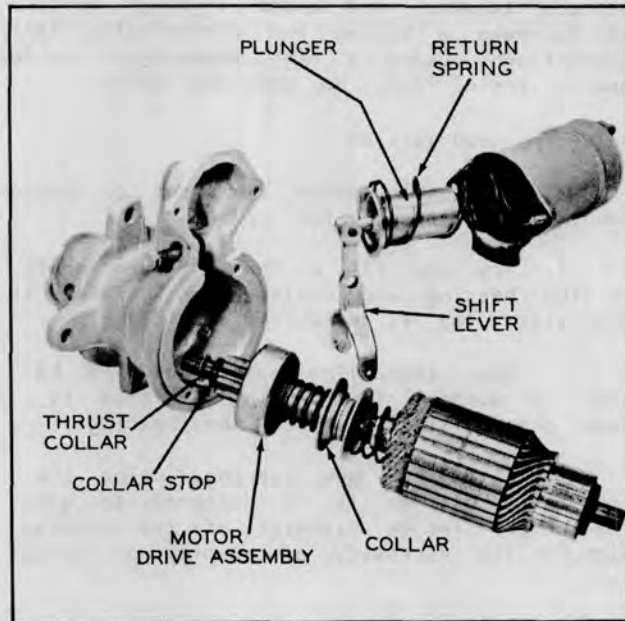


Plate 6238. Starter With Enclosed Solenoid Housing

Failure of the overrunning clutch drive to disengage is usually caused by binding between the armature shaft and the drive. If the drive, particularly the clutch, shows signs of over-heating it indicates that it is not disengaging immediately after the engine starts. If the clutch is forced to overrun too long, it over-heats and turns a bluish color. For the cause of binding, look for rust or gum between the armature shaft and the drive, or for burred splines. Excess oil on the drive will lead to gumming, and inadequate air circulation in the flywheel housing will cause rust.

Overrunning clutch drives cannot be overhauled in the field so they must be replaced. In cleaning, never soak them in a solvent because the solvent may enter the clutch and dissolve the sealed-in lubricant. Wipe them off lightly with solvent and lubricate them sparingly with S.A.E. 10 or 10W oil.

When a Bendix Type Drive doesn't engage the cause usually is one of three things: either the drive spring is broken, one of the drive spring bolts has sheared off, or the screw-shaft threads won't allow the pinion to travel toward the flywheel.

In the first two cases, remove the drive by unscrewing the set screw under the last coil of the drive spring and replace the broken parts. Gummed or rusty screw-shaft threads are fairly common causes of Bendix drive failure and are easily cleaned with a little solvent or steel wool, depending on the trouble. Here again, as in the case of overrunning clutch drives, use light oil sparingly, and be sure the flywheel housing has adequate ventilation. Breather holes in the housing should be kept open.

Bendix Folo-Thru Drives: Incorporates a device that keeps the pinion engaged to the flywheel until the engine reaches a specified R.P.M. When replacing one of these drives, be sure that you have the correct drive for the vehicle. The drives are rated differently and the correct one must be used for the vehicle being serviced. The Folo-Thru, incidentally, is not supposed to be repaired in the field because of the danger of incorrectly assembling the carefully calibrated springs in the pinion head.



INDUSTRIAL TRUCK DIVISION



OPERATORS

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FOR

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CLARK EQUIPMENT COMPANY

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BATTLE CREEK, MICHIGAN, U.S.A.



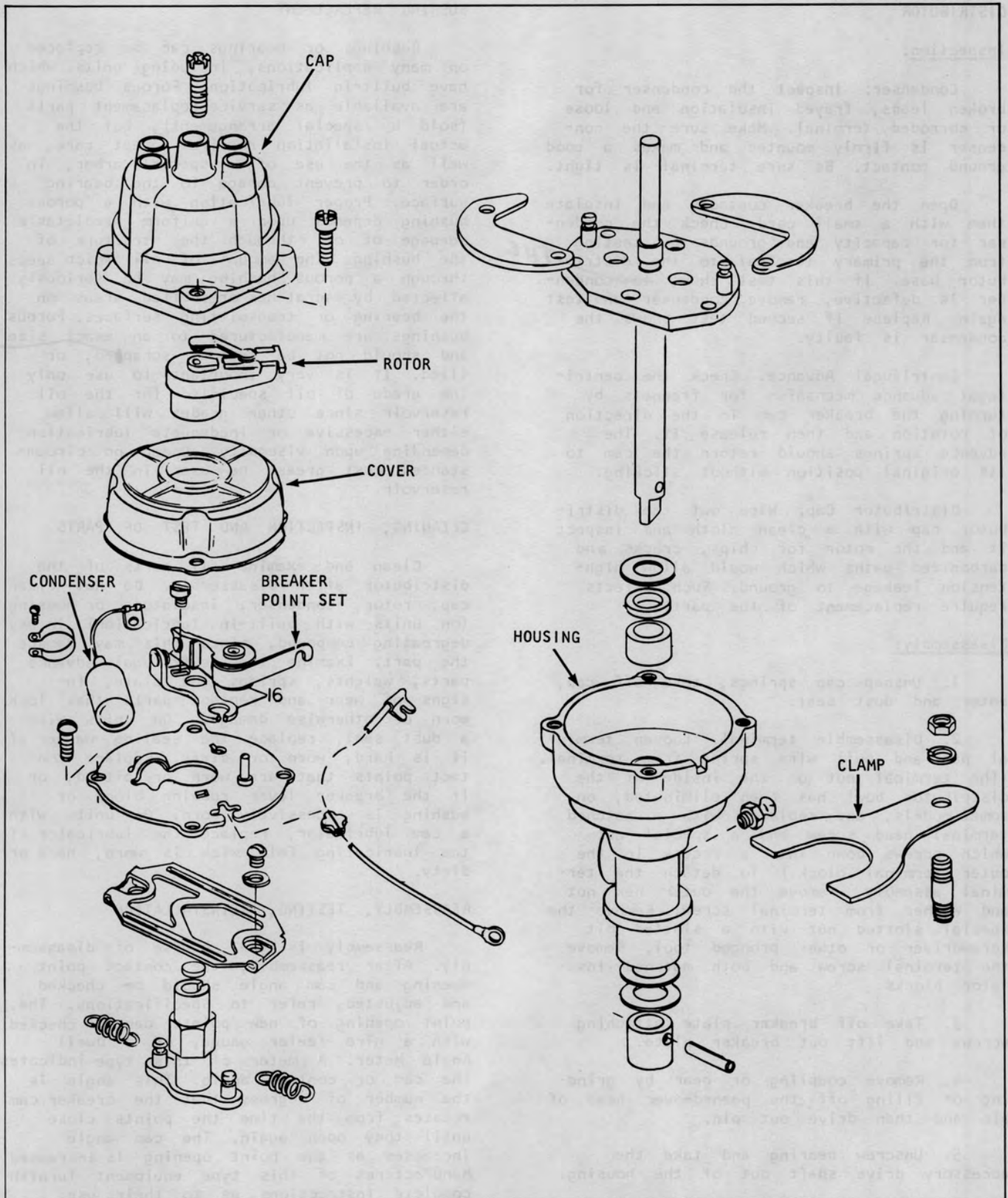


Plate 9633. Distributor

## DISTRIBUTOR

Inspection:

Condenser: Inspect the condenser for broken leads, frayed insulation and loose or corroded terminal. Make sure the condenser is firmly mounted and makes a good ground contact. Be sure terminal is tight.

Open the breaker contacts and insulate them with a small card. Check the condenser for capacity and grounds by testing from the primary terminal to the distributor base. If this test shows ~~to~~ <sup>THE</sup> condenser is defective, remove condenser and test again. Replace if second test shows the condenser is faulty.

Centrifugal Advance. Check the centrifugal advance mechanism for freeness by turning the breaker cam in the direction of rotation and then release it. The advance springs should return the cam to its original position without sticking.

Distributor Cap. Wipe out the distributor cap with a clean cloth and inspect it and the rotor for chips, cracks and carbonized paths which would allow high-tension leakage to ground. Such defects require replacement of the part.

Disassembly:

1. Unsnap cap springs, take off cap, rotor and dust seal.

2. Disassemble terminal. Loosen terminal nut and pull wire spring from terminal. (The terminal nut on the inside of the distributor bowl has been eliminated, on some models, and replaced with a notched terminal head screw and a special nut which screws down into a recess in the outer terminal block.) To detach the terminal assembly, remove the outer hex nut and washer from terminal screw. Remove the special slotted nut with a slotted bit screwdriver or other pronged tool. Remove the terminal screw and both matched insulator blocks.

3. Take off breaker plate attaching screws and lift out breaker plate.

4. Remove coupling or gear by grinding or filing off the peened-over head of pin and then drive out pin.

5. Unscrew bearing and take the accessory drive shaft out of the housing.

6. Shaft and advance mechanism can now be lifted out. Advance mechanism is disassembled by taking off nuts fastening hold-down plate in place.

## BUSHING REPLACEMENT

Bushings or bearings can be replaced on many applications, including units which have built-in lubrication. Forous bushings are available as service replacement parts (sold by special arrangement), but the actual installation requires great care, as well as the use of a special arbor, in order to prevent damage to the bearing surface. Proper lubrication with a porous bushing depends upon a uniform predictable seepage of oil through the structure of the bushing. The amount of oil which seeps through a porous bushing may be seriously affected by scratches or scuffed areas on the bearing or transmitting surfaces. Porous bushings are manufactured to an exact size and should not be reamed, scraped, or filed. It is very important to use only the grade of oil specified for the oil reservoir since other grades will allow either excessive or inadequate lubrication depending upon viscosity. Under no circumstances must grease be used in the oil reservoir.

## CLEANING, INSPECTION AND TEST OF PARTS

Clean and examine all parts of the distributor after disassembly. Do not clean cap, rotor, condenser, insulators or housing (on units with built-in lubrication) in any degreasing compound, since this may damage the part. Examine the centrifugal advance parts, weights, springs and plate, for signs of wear and replace parts that look worn or otherwise damaged. On units with a dust seal, replace the sealing washer if it is hard, worn or dirty. Replace contact points that are worn or pitted, or if the breaker lever rubbing block or bushing is excessively worn. On units with a cam lubricator, replace the lubricator if the lubricating felt wick is worn, hard or dirty.

## REASSEMBLY, TESTING, REINSTALLATION

Reassembly is the reverse of disassembly. After reassembly, the contact point opening and cam angle should be checked and adjusted, refer to Specifications. The point opening of new points can be checked with a wire feeler gauge, or a Dwell Angle Meter. A meter of this type indicates the cam or contact angle. This angle is the number of degrees that the breaker cam rotates from the time the points close until they open again. The cam angle increases as the point opening is increased. Manufactures of this type equipment furnish complete instructions as to their use. Refer to Specifications for dwell angle.

**CONTACT POINT PRESSURE**

The contact point pressure should be checked with a spring gauge. The scale should be hooked to the breaker lever and the pull exerted at an angle of 90° with the point surface. Reading should be taken just as points separate. The pressure can be adjusted by bending the breaker lever spring. If the pressure is excessive, it can be decreased by pinching the spring carefully. To increase, the lever must be removed from the distributor so the spring can be bent away from the lever. Avoid excessive spring distortion. New breaker lever springs may be stronger than required in service; be sure to check the spring tension of all new levers when installed. Remember that excessive pressure causes rapid rubbing block, cam, and contact point wear while insufficient pressure will permit high-speed point bounce which will, in turn, cause arcing and burning of the points and missing of the engine.

Breaker lever spring tension should be 17-21 ounces when measured at the center of the contact, or 19-23 ounces when measured just behind the contact. The tension may be measured with any suitable spring gauge, provided the pull is exerted at 90° and the reading taken just as the points begin to separate.

The distributor should be tested on a distributor tester that will check the centrifugal advance mechanism.

**REINSTALLATION**

When installing a distributor, observe the following cautions:

1. Be sure the distributor mounting is clean so there will be a good ground connection for the distributor.
2. Check engine breather pipes, since clogged pipes cause crankcase pressure which will force oil up into the distributor.
3. If the advance mechanism of the old distributor was found to be worn, check the engine for worn oil pump gears, since these cause backlash which produces torsional vibration; such vibration causes rapid advance mechanism wear.
4. Be sure to install the new distributor all the way down in its mounting well. If the distributor is not pushed all the way down, the distributor shaft is apt to freeze in the distributor housing and cause complete ~~destruction~~ of the distributor.
5. Be sure that unit is properly timed, refer to proper Operator's Manual.

R2



INDUSTRIAL TRUCK DIVISION



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**GENERATOR**

Maintenance procedures may be divided into two sections—Lubrication and Inspection.

**LUBRICATION**

It is very important that proper lubrication procedures be followed in order to obtain maximum life from the generator.

On generators having hinge cap oilers, a few drops of SAE No. 20 oil should be added at vehicle or engine lubrication periods. See Lubrication Chart.

**INSPECTION**

Inspection procedures are limited mostly to visual checks for loose mounting bolts, a loose drive belt, damaged wiring, and worn commutator brushes.

All mounting bolts should be kept tight, and the belt tension should be adjusted to conform with instructions in operators manual.

Wiring with frayed insulation should be replaced, and all connections should be checked for tightness and cleanliness.

If the commutator is dirty, it may be cleaned with No. 00 sandpaper, or with a brush seating stone, with the generator in operation. Blow away all dust after the cleaning operation. If the commutator is rough, out of round, or has high mica, the armature must be removed so the commutator can be turned down in a lathe and the insulation between bars undercut. Remove only enough material to make the commutator smooth and round, and undercut the insulation 1/32 inch deep and .033 inch wide. Finish with No. 00 sandpaper, and blow away all dust, particularly between bars.

If the brushes are worn down to less than half their original length, they should be replaced. New brushes can be seated to make good contact with the commutator by holding a brush seating stone on the commutator with the generator in operation or by applying brush seating compound to the commutator. Blow away all dust after the seating operation.

A visual inspection will often reveal the condition of the brush springs. If the springs are corroded, or if they are blued and discolored from excessive heat, they should be replaced. If the brush arms move freely, and if the brush moves freely in the holder, with no spring corrosion or discoloration, the springs most likely are satisfactory. If an additional check is desired, use a spring tension scale to measure the brush spring tension, and compare with specifications.



Figure 1. Measuring Brush Spring Tension

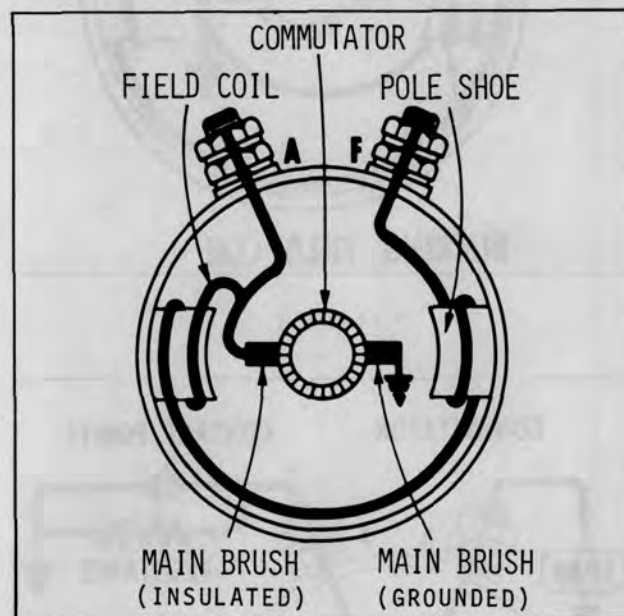


Figure 2.

**GENERATOR CIRCUIT**

This generator has a bucking field coil which is connected across the generator armature. The magnetism produced by the bucking field coil opposes the magnetism created by the main field coil. On generators of this type, only a small amount of magnetism is needed at high generator speeds for the generator to produce specified voltage. Since the main field magnetism and bucking field magnetism oppose each other, the current through both of these windings remains at a normal level at high speeds, but the opposing effect results in the small magnetic field needed at these speeds. With the

normal amount of current in the main field windings at high speeds, the regulator is able to retain voltage control. Without the bucking field, the main field current would have to decrease to an abnormally low value at high speeds. At such a low value, the regulator would not be able to control the voltage.

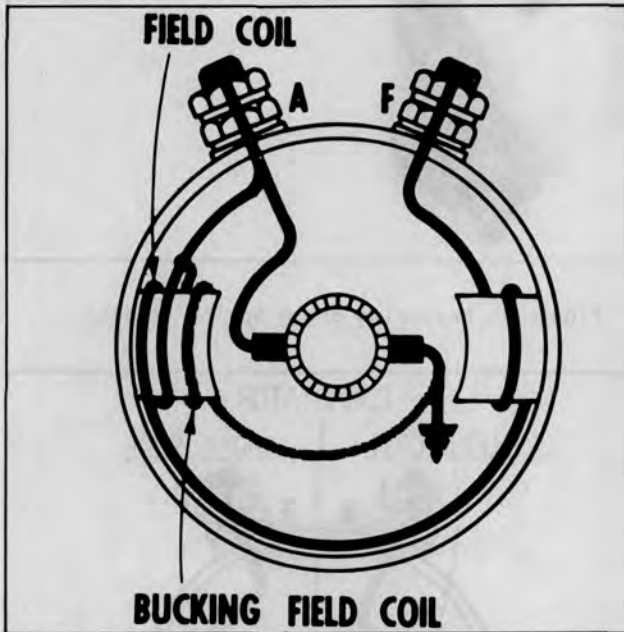


Figure 3.

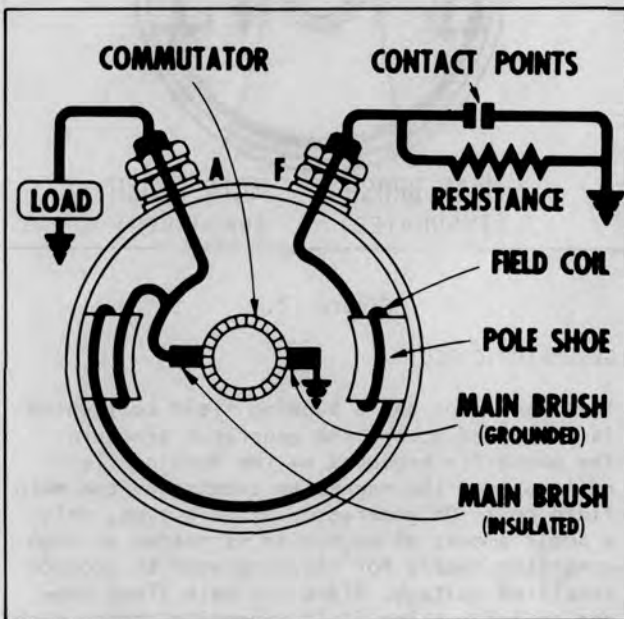


Figure 4.

**"A" CIRCUIT**

This generator is the "A" circuit type. The "A" circuit generator is shown in figure 4. In this type circuit, the field winding is connected to the insulated brush inside the generator and is connected to ground through the contact points in the regulator.

The check our circuit is shown in Figure 5.

**OUTPUT CHECKS**

To check the generator for electrical output, connect an ammeter in series with a battery to the generator output terminal. Also connect a voltmeter from the generator output terminal to ground, and a load rheostat across the battery. Then connect a jumper lead to the generator field terminal as shown in Figure 5. Operate the generator at specified speed, and adjust the load rhesotat as required to obtain the specified output.

If the generator does not perform according to specifications, it should be disassembled for further testing.

**DISASSEMBLY**

Generator disassembly can be accomplished first by removing the thru-bolts, of end frame attaching bolts, and then separating the two end frame assemblies from the field frame.

When removing bearings from the armature shaft or end frame, care should be taken to avoid damage to the balls and raceways. If the bearing is a press fit over the shaft, use bearing pullers against the inner race only. If the inner race is inaccessible, and it is necessary to pull against the outer race, the balls will be loaded and may be damaged. Similarly, when removing a bearing whose outer race is a press fit into the end frame, use an arbor press against the outer race to avoid loading the balls.

After bearing removal, wash in a clean solvent, and carefully inspect for worn surfaces, looseness, broken separators, a cracked ring or race, and a rough or catchy feeling. Always replace any bearing if its condition is doubtful.

**I M P O R T A N T**

REFER TO THE SECTION ENTITLED "MAINTENANCE" FOR PROPER LUBRICATION PROCEDURES.

When remounting bearings, use an arbor press and press firmly and evenly against the proper race to avoid loading the balls. If the mounting surfaces are clean, and the bearing is started properly and is not cocked or mis-aligned, it can be mounted without undue pressure.

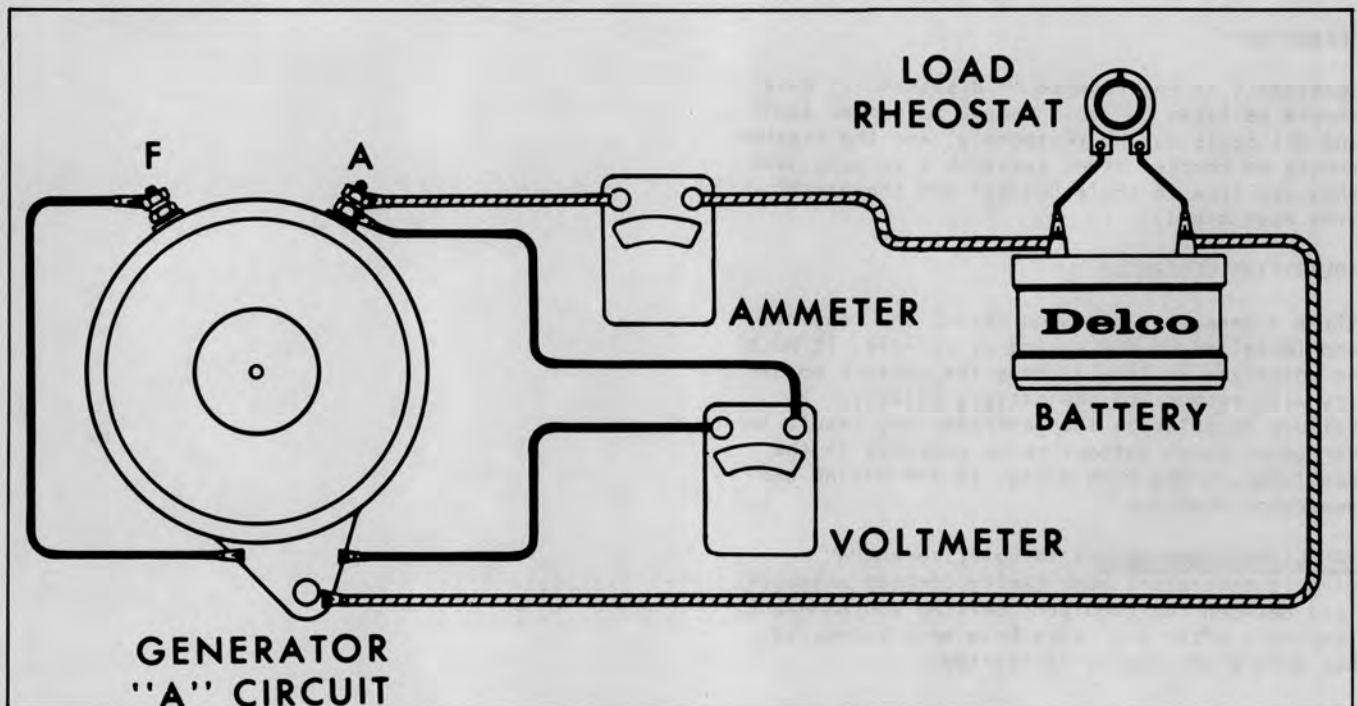


Figure 5. Connections for checking output on 'A' circuit generators.

Grease and oil seals should be replaced after appreciable mileage, or if the seal is worn or damaged in any way.

**ELECTRICAL TESTS**

After the generator has been disassembled, tests can be made of the armature and field coils to determine any electrical defects.

The armature should be checked for shorts, grounds, and opens. To check for shorts, place the armature in a growler, and slowly rotate with a metal blade held on the armature. If the metal blade vibrates, the windings are shorted.

To check the armature for grounds, touch one prod of a 110 volt test lamp to the commutator, and the other test lamp prod to the shaft or laminations. If the lamp lights, the windings are grounded.

To check the armature for opens, visually inspect the wiring connections to the commutator bars, and inspect the commutator for a burned or discolored commutator bar. An open circuit will cause one of the bars to burn and become discolored. Also, the armature may be checked for opens on a growler meter. If the meter reads low, the winding connected to the commutator bars to which the prods are connected is open.

The generator field windings should be checked for shorts, grounds and opens. To check for shorts, connect an ammeter and battery in series

with the field windings, and refer to specifications. If the current reading is higher than specified, the windings are shorted.

To check the field windings for grounds, connect one prod of a 110 volt test lamp to the field terminal, and the other prod to the generator frame. If the lamp lights, the windings are grounded.

To check the field windings for opens, connect the 110 volt test lamp prods across the windings. If the lamp fails to light, the windings are open.

A shorted, grounded, or open field will result in abnormal generator output. A shorted field winding will cause excessive burning of the voltage regulator contact points, resulting in reduced generator output. An open field winding will result in no generator output. A grounded field can cause excessive generator output if the ground is near the 'F' terminal. If the ground is near the end of the winding connected to the insulated brush, reduced generator output will be obtained.

On "bucking field" generators a shorted, grounded, or open bucking field winding can cause excessive generator voltage at high speeds.



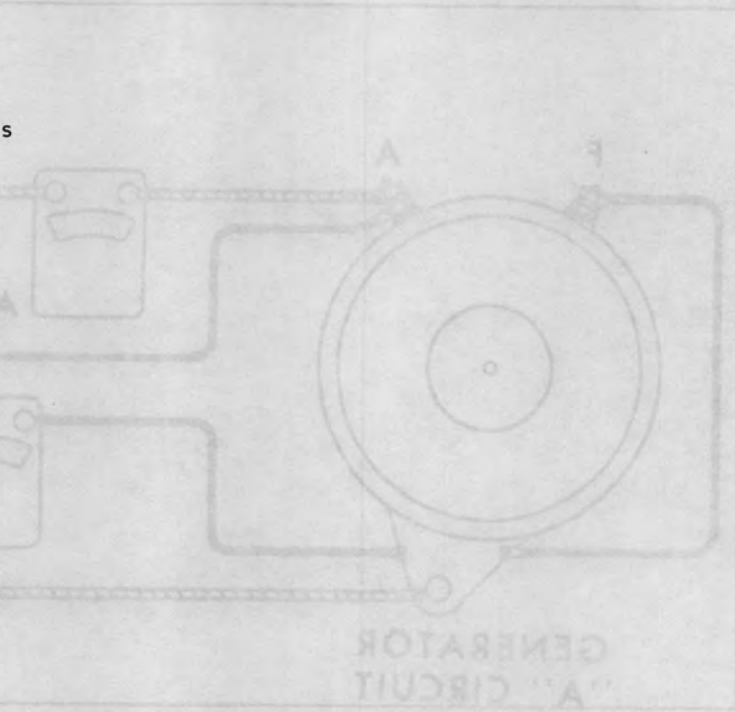
**REASSEMBLY**

Reassembly is the reverse of disassembly. Care should be taken to avoid damage to grease seals and oil seals during reassembly, and the brushes should be checked after reassembly to make sure they are free in their holders and the brush arms move freely.

**POLARIZING GENERATOR**

After a generator has been tested and repaired, and installed on the engine or vehicle, it must be polarized so it will have the correct polarity with respect to the battery polarity. Failure to polarize the generator may result in burned or stuck cuttout relay contacts in the regulator, along with damage to the wiring and generator windings.

**"A" Circuit Generator:** To polarize an "A" circuit generator, momentarily connect a jumper lead between the regulator BATTERY and ARMATURE terminals after all leads have been connected, but before the engine is started.



To check the field windings for shorts, connect the 110 volt test lamp probes across the windings. If the lamp fails to light, the windings are open. To check the field windings for grounds, connect one end of a 110 volt test lamp to the field terminal, and the other end to the generator frame. If the lamp lights, the windings are grounded.

To check the armature for shorts, place the armature in a growler and slowly rotate with a metal blade held on the armature. If the metal blade vibrates, the windings are shorted. To check the armature for grounds, touch one end of a 110 volt test lamp to the commutator and the other test lamp lead to the shaft or laminations. If the lamp lights, the windings are grounded.

To check the armature for open, visually inspect the wiring connections to the commutator bars and inspect the commutator for rounded or discolored commutator bars. An open circuit will cause one of the bars to burn and become discolored. Also, the armature may be checked for open on a growler when the meter leads for the winding connected to the commutator bar to which the probe connects is open. The generator field windings should be checked for shorts, grounds and open. To check for shorts, connect an ammeter and battery in series

After the generator has been disassembled, tests can be made of the armature and field coils to determine any electrical defects. The structure should be checked for shorts, grounds, and open. To check for shorts, place the armature in a growler and slowly rotate with a metal blade held on the armature. If the metal blade vibrates, the windings are shorted. To check the armature for grounds, touch one end of a 110 volt test lamp to the commutator and the other test lamp lead to the shaft or laminations. If the lamp lights, the windings are grounded.

The generator field windings should be checked for shorts, grounds and open. To check for shorts, connect an ammeter and battery in series with the field windings and check for shorts. If the current reading is higher than specified, the windings are shorted. To check the field windings for grounds, connect one end of a 110 volt test lamp to the field terminal, and the other end to the generator frame. If the lamp lights, the windings are grounded.

The generator field windings should be checked for shorts, grounds and open. To check for shorts, connect an ammeter and battery in series with the field windings and check for shorts. If the current reading is higher than specified, the windings are shorted. To check the field windings for grounds, connect one end of a 110 volt test lamp to the field terminal, and the other end to the generator frame. If the lamp lights, the windings are grounded.



AXLE ADAPTOR/DIFFERENTIAL AND AXLE ENDS

TROUBLE	PROBABLE CAUSE	CORRECTION
1. Continuous Axle Noise.	<ol style="list-style-type: none"> <li>1. Worn parts.</li> <li>2. Tires wear uneven.</li> <li>3. Lack of Lubricant.</li> </ol>	<ol style="list-style-type: none"> <li>1. Replace with new parts.</li> <li>2. Replace tires.</li> <li>3. Fill to level plug with proper oil.</li> </ol>
2. Axle Noise On Drive Or Coast Only.	<ol style="list-style-type: none"> <li>1. Ring gear and pinion gear of differential</li> <li>2. Worn pinion gears or side gear in differential case.</li> </ol>	<ol style="list-style-type: none"> <li>1. Replace worn part.</li> <li>2. Replace worn gears.</li> </ol>
3. Excessive Backlash In Axle.	<ol style="list-style-type: none"> <li>1. Axle Adaptor to transmission loose.</li> <li>2. Worn splines on axle shaft or side gears.</li> <li>3. Worn ring gear, drive pinion or differential case pinion.</li> </ol>	<ol style="list-style-type: none"> <li>1. Tighten screws.</li> <li>2. Replace axle shaft and/or side gears.</li> <li>3. Replace worn parts where necessary.</li> </ol>
4. Failure to operate.	<ol style="list-style-type: none"> <li>1. Broken drive pinion shaft</li> <li>2. Broken teeth on ring gear.</li> </ol>	<ol style="list-style-type: none"> <li>1. Replace shaft</li> <li>2. Replace ring gear.</li> </ol>



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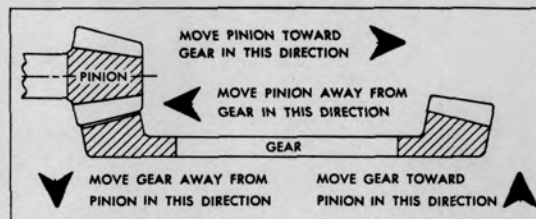
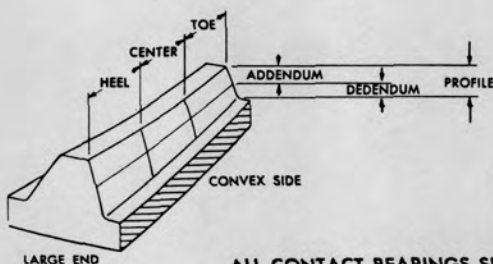
FORM NO. 1-60

CLARK EQUIPMENT COMPANY

PUBLISHED BY

TECHNICAL SERVICE DEPARTMENT  
BATTLE CREEK, MICHIGAN, U.S.A.

**SPIRAL BEVEL AND HYPOID TOOTH BEARING CONTACT CHART**



ALL CONTACT BEARINGS SHOWN BELOW ARE ON RIGHT HAND SPIRAL RING GEAR – THE DRIVE IS ON THE CONVEX SIDE OF THE TOOTH.



**FIG. 1**

TYPICAL PREFERRED BEARING ON BOTH SIDES OF TOOTH WHILE UNDER A LIGHT LOAD



**FIG. 2**

TOE BEARING ON BOTH SIDES OF TOOTH – GEAR SET NOISY. TO MOVE BEARING TOWARD HEEL INCREASE BACKLASH WITHIN LIMITS BY MOVING GEAR AWAY FROM PINION.



**FIG. 3**

HEEL BEARING ON BOTH SIDES OF TOOTH – GEARSET NOISY AND COULD RESULT IN EARLY GEAR FAILURE. TO MOVE BEARING TOWARD TOE DECREASE BACKLASH WITHIN LIMITS BY MOVING GEAR TOWARD PINION.



**FIG. 4**

LOW BEARING ON GEAR AND HIGH BEARING ON PINION. CORRECT BY PULLING PINION AWAY FROM GEAR (INCREASE MOUNTING DISTANCE).



**FIG. 5**

HIGH BEARING ON GEAR AND LOW BEARING ON PINION. CORRECT BY MOVING PINION IN TOWARD GEAR (DECREASE MOUNTING DISTANCE).



**BACKLASH**

BACKLASH SHOULD BE MEASURED WITH A DIAL INDICATOR RIGIDLY MOUNTED WITH THE STEM PERPENDICULAR TO THE TOOTH SURFACE AT THE EXTREME HEEL. THE AMOUNT SHOULD VARY FROM .007 TO .014 DEPENDING UPON THE PITCH OF THE GEAR – FINE PITCHES BEING NEAR THE LOW SIDE AND COARSER PITCHES NEAR THE HIGH SIDE.

ENGINEERING APPROVED  
REV. 5-1-63



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BATTLE CREEK, MICHIGAN, U.S.A.



AXLE ADAPTOR/DIFFERENTIAL AND AXLE ENDS

Description

The drive axle is of the full floating type consisting of the differential, axle adaptor and two axle ends.

The differential is of the bevel gear and pinion type with final reduction at the axle end.

The pinion and shaft are of one piece construction and inner end of shaft is splined for insertion into differential side gears. The drive pinion shaft is supported in the axle end by two ball type bearings.

If the axle ends and/or differential require major repair, they must be removed from the machine.

The axle adaptor and differential are components of the transmission; however, they will be discussed in this section.

Axle End Removal

Remove wheel attaching fasteners and remove wheel from axle end. Remove axle end mounting bolts and nuts and pull axle end away from axle adaptor. (See Plate 9477).

Axle Adaptor and Wheel End Removal

It is possible to remove the adaptor and wheel end as a unit. First Remove the upright assembly. Disconnect brake line at "T"

x  
 x  
 x W A R N I N G x  
 x SECURELY SUPPORT TRANSMISSION BEFORE x  
 x SEPARATING FROM AXLE ADAPTOR. x  
 x  
 x

Remove the axle to frame bolts. Drain transmission and adaptor at adaptor drain plug. Remove the attaching bolts and stud nuts and separate assemblies as shown in Plate 9533.

Axle End Disassembly (See Plate 5694)

1. Remove the driven disc from pinion drive shaft.
2. Remove bolts securing axle end hub cap.
3. Remove axle end spindle cotter, nut, washer and outer spindle bearing cone.

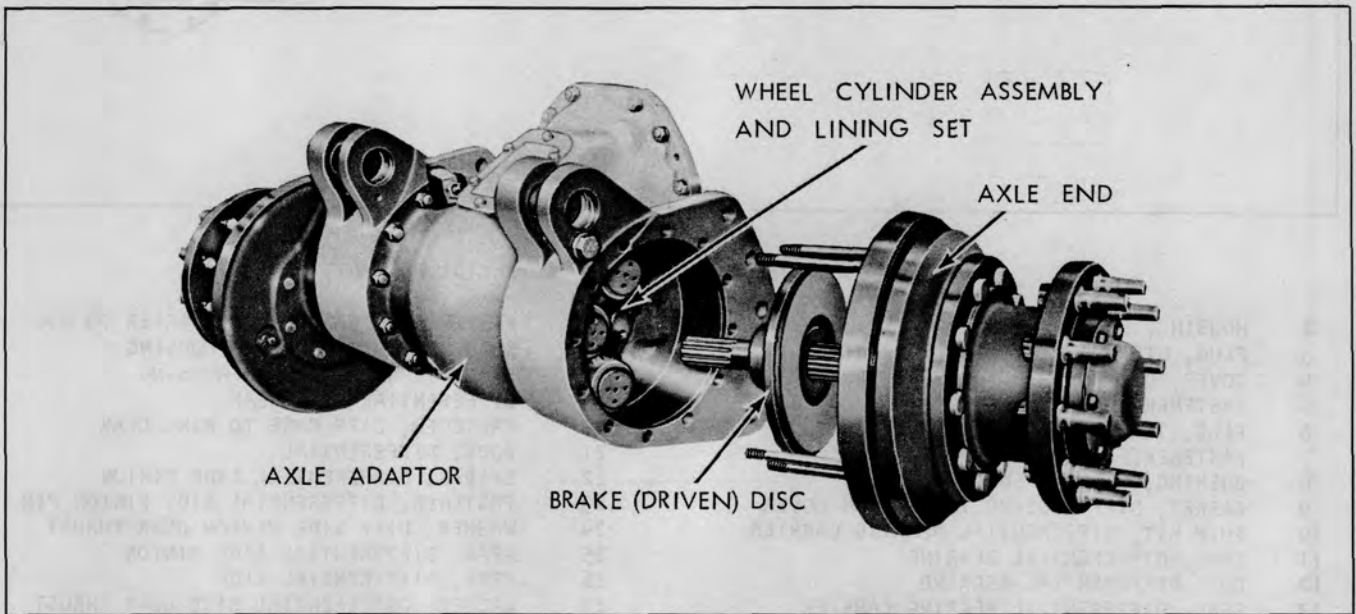


Plate 9477. Axle End Removal



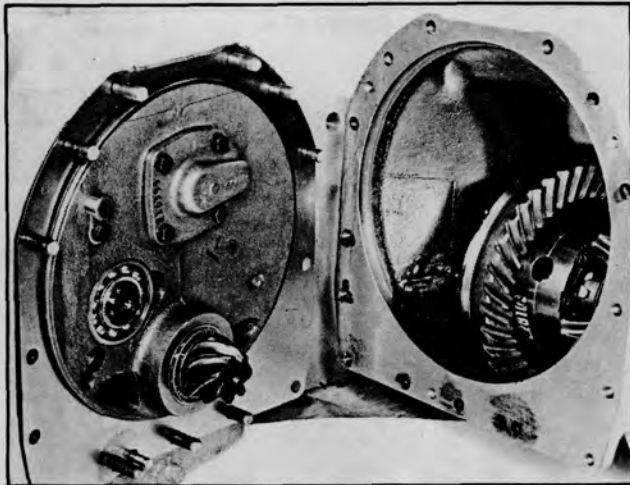


Plate 9533. Remove Adaptor From Transmission

4. Remove spindle housing and oil seal from spindle support.
5. Remove internal gear to hub assembly bolts and separate.
6. Remove pinion drive shaft and bearing from spindle support.
7. Remove spindle bolts (location "B") and remove from spindle support.

Differential Removal

It will be necessary to remove both wheel and assemblies to remove the differential. The pinion drive shafts are splined to both sides of differential.

1. Remove the bearing carrier stud nuts. (plate 6184.)
2. The differential will be free to be removed when bearing carriers are removed.

To aid in disassembly refer to exploded view of the axle adaptor and differential (Plate 9556).

**INSPECTION AND MAINTENANCE**

Immerse all parts, except bearings, in suitable cleaning fluid until parts are thoroughly cleaned.

Dip bearings in cleaning fluid and slush up and down slowly until bearings are clean.

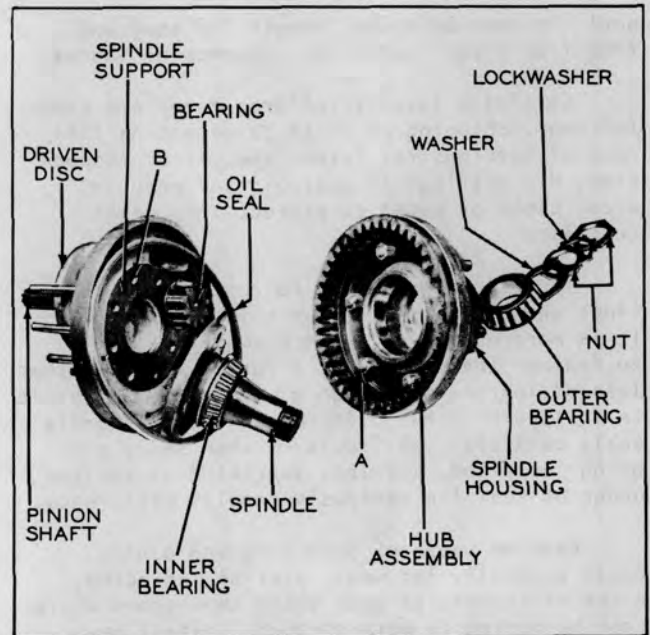


Plate 5694. Axle End Parts

Remove bearings from fluid and strike large side of cone flat against a block of wood to dislodge solidified particles of lubricant. Repeat above operation until bearings are cleaned thoroughly. Blow bearing dry with compressed air. Be careful to direct air stream across bearing to avoid spinning. Bearing may be slowly rotated by hand to facilitate drying procedure.

Clean interior of housing thoroughly and make sure the faces of the housing and axle adaptor are free of all foreign material.

Examine differential case, side gears, pinions and thrust washers for damage or excessive wear. Check clearance between pinions and pinion pin and thickness of all thrust washers. If differential side gears and pinions are worn or damaged, always replace with complete set consisting of four pinions, two side gears, all thrust washers, and spider.

Inspect all parts to detect cracks or fissures to determine serviceability of parts. Surface of spindle support which contacts oil -----  
----- CONTINUED ON NEXT PAGE -----



seal lip must be round, smooth finished and free from nicks, scratches, grooves or scores.

Carefully inspect rollers, cages and cups for wear, chipping or nicks to determine fitness of bearings for further use. After inspection, dip bearings in gear oil and wrap in clean cloth or paper to protect them until installed.

It will be necessary to replace all "O" rings and oil seals when unit is disassembled. It is more economical than premature overhaul to replace these parts at a future time. Further loss of lubricant through a worn seal may result in failure of other differential parts. Handle seals carefully, particularly when seals are being installed. Cutting, scatching or curling under of seal lip seriously impairs efficiency.

Examine teeth of both ring and pinion gears carefully for wear, pitting, chipping, nicks or scores. If gear teeth show spots where case hardening is worn through, install new ring gear and pinion set. Small nicks may be carefully removed with a suitable hone. Examine pinion gear teeth for wear and check pinion shaft for evidence of twisting, particularly at splines. If evident, install new set of gears.

Pinion and drive (ring) gears are available only in matched sets and must be installed as such to assure satisfactory operation.

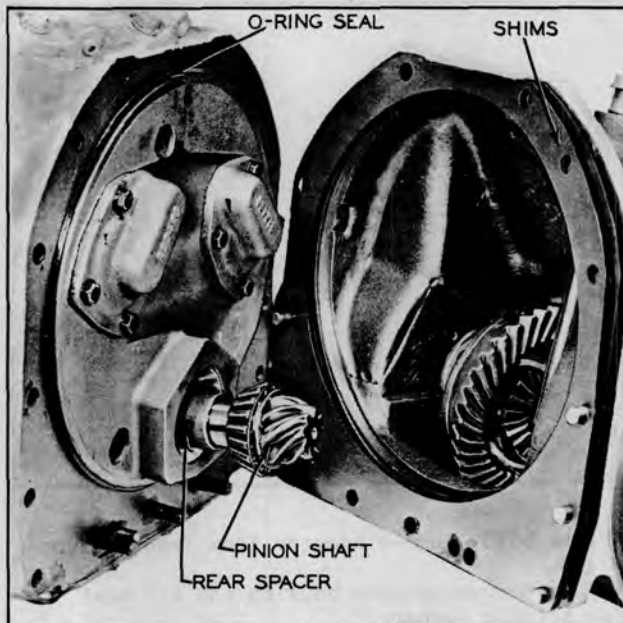


Plate 6188. Seal Ring & Shims

Axle Adaptor and Differential Reassembly

Reassembly is the reverse of disassembly. However, after the axle adaptor and differential has been reassembled the backlash should be checked. If the backlash is not right, it will be necessary to add or subtract bearing carrier shims in the axle adaptor and/or between the axle adaptor and transmission.

**N O T E**

When assembling the axle adaptor to transmission, exercise care not to damage (scratch, nick, etc.) the "O" ring seal located between the two components (See Plate 6188.)

Backlash should be measured with a dial indicator rigidly mounted with the stem perpendicular to the tooth surface at the extreme heel. The correct backlash should be between .006 and .008 inch. The backlash is measured through the filler plug on the axle housing (See Plate 9557 on Page 20M802E).

To check for correct tooth contact between ring gear and pinion - put red lead on three or four teeth of pinion and assemble axle adaptor to transmission housing. Rotate pinion until ring gear makes a complete revolution (See Page 20S802A) to check results of ring gear and pinion contact.

When results show that the pinion must be moved toward or away from ring gear, shims must be added or removed between axle adaptor and transmission housing. If ring gear must be moved in relation to the pinion, shims must be

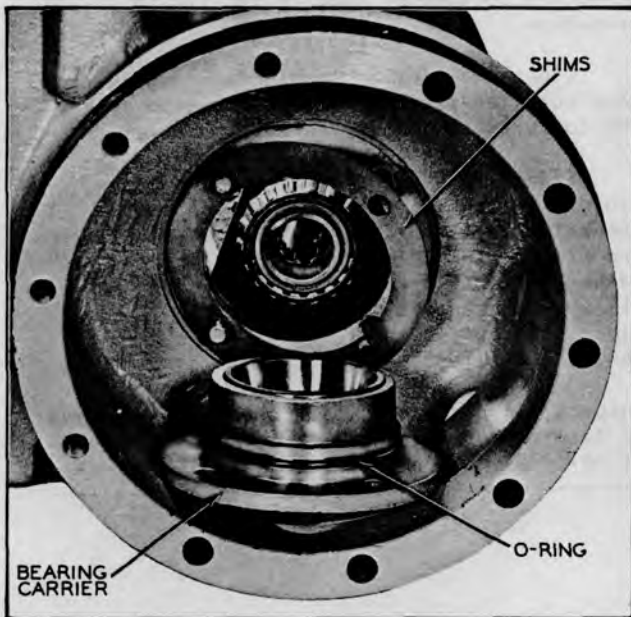


Plate 6184. Bearing Carrier Assembly



added or removed from the differential bearing caps (See Plate 6184 or 9500).

**N O T E**

When adding or removing shims, care should be exercised to not damage carrier "O" ring when removed and replacing bearing carrier to axle adaptor.

To obtain the correct part numbers for the variable sized shims refer to the Parts Book.

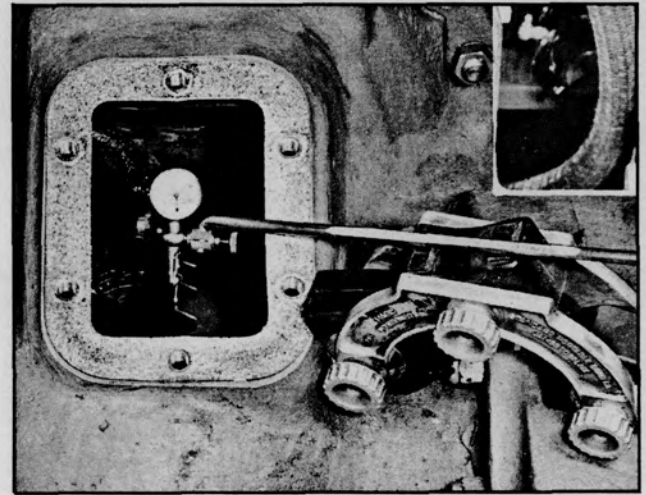


Plate 957. Check Backlash

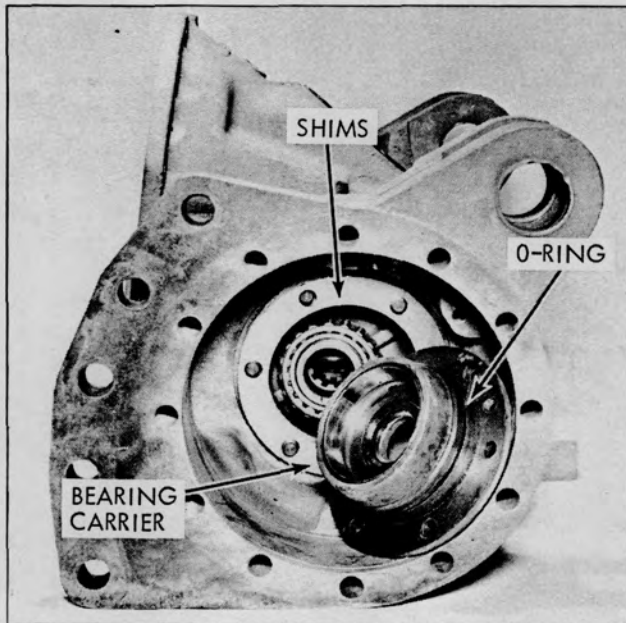


Plate 9500. Bearing Carrier Assy.



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BATTLE CREEK, MICHIGAN, U.S.A.

## HYDRAULIC ACTUATION OF THE MASTER CYLINDER FURNISHES FLUID PRESSURE.

In hydraulic actuation, a master cylinder responds to the amount of controlling force applied through the brake pedal leverage and supplies hydraulic pressure, through connecting lines. Unless a connecting line is blocked, the pressure rise is equal throughout the hydraulic system because of the natural movement of incompressible fluid throughout the system. Gas bubbles trapped in the sealed system would absorb this fluid movement, by compressing when under pressure, and cause a "spongy pedal" free. Therefore, admitted air or other gasses must be removed by a servicing operation called "bleeding."

### Brakes released

When foot pressure is removed from the brake pedal, the system returns to "off" position. A pedal return spring returns the brake pedal, pulling its piston rod away from the master cylinder.

### Cleaning and Inspection

Cylinder castings may be degreased, or cleaned with most commercial parts cleaners, provided they are thoroughly rinsed with Stoddard type solvent or brake fluid to remove all traces of solvent. Use compressed air or a lint-free cloth to dry parts after removing them from the cleaning solvent. All hydraulic parts must be thoroughly cleaned and protected (after cleaning), from dust or other air-borne foreign material, until the master cylinder is reassembled. Do not use cotton waste for cleaning or drying parts, as particles of lint or thread fibres may block the compensating port when the cylinder is placed in service. Clean rubber parts by washing them in clean Stoddard type solvent or hydraulic brake fluid.

### C A U T I O N

DO NOT USE MINERAL-BASE CLEANING SOLVENT SUCH AS GASOLINE, KEROSENE, DISTILLANT, CARBON-TETRACHLORIDE, ACETONE, PAINT THINNER, ETC. THESE SOLVENTS DETERIORATE RUBBER PARTS, CAUSING THEM TO BECOME SOFT, TACKY AND SWOLLEN IN AN EXTREMELY SHORT TIME.

### Disassembly and Assembly

1. Care should be taken when clamping the master cylinder in a vise so that its pressure will not distort the cylinder bore or damage other parts.
2. Remove caps (23) and (25) and empty brake fluid from cylinder.
3. Remove nut (5), Rings (4), Housing (3) with Spring (6), and "O" Ring (7).
4. Remove spacers (8), and piston (9) with cup (10).
5. With snap ring pliers remove snap ring (11) also piston (12) with cups (13).
6. Remove spring (14) and piston (16) with cups (15) and (17).
7. Dust boot (20) should be removed and replaced.
8. Replace all parts as contained in repair kit and all defective or broken parts.

### N O T E

ONE CAP IS VENTED. VENTED CAP SHOULD BE IN FRONT HOLE OR HIGHEST PART OF BODY.

Reassembly is essentially the reverse of disassembly. Make sure all parts are properly oriented and coated with clean brake fluid to prevent damage during assembly and to provide initial lubrication.

### PROBABLE SOURCES OF FAILURE.

#### Low Fluid (Air in System)

When the fluid level drops below the master cylinder ports, air will be taken into the system. If the master cylinder reservoir is refilled before the air is forced into the brake lines, a few strokes of the brake pedal will usually purge the air and restore proper braking. If this fails, the hydraulic system must be "bled" to remove the trapped air.



# MASTER MAINTENANCE MANUAL



## Blocked reservoir air vent

This produces a vacuum in the master cylinder reservoir which may be sufficient to permit air to enter the system around the secondary piston cup. Clean the filler cap air vent and bleed the hydraulic system.

## Fluid and/or air leak at secondary cup

A leak past the primary cup will not leave any external evidence, but will produce a soft pedal eventually leading to a sudden complete braking loss. The leak may be due to a faulty primary cup or severely pitted cylinder wall.

## Blocked compensating (by-pass) port

This prevents compensation within the system until surplus fluid causes hydraulic pressure to build up so that brakes "lock-up" and will not release. A blocked port is usually caused by dirt or corrosion, faulty (swollen) primary cup extending over the port, or improper pedal link adjustment. A swollen cup suggests use of improper or contaminated fluid.



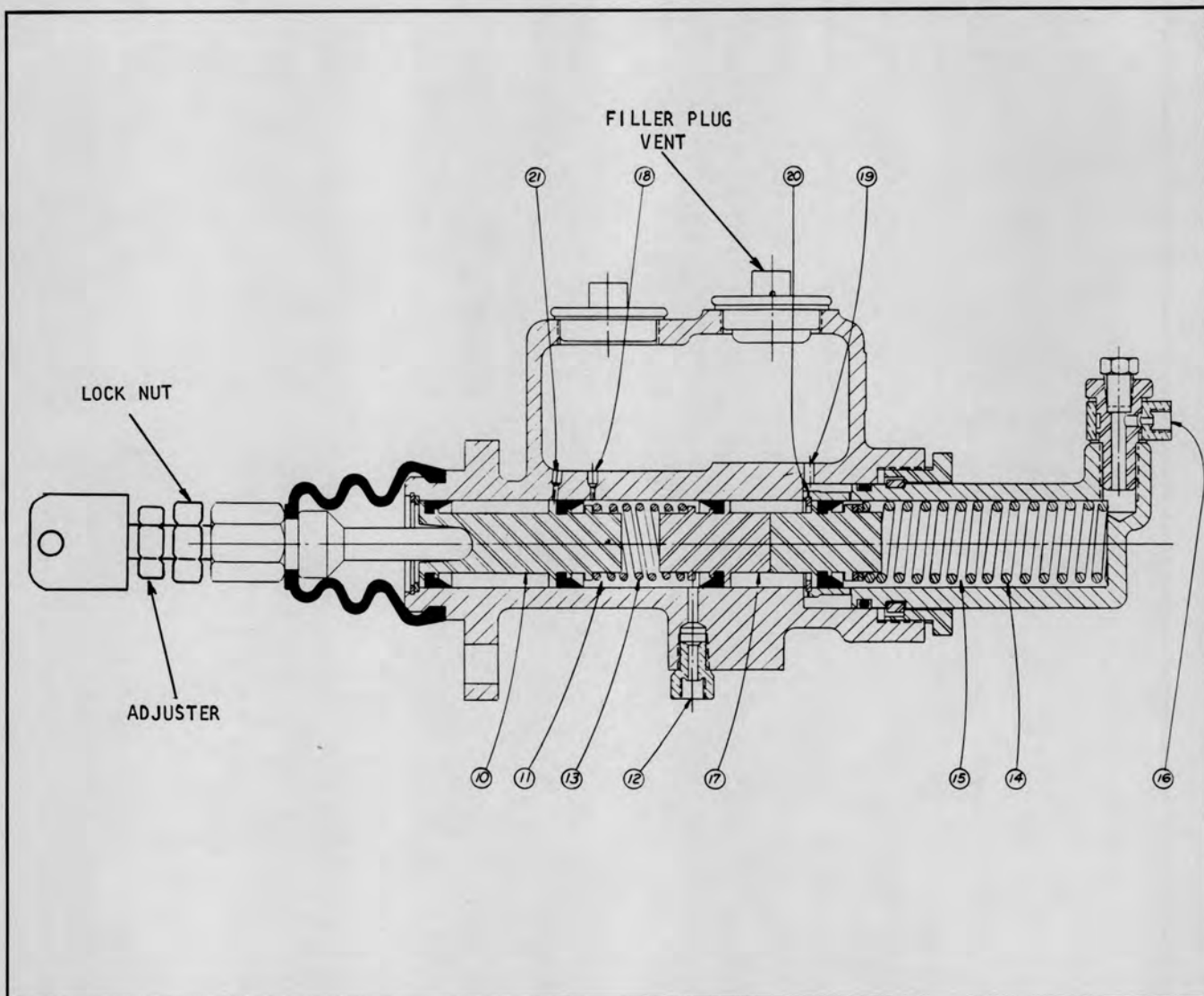


Plate 6987. Master Cylinder

The piston (10) is moved in conventional manner by linkage from the brake pedal. As this is done, oil from the cavity (11) is moved out thru port (12) to the inching control. Since spring (13) is lighter and more readily compressed than spring (14) the oil from cavity (11) will flow thru port (12) more readily and in greater volume than oil from cavity (15) thru port (16) the latter supplying the brake system.

As further motion is imparted to piston (10) from the brake pedal the pressure in (11) builds up to the pressure required for positive brake application. At this time piston (17) is caused to move further into cavity (15) thus forcing high pressure oil out of port (16) and into the brake system.

Thus it is seen that this unit provides initially, low pressure oil to actuate the inching mechanism and to partially actuate the brake mechanism, making brakes ready for immediate application, and finally, high pressure oil for complete brake actuation. In the reverse operation when brake pedal effort is released, the braking effort is removed first, and the inching effort second upon return of the brake to its normal position.

Hydraulic oil is provided to the system thru ports (18) and (19) from a conventional reservoir. Port (20) serves to vent any build up of oil pressure between the two sections of the piston (17). Port (21) serves to vent any build up of oil pressure between the two seals on piston (10).



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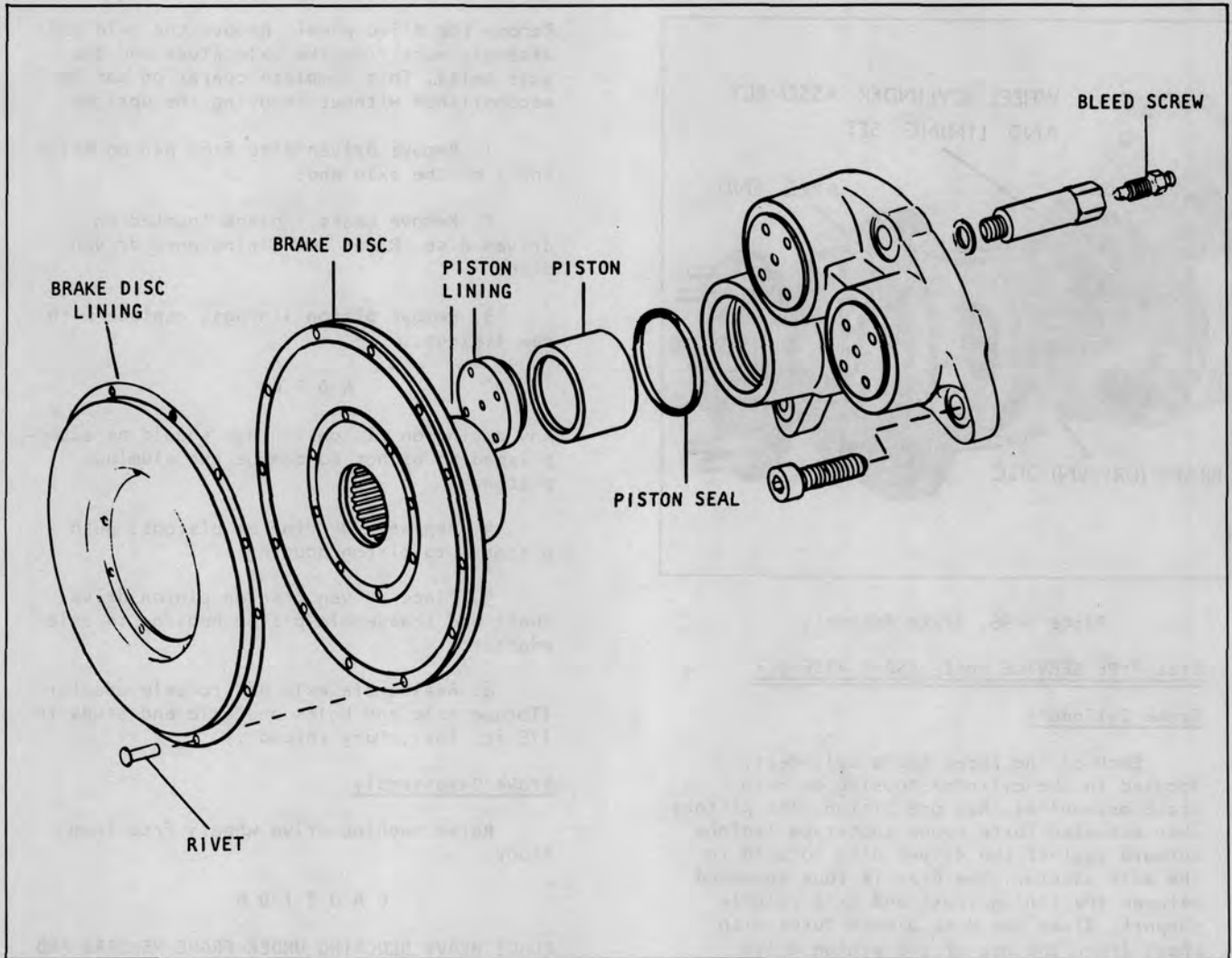


Plate 8261. Wheel Brake Assembly

DISC TYPE SERVICE WHEEL BRAKE ASSEMBLY

Description

When depressing the brake pedal hydraulic pressure is applied to the brakes, the pistons move out, clamping the rotating disc between the pistons and axle end producing the braking action. When hydraulic brake pressure is released, the clamping action is removed and the disc is again free to rotate.

If it is found that the brake effectiveness has gradually dropped to a noticeable degree (and the system has been properly bled and pedal free travel is adjusted correctly) the linings are worn beyond their designed limits. If lining wear has reached this point, the replacement of linings is necessary.

The original thickness of the brake disc lining is 0.221-inch. The disc lining is a ~~good~~ <sup>WORN</sup> effective until it is worn to 1/16-inch thickness. If after inspection it is found that the lining is worn to the extent that it will not be effective until the next inspection period, it should be replaced. The brake piston lining when new is 0.649-inch thick to the step on the lining. This lining should also be replaced if it is determined that it will be worn to within 1/16-inch of step before the next inspection period.

Before replacing axle ends, check the cylinders for leakage. The actual presence of fluid, other than mere dampness, indicates a fluid leak. Correct leaks as necessary by replacing the piston seals after cleaning the pistons and seal grooves thoroughly.

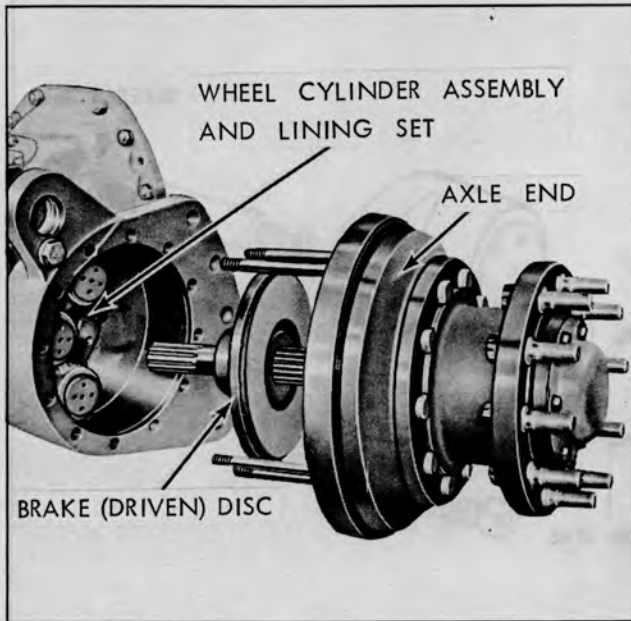


Plate 9496. Brake Assembly

DISC TYPE SERVICE WHEEL BRAKE ASSEMBLY

Brake Cylinders

Each of the three brake cylinders, located in the cylinder housing on both brake assemblies, has one piston. The pistons when actuated force round spot-type linings outward against the driven disc located in the axle adaptor. The disc is thus squeezed between the lining spots and axle spindle support. Since the disc always turns with wheel (thru the use of the pinion drive shaft), braking the disc stops the wheels, see Plate 9496.

**N O T E**

For disassembly and reassembly procedures, refer to the following write-up.

Brake Lining Change  
(See Plate 9496)

The wheel cylinders, shoes and brake housing are accessible by removing the axle end from the axle adaptor. This is accomplished by raising the machine drive wheels free from the floor and removing axle end.

**C A U T I O N**

PLACE HEAVY BLOCKING UNDER FRAME MEMBERS, AND REST THE WEIGHT OF MACHINE ON THIS HEAVY BLOCKING KEEPING DRIVE WHEELS OFF THE FLOOR.

Remove the drive wheel. Remove the axle end assembly nuts from the axle studs and the axle bolts. This complete operation can be accomplished without removing the upright.

1. Remove driven disc from pinion drive shaft of the axle end.

2. Remove brake linings located on driven disc. Rivet new lining onto driven disc.

3. Remove piston linings, replace with new linings.

**N O T E**

Any prying on piston linings should be accomplished so as not to damage the aluminum piston.

4. Replace "O" ring on pistons; push piston into piston housing.

5. Place driven disc on pinion drive shaft and reassemble piston housing in axle adaptor.

6. Reassemble axle end to axle adaptor. (Torque axle end bolts and axle end studs to 175 ft. lbs., "dry thread".)

Brake Disassembly

Raise machine drive wheels free from floor.

**C A U T I O N**

PLACE HEAVY BLOCKING UNDER FRAME MEMBERS AND REST THE WEIGHT ON THIS HEAVY BLOCKING KEEPING DRIVE WHEELS OFF THE FLOOR.

Remove the drive wheel. Remove the axle end assembly bolts and the nuts from the axle end studs, This may be accomplished without removing the upright or mast.

1. Press pistons to full off position, disconnect brake line and drain fluid into a container (brake fluid should never be used again).

2. Remove the brake housing retainer bolts and pull the brake housing from axle adaptor.

3. Drain the remaining fluid from the brake assembly housing and position a suitable brace across the faces of the pistons. Apply clean compressed air (7 to 19 P. S. I.) at the inlet ports and force the pistons far



enough out of the housing so they may be pulled by hand.

**NOTE**

The support is used to equalize the protrusions of the piston.

**CAUTION**

EXTREME CARE MUST BE EXERCISED TO AVOID BLOWING PISTONS COMPLETELY OUT OF HOUSING AND DAMAGING PISTONS.

4. Remove piston O-ring seals from cylinders and remove lining from pistons.

5. Remove brake linings from driven disc.

6. Remove bleeder screws from axle adaptor.

Inspection and Maintenance

1. Wash all metal parts in Stoddard Type Cleaning Solvent and dry thoroughly.

2. Wash O-ring seals in clean hydraulic brake fluid (only), inspect thoroughly for cuts, cracks and wear and place on clean surface. Replace O-rings if necessary.

3. Inspect bores and pistons for deposits and for scoring.

4. Inspect discs for flatness and wear. Disc worn to a thickness of .225-inch should be replaced.

Reassembly

1. Lubricate piston walls, O-ring seals and cylinder walls with a very thin coat of silicon grease, install O-rings in cylinder and install pistons in cylinders - pushing them to full bottom position. Following piston installation, relubricate cylinder walls with the silicon grease compound to assure complete coverage.

2. Position brake housing and secure in place in axle adaptor.

3. Install bleeder screws in axle adaptor.

4. Install lining on driven disc and place driven disc on pinion drive shaft of axle end. (Refer to torque specifications listed in chart on the following column.)

5. Install axle end to adaptor and connect brake lines.

6. Bleed the brake system as instructed on page of operators manual.

**NOTE**

There is not any adjustment necessary on this brake assembly. However, the brake system must be properly bled as previously explained. When discs and/or linings become worn to the extent that the brake system is not functioning properly they are to be replaced.

**AXLE ENDS - TO - AXLE ADAPTOR**

9/16", STUDS, TORQUE TO 165, TO 175 FT. LBS.

3/4" CAPSCREWS, TORQUE TO 165, TO 175 FT. LBS.

**FRAME - TO - ADAPTOR**

TORQUE TO 425 TO 450 FT. LBS.

ALL TORQUE SPECS. ARE "DRY THREAD" ASSEMBLY

PARKING BRAKE

**NOTE**

The brake assembly can be removed and serviced without pulling the transmission from the engine.

Removal

To remove the brake shoe housing (2), first remove the four capscrews and lock-washers (7) which hold the shoe housing to the transmission housing. The shoe housing can now be removed with the shoe cam lever (6).

Reassembly

Reassemble brake in transmission housing using the reverse procedure of removal.

Adjustment

See "Adjustment" on Page 1000H 1103-4 in front of manual.

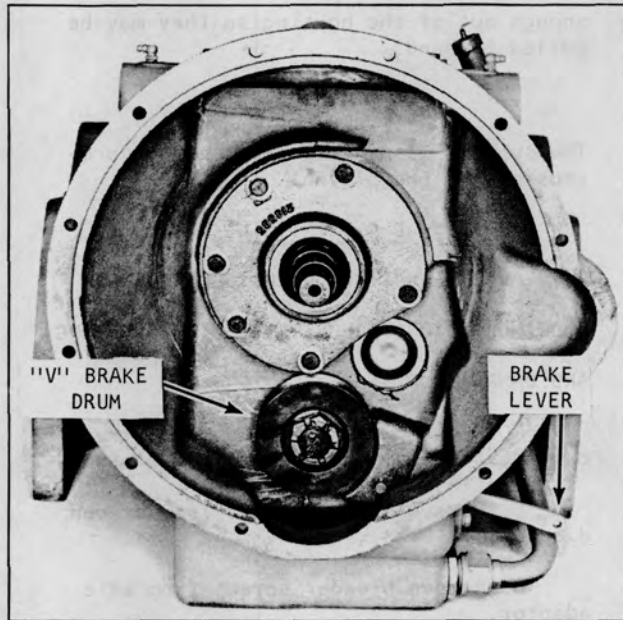


Plate 8915. Parking Brake Assembly

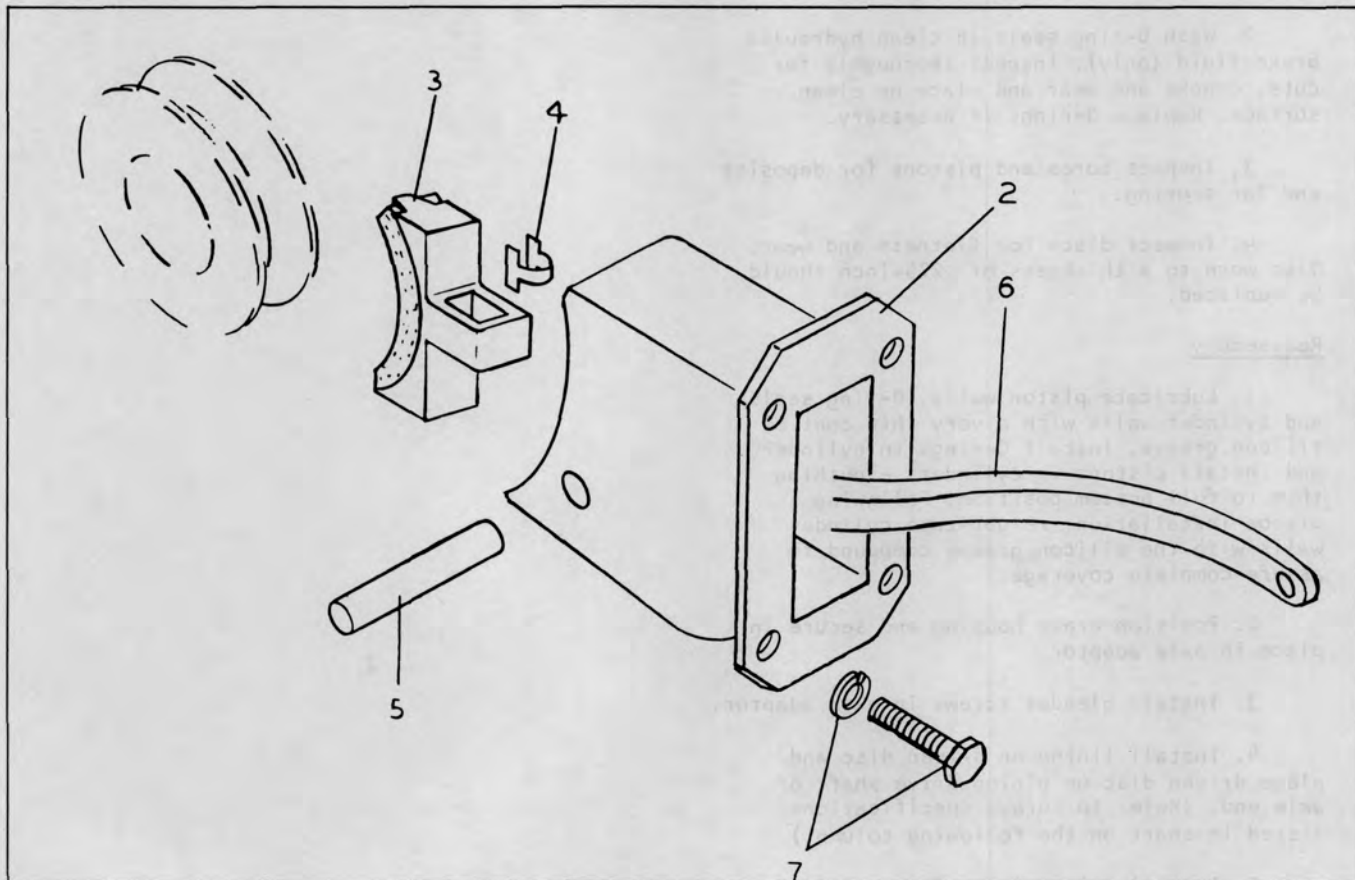


Plate 8916. Disassembled Parking Brake

SPLIT RIMS

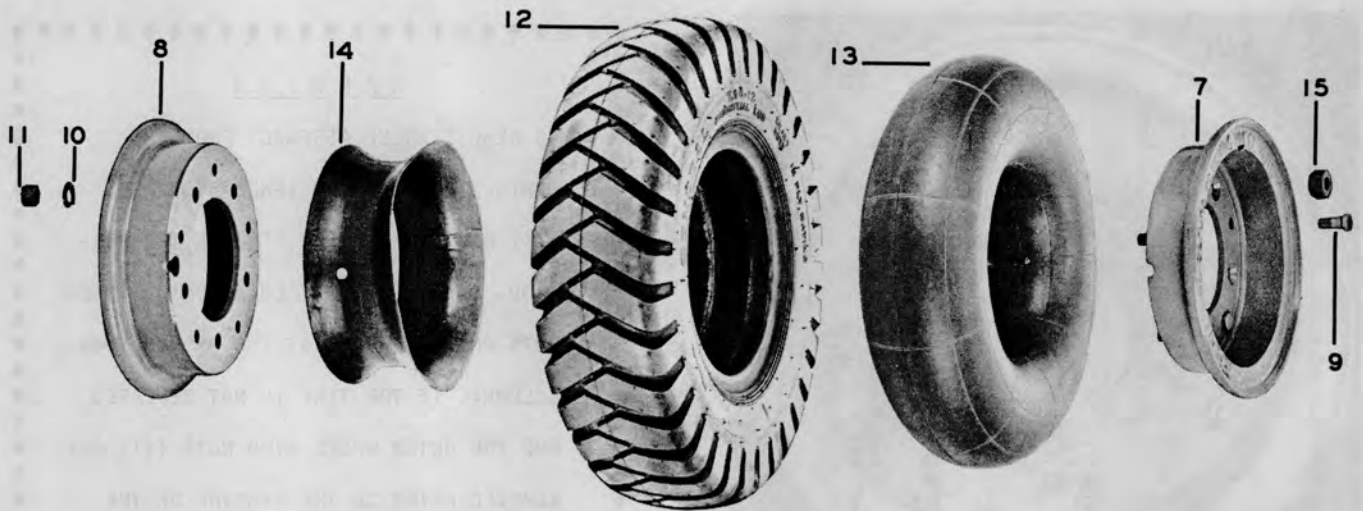


Plate 9180. Split Rim Assembly

- 7. Outer wheel half.
- 8. Inner wheel half.
- 9. Capscrew, (5 for each wheel)
- 10. Lockwasher, (5 for each wheel)
- 11. Nut, (5 for each wheel)

- 12. Tire
- 13. Tube
- 14. Flap
- 15. Nut, wheel to axle (5 for each wheel)

W A R N I N G

AN INFLATED TIRE AND RIM CAN BE VERY DANGEROUS. MANY ACCIDENTS, SOME FATAL, HAVE RESULTED FROM IMPROPER HANDLING AND OPERATION OF VEHICLE RIMS, TIRES AND WHEELS. IT IS, THEREFORE, OF THE UTMOST IMPORTANCE THAT THE FOLLOWING PRECAUTIONS BE NOTED BY ALL PERSONS CONCERNED TO AVOID PERSONAL INJURY AND COSTLY DAMAGE.

W A R N I N G

AFTER RAISING THE VEHICLE AND PRIOR TO REMOVAL OF WHEELS, PLACE ADEQUATE (HEAVY) BLOCKING (SUFFICIENT TO SUPPORT THE WEIGHT OF THE MACHINE) UNDER THE FRAME TO PREVENT ACCIDENTAL LOWERING OR FALLING OF THE MACHINE, THUS PREVENTING PERSONAL INJURY TO MECHANIC OR BYSTANDERS.



Plate 7613. Wheel with Inner and Outer Halves

## SPLIT RIMS (continued)

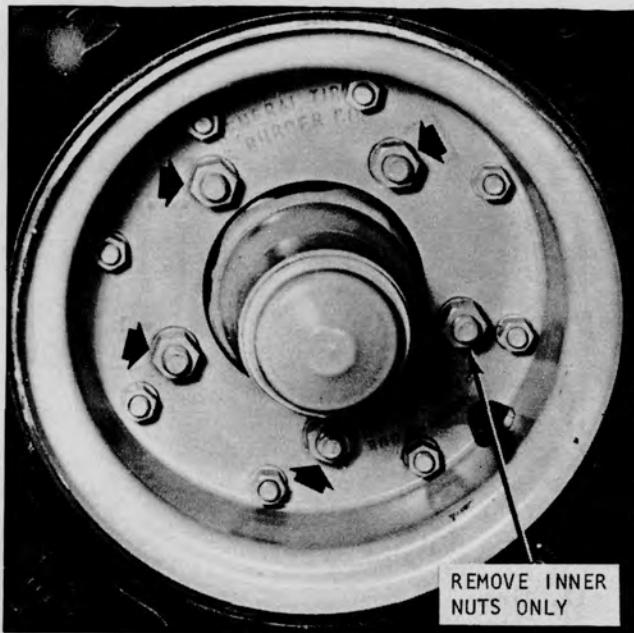


Plate 7425. Split Rim

### WARNING

IN ALL CASES, WHEN REMOVING TIRES WITH SPLIT RIMS FROM THE MACHINE FOR REPAIR OR PERIODIC ROTATION, COMPLETELY DEFLATE TIRES. THIS MAY BE ACCOMPLISHED BY REMOVING THE VALVE STEM CORE.

### WARNING

TO REMOVE WHEEL ASSEMBLY FROM THE VEHICLE, REMOVE THE INNER STUD NUTS (15) ONLY (SEE PLATE 9180 ON THE PREVIOUS PAGE, AND NOTE LOCATION OF INNER NUTS ON PLATE 7425 AT TOP OF PREVIOUS COLUMN). IF THE TIRE IS NOT DEFLATED, AND THE OUTER WHEEL STUD NUTS (11) ARE REMOVED PRIOR TO THE REMOVAL OF THE INNER WHEEL STUD NUTS, IT IS POSSIBLE FOR THE SPLIT RIMS TO SEPARATE WITH GREAT FORCE THAT COULD RESULT IN SERIOUS INJURY TO ANYONE STRUCK BY IT.

### WARNING

WHEN INFLATING TIRE, THE TIRE SHOULD NOT BE INFLATED WHILE IT IS "OFF" THE VEHICLE. CHECK FOR SECURITY OF ALL RIM RETAINMENT BOLTS AND WHEEL ATTACHING BOLTS BEFORE INFLATING TIRE. A CLIP-ON TYPE AIR CHUCK SHOULD BE USED SO THE OPERATOR CAN STAND TO ONE SIDE DURING TIRE INFLATION.



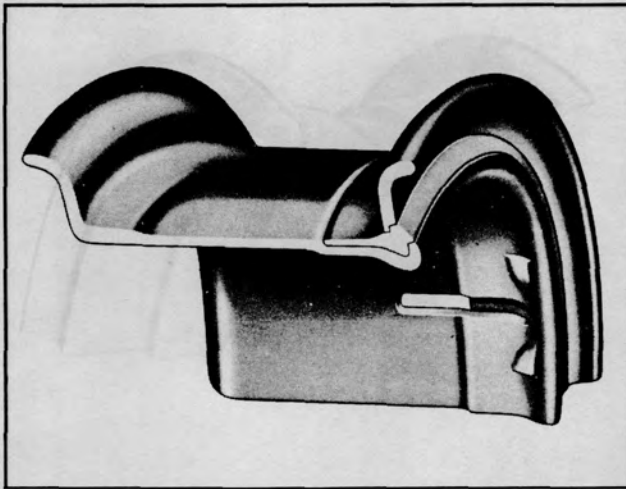


Plate 8918. 3 - Piece 5° Tube-Type Rim  
FOR CAST OR DISC WHEELS

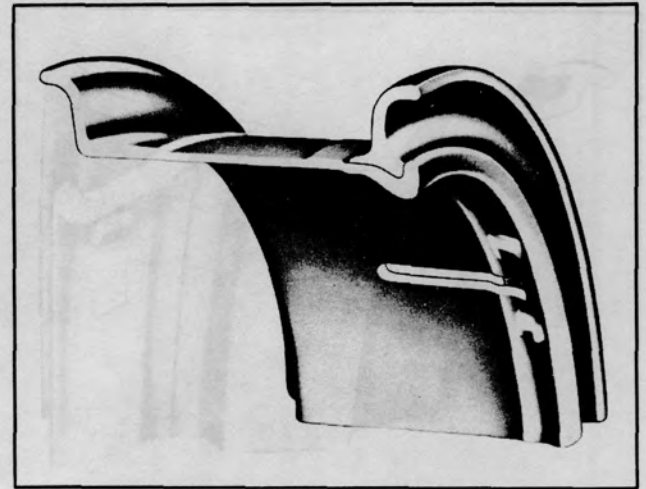


Plate 8919. 5° 2-Piece Rim for Tube-Type Tires  
FOR CAST OR DISC WHEELS

# MOUNTING MAINTENANCE, AND SAFETY PRECAUTIONS

FOR CAST OR DISC WHEELS

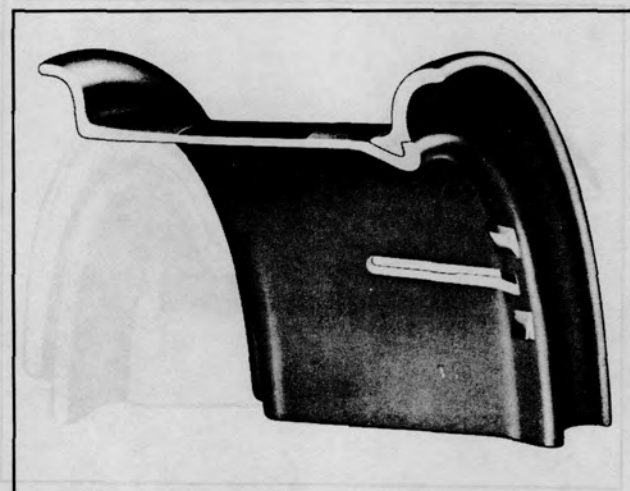


Plate 8920. 5° 2-Piece Rim for Tube-Type Tires

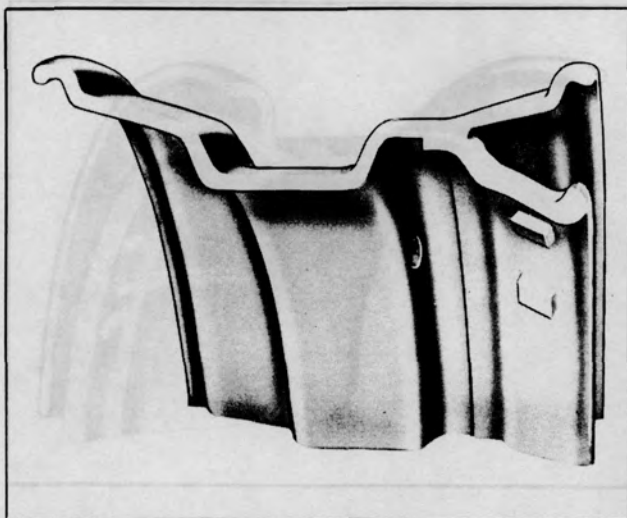


Plate 8921. 15° Drop-Center 1-Piece Rim for  
Tubeless Tires FOR CAST OR DISC WHEELS

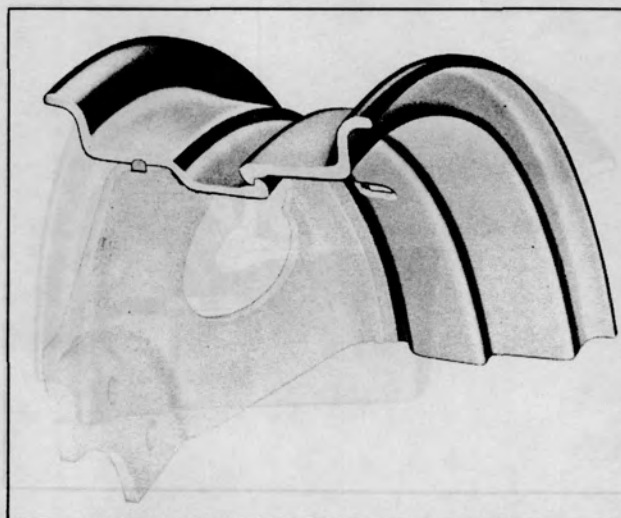


Plate 9001. 5° 2-Piece Rim for Tube-Type Tires  
FOR DISC WHEELS ONLY

# MOUNTING MAINTENANCE, AND SAFETY PRECAUTIONS

RHP FOR DISC WHEELS    RIP FOR CAST WHEELS

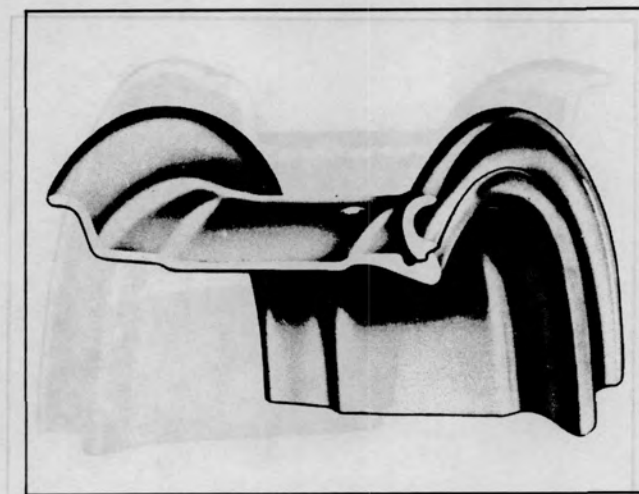


Plate 9002. Semi-Drop-Center, 2-Piece Rims for Tube-Type Tires

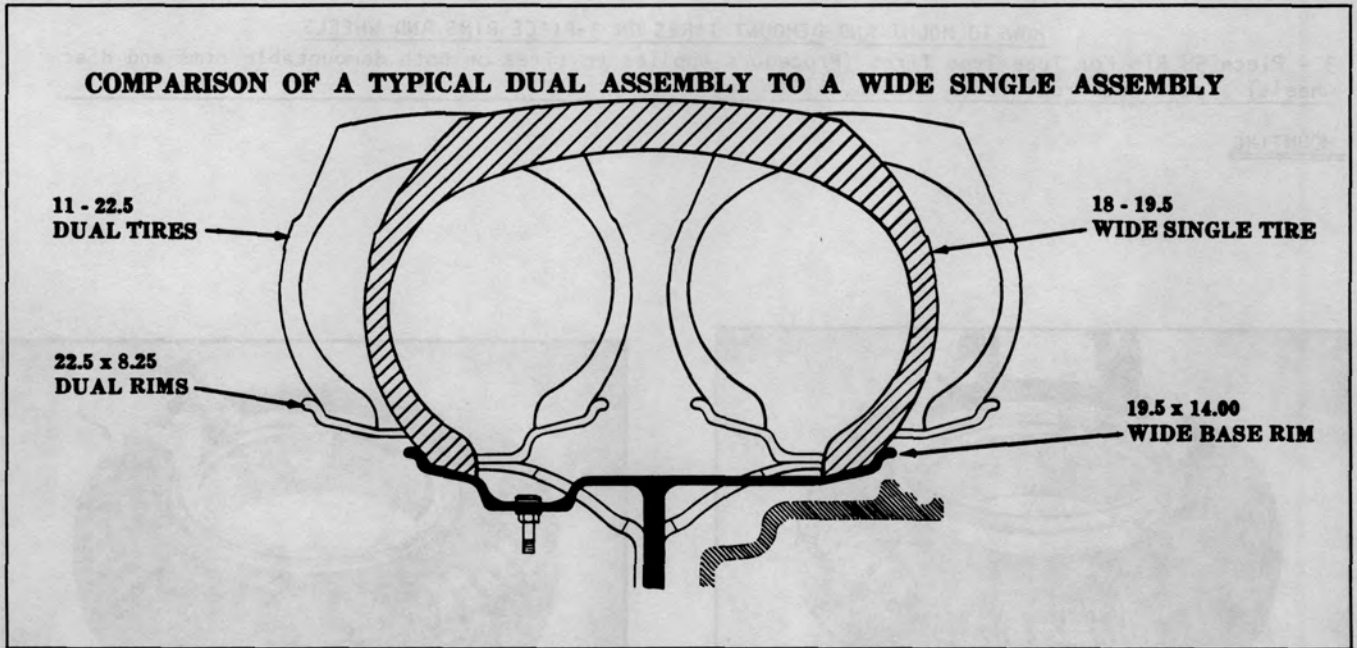


Plate 9005. Rims and Wheels for Wide Single Tires

The above drawing shows the cross-section of a single tire superimposed over dual tires. This illustrates the relationship of the wide

single assembly to a typical dual assembly where each have the same centerline.







DEMOUNTING

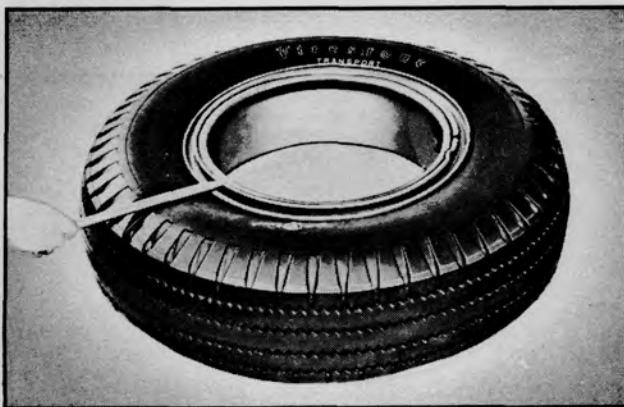


Plate 9009.

(1)  
Completely deflate tire by removing valve core or using deflator cap. Place tapered end of rim tool in depression in lock ring, or between rings, and press down on side ring to free bead. Continue downward pressure on side ring progressively around the tire until the bead is completely freed from the bead seat.



Plate 9010.

(2)  
To disengage lock ring from the gutter, insert rim tool in removing notch, near split in the ring, and move downward. If desired, a second similar tool may be used to facilitate removal.

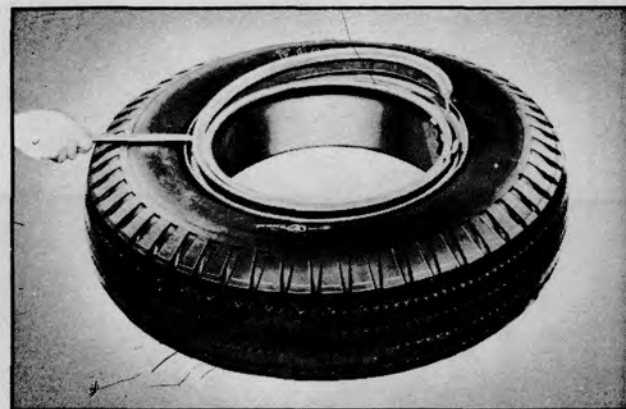


Plate 9011.

(3)  
Insert the rim tool between the lock ring and side ring and press downward to pry ring up. Move progressively around the rim until lock ring is free, then lift off lock and side rings. Turn assembly over, unseat tire bead, stand tire up and remove rim base.

WARNING

SAFETY PRECAUTIONS

1. USE ONLY PARTS FREE FROM DAMAGE OR HEAVY RUST.
2. INSURE THAT LOCK RING IS COMPLETELY SEATED BEFORE INFLATING TIRE. INFLATE TIRE IN SAFETY CAGE, OR USE CLIP-ON TYPE AIR CHUCK SO THAT OPERATOR WILL STAND ASIDE DURING INFLATION.
3. INSURE THAT TIRE IS COMPLETELY DEFLATED PRIOR TO REMOVAL OF RINGS.

HOW TO MOUNT AND DEMOUNT 2-PIECE RIMS AND WHEELS

2 - Piece 5<sup>0</sup> Rim For Tube Type Tires (Procedure applies to tires on both demountable rims and disc wheels) Tools Required: 1 Rim Tool, 1 Rim Tool (Hooked-end)

MOUNTING



Plate 9012.

(1)  
To fasten side ring, place foot at one end near the split and push down into place.

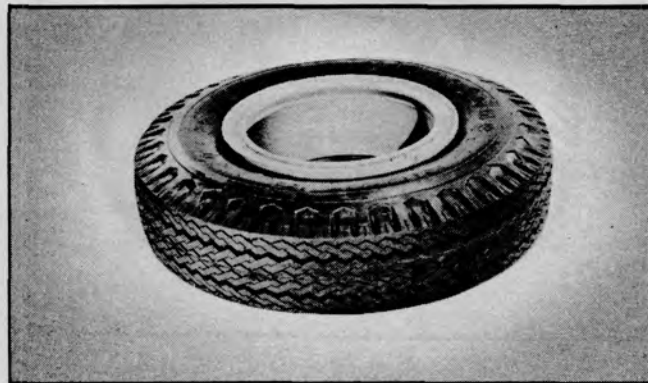


Plate 9014.

(3)  
Above illustration shows side ring fully engaged in rim gutter. Check seating of ring and inflate tire to recommended pressure.

DEMOUNTING



Plate 9013.

(2)  
Continue progressively around the rim "walking" the side ring firmly into place.



Plate 9015.

(1)  
Completely deflate tire, then with curved end of rim tool and hooked-end rim tool pry bead loose from side ring by downward pressure on rim tools.

CONTINUED ON FOLLOWING PAGE.



HOW TO MOUNT AND DEMOUNT 15° DROP-CENTER TUBELESS RIMS AND WHEELS

15° Drop-Center Tubeless Rims (Procedure applies to tires on both demountable rims and disc wheels)  
Tools Required: 2 Tubeless Tire Tools, 1 pair Vise-Grip Pliers, Lubricant and Brush (Rim Distributors can supply the proper compound that serves as a lubricant and rust preventive).

C A U T I O N

AVOID THE USE OF ANY LUBRICANT CONTAINING WATER, OR ANY SOLVENT INJURIOUS TO RUBBER.

MOUNTING



Plate 9018.

- (1) Be sure right valve is used and is properly installed in the rim. Inspect rim to insure bead seats are clean and smooth. Then place rim on floor with wide side down and lubricate first bead of tire and upper bead seat of rim.



Plate 9019.

- (2) Push first bead into well of rim and onto rim as far as possible. Using straight end of tool (with stop resting on rim flange) take small bites to work remaining section of first bead onto rim.







HOW TO MOUNT AND DEMOUNT 5° 2-PIECE RIMS FOR TUBE-TYPE TIRES

Rims. Tools Required: 1 Rim Mallet, 1 Rim Tool.

MOUNTING

(2)  
The two cutaway portions opposite each other in the inner diameter of the ring (points A) are placed so as to span the rim gutter. At point C, opposite valve, force half of ring into the gutter as far as possible using hand and rim mallet.

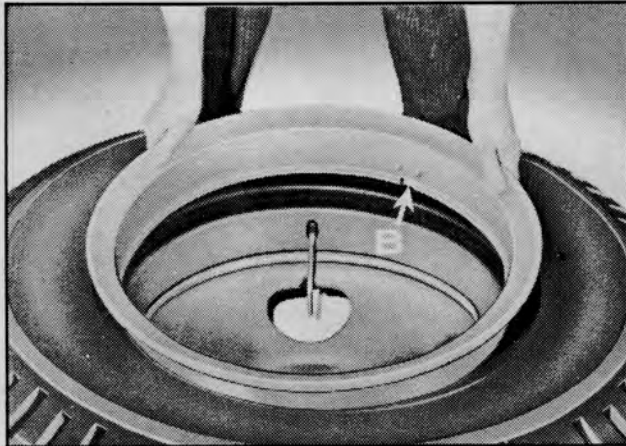


Plate 9024.

(1)  
Place disc portion of wheel on floor with rim gutter up. Apply tire with valve pointing in direction desired. Place side ring in position with operating notch located between two embossings (point B) approximately three inches from valve, on either side.

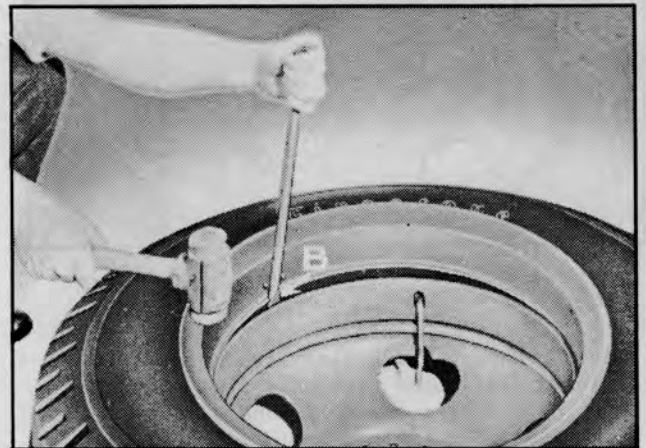


Plate 9026.

(3)  
Insert straight end of rim tool in operating notch (point B), then pull in direction indicated by arrow. Retain pressure with tool and strike ring downward with mallet at point between tool slot and cutaway portion, thereby engaging ring over rim gutter at that point. Remove tool and strike additional blows progressively toward other cutaway portion until entire toe of ring has passed over the rim gutter. Check seating of ring and inflate tire to recommended pressure.

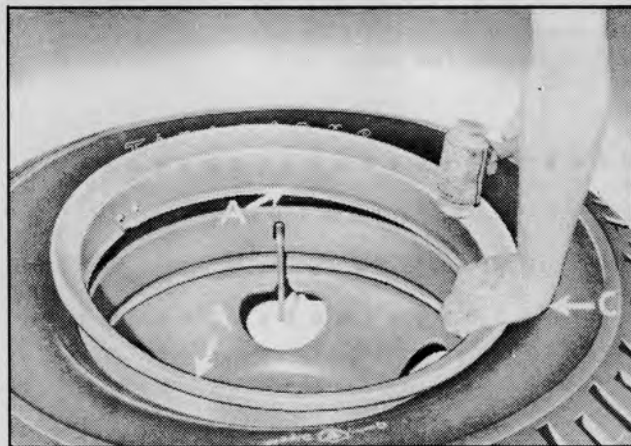


Plate 9025.

WARNING  
SAFETY PRECAUTIONS

1. USE ONLY PARTS FREE FROM DAMAGE OR HEAVY RUST.
2. INSURE THAT LOCK RING IS COMPLETELY SEATED BEFORE INFLATING TIRE. INFLATE TIRE IN SAFETY CAGE, OR USE CLIP-ON TYPE AIR CHUCK SO THAT OPERATOR SHOULD STAND ASIDE DURING INFLATION.
3. INSURE THAT TIRE IS COMPLETELY DEFLATED PRIOR TO REMOVAL OF RINGS.









HOW TO MOUNT AND DEMOUNT 2-PIECE RIMS FOR TUBE-TYPE TIRES

(Procedure applies to Demountable Rims and Disc Wheels) Tools Required: 2 Rim Tools, 1 Rim Mallet, 1 Tire Tool (Thin End).

MOUNTING

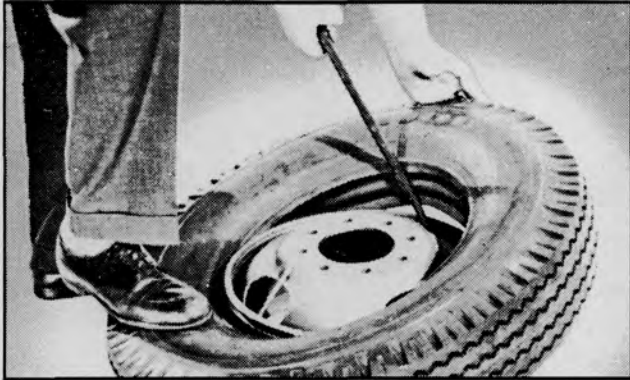


Plate 9031.

(1) Place tire on rim so that valve is in line with valve hole and insert valve through valve hole. Force first bead down into well of rim just to side of valve with foot. Mount first bead over rim gutter with rim tool progressing from each side of foot to point approximately opposite foot.

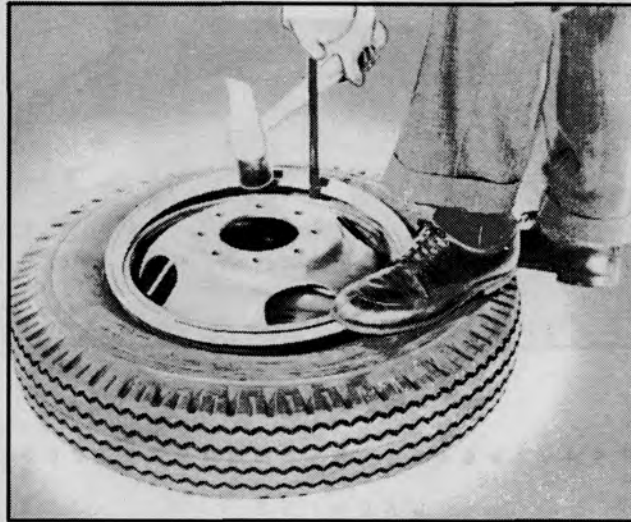


Plate 9033.

(3) Place half of side ring in rim gutter with cut-away portions in position as shown. Insert thin end of rim tool or heavy screw driver and pull ring outward toward centered position. Strike with mallet, forcing ring into gutter.

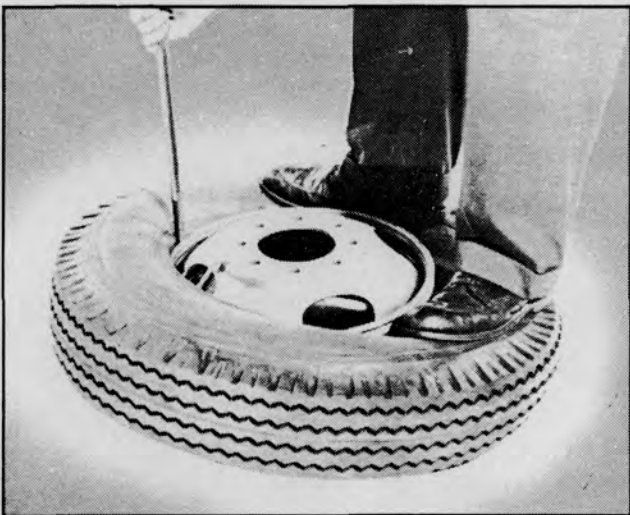


Plate 9032.

(2) To apply second bead, start at point opposite valve and press bead toe over rim gutter and into rim well with foot pressure. Mount remainder of bead over rim gutter by means of thin tire tool, being careful not to pinch tube.





DEMOUNTING (Continued)

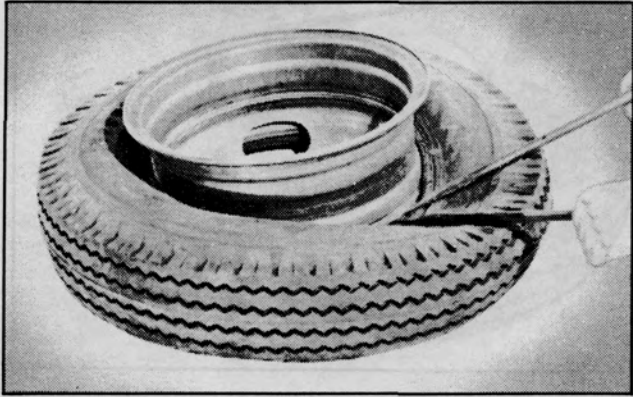
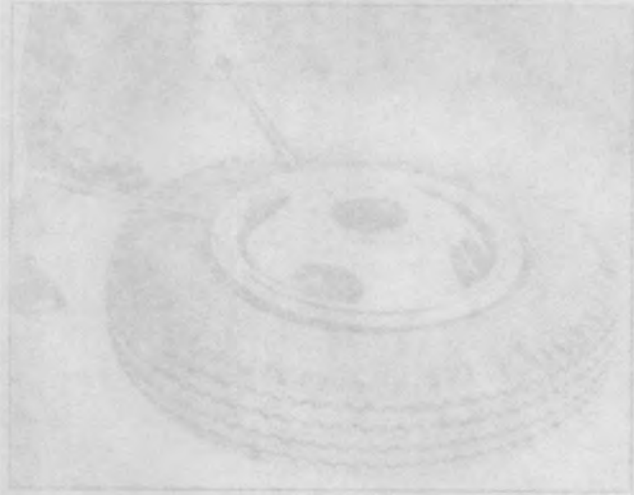


Plate 9037.

(4) Turn tire over and by means of rim tools, loosen bead on opposite bead seat. This can be further aided by using foot pressure.

Make sure one portion of second bead is still in the rim well, then pry opposite portion of bead over edge of rim. This will free the tire from the rim.





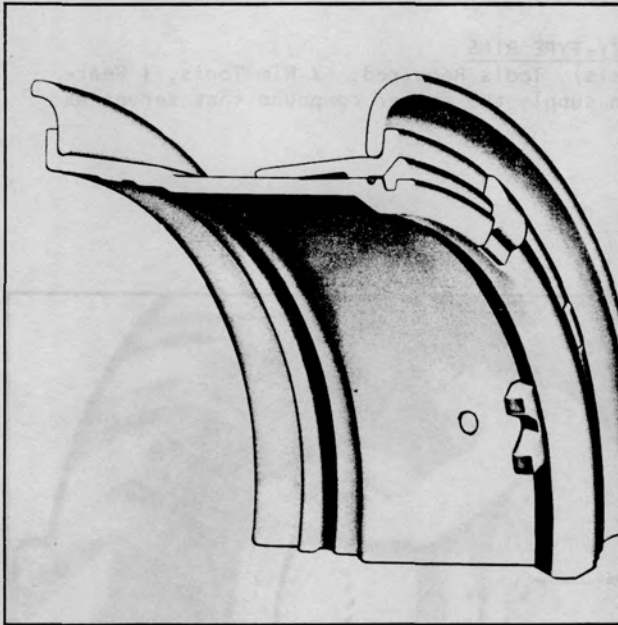


Plate 9003. Heavy-Duty Rims for Earth Mover Tires (Typical)

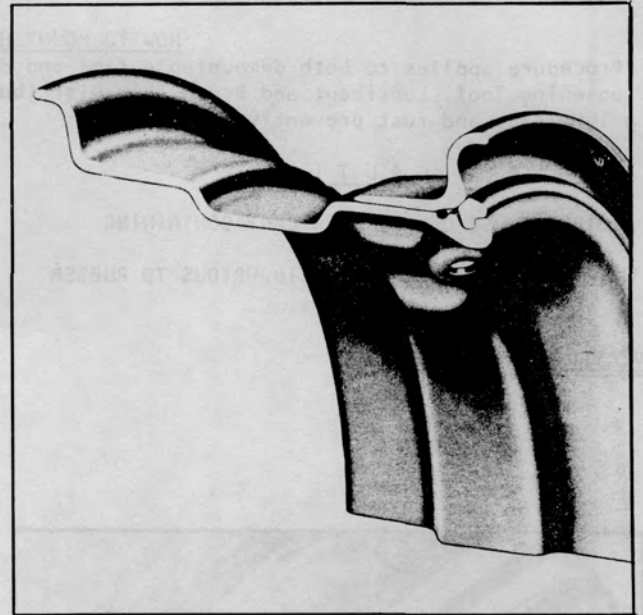


Plate 9004. Heavy-Duty Rims for Motor Grader and Construction Vehicle Tires (Typical)

**MOUNTING  
MAINTENANCE,  
AND  
SAFETY  
PRECAUTIONS**

HOW TO MOUNT HEAVY DUTY-TYPE RIMS

(Procedure applies to both demountable rims and disc wheels). Tools Required: 2 Rim Tools, 1 Bear-loosening Tool, Lubricant and Brush (Rim Distributors can supply the proper compound that serves as a lubricant and rust preventive.)

CAUTION

AVOID THE USE OF ANY LUBRICANT CONTAINING WATER OR SOLVENT WHICH IS INJURIOUS TO RUBBER

VERTICAL MOUNTING



Plate 9038.

(1)  
Place back rim flange over rim base making sure the drive lug properly engages the slot in the rim base. Put the tire on the rim base.

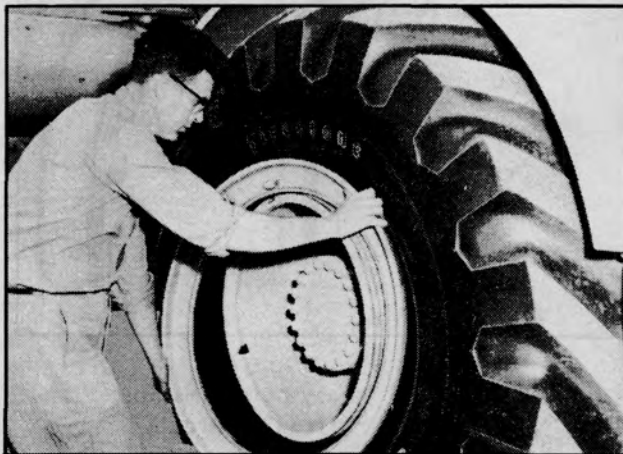


Plate 9039.

(2)  
Force tire back on base as far as possible. Place front rim flange in position. Align flange drive lug in approximate line with lock ring driver pocket on the rim base.

CONTINUED ON FOLLOWING PAGE.

VERTICAL MOUNTING (Continued)

necessary to move any of the parts, use only lead or brass hammer.

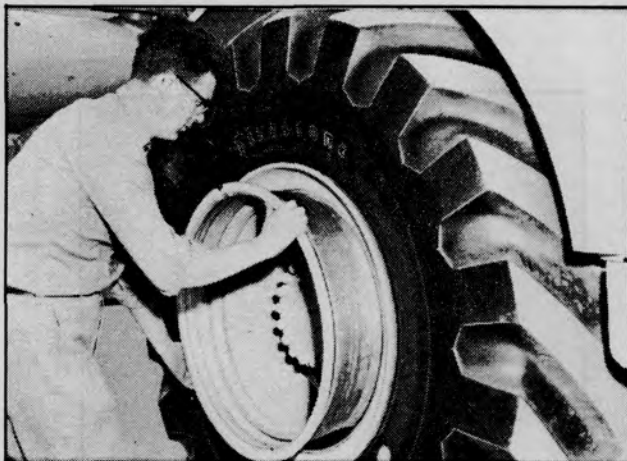


Plate 9040.

(3)

Place bead seat band in position over rim base. Use rim tools to force bead seat band as far back as possible. Fit slot in bead seat band over flange drive lug. Line up lock ring driver pockets on bead seat band and rim base.



Plate 9042.

(5)

Place the lock ring in gutter in rim base and make sure the lock ring driver engages in the pockets in the bead seat band and rim base. Rim tools will facilitate final seating of lock ring as shown.

CONTINUED ON FOLLOWING PAGE.

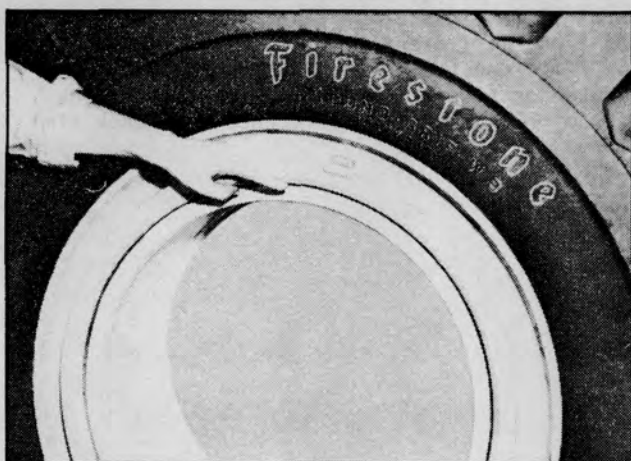


Plate 9041.

(4)

Be sure that all drive lugs and slots line up properly: (1) Flange drive lug with its slot in bead seat band; (2) Lock ring driver pocket on bead seat band with that on rim base. If

VERTICAL MOUNTING (Continued)



Plate 9043.

- (6) Lubricate "O" ring gasket with tire mounting lubricant and place in proper groove in rim base. Lubricate adjacent area so that "O" ring will not be forced out of groove when bead seat band moves out into position. Inflate tire.

**N O T E**

"O" ring not required for tube-type tire.

HORIZONTAL MOUNTING

Horizontal mounting follows the same procedure as described for vertical mounting with the following additional Steps:

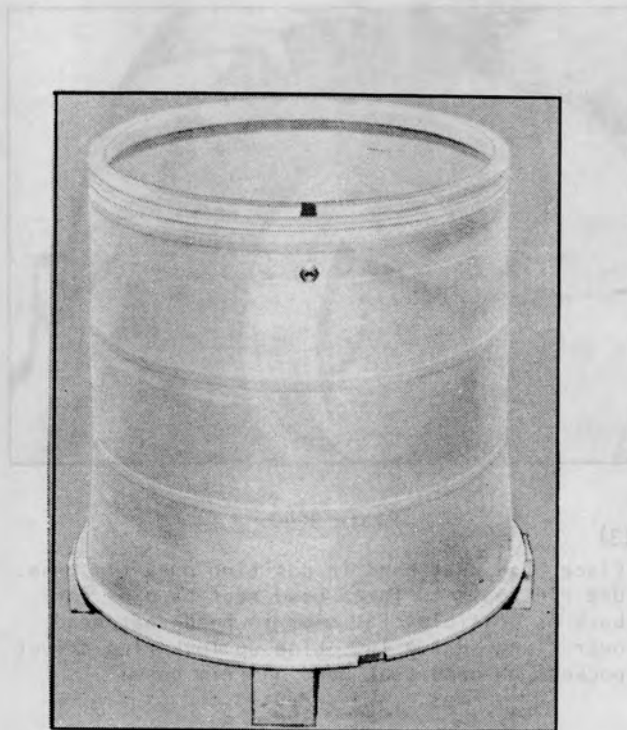


Plate 9044.

- (1) Prior to mounting, lay rim base on wood or metal blocks, gutter side up. Rim should be off floor sufficiently for the tire to rest on the rim without touching the floor. Blocks should not extend more than 1/2 inch beyond the edge of rim base or interference with back rim flange will result.

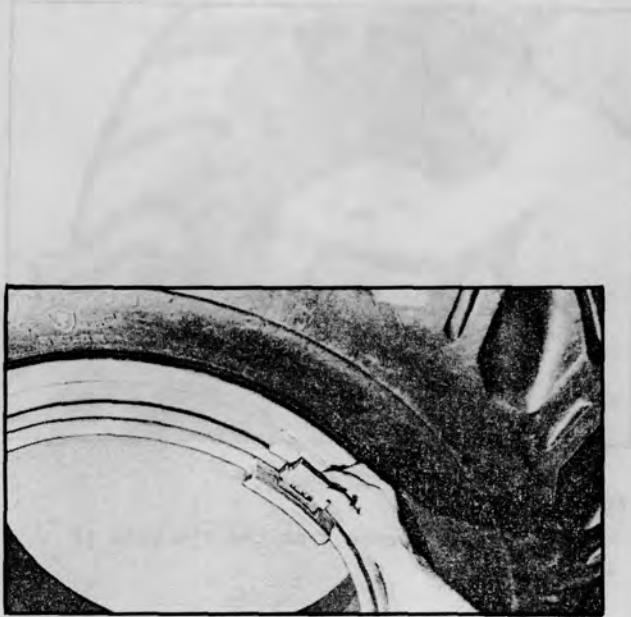


(2) To seat the tire, use a tire mounting tool to push the bead into the groove. (3) Check the tire for proper inflation. (4) Lock the tire in place with the lock ring. (5) Check the tire for proper inflation.



HOW TO MOUNT HEAVY-DUTY OUTBOARD DRIVERS

Parts Required: 2 Brackets attached to rim base and bead seat band. 1 Key.

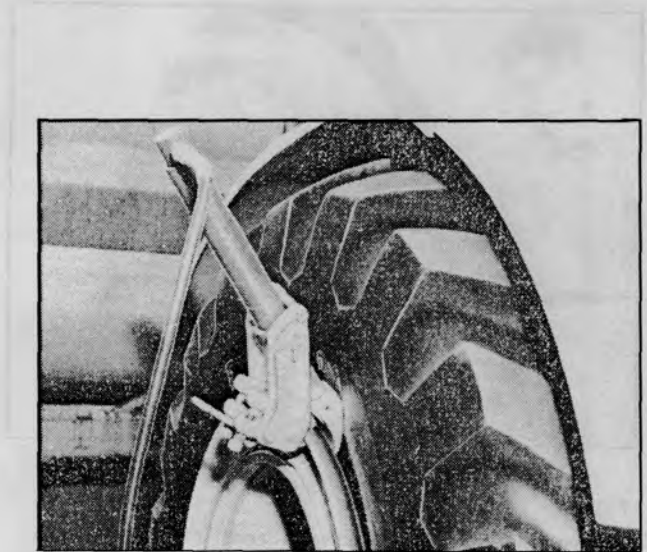


- (1) **Plate 9045.**  
Before inflating tire align brackets of rim base and bead seat band and insert key into base bracket.



- (2) **Plate 9046.**  
Recheck alignment of parts and inflate tire to desired pressure. Bead seat bracket will move outward and lock key in place.

HOW TO DEMOUNT HEAVY-DUTY RIMS



- (1) **Plate 9047.**  
After deflating, loosen the tire bead on the gutter side of the rim, using approved tools and procedure. Exercise caution to avoid damage to tire beads.



- (2) **Plate 9048.**  
Use rim tools to remove the lock ring as shown above. Bead seat band may require pushing back toward tire to remove lock ring.

CONTINUED ON FOLLOWING PAGE.

DEMOUNTING HEAVY-DUTY RIMS (continued)



Plate 9049.

(3)  
Remove the "0" ring gasket from its groove. Do not re-use this "0" ring gasket.

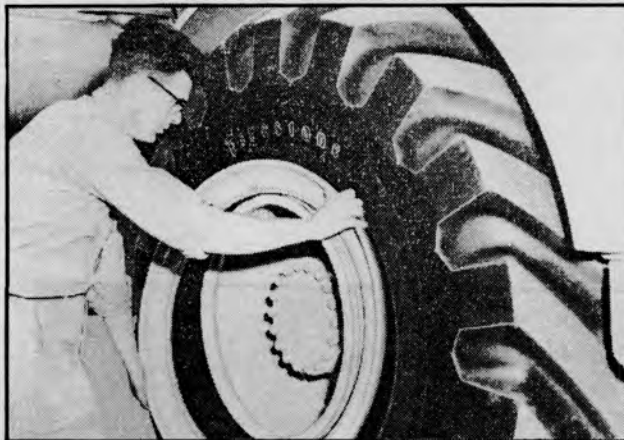


Plate 9051.

(5)  
Remove the rim flange from the rim base as shown above.



Plate 9050.

(4)  
Remove the bead seat band.

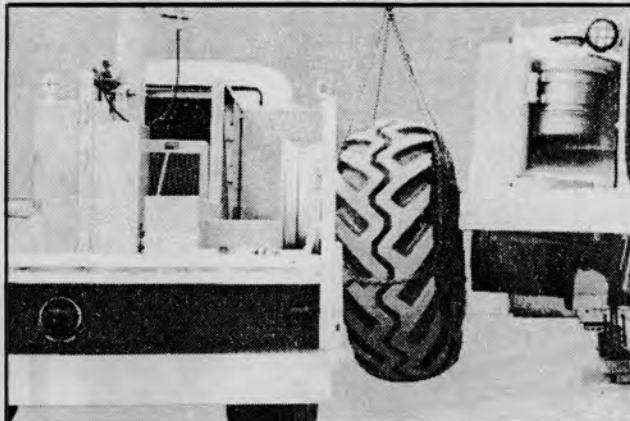


Plate 9052.

(6)  
Loosen the tire bead on the back flange side using approved tools and procedure and remove the tire from the rim base.

WARNING SAFETY PRECAUTIONS

- 1. Insure that all parts are free from damage and heavy rust, especially in gutter and "0" ring groove areas prior to mounting.
- 2. Use new rubber "0" ring with each mounting. Insure that all components parts are

- properly aligned and seated prior to inflation of tire.
- 3. Use clip-on type air chuck so that operator may stand aside during inflation.
- 4. Remove valve core to insure that tire is completely deflated, prior to demounting.

HOW TO MOUNT AND DEMOUNT HEAVY-DUTY RIMS

(Procedure applies to both demountable rims and disc wheels.) Tools Required: 1 bead-loosening tool, 2 Rim tools, Lubricant and brush (Rim Distributors can supply the compound that serves as a lubricant and rust preventive.)

C A U T I O N

AVOID THE USE OF THE LUBRICANT CONTAINING WATER OR SOLVENT WHICH IS INJURIOUS TO RUBBER.

MOUNTING



Plate 9053.

(1)  
Place tire on rim base. Support rim base with wood blocks so that tire clears floor.



Plate 9054.

(2)  
Apply flange ring over rim gutter.

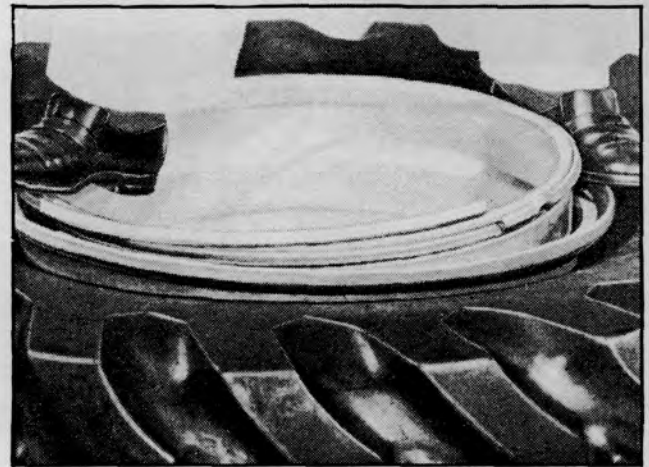


Plate 9055.

(3)  
Place end of split lock ring in gutter with hump of tool slot pointing upward. Snap the ring in place with foot.

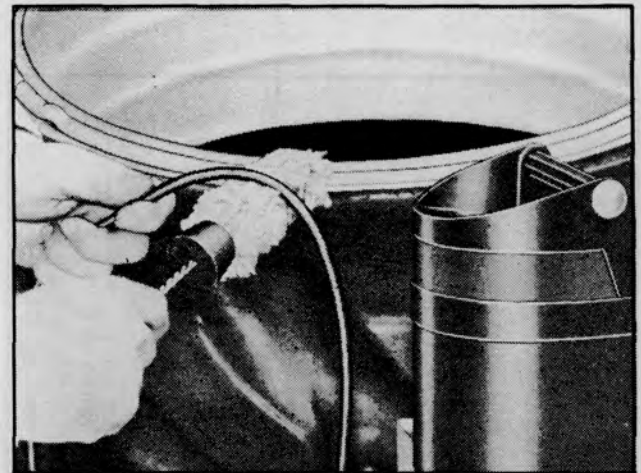


Plate 9056.

(4)  
Lubricate "O" ring gasket with tire-mounting lubricant.

N O T E

"O" ring is not required for tube-type tires.

CONTINUED ON FOLLOWING PAGE.







HOW TO PROPERLY INSTALL RIMS AND WHEELS

Proper installation of rims and wheels on a vehicle is essential to safe, economical, trouble-free service. Use only the specified sizes of studs, nuts and clamps.

RECOMMENDED INSTALLATION PROCEDURE

DEMOUNTABLE RIMS

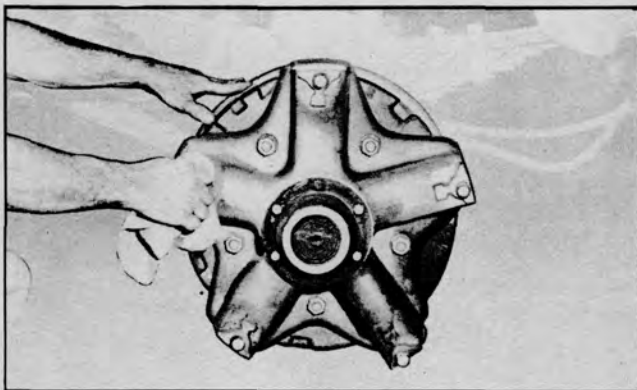


Plate 9060.

Make sure that all parts, including rims, rings, spacer bands and cast wheel studs are free from damage, dirt or rust. Replace any defective parts.

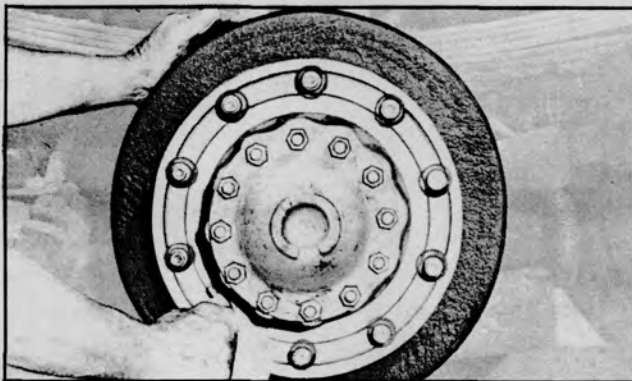


Plate 9061.

Place rims and spacer band on wheel. Secure clamps evenly in position and draw up nuts alternately in the sequence shown in Plate 9062. Do not tighten them fully, however. This procedure will permit the inside rim to properly align itself on the 28° mounting bevel on the back of the cast wheel, thus avoiding damaging wheel wobble.

Then, tighten nuts fully, using same alternate sequence. Be sure to tighten these nuts only to the torque level recommended in Specifications, and to maintain them at that level through planned, periodic checks (see Rim and Wheel Maintenance Procedure on the following pages.)

CAUTION

INSUFFICIENT MOUNTING TORQUE CAN CAUSE RIM SLIPPAGE, RESULTING IN BROKEN VALVES, WORN PARTS AND DAMAGED TIRES. EXCESSIVE MOUNTING TORQUE CAN CAUSE DAMAGE BY STRIPPING STUDS, COLLAPSING SPACER BANDS OR FORCING RIMS INTO AN OUT-OF-ROUND CONDITION.

Wrenches for Demountable Rims and Disc Wheels: Double-end socket wrenches normally are adequate to install and remove all rims and wheels, when used with a 3-foot bar. A 150-pound man, exerting his entire weight, 2.5 feet out on a bar, can apply 375 foot-pounds of torque to a wrench (150 x 2.5). Air wrenches however, sometimes are used to save time and labor. The torque they deliver depends on the air line pressure from which they operate. Periodic checks by torque wrench, or other means, should be made to insure accuracy of these air wrenches.

DISC WHEELS

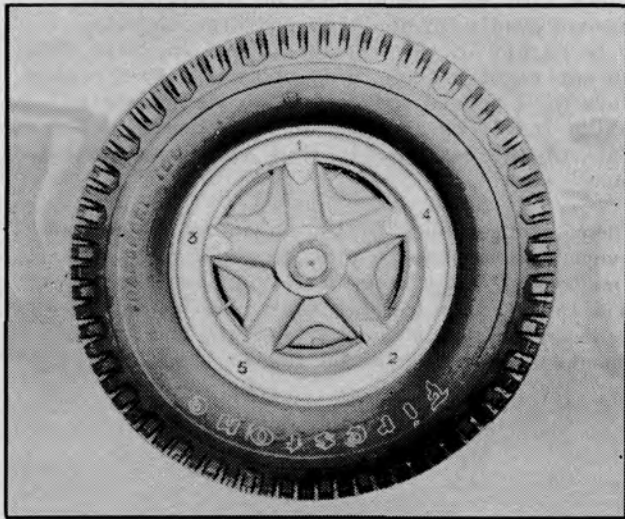


Plate 9062.

Check all parts for damage, including wheels and rings. Insure that studs, nuts and mounting faces of hub and wheels are clean and free from grease. Replace any defective parts.

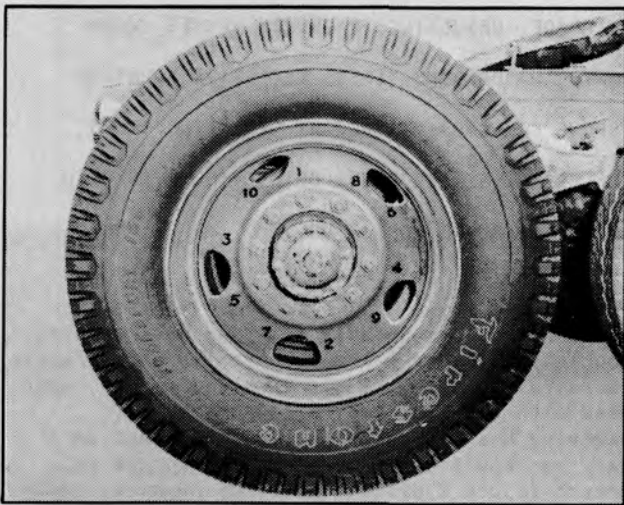


Plate 9063.

Mount single wheel or inner dual wheel (also, outer dual wheel for hub-type mounting) over studs, being careful not to damage stud threads. Draw up nuts alternately in the sequence shown in Plate 9063. Do not tighten them fully, however. This procedure will permit the uniform seating of nuts and insure the even, face-to-face contact of wheels and hub.

Tighten nuts fully, using the same alternate sequence. Mount the outer wheel (for double cap mounting) and repeat the entire procedure. In each case, be sure to tighten wheel nuts only to the torque level recommended in Specifications, and to maintain them at that level through planned, periodic checks (see Rim and Wheel Maintenance Procedure).

NOTE

When inner cap nuts are re-tightened, be sure first to loosen outer cap nuts several turns; then, re-tighten them.



CAUTION

INSUFFICIENT MOUNTING TORQUE CAN CAUSE WHEEL SHIMMY, RESULTING IN DAMAGE TO PARTS AND EXTREME TIRE TREAD WEAR. EXCESSIVE MOUNTING TORQUE CAN CAUSE STUDS TO BREAK AND DISC TO CRACK IN THE STUD HOLE AREA.







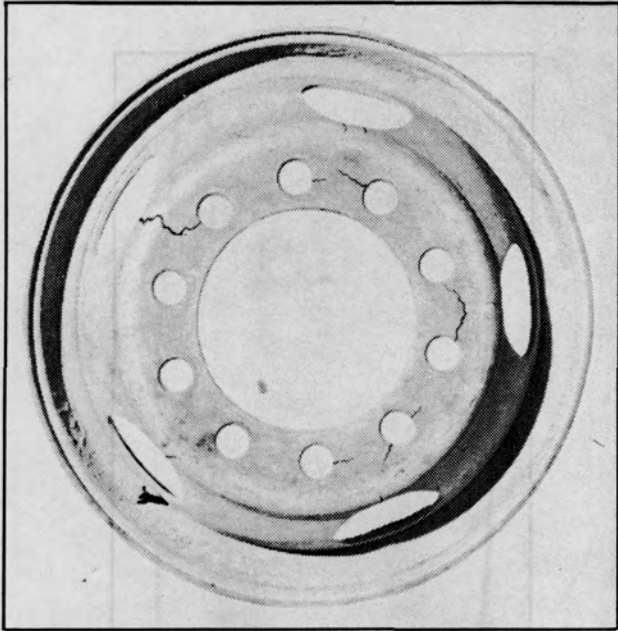


Plate 9065.

Cracks in the wheel disc, between stud holes or hand holes. These are caused by loose wheel nuts, improper installation procedures and use of incorrect sizes or types of attaching parts.

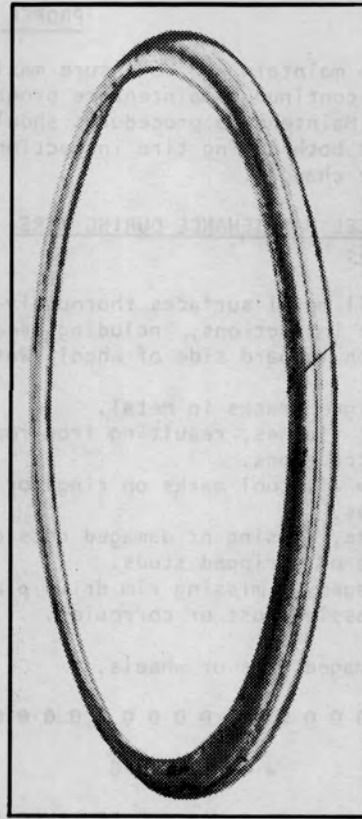


Plate 9066.

Cracks through side ring, spreading laterally through the entire section. These are caused by improper mounting and demounting techniques, impact with road obstructions, and excessive clamping torques.



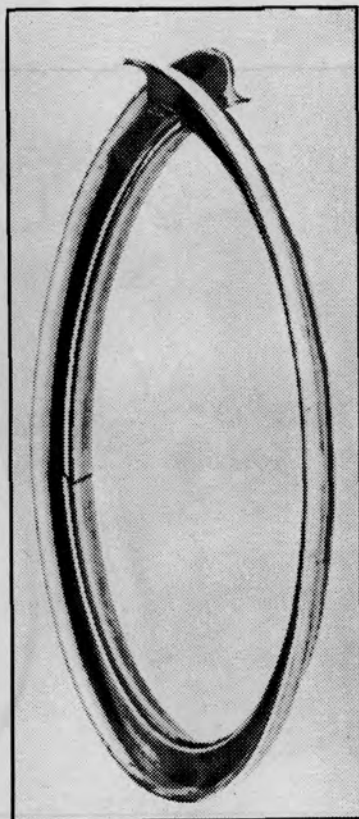


Plate 9067.

Sprung side ring, resulting from improper mounting and demounting procedures.

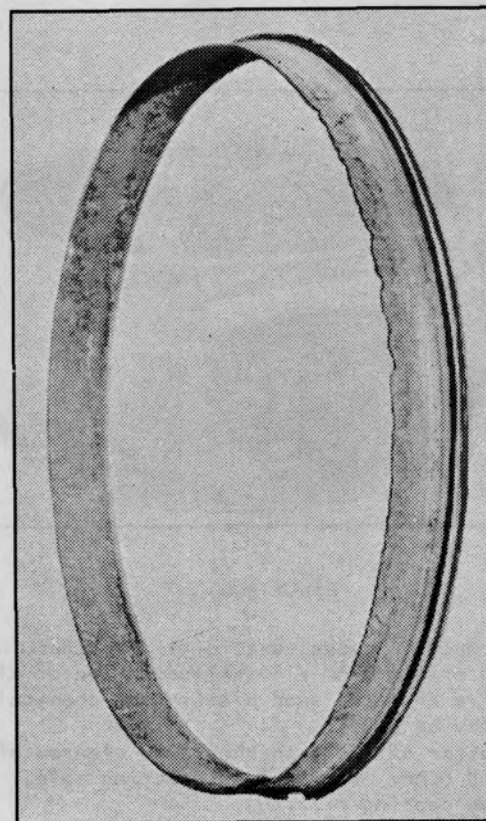


Plate 9068.

Erosion and chipping of bead seat of lock ring, resulting from excessive corrosion. This may occur with this part as well as others if protective measures described on following page are not taken.

2. Replace damaged parts.

**W A R N I N G**

INSURE THAT REPLACEMENTS ARE MADE WITH THE PROPER SIZES AND TYPES OF RIMS AND RINGS.



Plate 9069.

3. Thoroughly remove rust, dirt and other foreign materials from all surfaces. Hand or electric wire brushes, sand blasting or chemical baths may be used.

Gutter of rim base should be cleared of rust and other materials obstructing safe, positive seating of rings.

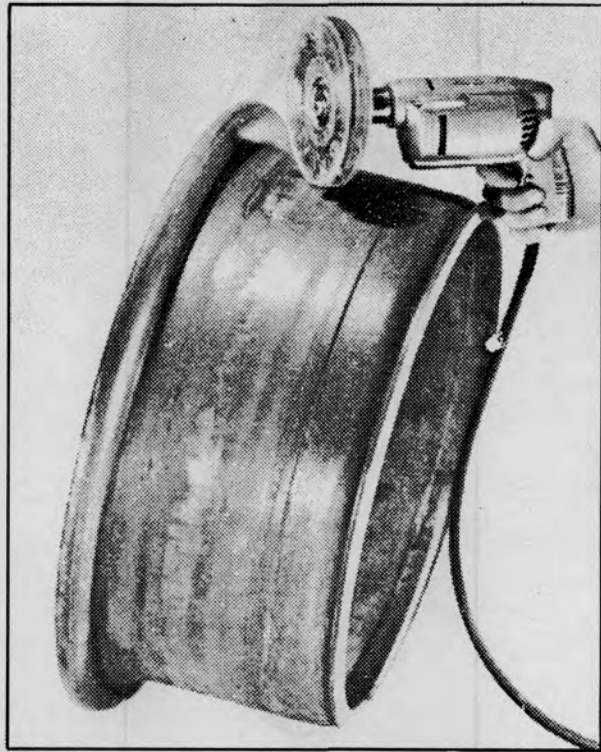


Plate 9070.

Bead seat areas of rim should be free of rust and rubber deposits. This is especially important for drop-center tubeless rims, because the 15° bead seat is the air-sealing element.

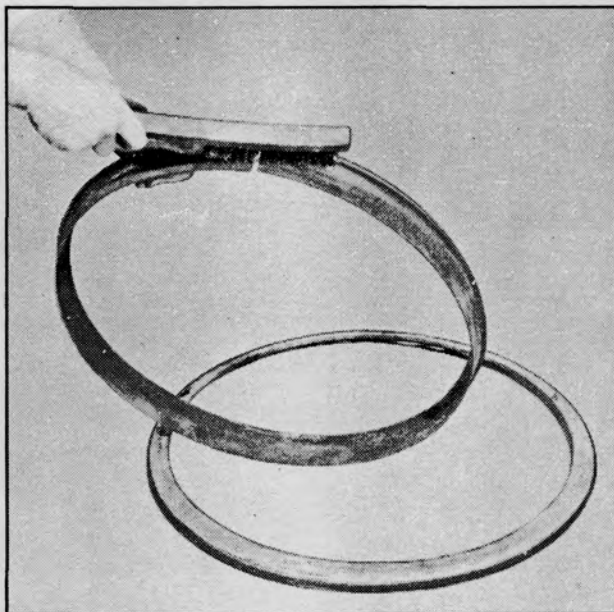


Plate 9071.

Rings should be cleaned with wire brush. Pay particular attention to seating surfaces and bead seat areas.

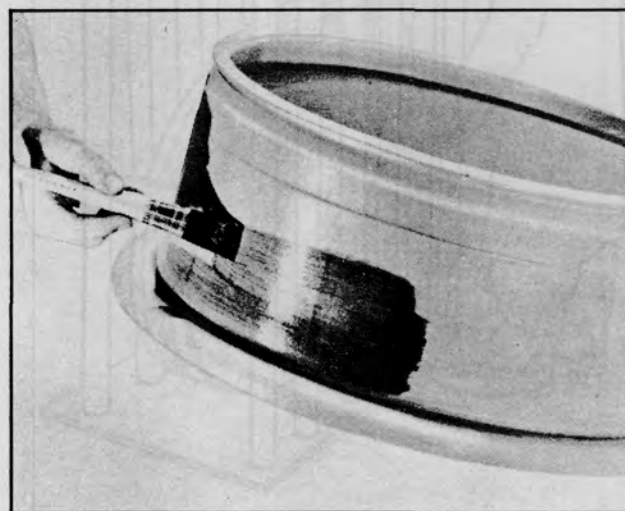


Plate 9073.

5. Lubricate tire side of rim base just prior to mounting tire. Avoid the use of any lubricant which contains water or solvent that is injurious to rubber. A combination lubricant and rust-preventive compound is preferable. This protective measure is of particular importance with drop-center tubeless rims as the air in the tire is contained by the tire-side rim surface.



Plate 9072.

4. Paint rim by brush or spray with a fast-drying metal primer. Surfaces should be clean and dry prior to painting. Insure that bare metal areas on outside or tire side of rim are covered. This is especially important on drop-center tubeless rims, because warm and sometimes moist air is in constant contact with the metal surface on the tire side of the rim.







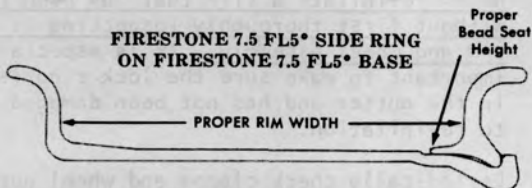
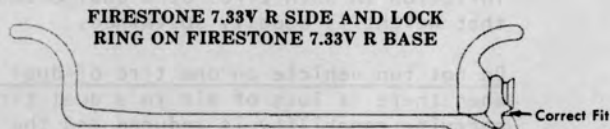
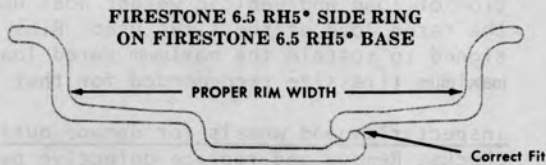
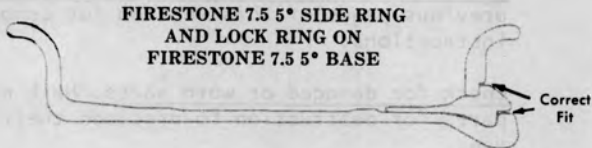
HOW TO INSURE GREATER SAFETY AND SERVICE  
BY PROPERLY MATCHING SIDE AND LOCK RINGS

It is important to recognize that the various types of highway rims produced by their manufacturers all differ to some degree in design. This is particularly true of removable rings and, as a result, side and lock rings of different rim types are not interchangeable. Some may appear to be, but they actually do not fit

properly on the rim base. Serious accidents to personnel have resulted from the use of mismatched rings.

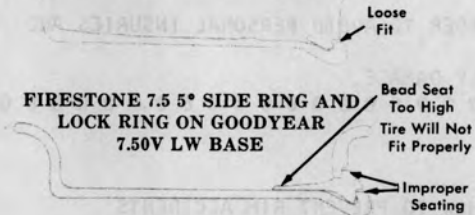
The drawings below illustrate the potentially dangerous conditions which can result from the mismatching of rings and bases.

**CORRECT**



**INCORRECT**

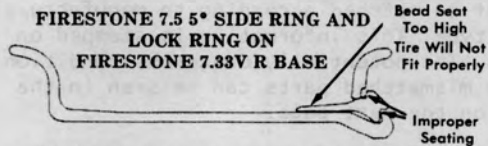
**GOODYEAR 7.50V LW SIDE RING ON FIRESTONE 7.5 5° BASE**



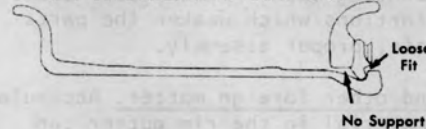
**FIRESTONE 6.0 RH5° SIDE RING ON FIRESTONE 6.5 RH5° BASE**



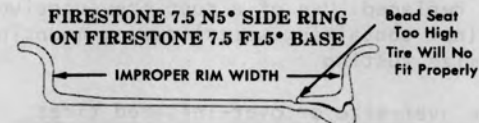
**FIRESTONE 7.5 5° SIDE RING AND LOCK RING ON FIRESTONE 7.33V R BASE**



**FIRESTONE 7.33V R SIDE AND LOCK RING ON FIRESTONE 7.5 5° BASE**



**FIRESTONE 7.5 N5° SIDE RING ON FIRESTONE 7.5 FL5° BASE**



SIDE RINGS, LOCK RINGS AND MOUNTING RINGS  
FOR RIMS AND WHEELS

FOR 5° COMMANDER RIM



Size	Side Ring Part No.	Wt. Lbs.	Lock Ring Part No.	Wt. Lbs.
17x 5.0	Typical	3.5	Typical	5.5
20x 5.0		5.0		7.0
15x 5.5	For illustrative purposes only.	3.8	For illustrative purposes only.	5.0
17x 5.5		4.8		5.5
20x 5.5		5.0		7.0
15x 6.0		4.5		6.0
20x 6.0		5.7		7.8
15x 6.5		5.7		6.0
18x 6.5		6.7		7.0
20x 6.5		7.3		7.7
24x 6.5		8.7		9.5
15x 7.0		7.0		7.2
18x 7.0		8.2		9.0
20x 7.0		9.5		10.0
15x 7.5		8.3		7.2
18x 7.5		9.7		9.0
20x 7.5	10.5	10.0		
22x 7.5	11.7	10.5		
24x 7.5	12.0	11.5		
20x 8.0	12.0	10.0		
22x 8.0	13.0	10.5		
24x 8.0	14.0	11.5		
19x 8.5	14.0	10.5		
20x 8.5	15.0	11.0		
24x 8.5	17.0	13.0		
20x10.0	17.8	17.3		
24x10.0	20.2	20.0		

†Not currently in production.

FOR FL-5° CHALLENGER RIM



Size	Side Ring Part No.	Wt. Lbs.
20x6.0		11.2
20x6.5		12.6
20x7.0		12.6
20x7.5		14.0
22x7.5		15.5

FOR RH-5° RIM



Size	Side Ring Part No.	Wt. Lbs.
18x5.0		10.5
20x5.0		11.5
17x5.5		12.0
17x6.0		14.0
20x6.0		16.5
20x6.5		19.0

FOR N-5° CHALLENGER RIM



Size	Side Ring Part No.	Wt. Lbs.
20x7.5		15.5
22x7.5		17.0

FOR RHP AND RIP RIMS



Size	Side Ring Part No.	Wt. Lbs.
13x5.50	Typical, for illustrative purposes only.	3.0
14x5.50		3.0
15x5.50		3.5
16x5.50		4.0
20x5.50		4.7
13x6.00		4.0
15x6.00		4.7
16x6.00		5.0

FOR R RIM (OBSOLETE)



Size	Side Ring Part No.	Wt. Lbs.
15x5.00S	Typical For illustrative purposes only.	10.3
20x5.00S		16.3
18x6.00T		15.0
20x6.00T		16.3
22x6.00T		18.5
24x6.00T		20.0
15x7.33V		17.3
20x7.33		24.5
22x7.33		26.9
24x7.33		29.3
19x8.37V		23.5
20x8.37V		24.5
22x8.37V	26.9	
24x8.37V	29.3	

MOUNTING RINGS  
(for V-Belt Drive Applications)



Size (Dia.)	Mtg. Ring Part No.	Wt. Lbs.
20"	Typical	16.0
22"		17.7



RINGS AND ACCESSORIES  
FOR EARTH MOVER RIMS AND WHEELS

**EMT SIDE RINGS**



EMT Side Ring

Size	Side Ring Part No.	Wt. Lbs.
25x2"		29.4
25x2½"	Typical, for illustrative purposes only.	50.0
25x3"		63.2
25x3½"		76.8
29x3"		71.9
29x3½"		87.3
33x2½"		66.0
33x4"		132.1
33x4½"		153.7
35x3"		94.0
35x3½"		115.0
39x4"	152.0	
49x2½"	92.5	

Rim assembly requires two interchangeable side rings.

**EMT LOCK RINGS**



EMT Lock Ring (with standard driver)

Size (Dia.)	Lock Ring *Part No.	Wt. Lbs.
25"	Typical, for illustrative purposes only.	12.8
25"		12.1
29"		14.7
29"		14.0
33"		16.9
33"		16.2
35"		15.6
39"		17.6
49"		25.3

\*\*"L" suffix indicates standard driver omitted for use with heavy-duty driver.

**EMT BEAD SEAT BANDS**

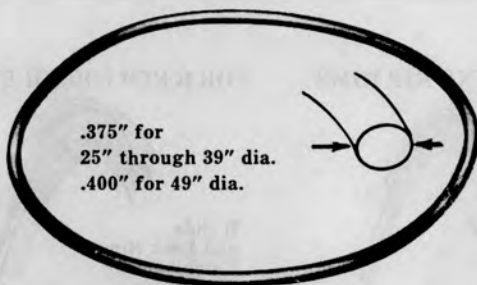


EMT Bead Seat Band (with notch for standard driver)

Size	Bead Seat *Part No.	Wt. Lbs.
25x4"		58.9
25x5"	Typical, for illustrative purposes only.	66.4
25x5"		67.8
29x5"		78.0
29x5"		79.4
33x4"		80.4
33x5"		87.6
33x5"		89.0
35x4"		103.4
35x5"		98.0
39x5"		108.6
49x4"	123.4	

\*\*"L" suffix indicates ring with welded bracket for use with heavy-duty driver.

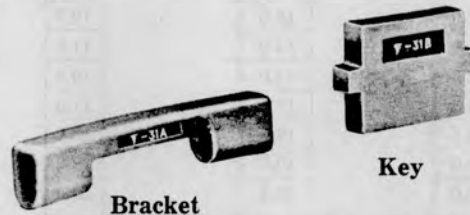
**EMT "O" RINGS**



EMT "O" Ring (Rubber Gasket)

Size	"O" Ring Part No.	Wt. Lbs.
25"	Typical	.4
29"		.5
33"		.5
35"		.5
39"		.6
49"		.8

**EMT HEAVY-DUTY DRIVER ASSEMBLY**



Bracket

Key

Heavy-Duty Driver

Rim Type	Bracket Part No.	Wt. Lbs.	Key Part No.	Wt. Lbs.
EMTL	Typical	1.4	Typical	1.0
EMTC		1.4		1.2
EMTCC		1.4		1.7

Assembly requires two brackets (1 each for Base and Bead Seat Band) and one key.



RINGS AND ACCESSORIES FOR MOTOR GRADER -  
CONSTRUCTION VEHICLE, COMPACTOR RIMS AND WHEELS

**T-5° SIDE RINGS**



T-5°  
Side Ring

Size	Side Ring Part No.	Wt. Lbs.
24x 8.00	Typical	18.8
24x10.00		41.7

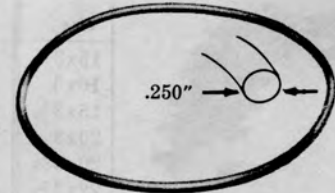
**T-5° LOCK RINGS**



T-5°  
Lock Ring

Size	Lock Ring Part No.	Wt. Lbs.
24x 8.00	Typical	4.8
24x10.00		4.8

**T-5° "O" RINGS**



T-5° "O" Ring  
(Rubber Gasket)

Size (Diam.)	"O" Ring Part No.	Wt. Lbs.
24"	Typical	.2

**5° COMPACTOR SIDE RINGS**



5° Compactor Side Ring

Rim Type	Size	Side Ring Part No.	Wt. Lbs.
5° (Standard)	15x6.0	Typical	4.5
5° (Heavy-Duty)	15x6.0		7.0

**5° COMPACTOR LOCK RINGS**



5° Compactor Lock Ring

Rim Type	Size	Lock Ring Part No.	Wt. Lbs.
5° (Standard)	15x6.0	Typical	6.0
5° (Heavy-Duty)	15x6.0		7.2

**HDC COMPACTOR  
SIDE RINGS**



HDC Compactor  
Side Ring

Size	Side Ring Part No.	Wt. Lbs.
24x2"	Typical	31.3
25x2½"		50.0
25x3"		63.2

**HDC COMPACTOR  
LOCK RINGS**



HDC Compactor  
Lock Ring

Size	Side Ring Part No.	Wt. Lbs.
24" Dia.	Typical	12.4
25" Dia.		12.8

**HDC COMPACTOR  
BEAD SEAT BANDS**



HDC  
Compactor  
Bead Seat  
Band

Size	Bead Seat Part No.	Wt. Lbs.
24x2"	Typical	55.0
25x4"		58.9

SPACER BANDS AND TOOLS  
FOR RIMS AND WHEELS

**CORRUGATED SPACER BANDS**

**CHANNEL SPACER BANDS**

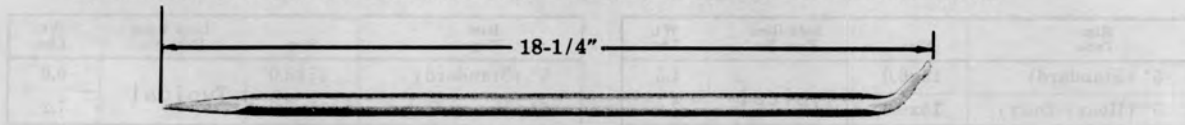


Size	Part No.	Wt. Lbs.
15x3	Typical, for illustrative purposes only.	3.5
16x3		4.0
15x3 3/8		4.2
20x3		5.0
20x3 3/8		5.7
22x3 3/8		6.2
24x3 3/8		7.5
20x3 1/2		6.0
22x3 1/2		6.7
15x4		5.0
20x4		6.7
22x4		7.5
24x4		8.0
20x4 3/8		7.2
22x4 3/8		8.0
20x4 1/2		9.0
22x4 1/2	10.5	
24x4 1/2	12.0	

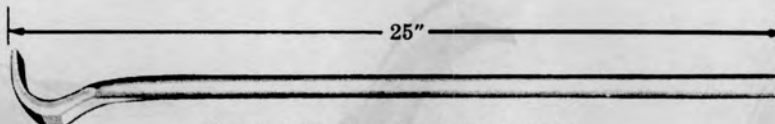


Size	Part No.	Wt. Lbs.
24x3	Typical, for illustrative purposes only.	6.5
20x3 3/8		7.2
22x3 3/8		8.7
20x4		8.5
22x4		9.2
20x5 3/8		16.5
24x5 3/8		20.0

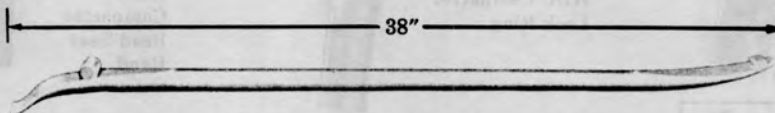
**RIM TOOLS FOR MOUNTING AND DEMOUNTING TIRES ON RIMS**



**RT29 AND RT30 (DELUXE)\* RIM TOOL**  
For mounting and demounting Firestone tube-type rims  
Approx. Wt. 2.0 lbs.  
\*High Strength Steel.



**RT-32 BEAD-LOOSENING TOOL**  
For assistance in demounting Firestone FL-5° and N-5° Rims  
Approx. Wt. 3.5 lbs.

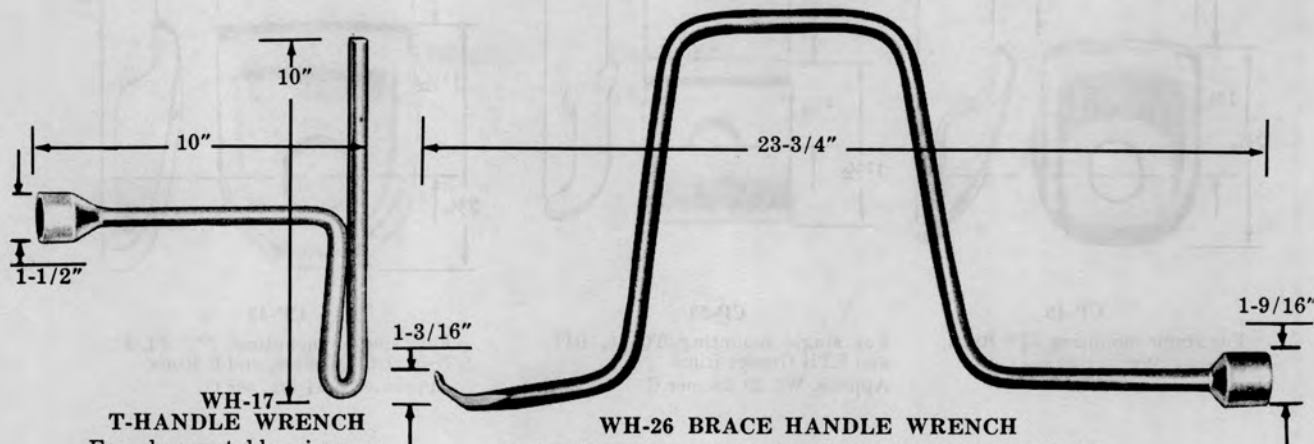


**RT-31 TUBELESS RIM TOOL**  
For mounting and demounting Firestone 15° Tubeless drop-center rims  
Approx. Wt. 4.5 lbs.

TOOLS FOR MOUNTING AND DEMOUNTING  
RIMS AND WHEELS

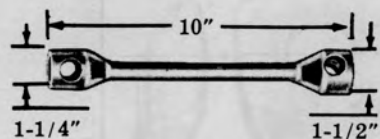
RIM AND WHEEL WRENCHES

For Attaching Demountable Rims to Cast Spoke Wheels and Disc Wheels to Wheel Hubs.

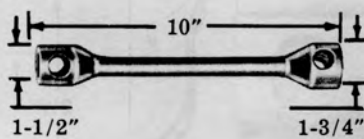


**WH-17  
T-HANDLE WRENCH**  
For demountable rims secured by 5/8" nuts with 1-1/16" hex.  
Approx. Wt. 2.0 lbs.

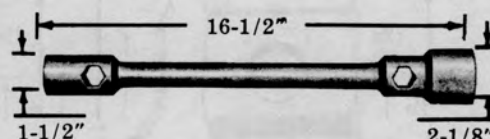
**WH-26 BRACE HANDLE WRENCH**  
For RHP Wheels\* secured by 5/8" nuts with 1-1/16" hex.  
Approx. Wt. 3.0 lbs.  
\*Rim tool end designed for RHP rim operation



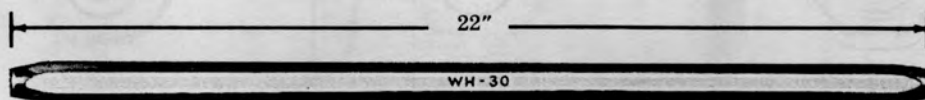
**WH-25  
DOUBLE SOCKET  
WRENCH**  
For demountable rims secured by 1/2" nuts with 7/8" hex or 5/8" nuts with 1-1/16" hex.  
Approx. Wt. 1.0 lb.  
(RT-29 can be used as handle.)



**WH-33 DOUBLE SOCKET  
WRENCH**  
For demountable rims secured by 5/8" nuts with 1-1/16" hex or 3/4" nut with 1-1/4" hex.  
Approx. Wt. 1.1 lbs.  
(RT-29 can be used as handle.)



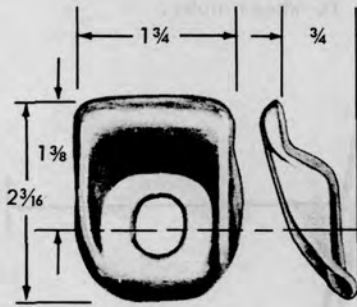
**WH-29 DOUBLE SOCKET WRENCH**  
For disc wheels secured by 3/4" inner cap nut with 13/16" square or 3/4" single and 1-1/8" outer cap nut with 1-1/2" hex. Applicable to wheels with 7-5/8" offset on which 12.00 or 12-24.5 tires are mounted.  
Approx. Wt. 4.4 lbs.  
(WH-30 can be used as handle.)



**WH-30 HEX WHEEL WRENCH HANDLE**  
For leverage on WH-29 wheel wrench. Approx. Wt. 3.0 lbs.

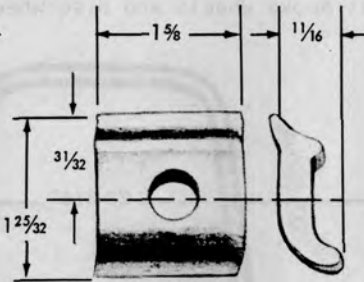
CLAMPS FOR HIGHWAY, GRADER AND  
CONSTRUCTION VEHICLE DEMOUNTABLE RIMS

CLAMPS FOR 1/2" STUDS



CP-46

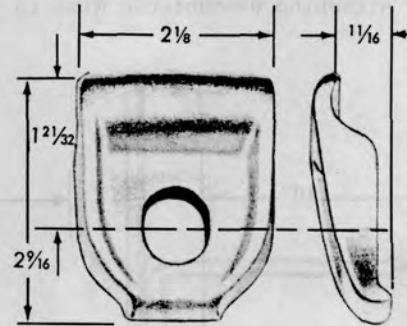
For single mounting RIP Rims.  
Approx. Wt. 20 lbs. per C



CP-53

For single mounting TG-5°, RIT,  
and RTH Grader Rims.  
Approx. Wt. 25 lbs. per C

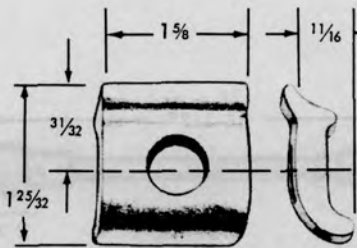
CLAMP FOR 5/8" STUDS



CP-45

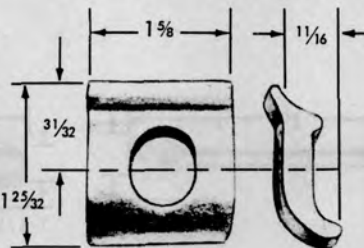
For single mounting 5°, FL-5°,  
N-5°, DC Tubeless, and R Rims.  
Approx. Wt. 41 lbs. per C

CLAMPS FOR 5/8" STUDS



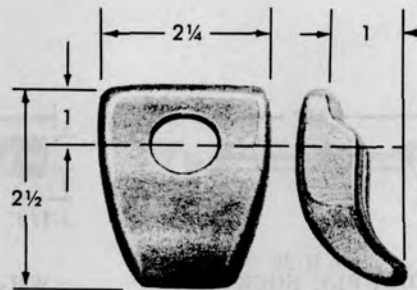
CP-63

For single mounting RIT and RTH  
Grader Rims.  
Approx. Wt. 30 lbs. per C



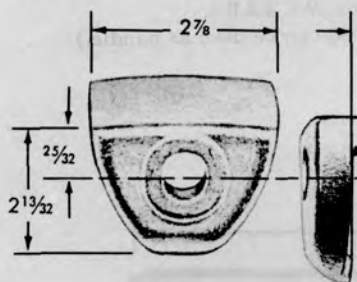
CP-141

For single mounting TG-5°, RIT  
and RTH Grader Rims.  
Approx. Wt. 30 lbs. per C



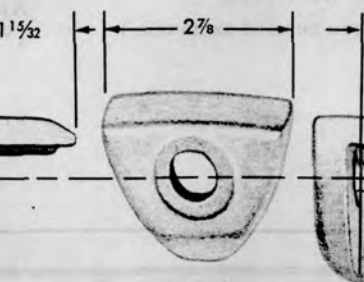
CP-145

For single mounting 5°, FL-5°,  
N-5°, DC Tubeless, and R Rims.  
Approx. Wt. 61 lbs. per C



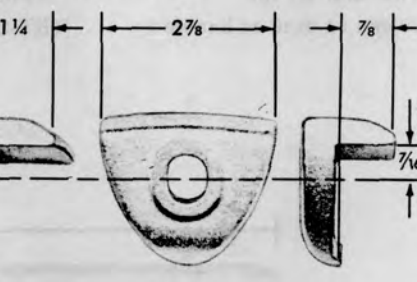
CP-146

For dual mounting 5°, FL-5°, DC  
Tubeless and R Rims with 3-3/8"  
spacer bands.  
Approx. Wt. 109 lbs. per C



CP-147

For dual mounting 5°, FL-5°, DC  
Tubeless and R Rims with 3-5/8"  
spacer bands.  
Approx. Wt. 103 lbs. per C



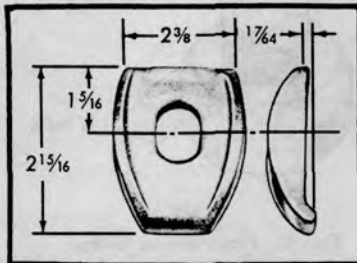
CP-148

For dual mounting 5°, FL-5°, N-5°,  
DC Tubeless and R Rims with 4"  
spacer bands.  
Approx. Wt. 94 lbs. per C



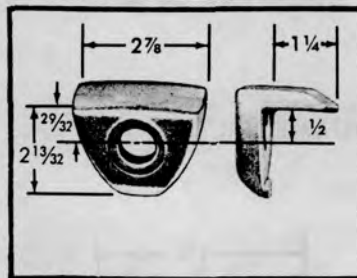
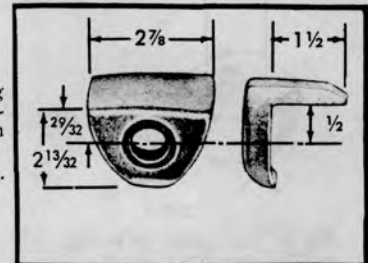
CLAMPS FOR HIGHWAY, GRADER AND CONSTRUCTION VEHICLE DEMOUNTABLE RIMS (continued)

**CLAMPS FOR 3/4" STUDS**



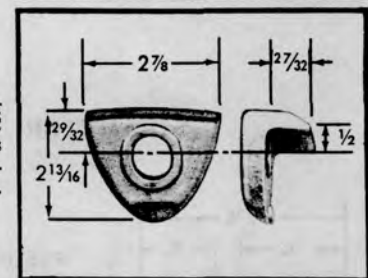
**CP-120**  
For heavy-duty single mounting size 10.0 5° and R Rims.  
Approx. Wt. 70 lbs. per C

**CP-149**  
For dual mounting 5°, FL-5°, DC Tubeless and R Rims with 3-3/8" spacer bands.  
Approx. Wt. 106 lbs. per C



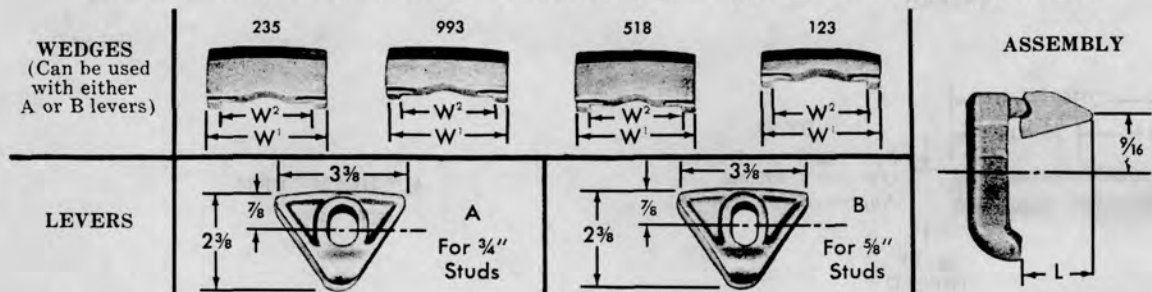
**CP-150**  
For dual mounting 5°, FL-5°, DC Tubeless and R Rims with 3-5/8" spacer bands.  
Approx. Wt. 94 lbs. per C

**CP-151**  
For dual mounting 5°, FL-5°, N-5°, DC Tubeless and R Rims with 4" spacer bands.  
Approx. Wt. 87 lbs. per C



**WEDGEMASTER 2-PIECE CLAMPS**

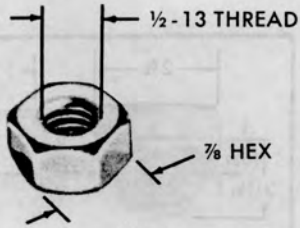
For dual mounting 5°, FL-5°, N-5°, DC Tubeless and R Rims with 3-3/8", 3-5/8", and 4" spacer bands.



CLAMP ASSEMBLY				COMPONENTS					
Assembly Part No.	Spacer Band Width	Effective Wedge Length "L"	Approx. Wt. per C	LEVER		WEDGE			
				Lever Part No.	Approx. Wt. per C	Wedge Part No.	Overall Width W <sup>1</sup>	Spoke* Width W <sup>2</sup>	Approx. Wt. per C
Typical, for illustrative purposes only.	3 3/8"	1 5/8"	109 lbs.	A	56 lbs.	Typical, for illustrative purposes only.	3 5/16"	2 9/16"	53 lbs.
	3 3/8"	1 5/8"	118 lbs.	A	56 lbs.		3 13/16"	3 5/16"	62 lbs.
	3 5/8"	1 5/16"	100 lbs.	A	56 lbs.		3 3/8"	2 9/16"	44 lbs.
	3 5/8"	1 5/16"	106 lbs.	A	56 lbs.		3 11/16"	3 3/16"	50 lbs.
	3 5/8"	1 3/4"	112 lbs.	A	56 lbs.		3 5/16"	2 9/16"	56 lbs.
	4"	1"	86 lbs.	A	56 lbs.		3 5/16"	2 9/16"	30 lbs.
	4"	1"	84 lbs.	A	56 lbs.		3 3/16"	3 3/16"	28 lbs.
	3 3/8"	1 5/8"	110 lbs.	B	57 lbs.		3 5/16"	2 9/16"	53 lbs.
	3 3/8"	1 5/8"	119 lbs.	B	57 lbs.		3 13/16"	3 5/16"	62 lbs.
	3 5/8"	1 5/16"	101 lbs.	B	57 lbs.		3 3/8"	2 9/16"	44 lbs.
	3 5/8"	1 5/16"	107 lbs.	B	57 lbs.		3 11/16"	3 3/16"	50 lbs.
	3 5/8"	1 3/4"	113 lbs.	B	57 lbs.		3 5/16"	2 9/16"	56 lbs.
	4"	1"	87 lbs.	B	57 lbs.		3 5/16"	2 9/16"	30 lbs.
	4"	1"	85 lbs.	B	57 lbs.		3 3/16"	3 3/16"	28 lbs.

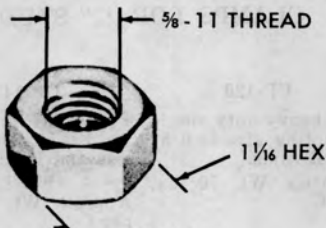
Suffix—"W" indicates wide wedge for IHC wheels and other wide six-spoke wheels.  
 \*The wedge spoke width is the distance between the drivers built along the edges of each wedge to position it on wheel spoke.  
 \*\*518 wedge provides additional wedge length for truck wheels with 6 13/16" spoke lengths.

NUTS, STUDS AND BOLTS FOR  
DEMOUNTABLE RIMS



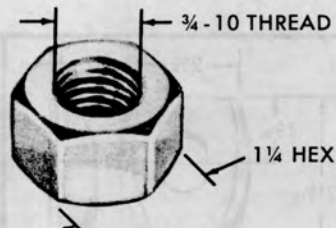
**NT-4**

For 1/2" rim studs or bolts.  
Approx. Wt. 6 lbs. per C



**NT-16**

For 5/8" rim studs or bolts.  
Approx. Wt. 13 lbs. per C

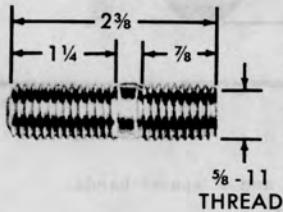


**NT-17**

For 3/4" rim studs or bolts.  
Approx. Wt. 27 lbs. per C

RIM STUDS AND BOLTS

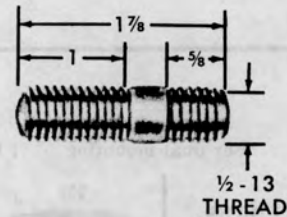
5/8" DIAMETER



**BT-52**

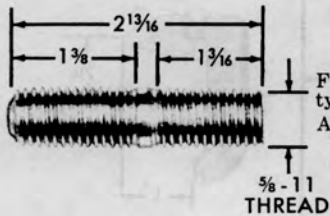
For rims on Dayton  
type truck wheels and  
grader wheels.  
Approx. Wt. 18 lbs. per C

1/2" DIAMETER



**BT-53**

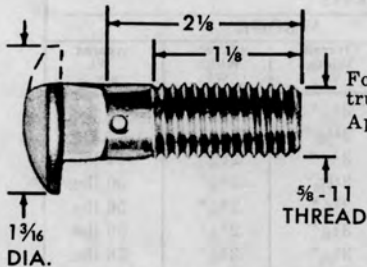
For rims on lighter  
truck wheels.  
Approx. Wt. 27 lbs. per C



**BT-87**

For rims on Dayton  
type truck wheels.  
Approx. Wt. 23 lbs. per C

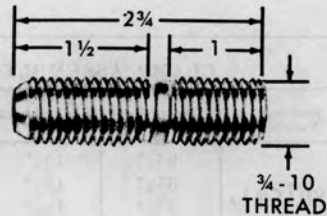
3/4" DIAMETER



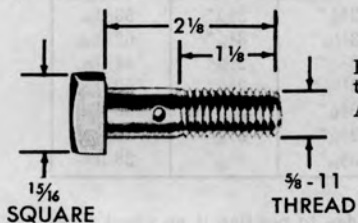
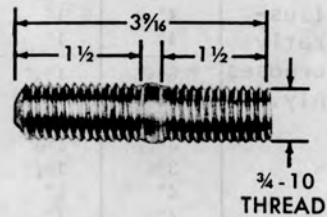
**BT-101**

For rims on Erie type  
truck wheels.  
Approx. Wt. 19 lbs. per C

**BT-102**  
For rims on Dayton  
type truck wheels.  
Approx. Wt. 28 lbs. per C



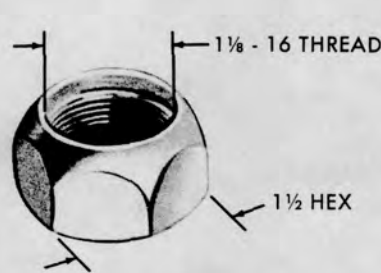
**BT-103**  
For rims on Dayton  
type truck wheels.  
Approx. Wt. 34 lbs. per C



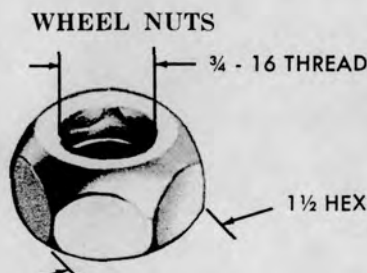
**BT-104**

For rims on Gunitite type  
truck wheels.  
Approx. Wt. 25 lbs. per C

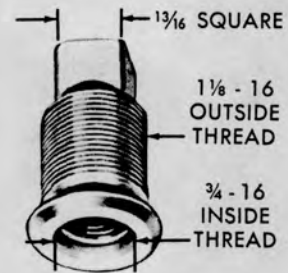
**NUTS, STUDS AND BOLTS FOR WHEELS**



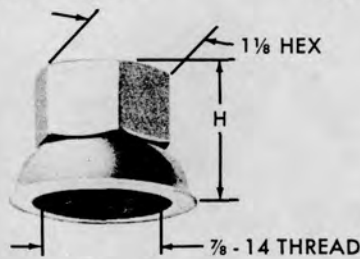
**NTR-25 (Right) Outer Dual Cap Nut**  
**NTL-25 (Left) Outer Dual Cap Nut**  
For outer dual mounting of Firestone DCN Stud-Type wheels on 3/4" studs  
Approx. Wt. 19 lbs. per C



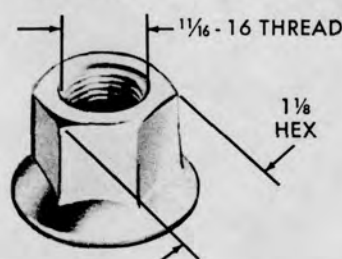
**NTR-26 (Right) Single Cap Nut**  
**NTL-26 (Left) Single Cap Nut**  
For single mounting of Firestone DCN Stud-Type wheels on 3/4" studs  
Approx. Wt. 32 lbs. per C



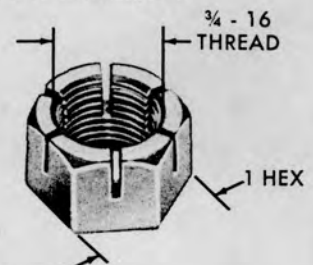
**NTR-27 (Right) Inner Dual Cap Nut**  
**NTL-27 (Left) Inner Dual Cap Nut**  
For inner dual mounting of Firestone DCN Stud-Type wheels on 3/4" studs  
Approx. Wt. 38 lbs. per C



**NT-28 Cone Lock Nut (H=7/8")**  
**NT-29 Cone Lock Nut (H=1-3/8")**  
For single and dual mounting of Firestone Hub-Type Cone Lock Nut wheels on 7/8" studs.  
Approx. (NT-28) 25 lbs. per C  
(NT-29) 34 lbs. per C



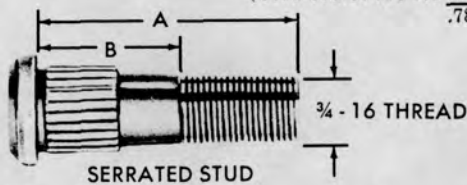
**NT-30 Flanged Nut**  
For single and dual mounting of Firestone Hub-Type Flanged Nut wheels on 11/16" studs.  
Approx. Wt. 25 lbs. per C



**NT-31 Back Nut**  
For attaching drum and hub with 3/4" shoulder studs.  
Approx. Wt. 8 lbs. per C

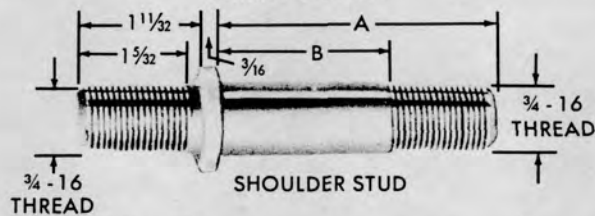
**WHEEL STUDS**

For mounting Firestone DCN Stud-Type wheels on 3/4" studs  
(Stud bodies are for .781 Dia. hub stud holes)  
.783



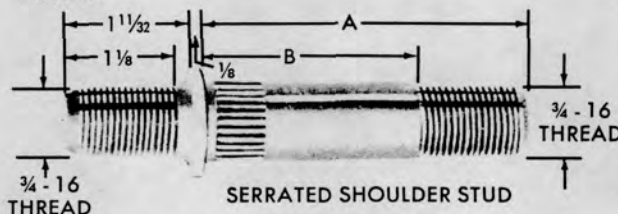
**SERRATED STUD**

Part Number		Dimensions		Approx. Wt. per C
Right	Left	A	B	
Typical	Typical	2-7/8"	1-1/2"	47 lbs.
		2-7/16"	1-1/4"	39 lbs.



**SHOULDER STUD**

Part Number		Dimensions		Approx. Wt. per C
Right	Left	A	B	
Typical	Typical	2-1/16"	1-1/16"	43 lbs.
		2-11/16"	1-21/32"	52 lbs.



**SERRATED SHOULDER STUD**

Part Number		Dimensions		Approx. Wt. per C
Right	Left	A	B	
Typical	Typical	3"	1-15/16"	56 lbs.



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BATTLE CREEK, MICHIGAN, U.S.A.



**STEERING GEAR DISASSEMBLY**

1. Rotate steering worm until nut is in center of travel.
2. Remove sector shaft nut.
3. Use puller to remove pitman arm.
4. Remove side cover screws and remove side cover and sector shaft from housing.
5. To remove side cover from sector shaft, turn adjustor screw in end of sector shaft down through cover.
6. Remove screws and take out end cover with worm bearing, adjustor and lock nut.
7. Lift out worm bearing from end cover, loosen worm bearing adjustor lock nut and turn adjustor screw thru cover.
8. Grasp lower end of steering worm and draw steering shaft and nut out of steering housing. Disassembly of worm nut is not recommended.

**CAUTION**

BE SURE TO KEEP SHAFT IN HORIZONTAL POSITION SO THAT NUT DOES NOT MOVE AGAINST STOPS AT ANY TIME, CAUSING DAMAGE TO BALL RETURN MECHANISM.

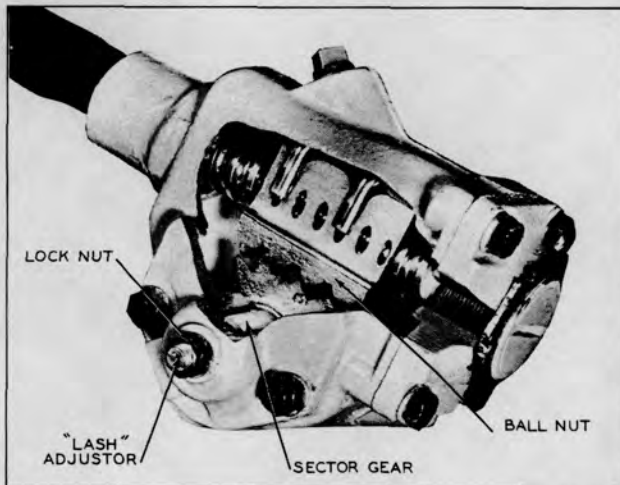


Plate 6637. Steering Gear Lash Adjustment (Sector Gear)

**INSPECTION**

1. Clean all parts in a Stoddard type cleaning solvent.

2. Inspect all bearings for pitting or wear.

3. Inspect worm, and re-circulating ball nut for nicks or excessive wear. If either of these parts are unfit for use it will be necessary to replace with a new sub-assembly as they are not serviced separately.

4. Inspect sector shaft for nicks or excessive wear.

5. Inspect side cover bushing for excessive wear. If the bushing cannot be reused it will be necessary to replace the side cover new as the bushing is not serviced separately.

**STEERING GEAR REASSEMBLY**

1. Install worm shaft and nut assembly in gear housing, keeping ball nut away from stops on worm.

2. Install worm bearing adjusting screw with lower worm bearing, and adjustor lock nut in end cover.

3. Install end cover and attaching parts on gear housing, making sure bearings seat properly.

4. Tighten worm bearing adjusting screw until a slight drag is felt on bearings. Do not tighten lock nut.

5. Install a new gasket on side cover.

6. Install sector shaft and adjusting screw inside cover.

7. Rotate steering worm until ball nut is in center of travel so that center tooth on sector shaft will enter center space on nut.

8. Install side cover and sector shaft in gear housing.

9. Tighten sector shaft adjusting screw until a slight drag is felt on bearing but do not tighten lock nut.

10. After steering gear is installed in vehicle and is properly lubricated adjust as follows:

**ADJUSTMENTS**

1. Disconnect drag link from pitman arm.

2. Loosen sector shaft lash adjustor screw a few turns to relieve load from bearings.

3. Turn steering wheel in one direction until stopped by gear, then back away about one turn.

4. With a spring scale hooked to rim of steering wheel, measure pull required to keep wheel in motion. If not within the limits outlined in specifications, adjust worm bearings as follows:

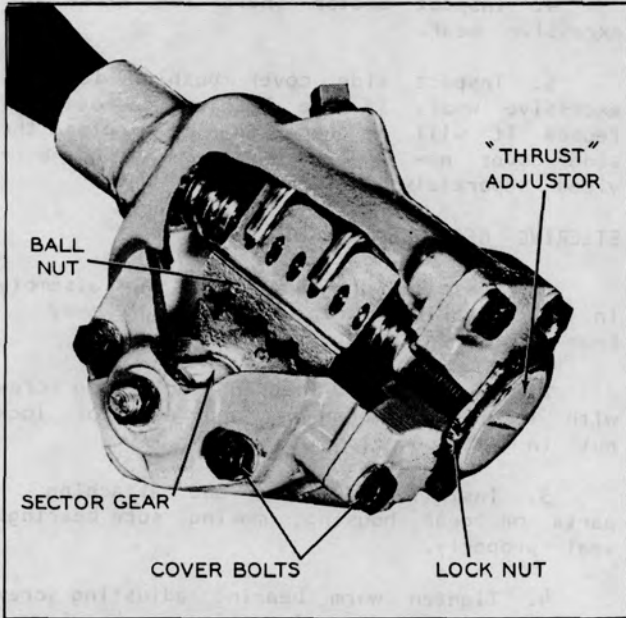


Plate 6636. Steering Gear Thrust Adjustment (Worm Bearings)

a. Loosen worm bearing adjustor lock nut and turn adjustor until there is no perceptible end play in worm. Check pull at wheel rim, readjusting as required to obtain proper pull. Tighten lock nut and recheck pull.

b. After worm bearing adjustment is completed and all mounting bolts tightened, adjust sector shaft end play.

c. With steering wheel in straight-ahead position, turn lash adjustor screw clockwise to remove all lash and tighten lock nut.

d. Check pull at rim of steering wheel, taking highest reading on scale as wheel is turned through the central or straight-ahead position. If this reading exceeds the limits outlined in specifications, turn lash adjustor screw counter-clockwise, then take up on the adjustment in a clockwise motion.

e. Tighten lock nut and recheck pull.



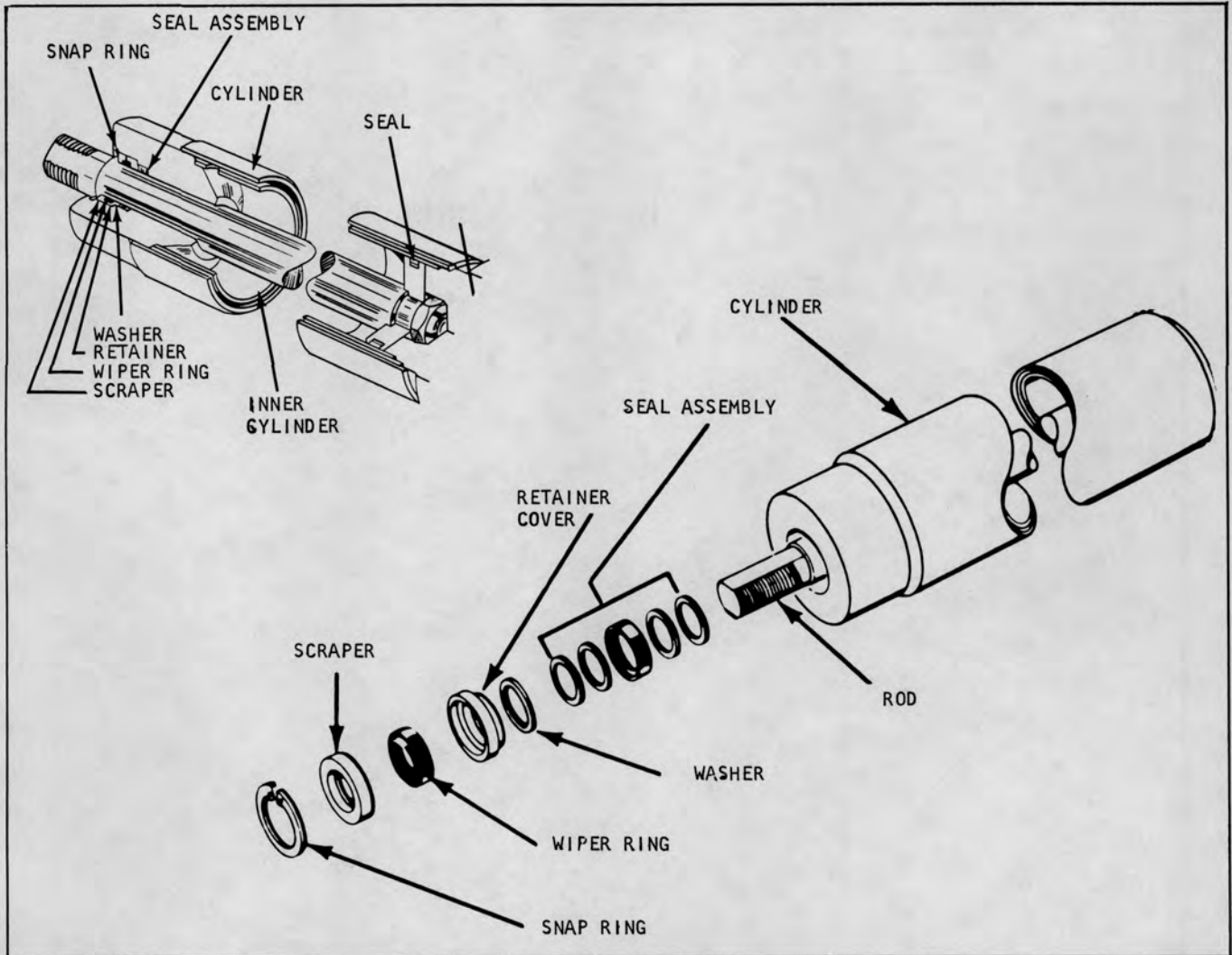


Plate 6905. Cutaway View Steering Cylinder Assembly

**STEERING CYLINDER DISASSEMBLY**

The cylinder assembly is a sealed unit. Overhaul procedures are restricted to replacing the sealing parts on the rod end of the cylinder.

1. Remove nut, bolt, and lockwasher from the rod end and unscrew from cylinder piston rod.

2. Remove retainer snap ring with snap ring pliers. Rotate the rod and withdraw it far enough from the cylinder to expose scraper, wiper ring, retainer and washer. The shaft seal may be removed with a hooked scriber.

**INSPECTION**

1. Inspect cylinder shaft for damage and straightness to insure proper sealing.

**CYLINDER REASSEMBLY**

1. After making sure that the cylinder cap bore is clean, coat the rod seal assembly parts with petroleum jelly. Install two back-up rings over the rod and in the cylinder cap bore. Be sure that the split ends are staggered. Install the seal ring and two outer back-up rings, again with split ends staggered. Install the washer, retainer, wiper and scraper. Install the snap ring.

2. Screw the rod end sub-assembly onto the end of the cylinder rod. Align the split collar with the flat on the rod and install the locking bolt, nut and lockwasher.



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# MASTER MAINTENANCE MANUAL



## TROUBLE SHOOTING

TROUBLE	PROBABLE CAUSE	REMEDY
FLUCTUATING PRESSURE	FAULTY OPERATION OF RELIEF VALVE	Fluctuating pressure or loss of pressure in the system is usually caused by scale, chips, sludge, filings that have lodged between the relief valve and seat or by a damaged spring or worn valve. Flush and refill system. If condition still exists, overhaul valve assembly.
LOSS OF SYSTEM PRESSURE  CYLINDER PISTON ROD BINDING OR STICKING	SLIPPAGE OF PUMP DRIVE, OTHER PUMP MALFUNCTION  CRAMPING OF LINKAGE	Check pump according to manufacturer's recommendations.  With hydraulic flow shut off from the unit and the rod end uncoupled the rod should slide freely in or out by hand with a maximum force of 30 lbs. If binding is apparent, replace the unit and readjust pitman arm stops to prevent recurrence of damage.
CHATTER CONDITIONS	LOOSE MOUNTINGS OR LINKAGE RELIEF VALVE SET TOO LOW INSUFFICIENT PUMP FLOW	Make certain all ball stud mounting and other linkage is tight. Check pitman arm stops to be certain the arm strikes the stops slightly before the steering knuckles contact the stops on the axle. Set relief valve at least 150 PSI higher than normal steering requirements of the vehicle. Bleed air from system. Insufficient pump flow at idle speeds can be corrected by increasing engine idle rpm.
UNSATISFACTORY STEERING IN EITHER DIRECTION	AIR IN SYSTEM, EXCESSIVE WEAR IN STEERING CYLINDER, INCORRECT SYSTEM PRESSURE, WORN PUMP	Check for air in system. Excessive noise or foamy condition of oil indicates aeration. Check to be sure air is not entering system through poor threads, hoses, pump seals, "O" rings, gaskets and loose connections. Excessively worn cylinders result in leakage past the piston. Correct by replacing cylinder. Set relief valve at least 150 PSI higher than normal steering requirements of the vehicle. Repair or replace pump.



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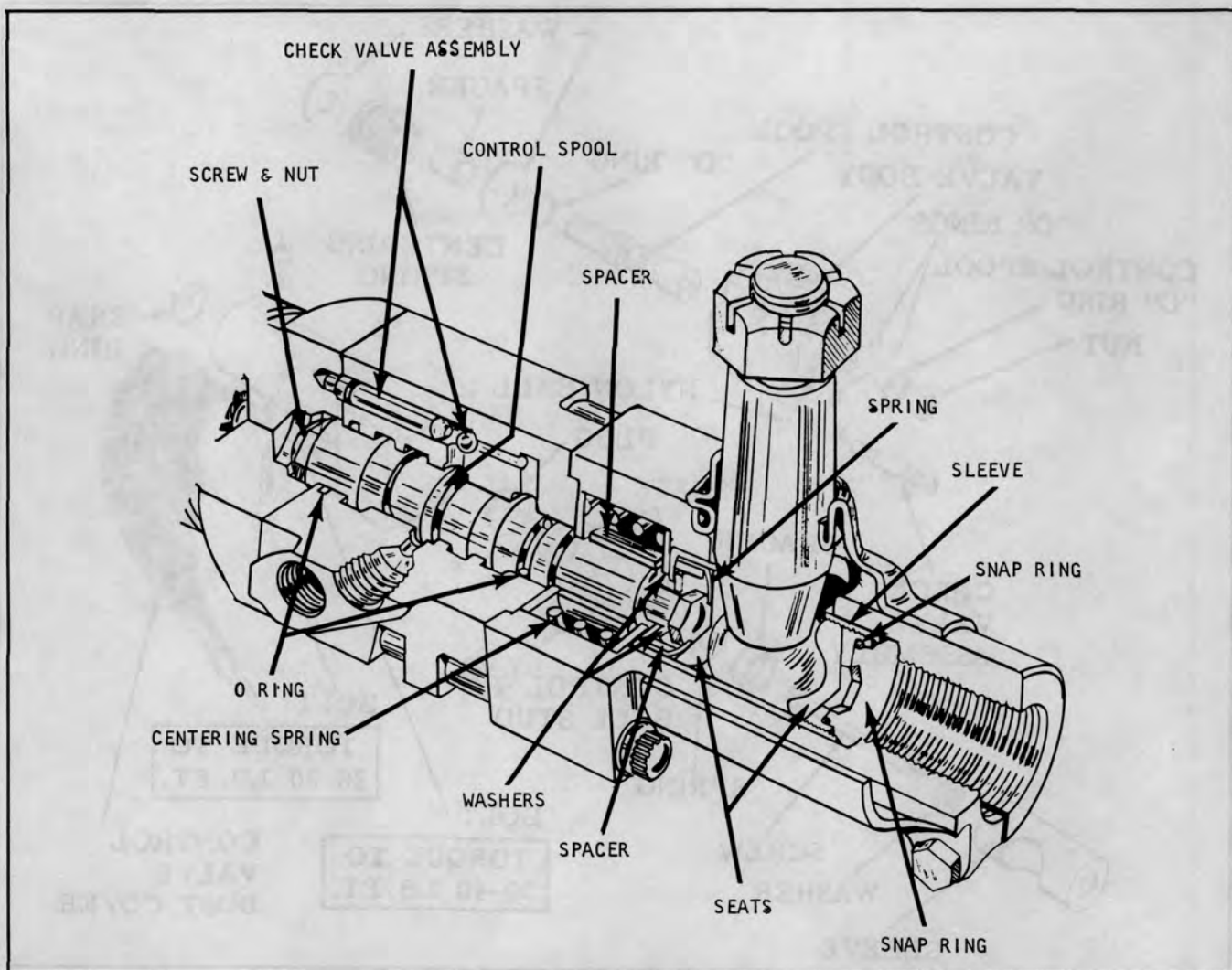


Plate 6904. Cutaway View Steering Valve Assembly

**STEERING VALVE DISASSEMBLY**

1. Hold control ball stud housing and valve assembly in a vise, by lightly clamping valve body. Use care not to distort spool bore in valve body.

2. Remove control valve dust cover and remove the wire snap ring which locks the control ball stud sleeve plug and remove plug. Remove control ball stud, two ball stud seats, spring washer and spacer.

3. Remove the bolts securing the ball stud housing to the valve and remove self-locking nut from spool capscrew. Remove capscrew, washer and control ball stud sleeve. Then lift the two centering spring retaining washers, centering spring and spacer from the valve body. Remove "O" rings from valve body and from the spool.

4. Remove the check valve, "O" ring, and ball from the valve body to complete the disassembly.

**INSPECTION**

1. Discard all "O" rings and seals and replace with new upon reassembly.

2. Wash all parts in a Stoddard type cleaning solvent.

3. Inspect all fluid passages in valve body to be certain they are clean and free of obstructions.

4. Check each disassembled part for wear, cracks or pitting that would render them unfit for continued use. Replace all defective parts.

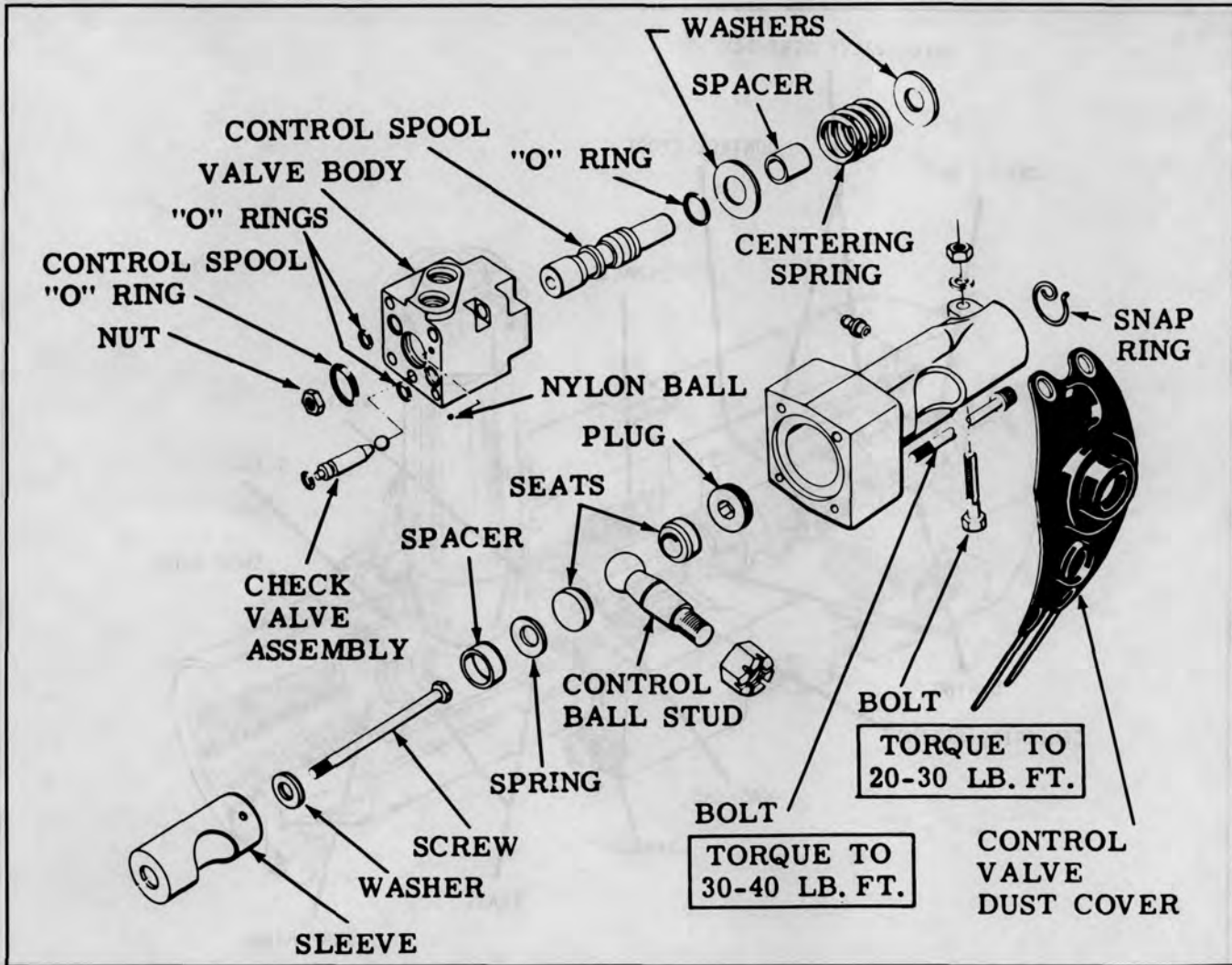


Plate 6977. Exploded View of Steering Valve

5. Inspect valve spool and valve spool bore for deep scoring and excessive wear. As these parts are not ordinarily serviced separately they should be replaced as a unit if badly worn. Do not rework or attempt to touch up the valve spool. This practice will only result in improper steering unit operation and performance.

**REASSEMBLY**

1. Immerse all parts in clean hydraulic fluid to facilitate assembly. Coat all "O" rings and seals with petroleum jelly prior to assembly.

2. Install new "O" ring (coated with grease or petroleum jelly) in cylinder end of valve body and on control ball stud end of valve spool. Install spool in bore from the control ball stud end to avoid "O" ring interference during assembly.

3. Install washer, spacer, centering spring, washer, control ball stud sleeve, capscrew washer and capscrew. Install self locking nut and tighten until play between parts is removed. Be sure that nut is in good condition and that the centering spring remains aligned between the two retaining washers. Back nut off one flat (1/6 turn or 60°).

4. Start control ball stud sleeve plug in control ball stud sleeve.

5. Slide the control ball stud housing over the ball stud sleeve.

6. Install new "O" ring on check valve and place ball and check valve in valve body recesses and hold valve against its port end mating surface making sure the locating pin on the check valve engages the recessed hole to insure proper port alignment.



7. Locate control ball stud housing in desired position relative to control ball stud. Install four capscrews while holding valve and control assembly in place to prevent misalignment of "O" rings. Tighten capscrews to proper torque. (Refer to specifications).

8. Install control ball stud spacer. The spring washer must be installed with its convex (raised inside diameter) face toward ball stud to provide spring tension on ball stud. Next install ball stud seats

and control ball stud. Position the stud and sleeve so that the stud is centered in the sleeve opening.

9. Tighten control ball stud sleeve plug snugly against seat. Back plug off until slot in plug lines with one of snap ring anchor holes in sleeve which are spaced at 60° intervals in control ball stud sleeve. Install hooked end in anchor hole and engage snap ring in groove in sleeve plug. This can most easily be done by engaging tang in hole in sleeve and then applying pressure with small screwdriver opposite tang on outside edge of snap ring.



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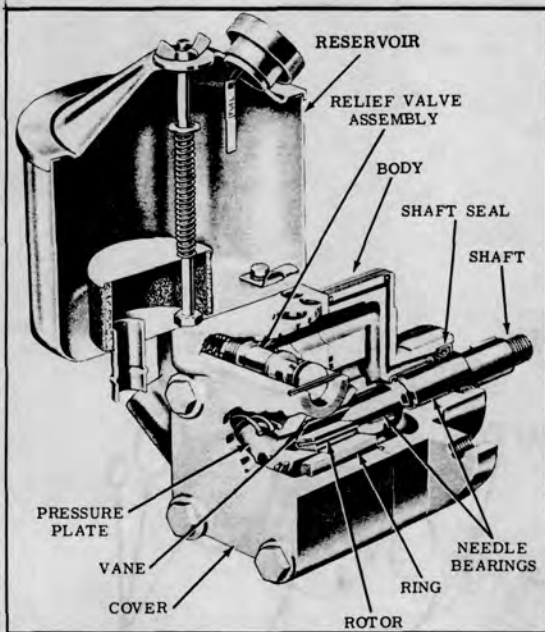


Plate 9471. Integral Reservoir Pump

**GENERAL**

The VTM series power steering pump is designed for direct mounting with most of the bearing load carried by the external mounting.

Principal components consist of the reservoir, body, cover, ring, rotor, vanes, pressure plate, relief valve and drive shaft assembly. The VTM-40 series is designed for direct mounting with most of the bearing load carried by the external mounting.

**OVERHAUL**

Disassembly

(1) Remove the pressure line and "O" ring and free the reservoir from pump.

(2) Clamp pump mounting flange in a machinists vise, being certain to use protective jaws. Remove cover mounting cap screws. Separate the cover from the pump body. Remove pressure plate spring and pressure plate. Remove adapter plate and "O" rings. Remove pump ring, locating pins, rotor and vanes, and the two "O" rings.

Mount the cover in a vise. Drive out retaining pin with pin punch. Protect the relief valve plug and subassembly against falling from bore. Work the plug, control valve and spring from the bore.

Remove the shaft and seal from the pump body. The shaft bushing is included in the body subassembly and can not be serviced separately.

Inspection, Repair, Replacement

(1) Wash all parts, except seals, in clear Stoddard type solvent and lay them aside for inspection. Replace all old seals and "O" rings at reassembly.

(2) Inspect the surfaces of all parts which are subject to wear. Light scoring may be removed from the faces of the body or wear plate with crocus cloth (by placing the cloth on a flat surface), medium India stone or by lapping. Check the edges of vanes for wear. Vanes must not have excessive play in slots or burrs on edges. Replace if necessary. Check each rotor slot for sticky vanes or wear. Vanes should drop in rotor slots by their own weight when both slot and vane are dry.

(3) Insert relief valve in its bore in pump cover. There should be no binding. Check valve and bore for excessive wear and scoring. Replace if necessary.

(4) Wash bearing and shaft assembly thoroughly. If the bushing is worn, replacement of the body subassembly is necessary.

(5) Replace the shaft seal at each overhaul to prevent oil leakage. Check the drive shaft oil seal diameter for wear and scoring. Do not install a new seal on a shaft which is worn or damaged at the oil seal diameter. Replace the shaft if worn. Stone and polish sharp edges on the shaft to prevent damage to the seal.

(6) Stone all mating surfaces of the body and cover with a medium India stone to remove all burrs and sharp edges. Rewash all parts after stoning.

Reassembly

**N O T E**

Immerse all parts in clean hydraulic fluid to facilitate reassembly.

**N O T E**

Tools for installing bearings can be made from round stock the outside diameter of which is slightly smaller than the outside diameter of the bearing and the inside diameter slightly larger than the shaft diameter. Do not score or otherwise damage the shaft during this operation.

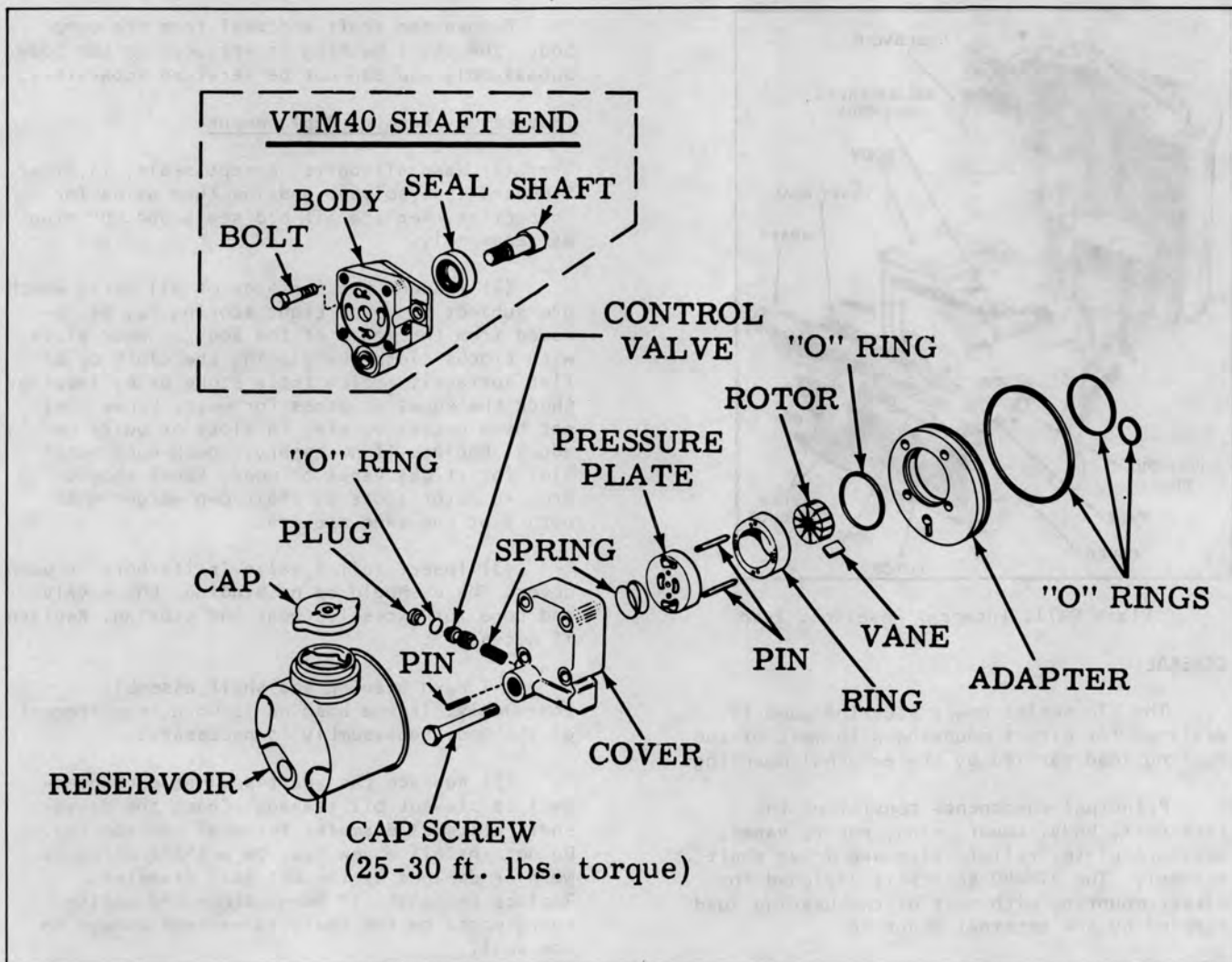


Plate 9472. Hydraulic Pump Exploded View

Position the seal on the shaft end of the body, being careful not to damage seal. Using special tool (see above note) press seal in until it engages the shoulder in the body. This shoulder acts as a positive stop for the seal. Do not overpress as damage to the seal will result.

Carefully install shaft to prevent damage to shaft bushing and seal surfaces.

(2) Install locating pins in body. Install ring over pins in correct direction of rotation. Then install rotor with Chamfered edge of splined hole "in" or toward pump body. The chamfer facilitates assembly.

Install vanes with their radius edge toward the inner ring contour. Then install the adapter plate and "O" rings.

Oil the cartridge with clean hydraulic fluid and install pressure plate.

Install "O" rings, install pressure plate spring and cover. Tighten cover screws to 25 - 30 lb ft. torque.

Install pressure compensating spring in relief valve bore. Insert valve assembly with the hex toward the spring. Install plug with "O" ring in bore and hold it in position while driving a new retaining pin.

Install the two pump mounting bolts in the body flange. Install a new "O" ring on adaptor plate. Install reservoir so the hole is aligned with the cover discharge port. Install a new "O" ring on the discharge fitting and install fitting to secure reservoir. Be careful that the "O" ring is not damaged as it is forced through the hole in the reservoir.



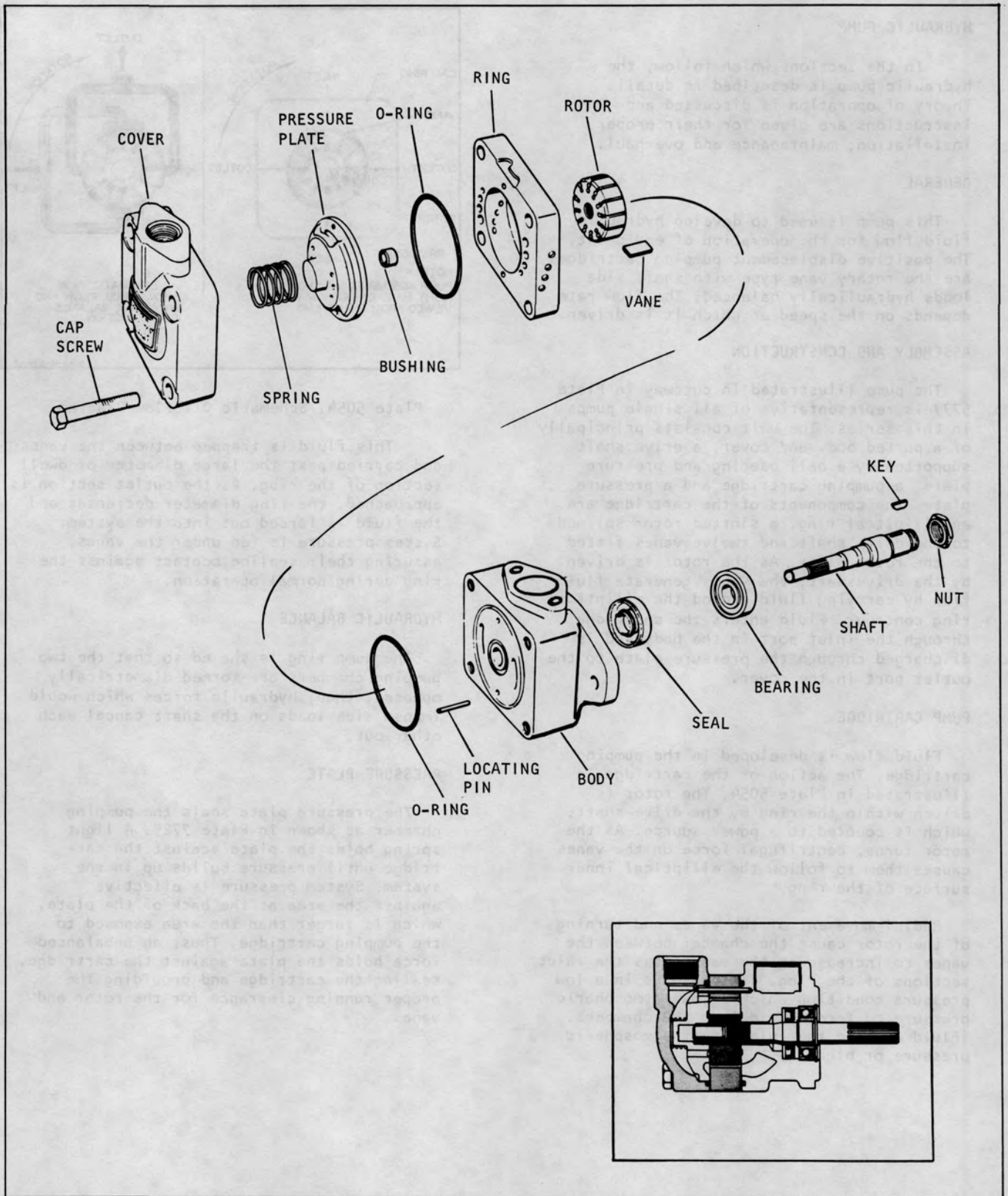


Plate 5777 Cut-a-way View of Pump

**HYDRAULIC PUMP**

In the sections which follow, the hydraulic pump is described in detail. Theory of operation is discussed and instructions are given for their proper installation, maintenance and overhaul.

**GENERAL**

This pump is used to develop hydraulic fluid flow for the operation of equipment. The positive displacement pumping cartridges are the rotary vane type with shaft side loads hydraulically balanced. The flow rate depends on the speed at which it is driven.

**ASSEMBLY AND CONSTRUCTION**

The pump illustrated in cutaway in Plate 5777 is representative of all single pumps in this series. The unit consists principally of a ported body and cover, a drive shaft supported by a ball bearing and pressure plate, a pumping cartridge and a pressure plate. The components of the cartridge are an elliptical ring, a slotted rotor splined to the drive shaft and twelve vanes fitted to the rotor slots. As the rotor is driven by the driveshaft, the vanes generate fluid flow by carrying fluid around the elliptical ring contour. Fluid enters the cartridge through the inlet port in the body and is discharged through the pressure plate to the outlet port in the cover.

**PUMP CARTRIDGE**

Fluid flow is developed in the pumping cartridge. The action of the cartridge is illustrated in Plate 5054. The rotor is driven within the ring by the drive-shaft, which is coupled to a power source. As the rotor turns, centrifugal force on the vanes causes them to follow the elliptical inner surface of the ring.

Radial movement of the vanes and turning of the rotor cause the chamber between the vanes to increase as the vanes pass the inlet sections of the ring. This results in a low pressure condition which allows atmospheric pressure to force fluid into the chambers. (Fluid outside the inlet is at atmospheric pressure or higher.)

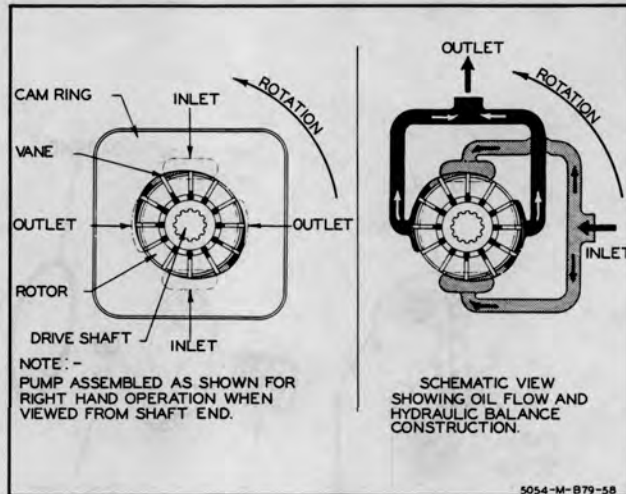


Plate 5054. Schematic Oil Flow Diagram

This fluid is trapped between the vanes and carried past the large diameter or dwell section of the ring. As the outlet section is approached, the ring diameter decreases and the fluid is forced out into the system. System pressure is fed under the vanes, assuring their sealing contact against the ring during normal operation.

**HYDRAULIC BALANCE**

The pump ring is shafted so that the two pumping chambers are formed diametrically opposed. Thus, hydraulic forces which would impose side loads on the shaft cancel each other out.

**PRESSURE PLATE**

The pressure plate seals the pumping chamber as shown in Plate 7725. A light spring holds the plate against the cartridge until pressure builds up in the system. System pressure is effective against the area at the back of the plate, which is larger than the area exposed to the pumping cartridge. Thus, an unbalanced force holds the plate against the cartridge, sealing the cartridge and providing the proper running clearance for the rotor and vanes.

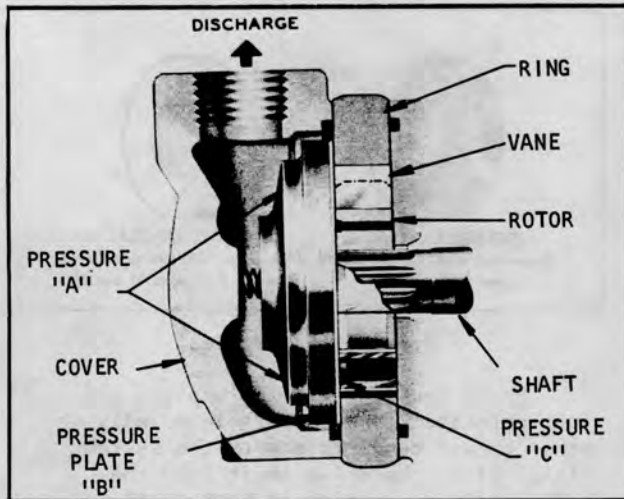


Plate 7725. Schematic View Pump Cartridge and Cover Recess

SHAFT ROTATION

N O T E

THESE PUMPS MUST BE DRIVEN IN THE DIRECTION OF THE ARROWS CAST ON THE PUMP RING.

C A U T I O N

NEVER DRIVE A PUMP IN THE WRONG DIRECTION OF ROTATION. SEIZURE MAY RESULT, NECESSITATING EXPENSIVE REPAIRS.

INSPECTION

Periodic inspection of the fluid condition and tube or piping connections can save time-consuming breakdowns and unnecessary parts replacement. The following should be checked regularly.

1. All hydraulic connections must be kept tight. A loose connection in a pressure line will permit the fluid to leak out and damage to the pump can result. In suction or return lines, loose connections permit air to be drawn into the systems, resulting in noisy and/or erratic operation.

2. Clean fluid is the best insurance for long service life. Therefore, the reservoir should be checked periodically for dirt or other contaminants.

If the fluid becomes contaminated the system should be thoroughly drained and the reservoir cleaned before new fluid is added.

3. Filter elements also should be checked and replaced. A clogged filter element results in a higher pressure drop. This can force particles through the filter which would ordinarily be trapped, or can cause the by-pass to open, resulting in a partial loss of filtration.

4. A pump which is running excessively hot or noisy is a potential failure. Should a pump become noisy or overheated, the machine should be shut down immediately and the cause of improper operation corrected.

GENERAL

Plug all removed units and cap all lines to prevent the entry of dirt into the system. During disassembly, pay particular attention to identification of the parts, especially the cartridges, for correct reassembly. Plate 5777 is an exploded view which shows the proper relationship of the parts for disassembly and reassembly.

DISASSEMBLY

1. Disassembly of Basic Pump - See Plate 5777. Clamp the pump body in a vise (not too tightly), cover end up, and remove the four cover screws. Note the position of the cover port with respect to the body port before lifting off the cover and "O" Ring.

Remove the pressure plate and spring and note the position of the ring for correct reassembly. Lift off the ring and remove the locating pin. Separate the vanes from the rotor and remove the rotor from the shaft.

Turn the pump body over and remove the shaft key and the snap ring which retains the outer bearing. Tap with a soft hammer so the splined end of the shaft to force the shaft out of the body. Support the bearing inner race and press the shaft out of the bearing. Pull the shaft seal out of the body with a suitable hooked tool and press out the inner bearing.

INSPECTION AND REPAIR

1. Discard the used shaft seal and all "O" rings. Wash the metal parts in mineral oil solvent, blow them dry with filtered compressed air and place them on a clean surface for inspection.

2. Check the wearing surfaces of the body, pressure plate, ring and rotor for scoring and excessive wear, remove light score marks by lapping. Replace any heavily scored or badly worn parts.



3. Inspect the vanes for burrs, wear and excessive play in the rotor slots. Replace the rotor if the slots are worn.

4. Check the bearings for wear and looseness. Rotate the bearings while applying pressure to check for pitted or cracked races.

5. Inspect the oil seal mating surface on the shaft for scoring or wear. If marks on the shaft cannot be removed by light polishing, replace the shaft.

**REASSEMBLY**

Coat all parts with hydraulic fluid to facilitate reassembly and provide initial lubrication. Use small amounts of petroleum jelly to hold "O" rings in place during assembly.

**N O T E**

DURING HANDLING AND SHIPPING OF THE PRECISION MACHINED CARTRIDGE PARTS, IT IS POSSIBLE TO RAISE BURRS ON THE SHARP EDGES. ALL SHARP EDGES ON THE PARTS OF A NEW CARTRIDGE KIT SHOULD BE STONED PRIOR TO INSTALLATION.

1. Reassembly of Pump - See Plate 5777. Begin reassembly by pressing the shaft into the front bearing while supporting the bearing inner race. Next, press the inner bearing into the body, using a driver which contacts the outer race only. Be certain both bearings are firmly seated.

**N O T E**

BEFORE ASSEMBLING THE SHAFT SEAL, DETERMINE THE CORRECT POSITION OF THE SEALING LIP. (SEE PLATE 8293) DOUBLE LIP SEALS ARE ASSEMBLED WITH THE SPRING TOWARD THE PUMPING CARTRIDGE. SINGLE LIP SEALS HAVE TWO PRESSURE HOLES, WHICH ARE ASSEMBLED TOWARD THE SHAFT END OF THE PUMP.

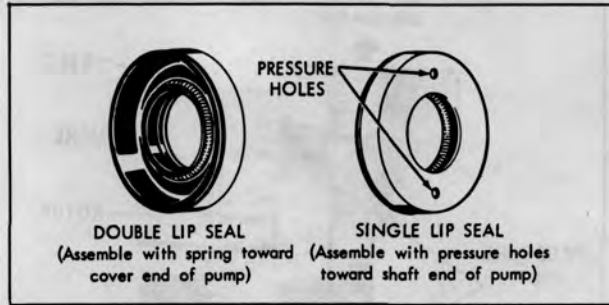


Plate 8293. Shaft Seal

Press the seal firmly in place and lubricate the lip with petroleum jelly or other grease compatible with the system fluid. Slide the drive shaft into the body until the bearing is seated. If necessary tap lightly on the end of the shaft. Install the snap ring.

Install new "O" rings in the body and cover. Insert the ring locating pins in the body and assemble the ring so that the arrow on the perimeter points in the proper direction of rotation. Install the rotor on the shaft and insert the vanes in the rotor slots. Be certain the radius edges of the vanes are toward the cam ring.

Place the pressure plate on the locating pins and flat against the ring. Use a small amount of petroleum jelly or grease to stick the spring on the protrusion of the pressure plate. Carefully install the cover with the outlet port in the correct position. Torque the cover screws 65 to 75 ft. lbs. Turn the shaft through by hand to insure that there is no internal binding. Install the shaft key.

Assemble the pump to its mounting flange using a new gasket. Be certain it is flat to avoid misalignment of the shaft.



## TROUBLE SHOOTING

It should always be remembered that many apparent pump failures are actually the failures of other parts of the systems. The cause of improper operation is best diagnosed with adequate testing equipment and a thorough understanding of the complete hydraulic system.

TROUBLE	PROBABLE CAUSE	REMEDY
PUMP NOT DELIVERING FLUID	DRIVEN IN THE WRONG DIRECTION OF ROTATION	The drive direction must be changed immediately to prevent seizure. Plate 5054 shows the correct ring position (viewed from cover end.)
	KEY OR SHAFT SHEARED OR DISENGAGED	Disassemble the pump and check the shaft and cartridge for damage. Replace the necessary parts.
	FLUID INTAKE PIPE IN RESERVOIR RESTRICTED	Check all filters/strainers for dirt and sludge. Clean if necessary.
	FLUID VISCOSITY TOO HEAVY TO PICK UP PRIME	Completely drain the system. Add new filtered fluid of the proper viscosity. Replace filter/strainers.
	AIR LEAKS AT THE INTAKE. PUMP NOT PRIMING	Check the inlet connections to determine where air is being drawn in. Tighten any loose connections. Check the minimum drive speed which may be too slow to prime the pump.
	VANE(S) STUCK IN THE ROTOR SLOTS(S)	Disassemble the pump. Check for dirt or metal chips. Clean the parts thoroughly and replace any damaged pieces. If necessary flush the system and refill it with clean fluid.
INSUFFICIENT PRESSURE BUILD-UP	WORN PARTS CAUSING INTERNAL LEAKAGE OF PUMP DELIVERY	Replace pump cartridge.
PUMP MAKING NOISE	PUMP INTAKE PARTIALLY BLOCKED	Service the filters/strainers. Check the fluid condition and, if necessary, drain and flush the system. Refill with clean fluid.
	AIR LEAKS AT THE INTAKE OR SHAFT SEAL. (OIL IN RESERVOIR WOULD PROBABLY BE FOAMY)	Check the inlet connections and seal to determine where air is being drawn in. Tighten any loose connections and replace the seal if necessary.
	PUMP DRIVE SPEED TOO SLOW OR TOO FAST	Operate the pump at the recommended speed.



INDUSTRIAL TRUCK DIVISION



OPERATORS

MAINTENANCE

PARTS

MANUAL

FOR

CY-60

FORM NO. 1-60

CLARK EQUIPMENT COMPANY

PUBLISHED BY

TECHNICAL SERVICE DEPARTMENT  
BATTLE CREEK, MICHIGAN, U.S.A.



# INDUSTRIAL TRUCK DIVISION



## HYDRAULIC SYSTEM

### TROUBLE SHOOTING GUIDE

The following chart lists the difficulties which may possibly be experienced with the pump and hydraulic system and indicates the cause and remedy for each of the troubles listed. It should always be remembered that

"Pressure" and "Delivery" are factors which are usually dependent upon each other. Next to having adequate tools, it is probably most important to have adequate pressure gauge equipment when doing repair work.

TROUBLE	PROBABLE CAUSE	CORRECTION
A. Pump not delivering oil.	1. Wrong direction of rotation.	1. Must be reversed immediately to prevent seizure and breakage of parts due to lack of oil.
	2. Tank oil level low.	2. Add recommended oil.
	3. Oil intake pipe or suction filter plugged.	3. Filters must be cleaned of lint soon after new oil is added, due to fact new oil contains considerable amount.
	4. Air leak in suction line.	4. Will prevent priming, or cause noise and irregular action of control circuit.
	5. Oil viscosity too heavy to pick up prime.	5. Thinner oil should be used, per recommendations for given temperature and service.
	6. Broken pump shaft or rotor.	6. Refer to preceding service data for replacement instructions.
B. Pump not developing pressure.	1. Pump not delivering oil for any of the above reasons.	1. Check oil circulation by watching oil in tank.
	2. Relief valve setting not high enough.	2. Block machine travel, or oil circulation, and test with pressure gauge.
	3. Relief valve sticking open.	3. Dirt under pressure adjustment ball. See relief valve instructions.
	4. Leak in hydraulic control system (cylinders or valves).	4. Find leak and correct.
	5. Vane or vanes stuck in rotor slots.	5. Inspect for wedged chips.
	6. Head too loose. (Very frequent).	6. Must not be tightened too tightly.
	7. Broken core passages in pump body.	7. Replace body and check maximum relief valve setting immediately for shock overload condition.
	8. Partially clogged intake line, intake filter or restricted intake pipe.	8. Pump must receive intake oil freely or cavitation will take place.



# INDUSTRIAL TRUCK DIVISION



TROUBLE	PROBABLE CAUSE	CORRECTION
C. Pump making noise.	<ol style="list-style-type: none"> <li>1. Small air leak at pump intake piping joints.</li> <li>2. Air leak at pump shaft packing.</li> <li>3. Stuck pump vane.</li> <li>4. Pump head too loose.</li> <li>5. Tank air vent plugged.</li> <li>6. Too high oil viscosity.</li> <li>7. Shaft packing worn.</li> </ol>	<ol style="list-style-type: none"> <li>1. Test by pouring oil on joints while listening for change in operation. Tighten as required.</li> <li>2. Repair or replace.</li> <li>3. Inspect for wedged chips or sticky oil and reassemble per preceding instructions.</li> <li>4. Test by pouring oil over head.</li> <li>5. Must be open thru breather opening or air filter.</li> <li>6. Use recommended oils.</li> <li>7. Replace shaft packing per preceding instructions.</li> <li>8. Replace filter element.</li> </ol>
D. Forks do not lift to maximum height.	<ol style="list-style-type: none"> <li>1. Hydraulic Oil level low.</li> </ol>	<ol style="list-style-type: none"> <li>1. Fill sump tank.</li> </ol>
E. Load on forks drifts down or tilts forward with controls in neutral.	<ol style="list-style-type: none"> <li>1. Worn or damaged lift or tilt seal.</li> <li>2. Leak in hydraulic system between lift cylinder and valve or tilt cylinder and valve.</li> <li>3. Oil leaking through valve due to wear or damage to valve parts.</li> </ol>	<ol style="list-style-type: none"> <li>1. Install new seal.</li> <li>2. Locate leak and tighten connections or replace parts as indicated.</li> <li>3. Replace worn or damaged valve section complete with new valve plunger or spool.</li> </ol>
F. Lift or tilt action fails.	<ol style="list-style-type: none"> <li>1. Loss of oil pressure.</li> </ol>	<ol style="list-style-type: none"> <li>1. Remove pump to valve line at pump and install a "Tee" into line. Install a pressure gauge capable of registering 2000 PSI into "Tee". If a pressure of 1900 PSI is not indicated at full volumn flow thru the relief valve, check the relief valve for chips or foreign matter which may be holding the plunger off the seat. If the valve is clean adjust the relief valve screw in one turn and check again if pressure fails to respond look for trouble in pump. Do not adjust relief valve too far for unseating of seals can result. If the relief valve pressure is correct, check the pressure in the lift and tilt lines. If relief valve pressure is not being delivered, trouble may be leaks around plungers back to sump instead of to lines selected.</li> </ol>
G. Oil leak at top of lift cylinder assembly.	<ol style="list-style-type: none"> <li>1. Worn or damaged lift piston seal.</li> <li>2. Scored cylinder wall.</li> <li>3. Plugged vent line.</li> </ol>	<ol style="list-style-type: none"> <li>1. Replace seal.</li> <li>2. Replace cylinder.</li> <li>3. Clean out vent line. Replace if collapsed.</li> </ol>
H. Oil leak around piston rod at tilt cylinder.	<ol style="list-style-type: none"> <li>4. Worn or damaged oil seal.</li> <li>1. Worn seal.</li> <li>2. Scored piston rod.</li> </ol>	<ol style="list-style-type: none"> <li>4. Replace seal.</li> <li>1. Replace seal.</li> <li>2. Replace rod and eliminate cause of scoring which may be caused by misalignment, worn bearing or foreign matter.</li> </ol>
I. With load centered on lift forks load is lifted unevenly.	<ol style="list-style-type: none"> <li>1. Lift chains out of adjustment.</li> </ol>	<ol style="list-style-type: none"> <li>1. Adjust chains.</li> </ol>





# MASTER MAINTENANCE MANUAL



## TESTING THE HYDRAULIC SYSTEM

### SCHROEDER HYDRA-SLEUTH

	PAGES
A. A pictorial and Schematic diagram of the unit and instructions for its usage. ....	29M900B
B. A description of the Basic Test Method: (1) The Supply System Test which includes the pump test. .... (2) The "Tee Test" .....	29M900C 29M900F
C. How to Interpret "Strange Readings".	29M900K
D. How to Make Some Field Repairs to the Hydra-Sleuth. ....	29M900L
E. Addendum .....	29M900M

Your Schroeder Hydra-Sleuth is an invaluable instrument for:

- (1) Determining the condition of a hydraulic pump.
- (2) Troubleshooting a hydraulic system.
- (3) Testing hydraulic system before and after rebuild.
- (4) Preventive maintenance testing of a hydraulic system.

With the Hydra-Sleuth you can tell how much hydraulic horsepower (flow times pressure) your system will deliver to the cylinder (or motor) that does the work.

You can also learn where you are losing this "Hydraulic Horsepower" in a weak system.

The section has been carefully compiled to enable you to put the Hydra-Sleuth to its maximum use. We strongly urge you to read it thoroughly.

### PRESSURE GAUGE:

Reads directly in pounds per square inch (PSI)

### TEMPERATURE GAUGE:

Reads directly in degrees Fahrenheit and indicates the temperature of the oil passing through the instrument.

### FLOW GAUGE:

Reads two scales in gallons per minute

- 0 - 30 gallons
- 9 - 30 gallons

Read the scale that corresponds with the orifice selector position.

Turn orifice selector to the left (counter-clockwise) to read 10 Gal. Scale. Turn orifice selector to the right (clockwise) to read 30 gallons scale.

You may switch from one scale to the other, while operating machine. Always start on 30 gallon scale.

### LOAD VALVE:

The load valve is a flow restrictor or shut off valve. Turning the valve to the right throttles flow through the Hydra-Sleuth, thus the operator may load a hydraulic pump or circuit to the desired test pressure, simulating work.

### SAFETY PLUG:

Located opposite the load valve this plug protects the Hydra-Sleuth and the tested system from pressures in excess of 3200 PSI. When pressure becomes higher the plug will rupture and dump oil to atmosphere.

### HYDRAULIC FLUID:

Unless marked to the contrary, the unit is for use with petroleum, hydraulic fluids.

### HOW TO CONNECT THE PORTABLE TESTER:

Using a 1/2" hose or larger, connect tester INLET PORT to the flow to be tested. Connect the tester outlet port to reservoir fill port, or system return line.

### HYDRA-SLEUTH ADJUSTMENTS BEFORE OPERATION:

- A. Depending on flow (GPM) to be checked choose proper orifice. (It is good practice to start always on 30 gallon scale.)
- B. Fully open load valve by turning all the way to the left.

### HYDRA-SLEUTH ADJUSTMENTS DURING OPERATION:

1. Turn load valve to right to develop test pressure.

### C A U T I O N

LOAD VALVE IS CAPABLE OF VERY HIGH PRESSURES.

## HYDRA-SLEUTH-PICTORIAL & SCHEMATIC

SAFETY BUILT-IN  
BLOW-OUT PLUG  
RELIEVES TO ATMOS-  
HERE THIS SIDE

PRESSURE GAUGE

INLET PORT

TEMPERATURE  
GAUGE

OPERATING  
INSTRUCTIONS

LOAD VALVE  
HANDLE

CARRYING HANDLE

SPARE BLOW-OUT  
PLUG CARRIED  
THIS END

FLOW GAUGE

OUTLET PORT  
THIS SIDE

ORIFICE  
SELECTOR HANDLE

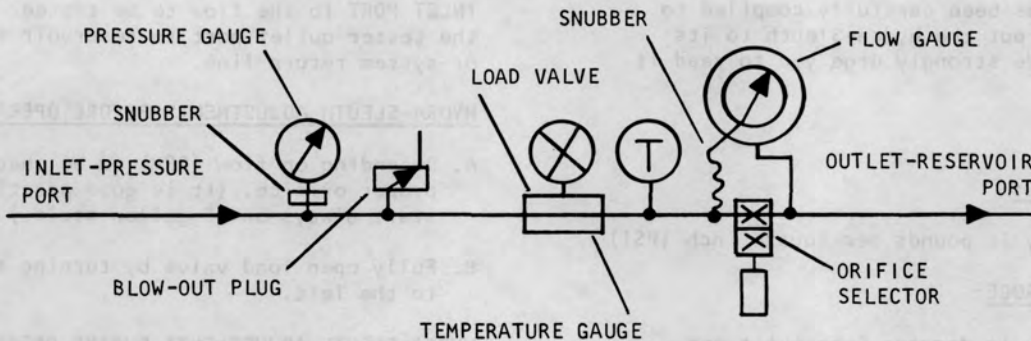


Plate 8625. Hydra-Sleuth Pictorial and Schematic Illustrations

- A. Always start test with load valve fully open.
- B. Do not exceed design pressure of system under test.
- C. Keep load pressures within range of the Hydra-Sleuth pressure gauge.

THE BASIC TEST METHOD

The Hydra-Sleuth is an instrument that will:

- (1) Measure the volume of oil passing thru it.
- (2) Measure the temperature of the oil passing thru it.
- (3) Furnish a manually variable means of restricting the oil passing thru it and a measurement of the resultant pressure.
- (4) Determine the amount of power the system is capable of delivering (Horsepower = Flow X Pressure).

The test consist of:

- (1) First learning how much fluid in gallons per minute is circulating in the system at no load, and then:
- (2) By applying a desired pressure on all the components, find out how much of this fluid is not available for work because it is:
  - a. Not being delivered by pump due to internal slippage caused by wear.
  - b. Not being delivered to the working component (cylinder or motor) because it is leaking back to tank by passageways that are supposedly closed; namely valve leakage.
  - c. Not being used properly by the cylinder or motor because it is leaking past the cylinder packing (or the parts of the motor) and returning to the tank without having produced any useful work.

There are two ways of using your Hydra-Sleuth to learn these things about a hydraulic circuit. The simplest and most readily understood is the "Supply System Test." This test has the disadvantages of (1) being more laborious since it requires reconnecting the tester frequently and (2) not providing a test for the cylinder or motor.

The other method is called the "Tee Test." Once the user has acquired some skill, the tee test is the better test since it requires less

work and tests ALL the components of the system from one point.

Both methods will be described but certain things should be done before either is attempted:

- (1) Know the output of the pump and the proper relief valve setting of the system you will test.
- (2) Bring the oil up to normal operating temperature.
- (3) Keep engine RPM constant during test.

SUPPLY SYSTEM TEST (See Sketch A)

Hydraulic trouble has been reported and with the Hydra-Sleuth you want to locate the trouble in a circuit the same or similar to Sketch A, on following page.

TESTING THE PUMP (See Sketch B)

**N O T E**

The first step or pump test is a good way to familiarize yourself with the Hydra-Sleuth. Purpose, to determine if pump is o.k., completely "shot" or partially worn.

This is done by disconnecting the discharge line of the pump from the system. (Point 1), reconnecting it to the inlet port of the Hydra-Sleuth and connecting the outlet port of the instrument back to the tank, through the fill or any return line.

Then start the machine, drive the pump at full RPM and measure the oil pumped through the tester to the reservoir at no load.

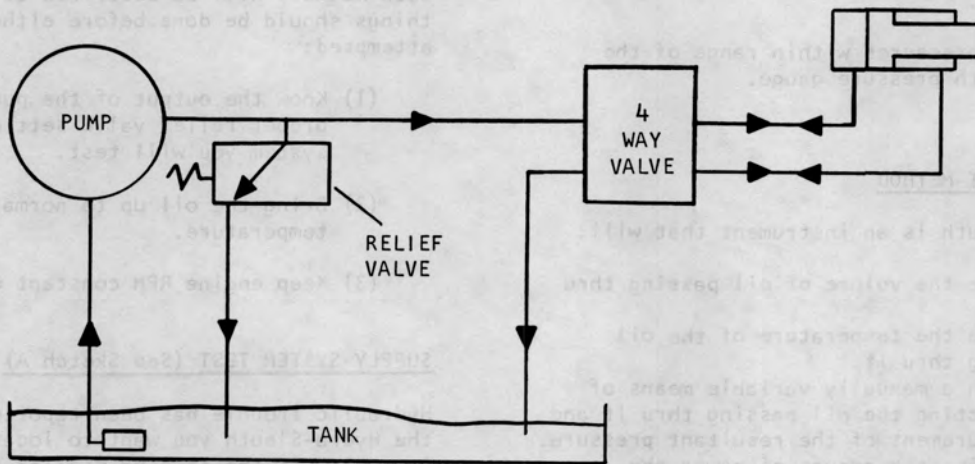
Then by turning the load valve to the right; make the pump deliver oil through the tester at the desired working pressure - and measure the oil at this pressure. This GPM reading is the usable oil delivered by the pump at operating pressures and temperature and tells you what the pump is delivering under actual working conditions.

The GPM difference between the two readings - no load and operating pressures will be the internal slippage in the pump.

If the difference in these readings is small, the pump is O.K. and you must look elsewhere for the trouble. If it is large, you have located at least part of the trouble.



SUPPLY SYSTEM TEST - SKETCH A



TESTING THE PUMP (See Sketch B)

N O T E

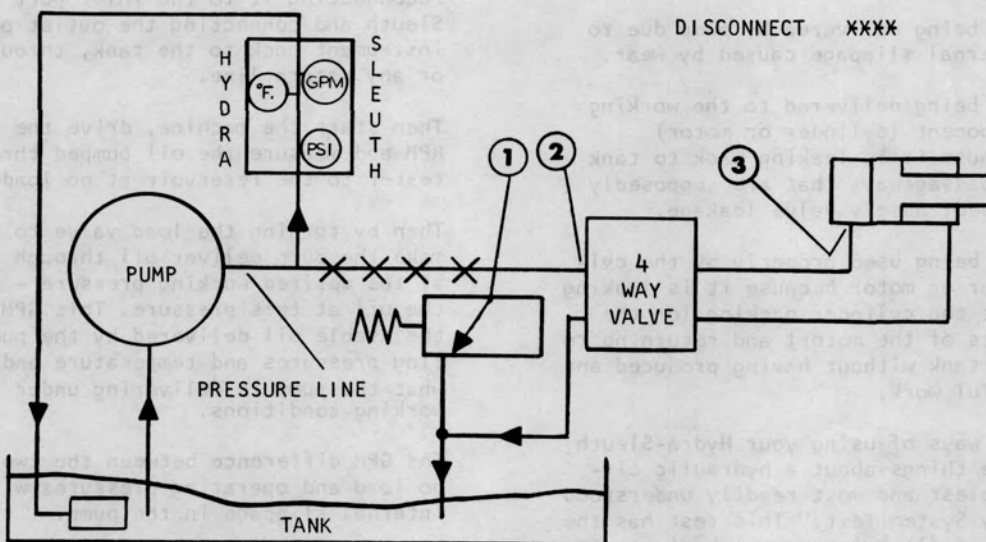


Plate 8626. Supply System Test—Sketch "A" (Upper Illustration),  
Testing the Pump - Sketch "B" (Lower Illustration)



GPM at NO LOAD	GPM at Operating Pressures	Interpretation of Reading
20	19	Pump is O.K.
20	10	Pump is partilly worn & 50% efficient. Cyl. in Sketch A would take twice the time to complete its movement.
20	0	Pump is completely shot there will be no Cyl. movement under load.

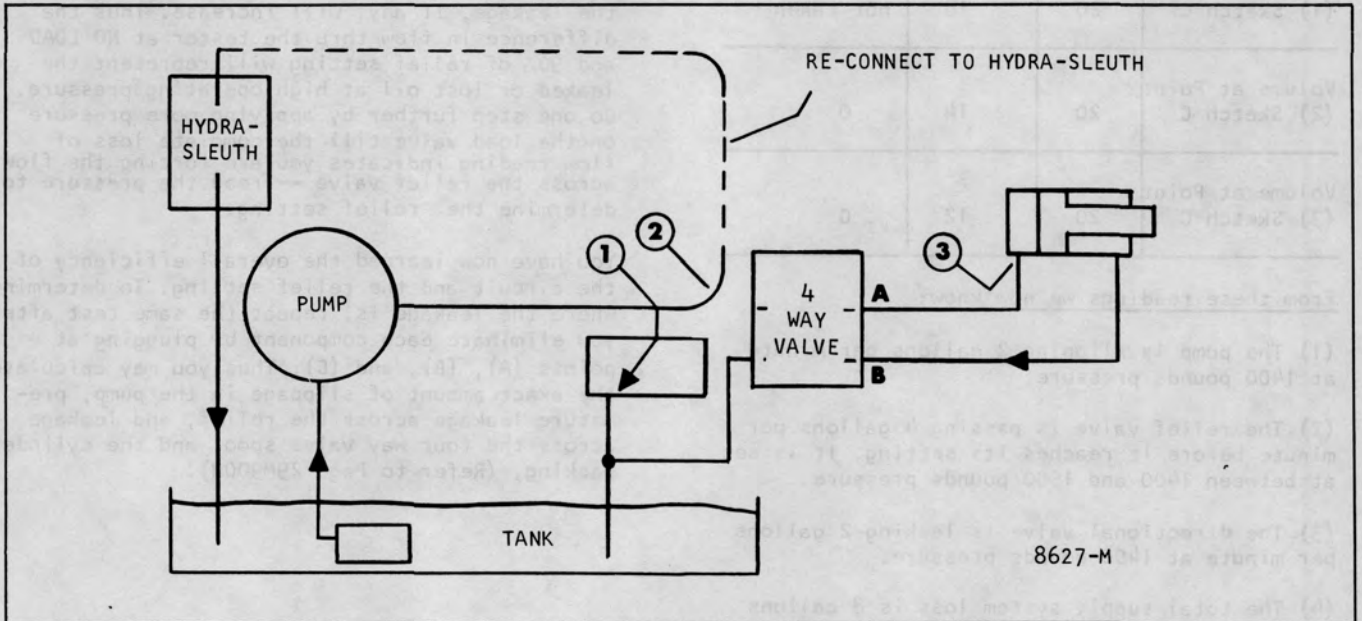


Plate 8627. Testing Other Components of the Supply System—Sketch "C"

Having learned the condition of the pump and relief, disconnect the line at point (3) and connect it to the Hydra-Sleuth and take additional readings — any further reduction will be the leakage in the four way valve.

At point (3) you are also measuring the oil delivered to the working component (cylinder or motor).

Let us say the readings you have taken are as follows:

	Operating Relief Valve		
	No Load 0 PSI	Pressure 1400 PSI	Setting 1500 PSI
Volume at Point (1) Sketch C	20	18	not taken
Volume at Point (2) Sketch C	20	14	0
Volume at Point (3) Sketch C	20	12	0

From these readings we now know:

- (1) The pump is slipping 2 gallons per minute at 1400 pounds pressure.
- (2) The relief valve is passing 4 gallons per minute before it reaches its setting. It is set at between 1400 and 1500 pounds pressure.
- (3) The directional valve is leaking 2 gallons per minute at 1400 pounds pressure.
- (4) The total supply system loss is 8 gallons per minute.

Replacement of the relief valve is indicated at once and the wise maintenance man will schedule the four ways valve for a change at the next convenient time. Pump is in Good Shape.

THE "TEE TEST"

This test consists of placing a tee in the discharge line of the pump (Refer to Page 29M900G for hookup and Sketch D Page 29M900H for procedure) connecting the inlet port of the Hydra-Sleuth to the tee and the outlet port of the Hydra-Sleuth to the tank. By doing so you can apply any desired pressure to all parts of the system and determine their condition. Also note that by closing the load valve altogether you leave the Hydra Sleuth pressure gauge in the

circuit but cut out the pressure gauge and temperature gauge. This gives you a "teed-in" pressure gauge and enables you to check the setting of the main relief valve.

By positioning the spool of the four way valve to direct oil to cylinder port A and closing the Hydra-Sleuth load valve just enough to run the piston of the cylinder out to the end of its travel, the oil may now flow to the tank either:

- (1) Through the Hydra-Sleuth, or
- (2) Through supposedly closed passages - i. e. leaks.

By opening the Hydra-Sleuth load valve the pump flow will all pass thru the Hydra-Sleuth — by slowly closing the load valve the pressure on each and evenly component is increased and hence the leakage, if any, will increase. Thus the difference in flow thru the tester at NO LOAD and 90% of relief setting will represent the leaked or lost oil at high operating pressure. Go one step further by applying more pressure on the load valve till the complete loss of flow reading indicates you are forcing the flow across the relief valve — read the pressure to determine the relief setting.

You have now learned the overall efficiency of the circuit and the relief setting. To determine where the leakage is, repeat the same test after you eliminate each component by plugging at points (A), (B), and (C). Thus you may calculate the exact amount of slippage in the pump, premature leakage across the relief, and leakage across the four way valve spool and the cylinder packing, (Refer to Page 29M900H).

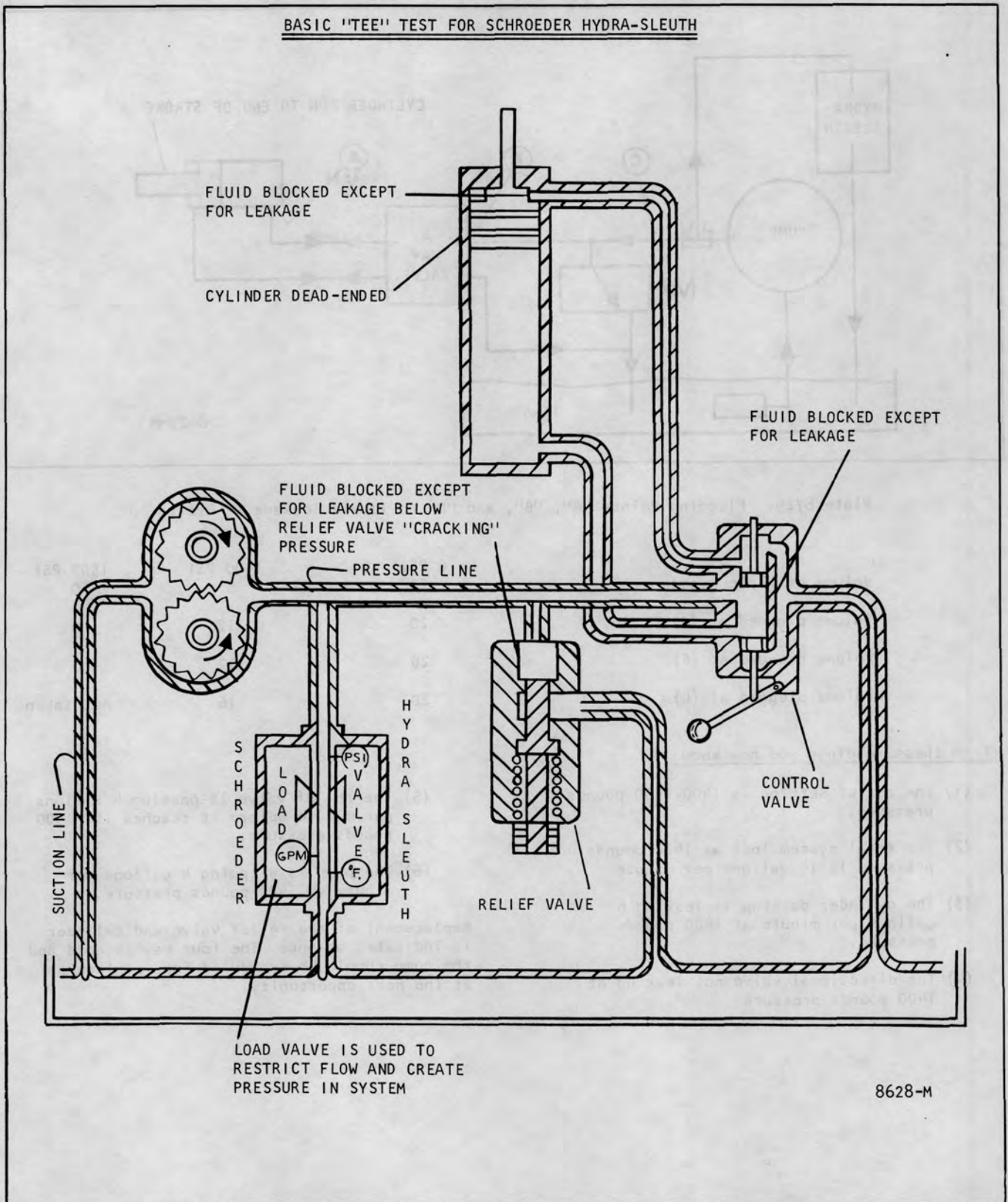


Plate 8628. Basic "Tee" Test For Schroeder Hydra-Sleuth Tester

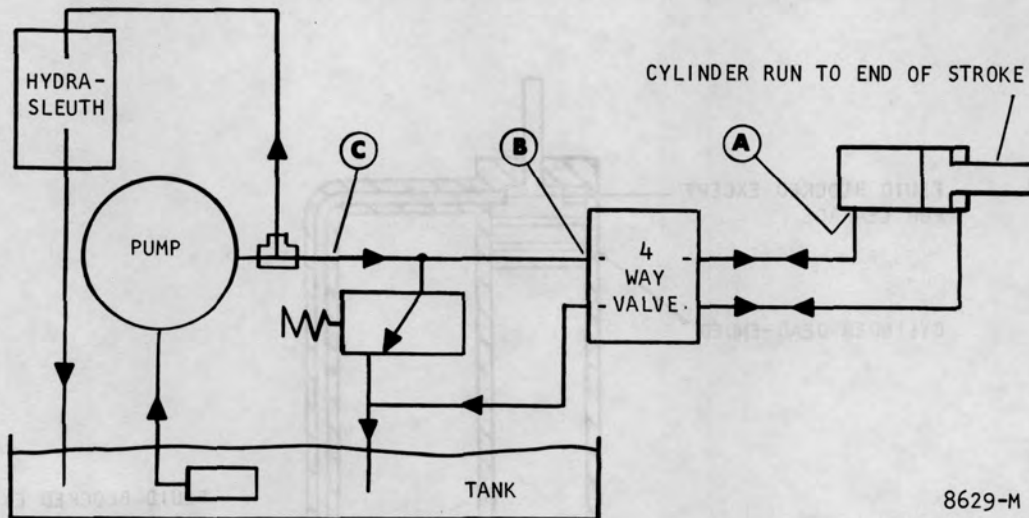


Plate 8729. Plugging Points "A", "B", and "C" to locate leakage — Sketch "D"

	0 PSI	1400 PSI	1500 PSI
Volume of whole system	20	6	0
Volume plugged at (A)	20	12	0
Volume plugged at (B)	20	12	0
Volume plugged at (C)	20	16	not taken

From these readings you now know:

- (1) The relief setting is 1400-1500 pounds pressure.
- (2) The total system loss at 1400 pounds pressure is 14 gallons per minute.
- (3) The cylinder packing is leaking 6 gallons per minute at 1400 pounds pressure.
- (4) The directional valve not leaking at 1400 pounds pressure.
- (5) The relief valve is passing 4 gallons per minute before it reaches its 1500 pounds pressure.
- (6) The pump is slipping 4 gallons per minute at 1400 pounds pressure.

Replacement of the relief valve and cylinder is indicated at once. The four way is good and the pump should be scheduled for replacement at the next opportunity.



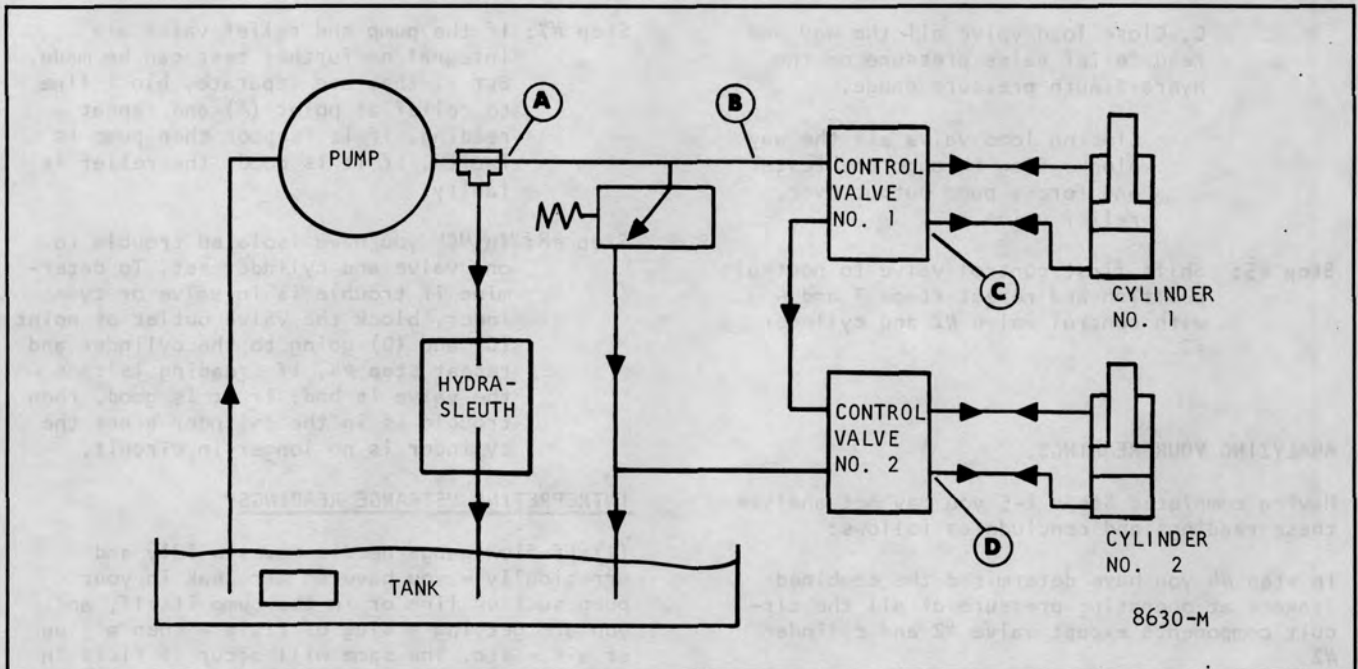


Plate 8630. Hydraulic Schematic Showing Test Points — Sketch E

This tee test may be applied to simple or complicated circuits. A stop-by-stop procedure for a multiple circuit is described below:

**Step #1:** Connect Hydra-Sleuth inlet port to a Tee at point (A) between pump and first control valve.

**Note:** An extra pressure port in relief valve or control valve can be used.

Connect Hydra-Sleuth return port to reservoir or low pressure return line.

**Step #2:** Start machine and if gasoline or diesel engine is involved increase throttle to desired RPM. Bring oil to operating temperature.

**Step #3:** Shift first control valve in circuit

to operating position and partially close load valve to fully extend cylinder. Observe pressure while cylinder is moving. Excessive pressure indicates a mechanical bind.

**Step #4:** When first cylinder is fully extended FULLY OPEN LOAD VALVE.

**A.** Read Gallons per Minute at "NO LOAD" Pressure. With cylinder fully extended and control valve open, pump output would normally pump over relief and flow thru tester.

**B.** Close load valve enough to create operating pressure and again read gallons per minute.

C. Close load valve all the way and read relief valve pressure on the Hydra-Sleuth pressure gauge.

Closing load valve all the way blocks flow through the tester and forces pump output over relief valve.

Step #5: Shift first control valve to neutral position and repeat steps 3 and 4 with control valve #2 and cylinder #2.

#### ANALYZING YOUR READINGS.

Having completed Steps 1-5 you may not analyze these readings and conclude as follows:

In step #4 you have determined the combined leakage at operating pressure of all the circuit components except valve #2 and cylinder #2.

In step #5 you have determined the combined leakage of all components except valve #1 and cylinder #1.

- A. If both readings show good circuit gallonage and pressures compared with system specifications the whole system is sound.
- B. If both readings show poor gallonage under pressure you have pump or relief valve trouble (PROBABLE - See Step 5) since these are components common to both readings.
- C. If one circuit is good and the other poor the circuit showing the poor reading has a faulty valve or cylinder or both (See Step #8).

THIS TEST IS AN EXCELLENT METHOD TO PROVE CONDITION OF A REBUILT HYDRAULIC SYSTEM.

Now proceed with the following steps 6-7-8- indicated:

Step #6: If readings to both sets of valves and cylinders (See Steps 4 and 5) are poor then block the hose or pipe to the first valve at point (B), repeat reading with the Tester. If reading is same as steps 4 and 5 then you are certain that the trouble is in pump or relief valve.

Step #7: If the pump and relief valve are integral no further test can be made. But if they are separate, block line to relief at point (A) and repeat reading. If it is poor then pump is faulty. If it is good, the relief is faulty.

Step #8: In "C" you have isolated trouble to one valve and cylinder set. To determine if trouble is in valve or cylinder, block the valve outlet at point (C) and (D) going to the cylinder and repeat step #4. If reading is same the valve is bad. If it is good, then trouble is in the cylinder since the cylinder is no longer in circuit.

#### INTREPRETING "STRANGE READINGS"

- (1) If flow gauge needle moves wildly and erratically - you have an air leak in your pump suction line or in the pump itself, and you are getting a slug of fluid - then a slug of air - etc. The same will occur if fluid in the sump tank is low.
- (2) If flow gauge needle shows below correct pump flow even at NO LOAD and holds close to this volume at higher loads - you have a restriction in your suction line.
- (3) If oil flows out of the safety blow out plug on the side of the Hydra-Sleuth you have ruptured the disc by exceeding the pressure of the Hydra-Sleuth Pressure Gauge - replace disc - see instructions on Field Repairs.
- (4) If flow gauge needle persistently reads backwards (dropping below Zero GPM) the flow thru the Hydra-Sleuth is reversed. Correct flow direction by interchanging inlet and outlet or change position of directional control valve. Flow gauge may have been damaged. See Instructions under Field Repairs.
- (5) If flow gauge needle swishes quickly back and forth over dial during start up or throwing of a valve, this is a sign of high flow and pressure surges. Only in extreme cases will the flow gauge be damaged. (See Field Repairs.)
- (6) The temperature gauge will show a higher reading, while load valve is operated (due to heating of the oil, approximately 7 degrees per 1000 PSI) and will return to inlet oil temperature when load valve is opened.
- (7) If flow gauge needle does not return exactly into "Zero" zone, while Hydra-Sleuth is subjected to extreme temperatures, flow readings are still correct. If gauge does not return to zero at room temperature check for cause. (See Field Repairs)



# MASTER MAINTENANCE MANUAL



## HOW TO MAKE SOME FIELD REPAIRS TO THE HYDRA-SLEUTH

The Schroeder Hydra-Sleuth is a rugged instrument which seldom needs repair. It is constructed for easy maintenance and all repairs can be made in the field.

### FAULT

### CAUSE AND REMEDY

Blow out plug disc ruptured

Caused by excess pressure. Install new cap and disc assembly (a spare is carried in the orifice pocket). Torque should be limited to approximately 150 inch pounds.

Flow gauge does not read correctly and does not return to zero

Remove flow gauge. If it returns to zero blow air into 1/8" bushing to clear obstruction in capillary snubber tube. If it does not return to zero replace with a new flow gauge. Make sure gauge needle is below the level of the surrounding steel housing so that it is free to move. Broken flow gauges are the result of excess flow, reverse flow, or severe surges.

Examine the plastic bag in the flow gauge housing, replace if broken. Reassembly the Hydra-Sleuth. Then pour clean, clear glycerin through 1/8" hole in the bottom of the Hydra-Sleuth until the flow gauge housing is filled. Before installing 1/8" plug direct 10 PSI air pressure (use paint spray reducer) into outlet of tester with inlet plugged. This is partially to inflate the plastic bag while air pressure is applied. Insert and tighten 1/8" socket head pipe plug. (The partially inflated bag absorbs the volume of glycerin that is pushed into the housing by the pipe plug and will absorb the glycerin expansion when Hydra-Sleuth is used with hot oil.

Temperature gauge does not record temperature changes

Install new temperature gauge. Thread deep enough into bushing to clear Plexiglass cover. Caused by excessive back pressure - the sensing tube may be collapsed.

Pressure gauge reads incorrect

Install new pressure gauge. Thread deep enough into block that the gauge clears the Plexiglass cover.

Leakage

Tighten gauges or plugs to eliminate leakage. The inlet and outlet threads are straight threads with 1/0" rings to seal. Do not over-tighten the fittings but replace with 1/0" rings to seal again against the aluminum block and the Plexiglass. Replace if 1/0" rings become damaged during repair work.

Load Valve and Orifice Selector Leakage

Replace Faulty 1/0" Rings.

USE ONLY GENUINE SCHROEDER PARTS



# MASTER MAINTENANCE MANUAL



## ADDENDUM

We have run extensive tests on pressure drops through 1/4" gauge ports on flow control valve and relief valves at both 100° F and 150° F.

Pressure required to flow from these ports 50 GPM averages 165 PSI and to flow 35 GPM, 90 PSI.

There is remarkable little difference in these pressures with temperature changes.

Tee Tests with the Hydra-Sleuth can be run by using 1/4" or larger gauge ports (commonly found in relief valves) as Tees if the flow rate does not exceed 50 GPM with 1.4" ports.

With this hook up add the following pressures to the reading of the load gauge:

Flows up to 20 GPM add 50 PSI

Flows up to 30 GPM add 80 PSI

Do not apply these adders to the load gauge readings when testing relief valve settings.



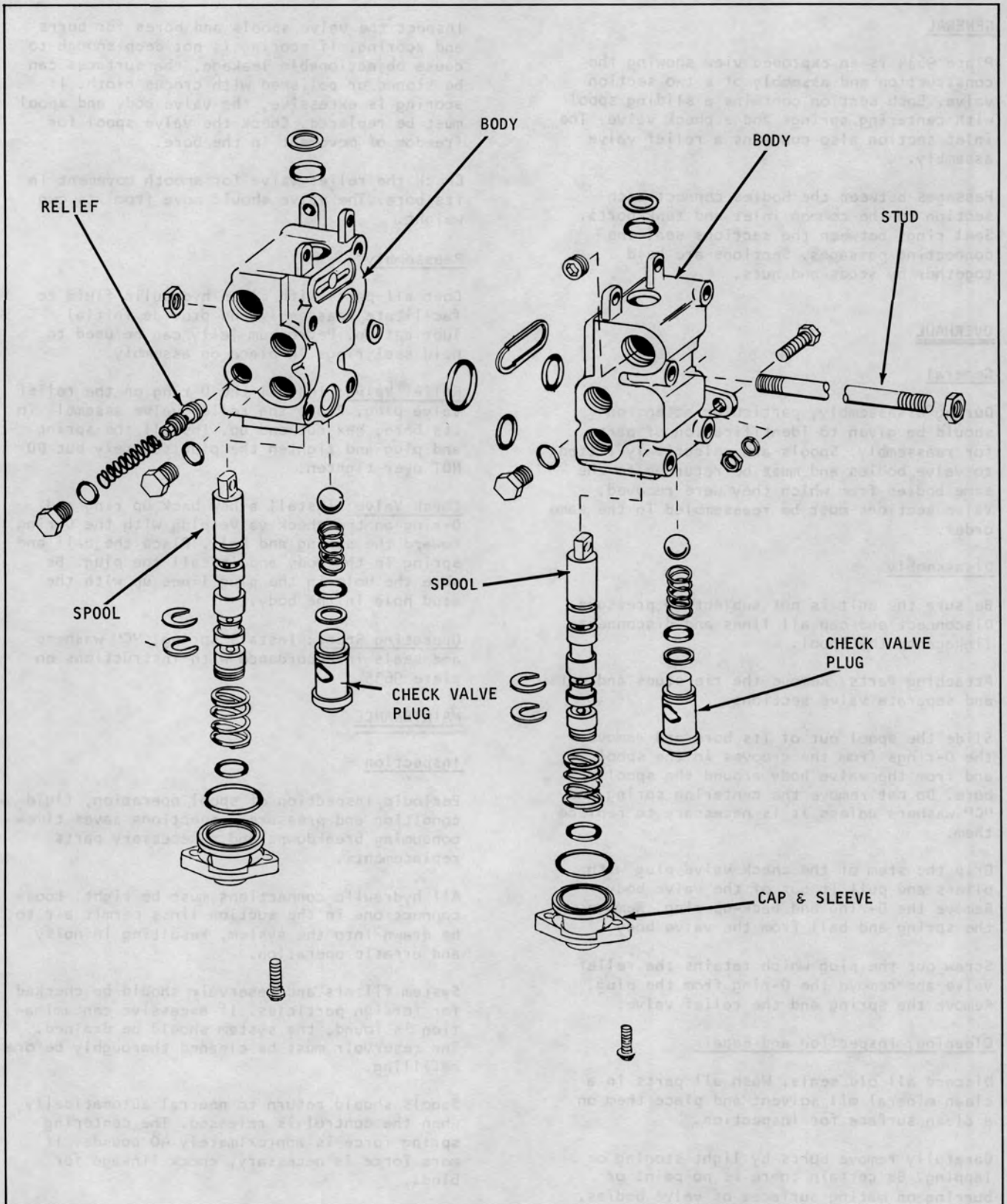


Plate 9634. Hydraulic Valve

GENERAL

Plate 9634 is an exploded view showing the construction and assembly of a two section valve. Each section contains a sliding spool with centering springs and a check valve. The inlet section also contains a relief valve assembly.

Passages between the bodies connect each section to the common inlet and tank ports. Seal rings between the sections seal the connecting passages. Sections are held together by studs and nuts.

OVERHAULGeneral

During disassembly, particular attention should be given to identification of parts for reassembly. Spools are selectively fitted to valve bodies and must be returned to the same bodies from which they were removed. Valve sections must be reassembled in the same order.

Disassembly

Be sure the unit is not subject to pressure. Disconnect and cap all lines and disconnect linkage to the spool.

**Attaching Parts:** Remove the tie studs and nuts and separate valve sections.

Slide the spool out of its bore and remove the O-rings from the grooves in the spool and from the valve body around the spool bore. Do not remove the centering spring and "C" washers unless it is necessary to replace them.

Grip the stem of the check valve plug with pliers and pull it out of the valve body. Remove the O-ring and back-up ring. Remove the spring and ball from the valve body.

Screw out the plug which retains the relief valve and remove the O-ring from the plug. Remove the spring and the relief valve.

Cleaning, Inspection and Repair

Discard all old seals. Wash all parts in a clean mineral oil solvent and place them on a clean surface for inspection.

Carefully remove burrs by light stoning or lapping. Be certain there is no paint or burring on mating surfaces of valve bodies.

Inspect the valve spools and bores for burrs and scoring. If scoring is not deep enough to cause objectionable leakage, the surfaces can be stoned or polished with crocus cloth. If scoring is excessive, the valve body and spool must be replaced. Check the valve spool for freedom of movement in the bore.

Check the relief valve for smooth movement in its bore. The valve should move from its own weight.

Reassembly

Coat all parts with clean hydraulic fluid to facilitate reassembly and provide initial lubrication. Petroleum jelly can be used to hold seal rings in place on assembly.

**Relief Valve:** Install the O-ring on the relief valve plug. Place the relief valve assembly in its bore, hex nut end up. Install the spring and plug and tighten the plug securely but DO NOT over tighten.

**Check Valve:** Install a new back up ring and O-ring on the check valve plug with the O-ring toward the spring and ball. Place the ball and spring in the body and install the plug. Be sure the hole in the plug lines up with the stud hole in the body.

**Operating Spool:** Install spring, "C" washers and seals in accordance with instructions on plate 9635.

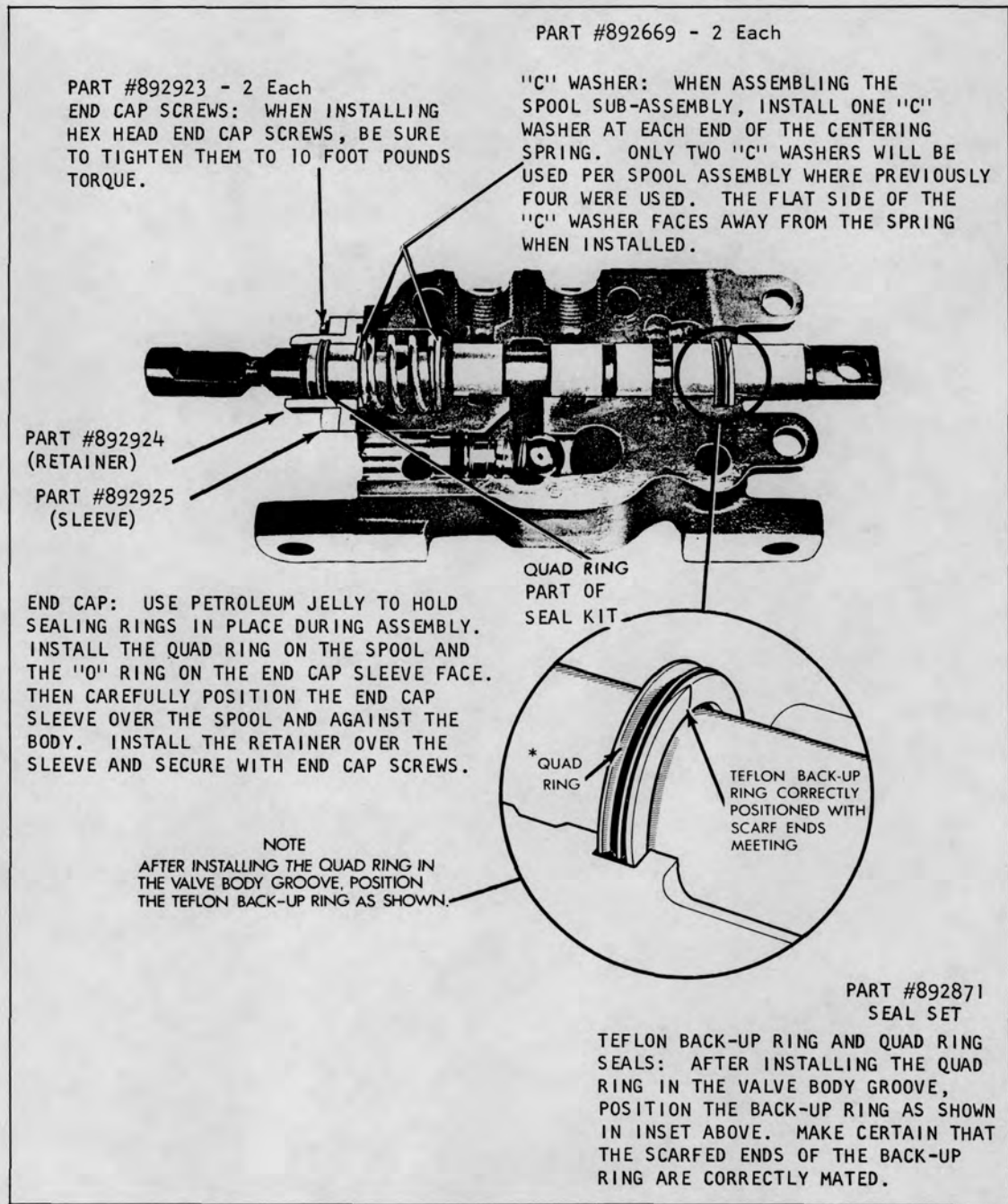
MAINTENANCEInspection

Periodic inspection of spool operation, fluid condition and pressure connections saves time-consuming breakdowns and unnecessary parts replacements.

All hydraulic connections must be tight. Loose connections in the suction lines permit air to be drawn into the system, resulting in noisy and erratic operation.

System filters and reservoir should be checked for foreign particles. If excessive contamination is found, the system should be drained. The reservoir must be cleaned thoroughly before refilling.

Spools should return to neutral automatically when the control is released. The centering spring force is approximately 40 pounds. If more force is necessary, check linkage for binds.



COURTESY OF:  
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DIVISION OF SPERRY RAND CORPORATION



INDUSTRIAL TRUCK DIVISION



OPERATORS

MAINTENANCE

PARTS

MANUAL

FOR

CY-60

FORM NO. 1-60

CLARK EQUIPMENT COMPANY

PUBLISHED BY

TECHNICAL SERVICE DEPARTMENT  
BATTLE CREEK, MICHIGAN, U.S.A.



**UPRIGHT REMOVAL AND DISASSEMBLY**

To remove upright, support upright assembly with a chain fall of sufficient capacity using an "A" frame or other suitable support. Remove tilt cylinder support pin and bolts attaching upright at frame.

Remove tilt cylinder rod end pins.

Disconnect hydraulic hoses.

Place the upright assembly on a clean surface with the fork carriage upward. Disconnect the lift chains at the lift carriage. Slide the lift carriage out the bottom of the upright.

With the carriage removed, disconnect the lift chains at the lift cylinder and remove chains.

Remove the bolts securing sheave carrier to sheave carrier guide and remove carrier set screw to cylinder. Remove Lift Cylinder.

To aid in disassembly and reassembly refer to the parts illustration in the parts manual, and refer to the illustrations in this section.

**LIFT CYLINDERS**

There is very little maintenance to perform on the lift cylinder other than a periodic check on security of mounting and leaks at the hydraulic connections.

**N O T E**

WHEN INSTALLING O-RINGS AND BACK-UP RINGS, PACK O-RING GROOVES WITH CHASSIS GREASE TO FACILITATE ASSEMBLY AND TO PREVENT DAMAGE TO THE SEALS (CUTTING, SCRATCHING ETC.).

When lift cylinder is removed from upright, place the lift cylinder on a clean surface. Note the position of the hydraulic connection, on the cap with that of the cylinder base so this position may be duplicated at time of reassembly.

**C A U T I O N**

CLEANLINESS CANNOT BE OVEREMPHASIZED AS EVEN THE SMALLEST OF PARTICLES (LINT, DIRT, DUST, WATER, SEALING COMPOUND ETC.) IS HARMFUL TO THE HYDRAULIC SYSTEM.

**CYLINDER REPAIR**

Remove setscrew and setscrew plug from cylinder cap. Remove rod wiper and "O"-ring in cap. Remove snap ring from lower end of cylinder rod and replace "U" cup and filler and other broken, worn or damaged parts.

Remove cylinder flow control valve from bottom of cylinder and replace "O" rings.

Replace "O" ring on hose elbow fitting.

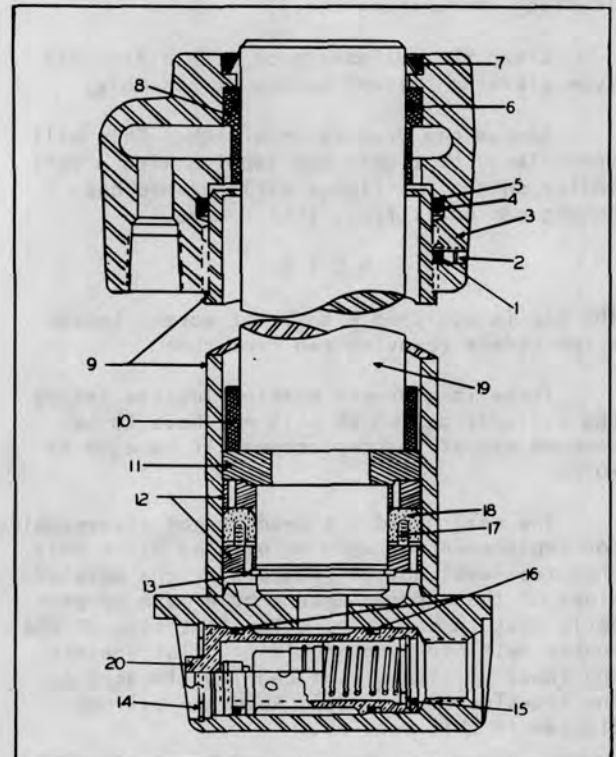


Plate 5972. Lift Cylinder

- (1) Plug, Cylinder Cap Setscrew
- (2) Setscrew, Cylinder Cap
- (3) Cylinder Cap
- (4) O-ring, Cylinder Cap
- (5) Back-up Ring, Cylinder Cap (Not Used)
- (6) O-ring, Piston Rod
- (7) Seal Guard Kit
- (8) Bronze Bushing (will need to be removed in the event of replacement only).
- (9) Cylinder Tube
- (10) Spacer (when used)
- (11) Piston (split rings)
- (12) Piston Follower
- (13) Retainer Ring, Piston Rod
- (14) Snap Ring, Flow Regulator Assy
- (15) Snap Ring, Flow Regulator Assy

- (16) O-rings, Flow Regulator Assy
- (17) Filler Ring
- (18) U-Cup
- (19) Piston Rod
- (20) Flow Regulator Assembly

LIFT CYLINDERS

**N O T E**

When installing O-rings and back-up rings, pack O-ring grooves with chassis grease to facilitate assembly and to prevent damage to the seals (cutting, scratching etc.).

Clean the cylinder tube with a Stoddard Type cleaning solvent before disassembly.

Remove cap from cylinder tube. This will very likely be tight, and tapping with a soft mallet on the cap flange will release cap. Rotate cap until free, then remove.

**N O T E**

The cap is equipped with a set screw, loosen screw before removing cap from tube.

There is a bronze bushing located inside the cylinder cap which will not have to be removed except for replacement if damaged or worn.

The seal guard kit needs to be disassembled for replacement of worn or damaged parts only. When reassembling seal guard kit, the beveled sides of these components should mate or properly seat in each other. The flat side of the rubber retainer ring should fit flat against the inner portion of the cap lip (located on the top-side of the cap). Refer to cylinder diagram in this section.

Remove piston from top-end of cylinder tube. Be careful not to damage or scratch cylinder wall.

From the bottom-end of piston rod, remove retainer ring (or snap ring) releasing piston follower or followers, filler ring, U-cup and piston.

Remove spacer. Take special note of position and location of these items so they may be replaced correctly at reassembly. The filler ring is partially positioned in the U-cup, and the U-cup is faced downward toward rod-end (or base end) of the piston rod. The piston follower fits flat against the filler ring and U-cup. The retainer ring holds these components in position (in a compressed state).

Reassemble Lift Cylinders

**N O T E**

Upon reassembly of the lift cylinders take care not to damage O-rings. check cylinders, making sure the sealing areas are free from nicks, burrs or sharp edges that might damage O-rings. Clean all parts in a Stoddard Type cleaning solvent. Clean O-rings in hydraulic fluid ONLY

When reassembling cylinder, tighten cylinder cap until it bottoms (metal to Metal). This is important as the cap must be tightened as close as possible to the tube. However, If the cap is not in proper alignment with the piston head, back it off until it is, When the cap is in proper alignment with the piston head, lock in position with setscrew and plug. Cylinder connections must be in proper alignment with each other so that the vent pipe is not damaged upon reassembly.

TILT CYLINDER

Maintenance of the tilt cylinders consists mainly of periodic visual inspections and lubrication at the pivot points. Should it be found that the tilt cylinders will not hold upright at desired angle of tilt, it will be necessary to remove and disassembly cylinder to determine the faulty condition.

Tilt upright to full forward position, disconnect hose lines at front and rear of cylinder.

x  
 x  
 x                    W A R N I N G                    x  
 x                    x                    x  
 x    SECURE UPRIGHT WITH A CHAIN TO PRE-    x  
 x                    x                    x  
 x    VENT FALLING.                    x  
 x

Remove tilt cylinder pivot pins at rear mounting and at upright. Remove tilt cylinder from machine.

An exploded view of the tilt cylinder is shown on the following page to aid in disassembly and reassembly of the unit.

Disassembly

1. Remove three retainer bolts (A) securing the cover (B), seal guard kit (C), retainer (D) and shims (E). (See Plate 5902). Pull these components from end of cylinder and piston rod.

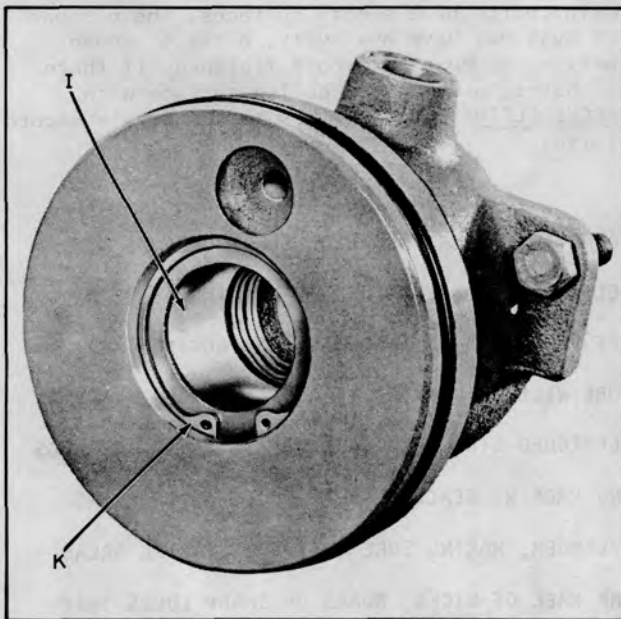


Plate 6193. Gland Bushing and Snap Ring

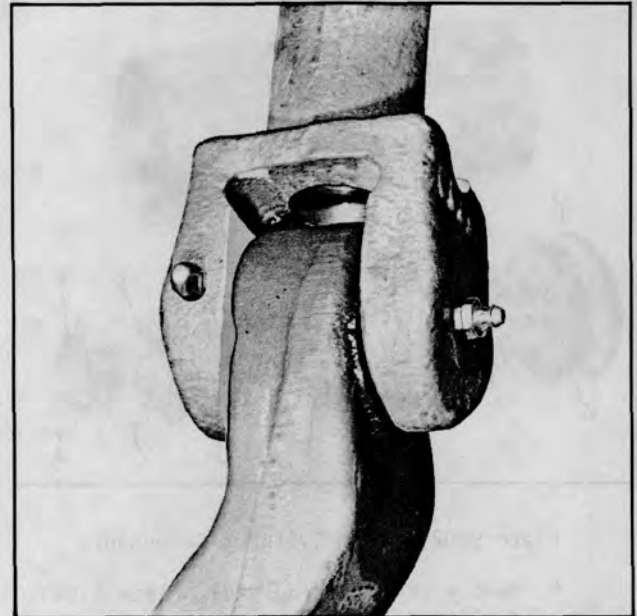


Plate 6049. Tilt Cylinder Pivot Pin Lubrication

2. Loosen gland bolts (F) using suitable wrench. Then, using a screwdriver, rotate each bolt until head is against gland assembly (See Plate 6194).

3. Now tap gland assembly inward into cylinder being careful not to mar, nick, scratch etc, the piston rod. Use a wooden or plastic mallet that does not have a metal frame that might contact piston rod when tapping gland.

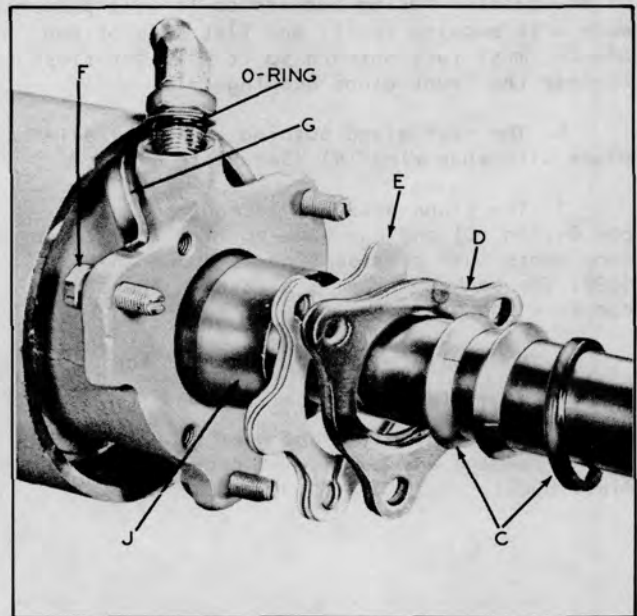


Plate 6194. Seal Guard Kit & Gland Removal



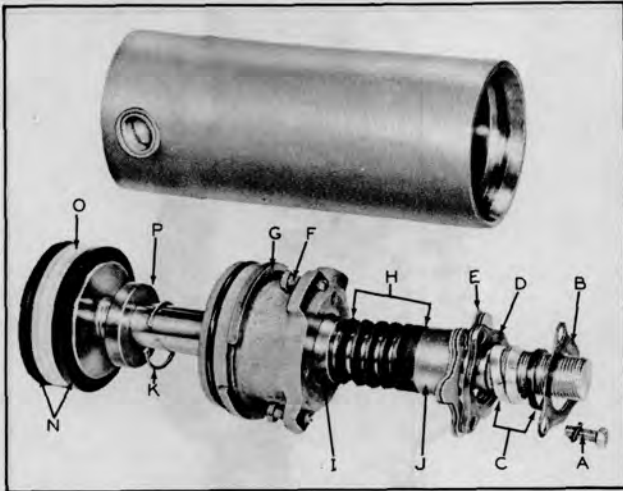


Plate 5902. Tilt Cylinder Components

4. Remove segment rings (G), Plate 6194. This will allow the gland assembly to be pulled from cylinder and piston rod.

5. Refer to Plate 5902. If it is necessary to remove and replace packing set (H) or seal guard kit (C), upon reassembly be sure that all components mate or properly seat in one another. The seal guard kit (C) must be correctly positioned in the seal guard retainer (D), and the flat side of the rubber ring must face outward so the beveled sides of the ring will properly mate with both bronze wiper rings. The packing set has both a bottom and top adaptor. The flat side of the bottom adaptor must set flat against the rear gland bushing (L) with the beveled side of the adaptor facing outward so it will properly mate with packing seals, and flat side of top adaptor must face outward so it will set flush against the front gland bushing (J).

6. The rear gland bushing (L) is held in place with snap ring (K) (See Plate 6193).

7. The gland assembly is equipped with one O-ring (L) and one back-up ring (M). These components must be assembled as shown in Plate 6192. The back-up ring is always on the side opposite the pressure.

8. Now pull the piston rod from the cylinder tube.

9. Check U-cup (N) and wear ring (O) for wear or damage and replace if necessary (See Plate 5902).

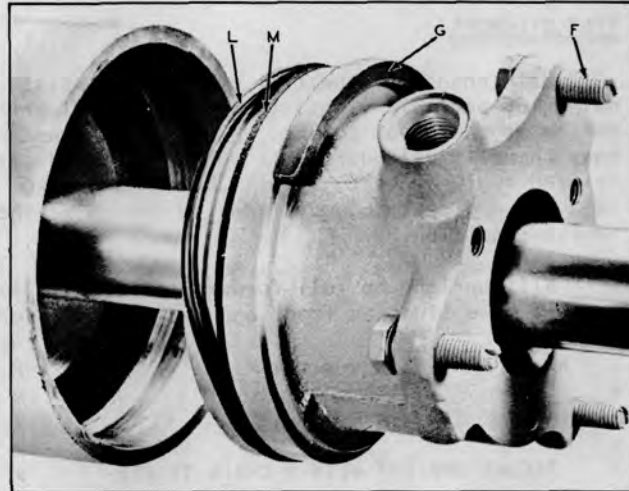


Plate 6192. Gland O Ring & Back-Up Ring

Cleaning and Inspection

1. After disassembly, clean all metal parts in a Stoddard Type cleaning solvent and dry thoroughly with compressed air.

C A U T I O N

CLEAN ALL RUBBER, PLASTIC, FIBER, OR SYSTHETIC PARTS IN CLEAN HYDRAULIC FLUID.

2. Before reassembly, check all parts for further serviceability. Replace all O-rings, and check packings for wear or damage. Be sure that mating parts have smooth surfaces. The piston rod must not have any burrs, nicks or rough spots - rod must be smooth finished. If there are burrs, nicks etc., polish surface with CROCUS CLOTH until rod has an absolutely smooth finish.

C A U T I O N

DO NOT USE EMERY CLOTH OR SANDPAPER. DO NOT POLISH SO MUCH THAT CHROME PLATING IS WORN OFF ROD. THIS IS IMPORTANT AS PACKINGS AND TUBE WILL BE DAMAGED IF ROD IS BURRED, NICKED, SCRATCHED ETC. TAKE CARE NOT TO DAMAGE O-RINGS AND PACKING SEALS AT REASSEMBLY BY CHECKING CYLINDER, MAKING SURE THAT THE SEALING AREAS ARE FREE OF NICKS, BURRS OR SHARP EDGES THAT MIGHT DAMAGE SEALS. LUBRICATE EACH COMPONENT WITH CLEAN HYDRAULIC FLUID TO FACILITATE ASSEMBLY.



Reassembly

For detail in reassembling the tilt cylinder covered in this section refer to Plate 6194, 6192, 5902, 9858, and 9954 for this reassembly write-up.

1. Install tilt cylinder piston U-cups (5) and wear ring (8) on piston and rod assembly (3). After installing spacer (4), (See Plate 9954), position piston assembly in cylinder assembly.

CAUTION

WHEN INSTALLING THE SEALS, PACKINGS, RINGS ETC. THAT MAKE UP THE TILT CYLINDER BE SURE TO LUBRICATE ALL PARTS WITH CLEAN HYDRAULIC FLUID.

2. Install tilt cylinder piston and spacer (14) on piston and rod assembly (3).

3. Install snap ring (6) in tilt cylinder gland (17). Then, position gland on piston rod (3).

4. Install bushing (36) with compression springs (37) on piston rod.) with packing (19) and bushing (18).

5. Replace "O" ring (L) and Back-up ring (M) (Plate 6192) and install gland (17) (Plate 9954) in place by inserting tilt cylinder gland positioning ring (G), and securing gland in place with screws (F) (Plate 6192).

6. Install tilt cylinder gland cover (10) over gland assembly end of tilt cylinder. When installing cover (10), align threaded fitting hole in gland (17) with hole provided in cover. (Plate 9954).

7. After installing shims (E) - install all of the shims supplied in the repair kit - install the gland shim retainer (D). Plate 6194).

NOTE

After the machine has been in service with the tilt cylinder in use, you may want to remove shims (E) (Plate 5902) to increase pressure on packings (H) preventing cylinder leakage.

8. Install Tilt cylinder rod wipers (C). (Plate 6194).

9. Secure wiper with tilt cylinder rod wiper retainer (13). Fasten retainer (B) with cap screw and lockwasher (A).

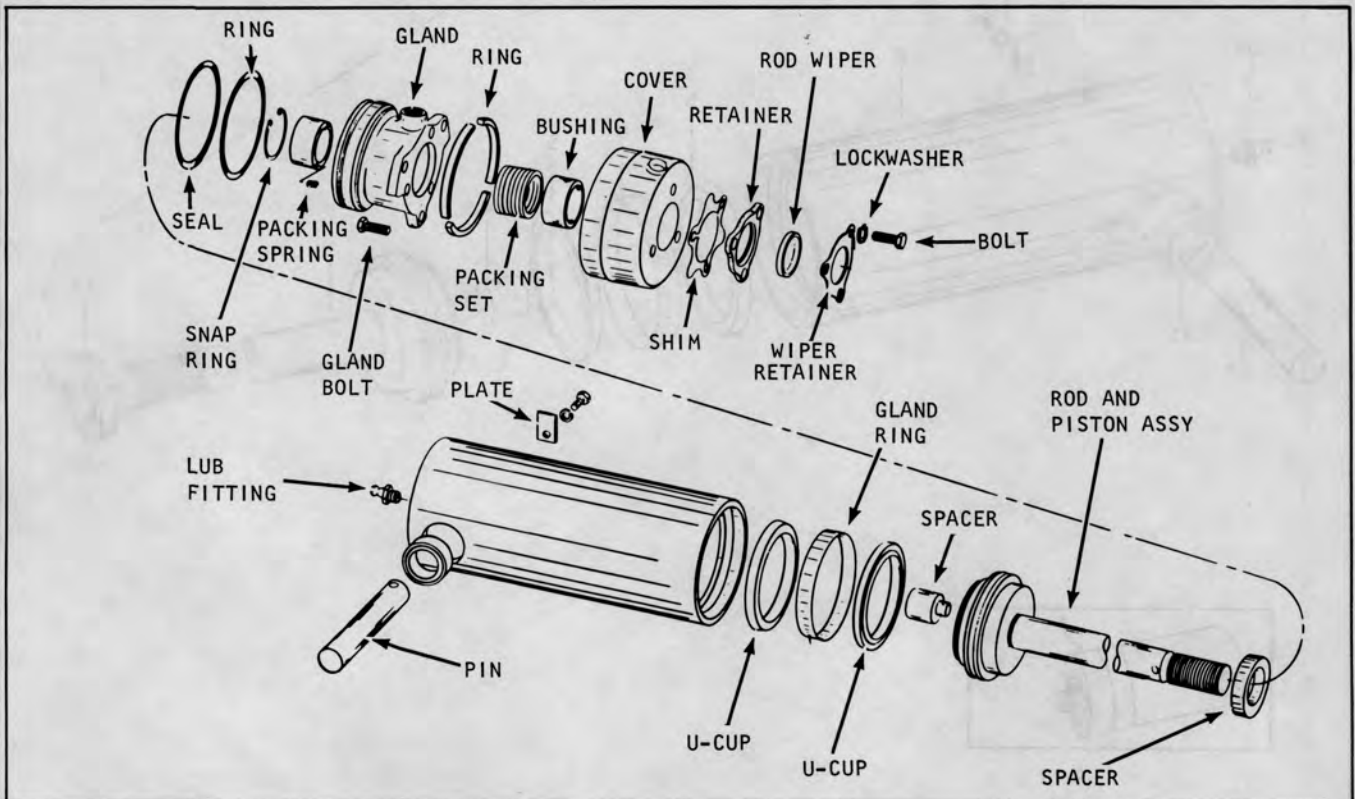


Plate 9858. Tilt Cylinder

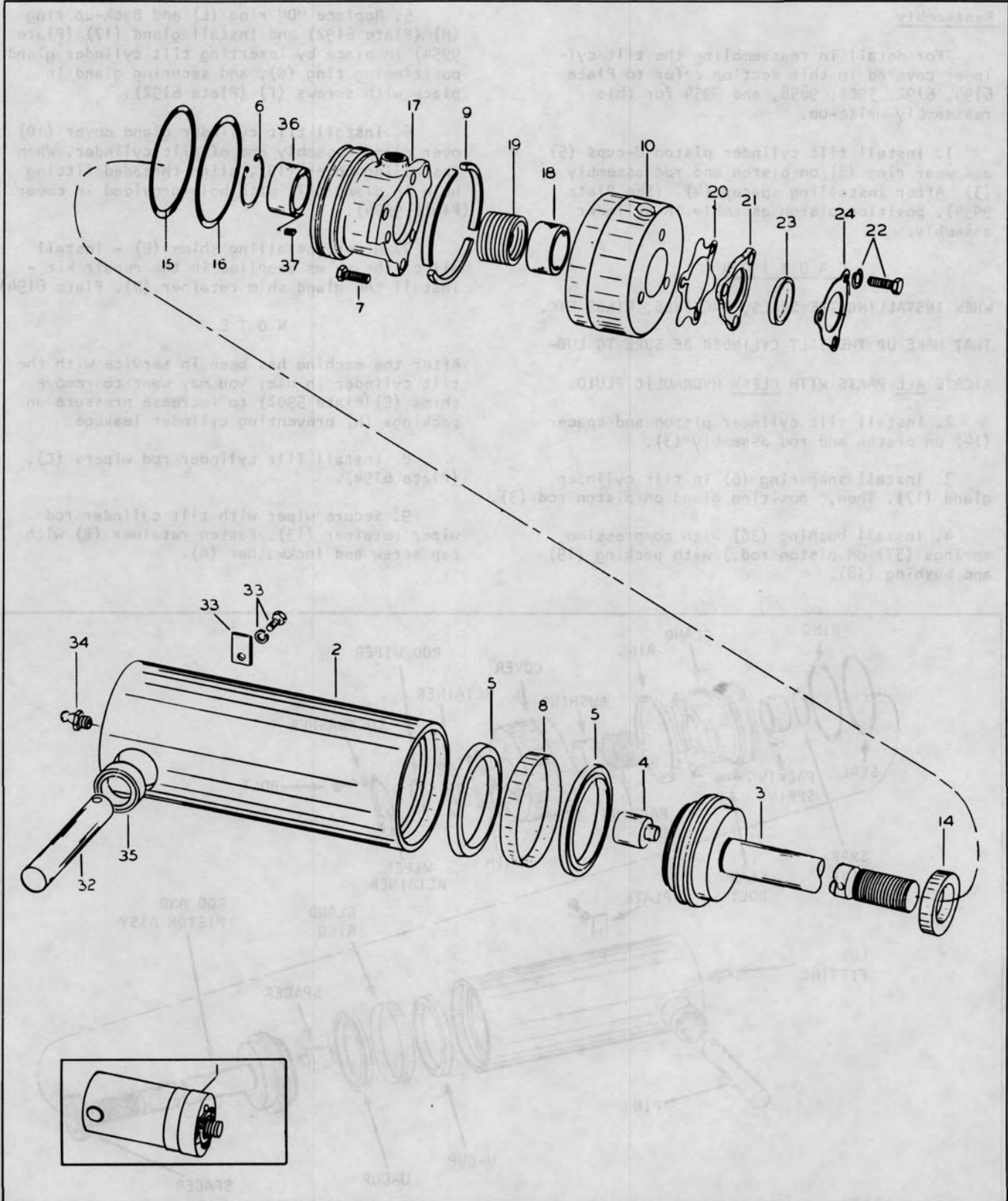


Plate 9954. Tilt Cylinder



