Lyle Hausmann

MAINTENANCE MANUAL

for

LW Motor Graders

Model 330
AND
Model 440

LeTOURNEAU LW WESTINGHOUSE

LeTOURNEAU-WESTINGHOUSE COMPANY
INDIANAPOLIS 6, INDIANA, U. S. A.

FOREWORD

This manual contains instructions for maintenance and repair for Models 330 and 440 Motor Graders.

These operations should be performed in a well equipped shop by trained mechanics.

The mechanic should study this manual carefully to familiarize himself with the part or sub-assembly which is to be repaired.

Your LeTourneau-Westinghouse Distributor is equipped to do your major repairs and rebuild work.

LETOURNEAU-WESTINGHOUSE COMPANY
Indianapolis 6, Indiana, U.S.A.

Printed in U.S.A. 4-62

Table of Contents

SECTION 1 - CLUTCH -- 1

SECTION 2 - TRANSMISSION -- 2

SECTION 3 - TANDEMS -- 3

SECTION 4 - CONTROLS -- 4

SECTION 5 - HYDRAULIC PUMP -- 5

SECTION 6 - FRONT AXLE -- 6

SECTION 7 - STEERING -- 7

SECTION 8 - CAB -- 8

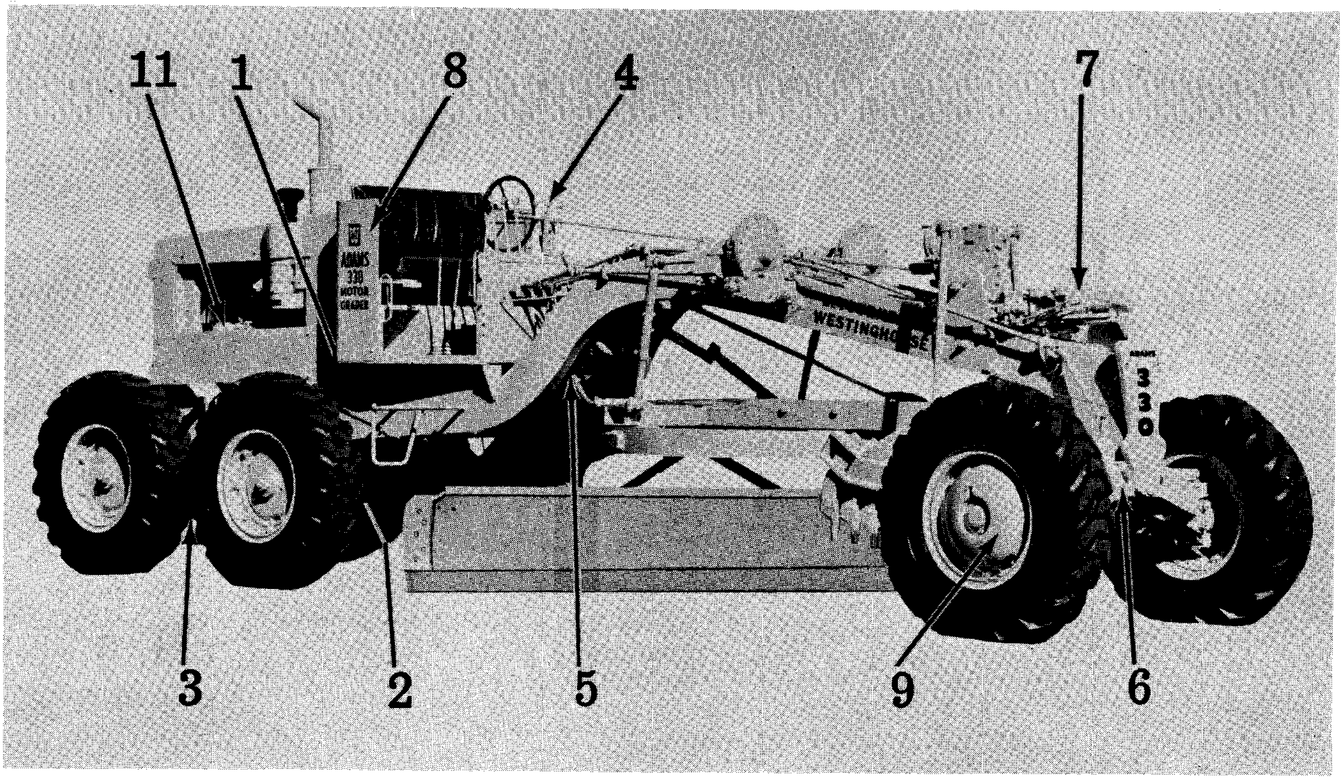
SECTION 9 - WHEELS -- 9

SECTION 10 - LUBRICATING INSTRUCTIONS -- 10

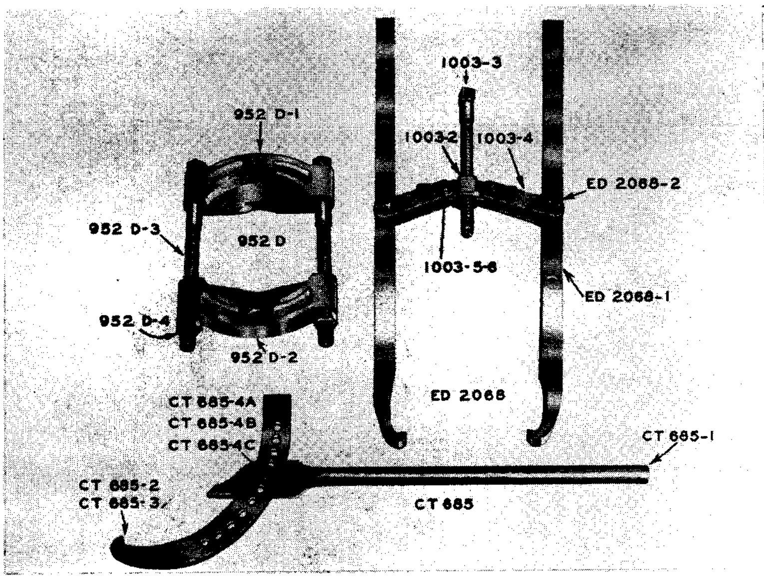
SECTION 11 - ELECTRICAL -- 11

SECTION 12 - TROUBLE SHOOTING -- 12

SECTION 13 - INDEX -- 13



SECTION NO.	ASSEMBLY DESCRIPTION
1	CLUTCH
2	TRANSMISSION
3	TANDEMS
4	CONTROLS
5	HYDRAULIC PUMP
6	FRONT AXLE
7	STEERING
8	CAB
9	WHEELS
10	LUBRICATING INSTRUCTIONS
11	ELECTRICAL
12	TROUBLE SHOOTING
13	INDEX



TRANSMISSION

Factory Approved

The tools illustrated at left were designed for servicing the Transmission. They are purchased from:

Indiana Bearings, Inc.
801 North Capitol Avenue
Indianapolis, Indiana

With these tools it is possible to remove the bearings, gears and bearing inner races, etc. from the Transmission and does these jobs at a substantial saving of time and labor and without damage to costly parts. They will also make your customers more satisfied with your service work.

O. T. C. TOOL NO.

ED-2068 Grip-O-matic puller complete (Includes the following):

2 - ED-2068-1	Jaws	1 - 1003-3	Forcing Screw
2 - ED-2068-2	Special Pins	4 - 1003-4	Straps
1 - 1003-2	Forged Head	2 - 1003-5-6	Cap Screws & Nuts

952D Bearing puller attachment complete (Includes the following):

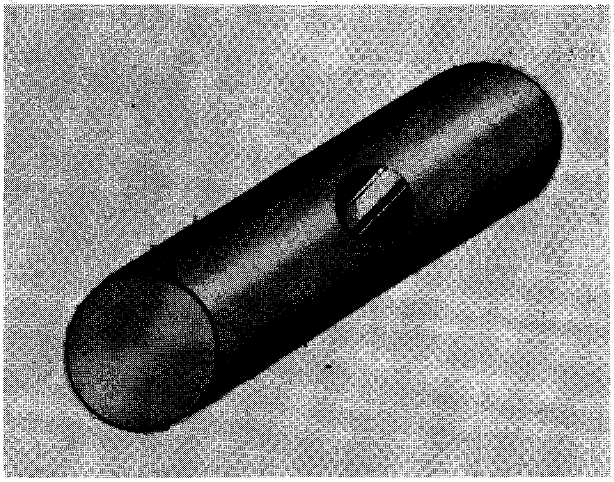
1 - 952D-1	Block (top)	2 - 952D-3	Bolts
1 - 952D-2	Block (bottom)	2 - 952D-4	Nuts

CT685 Adjustable spanner wrench complete (Includes the following):

1 - CT685-1	Handle	1 - CT685-4A	Pivot Pin Bolt
1 - CT685-2	3/8" Thick Jaw	1 - CT685-4B	Pivot Pin Screw
1 - CT685-3	3/4" Thick Jaw	1 - CT685-4C	Pivot Pin Washer

The pinion setting gauge was designed for adjusting pinion and ring gear in trans-mission. Order from:

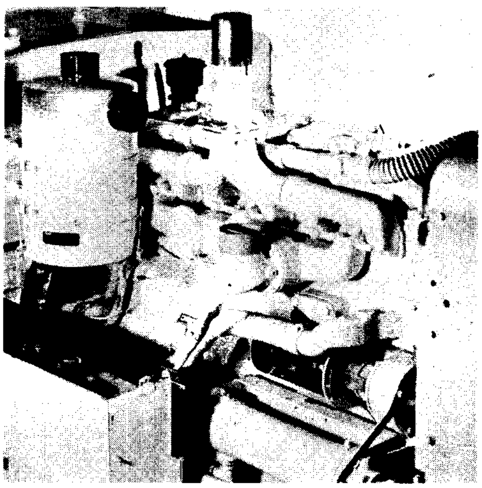
LeTourneau-Westinghouse Co.
Indianapolis, Indiana
Part Number 723017 - gauge.



CLUTCH

ENGINE REMOVAL

When major repairs to the engine are necessary, the engine must be removed from the frame. Since removal of Cummins and General Motors engines are similar, the following instructions and illustrations will aid in the removal of either engine.



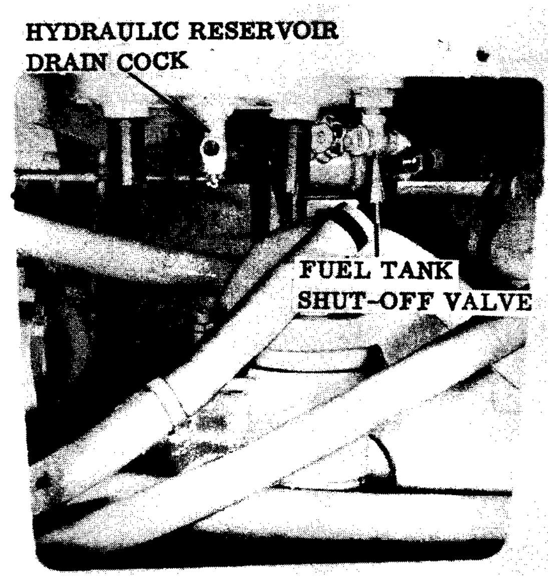
Illust. 1

Remove air cleaner cap or air pre-cleaner, muffler, hood, lower hood sides and air cleaner hose with elbow (Illust. 1).

Drain hydraulic reservoir by installing a suitable length of hose onto drain cock. Open drain cock and allow oil to drain in a container. When reservoir is empty, close drain cock and remove hose. Next, shut fuel off at fuel shut-off valve. Disconnect fuel outlet and return lines from tank. Disconnect vent pipe from top of tank (Illust. 2).

Remove reducer from top of fuel tank and install a lift eye (Illust. 3).

Disconnect battery cables from engine. Remove wiring from voltage regulator and clamps from fire wall.

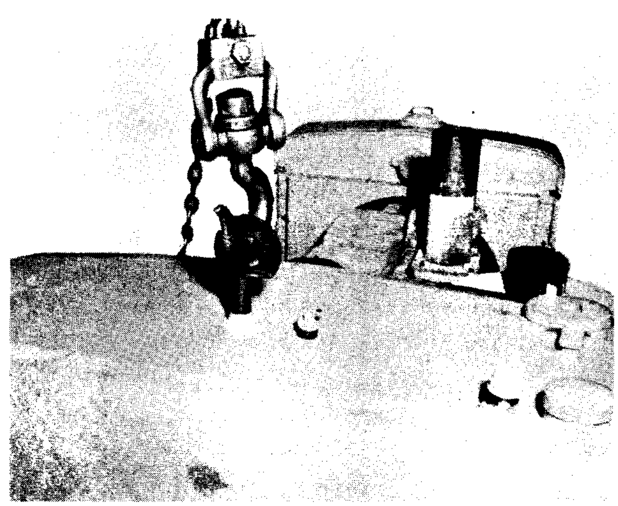


Illust. 2

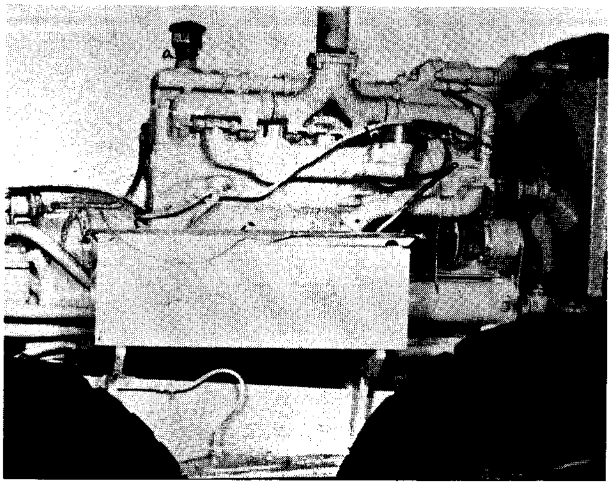
Remove fuel tank support anchor cap screws, nuts and lock washers. Lift fuel tank from frame, using a chain hoist (Illust. 3).

Disconnect wiring from cranking motor and generator. Remove all wiring harness clamps from engine (Illust. 4).

Disconnect engine solenoid switch cable on Cummins engine and engine shut-down cable on General Motors engine.



Illust. 3



Illust. 4

Disconnect hour meter cable from switch on engine.

Remove heat indicator cable from engine.

Disconnect heater hoses from engine and lower radiator pipe, if so equipped. Remove heater hose clamp on clutch housing.

Disconnect ether starting aid cable at engine, if so equipped.

Disconnect radiator shutter cable at radiator, if so equipped.

Disconnect oil line at engine.

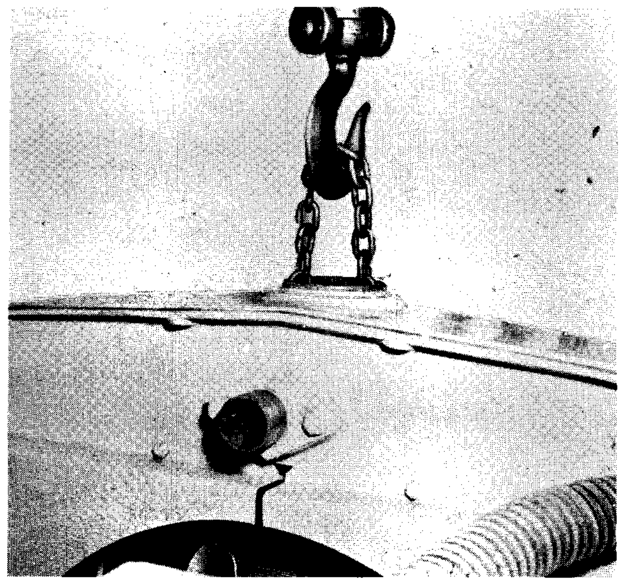
Disconnect clutch pedal linkage at engine.

Disconnect throttle cable at engine.

Remove propeller drive shaft under cab. Remove P.T.O. bearing cage cap screws and slide bearing cage with P.T.O. shaft from upper transmission. NOTE: Cab must be raised to accomplish this step.

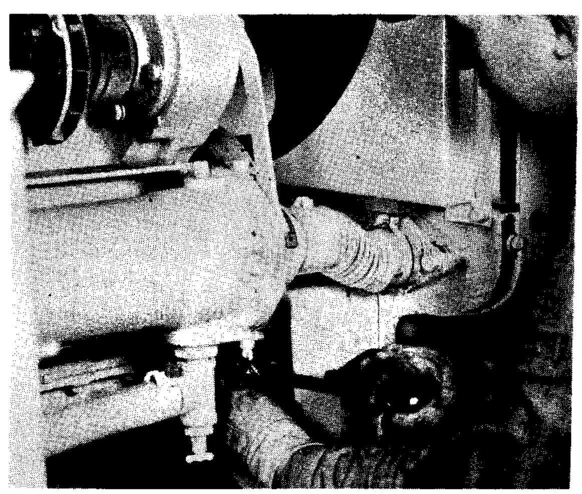
To raise cab, remove stay bars from cab and control shaft knuckles from power box. Next, remove pedal springs from floor board. Disconnect throttle linkage and hand brake cable under cab. If necessary, remove pedal pads. Remove cab hold down cap screws. Raise cab approximately 8" above frame.

Drain radiator and disconnect both radiator connections. Next, remove radiator cap and insert a tool (Illust. 5). Using a chain hoist, apply enough pressure to radiator to prevent radiator from falling when mounting bolts are removed.

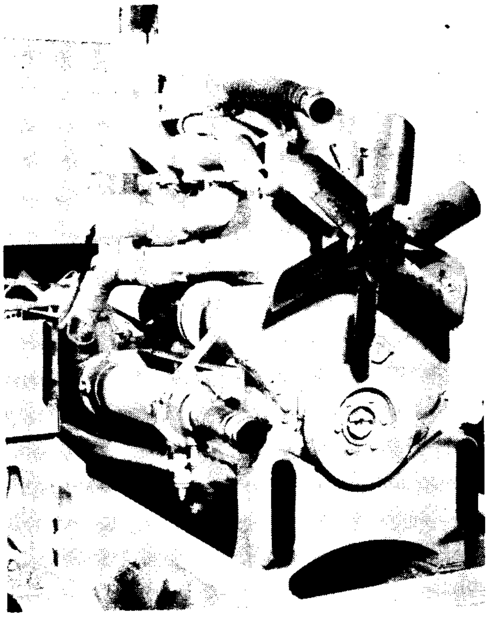


Illust. 5

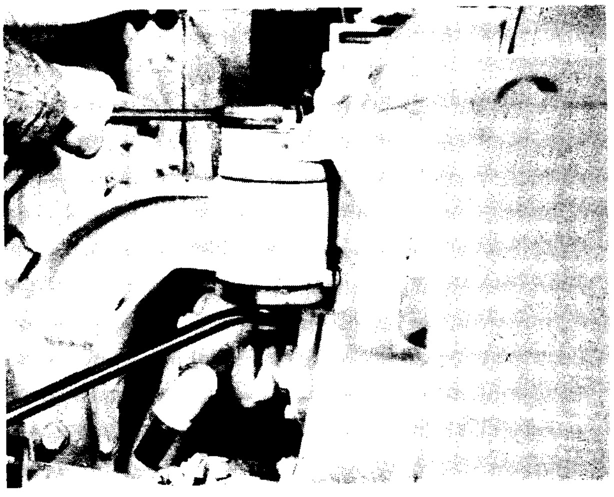
Remove radiator mounting bolts (Illust. 6) and radiator (Illust. 7).



Illust. 6



Illust. 7



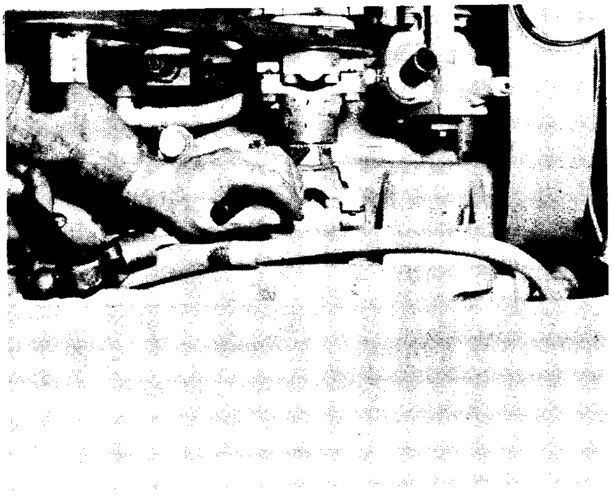
Illust. 8

Remove rear engine mounting bolts (Illust. 8). When removing bolts and rubber bonded washers, it is important to note the amount of shims removed from top and bottom of rubber bonded washers. Apply same amount of shims to each washer when reassembling engine.

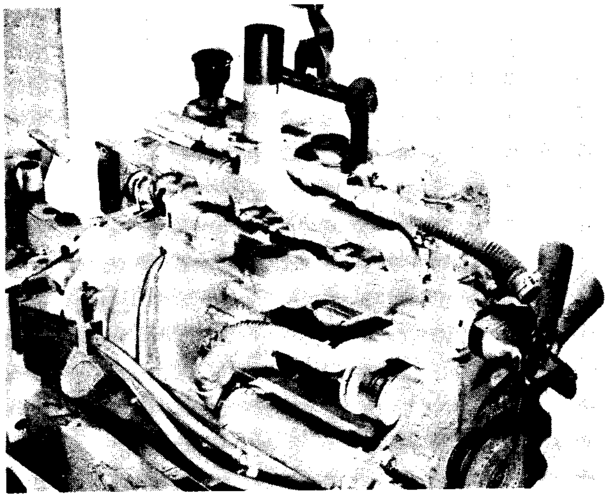
Remove engine support bolts (Illust. 9).

Mark yoke fitting of universal joint and also yoke stud with a center punch (Illust. 10). This is important when reassembling en-

Illust. 9



Illust. 10



Illust. 11

gine for proper alignment of yoke stud and yoke fitting splines. If yoke stud and yoke fitting are not aligned properly, undue vibration will occur.

Remove engine from frame (Illust. 11).

To reassemble engine, reverse removal procedure.

ENGINE MOUNT GAP

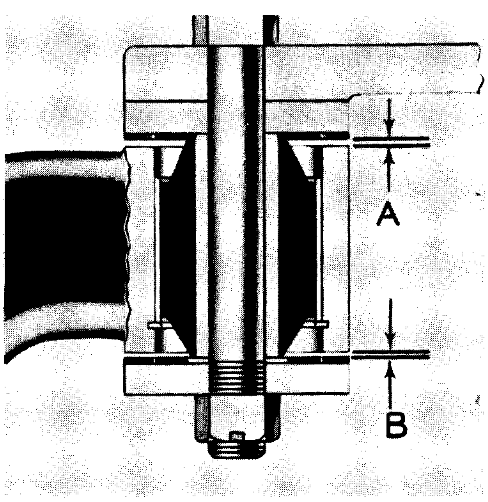
When installing an engine, the rear mounts are to be tightened first.

If new motor mounts are installed, clearance (A) and (B) (Illust. 1) are as follows:

A	B
.120 to .140	.000 to .020

If motor mounts are reused, clearance (A) and (B) (Illust. 1) are as follows:

A	B
.060 MIN.	.1875 MAX.

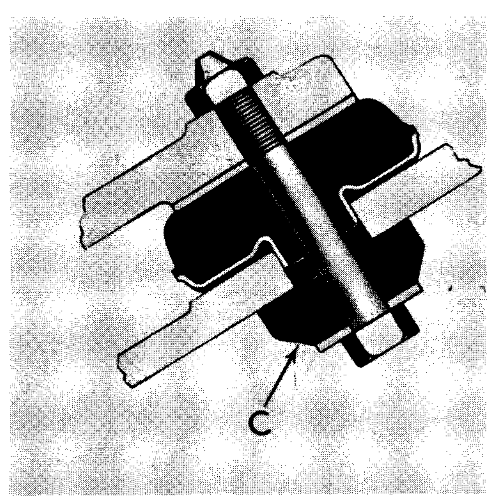


Illust. 1

Proper gap at (A) and (B) can be maintained by removing shims from gap (B) and reinstalling shims at gap (A), as the mount settles over a period of time. However, if the peoper gap clearance cannot be maintained by use of shims, install new rubber mounts.

Front engine mounts are adjusted and tightened until biscuit "C" (Illust. 2) can be turned with effort by hand, then tighten cap screw one (1) more round.

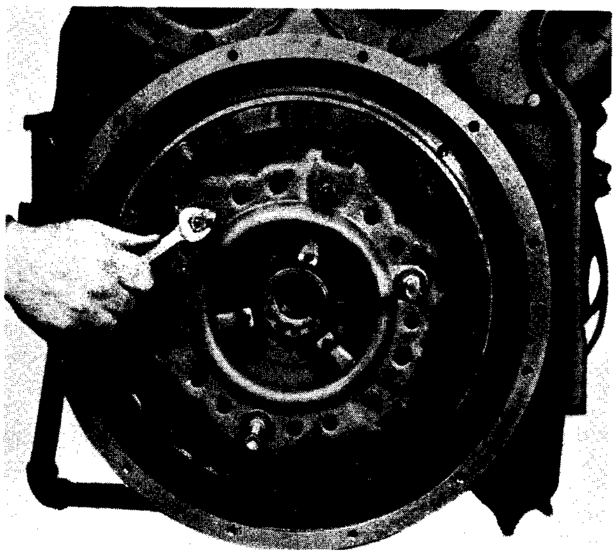
CUMMINS ENGINE ONLY: Loosen trunnion cap on timing gear cover before tightening motor mounts.



Illust. 2

CLUTCH
(Models 330 and 440 Motor Graders)

Manufacturer	Rockford Clutch Division
Size - Model 330	14"
Size - Model 440	15"
Type - Models 330 and 440	Single Disc, Spring Loaded
Number of Springs - Model 330	15
Number of Springs - Model 440	18
Throwout Bearing Type	Ball
Pilot Bearing Type	Ball



Illust. 1

After considerable service, or if the clutch has been subjected to intense heat, causing pressure springs to discolor due to the clutch slipping, the pressure plate should be taken apart and the tension of the springs checked. It is necessary to remove the engine from the grader in order to replace the clutch. To remove engine, see "Engine Removal".

NOTE: Before removing the pressure plate from flywheel, three (3) hold down set screws (3/8" x 4") with jam nuts and washers must be installed in the tapped holes in the inner spring circle (Illust. 1). The purpose of these set screws is to relieve the pressure on clutch assembly so it may be removed.

After removal of clutch pressure plate assembly, the face of pressure plate should be checked for cracks, scores and warpage. Heat cracks and scores can be detected by visual inspection. Warping can be checked by running a straight edge across the face of the plate. A badly scored, cracked or warped pressure plate will wear facings quickly and should be replaced with a new one.

Clutch pressure springs which have lost their tension will not exert sufficient pressure on the clutch pressure plate to prevent slippage and accompanying wear to the clutch facings. Therefore, clutch pressure springs should be checked before reassembling the clutch. Springs which have been used will often take a set and will, therefore, not return to their original free length but will still develop sufficient pressure to be usable. Therefore, the springs should not be discarded unless they do not meet the minimum allowable spring pressure.

If springs do not meet test specifications shown in the table, they should be replaced.

To disassemble clutch, reverse assembly procedure.

Diameter of Clutch	Back Plate Material	No. of Springs	Spring Free Length	Test Springs at Length	Lbs. Pressure
Model 330 14"	Steel	15	2-9/16"	1-13/16"	170 - 180
Model 440 15"	Steel	18	3-5/32"	2-1/8"	170 - 180

It is recommended that the lever assembly working parts and drive contacts between back plate and pressure plate be lubricated with "Lubriplate No. 220", manufactured by Lubriplate Division of Fiske Bros. Refining Company, Toledo, Ohio.

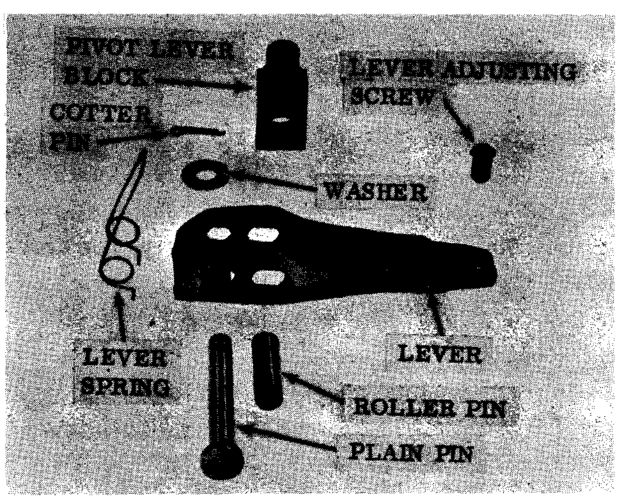
The clutch assembly procedure for Models 330 and 440 Motor Graders is identical except for adjustments.

Illust. 2 is an exploded view of lever assembly.

Tighten lever adjusting screw into lever until one (1) thread extends from underneath side of lever (Illust. 3).

Insert pivot lever block into lever. Align pin hole in block with slotted hole (nearest adjusting lever screw) in lever and insert rolled pin (Illust. 4). Pin to be flush with sides of lever.

Illust. 3



Illust. 2

Illust. 4

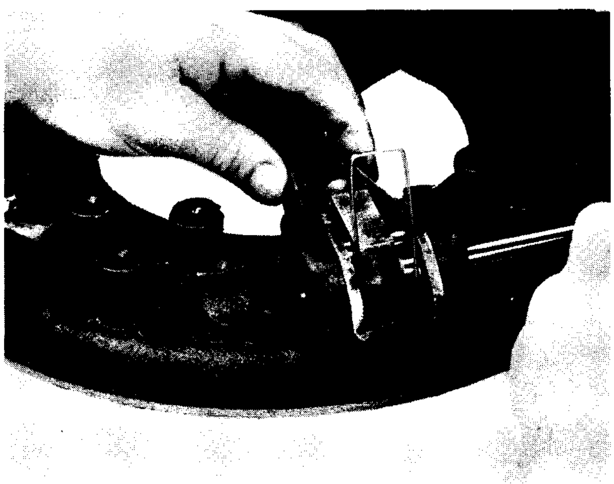
Illust. 5

Insert lever between back plate brackets. Next, insert lever spring into lever with short ends of spring fitting into opening in lever (Illust. 5).

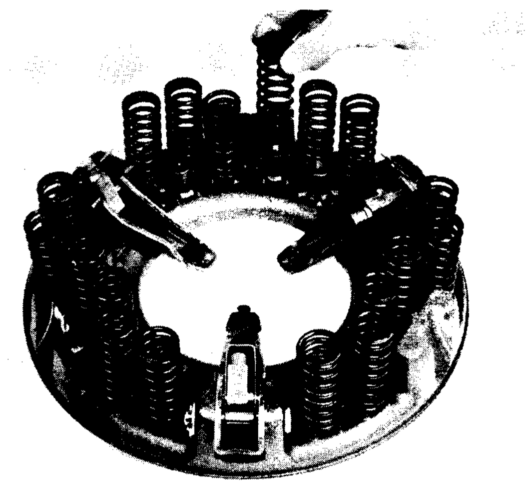
Align pin holes in lever, spring and back plate brackets, then insert plain pin (Illust. 6). NOTE: Head of pin to be against thrust of back plate.

Install washer and cotter pin on plain pin. Spread cotter pin (Illust. 7).

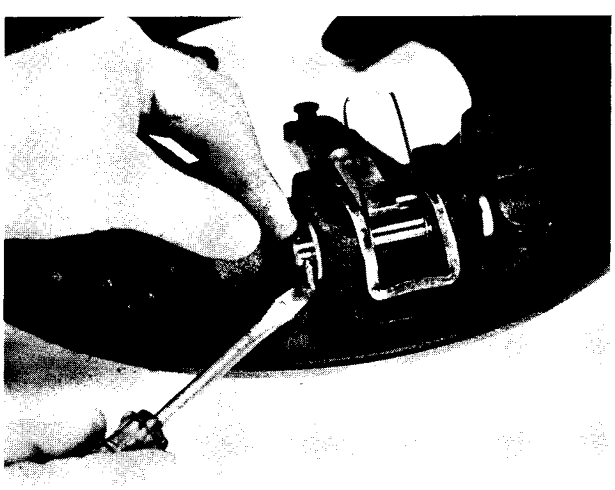
Install springs to back plate (Illust. 8). NOTE: 330 Motor Grader clutch contains



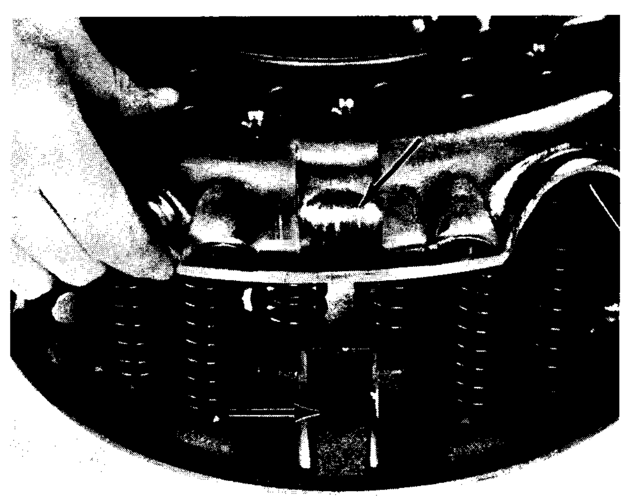
Illust. 6



Illust. 8



Illust. 7



Illust. 9

15 springs. 440 Motor Grader clutch contains 18 springs.

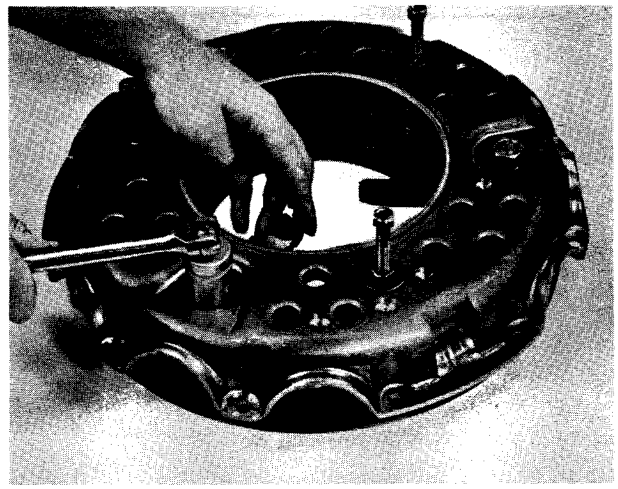
Install pressure plate onto springs. Be sure lock in pressure plate is in line with slot of back plate (Illust. 9). Also, springs are in their respective place in pressure plate.

Install three (3) hold down set screws. Tighten set screw jam nuts evenly until pivot lever block threaded end extends through pressure plate. Install Shakeproof lock washer and nut. Tighten nut securely (Illust. 10). NOTE: While tightening nut, be sure the levers have a small amount of play.

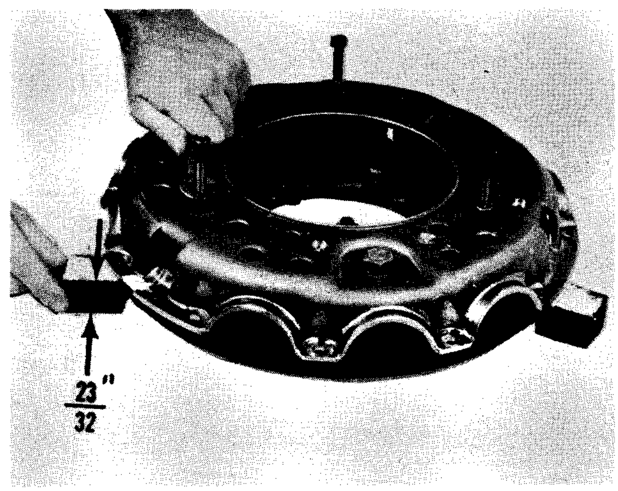
Before attempting to make lever adjustments on either 330 or 440 Motor Grader cover assembly, the assembly must be placed on a smooth level work bench to obtain accurate adjustments.

Adjustments for 330 Motor Grader Cover Assembly: Place three (3) blocks 23/32" thick under flange of pressure plate and in line with hold down set screws. Tighten set screw jam nuts until flange of pressure plate touches each block (Illust. 11). Adjust lever adjusting screws until 1-29/32" is obtained (Illust. 12). NOTE: After lever adjusting screws have been adjusted, there must be at least one (1) thread of adjusting screw beyond underneath edge of levers.

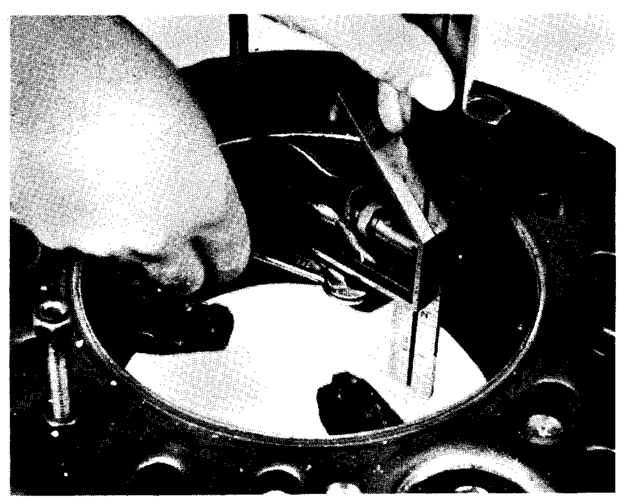
Adjustments for 440 Motor Grader Cover Assembly: Place three (3) blocks 1-9/32" thick under flange of pressure plate and in line with hold down set screws. Tighten set screw jam nuts until flange of pressure plate touches each block (Illust. 13). Adjust lever adjusting screws until 2-9/32" is obtained (Illust. 14). NOTE: After lever adjusting screws have been adjusted, there must be at least one (1) thread of adjusting screw beyond underneath edge of levers.



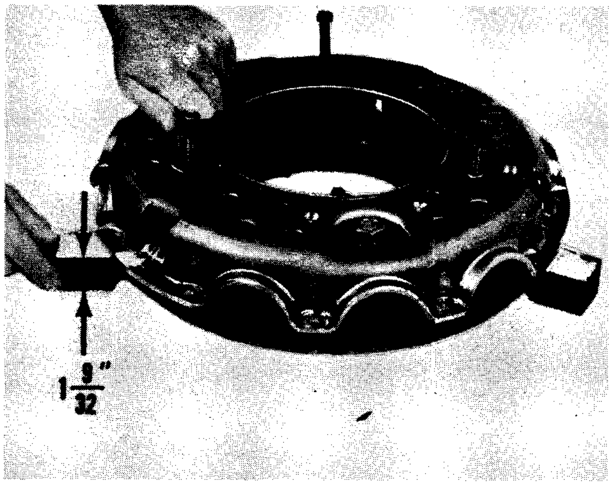
Illust. 10



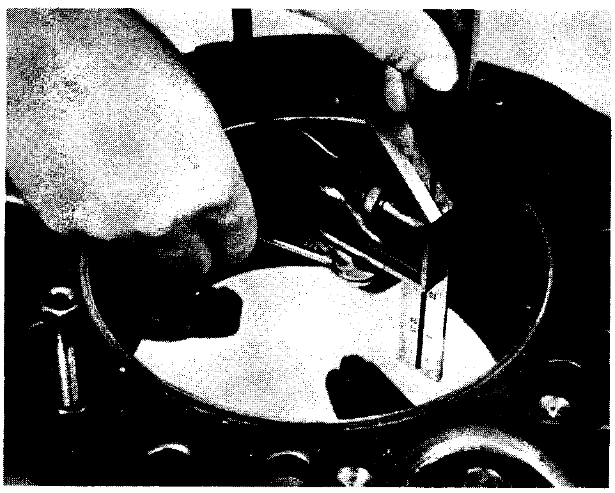
Illust. 11



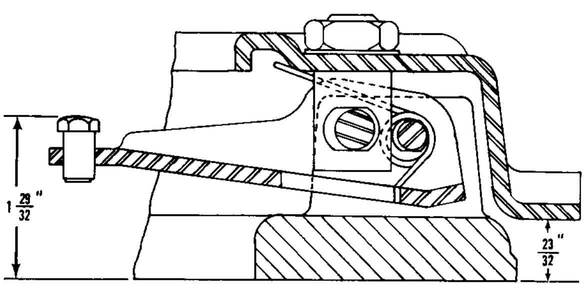
Illust. 12



Illust. 13

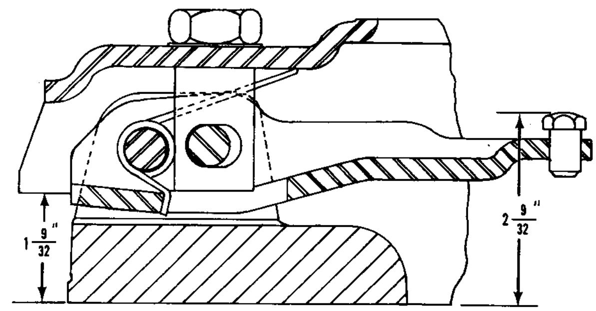


Illust. 14



Illust. 15

Illusts. 15 (Model 330) and 16 (Model 440) show cross section views of the cover assemblies. The illustrations also show di-



Illust. 16

mensions necessary for adjusting the levers. These adjustments can best be made on a regular clutch locating fixture, although it is possible to make the adjustments with a straight edge or ruler.

After adjustments have been made, cover assembly is ready for installation to flywheel.

IMPORTANT: When cover assembly has been installed to flywheel or a new cover assembly is installed, be sure the three (3) hold down set screws or cap screws have been removed.

CLUTCH RELEASE AND BRAKE HOUSING (Models 330 and 440 Motor Graders)

The engine must be removed to repair or replace parts in the clutch release brake housing assembly. To remove engine, see "Engine Removal".

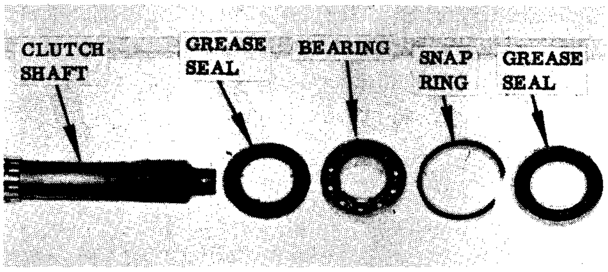
Inspect all parts for excessive wear or damage.

Illust. 1 is an exploded view of the clutch shaft assembly.

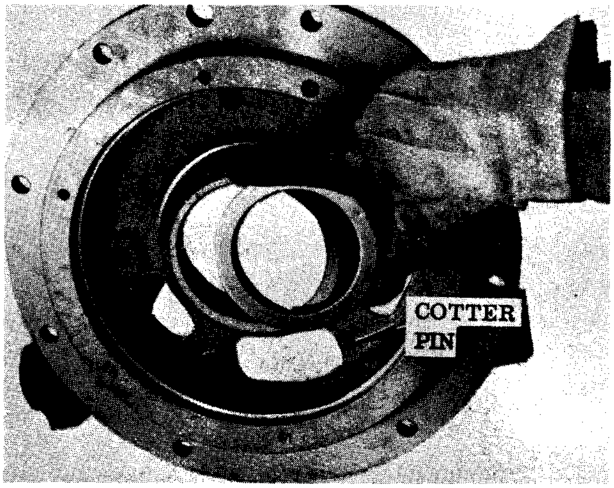
Press grease seal into clutch release brake housing (Illust. 2). Lip of seal toward inside of housing. Next, install cotter pin and spread.

Press or drive bearing into housing (Illust. 3).

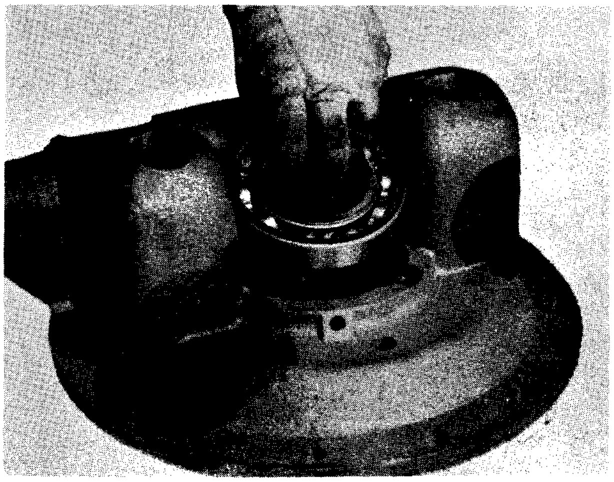
Install snap ring into groove of housing (Illust. 4).



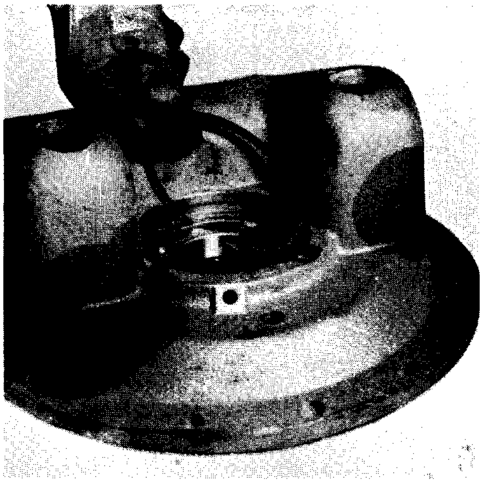
Illust. 1



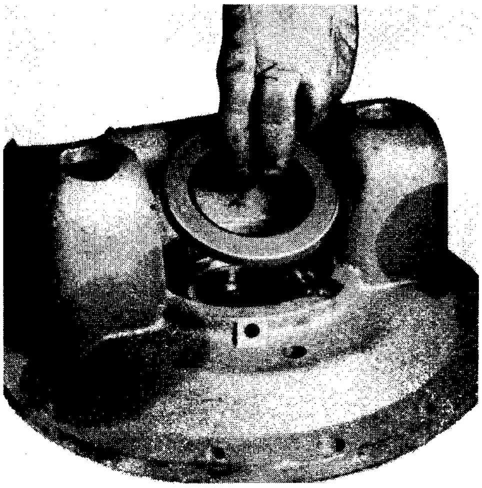
Illust. 2



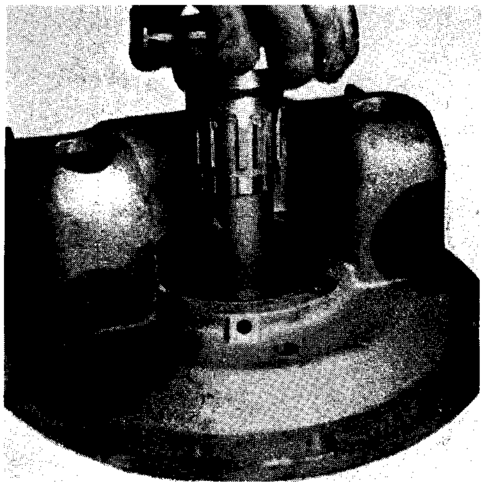
Illust. 3



Illust. 4



Illust. 5



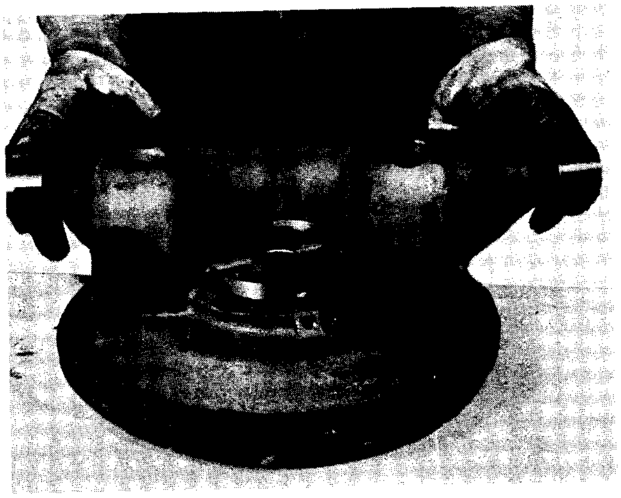
Illust. 6

Press or drive grease seal (used as a dust seal) into housing (Illust. 5). Lip of seal away from bearing.

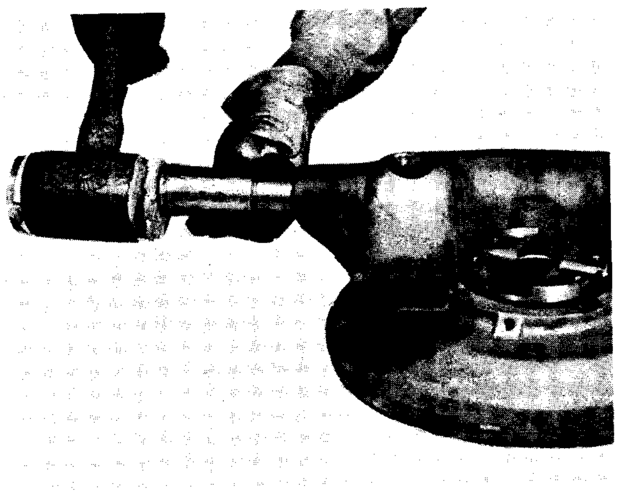
Insert clutch shaft into housing with the splined end toward inside of housing (Illust. 6). Using a rawhide mallet, drive clutch shaft into bearing.

Install bushings (Illust. 7) into housing. Using a rawhide mallet and bronze drift pin, drive bushings into place (Illust. 8).

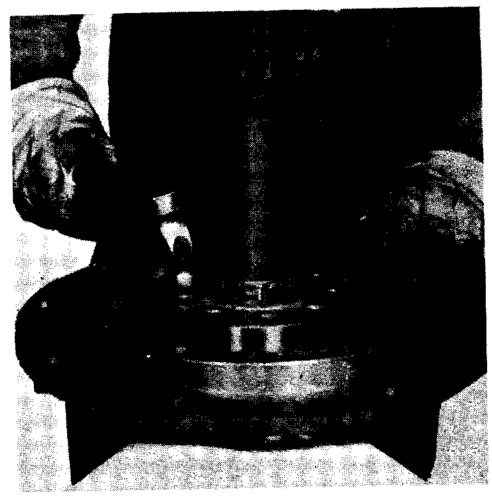
Install brake drum onto clutch shaft. Long end of hub fitting into grease seal. The short spline of brake drum over wide slot



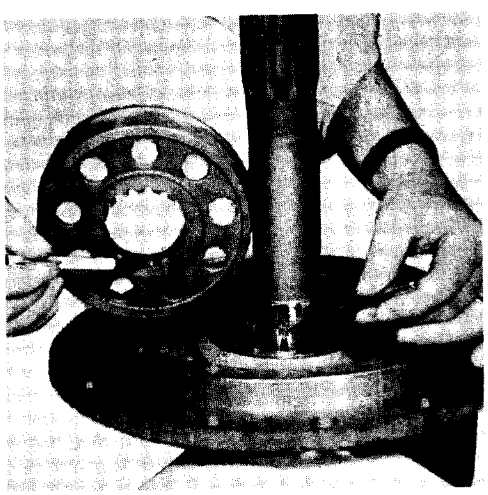
Illust. 7



Illust. 8



Illust. 10



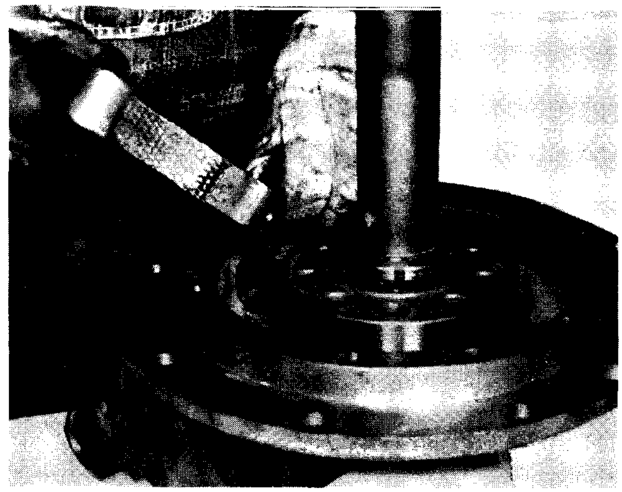
Illust. 9

Illust. 11

of spline on shaft, as indicated with the pencils in Illust. 9. Tap drum down over splines with a rawhide mallet (Illust. 10).

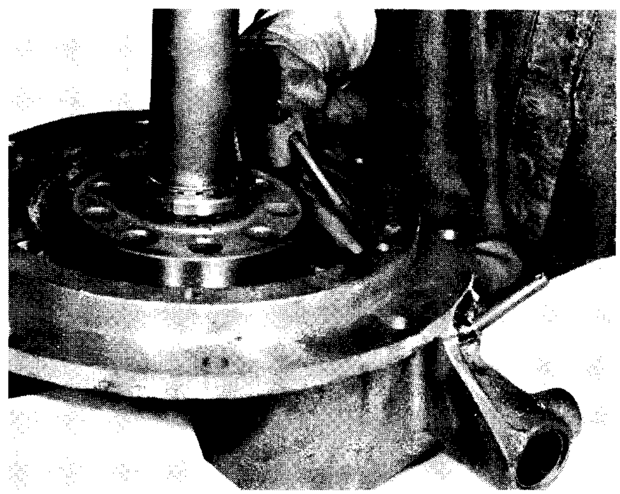
Install lock washer and lock nut onto clutch shaft (Illust. 11). Ears of lock washer in an upward position. Lock on inside diameter of lock washer to fit in wide slot of spline on shaft. Tighten nut securely with a spanner wrench (Illust. 12). Using a drift pin and hammer, lock ears of lock washer in as many slots of lock nut as possible (Illust. 13).

Install clutch brake band and spring (Illust. 14). Hook one end of spring into hole in

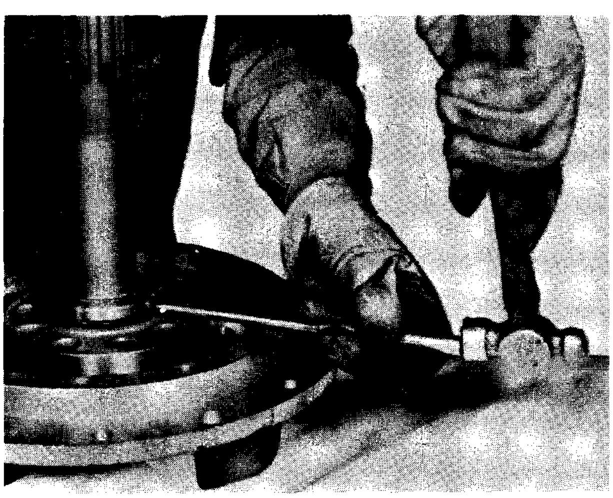


Illust. 14

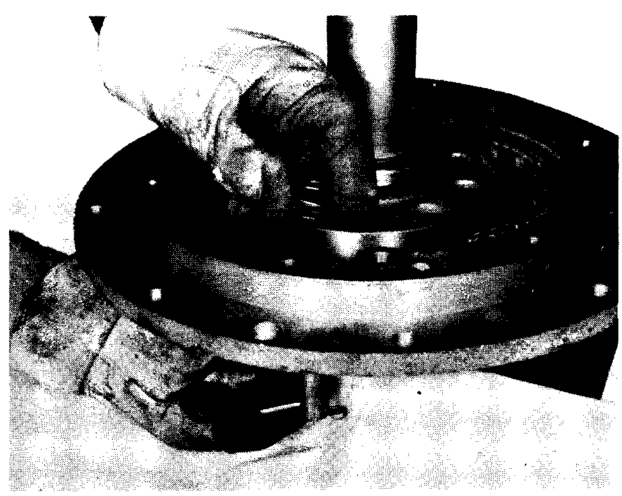
Illust. 12



Illust. 15



Illust. 13



Illust. 16

brake band and the other end into cotter pin head.

Insert clutch brake pull rod through housing and into clutch brake band. Next, install slotted nut and cotter pin (Illust. 15). Spread cotter pin.

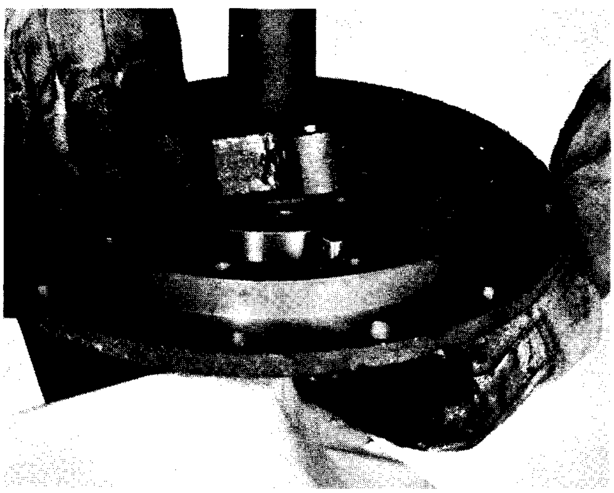
Insert cotter pin into pin. Spread cotter pin. Insert pin with cotter pin through housing. Next, install spring onto pin (Illust. 16).

Install brake band onto pin with spring (Illust. 17).

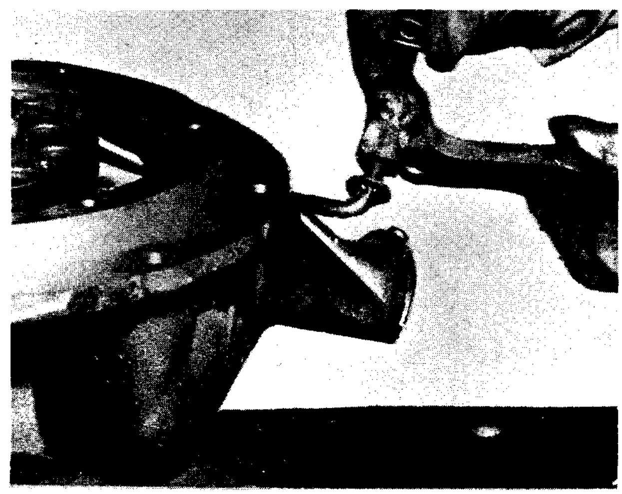
Install stud into housing (Illust. 18).

Install cotter pin into clutch brake pull rod. Next, install cut washer onto pull rod (Illust. 19). Install operating lever onto clutch brake pull rod and onto stud. Install cut washer and cotter pin. Spread cotter pin. Install nut on stud and tighten only enough to allow free movement in operating lever.

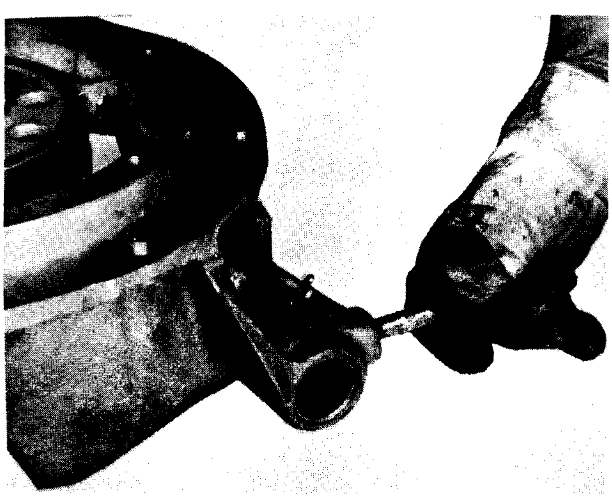
Insert lock cam through clutch release bearing sleeve support with flat side of cam head against brake band (Illust. 20). Next, install lock washer and nut onto cam. Do not tighten nut.



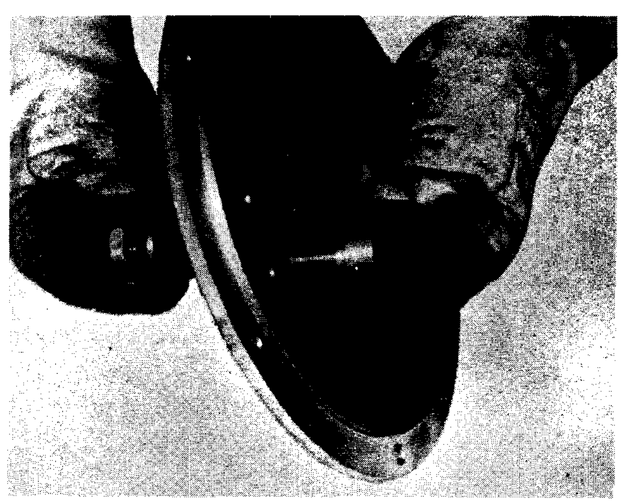
Illust. 17



Illust. 19



Illust. 18

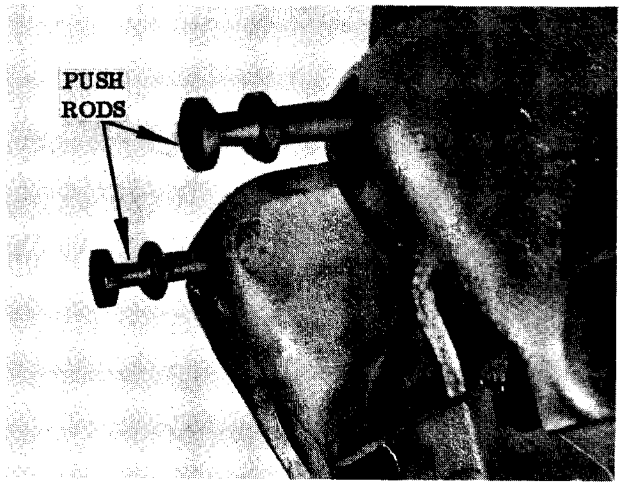


Illust. 20

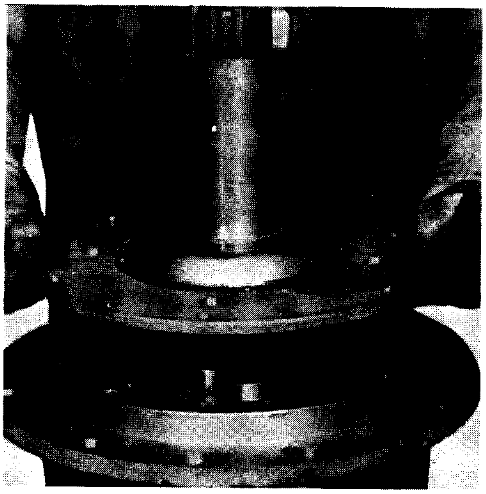
Install clutch release bearing sleeve onto clutch shaft (Illust. 21). Align dowel pin holes in clutch release bearing sleeve with those in clutch release bearing housing. Tap sleeve with a rawhide mallet to allow sleeve to go over clutch brake band pin.

Next, install dowel pin and cotter pin (Illust. 22). Spread cotter pin. Install and tighten cap screws.

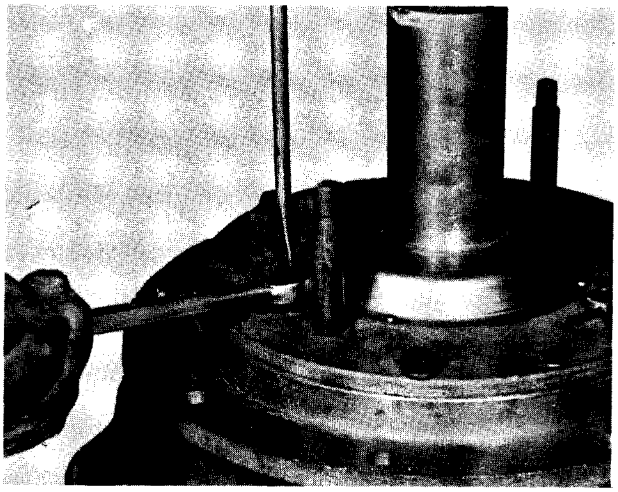
Install push rods (Illust. 23). Heads of push rods toward the rear of housing, with the tapered portion of head downward.
NOTE: Apply grease to push rods before assembling.



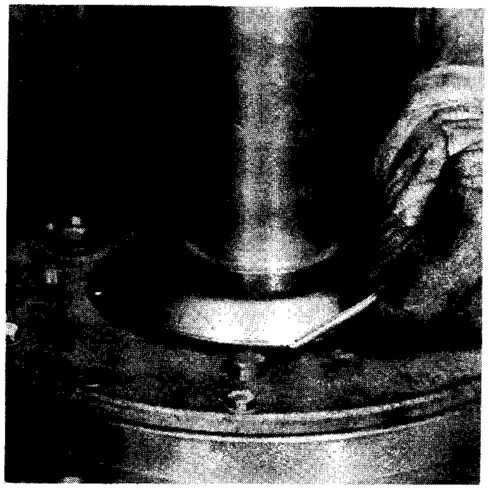
Illust. 23



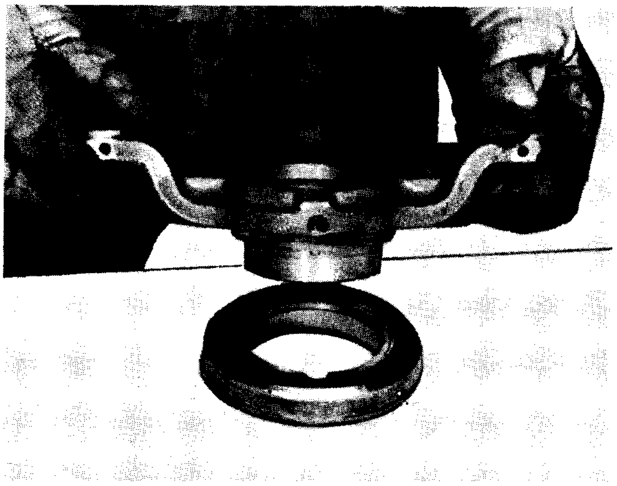
Illust. 21



Illust. 24



Illust. 22



Illust. 25

Turn cam with screw driver until tight against brake band. Back off cam either clockwise or counter-clockwise until there is freeness in push rods, then tighten jam nut (Illust. 24).

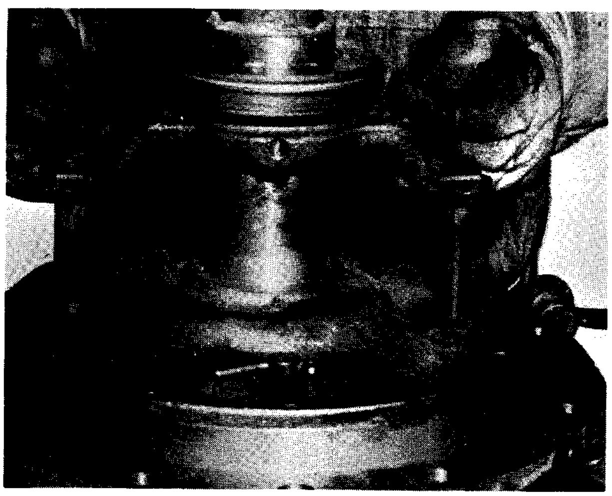
Press or drive bearing onto clutch release bearing sleeve (Illust. 25). Align grease hole in sleeve with grease hole in bearing. Fill bearing sleeve with grease.

Install clutch release bearing sleeve onto sleeve support and onto push rods (Illust. 26). Next, insert cotter pins and spread.

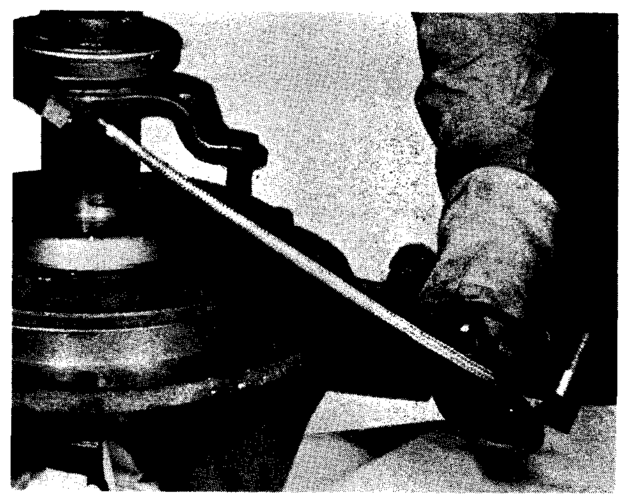
Install lubrication tube into block head fitting and tighten (Illust. 27).

Install lube fitting elbow into clutch release bearing sleeve. Next, install and tighten lubrication tube with block head into clutch release bearing sleeve lube fitting elbow (Illust. 28). NOTE: Lubrication tube to clear the clutch release bearing sleeve support.

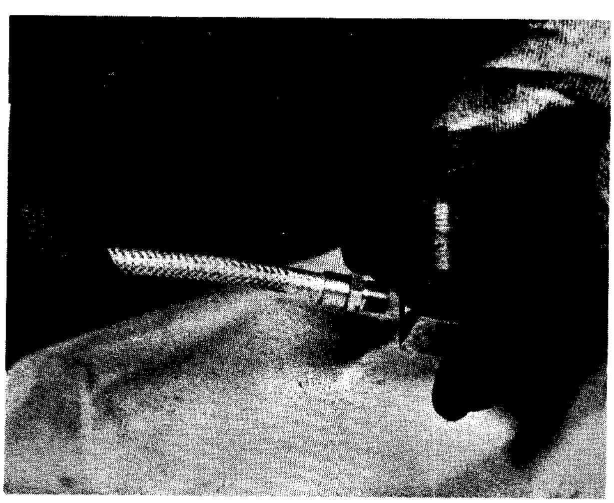
Install clutch release and brake assembly housing onto clutch housing. Install bolts and lock washers. Install block head through clutch housing and clutch release



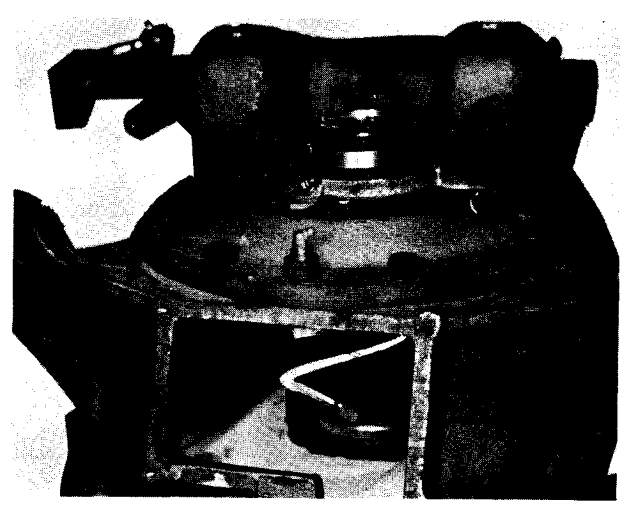
Illust. 26



Illust. 28



Illust. 27



Illust. 29

and brake housing (Illust. 29). Install lock washer and nut. Tighten nut securely. Install lube fitting and tighten. Tighten bolts.

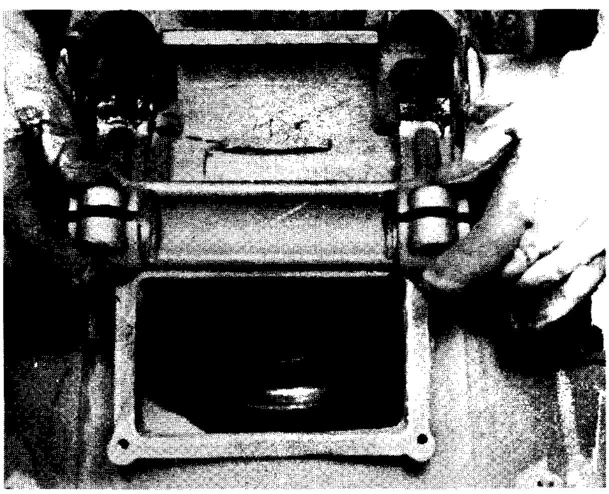
Install fork onto clutch housing (Illust. 30). Forked ends between heads of push rods.

Insert clutch throw-out shaft (Illust. 31) through clutch housing and fork. Keyways in shaft in line with slots in fork.

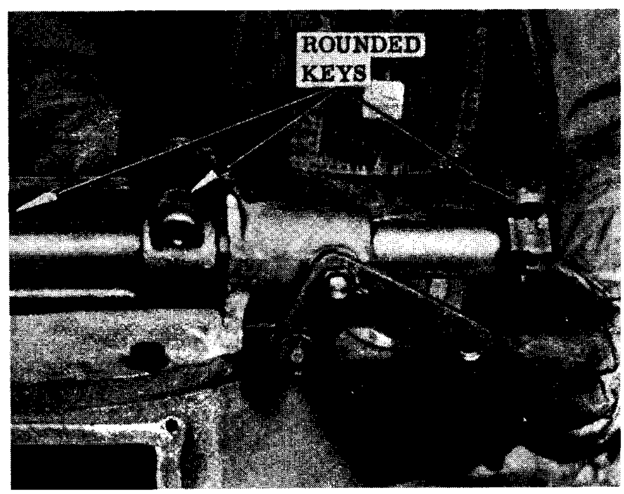
Insert rounded keys into slots of fork (Illust. 32). Tap keys down into keyways of shaft. Next, install fork cap screws with lock washers and tighten securely.

Install clutch lever onto end of clutch shaft (Illust. 32). Long end of lever pointing toward bottom of clutch housing, also, hub of lever toward the fork. Install rounded key in slot of lever. Tap key down into keyway of shaft. Next, install lever cap screw, lock washers and nut. Tighten nut securely.

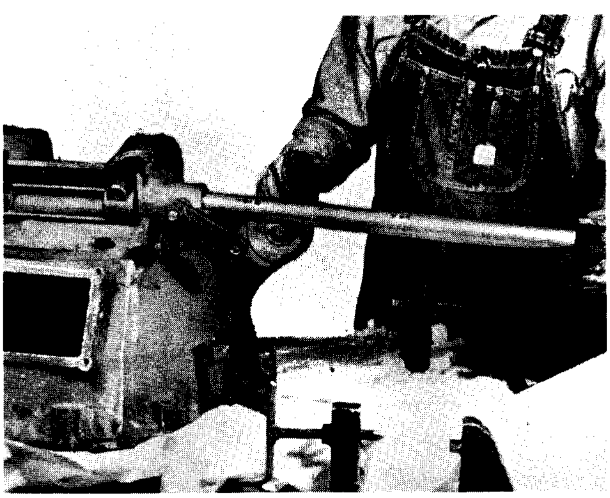
Install the ball socket to clutch lever (Illust. 33). Install cut washer and slotted nut. Tighten nut securely and insert cotter pin and spread.



Illust. 30

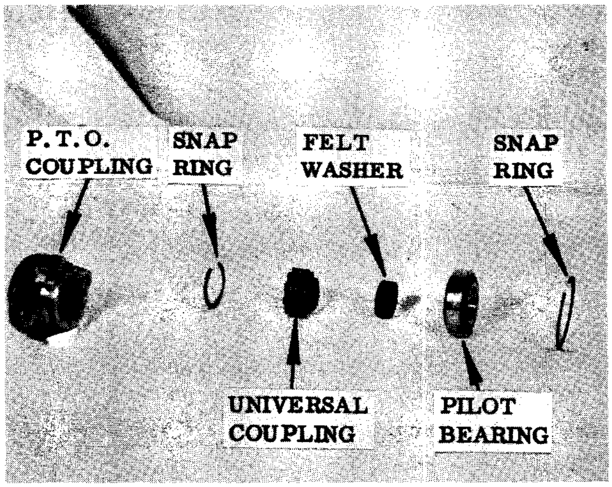


Illust. 32



Illust. 31

Illust. 33



Illust. 1

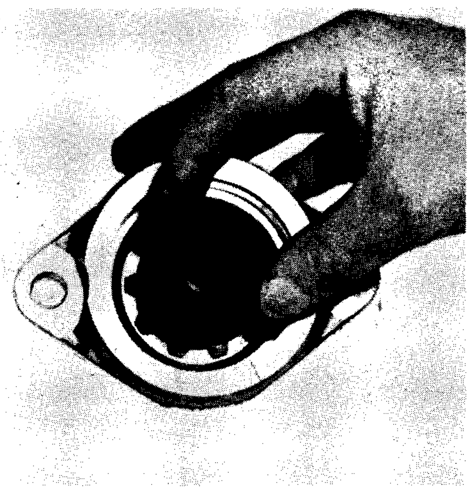
POWER TAKE-OFF BEARING CAGE (CUMMINS ENGINE)
(Models 330 and 440 Motor Graders)

Illust. 1 is an exploded view of the P.T.O. coupling used on the Cummins Engine only.

Insert small snap ring into groove of P.T.O. coupling (Illust. 2).

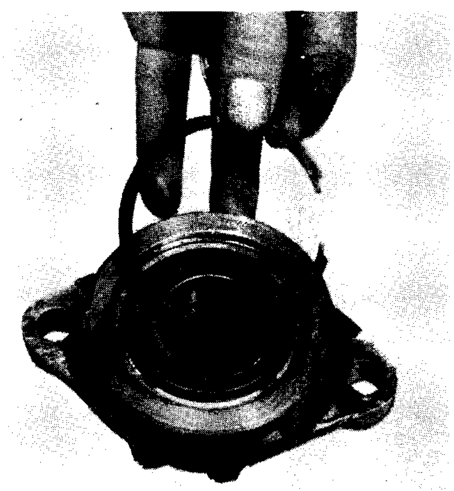
Apply grease to inside of P.T.O. coupling and insert splined coupling (Illust. 3). Insert long hub of splined coupling into large bore of P.T.O. coupling.

Illust. 2



Illust. 4

Illust. 3

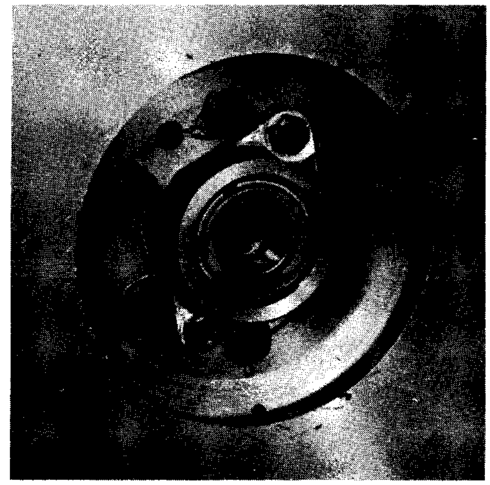


Illust. 5

Install felt washer into P.T.O. coupling and onto splined coupling (Illust. 4).

Press or drive bearing into P.T.O. coupling. Next, insert large snap ring into groove of P.T.O. coupling (Illust. 5).

Install P.T.O. coupling assembly onto flywheel (Illust. 6). Long hub of P.T.O. coupling going into flywheel. Install lock washers and coupling bolts and tighten securely.



Illust. 6

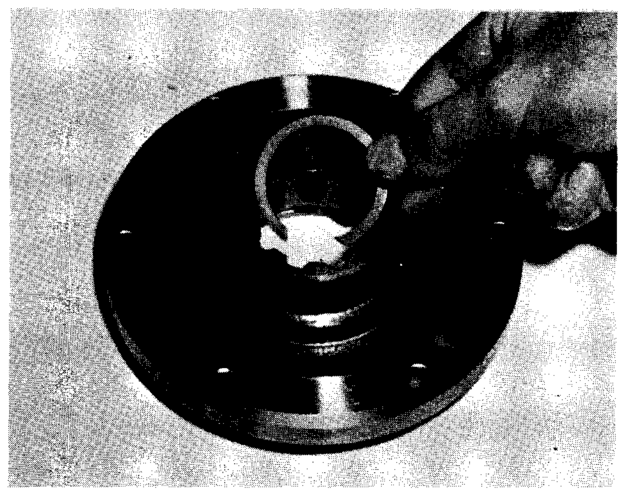
POWER TAKE-OFF BEARING CAGE
(GENERAL MOTORS ENGINE)
(Models 330 and 440 Motor Graders)

Illust. 1 is an exploded view of the P.T.O. coupling used on the General Motors engine only.

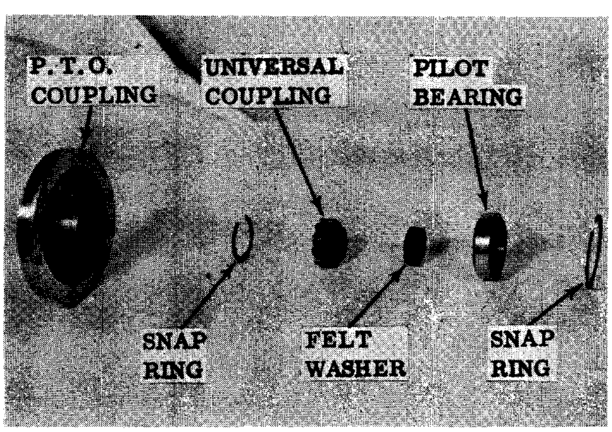
Insert small snap ring into groove of P.T.O. coupling (Illust. 2).

Apply grease to inside of P.T.O. coupling and insert splined coupling (Illust. 3). Insert long hub of splined coupling into large bore of P.T.O. coupling.

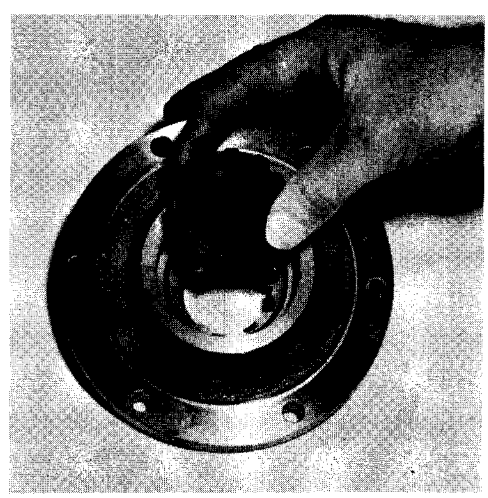
Install felt washer into P.T.O. coupling and onto splined coupling (Illust. 4).



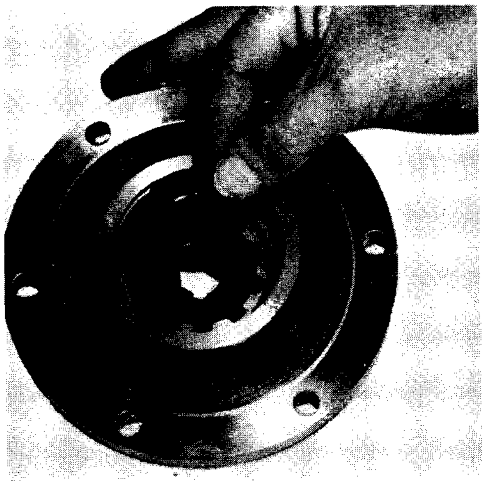
Illust. 2



Illust. 1



Illust. 3



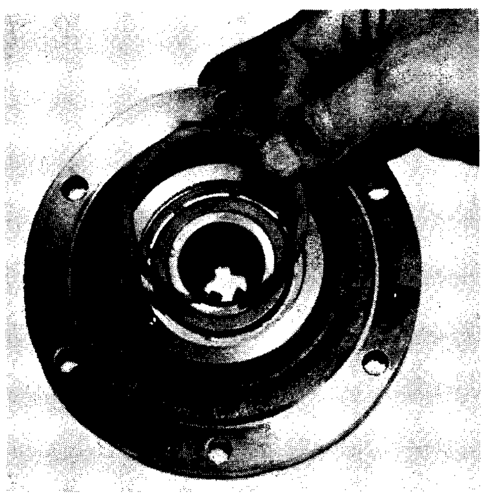
Illust. 4

Press or drive bearing into P.T.O. coupling. Next, insert large snap ring into groove of P.T.O. coupling (Illust. 5).

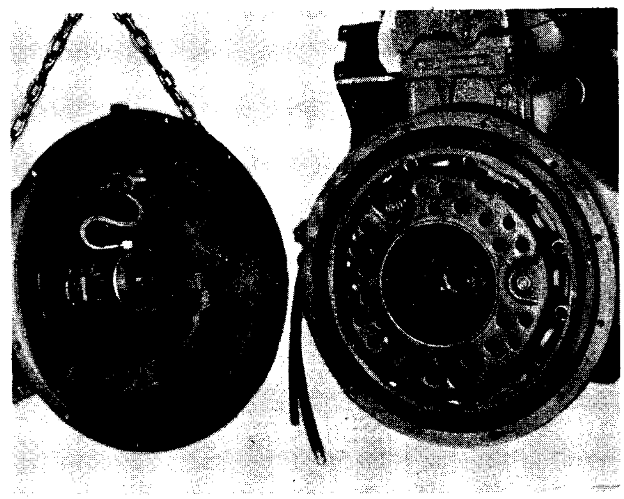
Install P.T.O. coupling assembly onto flywheel (Illust. 6). Long hub of P.T.O. coupling going into flywheel. Install lock washers and coupling bolts and tighten securely.

Install disc and cover assembly onto flywheel. Install cap screws with lock washers. Tighten cap screws securely (Illust. 7). Remove three hold down set screws or cap screws.

Install clutch release and brake housing assembly. Insert splined end of clutch

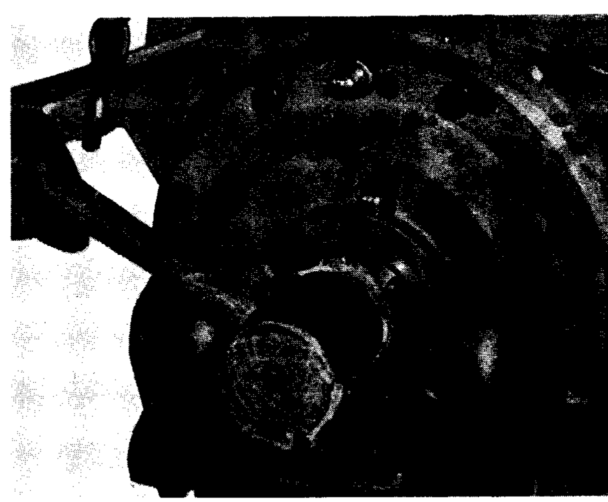


Illust. 5



Illust. 7

Illust. 6

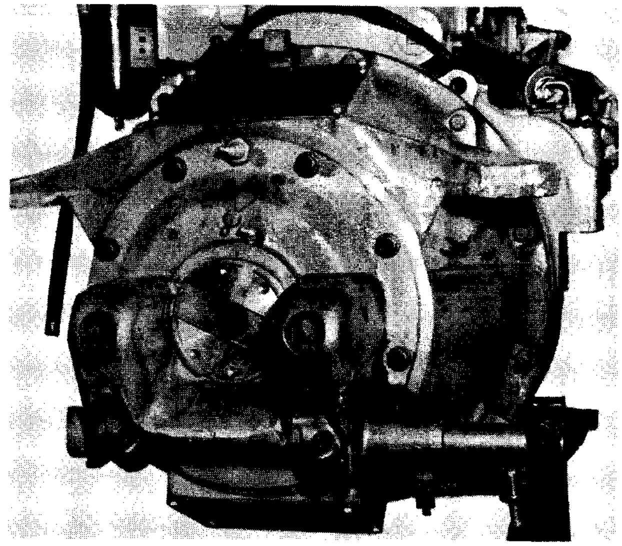


Illust. 8

shaft into clutch gear splines.
NOTE: Grease splined end of clutch shaft before inserting into clutch gear. Use a rawhide mallet to tap outside end of clutch shaft to seat into gear (Illust. 8).

Illust. 9 shows the clutch release and brake housing installed to the flywheel housing. Install lock washers and cap screws. Tighten cap screws securely. Check to determine if all clutch levers have uniform pressure against release bearing. Install covers with gaskets. Install lock washers and cap screws. Tighten cap screws securely.

The engine is now ready to be reassembled to the grader.



Illust. 9

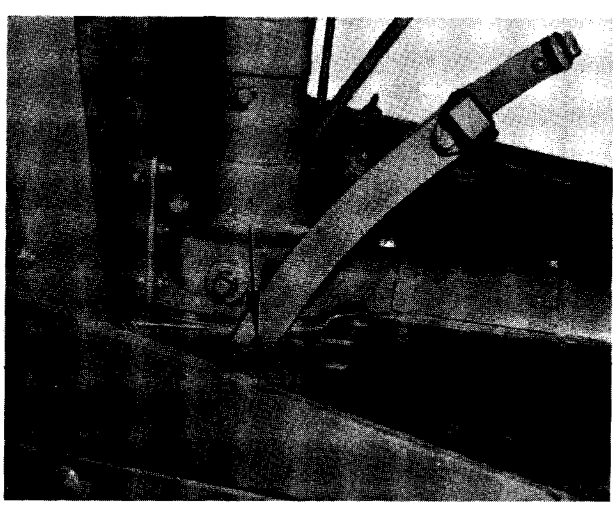
CLUTCH PEDAL ADJUSTMENT

(Model 330 Motor Grader - S/N 1 thru 1599)
(Model 440 Motor Grader - S/N 1 thru 2399)

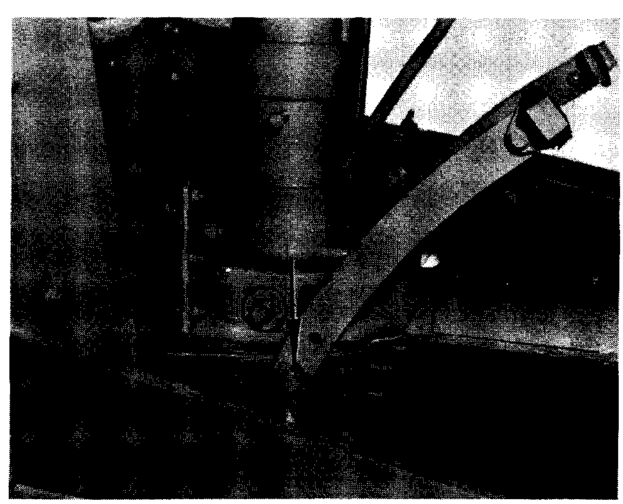
MAXIMUM TRAVEL: Adjust the maximum free pedal movement so upper hole in lever (Illust. 1) is flush with the floor board when the pedal is depressed.

As the clutch disc wears, the free pedal movement decreases and an adjustment is necessary.

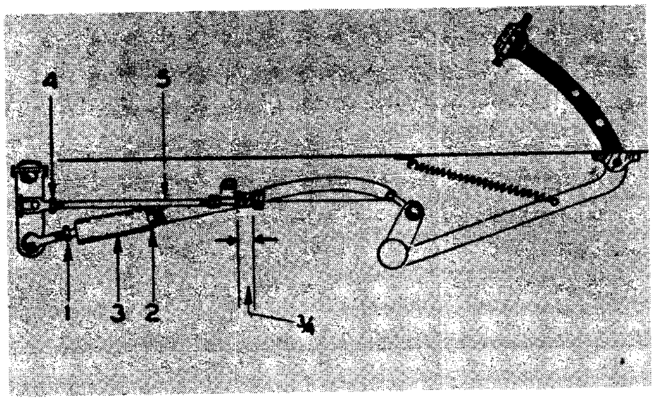
MINIMUM TRAVEL: When the lower hole in lever appears flush with floor board (Illust. 2) with the clutch pedal depressed,



Illust. 1



Illust. 2



Illust. 3

adjustment should be made before serious damage occurs to the clutch disc.

When adjustment is necessary, it can be accomplished by loosening the lock nuts (1) and (2) (Illust. 3). Turn coupling (3) to lengthen pull rod to obtain the free pedal travel. After adjustment has been made, tighten lock nuts (1) and (2) securely. There is no other adjustment to compensate for wear in the clutch.

CLUTCH BRAKE ADJUSTMENT

The spring on the front end of the clutch brake pull rod should be adjusted with the hex nut to a length of 3/4" (Illust. 3). To adjust the clutch brake, loosen the lock nut (4) and turn the pull rod (5) to shorten the pull rod until, with the clutch pedal held against the floor plate of the cab, the pull rod spring will be compressed 1/8" (i.e., the spring will be compressed to 5/8" length instead of the normal 3/4" length). After completing the adjustment, tighten the lock nut (4) securely.

With engine running at full throttle, brake should stop clutch in not less than 3 seconds and not more than 4 seconds after pedal is depressed to cab floor.

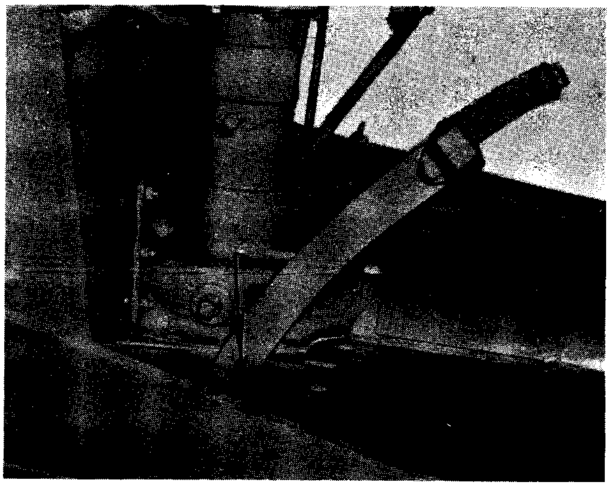
OPERATION OF THE CLUTCH BRAKE

This machine is equipped with a clutch brake which will stop the clutch from spinning when the clutch pedal is depressed all the way to the floor. The clutch pedal has approximately 2" of free pedal movement at the beginning of its stroke. From that point on down to a point approximately 2" to 3" from the floor plate, the clutch is released but the clutch brake is not applied. In the last 2" to 3" of clutch pedal travel at the bottom of the stroke, the clutch brake is applied.

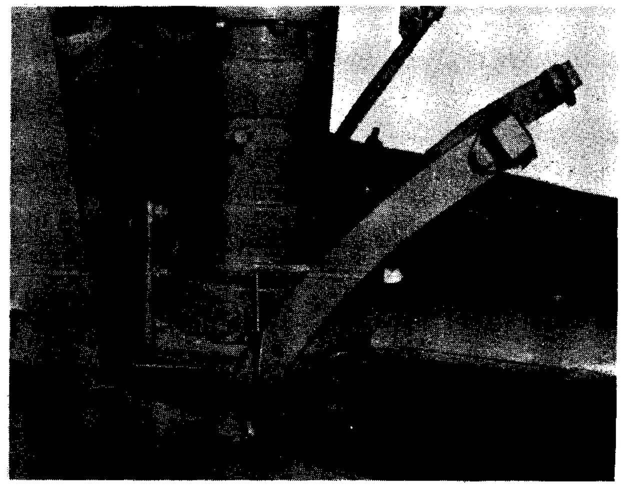
It is necessary for the operator to get the "feel" of the brake operation after which shifting of gears under various operating conditions is made easier. Generally speaking, the clutch brake is used (the pedal is depressed all the way to the floor board) only when the machine is standing still and the operator is shifting from neutral into one of the gears. If the gears are being shifted while the machine is rolling, the brake may be used to slow the driving gears down slightly in order to synchronize the speed of the gears for shifting. However, under some operating conditions it may be necessary to "double" clutch the grader, in order to increase the speed of the driving gear to match the speed of the driven gears. A brief period of practice will provide the average operator with sufficient skill to handle the clutch brake quite adequately.

CLUTCH PEDAL ADJUSTMENT
(Model 330 Motor Grader - S/N 1600 & Later)
(Model 440 Motor Grader - S/N 2400 & Later)

MAXIMUM TRAVEL: Adjust the maximum free pedal movement so upper hole in lever (Illust. 4) is flush with the floor board when the pedal is depressed.



Illust. 4



Illust. 5

As the clutch discs wear, the free pedal movement decreases and an adjustment is necessary.

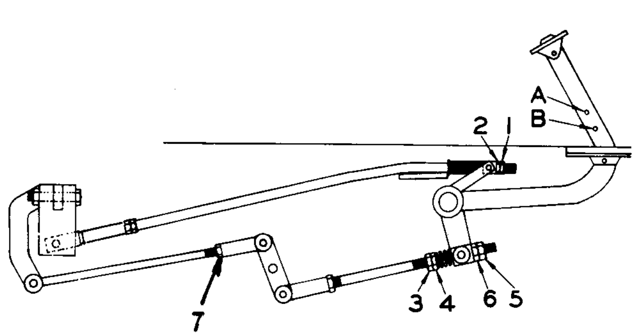
MINIMUM TRAVEL: When the lower hole in lever appears flush with floor board (Illust. 5) with the clutch pedal depressed, adjustment should be made before serious damage occurs to the clutch disc.

To adjust the free pedal travel, loosen jam nut (1) (Illust. 6). Tighten or loosen nut (2) at swivel block until the upper hole (Illust. 4) in lever is flush with cab floor, when pedal is depressed. After completing this adjustment, tighten jam nut (1) (Illust. 6).

CLUTCH BRAKE ADJUSTMENT

To adjust clutch brake, loosen jam nut (3) (Illust. 6). Tighten or loosen nut (4) until spring can be compressed 1/8" when clutch pedal is depressed all the way to the floor of the cab. Retighten jam nut (3). Loosen jam nut (5). Tighten front nut (6) against swivel finger to prevent rattle or obvious looseness. Retighten jam nut (5).

With engine running at full throttle, brake should stop clutch in not less than 3 seconds and not more than 4 seconds after



Illust. 6

pedal is depressed to cab floor.

Should clutch brake fail to stop after linkage adjustment, depress pedal to floor board and check for interference between front pull rod yoke and pivot lever. If interference is experienced, remove pull rod yoke from pivot lever. Loosen jam nut (7) and tighten yoke into rod (shortening rod). Reassemble yoke to pivot lever. Readjust front linkage.

OPERATION OF CLUTCH BRAKE

This machine is equipped with a clutch brake which will stop the clutch from spinning when the clutch pedal is depressed all the way to the floor. The clutch pedal has approximately 2" of free pedal movement at the beginning of its stroke. From that point on down to a point approximately 2" to 3" from the floor plate, the clutch is released but the clutch brake is not applied. In the last 2" to 3" of clutch pedal travel at the bottom of the stroke, the clutch brake is applied.

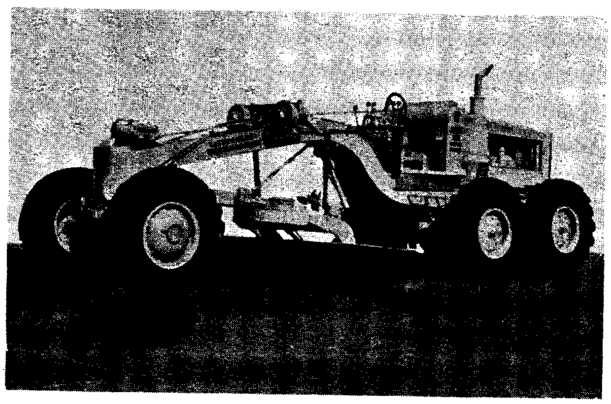
It is necessary for the operator to get the "feel" of the brake operation after which shifting of gears under various operating conditions is made easier. Generally speaking, the clutch brake is used (the pedal is depressed all the way to the floor board) only when the machine is standing still and the operator is shifting from neutral into one of the gears. If the gears are being shifted while the machine is rolling, the brake may be used to slow the driving gears down slightly in order to synchronize the speed of the gears for shifting. However, under some operating conditions, it may be necessary to "double" clutch the grader, in order to increase the speed of the driving gears to match the speed of the driven gears. A brief period of practice will provide the average operator with sufficient skill to handle the clutch brake quite adequately.

— NOTES —

COMPLETE DRIVE UNIT

The complete transmission and tandem assemblies must be removed whenever transmission repairs become necessary.

Turn moldboard of grader crosswise to the center line of the frame and lower it to the ground (Illust. 1). Raise front end of grader until front wheels are approximately 10 inches above the ground.



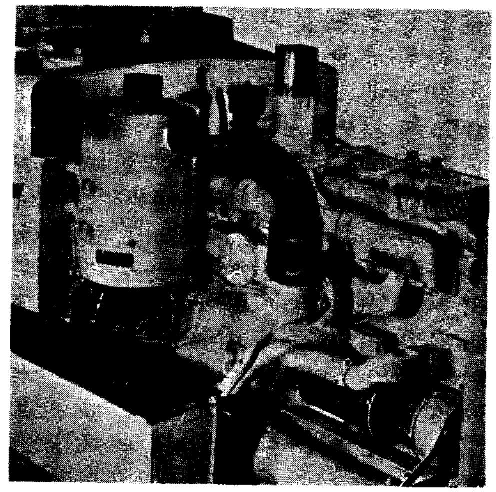
Illust. 1

Remove muffler, air cleaner cap or air pre-cleaner, hood and lower hood sides. Next, remove air cleaner hose between elbow and air cleaner (Illust. 2).

Drain hydraulic reservoir by installing a suitable length of hose onto drain cock. Open drain cock and allow oil to drain in a container. When reservoir is empty, close drain cock and remove hose. Next, shut fuel off at fuel shut-off valve. Disconnect fuel outlet and return lines from tank (Illust. 3). Disconnect vent pipe from top of tank.

Disconnect battery cables at engine. Remove wiring from voltage regulator and clamps from fire wall.

Disconnect wiring from cranking motor and generator. Remove wiring clamps from engine.



Illust. 2

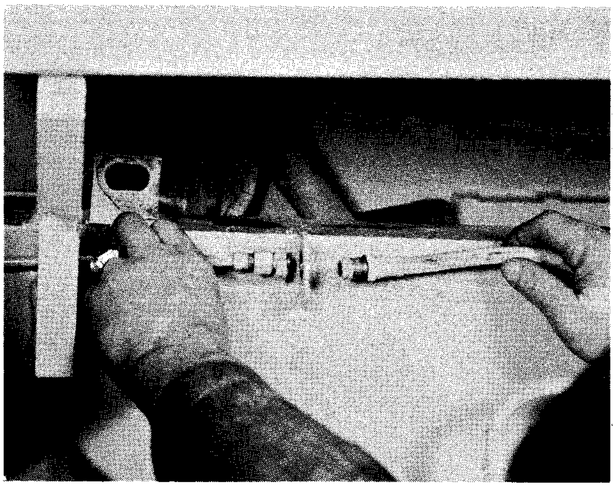
Illust. 3

Disconnect engine solenoid switch cable on Cummins engine and engine shut down cable on General Motors engine.

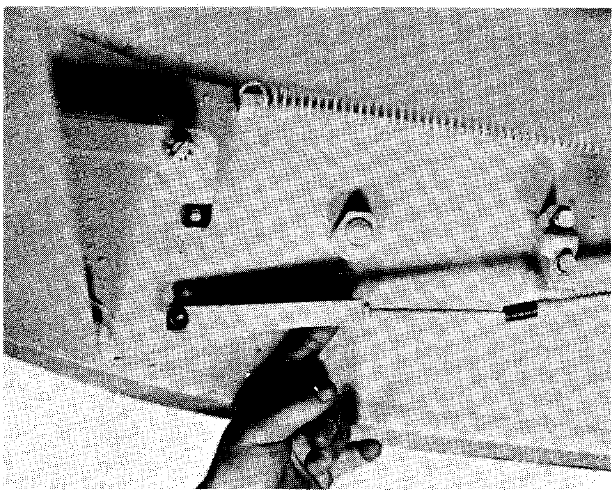
Disconnect hour meter cable from switch or engine.

Remove heat indicator cable from engine.

Disconnect heater hoses from engine and lower radiator pipe, if so equipped. Remove heater hose clamps on clutch housing.



Illust. 4



Illust. 5

Disconnect ether starting aid cable at engine, if so equipped.

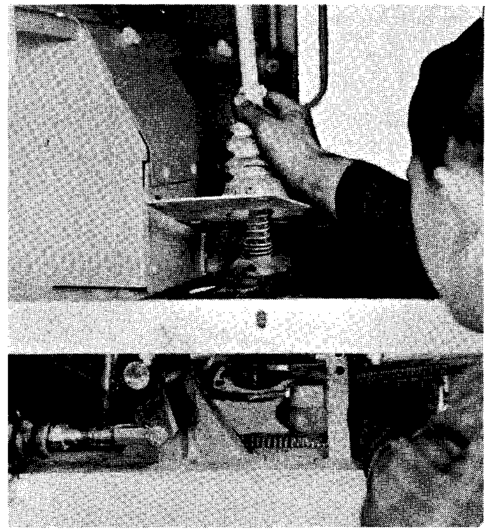
Disconnect radiator shutter cable at radiator, if so equipped.

Disconnect oil line at engine.

Disconnect air cleaner tubing at air cleaner.

Disconnect brake hoses from tubing (Illust. 4).

Disconnect clutch pedal linkage under cab.



Illust. 6

Disconnect handbrake cable under cab (Illust. 5).

Disconnect throttle cable.

Disconnect propeller drive shaft coupling at shear pin under cab.

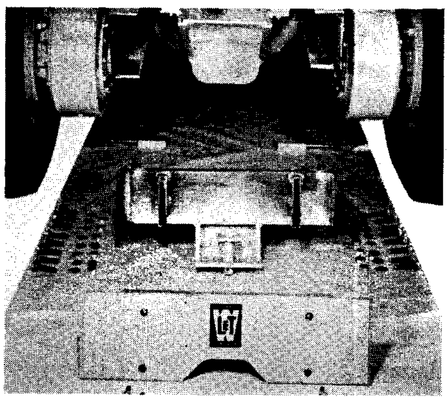
Disconnect parking brake hydraulic tubing behind parking brake backing plate.

Remove shifter lever floor plate cap screws. Loosen upper boot clamps and slide floor plate up on shifter levers. Remove rubber cover clamp and cover. Next, remove ball cap cap screws. Lift shifter levers and shims from shifter housing (Illust. 6).

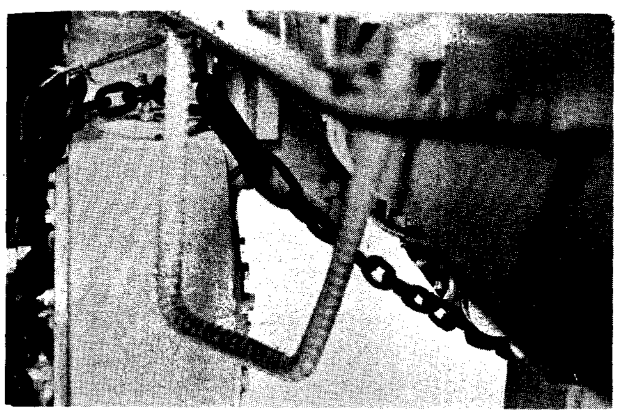
Remove rear closure plate cap screws and rear closure plate from rear cross member. Next, remove rear cross member cap screws from frame and slide rear cross member from frame. Remove rear axle cap screws and caps (Illust. 7).

Attach a chain around front portion of each tandem, using care to prevent crushing of brake lines. Bring chain under front end of transmission (Illust. 8). Also, place a heavy piece of wood from tandem to tandem under radiator end of engine (Illust. 11). The chain and heavy piece of wood will act as safety measures preventing unit from pivoting as unit is rolled from frame.

Remove transmission support bar (Illust. 9). IMPORTANT: When reassembling support bar and new support biscuits are used, tighten bolts until a 1/8" clearance is obtained between clamp bar and support bracket; 1/16" clearance if biscuits are reused.

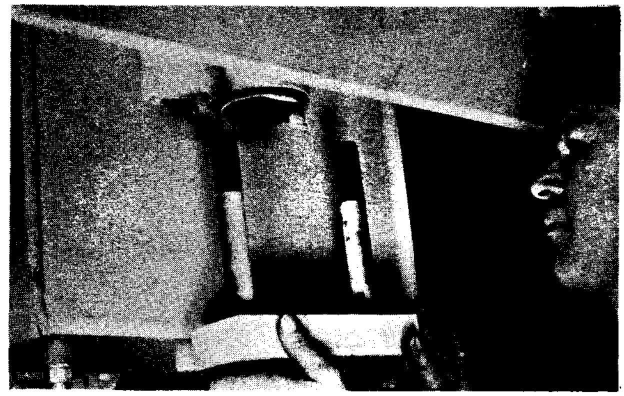


Illust. 7

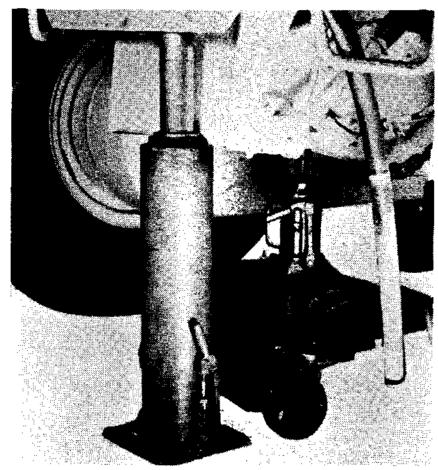


Illust. 8

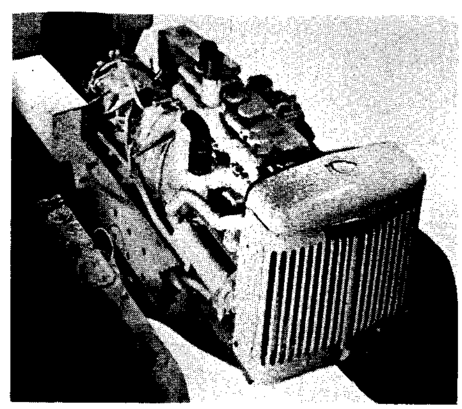
Use two hydraulic jacks, one on a dolly under front end of transmission and the other jack under moldboard stop angle (Illust. 10). Alternate the raising of frame and front of transmission until there is clearance between shifter housing and moldboard stop angle, axle carriers and frame. When



Illust. 9



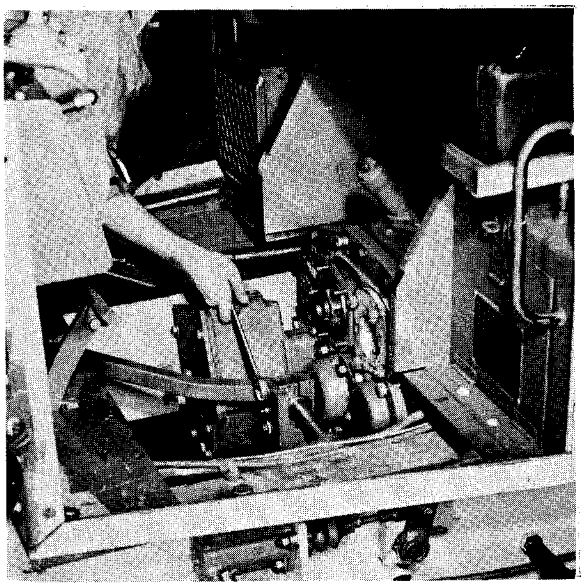
Illust. 10



Illust. 11

clearance is obtained at these points, roll unit from frame (Illust. 11).

To install unit into frame, reverse removal procedure.



Illust. 1

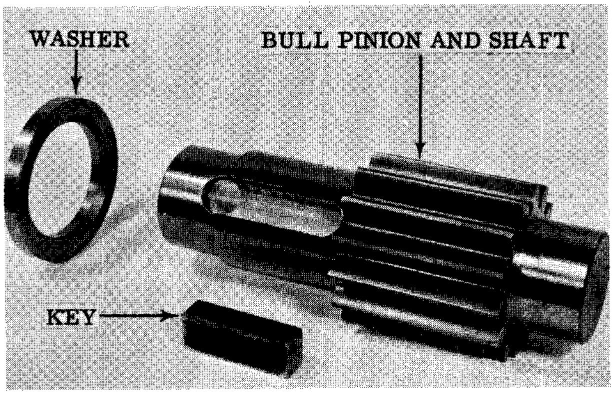
TRANSMISSION

The upper transmission can be serviced in the machine (Illust. 1).

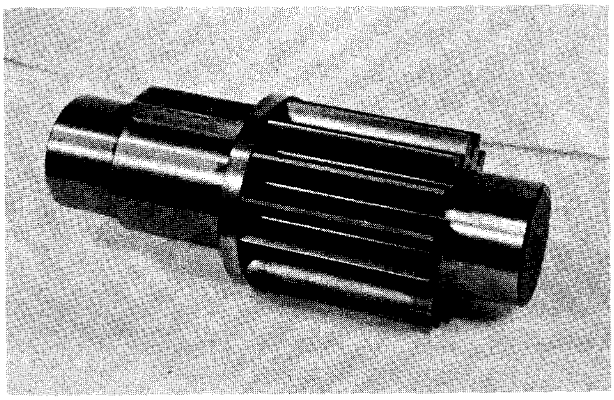
The creeper gears can be installed without removal of the transmission from the machine.

The balance of this section is written on a basis that the transmission is removed from the machine.

As you will note throughout this section, certain parts must be heated sufficiently in oil before assembling. The oil should be heated to a temperature of approximately 350° F.



Illust. 2



Illust. 3

FINAL DRIVE

Illust. 2 is an exploded view of the bull pinion and shaft.

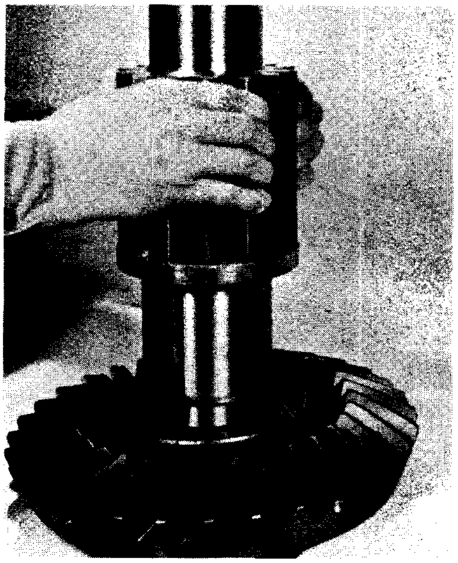
Heat washer in oil and press onto bull pinion shaft, inside chamfered edge of washer against pinion. Next, insert key in keyway (Illust. 3).

Heat spiral bevel gear in oil. Press bull pinion shaft through spiral bevel gear (Illust. 4). Hold in press until gear is set. NOTE: Be sure the gear is tight against the washer.

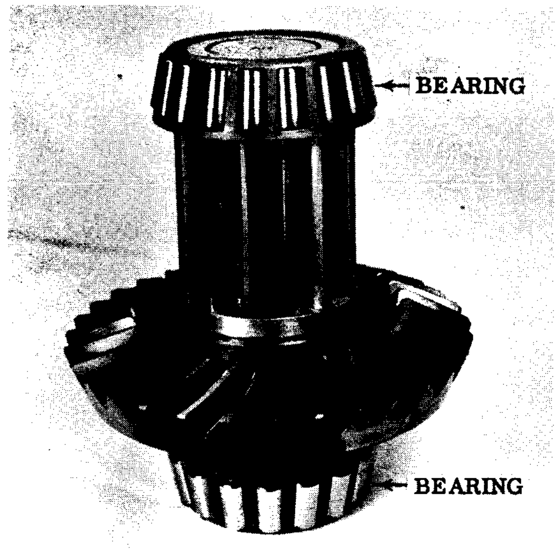
To remove spiral bevel gear from bull pinion and shaft, use a 100 ton press.

Heat bearings in oil and press onto bull pinion and shaft. Hold bearings until set (Illust. 5).

Drive bearangs cups into L.H. and R.H. jackshaft bearing cages (Illust. 6). Next, install "O" rings in grooves of jackshaft bearing cages.



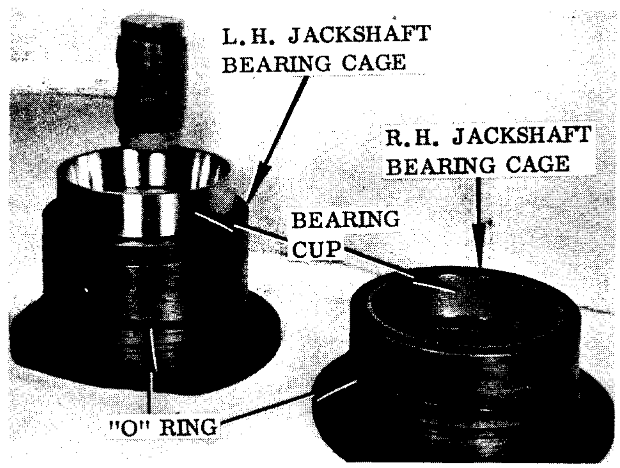
Illust. 4



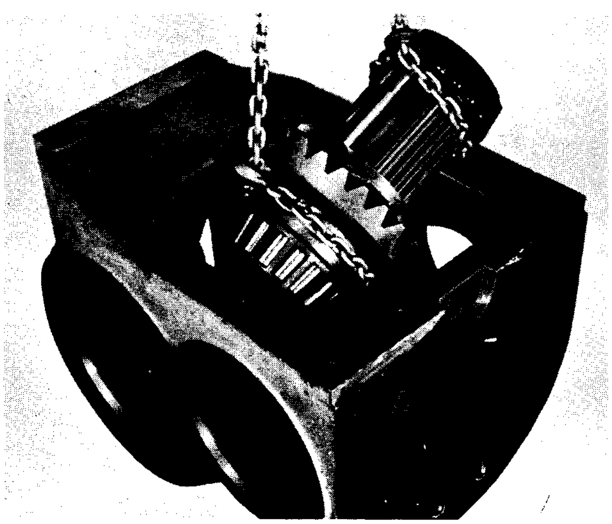
Illust. 5

Install bull pinion and shaft assembly into the final drive housing (Illust. 7).

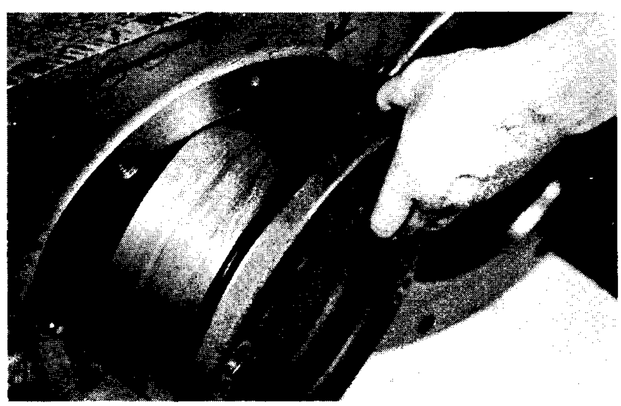
Insert left hand jackshaft bearing cage, less shims (bearing cage with long hub) onto left side of final drive and over bearing of bull pinion and shaft (Illust. 8). To determine the left and right side of the final drive, stand in rear of machine and look toward the front of the machine. Next, install the cap screws and lock washers. Tighten cap screws (Illust. 9).



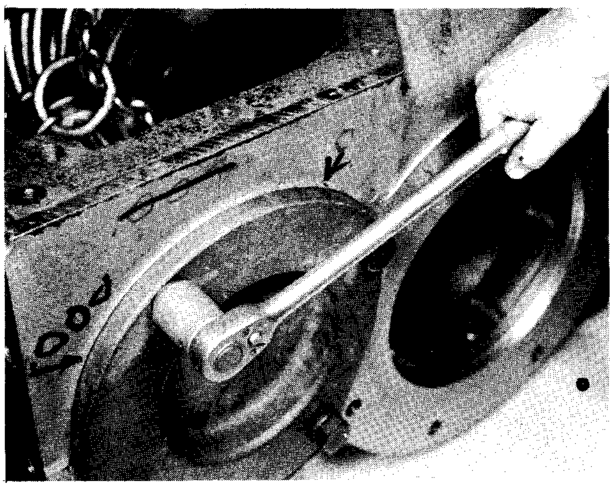
Illust. 6



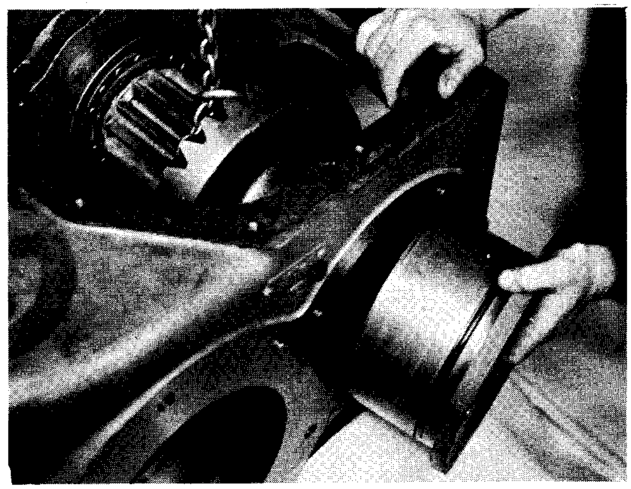
Illust. 7



Illust. 8



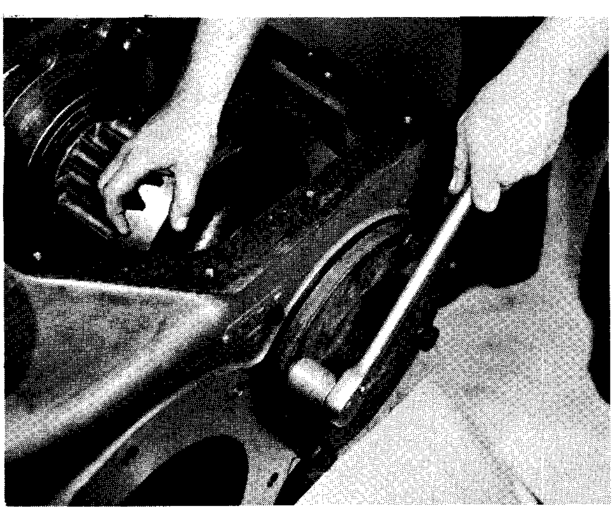
Illust. 9



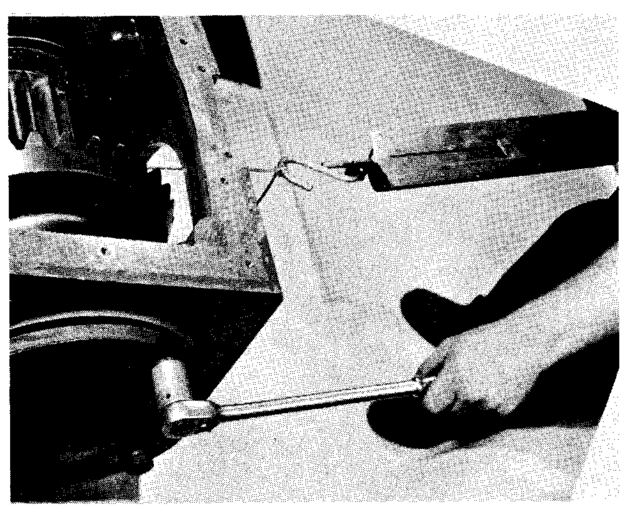
Illust. 10

Insert right hand jackshaft bearing cage, less shims (bearing cage with short hub) onto right side of final drive and over bearing of bull pinion and shaft (Illust. 10). Install cap screws and lock washers. While tightening cap screws, rotate bevel gear (Illust. 11). This will seat the bearings in the bearing cups. Continue tightening cap screws until a slight drag is noted on the pinion and shaft assembly.

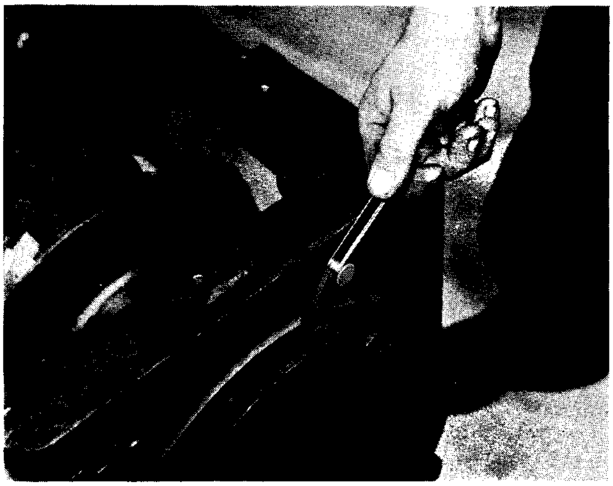
To pre-load the bearings, use a piece of rope and a fish scale. Wrap one end of the rope around the pinion teeth. Attach a fish scale to the other end of the rope. Pull on fish scale (Illust. 12) and at the same time, tighten jackshaft bearing cage cap screws until a reading of 14-1/2 to 18 pull pounds is obtained. After this reading is obtained, use a feeler gauge (Illust. 13) to determine the amount of shims needed between the jackshaft bearing cage and the final drive housing.



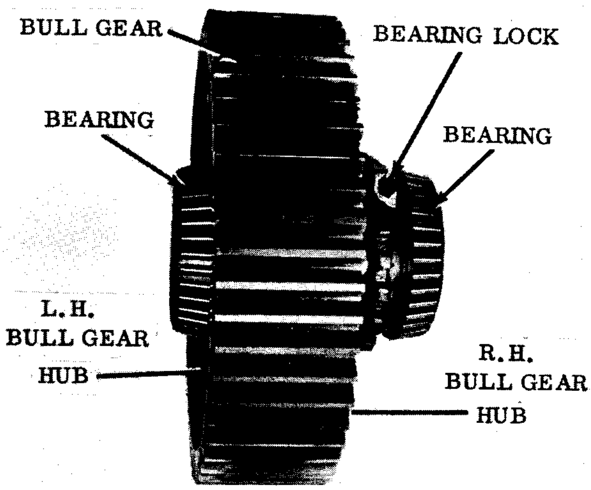
Illust. 11



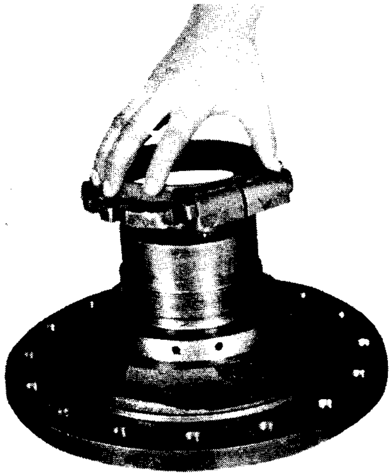
Illust. 12



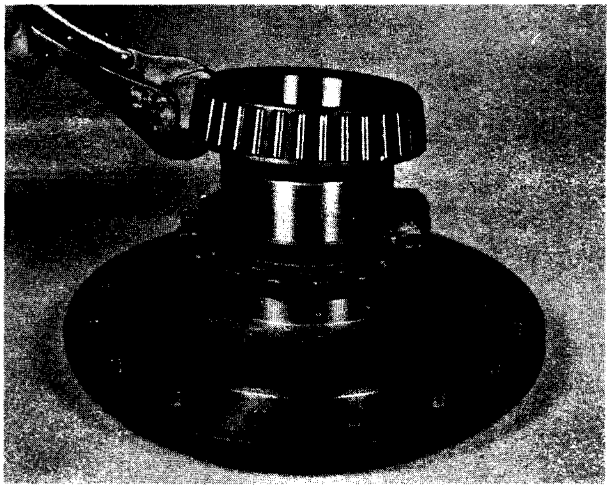
Illust. 13



Illust. 14



Illust. 15



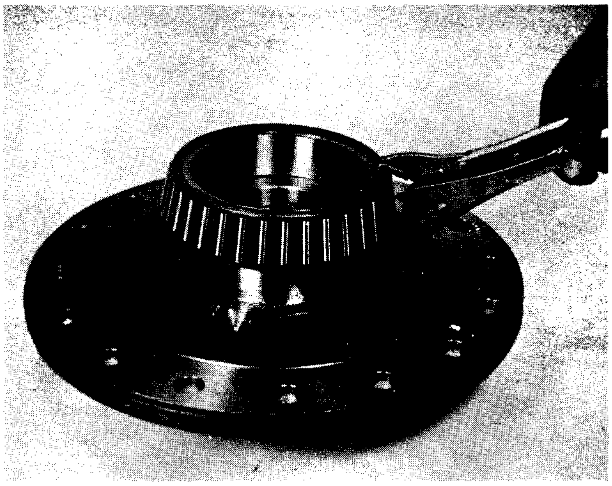
Illust. 16

Next, install the correct amount of shims needed. Retighten the cap screws, then recheck the pull poundage. NOTE: Loosen jackshaft bearing cage to check pre-load of bull gear.

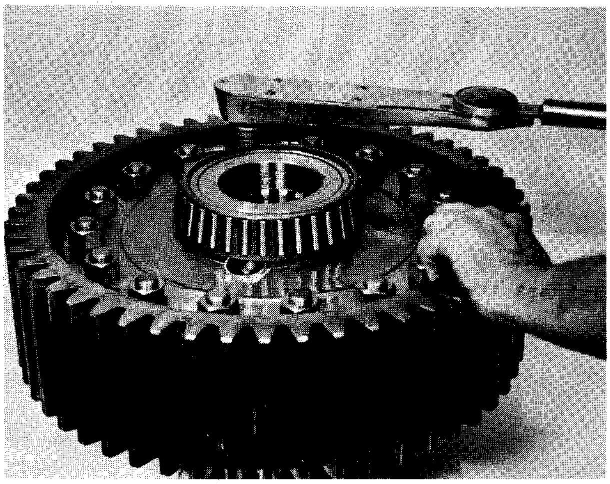
Illust. 14 is an assembly view of the bull gear.

Install bearing lock to right hand bull gear hub (Illust. 15). Screw bearing lock on hub until lock has passed bearing seat. Heat bearing in oil and press onto bull gear hub (Illust. 16). Hold bearing until set.

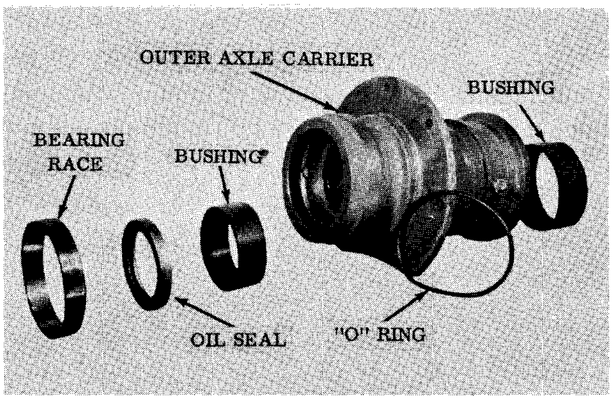
Heat bearing in oil and press onto left hand bull gear hub (Illust. 17).



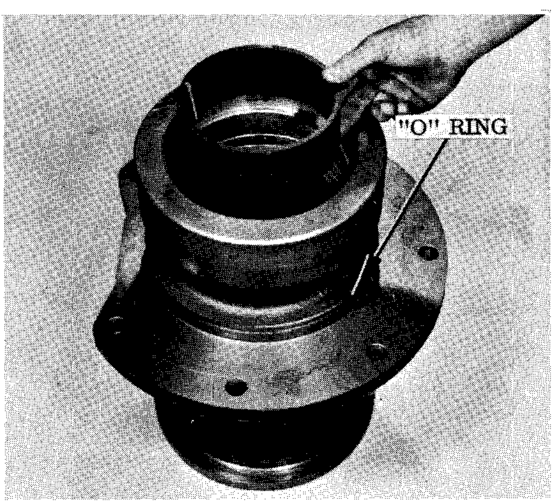
Illust. 17



Illust. 18

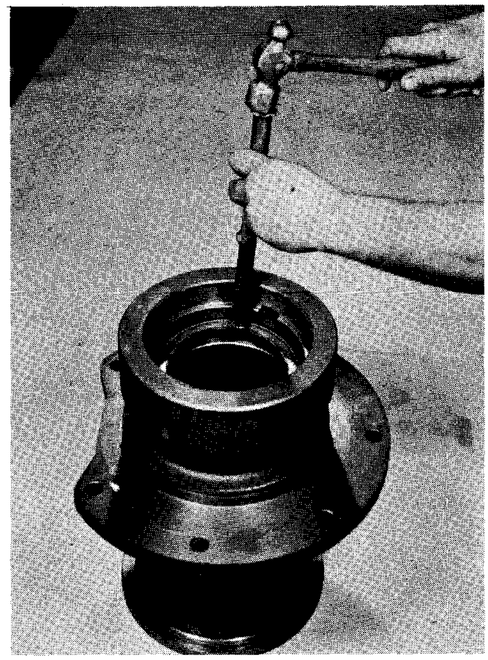


Illust. 19



Illust. 20

Install left and right hand hub assemblies to bull gear. Insert heat treated cap screws

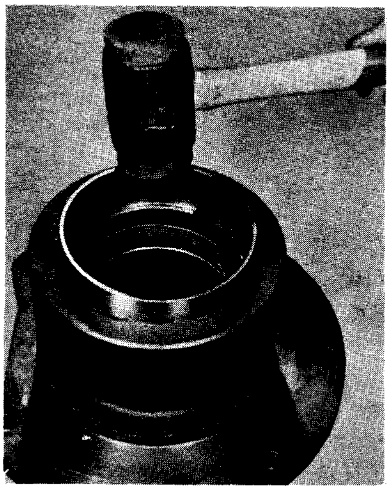


Illust. 21

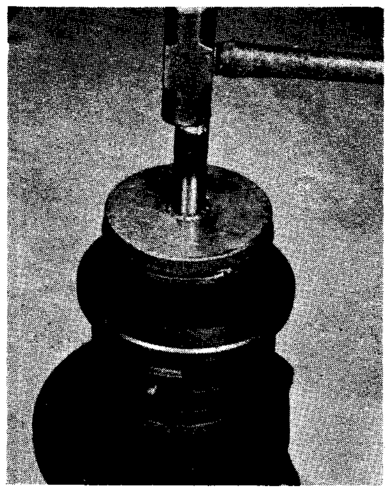
through right hand hub, bull gear and through left hand hub. Coat threads of cap screws with white lead or a sulfur based oil to prevent galling of the locking nuts. Install self-locking nuts and tighten nuts to a torque reading of 265 foot pounds (Illust. 18).

Illust. 19 is an exploded view of the outer axle carrier.

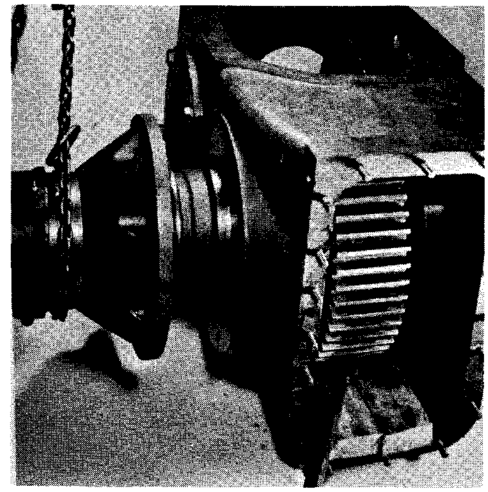
Press or drive large bushings into left and right hand outer axle carriers. Groove in I. D. of bushing to align with groove in axle carriers (Illust. 20). Lubricate bushings before pressing or driving into axle carriers. Next, install "O" rings in groove of outer axle carriers. Using a soft drift pin and hammer (Illust. 21), drive grease seal into outer axle carrier, lip of grease seal away from bushing. NOTE: Be careful not to damage seal while driving into position.



Illust. 22



Illust. 23



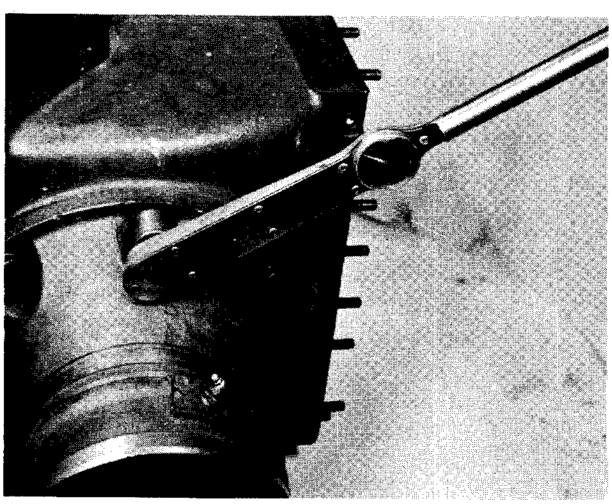
Illust. 24

Press or drive bearing cups into left and right hand outer axle carriers. Use a mallet to drive cups (Illust. 22).

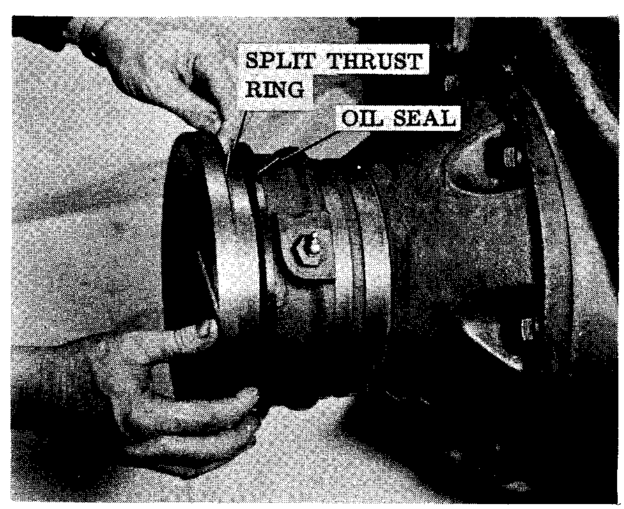
Turn axle carriers over and press or drive small diameter bushings into left and right hand outer axle carriers flush with inside shoulder of carrier (Illust. 23). Lubricate bushings before driving or pressing bushings into outer axle carriers.

Roll bull gear assembly into position in the final drive housing with bearing lock to the right. Use blocks to align bull gear assembly with axle carriers. Install left hand outer axle carrier to final drive housing (Illust. 24). Install lock washers and cap screws and tighten cap screws to a torque reading of 275 foot pounds (Illust. 25). Install right hand outer axle carrier in the same manner.

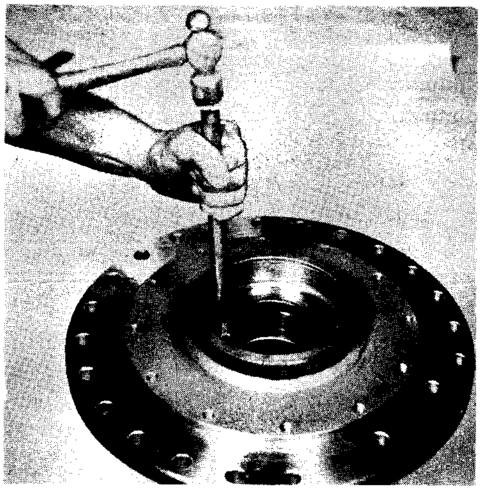
Install oil seal and split thrust ring on outer axle carriers (Illust. 26).



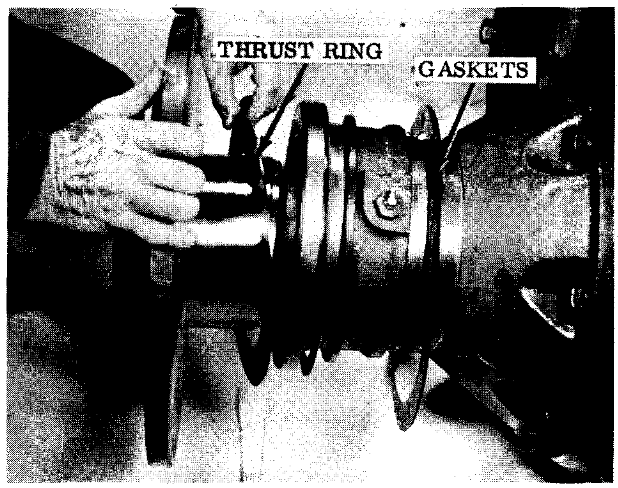
Illust. 25



Illust. 26



Illust. 27



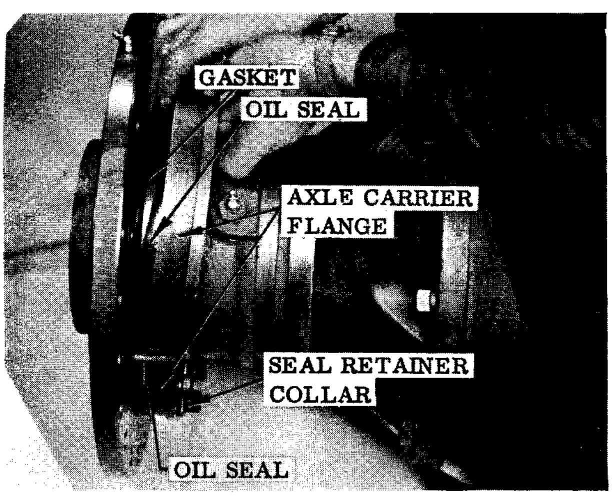
Illust. 28

Press or drive oil seal into left and right hand inner axle carriers (Illust. 27) lip of seals toward long hub of carrier. To insert seal by driving, use a soft drift pin and hammer. Tap seal into place, using care not to damage seal.

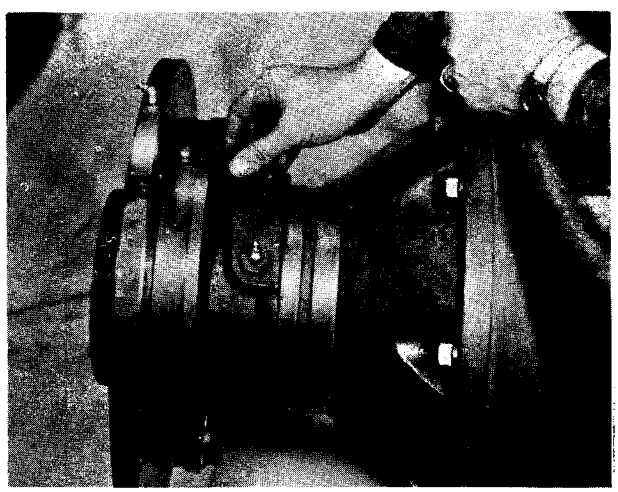
Install gaskets on left and right outer axle carriers. Next, install thrust ring on inner axle carriers (Illust. 28). Insert inner axle carriers in outer axle carriers.

Install lower half of axle carrier flange and one section of seal retainer collar on axle carriers and over oil seals (Illust. 29), oil seal to fit in groove of lower flange. Install cap screws with lock washers through retainer collar, through ends of flange and into inner axle carrier. This will hold lower flange and seal retainer collar in place. Install the two small oil seals, one on each end of lower flange.

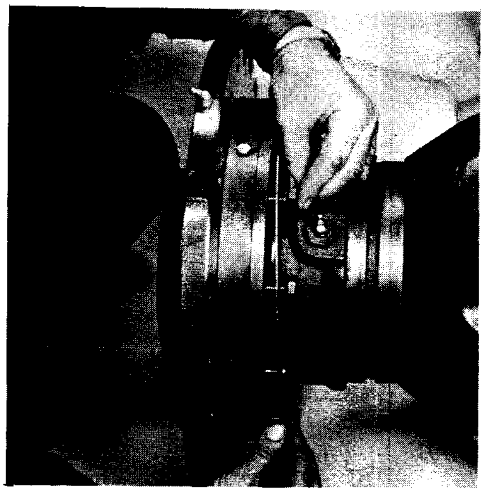
Install upper flange to outer axle carrier and over oil seals (Illust. 30), oil seals to fit in groove of upper flange. Next, install the other two oil seal retainers. Insert cap screws with lock washers through retainers, flange and into inner axle carriers (Illust. 31). Tighten all cap screws securely.



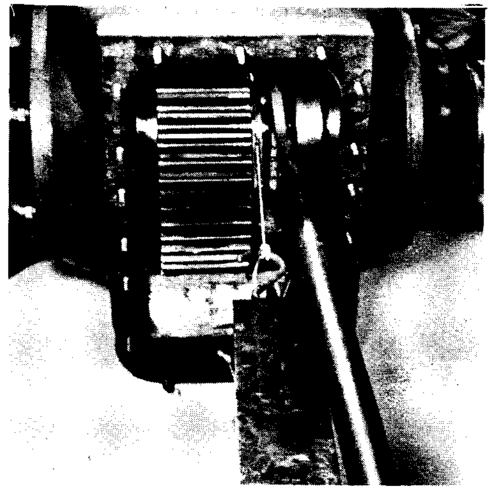
Illust. 29



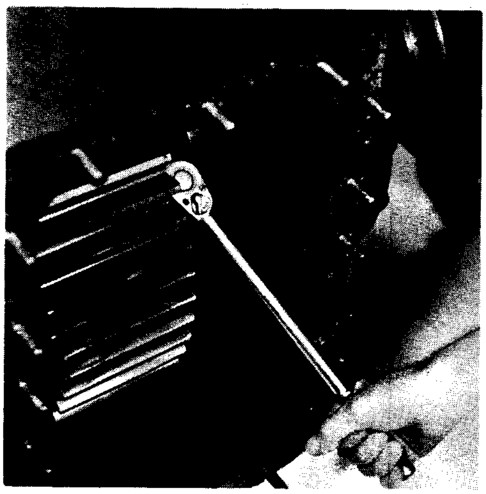
Illust. 30



Illust. 31



Illust. 33



Illust. 32

Illust. 34

Rotate inner axle carrier and check for drag and end play in carrier. If inner axle carrier is not free to rotate, add sufficient amount of shims between upper and lower flange and inner axle carrier. If inner axle carrier has end play, replace thrust ring.

Tighten bearing lock cap screw (Illust. 32). After cap screw is tightened, loosen cap screw 1-1/2 rounds. Next, pre-load bull gear by first wrapping one end of a piece of rope around bull gear hub (Illust. 33). Attach other end of rope to a fish scale. Now, by use of a spanner wrench, tighten bearing lock until a rolling torque reading of 19-1/2 to 25 pounds is obtained. After pull poundage is obtained, install lock and lock cap screws. Tighten cap screws securely (Illust. 34). Lock cap screws with wire. Next, tighten bearing lock cap screw securely. Insert a piece of wire through head of bearing lock cap screw and bearing lock. Lock wire securely, as illustrated.

LOWER TRANSMISSION

Install snap rings into the two bored holes in the back of lower transmission housing (Illust. 1). Press or drive bearing into small bore (Illust. 2). NOTE: This bearing may extend slightly over face of housing. Press or drive bearing race into large bore, as shown in illustration.
NOTE: This race must be flush or under flush with face of housing.

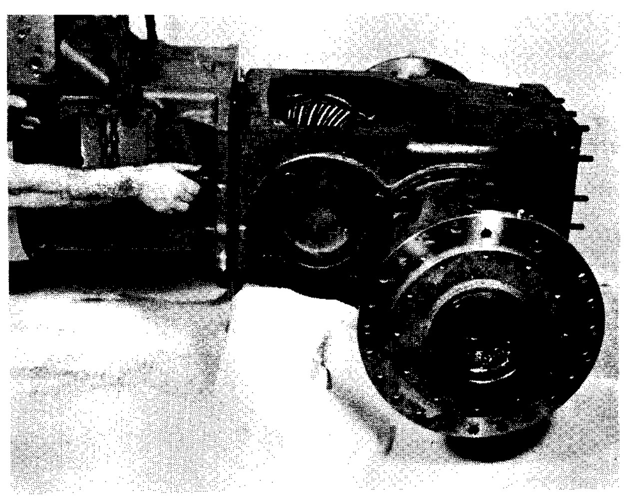
Illust. 1

Illust. 2

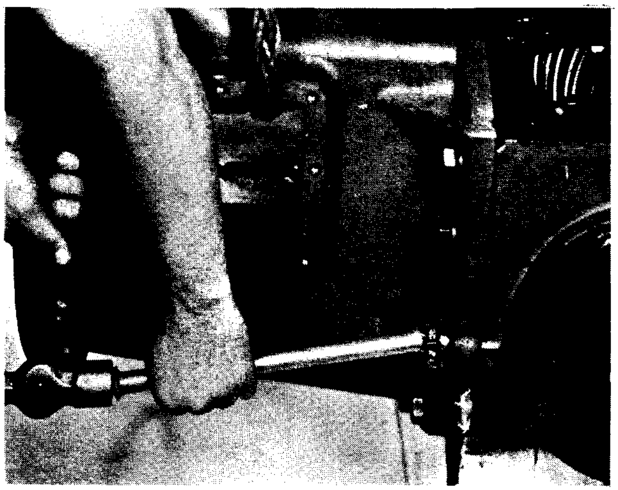
Insert dowel pin in lower transmission housing (Illust. 3). Shellac gasket surface of final drive housing and install gasket.

Insert dowel pins into lower transmission housing. Do not drive dowel pins through housing. Install lower transmission hous-

Illust. 3



Illust. 4

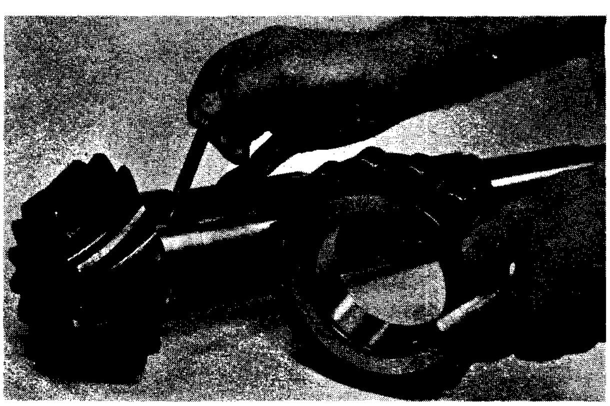


Illust. 5

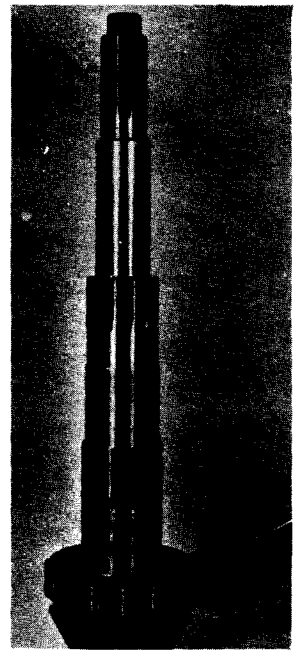
ing to final drive housing. Insert cap screws with lock washers (Illust. 4). Snug cap screws.

To prevent damage to dowel pin threads, install nut on threaded end of dowel pins. Drive dowel pins through lower transmission housing and into final drive housing (Illust. 5). Use a soft drift pin and hammer or mallet to drive dowel pins. After dowel pins have been driven into final drive housing, remove nut from dowel pins. Tighten cap screws to a torque reading of 190 foot pounds.

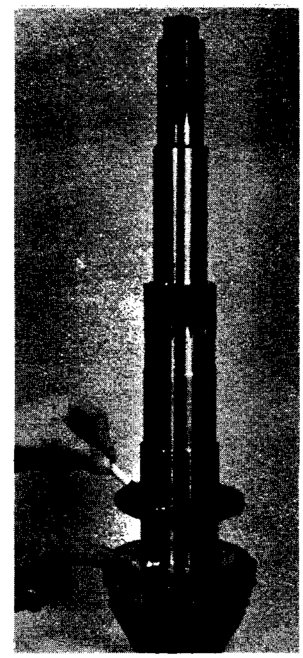
SPIRAL PINION SHAFT
(Lower Transmission)



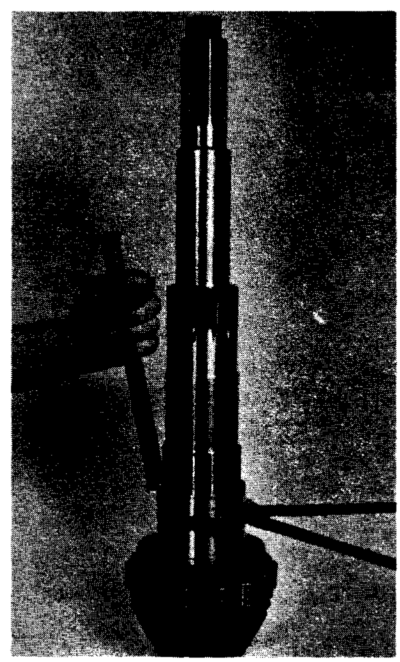
Illust. 1



Illust. 2



Illust. 3



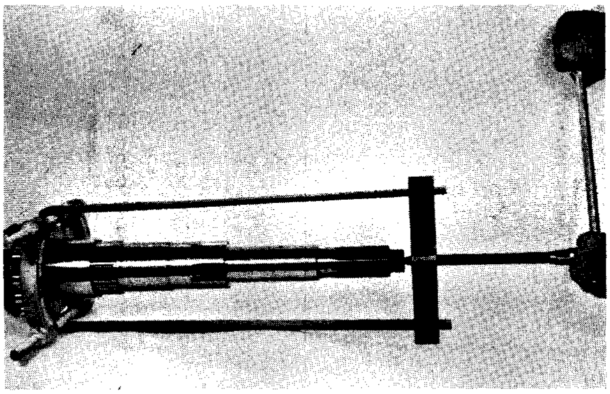
Illust. 4

Heat spiral pinion shaft bearing in oil. Press bearing onto shaft with radius of bearing against spiral pinion (Illust. 1). Hold bearing against pinion until set (Illust. 2).
Insert pin, as illustrated with finger in Illust. 3, into spiral pinion shaft. Next, in-

stall spacer. Slot in spacer, as illustrated by pencil, over head of pin and against bearing.

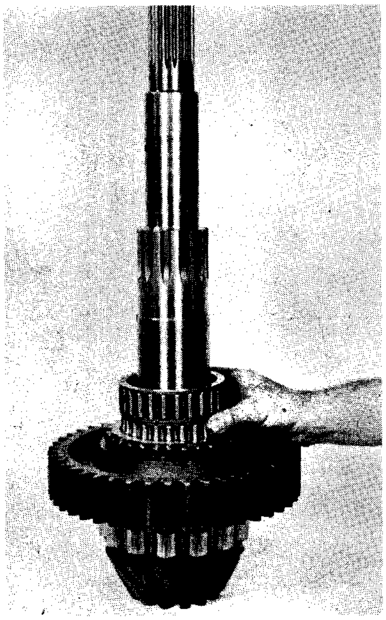
Heat inner race in oil and install onto spiral pinion shaft (Illust. 4). Hold inner race until set.

To prevent breakage of pin, use a gear puller to remove spacer and bearings (Illust. 5).



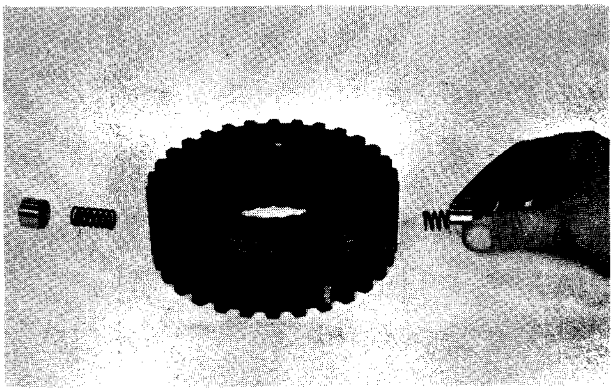
Illust. 5

Install 44 tooth gear (1st gear) onto spiral pinion shaft with chamfered end of gear hub against spacer (Illust. 6). Next, insert two roller bearings into gear, as illustrated.



Illust. 6

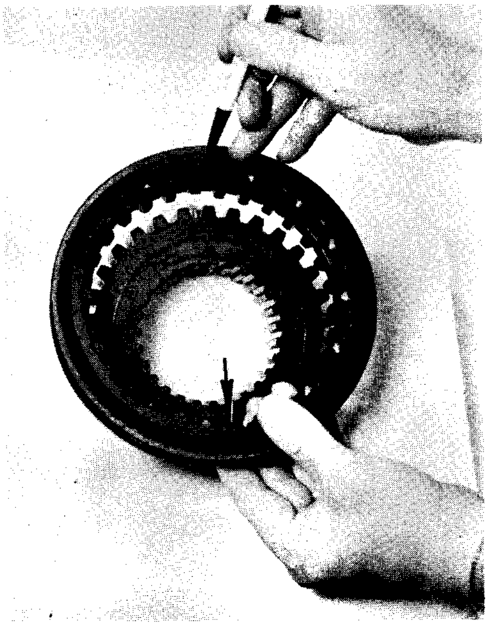
Insert poppet springs and poppets into shifter gear (Illust. 7).



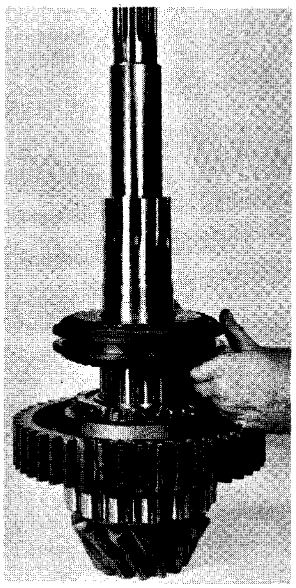
Illust. 7

Install shifter collar over poppets and onto shifter gear. As you will note, shifter collar (Illust. 8) has four tapered teeth; two teeth on each side of collar. Install collar so two tapered teeth slide over poppets and poppets fall in groove of collar.

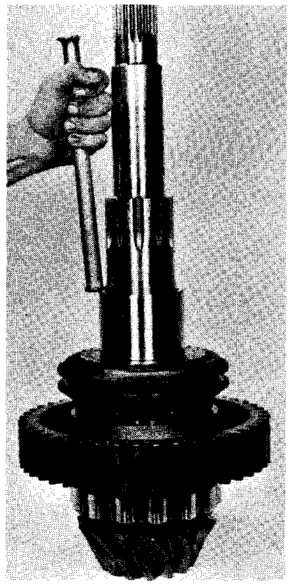
Install shifter gear with collar onto spiral pinion shaft (Illust. 9).



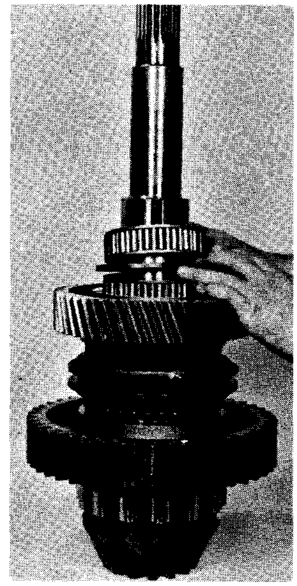
Illust. 8



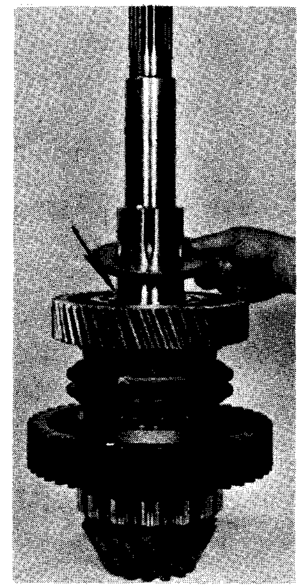
Illust. 9



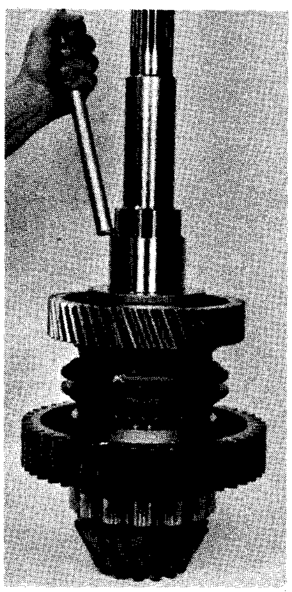
Illust. 10



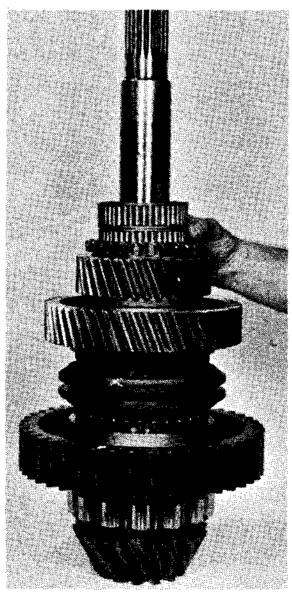
Illust. 11



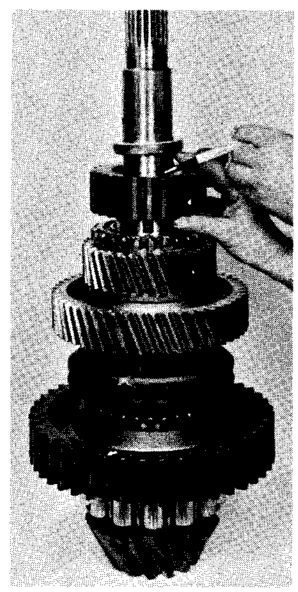
Illust. 12



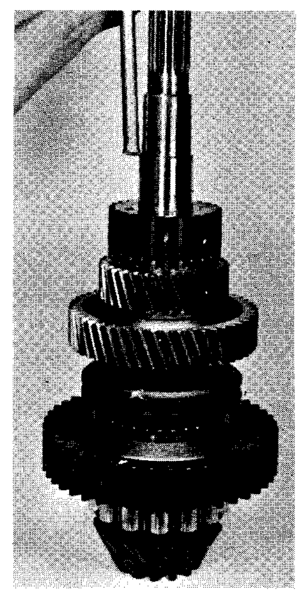
Illust. 13



Illust. 14



Illust. 15



Illust. 16

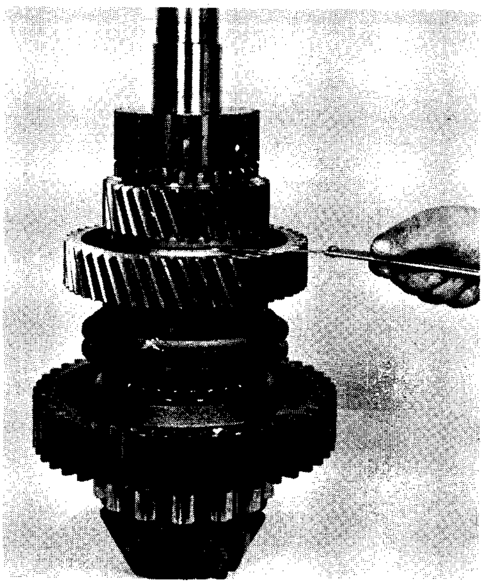
Heat inner race in oil and install on spiral pinion shaft. Hold race until set (Illust. 10).

Install 49 tooth gear (2nd gear) onto spiral pinion shaft. Insert roller bearing, spacer and second roller bearing into gear (Illust. 11).

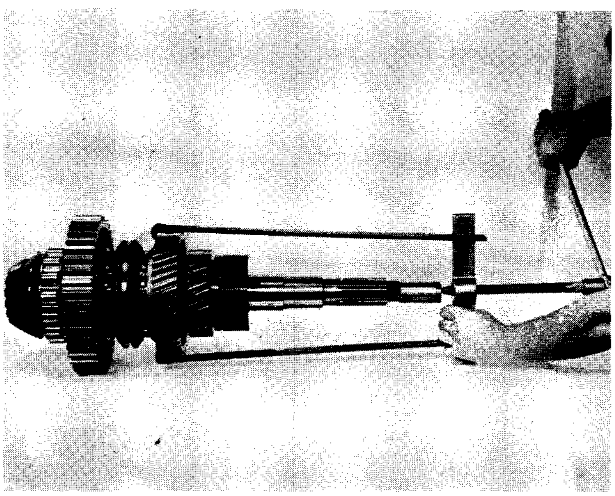
Insert pin in spiral pinion shaft. Next, install spacer. Slot in spacer over head of pin (Illust. 12).

Heat bearing race in oil and install race on spiral pinion shaft. Hold race until set (Illust. 13).

Install 33 tooth gear (3rd gear) onto spiral pinion shaft. Insert two roller bearings into gear (Illust. 14).



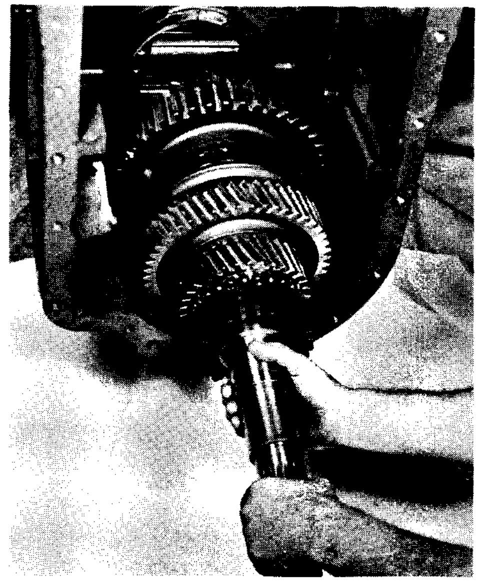
Illust. 17



Illust. 18

Install 26 tooth shifter gear onto spiral pinion shaft. Counter bore in gear, as illustrated by pencil in Illust. 15, away from 33 tooth gear. Next, insert spacer into sliding gear, chamfered edge of spacer next to counter bore of gear. NOTE: This gear does not have poppets.

Heat inner race in oil and install race onto spiral pinion shaft. Hold race until set (Illust. 16).



Illust. 19

Check clearance between gears with a feeler gauge (Illust. 17). The clearance should read between .005 and .025.

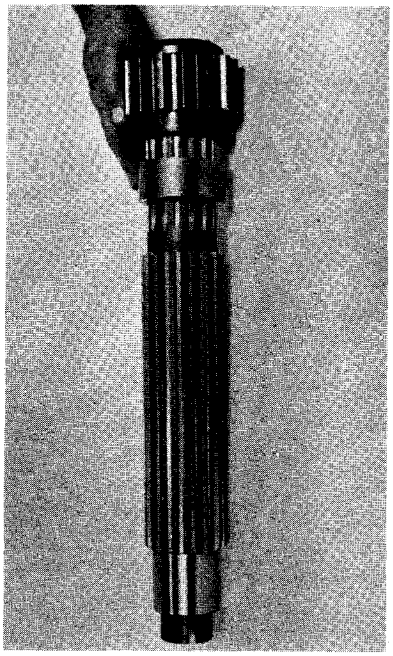
To prevent breakage of pin, use a gear puller to remove gears and races (Illust. 18).

Insert spiral pinion shaft assembly into lower bore of transmission housing (Illust. 19). NOTE: The pinion is to be matched with spiral bevel gear by number.

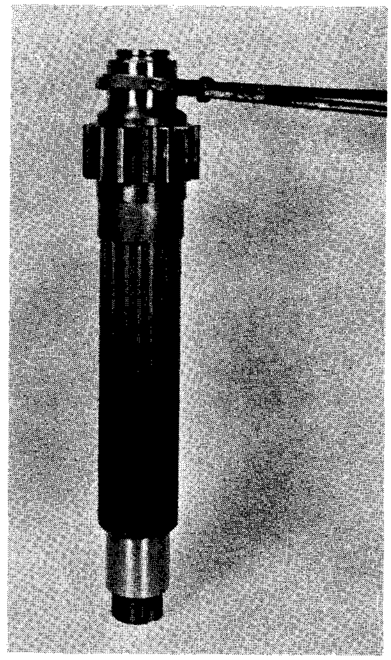
UPPER SHAFT
(Lower Transmission)

Insert spacer and 15 tooth gear (1st gear) onto upper shaft of lower transmission (Illust. 1). Chamfered end of gear away from threaded end of shaft.

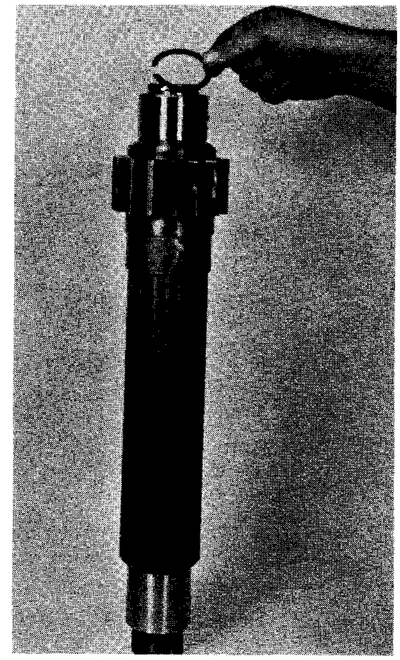
Heat inner bearing race in oil and install race onto shaft. Inside chamfer of race toward gear. Hold race until set (Illust. 2). Next, install snap ring in groove in shaft (Illust. 3).



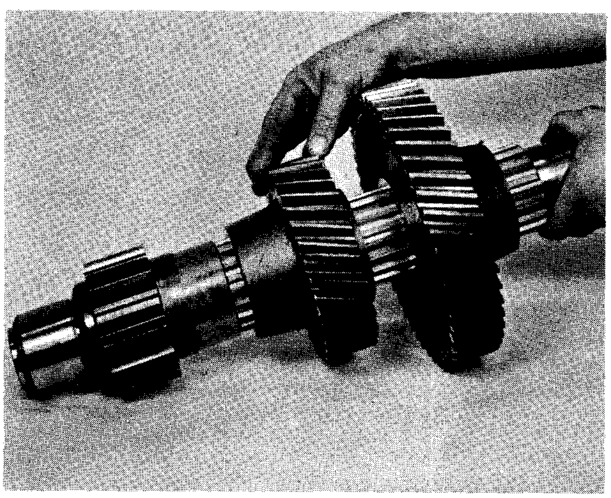
Illust. 1



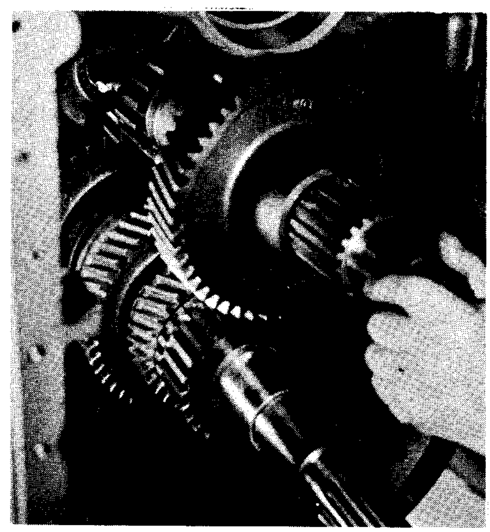
Illust. 2



Illust. 3



Illust. 4



Illust. 5

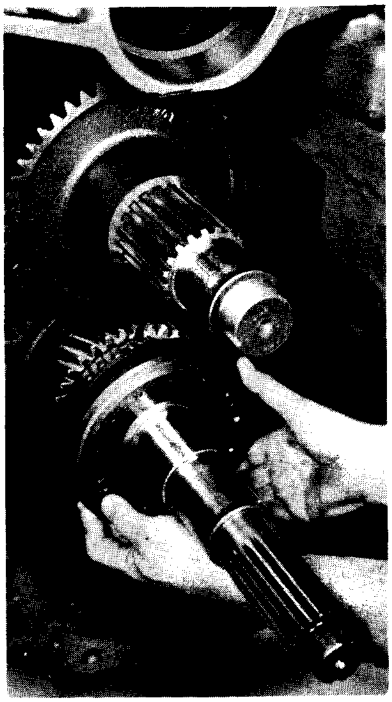
Install 34 tooth gear (2nd gear) onto shaft, long end of hub toward spacer. Next, install 50 tooth gear (3rd gear) onto shaft, long end of hub toward threaded end of shaft (Illust. 4).

Insert upper shaft assembly into lower transmission (Illust. 5).

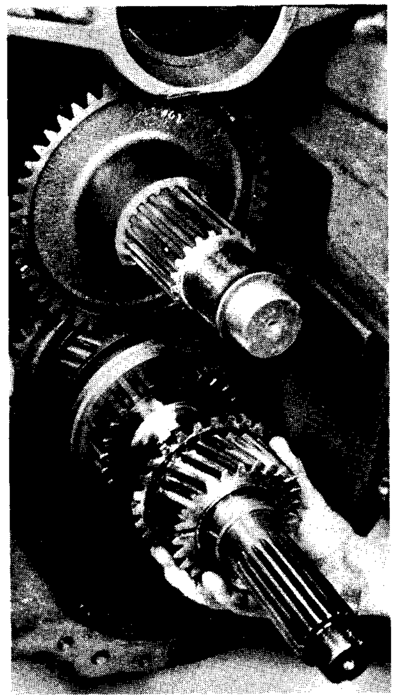
Install shifter collar over 26 tooth sliding gear on spiral pinion shaft (Illust. 6). Next, install 24 tooth (4th gear) onto spiral pinion shaft (Illust. 7).

Install 59 tooth all speed gear onto upper shaft of lower transmission (Illust. 8). Long hub of gear away from threaded end of shaft.

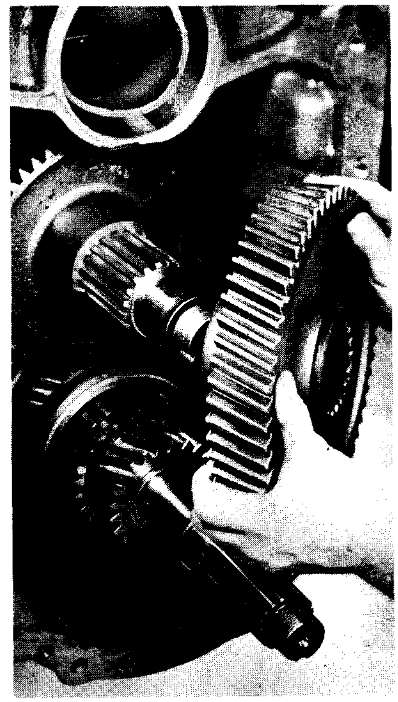
Insert pin into lower shaft (Illust. 9). Next, install slinger. Square notch in slinger over head of pin.



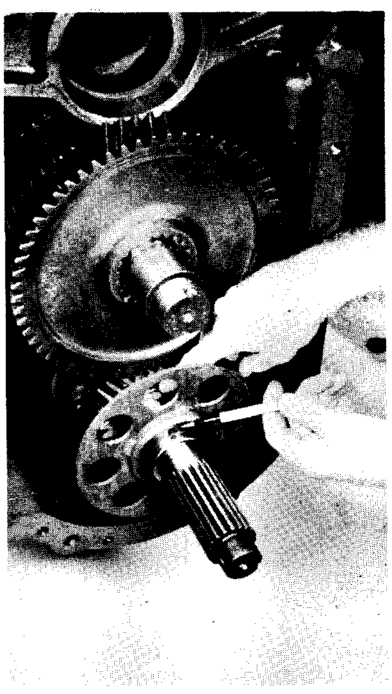
Illust. 6



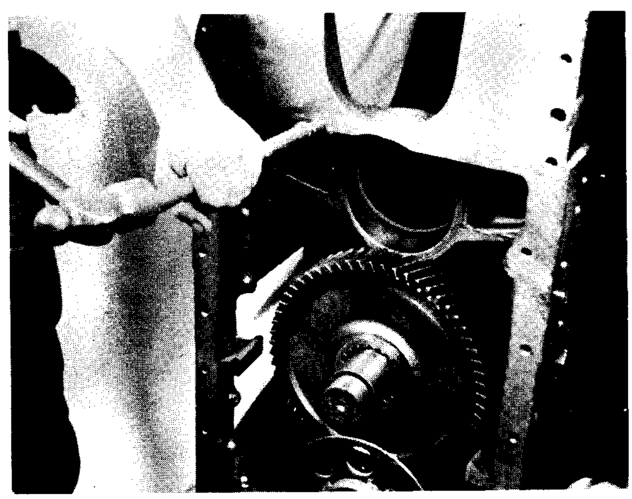
Illust. 7



Illust. 8



Illust. 9

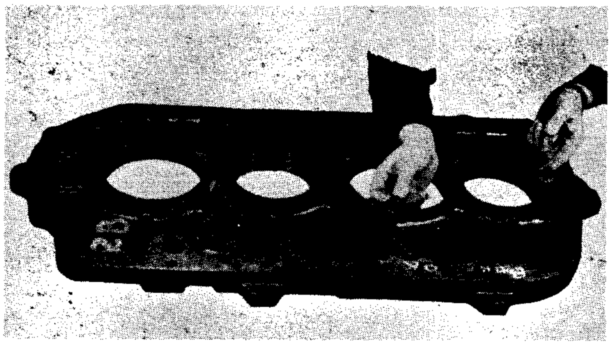


Illust. 10

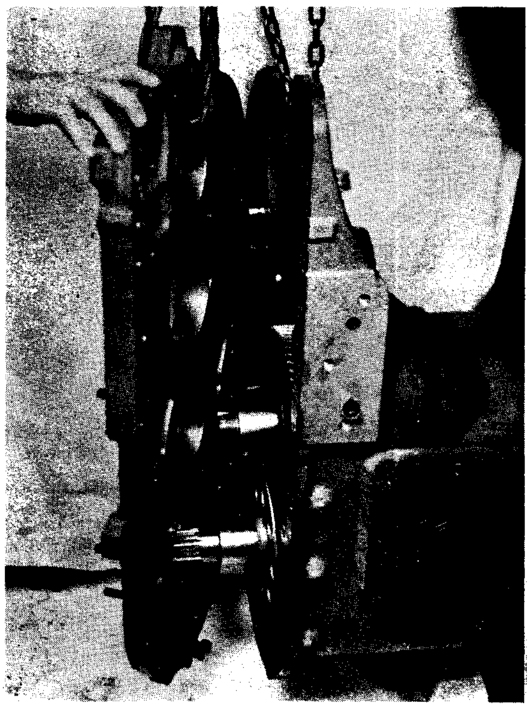
Install shouldered dowel pin into lower transmission housing (Illust. 10). Long end of dowel pin going into lower transmission. Use a soft drift pin and hammer or mallet to drive dowel pin.

INTERMEDIATE PLATE

Install two bearing locks on both upper shaft bores of intermediate plate (Illust. 1). Drive dowel pin into lower dowel pin hole of intermediate plate. NOTE: Do not drive dowel pin through intermediate plate.

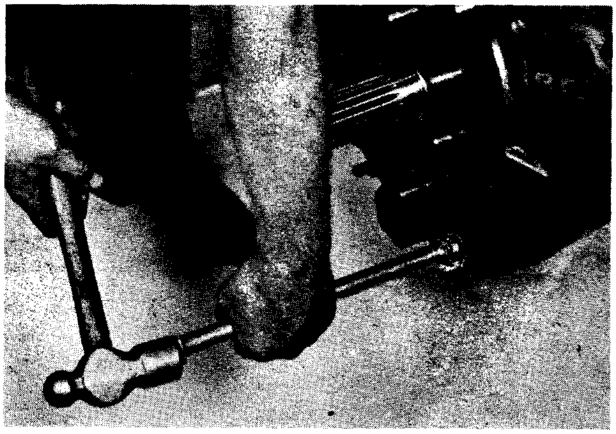


Illust. 1

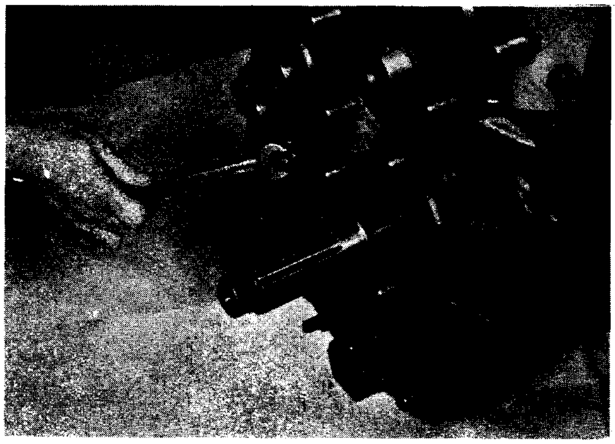


Illust. 2

Shellac gasket onto front of lower transmission housing. Align dowel pin hole in intermediate plate with dowel pin in lower transmission housing. Install intermediate plate (Illust. 2). Install cap screws with lock washers. Do not tighten cap screws. Next, install nut on lower intermediate plate dowel pin to prevent damage to threads. Drive dowel pin through intermediate plate and into lower transmission (Illust. 3). Use a soft drift pin and hammer or mallet to drive dowel pin. When dowel pin is seated, remove nut from dowel pin. Tighten cap



Illust. 3



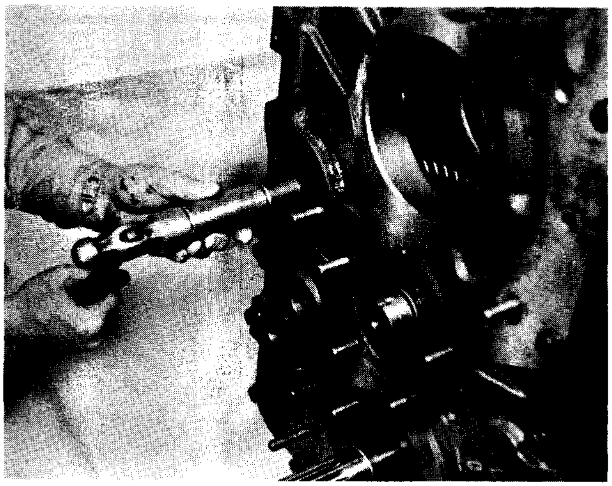
Illust. 4

screws to a torque reading of 190 foot pounds.

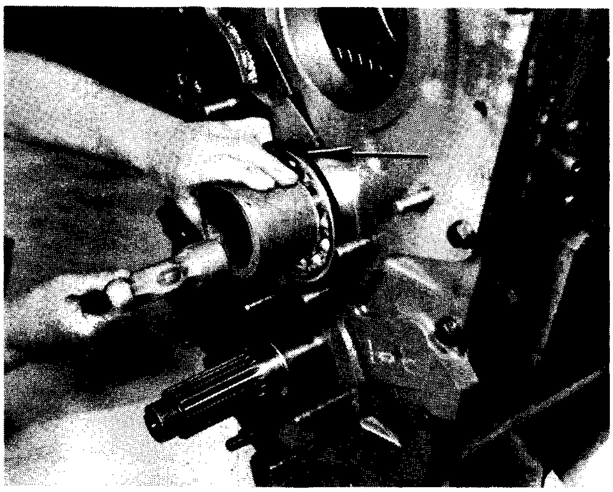
Install studs into intermediate plate (Illust. 4). Tighten studs into intermediate plate, using two nuts locked together on studs.

Drive bushing, using a hammer and a piece of pipe or similar tool, into rocker shaft bore of intermediate plate (Illust. 5).

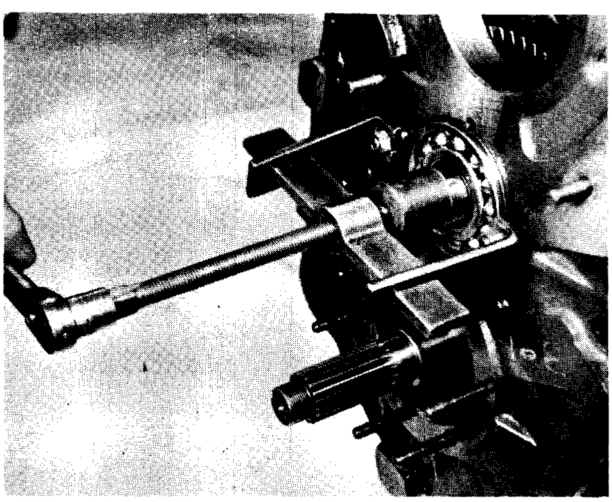
Drive bearing over upper shaft of lower transmission and into intermediate plate (Illust. 6). NOTE: Open ends of snap ring to be in line with oil hole in intermediate plate, as illustrated by arrows in illustration.



Illust. 5



Illust. 6



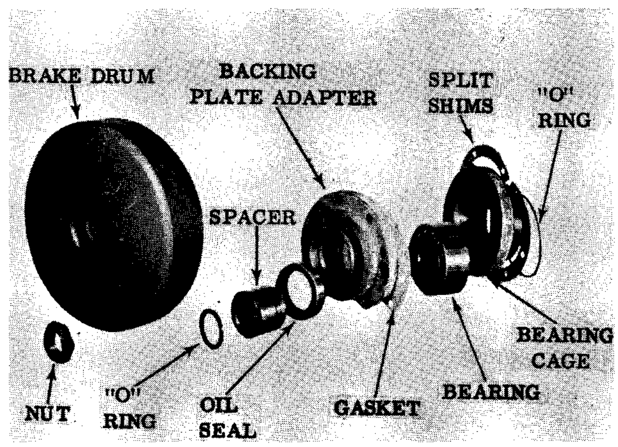
Illust. 7

To remove intermediate plate from lower transmission, remove cap screws. Next, install two stud nuts on studs; one nut on each side of bearing. Then, by use of a puller (Illust. 7), pull intermediate plate with bearing from lower transmission.

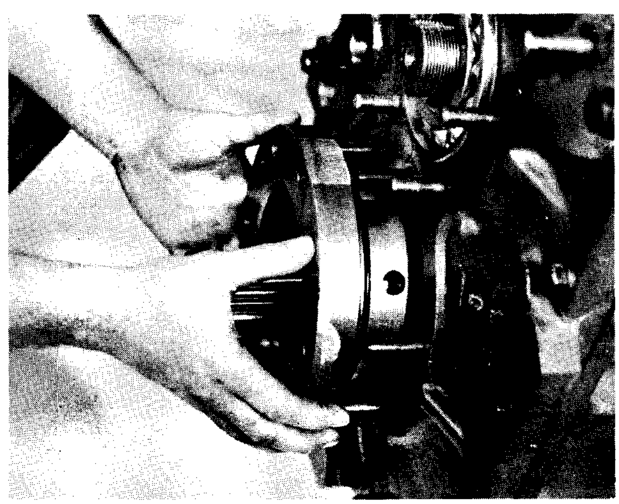
BEARING CAGE & ADAPTER ASSEMBLY

Illust. 1 is an exploded view of bearing cage and adapter assembly.

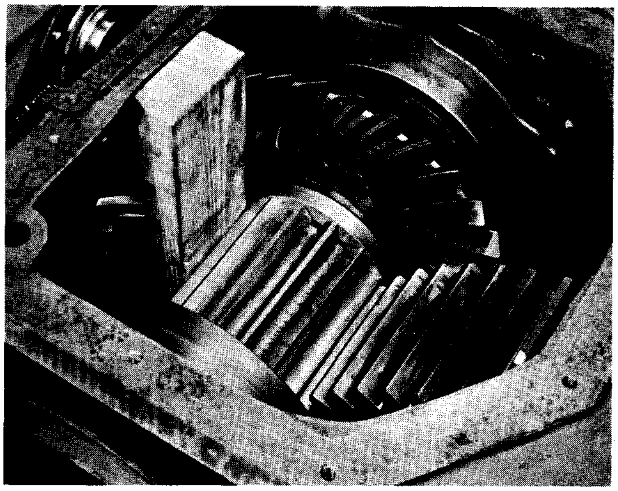
Install "O" ring on bearing cage and insert bearing cage into intermediate plate (Illust. 2). Apply white lead to "O" ring to prevent damage before inserting bearing cage into intermediate plate.



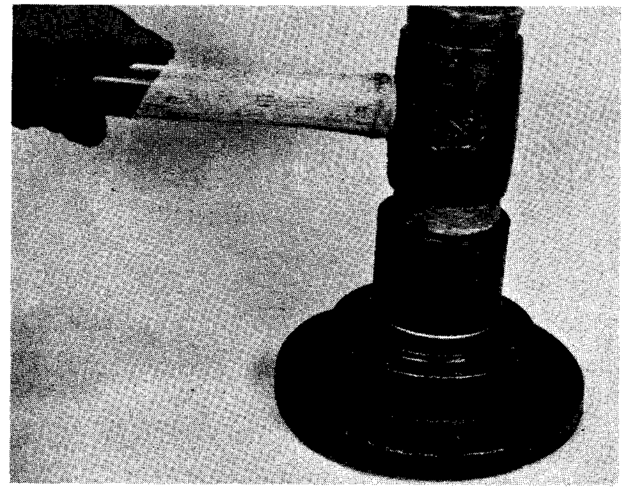
Illust. 1



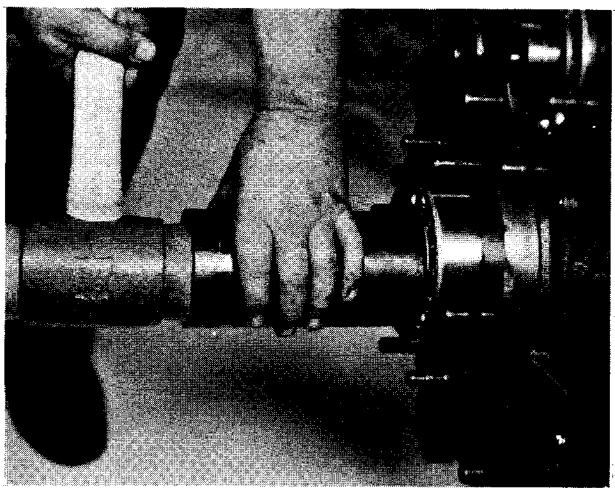
Illust. 2



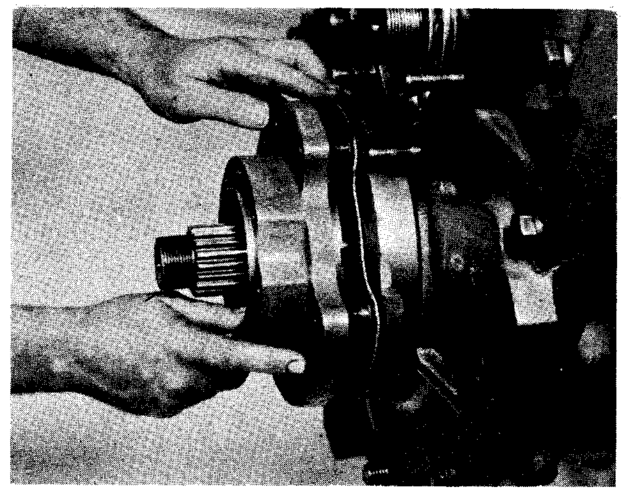
Illust. 3



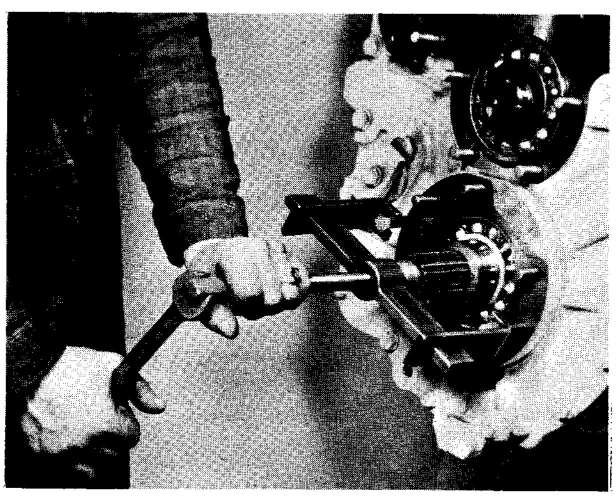
Illust. 6



Illust. 4



Illust. 7

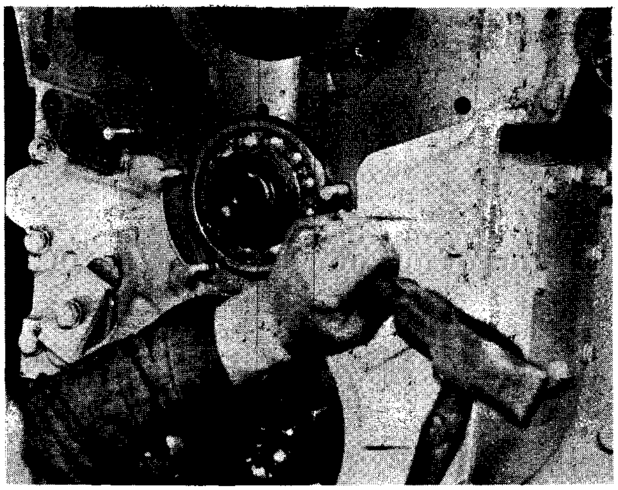


Illust. 5

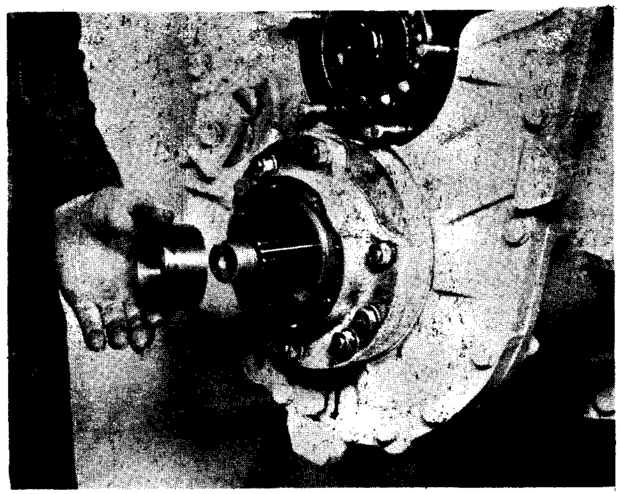
Place a block of wood between spiral pinion and spiral bevel gear in final drive housing (Illust. 3). Block of wood will prevent lower shaft assembly from being driven back into spiral bevel gear when bearing is driven into bearing cage (Illust. 4).

To remove bearing cage, install two cap screws in pull holes in bearing cage. Use a puller (Illust. 5) to remove bearing cage.

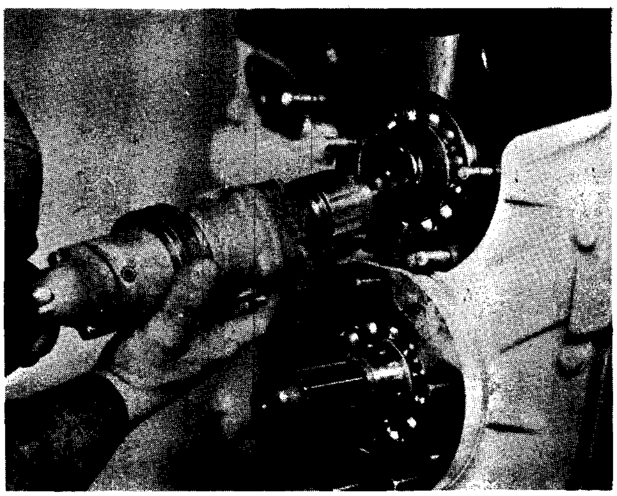
Press or drive oil seal into backing plate adapter (Illust. 6). Lip of seal away from hub of adapter.



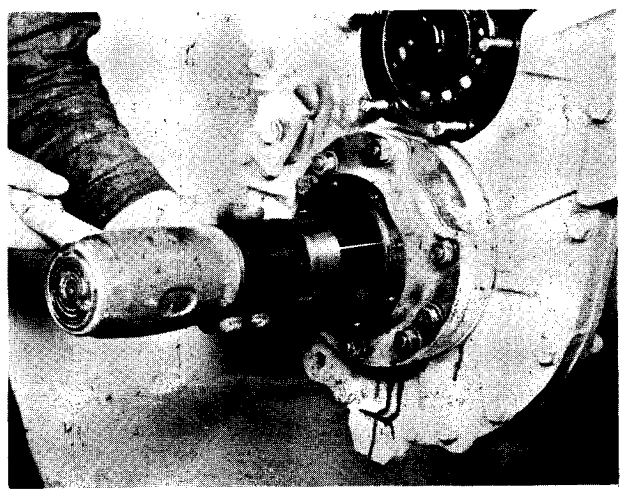
Illust. 8



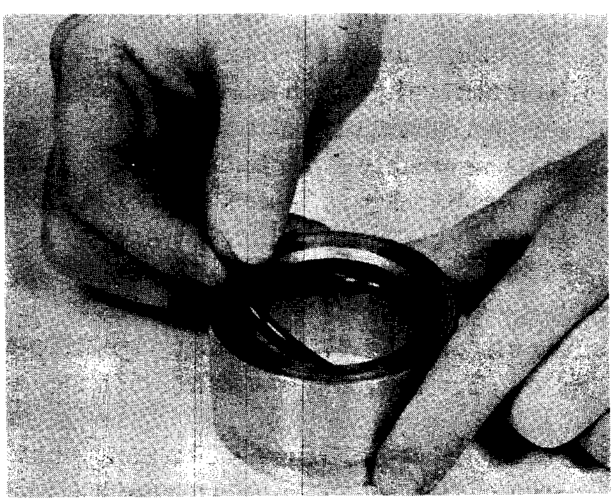
Illust. 11



Illust. 9



Illust. 12

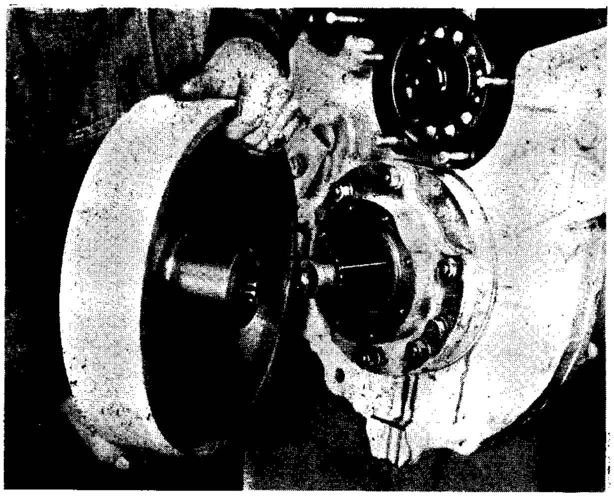


Illust. 10

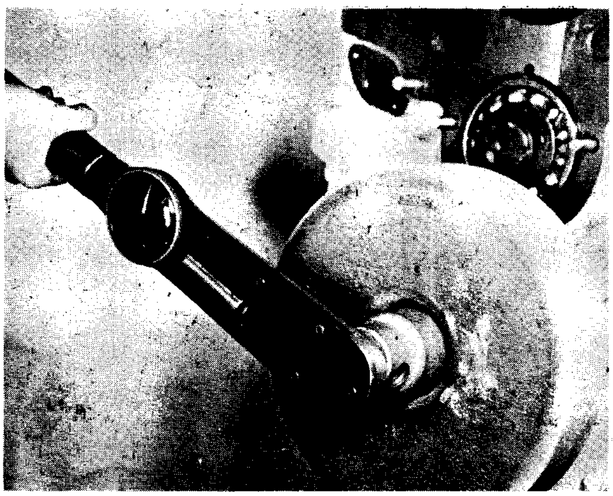
Install backing plate adapter gasket and backing plate adapter (Illust. 7) over studs and against bearing cage. Install stud nuts with lock washers. Tighten stud nuts securely.

Install nut to upper shaft of lower transmission. Shift transmission into two (2) gears and tighten nut to a torque reading of 600 foot pounds. After nut has been tightened, stake nut (Illust. 8) using a drift pin and hammer.

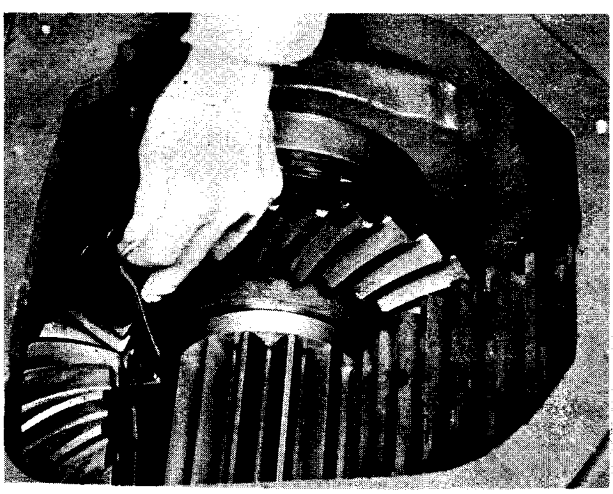
To remove staked nut from upper shaft, use a drill (Illust. 9).



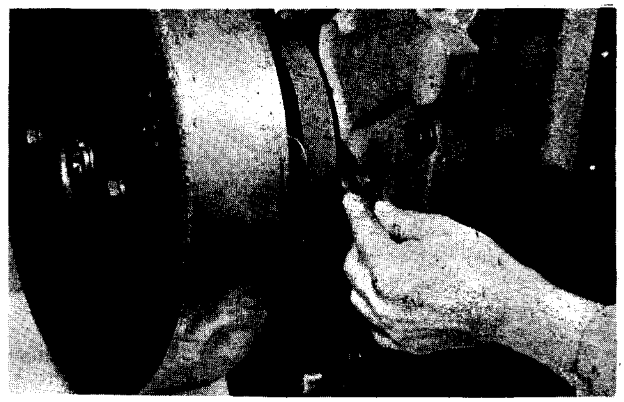
Illust. 13



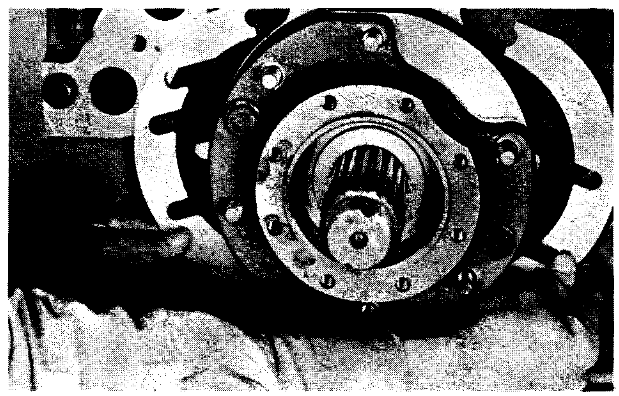
Illust. 14



Illust. 15



Illust. 16

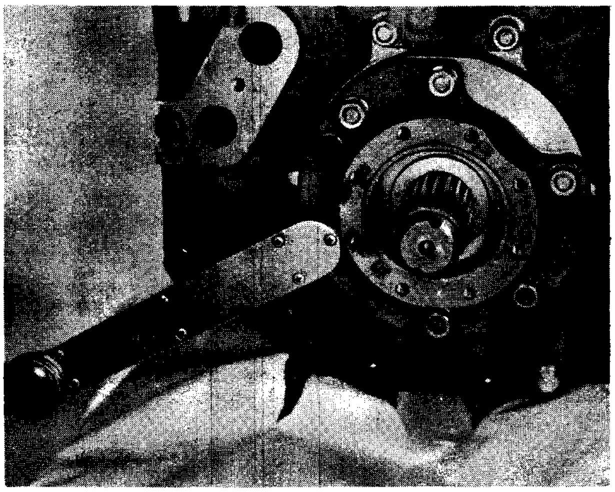


Illust. 17

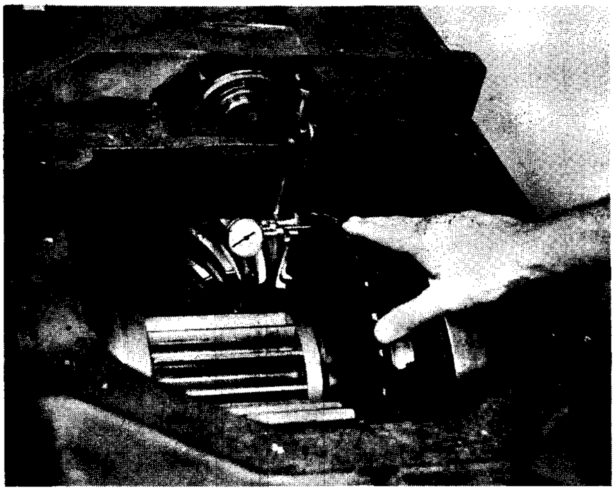
Install "O" ring in groove of spacer (Illust. 10). Apply white lead to "O" ring and install onto lower shaft (Illust. 11). White lead will prevent damage to "O" ring. Next, drive spacer onto lower shaft and into adapter (Illust. 12), end of spacer with "O" ring against bearing.

In order to obtain pinion depth setting, install brake drum (Illust. 13). Next, install nut and tighten to a torque reading of 600 foot pounds (Illust. 14).

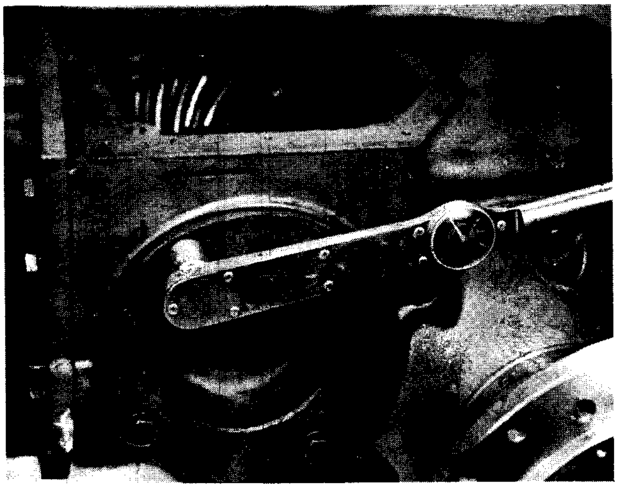
A special gauge block, Adams No. 723017, is required to obtain the correct pinion setting. Insert this gauge between spiral gear setting disc and pinion (Illust. 15). Bump pinion shaft assembly back towards setting disc until a reading of 1.325 (gauge block length) to 1.330 is obtained.



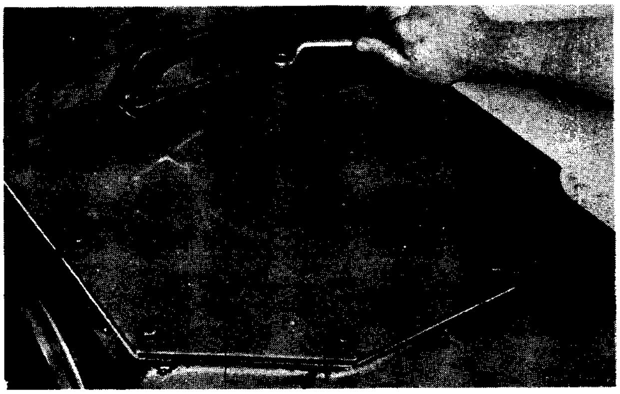
Illust. 18



Illust. 19



Illust. 20



Illust. 21

When pinion depth setting is obtained, use a feeler gauge and measure gap between bearing cage and intermediate plate (Illust. 16). Next, remove brake drum. Insert correct amount of split shims required to fill gap (Illust. 17). Install bearing cage stud nuts with lock washers and tighten to a torque reading of 65 foot pounds (Illust. 18). Recheck pinion depth setting. If the required setting is not correct, repeat the operation, adding or removing split shims. When setting is correct, shift gears into neutral.

To adjust backlash between spiral bevel gear and pinion, use a dial indicator (Illust. 19). To obtain backlash, remove shims as needed, from right hand jackshaft bearing cage and install to left hand jackshaft bearing cage until a reading of between .010 to .014 is obtained on dial indicator. To assure accuracy, reading should be taken from three (3) or more positions on bevel gear. After correct reading is obtained, tighten jackshaft bearing cages cap screws to a torque reading of 275 foot pounds (Illust. 20).

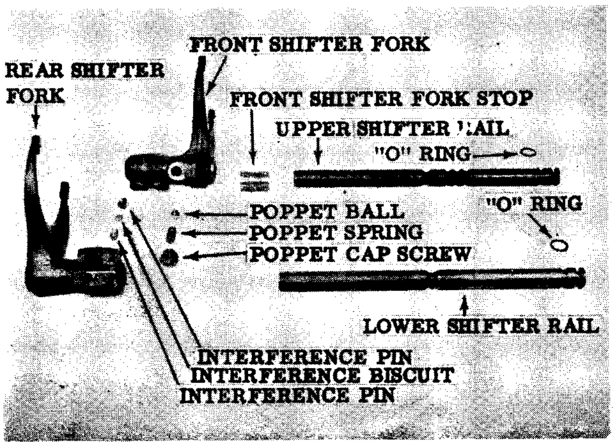
Shellac around top opening of final drive housing and opening in rear of lower transmission housing. Next, install closure cap gasket and cap. Install cap screws with lock washers and tighten securely (Illust. 21).

SHIFTER RAILS AND FORKS

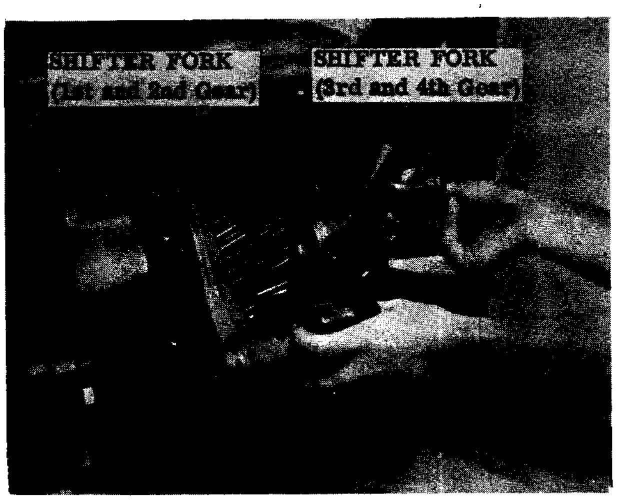
Illust. 1 is an exploded view of shifter rails and forks.

Insert shifter forks into lower transmission and over shifter collars (Illust. 2). Next, insert upper shifter rail through intermediate plate and through stop (Illust. 3). Insert upper shifter rail into 3rd and 4th gear shifter fork enough to hold fork upward (Illust. 4). Next, insert lower shifter rail through intermediate plate and 1st and 2nd gear shifter fork, as shown in illustration.

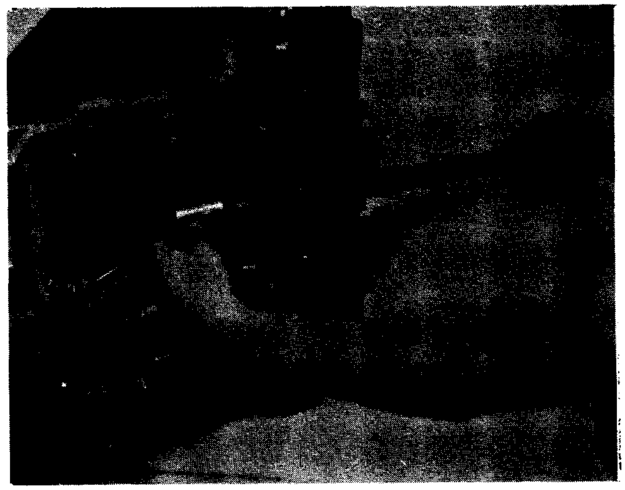
Install "O" rings in groove of upper and lower shifter rails (Illust. 5).



Illust. 1

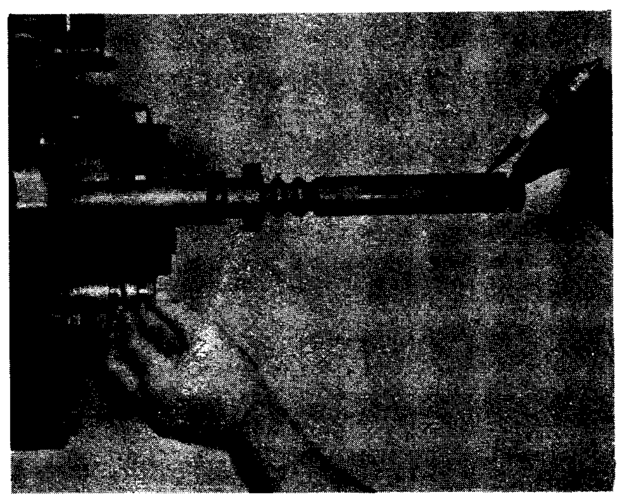


Illust. 2

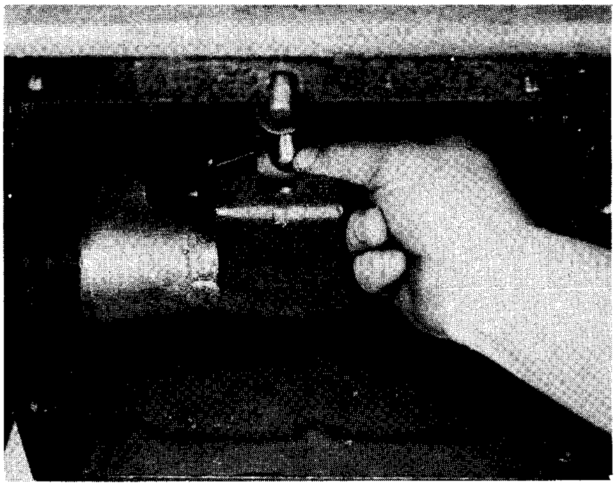


Illust. 3

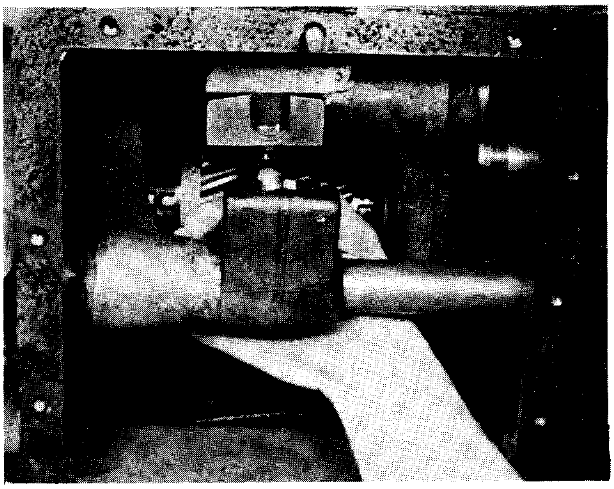
Illust. 4



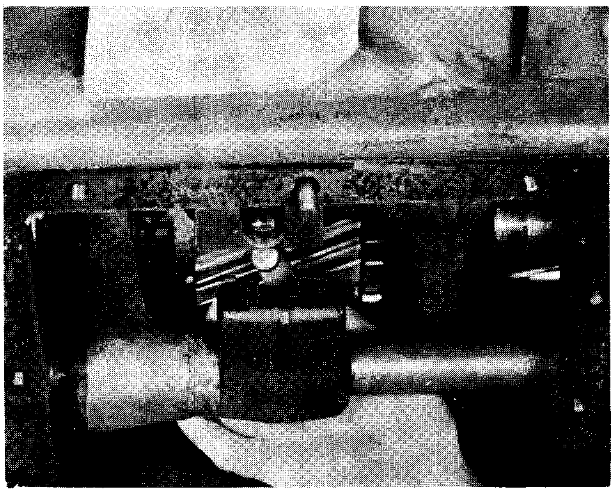
Illust. 5



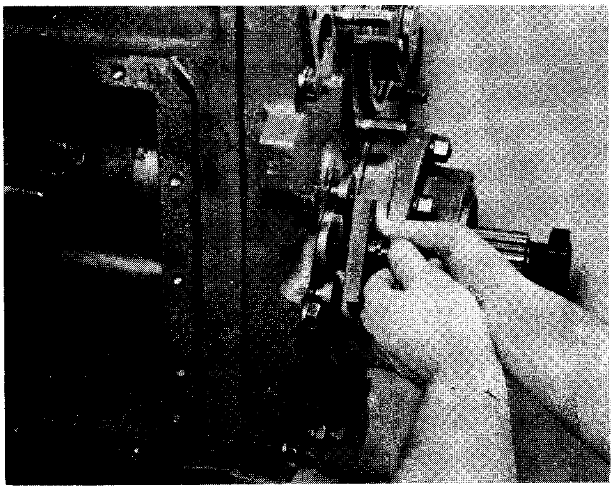
Illust. 6



Illust. 8

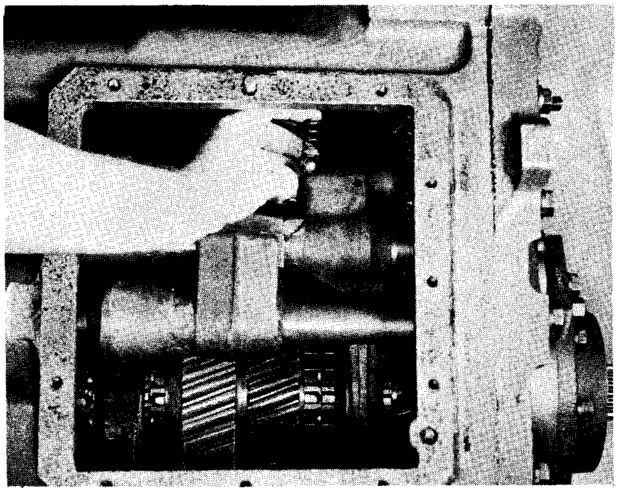


Illust. 7

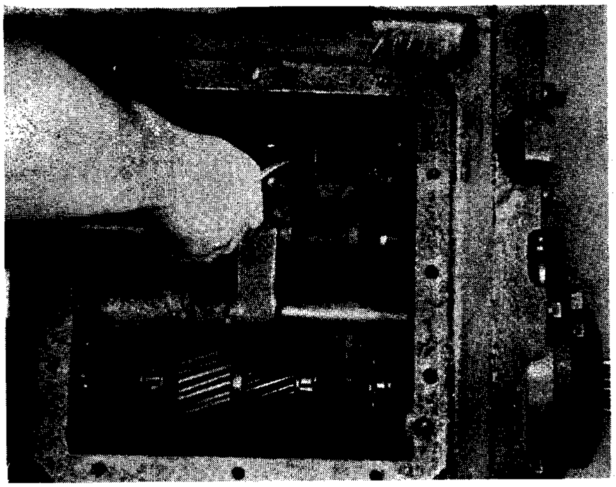


Illust. 9

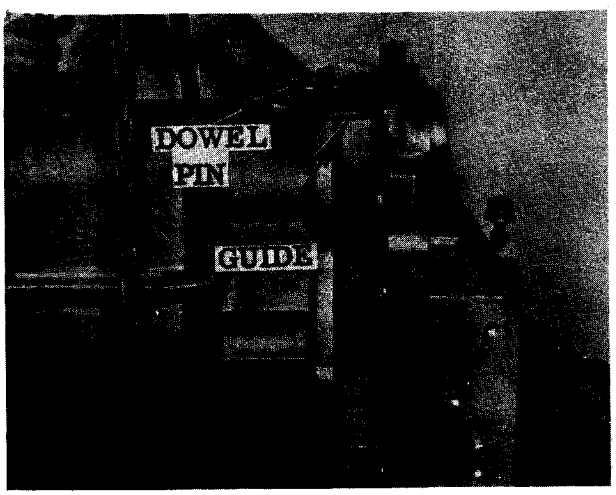
Pull top rail out of front fork only enough to allow front fork to be raised. Now, insert interference pin into hole of 1st and 2nd gear shifter fork, round head of pin toward lower rail (Illust. 6). Push lower shifter rail through fork and into lower transmission housing until interference pin seats itself in groove of shifter rail. Next, insert interference biscuit into hole of shifter fork (Illust. 7). Insert second interference pin into hole of shifter fork (Illust. 8). Round head of interference pin in an upward position. Use grease on each part before installing into shifter fork to hold parts in place. To protect "O" rings from damage, use white lead.



Illust. 10



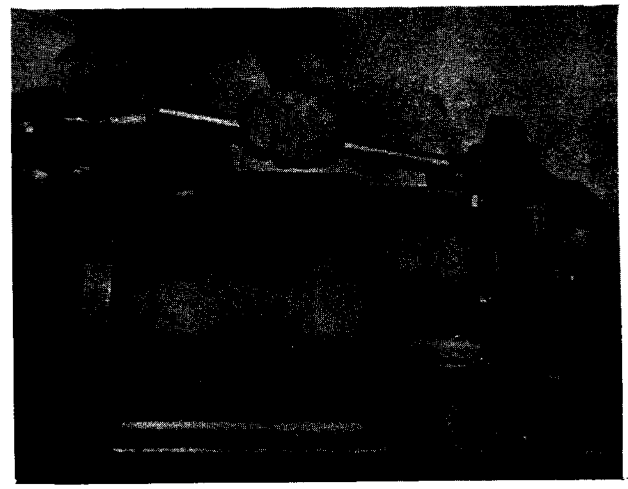
Illust. 11



Illust. 12

Insert upper shifter rail through 3rd and 4th gear shifter fork and into lower transmission. Next, insert locking disc into grooves of upper and lower shifter rails. Install clamp bar with cap screw and lock washer (Illust. 9). Tighten cap screws securely.

Install poppet ball and spring into 3rd and 4th gear shifter fork (Illust. 10). Next, install poppet capscrew and tighten securely. Insert a piece of wire through head of cap screw and through hole of shifter fork (Illust. 11). Lock wire by twisting.



Illust. 13

Before installing upper transmission housing to intermediate plate, punch mark intermediate plate at lower and upper shaft bores, in line with bearing locks. These punch marks will aid when installing upper and lower shaft assemblies.

Install a guide in upper cap screw hole to guide upper transmission housing into place (Illust. 12).

Shellac intermediate plate and install upper transmission housing gasket.

Install dowel pin (Illust. 12) into upper transmission housing. Do not drive dowel pin through housing. To prevent damage threads of dowel pin, use a nut on threads (Illust. 13).

Install upper transmission housing onto guide and against intermediate plate (Illust. 12). Next, install cap screws with lock washers. Remove guide. Snug cap screws until dowel pin (Illust. 13) is driven into intermediate plate, then tighten cap screws securely.

Remove nut from dowel pin.

UPPER TRANSMISSION LOWER SHAFT

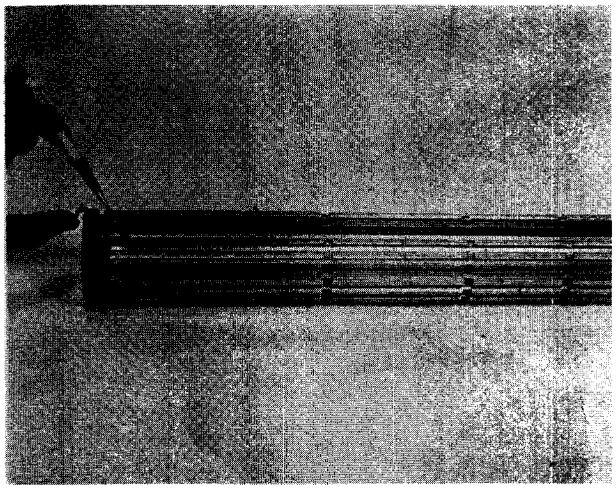
Press or drive oil seal into seal retainer (Illust. 1). Lip of oil seal away from milled surface of retainer. Next, install "O" ring (indicated by arrow) into groove of seal retainer.

Install seal retainer onto hub of 28 tooth (high range) gear (Illust. 2). Milled surface of seal retainer toward teeth of gear.

Press or drive bearing onto hub and down to shoulder of gear (Illust. 3). Radius of bearing, as indicated by screw driver in Illust. 2, toward retainer.

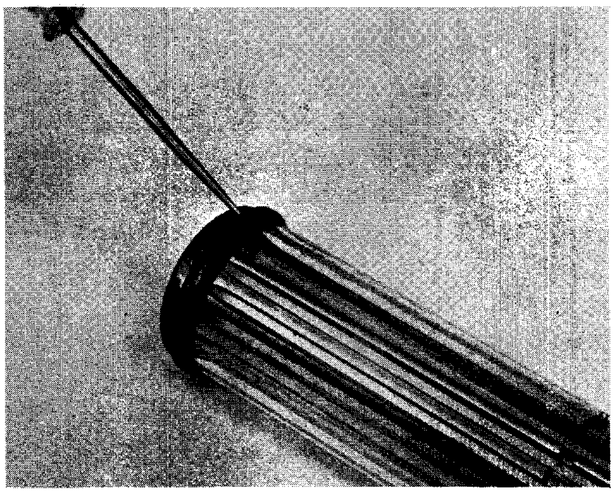
Illust. 3

Illust. 1

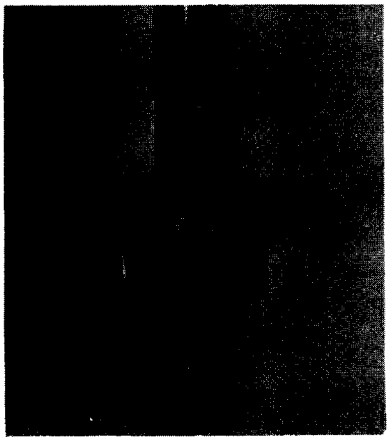


Illust. 4

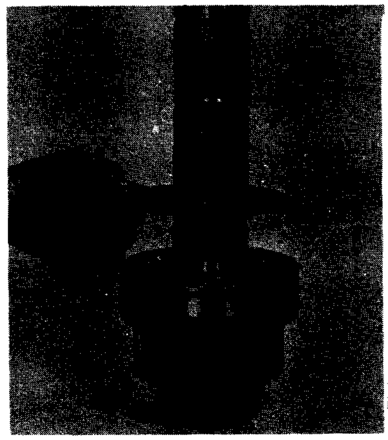
Illust. 2



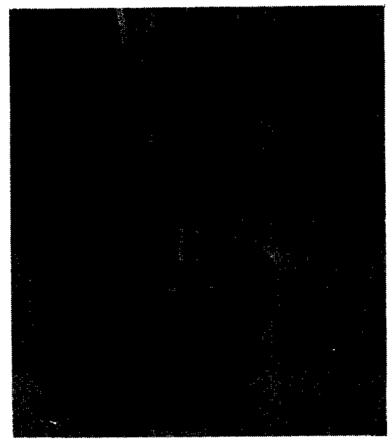
Illust. 5



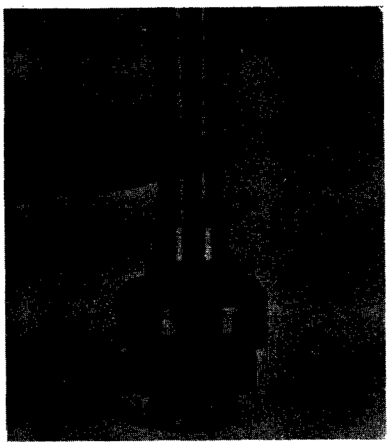
Illust. 6



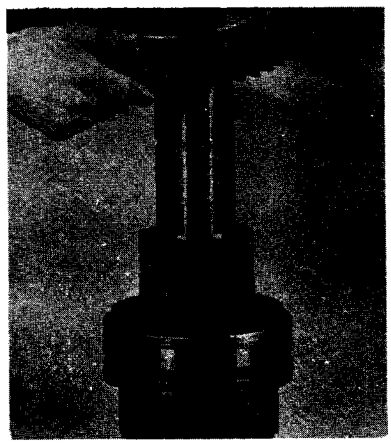
Illust. 7



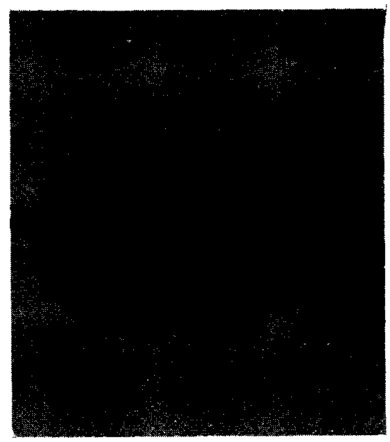
Illust. 8



Illust. 9



Illust. 10



Illust. 11

Install "O" ring (indicated by pencil) and "O" ring retainer into groove of lower shaft (Illust. 4). Next, install snap ring into groove (Illust. 5).

Install 28 tooth (high range) gear with retainer onto shaft (Illust. 6).

Install spacer onto shaft and against bearing (Illust. 7).

Heat bearing race in oil and install onto shaft and against spacer. Hold race until set (Illust. 8).

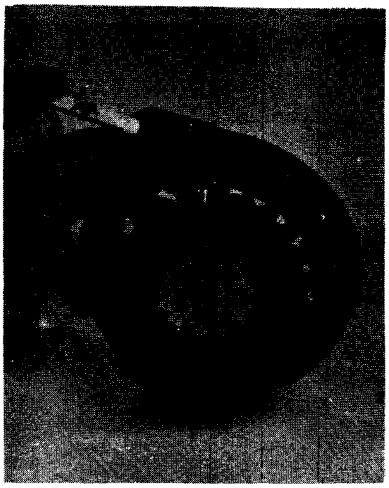
Install bearings onto bearing race (Illust. 9).

Install 42 tooth gear onto shaft and over bearings (Illust. 10).

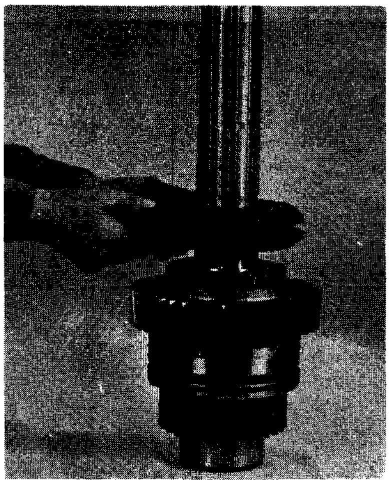
Insert springs and poppets into shifter gear (Illust. 11). Next, install shifter collar over shifter gear and poppets.
NOTE: Shifter collar has 4 tapered teeth (Illust. 12). Install collar so tapered teeth will slide over poppets. Poppets will fall into space between teeth of collar.

Install shifter gear onto shaft (Illust. 13).

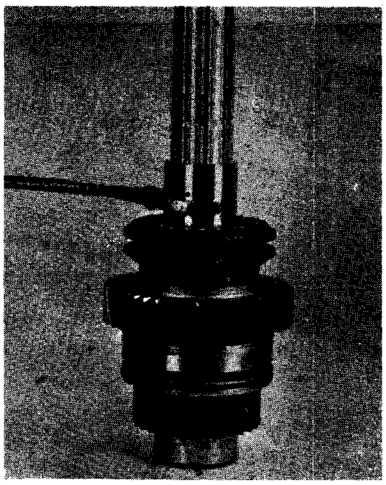
Heat bearing race in oil and install on shaft. Hold race until set (Illust. 14).



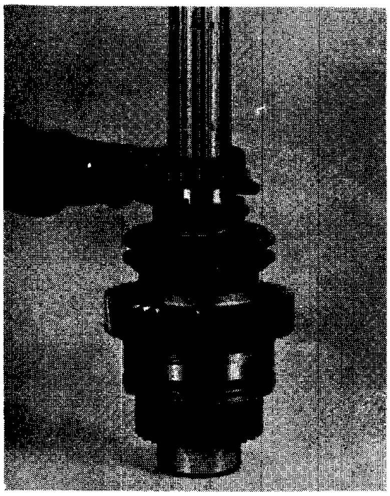
Illust. 12



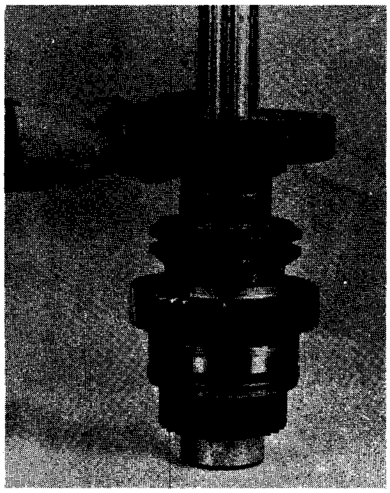
Illust. 13



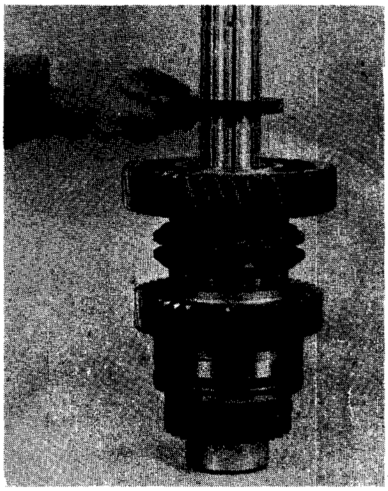
Illust. 14



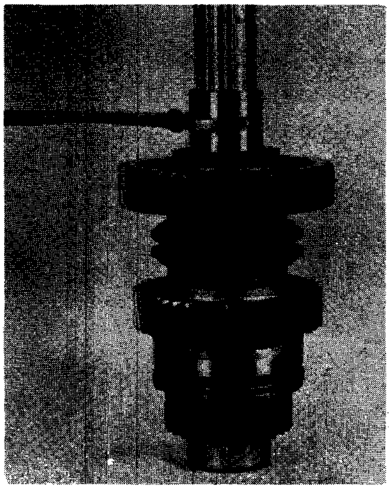
Illust. 15



Illust. 16



Illust. 17



Illust. 18

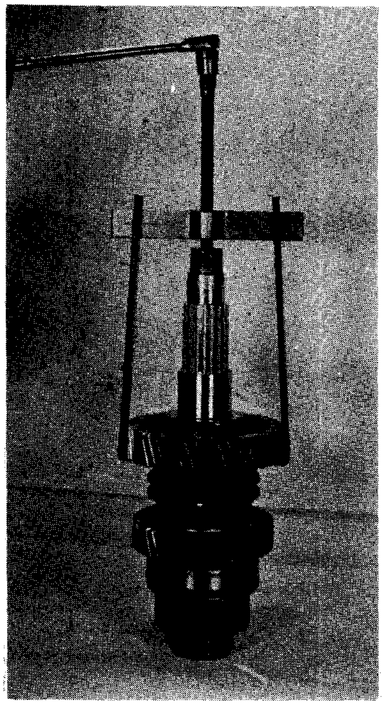
Install bearings onto race (Illust. 15). Next, install 48 tooth (low range) gear onto bearings (Illust. 16).

Install spacer onto shaft (Illust. 17).

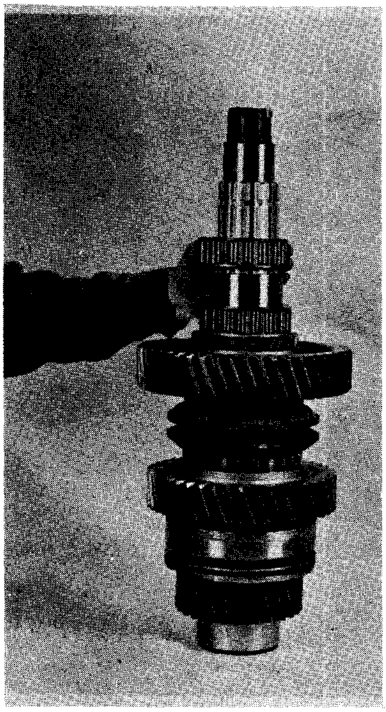
Heat bearing race in oil and install onto shaft. Hold race until set (Illust. 18).

To remove gears from shaft, use a gear puller (Illust. 19).

Install bearings onto bearing race (Illust. 20). Next, install 47 tooth gear onto shaft and over bearings (Illust. 21).

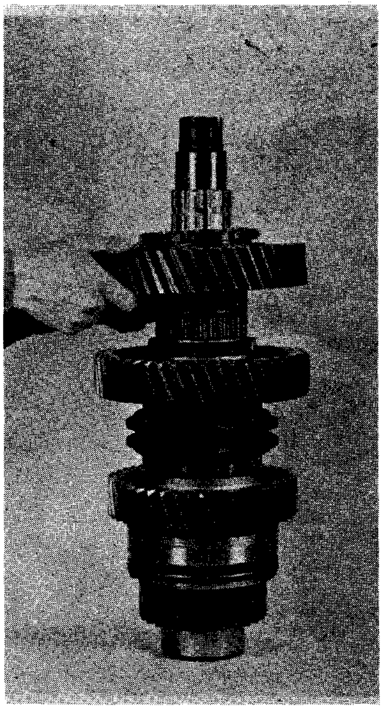


Illust. 19

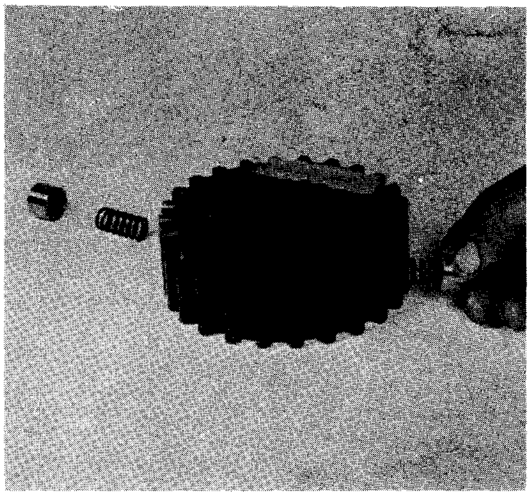


Illust. 20

Insert springs and poppets into second shifter gear (Illust. 22). Next, install shifter collar over shifter gear and poppets.



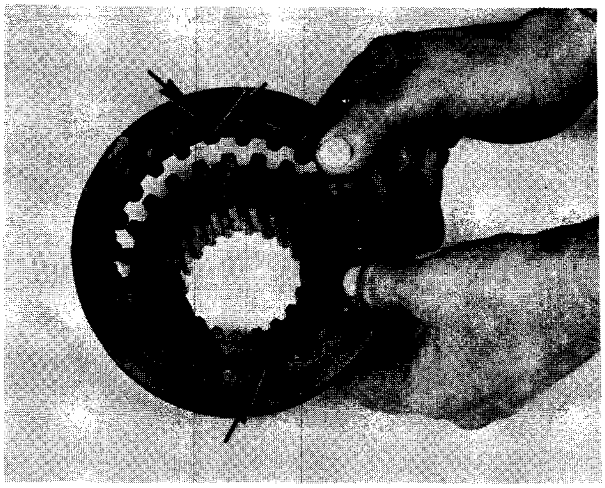
Illust. 21



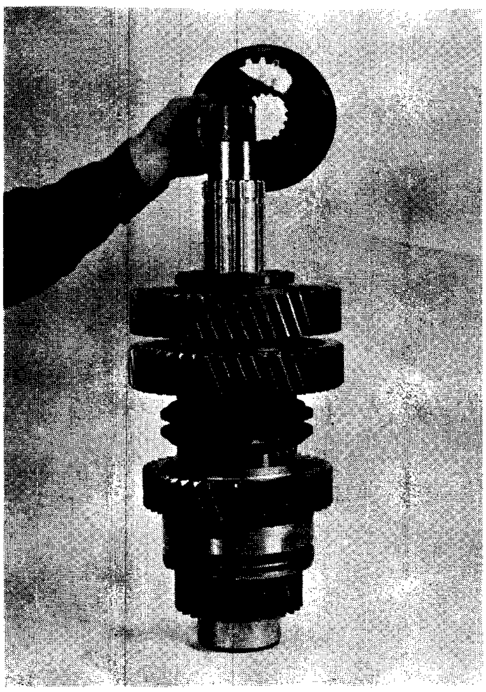
Illust. 22

NOTE: Shifter collar has 4 tapered teeth (as indicated with arrows). Install collar so tapered teeth will slide over poppets (Illust. 23). Poppets will fall in space between teeth of collar.

Install shifter gear onto shaft (Illust. 24). NOTE: Shifter gear is marked "Engine Side". Install gear so marking is toward



Illust. 23



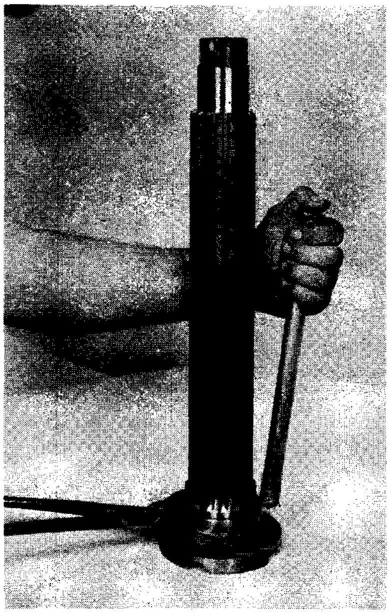
Illust. 24

engine, as illustrated. Next, install spacer. NOTE: This spacer is used only in the absence of creeper gears.

UPPER SHAFT

Press or drive oil seal into retainer (Illust. 1). Lip of oil seal away from milled surface of retainer. Next, install "O" ring (indicated by pencil) into groove of retainer.

Illust. 1

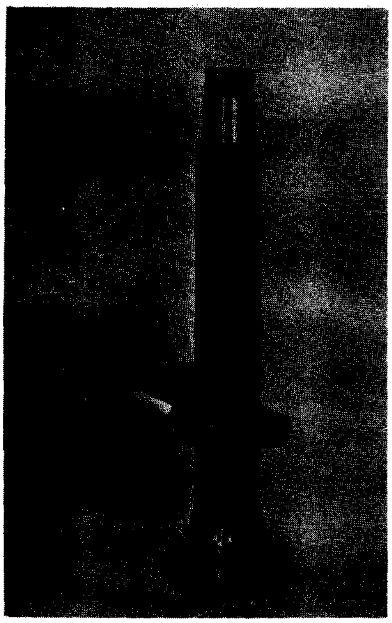


Illust. 2

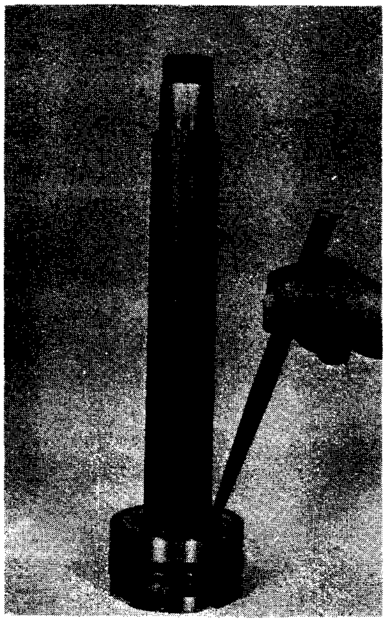
Heat spacer in oil and install onto upper shaft. Chamfered edge of spacer toward engine. Hold spacer until set (Illust. 2).

Install oil seal retainer onto shaft (Illust. 3). Lip of seal away from spacer.

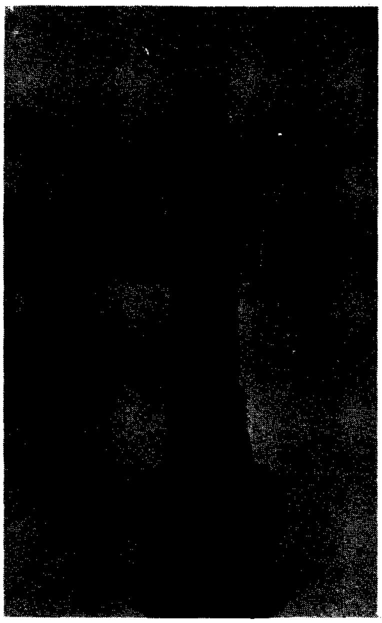
Heat bearing in oil and install onto upper shaft (Illust. 4). Sleeve of bearing away from retainer. Hold bearing until set (Illust. 5).



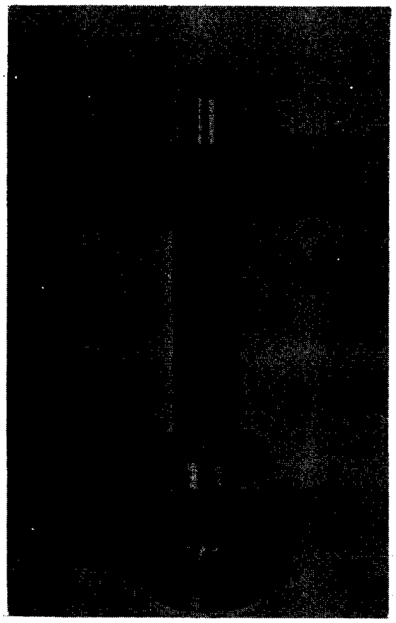
Illust. 3



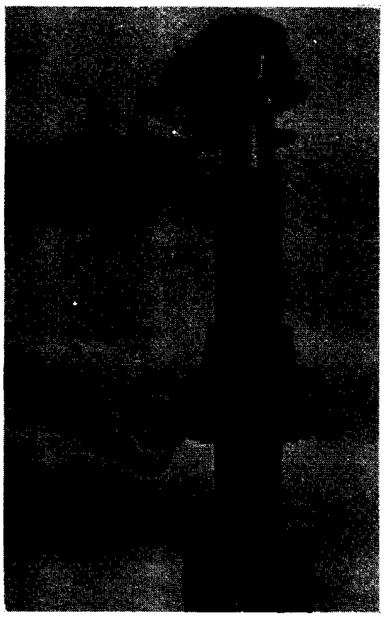
Illust. 5



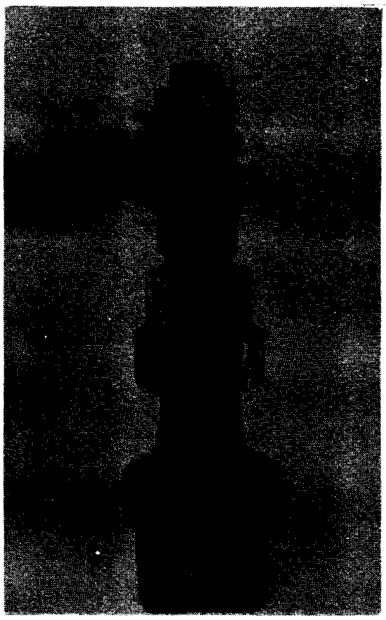
Illust. 7



Illust. 4



Illust. 6



Illust. 8

Install 31 tooth gear onto upper shaft (Illust. 6). Hub of gear toward threaded end of shaft. Next, install spacer.

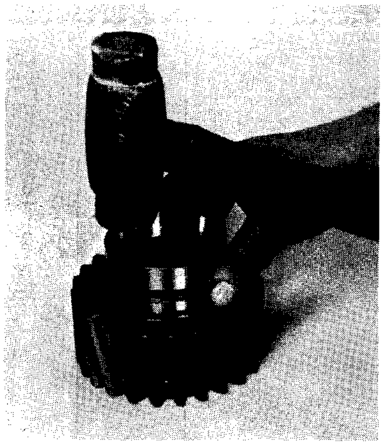
Install sliding gear onto shaft (Illust. 7).

Install two spacers onto shaft (Illust. 8).

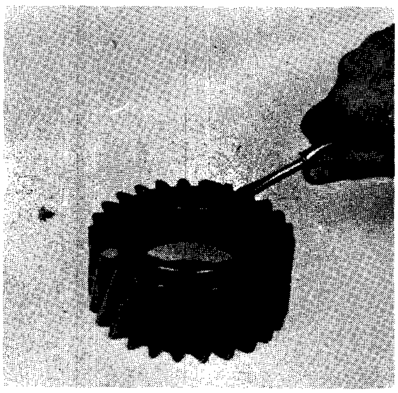
INSTALLATION OF LOWER, UPPER AND IDLER SHAFTS

Press or drive cup into idler gear (Illust. 1).

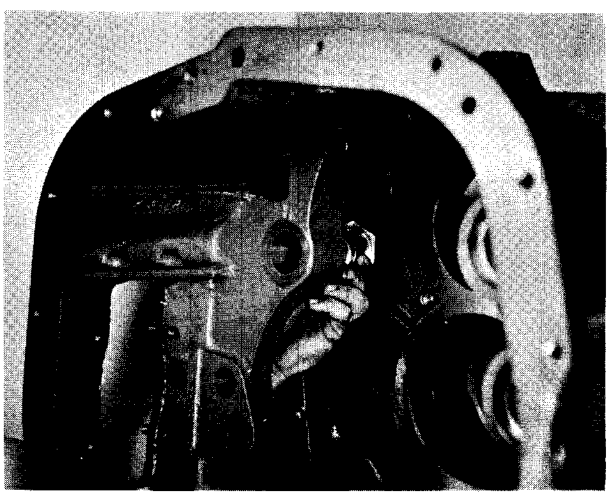
Install snap ring into groove of idler gear (Illust. 2).



Illust. 1

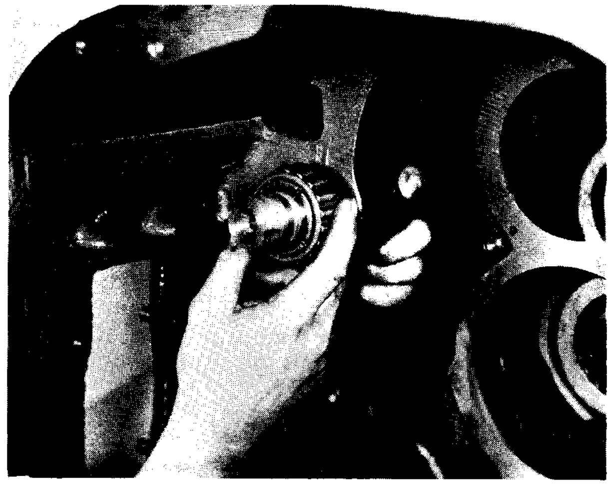


Illust. 2



Illust. 3

Install idler gear shaft into housing (Illust. 3).



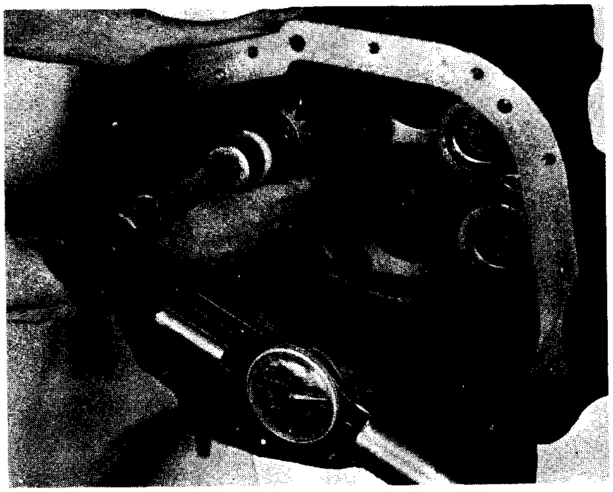
Illust. 4

Illust. 5

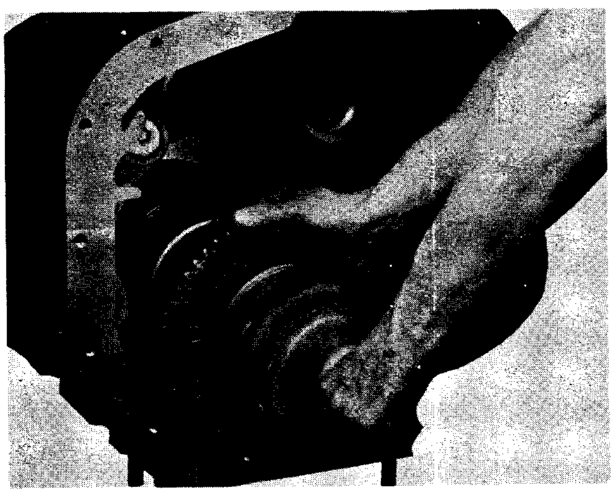
Install bearing cone onto idler shaft (Illust. 4).

Install idler gear and second bearing cone onto idler shaft (Illust. 5).
IMPORTANT: Etched number and letter on edge of bearing cup to correspond with number and letter etched on bearing cone.

Install locking nut onto shaft. Tighten nut to a torque reading of 600 foot pounds (Illust. 6). NOTE: While nut is being tightened, rotate gear to center bearings in cup. After torque reading is obtained, remove torque wrench and check for binding. If binding occurs, remove bearings and in-



Illust. 6

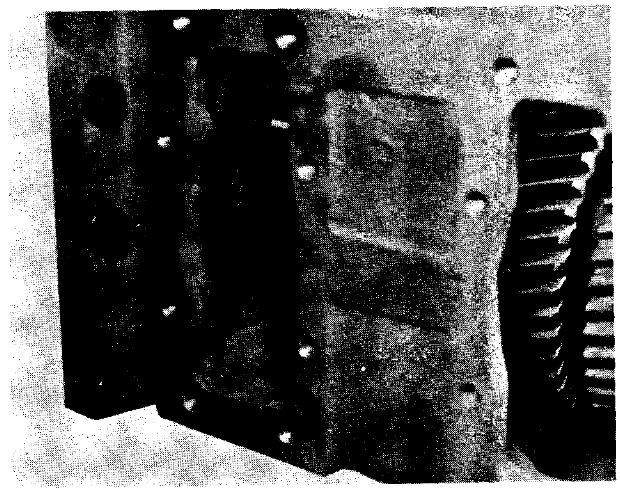


Illust. 7

spect for defective bearings and cup. Foreign matter in bearings will also cause binding.

Remove locking nut from idler shaft. Next, remove bearing cone, idler gear and second bearing cone from idler shaft.

Insert lower shaft assembly into upper transmission housing (Illust. 7).
NOTE: Align milled surface of retainer with punch mark in intermediate plate (Illust. 8). Bump end of shaft, using a rawhide mallet, until milled surface of retainer is flush with lock in intermediate plate.

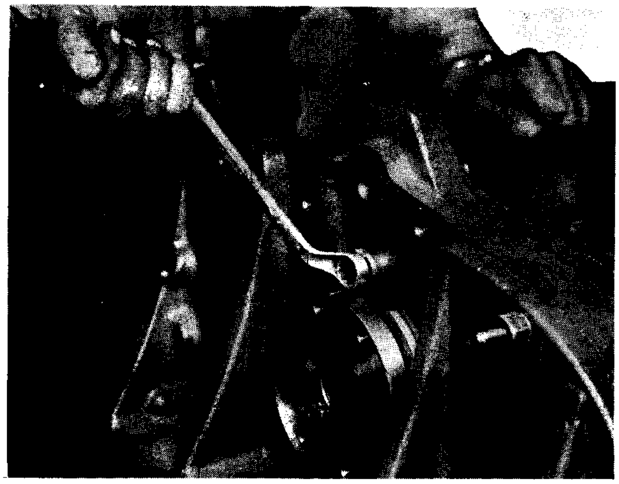


Illust. 8

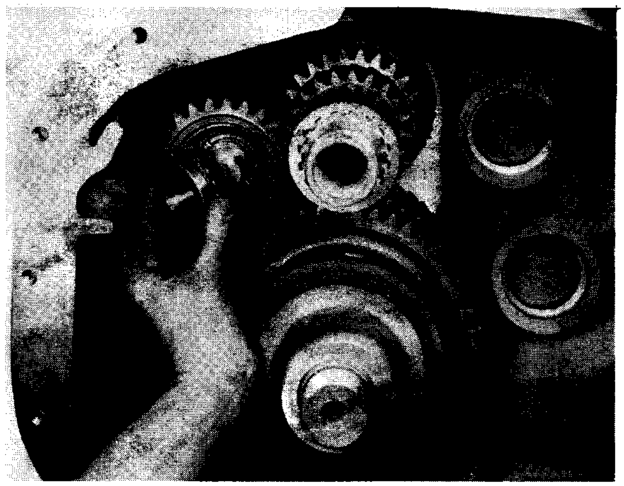
Illust. 9

Insert upper shaft assembly into upper transmission housing (Illust. 9).
NOTE: Milled surface of retainer in an upward position. Bump end of shaft, using a rawhide mallet until surface is flush with engine side of intermediate plate. Next, install lock and cap screw to intermediate plate (Illust. 10). Insert locking portion of lock in hole in intermediate plate. Tighten cap screw securely. The lock will prevent retainer from rotating as shaft rotates, preventing wear to "O" ring.

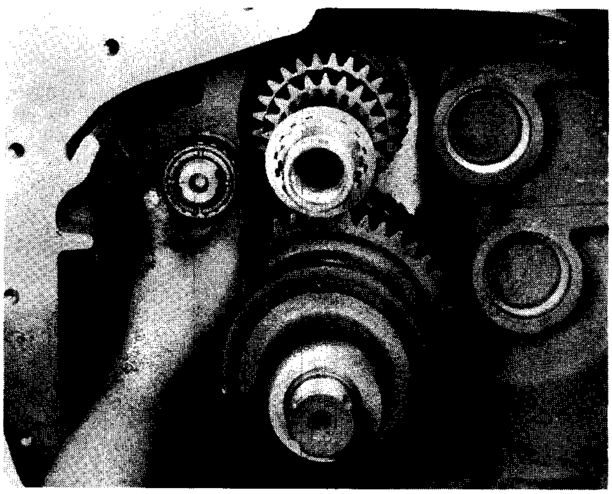
Install idler bearing cone onto idler shaft (Illust. 11).



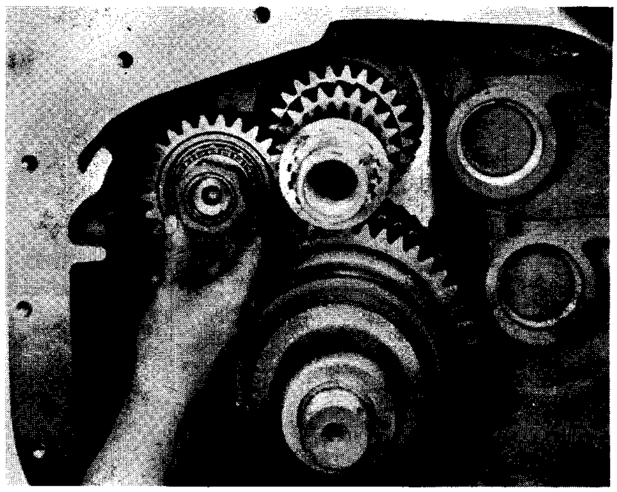
Illust. 10



Illust. 12



Illust. 11



Illust. 13

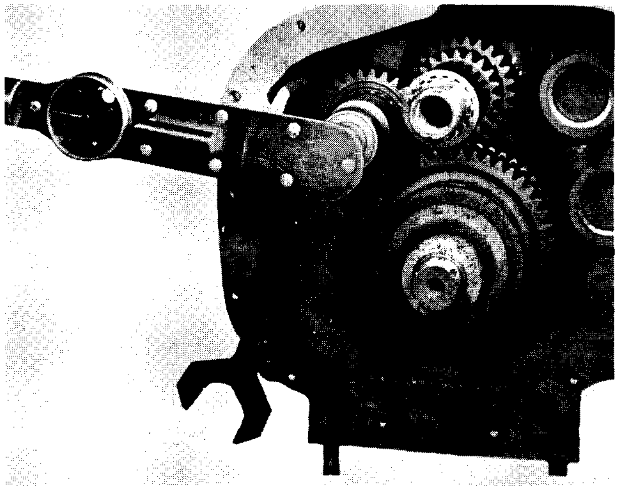
Install idler gear and second bearing cone onto shaft (Illust. 12). NOTE: Etched number and letter on edge of bearing cup to correspond with number and letter etched on bearing cones.

Install locking nut to idler shaft (Illust. 13).

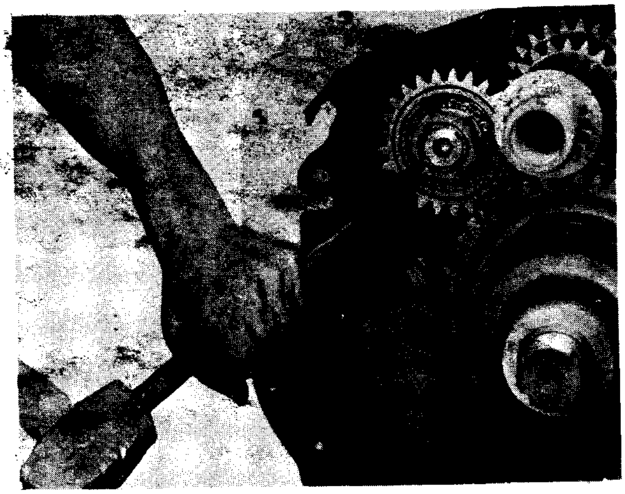
Tighten nut to a torque reading of 600 foot pounds (Illust. 14).

Stake locking nut, using a hammer and drift pin (Illust. 15).

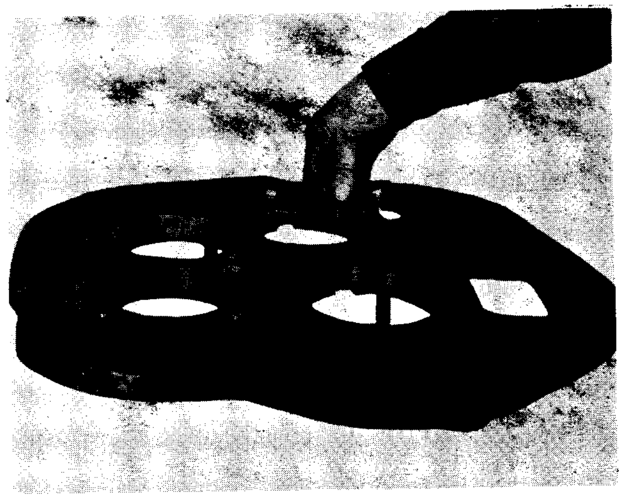
To remove stake from locking nut, use a drill (Illust. 16).



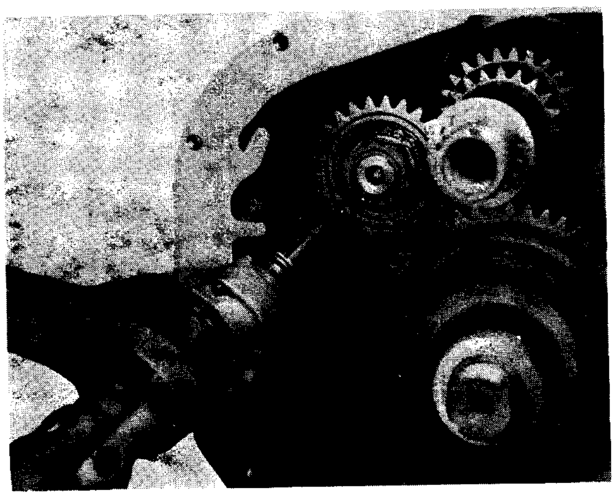
Illust. 14



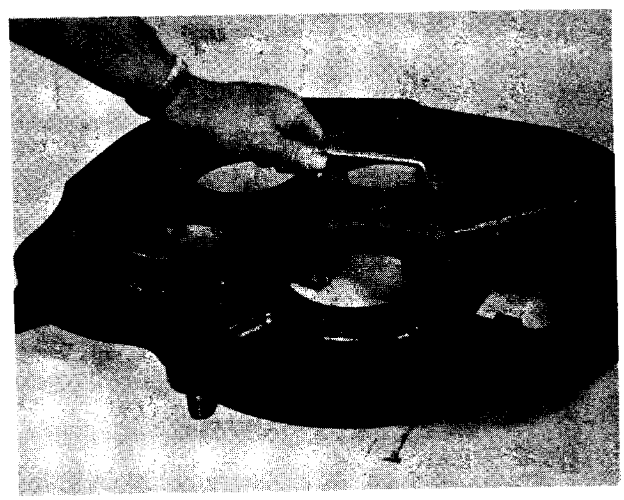
Illust. 15



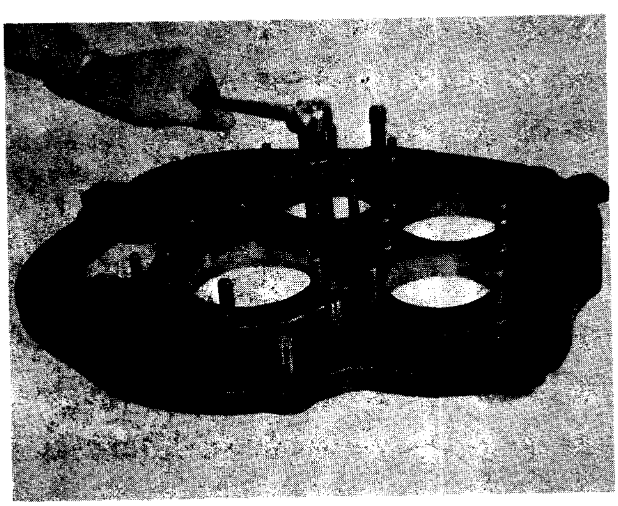
Illust. 18



Illust. 16



Illust. 19



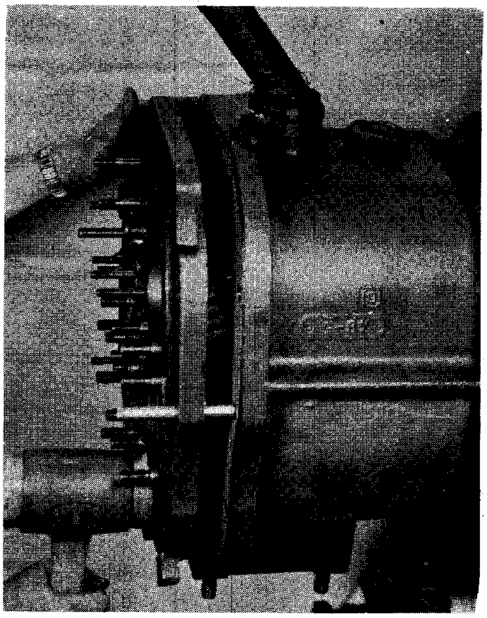
Illust. 17

Install studs into upper transmission cover (Illust. 17). Install dowel pins, using a rawhide mallet. Do not drive dowel pins through cover.

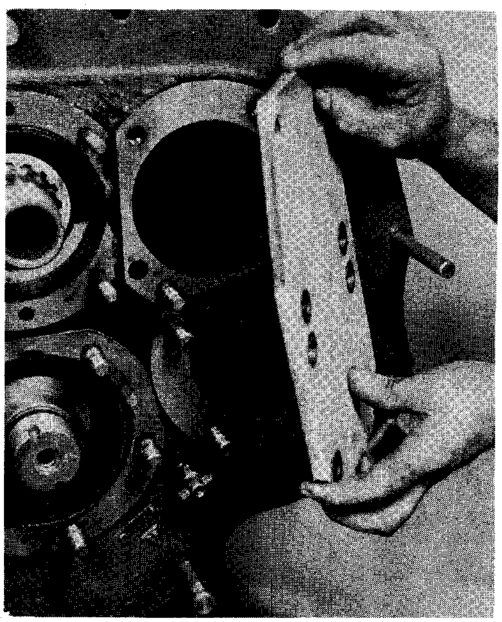
Turn upper transmission cover over and install baffle and gasket (Illust. 18), long side of baffle toward gear box. Install cap screws with lock washers. Tighten cap screws securely (Illust. 19).

Shellac gasket to upper transmission. Install two or more guides in upper transmission cap screw holes.

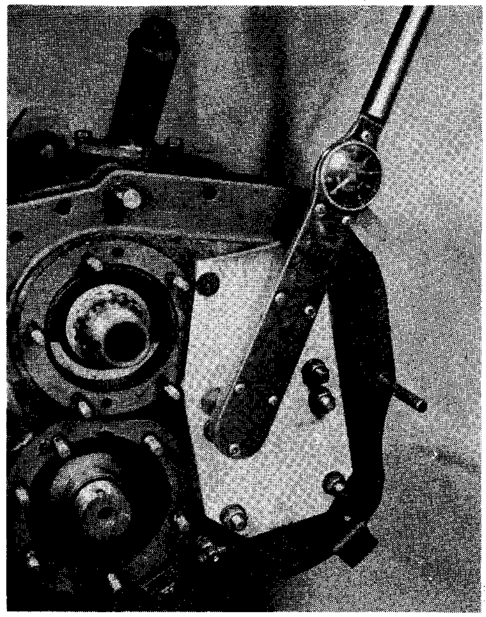
Install cover onto guides. Bump cover,



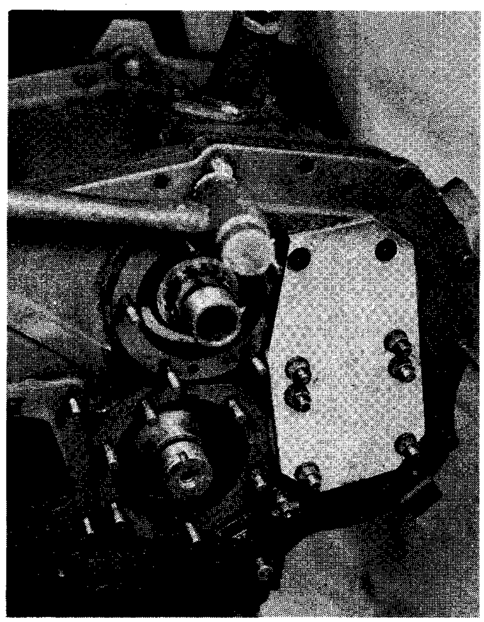
Illust. 20



Illust. 21



Illust. 22



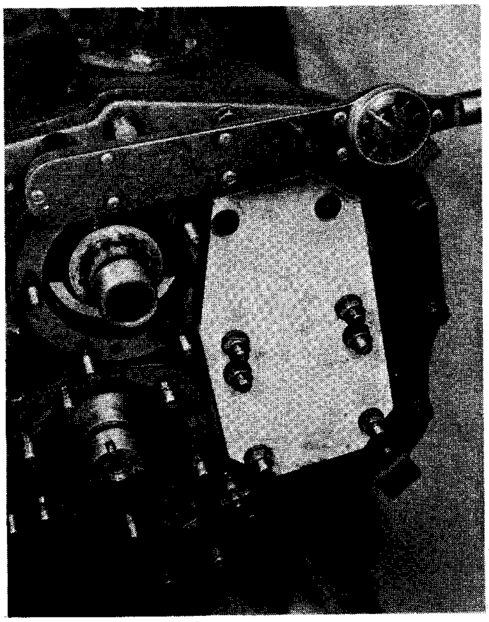
Illust. 23

using a rawhide mallet, until cover is against gasket (Illust. 20).

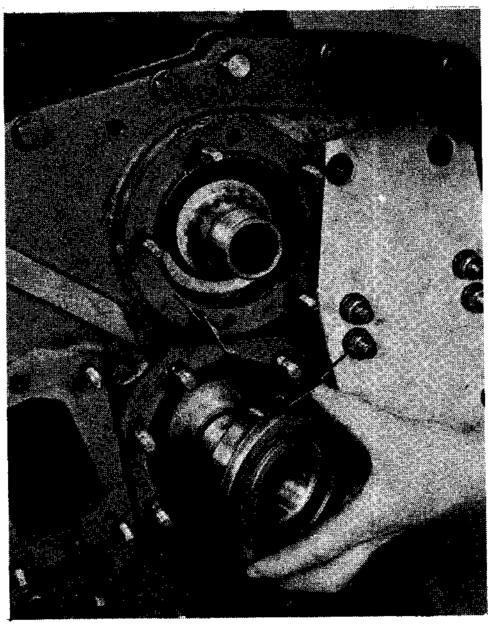
Shellac cover plate gaskets to upper transmission cover. Next, install cover plate (Illust. 21).

Install two hex socket head cap screws with copper washers. Next, install lock washers and stud nuts. Tighten cap screws and nuts to a torque reading of 65 foot pounds (Illust. 22).

Install four upper transmission cover plate cap screws with lock washers (two on each side of cover). Snug cap screws. Next, using a rawhide mallet, drive dowel pins



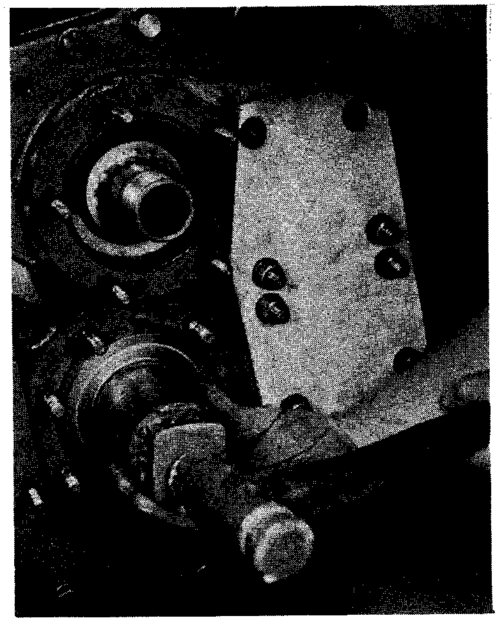
Illust. 24



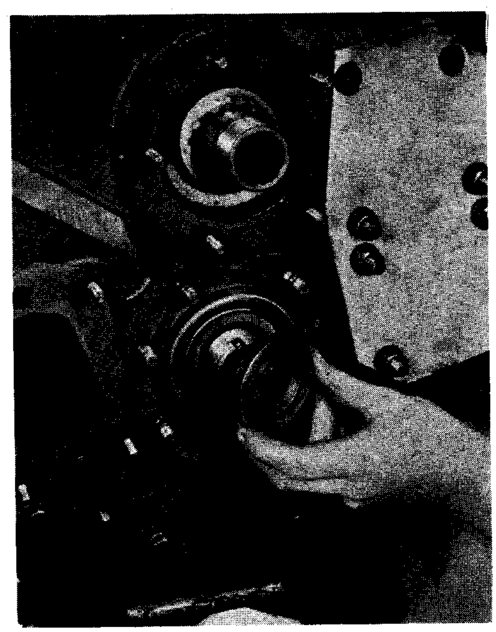
Illust. 25

through cover and into upper transmission (Illust. 23).

Remove guides from upper transmission and install remaining cover cap screws with lock washers. Tighten cap screws to a torque reading of 65 foot pounds (Illust. 24).



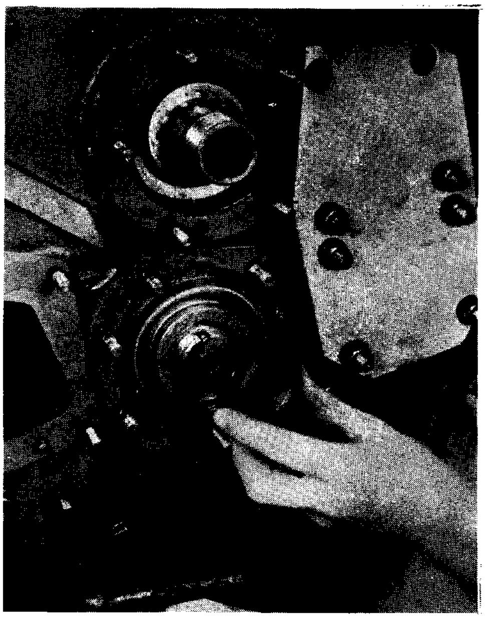
Illust. 26



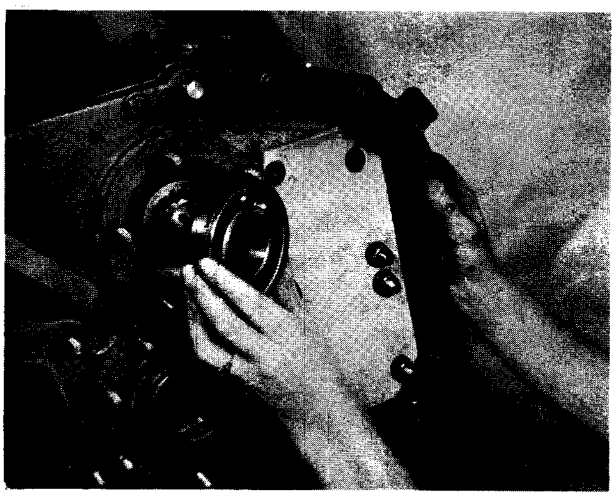
Illust. 27

Install bearing with snap ring onto lower shaft and into cover (Illust. 25). Slot in snap ring to be in line with oil hole in cover. Using a driver and hammer, drive bearing into bore of housing until snap ring is against cover (Illust. 26).

Install spacer onto lower shaft and against bearing (Illust. 27).



Illust. 28

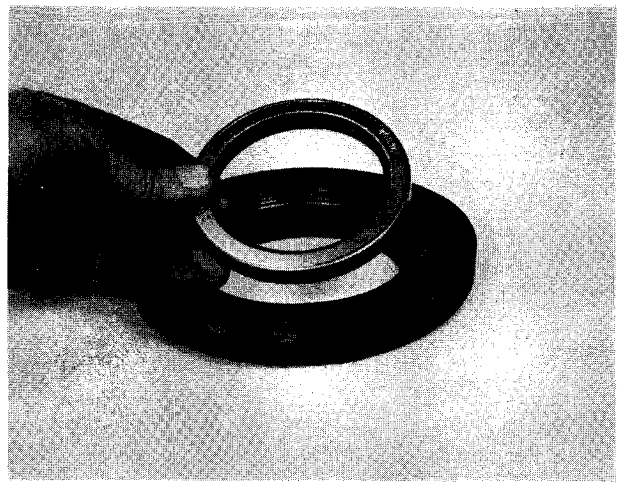


Illust. 29

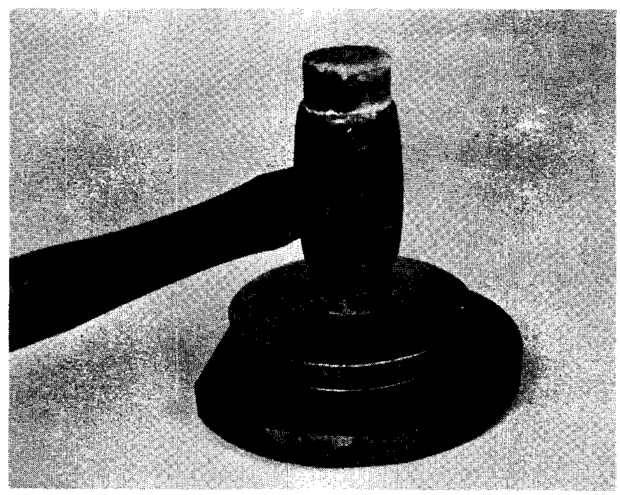
Install locking nut onto lower shaft (Illust. 28).

Install bearing onto shaft and into cover (Illust. 29). Using a hammer and driver, drive bearing into bore of housing until ring is against cover.

Install oil seal into oil seal retainer (Illust. 30). Lip of seal toward bearing. Using a hammer and driver, drive oil seal into retainer to pilot (Illust. 31).

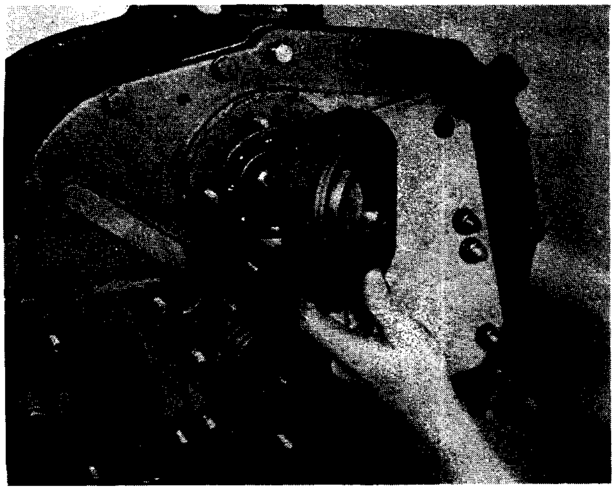


Illust. 30



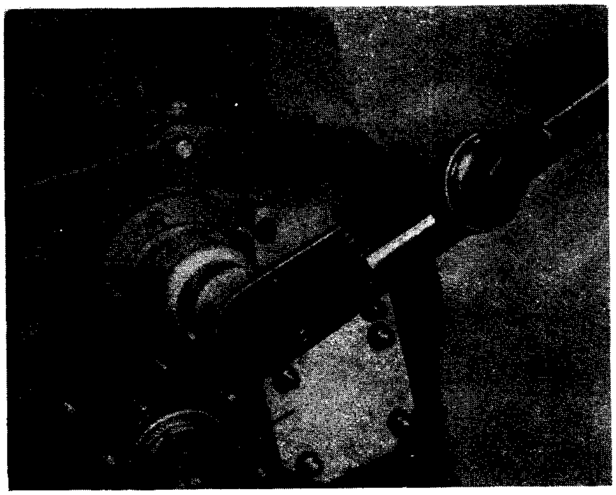
Illust. 31

Illust. 32



Illust. 33

Illust. 34



Illust. 35

Illust. 36

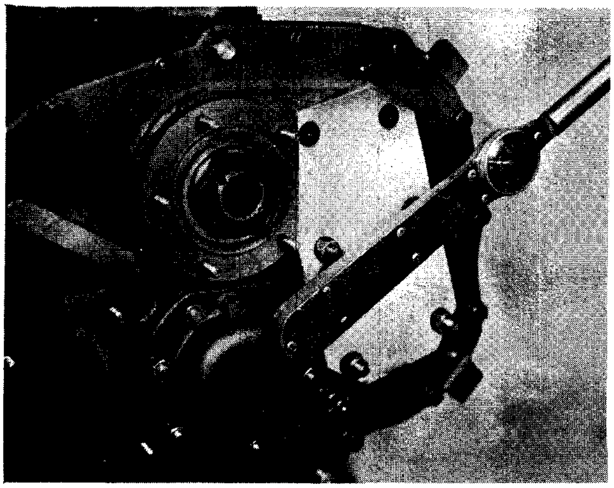
Illust. 37

Insert chamfered spacer into oil seal (Illust. 32). Chamfered end of spacer away from lip of seal.

Install retainer gasket and retainer over studs of upper shaft bore of cover (Illust. 33).

Install lock nut onto upper shaft (Illust. 34). Tighten nut to a torque reading of 750 foot pounds (Illust. 35). Stake lock nut, using a drift pin and hammer (Illust. 36).

Tighten lower shaft nut, as indicated by arrow (Illust. 35) to a torque reading of 750



Illust. 38

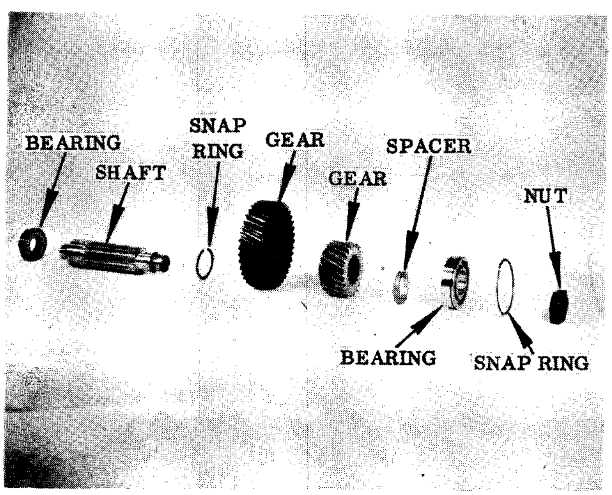
foot pounds. Stake lock nut, using a drift pin and hammer.

To remove stake from both upper and lower shafts, use a drill and drill out stakes. Use care not to damage threads of shafts.

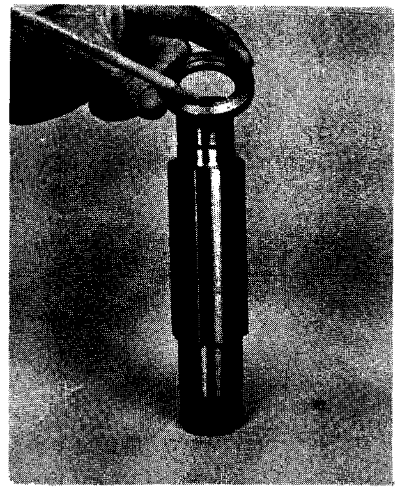
Install lower shaft bearing cap and gasket (Illust. 37). Install stud nuts and lock washers. Tighten stud nuts to a torque reading of 65 foot pounds (Illust. 38).

UPPER CREEPER GEARS

Illust. 1 is an exploded view of the upper creeper gears.



Illust. 1



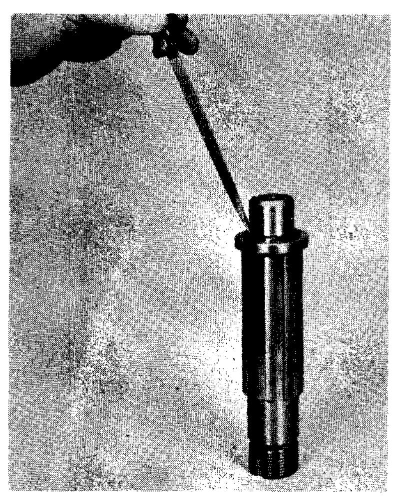
Illust. 2

Install spacer onto shaft (Illust. 2). Tapered end of spacer away from splines of shaft.

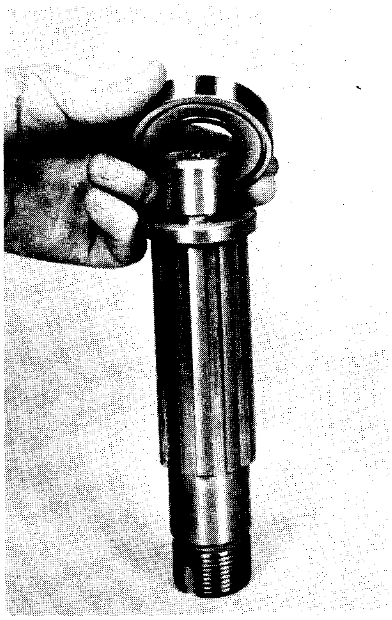
Install snap ring into groove of shaft (Illust. 3).

Install bearing onto shaft (Illust. 4). Shielded side of bearing toward snap ring. Press or drive bearing onto shaft and down to snap ring (Illust. 5).

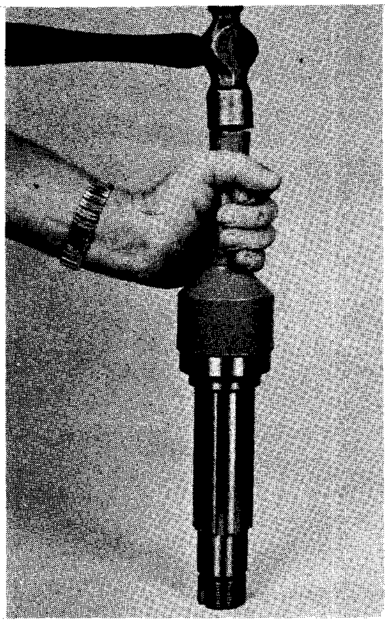
Install 38 tooth gear onto shaft and down to spacer (Illust. 6). Long hub of gear toward threaded end of shaft.



Illust. 3



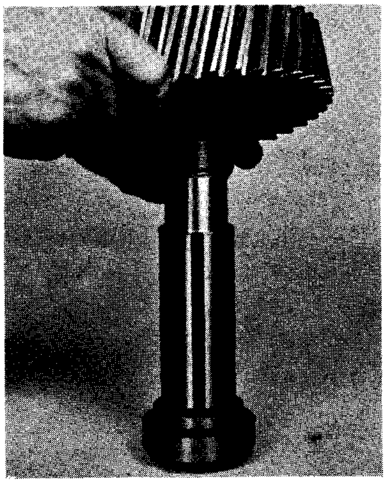
Illust. 4



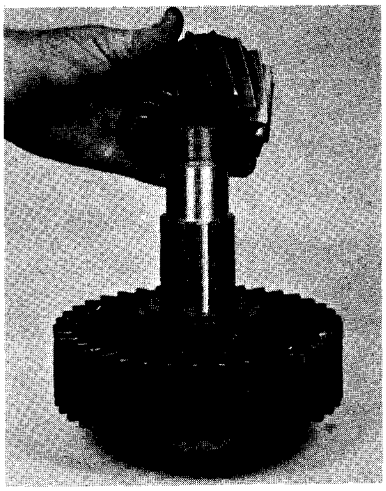
Illust. 5

Install 16 tooth gear onto shaft and down to 38 tooth gear (Illust. 7). Long hub of gear toward threaded end of shaft.

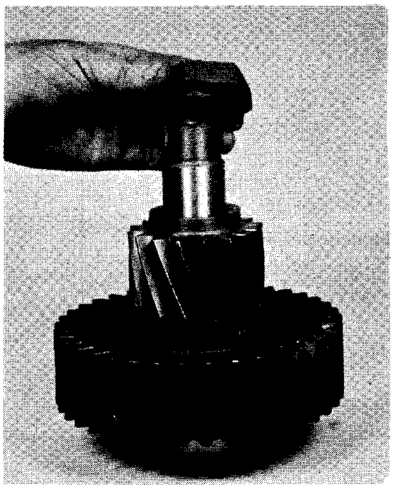
Install nut onto shaft (Illust. 8). Do not tighten nut.



Illust. 6



Illust. 7



Illust. 8

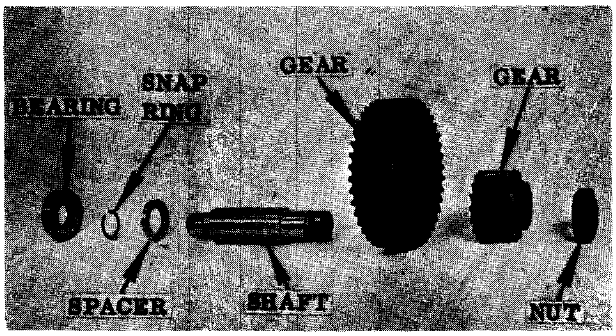
LOWER CREEPER GEARS

Illust. 1 is an exploded view of the lower creeper gears.

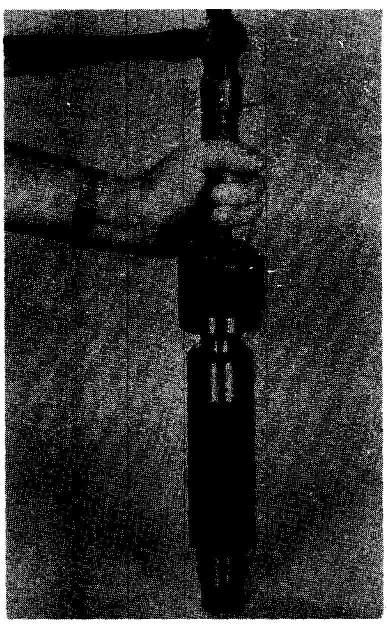
Press or drive small bearing onto shaft (Illust. 2). Shielded side of bearing toward threaded end of shaft.

Install snap ring into groove of shaft (Illust. 3).

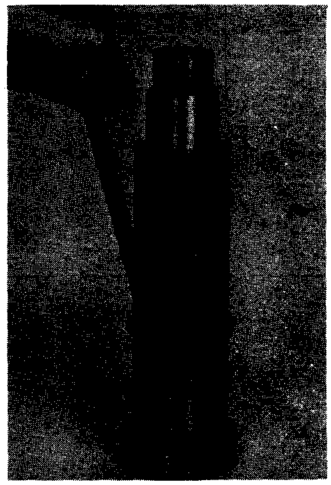
Install 38 tooth gear onto shaft (Illust. 4). Long hub of gear away from snap ring.



Illust. 1



Illust. 2



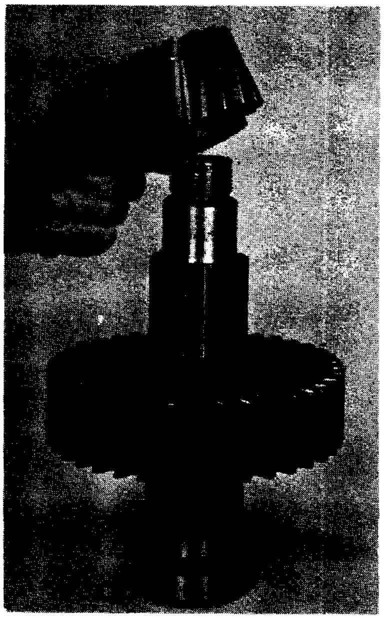
Illust. 3

Illust. 4

Install 22 tooth gear onto shaft (Illust. 5). Smooth side of gear away from 38 tooth gear.

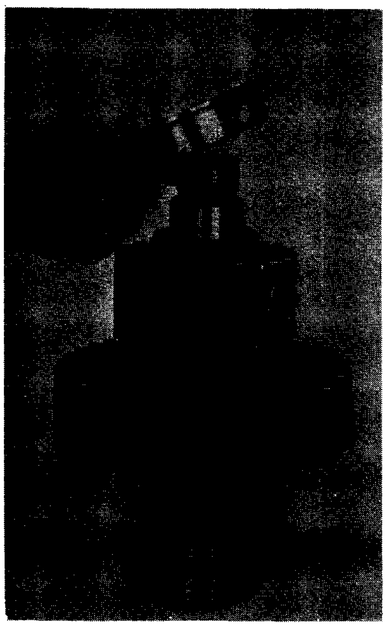
Install spacer onto shaft. Chamfered edge of spacer toward 22 tooth gear. Next, install bearing onto shaft (Illust. 6). Press or drive bearing (Illust. 7). Snap ring groove in bearing toward threaded end of shaft.

Install locking nut onto shaft (Illust. 8).

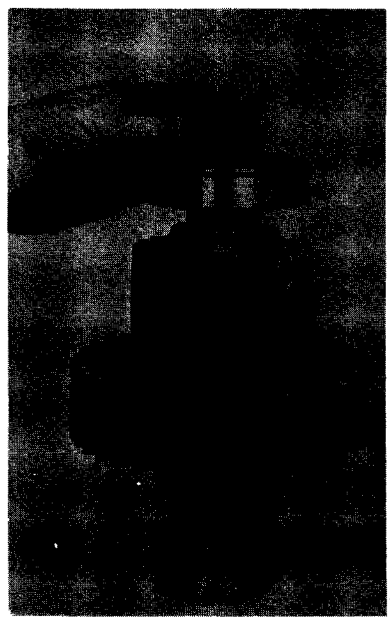


Illust. 5

Illust. 7



Illust. 6

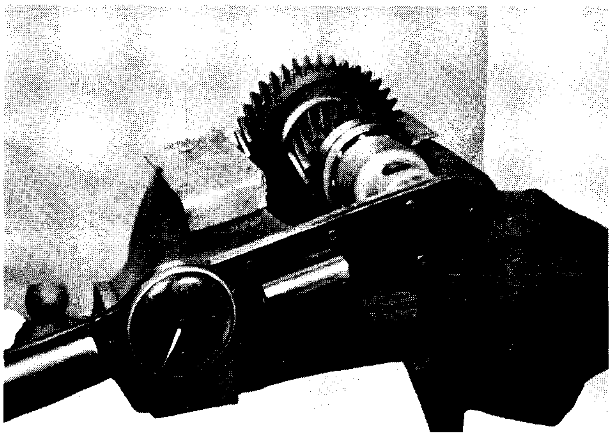


Illust. 8

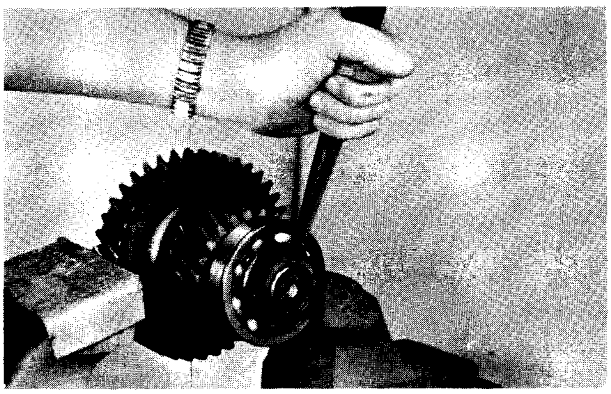
Place lower creeper gear assembly into a vise. Use a soft metal over vise jaws to prevent damage to gear teeth. Tighten locking nut to a torque reading of 600 foot pounds (Illust. 9).

After torque reading is obtained, stake locking nut, using a drift pin and hammer (Illust. 10).

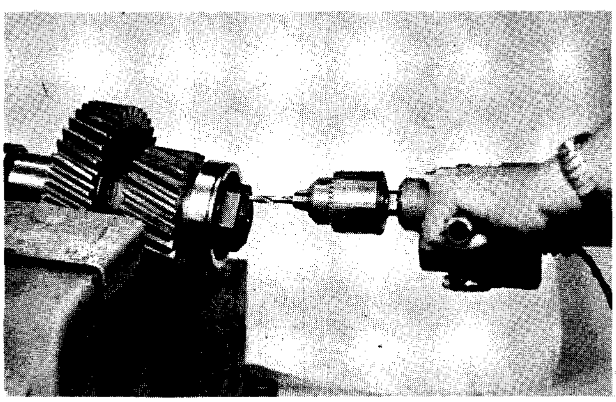
To remove stake from locking nut, use a drill (Illust. 11). Use care in drilling out stake to prevent damage to threads of shaft.



Illust. 9



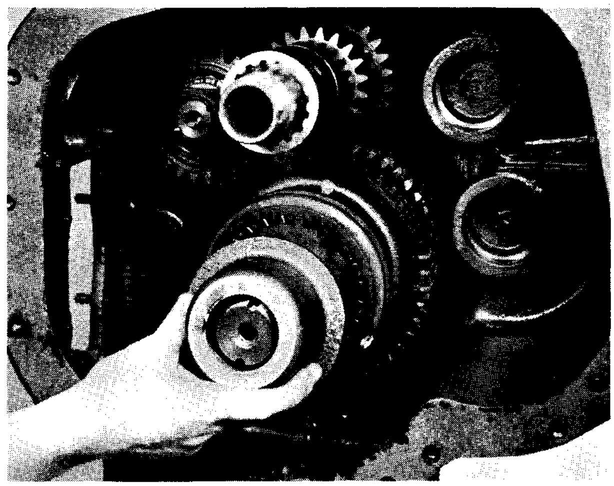
Illust. 10



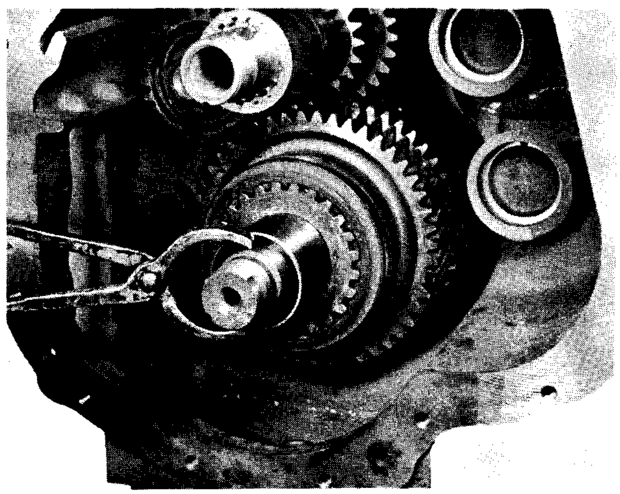
Illust. 11

INSTALLATION OF CREEPER GEARS

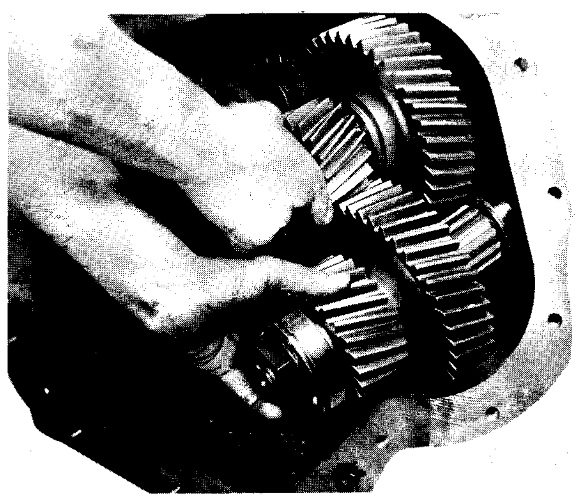
When installing creeper gears for the first time, the spacer (Illust. 1) must be removed from the lower shaft. Another gear must be added in its place.



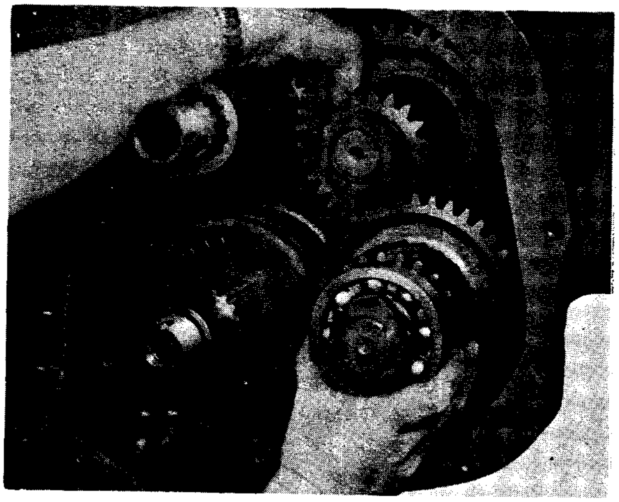
Illust. 1



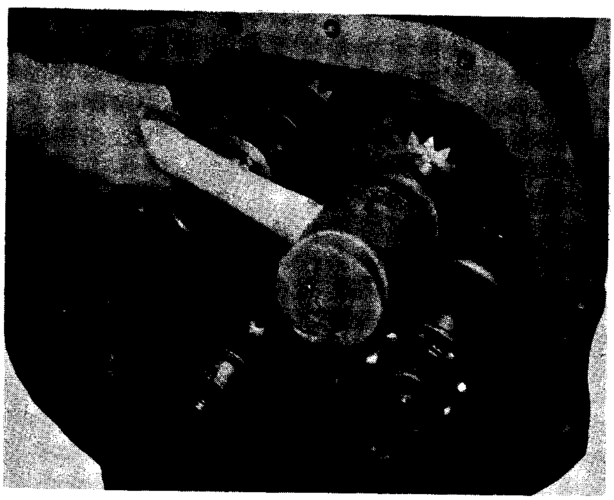
Illust. 2



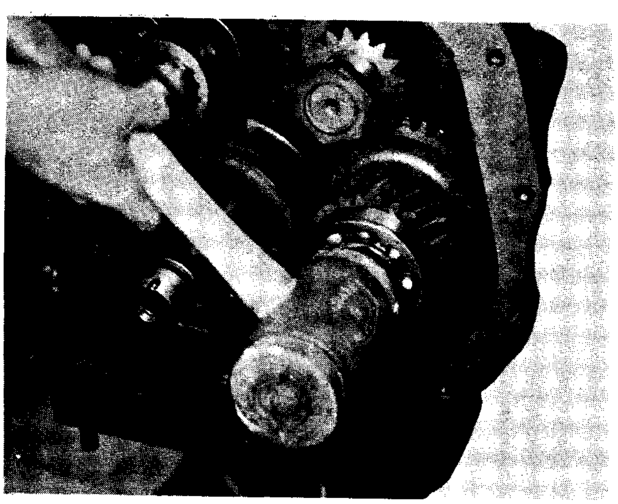
Illust. 3



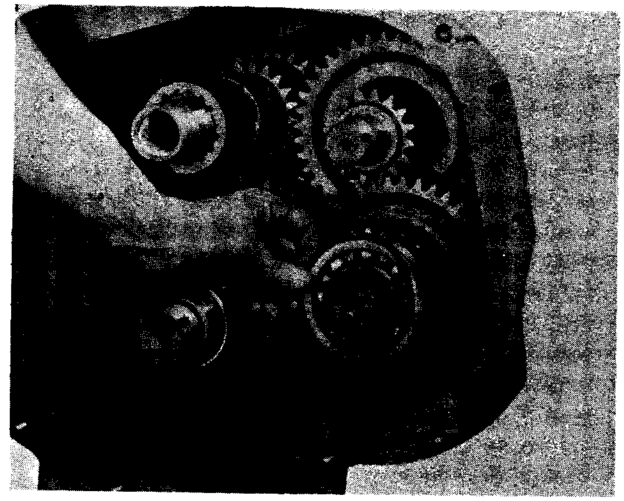
Illust. 4



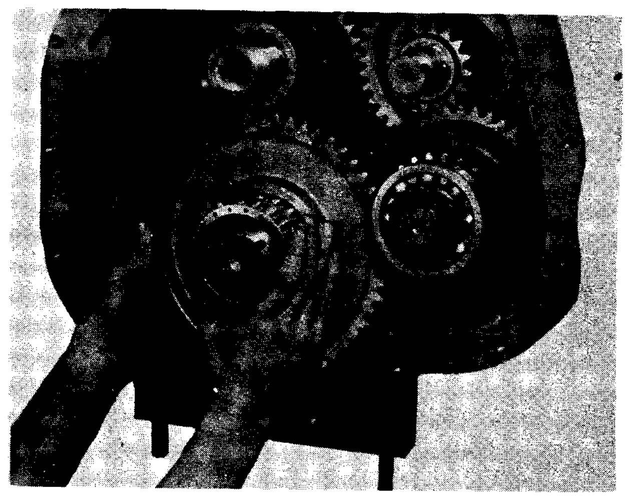
Illust. 5



Illust. 6



Illust. 7



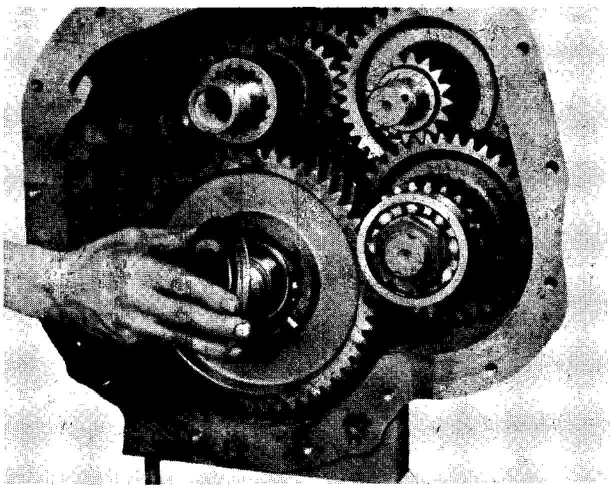
Illust. 8

Heat bearing race in oil and install to lower shaft (Illust. 2). Race to be against shifter gear. Hold race until set.

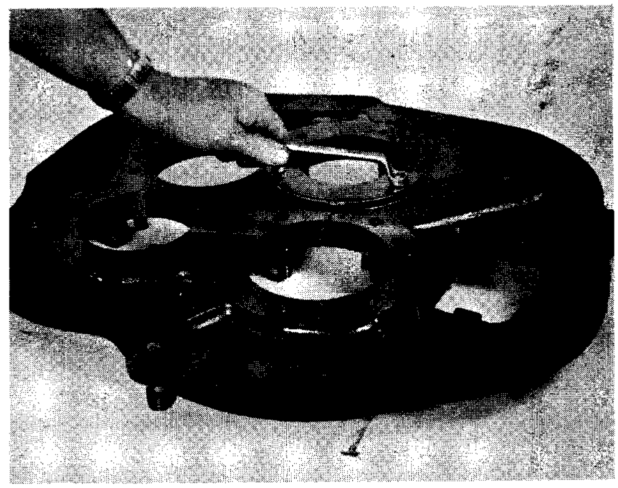
Install both upper and lower creeper gear assemblies into upper transmission at the same time (Illusts. 3 and 4). Using a rawhide mallet, bump both shafts until seated in housing (Illusts. 5 and 6). Remove locking nut from upper creeper shaft.

Remove snap ring from bearing of lower creeper shaft (Illust. 7).

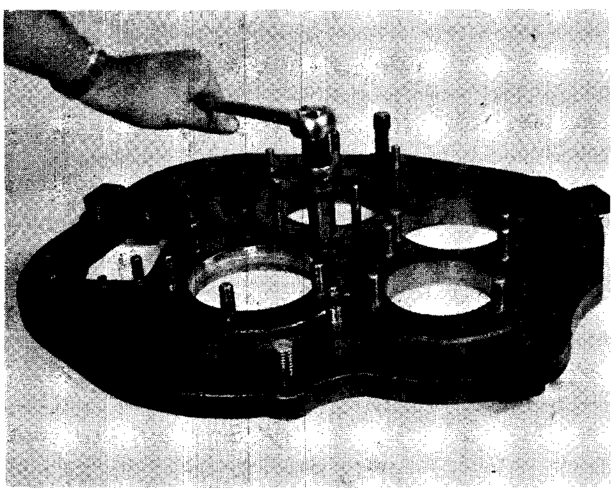
Install 53 tooth gear onto lower shaft. Next, insert bearings into gear and onto bearing race (Illust. 8).



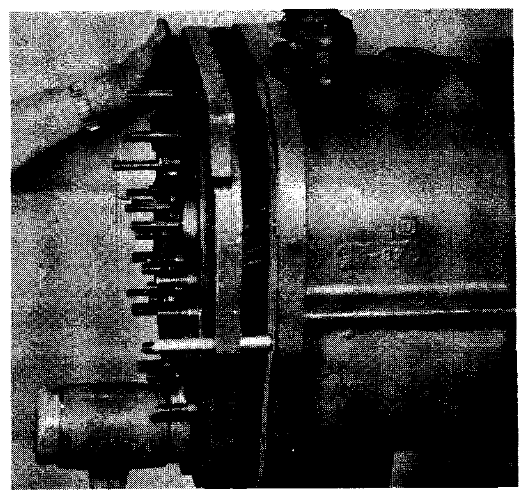
Illust. 9



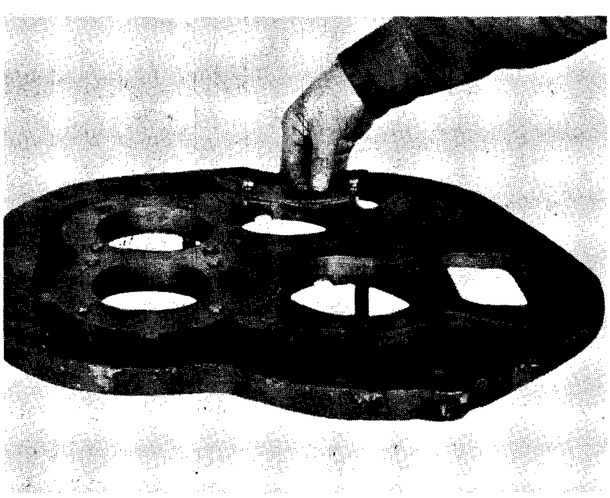
Illust. 12



Illust. 10



Illust. 13



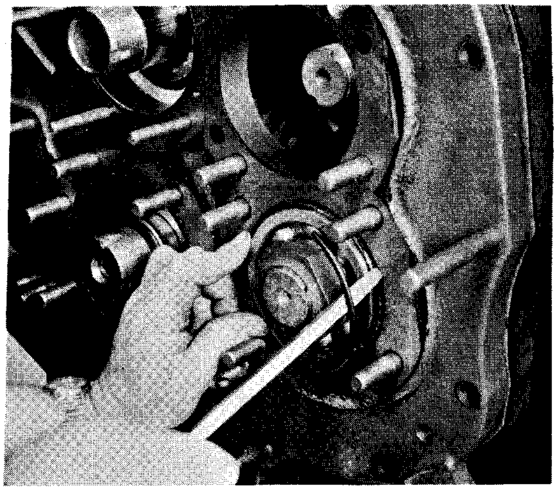
Illust. 11

Turn upper transmission cover over and install baffle and gasket (Illust. 11), long side of baffle toward gear box. Install cap screws and lock washers. Tighten cap screws securely (Illust. 12).

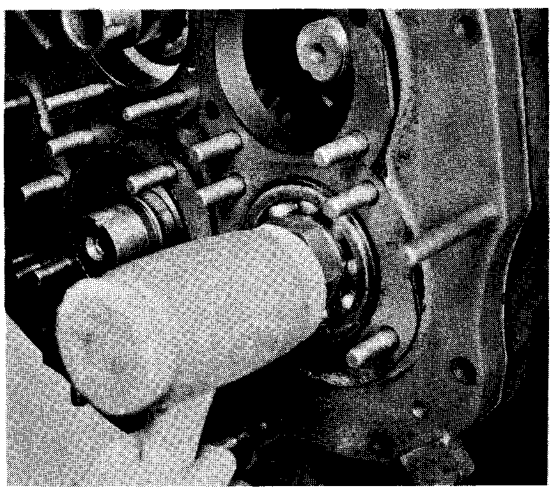
Shellac gasket to upper transmission. Install two or more guides into upper transmission cap screw holes.

Install spacer onto lower shaft (Illust. 9). Flat side of spacer toward gear.

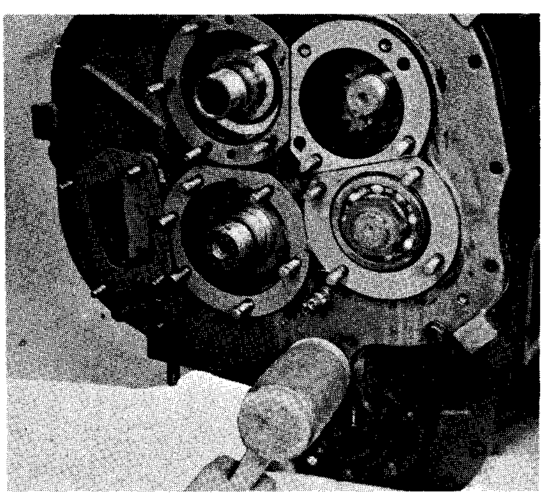
Install studs into upper transmission cover (Illust. 10). Install dowel pins, using a rawhide mallet. Do not drive dowel pins through cover.



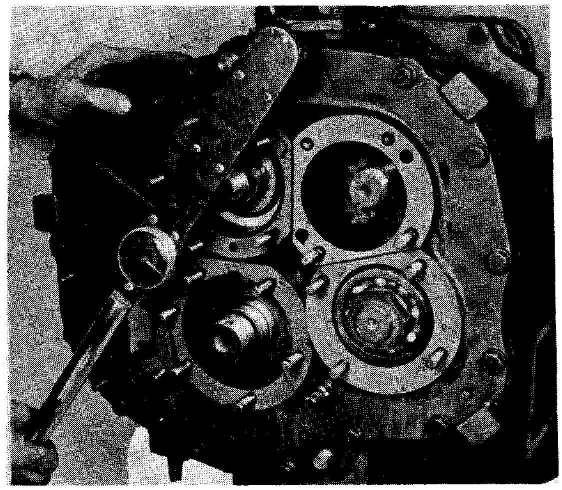
Illust. 14



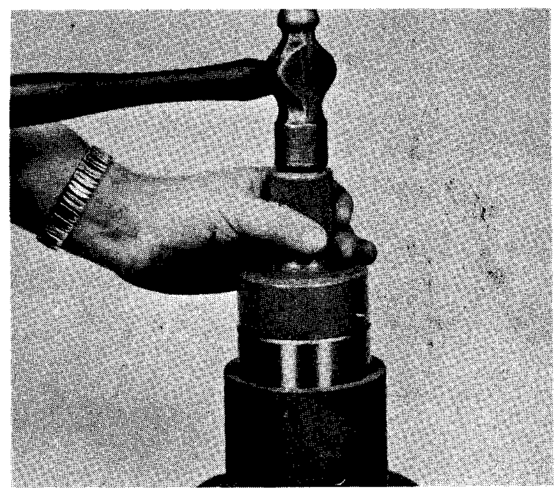
Illust. 15



Illust. 16



Illust. 17

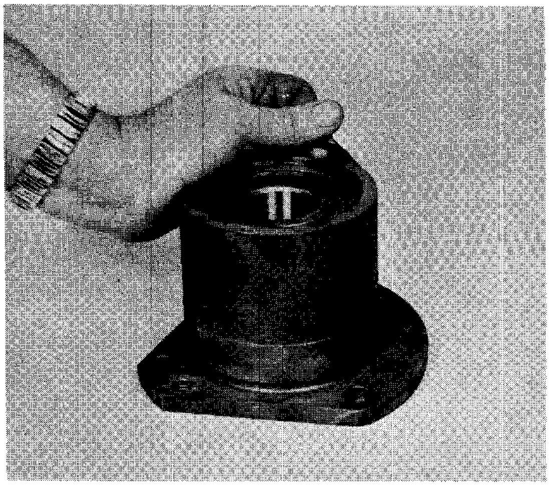


Illust. 18

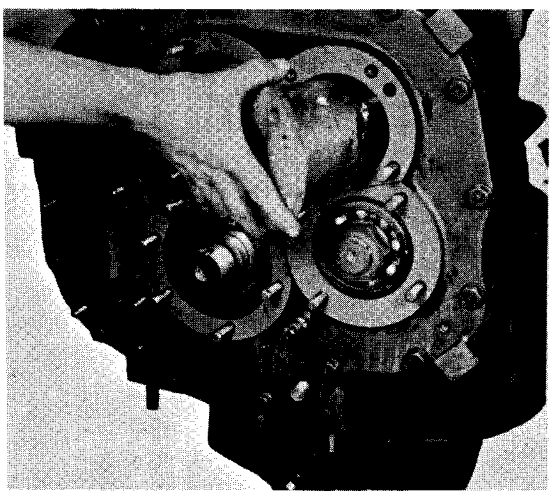
Install cover onto guides. Bump cover, using a rawhide mallet, until cover is against gasket (Illust. 13).

Install snap ring into groove of lower creeper shaft bearing (Illust. 14). Using a rawhide mallet, bump shaft back into upper transmission housing until snap ring in bearing is against cover (Illust. 15).

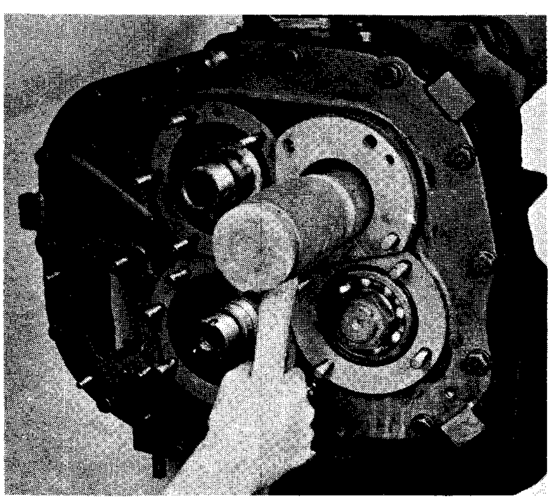
Install four upper transmission cover cap screws with lock washers. Do not tighten cap screws. Next, remove guides. Drive dowel pins through cover and into housing, using a rawhide mallet (Illust. 16).



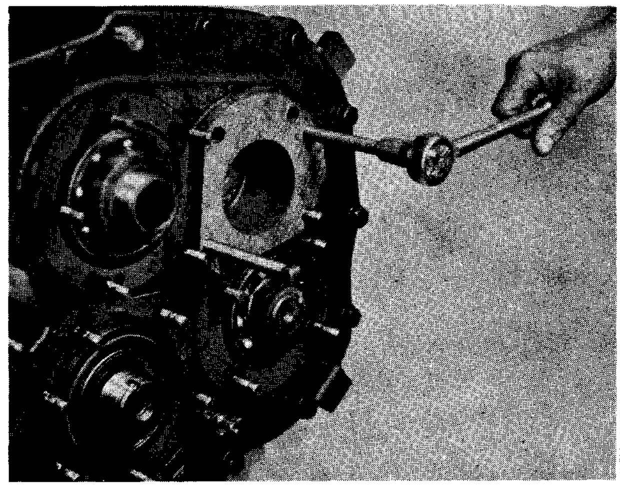
Illust. 19



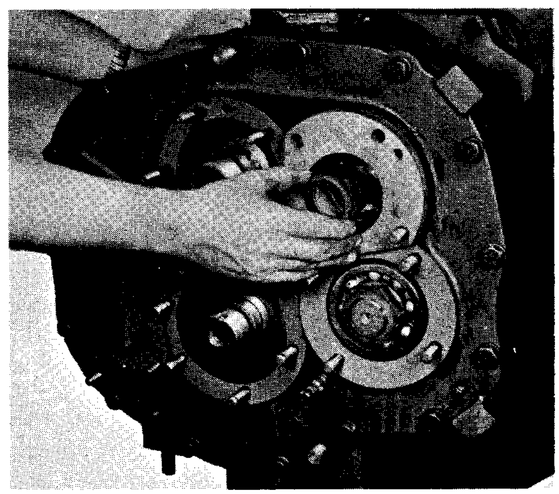
Illust. 20



Illust. 21



Illust. 22



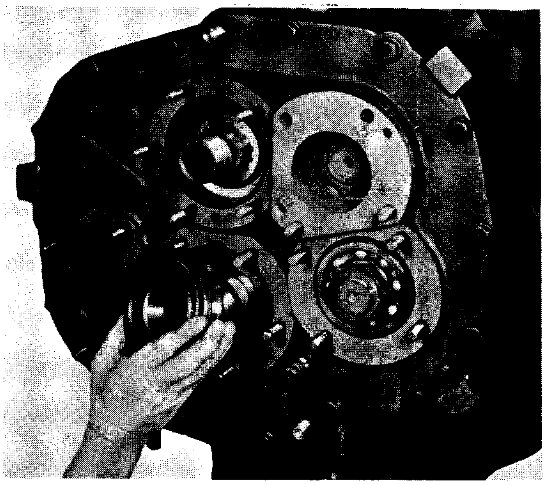
Illust. 23

Install remaining cover cap screws with lock washers. Tighten cap screws to a torque reading of 65 foot pounds (Illust. 17).

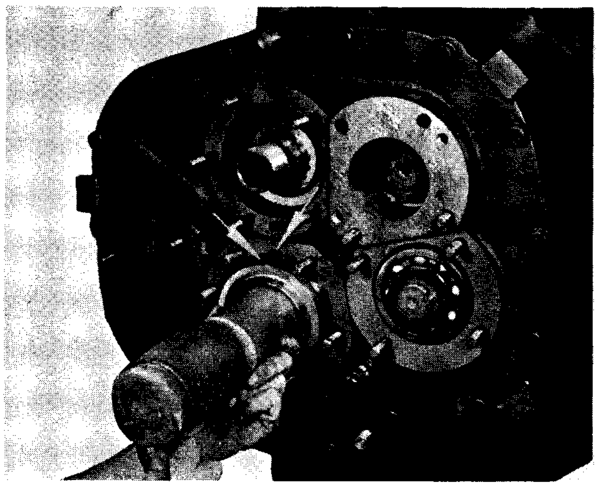
Press or drive bearing into bearing cage (Illust. 18). Next, install snap ring in groove of bearing cage (Illust. 19).

Shellac bearing cage gasket and lower creeper shaft cover gasket to upper transmission cover.

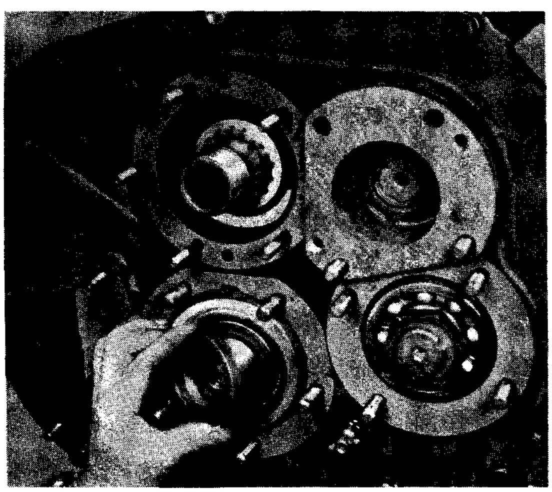
Install bearing cage with bearing into cover (Illust. 20). Using a rawhide mallet and



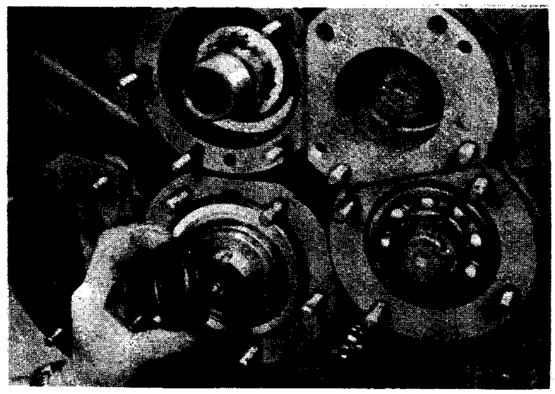
Illust. 24



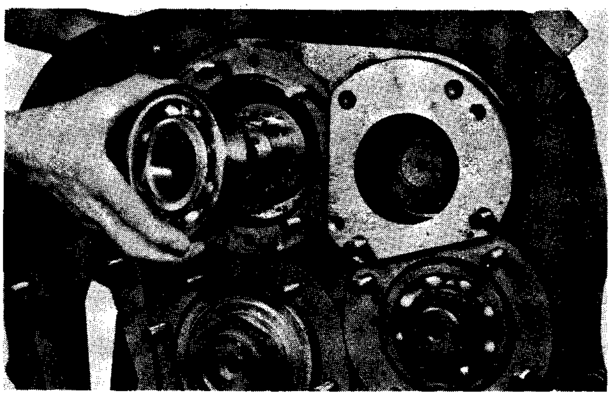
Illust. 25



Illust. 26



Illust. 27



Illust. 28

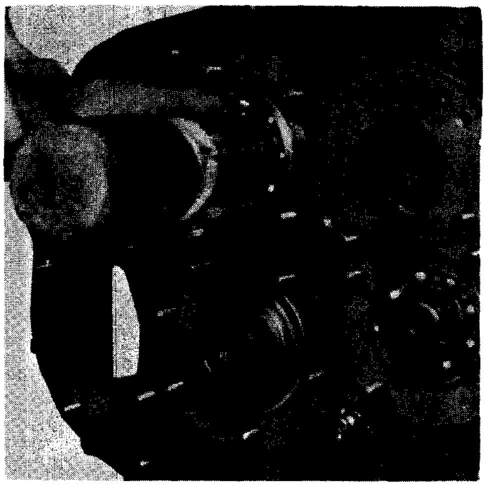
driver, drive bearing onto upper creeper shaft (Illust. 21).

To remove cage with bearing, install two set screws into cap screw holes (Illust. 22). By tightening set screws, cage will be forced from cover.

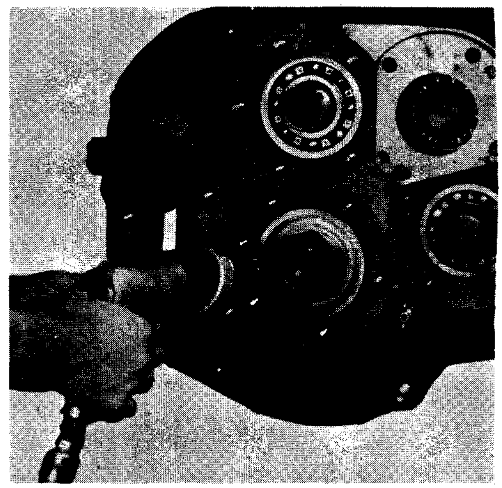
Install nut to upper creeper shaft (Illust. 23).

Install bearing with snap ring onto lower shaft of upper transmission (Illust. 24). Using a rawhide mallet and driver, drive bearing over shaft and into cover (Illust. 25). Snap ring to be against cover.
NOTE: Slot in snap ring to be in line with oil hole in cover.

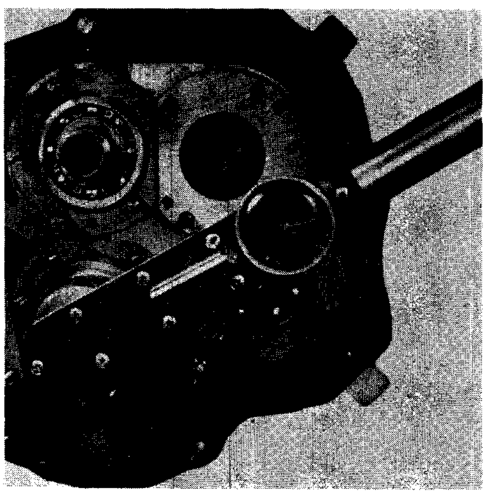
Install spacer onto lower shaft (Illust. 26).



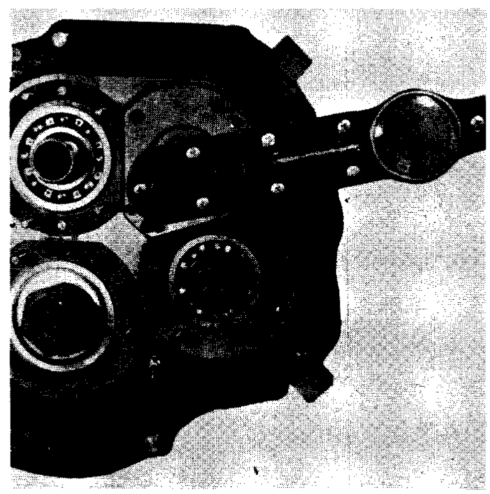
Illust. 29



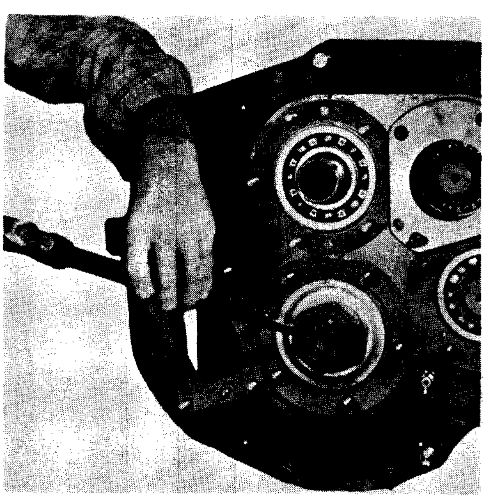
Illust. 32



Illust. 30



Illust. 33



Illust. 31

Install locking nut onto lower shaft (Illust. 27).

Install bearing with snap ring onto upper shaft (Illust. 28). Using a hammer and driver (Illust. 29), drive bearing onto shaft and into upper transmission cover.
NOTE: Hold a block of wood against flanged end of shaft to avoid driving upper shaft through rear bearing and retainer.

Tighten lower shaft locking nut to a torque reading of 750 foot pounds (Illust. 30). Stake nut, using a hammer and drift pin (Illust. 31).

To remove stake from locking nut, use a drill (Illust. 32). Avoid damaging threads of shaft when drilling out stake.

Tighten upper creeper shaft locking nut to a torque reading of 600 foot pounds (Illust. 33). Stake locking nut, using a blunt chisel and hammer (Illust. 34).

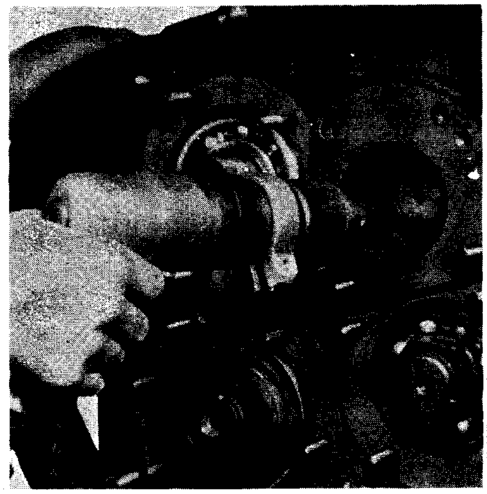
To remove stake from locking nut, use a drill (Illust. 35). Avoid damaging threads of shaft when drilling out stake.

Install gasket and upper creeper cover over studs and onto upper transmission cover. Install two hex socket head cap screws with copper washers. Next, install stud nuts with lock washers. Tighten hex socket head cap screws and stud nuts to a torque reading of 65 foot pounds (Illust. 36).

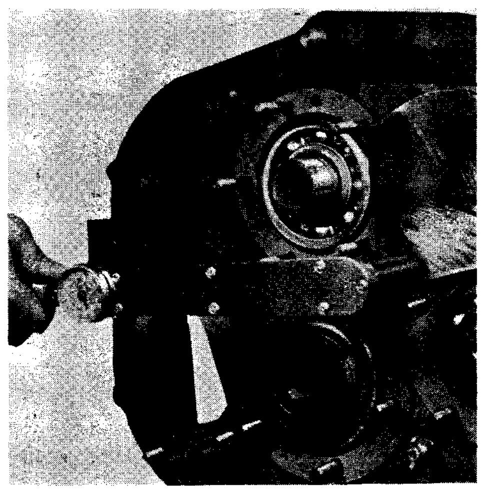
Install gasket and lower creeper cover over studs and onto upper transmission cover. Next, install lock washers and stud nuts. Tighten stud nuts to a torque reading of 65 foot pounds (Illust. 37).

Install gasket and lower shaft cover over studs and onto upper transmission cover. Install lock washers and stud nuts. Tighten stud nuts to a torque reading of 65 foot pounds (Illust. 38).

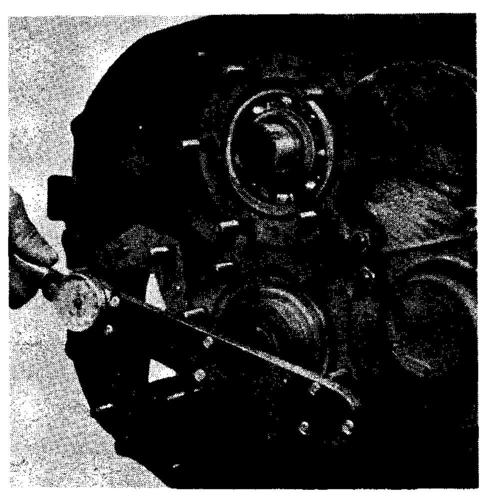
Illust. 34



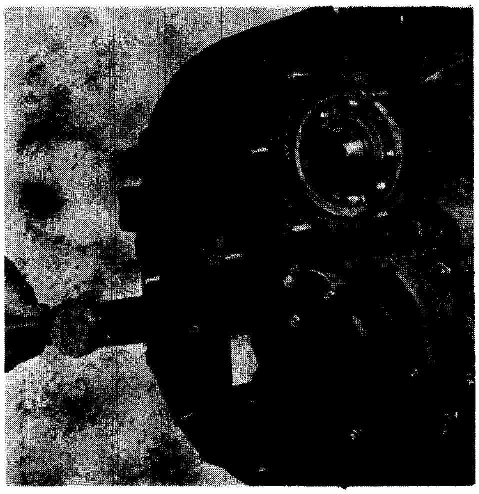
Illust. 35



Illust. 36

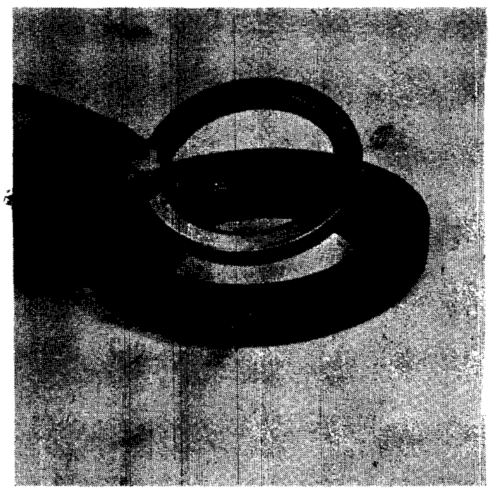


Illust. 37

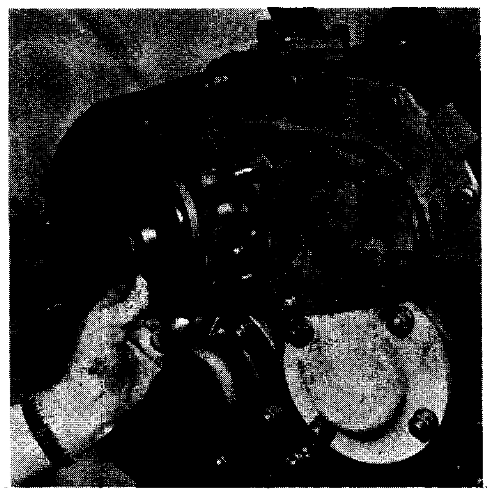


Illust. 38

Illust. 41



Illust. 39



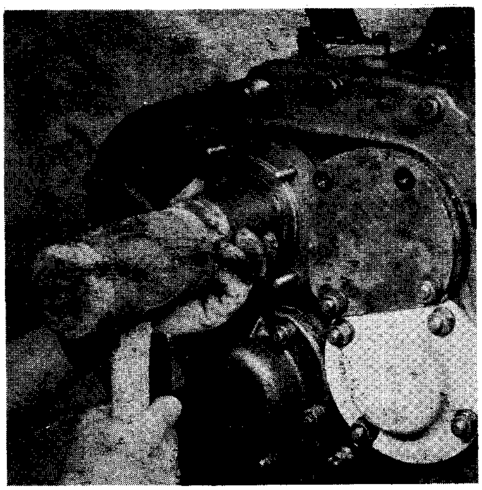
Illust. 42

Illust. 40

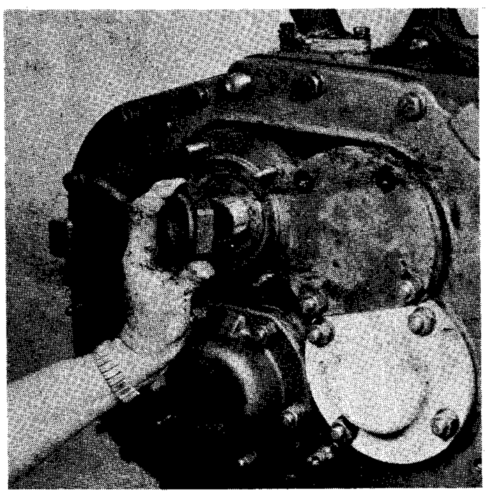
Install oil seal into retainer (Illust. 39). Lip of seal toward bearing. Using a driver and hammer, drive oil seal to pilot (Illust. 40). NOTE: Use shellac to seal around oil seal.

Insert spacer into oil seal (Illust. 41). Chamfered end of spacer away from lip of oil seal.

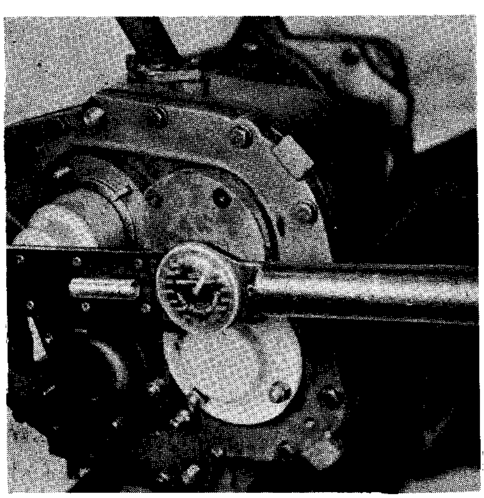
Install gasket and seal retainer over upper shaft and onto cover (Illust. 42). Using a hammer and driver, drive spacer onto shaft (Illust. 43).



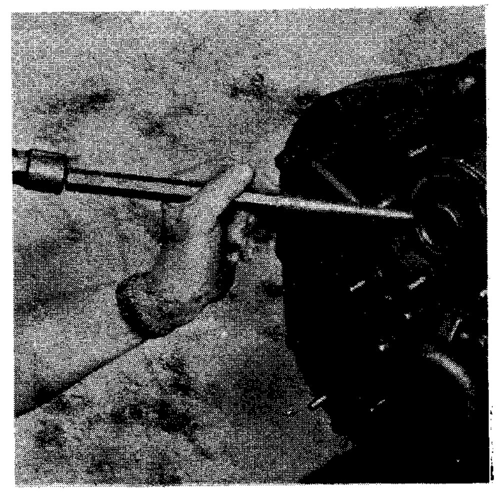
Illust. 43



Illust. 44



Illust. 45



Illust. 46

Install lock nut onto upper shaft (Illust. 44).

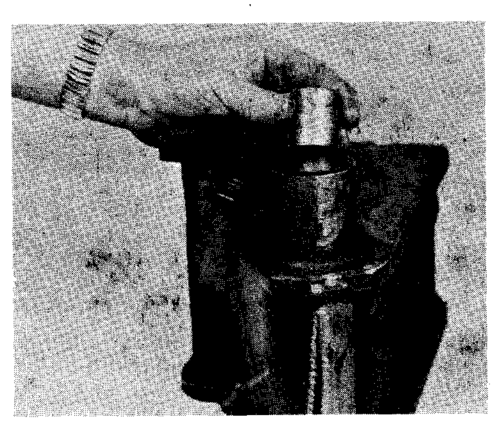
Tighten nut to a torque reading of 750 foot pounds (Illust. 45).

Stake locking nut, using a drift pin and hammer (Illust. 46).

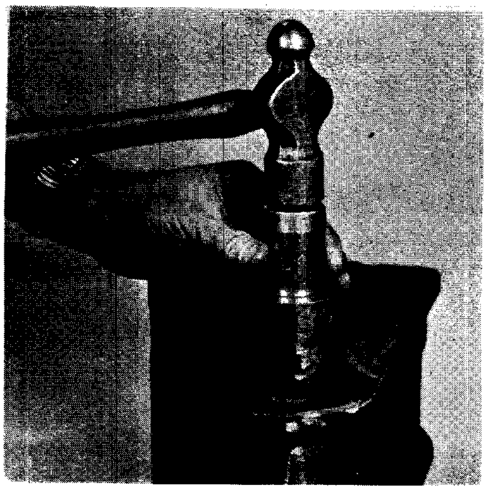
To remove stake from locking nut, use a drill. Avoid damaging threads of shaft, when drilling out stake.

SHIFTER MECHANISM

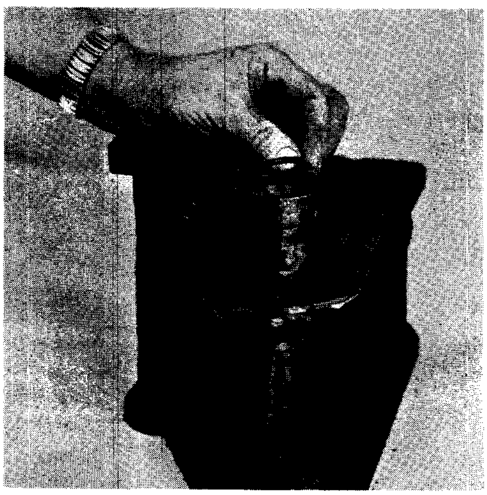
Insert bushing into shifter housing (Illust. 1). Using a hammer and driver, drive bushing into housing (Illust. 2).



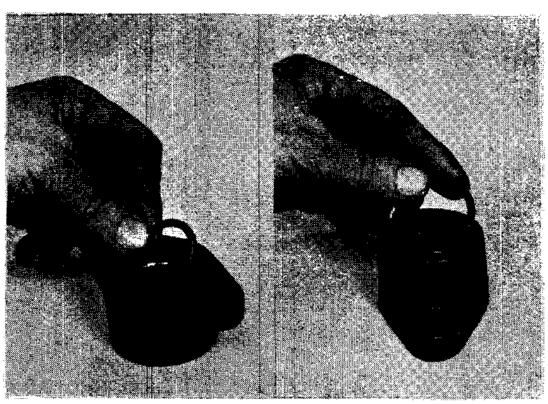
Illust. 1



Illust. 2

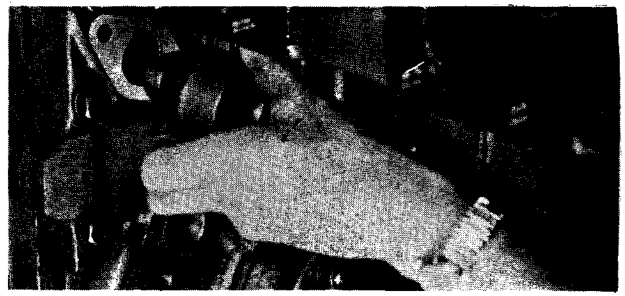


Illust. 3

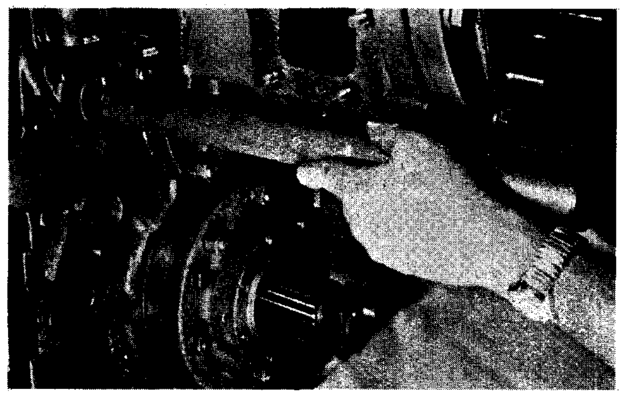


Illust. 4

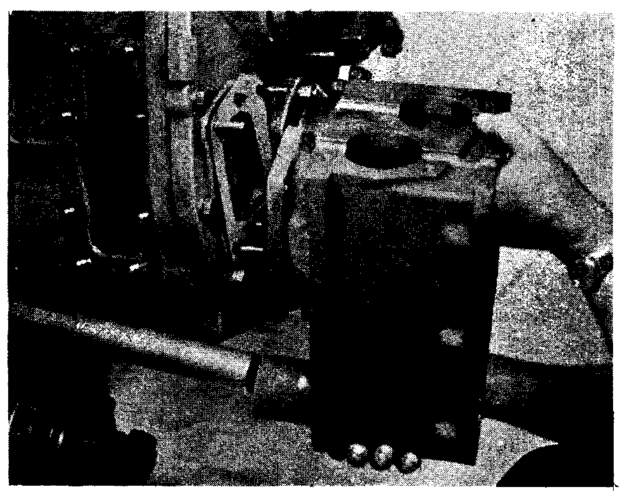
Install "O" ring into groove of shifter housing (Illust. 3).



Illust. 5



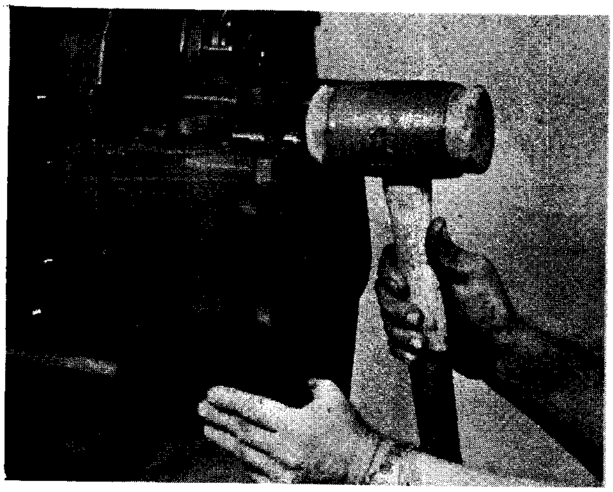
Illust. 6



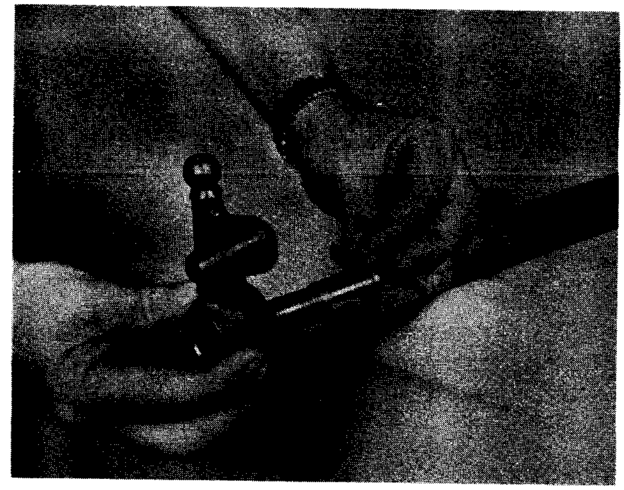
Illust. 7

Insert small "O" ring into groove of rocker shaft end. Turn rocker shaft end over and insert large "O" ring (Illust. 4).

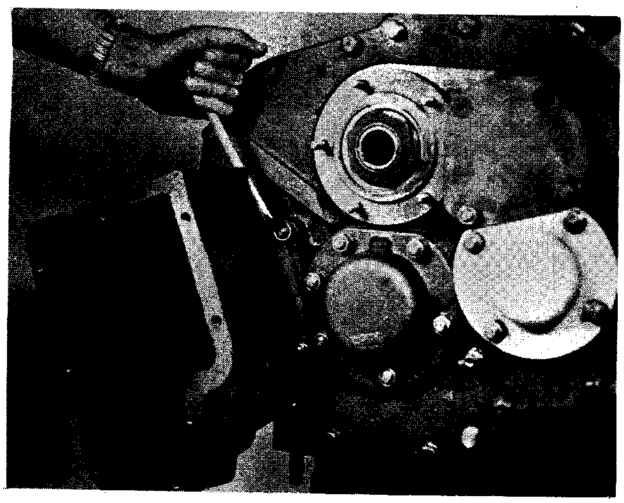
Install rocker shaft end with gasket to intermediate plate (Illust. 5). Install cap screws with lock washers, but do not tighten.



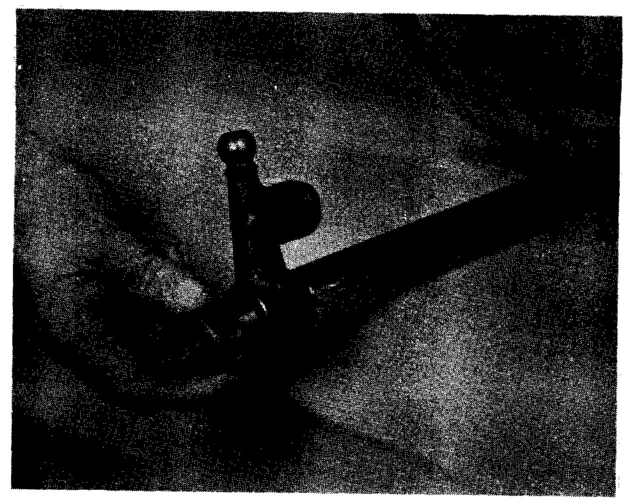
Illust. 8



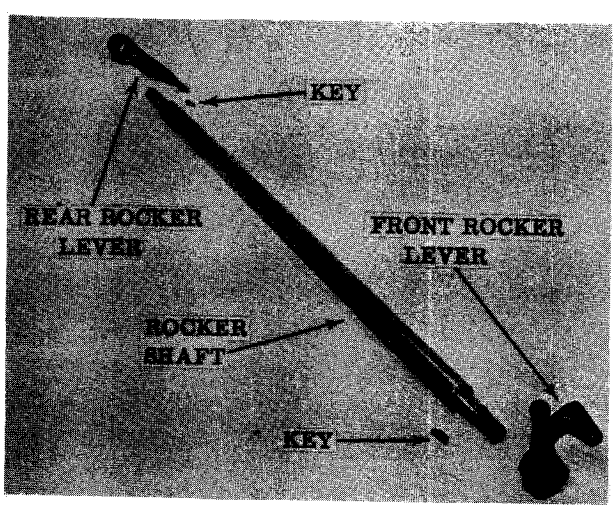
Illust. 11



Illust. 9



Illust. 12



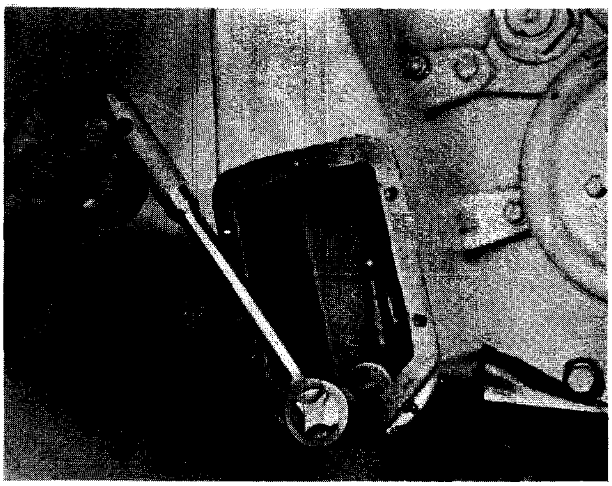
Illust. 10

Insert rocker shaft tube into rocker shaft end (Illust. 6). NOTE: To protect "O" ring from damage, use white lead.

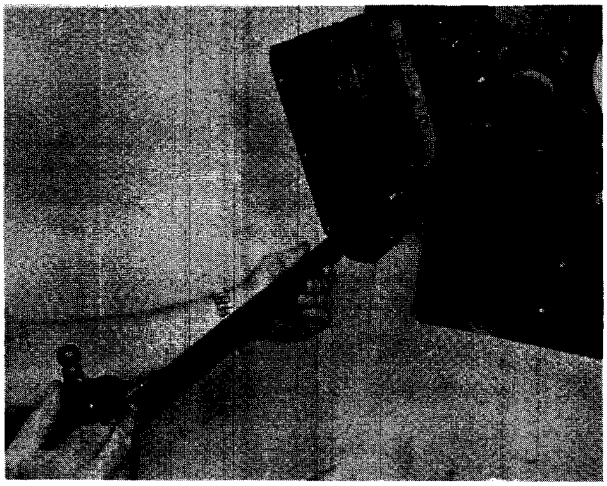
Shellac shifter housing gasket to upper transmission cover. Next, install shifter housing onto studs and at the same time, insert rocker shaft tube into shifter housing (Illust. 7). NOTE: To protect "O" ring from damage, use white lead.

Using a rawhide mallet, bump shifter housing onto dowels (Illust. 8).

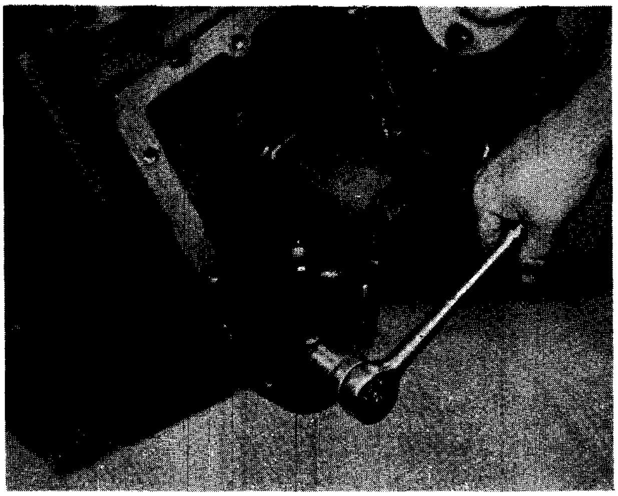
Install stud nuts with lock washers. Tighten nuts securely (Illust. 9).



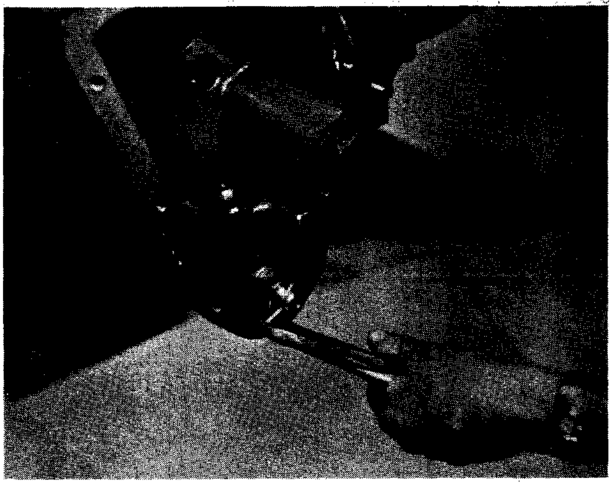
Illust. 13



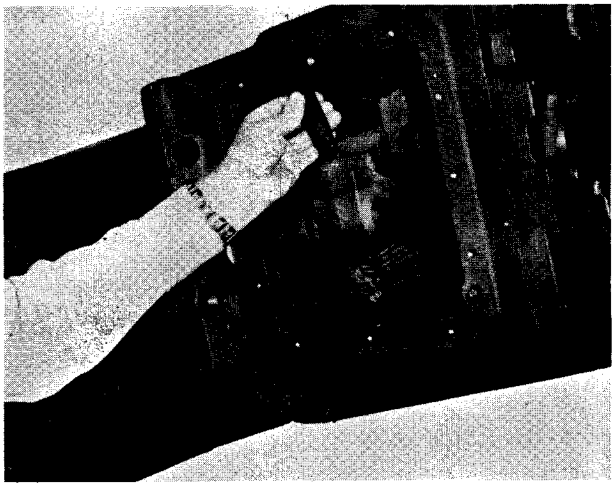
Illust. 14



Illust. 15



Illust. 16



Illust. 17

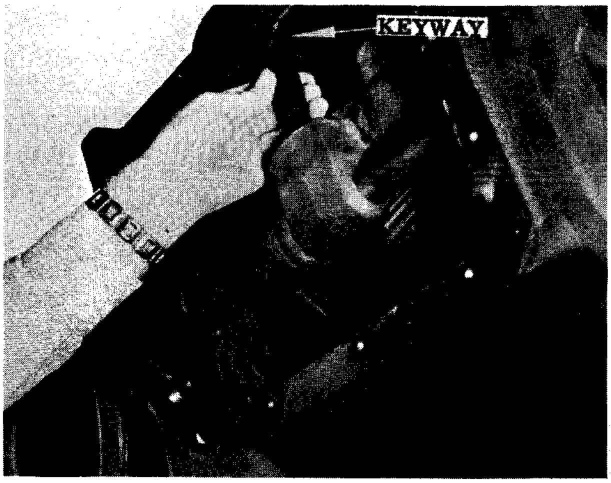
Illust. 10 is an exploded view of the rocker shaft.

Insert key in keyway of rocker shaft. Next, insert front rocker lever onto shaft and over key (Illust. 11).

Install nut onto shaft (Illust. 12).

Insert second key in keyway of rocker shaft (Illust. 13).

Insert rocker shaft into shifter housing, through rocker shaft tube and into lower transmission (Illust. 14). NOTE: Key in rocker shaft toward gears in lower transmission.

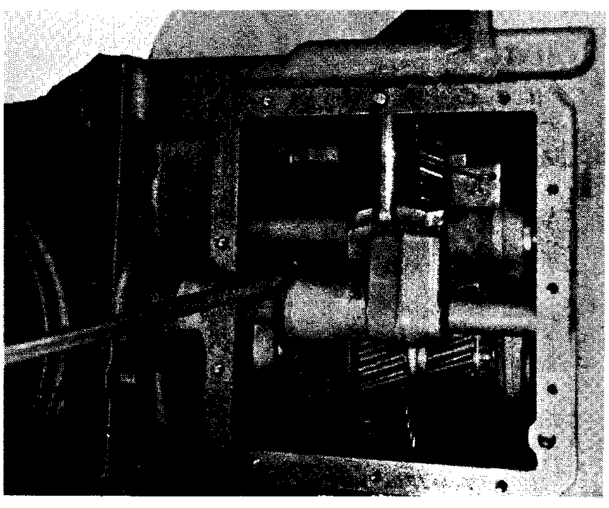


Illust. 18

Illust. 21

Illust. 19

Illust. 22



Illust. 20

Install front nut to rocker shaft. Tighten nut securely (Illust. 15). Next, install cotter pin and spread (Illust. 16).

To install rear rocker shaft lever, insert knob of lever into slots of shifter forks (Illust. 17). Next, install lever onto rocker shaft and over key (Illust. 18).
NOTE: Keyway in lever toward gears in lower transmission.

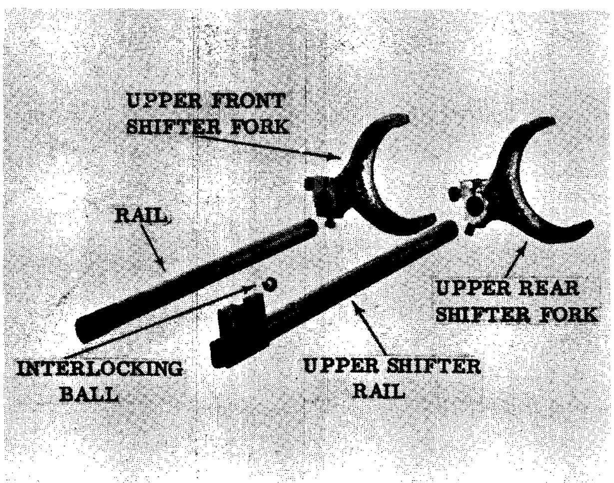
Install rear nut to rocker shaft (Illust. 19). Tighten nut securely. NOTE: It is necessary to shift lower fork forward (Illust. 20) to allow sufficient space for wrench.

Install cotter pin in rocker shaft and spread (Illust. 21).

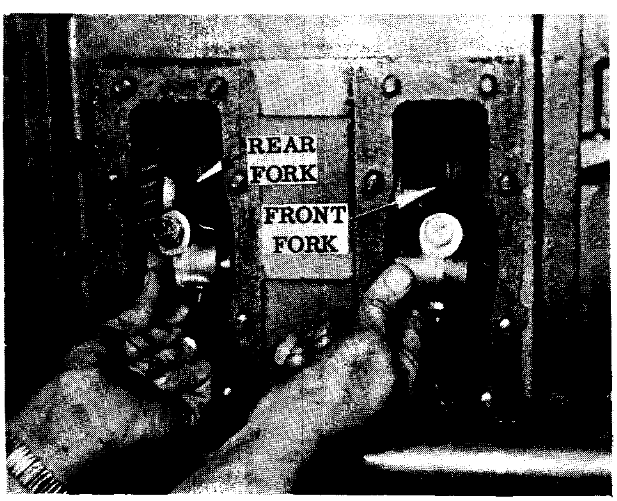
Tighten rocker shaft tube end cap screws and at the same time, check for bindness of shifter shaft (Illust. 22). If bindness is noted, loosen rocker shaft tube end cap screws and tap tube end with a mallet. When binding is eliminated, retighten cap screws.

UPPER SHIFTER RAILS

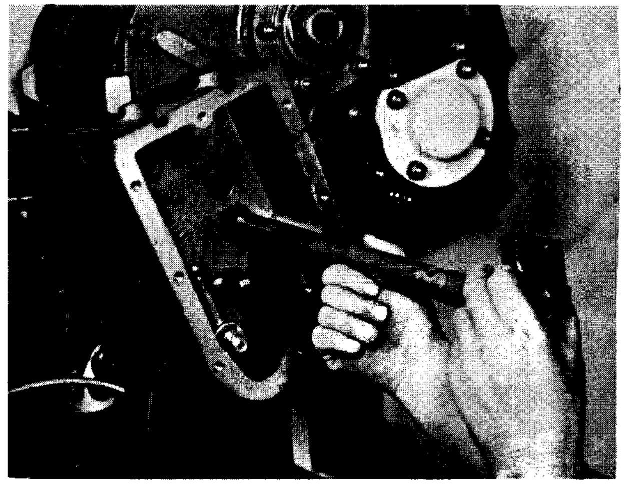
Illust. 1 is an exploded view of upper shifter rails.



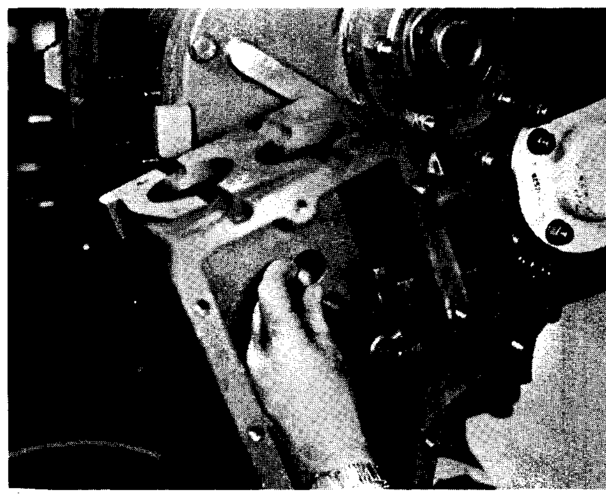
Illust. 1



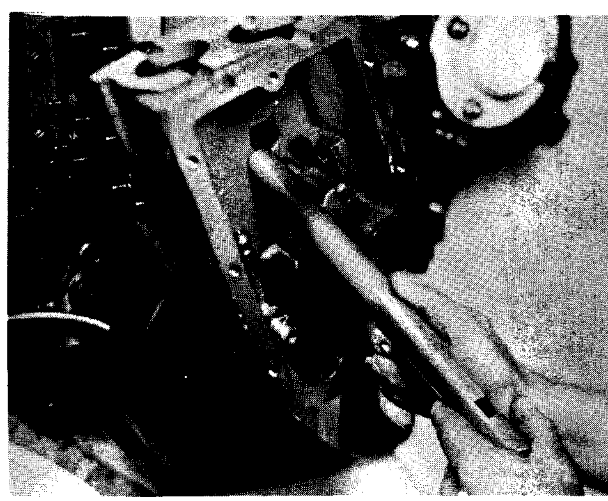
Illust. 2



Illust. 3



Illust. 4



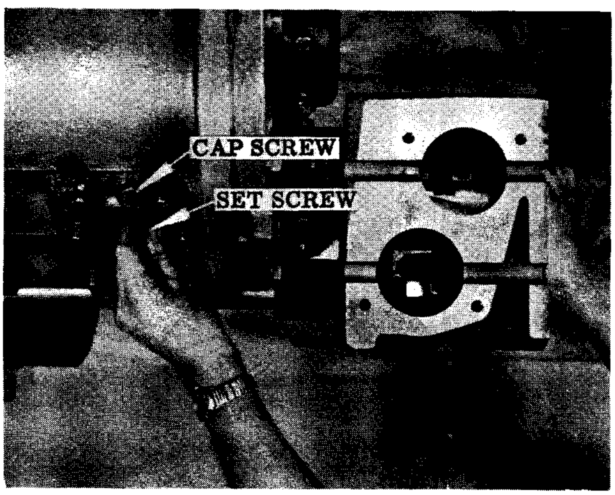
Illust. 5

Insert two forks into upper transmission and over shifter collars (Illust. 2). Long hub of forks facing each other.

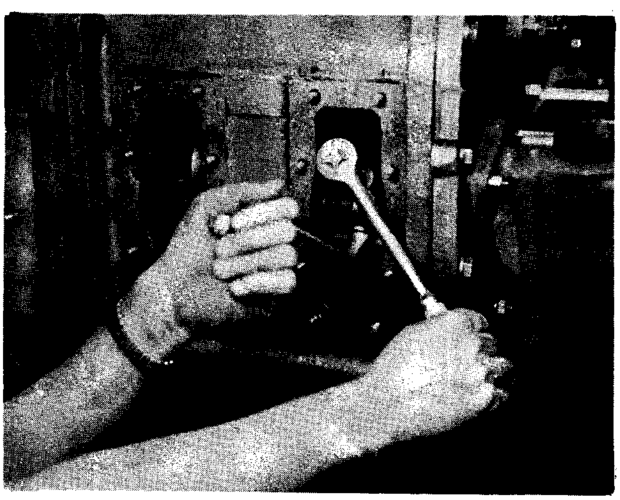
Insert lower shifter rail into lower hole of shifter housing (Illust. 3). NOTE: Shifter rail to be inserted under front shifter fork and into rear shifter fork.

Insert interlocking ball into vertical hole of upper rail hole in shifter housing (Illust. 4). NOTE: Be sure ball is in groove of lower shifter rail.

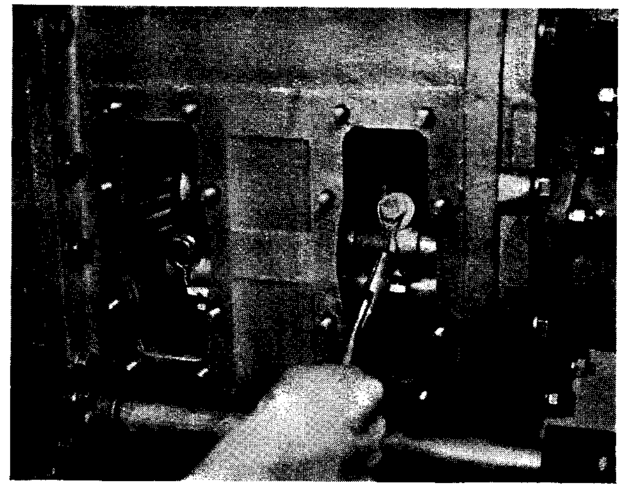
Insert upper shifter rail into upper hole of shifter housing (Illust. 5). NOTE: Shifter rail to be inserted into front shifter fork.



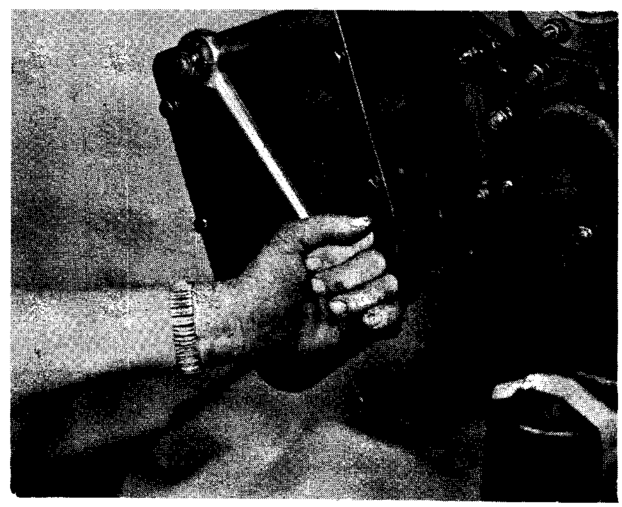
Illust. 6



Illust. 7



Illust. 8



Illust. 9

Install cap screws and tapered end set screws into both front and rear shifter forks (Illust. 6). NOTE: Turn upper and lower shafts until hole in shafts align with set screws.

Tighten set screws securely, back off one-fourth of a turn, then tighten cap screws securely (Illust. 7). Retighten set screws to a torque reading of 65 foot pounds.

Lock cap screws and set screws securely with wire (Illust. 8).

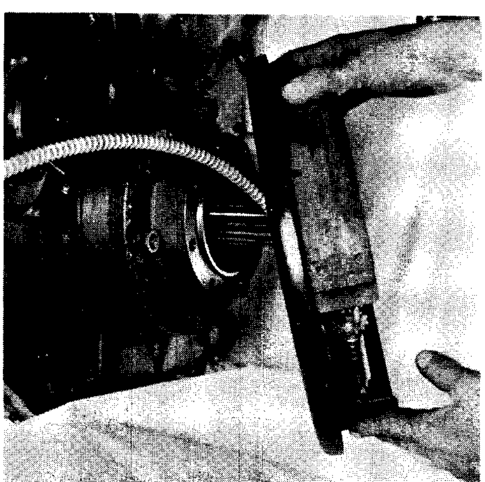
Illust. 10

Install gasket and cover to shifter housing (Illust. 9). Next, install cap screws and lock washers. Tighten cap screws securely.

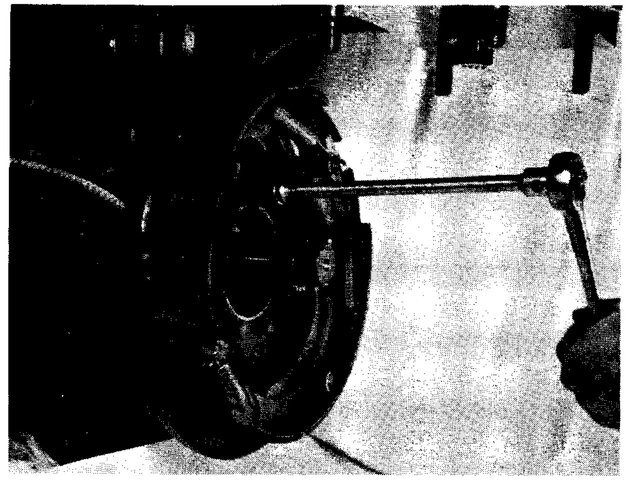
Install cork gaskets to upper tranamission. Install covers (Illust. 10). NOTE: Cover with magnet over front opening. Install stud nuts and lock washers. Tighten nuts securely.

PARKING BRAKE

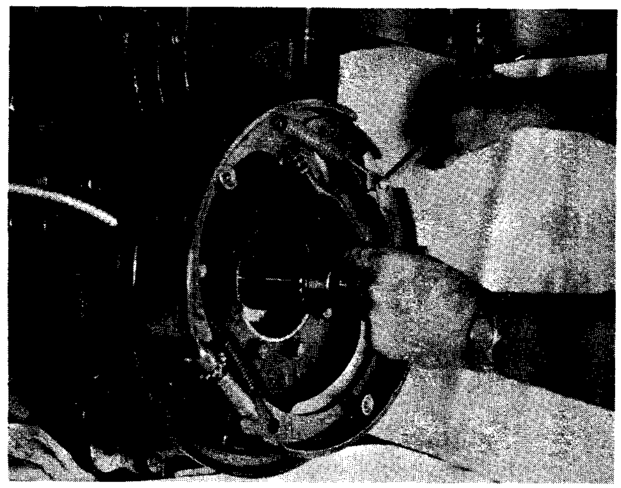
Install brake backing plate onto adapter plate (Illust. 1). Install cap screws and lock washers. Tighten cap screws securely (Illust. 2).



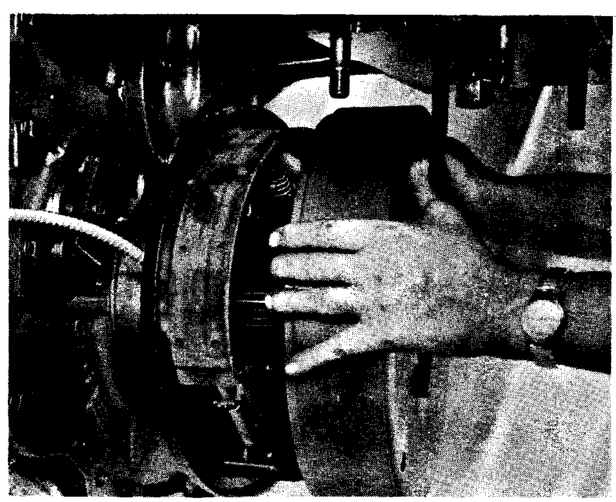
Illust. 1



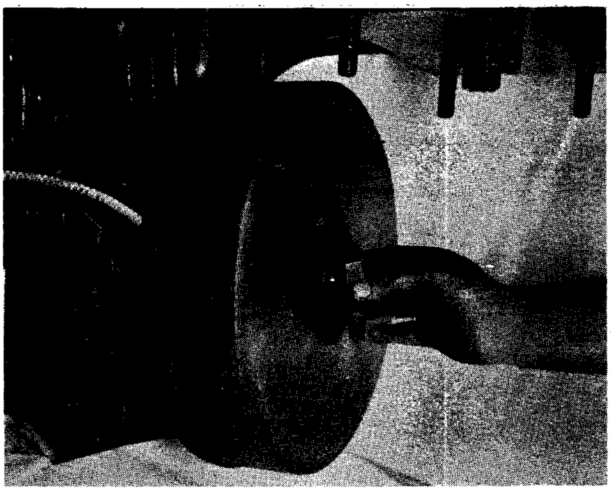
Illust. 2



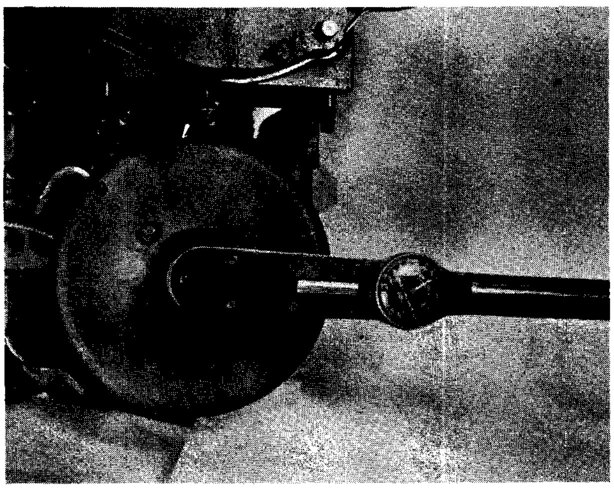
Illust. 3



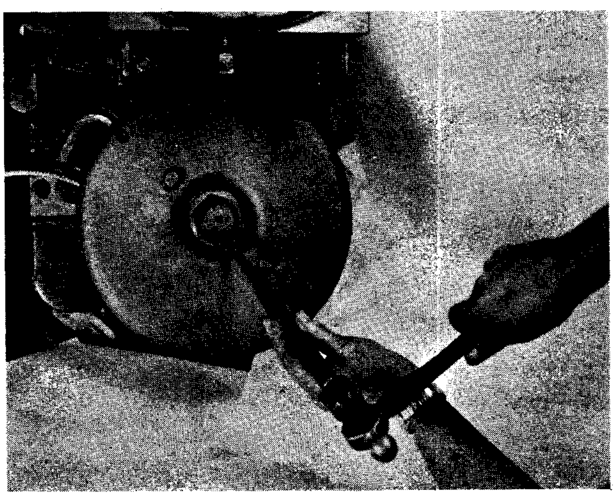
Illust. 4



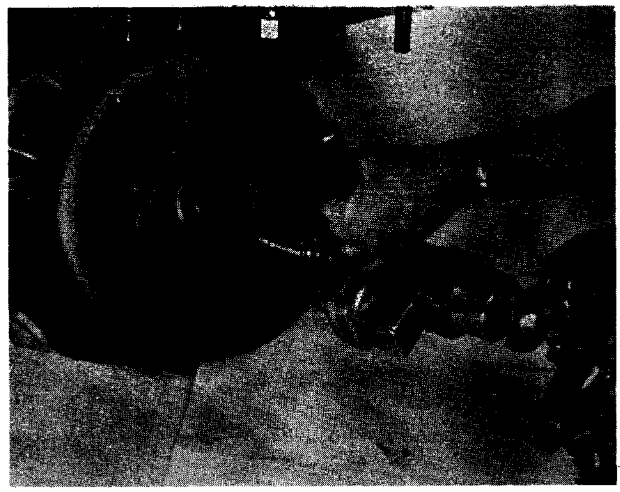
Illust. 5



Illust. 6



Illust. 7



Illust. 8

Install strut and springs (Illust. 3). NOTE: Use a screw driver to expand shoes to install strut and springs.

Install brake drum onto shaft and over brake shoes (Illust. 4).

Install lock nut (Illust. 5). Tighten nut to a torque reading of 600 foot pounds (Illust. 6). NOTE: To tighten nut, shift upper and lower transmission into gear.

Stake lock nut, using a drift pin and hammer (Illust. 7).

To remove stake from lock nut, drill out stake in line with slot in transmission shaft (Illust. 8).

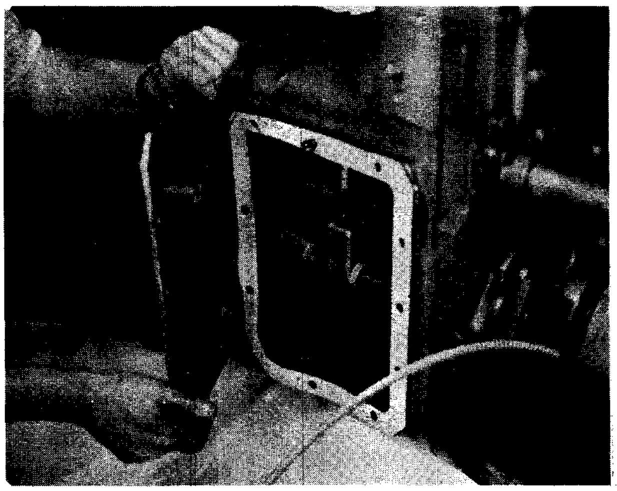
Shift upper and lower transmission into neutral gear.

SUPPORT BRACKET, COVERS, MOUNTING BRACKETS AND MOTOR SUPPORT

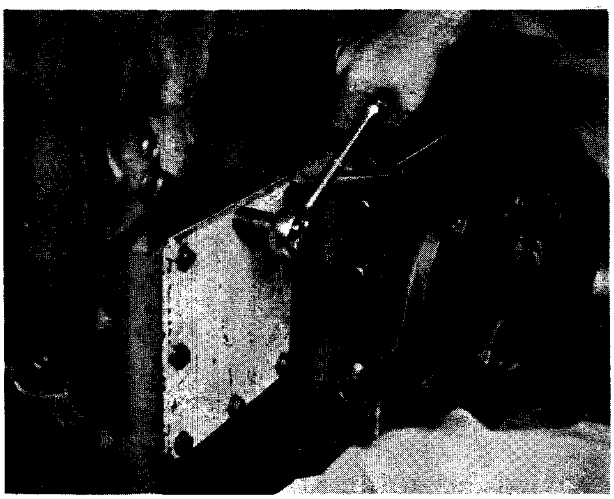
Install transmission support bracket (Illust. 1). Install stud nuts and lock washers. Tighten nuts securely.

Install right lower transmission side cover and cork gasket (Illust. 2). NOTE: Magnets on cover to be toward bottom of transmission.

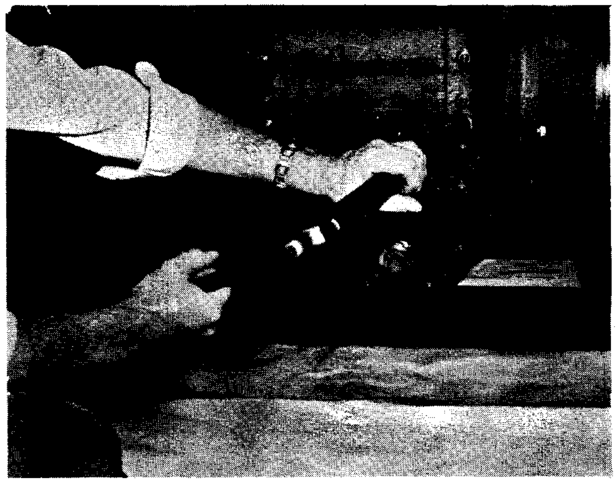
Illust. 1



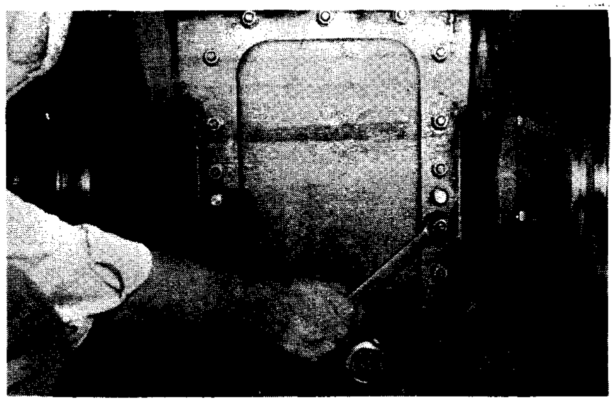
Illust. 2



Illust. 3



Illust. 4



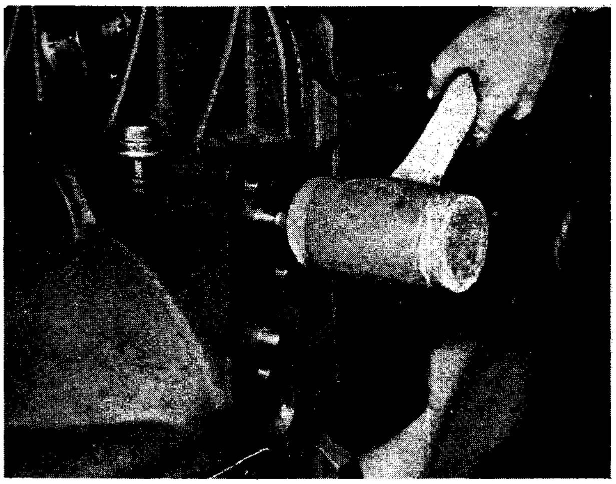
Illust. 5

Install cover cap screws with lock washers. Tighten cap screws securely.

Install left lower transmission cover and gasket. Install cap screws and lock washers. Tighten cap screws securely (Illust. 3).

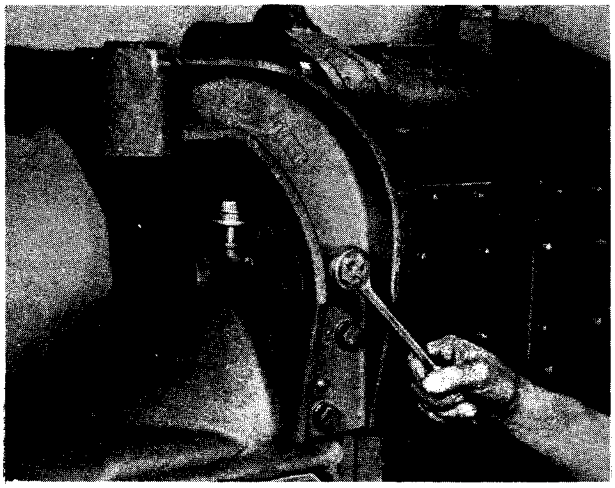
Install lower motor support and gasket to final drive housing. Install stud nuts and lockwashers. Snug stud nuts. Place a nut on dowel pins to protect dowel pin threads. Drive dowel pins through motor support and into final drive housing (Illust. 4).

When dowel pins have been seated, tighten stud nuts securely (Illust. 5). Remove nuts on dowel pins.



Illust. 6

Illust. 7



Illust. 8

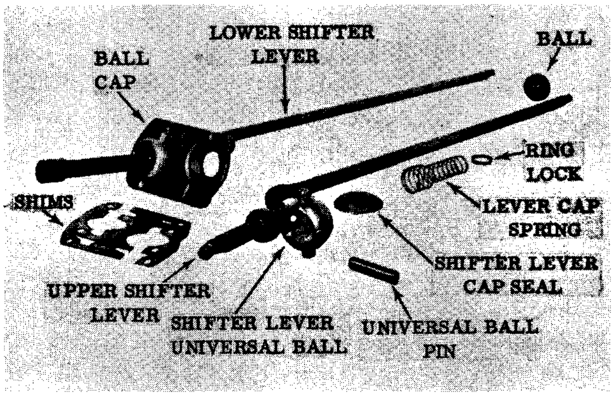
Install dowel pins in both sides of lower transmission housing (Illust. 6).

Install snap ring into bottom groove in both left and right flywheel motor mounts (Illust. 7). Next, press tubular motor supports into mounts.

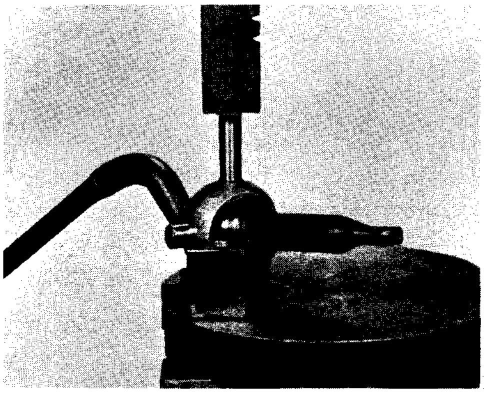
Install left and right flywheel motor mounts onto dowel pins. Bump mounts with mallet until flush against housing. Install cap screws with lock washers. Tighten cap screws securely (Illust. 8).

SHIFTER LEVERS

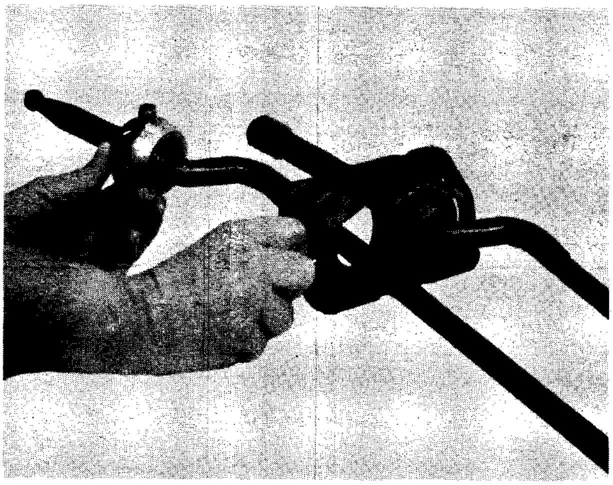
Illust. 1 is an exploded view of the shifter levers.



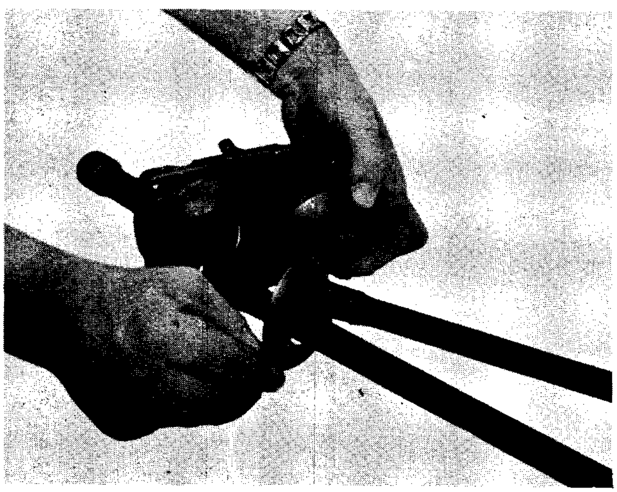
Illust. 1



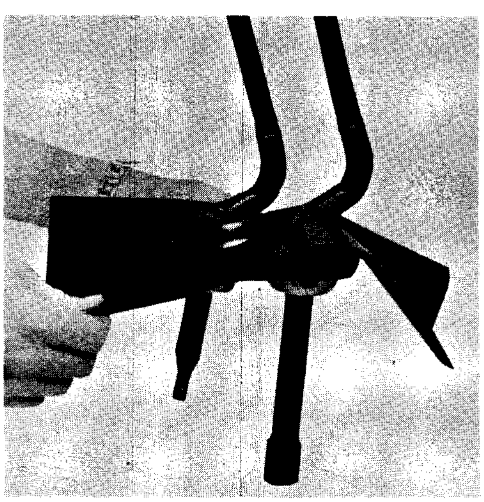
Illust. 2



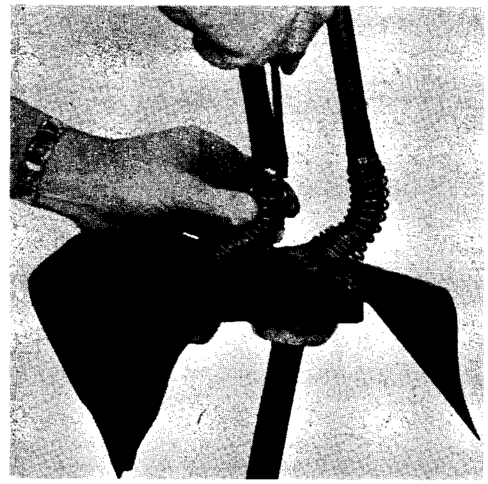
Illust. 3



Illust. 4



Illust. 5



Illust. 6

Install shifter lever universal ball onto shifter lever. Align hole in shifter ball with hole in lever. Apply white lead on universal ball pin and press pin through shifter until top of pin is flush with universal ball (Illust. 2). NOTE: To prevent universal ball from becoming elongated, place ball on a block with a radius the same as that of ball.

After pin has been pressed into ball and lever, check ball for freeness. If unable to move ball by hand, tap ball with a rawhide mallet.

Install second universal ball to other shifter lever in the same manner.

Install ball cap onto shifter levers (Illust. 3). IMPORTANT: Install cap so rounded portion of holes in cap are away from bend in levers.

Install shifter lever cap seals onto shifter levers (Illust. 4). Long rounded side of cap seals away from bend in levers.

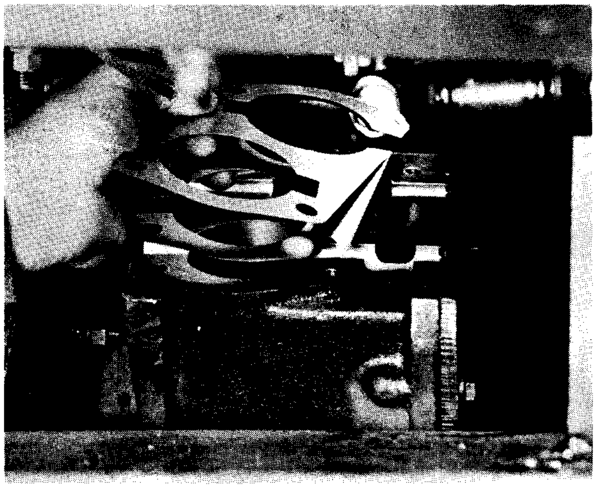
Install rubber cover over shifter levers and down on ball cap (Illust. 5). Long portion of cover away from bend in levers.

Install lever cap springs onto levers (Illust. 6). Next, install snap rings onto levers. Press down on springs until snap rings can be installed into groove of levers.

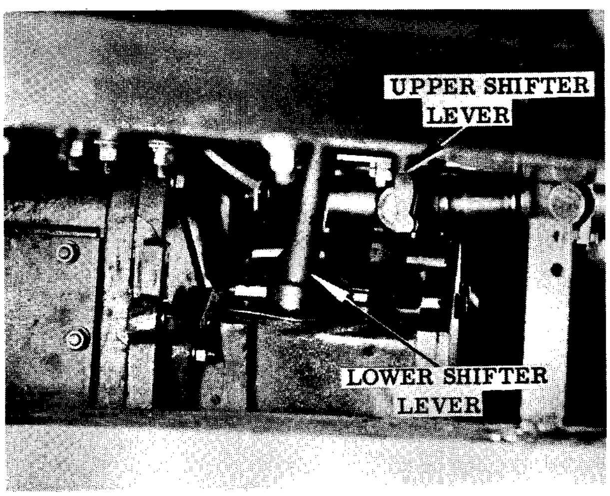
INSTALLATION OF SHIFTER LEVERS

Install two (2) or more shims onto shifter housing (Illust. 1).

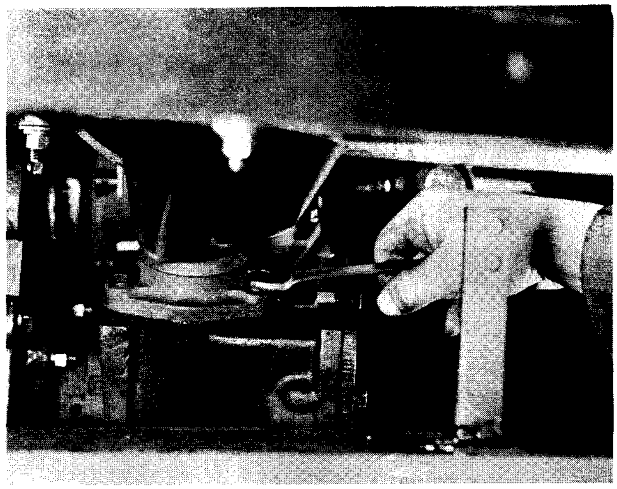
Install shifter levers through cab floor opening and into shifter housing (Illust. 2). NOTE: Ball end of upper shifter lever to fit into slots of upper transmission shifter rails. Socket end of lower shifter lever to fit over front rocker lever ball.



Illust. 1



Illust. 2



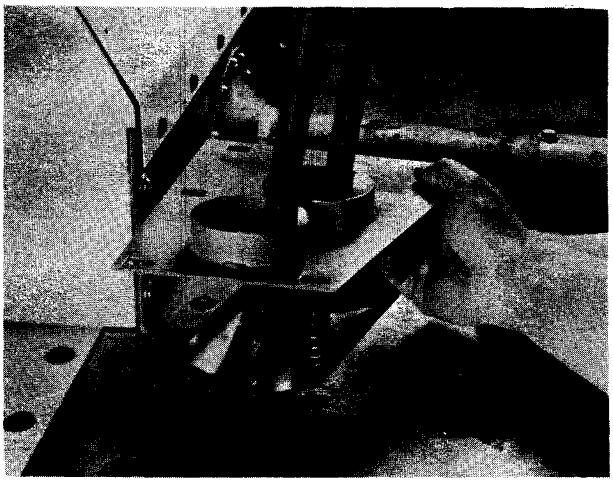
Illust. 3

Illust. 4

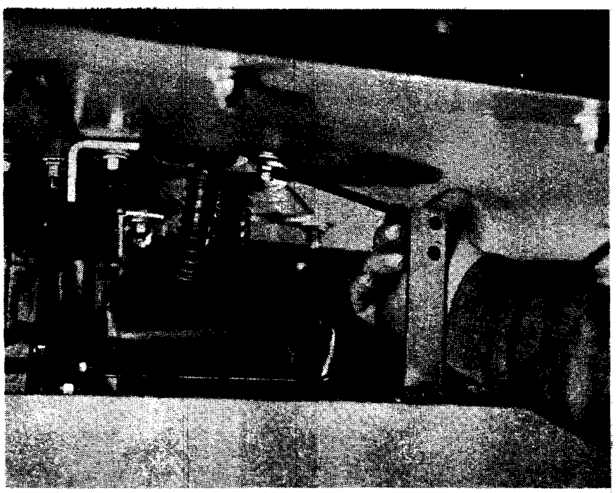
Check shifter levers for freeness. Levers should be snug enough to allow easy shifting of levers. If levers are either too loose or tight, remove ball cap and add or remove shims as needed.

Fold rubber cover around shifter housing. Next, apply a piece of wire around cover and twist until tight (Illust. 4). On later machines, install clamp around shifter housing cover and tighten securely.

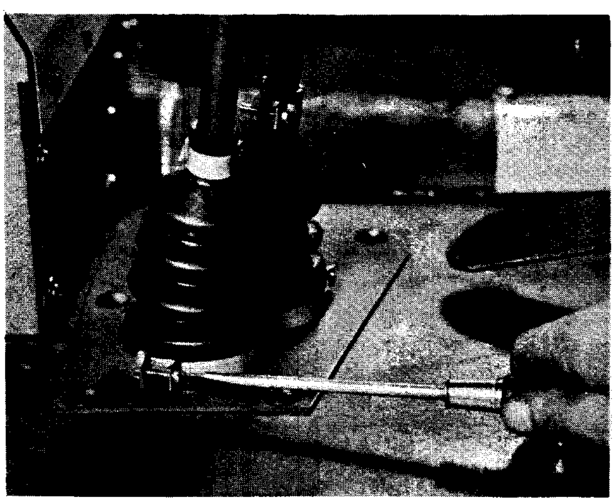
Install ball cap cap screws and tighten securely (Illust. 3).



Illust. 5



Illust. 6



Illust. 7

Install shifter hole cover plate (Illust. 5). Next, install carriage bolts, lock washers and nuts. Snug but do not tighten nuts. IMPORTANT: Adjust cover plate so levers, when in any shifting position, will not strike any portion of holes in cover.

When this has been accomplished, tighten carriage bolt nuts securely (Illust. 6).

Install boots over shifter levers and down over holes in cover plate. Next, install boot clamps and tighten clamps securely (Illust. 7).

ENGINE MOUNT GAP

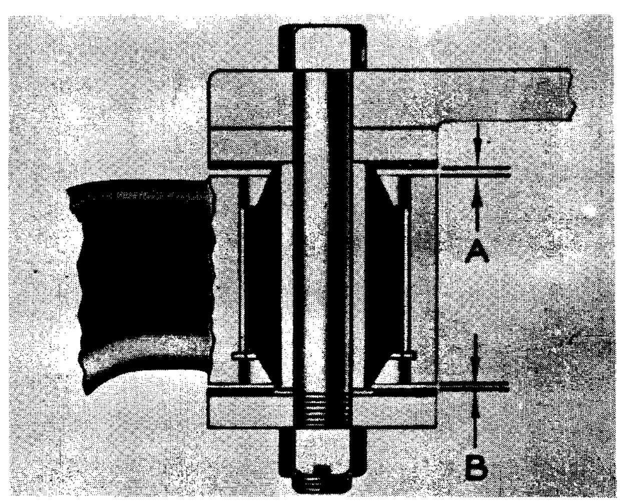
When installing transmission into frame, rear mounts are to be tightened first.

If new mounts are installed, clearances (A) and (B) (Illust. 1) are as follows:

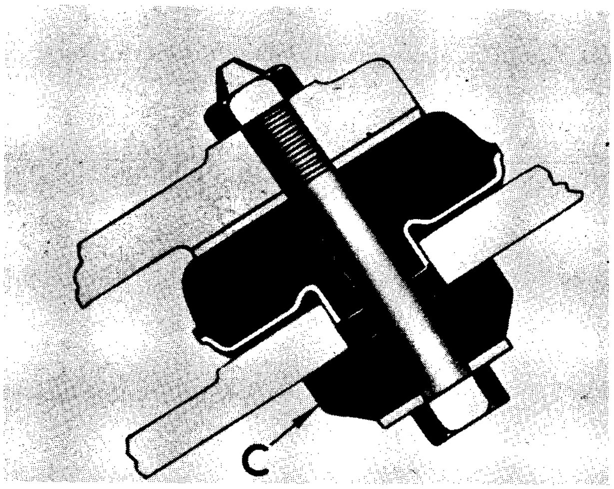
A	B
.120 to .140	.000 to .020

If mounts are reused, clearance (A) and (B) are as follows:

A	B
.060 MIN.	.1875 MAX.



Illust. 1



Illust. 2

Proper gap at (A) and (B) can be maintained by removing shims at gap (B) and reinstalling shims at gap (A), as the mounts settle over a period of time. However, if the proper gap clearances cannot be maintained by the use of shims, install new mounts.

Front engine mounts are adjusted by tightening cap screw until biscuit (C) (Illust. 2) can be turned, with effort, by hand. Tighten cap screw one more turn.

IMPORTANT: Loosen trunnion cap on timing gear housing before attempting to tighten engine mounts.

— NOTES —

TANDEM DRIVE

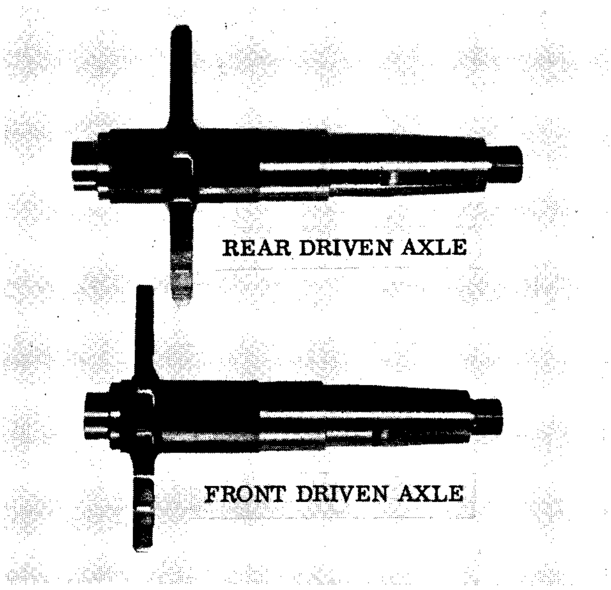
The following illustrations and instructions are given for assembly of the left hand tandem drive. However, the assembly of the right hand tandem drive is exactly the same with the exception that each part is assembled on the opposite side from which it is shown in the illustrations.

Although in the following illustrations, the tandem drive assembly is shown being repaired while it is removed from the grader; most repairs can be made without removing the tandem from the grader. Either front or rear axle assembly can be removed, disassembled, inspected, repaired and reassembled without removing the tandem drive from the grader. Even the driving axle can be removed (Illust. 5 - Tandem Removal) without the removal of the tandem assembly.

DISASSEMBLY

Due to the fact that during the reassembly operation all adjustment and settings must be accomplished, a detailed description is given under that heading. The disassembly procedure is merely the reverse of the reassembly and therefore, no detailed description is necessary. If the tandem assembly is not completely disassembled as shown, only that portion of the instructions which apply need be carried out.

However, before disassembling the tandem, the reassembly instructions should be read in order to determine any points which should be watched. Naturally, such settings as shim adjustments, etc., should be noted during the disassembly procedure as this will materially help during the reassembly operation.



Illust. 1

INSPECTION

Inspect all parts for excessive wear or other damage. Bearings, shafts, etc. will sometimes seize and score due to insufficient lubricant or improper lubricant being used. Any parts which are defective should be repaired or replaced. Replace all gaskets and grease seals when reassembling.

REASSEMBLY

Illust. 1 is a view of the driven axles used in both tandems. NOTE: Parts being assembled to the driven axles are identical.

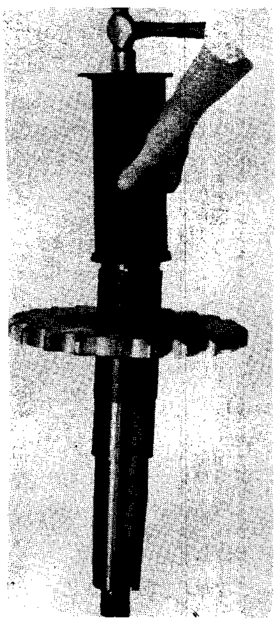
Press or drive seal onto hub of driven axle (Illust. 2). Groove in seal toward sprocket. Seal to fit snug against shoulder of axle.

Heat bearing in oil (350° F.) until bearing has expanded sufficiently, then install onto hub of axle (Illust. 3). Bearing to fit against shoulder of axle. NOTE: Hold bearing until set.

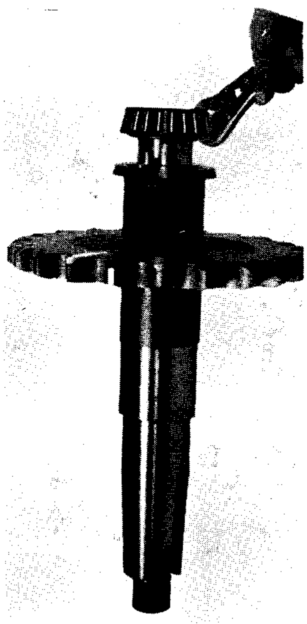
Press or drive seal onto driven axle (Illust. 4). Groove in seal toward sprocket. Seal to fit snug against shoulder of axle.

Heat bearing in oil (350° F.) until bearing has expanded sufficiently, then install onto driven axle (Illust. 5). Bearing to fit against shoulder of axle. NOTE: Hold bearing until set.

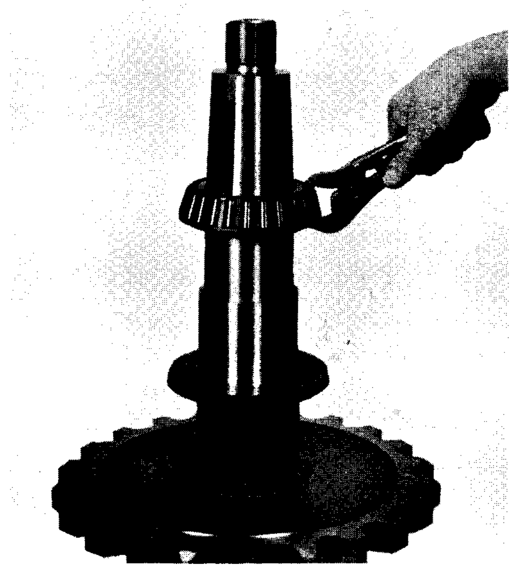
Press or drive grease seal and bearing cup



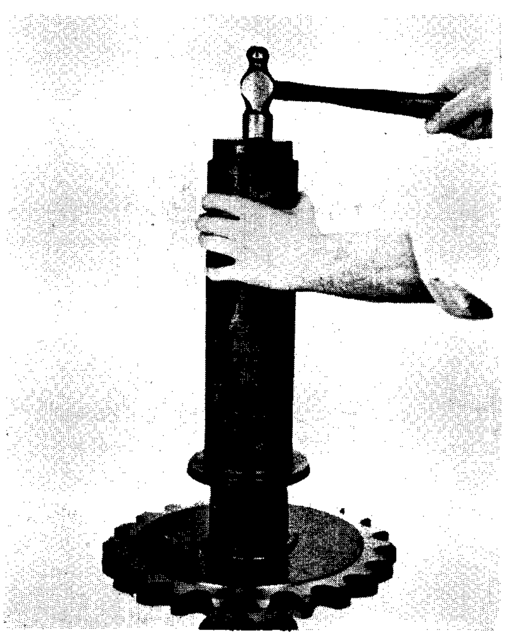
Illust. 2



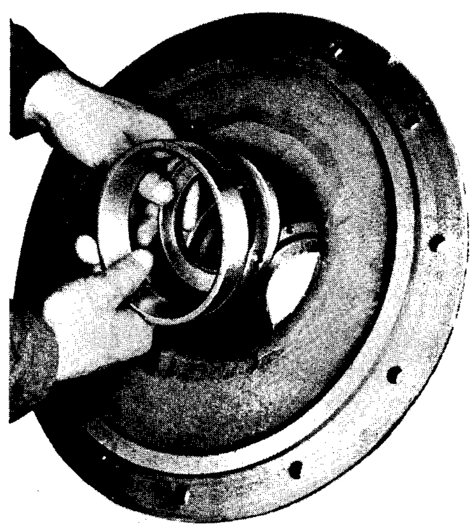
Illust. 3



Illust. 5



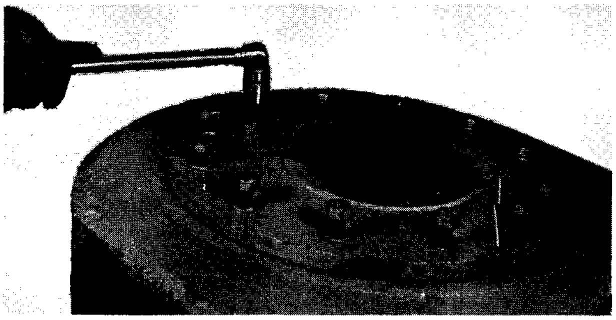
Illust. 4



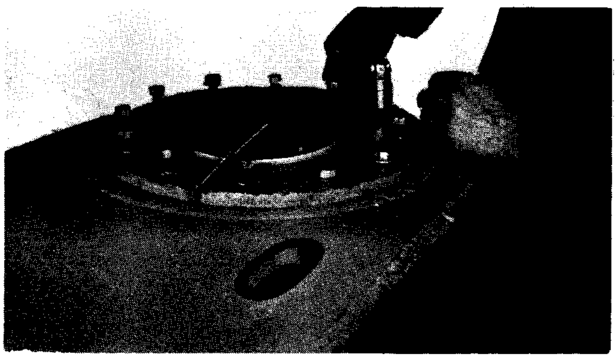
Illust. 6

into outer eccentric housing (Illust. 6). Lip of seal toward inside of tandem.

Install the inner eccentric housings (Illusts. 7 and 8). NOTE: When installing these housings, be sure the notch in the edge of the housings are turned toward the center of the tandem housing. (Notches indicate the short side of the eccentric). This will position the driven axle assemblies as close to the driving axle assembly as possible, thereby allowing the maximum amount of adjustment on the chains.



Illust. 7

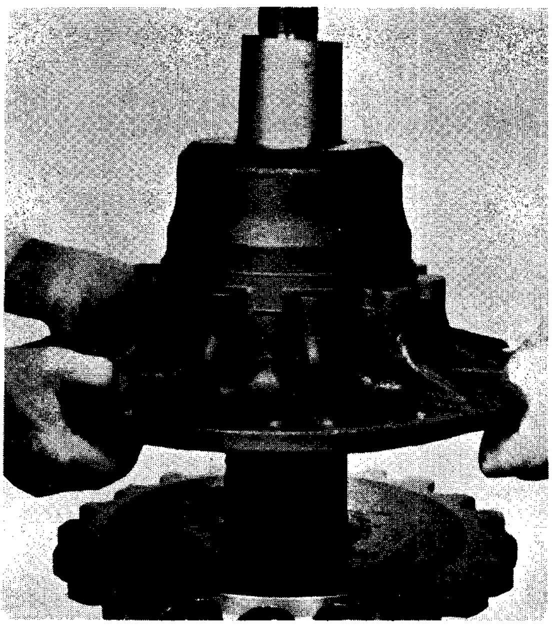


Illust. 8

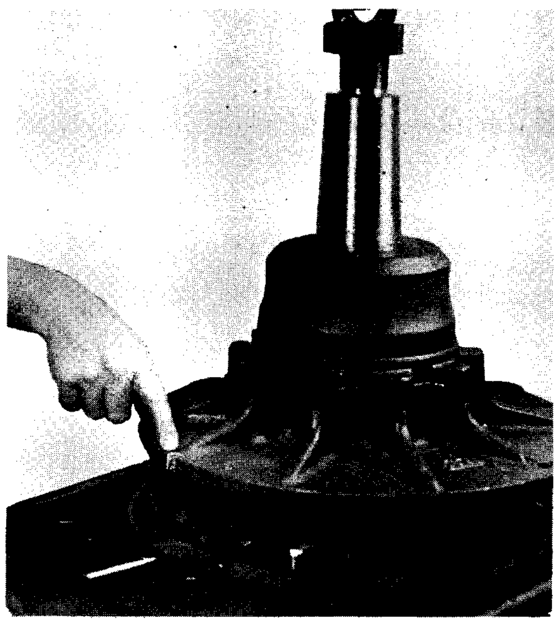
Install outer eccentric housing onto driven axle (Illust. 9). NOTE: To prevent damage to seal, use a piece of shim stock over axle.

Shellac gasket to tandem, then install driven axle with eccentric housing to tandem (Illust. 10). NOTE: Be sure notch in the edge of the outer eccentric housings are turned toward the center of the tandem. (Notches indicate the short side of the eccentric). Next, install cap screws with lock washers. Tighten cap screws securely.

Tap rolled pin into key. Next, insert key into keyway of axle (Illust. 11). Rolled pin in key to fit in pin hole in axle.



Illust. 9

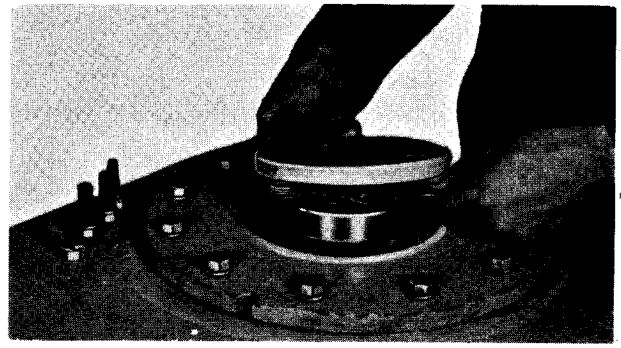


Illust. 10

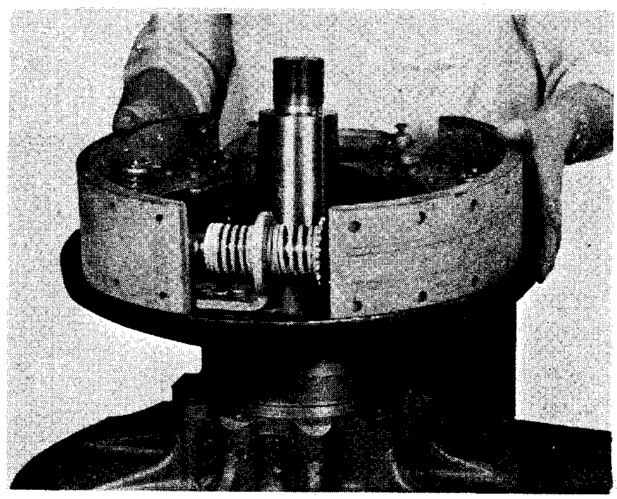
Illust. 12. Using a soft hammer, drive inner bearing cup into inner eccentric housing. The next step is to pre-load the bearings. NOTE: Bearings should be free of dirt and oil before pre-loading.

To pre-load the bearings, install hub cap less shims. Install cap screws and tighten until a slight drag is placed on the bearings. (Check by rotating sprocket by hand). NOTE: Be sure hub cap is drawn down evenly. Measure the gap between the cap and inner eccentric housing, using either a feeler gauge or shims, to determine the amount of shims to be installed. With new bearings, a .005" to .010" pre-load will exist and with used bearings, a snug fit will exist. Remove hub cap and install the correct amount of shims required to fill the gap (Illust. 12). Install hub cap, shims and cap screws with lock washers. Tighten cap screws securely. Recheck pre-load by rotating sprocket by hand. Repeat this operation on the other driven axle assembly.

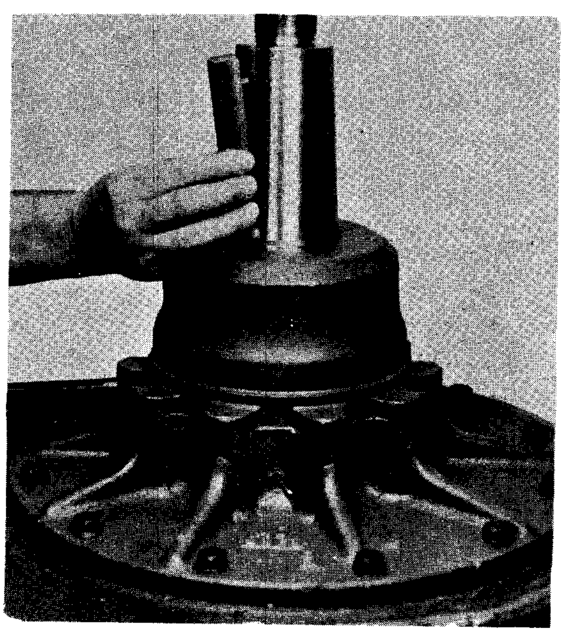
Install wheel brake onto outer eccentric housing (Illust. 13). Adjusting wheel to-



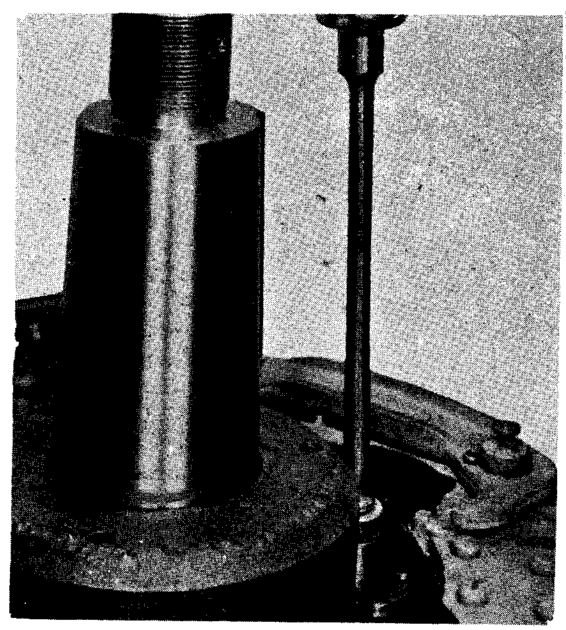
Illust. 12



Illust. 13



Illust. 11



Illust. 14

ward bottom of tandem. NOTE: The letter "R" (right) or "L" (left) stamped after the number on back of backing plate will aid in identifying which side of machine the wheel brake is to be installed.

Install cap screws with lock washers. Tighten cap screws securely (Illust. 14).

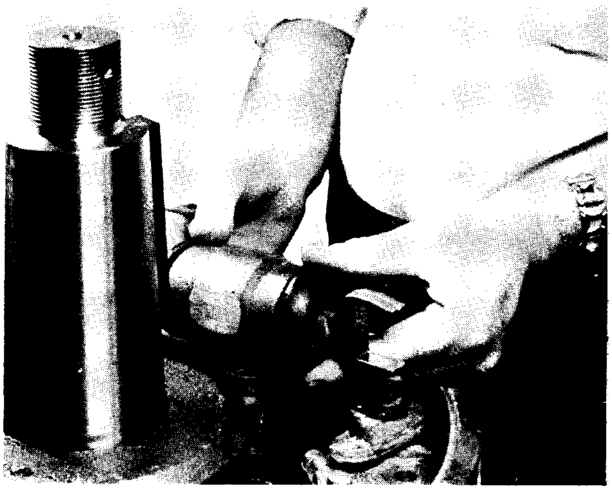
Install wheel cylinder into wheel brake (Illust. 15). Connecting links to fit over knobs and into slots in brake shoes (Illust. 16).

Install wheel cylinder cap screws. Tighten cap screws securely (Illust. 17).

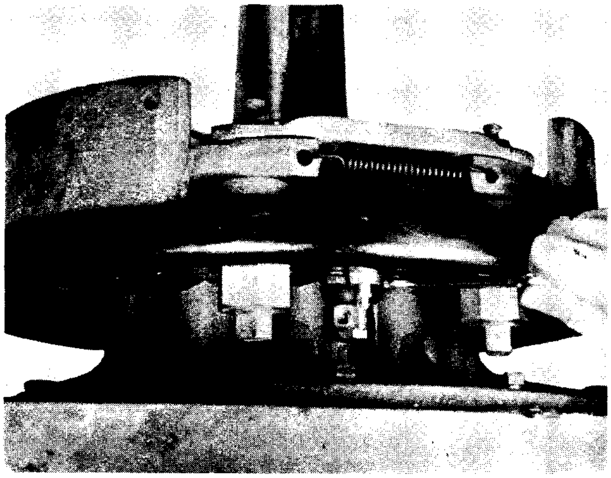
To install springs, hook short ends of springs into holes in brake shoes. Using a screw driver or similar tool, bring long end of springs over anchor pins (Illust. 18).

Install and tighten brake line to wheel cylinder connection (Illust. 19). NOTE: Carefully tighten brake line fitting to prevent damage to threads of fitting.

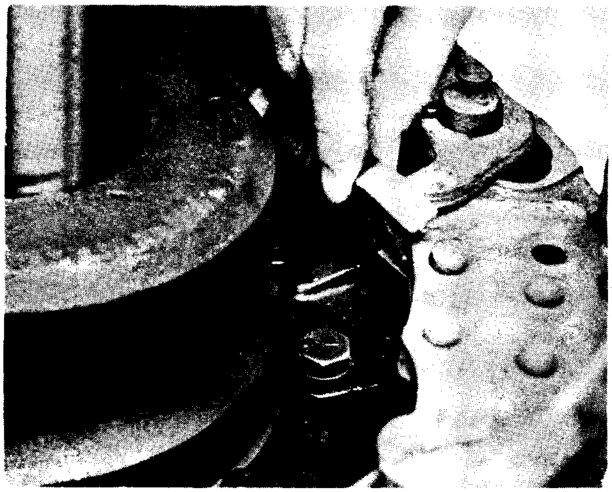
Press or drive ball bearing onto outer end



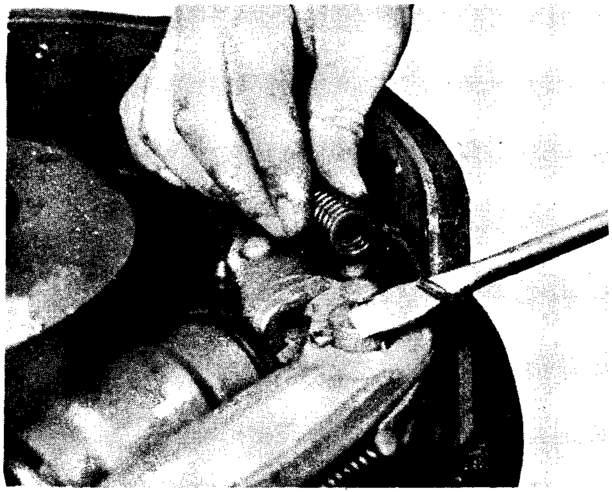
Illust. 15



Illust. 17

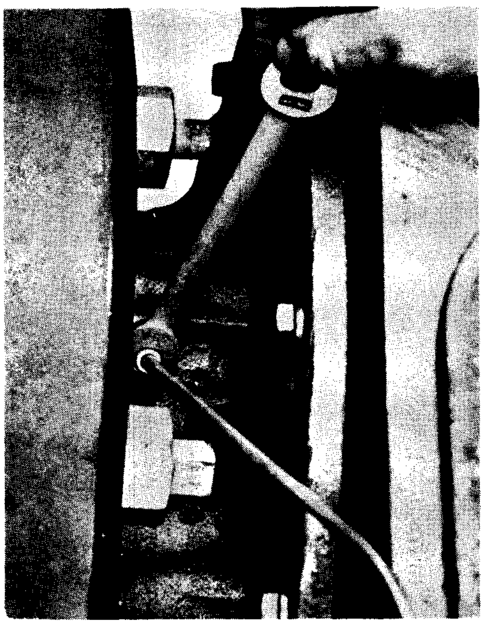


Illust. 16

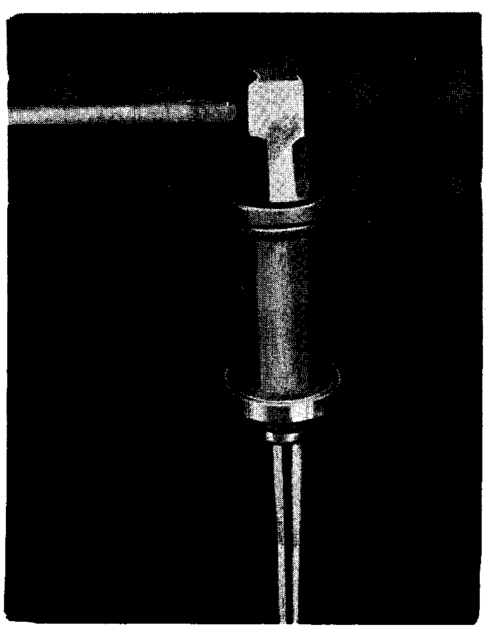


Illust. 18

of driving axle. Shielded side of bearing toward outer end of axle.(Illust. 20). Bearing to be tight against shoulder of axle. NOTE: When pressing or driving bearing into place, a piece of pipe or similar tool should be used so that the driving force is transmitted only to the inner race of the bearing.



Illust. 19

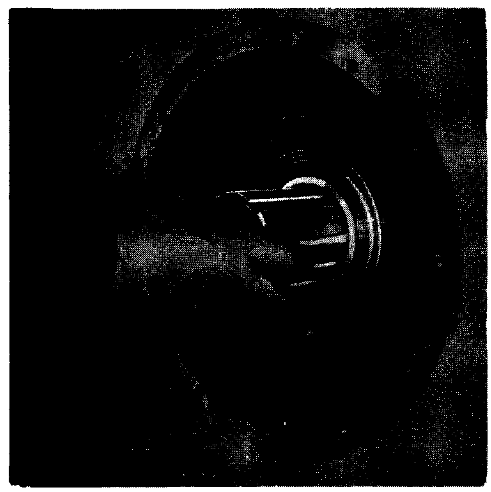


Illust. 20

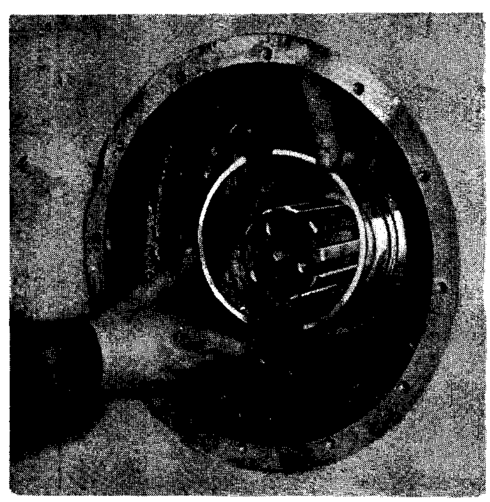
Insert axle with bearing into inner axle carrier (Illust. 21).

Insert axle with bearing into inner axle carrier (Illust. 21) using care to prevent damaging leather in grease seal. Next, install snap ring in the inner axle carrier (Illust. 22).

Install driving sprocket onto axle (Illust. 23). Long hub of sprocket toward transmission. Next, install axle bolting plate. Install bolting plate drilled cap screws and tighten securely (Illust. 24).

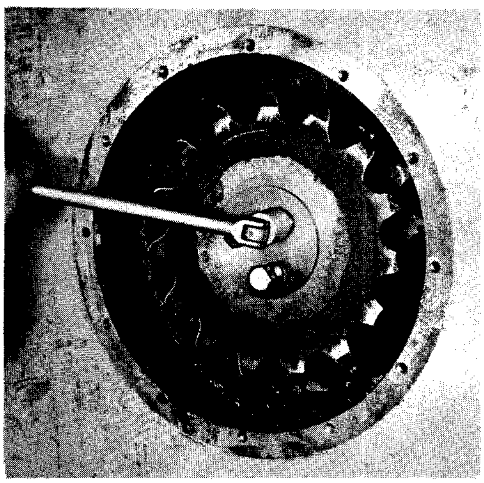


Illust. 21

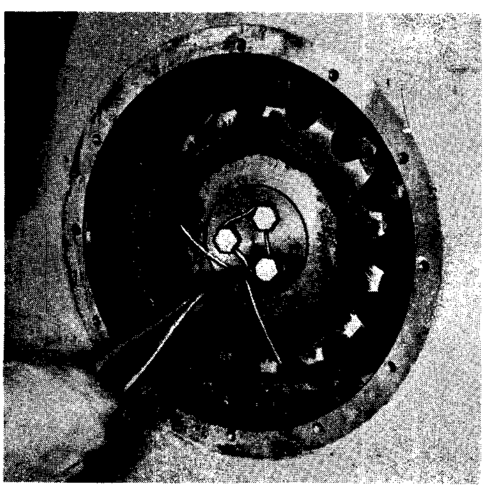


Illust. 22

Illust. 23



Illust. 24

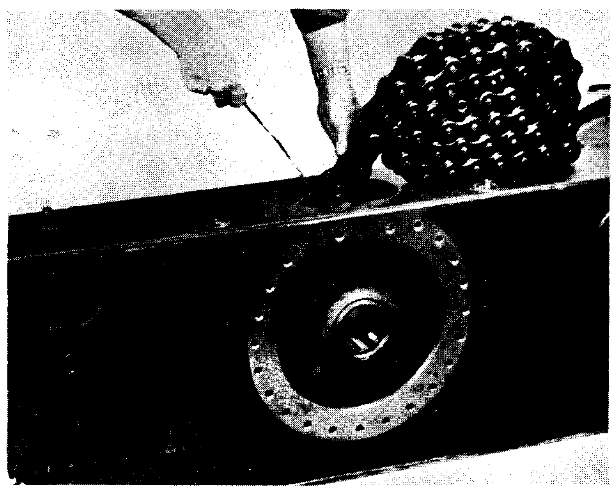


Illust. 25

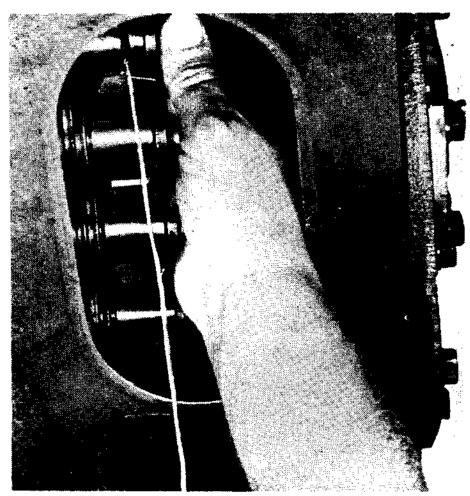
Insert a piece of wire through drilled heads of cap screws (Illust. 25) and lock securely by twisting ends of wire.

To install the drive chains, first coil chain on top of tandem housing (Illust. 26). Next, connect a soft wire to the end link of chain. Run the wire down through the center port hole of tandem, through the upper inside of tandem, around driven axle, through the lower inside of tandem, around driving sprocket and out the center port hole (Illust. 26).

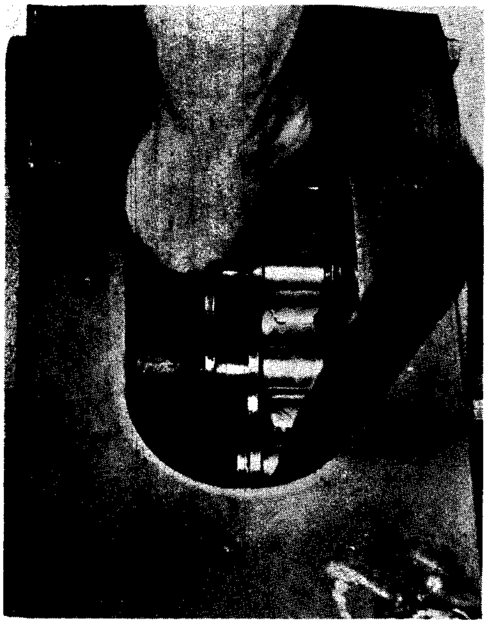
Pull on wire and at the same time guide



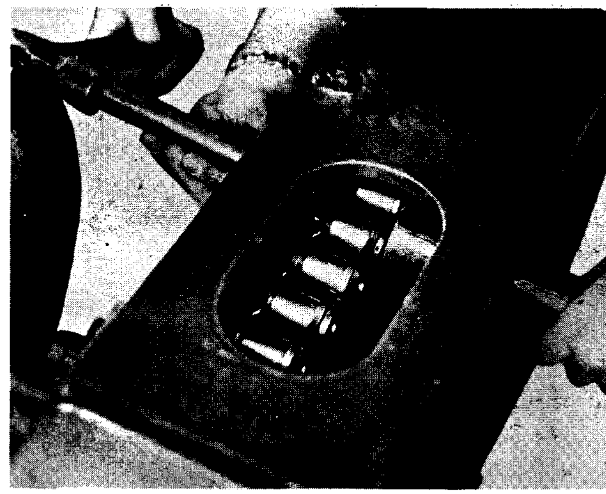
Illust. 26



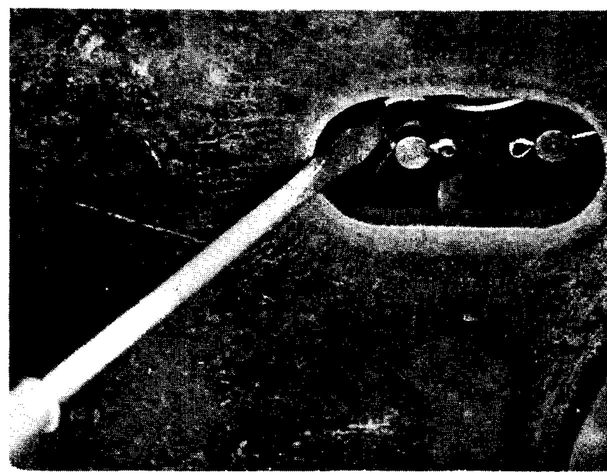
Illust. 27



Illust. 28



Illust. 29



Illust. 30

chain over teeth of driven axle. Continue pulling chain until chain is over teeth of driving sprocket. Bring loose end of wire through upper inside of tandem and out end port hole in tandem. Continue pulling on wire until end links of chain are near center of sprocket (Illust. 27). NOTE: Manual turning of axle will also aid in the chain installation.

Pull the chain up tight, using the wire or a pry bar. Insert the coupler link into end links of chain (Illust. 28). Remove wire from link. NOTE: When installing the drive chains, be sure to install them so the inside chain has the cotter pin side turned toward the center of the grader and the outside chain has the cotter pin side turned toward the outside of the grader. In other words, install the chains so as they pass over the driving sprockets, the cotter pin sides of the chain will be opposite each other.

Back up the chain until coupler link appears centered in the side port hole of tandem. Install connecting bar and drive bar onto coupler link (Illust. 29).

Install cotter pins into coupler link and spread (Illust. 30).

Install tandem to inner axle carrier. Install cap screws with lock washers. Tighten cap screws securely. NOTE: Do not use a gasket between the axle carrier and tandem. Coat the surfaces with a gasket shellac or similar compound.

Install tandem top, side port hole covers and side cover plate to tandems. Lubricate tandems as described in the Lubrication section of this manual.

TANDEM REMOVAL

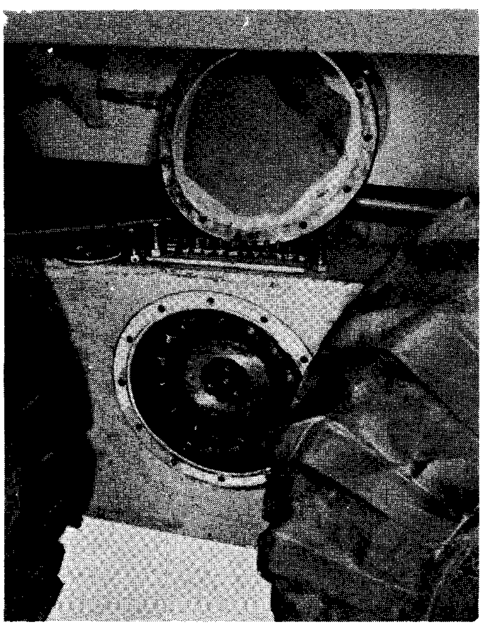
There are three basic types of removal in connection with the tandem drive assembly. The choice between these three types of removal depends entirely upon the work to be done.

These three types of removal can be classified as follows:

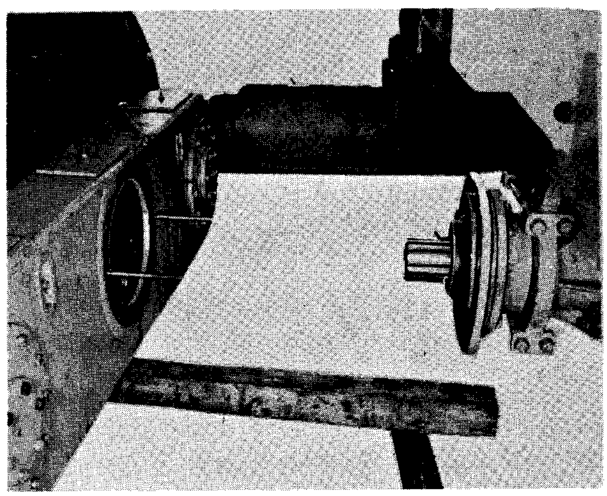
1. Removal of the tandem housing assembly leaving the driving axle and inner axle carrier on the machine.
2. Removal of the complete tandem assembly with driving axle and inner axle carrier.
3. Removal of the driving axle without the removal of the tandem or inner axle carrier.

These three types of removal will be discussed in the order listed.

The first type of removal is shown in Illusts. 1 and 2. The first step to be taken in this type of removal is to remove the center cover plate and axle bolting plate (Illust. 1). Next, start the engine and rotate the moldboard until the point of the moldboard points toward the tandem to be removed. Lower the moldboard to the ground and continue to lower until the weight of the grader is removed from the tandem assembly. If jacks and blocking are available, the grader can be raised and blocked in a similar manner. Remove the cap screws which hold the inner axle carrier to the tandem housing, disconnect the hydraulic brake hose, install two studs to aid in guiding the tandem housing assembly as it is removed, place a long beam under the center of the tandem housing and slide the complete assembly out (Illust. 2). The tandem assembly is replaced by reversing the above outlined procedure.



Illust. 1



Illust. 2

The second type of tandem removal, that of removing the tandem assembly with driving axle assembly and inner axle carrier; becomes necessary when the inner axle carrier or the bushings between the inner axle carrier and the outer axle carrier are to be replaced. This type of removal is also necessary when rebuilding the transmission assembly. However, when the transmission and tandem drive assemblies are removed from the grader as a unit, the tandems are then removed from the transmission assembly.

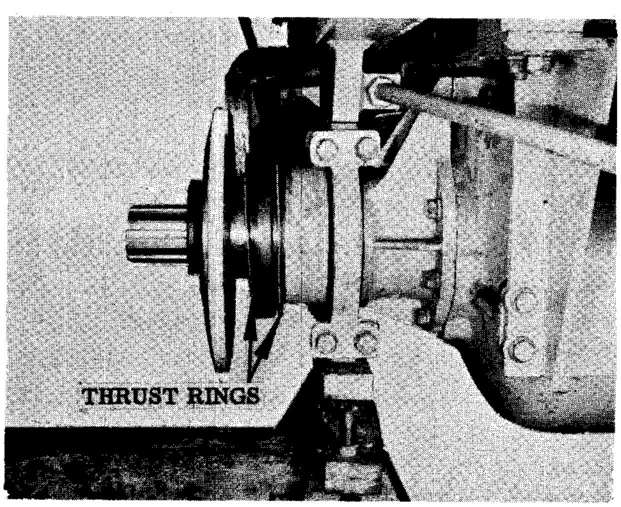
In either of these cases, it is only necessary to disconnect the hydraulic brake hose leading from the main frame of the grader to the tandem assembly. Remove the three seal retainer collars and two axle carrier flanges. The complete assembly then can be slid out from the outer axle carrier and disassembled separately.

The weight of the rear end of the grader can be supported in the same manner as that described for the first type or removal. When replacing the assembly, be sure to install the thrust rings pointed out in Illust. 3. Install the grease seals (Illust. 3). The fiber gaskets pointed out in the illustration are split to provide easy removal and installation when adjusting the running clearance at this point. Sufficient fiber gaskets should be installed or removed as needed to provide the minimum amount of clearance and yet eliminate all binding. The inner axle carrier should oscillate freely.

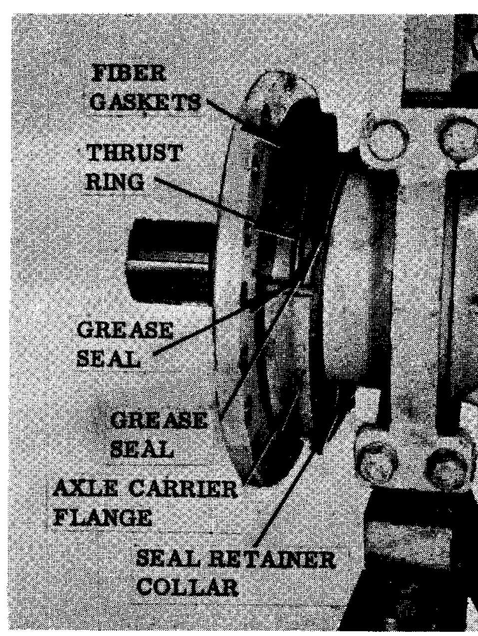
Although Illusts. 3 and 4 show the tandem housing assembly removed from the inner axle carrier previous to its removal from the machine, this is not necessary since the complete unit can be removed as one assembly.

The third type of removal is shown in Illust. 5. This illustration shows the method of removing the driving axle assembly while the tandem housing remains assembled to the grader. The weight of the grader is relieved from the tandem assembly in the same manner as that outlined for the first and second types of removal. The first step to be taken in this type of removal is to remove the center cover plate and axle bolting plate. Next, uncouple both front and rear drive chains and fold them back into the tandem housing out of the way. Next, remove the driving sprockets and the snap ring which hold the driving axle bearing into the inner axle carrier. The driving axle with bearing may then be withdrawn, as shown in the illustration.

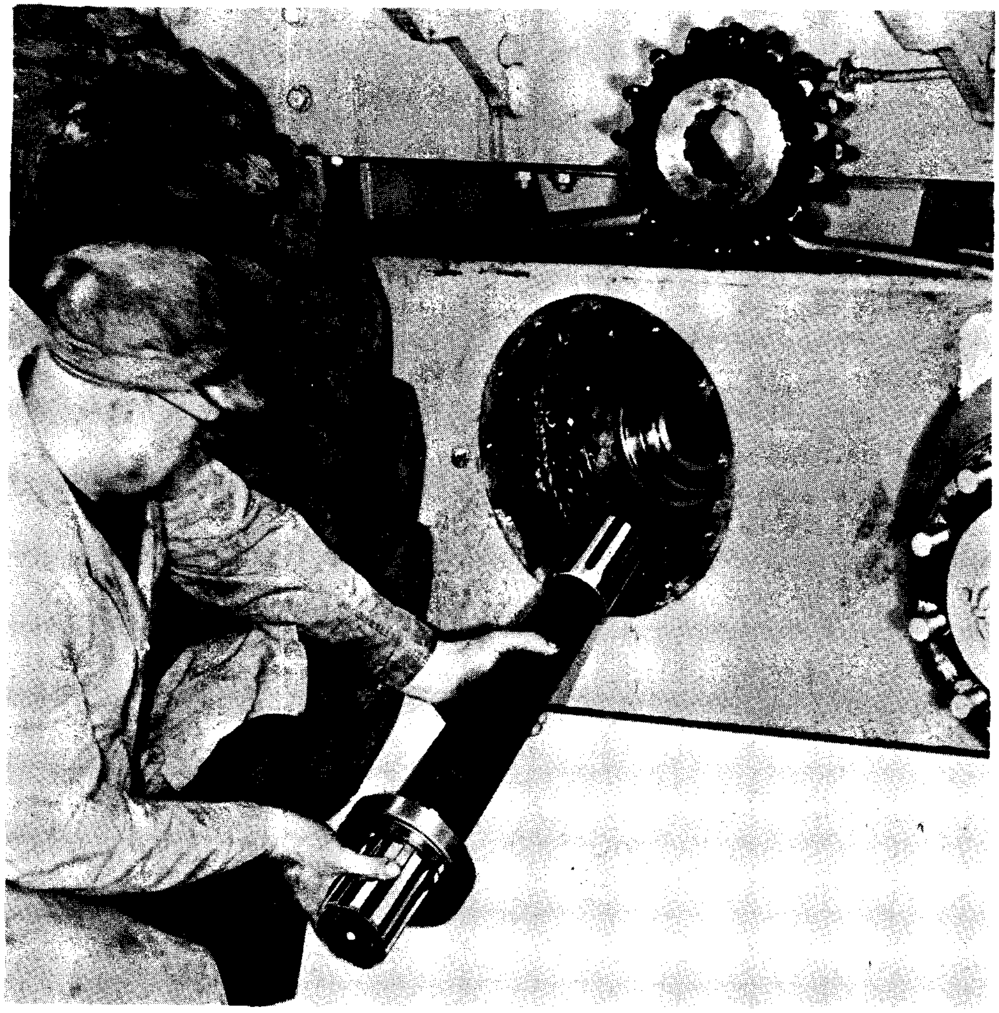
NOTE: It is necessary to remove the front wheel from the tandem assembly in order to provide clearance for backing up the tandem drive chain to install coupler link,



Illust. 3



Illust. 4



Illust. 5

connecting bar and cotter pins.

The three types of removals outlined will cover any and all cases. The type of removal which should be used in any particular case depends entirely upon the work to be done. As outlined previously, it is not necessary to remove the tandem assembly in order to rebuild either front or rear driven axle assembly. This work can be done with the tandem assembly mounted on the grader.

FOOT BRAKES

The brake assemblies are of a two shoe, internal expansion type with primary and secondary shoes. Both primary and secondary shoes should be equipped with molded linings.

Detailed instructions on disassembly are not necessary, due to the simple design of the brakes. Therefore, the only instructions given here are for reassembly. If difficulty is experienced in disassembling, read the reassembly instructions and reverse the procedure outlined.

INSPECTION

Inspect all parts carefully for excessive wear and scoring. Replace or repair all badly worn or damaged parts.

REASSEMBLY

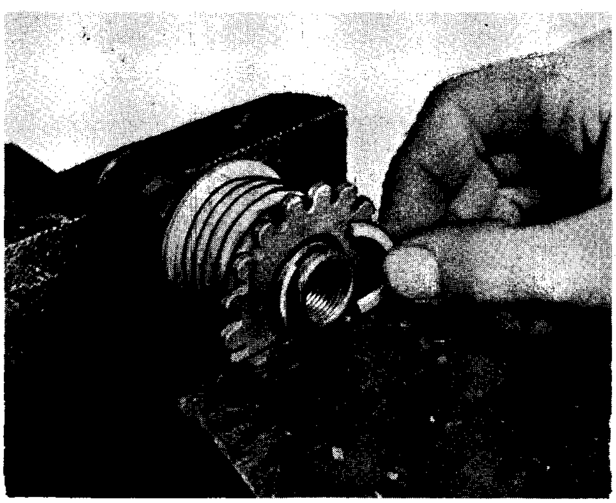
The first step of reassembly is to install inner centralizer spring retainer onto adjusting nut. NOTE: Be sure to install retainer over end of adjusting nut which has the two flat sides. Countersunk portion of retainer against shoulder in center of adjusting nut. Next, install centralizer spring and adjusting nut wheel onto adjusting nut. Hub of wheel to fit into spring. After compressing spring sufficiently, install the two centralizer spring retainer locks in groove of adjusting nut (Illust. 1).

Install centralizer bracket onto adjusting nut. Studded end of bracket away from adjusting nut wheel. Install the second inner centralizer spring retainer. Countersunk portion of retainer against shoulder in center of adjusting nut. Next, install spring and outer centralizer spring retainer onto nut. When spring has been compressed sufficiently, install the remaining two centralizer spring retainer locks in groove of adjusting nut (Illust. 2).

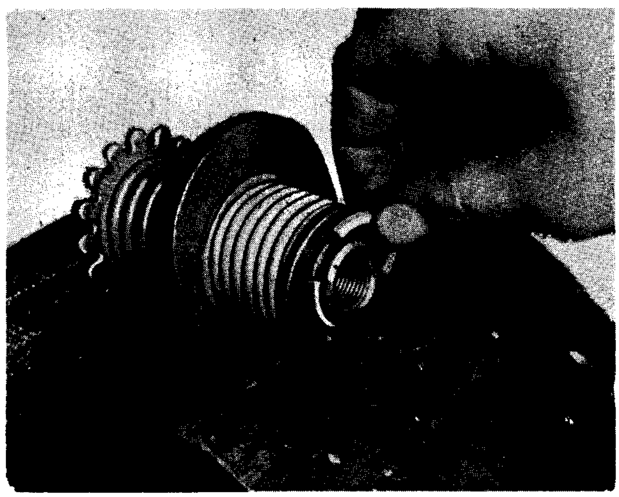
Install the right and left hand adjusting screws in the centralizer assembly. The adjusting screws should be turned back into the adjusting nut as far as possible. NOTE: Be sure that both adjusting screws are turned into the adjusting nut an equal amount.

The centralizer assembly is now ready for installation onto backing plate. Install the assembly (Illust. 3) with the two studs through the slotted holes in the backing plate. Install the centralizer plate, two lock washers and two nuts. Do not tighten nuts.

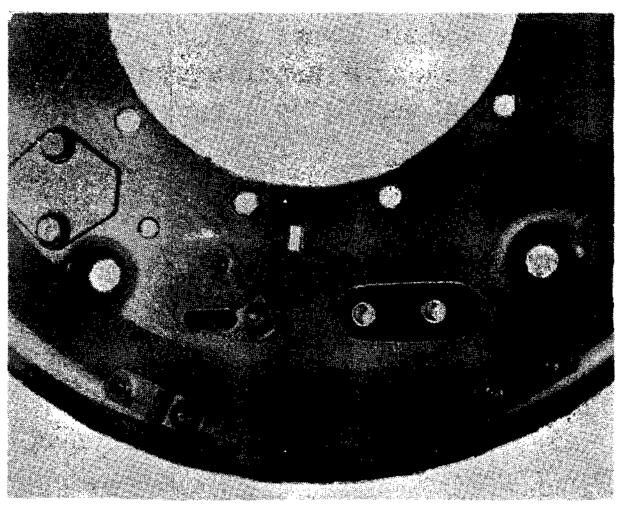
Install the two anchor pins in the backing



Illust. 1



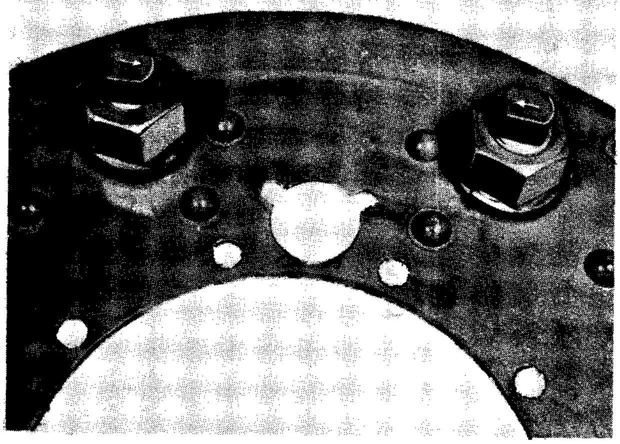
Illust. 2



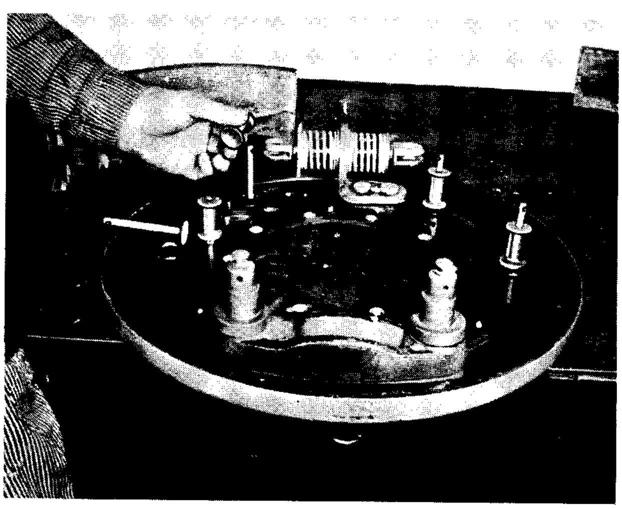
Illust. 3

plate. Next, install lock washers and hex nuts. Do not tighten nuts. Turn the anchor pins so arrows on outside ends of anchor pins point directly toward each other (Illust. 4). The anchor pins are made eccentric and by positioning them in this manner, the brake adjustment is slacked off to its minimum, therefore, giving the minimum circumference around the brake shoes.

Install four shoe hold down pins and shoe spacers (Illust. 5). The shoe spacers are slightly smaller on one end than on the other. The large end is machined out concave to fit onto the convex shape of the backing



Illust. 4



Illust. 5

plate around each of the shoe hold down pins. Be sure that each of the shoe spacers are mounted with the concave end against the backing plate.

If the linings show excessive wear, they should be replaced. There are several fundamentals necessary in properly relining brake shoes.

1. Snug fit between liners and shoes.
2. Selection of proper rivets.
3. Removal of high spots on lining.

Snug fit is absolutely necessary between liners and shoes if maximum efficiency is expected. Loosely applied liners contact only a small part of their area due to the humps between rivets.

There are several lining stretchers on the market that pull the liners tightly to the shoe before riveting. Stretchers are not necessary if care is used and the center rivets are set first. The operator then works toward both ends of the lining.

Proper selection of rivets is necessary to insure a close fit between rivet shank and drilled hole in liner and shoe. Rivets with small shank permit the liner to shift on shoe under pressure. This shifting gradually loosens liners and sometimes shears all rivets. The rivet should be long enough to properly upset the end, securely binding the lining. Should the rivet shank be too long, the upset end will split, materially weakening the job. Aluminum rivets should not be used.

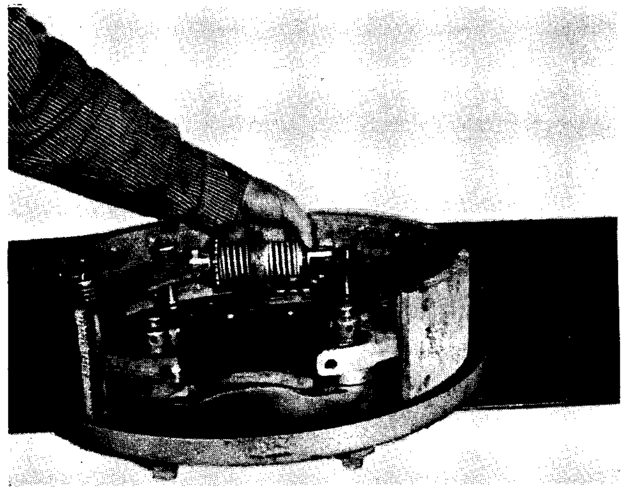
If the brake drum is scored or out of round, it should be turned on a lathe. Do not remove any more metal from the drum than necessary to "true" it.

When installing the brake shoe assemblies on the backing plate, be sure to mount each shoe with the projecting fingers (see arrows

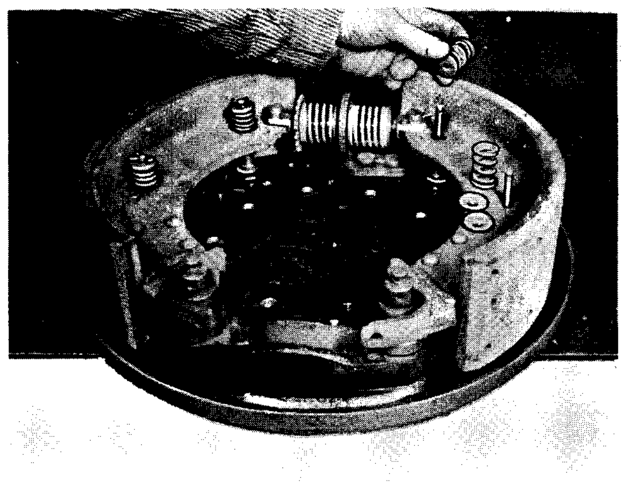
Illust. 6) turned toward the backing plate. This is extremely important as the brake shoe will not operate satisfactorily if it is mounted in a reverse manner.

Install the brake shoes with the primary shoe on the side of the backing plate which will be toward the front of the machine, and the secondary shoe on the rear side of the plate. The shoe assemblies shown installed (Illust. 7) are for the right hand side and therefore, the primary shoe is mounted to the left in the illustration, and the secondary shoe is mounted to the right. Be sure that all shoe hold down pins enter the brake shoes properly and install the brake shoe pivot pin from the inside out as shown in illustration. Install and spread 5/32" x 1-1/8" cotter pin through the end of the pivot pin. NOTE: The only obvious difference will be the shape of the shoes and the location of the projecting finger (Illust. 6).

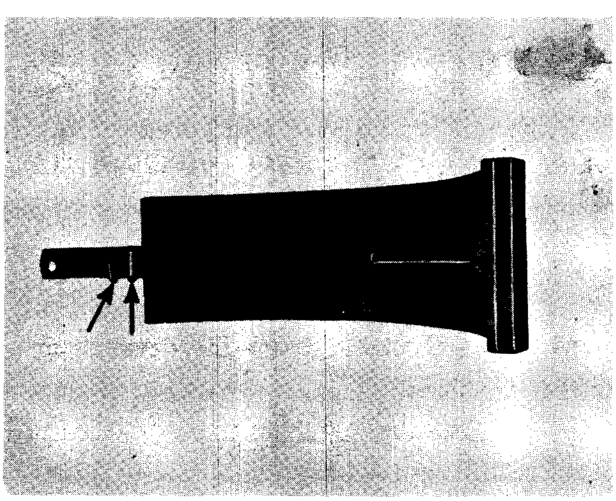
Install the four shoe hold down spring cups, four shoe hold down springs and four shoe hold down spring cups. Compress the springs sufficiently to install a 5/32" x 5/8" cotter pin through the end of the shoe hold down pins (Illust. 8). Spread the cotter pins sufficiently to prevent their falling out during operation.



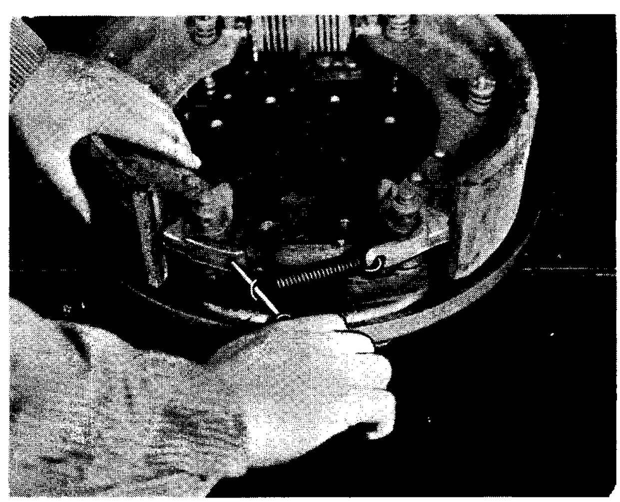
Illust. 7



Illust. 8



Illust. 6

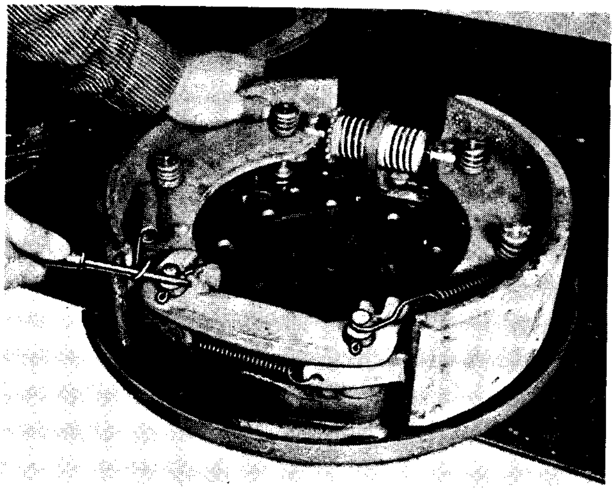


Illust. 9

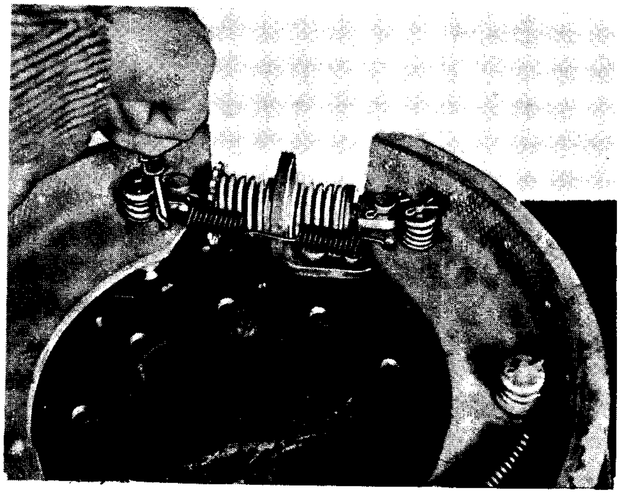
Install the primary to secondary shoe spring (Illust. 9). Be sure that the ends of the spring are hooked securely in the holes in the ends of the primary and secondary shoes. Install the anchor pin reinforcement plate and install and spread a 3/16" x 1-1/8" cotter pin in each anchor pin.

Install the primary and secondary anchor to shoe springs (Illust. 10). The front or primary shoe spring is lighter than the rear or secondary shoe spring. Be sure they are installed with the light spring on the front shoe.

Install the adjusting screw spring (Illust.



Illust. 10

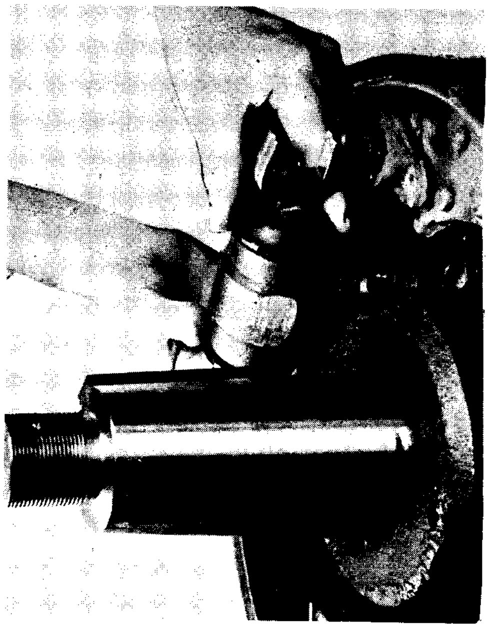


Illust. 11

11). This spring is made with two coils and a straight section which is in the middle. Make sure that the spring is installed with the straight center section clearing the centralizer bracket. If this spring is installed backward, it will rub on the centralizer bracket thus causing the spring to bind and therefore, work improperly. The coils of the spring act as an adjustment lock by riding down against the adjusting nut wheel.

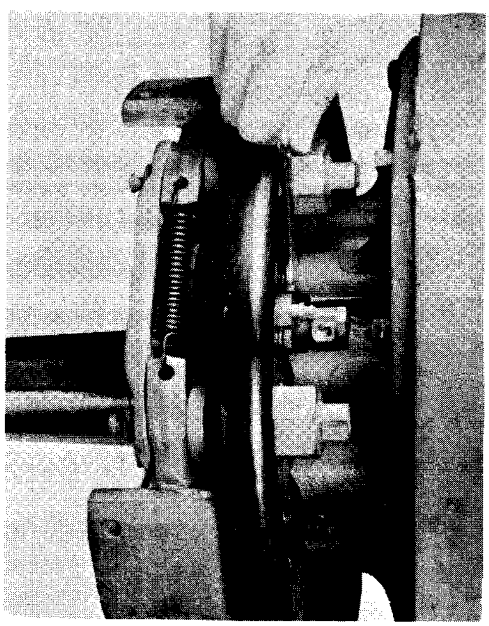
The brake shoe assembly is now ready for installation on the tandem housing.

Install the assembly so that it is at a slight angle toward the front from vertical, the exact position can be determined by locating the brake cylinder in relation to the end of the hydraulic brake tubing on top of the tandem housing. The four cap screws which hold the brake shoe backing plate to the eccentric housing are of the type which have a very thin head while the remainder are of the standard type. The reason for the thin heads is to provide clearance. Install cap screws and lock washers. Tighten cap screws securely.



Illust. 12

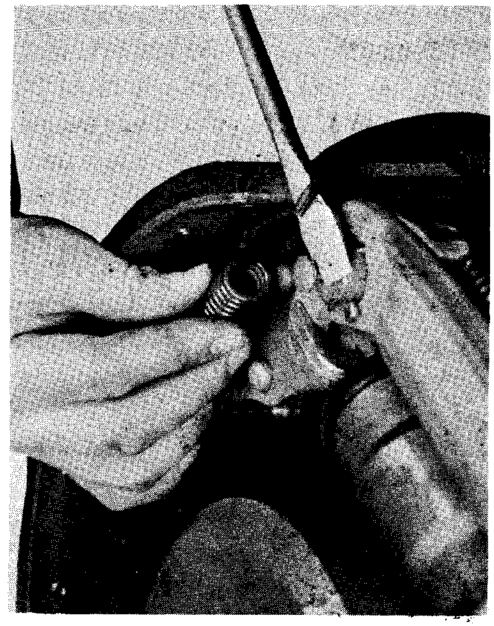
Illust. 13



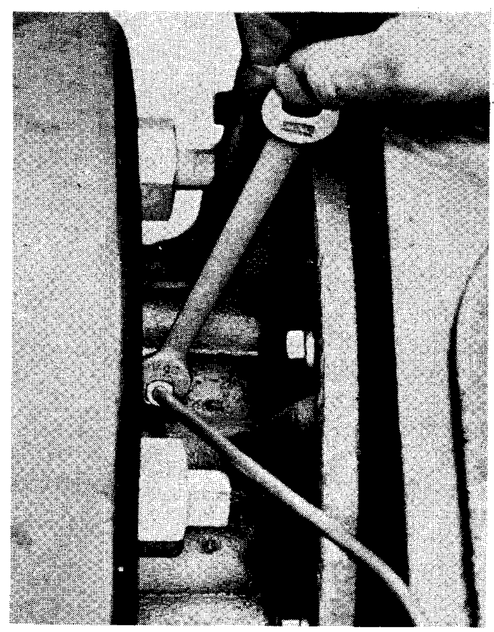
Illust. 14

Install wheel brake cylinder to backing plate (Illust. 12). Connecting links to fit over knobs and into slots in brake shoes (Illust. 13).

Install wheel brake cylinder cap screws and lock washers. Tighten cap screws securely (Illust. 14).



Illust. 15



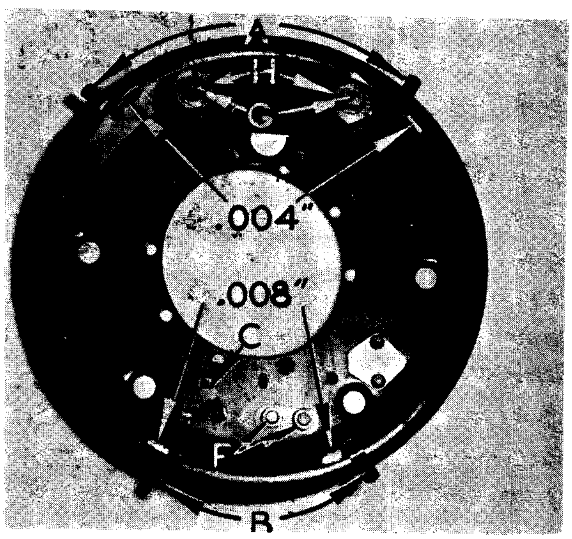
Illust. 16

Install and tighten brake line to wheel cylinder connection (Illust. 16). NOTE: Carefully tighten brake line fitting to prevent damage to threads of fitting.

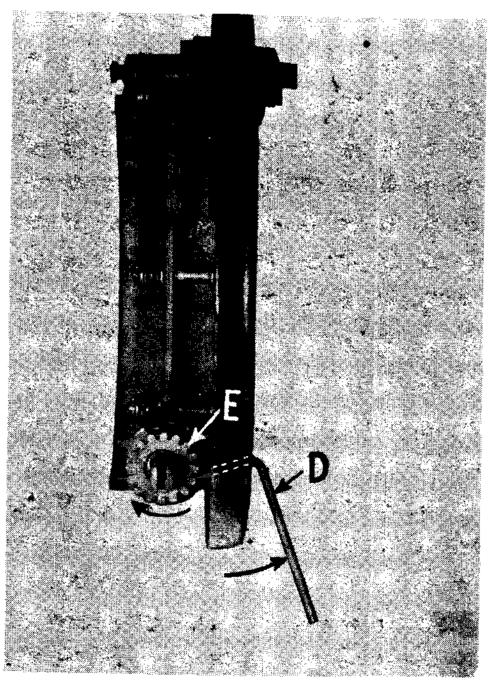
To install springs, hook short end of springs into holes in brake shoes. Using a screw driver or similar tool, bring long end of springs over anchor pins (Illust. 15).

ADJUSTMENT

Never attempt to adjust the brake shoes with the wheel raised clear of the ground. The full weight of the machine should be supported on the wheels in order to assure proper centering of the brake drum around the brake shoe assemblies. Be sure that all adjustments, locks and nuts are loose. Brakes and brake drums should be approximately room temperature when making adjustments. If brakes are adjusted when drums are hot and expanded, the shoes may drag when the drums cool and contract. Turn the spring clips (A), (B) and (C) off from the holes in the backing plate (Illust. 17). Insert the adjusting tool (D) (Illust. 18) and turn the adjusting wheel (E) in the direction shown by arrow until the lower end of both brake shoes are expanded tightly against the drum. Tap the backing plate near the centralizer with a light hammer to insure centralizer taking correct position between shoe ends. Tighten the two nuts (F) securely. The centralizer assembly is now properly located in the slotted holes in the backing plate which was shown in Illust. 3. Loosen the wheel centralizer adjustment by turning the wheel (E) (Illust. 18) in the opposite direction. Insert a .008" feeler gauge through each of the slots in the backing plate at (B) (Illust. 17). Insert a .004" feeler gauge through each one of the slots (A). Be sure that the feeler gauges have entered between the brake lining and the drum at all four points. Turn the anchor pins (G) in the direction of the arrows until a slight perceptible drag is felt on each of the feeler gauges inserted through the slots (A). Turn the adjusting wheel (E) with the adjusting tool (D) (Illust. 18) in the direction of the arrow until a slight perceptible drag is felt on the feeler gauges inserted through the slots (B) (Illust. 17). Check all four feeler gauges at (A) and (B) to be sure that none are too tight. Hold the anchor pins (G) in their positions and tighten the lock nuts (H) securely. Check the feeler gauges again to see if the adjustments have changed. Due to the possibility of having drum distorted slightly or off center, it is best to revolve the wheel 180° and check all clearances again. This is especially



Illust. 17



Illust. 18

true if drums have not been trued on a lathe. If any clearances have changed, adjust the shoes to a minimum of .004" and .008" as described above. Remove all four feeler gauges and turn all spring covers over the slots (A), (B) and (C).

Road test the grader. The brakes either may or may not be "run-in" depending on the desired results. If it is necessary to meet certain braking requirements which necessitate a 100% brake lining contact with the drum, then it will be necessary to "run-in" the brakes. However, if this is not necessary, it is better to allow the brakes to wear in normally and readjust them after they have become seated to the drums.

If it is decided to "run-in" the brakes, run them in as follows: With the grader operating at half throttle in low gear, apply the brakes firmly for 10 second intervals, releasing them completely for 15 seconds between each application. Apply the brakes 25 or 30 times. If the brakes tend to overheat; increase the time between applications to 20 or 30 seconds. Readjust the brakes after running them in and allowing them to cool.

HYDRAULIC BRAKE SYSTEM

The hydraulic system used to actuate the brake mechanism consists of a compensating type master cylinder in which the hydraulic pressure is originated; individual wheel cylinders in which the hydraulic pressure is applied, which serve to actuate the brake shoes against the brake drum of each wheel; and the "line" consisting of steel tubing, flexible hose, brakcets and unions, interconnecting the master cylinder and wheel cylinders. The master cylinder and wheel cylinders are fitted with pistons, all of which are provided with cup packing which act as a seal to maintain pressure and prevent loss of brake fluids. Depressing the brake pedal moves the piston within the master cylinder, thus displacing the brake fluid from the master cylinders through its outlet orifices, tubing and flexible hose connections into wheel cylinders. The brake fluid, being non-compressible, enters each of the wheel cylinders, causing the cylinder pistons to move outward and actuate the brake shoes. As pressure on the pedal is increased, greater hydraulic pressure is built up within the wheel cylinders and consequently greater force is exerted against the shoes.

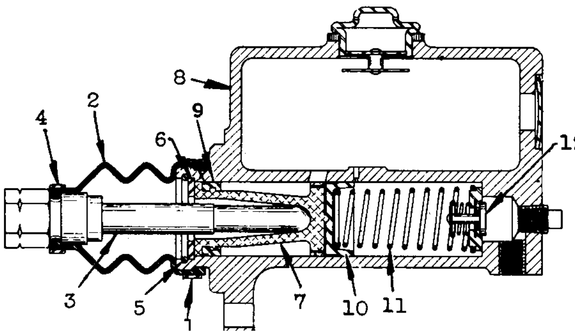
When the pressure on the pedal is released, the brake shoe retracting springs return the brake shoes to their normal or released position. The return movement of the brake shoes, in turn, causes movement of the wheel cylinder pistons toward their released position, thus forcing the fluid back through the tubing and into the master cylinder.

Always use hydraulic brake fluid in the hydraulic brake system. The introduction of mineral based oil into the system will cause rubber parts to swell and become inoperative.

MASTER CYLINDER

The combination type master cylinder (Illust. 19) consists of a barrel and tank casting (8), double check valve (12), piston cup return spring (11), primary piston cup (10), secondary piston cup (9), piston (7), piston stop (6), piston stop wire (5), boot (2) and connecting link (3). The boot straps (1) and (4) hold the boot in place on the barrel and tank casting (8) and the connecting link (3). The fluid reservoir or supply tank is cast integral over the master cylinder barrel. A combination filler and breather plug permits atmospheric pressure on the reserve fluid at all times.

Depression of the pedal causes piston (7) and cups (9) and (10) to move forward in the



Illust. 19

cylinder barrel. A very small forward movement of the cup (10) closes the by-pass port above the cup and pressure stroke commences. Actual pressure is not built up until the fluid displaced has caused all shoes to go into contact with their drums. Additional pressure on the pedal produces hydraulic pressure within the brake system.

Removal of the operator's foot from the brake pedal after each brake application permits the brake pedal and push rod (3) to return independently to their off position.

The return of piston (7) and cups (9) and (10) is accomplished by the piston return spring (11). The piston for this type of unit is designed to carry a primary cup (10) and a secondary cup (9). The construction of the piston is such that reserve fluid from the tank passes through the vent between cups (9) and (10) into the recessed area in the piston (8). Thus, we have fluid on both sides of the primary cup. The secondary cup (9) is merely a seal to prevent loss of reserve fluid into the boot (2).

The combination type master cylinder is also known as a compensating type. Its primary compensating function is to maintain a constant volume of fluid in the system at all times, regardless of expansion (heat) or contraction (cold). The secondary compensating function is the replacement of additional fluid into the system to counterbalance any loss due to gravity.

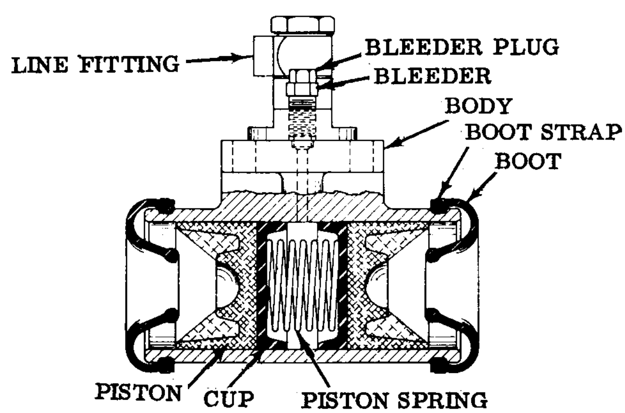
The return to "off" position of piston (7) and cup (10) is much faster in displacing volume than the return of the fluid through the "line" into the master cylinder. A momentary vacuum is created in the cylinder barrel and additional fluid is drawn into the system through the drilled holes in piston (7) and past the lip of cup (10). The operating fluid returns more slowly from the wheel cylinder barrel. Any excess is by-passed by the port ahead of the primary cup into the reservoir. Thus, we have a cylinder full of fluid for the next brake application.

ADJUSTMENT

When the brake control system is in release position, the push rod (3) (Illust. 19) should travel approximately 1/32" before moving the piston (7). This free travel is required to prevent blocking of the by-pass port in the master cylinder. The brakes will drag if the by-pass port becomes blocked due to pressure building up in the system. Should all brakes drag, pressure may be relieved by screwing the push rod (3) back onto the yoke on the brake pedal linkage.

WHEEL CYLINDERS

Illust. 20 is a view of the wheel cylinder.



Illust. 20

This unit changes the applied hydraulic pressure into mechanical force to actuate the brake shoes.

It is possible to rehone the majority of wheel cylinders when they become worn and place them in good working condition; however, this requires the use of up-to-date honing equipment and plug gauges. If this equipment is not available, the cylinders may be taken to the nearest Wagner service branch or authorized service station for repairing. Cylinders and the parts must not be washed in gasoline, kerosene or oil. Use high grade denatured alcohol for all cleaning.

Keep all lubricant and brake fluid away from the brake linings. Do not allow any mineral based oil to come in contact with any of the hydraulic brake parts.

BLEEDING

Any air inside the hydraulic system must be removed. Whenever a line has been disconnected at master cylinder, the entire system must be bled at all wheels until all air is completely expelled. When a line has been disconnected at any wheel or if the hose leading to the tandem assembly has been disconnected, the cylinder on that side must be bled. Air in the system will cause a springy, rubbery action of the brake pedal. Should a sufficient quantity be introduced into the system, the brake pedal will go to the floor board under normal pressure.

Fill the master cylinder supply reservoir with brake fluid and see that it is kept at least half full during entire bleeding operation.

Remove the bleeder plug from the end of the bleeder (Illust. 20) and attach the bleeder tube. Allow the tube to hang into a clean container, such as a glass jar. Unscrew the bleeder connection 3/4 of a turn and depress the brake pedal, using half strokes, close bleeder connection on return stroke. Pumping brake pedal forces fluid out into the glass jar and carries with it any air which might be present in the system. Watch flow of fluid from tube, the end of which should be kept below surface of fluid in glass jar and when all air bubbles cease to appear or when stream is a solid fluid mass, close bleeder connection. Remove bleeder tube and install bleeder plug.

Fluid withdrawn in bleeding operation should not be used again unless absolutely certain that it does not contain impurities. Fluid of which cleanliness is questionable, should never be used. Fluid should be replenished in supply reservoir after each cylinder is bled. Should supply reservoir be drained during bleeding operation, air will enter the system and re-bleeding will then be necessary.

PARKING BRAKE

The parking brake is operated by a hand lever at the operator's right. It is an internal band expanding type brake. It operates in a drum mounted on the lower shaft of the transmission

The brake has both mechanical and hydraulic action. It is activated mechanically by use of the hand brake lever. It is hydraulically activated by use of the foot brake. This helps slow down the machine by braking the transmission simultaneously with the w heels when the foot brake is depressed.

ADJUSTMENT

When brake adjustment becomes necessary, always adjust shoe contact to drum first before attempting to adjust cable length.

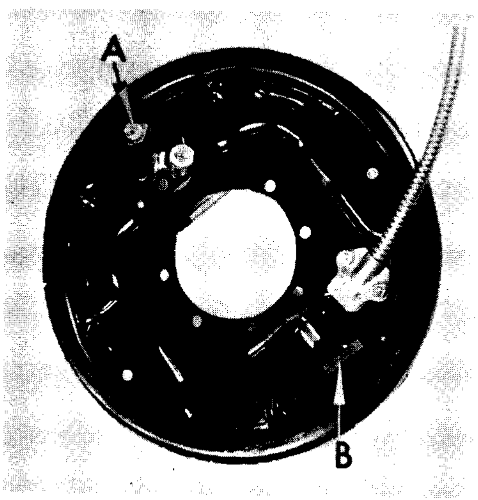
To adjust shoe contact, loosen lock nut on anchor pin (A) (Illust. 1). Remove clip (B) and insert brake adjusting tool in slot until it makes contact with the adjusting wheel.

Move tool in direction of arrow (Illust. 2) to move brake shoes toward the drum. Move shoes out as far as possible. With a hammer, tap around the outer edge of brake drum to centralize brake shoes.

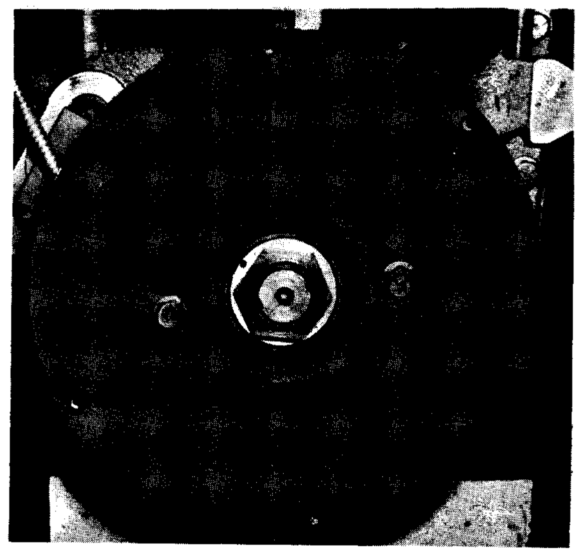
Tighten lock nut on anchor pin (A) (Illust. 1). Rotate adjusting wheel in the opposite direction, approximately eight (8) notches.

Remove the socket head plug from the brake drum. Rotate brake drum until the hole is in position (A) (Illust. 3). The clearance at this point and point (B) should be .004". If this clearance is less than .004"; loosen anchor pin lock nut. With a hammer, tap anchor pin down until a .004" clearance is obtained at point (A) and (B). Tighten lock nut. Rotate brake drum around to point (C) (Illust. 3).

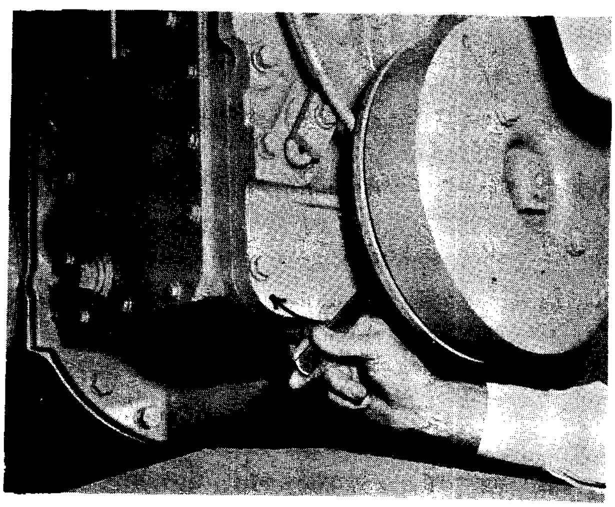
Insert a .008" feeler gauge at this point. Adjust brake shoes until the .008" feeler gauge is a snug fit at point (C) and (D).



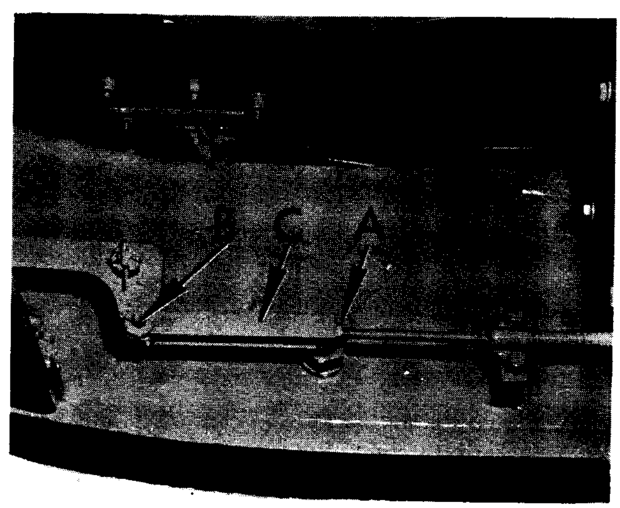
Illust. 1



Illust. 3



Illust. 2



Illust. 4

To adjust the parking brake cable, remove cotter pin and pin (B) (Illust. 4). Loosen lock nut (A), turn yoke (C) clockwise to shorten. By exerting a normal pull, the brake shoes should make holding contact with the drum before the parking brake lever is half out of its holder.

AUTO-MATIC BRAKE

The auto-matic brake mechanism consists of a small diameter steel cable with a hook and anchor fitting attached, a cable guide, adjusting lever, adjusting screw, adjusting screw nut, adjusting screw socket and spring.

Adjustment is made only during reverse brake action.

The auto-matic adjuster is mounted on rear shoe. When both linings wear (front and rear) enough to require an adjustment, the rear shoe moves away from the anchor during reverse brake application. This causes cable to lift adjuster lever into engagement with the next tooth in starwheel.

When adjusting lever engages this tooth, brake is released and rear shoe returns to anchor. This shortens distance from anchor to cable guide. Cable and adjusting lever are pulled back to their original position by adjuster spring, thereby turning starwheel one-twentieth of a revolution.

Normal grader operation involving brake applications made during reverse movement will maintain correct shoe adjustment eliminating the necessity for periodic manual brake adjustment.

Due to the simple design of auto-matic brakes, disassembly instructions are not necessary. Therefore, reassembly instructions are given.

If difficulty is experienced in disassembling, reverse reassembly procedure.

If linings show excessive wear, they must be replaced. There are several fundamentals necessary in properly relining brake shoes.

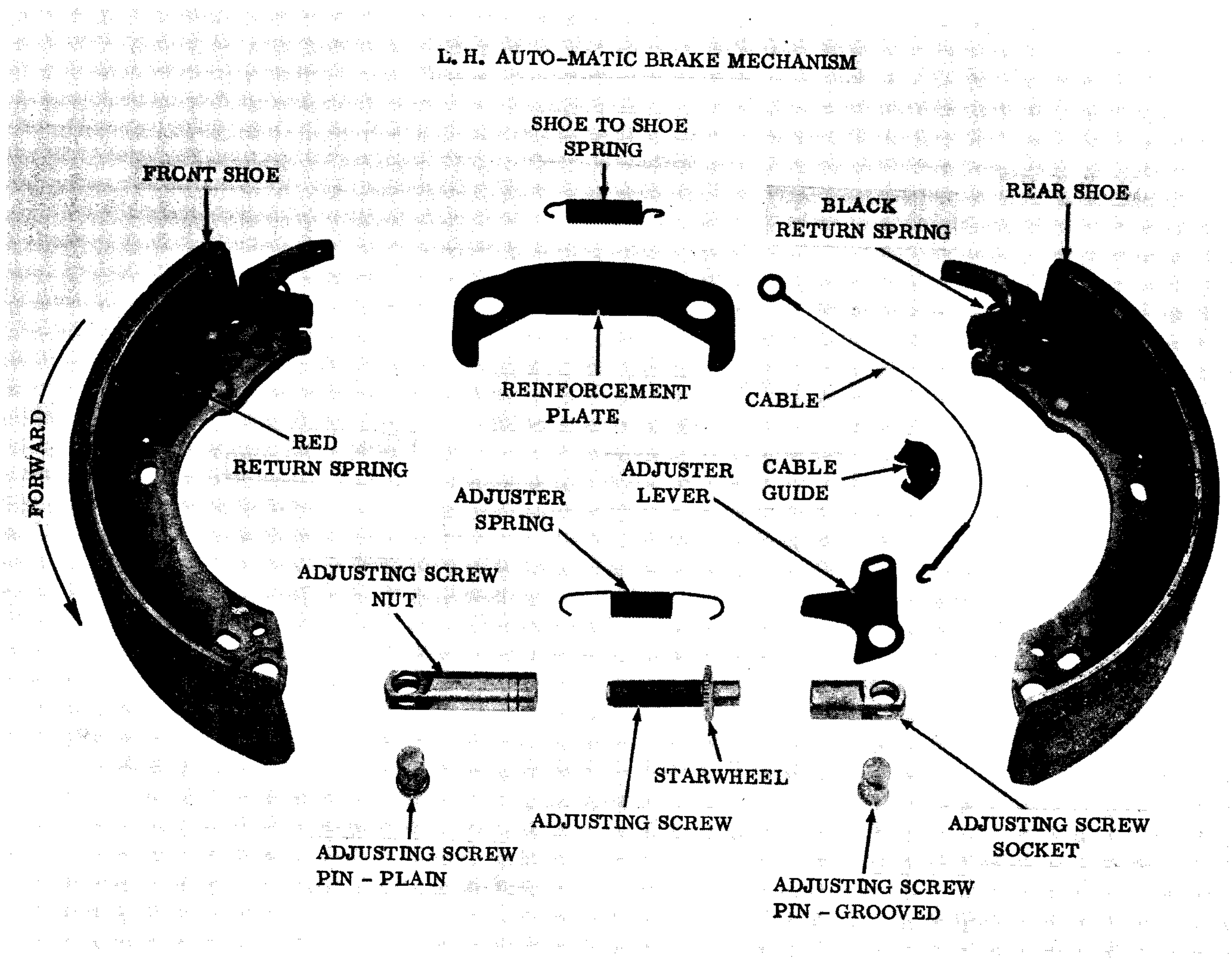
1. Snug fit between liners and shoes.
2. Selection of proper rivets.
3. Removal of high spots on lining.

Snug fit is absolutely necessary between liners and shoes if maximum efficiency is expected. Loosely applied liners contact only a small part of their area due to humps between rivets.

There are several lining stretchers on the market that pull liners tightly to shoes before riveting. Stretchers are not necessary if care is used and center rivets are set first. The operator then works toward both ends of lining.

Proper selection of rivets is necessary to insure a close fit between rivet shank and drilled hole in liner and shoe. Rivets with small shank permit liner to shift on shoe under pressure. This shifting gradually loosens liners and sometimes shear all rivets. Rivet must be long enough to properly upset end, securely binding lining. Should rivet shank be too long, upset end will split, materially weakening the job. Aluminum rivets must not be used.

If brake drum is scored or out of round, it must be turned on a lathe. Do not remove any more metal from drum than necessary to "true" it.



Illust. 1

REASSEMBLY

Illusts. 1 and 2 are exploded views of L.H. and R.H. Auto-matic Brake Mechanism.

Detailed instructions shown are for R.H. Auto-matic Brake Mechanism.

Parts are reassembled in reverse for L.H. Auto-matic Brake Mechanism. See Illust. 1.

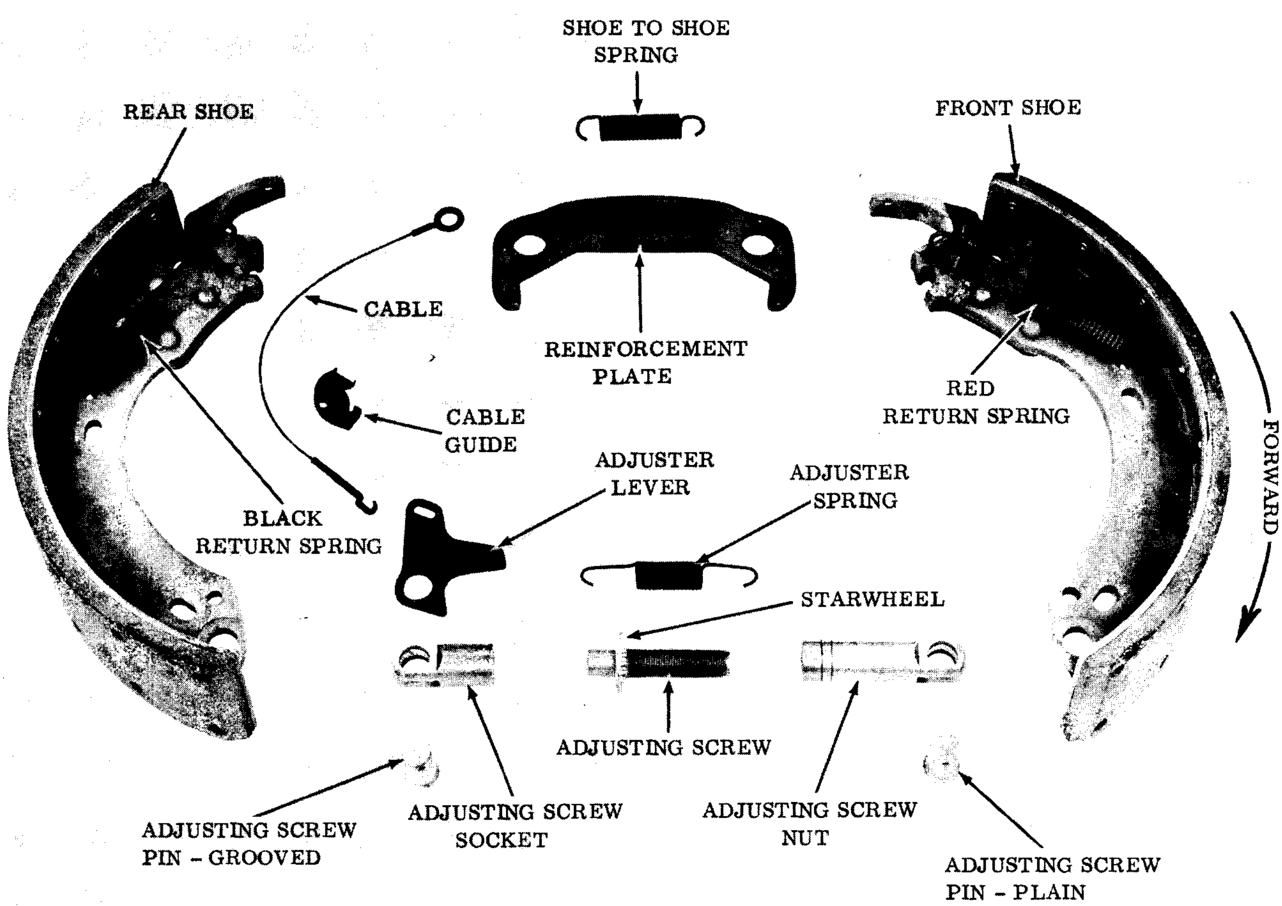
Before reassembling brake mechanism, loosen anchor pin nuts so anchor pins will turn freely. Turn anchor pins so arrows on outside end of pins are pointing directly toward each other.

(Illust. 3). Anchor pins are made eccentric. By positioning them in this manner, brake adjustment is slacked off to its minimum circumference around brake shoes.
NOTE: Before installing brake drums, tighten anchor pin nuts securely.

Lubricate adjusting screw threads and adjusting screw socket end with Lubriplate No. 630AA Type 2 grease.

Lay shoes on a bench with shoe end rivets

R. H. AUTO-MATIC BRAKE MECHANISM



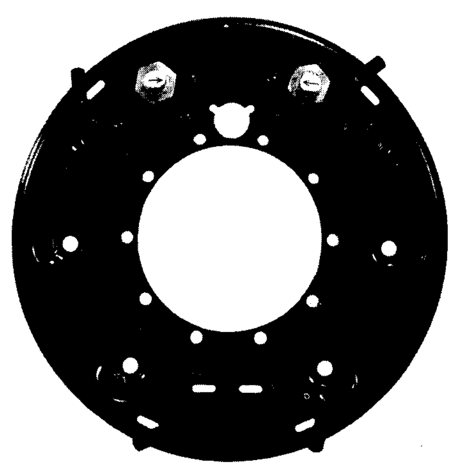
Illust. 2

pointing upward. Install adjusting screw socket in position (Illust. 4). on rear shoes.

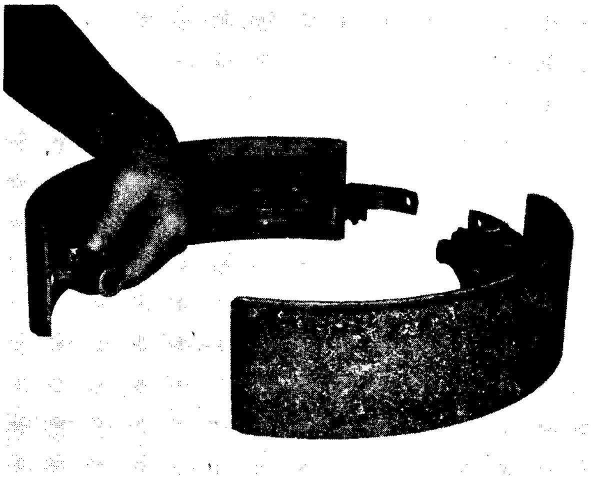
Insert grooved socket pin from underside of shoe (Illust. 4). Insert and spread cotter pin.

Thread adjusting screw into adjusting screw nut to limit. Install adjusting screw nut on front shoe in the same manner (Illust. 5). Install and spread cotter pin. Back adjusting screw off 1/2 to 1 turn.

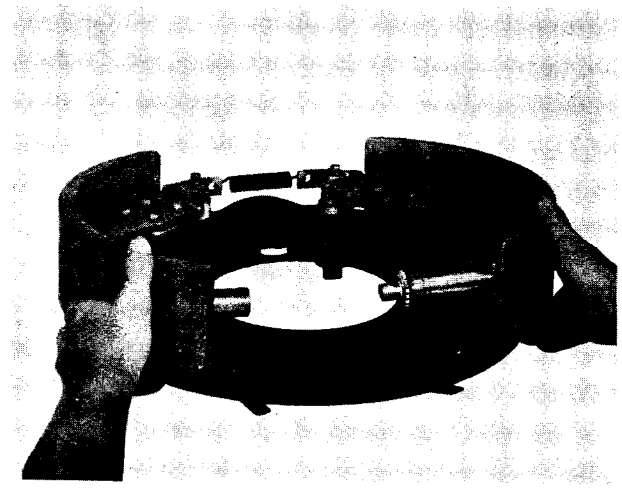
Install shoe to shoe spring (Illust. 6) in



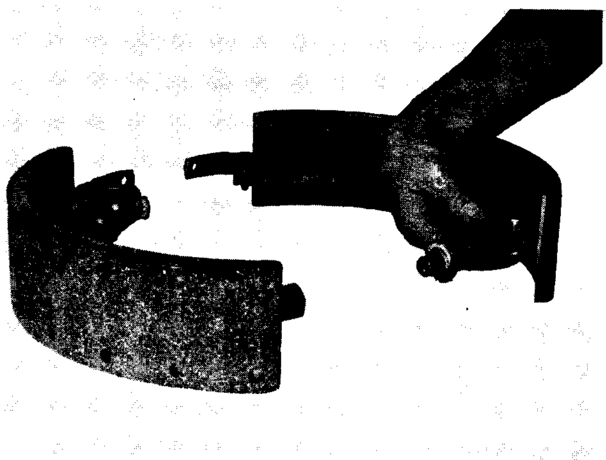
Illust. 3



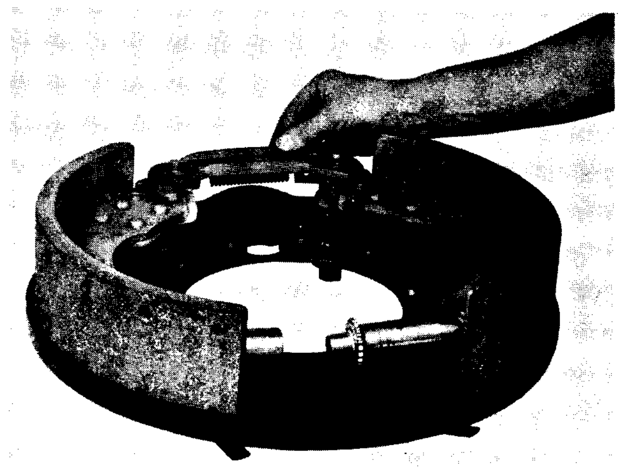
Illust. 4



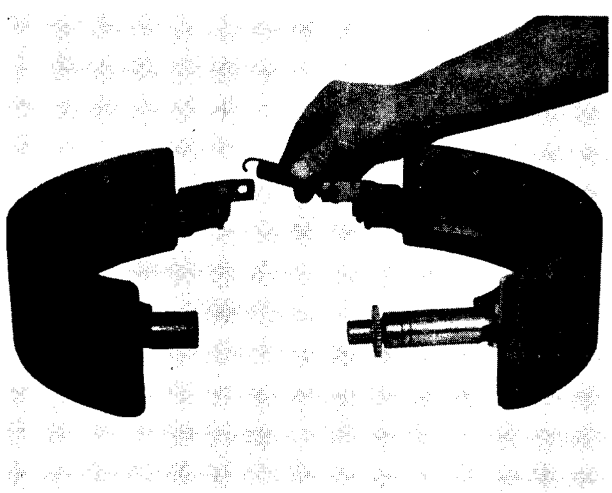
Illust. 7



Illust. 5



Illust. 8



Illust. 6

upper ends of shoes with hook ends inward.

Spread adjusting ends of shoes apart to permit placing them in position on anchor pins (Illust. 7). When upper ends of shoes are on pins, bring lower ends together just enough to allow both shoes to rest on backing plate.

Install reinforcement plate onto anchor pins (Illust. 8).

Install cable ring end onto rear shoe anchor pin (Illust. 9). Flat side of ring against reinforcement plate.

Insert short hooked end of return spring (black) through hole in cable guide. Continue to insert hook through proper hole in shoe web (Illust. 10).

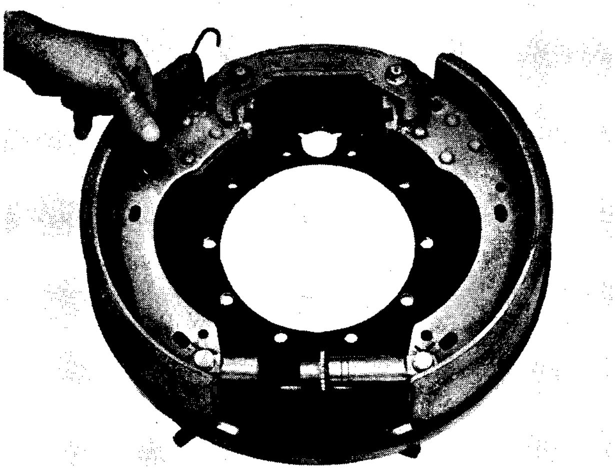
Install hooked end of cable in slotted hole of adjuster lever. Open end of hook facing away from backing plate (Illust. 11).
CAUTION: Cable must not be twisted or kinked and must be around outer edge of guide.

Place rounded hole in adjuster lever over pin and into groove. Lever to pivot in groove.

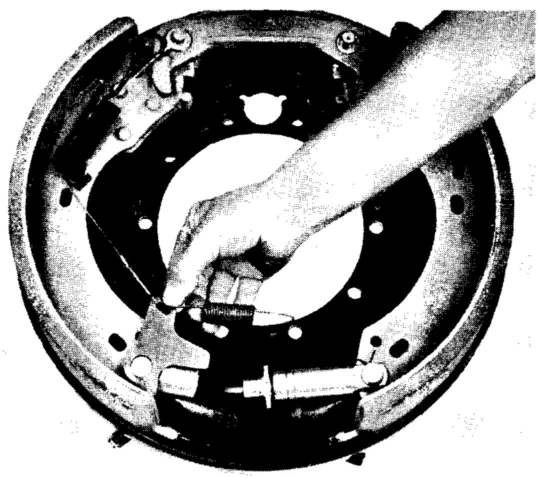
Hook end of adjuster spring (blue) into slotted hole of lever (Illust. 11).

Align adjusting screw with socket and pull shoes together until starwheel contacts socket end. Hold shoes in place and hook loose end of spring into hole in front shoe web (Illust. 12). This will hold shoes in place for installation of hold-down springs.

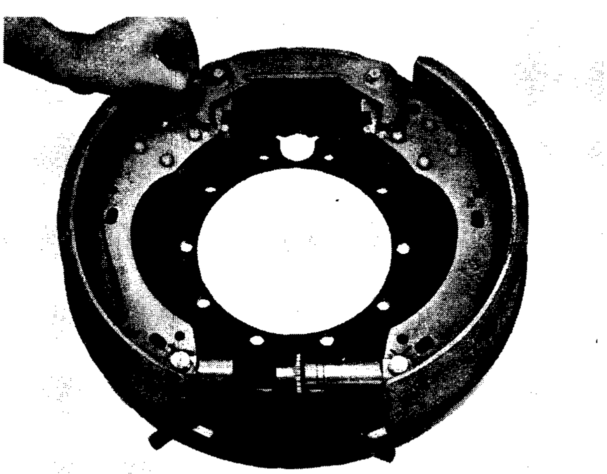
Insert hold-down pin through countersunk hole in backing plate and shoe web. Cotter pin hole in hold-down pin must align with shoe web.



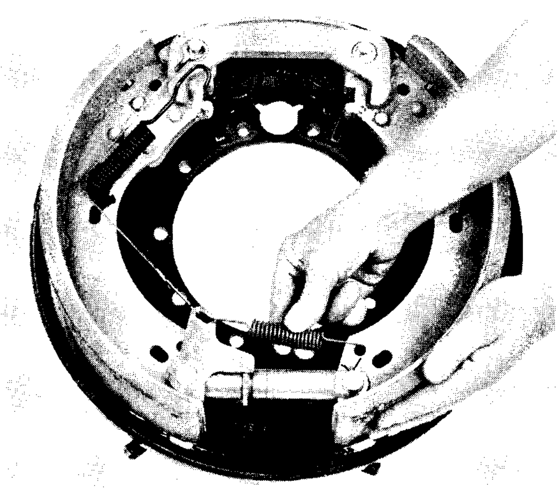
Illust. 10



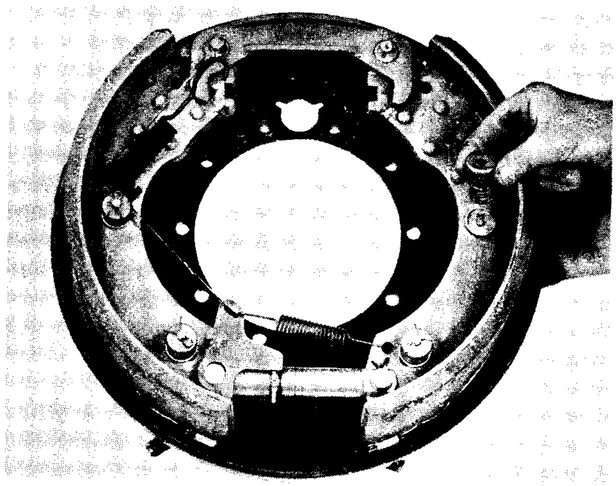
Illust. 11



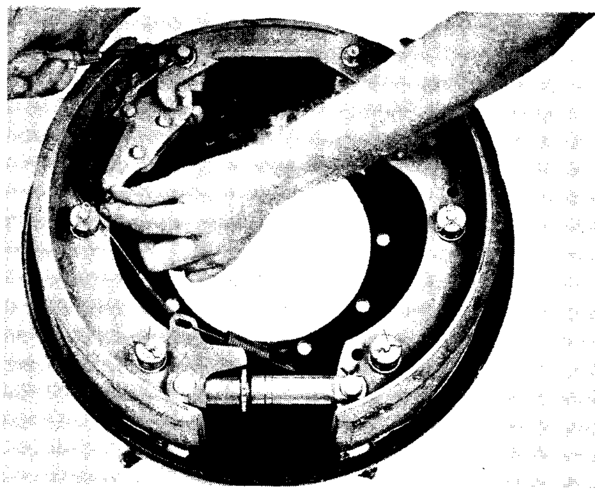
Illust. 9



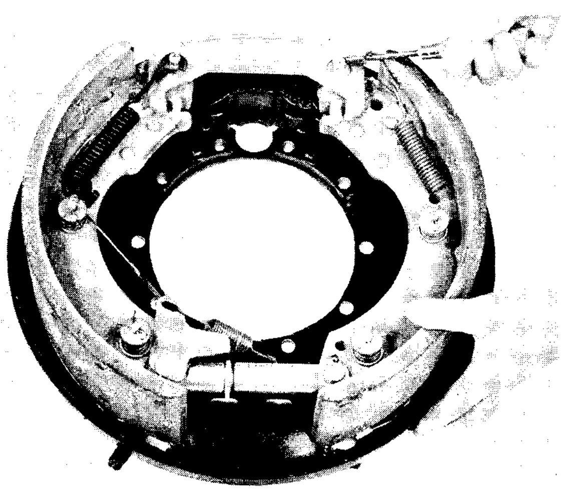
Illust. 12



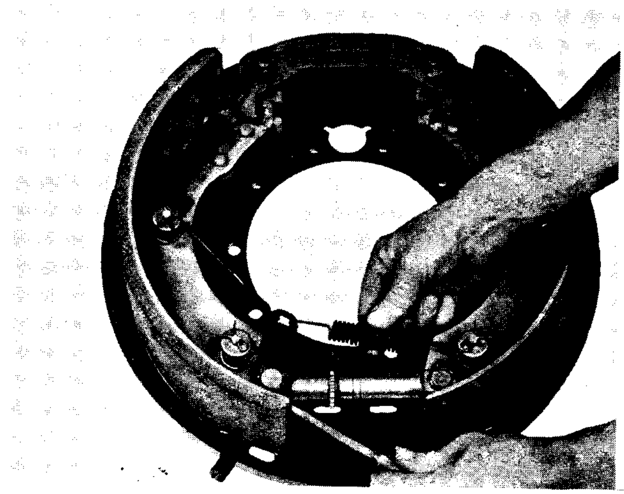
Illust. 13



Illust. 14



Illust. 15

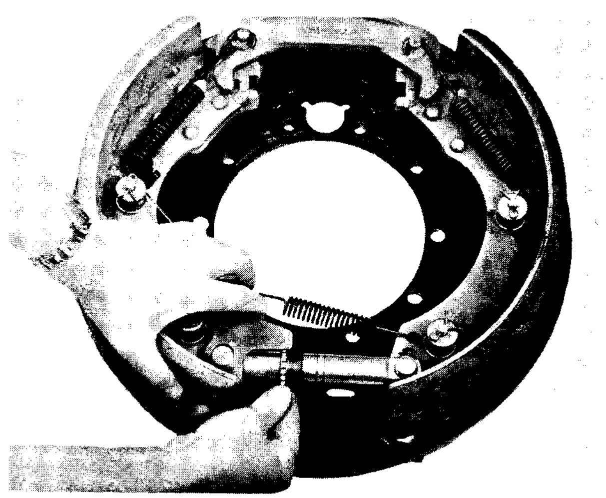


Illust. 16

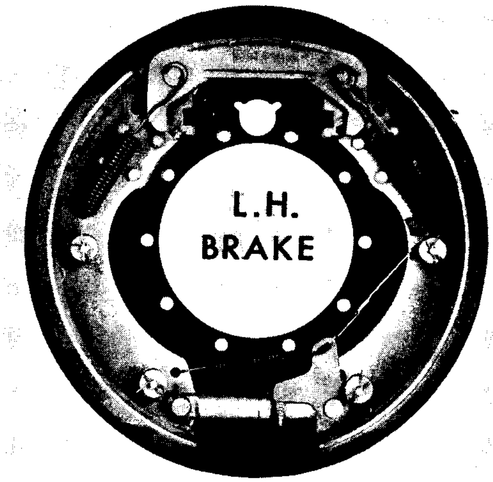
Insert cup, spring and cup onto pin (Illust. 13). Depress cup and spring with a 3/4" open end wrench or other suitable tool until cup is below cotter pin hole in pin. Insert and spread cotter pin.

Install remaining three hold-down pins in the same manner.

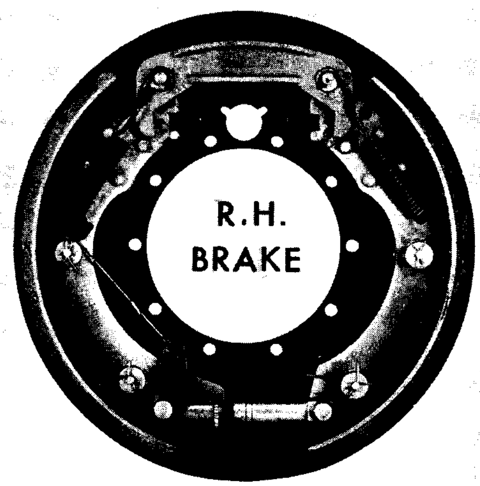
Unhook adjuster spring (blue) from shoe web to free cable guide. See that cable guide is seated properly on shoe web with upper end of groove against outer side of return spring (black). Hook return spring over rear shoe anchor pin with a spring in-



Illust. 17



Illust. 18



Illust. 19

stalling tool (Illust. 14). Spring hook to be over cable fitting.

Hook front shoe spring (red) to anchor pin in same manner (Illust. 15).

Pull adjuster lever over and into groove of adjusting screw pin. Hold in place (Illust. 16) and rehook adjuster spring.

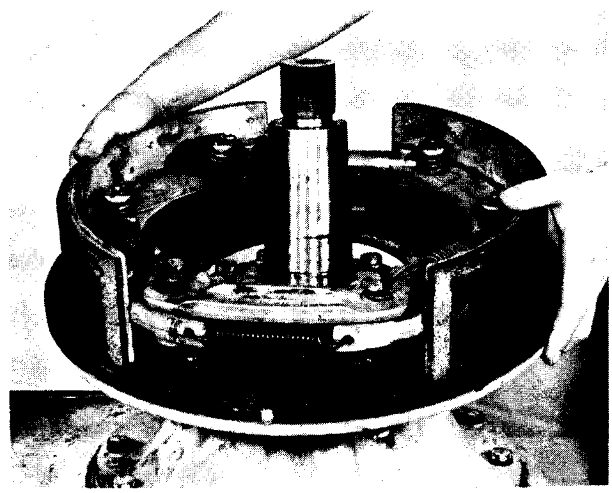
Hold adjuster lever away from starwheel. Manually turn starwheel outward until approximately six screw threads are showing (Illust. 17).

Illusts. 18 and 19 are views showing complete assembly of L.H. and R.H. brake mechanism.

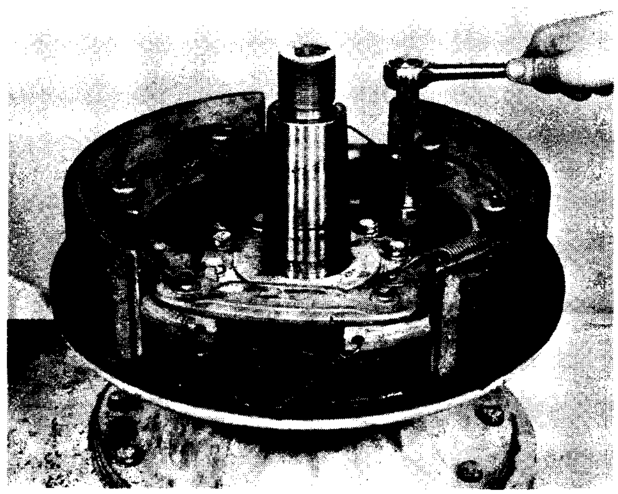
Auto-matic brake mechanism is ready for installation onto eccentric housing.

INSTALLATION

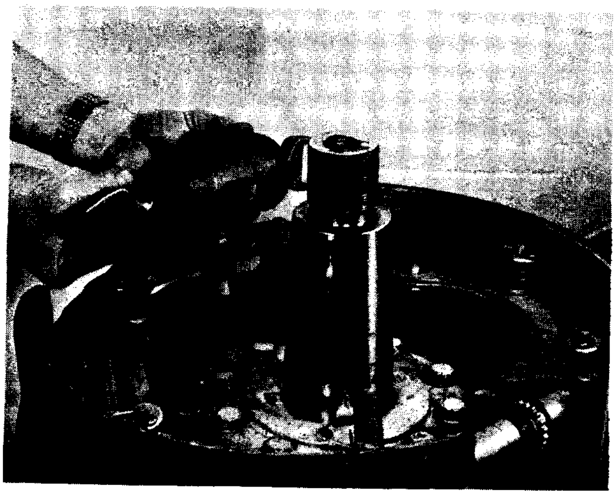
Install brake mechanism onto eccentric housing (Illust. 1). Reinforcement plate toward top. The exact position is determined by location of brake cylinder in relation to end of hydraulic brake tubing on top of tandem.



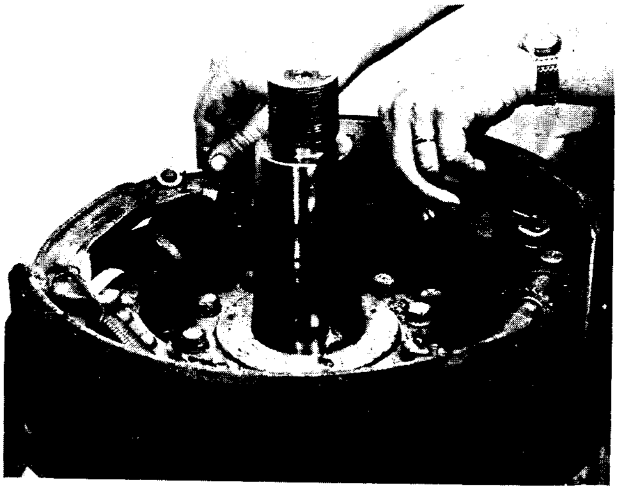
Illust. 1



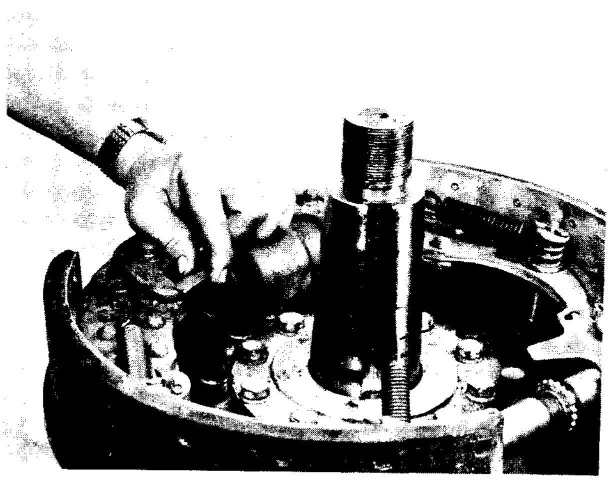
Illust. 2



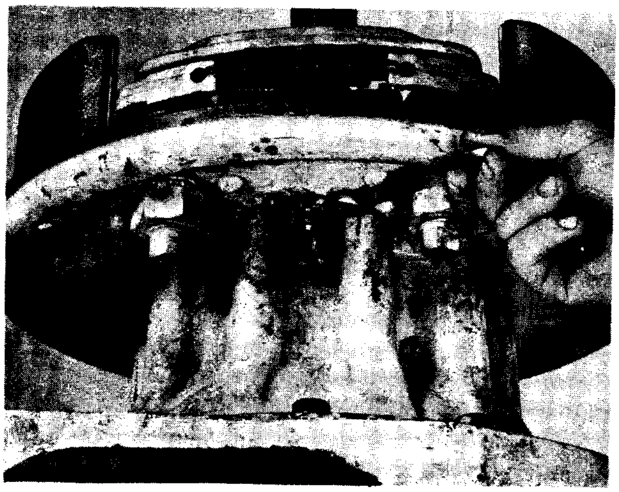
Illust. 3



Illust. 6



Illust. 4



Illust. 5

Unhook return springs, adjuster spring, shoe to shoe spring and cable fitting from anchor pin.

Install cap screws and lock washers. Tighten cap screws securely (Illust. 2).
NOTE: Tighten four long cap screws into top holes of backing plate.

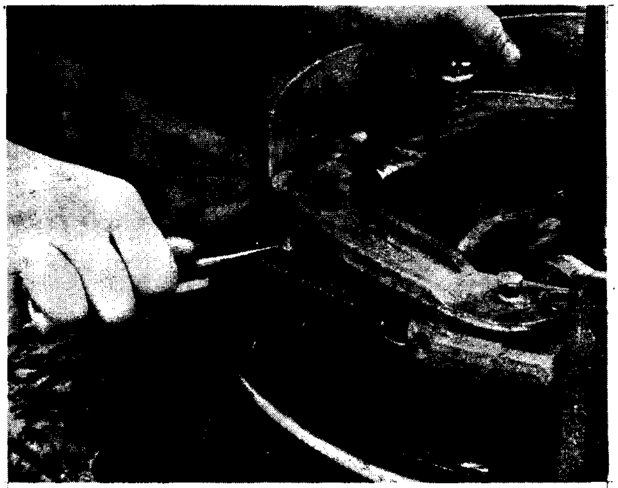
Install wheel cylinder onto backing plate. Connecting links to fit over knobs and into slots of shoes (Illusts. 3 and 4).

Install wheel cylinder cap screws and lock washers. Tighten cap screws securely (Illust. 5).

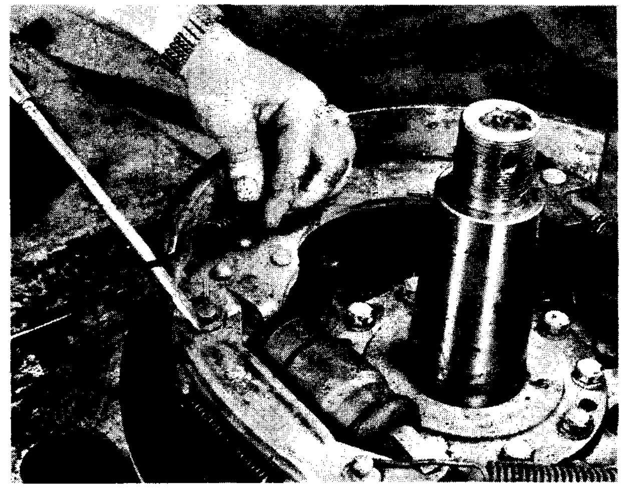
Install cable ring end onto rear shoe anchor pin. Flat side of ring against reinforcement plate. Bring cable around outer edge of guide plate. Install hooked end of cable in slotted hole of adjuster lever (Illust. 6). Open end of hook facing away from backing plate.

CAUTION: Cable must not be twisted or kinked.

Rehook shoe to shoe spring (Illust. 7). Hook ends pointing inward.



Illust. 7



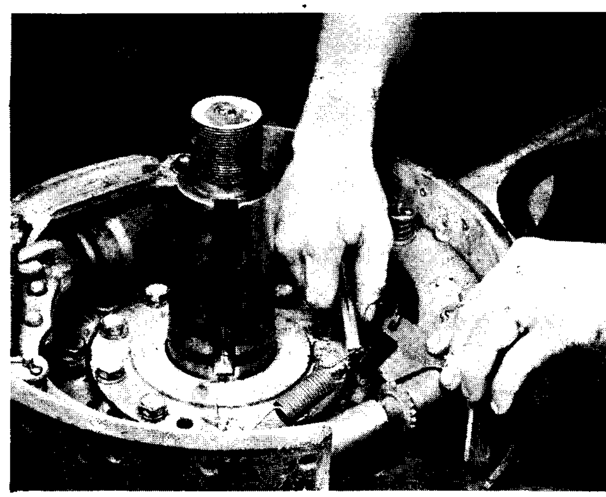
Illust. 8

Be sure cable guide is seated on shoe web properly with upper end groove against outer side of return spring.

Rehook return spring over rear shoe anchor pin (Illust. 8).

Rehook front shoe spring in same manner.

Hold adjuster lever in place in groove of adjusting screw pin. Rehook adjuster spring (Illust. 9).

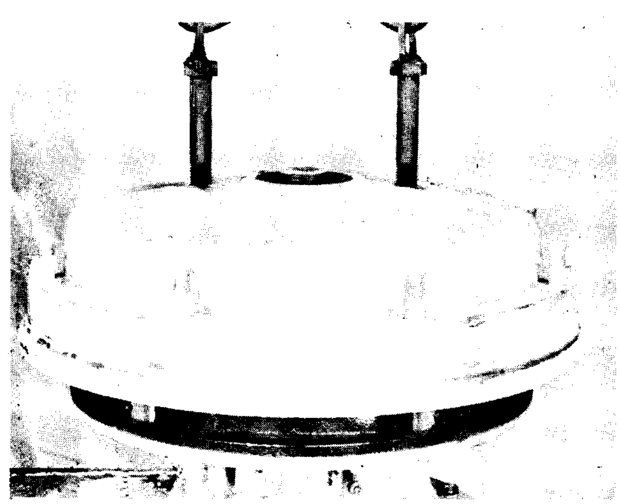


Illust. 9

Before installing brake drums, be sure both anchor pin nuts are loose and that pins rotate freely. Arrows on pins must be pointing toward one another.

Install brake drum (Illust. 10). Install washer and nut. Tighten nut to a torque reading of 600 foot pounds.

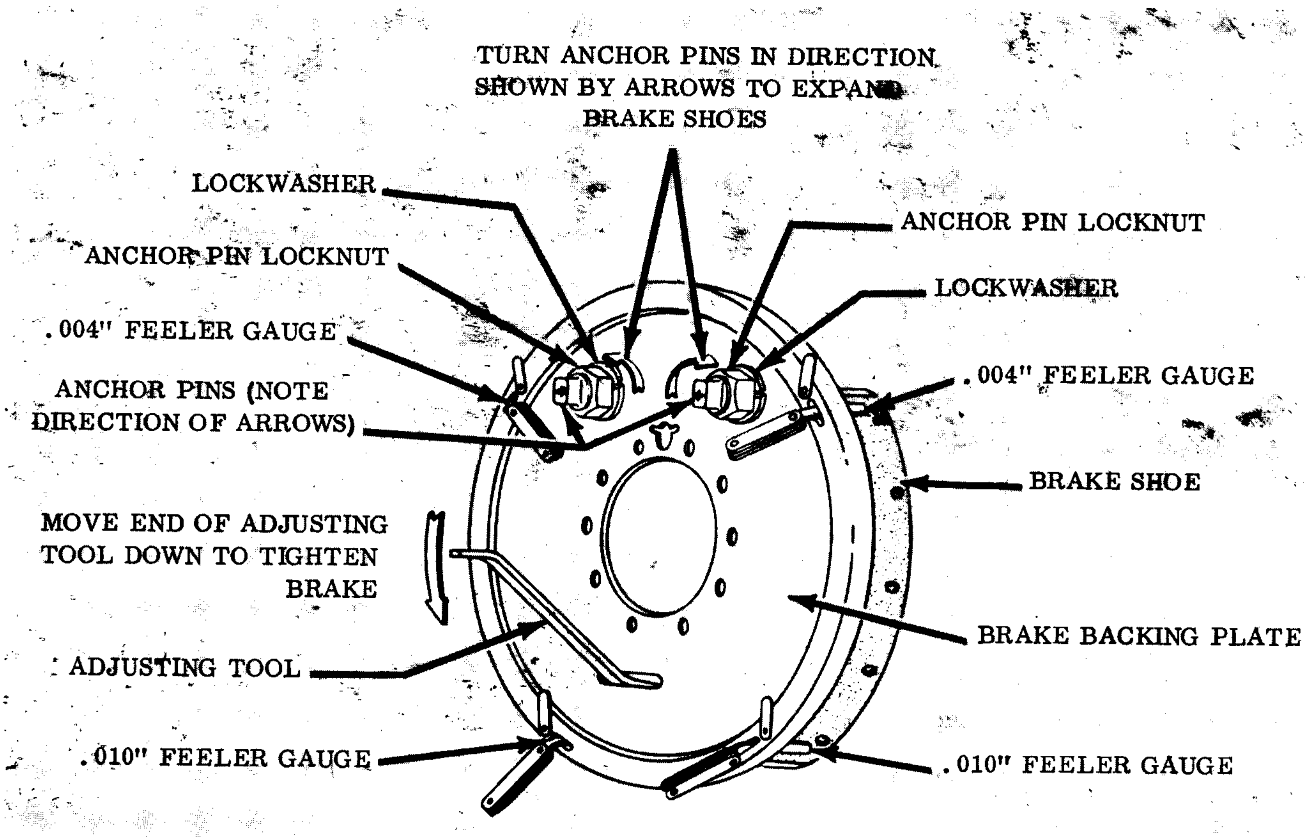
If slot in nut does not align with cotter pin hole in axle, tighten nut to next slot. Install and spread cotter pin.



Illust. 10

INITIAL ADJUSTMENT

Open 4 adjusting covers on backing plate. Insert .010" feeler gauges in each bottom



Illust. 11

slot. Gauge to be between linings and drum (Illust. 11).

Tighten adjusting screw in direction of arrow in Illust. 11, until lower end of both shoes cause a slight drag on gauges. CAUTION: DO NOT OVER TIGHTEN.

Tap brake drum lightly to center brake mechanism in drum.

Leave .010" gauges in place in lower slots and insert .004" gauges in upper slots (Illust. 11).
NOTE: Gauges must be between lining and drum.

Turn anchor pins (in direction necessary) until a slight drag is established on .004" gauges.

Recheck bottom feeler gauges to make certain .010" clearance is maintained. Readjust if necessary. If readjustment is necessary, adjust lower shoes outward by turning adjustment screw.

When adjustments have been made, remove feeler gauges.

Hold anchor pins in position with a wrench and tighten locking nuts to a torque reading of 400-440 foot pounds.

Close covers over slots.

FINAL ADJUSTMENT

Apply brakes from a seated position with wheels not turning. Top of brake pedal must measure 6 inches above cab floor, measured along curve of brake lever.

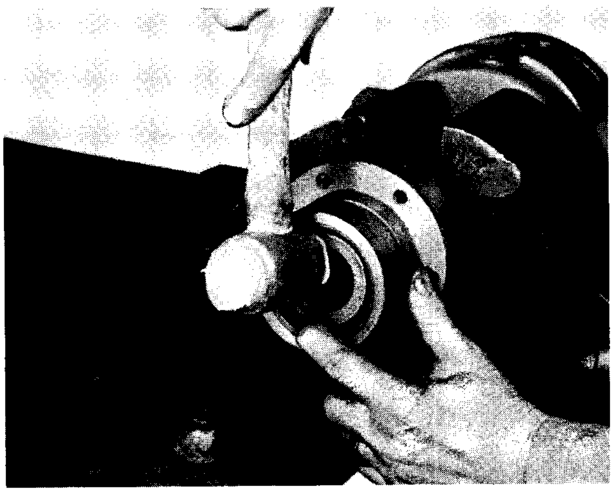
Pedal clearance is made by adjusting adjusting screw through slot in backing plate (Illust. 11).

POWER CONTROLS

POWER BOX REDUCTION DRIVE

It is seldom necessary to completely overhaul the power control box. Usually it is only necessary to repair an individual unit in the box. If a complete overhaul is to be attempted, the procedure outlined below should be followed. Due to the fact that during the reassembly operation all adjustments and settings must be established, a detailed discussion is given only of reassembly operation.

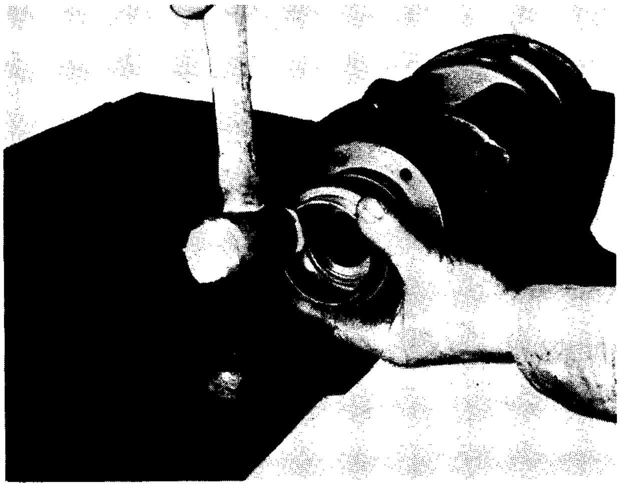
The following description and illustrations are with complete power control box removed from grader.



Illust. 1

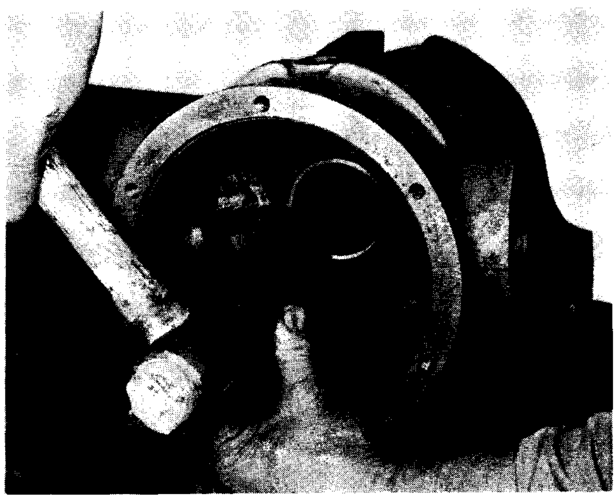
The first step in reassembly after all parts are cleaned and ready for installation, is to install leather grease seal in top end of power box drive housing (Illust. 1). Install seal with sharp edge toward top of housing, install as a grease seal. Drive seal into housing as far as it will go, using a soft hammer. Lubricate leather in seal with machine oil before installing.

Install bearing cup into top end of power box drive housing, making sure that small end of taper goes to the inside. Use a soft hammer and drive cup in as far as it will go (Illust. 2)



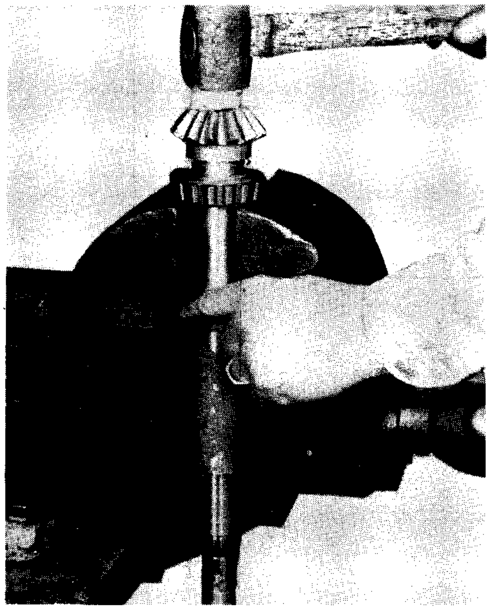
Illust. 2

Install bearing cup into bottom end of power box drive housing, making sure that small end of taper goes to the inside. Use a soft hammer and drive cup in as far as it will go (Illust. 3).



Illust. 3

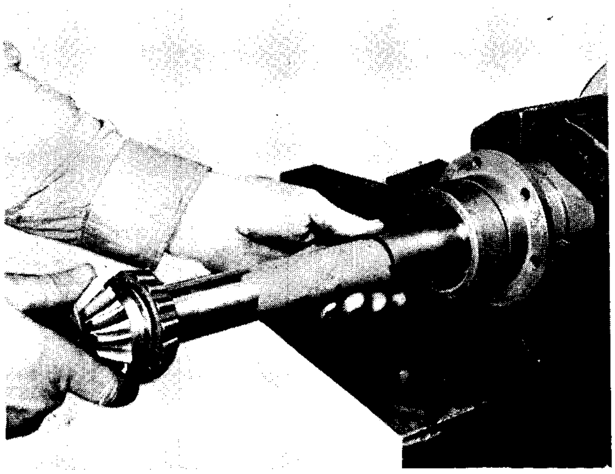
Install tapered roller bearing on vertical drive shaft (Illust. 4). Be sure that the large diameter of the bearing is driven up against the shoulder behind the bevel drive gear. All bearings should be lubricated with machine oil before installing.



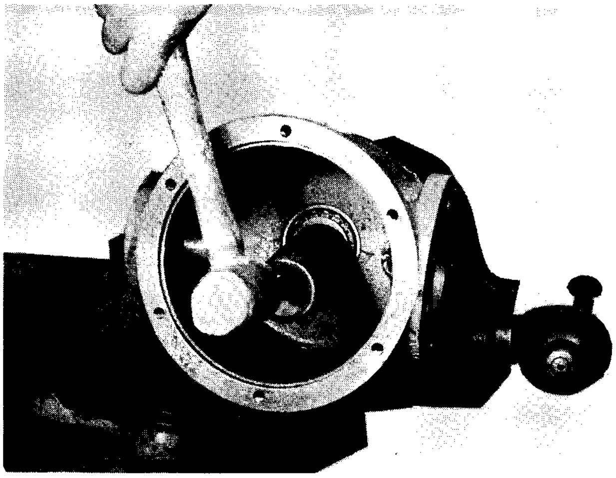
Illust. 4

The vertical drive shaft with bearing may now be installed into housing. When inserting shaft through leather seal in top end of housing, be sure not to damage seal. One way of expanding leather seal over shoulder of shaft is by wrapping a strip of thin shim stock around shaft in a funnel shape. Illust. 5 is the installation of drive shaft through seal with the use of shim stock.

Press or drive lower bearing on shaft (Illust. 6). When pressing or driving bearing into place, use a piece of pipe



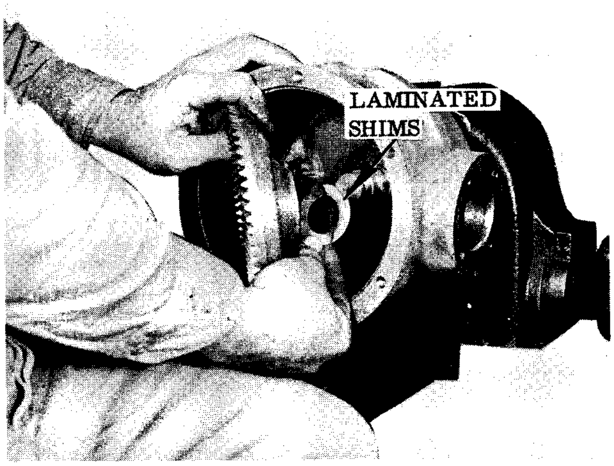
Illust. 5



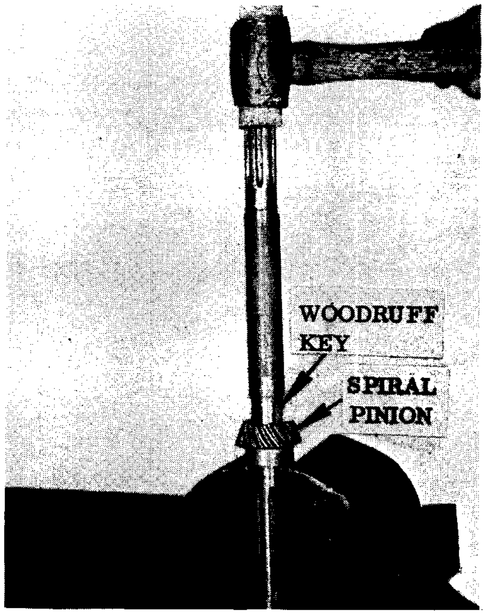
Illust. 6

or similar driver which will fit against the inner race of bearing.

Install the two (2) laminated spiral gear shims (Illust. 7). Next, install spiral bevel gear. Install hex slotted nut and tighten securely. Back hex slotted nut off one (1) slot. Install and spread cotter pin. Using a block of wood or a soft drift, bump the shaft sharply. The bearings should now be pre-loaded. The specifications on the pre-load of these bearings are 4-8 inch pounds. If it should be necessary to remove the bevel gear for any reason, the reassembly would be the same as the above mentioned procedure.

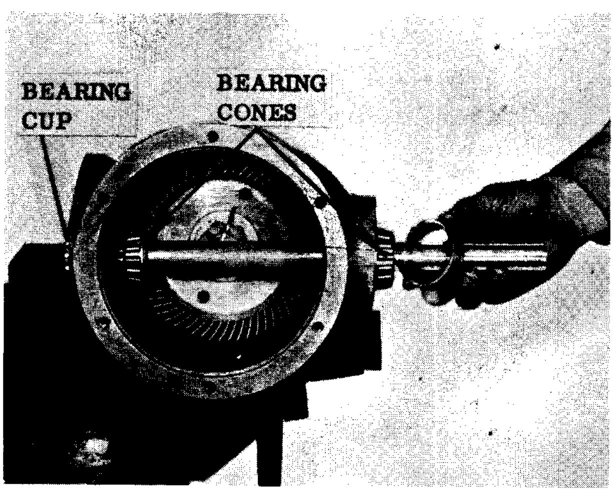


Illust. 7



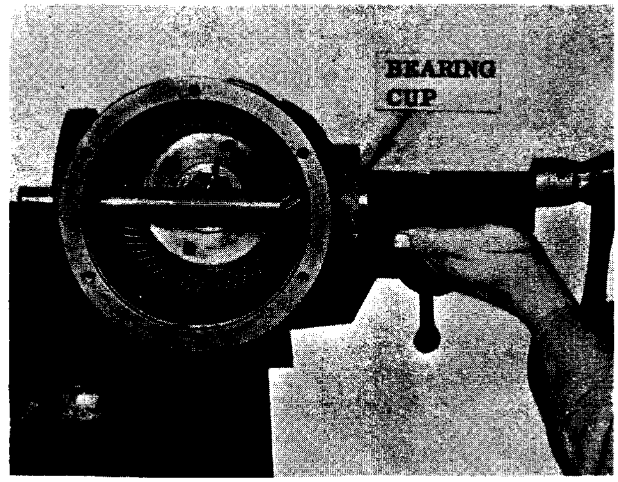
Illust. 8

Install Woodruff key (Illust. 8) into keyway of spiral pinion drive shaft. Install spiral pinion onto shaft (Illust. 8) with hub of gear toward the long splined end of shaft. Use a soft hammer or piece of pipe to drive the gear to shoulder of shaft.



Illust. 9

Install bearing cup into pump opening housing (Illust. 9) using a soft hammer or piece of pipe. Assemble bearing cones on spiral pinion drive shaft, small tapered ends of cones facing ends of shaft. Insert spiral pinion drive shaft,



Illust. 10

Illust. 11

with short splined end of shaft first (Illust. 9). Install bearing cup (Illust. 10) using a soft hammer or piece of pipe.

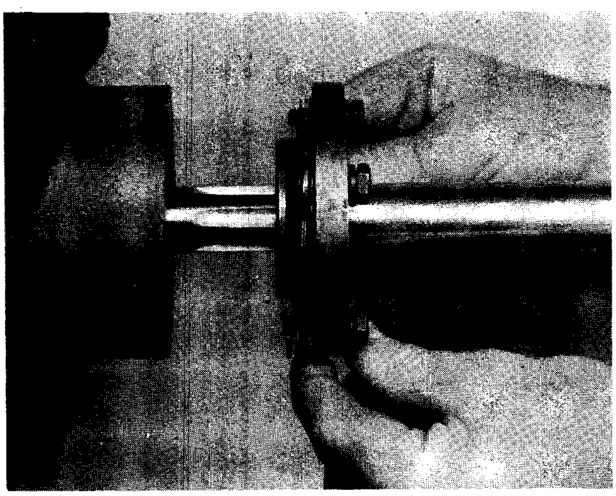
Spiral pinion gear and bevel pinion gear to run flush at toe end of gears.

Press or drive oil seal into seal cap (Illust. 11). Lip of seal toward vertical drive housing.

Install "O" ring in groove of seal cap (Illust. 12).

Illust. 12

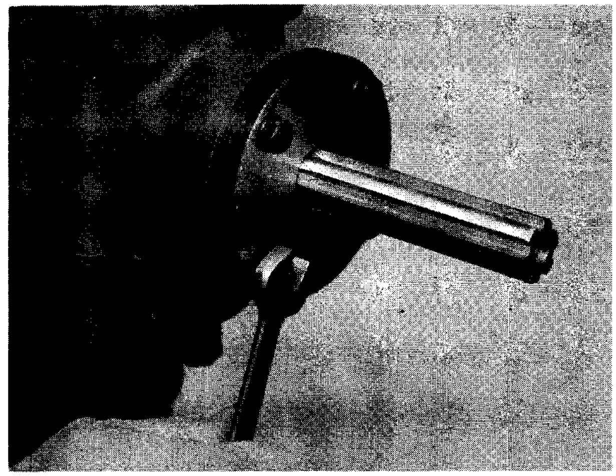
Install shims onto hub of seal cap. Next, install seal cap onto long splined end of spiral pinion drive shaft (Illust. 13). NOTE: To protect oil seal leather from damage, wrap a thin piece of shim stock over splines of shaft; also, use white lead on "O" ring to prevent damaging "O" ring when hub of seal cap is inserted into vertical drive housing.



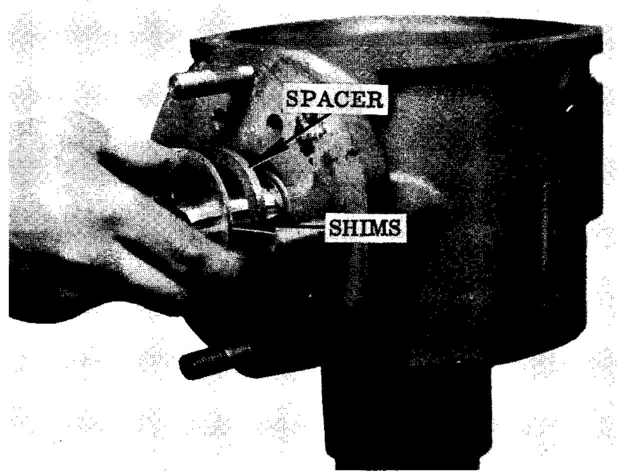
Illust. 13

Install cap screws and lock washers. Tighten cap screws securely (Illust. 14).

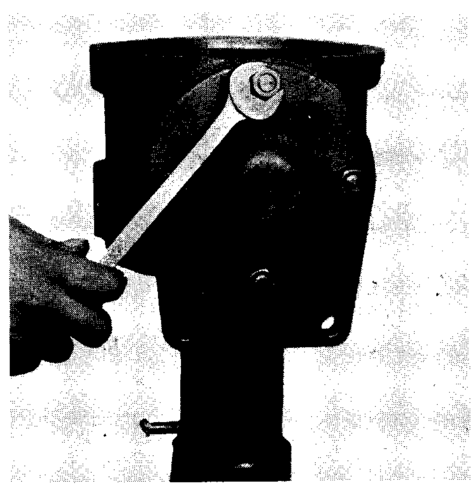
Install spacer and shims onto short splined end of spiral pinion drive shaft (Illust. 15).



Illust. 14



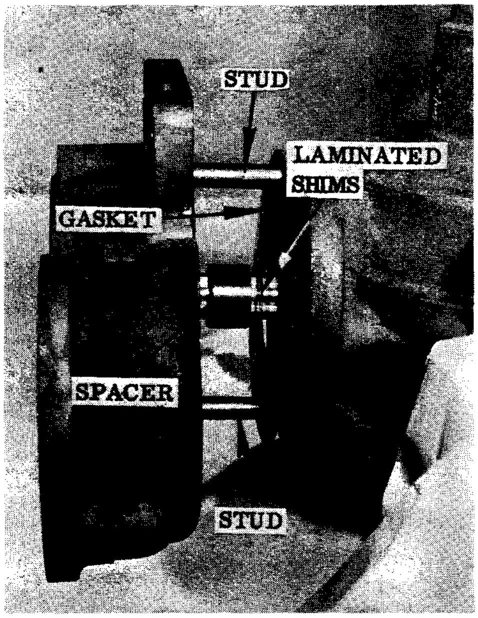
Illust. 15



Illust. 16

Install pump opening cover less gasket (Illust. 16). Install stud nuts and lock washers. Tighten nuts.

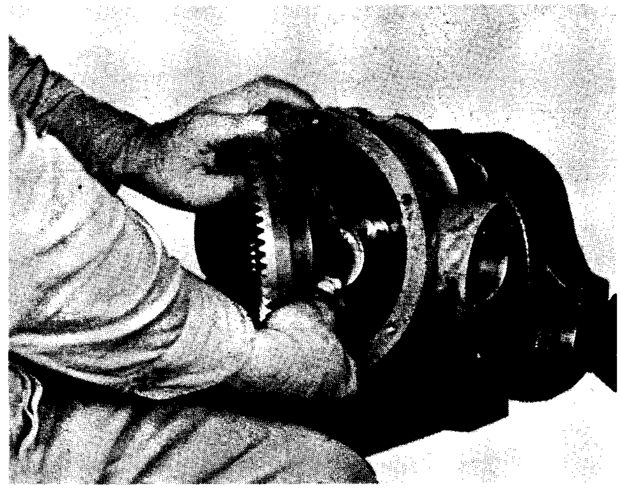
NOTE: Pump opening cover is used only when equipped with manual steering.



Illust. 17

For Models equipped with power equipment, such as power steering, power shift moldboard, etc., install shims, spacer and pump mounting gear housing, less gasket (Illust. 17) onto vertical drive housing. Install cap screws with lock washers. Tighten cap screws securely.

Illust. 18



Illust. 19

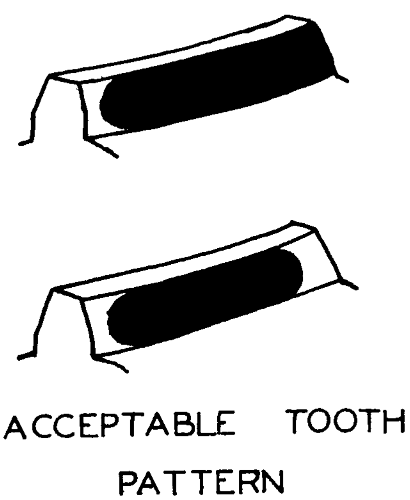
Pre-load the bearings to a torque reading of 4-8 inch pounds (Illust. 18). To obtain this reading, remove or add shims at seal cap as necessary. If reading still cannot be obtained, remove or add shims at pump opening cover (Models equipped with manual steering) or pump mounting gear housing (Models equipped with power accessories.

To obtain the pinion depth setting, set toe end or spiral gear flush with toe end of bevel gear, remove shims as necessary from one side of vertical drive housing and add the same amount of shims to the opposite side (Illusts. 22 and 23).

To obtain the backlash between spiral pinion gear and bevel gear, use a dial indicator. Remove or add shims under bevel gear (Illust. 19) until a reading of .004" to .012" is obtained. Backlash should be measured at the tightest point.

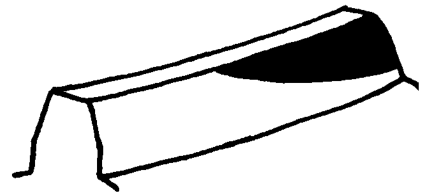
In order to be sure that the spiral pinion and spiral bevel gears are in proper mesh, it is necessary to make a surface pattern check. This may be done by mixing powdered red lead with any light machine oil and spreading it over the working surfaces of the teeth with a brush to show clearly the tooth contact obtained. Prussian blue may also be used. NOTE: Gears are to be clean and free from oil.

Revolve the gears several revolutions in the forward speed direction. Inspect the teeth of the gears for portions where the paint has been removed by the contact of the two (2) gears. Compare the results with the surface patterns shown in Illust. 20.

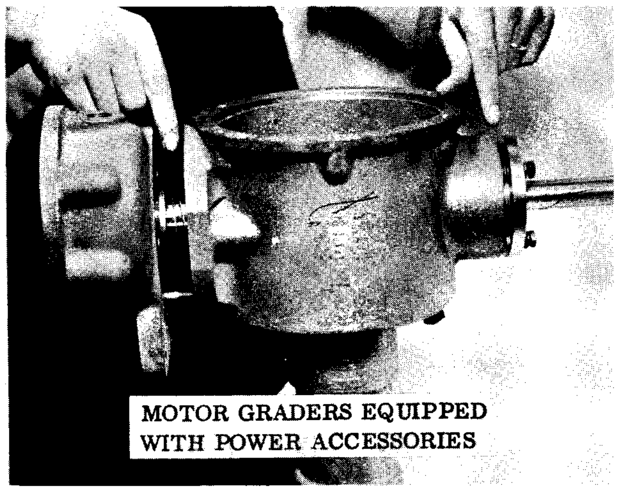


Illust. 20

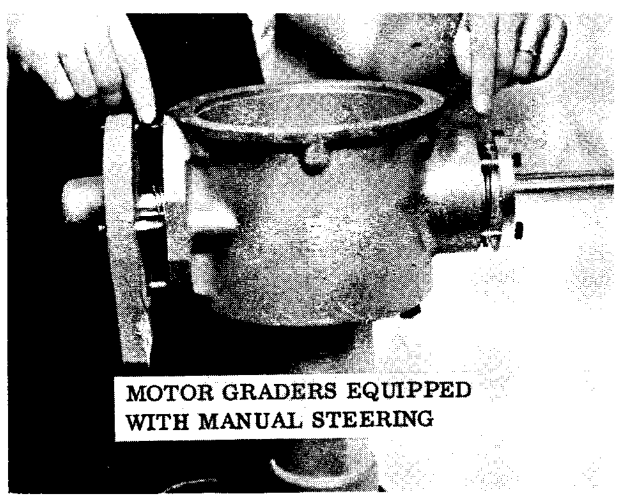
When you have a tooth pattern as in Illust. 21., it is necessary to remove shims from the seal cap side of vertical drive housing and add the same amount of shims to the pump opening side (Models equipped with manual steering only (Illust. 22) or pump mounting gear housing side (Models equipped with power accessories) (Illust. 23) of vertical drive housing.



Illust. 21

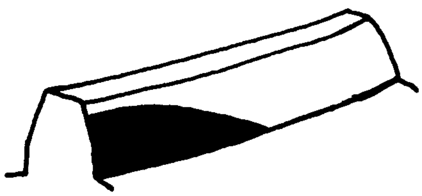


Illust. 22

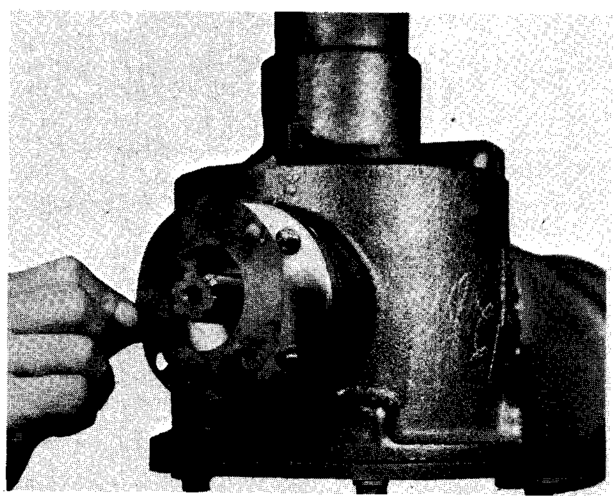


Illust. 23

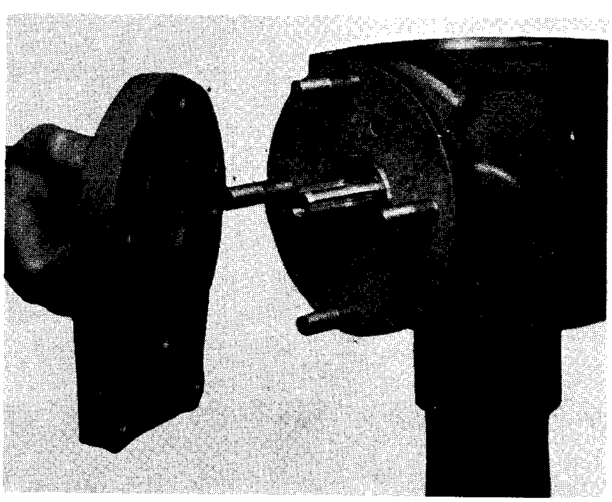
When you have a tooth pattern as in Illust. 24, it is necessary to remove shims from the pump opening side (Models equipped with manual steering only) (Illust. 22) or pump mounting gear housing side (Models equipped with power accessories) (Illust. 23) of vertical drive housing and add the same amount of shims to the seal cap side of vertical drive housing.



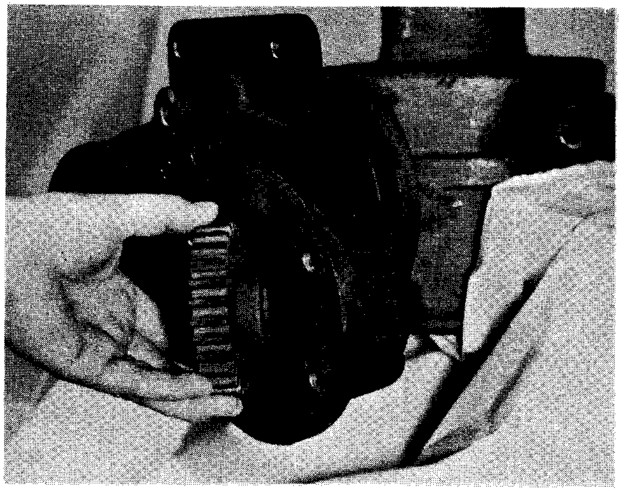
Illust. 24



Illust. 25



Illust. 26



Illust. 27

After the pre-loading of bearings, pinion depth setting, backlash of gears and tooth pattern is obtained, remove pump opening cover from vertical drive housing. Shellac gasket (Illust. 25) to vertical drive housing.

Install cover onto vertical drive housing (Illust. 26). Install lock washers and nuts onto studs. Tighten nuts securely. Next, tighten seal cap, cap screws securely.

Shellac bottom cover plate gasket to vertical drive housing and install cover plate. Install cap screws and lock washers. Tighten cap screws securely.

The vertical drive housing used on Models equipped with manual steering is complete and ready for installation to power box.

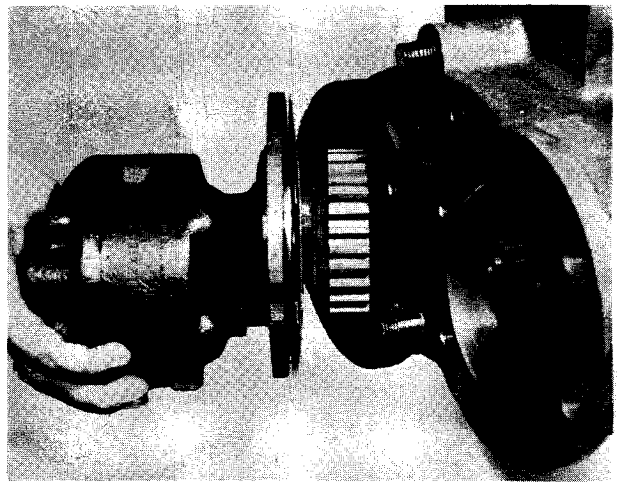
To complete the vertical drive housing used on Models equipped with power accessories, remove pump mounting gear housing from vertical drive housing. Shellac gasket to vertical drive housing and install pump mounting gear housing on studs just enough to hold housing into position.

Insert pump drive gear into pump mounting gear housing and on to splined end of vertical drive shaft (Illust. 27).

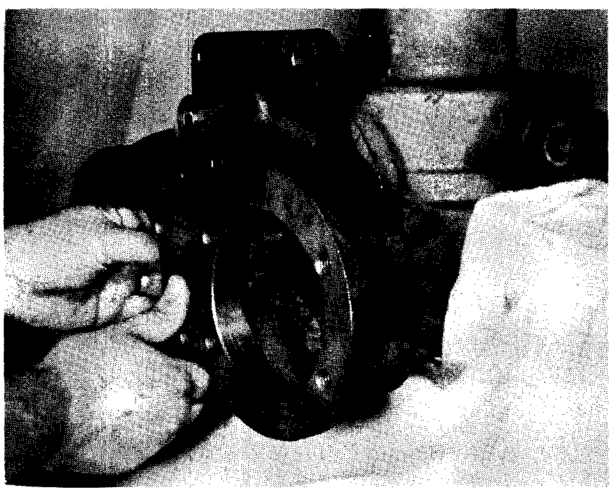
After gear is started on the splined shaft, slide gear and housing siumltaneously until housing is against vertical drive housing (Illust. 28).

Install cap screws and lock washers. Tighten cap screws securely (Illust. 29).

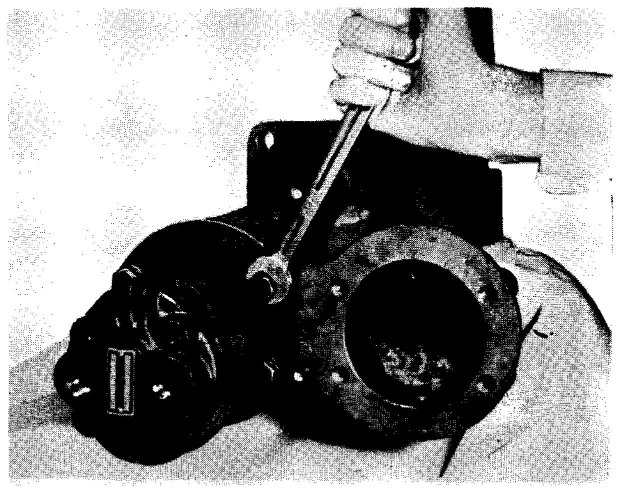
Next, install pump to housing (Illust. 30). Install cap screws and lock washers. Tighten cap screws securely (Illust. 31).



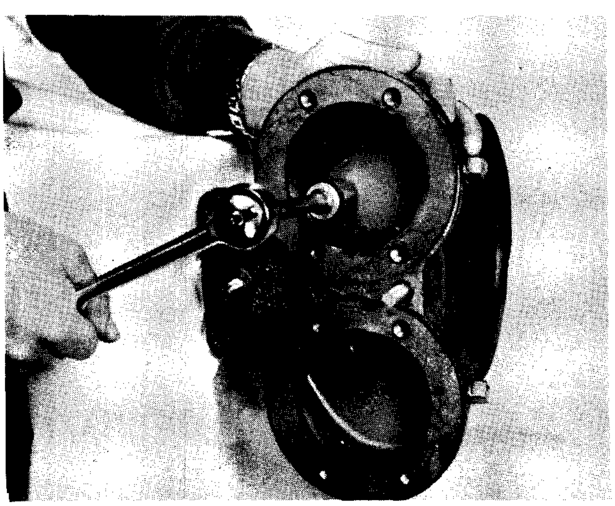
Illust. 30



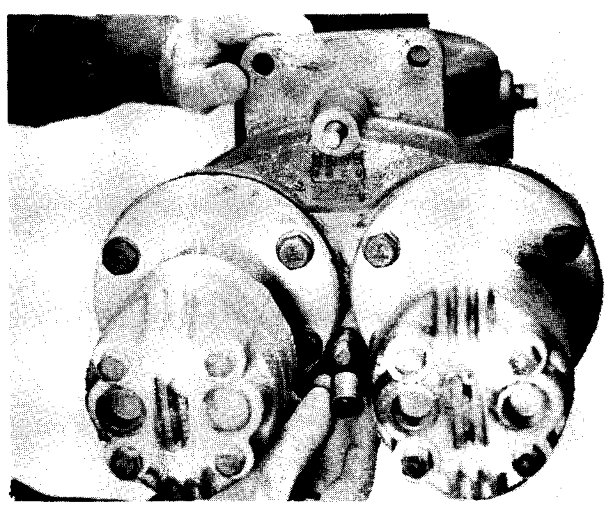
Illust. 28



Illust. 31



Illust. 29



Illust. 32

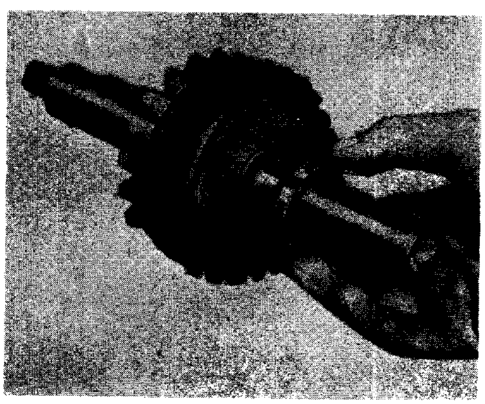
Illust. 33

Install spacer onto stud (Illust 32) and stud nuts and lock washers. Tighten stud nuts securely (Illust. 33).

Shellac bottom cover plate gasket to vertical drive housing and install cover plate. Install cap screws and lock washers. Tighten cap screws securely.

POWER BOX

Install Woodruff key in center shaft and install front bevel gear by supporting the gear in a press and pressing on shaft. Install the lock washer, being sure that inside lip of lock washer enters keyway in shaft. Install lock nut (Illust. 1) and tighten securely. Bend ears into slots of lock nut.



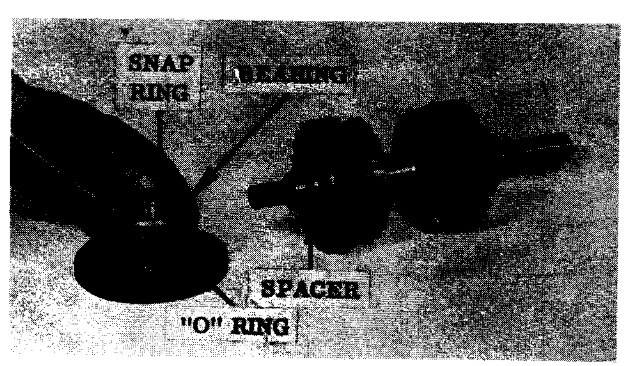
Illust. 1

Install a roller bearing and ball bearing in the rear bevel drive gear and assemble it on the opposite end of the center drive shaft. The proper assembly of bearings in rear bevel drive gear is shown in Illust. 2.

Install spacer on shaft and install ball bearing in the rear bearing carrier. Install snap ring and "O" ring in the rear bearing carrier (Illust. 3).

Illust. 2

Assemble rear bearing cage with "O" ring (Illust. 4) into power box. Be sure and apply white lead to "O" ring. This

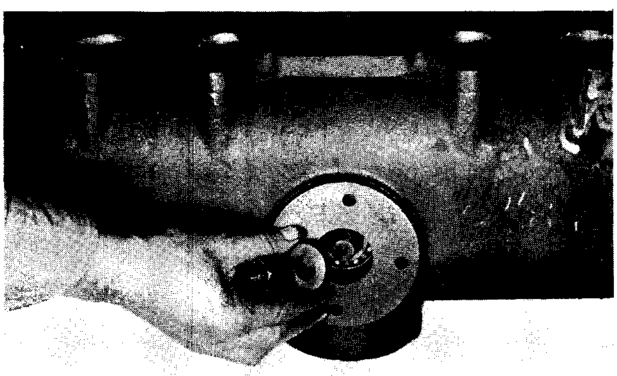


Illust. 3

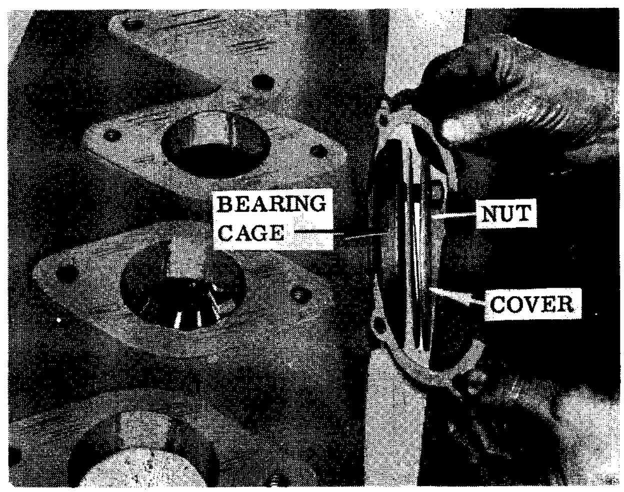
will help prevent damage to "O" ring when installing cage to the housing. Slide threaded end of center shaft into bearing in rear bearing cage. Install spacer and hex slotted nut (Illust. 4). Tighten hex slotted nut securely, being sure ball bearing is pressed securely against shoulder on the center shaft.

In order to properly adjust bevel gear and drive pinion, it will be necessary to assemble the bearings and gears on the center shaft and install in power box with cover in place. This will hold center shaft in operating position while gears are being adjusted.

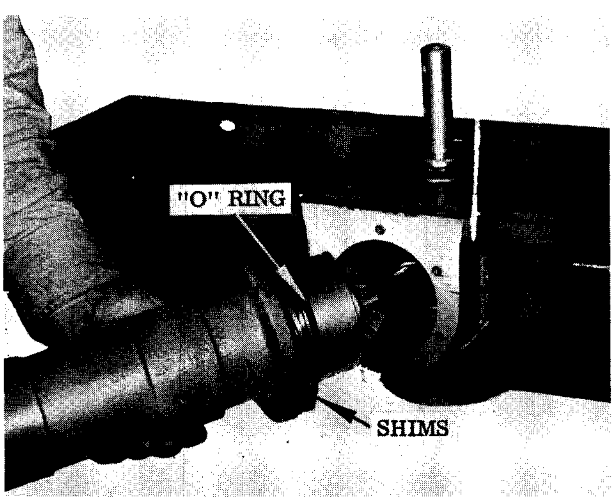
Install drive housing in power box. Maneuver gauge (.500" + .005") into power box through lever hole on right of center shaft. Place in position between center shaft and drive pinion gear (Illust. 7). Push drive housing into power box until gear and gauge are tight against center shaft. Use feeler gauge to measure clearance between bottom of power box and drive housing bolting flange. The reading obtained is the amount of shims required. Insert shims and "O" ring (Illust. 5) in groove at top of housing and assemble to power box. Tighten securely. NOTE: Apply white lead to "O" ring to prevent damage.



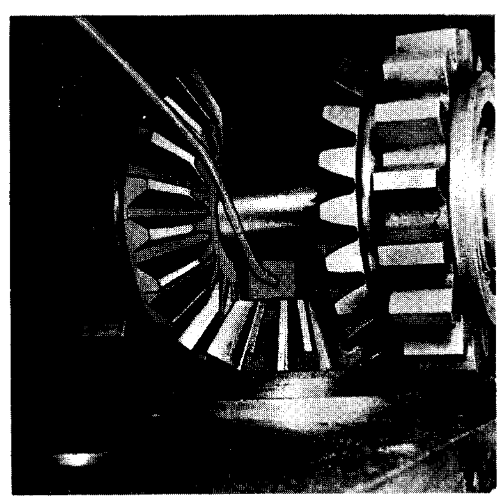
Illust. 4



Illust. 6



Illust. 5

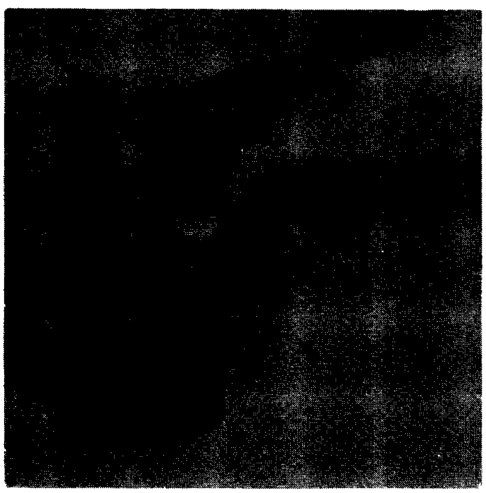


Illust. 7

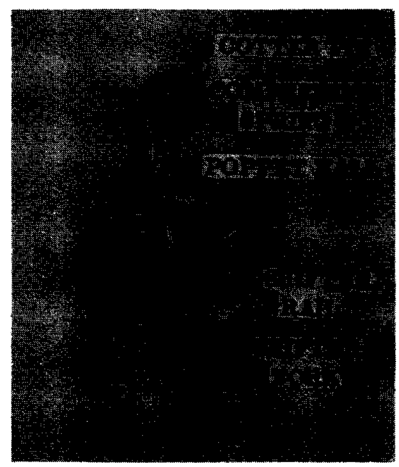
Adjust bevel gears by tightening nut (Illust. 6) until there is no backlash in either gear. Use feeler gauge to measure clearance between bearing cage (Illust. 6) and power box body. Back-off nut two (2) constellations plus whatever is necessary to align pin hole in shaft with nut. Install cotter pin. Add .010 to feeler gauge reading taken above and install the equivalent in shims (Illust. 6). Now, install cover (Illust. 6) making sure all cap screws have lock washers. Tighten cap screws securely. Backlash will now be approximately .008 to .010.

Install notched end of snap ring in the groove at the base of clutch jaws (Illust. 8). NOTE: The ring is to be hooked on clutch jaws to prevent rotating. Place the clutch on the clutch shaft, with the broad side of clutch facing the long end of clutch shaft (Illusts. 9 and 11).

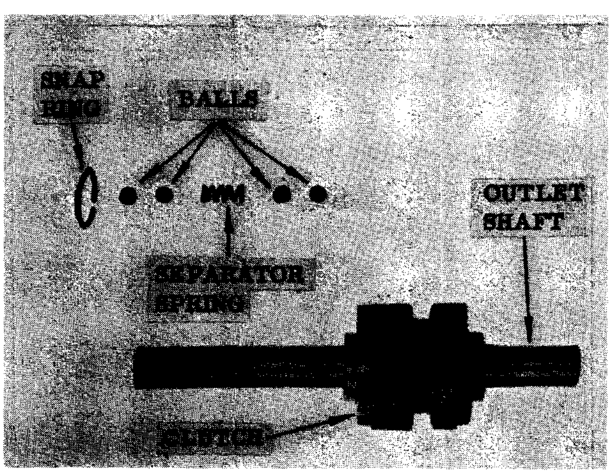
Before installing second snap ring, place 4 steel balls and one separator spring in each of the 3 designated spots in clutch spline. Then install second snap ring (Illust. 9). However, the second control from right, used to control front leaning wheel housing, will be assembled with 15 balls, 5 balls and no springs in each of the 3 grooves.



Illust. 8



Illust. 10



Illust. 9

Illust. 11

In installing the shifter fork, place the countersunk end of shifter rail extending out from the flat side of shifter fork. Align poppet seats in shifter rail, with the poppet, compression spring and cotter pin. See Illusts. 10 and 11.

To assemble clutch shaft, start at each end of splined shoulder by placing one small beveled thrust washer, one roller bearing, one clutch gear, one large thrust washer and one roller bearing. NOTE: Be sure to place beveled side of small thrust washer against the spline shoulder. Note assembly in Illust 11.

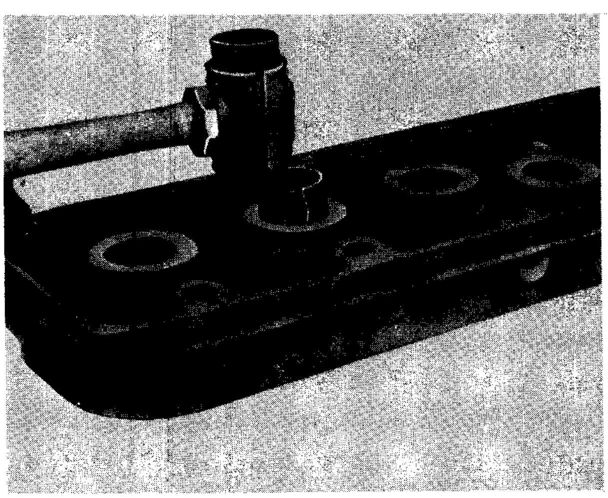
Install the roller bearing outer races in the power box housing and power box housing cover (Illust. 12). These races should be driven into the housing and cover so the edge of the race is flush with the inside surface of the housing. Thrust washers are installed before the bearing race is driven into housing. No thrust washers are used in cover.

In installing clutch shaft and shifter fork, start from center shaft first and work toward the ends of power control box.

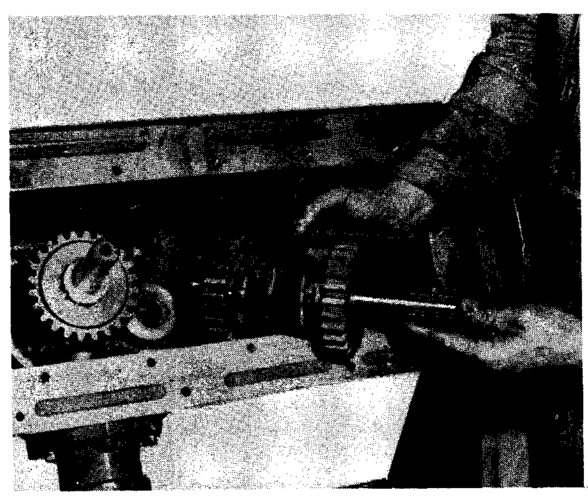
Install with the long end of shaft extending out from open side of housing. Illust. 13 shows this and also shows the complete unit of clutch shaft and shifter fork being installed in housing. (The roller bearing, large thrust washer and clutch gear can be left off all six clutch shafts. This allows less weight to handle, more visibility in lining the clutch shaft and shifter fork shaft in their bosses and less chance to have slippage between clutch and spline shaft which often causes loss of steel balls).

When installing the housing cover, be sure that the gasket is held firmly in position and that the cover fits over the two dowel pins in the housing. (Illust. 14). Install and tighten the cap screws in the housing cover.

Install the grease seals on the clutch shaft with the sharp edge of the leather seal pointing toward the inside of the housing, i.e., install as a grease seal. Expand the seal over the end of the shaft by wrapping the shaft with a piece of thin shim stock shaped like a funnel (Illust. 15). CAUTION: Be sure the edge of the seal does not drop into the pin hole in the shaft, thus damaging the seal. Drive the seal in with a piece of pipe that will fit the seal.

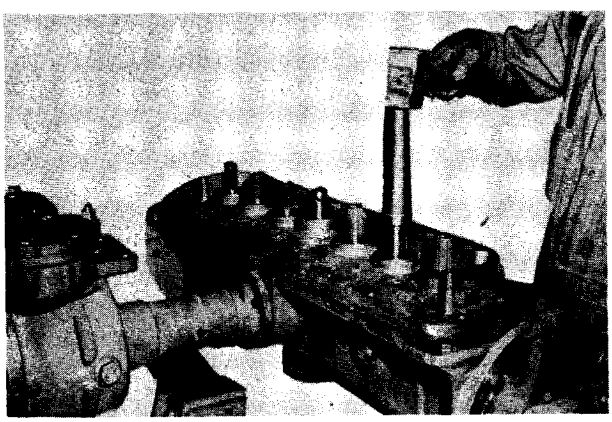


Illust. 12

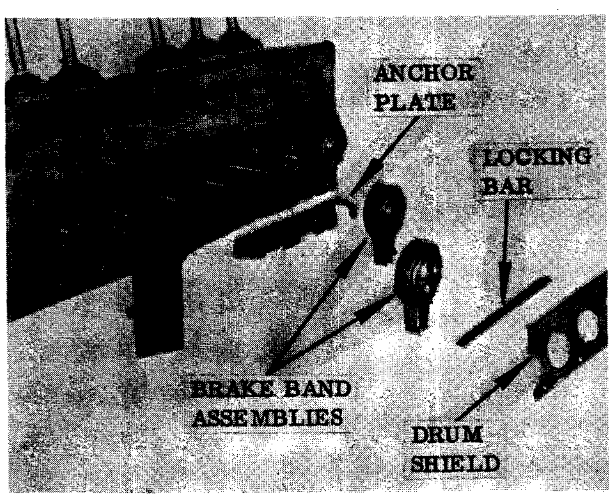


Illust. 13

Illust. 14



Illust. 15



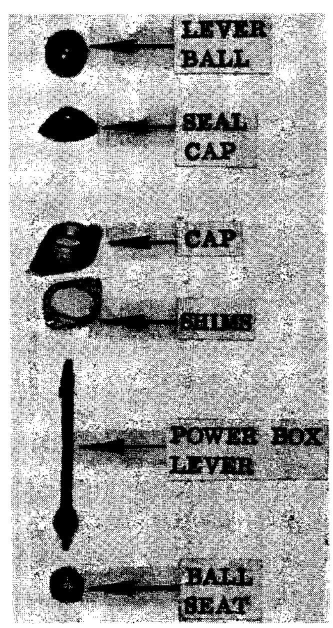
Illust. 16

After installing the housing cover, adjust the shifter fork assembly by sliding shifter fork rail back and forth until the countersunk end of the shifter fork rail indexes with hole in the housing cover.

NOTE: Install the cone point set screw first, followed by the cup point set screw.

Install the brake assembly (Illust. 16). First, install anchor plate. Then install brake drum and brake band assemblies as shown. Install the drum shield. Installing the locking bar, place bar back of fingers on the anchor plate, then align the holes of locking bar with the holes in anchor plate and drum shield.

To install the control levers that have been disassembled, reassemble them by installing the ball seat, power box lever arms, laminated shims, power box lever caps, lever seal caps and lever balls (Illust. 17). NOTE: Apply the amount of shims necessary so there will be a maximum of 1/32" vertical



Illust. 17

free movement on the lever arm assemblies. The lever seal cap is pressed on the lever arm. Illust. 18 shows the lever arm assembly being installed.

Install universal joints on splines of power control outlet shafts (Illust. 18). NOTE: End of outlet shaft to be flush with inside surface of universal joint yoke. Tighten universal joint clamp cap screw securely.

POWER CONTROL BOX REMOVAL

To remove power control box from cab, remove bearing cap from bracket which supports steering shaft. Swing steering shaft with steering wheel to one side. (Roadster Cab). Steering wheel and shaft must be removed on machines equipped with canopy top and enclosure.

Remove control shafts leading from power control box.

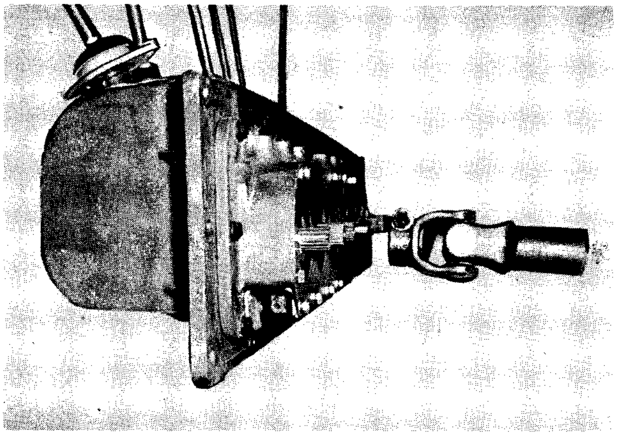
Remove both power control box stay rods which lead from front cab sheet to main frame.

Remove instrument box from each side of power control box and lay on cab floor.

Remove emergency brake from power control box.

Disconnect propeller shaft under cab by removing shear pin from discs.

To further simplify removing power control box, disconnect vertical drive housing from power control box. Lower vertical drive housing enough to allow clearance for removing power control box. To lower vertical drive housing, use blocks or hydraulic jack.



Illust. 18

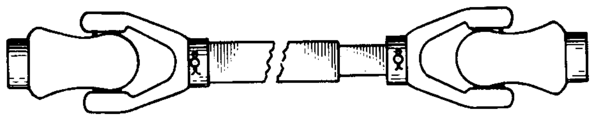
By using a chain hoist to hold power control box from falling, remove the anchor bolts from front sheet. Next, remove power control box from cab.

The vertical drive housing may also be removed.

POWER CONTROL SHAFTS

The power control shafts should be maintained in good condition at all times. A close inspection of all universal joints should be made occasionally to determine if any of the joints are worn to the point where efficiency of the controls is impaired. Any universal joints found to be badly worn should be immediately replaced.

Inspect all telescopic shafts for excessive wear or other damage. When assembling the square shaft into the hollow square on the telescopic unit, be sure to assemble it so fingers of the universal joint lie in the same relative plane. The proper assembling of the square shaft into the hollow square is shown in Illust. 1, with exception of front tilt square shaft and universal. If the shafts are assembled otherwise,

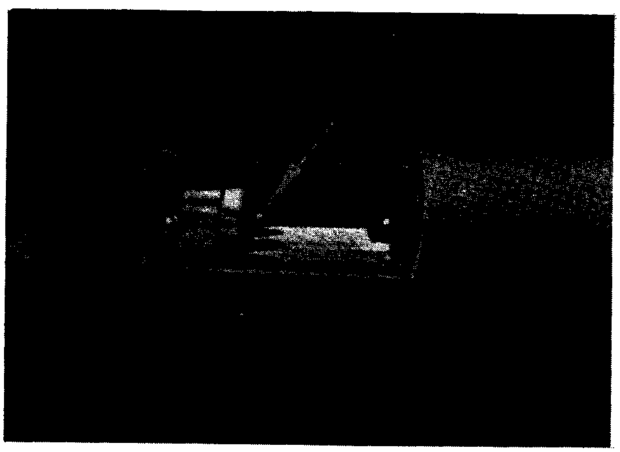


Illust. 1

it may cause excessive vibration of the control rods, thus causing difficult operation.

PROPELLER DRIVE SHAFT

The power box has a shear pin in the power box drive line (Illust. 1) making



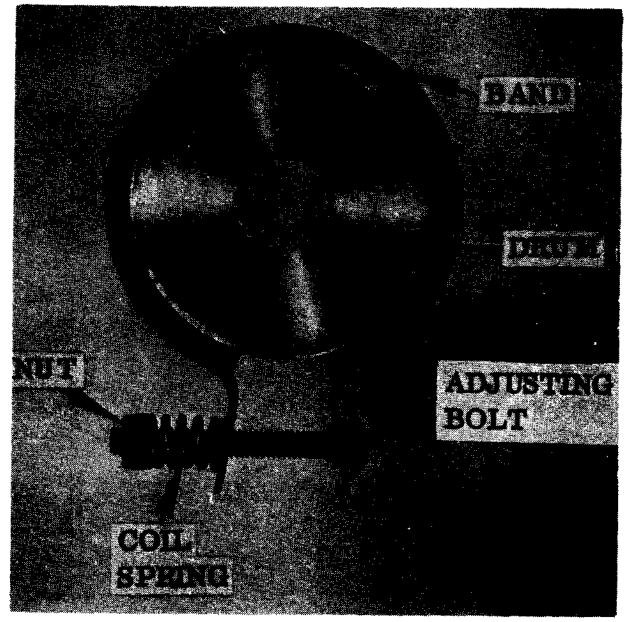
Illust. 1

it possible to use the positive connection between outlet shaft and "U" joint. This shear pin "A" may be replaced through the opening in cab floor (Illust. 1) or may be replaced from under the cab.

POWER BOX ANTI-COAST BRAKE

The anti-coast brake (Illust. 1) is furnished on all motor graders.

The anti-coast brake band should be removed periodically to remove any dust or foreign matter that may have accumulated on the lining. The first step of reassembly should be to install band onto drum.



Illust. 1

Install bolt through band as illustrated. Install coil spring and nut. Tighten nut until proper adjustment is obtained.
NOTE: The thrust bearings on the gear housings must be properly adjusted before anti-coast brakes are adjusted in order to insure the maximum efficiency of the two adjustments in controlling coasting.

ADJUSTMENT

When adjusting the brakes, the adjusting nut (arrow)(Illust. 2) should be tight-

Illust. 2

ened until a 12 foot pound pull is necessary to turn the drum within the band. There may be some instances when it will be necessary to vary the adjustments to obtain the desired results.

If the band is too tight, the lever may not work smoothly, there may be an excessive amount of chatter in the lever and the lining will wear excessively.

If the band is too loose, the brake will not be effective, therefore, it will not serve its purpose in eliminating coasting.

You will note that in the installation of the drum shields and locking bars, the holes in the locking bars are tapped. The locking bars, mounted behind the anchor plates, serve as the locking agent for the cap screws used in securing the drum shields, anchor plates and locking bar assemblies.

MOLDBOARD LIFTS AND LATERAL HOUSINGS

The moldboard lift housings and lateral shift housing are so much alike, it is not necessary to describe the repair of all three. Instructions and illustrations in this section are for the repair of the right hand lift housing.

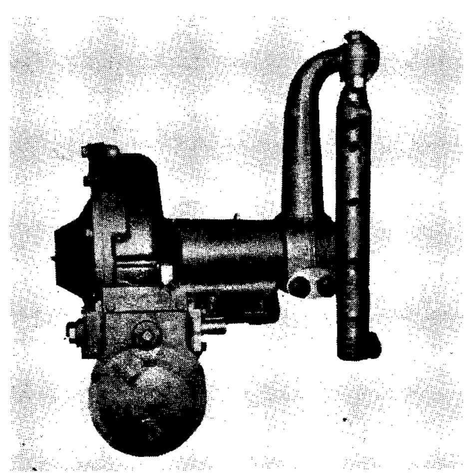
To repair the left hand lift housing, it must be remembered when following the illustrations, that the worm shaft is inserted into the lift housing from the left side, also the spiral gear housing and its component parts are assembled on the left side of lift gear housing.

The lateral shift housing is assembled in a similar manner as the right hand lift housing.

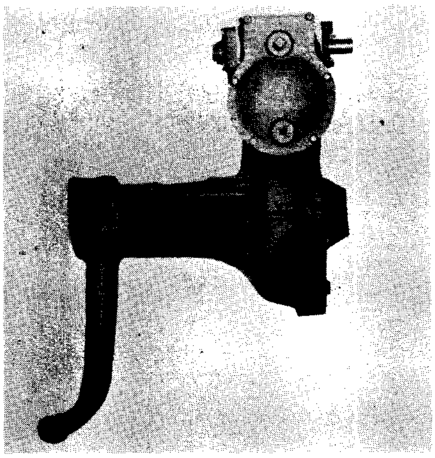
The extent of this assembly depends on the work to be done. If a complete disassembly is necessary, it is best to remove the complete unit from the frame of the grader and disassemble it on a bench. Due to the fact that during the reassembly operation all adjustments and settings must be established, a detailed description is given here for the reassembly operations only.

Inspect all parts for excessive wear, breakage or other damage. Gears, bearings and shafts will sometime score due to insufficient lubricant or improper lubricant being used. Parts which are damaged should be replaced. Inspect "O" rings for mars and cuts and replace with new ones if damaged. If any of the bushings are being replaced, they should be installed by supporting a housing in a press and pressing in the bushings. No reaming is necessary on any of the bushing before installation.

Illust. 1 is a view of right hand lift housing.



Illust. 1

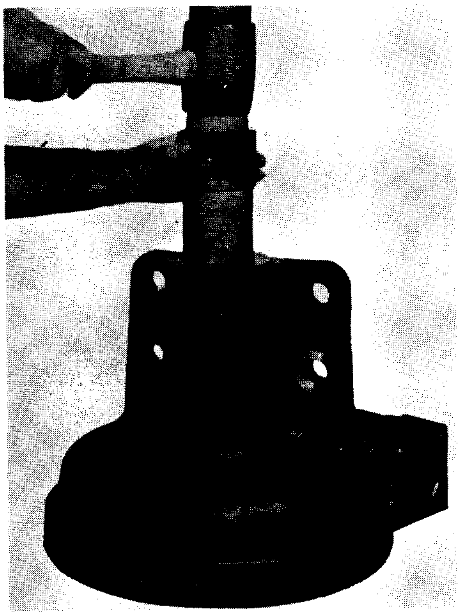


Illust. 2

Illust. 2 is a view of the lateral shift housing. Note the positioning of the reduction gear housing compared with the reduction gear housing in Illust. 1.

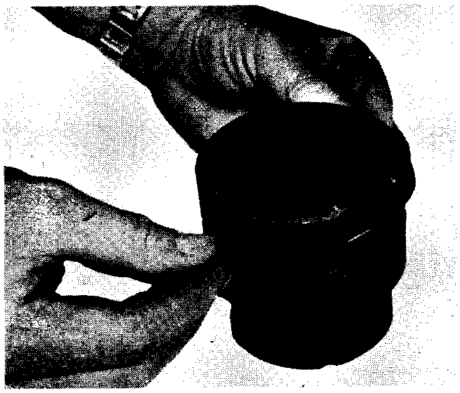
Press or drive bushing into housing (Illust. 3). Bushing to be flush with outside bore of housing.

Press or drive bushing into worm thrust bearing (Illust. 4).

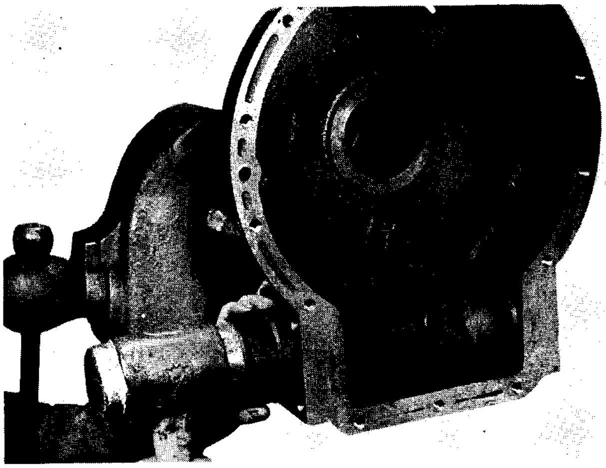


Illust. 3

Illust. 4



Illust. 5



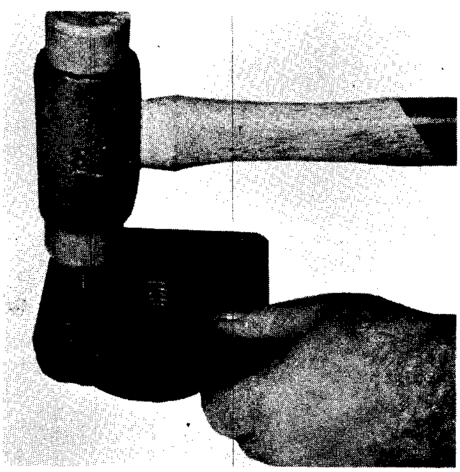
Illust. 6

Install "O" ring in groove of thrust bearing (Illust. 5).

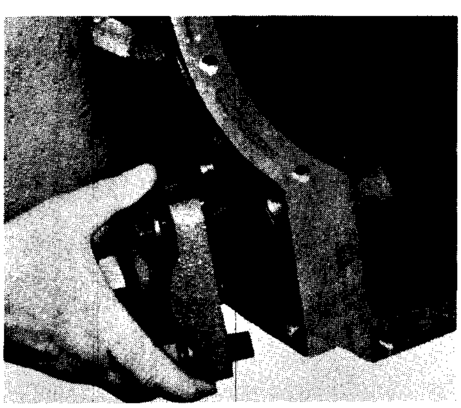
Install thrust bearing into housing (Illust 6). Dowel pin hold toward top of housing. NOTE: Apply white lead to "O" ring to prevent damage.

Drive dowel pin into bearing cap (Illust. 7). Next, install an adjusting set screw and jam nut. Do not tighten set screw or jam nut.

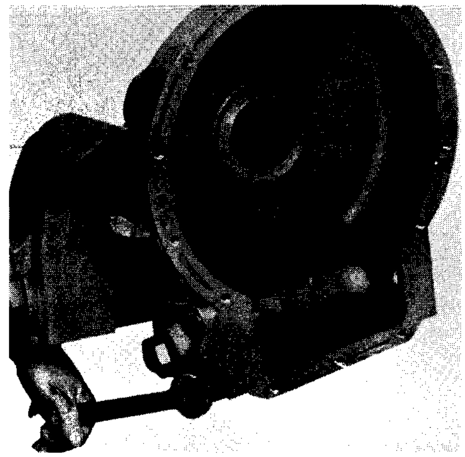
Install bearing cap with cap screws and lock washers onto housing (Illust. 8). Dowel pin in cap to align with dowel pin hole in thrust bearing. NOTE: No gasket is required. Next, tighten cap screws securely (Illust. 9).



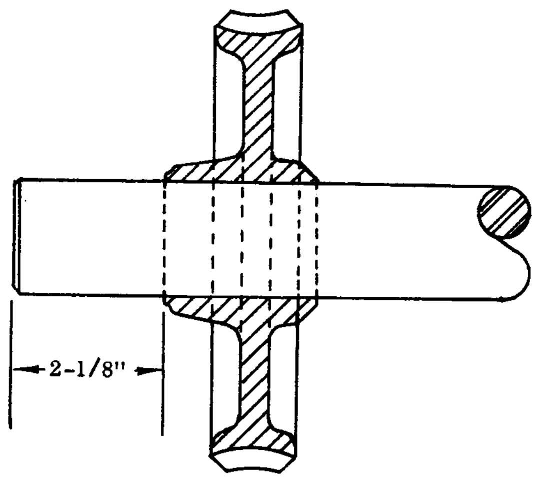
Illust. 7



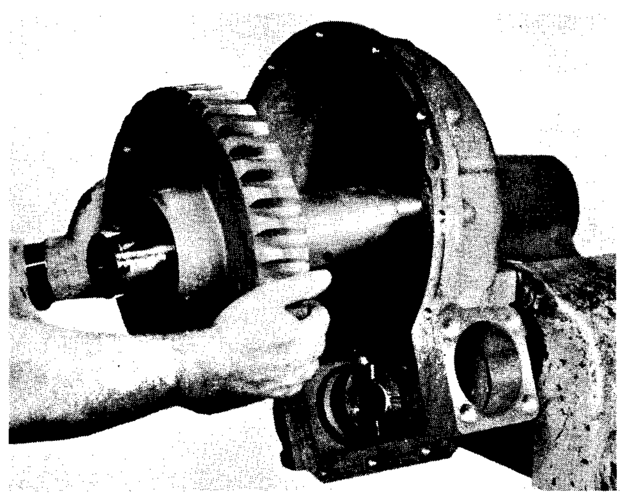
Illust. 8



Illust. 9



Illust. 10

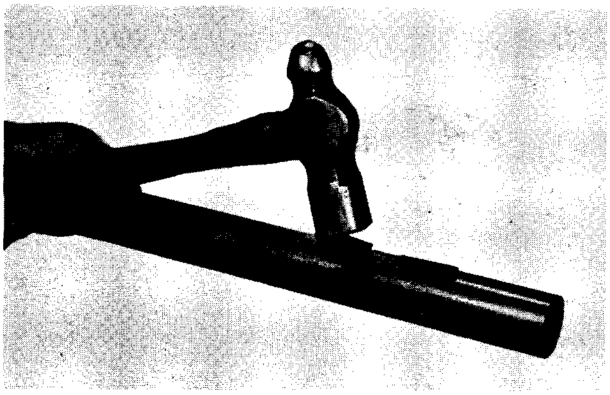


Illust. 11

Press worm gear on shaft. Long hub of gear toward end of shaft. Hub of gear to be 2-1/8" from end of shaft (Illust. 10).

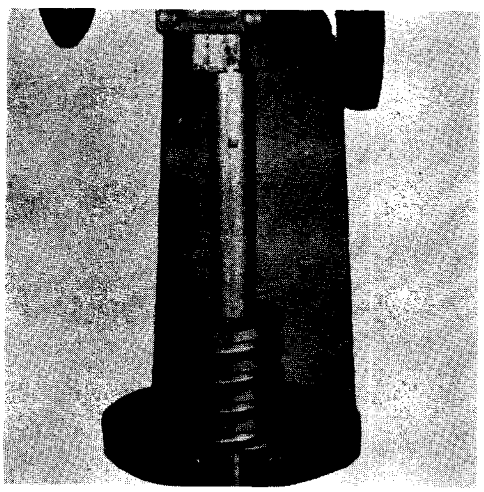
Install shaft and gear into housing (Illust. 11).

Drive keys in keyways of worm shaft (Illust. 12).



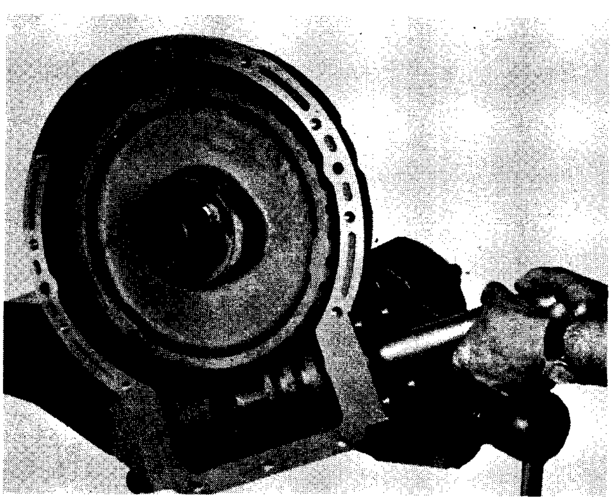
Illust. 12

Align keys in shaft with keyway in worm then press shaft into worm until keyed end of shaft extends 2-1/32" out of worm (Illust. 13).



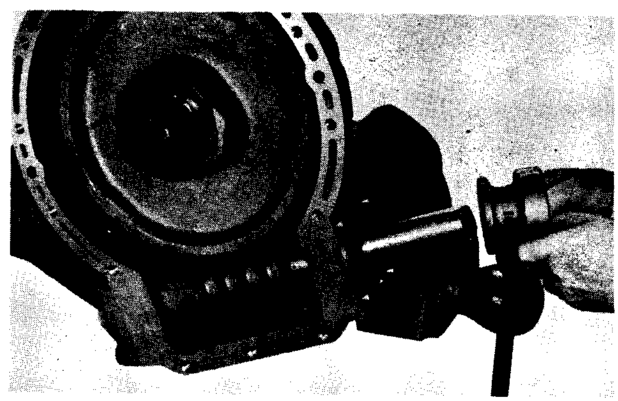
Illust. 13

Install worm and shaft into housing (Illust. 14). Rotate shaft until end of shaft is well seated into thrust bearings.

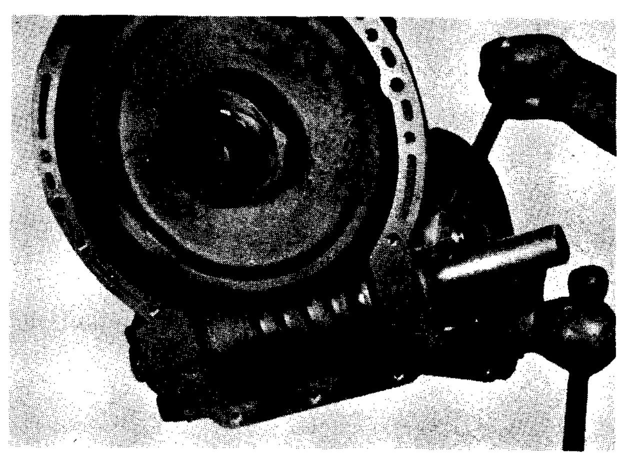


Illust. 14

Install worm thrust bearing onto shaft and into housing (Illust. 15). Notch and



Illust. 15



Illust. 16

thrust bearing should be in an upward position.

Install and tighten studs into the lift housing. If unable to use stud driver, use two (2) nuts locked together on studs (Illust. 16). Tighten studs to a torque reading of 100 foot pounds (Illust. 17).

Install snap ring into reduction housing. NOTE: For easy installation start snap ring into bore of housing in a vertical position (Illust. 18).

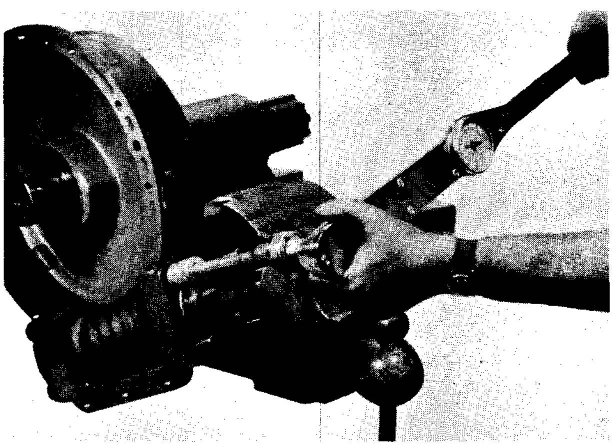
Drive snap ring into groove of housing (Illust. 19).

Press or drive bushing into housing until bushing is down on snap ring (Illust. 20).

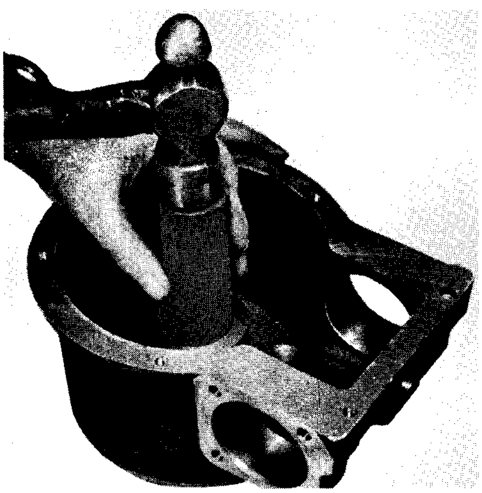
Install "O" ring into groove of housing (Illust. 21).

Install key in keyway of thrust bearing Next, install gasket onto housing. Install housing onto shaft and onto studs (Illust. 22). Key in thrust bearing to fit into slot of housing.

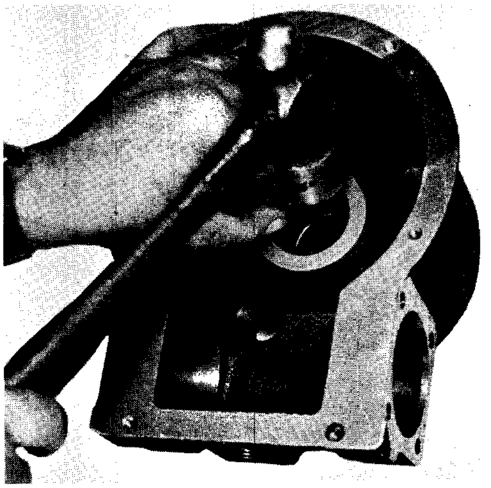
Install stud nuts and tighten to a torque reading of 135 foot pounds (Illust. 23).



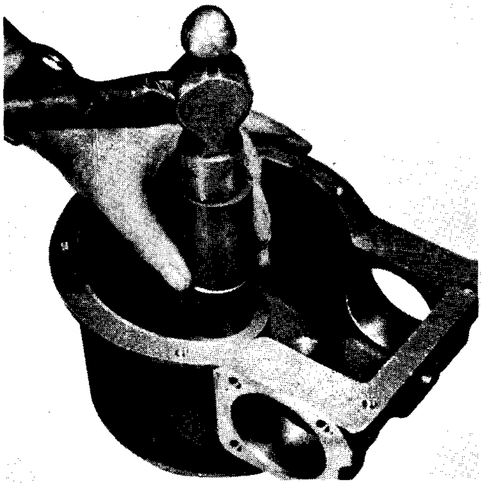
Illust. 17



Illust. 19

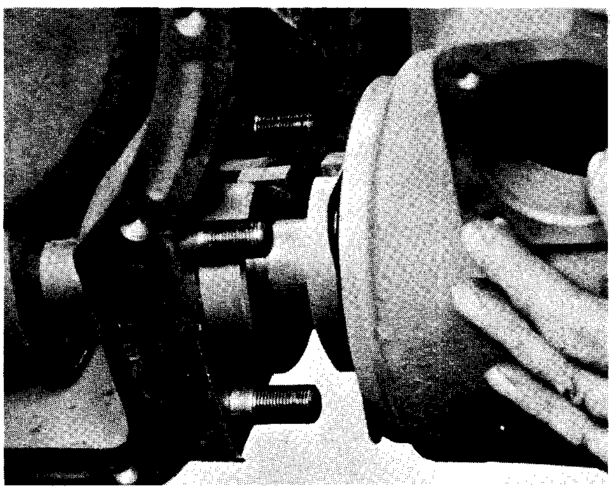


Illust. 18

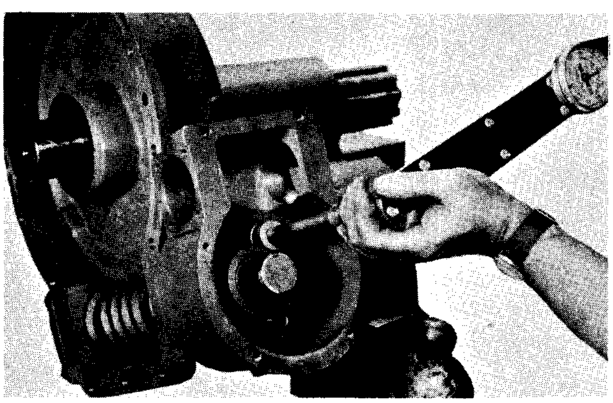


Illust. 20

Illust. 21



Illust. 22



Illust. 23

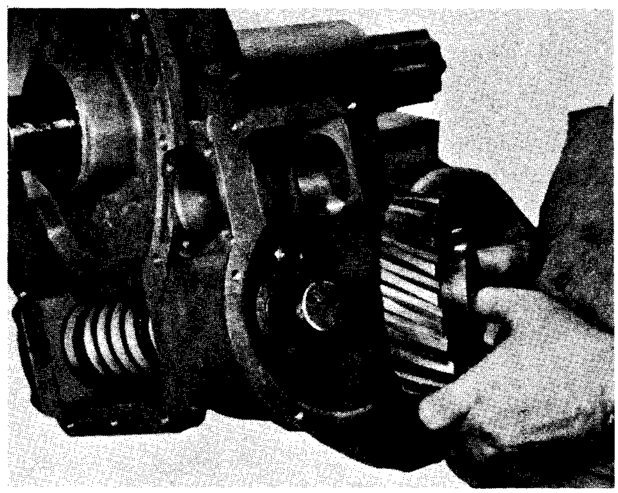
Install spiral gear onto shaft (Illust. 24). Long hub of gear toward outside of housing. Key and gear align with keyway in shaft.

Drive key in keyway of gear and shaft (Illust. 25).

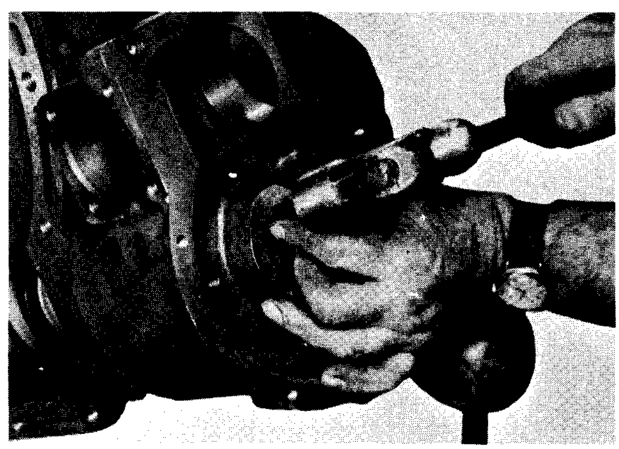
To remove gear from shaft, use a gear puller (Illust. 26).

Press or drive bushing into reduction housing thrust bearing (Illust. 27).

Install "O" ring into groove of thrust bearing (Illust. 28).



Illust. 24

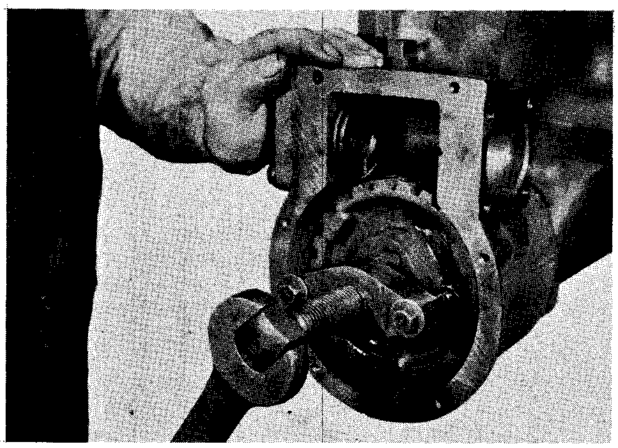


Illust. 25

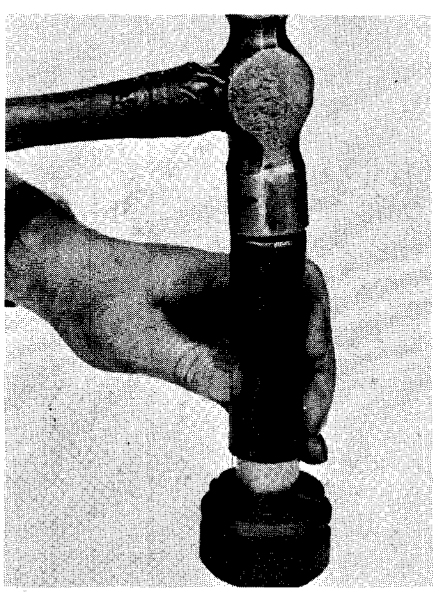
Install thrust bearing into housing (Illust. 29). NOTE: Dowel pin hole in thrust bearing in an upward position. To prevent damaging "O" ring, use white lead.

Drive roll pin into bearing cap (Illust. 30). Next, install adjusting set screw and jam nut. Do not tighten jam nut.

Install bearing cap with cap screws and lock washers onto reduction housing (Illust. 31). Roll pin in cap to align with pin hole in thrust bearing.

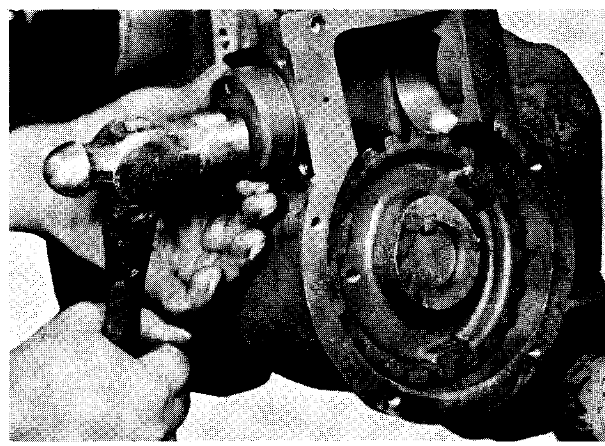


Illust. 26

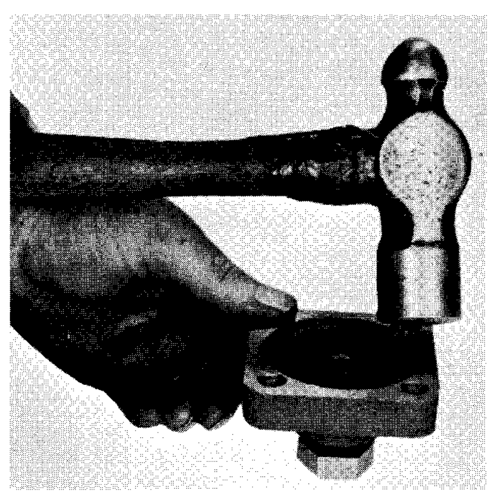


Illust. 27

Illust. 28



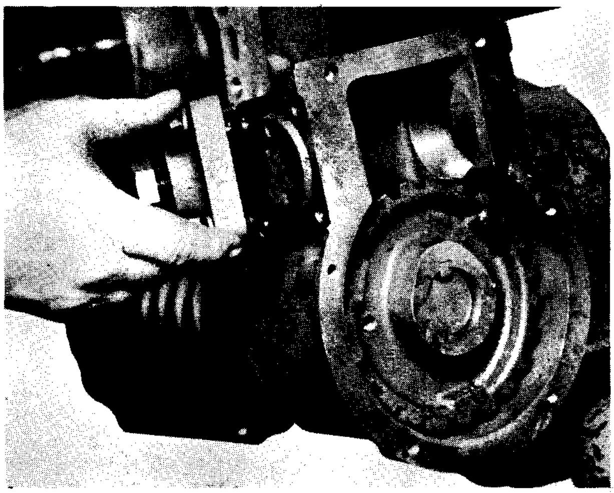
Illust. 29



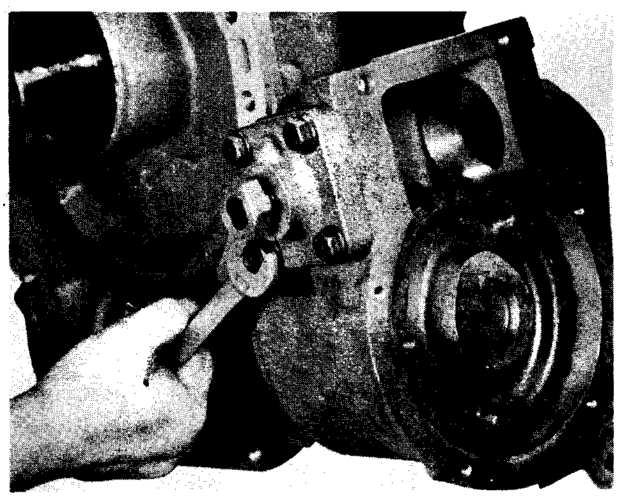
Illust. 30

Tighten cap screws securely (Illust. 32).

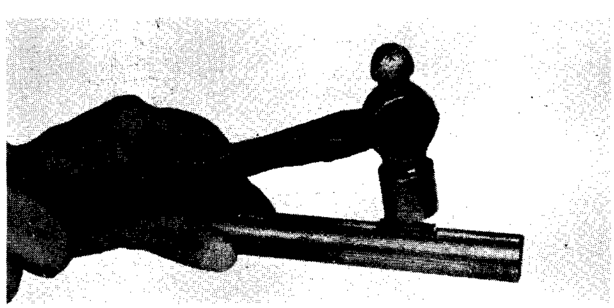
Install key in keyway of pinion shaft (Illust. 33).



Illust. 31



Illust. 32



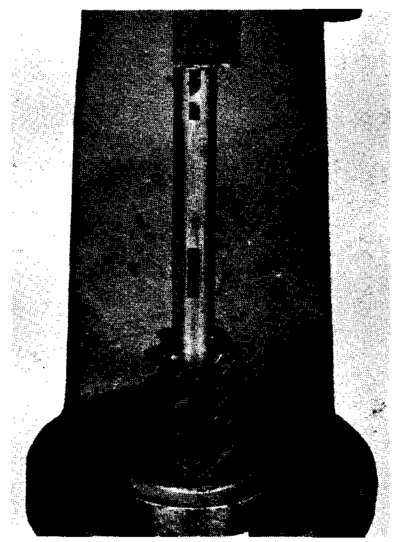
Illust. 33

Align key in shaft with keyway and spiral pinion. Press shaft into spiral pinion until shaft extends 1" out or pinion (Illust. 34).

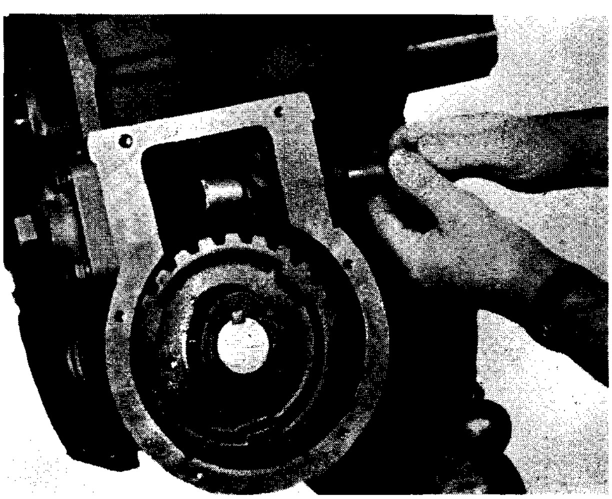
Install pinion shaft into reduction housing (Illust. 35). Rotate shaft until end of shaft is seated into thrust bearing.

Install "O" ring in groove of bearing cap (Illust. 36).

Install bearing cap with cap screws and lockwashers onto reduction housing (Il-



Illust. 34



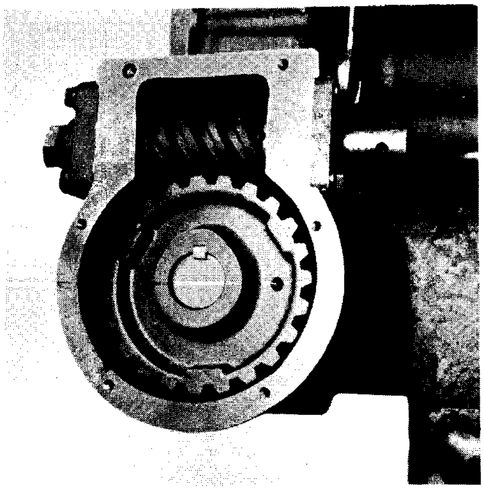
Illust. 35

lust. 37). NOTE: Apply white lead to "O" ring to prevent damage.

Tighten cap screws securely (Illust. 38).

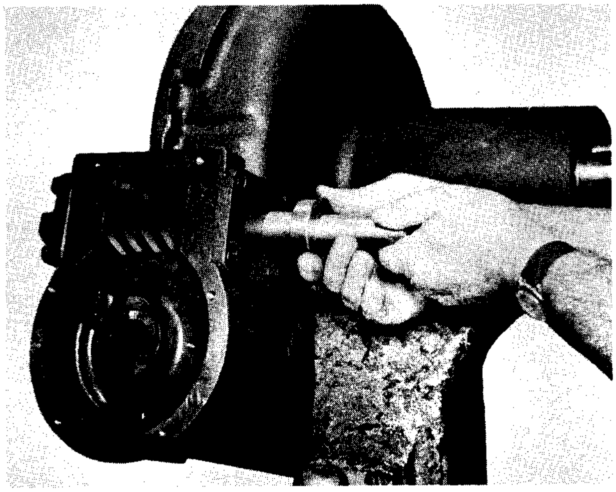
Install grease seal into bearing cap (Illust. 39). Lip of seal toward inside of housing. NOTE: To install seal over shaft, use a piece of shim stock shaped like a funnel. Next, drive seal into cap (Illust. 40).

To adjust the thrust bearings, it is important that the main thrust bearing be adjusted first. To adjust the main

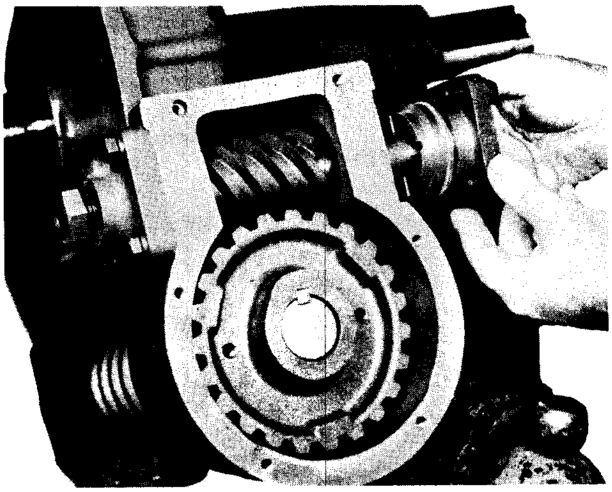


Illust. 38

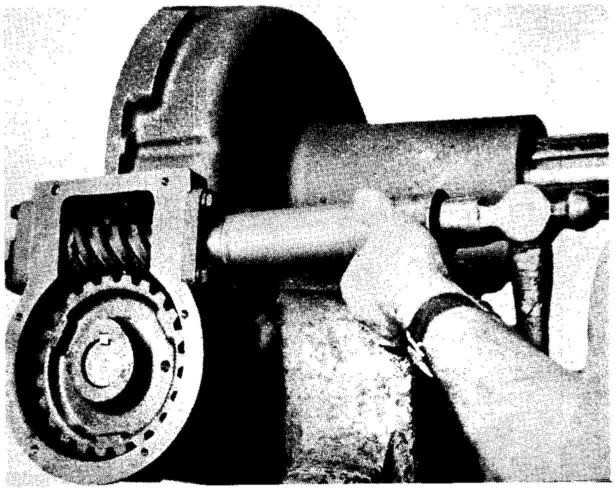
Illust. 36



Illust. 39



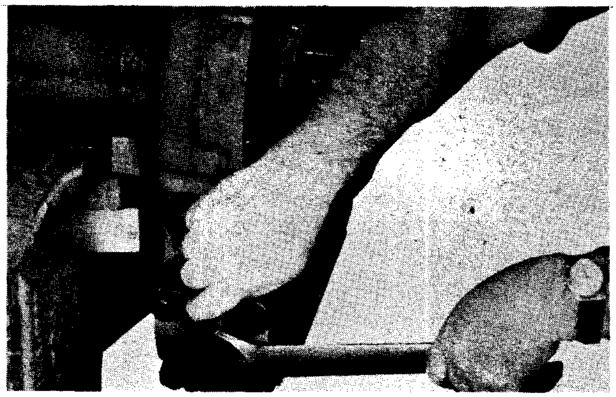
Illust. 37



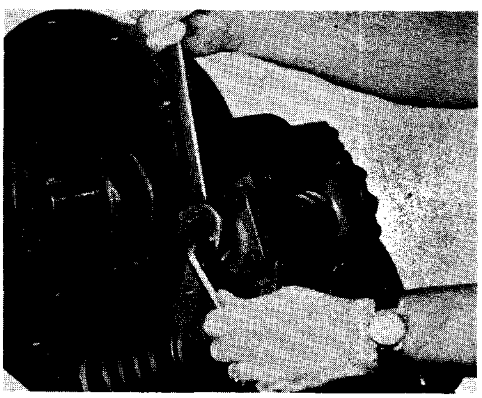
Illust. 40

thrust bearing, tighten adjusting set screw until a noticeable drag is felt while rotating worm shaft. Loosen set screw slightly until drag is eliminated. Holding set screw in this position, tighten jam nut securely (Illust. 41).

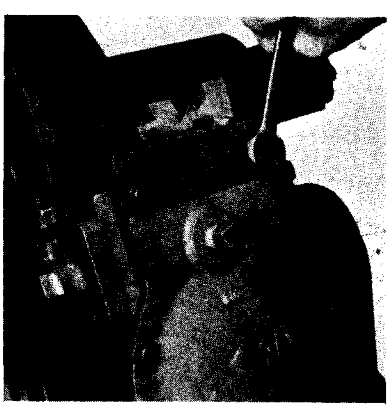
Adjust the thrust bearings in the reduction housing in the same manner. When adjustment has been made, hold set screw in position and tighten jam nut securely (Illust. 42).



Illust. 41



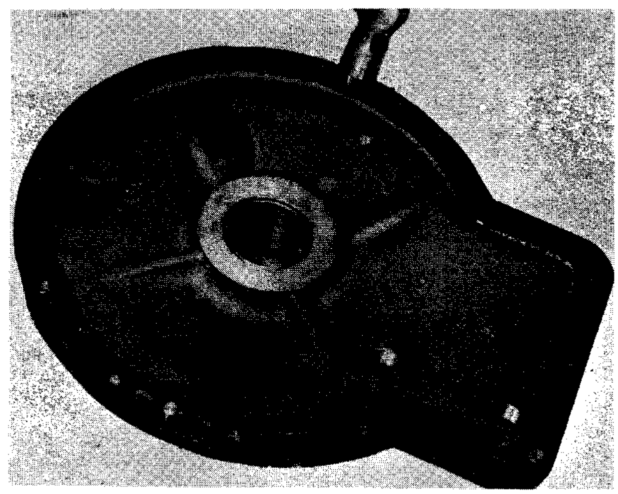
Illust. 42



Illust. 43

Shellac gasket to reduction housing cover. Install cover onto reduction housing. Install cap screws with lock washers. Tighten cap screws securely (Illust. 43).

Drive dowel pins into lift housing cover (Illust. 44). Next, shellac gasket to lift housing. Install cover onto housing. NOTE: For easy installation, use two (2) pilots in housing. Install cover over



Illust. 44

Illust. 45

pilots and onto housing. Bump cover with a mallet to seat dowel pins in housing. Remove pilots.

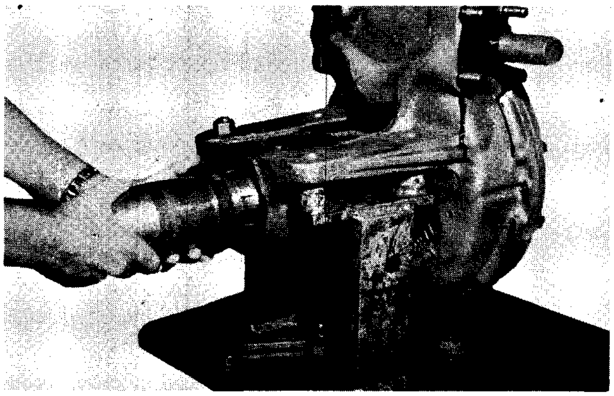
Install cap screws and lock washers. Tighten cap screws securely (Illust. 45).

Illusts. 46 and 47 refer to the lateral shift housing only.

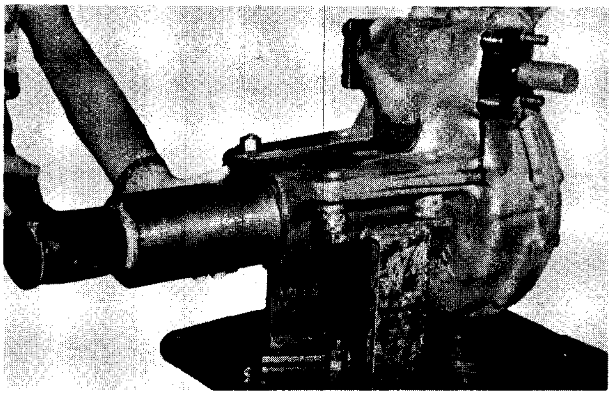
Install oil seal onto shaft, using a piece of shim stock over splines of shaft to prevent damage to seal (Illust. 46).

Drive seal into housing (Illust. 47). Remove shim stock.

Install bolts with lock washers and nuts. Tighten nuts securely (Illust. 48).



Illust. 46



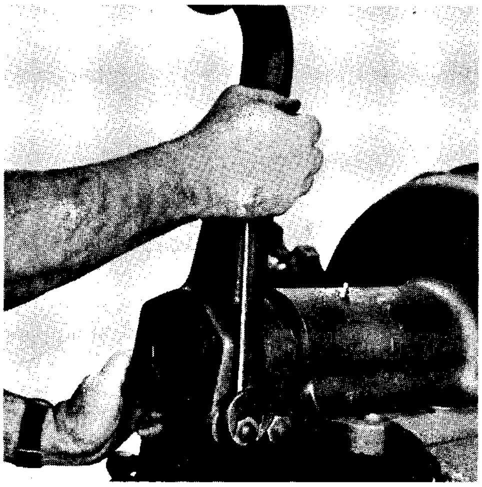
Illust. 47

NOTE: Heads of bolts toward main frame.

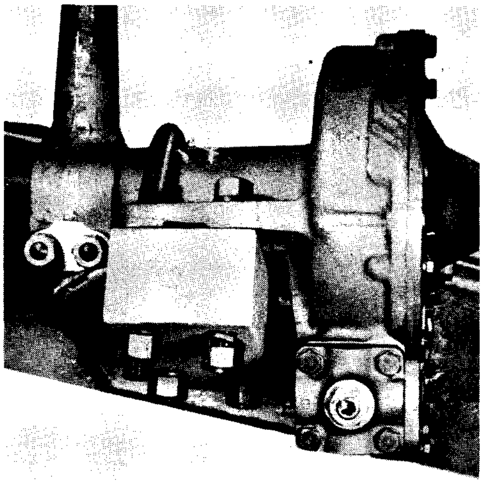
Install lift housing to lift beam. Install bolts and "U" bolt, lock washers and nuts (Illust. 49). Tighten all nuts securely.

Install arm onto spline shaft.

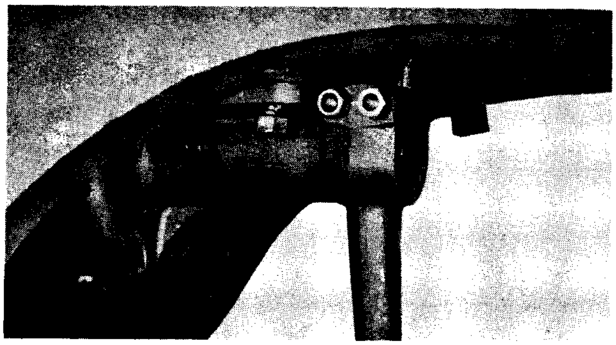
NOTE: To install arm, drive a cold chisel into slot in arm. Align splines in arm with those in shaft. Using a mallet, tap arm onto shaft until arm is even with chamfer.



Illust. 48



Illust. 49

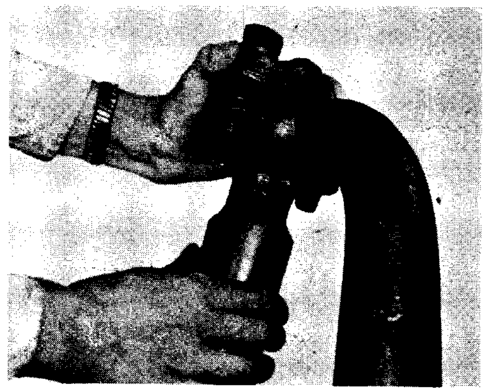


Illust. 50

Install lateral housing to cross beam. Install bolts, lock washers and nuts (Illust. 50). Tighten nuts securely.

ADJUSTABLE BALL AND SOCKET

(Illust. 1) The ball and socket joints on the lift links and lateral shift links are adjustable for wear. The laminated shims take care of the wear at these points. In order to make this adjustment the two clamp cap screws and caps should be removed as shown.



Illust. 1

The laminated shims under the cap can be removed from the clamp cap screws and layers of shims peeled off with a knife.

Do not remove any more shims than necessary to remove the free play in the joint. The joint should never bind and should always work freely. It will be found that these joints wear egg-shaped. Therefore, they should be adjusted in the position in which they will operate.

CIRCLE REVERSE MECHANISM

The circle reverse mechanism is contained in two separate housings consisting of the circle reverse housing and transfer housing. Either of these housings should be removed from circle drawbar when major repairs are necessary. Minor repairs may be made of either assembly without removal from the drawbar.

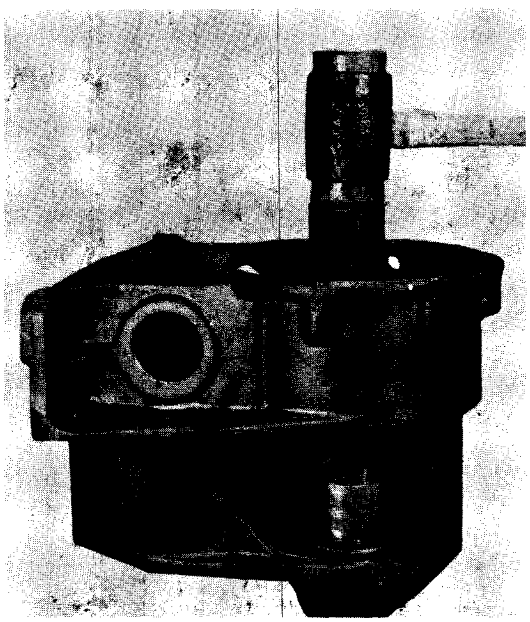
The extent to which the circle reverse housing is disassembled depends upon the work to be done. In the disassembly of the worm thrust bearing and pinion gear shaft assembly, care should be taken not to distort or damage the "O" rings.

Inspect all parts for excessive wear or damage. Bearings, gears and shafts will sometimes score due to insuffieient lubricant or improper lubricant being used. Parts that are damaged in this manner should be replaced with new ones. All gaskets, seals and "O" rings should be replaced when reassembling the housing. When installing the bushings, care should be taken to prevent distortion or damaging during assembly. They should be installed with a press or wood block and hammer. Care should be taken that bushings enter the bore squarely.

(Model 330 Motor Graders - Serial Nos. 1 and Later with Bracket or Slide-Shift Moldboards, also, Serial Nos. 1645 and Later with Power-Shift Moldboards). (Model 440 Motor Graders - Serial Nos. 1 and Later with Bracket or Slide-Shift Moldboards, also, Serial Nos. 2559 and Later with Power - Shift Moldboards).

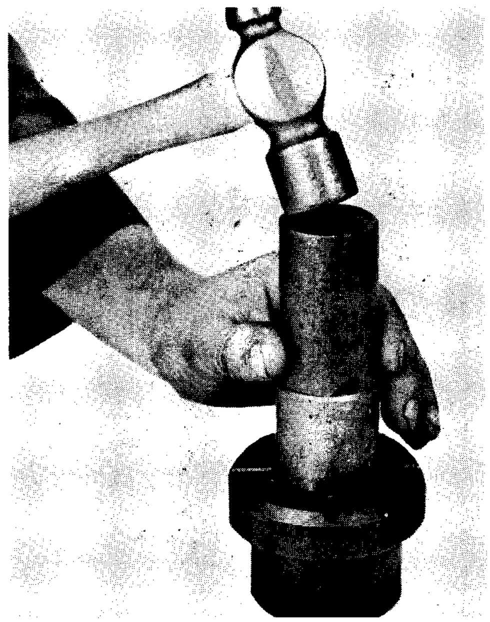
To remove splined universal joint from circle reverse housing worm shaft, loosen top circle transfer housing cap screw. Remove remaining cap screws. Pivot bottom of circle transfer housing toward front of motor grader until universal joint slides from circle housing worm shaft.

Press or drive bushing into circle reverse housing (Illust. 1). Bushing to be flush with bottom of chamfer in housing.

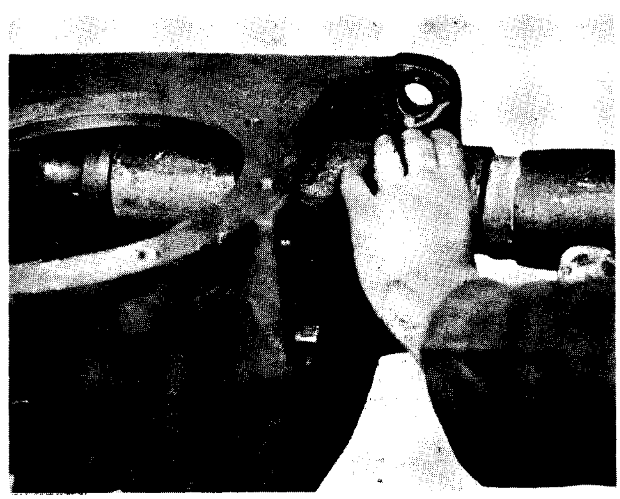


Illust. 1

Illust. 2



Illust. 3



Illust. 4

Press or drive dowel pin into shouldered worm bearing (Illust. 2).

Press or drive bushing into shouldered worm bearing (Illust. 3). Bushings to be flush with bottom of chamfer.

Align dowel pin in shouldered worm bearing with dowel pin hole in housing, then drive bearing into housing (Illust. 4).

Install "O" ring in groove of pinion shaft (Illust. 5).

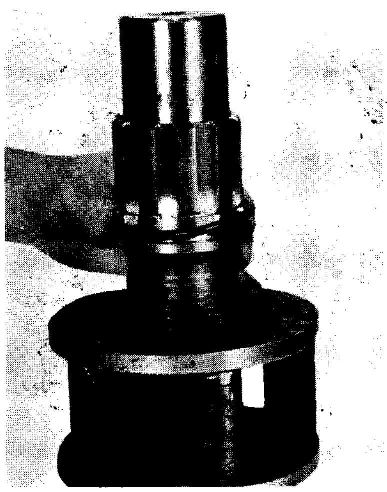
Apply white lead to "O" ring. Press pinion shaft into circle reverse gear (Illust. 6). Flange side of gear toward pinion.

Install oil seal into groove in housing (Illust. 7).

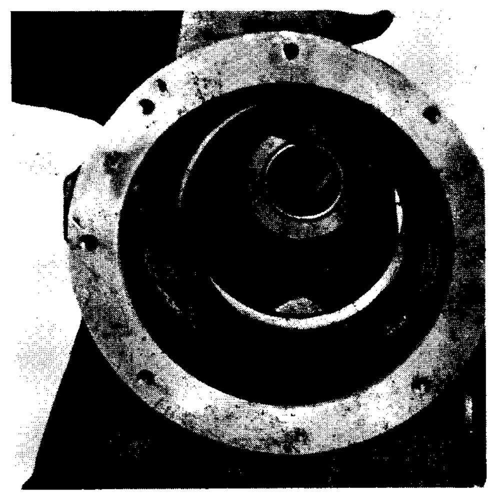
Install gear with pinion into housing (Illust. 8). NOTE: Lubricate oil seal thoroughly before installing gear with pinion.

Drive two keys in keyways of worm shaft (Illust. 9).

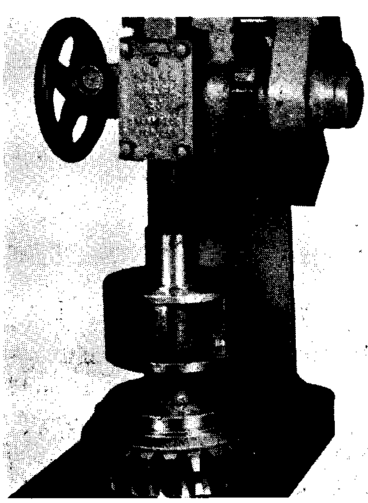
Align keys in shaft with keyway in worm



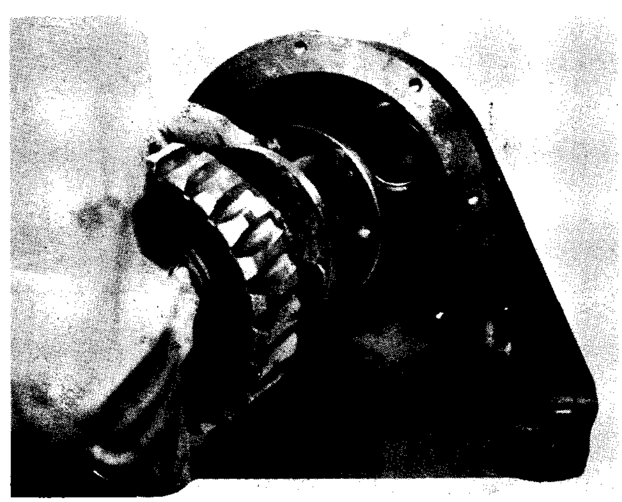
Illust. 5



Illust. 7

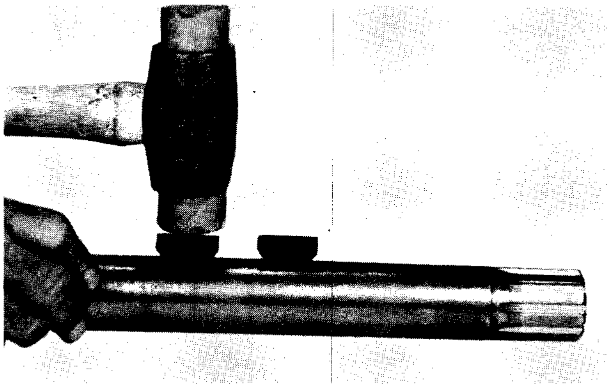


Illust. 6

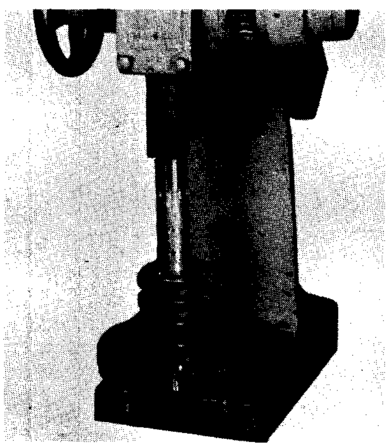


Illust. 8

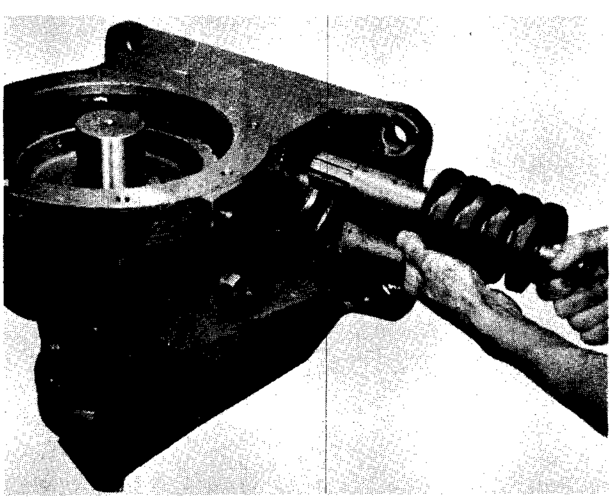
and press shaft into worm until splined end of shaft extends 5-13/32" from face of worm (Illust. 10).



Illust. 9



Illust. 10



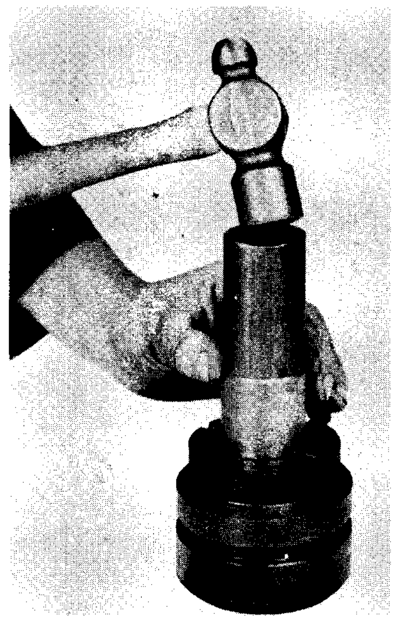
Illust. 11

Install worm shaft into circle reverse housing (Illust. 11).

Rotate shaft until face of worm is approximately 1/16" away from face of worm bearing.

Press or drive bushing into worm thrust bearing (Illust. 12).

Install "O" ring into groove of worm thrust bearing (Illust. 13).



Illust. 12

Illust. 13

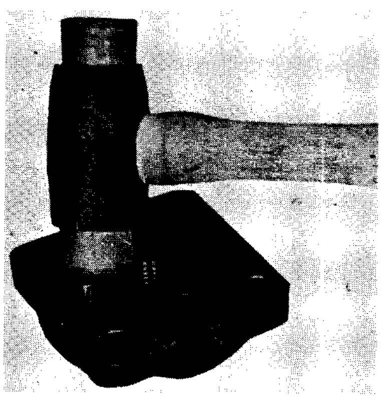
Apply white lead to "O" ring. Install worm thrust bearing into housing and over shaft (Illust. 14).

Drive dowel pin into bearing cap (Illust. 15). Next, install adjusting set screw and jam nut. Do not tighten jam nut.

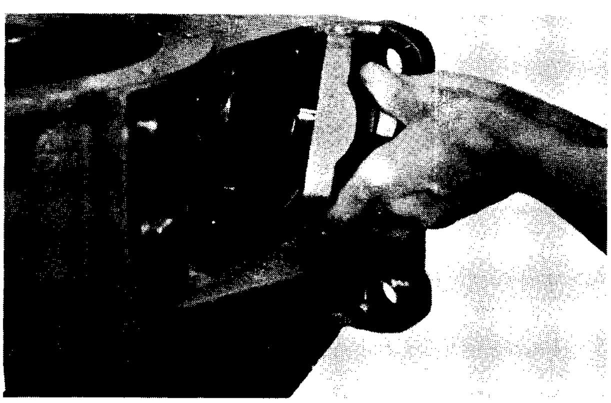
Align dowel pin in cap with dowel pin hole in worm thrust bearing. Install cap to housing (Illust. 16). Next install cap screws with washers. Tighten cap screws securely (Illust. 17).

Install oil seal over shaft and into housing. Lip of seal toward inside of housing. NOTE: Use a piece of shim stock over splines of shaft to prevent damage to leather of oil seal (Illust. 18). Drive seal into housing.

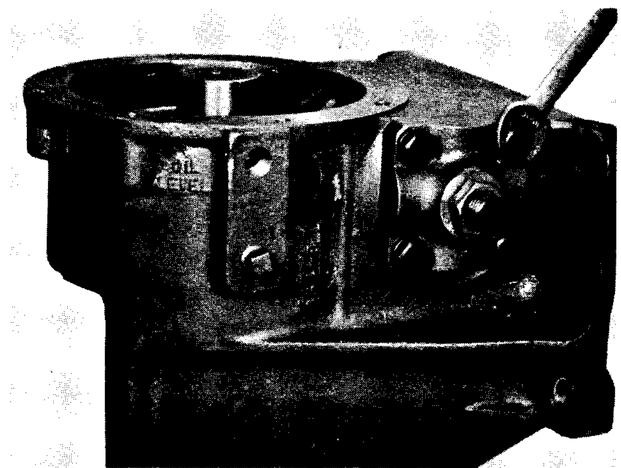
Illust. 14



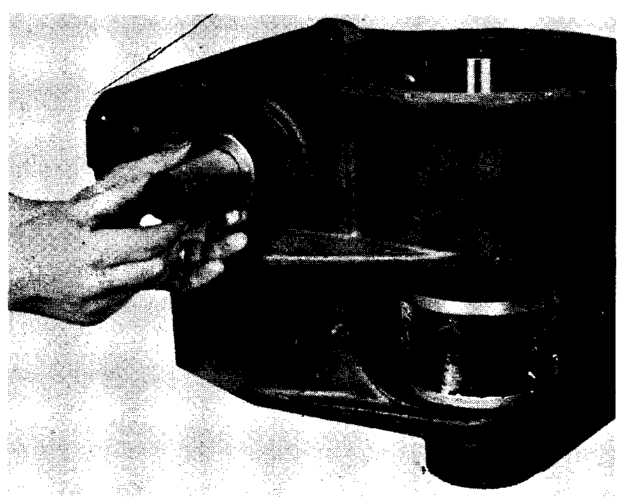
Illust. 15



Illust. 16



Illust. 17



Illust. 18

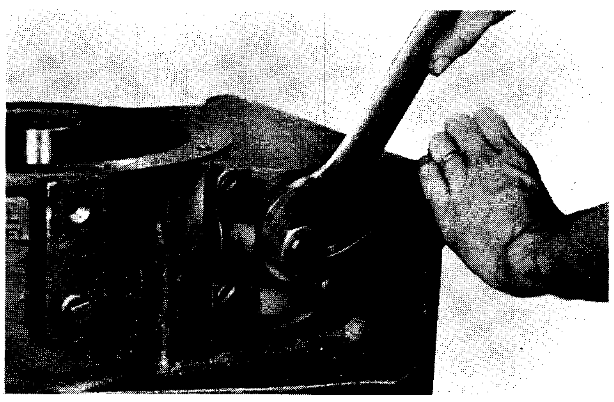
To adjust thrust bearings, tighten adjusting screw while at the same time rotating shaft until a noticeable drag is obtained. Loosen set screw until drag is eliminated. Holding set screw in this position, tighten jam nut securely (Illust. 19).

Press or drive bushing into circle housing cover (Illust. 20). Bushing to be flush with bottom of chamfer in cover.

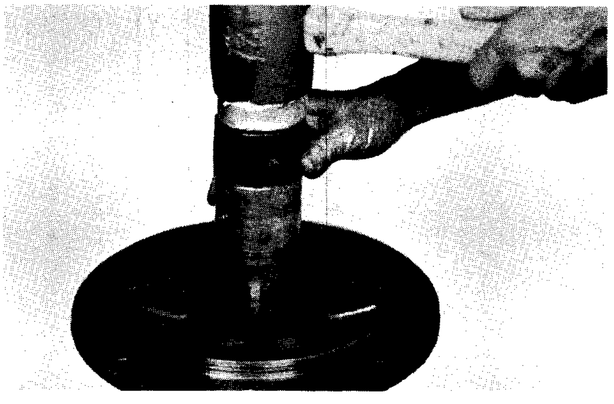
Install "O" ring in groove of cover (Illust. 21).

Apply white lead to "O" ring. Install cover onto housing (Illust. 22). Install cap screws with lock washers. Tighten cap screws securely (Illust. 23).

Install sleeve on splines of shaft.

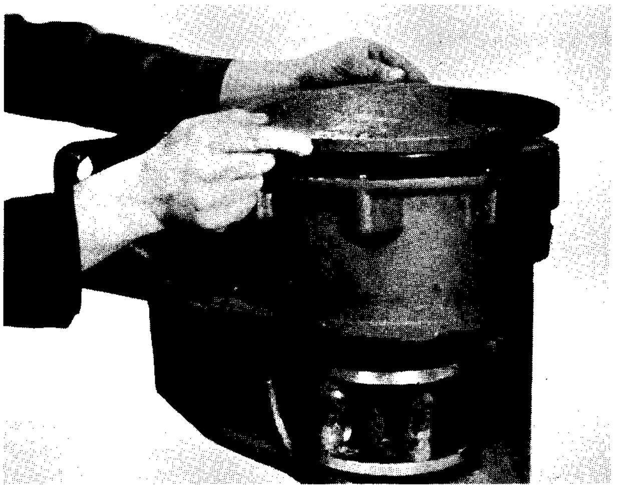


Illust. 19

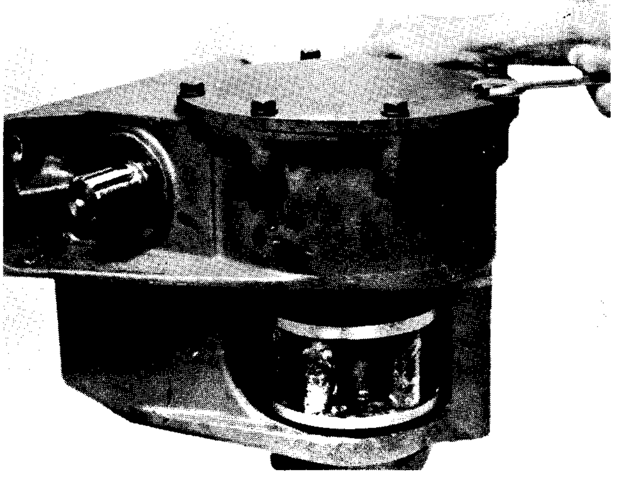


Illust. 20

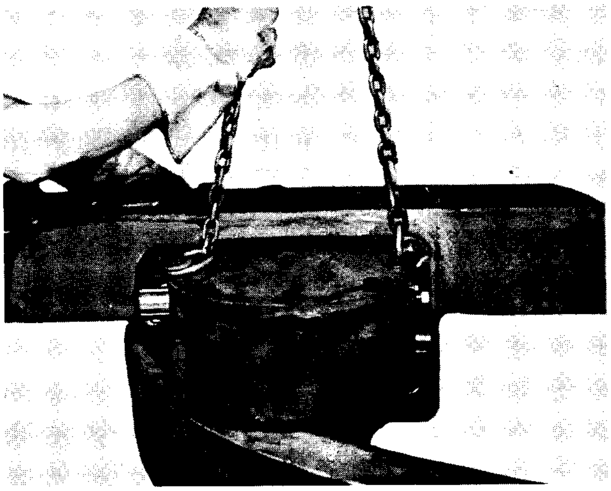
Illust. 21



Illust. 22

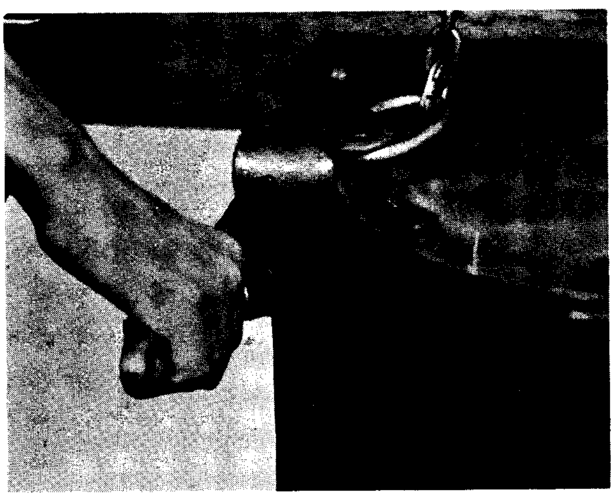


Illust. 23



Illust. 24

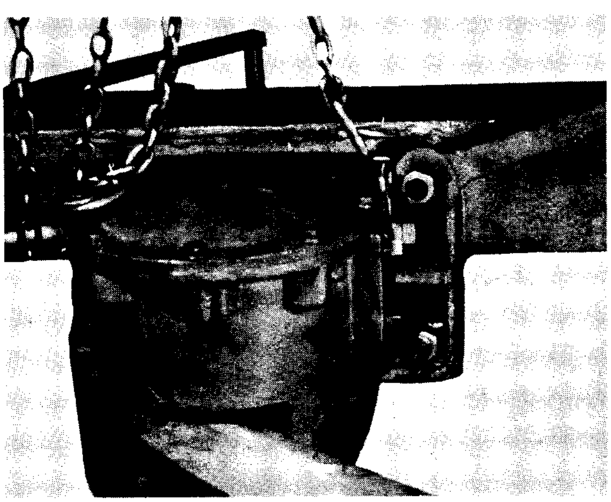
To install circle reverse housing to drawbar, mesh teeth in pinion gear with teeth in rack of circle (Illust. 24). Rotate sleeve (using a pipe wrench) counter clockwise until housing is flush with circle drawbar (Illust. 25). Insert the two long bolts (upper bolts) through drawbar and through circle housing just enough to hold circle housing in place. Insert lower bolts (short bolts) through drawbar and circle housing. Install lock washers and nuts. Tighten nuts securely (Illust. 26). IMPORTANT: Be sure all four circle housing pads are flush against drawbar. Should there be shims between circle reverse housing and drawbar, it is important that the shims be replaced in their original position.



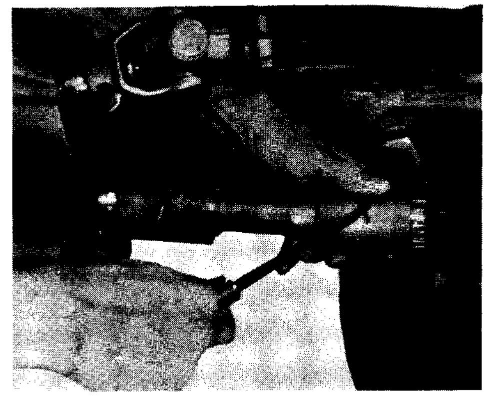
Illust. 25

(Model 330 Motor Graders - Serial Nos. 1 thru 1644 with Power-Shift Moldboards). (Model 440 Motor Graders - Serial Nos. 845 thru 2558 with Power-Shift Moldboards).

Install splined sleeve onto spline shaft. Install pins and cotter pins. Spread cotter pins (Illust. 27). NOTE: Sleeve should be free on spline shaft at all times.



Illust. 26



Illust. 27

Install adjusting plate onto drawbar bolts (Illust. 28). Cut away edge toward circle housing.

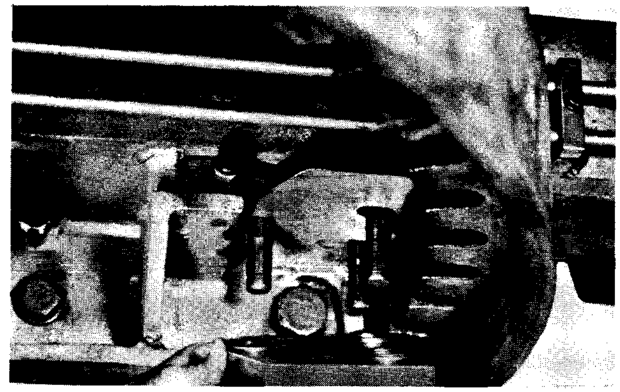
Install retaining plate with shims on bolts (Illust. 29). NOTE: When removing retaining plate, note the amount of shims taken from each bolt and replace the same amount.

Install washers and slotted nuts to bolts and tighten securely. Next, install cotter pin and spread (Illust. 30). Tighten wedge nut securely.

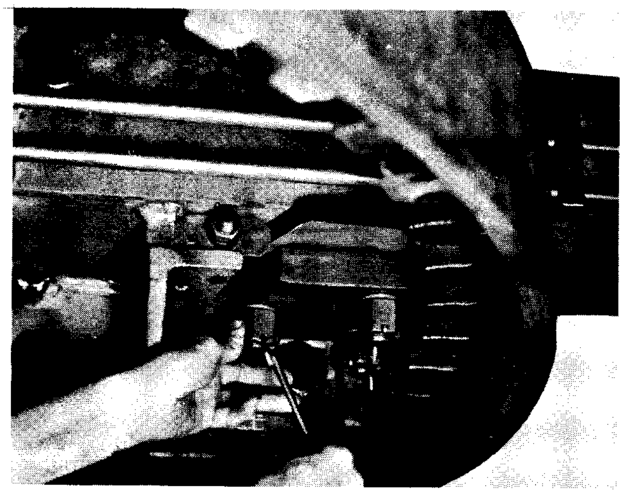
(Model 330 Motor Graders - Serial Nos. 1 and Later with Bracket or Slide-Shift Moldboards, also, Serial Nos. 1645 and Later with Power - Shift Moldboards).

(Model 440 Motor Graders - Serial Nos. 1 and Later with Bracket or Slide-Shift Moldboards, also, Serial Nos. 2559 and Later with Power - Shift Moldboards).

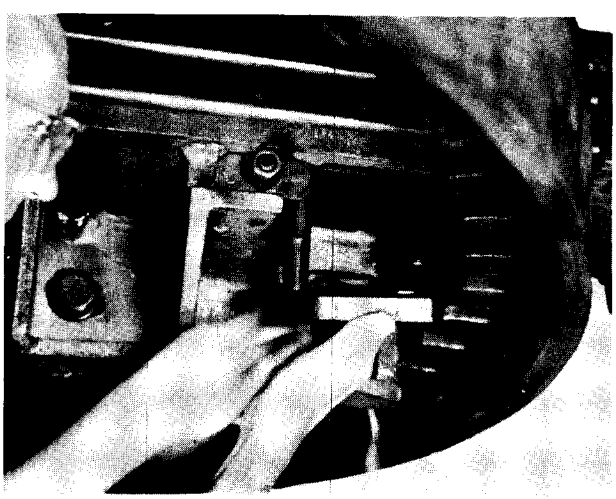
Pivot bottom of transfer housing toward rear end of motor grader while at the same time slide splined universal joint onto circle splined shaft (Illust. 31).



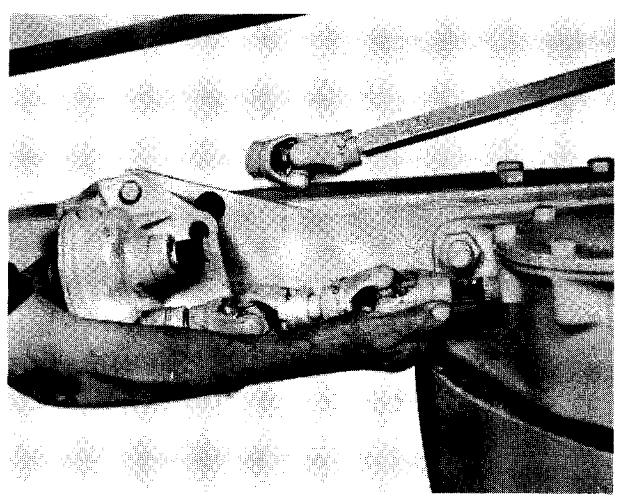
Illust. 29



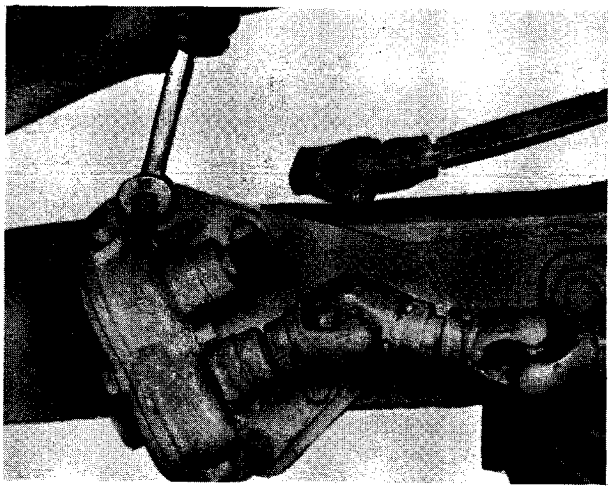
Illust. 30



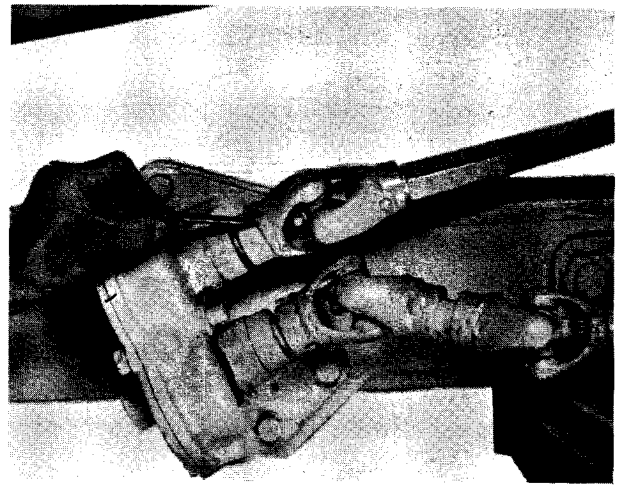
Illust. 28



Illust. 31



Illust. 32



Illust. 33

Install remaining transfer housing cap screws and tighten securely (Illust. 32).

NOTE: When installing universal joint to upper pinion shaft, be sure universal joints on square hollow shaft and square shaft lie in the same relative plane.

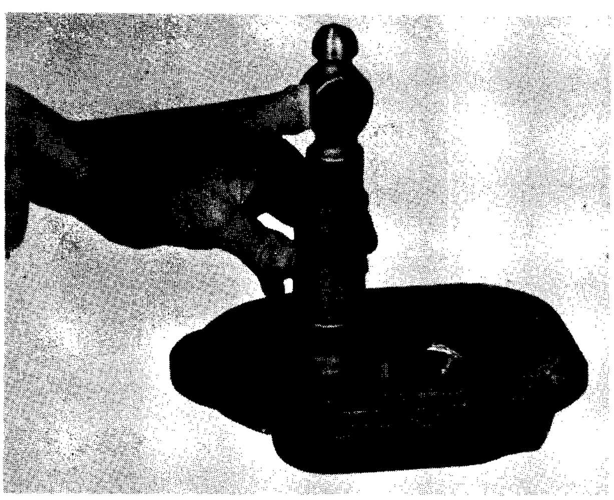
Install circle square shaft universal joint onto upper transfer pinion shaft. Install drilled pin and cotter pin. Spread cotter pin (Illust. 33).

TRANSFER HOUSING

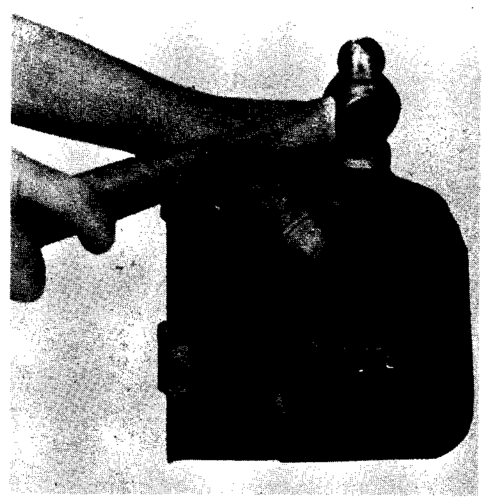
(Model 330 Motor Graders - Serial Nos. 1 thru 1644).
(Model 440 Motor Graders - Serial Nos. 1 thru 2558).

Press or drive bushings into transfer housing cover (Illust. 1). Bushings to be flush with bottom of chamfer in housing.

Press or drive bushing into transfer



Illust. 1



Illust. 2

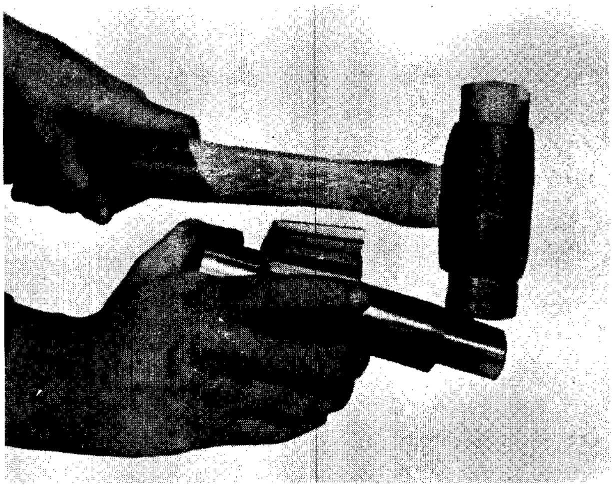
housing (Illust. 2). Bushing to be flush with bottom of chamfer in housing.

Drive key into keyway of upper pinion with shaft (Illust. 3).

Shellac gasket to transfer housing. Next, install upper pinion shaft into housing (Illust. 4).

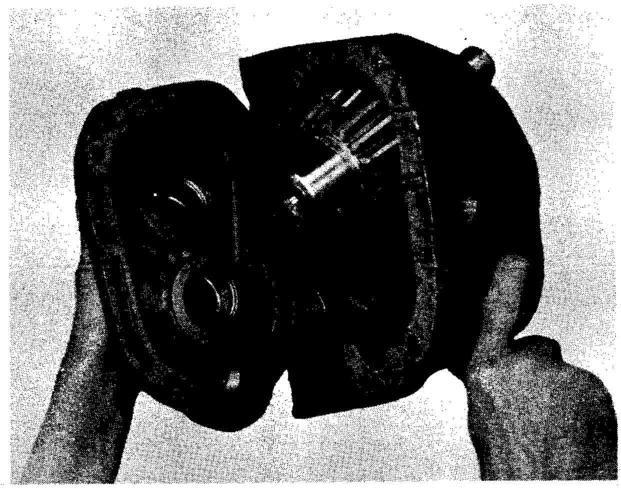
Install cover to transfer housing (Illust. 5). Next, install cap screws with lock washers. Do not tighten cap screws.

Drive dowel pins through cover and in-

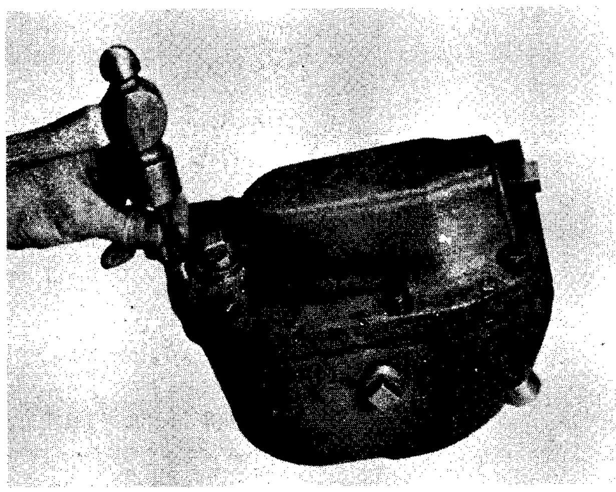


Illust. 3

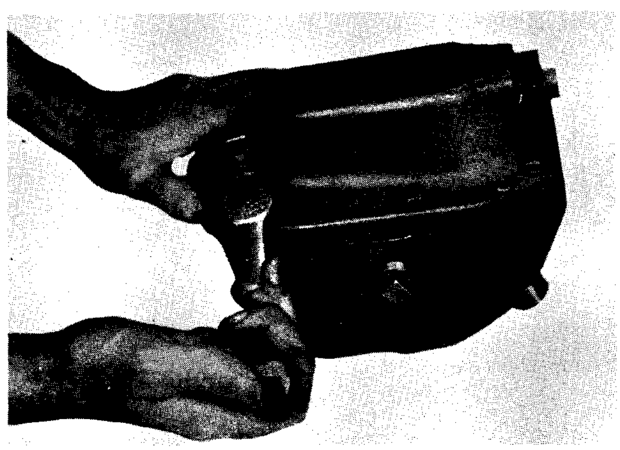
Illust. 4



Illust. 5



Illust. 6



Illust. 7

to housing (Illust. 6). Dowel pins to be flush with cover.

To remove cover from transfer housing, it is necessary to drive dowel pins out of their holes in housing.

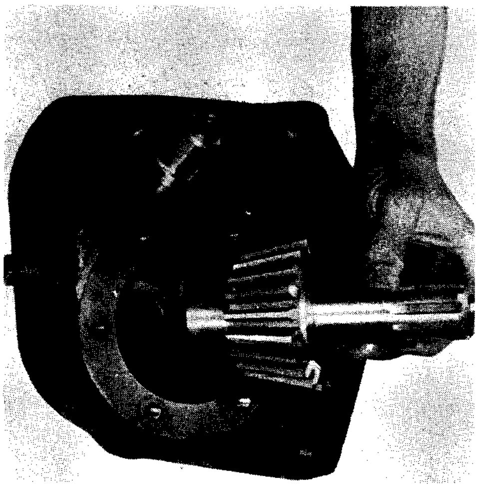
Tighten cover cap screws securely (Illust. 7).

Install lower pinion shaft into housing (Illust. 8).

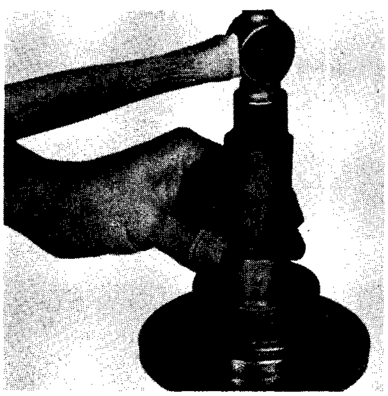
Install bushing into gear cover (Illust. 9).

Shellac gasket to cover and install cover onto transfer housing (Illust. 10). Install cap screws with lock washers and tighten securely (Illust. 11).

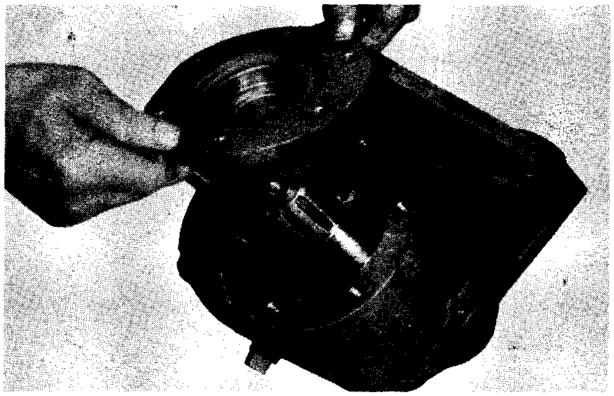
Install grease seals onto upper and lower pinion shafts. Lips of seals toward inside of housing. NOTE: Use shim stock around shafts to prevent leather in oil seals from damage (Illust. 12).



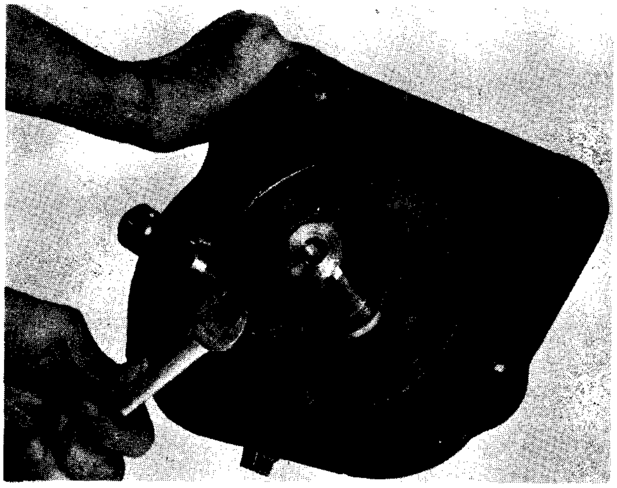
Illust. 8



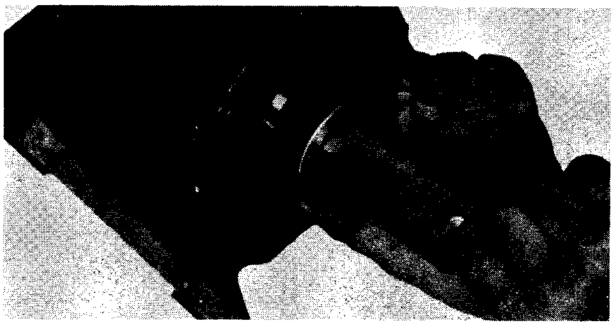
Illust. 9



Illust. 10

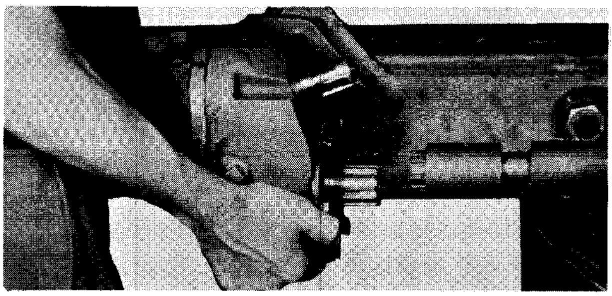


Illust. 11



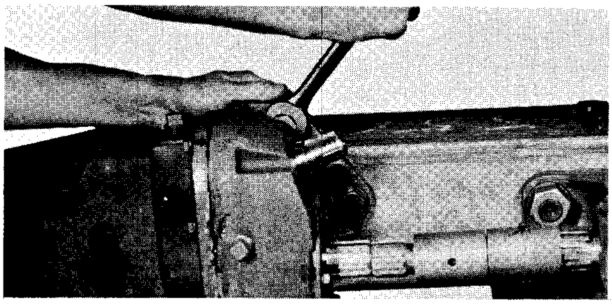
Illust. 12

Drive seals into housing, using a piece of pipe and hammer.



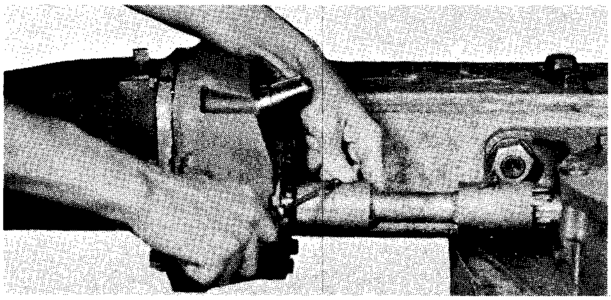
Illust. 13

Install transfer housing onto circle drawbar (Illust. 13). Next, install bolts, lockwashers and nuts. Tighten nuts securely (Illust. 14).



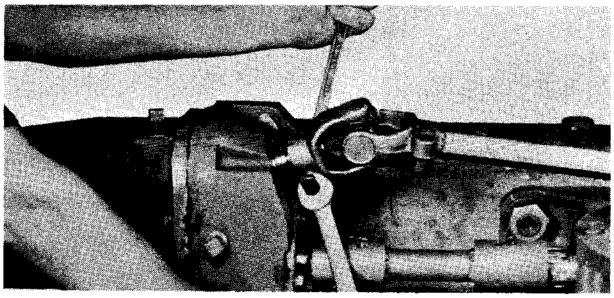
Illust. 14

Install couplings and shaft. NOTE: To install the couplings and shaft, slide couplings toward center of shaft. Insert shaft between transfer and circle reverse housings. Slide couplings onto the mating shafts until the drilled pins can be inserted through couplings.

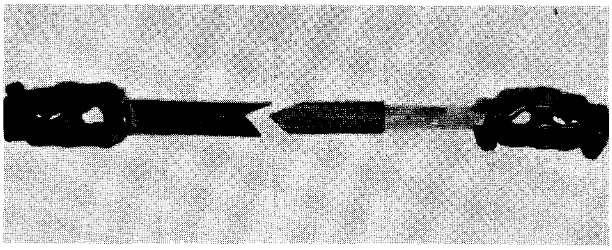


Illust. 15

Install and spread cotter pins (Illust. 15). The shaft should have a small amount of end clearance at all times



Illust. 16



Illust. 17

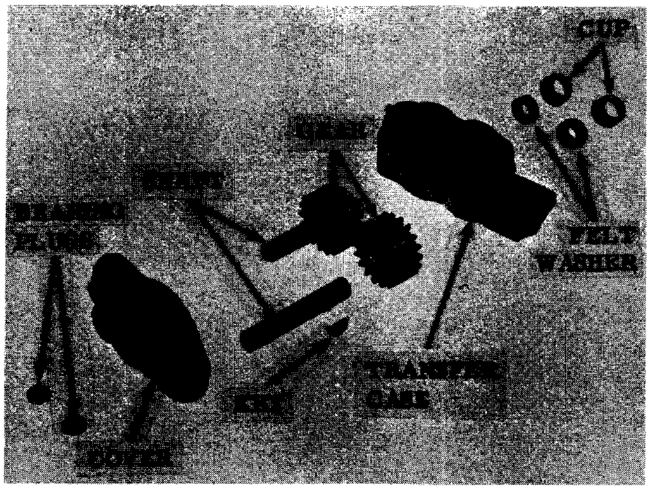
Install circle control square shaft universal joint onto upper pinion shaft. Tighten clamp cap screw securely (Illust. 16). NOTE: Be sure the universal joints on square and hollow shafts lie in the same relative plane (Illust. 17).

Fill transfer case with correct lubricant.

TRANSFER CASE

(Model 330 Motor Graders-Serial Nos. 1645 and Later)
(Model 440 Motor Graders-Serial Nos. 2559 and Later)

Illust. 1 is an exploded view of transfer case.



Illust. 1

Press or drive keys into keyways of shafts (Illust. 2).

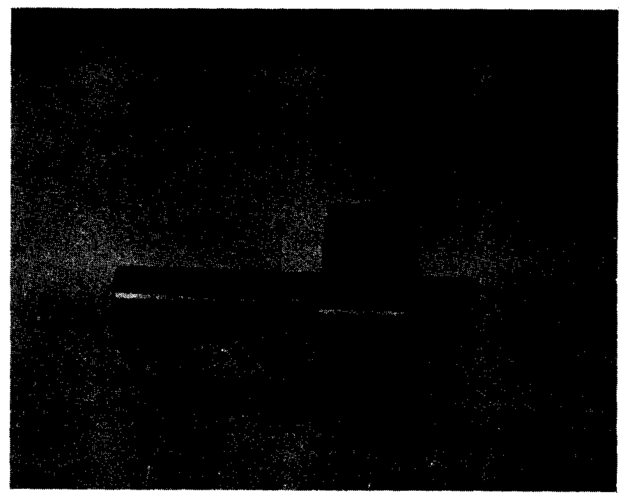
Align keys in shafts with keyways in gears then press gears onto shafts (Illust. 3) until 1" of shaft extends from gear (Illust. 4).

Insert shafts into transfer case (Illust. 5).

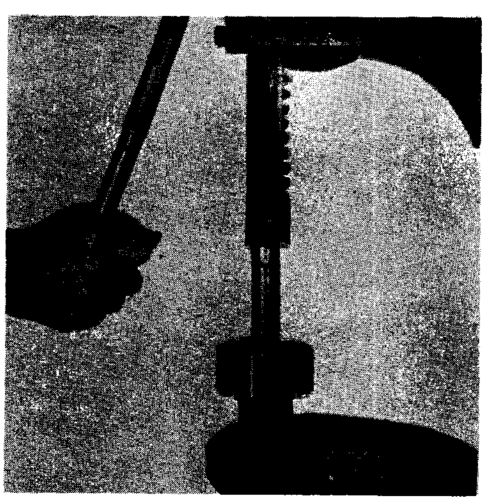
Shellac gasket to transfer case and install cover (Illust. 6).

Install cover cap screws and lock wash-

Illust. 2



Illust. 4



Illust. 3

Illust. 5

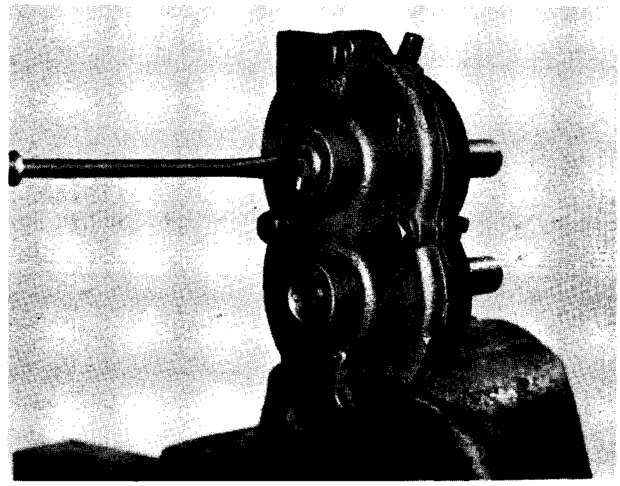
ers. Tighten cap screws securely (Illust. 7).

Install and tighten two (2) bearing plugs into cover (Illust. 8).

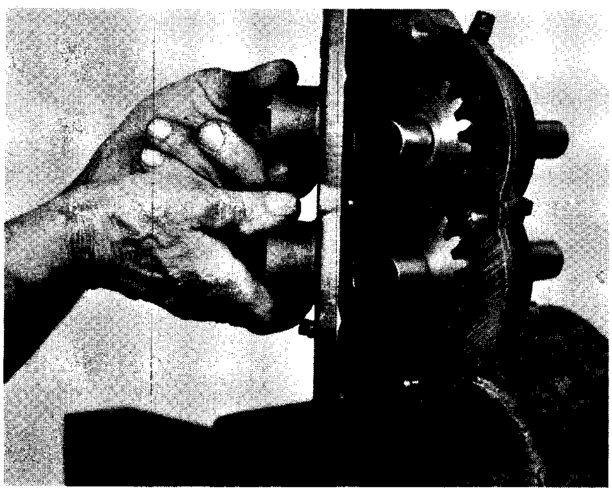
Install two (2) felt washers onto shafts, one (1) washer to each shaft. Next, install two (2) cups (Illust. 9), one (1) cup to each shaft. Felt washers to fit inside cups.

Drive cups into place (Illust. 10). Edge of cups to fit against transfer case.

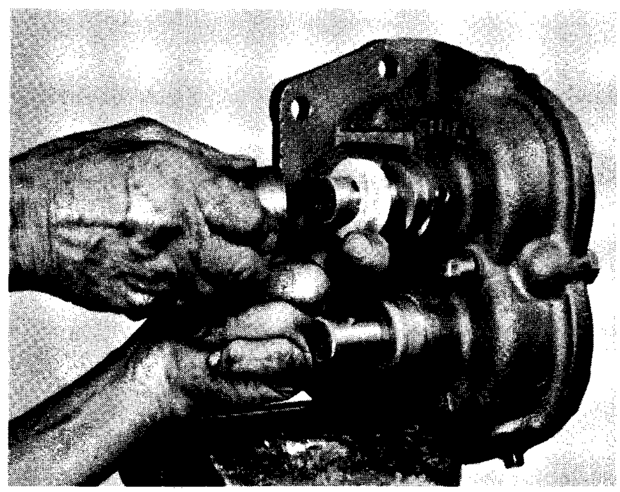
Install universal joint linkage to lower



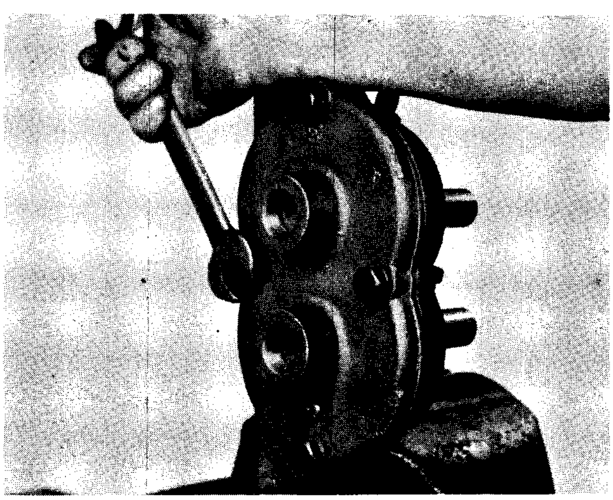
Illust. 8



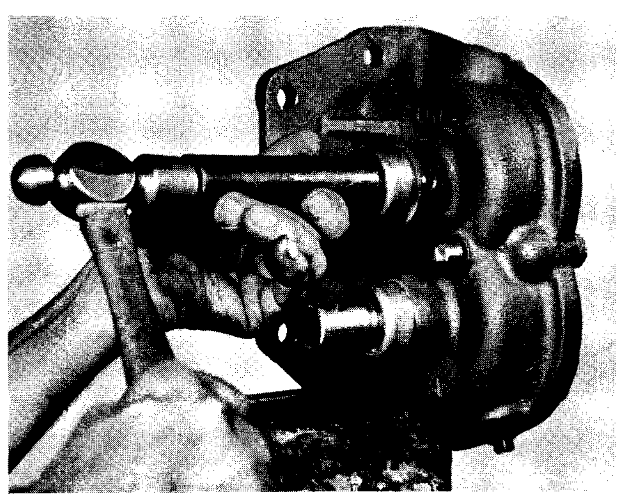
Illust. 6



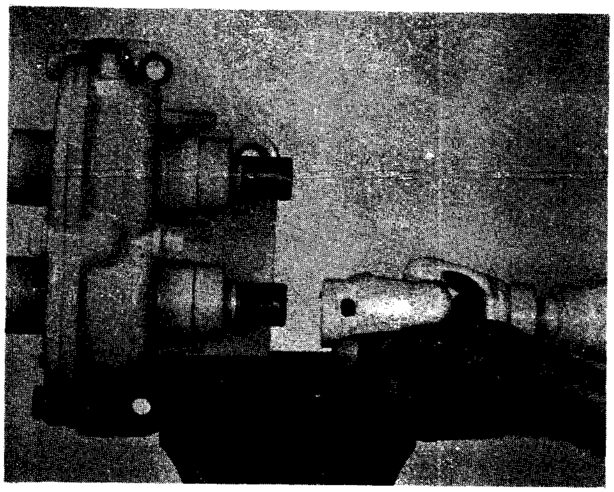
Illust. 9



Illust. 7



Illust. 10

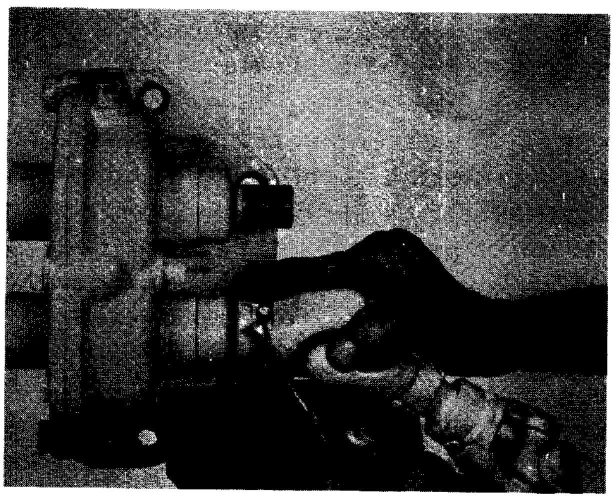


Illust. 11

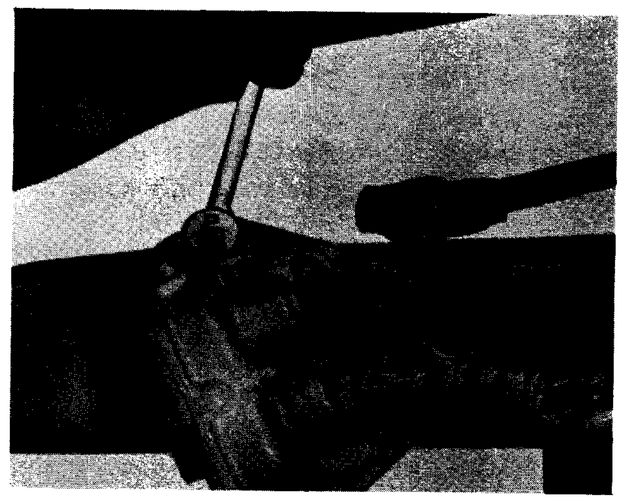
shaft (Illust. 11). Align drilled pin hole in universal joint with hole in shaft then insert drilled pin. Insert cotter pin and spread (Illust. 12).

To install transfer case to circle drawbar, slide splined universal joint onto splines of circle housing pinion shaft (Illust. 13). Place transfer case against drawbar and install cap screws and lock washers. Tighten cap screws securely (Illust. 14).

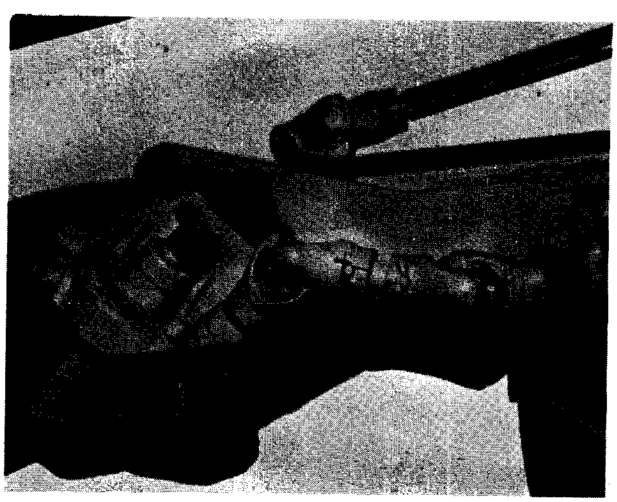
Install square shaft universal joint to upper shaft. Align drilled pin hole in universal joint with hole in shaft then



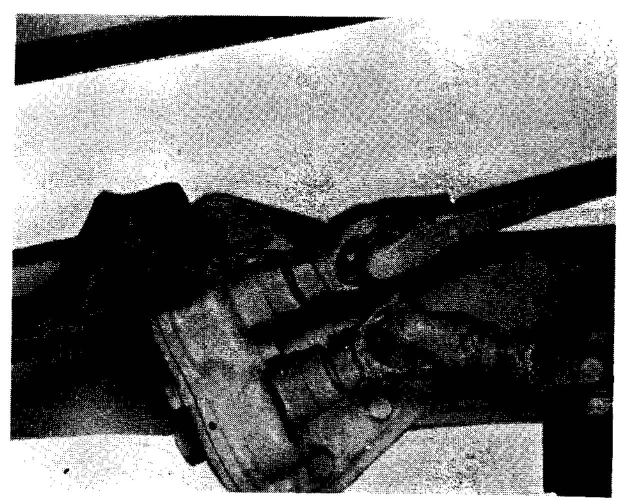
Illust. 12



Illust. 14



Illust. 13



Illust. 15

insert drilled pin. Insert cotter pin into drilled pin and spread (Illust. 15). NOTE: Be sure universal joints on square hollow shaft and square shaft lie in the same relative plane.

Fill transfer case with correct lubricant. (See Lubricating instructions).

CIRCLE AND DRAWBAR

CIRCLE

(For 330 Motor Grader - Serial Nos. 1 and Later with Bracket or Slide-Shift Moldboards, also Serial Nos. 1645 and Later with Power-Shift Moldboard).

(For 440 Motor Grader - Serial Nos. 1 and Later with Bracket or Slide-Shift Moldboards, also Serial Nos. 2559 and Later with Power-Shift Moldboard).

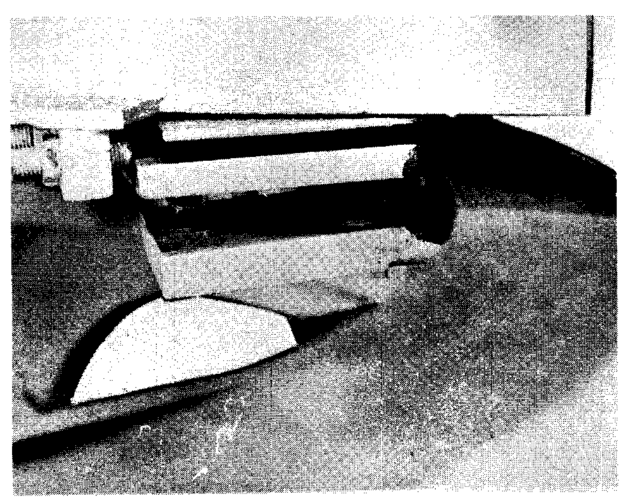
The drawbar and circle assemblies require very infrequent repairs or adjustments. Occasionally, the circle may become bent slightly due to misuse or accident. It is important that the circle be true within certain limits in order to maintain proper operating efficiency. The two dimensions on the circle which should be checked are for out of plane and out of round.

The circle is attached to the drawbar at three points by three sets of adjusting and wearing plates. Shim washers are provided between the lower or retaining plate and the center or adjusting plate of each set for adjustment to compensate for wear. Illust. 1, shows one of the three sets of adjusting and wearing plates. The upper or wearing plate and the lower or retaining plate are reversible. In other words, when these plates become badly worn on one side, they can be removed and turned over to provide a new wearing surface.

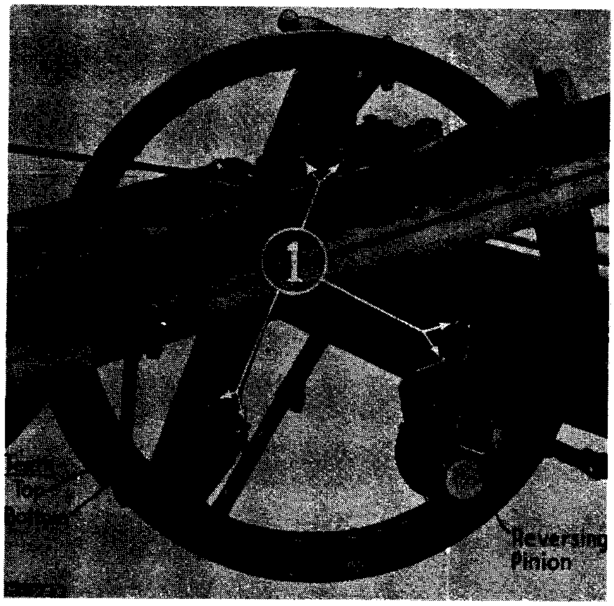
ADJUSTMENT

The vertical clearance between circle and the upper or wearing plate of each set should be 1/16" when moldboard is suspended clear of ground. When all shims have been removed and the vertical clearance is greater than 1/16", the lower or retaining plate of each set should be turned over with the unworn side against the circle. Sufficient shim washers should be replaced between it and the center or adjusting plate of each set to obtain the 1/16" clearance between the circle and the top or wearing plate (Illust. 1).

The center or horizontal adjusting plate of each set can be adjusted by set screws (1) in Illust. 2 against the inside edge of circle to remove horizontal side



Illust. 1



Illust. 2

Illust. 3

clearance due to wear. The clearance at these points should be 1/16".

When any new parts are installed or adjustments made on the circle, the circle must be checked and centered, if necessary, to get the correct mesh of the circle reverse pinion and the gear rack on the inside of the circle.

Set horizontal adjusting blocks so the circle can be rotated; then turn circle and, by sight, note where the pinion meshes deepest in the gear rack. With the circle in this position, push it in so that it contacts the front and the left adjusting plates or adjust plates to meet circle. Be sure to leave a minimum clearance of 3/16" between the top of the pinion tooth and the bottom of the tooth "A" in the gear rack (Illust. 3).

This minimum clearance can be checked by making two right angle bends in a 3/16" rod so that it can be placed between the top and the bottom of the teeth. Set the adjusting blocks to obtain correct clearance.

NOTE: There must be at least 1/8" clearance "B" between the top of each tooth on the gear rack and the left side of the circle reverse housing. To increase this clearance the two rear adjusting blocks should be adjusted. The right rear block should be slacked back, toward the center of the circle and the left rear block pushed out. This will cause a side shifting of the circle in relation to the drawbar. It will then be necessary to readjust the pinion mesh with the circle rack as outlined above. Rotate circle and check the clearance between the top of each pinion tooth and the bottom of the tooth in the rack. This clearance should run from 3/16" minimum to 3/8" maximum. Under no condition should the circle be operated under load when the maximum clearance between the teeth is more than 3/8" as this will damage the circle reverse gear mechanism.

CIRCLE

(For Model 330 Motor Graders-Serial Nos. 1 thru 1644 with Power - Shift Moldboard).

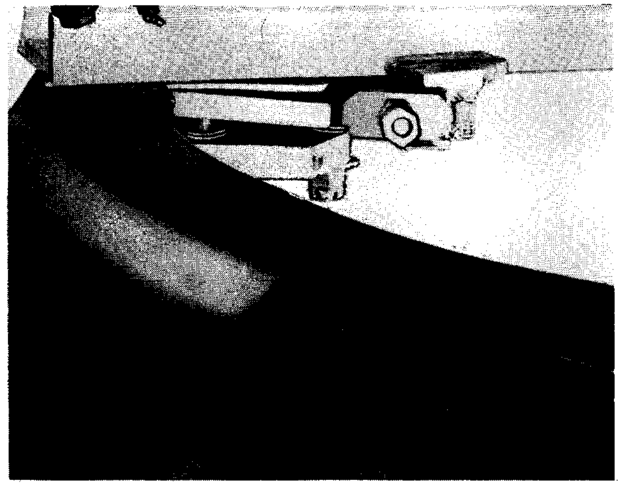
(For Model 440 Motor Graders-Serial Nos. 1 thru 2558 with Power - Shift Moldboard).

The drawbar and circle assemblies require very infrequent repairs or adjustments. Occasionally, the circle may become bent slightly due to misuse or accident. It is important that the circle be true within certain limits in order to maintain proper operating efficiency. The two dimensions on the circle which should be checked are (1) for out of plane and (2) out of round A circle is attached to the drawbar at three points by three sets of adjusting and wearing plates. Shim washers are provided between the lower or retaining plate and the center of adjusting plate of each set for adjustment to compensate for wear. Illust. 1 shows one of three sets of adjusting and wearing plates. The upper or wearing plate and the lower or retaining plate are reversible. In other words, when these plates become worn badly on one side, they can be removed and turned over to provide a new wearing surface.

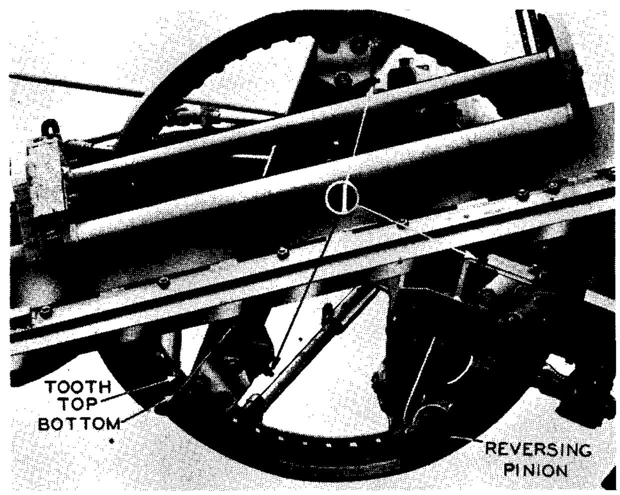
ADJUSTMENT

The vertical clearance between the circle and the upper or wearing plate of each set should be 1/16" when moldboard is suspended clear of ground. When all shims have been removed and the vertical clearance is greater than 1/16", the lower or retaining plate of each set should be turned over with the unworn side against the circle and sufficient shim washers replaced between it and the center or adjusting plate of each set to obtain the 1/16" clearance between the circle and the top or wearing plate (Illust. 4).

The center or horizontal adjusting plate of each set can be adjusted by wedge blocks (1) (Illust. 5), against the inside edge of circle to remove horizontal side clearance due to wear. The clearance at these points should be 1/16".



Illust. 4

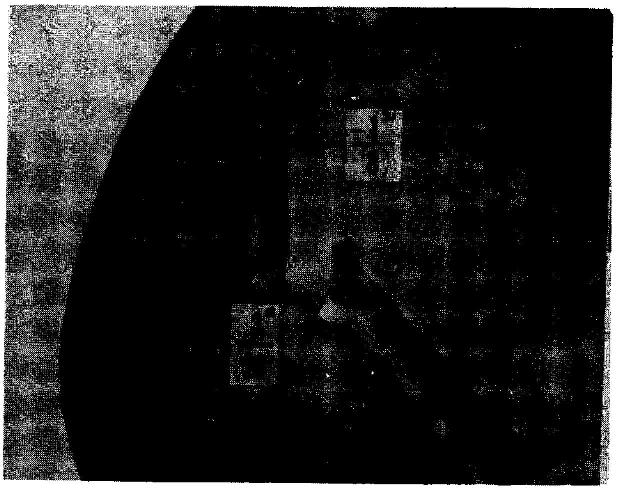


Illust. 5

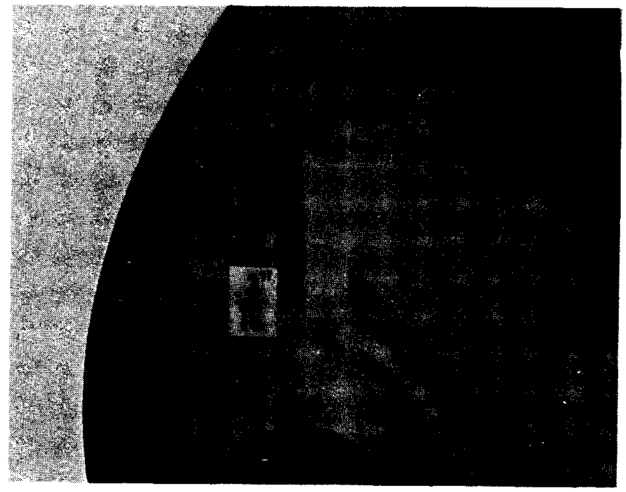
When any new parts are installed or adjustments made on the circle, the circle must be checked and centered, if necessary, to get the correct mesh of the circle reverse pinion and the gear rack on the inside of the inside of the circle.

For 54" Circle: 330 Motor Graders - Serial Nos. 1 thru 1999 and 440 Motor Graders - Serial Nos. 1 thru 3199 with Bracket, Slide-Shift and Power-Shift Moldboards.

Set horizontal adjusting blocks so the



Illust. 6



Illust. 7

circle can be rotated; then turn circle and by sight, note where the pinion meshes deepest in the gear rack. With the circle in this position, push it in so that it contacts the front and the left adjusting plate, or adjust plate to meet circle, being sure to leave a minimum clearance of 3/16" between the top of the pinion tooth and the bottom of the tooth "A" in the gear rack (Illust. 6).

This minimum clearance can be checked by making two right angle bends in a 3/16" rod so that it can be placed between the top and bottom of the teeth. Set the adjusting blocks to obtain the correct clearance.

NOTE: There must be at least 1/8" clearance "B" between tooth on the gear rack and the left side of the circle reverse housing. To increase this clearance the two rear adjusting blocks should be adjusted. The right rear block should be slacked back toward the center and the left rear block pushed out. This will cause a side shifting of the circle in relation to the drawbar. It will then be necessary to readjust the pinion mesh with the circle rack.

Rotate circle and check the clearance between the top of each pinion tooth and the bottom of the tooth in the rack. This clearance should run from 3/16" minimum. Under no condition should the circle be operated under load when the maximum clearance between the teeth is more than 3/8" as this will damage the circle gear mechanism.

For 63" Circle: 330 Motor Graders - Serial Nos. 2000 and Later, also, 440 Motor Graders - Serial nos. 3200 and Later with Bracket, Slide-Shift and Power-Shift Moldboards.

Set horizontal adjusting blocks so the circle can be rotated; then turn circle, and by sight, note where the pinion meshes deepest in the gear rack. With the circle in this position push it in so that it contacts the front and the left adjusting plate, or adjust plate to meet circle, being sure to leave a minimum clearance of 3/16" between the top of the pinion tooth and the bottom of the tooth "A" in the gear rack (Illust. 7).

This minimum clearance can be checked by making two right angle bends in a 3/16" rod so that it can be placed between the top and bottom of the teeth. Set the adjusting blocks to obtain the correct clearance.

Rotate circle and check the clearance between the top of each pinion tooth and the bottom of the tooth in the rack. This clearance should run from 3/16" minimum. Under no condition should the circle be operated under load when the maximum clearance between the teeth is more than 3/8" as this will damage the circle gear mechanism.

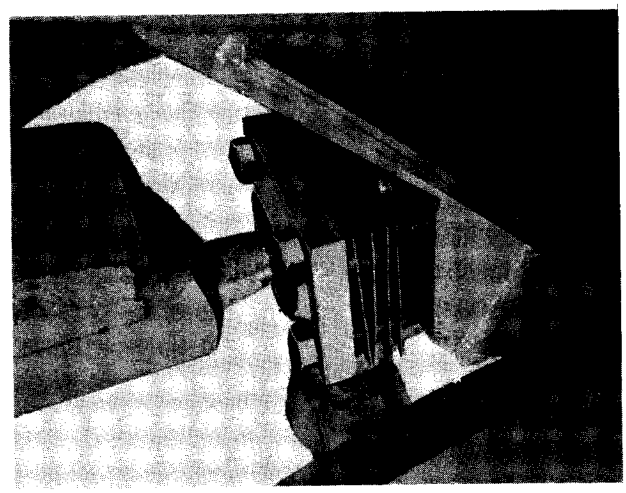
KEEP CIRCLES LUBRICATED

Clean dirt off circle flange and moldboard slide bar or bars daily or oftener, if necessary.

IMPORTANT: Lubricate circle flange and moldboard slide bar or bars daily with a coating of transmission oil. On later style moldboards, apply a coating of pressure gun grease under moldboard slide angle.

DRAWBAR BALL AND SOCKET

The ball and socket joint which attaches the drawbar assembly to the frame of the grader is equipped with shims which



Illust. 8

can be removed to compensate for wear. Two different thicknesses of shims are provided at this point and when looseness becomes excessive, the four cap screws which hold the drawbar bearing cap to the main frame, should be removed (Illust. 8) and sufficient shims removed from the joint to remove the free play in the ball joint. The joint should never bind but should always work freely. After reassembling and tightening the four cap screws, a soft wire should be passed through the drilled heads of the cap screws and twisted tight to prevent their working loose during operation of the machine.

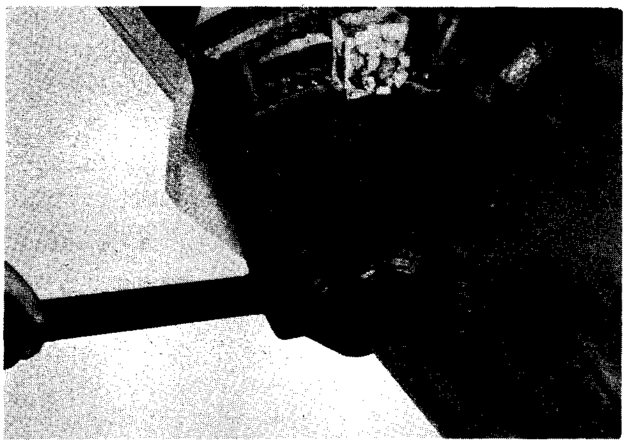
MOLDBOARDS

SLIDE-SHIFT MOLDBOARD REMOVAL

To remove moldboard from circle legs, lower moldboard to ground using controls.

Remove cotter pins from both L.H. and R.H. tilt plate pivot bolts. Next, slightly loosen pivot bolts (Illust. 1).

Remove cotter pins, nuts and pitch adjusting locks from L.H. and R.H. tilt plate bolts.



Illust. 1

Slightly raise moldboard (using controls) until moldboard pitches forward. Again lower moldboard until weight of moldboard is off tilt plate pitch adjusting bolts. Place blocks in front and rear of moldboard to prevent moldboard from falling.

Pry L.H. tilt plate away from circle leg (Illust. 2).

To pry R.H. tilt plate away from circle leg, it is necessary to cut away weld from heads of pivot bolt and pitch adjusting bolt.

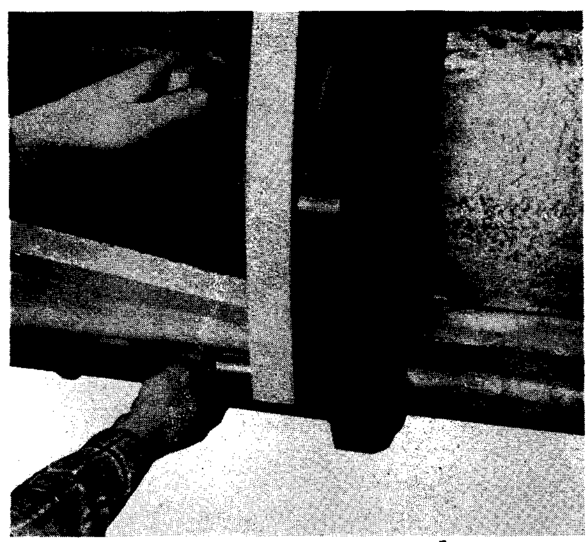
Remove both bolts from circle leg (Illust. 3).

Start engine. Move motor grader back from moldboard.

TILT PLATE REMOVAL

To remove tilt plates, follow the same procedure as outlined under "Slide-Shift Moldboard Removal".

Illust. 2

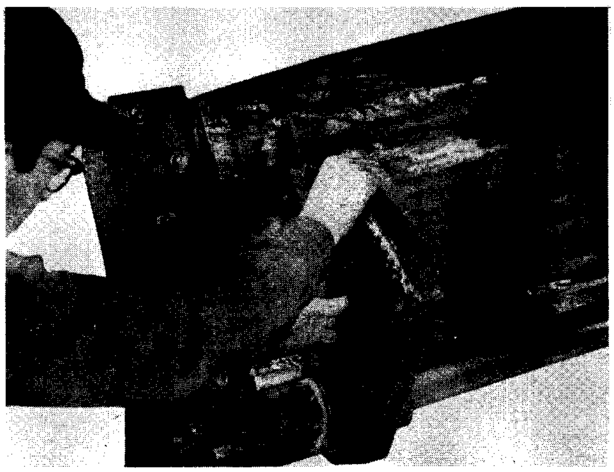


Illust. 3

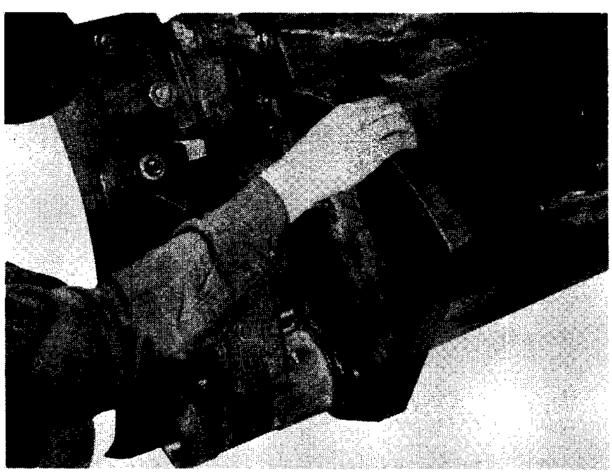
The L. H. flag socket must be removed from moldboard slide bar.

Slide L. H. tilt plate off left end of moldboard (Illust. 1).

To remove R. H. tilt plate from moldboard, raise lock pin from moldboard slide bar notch by turning lock control shaft. Now, slide R. H. tilt plate off left end of moldboard (Illust. 2).



Illust. 1



Illust. 2

R. H. TILT PLATE ASSEMBLY

To repair R. H. tilt plate, it must be removed from moldboard.

The illustrations and instructions given are for the reassembly procedure. To disassemble, reverse reassembly procedure.

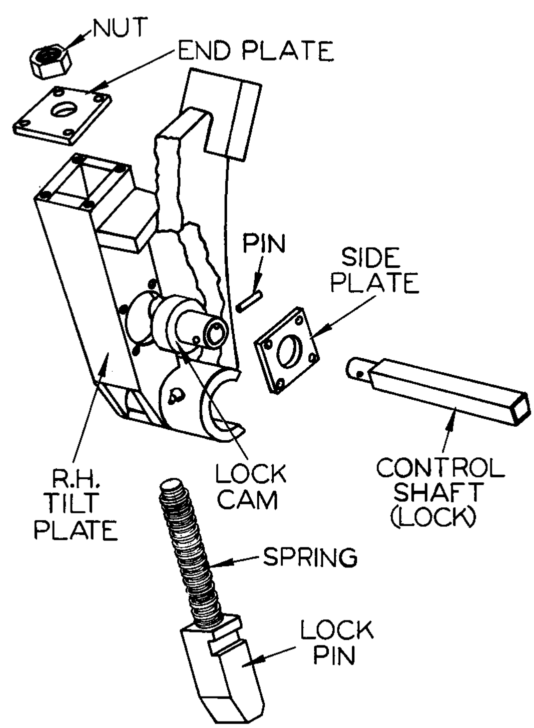
Inspect all parts for wear or damage and replace parts if necessary. Apply a light coating of oil to parts before reassembly.

Illust. 1 is an exploded view of R. H. tilt plate.

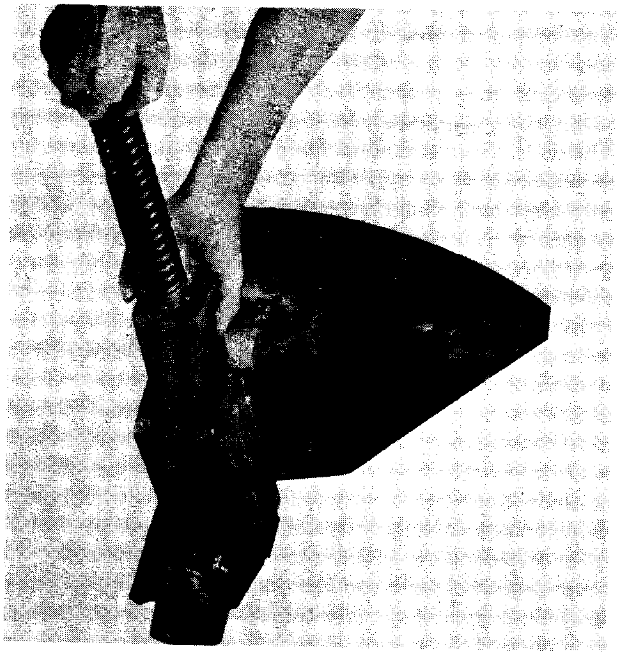
Install spring onto lock pin. Insert lock pin into box of tilt plate (Illust. 2). Slot in pin toward tilt plate.

Install end plate onto box. Install cap screws and lock washers. Tighten cap screws securely (Illust. 3).

Install lock nut onto lock pin. Tighten nut until boss on lock cam can be inserted into slot of lock pin (Illust. 4).



Illust. 1

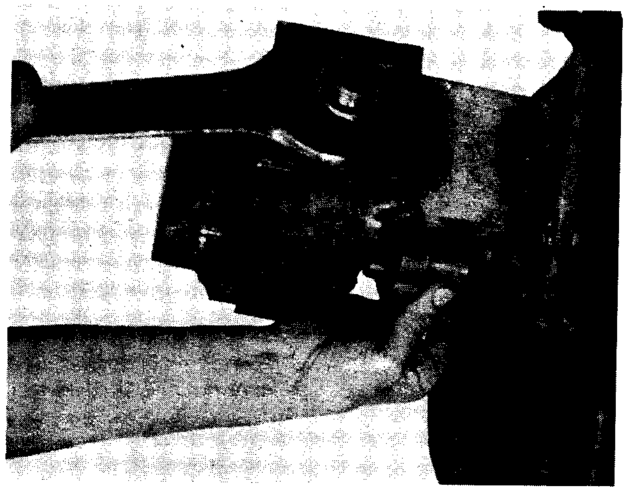


Illust. 2

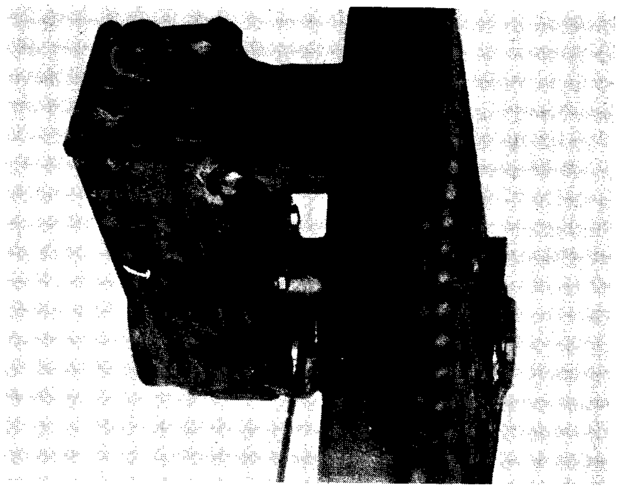
Illust. 3

Install side plate, cap screws and lock washers. Tighten cap screws securely (Illust. 5).

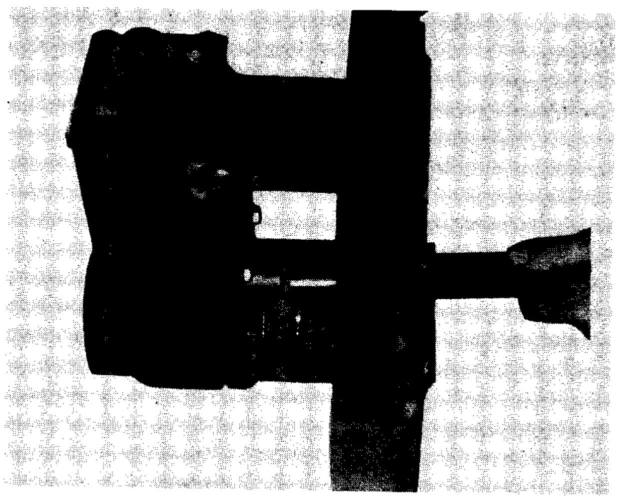
Insert lock control shaft through hole in tilt plate and into lock cam (Illust. 6).



Illust. 4



Illust. 5



Illust. 6

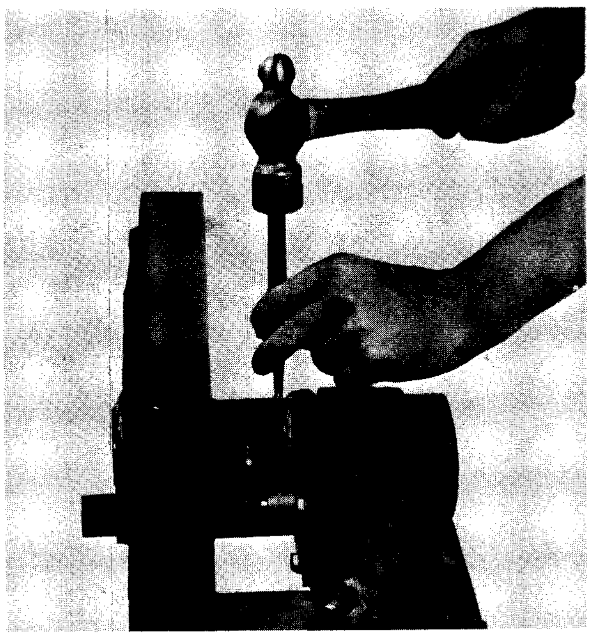
Align rolled pin hole in shaft with hole in cam. Drive rolled pin into cam and shaft (Illust. 7).

Check the locking and unlocking action by turning shaft (Illust. 8). Should any tightness appear, loosen lock nut until tightness is eliminated.

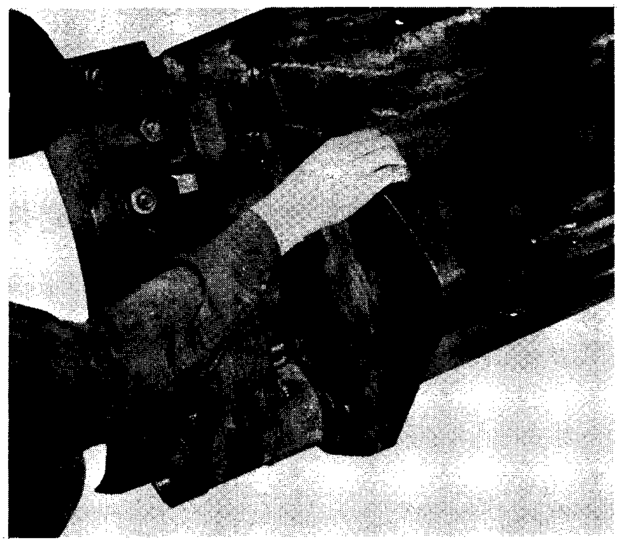
With lock pin in an unlocked position (Illust. 9) slide R. H. tilt plate onto moldboard. NOTE: Apply grease to slide bar and under slide angle before installing tilt plate to moldboard.

Slide R. H. tilt plate to right side of moldboard.

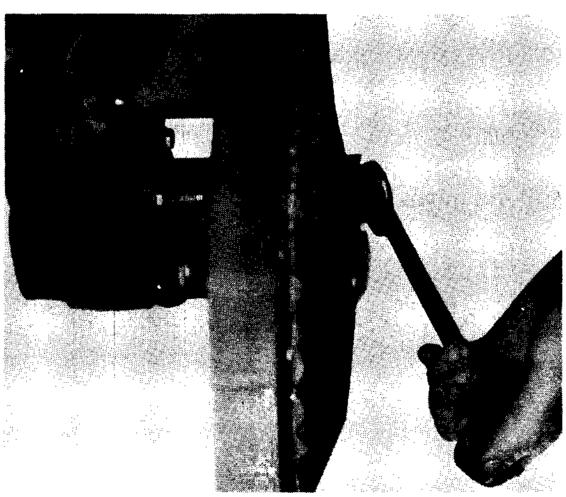
Slide L. H. tilt plate onto moldboard (Illust. 10).



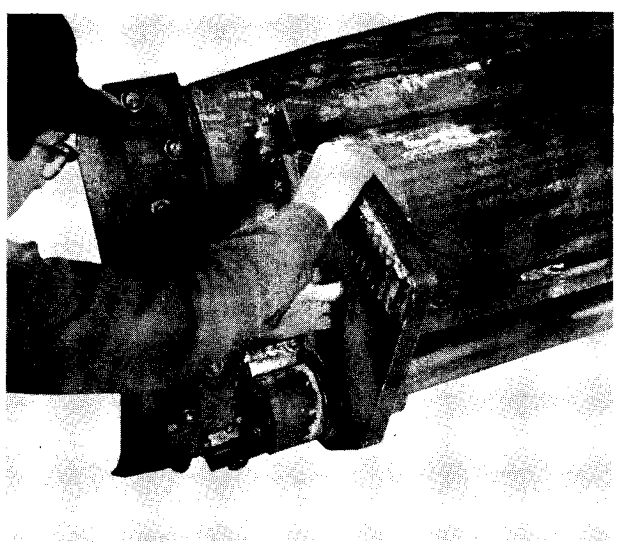
Illust. 7



Illust. 9



Illust. 8



Illust. 10

Start engine and move motor grader forward, slowly, until R. H. circle leg is between R. H. tilt plate and tilt plate box. When bolt holes are aligned, insert bolts through circle leg and tilt plate (Illust. 11).

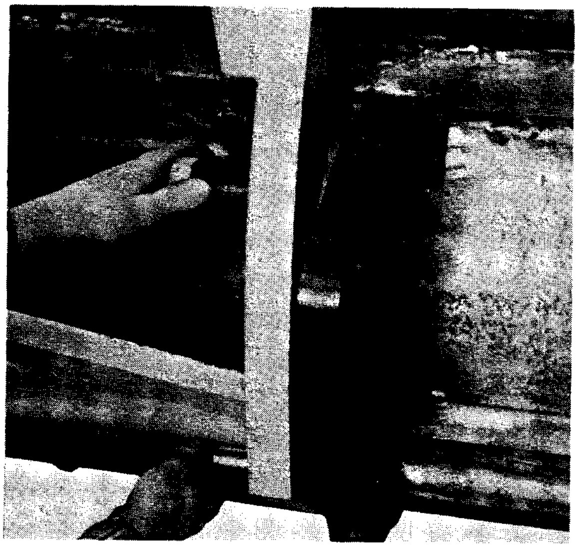
Install L. H. tilt plate onto left circle leg bolts (Illust. 12).

Install L. H. and R. H. tilt plate pivot bolt nuts (Illust. 13) but do not tighten.

Start engine. Slowly move motor grader forward until the desired pitch of moldboard is obtained.

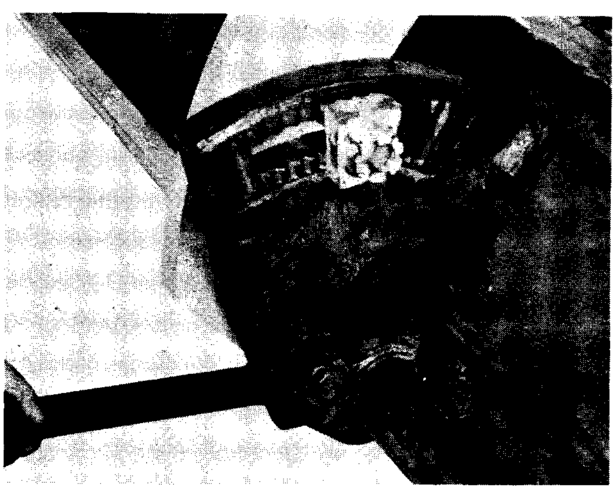
Install pitch adjusting locks and nuts. Tighten nuts securely (Illust. 14). Next, tighten pivot bolt nuts securely.

Install and spread cotter pins (Illust. 15).

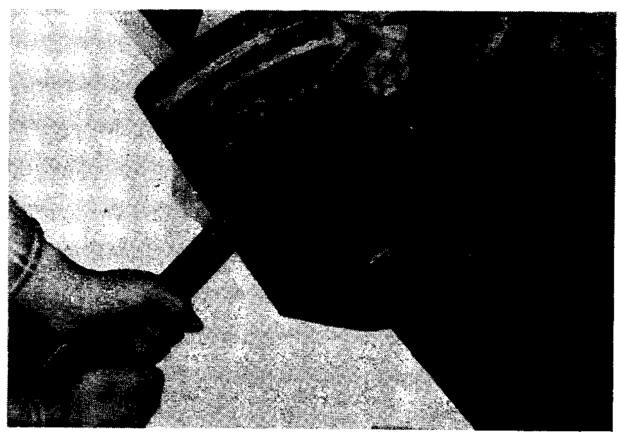


Illust. 11

Illust. 12



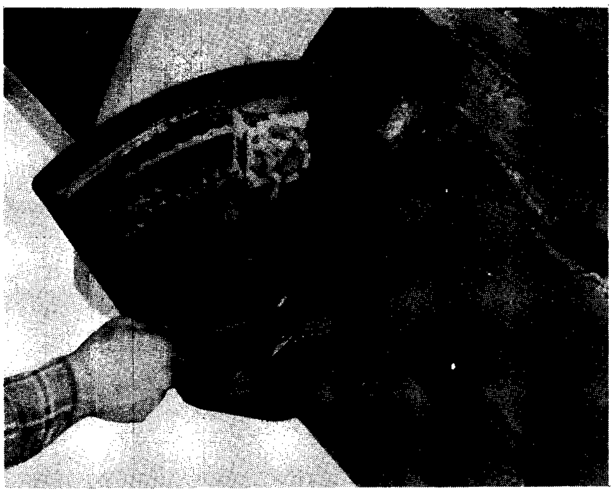
Illust. 13



Illust. 14

Illust. 15

Turn lock control shaft (Illust. 16) until lock pin rests on slide rail. Move moldboard either manually or mechanically until lock pin falls in the desired notch.



Illust. 16

POWER-SHIFT MOLDBOARD REMOVAL

The power-shift moldboard may be removed from circle legs without removing hydraulic ram.

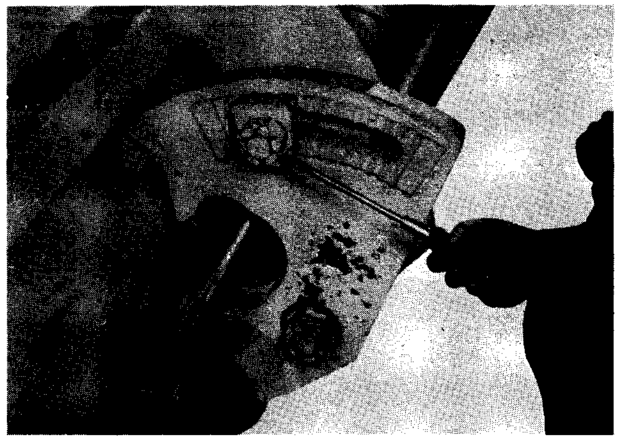
To remove moldboard from circle, lower moldboard to ground using controls. Place blocks at front and rear (under rail) of moldboard.

Remove cotter pins from L. H. and R. H. tilt plate pivot and pitch adjusting bolts (Illust. 1).

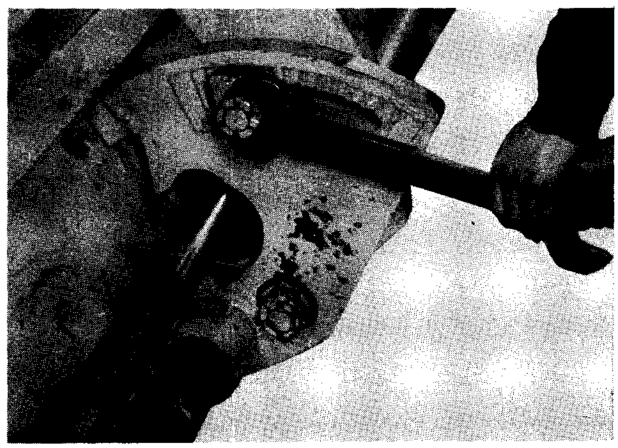
Remove L. H. and R. H. pitch adjusting nut and lock from bolt (Illust. 2). Also remove pivot bolt nut.

Start engine and shift moldboard to right (using control) until R. H. tilt plate is off bolts (Illust. 3).

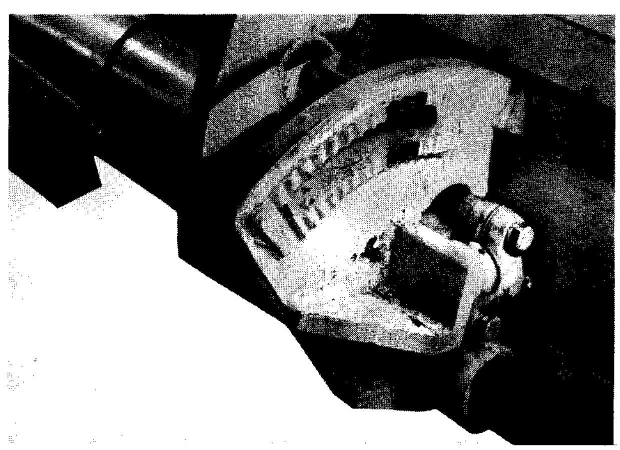
Disconnect hoses at rotary connection elbows (Illust. 4). NOTE: Plug ends of hoses to prevent dirt from entering.



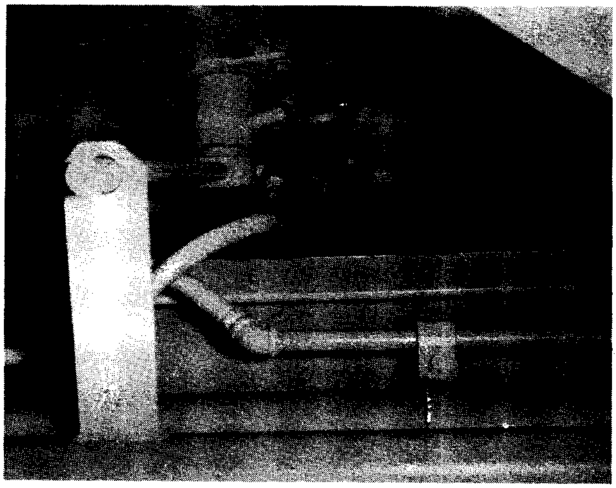
Illust. 1



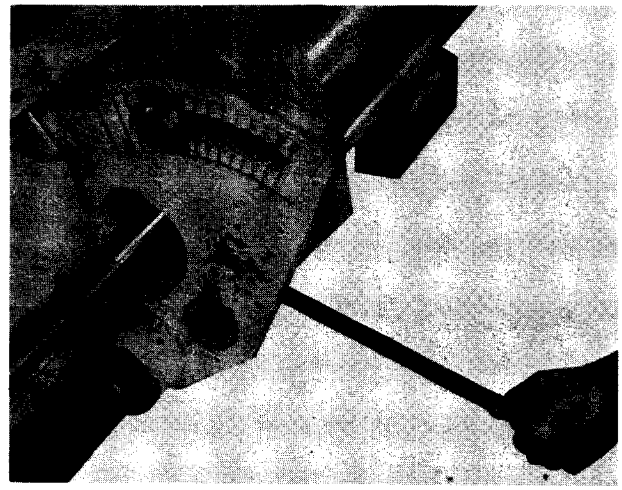
Illust. 2



Illust. 3



Illust. 4



Illust. 5

IMPORTANT: Be sure to unplug ends of hoses before installation.

Pry L.H. tilt plate from bolts (Illust. 5).

When both tilt plates are clear of bolts and hydraulic hoses have been placed on hydraulic ram, move motor grader back away from moldboard.

To install moldboard, reverse "Removal" procedure.

Check hydraulic reservoir oil level and add oil if necessary (See "Lubricating Instructions").

TILT PLATE REMOVAL

To remove tilt plates, hydraulic ram must be removed. Follow "Power-Shift Moldboard Removal" procedure.

When ram has been removed, remove flag socket and slide tilt plates from moldboard.

To install tilt plates, apply grease to moldboard slide rail and under slide angle.

CONTROL VALVE
(Power-Shift Moldboard)

Very little trouble should be experienced with the power-shift control valve, providing the hydraulic system has been kept clean. The various parts are replaceable as separate items. However, when such replacements are made, the surrounding parts should be inspected very carefully to determine whether they will work satisfactorily with the new parts.

Clean the outside of the valve with an oil solvent or similar fluid and dry thoroughly. The control valve may be disassembled by reversing the reassembly procedure.

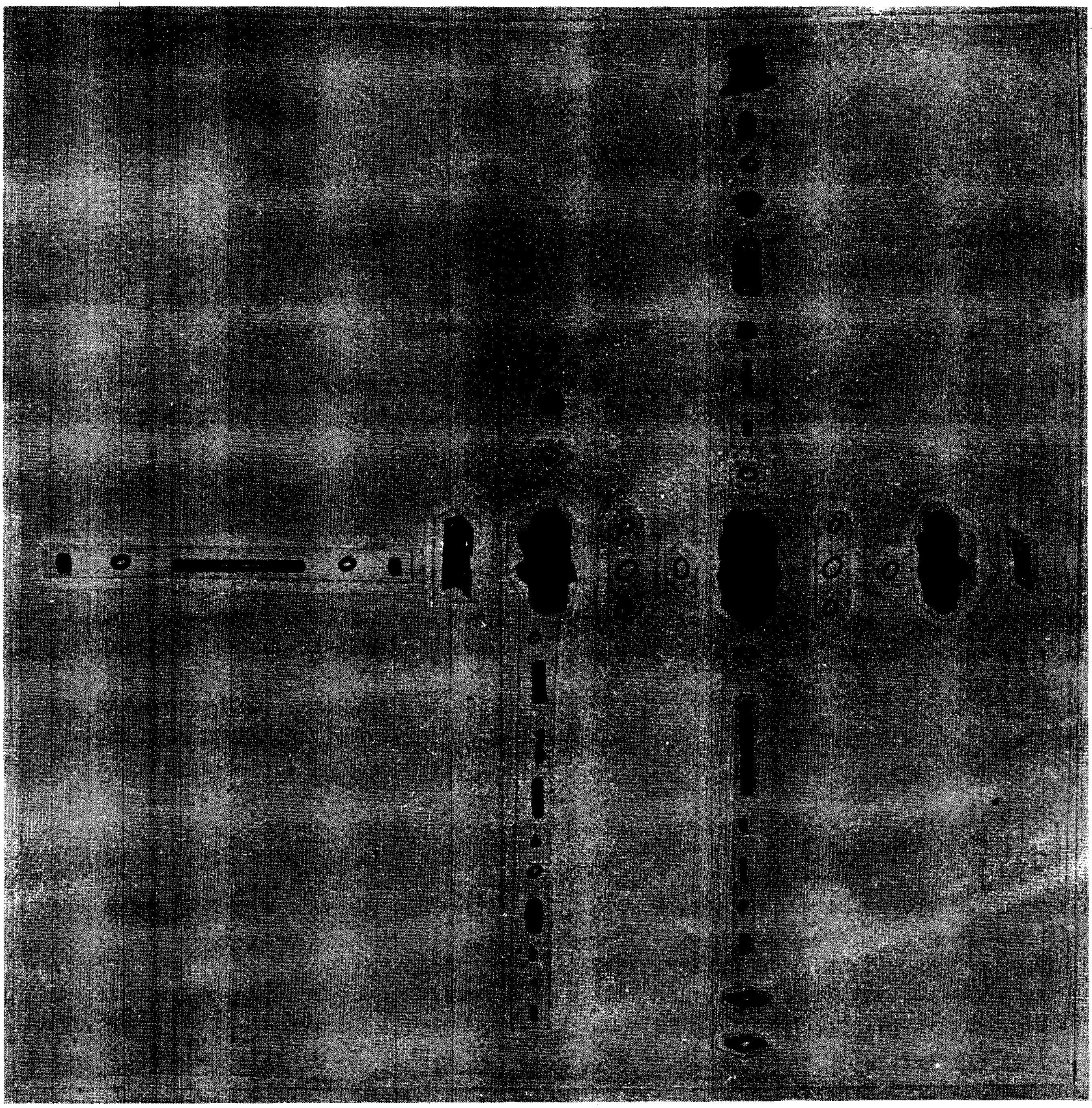
Apply oil to parts before installation.

Illust. 1 is an exploded view of the power-shift moldboard control valve.

Illusts. 2 and 3 are exploded views of the inlet and center sections of the control valve.

INLET SECTION OF VALVE

Install seal ring into groove of valve seat. Insert valve seat into inlet section housing. NOTE: Apply white lead to seal ring to prevent damage.



Illust. 1

Install plunger, spring and spring guide into inlet section housing. Install seal ring into groove of cap and tighten cap into housing. NOTE: Apply white lead to seal ring to prevent damage.

Install adjusting screw with jam nut into cap. After control valve has been adjusted to specified P.S.I., adjusting screw jam nut and acorn nut may be tightened.

CENTER SECTION OF VALVE

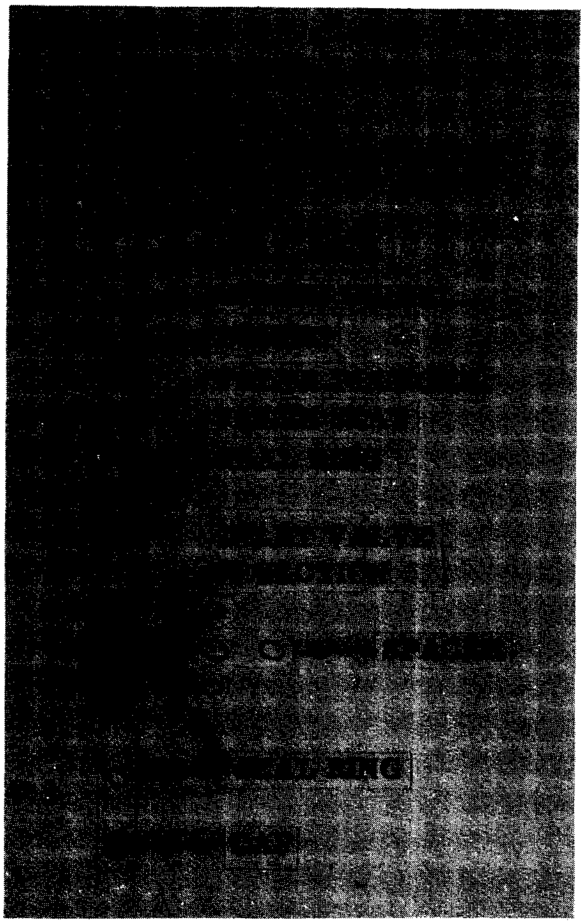
Insert seal rings into grooves of center section housing.

Insert check plunger into plunger. Next, install spring onto check plunger and install seal ring onto plunger.

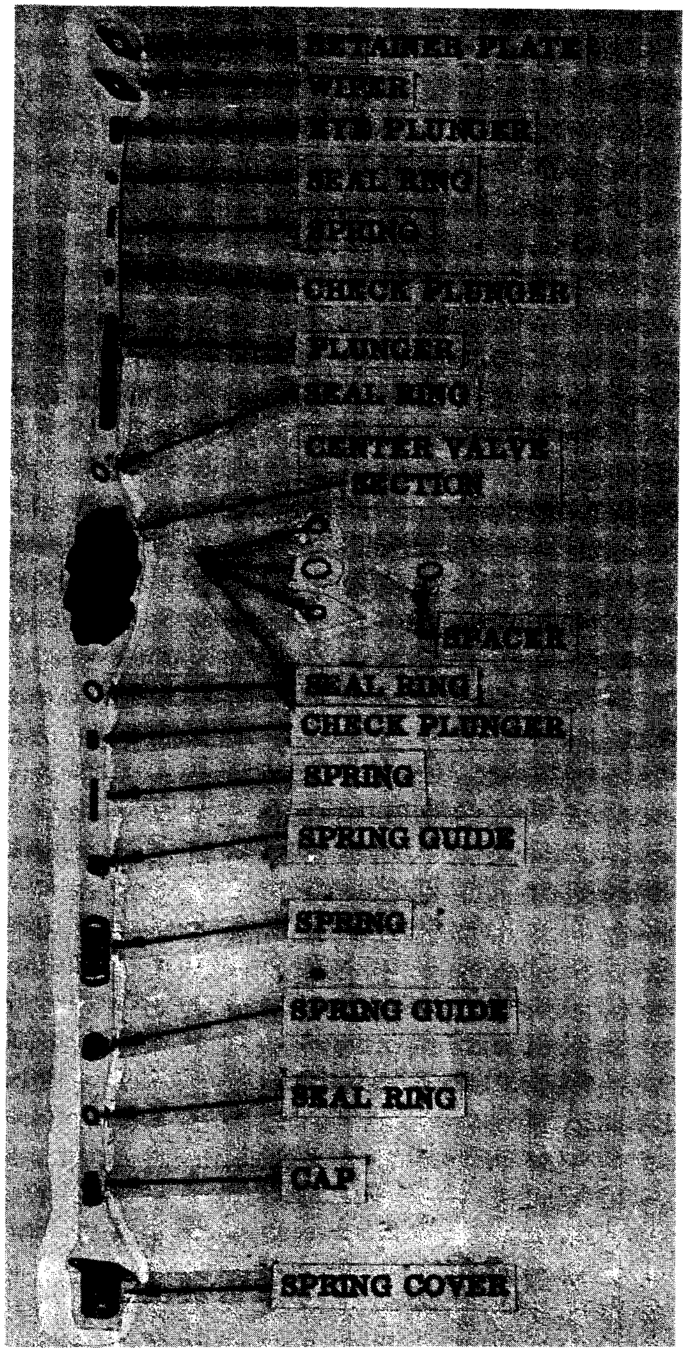
Install and tighten eye plunger into plunger.

Insert plunger assembly into valve housing. NOTE: Apply white lead to seal rings to prevent damage.

Insert check plunger and spring into lower portion of plunger. Next, install spring



Illust. 2



Illust. 3

guide, spring, second spring guide, seal ring and cap.

Install spring cover with cap screws. Tighten cap screws securely.

To complete the assembly of the center section housing, install wiper and retainer plate. Install cap screws and tighten securely.

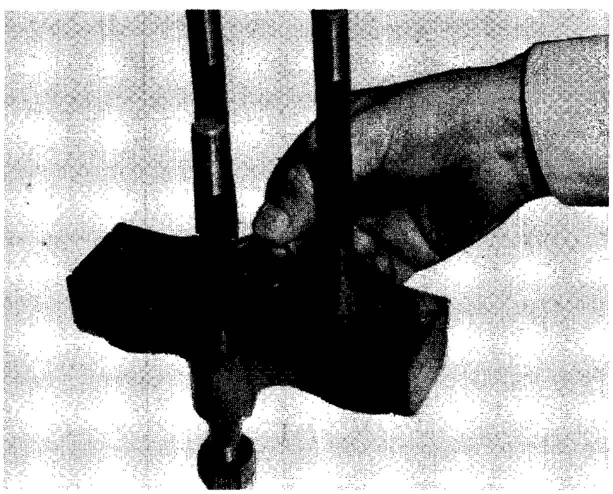
Install mounting bracket on studs with lock washers and nuts. Install end section housing on studs (Illust. 4). Next, install seal rings in end holes of housing and spacer and seal ring in center hole.

Install center section housing on studs and down on end section housing (Illust. 5). Install seal rings in end holes and spacer and seal ring in center hole.

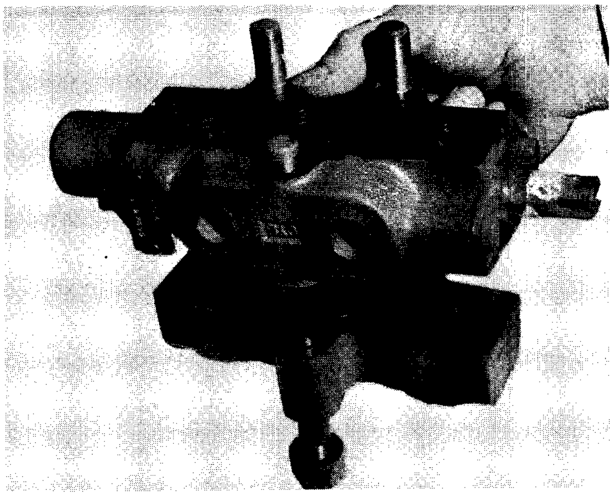
Install inlet section housing on studs and down on center section housing (Illust. 6).

Install mounting bracket onto studs. Install lock washers and nuts. Tighten nuts to a torque reading of 50 foot pounds (Illust. 7).

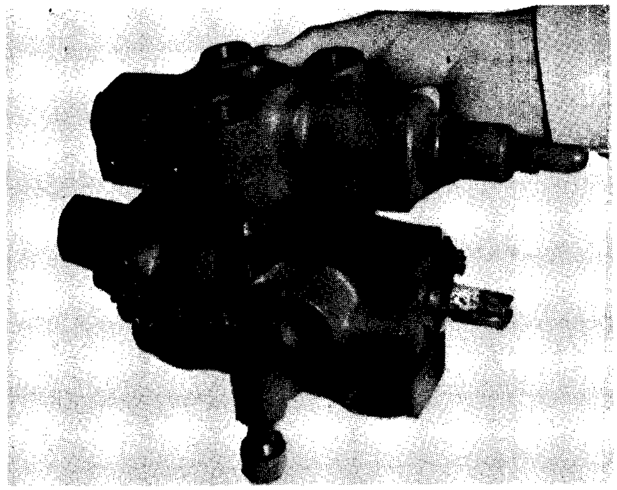
Install fittings into valve. NOTE: Apply pipe sealing compound to threads of fittings.



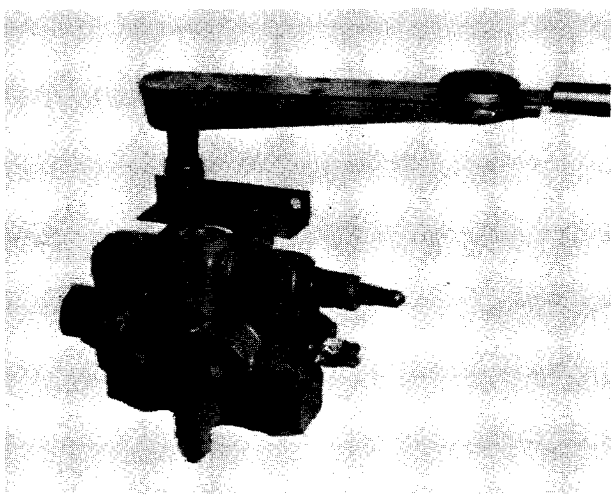
Illust. 4



Illust. 5



Illust. 6



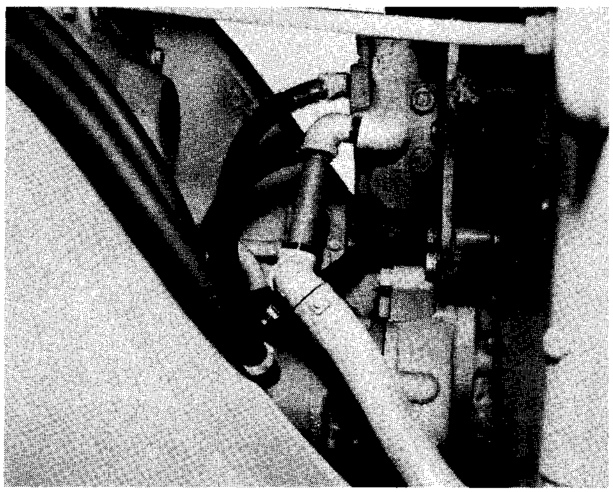
Illust. 7

Install control valve onto valve base. Install cap screws with lock washers. Tighten cap screws securely (Illust. 8).

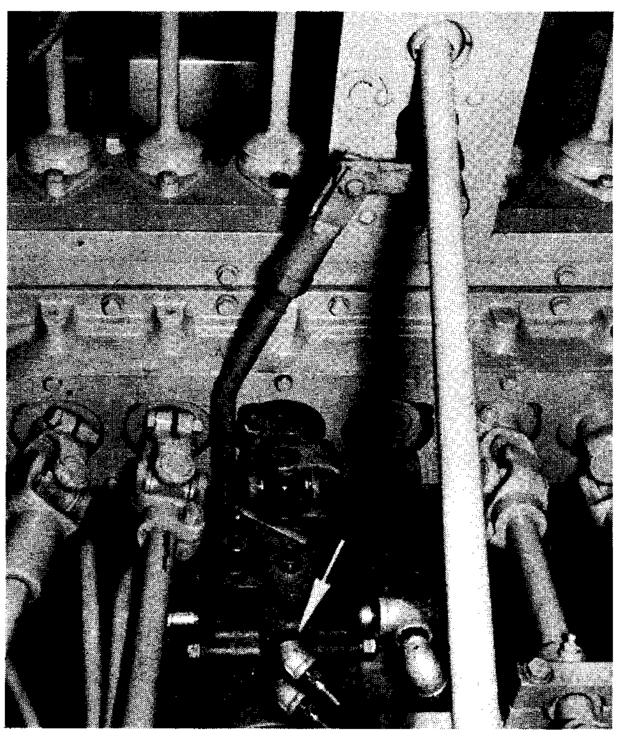
CONTROL VALVE ADJUSTMENT

To adjust control valve, remove upper pressure hose from elbow in center section of control valve as indicated by arrow (Illust. 9). Install a pressure gauge in center section. Remove acorn nut and loosen jam nut. Start engine. Using a screw driver, turn set screw until a reading of 1000 p.s.i. is obtained. Hold set screw in this position and tighten jam nut. Recheck gauge reading.

When reading is obtained, install and tighten acorn nut. Remove gauge and install elbow and hose. Start engine and check for leakage.



Illust. 8

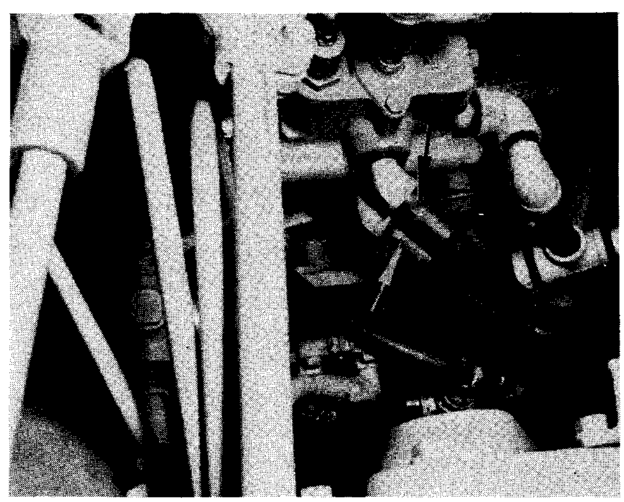


Illust. 9

HYDRAULIC LINE INSTALLATION

Hydraulic tubes and lines should be cleaned with a cleaning solvent. Blow tubes and lines out with air to remove any dirt or foreign matter before installing.

Install pressure hoses in elbows of center valve housing (Illust. 1).



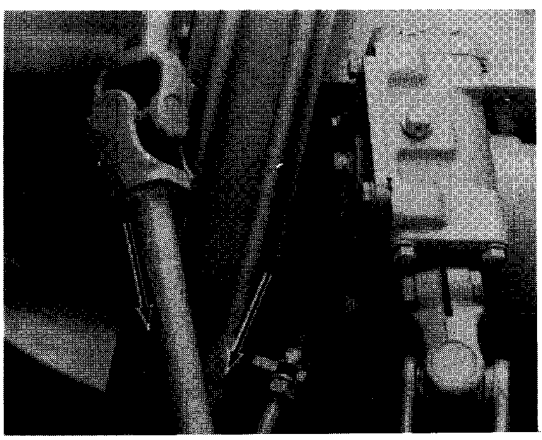
Illust. 1

Install hydraulic tubes with nuts on top of frame (Illust. 2). Install tube clamps over tubes. Install cap screws with lock washers. Tighten cap screws securely.

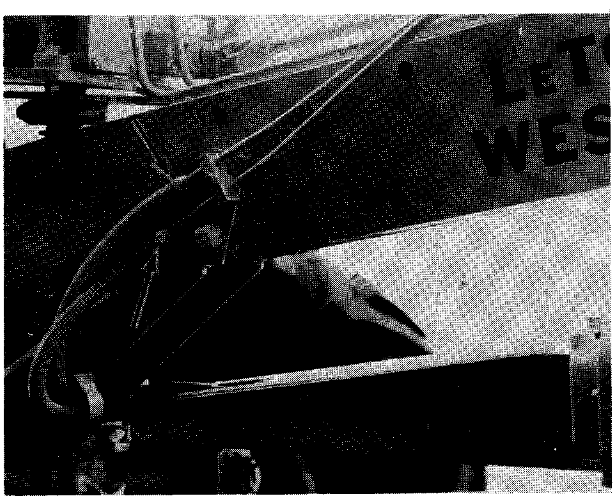
Install and tighten pressure hoses into tubes (Illust. 2).

Install and tighten pressure hoses into pressure tubes (Illust. 3).

Insert pressure hoses through eye and into end of circle drawbar (Illust. 3) and out slot in right side of circle drawbar.



Illust. 2

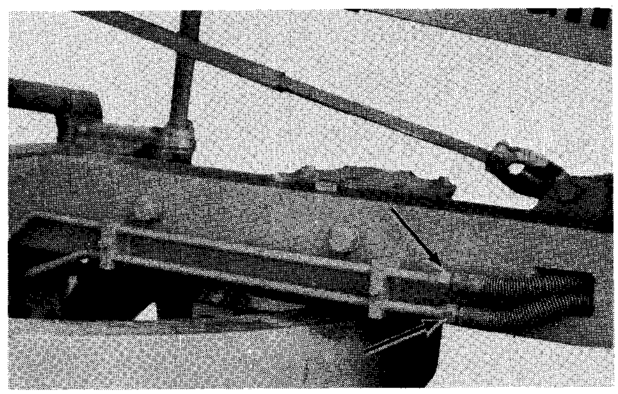


Illust. 3

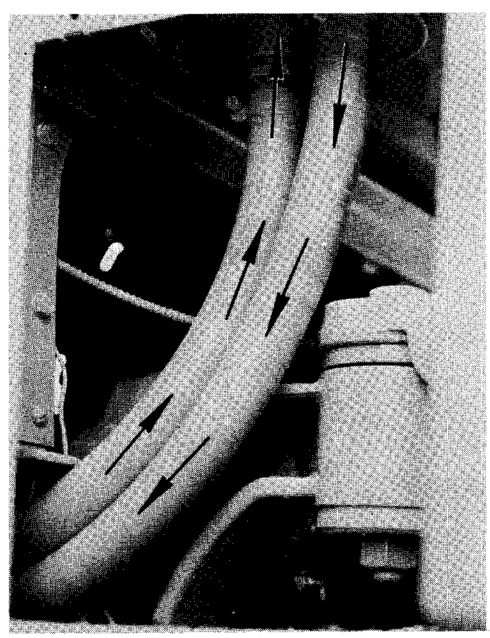
Install hydraulic tubes to rotary control valve body fittings. Do not tighten nuts. Install and tighten pressure hoses to tubes (Illust. 4), then tighten hydraulic tube nuts on rotary control valve body fittings securely.

Install tube clamps over tubes. Install cap screws with lock washers. Tighten cap screws securely.

Install pressure lines from rotary fittings to hydraulic ram pipe elbows (Illust. 6). Tighten nuts securely.



Illust. 4

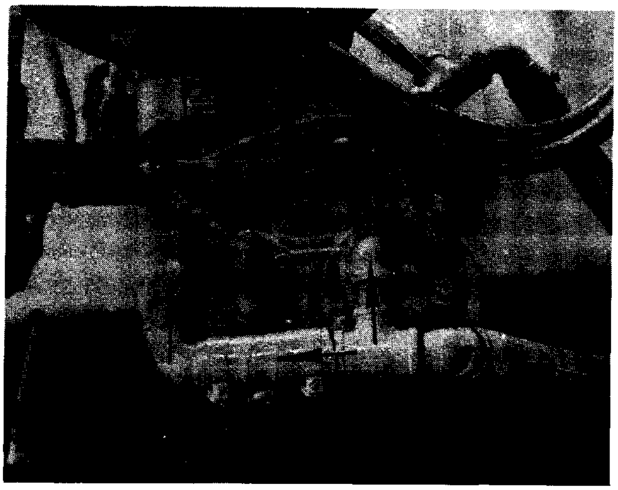


Illust. 5

Illusts. 5, 6 and 7 shows the flow of oil from reservoir through pump, control valve and into lines.

Install suction and return hoses to reservoir. Install and tighten clamps at reservoir. NOTE: Suction hose is shown in Illust. 5 with arrows pointing downward while return hose is shown with arrows pointing upward.

Bring both hoses over top of frame, clamping them to floor board.



Illust. 6

Illust. 7

Clamp suction hose to pump pipe nipple and return hose to pipe nipple in tee at control valve (Illust. 6).

CONTROL VALVE LEVER

Illust. 1 is an exploded view of the powershift moldboard control lever.

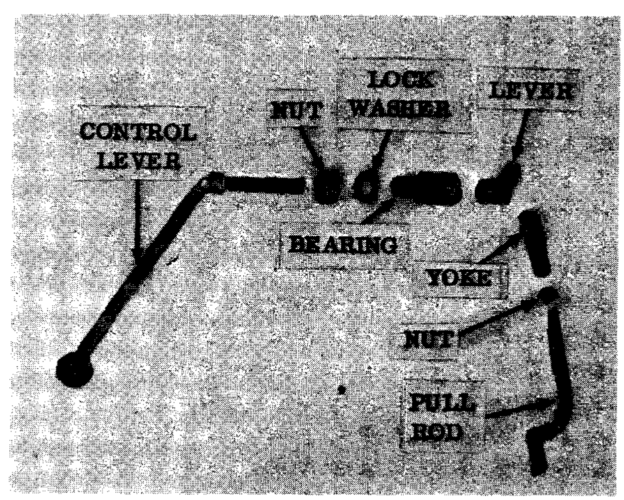
Install bearing through steering post. Install nut and lock washer onto control lever and insert lever through bearing. Tighten nut securely.

Install lever onto control lever. Align pin hole in lever with pin hole in control lever. Drive rolled pin into levers.

Install yoke and jam nut onto pull rod.

Install pull rod eye plunger on control valve. Insert pin through eye plunger and pull rod. Install cotter pin and spread.

Center control lever in cab. Loosen yoke on pull rod until holes in yoke align with hole in lever. Insert pin and cotter pin. Spread cotter pin, then tighten yoke jam nut.



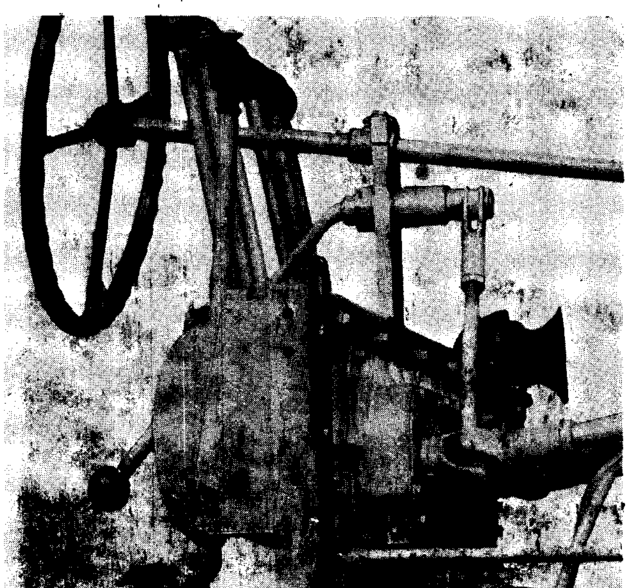
Illust. 1

Illust. 2 shows the control lever assembly installed on motor grader.

Fill hydraulic reservoir with specified oil (See "Lubricating Instructions") to level shown on dip stick. Start engine and shift moldboard to left and right to fill lines and ram with oil. Shut engine off and recheck hydraulic reservoir oil level. Add oil if necessary.

Start engine and shift moldboard to both extremes, then inspect all line connections for leakage.

The moldboard should operate to the right when the operating lever is operated to the right, and to the left when the operating lever is operated to the left. If moldboard shifts in the opposite direction of the operating lever, reverse the pressure hoses connecting into the tubes at front of circle drawbar or at slot in right side of circle drawbar.



Illust. 2

HYDRAULIC CYLINDER

Hydraulic cylinder described is used on Models 330 Motor Graders - Serial Nos. 1 thru 1999 and 440 Motor Graders - Serial Nos. 1 thru 3199.

The hydraulic cylinder will provide care free service with the proper care. It is necessary that the hydraulic piston be free from dirt. The 200 wire mesh filter screen should be checked often for clogging. Check hose fittings daily for breakage or looseness.

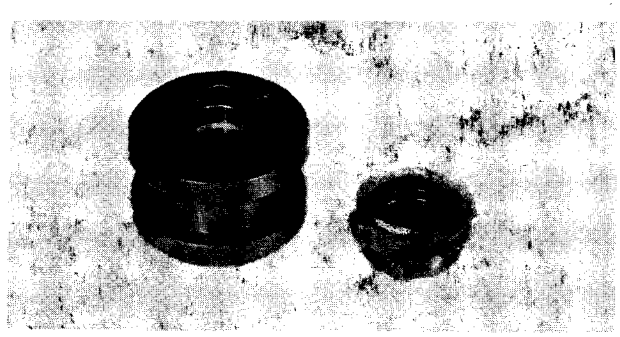
Before disassembling, clean outside cylinder with an oil solvent or similar fluid and dry thoroughly.

Inspect all parts for damage or wear. Clean and dry all parts before installation. Apply a thin coat of oil to parts before installation.

The following instructions and illustrations are given for hydraulic ram assembly. Reverse the assembly procedure to disassemble ram.

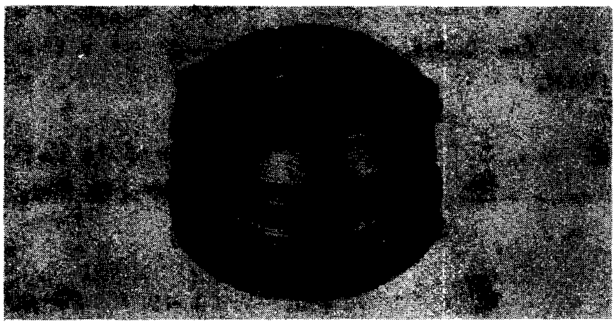
Install "O" ring into groove of piston. Next, install wiper into nut (Illust. 1). Sharp edge of wiper toward outer edge of nut.

Press or drive bushing into stuff box. Install back-up ring and seal ring in grooves of stuff box (Illust. 2).



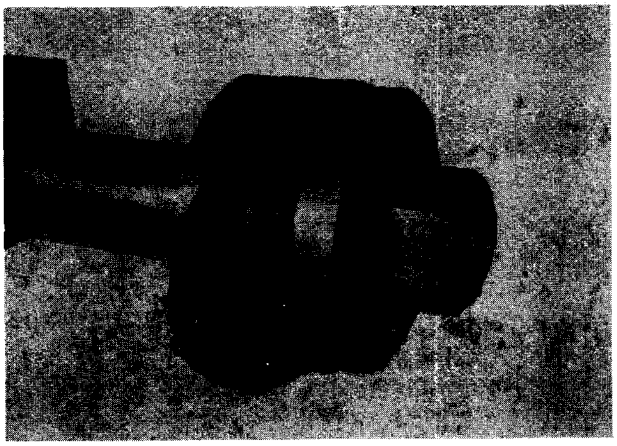
Illust. 1

Illust. 3 shows the assembly of the piston rod. Install packing nut onto piston rod. Threads on nut toward thread end of piston rod. Next, install packing, stuff box and piston in the order named. NOTE: "O" ring end of piston away from threaded end of piston rod. Install nut and tighten securely. Stake nut, using a center punch and hammer.



Illust. 2

Illust. 3



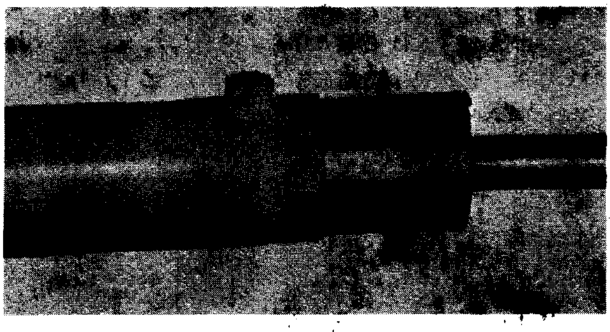
Illust. 4

Install packing onto groove of piston rod (Illust. 4). Lips of packing toward nuts.

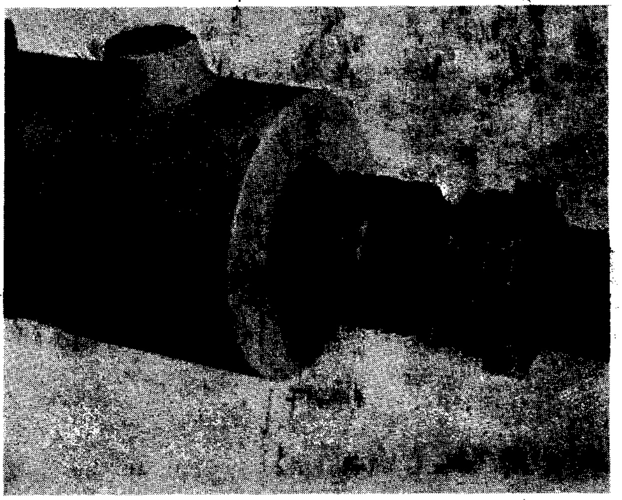
Install piston rod assembly into cylinder tube (Illust. 5). NOTE: Use a piece of shim stock over packing to prevent damage.

Tighten stuff box (Illust. 6) into cylinder tube, using a spanner wrench. Next, insert packing into stuff box and tighten packing nut. NOTE: Tighten nut only enough to prevent oil leakage.

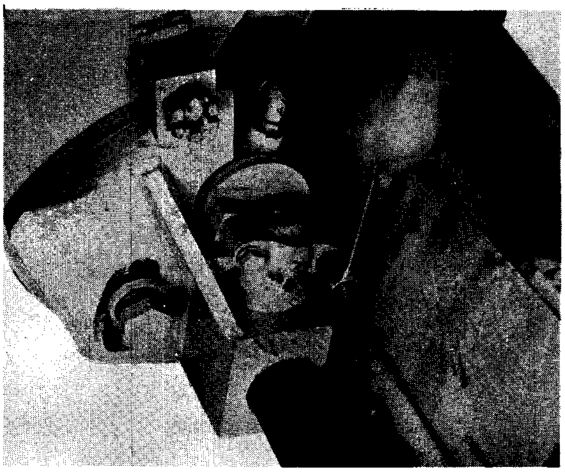
Insert hydraulic cylinder through concaves of tilting plates. NOTE: Piston end of cylinder to fit on moldboard ball. Cylinder tube end to fit on R. H. tilt plate ball.



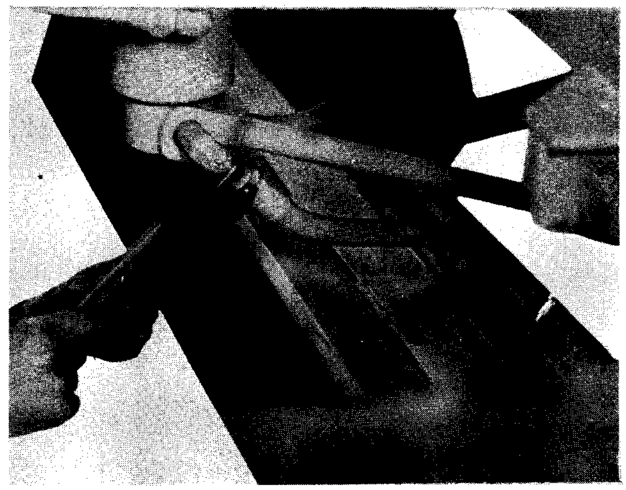
Illust. 5



Illust. 6



Illust. 7



Illust. 8

Install piston end of cylinder on moldboard ball. Install bearing cap with shims, cap screws and lock washers. Tighten cap screws securely.

Install bearing cap with shims, cap screws and lock washers. Tighten cap screws securely (Illust. 7).

IMPORTANT: Center hydraulic cylinder in left tilt plate, also cylinder to be parallel with moldboard.

Install elbow fittings into cylinder tube. Next, install piping in elbows. Install clamps over cylinder tube and over piping (Illust. 8).

Reset moldboard to desired pitch, then tighten pitch adjusting "U" bolts. Next, tighten pitch adjusting link lock nuts and tilting plate drilled bolts. Install all cotter pins and spread.

REMOVAL

To remove hydraulic cylinder, loosen both tilting plate drilled bolts, pitch adjusting link "U" bolts and pitch adjusting link lock bolts. Allow moldboard to pitch forward to extreme position.

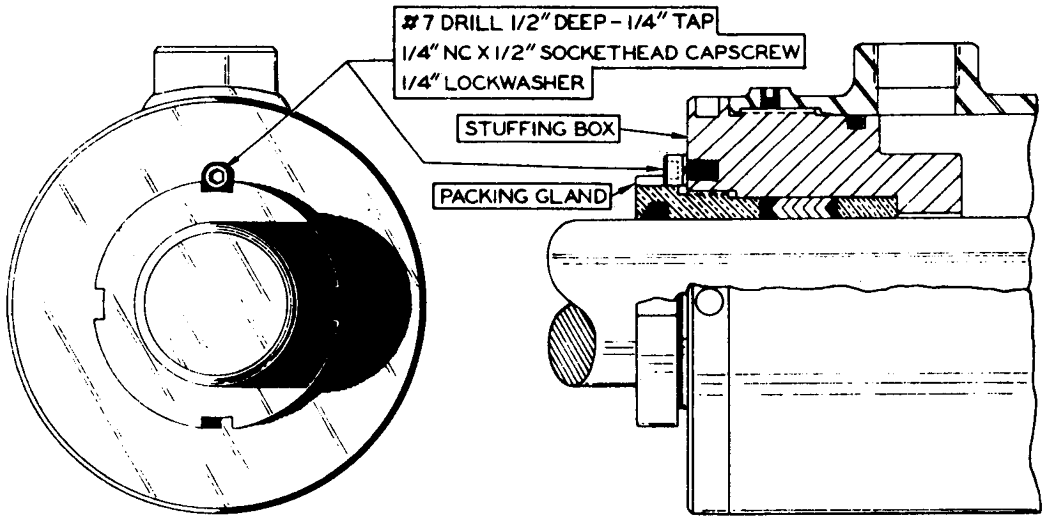
Remove pressure lines from pipes. Next, remove pipes from elbows and elbows from cylinder tube.

Remove clamps from hydraulic cylinder and bearing cap from R. H. tilting plate ball.

Remove bearing cap from moldboard ball.

Turn hydraulic cylinder until bosses on cylinder tube are toward moldboard, then remove cylinder.

A hex socket head cap screw has been added to stuff box of power-shift moldboard hydraulic rams. This cap screw will help prevent the packing gland from backing out. Refer to "A" and "B" in Illust. 9. This hex socket head cap screw can be added to rams on machines in the field by drilling and tapping a hole in stuff box.



END VIEW OF RAM
(A)

SIDE VIEW OF RAM
(B)

Illust. 9

Drill hole in stuff box with a #7 drill approximately 1/2" from the I.D. of stuff box, 1/2" deep and tap with a 1/4" UNC tap. Be sure there will be clearance between cap screw head and packing gland.

Use a 1/4" x 1/2" UNC hex socket head cap screw and a 1/4" lock washer.

Tighten packing gland, then back off gland approximately 1/4 turn until hex socket head cap screw hole in stuff box is in line with one of the wrench notches in packing gland. Install and tighten cap screw securely.

HYDRAULIC CYLINDER

Hydraulic cylinder described is used on Model 330 Motor Graders - Serial Nos. 2000 and Later, Also, Model 440 Motor Graders - Serial Nos. 3200 and Later.

The hydraulic cylinder will provide care free service with proper care. It is necessary that the hydraulic system be free from dirt. The 200 wire mesh filter screen should be checked often for clogging. Check hose fittings daily for breakage or looseness.

Before disassembly, clean outside of cylinder with an oil solvent or similar fluid and dry thoroughly. Inspect all parts for damage or wear. Clean and dry all parts before installation. Apply a thin coat of oil to parts before installation.

HYDRAULIC RAM REMOVAL

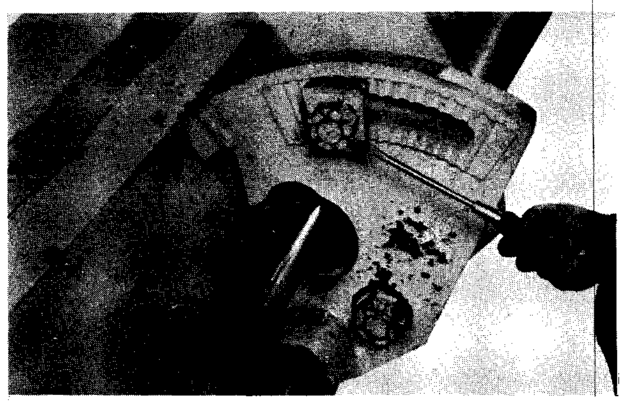
To remove hydraulic ram, lower moldboard to ground, using controls.

Remove cotter pins from L.H. and R.H. tilt plate pivot and pitch adjusting lock bolts (Illust. 1).

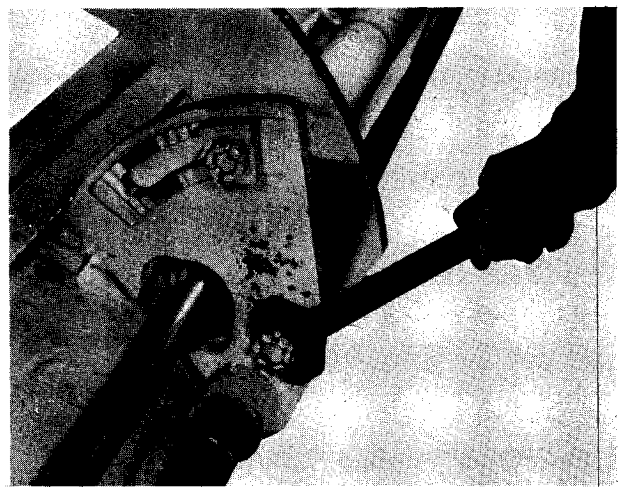
Loosen L.H. and R.H. tilt plate pivot bolts (Illust. 2). Next, remove both tilt plate pitch adjusting nuts and locks (Illust. 3).

Start engine and slightly raise moldboard (using controls) until moldboard pitches forward. Again lower moldboard until weight is off tilt plate pitch adjusting bolts. Place blocks at front and rear of moldboard to prevent moldboard from falling.

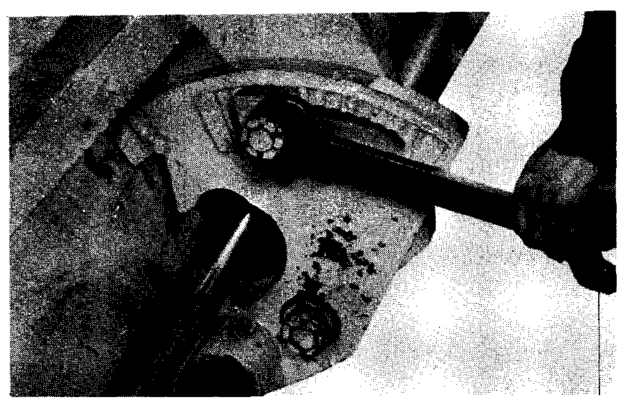
Remove L.H. and R.H. tilt plate pivot bolt nuts.



Illust. 1

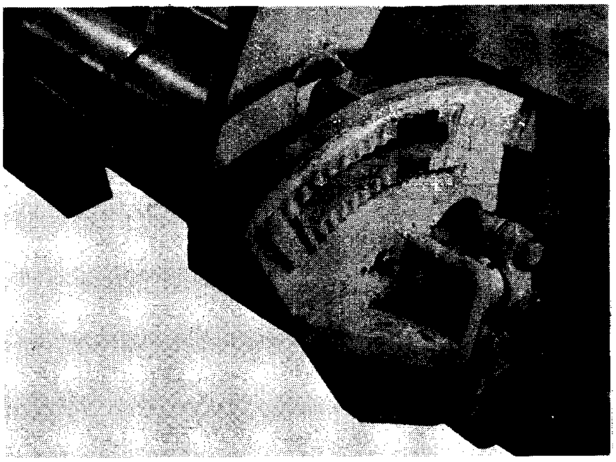


Illust. 2

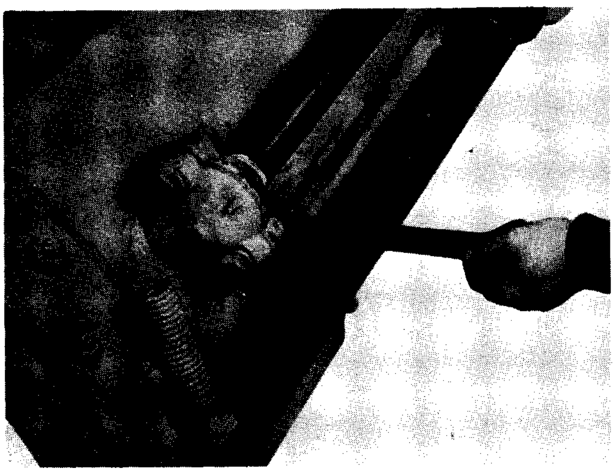


Illust. 3

Start engine and shift moldboard operating lever slightly to right until R.H. tilt plate moves to ends of bolts (Illust. 4).



Illust. 4



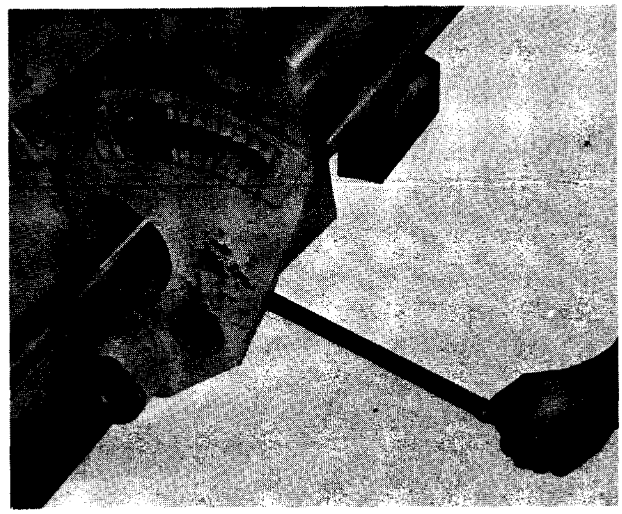
Illust. 5

Remove ram piston cap screw nuts, cap screws, shims and cap from moldboard ball (Illust. 5).

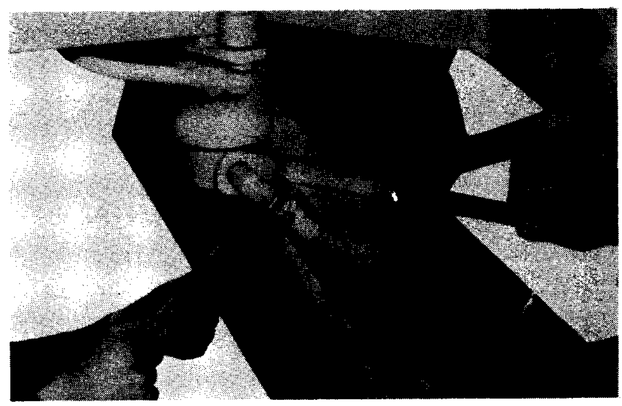
Again start engine. Shift moldboard operating lever to right until piston end of ram is collapsed to approximately 18" from stuff box end of cylinder.

Pry L.H. tilt plate away from circle leg until tilt plate is to ends of drilled bolts (Illust. 6).

Disconnect hoses from elbows in rotary connection (Illust. 7). NOTE: When hoses have been removed, plug ends of hoses to prevent dirt from entering.



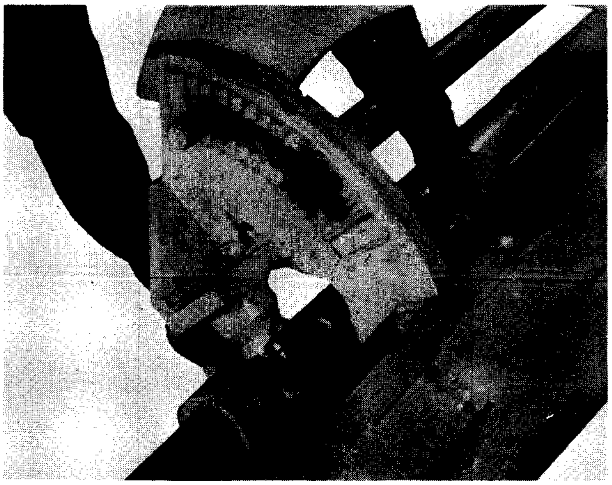
Illust. 6



Illust. 7

Illust. 8

Remove ram cylinder cap screw nuts, cap screws, cap and shims from R.H. tilt plate ball (Illust. 8).

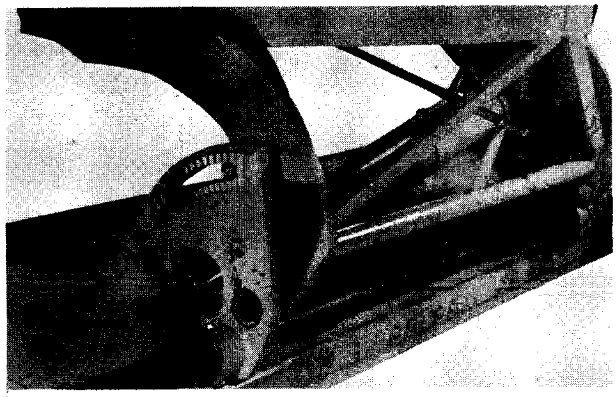


Illust. 9

Lower ram to shift rail (Illust. 9). Slide ram to left along rail until cylinder end clears R. H. tilt plate. Raise cylinder end up and pull ram up over moldboard rotating ram slightly (Illust. 10).

To install ram, reverse removal procedure.

When installing hoses to rotary connection



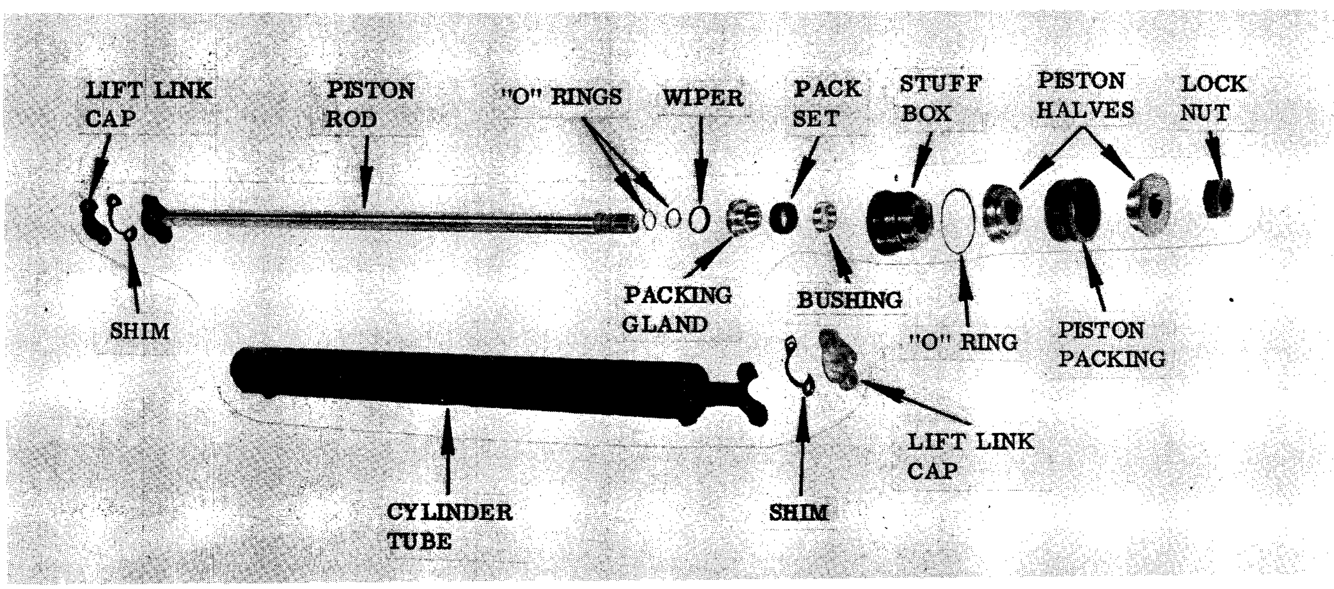
Illust. 10

elbows, be sure plugs from end of hoses have been removed. Tighten left cylinder tube plumbing hose to right elbow of rotary connection. Right cylinder tube plumbing hose to left elbow. Be sure hoses are not twisted after installation.

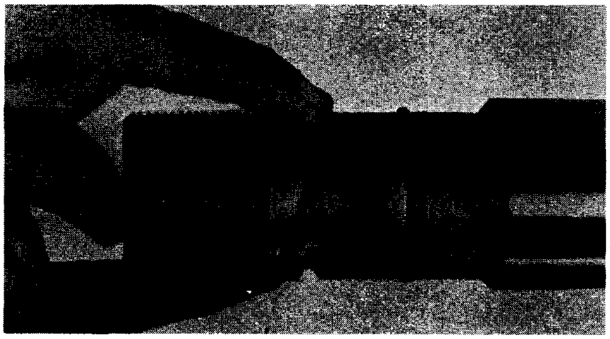
Start engine and operate moldboard from left to right and check for leaks.

Check hydraulic reservoir oil level. Add oil if necessary (See "Lubricating Instructions").

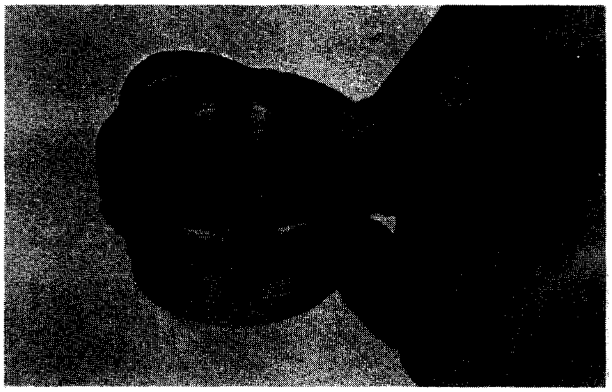
REASSEMBLY



Illust. 1



Illust. 2



Illust. 3

The following instructions and illustrations are given for hydraulic ram assembly. Reverse the assembly procedure to disassemble ram.

Illust. 1 is an exploded view of the hydraulic cylinder.

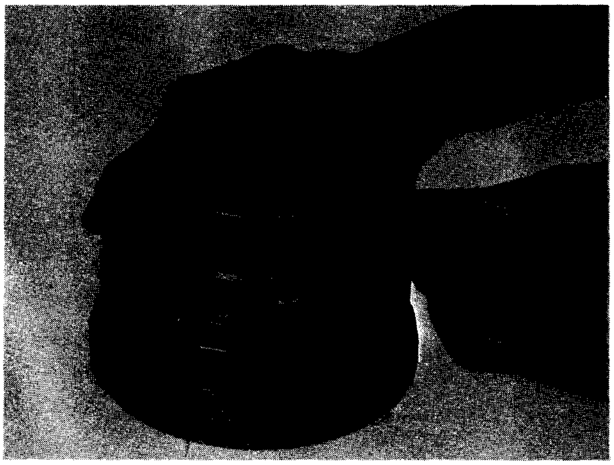
Install "O" rings in grooves of piston rod (Illust. 2).

Install wiper into packing gland (Illust. 3). "V" in wiper to fit on inside shoulder of gland. Install packing gland, pack set and bushing onto piston rod (Illust. 4). NOTE: Packing set to be installed with the "V" toward packing gland.

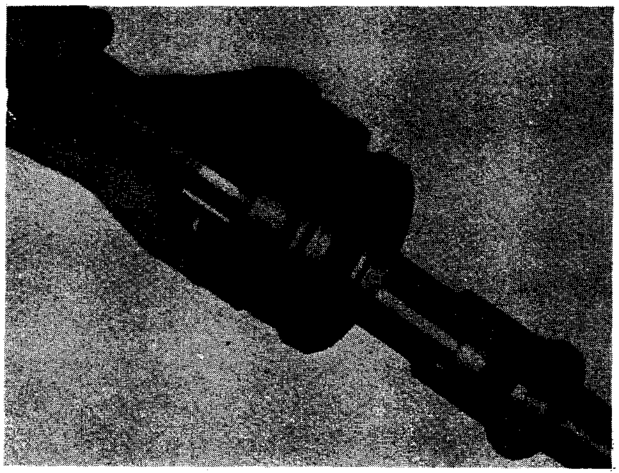
Install "O" ring in groove of stuff box (Illust. 5).

Install stuff box onto piston rod (Illust. 6).

Illust. 4

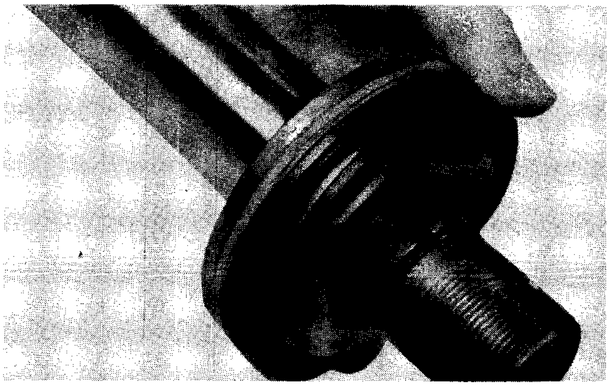


Illust. 5

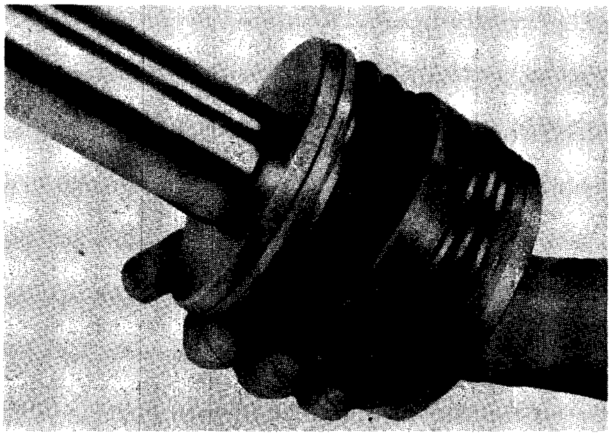


Illust. 6

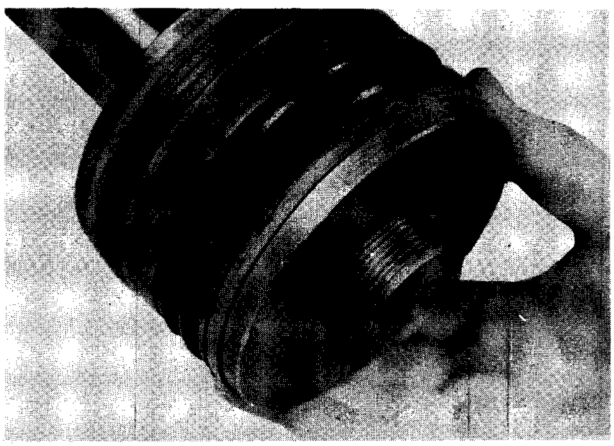
Install first half of piston onto piston rod along with 4 sections of packing set. "V"



Illust. 7

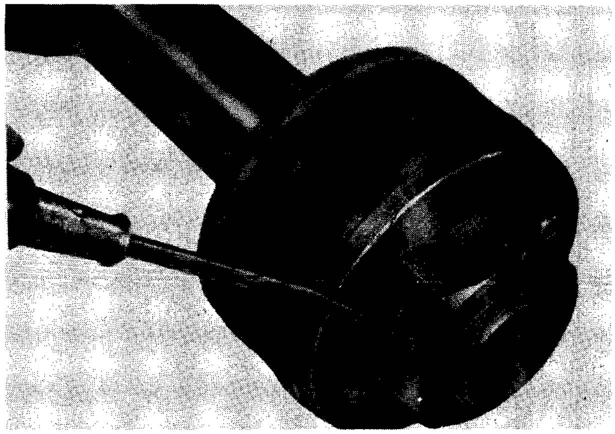


Illust. 8

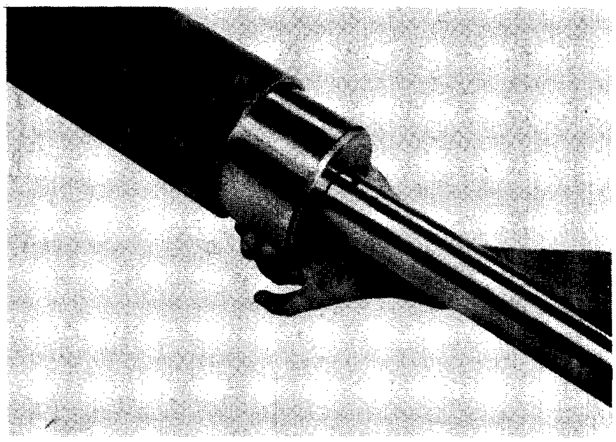


Illust. 9

in sections pointing toward threaded end of piston rod (Illust. 7). Next, install the large center section of packing set and second half of piston with remaining 4 sections of packing set. "V" in remaining sections



Illust. 10



Illust. 11

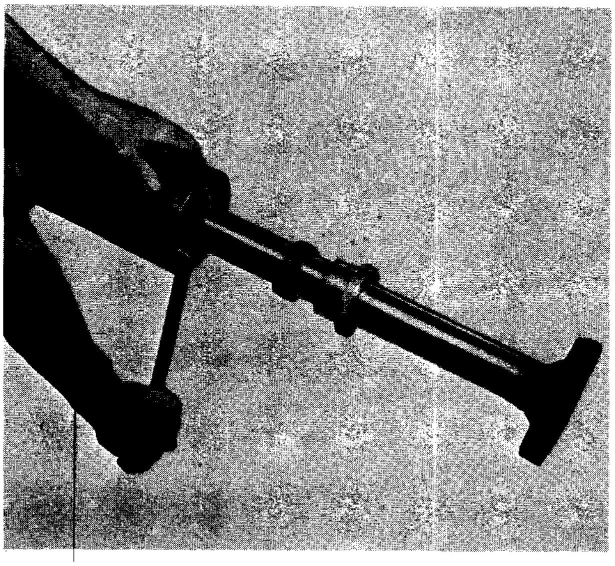
pointing away from threaded end of piston rod (Illust. 8). NOTE: Apply white lead to "O" rings to prevent damage.

Illust. 9 shows piston with packing set on piston rod.

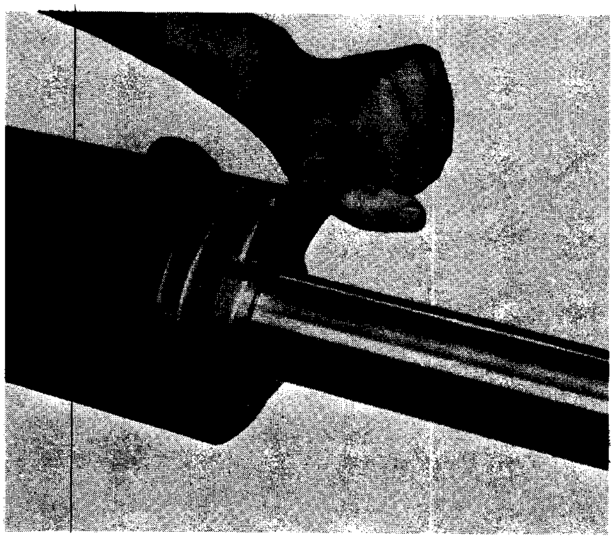
Install nut on piston rod and tighten securely. Next, install cotter pin and spread (Illust. 10).

Using a piece of thin shim stock around piston, insert piston rod into cylinder tube (Illust. 11). Shim stock will protect packing set from being damaged.

Install and tighten stuff box into cylinder tube (Illust. 12). NOTE: Apply white lead to "O" rings on stuff box to prevent damage.



Illust. 12

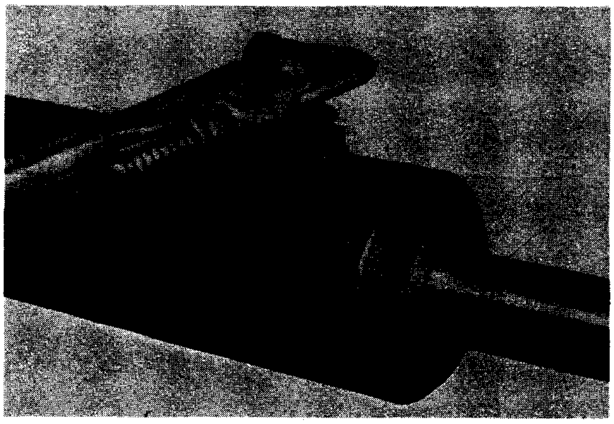


Illust. 13

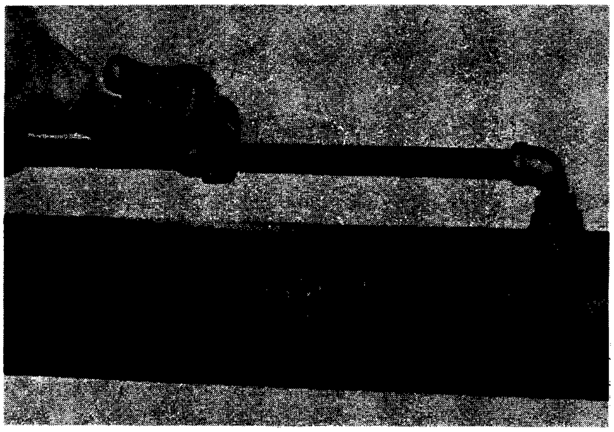
Install bushing and packing set into stuff box. Next, install and tighten packing gland nut, using a spanner wrench (Illust. 13).

Install and tighten reducers and elbows into cylinder tube (Illust. 14). NOTE: Use a pipe sealing compound on threads of pipe fittings.

Install and tighten a 45 degree elbow on each section of pipe. Install and tighten pipe into 90 degree elbows on cylinder tube (Illust. 15). NOTE: Apply a pipe sealing compound



Illust. 14



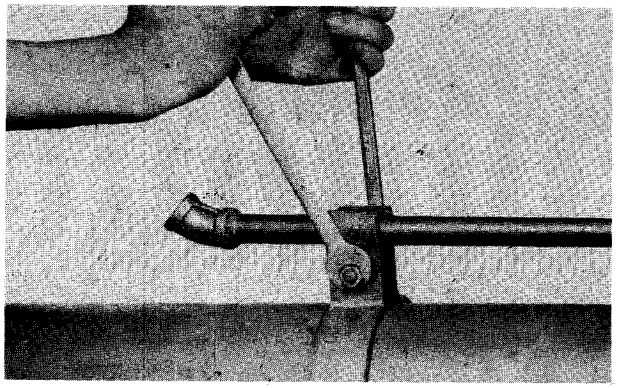
Illust. 15

on threads of pipe fittings.

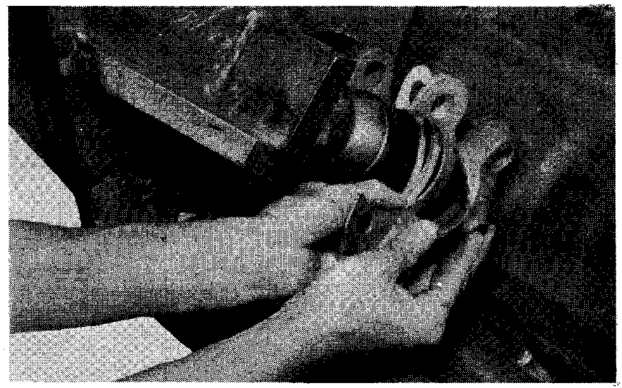
Install clamps to cylinder tubes. Install cap screws, lock washers and nuts. Tighten nuts securely (Illust. 16).

A hex socket head cap screw has been added to stuff box of power-shift moldboard hydraulic rams. This cap screw will help prevent the packing gland from backing out. Refer to "A" and "B" in Illust. 17. This hex socket head cap screw can be added to rams on machines in the field by drilling and tapping a hole in stuff box.

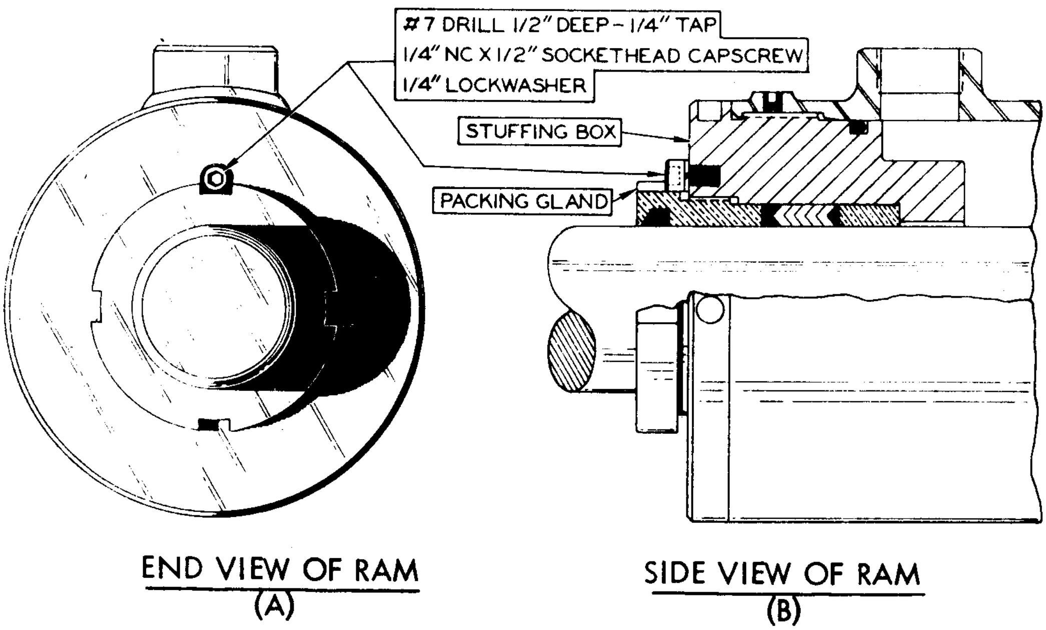
Drill hole in stuff box with a #7 drill approximately 1/2" from the I.D. of stuff box, 1/2" deep and tap with a 1/4" UNC tap. Be sure there will be clearance between cap screw head and packing gland.



Illust. 16



Illust. 18



Illust. 17

Use a 1/4" x 1/2" UNC hex socket head cap screw and a 1/4" lock washer.

Tighten packing gland, then back off gland approximately 1/4 turn until hex socket head cap screw hole in stuff box is in line with one of the wrench notches in packing gland. Install and tighten cap screw securely.

ADJUSTABLE BALL AND SOCKETS

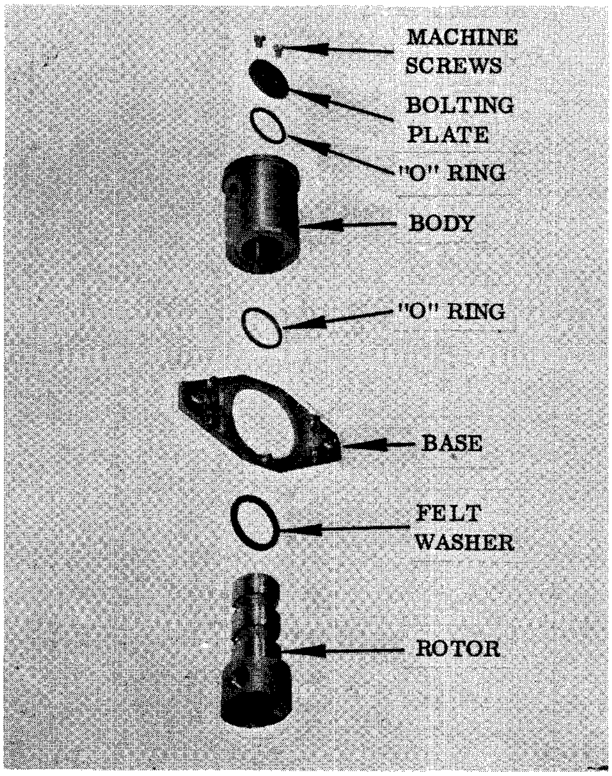
The ball and socket joint on each end of hydraulic ram are adjustable for wear. Laminated shims are provided to take care of this wear. Should signs of wear appear at either end of ram ball or socket, remove cap and shims. Peel layers of shims off with a knife (Illust. 18).

Do not remove any more layers of shims than necessary to remove the free play in joint. Joint should never bind but should always work freely. These joints may wear egg-shaped. Therefore, they should be adjusted in the position in which they will operate.

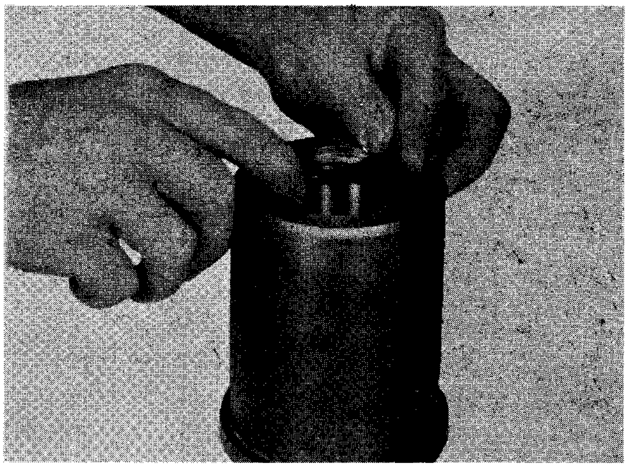
ROTARY CONTROL

The rotary control will provide care free service with proper care. It is necessary that the hydraulic system be free from dirt. The 200 wire mesh filter screen should not be allowed to become clogged. Check hose fittings daily for breakage or looseness.

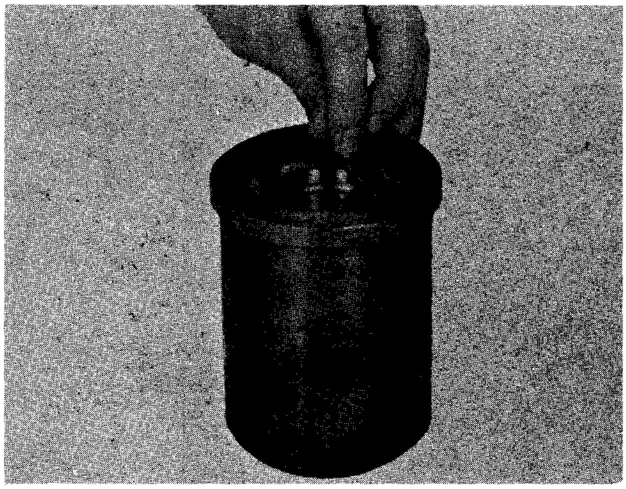
The oil used in the hydraulic system should be kept clean while in storage. A premium grade of SAE 10 engine crankcase oil should be used in cold weather and SAE 20 engine crankcase oil should be used in warm weather. IMPORTANT: Do not use hydraulic brake fluid or low viscosity naphtha base engine oils.



Illust. 1



Illust. 2



Illust. 3

Before disassembly, clean outside of rotary control with an oil solvent or similar fluid and dry thoroughly.

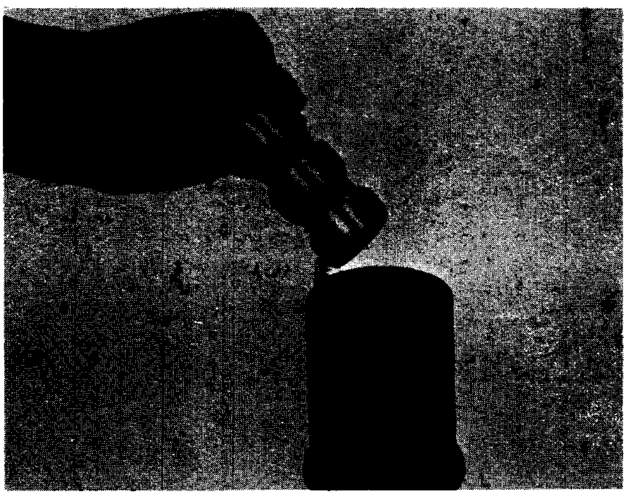
Inspect and replace all parts which are worn or damaged. Clean parts with a cleaning solvent and dry thoroughly. Also, apply oil to parts before installation.

Illust. 1 is an exploded view of the rotary control.

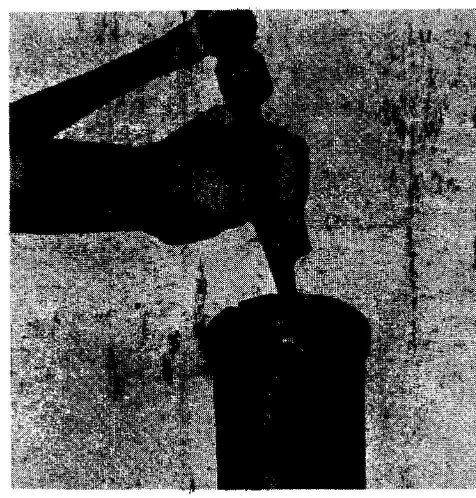
Install "O" ring into lower groove of body (Illust. 2). Next, install "O" ring into upper groove of body (Illust. 3).

Illust. 4

Illust. 7



Illust. 5



Illust. 8

Illust. 6

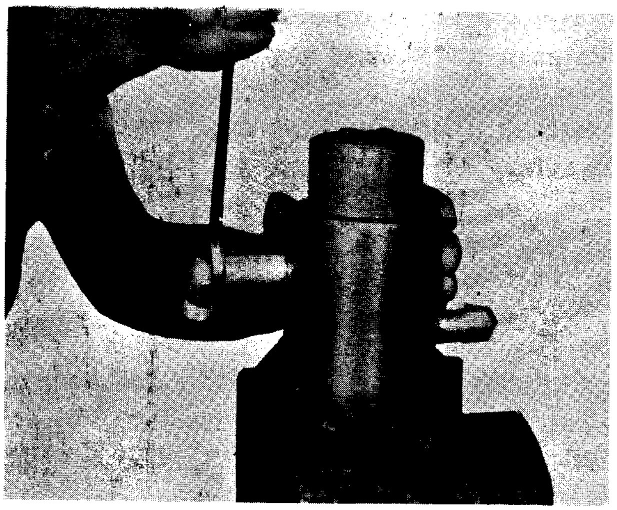
Install felt washer onto rotor (Illust. 4). Washer to fit onto shoulder of rotor. NOTE: Felt to be soaked in oil before assembly.

Apply white lead to "O" rings, then insert rotor into body, using care to prevent damaging felt washer (Illust. 5).

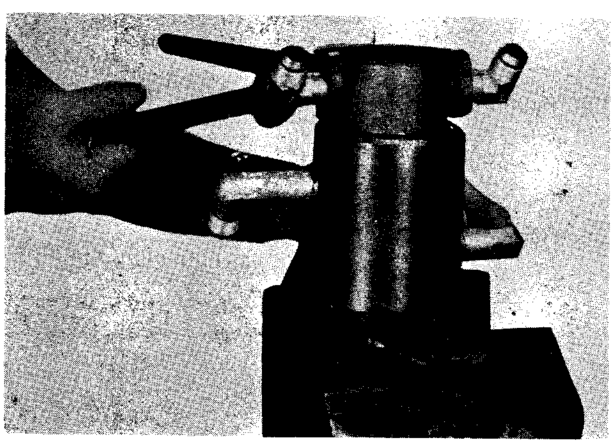
Install pipe plugs into rotor and tighten securely (Illust. 6). NOTE: Use pipe sealing compound on threads of plugs.

Install bolting plate onto rotor body (Illust. 7). Next, install flat head machine screws and tighten securely. Stake each machine screw in 4 places (Illust. 8).

Illust. 9



Illust. 10

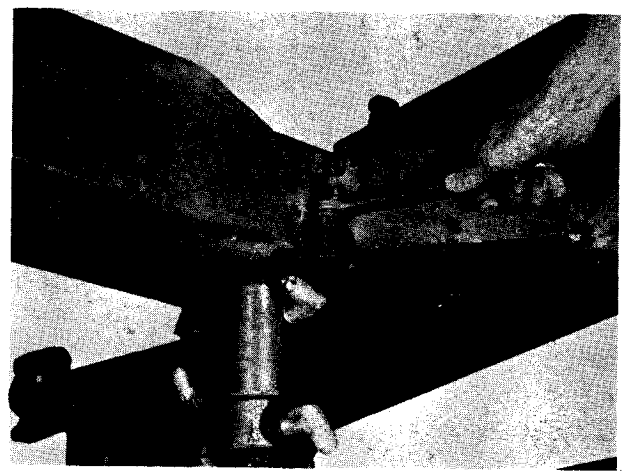


Illust. 11

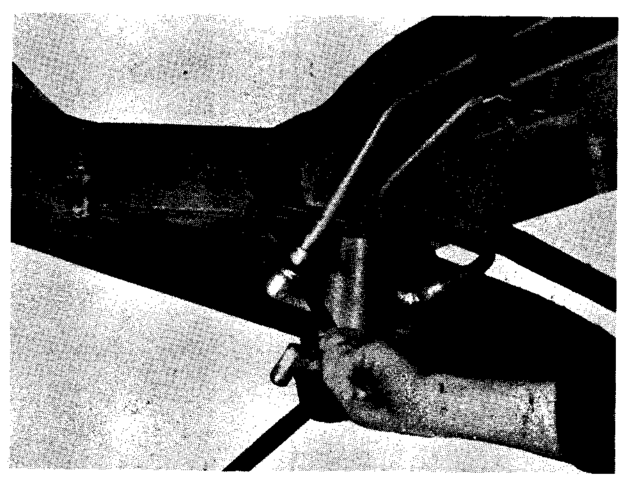
Install base onto body (Illust. 9).

Using a pipe sealing compound on threads of fittings, install and tighten fittings into rotary body (Illust. 10).

Illust. 12

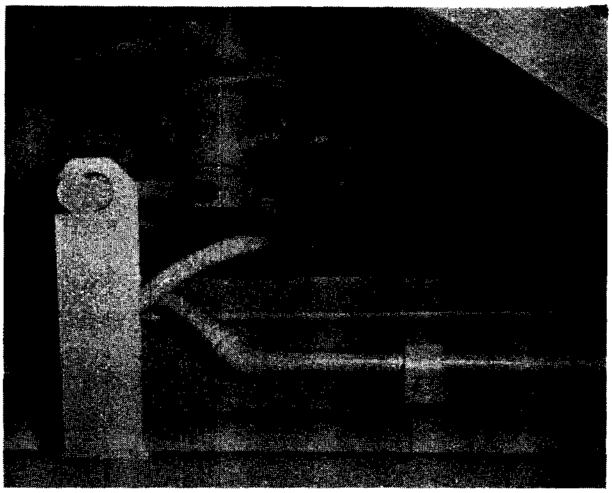


Illust. 13



Illust. 14

Align holes in drive link with fitting holes in rotor. Apply pipe sealing compound to threads of fittings, then install and tighten securely (Illust. 11).



Illust. 15

Install end of drive link into bracket on circle tie rod, then install rotary control onto drawbar (Illust. 12). IMPORTANT: FOR LATE MODEL MOTOR GRADERS ONLY - Locking lug on base to be in slot of body and pointing toward the front end of circle drawbar. The long elbow fitting to be on the right side of the rotary control. Both body fittings to be pointing toward the front end of circle drawbar. FOR EARLIER MODEL MOTOR GRADERS - Install end of drive link into bracket on circle tie rod, then install rotary control onto drawbar. Long elbow fitting to be on the right side of rotary control.

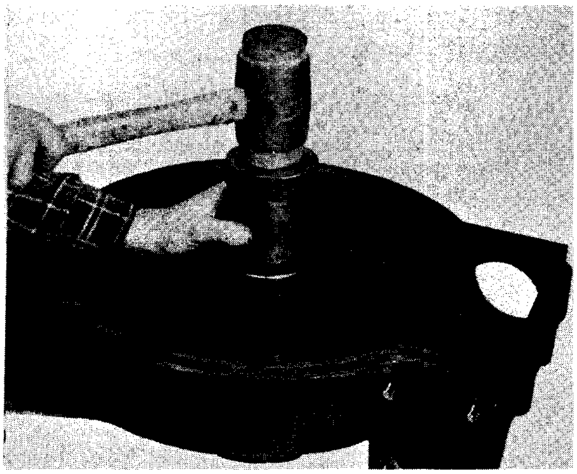
FOR LATE MODEL MOTOR GRADERS ONLY - Install bolts, washers and lock type nuts. Tighten nuts securely (Illust. 13).

FOR EARLIER MODEL MOTOR GRADERS ONLY - Install the four cap screws and lock washers and tighten securely.

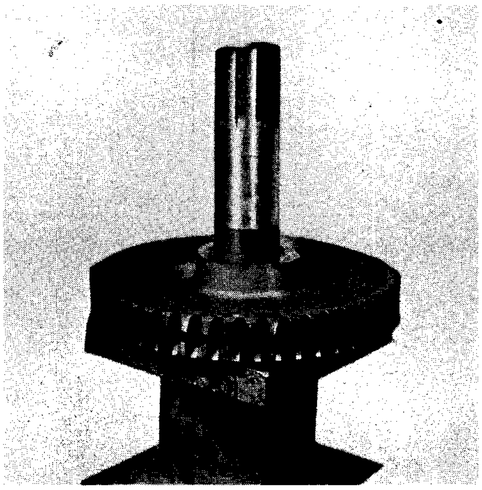
Install and tighten tube fittings onto elbows in rotary control body (Illust. 14).

Install and tighten ram hoses onto elbows in rotor (Illust. 15).

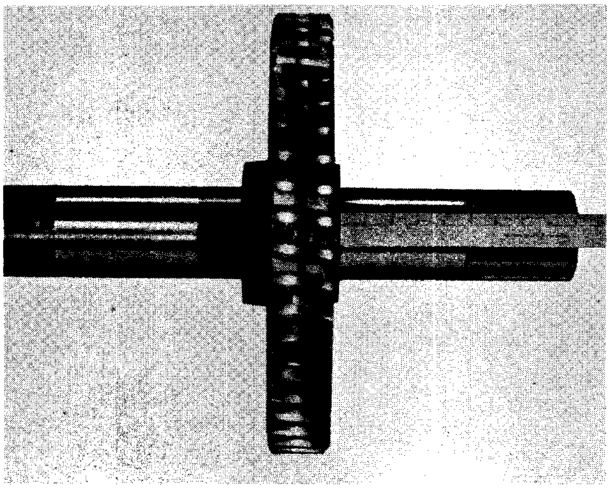
NOTE: Hose connecting onto piston end of ram to be connected to right rotor fitting. Hose connecting into ram cylinder to be on left elbow fitting.



Illust. 1



Illust. 2



Illust. 3

SCARIFIER LIFT

The scarifier lift takes tremendous shock loads. Therefore, the mechanism will occasionally need servicing.

To completely disassemble scarifier lift, it is necessary to remove the assembly from frame of grader. Instructions and illustrations outlined in this section covers the assembly procedure. To disassemble scarifier lift, reverse assembly procedure.

Instructions and illustrations outlined in this section covers a complete disassembly procedure. In case of a partial disassembly, only that portion of the instructions which apply need be followed.

The assembly is equipped with replaceable steel-back bushings at all points of wear. Should there be excessive wear to bushings, they can be replaced by supporting housing in a press and pressing in new bushings. These bushings require no reaming after installation.

Inspect all parts for excessive wear or other damage. Bearings, shafts and gears will sometimes score due to insufficient or improper lubricant being used. Parts damaged in this manner should be replaced.

Apply a coating of oil to parts before installation.

Press or drive bushing into scarifier housing (Illust. 1). Edge of bushing to be flush with bottom of chamfer.

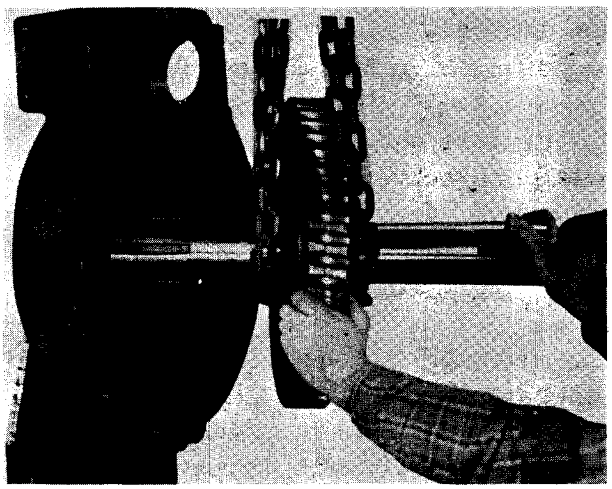
Heat worm gear in oil (approximately 350° F.) Support gear in a press, align splines in gear with splines of shaft, then press gear onto shaft (Illust. 2). Short hub of gear to be 7-1/2" from end of shaft (Illust. 3).

Insert worm gear and shaft assembly into housing (Illust. 4). Long hub of gear toward cover.

Press or drive two (2) bushings into worm thrust bearing (Illust. 5).

Install "O" ring in groove of worm thrust bearing (Illust. 6)

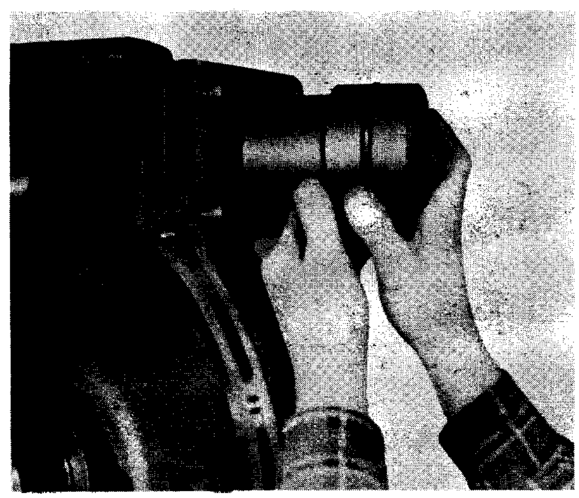
Insert worm thrust bearing into housing (Illust. 7). Apply white lead to "O" ring to prevent damaging. Bump thrust bearing into housing so dowel pin hole is in an up-



Illust. 4

Illust. 5

Illust. 6

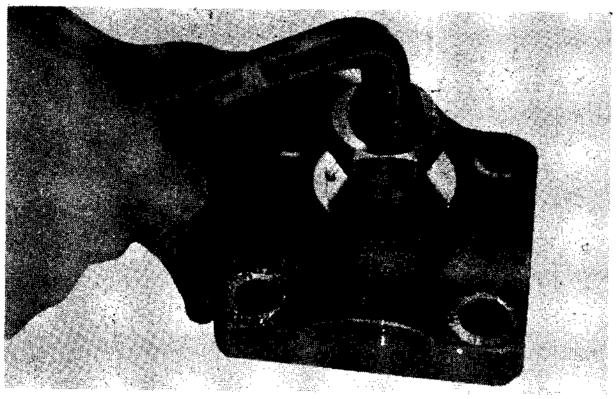


Illust. 7

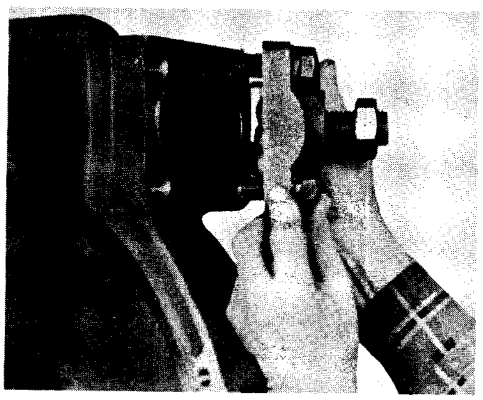
Illust. 8

ward position.

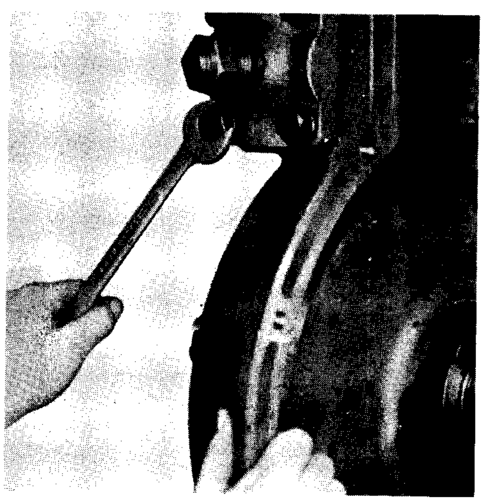
Drive dowel pin into bearing cap (Illust. 8). Next, install socket head cap screw and jam nut (Illust. 9). Do not tighten jam nut.



Illust. 9



Illust. 10



Illust. 11

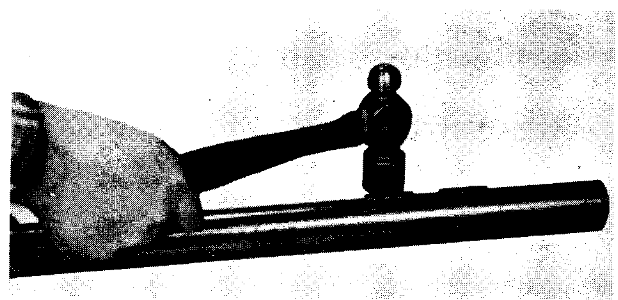
Install bearing cap onto housing (Illust. 10). Dowel pin in cap to insert into hole of worm thrust bearing.

Install cap screws and lock washers. Tighten cap screws securely (Illust. 11).

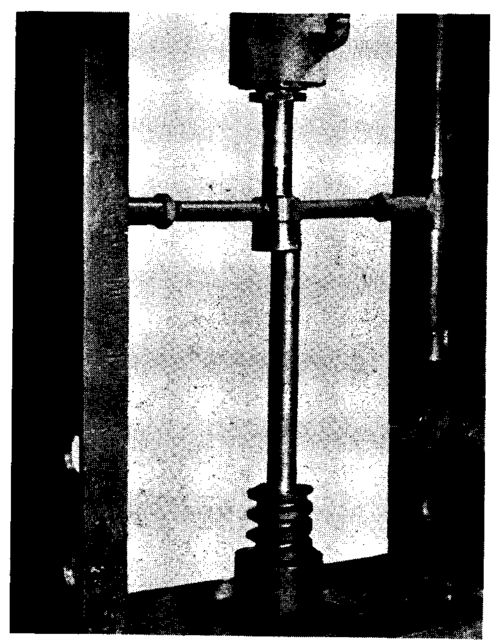
Drive keys in keyways of lift worm shaft (Illust. 12).

Align keys in shaft with keyway in worm, then press shaft into worm (Illust. 13). Shaft to extend out of worm 2-1/16" (Illust. 14).

Insert worm shaft into housing (Illust. 15). Rotate shaft until end of shaft seats into thrust bearing.



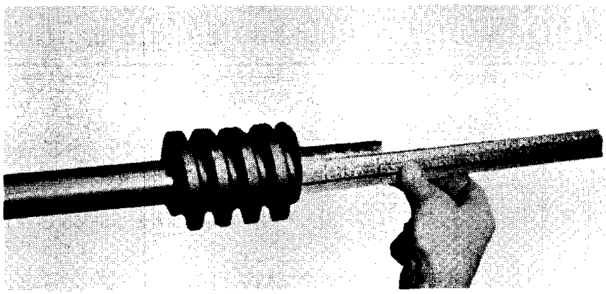
Illust. 12



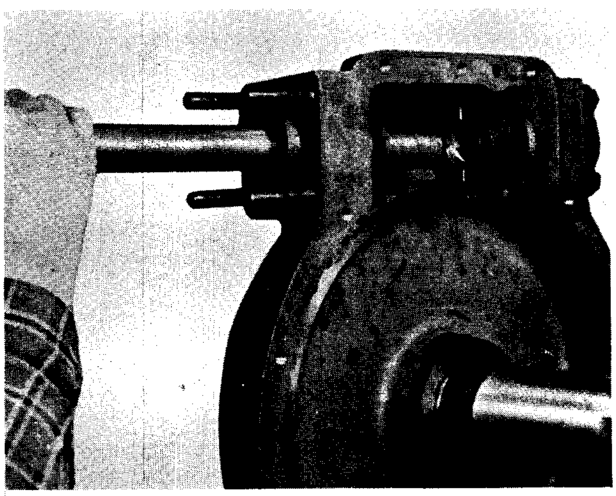
Illust. 13

Shellac gasket to worm thrust bearing. Next, install "O" ring in groove (Illust. 16).

Insert thrust bearing onto shaft and into housing (Illust. 17). Apply white lead to "O" ring to prevent damaging. Bump thrust bearing into housing.

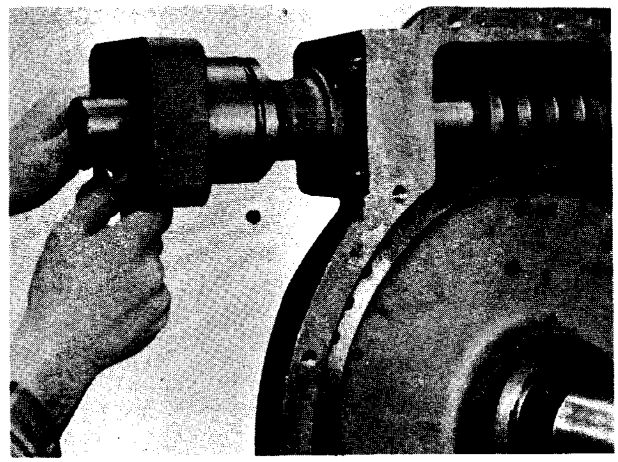


Illust. 14

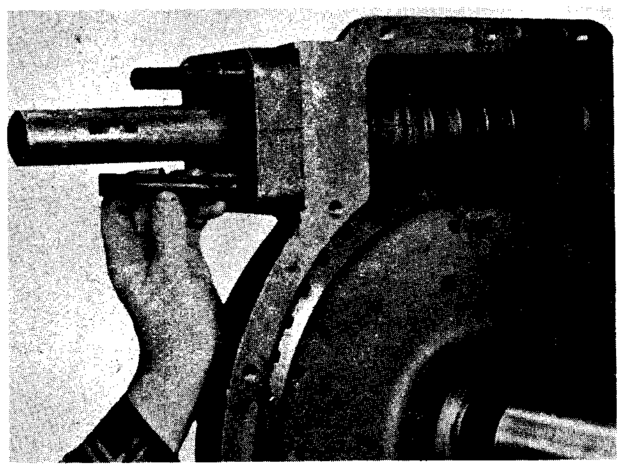


Illust. 15

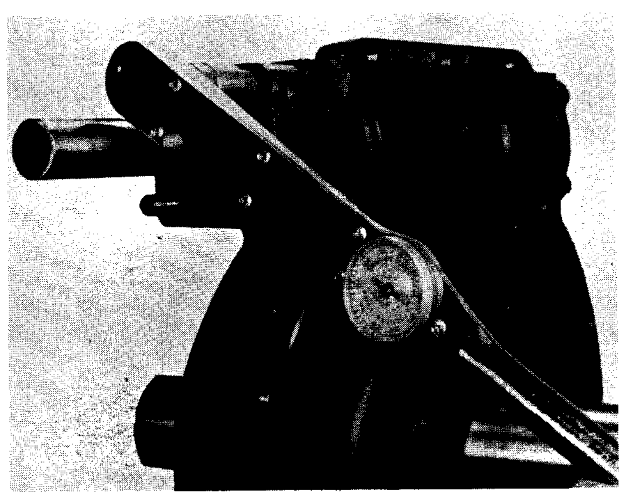
Illust. 16



Illust. 17



Illust. 18



Illust. 19

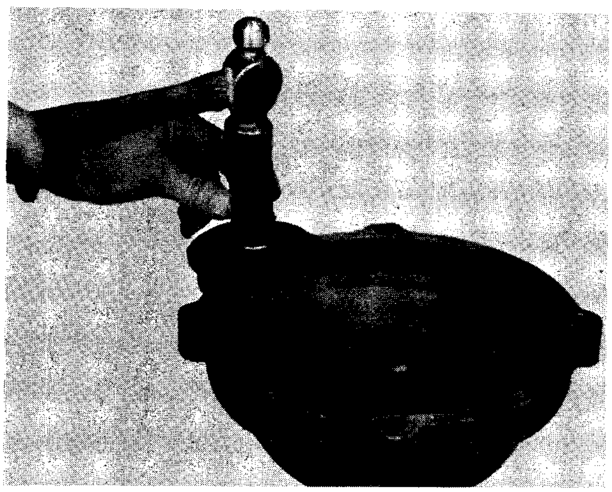
Install four (4) studs through worm thrust bearing and into housing (Illust. 18). Course threaded end to tighten into housing.

Tighten studs to a torque reading of 100 foot pounds (Illust. 19).

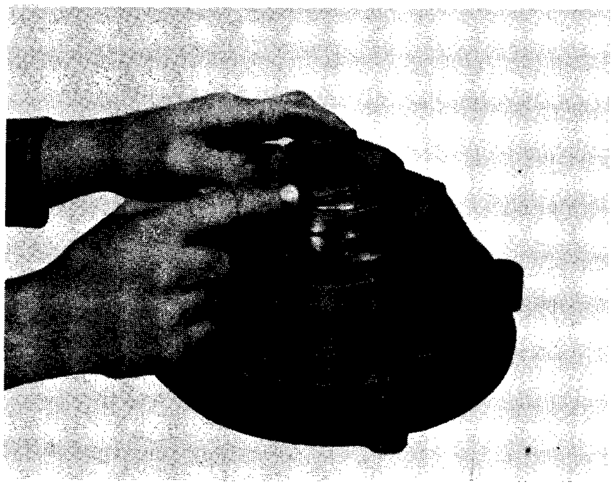
Press or drive bushing into reduction gear housing (Illust. 20). Edge of bushing to be flush with bottom of chamfer.

Install "O" ring in groove of housing (Illust. 21).

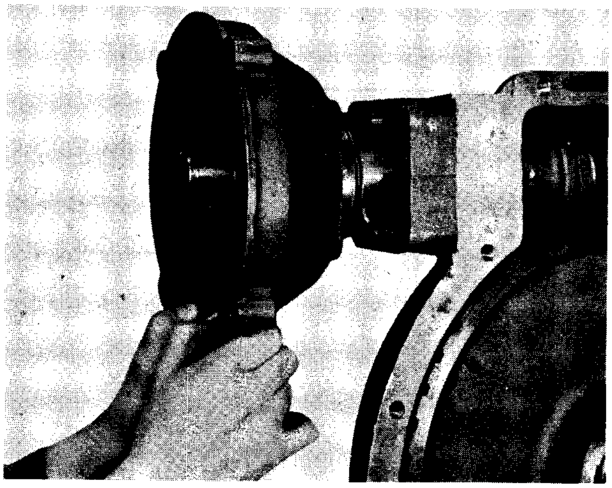
Shellac gasket to worm thrust bearing. Install reduction gear housing over studs and shaft (Illust. 22). Apply white lead to "O"



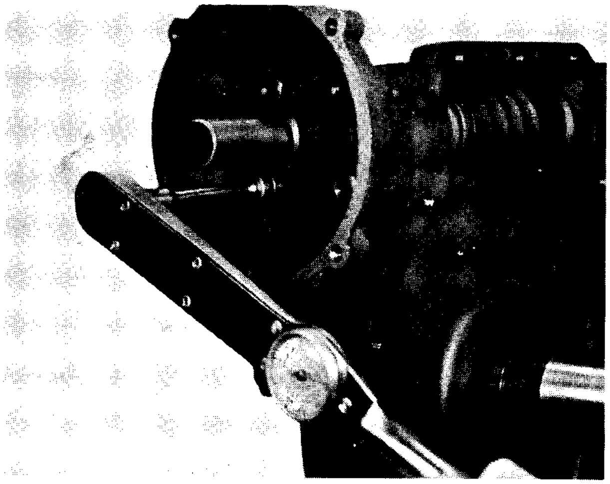
Illust. 20



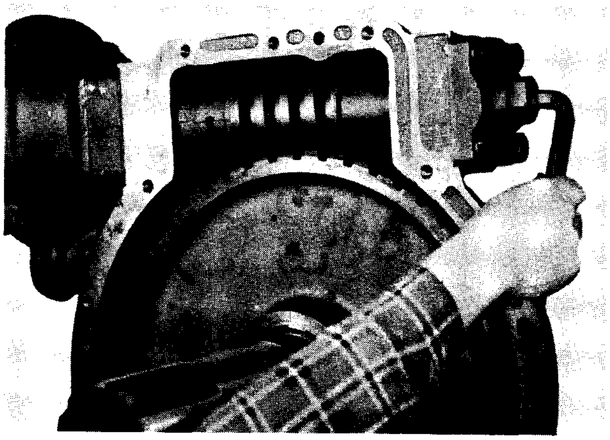
Illust. 21



Illust. 22

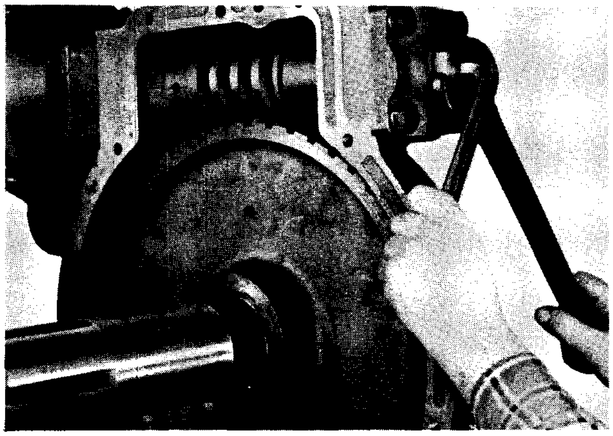


Illust. 23

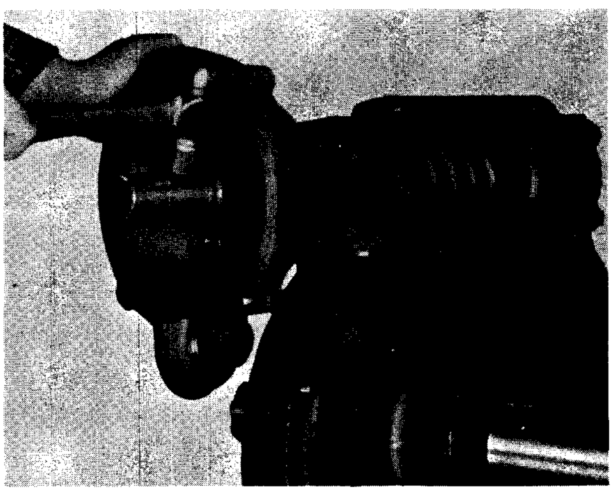


Illust. 24

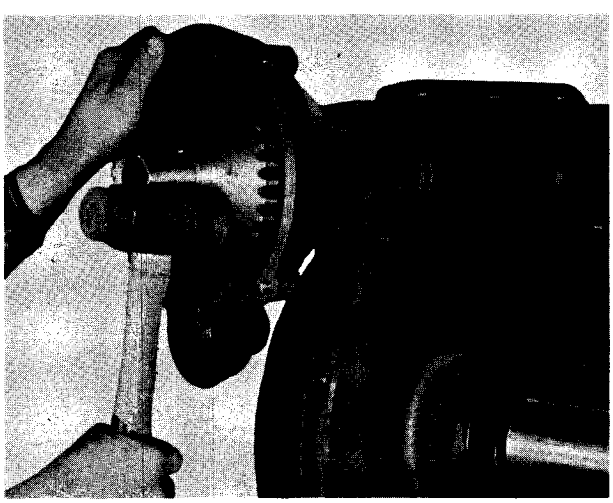
ring to prevent damaging. Bump reduction gear housing onto lift gear housing.



Illust. 25



Illust. 26



Illust. 27

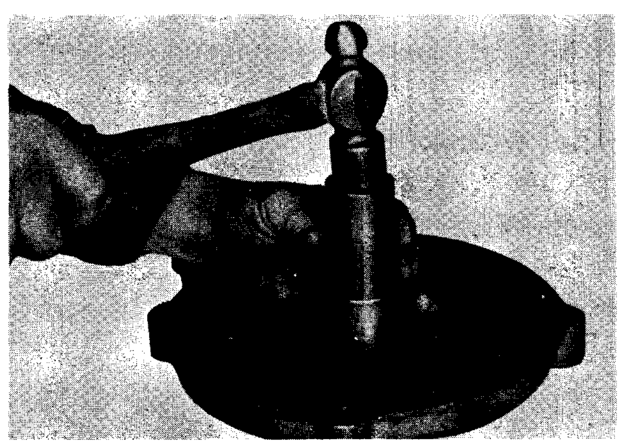
Install spherical nuts onto studs. Tapered end of nuts to fit in countersunk holes in reduction gear housing. Tighten nuts to a torque reading of 135 foot pounds (Illust. 23).

To adjust worm thrust bearing, tighten hex socket head set screw (Illust. 24) while rotating shaft until a noticeable drag is obtained. Slightly loosen set screw until drag is eliminated. Hold set screw in this position and tighten jam nut securely (Illust. 25).

Drive key in keyway of lift worm shaft (Illust. 26).

Align keyway in spur gear with key in shaft.

Illust. 28



Illust. 29

Bump spur gear onto shaft and over key until face of gear is flush with key (Illust. 27).

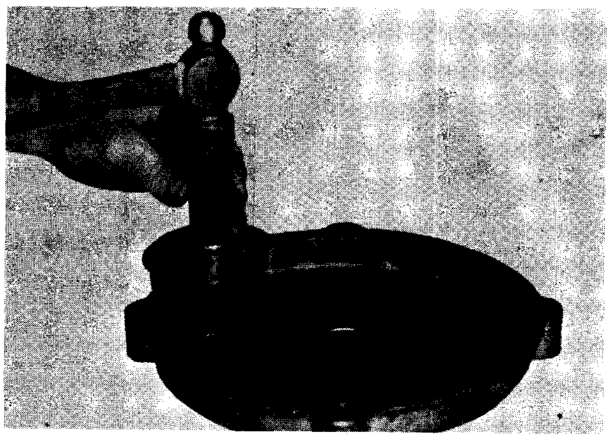
Insert pinion with shaft into reduction housing (Illust. 28).

Press or drive bushings into reduction gear housing cover (Illusts. 29 and 30).

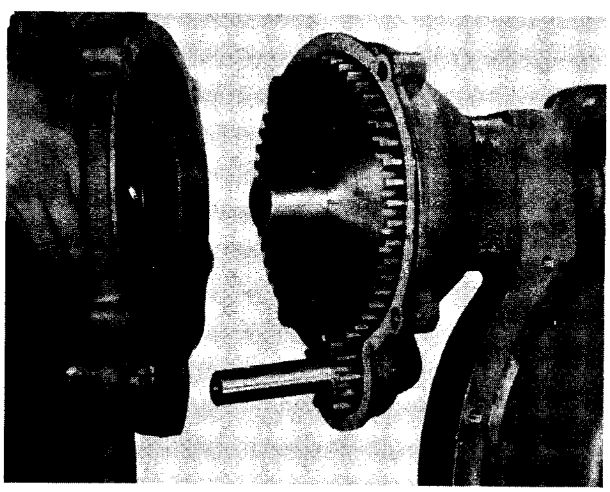
Shellac gasket to reduction gear housing. Install cover onto housing (Illust. 31).

Install cap screws and lock washers. Tighten cap screws securely (Illust. 32).

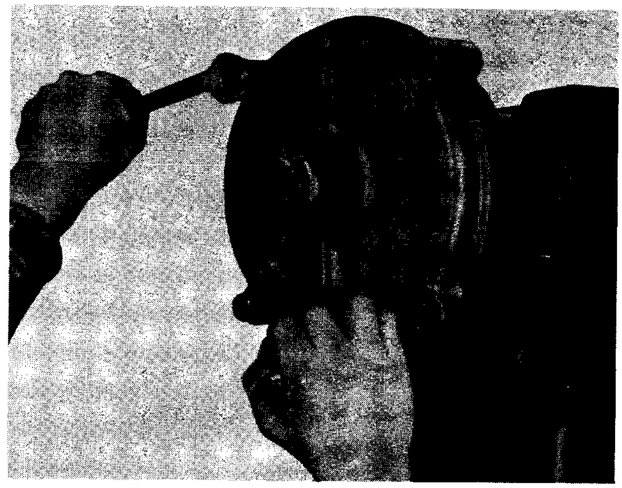
Insert a thin piece of shim stock approximately half-way through grease seal. Slide end of shim stock over end of shaft. Slide



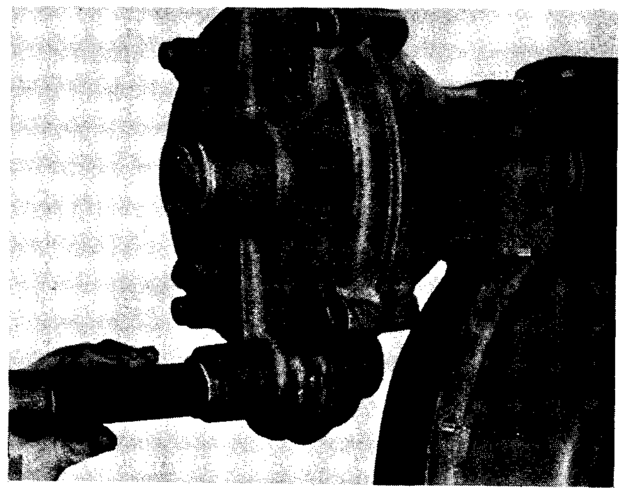
Illust. 30



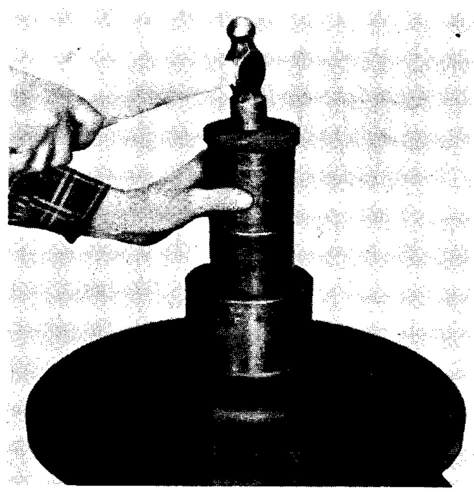
Illust. 31



Illust. 32



Illust. 33



Illust. 34

grease seal along shim stock until it is against cover. Remove shim stock, then drive seal into cover. Lip of grease seal toward inside of cover (Illust. 33). Shim stock will prevent damage to seal leather.

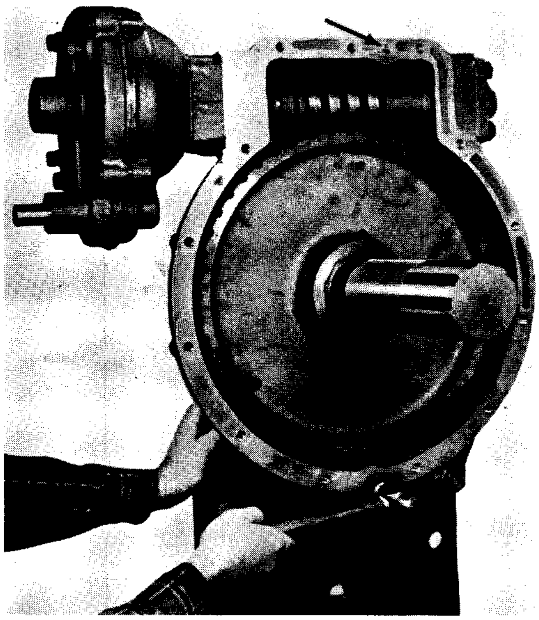
Press or drive bushing into lift gear housing cover (Illust. 34).

Drive dowel pins into lift gear housing (Illust. 35).

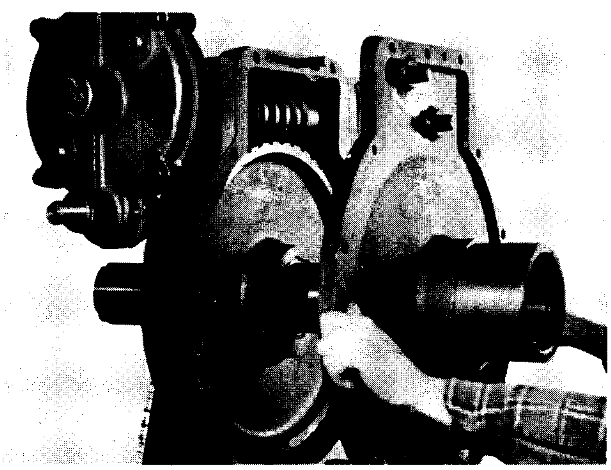
Shellac gasket to lift gear housing. Install two (2) or more guides into cap screw holes, then install cover onto housing (Illust. 36). Start several cap screws and lock washers, then remove guides.

Install the remaining cap screws and lock washers. Tighten cap screws securely (Illust. 37).

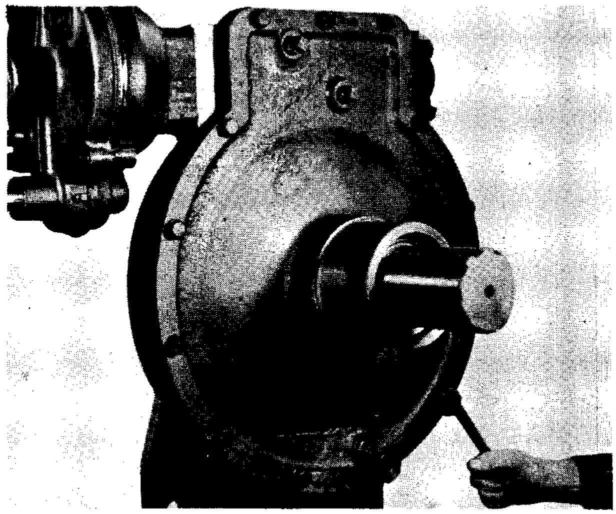
Insert a thin piece of shim stock approximately half-way through grease seal. Slide end of shim stock over end of shaft. Slide seal along shim stock until it is against cover. Remove shim stock, then drive seal into cover (Illust. 38). Lip of seal toward



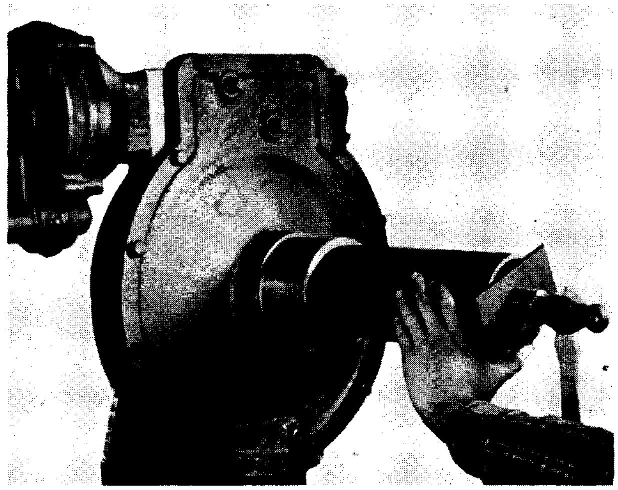
Illust. 35



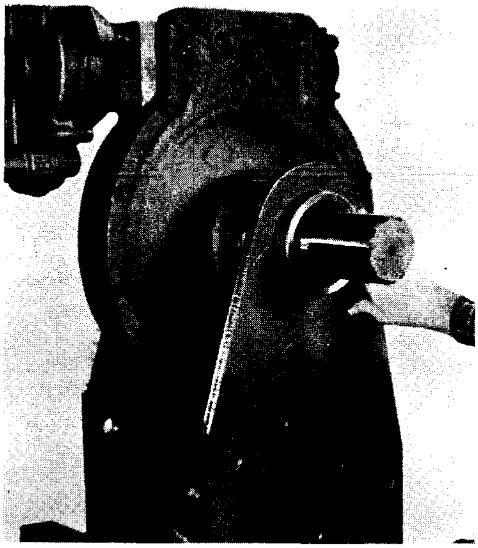
Illust. 36



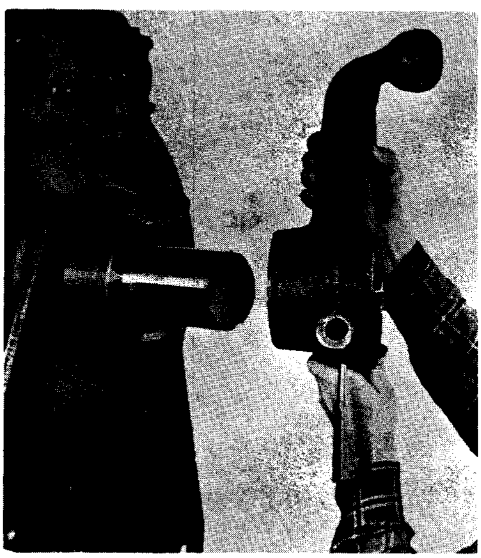
Illust. 37



Illust. 38



Illust. 39



Illust. 40

inside of cover. Shim stock will prevent damage to seal leather.

Install support plate onto hub of cover (Illust. 39).

Apply a coating of grease to splines of scarifier lift shaft. Drive a chisel into slot of arms. This will spread slot for easy arm installation. Align splines in arm with those in shaft, then install arms (Illust. 40). Bump arms onto shaft until rear face of arms are approximately 1/8" away from hubs of housing.

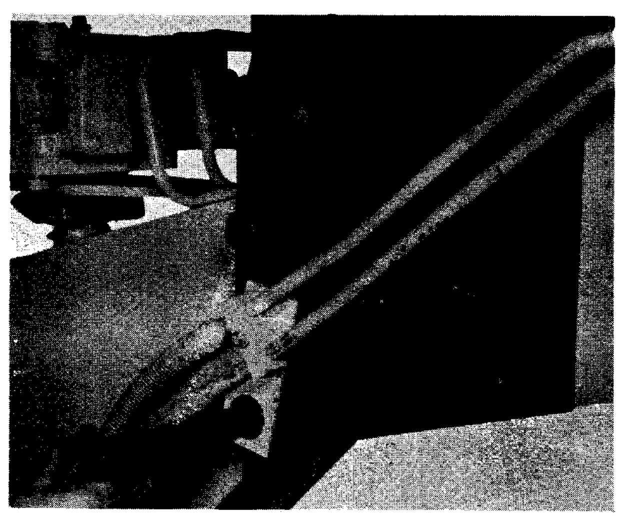
Illust. 41

NOTE: When the lift arms are in place on shaft splines, the two (2) lift balls should be within 1/8" alignment with shaft, both in parallel and in plane.

Remove chisel, then install clamp bolt and lock washer into arms. Next, install lock washer and nut. Tighten nut securely (Illust. 41).

SCARIFIER HOUSING INSTALLATION

Install scarifier housing onto frame, using



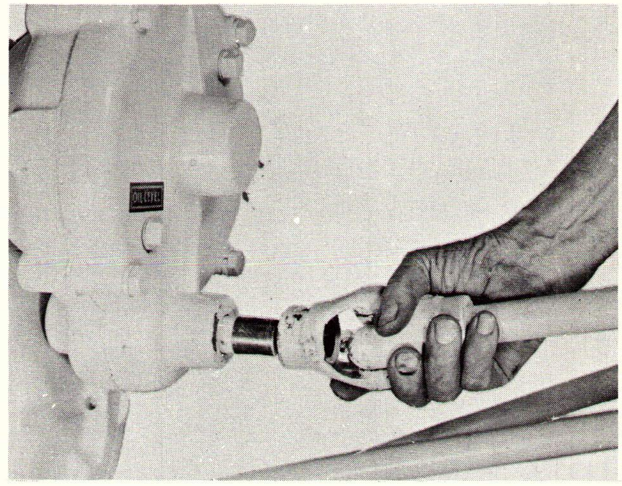
Illust. 1

a chain hoist. Insert bolts with lock washers through frame (Illust. 1). Bolt heads to be on L. H. side of frame.

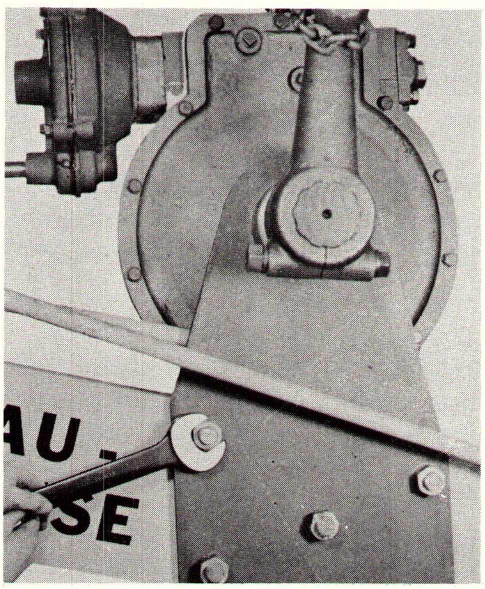
Install lockwashers and nuts. Tighten nuts securely (Illust. 2).

Install hydraulic tube clamp block cap screw and lockwasher and tighten securely (Illust. 3).

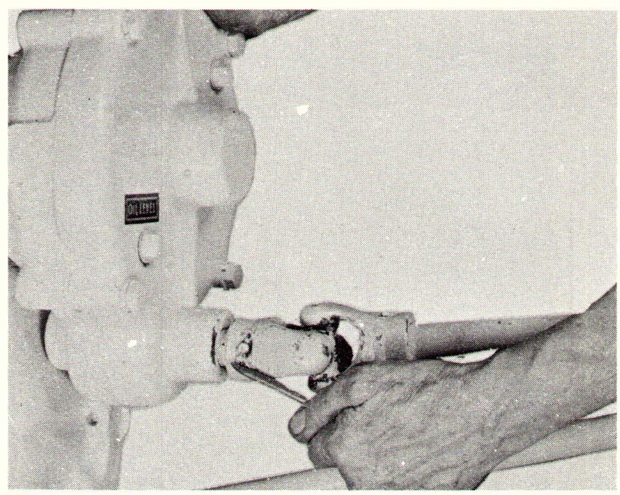
Install control shaft universal joint onto



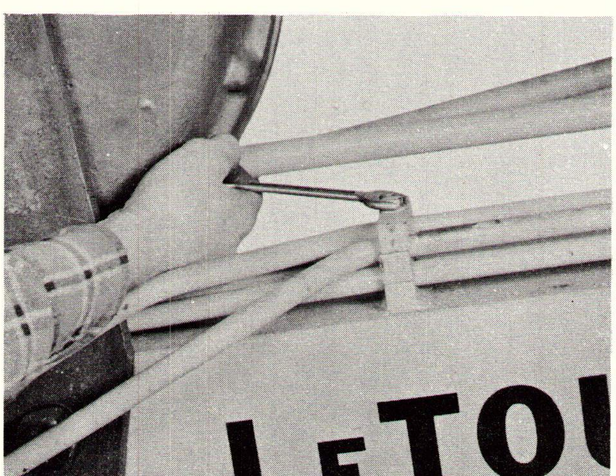
Illust. 4



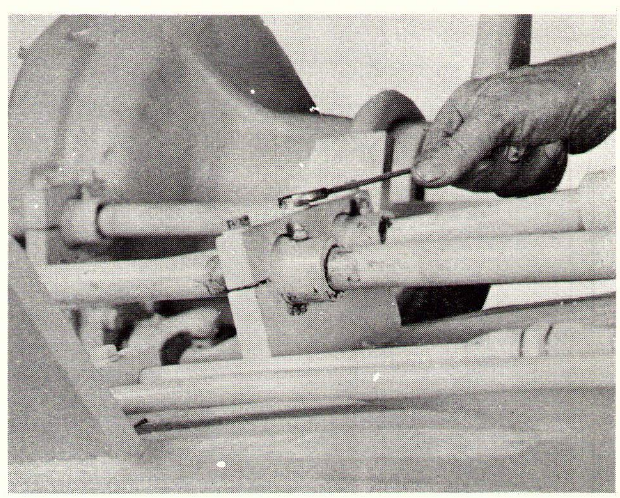
Illust. 2



Illust. 5



Illust. 3



Illust. 6

pinion shaft (Illust. 4). Align drilled pin hole in universal joint with hole in shaft and insert drilled pin. Insert cotter pin into drilled pin and spread (Illust. 5).

Install steering and scarifier control shaft bearings in frame bracket. Install bearing cap, cap screws and lock washers. Tighten screws securely (Illust. 6).

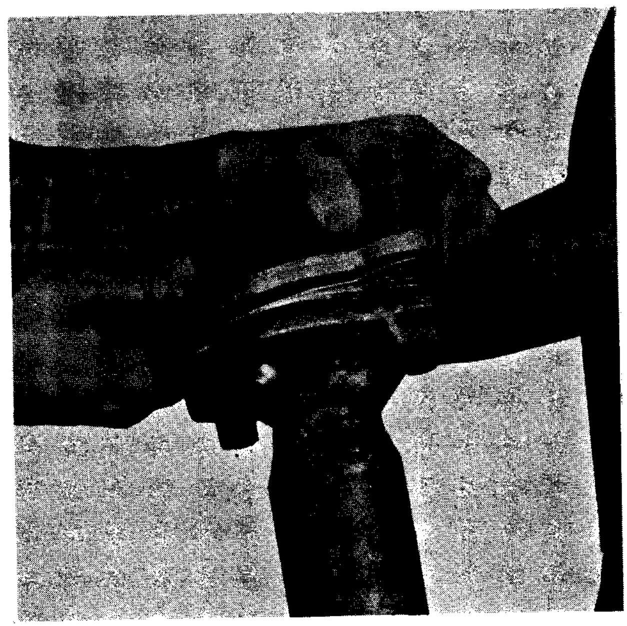
IMPORTANT: Fill both housings with correct lubricant to levels (See "Lubricating Instructions").

When housings have been lubricated, start engine and lower lift arms so ball on arms seat in concave of links. Install shims, caps, cap screws, lock washers and nuts. Tighten nuts securely.

ADJUSTABLE BALL AND SOCKET

Ball and socket joints on each end of scarifier lift links are adjustable for wear. Laminated shims are provided to take care of this wear (Illust. 7). Should signs of wear appear at either end of lift link ball or socket, remove cap and shims. Peel layers of shims off with a knife.

Do not remove any more layers of shims then necessary to remove the free play in joint. Joint should always work freely and never bind. These joints may wear egg-shaped, therefore, they should be adjusted in the position in which they will operate.



Illust. 7

— NOTES —

HYDRAULIC PUMP AND RELIEF VALVE

HYDRAULIC PUMP

The hydraulic steering booster pump used with either power steering, power-shift moldboard or both, will give good service with the proper care.

It is necessary to keep the whole system free from dirt. The oil used in the hydraulic system should be kept clean while in storage. The filter screen should be checked often. It is No. 200 wire mesh and should not be allowed to become clogged. Good oil should be used at all times. (Use a premium grade S.A.E. #10 in cold weather and S.A.E. #20 in warm weather.) Do not use hydraulic brake fluid, or low viscosity naphtha base motor oils. The hose and fittings should be checked daily for breakage or looseness.

REMOVAL

Clean outside of hydraulic pump with an oil solvent or similar fluid and dry thoroughly.

Drain hydraulic reservoir.

Remove hose connections from pump fittings.

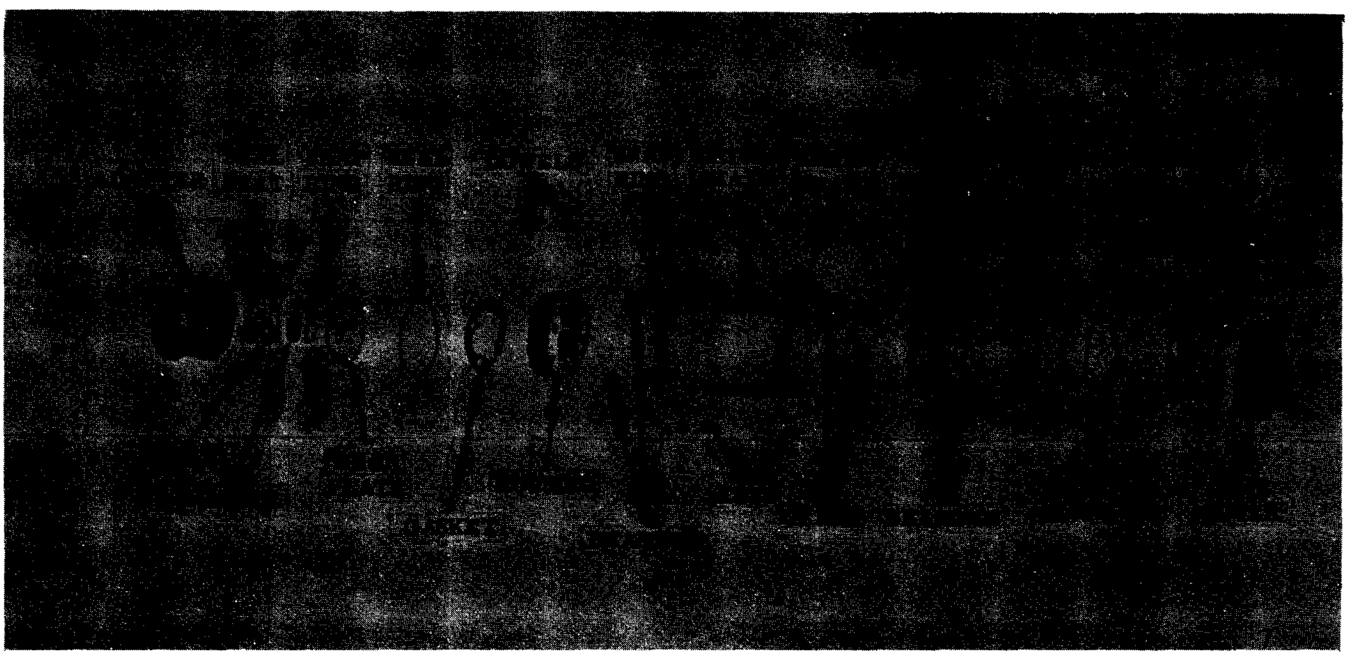
Remove pump from pump adapter housing.

Before disassembling pump, mark sections of pump with a prick punch to insure proper reassembly. Remove sharp edges or burrs from shaft splines, drill point, keyway or shaft end. The pump may be disassembled by reversing the assembly procedure.

Clean parts with an oil solvent or similar fluid and dry thoroughly. Inspect parts and replace those that are worn or damaged. Apply a thin coating of oil to parts before assembling.

REASSEMBLY

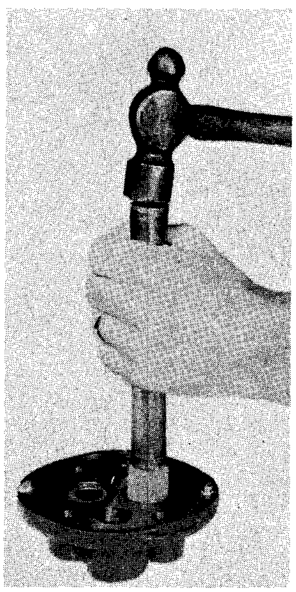
Illust. 1 is an exploded view of the hydraulic pump used with either power steering or power-shift moldboard.



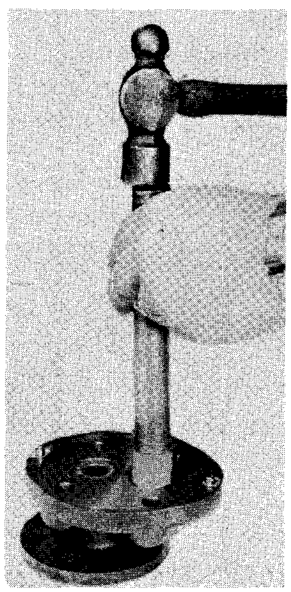
Illust. 1

Before installing needle bearings into adapter and end cover, bearings should be checked for freeness of rollers and pitted, broken or excessively worn rollers. The bearing should be replaced if it is possible to insert a .020" feeler between the rollers. If it is necessary to replace bearings, do so only with the same make and type as were originally installed.

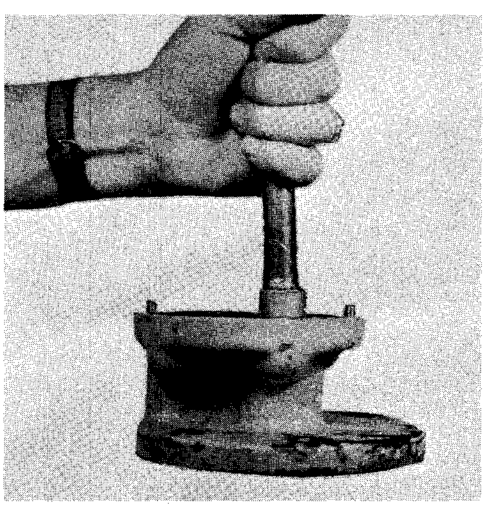
Install needle bearings into the end cover and adapter (Illusts. 2 and 3). Always apply pressure to lettered end of bearing. It is better to press them in if possible. If not, use a soft piece of tubing or drift pin, using care not to damage bearing. Bearings should be lubricated with a light grease.



Illust. 2



Illust. 3

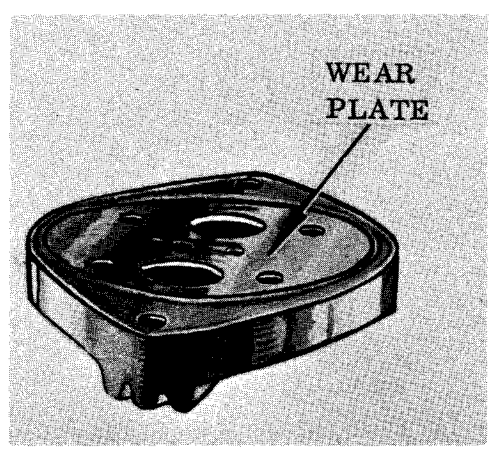


Illust. 4

Press or drive seal into adapter and against shoulder of adapter (Illust. 4). When driving seal seat into adapter, use a soft drift pin as illustrated.

Check wear plate (Illust. 5) for scoring or excessive wear. NOTE: Do not turn wear plate as the counter-bored relief pocket is on gear side only. If wear plate is steel backed, bronze side should be next to gears. Even though slight wear is shown on gear pattern, check for erosion path in vicinity of relief pocket and replace if in evidence. Also wear plate should be properly seated. If it has a slight rocking motion, check face of end cover or adapter for a burr. Be sure that the counter-bored relief pocket is up and in original position. Lubricate the contact surface of plate with light oil.

Proper clearance between the gear face and wear plate is provided by the



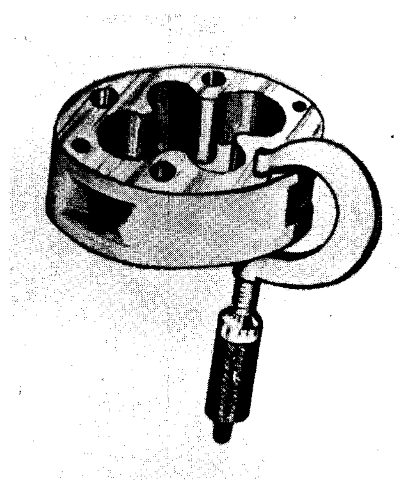
Illust. 5

plastic shim gasket between housing and adapter and housing and end cover. Using micrometers measure the width of the housing (Illust. 6) and width of gears (Illust. 7). If gear width is .002" greater than housing width, a red shim (.002") should be installed on adapter side and a red shim (.002") to end cover side. If gear width is .001" greater than housing, an amber shim (.001") should be installed on adapter side and a red shim (.002") to the end cover side. If housing and gears are the same width, an amber shim (.001") should be installed on adapter side and an amber shim (.001") to end cover side.

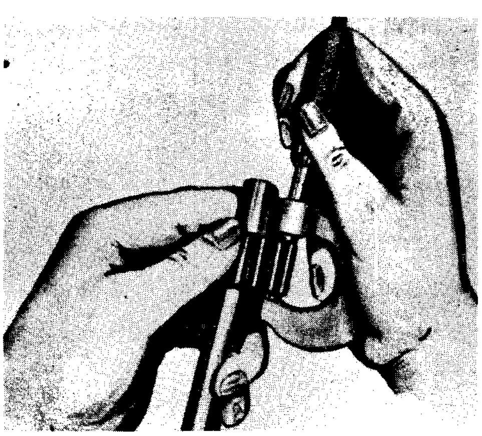
Press gear onto shaft. Center gear between the two (2) snap ring grooves in shaft. Next, install snap rings, one (1) on each end of gear. Install plate onto pump shaft. Next, install bearing (Illust. 8).

Install snap ring into groove on pump shaft (Illust. 9).

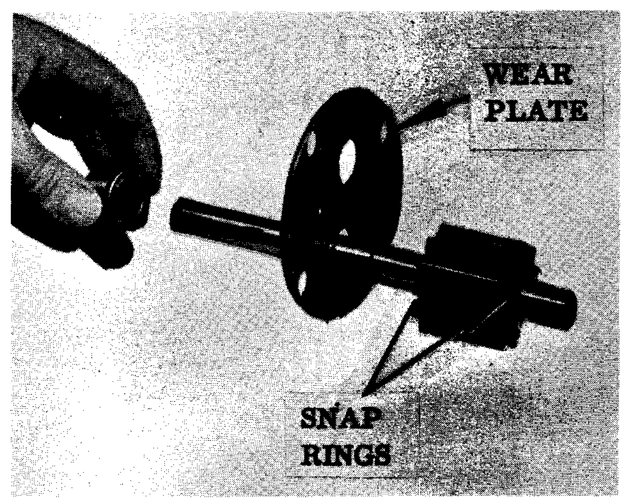
Install washer, spring, 2nd washer and seal on shaft (Illust. 10). Next, insert shaft through adapter (Illust. 11).



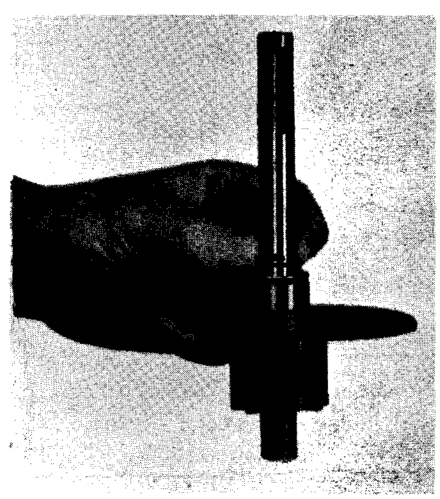
Illust. 6



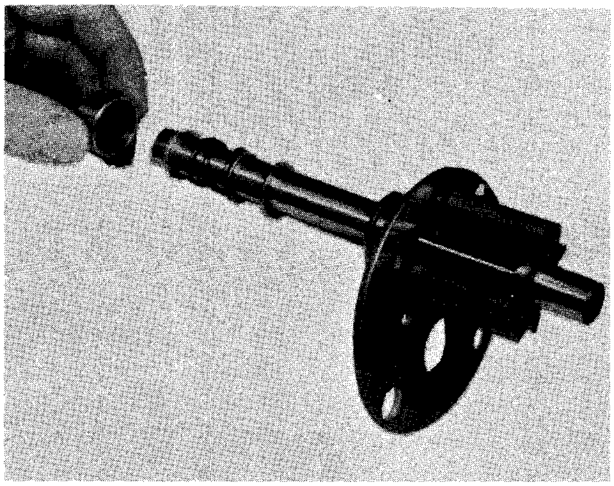
Illust. 7



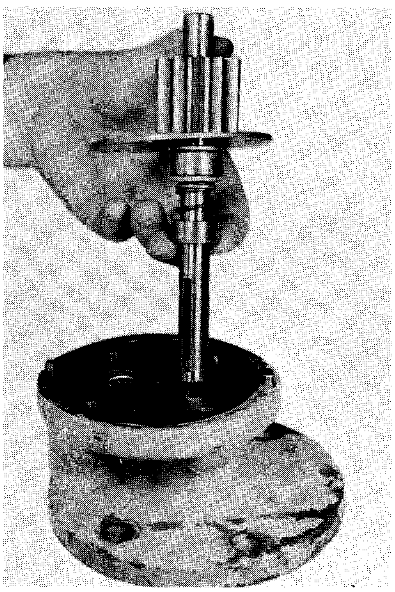
Illust. 8



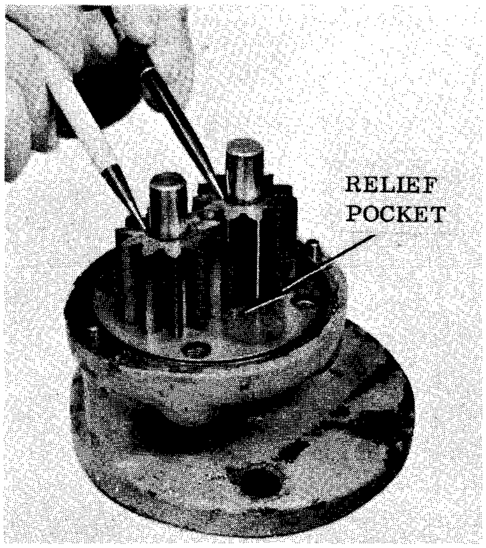
Illust. 9



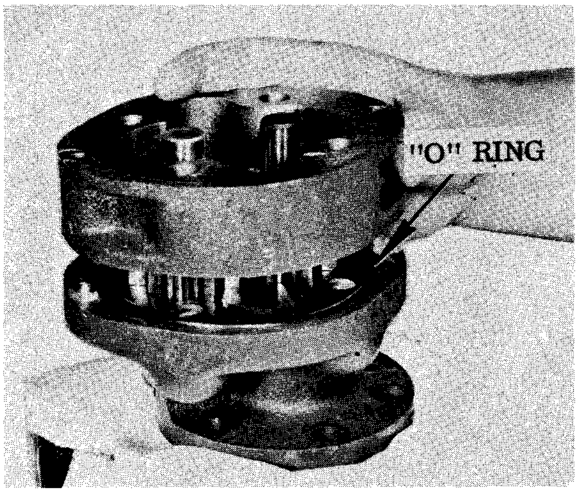
Illust. 10



Illust. 11



Illust. 12



Illust. 13

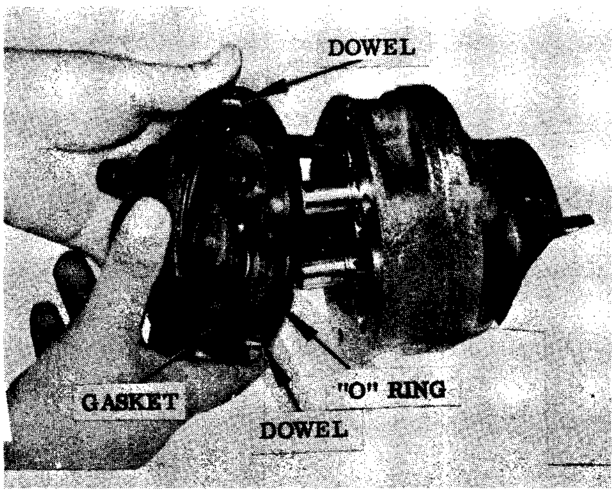
Install the gears (Illust. 12). Make sure that they are in their original position; that the relief pocket is in its original position, on the pressure side; and that edge of teeth and gear face are not scored. If new gears are installed, keep keyways 180° apart, as illustrated. Install "O" ring in groove outside of wear plate (Illust. 13). Install gasket shim, which was determined to be used, between adapter and housing. Align punch marks in housing with those in adapter then install housing over gears and gasket. Be sure dowels fit into holes in housing. Tap housing with fibre hammer to secure.

Install wearing plate to end cover, with relief pocket side toward gears, and on the same side of gears as relief pocket wear plate in the adapter. Be sure the bleed hole in wear plate is aligned with the corresponding size bleed hole in cover. Install "O" ring

(Illust. 14) and proper gasket shim. Lubricate face of wear plate with clean oil. Install dowels in cover. Align punch marks previously made on housing and end cover. Install end cover to housing and tap with fibre hammer until cover is tight against housing. Be careful not to damage "O" ring. Check to make sure that bleed backhole in cover is on the intake side of pump.

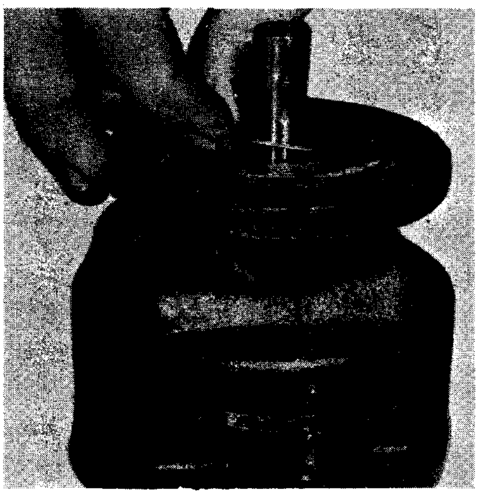
Install four Allenhead cap screws and lock washers. Gradually tighten opposite cap screws. Tighten cap screws to a torque reading of 60 foot pounds. After the assembly has been completed, turn shaft with a six inch wrench. The shaft should turn with a slight drag. If shaft is too tight or too free, add or remove as many gasket shims as necessary for proper clearance.

Install bearing over drive shaft and down into housing (Illust. 15)then install snap ring into groove (Illust. 16).

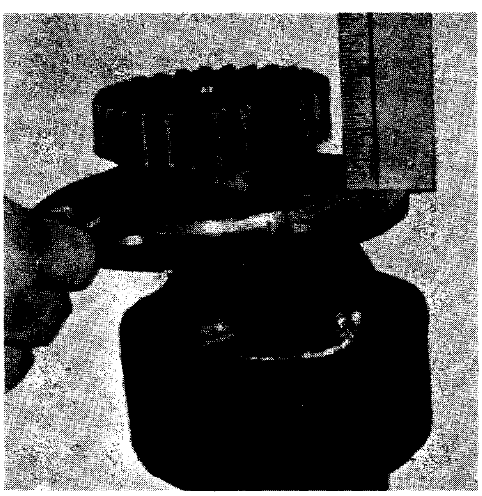


Illust. 14

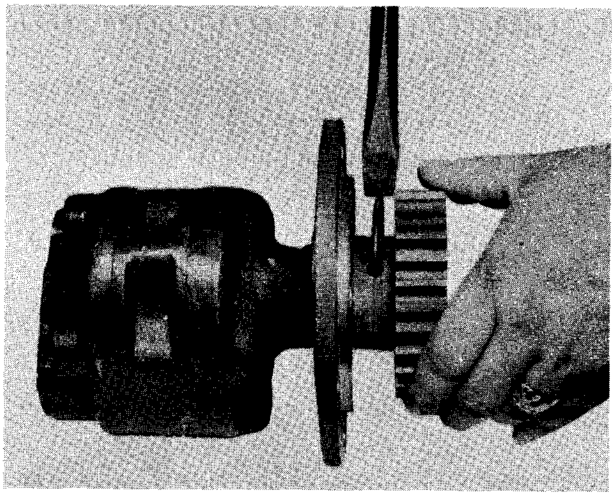
Illust. 15



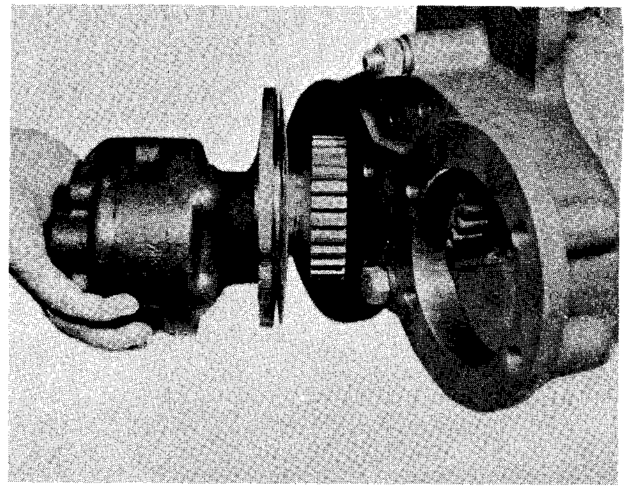
Illust. 16



Illust. 17



Illust. 18



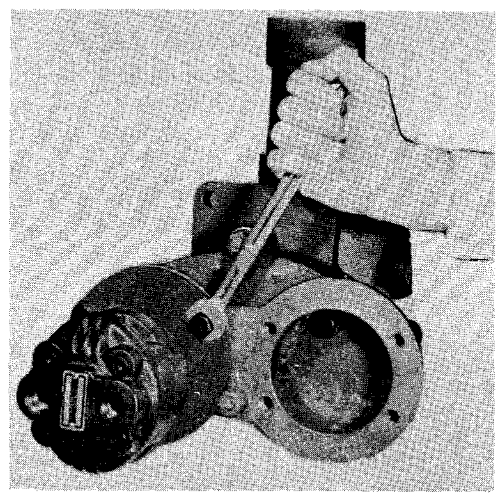
Illust. 19

Install key in keyway on pump shaft, then install driven gear (Illust. 17), using a fibre hammer or similar tool. The distance between flange of pump adapter to bottom edge of gear should be 15/16 of an inch. Install hex socket set screw and tighten securely.

Install snap ring (Illust. 18). End of snap ring to fit in set screw hole.

Using a new gasket, install hydraulic pump or pumps to pump adapter housing (Illust. 19). Install cap screws and lock washers (Illust. 20) and tighten securely.

Install pump opening cover (if only one (1) pump is used) and gasket. Secure with four cap screws and lock washers.



Illust. 20

IMPORTANT: Fill reservoir with correct lubricant. See "Lubricating Instructions".

RELIEF VALVE

REMOVAL
Clean outside of relief valve with an oil solvent or similar fluid and dry thoroughly.

Drain hydraulic reservoir.

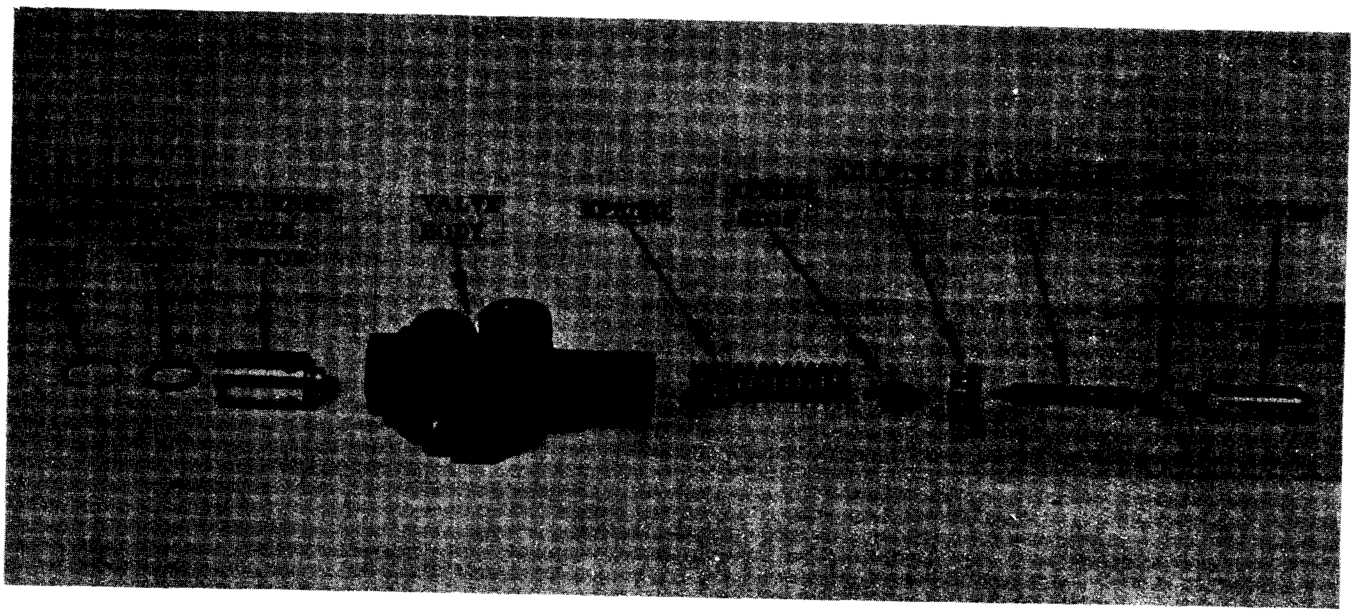
To remove the relief valve from motor grader, reverse the Installation procedure.

IMPORTANT: When hoses and tubing

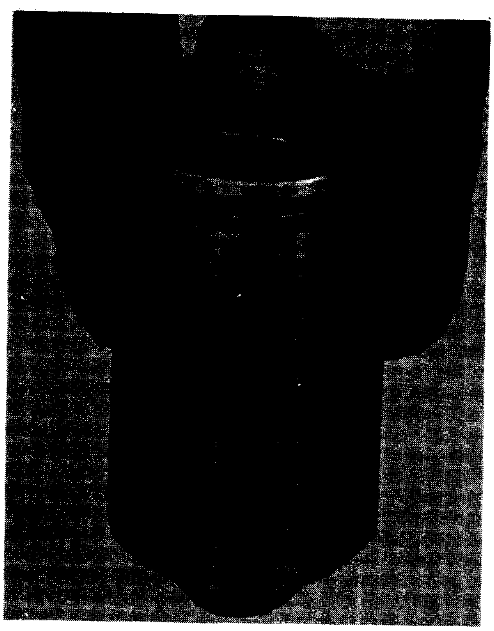
are removed, plug openings in hoses, tubing and fittings to prevent dirt or other foreign matter from entering system.

To disassemble valve, reverse reassembly procedure.

REASSEMBLY



Illust. 1



Illust. 2

After the valve has been completely disassembled, parts should be washed in an oil solvent and dried thoroughly.

Inspect all parts for wear, pitting or corrosion. Any parts showing wear should be replaced.

When reassembling the valve, apply oil to parts. Extreme care should be exercised to prevent dirt from entering valve.

Illust. 1 is an exploded view of the relief valve.

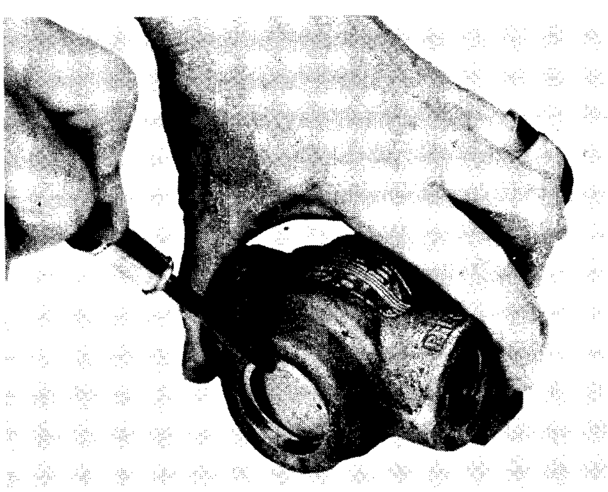
Install "O" ring in groove of cylinder with piston (Illust. 2).

Insert cylinder into valve body (Illust. 3). Push cylinder upward until bottom of cylinder is above snap ring groove. NOTE: Apply white lead to "O" ring to prevent damage.

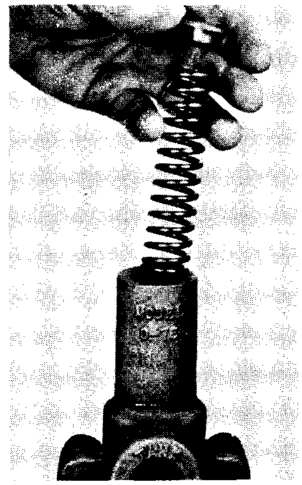
Insert snap ring into groove of valve body (Illust. 4).

Insert spring and spring stop into valve body (Illust. 5).

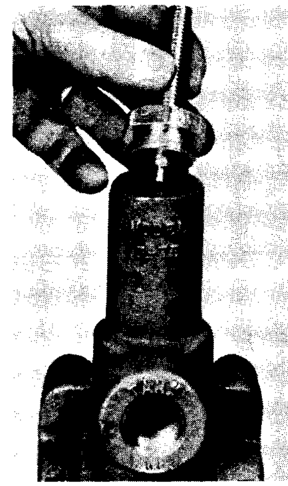
Illust. 3



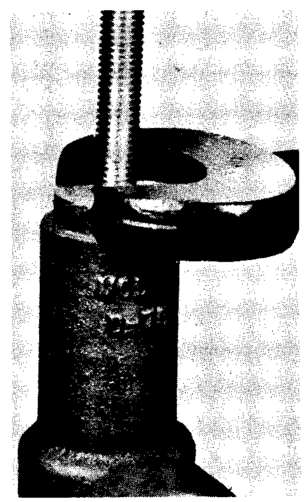
Illust. 4



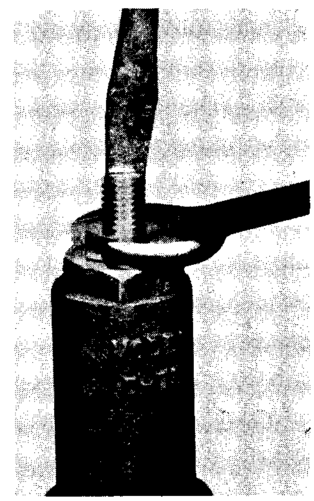
Illust. 5



Illust. 6



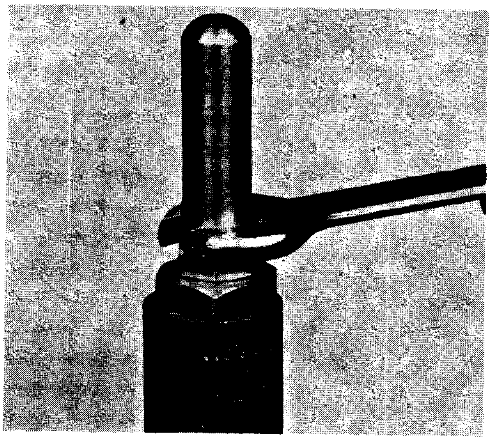
Illust. 7



Illust. 8

Install adapter onto adjusting screw. Next, install adapter into valve body (Illust. 6). Tighten adapter securely (Illust. 7). NOTE: Tip of adjusting screw to fit in hole of spring stop.

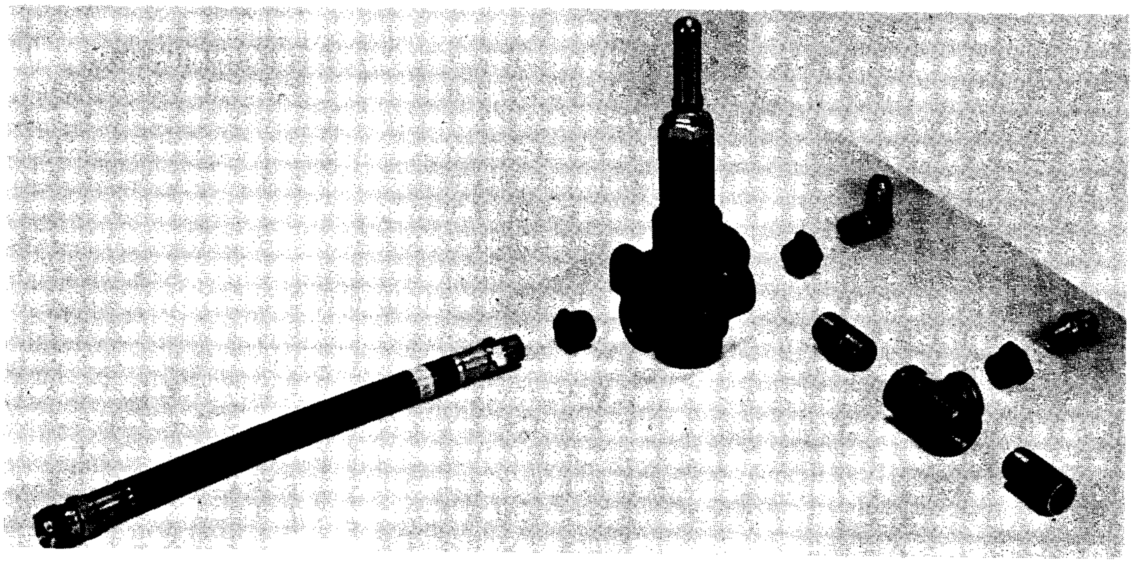
Install jam nut onto adjusting screw. NOTE: As a guide, tighten adjusting screw until bottom of slot is approximately 9/16 of an inch from top of jam nut then tighten jam nut securely (Illust. 8).



Illust. 9

Install cover onto adjusting screw and tighten securely (Illust. 9).

Illust. 10 is a view of the relief valve showing location of fittings. NOTE: Use a pipe sealing compound on threaded ends of all fittings. Tighten securely.



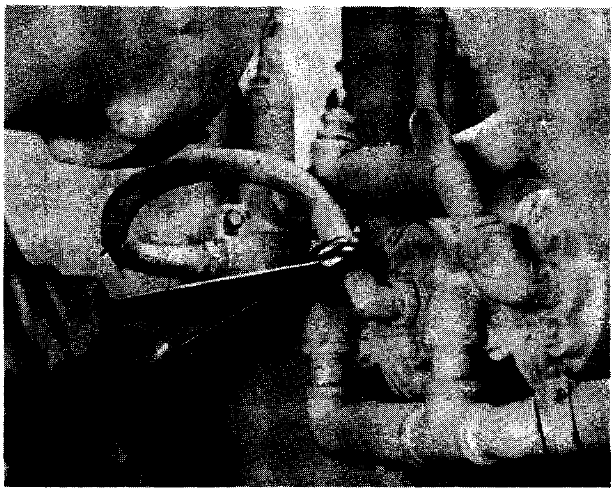
Illust. 10

Illust. 1

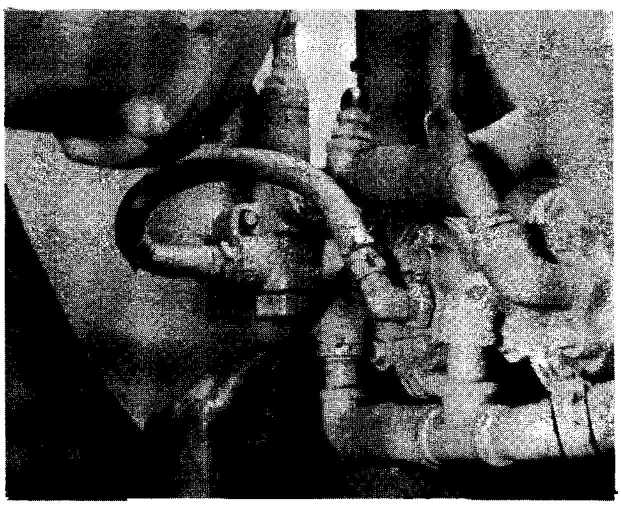
RELIEF VALVE INSTALLATION

Install relief valve onto frame. Next, install cap screws and lockwashers. Tighten cap screws securely (Illust. 1).

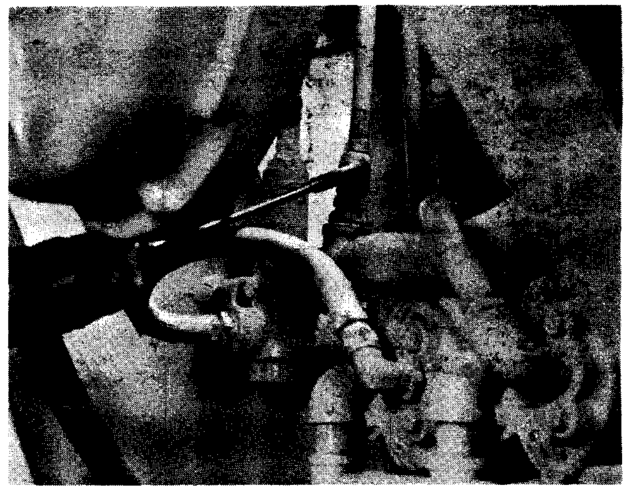
Install and tighten pressure hose to elbow fitting in pump (Illust. 2). NOTE: Do not twist hose while tightening.



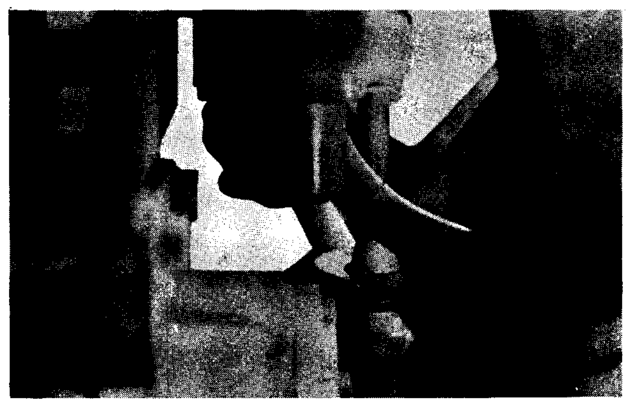
Illust. 2



Illust. 3



Illust. 4



Illust. 5

Install return hose onto nipple of relief valve, then tighten clamp securely (Illust. 3).

Install and tighten return line fitting to straight fitting of tee (Illust. 4).

Install and tighten pressure line fitting onto elbow in relief valve (Illust. 5).

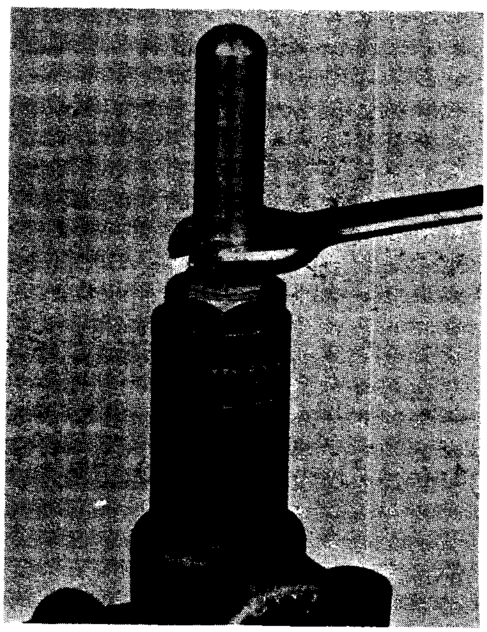
IMPORTANT: Fill hydraulic reservoir with correct lubricant. See "Lubricaing Instructions."

Start engine and check connections for leakage.

RELIEF VALVE ADJUSTMENT

To adjust the relief valve, remove pressure line from elbow in valve (Illust. 1). Next, remove elbow from valve body and install a pressure gauge.

Illust. 1



Illust. 2

Illust. 3

Remove cover from adjusting screw (Illust. 2).

Start engine and rev engine to maximum R. P. M. Loosen jam nut and with a screw driver turn adjusting screw until a reading of 1200 P. S. I. is obtained on the gauge (Illust. 3) then retighten jam nut while holding the screw driver in place.

Shut engine off and remove gauge. Reinstall cover, elbow and pressure line.

Check oil level in reservoir and add oil if necessary. Start engine and check for leaks.

— NOTES —

FRONT AXLE

In order to better understand the problems involved in maintaining the front axle of a motor grader and proper wheel alignment, it is well to have a thorough understanding of the alignment angles involved. The most important and better known alignment angles are:

1. TOE-IN OF THE WHEELS.
2. CASTOR OF THE AXLE.
3. CAMBER OF THE WHEELS.

A brief description and discussion of the purposes of each of these angles should prove of assistance in properly servicing the axle.

1. TOE-IN OF THE WHEELS: Toe-in is the setting of the front wheels closer together at the front of the axle than at the rear. The purpose of toe-in is to offset the effect of wheel camber and the resultant tire wear due to lateral slippage.

2. FRONT AXLE CASTOR: Castor is the inclination of the spindle fork toward the rear or toward the front of the grader. Positive castor is an inclination of the top of the spindle toward the rear; negative or reverse castor is an inclination of the top of the spindle fork toward the front of the grader. The purpose of castor is to provide stability in steering.

3. WHEEL CAMBER: Camber is the inclination of the wheel from a vertical plane. The primary object of camber is to offset the wear of spindle bearings and bushings and wheel bearings and the deflection or sagging of front axle parts, thereby preventing the wheel from going into a reverse camber position after long mileage. Positive camber is an outward inclination of the wheel at the top. Negative or reverse camber is an inclination of the top of the wheel toward the center of the axle.

The factors effecting steering are so closely related and interdependent that any specific complaint may be caused by a number of different items. It will usually be found that not one but several factors are out of line and so all must be corrected before the motor grader can be expected to operate satisfactorily.

In regard to castor, there is no adjustment. The castor is a fixed dimension maintained by the axle pivot pin in relation to the front bolster. Should the machine be worn at this point, no serious damage to the tires can result. Improper castor has no serious effects on the wear of front tires on units of this type when traveling at their governed speed. However, bushings are provided at these points in the axle which are replaceable when wear becomes excessive.

Therefore, the only two dimensions which need to be checked are camber and toe-in. Before attempting to correct improper camber or toe-in, by adjustment, always check the spindle and spindle fork to determine if excessive wear has occured on the bearings and bushings in these parts. If excessive wear has occured, they should be adjusted or removed and new parts installed.

The extent to which the front axle assembly is disassembled depends upon the parts which must be repaired or replaced and therefore, the work to be done. All points of wear are equipped with replaceable bushings which require no reaming after installation. A detailed description is given here only of the reassembly operation since it is at this time that all adjustments must be established. The disassembly is merely the reverse of the assembly procedure and is so simple that it requires no detailed explanation.

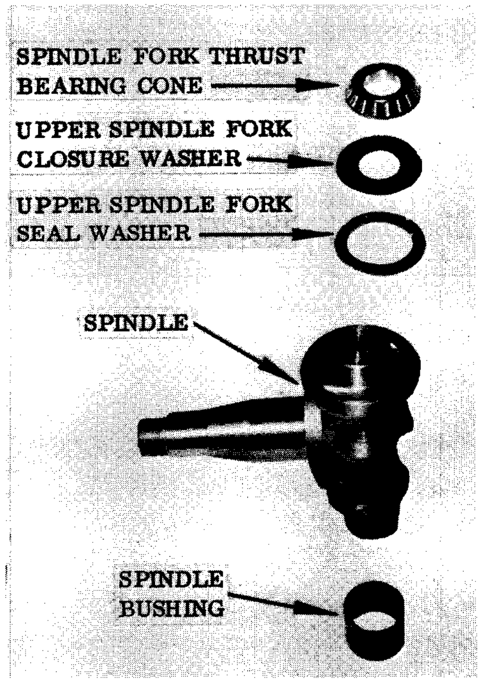
Inspect all parts for excessive wear, breakage or other damage. A close inspection should be made of the holes in the ends of the vibrating link to determine if they have become elongated. Occasionally, after long usage or severe operating conditions, these holes will become elongated thus allowing the front wheels to go into a reverse camber position. If this occurs, the complete vibrating link must be either repaired or replaced before reinstalling it on the machine.

Illust. 1 is a view of the spindle and component parts.

The first step is to install upper spindle fork seal washer onto spindle. Next, install upper spindle fork closure washer.

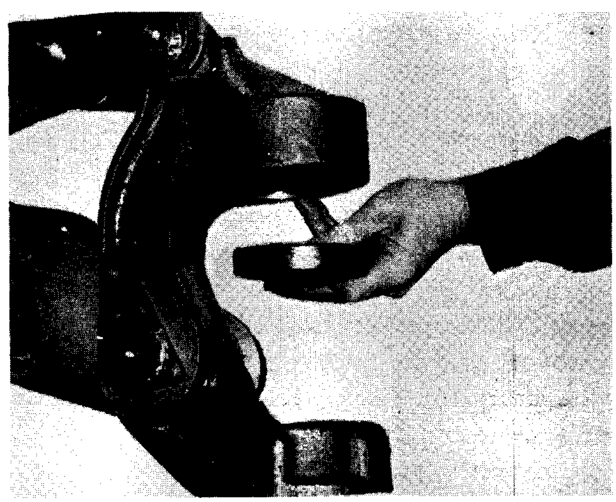
Heat spindle fork bearing cone in oil (350° F.) and install onto spindle. Hold bearing cone until set.

Heat spindle bushing in oil (350° F.) and install onto the lower end of spindle.



Illust. 1

Press or drive spindle fork bearing cup into spindle fork (Illust. 2)



Illust. 2

Install spindle fork into front axle (Illust. 3). Next, insert spindle fork and vibrating bar pins. Align tilt pin ear hole with hole in axle and install machine bolt with lock washer. Install lock washer and nut. Tighten nut securely. Align vibrating bar pin ear hole with hole in vibrating bar. and install machine bolt with lock washer. Install lock washer and nut. Tighten nut securely.

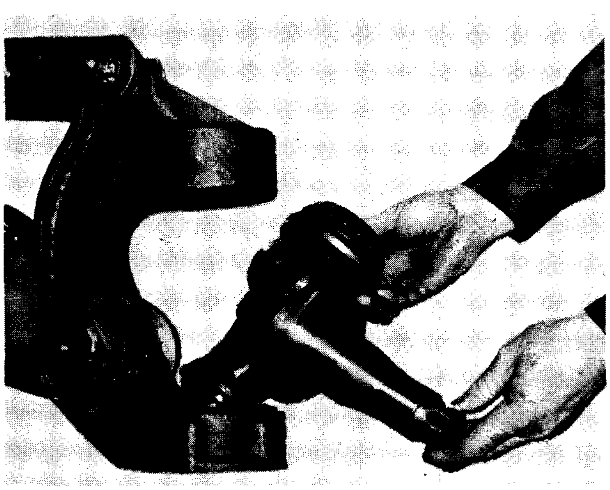
Install hex slotted nuts and washers to vibrating bar and tilt pin. Tighten nuts securely, then install cotter pins and spread.

Install spindle assembly in spindle fork (Illust. 4). Next, install spindle lower seal washer, closure washer and lower spindle fork bearing less shims (Illust. 5). NOTE: It is extremely important that the lug on the closure washer engage properly on the flat side of spindle.

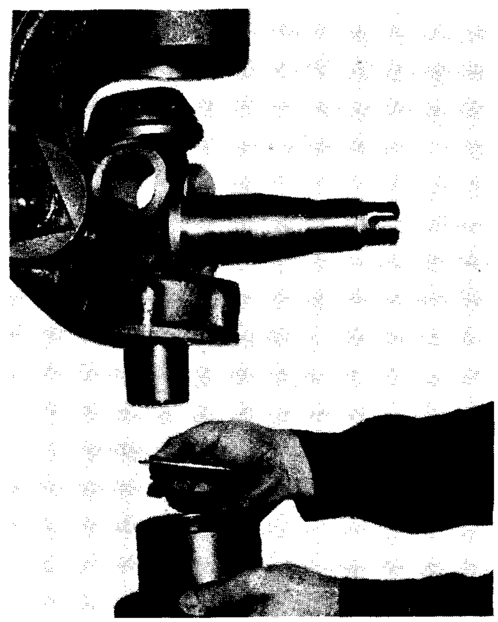
Component parts will not fit properly if closure washer is assembled any other way.

Install six (6) lower spindle fork bearing cap screws (Illust. 6). Install key

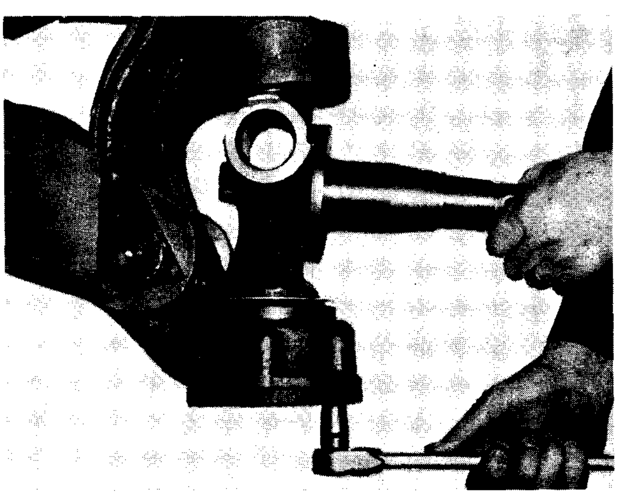
Illust.. 3



Illust. 4



Illust. 5



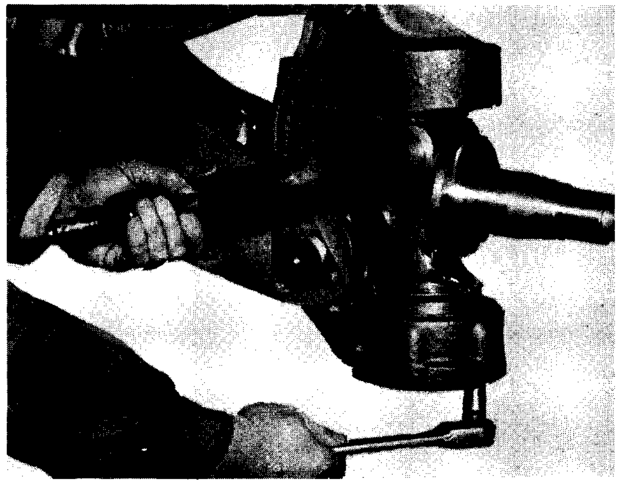
Illust. 6

in keyway of steering arm. Align key in arm with keyway in spindle and drive arm into spindle (Illust. 7). Install and tighten hex slotted nut securely. Next, install and spread cotter pin.

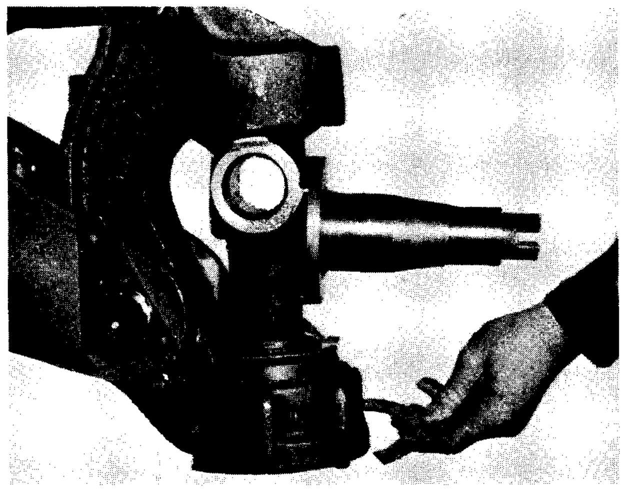
Pre-load bearings by tightening lower spindle fork bearing cap screws (Illust. 8) until the spindle cannot be turned by pulling on the steering arm. Measure the gap between lower spindle fork bearing and spindle fork (Illust. 9). Remove the bearing and install the required amount of shims needed to fill the gap. Reinstall spindle bearing, lock washers and cap screws. Tighten cap screws securely. Hook a spring scale into the cotter pin hole in steering arm. Pull the scale at right angles to the steering arm and in a plane at right angles to the vertical center line of spindle. Tap spindle with a rawhide mallet until a pull of 4 to 8 pounds is obtained.

It is not necessary to remove the steering arm from the spindle to remove spindle from spindle fork.

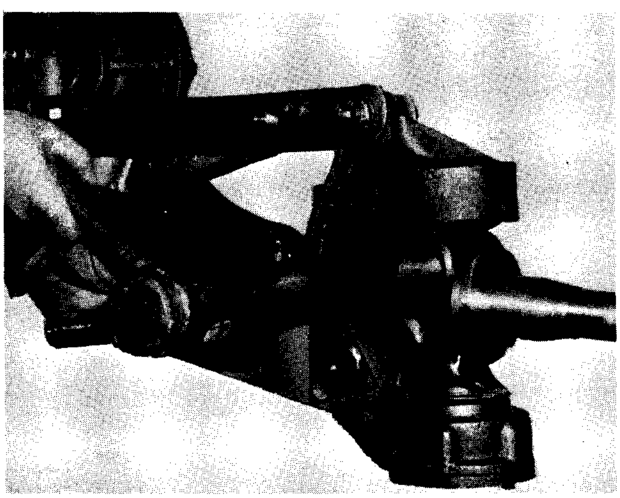
After bearings have been pre-loaded, install tie rod yoke assembly onto steering arm (Illust. 10). Lubrica-



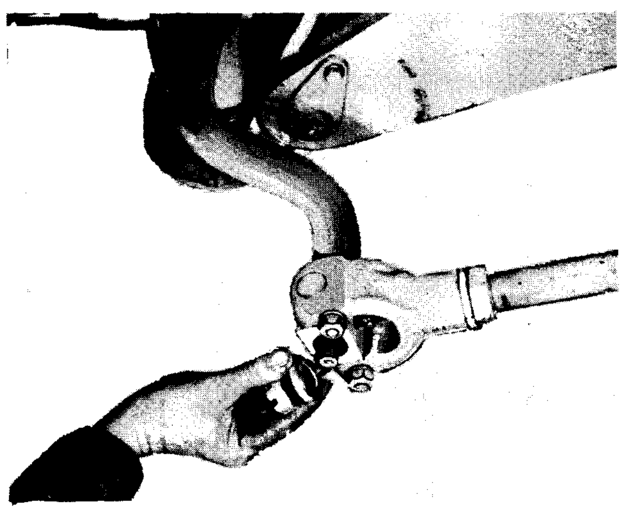
Illust. 8



Illust. 9



Illust. 7



Illust. 10

tion fitting to be toward inside of yoke. Next, install washer and hex slotted nut. Tighten nut securely, then install cotter pin and spread.

If the front axle tie rods have been disconnected from the steering ball, bring sockets over steering ball (Illust. 11) install shims, cap screws, lock washers and nuts. Tighten nuts securely.

The ball and socket joint is equipped with shims to provide an accurate adjustment and also to take up any free play which may occur due to wear in the joints. The joint should never bind but should always work freely. Never remove any more shims than necessary to remove the free play in the joints.

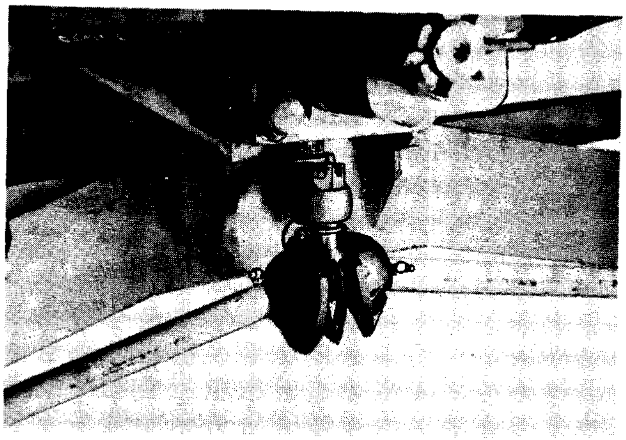
After joint has been assembled, install steering ball boot and lace securely (Illust. 12).

REMOVAL

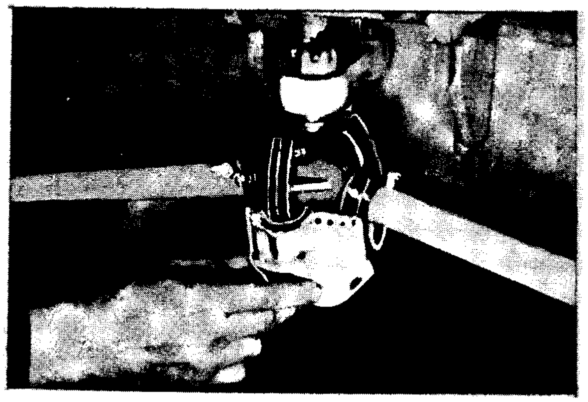
Although the front axle assembly can be completely rebuilt while it is still attached to the grader, there are occasions when it is desirable to remove it as an assembly, from the frame of the grader. An example of such removal would be the replacement of the bushings in the front axle assembly which fit around the bolster pin.

When such removal becomes necessary, the first step is to turn the moldboard crossways to the grader and lower it to the ground. Continue lowering on the moldboard until the front axle is raised slightly. Place blocks under the front axle to support its weight thereby preventing any danger of its turning over accidentally during the removal procedure.

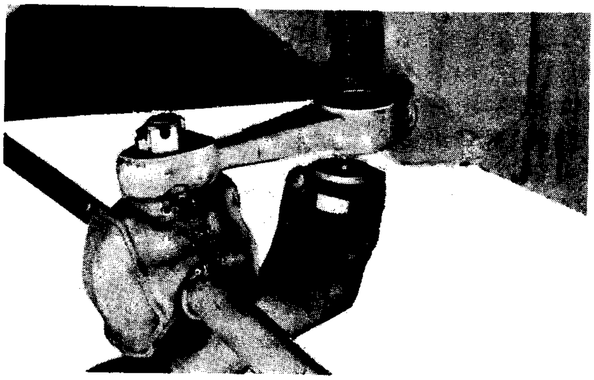
Remove the nut and lock washer from the lower end of the steering gear and remove the steering arm (Illust. 13).



Illust. 11



Illust. 12



Illust. 13

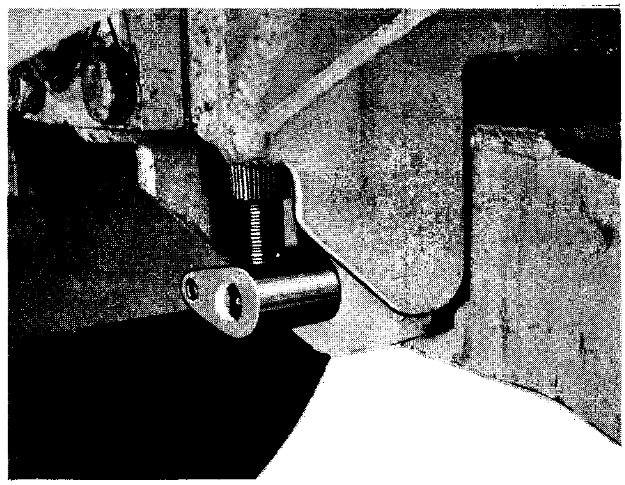
If the steering arm does not slide off the tapered serrations easily, support the shaft and drive down on the arm, using light hammer blows. IMPORTANT: Do not drive with excessive force on the steering arm, steering gear mechanism may be damaged.

Remove the cap screw which holds the bolster pin in place and drive the pin out towards the rear (Illust. 14). There are shims located between the axle and the front and rear front bolster plate which should be noted so they may be replaced in their original position.

The frame of the grader can now be raised clear of the axle by continuing to lower the moldboard through the use of the power controls.

If it becomes necessary to replace the bushings around the bolster pin, they can be driven into place through the use of a wooden block. No reaming is necessary of the bushings after they have been replaced. When reinstalling the front axle assembly on the grader, install the shims on front or rear sides of the axle as needed to provide proper clearance for free oscillation of the axle in the front bolster assembly. Install sufficient shims to remove all free play between the axle and bolster. Be sure to install the sleeve over the bolster pin between the front and rear bars of the axle.

When reassembling the telescopic shaft on the front wheel lean housing, be sure to assemble it so the forks of the universal joints are in the same relative plane. Install the steering arm on the tapered splines of the steering gear shaft. Install lockwasher and nut. Tighten nut securely.

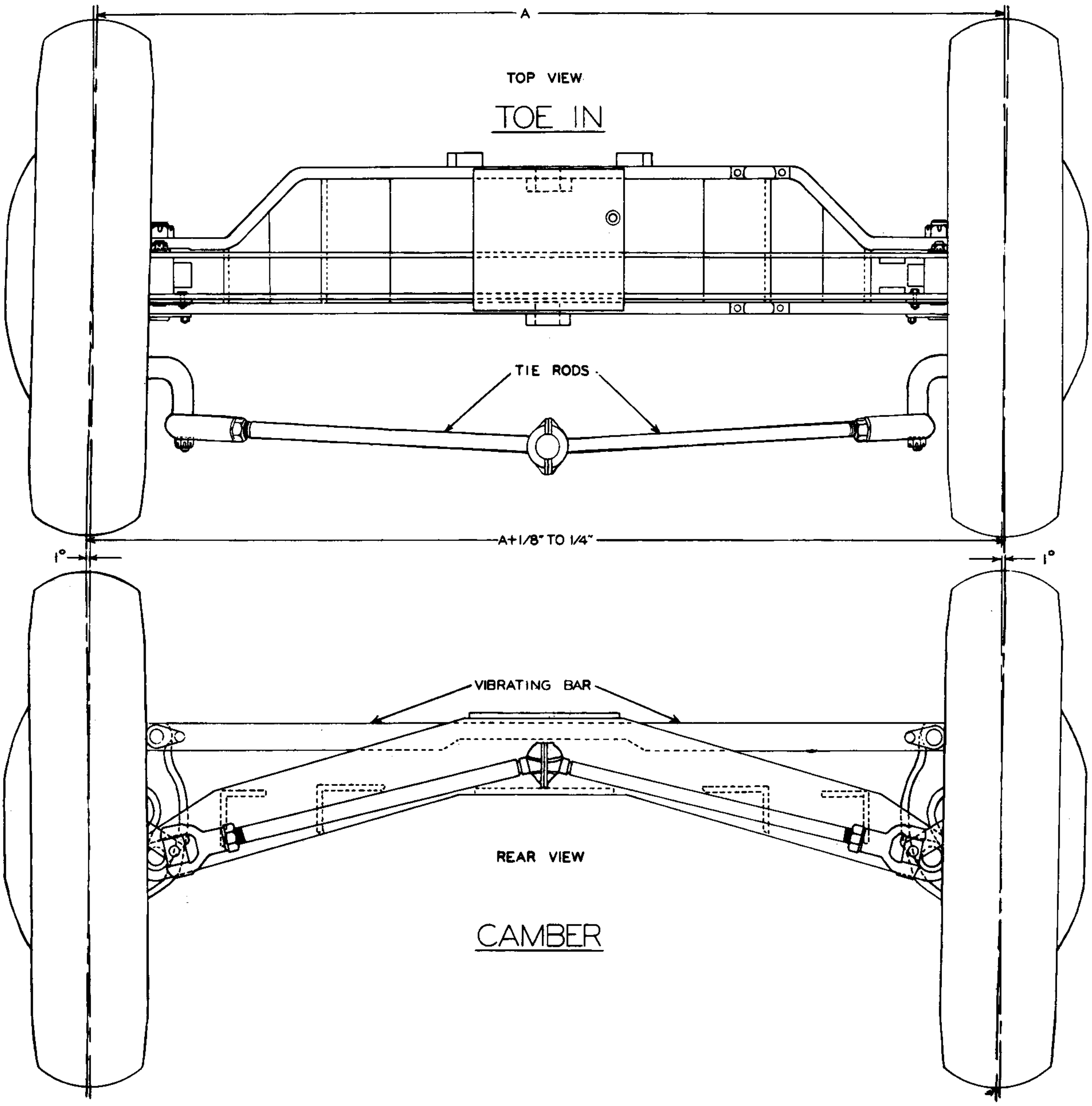


Illust. 14

ADJUSTMENT

Whenever the front axle is reconditioned as described above, the toe-in and the camber should be checked. If it becomes necessary to adjust the toe-in, the locking nuts on the ends of the tie rods should be loosened. The tie rods can then be turned in or out of the tie rod yokes to decrease or increase its total length, thereby changing the toe-in of the wheels. Both tie rods should be adjusted an equal amount in order to keep the steering ball centered.

Illust. 15 is a sketch of the front axle assembly with toe-in and camber dimensions. In order to properly measure toe-in, a line should be drawn down the center of each tire in order to compensate for any "run-out" of the tires. To do this, raise both front wheels clear of the ground and revolve each one rapidly by hand. As the wheel is revolved, hold a piece of chalk against the center of the tread and draw a true center line completely around each tire. Now lower the wheels to the ground so they support the full weight of the front end of the



Illust. 15

grader. Next, measure the distance between the lines at the front and at the rear of the axle. The distance between these lines should be from 1/8" to 1/4" greater at the rear than at the front; i.e., 1/8" to 1/4" toe-in. Both front wheels should have one degree positive camber (Outward inclination of the wheel at the top). This dimension should not be confused with the front leaning wheel feature. It is suggested that to make sure of the dimensions, the front wheel control be operated until one of the front wheels assumes a one-degree lean toward the outside. Then check the opposite wheel which should also have a one-degree lean toward the outside. In-

correct camber may be due to worn bushings, bent spindle forks, bent front axle or elongated holes in the vibrating link.
NOTE: It is important that the weight of the grader be supported by the front wheels when any measurements are taken so the wheels will be in their normal operating position.

FRONT LEANING WHEEL HOUSING

Aside from proper lubrication and occasional adjustment of the worm thrust bearings, the front leaning wheel gear assembly requires very little attention.

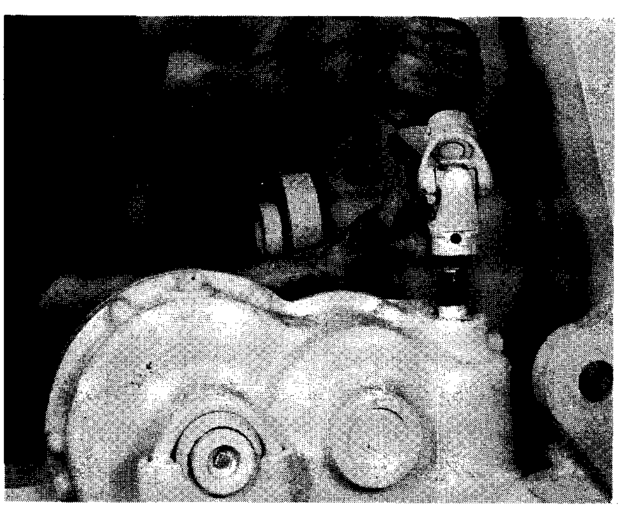
The extent to which the front leaning wheel gear assembly is disassembled depends upon the work to be done. The disassembly operation is so simple that no detailed explanation is necessary. Should trouble be experienced, the mechanism can be disassembled by reversing the reassembly procedure. It is always necessary to completely remove the front leaning wheel gear assembly from the front axle when disassembly of the unit becomes necessary.
IMPORTANT: As a safety factor, tilt front wheels to the extreme right before attempting removal of tilt housing.

Inspect all parts for excessive wear or other damage. Bearings, gears and shafts will sometimes seize and score due to insufficient or improper lubricant being used. Parts damaged in this manner should be replaced. Apply oil to parts before installation.

REMOVAL

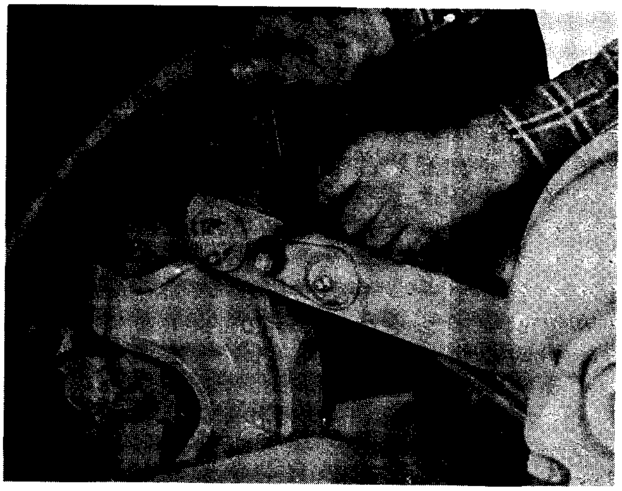
To remove the front leaning wheel gear assembly from front axle, remove drilled pin from universal joint. Bump universal from worm shaft (Illust. 1).

Remove cotter pin, hex nut and washer from vibrating bar pin (Illust. 2).



Illust. 1

Illust. 2

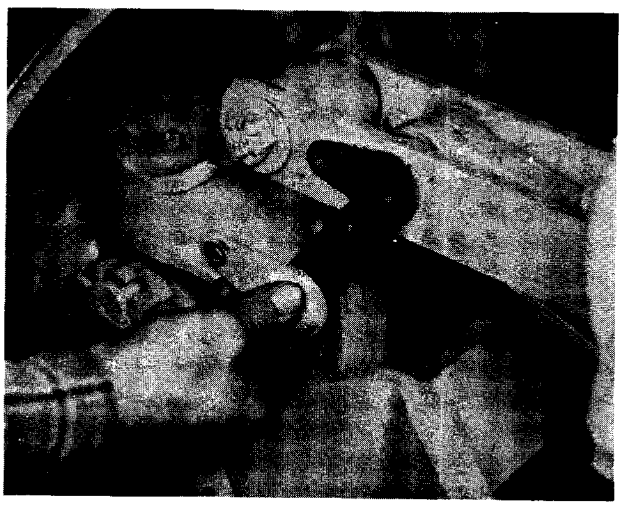


Illust. 3

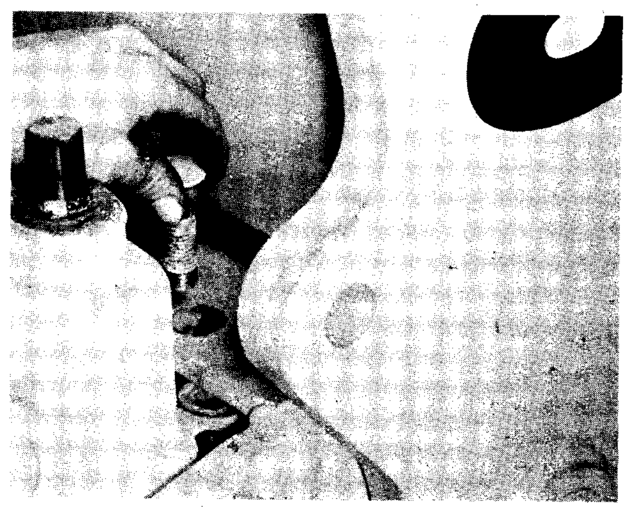
Remove machine bolt, nut and lock washers from vibrating bar pin (Illust. 3). Using a rawhide mallet, bump pin from vibrating bar (Illust. 4).

Remove nut and lock washer from anchor plow bolt (Illust. 5). Next, remove spacer and plow bolt from front axle (Illust. 6).

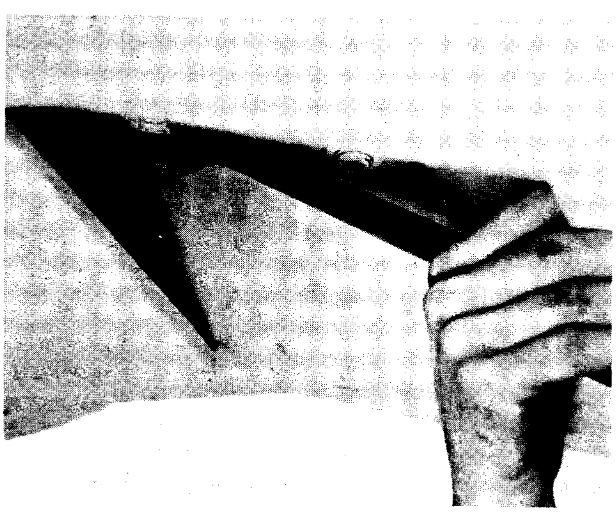
Remove "U" bolt nuts and lock washers (Illust. 7). Remove "U" bolts (Illust. 8). IMPORTANT: It is important, in the reassembly procedure, that the "U" bolt nuts must be so tight that shaft is clamped in self-aligning bearing.



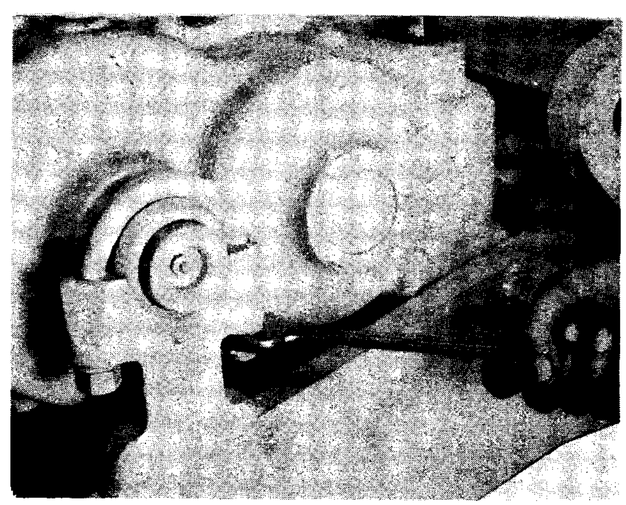
Illust. 4



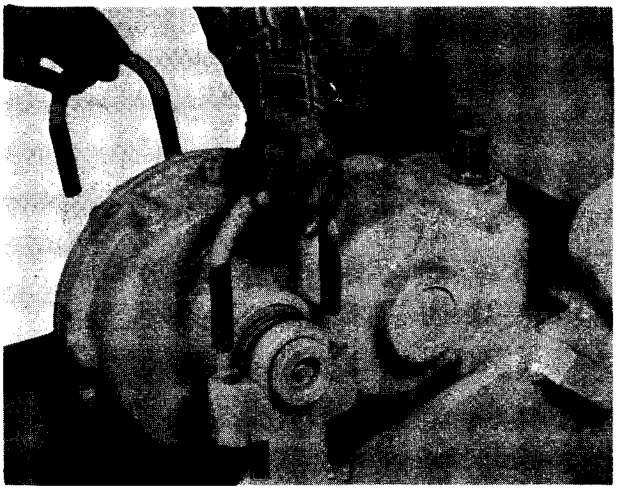
Illust. 6



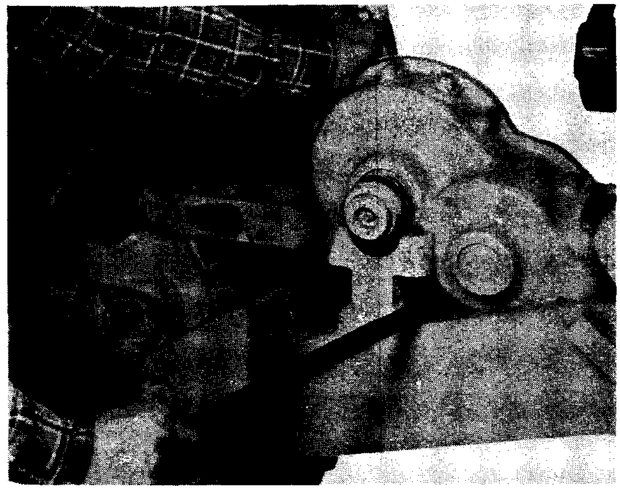
Illust. 5



Illust. 7



Illust. 8



Illust. 9

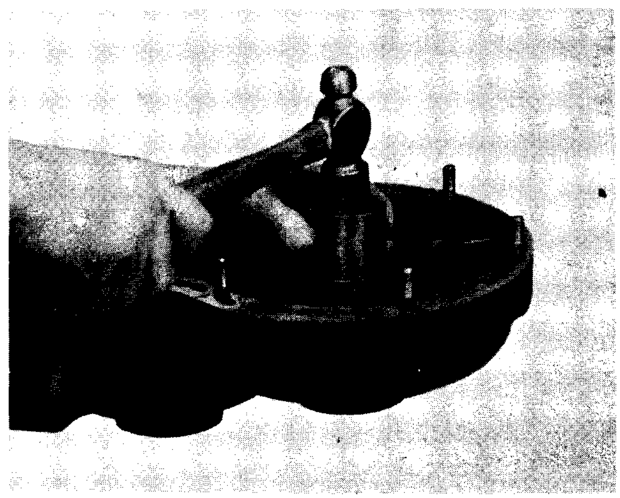
Using a pry bar, remove the assembly from front axle (Illust. 9).

REASSEMBLY

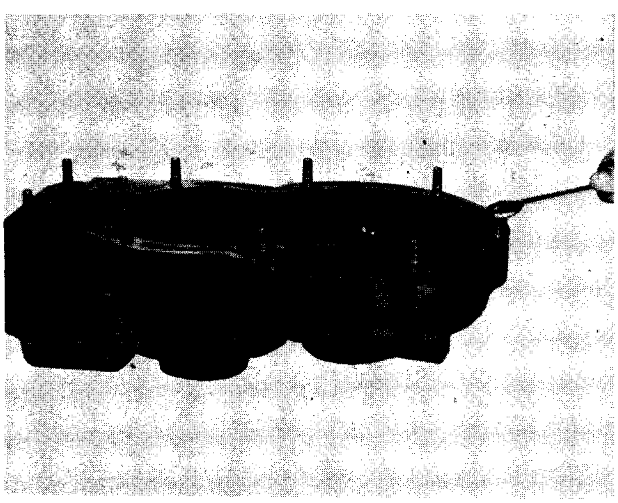
Install and tighten studs into housing, using two nuts locked together on studs (Illust. 1).

Press or drive bushings into housing (Illusts. 2 and 3). Bushings to be flush with surface of bore.

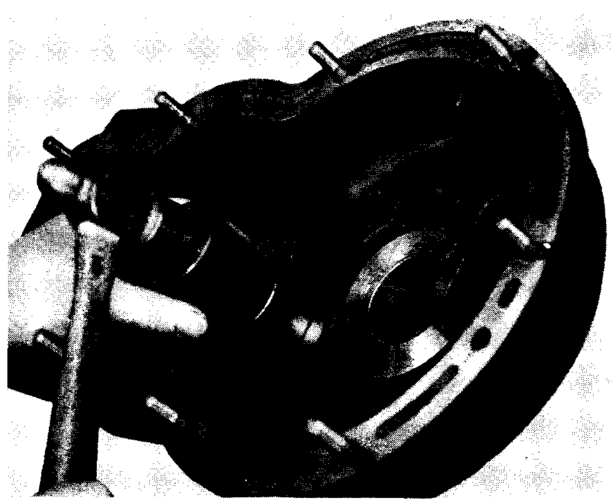
Press or drive small bushing into housing (Illust. 4). Bushing to be flush with inside shoulder of bore.



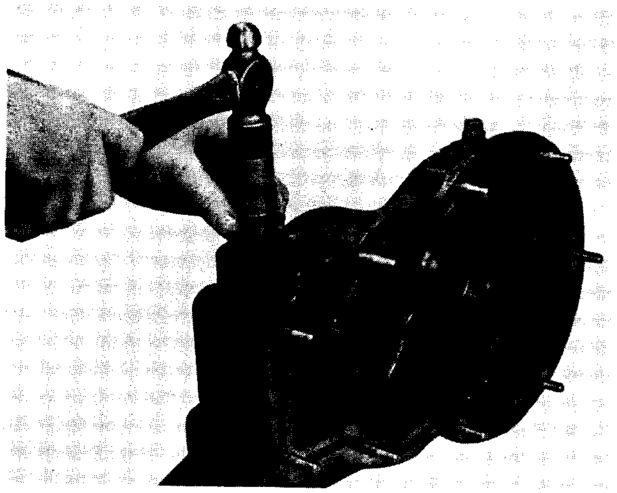
Illust. 2



Illust. 1



Illust. 3



Illust. 4

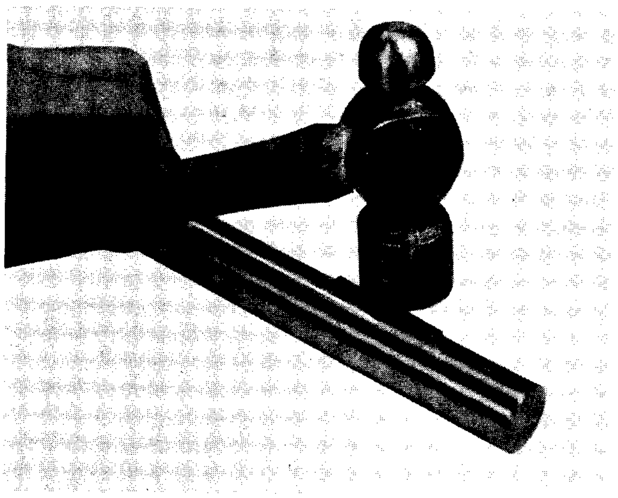
Drive key in keyway of worm shaft (Illust. 5).

Align key in shaft with keyway in worm. Press shaft through worm until 1 inch of shaft extends from worm (Illust. 6).

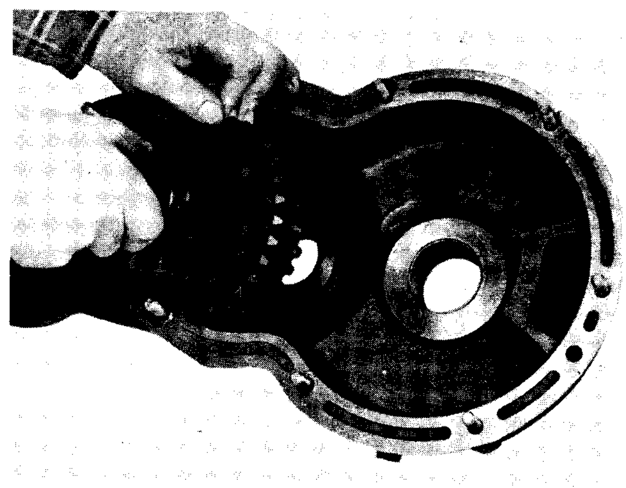
Install worm gear and pinion into housing (Illust. 7).

Install worm thrust washer onto worm shaft (Illust. 8).

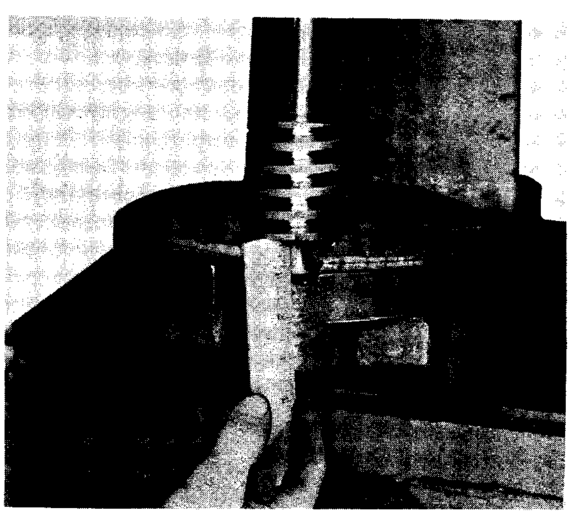
Insert worm shaft assembly into housing (Illust. 9). Rotate assembly until thrust



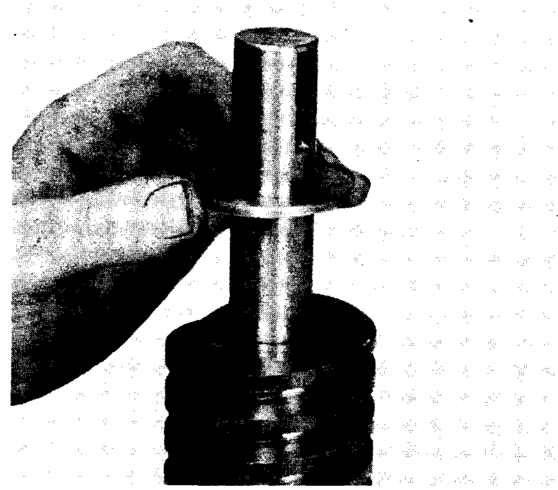
Illust. 5



Illust. 7



Illust. 6



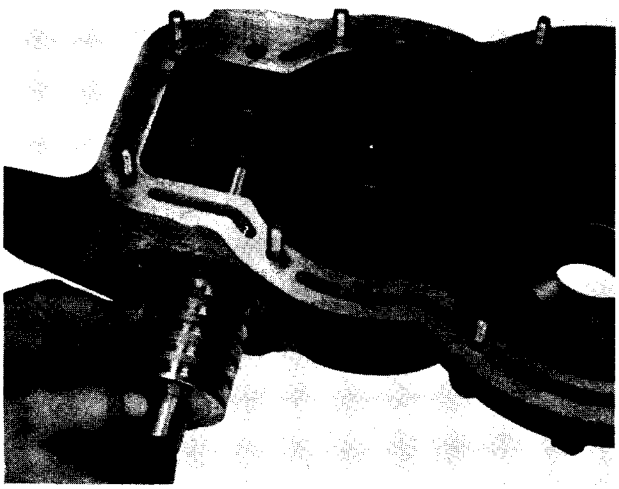
Illust. 8

washer is against smooth surface of housing.

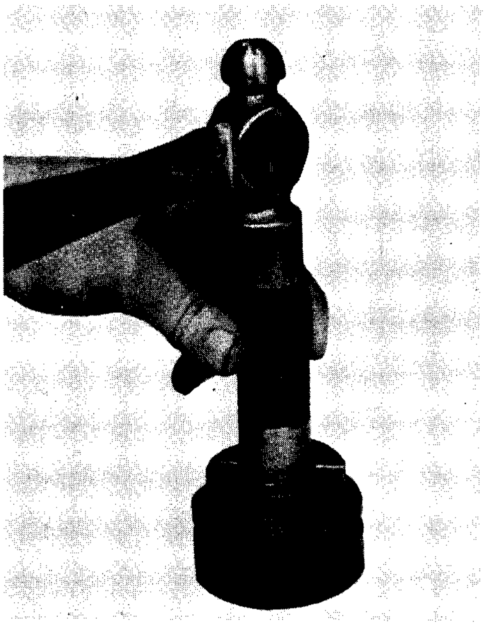
Press or drive bushing into worm thrust bearing (Illust. 10). Bushing to be flush with bottom of chamfer.

Install "O"ring in groove of thrust bearing (Illust. 11).

Insert thrust bearing into housing (Illust. 12).



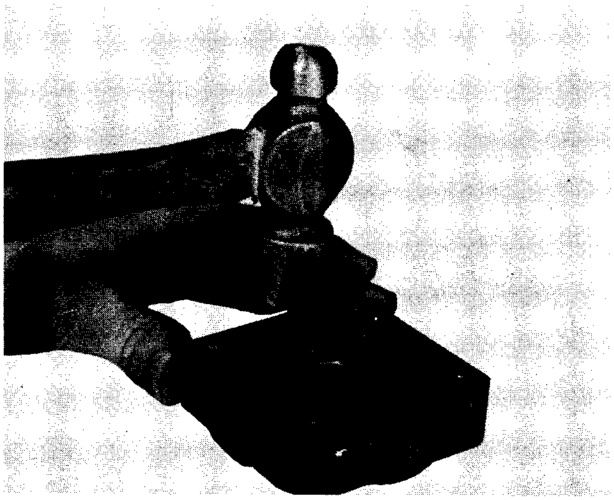
Illust. 9



Illust. 10

Illust. 11

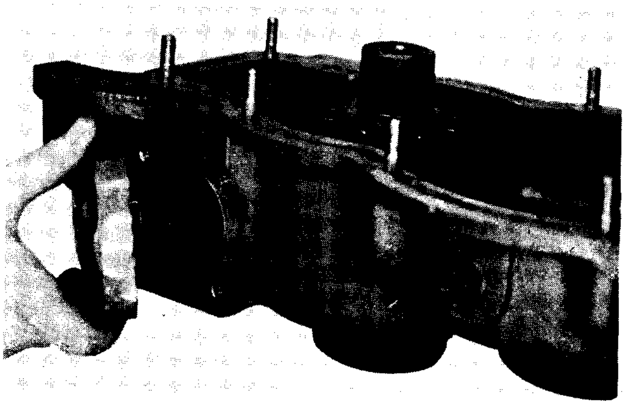
Illust. 12



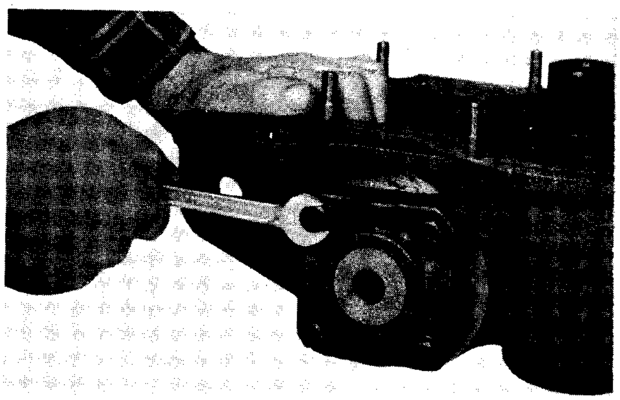
Illust. 13

Press or drive rolled pin into bearing cap (Illust. 13). NOTE: Apply white lead to "O" ring to prevent damaging.

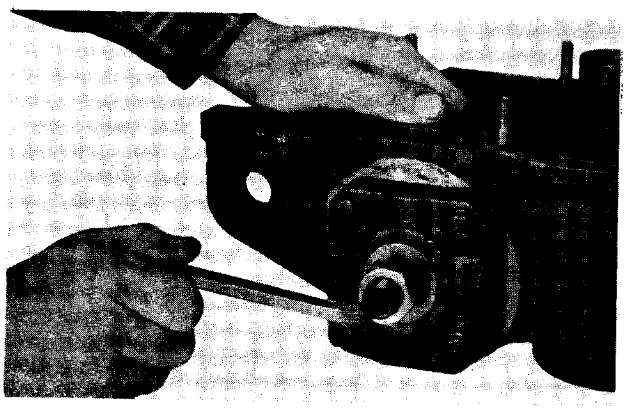
Install bearing cap onto housing (Illust. 14). Rolled pin to fit into bore of thrust bearing. NOTE: No gasket is required between bearing cap and housing.



Illust. 14



Illust. 15



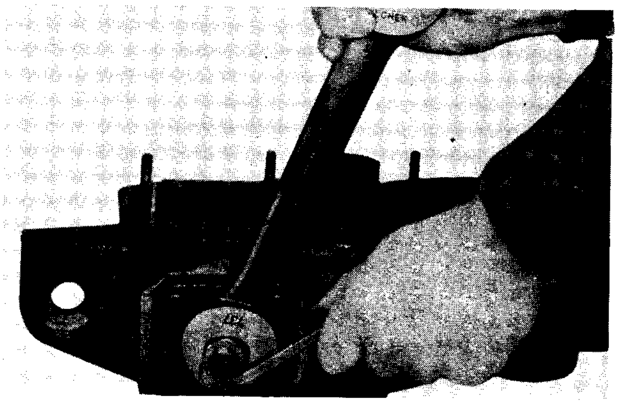
Illust. 16

Install and tighten cap screw with lock washers securely (Illust. 15).

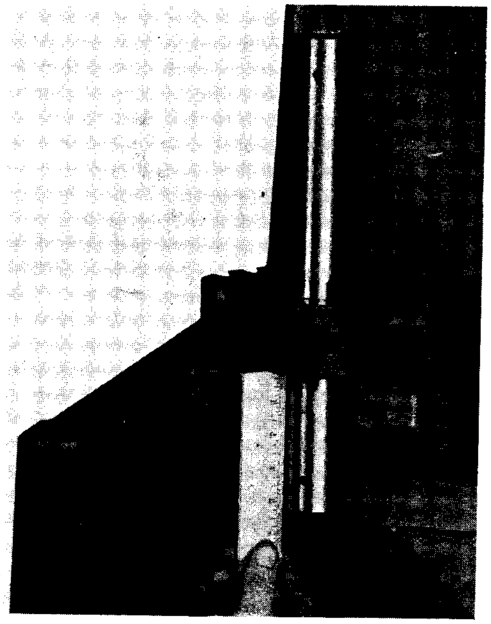
Install adjusting set screw and jam nut (Illust. 16), but do not tighten.

To adjust worm thrust bearing, tighten hex socket head set screw until a perceptible drag is obtained, then loosen set screw until drag is eliminated. Hold this position and tighten jam nut securely (Illust. 17).

Press or drive key in keyway of tilting shaft. Next, align key in shaft with keyway in half gear. Press shaft through gear until shaft extends out of gear 4-5/16 inches from hub of gear (Illust. 18).



Illust. 17



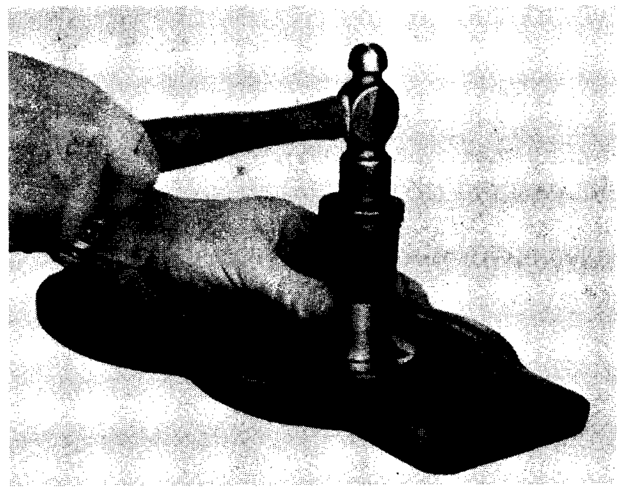
Illust. 18

Insert half gear and shaft into housing (Illust. 19). Tooth in worm gear and pinion to center in half gear.

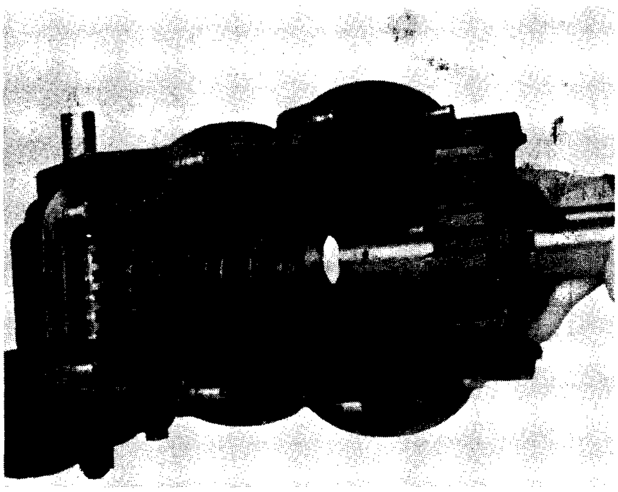
Press or drive bushings into bore of gear housing cover (Illusts. 20 and 21). Bushings to be flush with surface of bore.

Drive dowel pins into cover (Illust. 22). Do not drive dowel pins through cover.

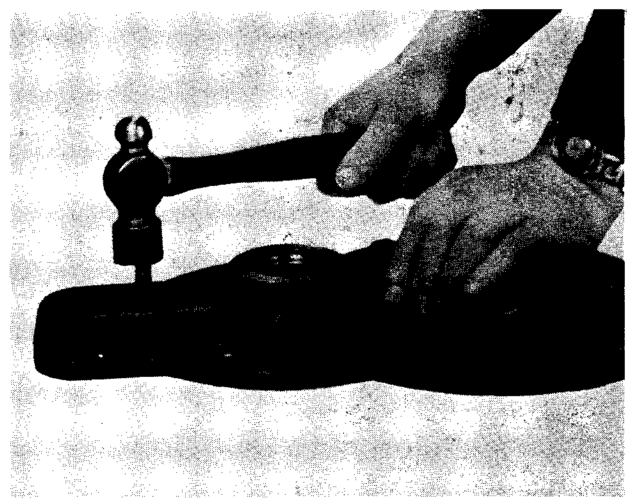
Shellac gasket to gear housing and install cover. Drive dowel pins into housing (Illust. 23). Dowel pins to be flush with outside face of cover.



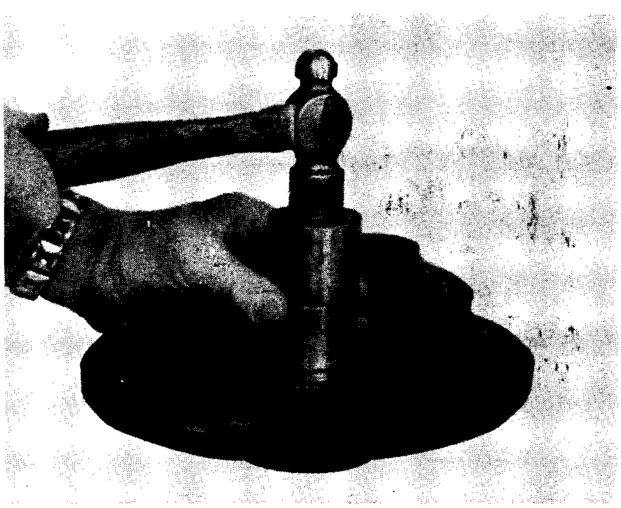
Illust. 21



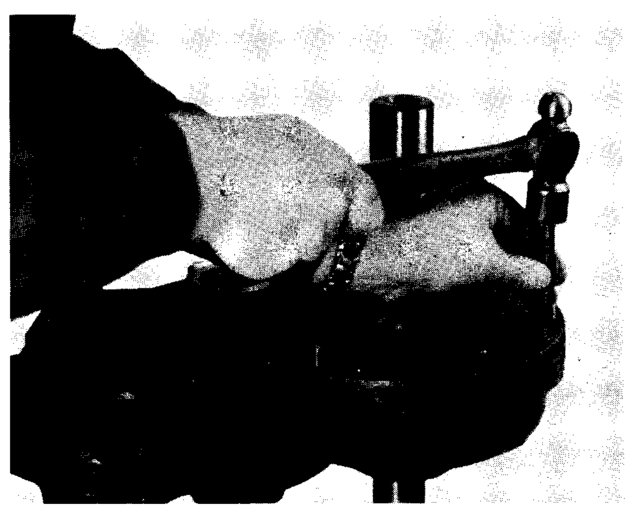
Illust. 19



Illust. 22



Illust. 20



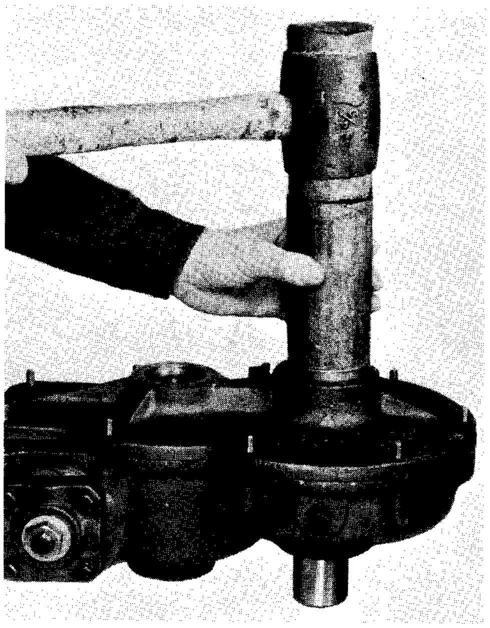
Illust. 23

Press or drive oil seal into cover (Illust. 24). Lip of seal toward inside of housing. NOTE: To start oil seal over end of shaft, use a piece of thin shim stock or tool. This will prevent damage to seal leather.

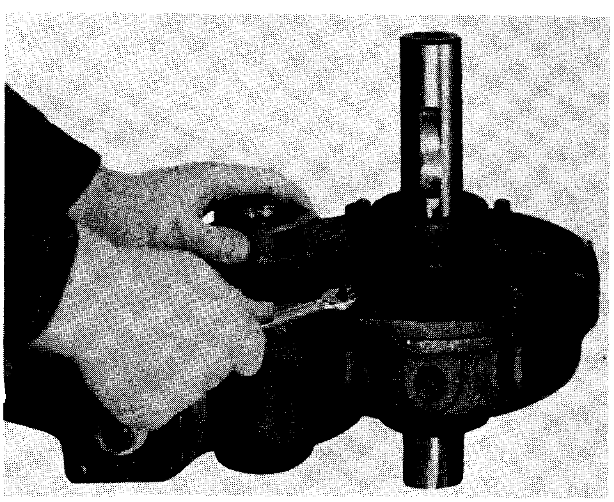
Install stud nuts and lock washers. Tighten nuts securely (Illust. 25).

Install welsh plug into bore of cover. To set welsh plug, use a hammer. Strike concave of plug until flush with outside edge of plug (Illust. 26).

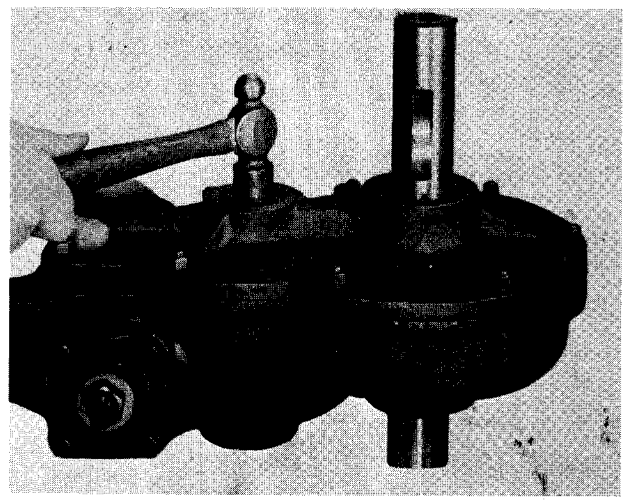
Press or drive oil seal into housing (Illust. 27). Lip of seal toward inside of housing. NOTE: To start oil seal over end of shaft, use a piece of thin shim stock or tool. This will prevent damage to seal leather.



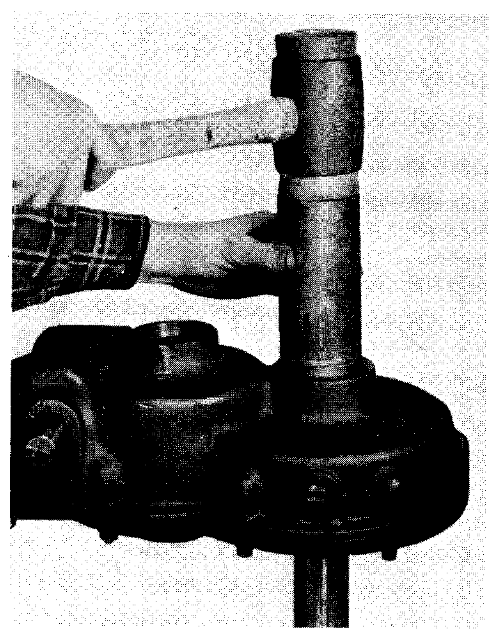
Illust. 24



Illust. 25



Illust. 26

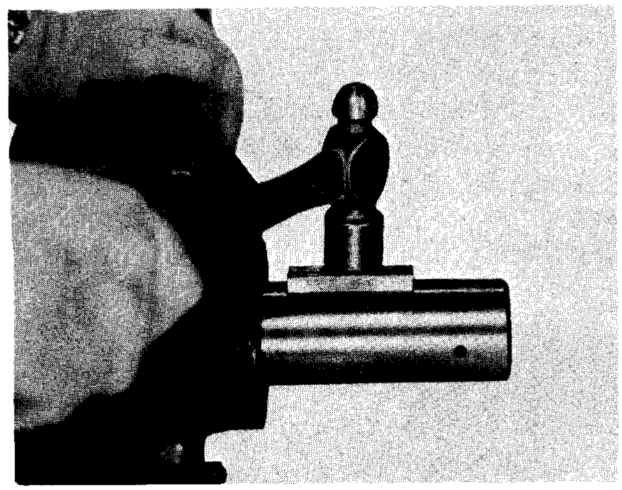


Illust. 27

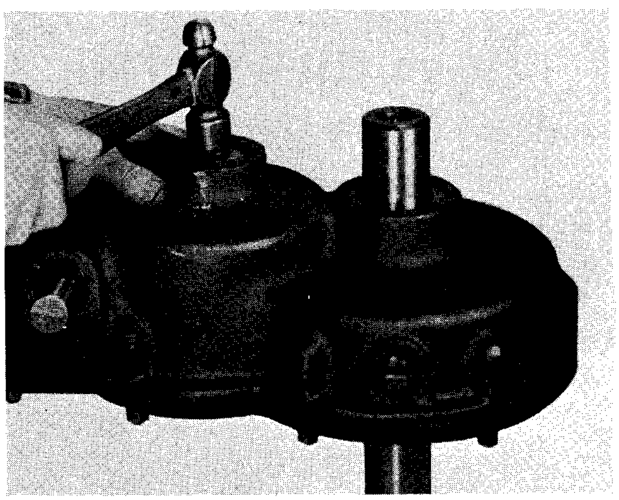
Install welsh plug into bore of housing. To set welsh plug, use a hammer. Strike concave of plug until flush with outside edge of plug (Illust. 28).

Press or drive oil seal into top bore of housing (Illust. 29). Lip of seal toward inside of housing. NOTE: To start oil seal over end of shaft, use a piece of thin shim stock or tool. This will prevent damage to seal leather.

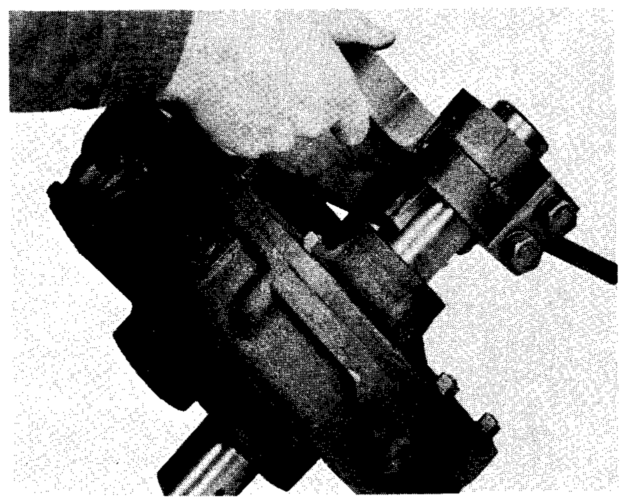
Drive key in keyway of tilting shaft (Illust. 30).



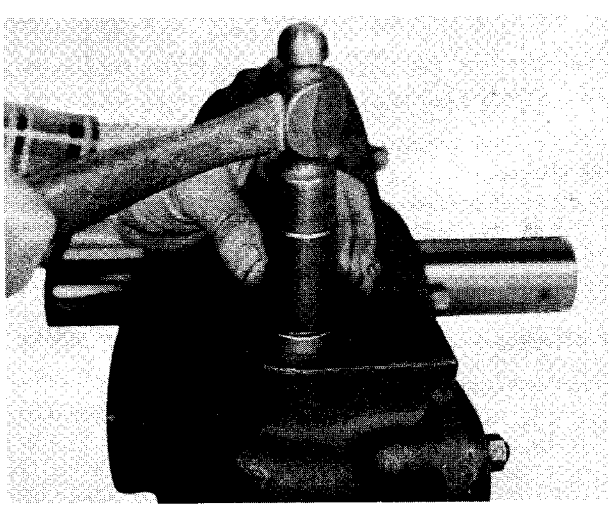
Illust. 30



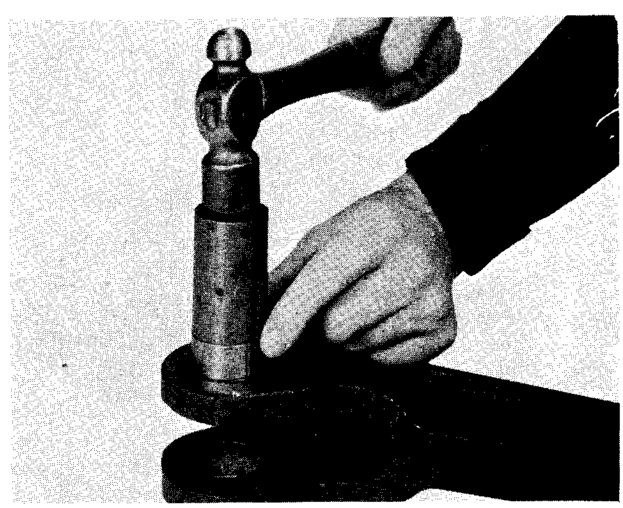
Illust. 28



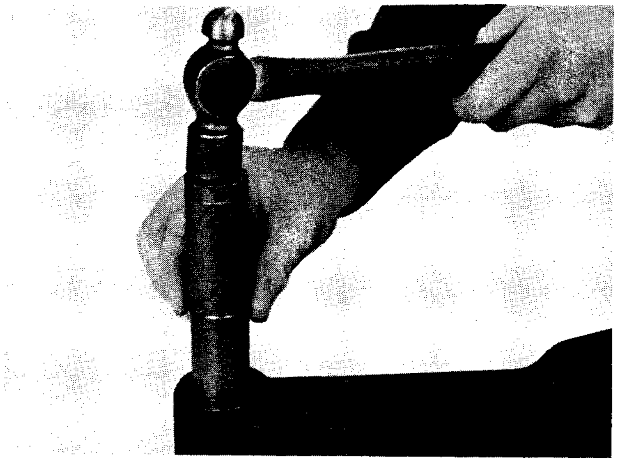
Illust. 31



Illust. 29



Illust. 32

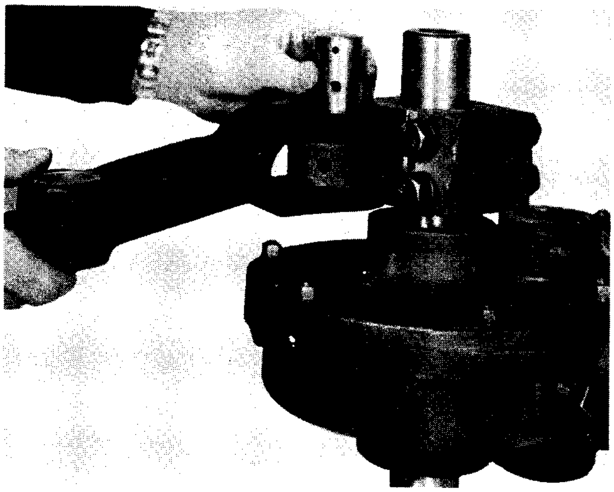


Illust. 33

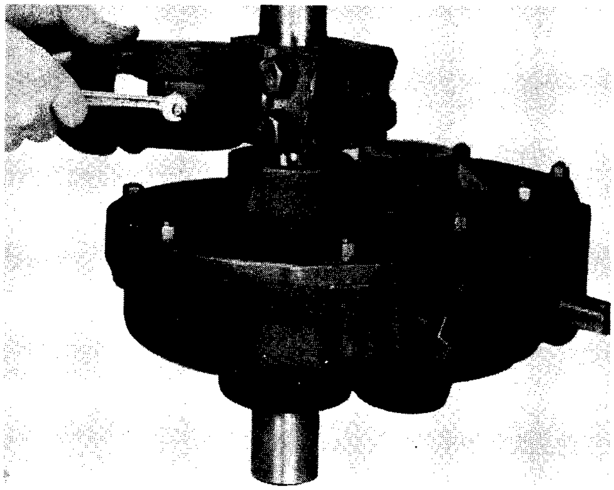
Align keyway in tilting crank with key in shaft, then install crank onto shaft (Illust. 31). Long end of crank toward anchor flange end of housing. NOTE: For easy installation, drive a flat tool into slot of tilt crank. Next, install machine bolts, lockwashers and nuts. Do not tighten nuts.

Press or drive bushings into tilting link (Illusts. 32 and 33).

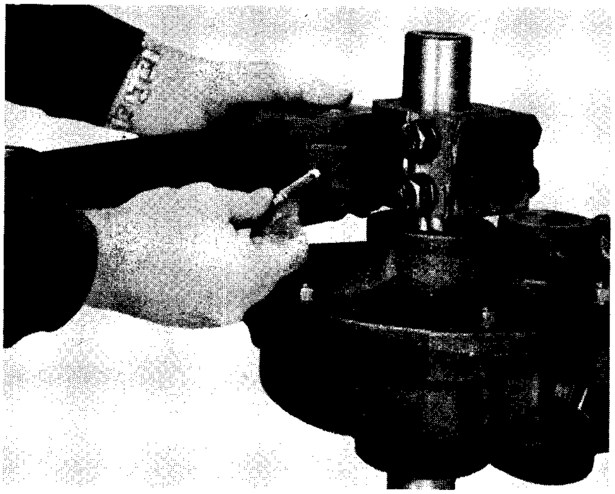
Align tilt link pin bore with bore of tilt crank, then insert tilt link pin (Illust. 34). Threaded bore in pin to align with bore of crank. Insert lubrication fitting (Illust. 35) and tighten securely (Illust. 36).



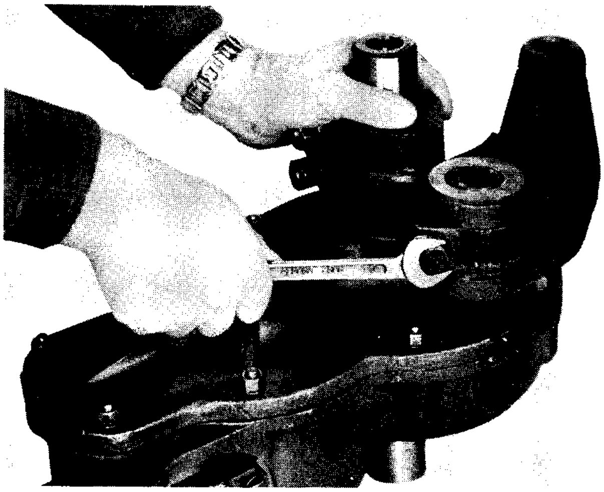
Illust. 34



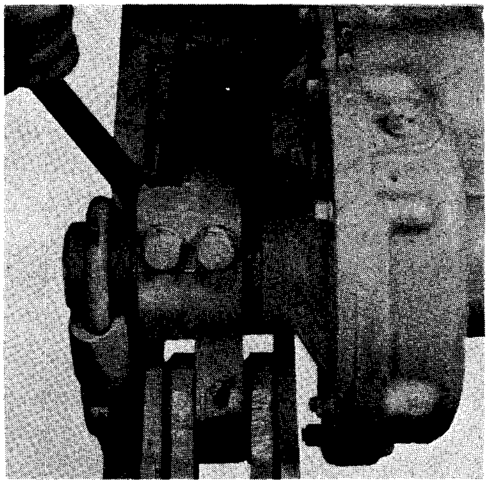
Illust. 36



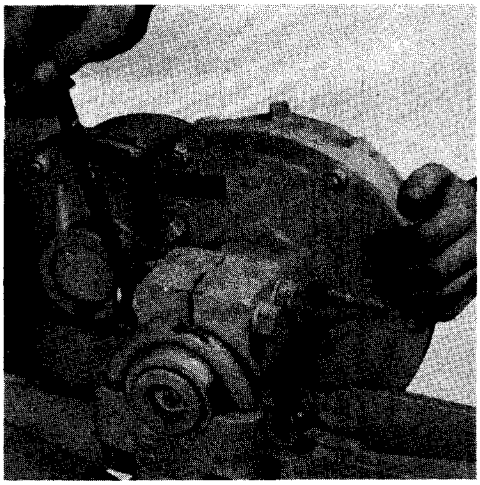
Illust. 35



Illust. 37



Illust. 38



Illust. 39

Install and tighten tilt crank cap screw (Illust. 37).

To install assembly to front axle, reverse "Removal" procedure.

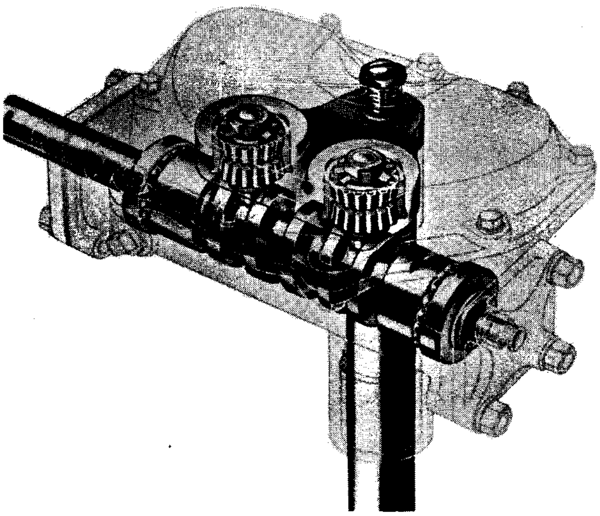
When housing has been installed to front axle, use a pry bar to center tilt link between vibrating bars (Illust. 38).

IMPORTANT: At no time should the tilt link rub vibrating bars.

After the tilt link has been centered, remove the flat tool from tilt crank slot and tighten machine bolts securely (Illust. 39).

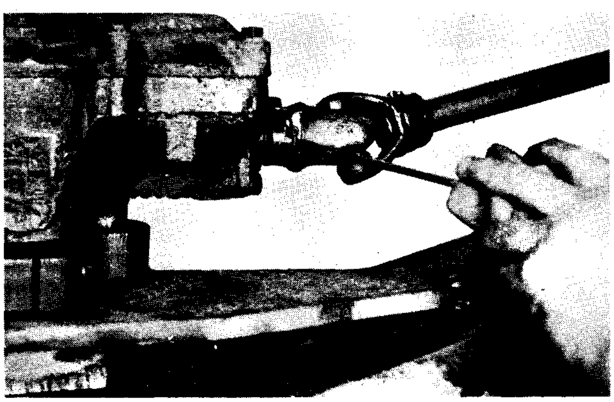
See "Lubricating Instructions" for correct lubrication of housing.

STEERING



Illust. 1

Illust. 2

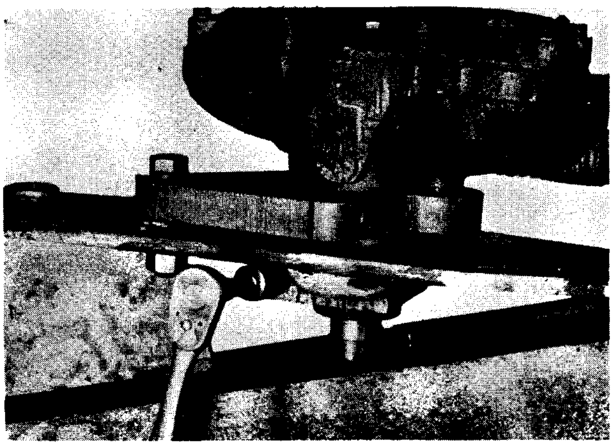


Illust. 3

MANUAL STEERING

Illust. 1 is a phantom view of the manual steering gear assembly. This view shows all of the important parts and their relationship to each other.

All minor repairs and adjustments to the steering gear can be made without removing it from the grader.



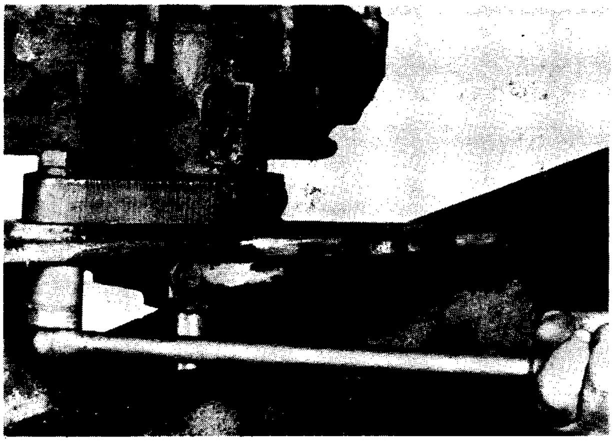
Illust. 4

REMOVAL

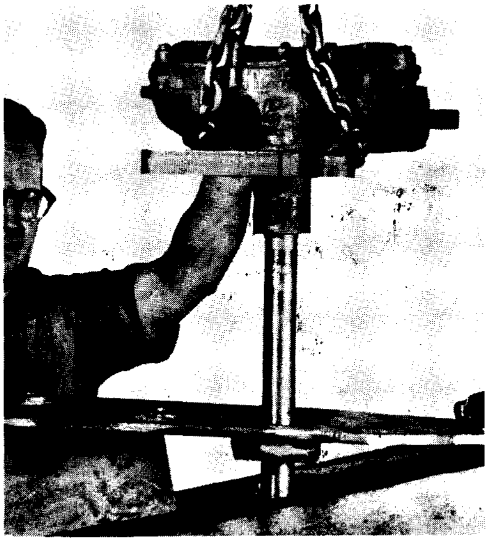
The first step in the removal procedure is to remove nut and lockwasher from end of shaft (Illust. 2). Next drive arm from serrations of shaft. IMPORTANT: When driving the arm from shaft, the end of shaft must be supported or serious damage to the steering gear will result. Use light hammer blows to remove arm.

Remove cotter pin from drilled pin (Illust. 3). Drive drilled pin from universal joint, then remove universal joint from steering cam shaft.

Loosen clamp bolt (Illust. 4) and remove torque plate bolt (Illust. 5).



Illust. 5

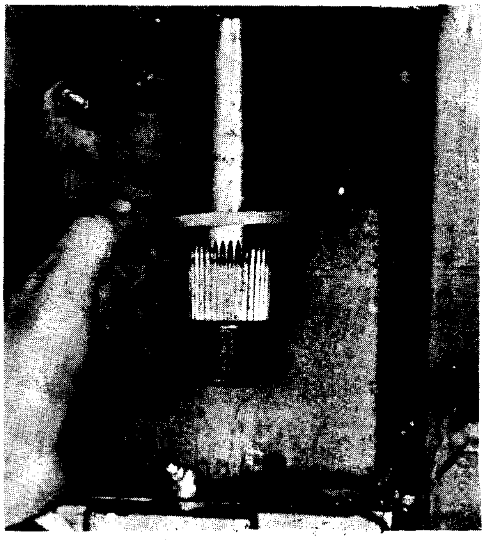


Illust. 6

Using a chain hoist, raise steering housing assembly (Illust. 6) from bolster until rubber washer can be removed from steering shaft (Illust. 7), then remove steering assembly from frame.

Should it become necessary to disassemble the steering housing, reverse the reassembly procedure.

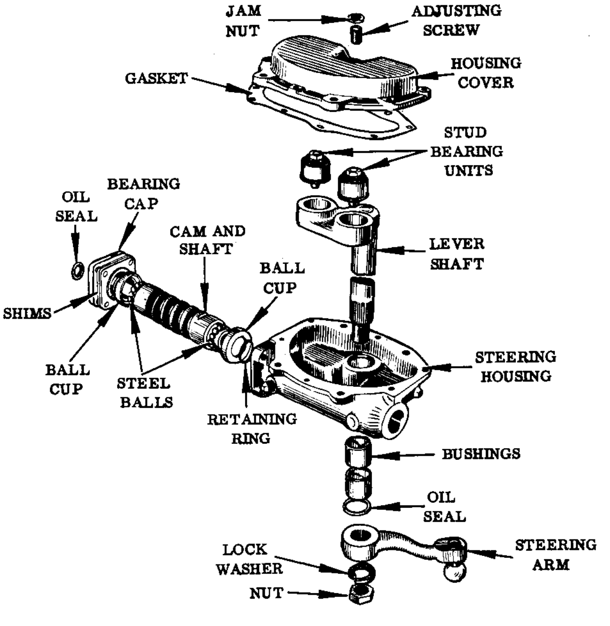
Inspect all parts of the assembly for wear and damage. Replace defective parts. Apply oil to parts before installation.



Illust. 7

REASSEMBLY

Illust. 1 is an exploded view of the steering housing assembly. Press or drive bushing into bore of steering housing (Illust. 2) until bushing is approximately 1/8 inch under flush with top of bore. NOTE: Use a pilot tool for pressing or driving bushing into place. This will prevent bushing from becoming out of round.



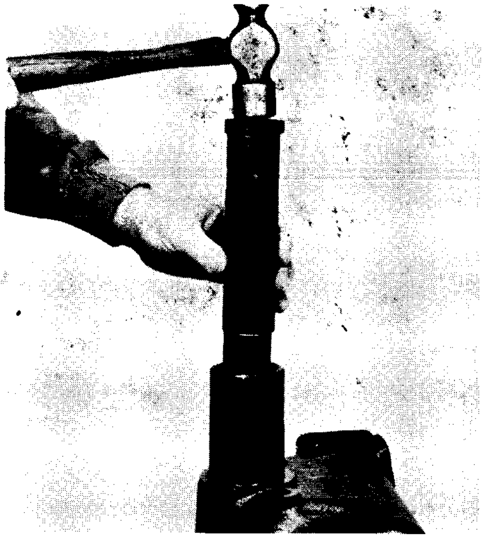
Illust. 1

Illust. 2

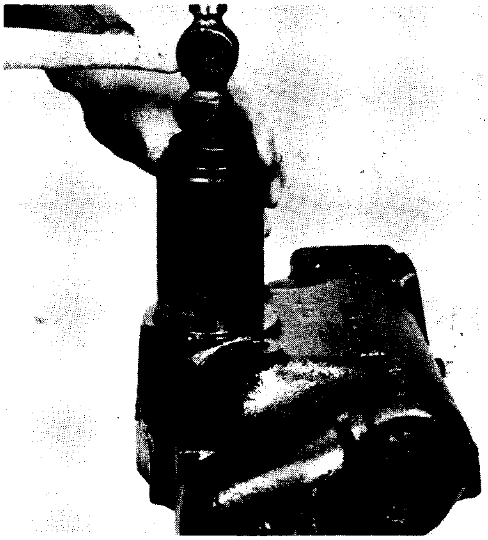
Illust. 3

Install welsh plug into bore of steering housing. Welsh plug to fit against shoulder of housing. NOTE: Apply a sealing compound around edge of plug.

To set or expand welsh plug in housing use a piece of steel bar the same diameter as bore. Place flat surface of bar against concave of welsh plug. Strike bar with a hammer (Illust. 3) until concave is flush with outside edge of welsh plug.



Illust. 4



Illust. 5

Turn steering housing over and press or drive second bushing into bore of housing (Illust. 4) until bushing is approximately 1/8 inch under flush with top of bore. NOTE: Use a pilot tool for pressing or driving bushing into place. This will prevent bushing from becoming out of round.

Press or drive oil seal into bore of steering housing (Illust. 5). Lip of seal toward bushing.

CAM AND SHAFT

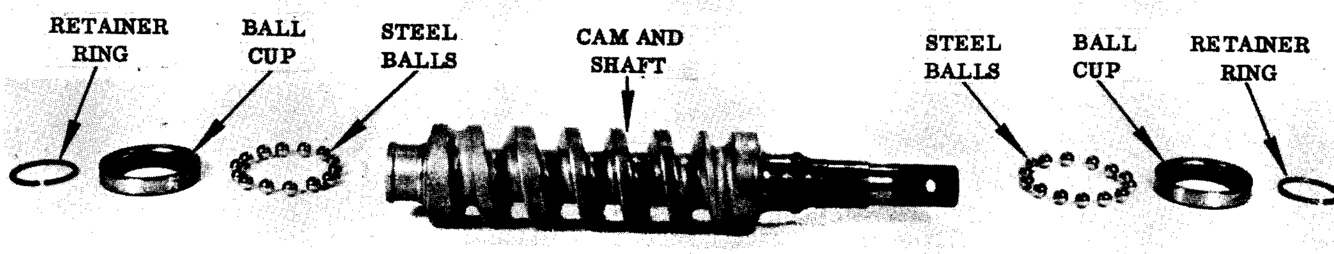
Illust. 1 is an exploded view of the cam and shaft assembly.

Install ball cup onto cam and shaft. Smooth side of cup toward long end of shaft. Install long end of cam and shaft into a vice with brass jaw protectors. Allow enough space between cup and cam to insert the 14 balls.

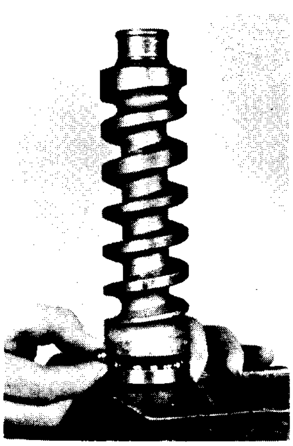
Insert 14 balls into cup (Illust. 2). NOTE: Apply grease to cup and balls to hold balls in place.

Remove cam and shaft from vice. Install retainer ring in groove of cam and shaft (Illust. 3).

Install second bearing cups onto cam and shaft. Smooth side of cup towards short end of shaft. Allow enough space between cup and shaft to insert the 14 balls.

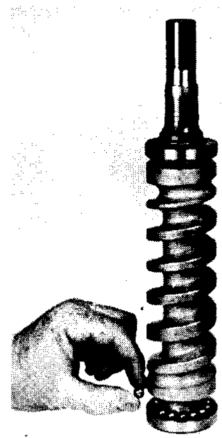


Illust. 1



Illust. 2

Illust. 3

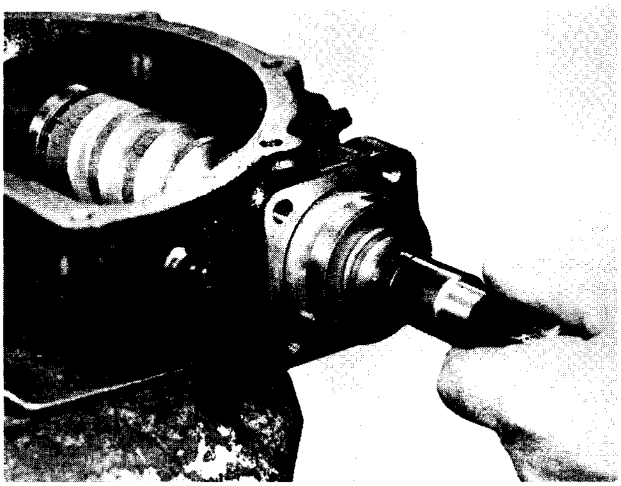


Illust. 4

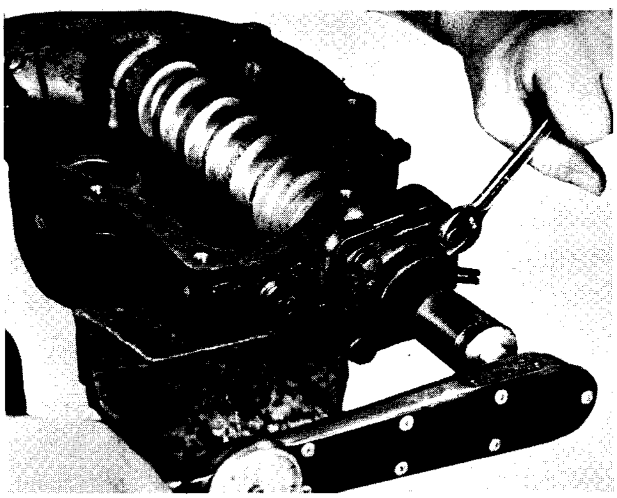
Illust. 5

Insert 14 balls into cup (Illust. 4). NOTE: Apply grease to cup and balls to hold balls in place.

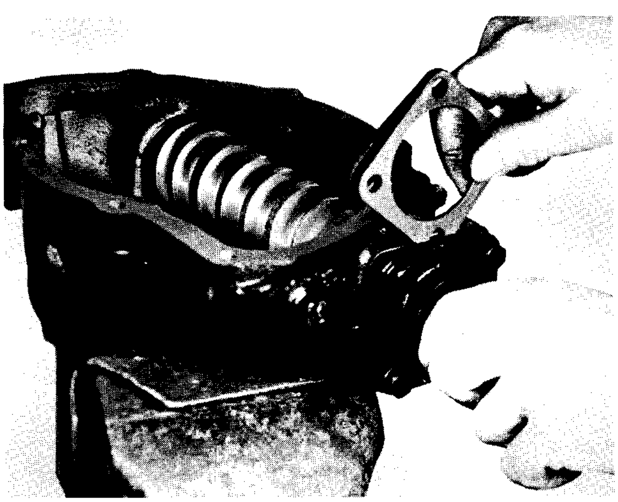
Install snap ring in groove of cam and shaft (Illust. 5).



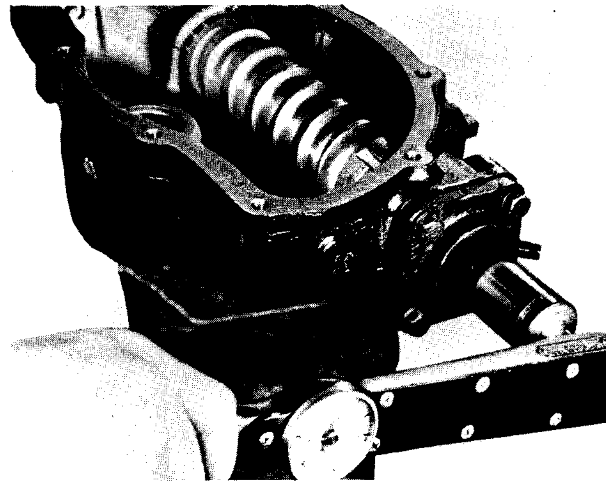
Illust. 6



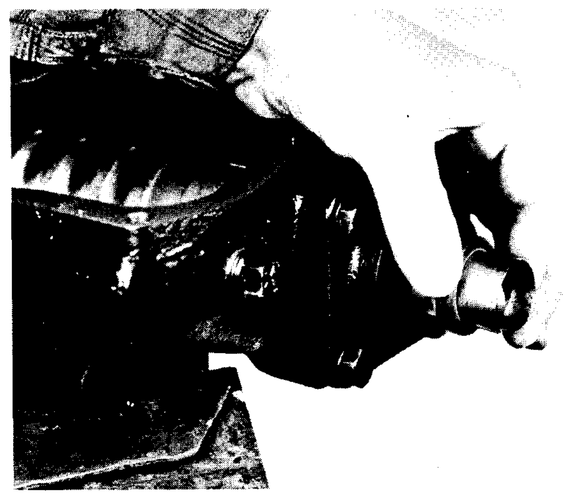
Illust. 7



Illust. 8



Illust. 9

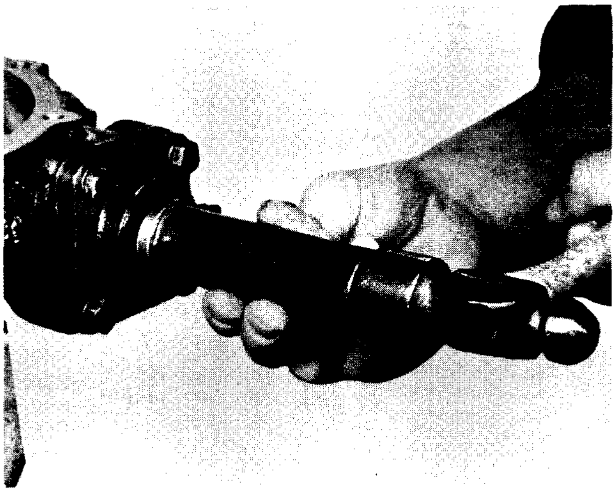


Illust. 10

Install cam and shaft into housing (Illust. 6).

To pre-load the bearings, install bearing cap less shims. Install cap screws. Tighten cap screws (Illust. 7) until a torque reading of 20 inch pounds is obtained. NOTE: Rotate shaft while tightening cap screws.

Measure gap between bearing cap and housing, using shims or feeler gauge (Illust. 8).



Illust. 11

Remove bearing cap and install the required amount of shims to fill gap. Install bearing cap with shims onto housing. Install cap screws with lock washers. Tighten cap screws securely. Recheck bearing pre-load (Illust. 9).

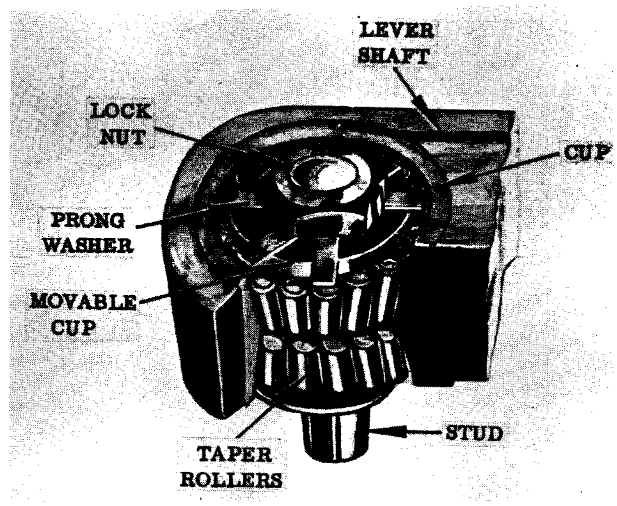
Install oil seal onto shaft, using a piece of shim stock over shaft to prevent damage to seal (Illust. 10). Lip of seal towards inside of bearing cap. When oil seal is on shaft, remove shim stock and drive seal into bearing cap (Illust. 11).

STUD ROLLER BEARING UNITS

Illust. 1 is a cut away view of the stud roller bearing unit.

To remove either stud roller bearing unit from lever shaft, use a piece of pipe the same diameter as bearing cup. Press or drive unit from shaft (Illust. 2). NOTE: When removing stud bearing unit from lever shaft, be sure lever shaft is in a downward position as illustrated.

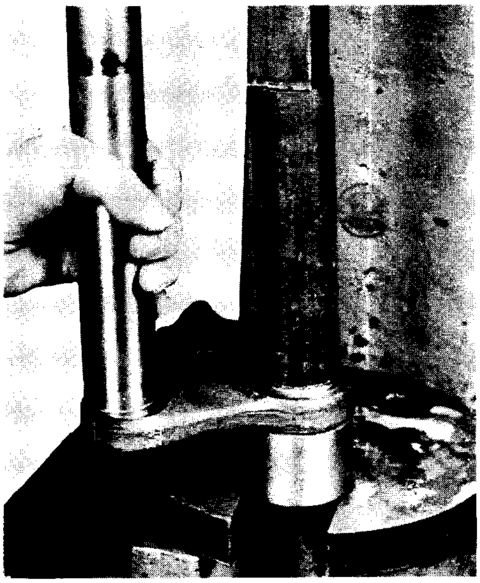
Press or drive stud bearing unit into lever shaft (Illust. 3), until shoulder of unit is flush against lever shaft.



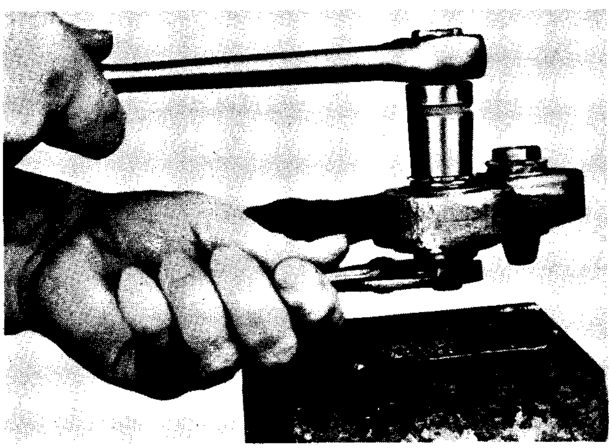
Illust. 1

Illust. 2

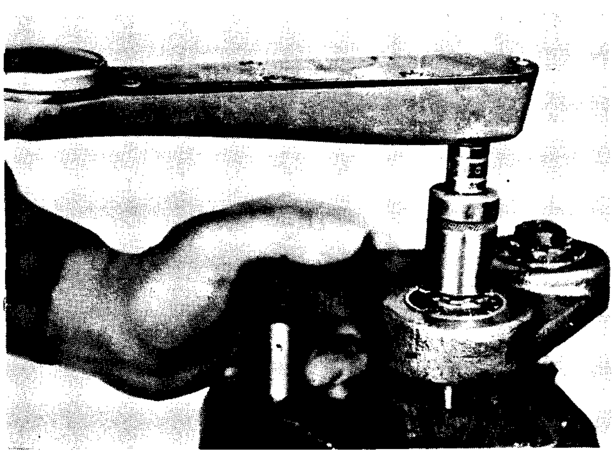
To pre-load the bearings, clamp stud with a pair of pliers using care not to burr or nick stud. Tighten nut (Illust. 4) until a noticeable drag is obtained. Rotate unit, using a torque wrench (Illust. 5). Torque reading should be minimum three inch pounds, never below. If reading is below three inch pounds, tighten nut still tighter. NOTE: Pre-load both stud roller bearing units exactly the same.



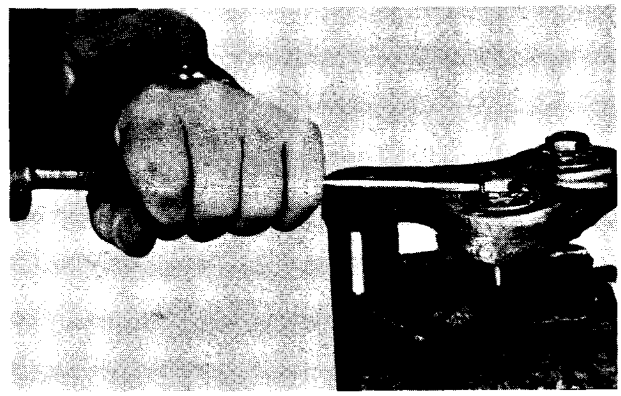
Illust. 3



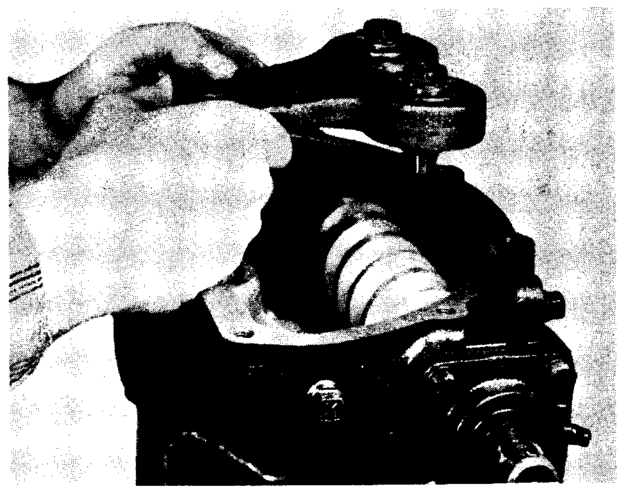
Illust. 4



Illust. 5



Illust. 6



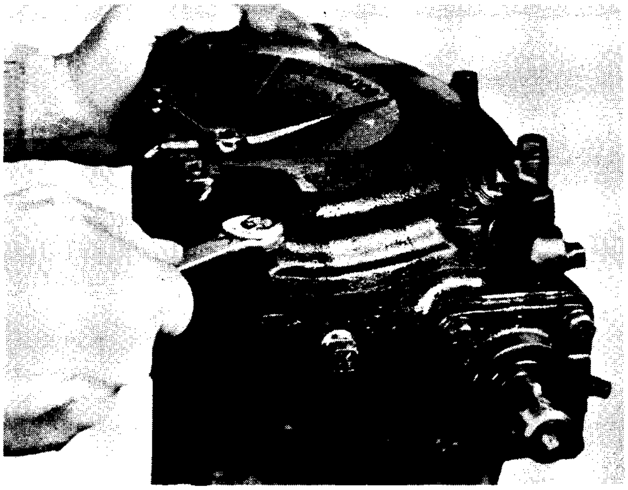
Illust. 7

Lock the nut by bending a prong of washer against a side of the nut (Illust. 6). NOTE: Bend a prong that is at right angles to a side of the nut. If old pronged washer is used, break off bent prong to prevent reusing.

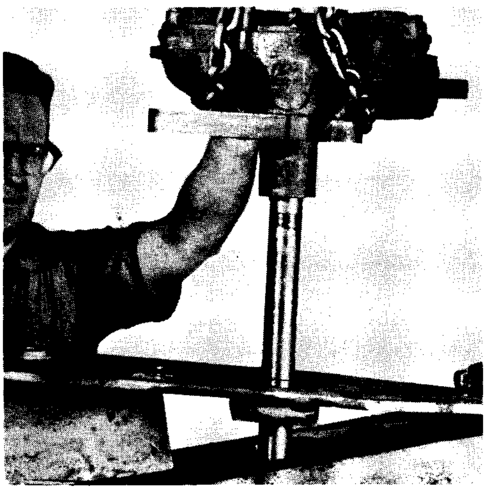
Install lever shaft into steering housing (Illust. 7). IMPORTANT: Center the shaft with stud bearing units in cam between lever stops in housing.

Install steering housing cover and gasket. Install cap screws with lock washers. Tighten cap screws securely (Illust. 8).

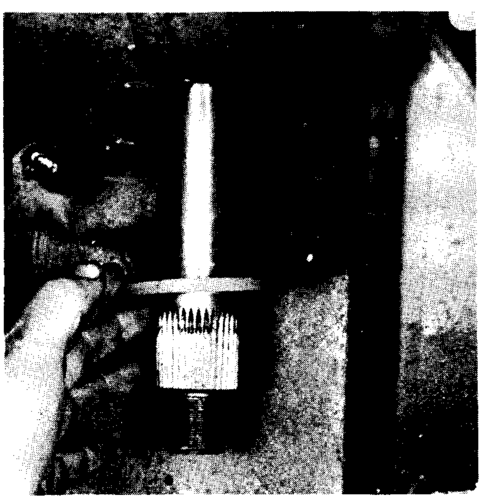
Install steering housing assembly into frame (Illust. 9).



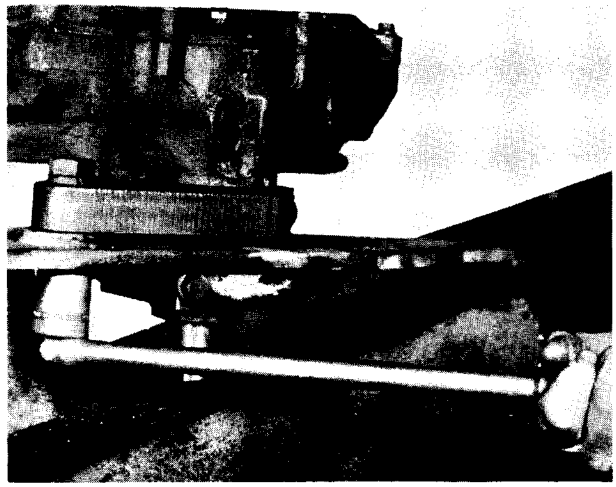
Illust. 8



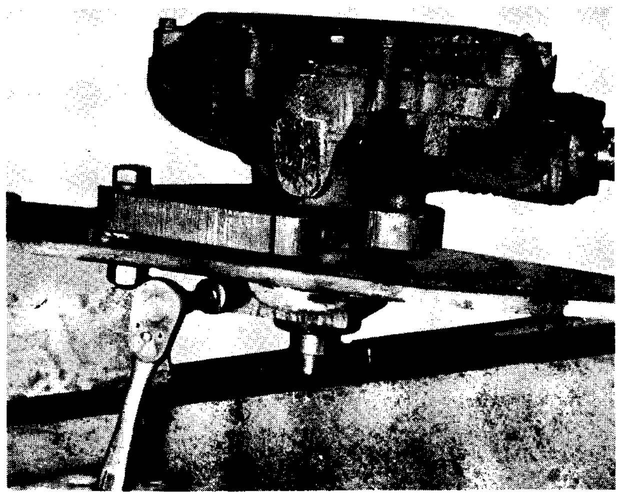
Illust. 9



Illust. 10



Illust. 11

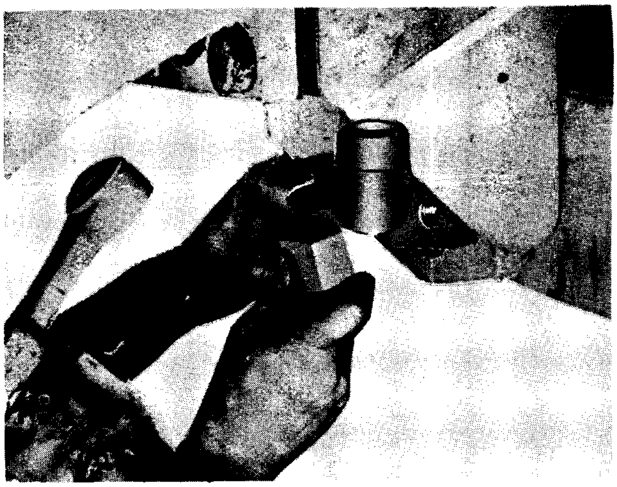


Illust. 12

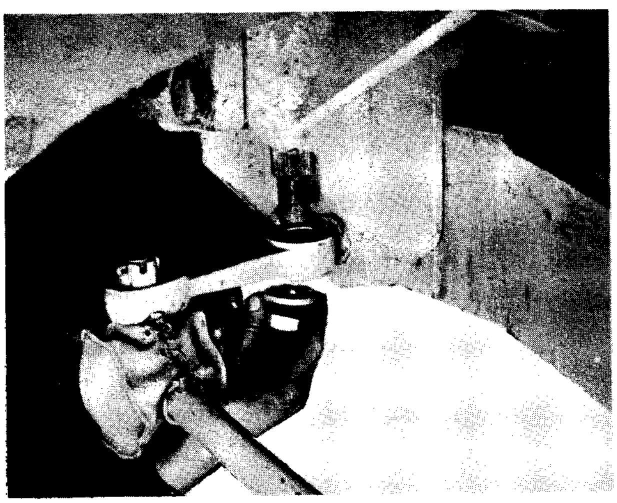
Lower steering housing through frame until end of shaft is well extended through bottom of frame, then install rubber washer.

(Illust. 10). Continue to lower steering housing until housing rests on bolster. Install torque plate bolt, lockwashers and nut. Tighten nut securely (Illust. 11). Next, tighten steering gear clamp bolt securely (Illust. 12).

It is not necessary to remove the self-aligning bearing (Illust. 13) when removing the steering gear. However,



Illust. 13



Illust. 14

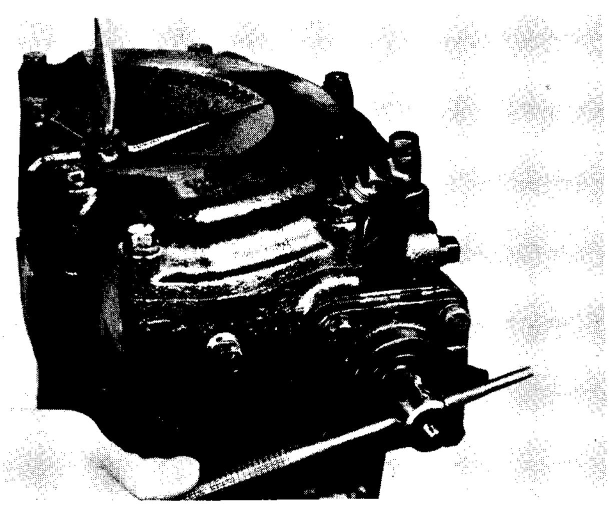
if it is removed for any reason, be sure to reinstall the bearing with the longest end turned up. Install the grease fitting before tightening the cap screws in the bearing cap. The two lower cap screws in the drawbar bearing hold the self-aligning bearing in position.

Install steering arm onto lever shaft (Illust. 14). IMPORTANT: Be sure to install steering arm onto shaft parallel with the center line of main frame.

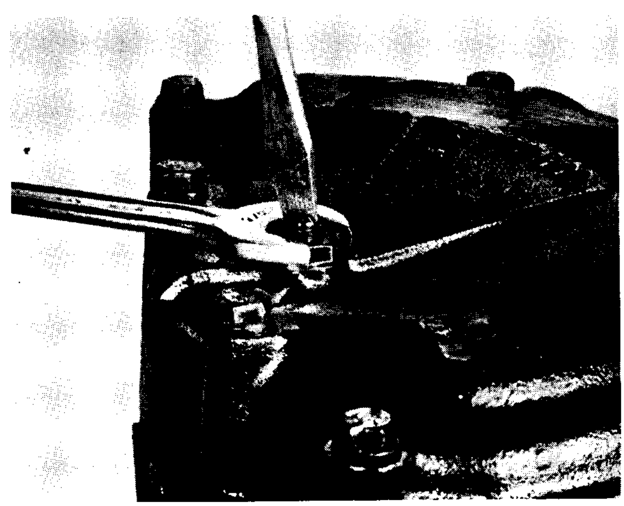
To adjust backlash between stud bearing units and cam, tighten set screw while at the same time slightly turn shaft clockwise and counterclockwise until a slight drag is obtained (Illust. 15). Tighten set screw jam nut securely (Illust. 16).

Align pin hole in universal joint with pin hole in cam shaft and install onto cam shaft. Install pin and cotter pin. Spread cotter pin (Illust. 17).

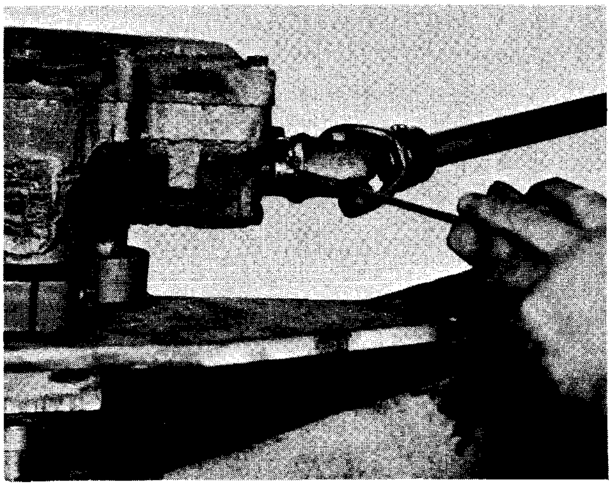
Should it become necessary to remove steering arm for repair, be sure be-



Illust. 15



Illust. 16



Illust. 17

fore, installing arm, center lever shaft in housing.

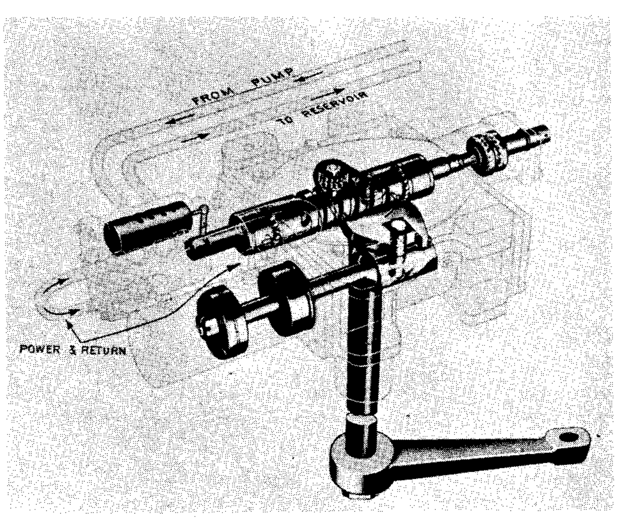
To center lever shaft in housing, count the number of turns required to turn the steering wheel from one extreme to the other. Turn steering wheel in the opposite direction one half the total number of turns. Install arm to lever shaft parallel with the center line of the main frame.

IMPORTANT: Be sure to fill manual steering housing with the correct lubricant. See "Lubricating Instructions"

POWER STEERING

STEERING GEAR

The power steering removal and assembly procedure described here refers to Model 330 motor graders Serial Nos. 1 thru 1641 except Serial Nos. 1606, 1609, 1627, 1630 and 1636. Model 440 motor graders Serial Nos. 1 thru 2705 except 2622 and 2652.



Illust. 1

Illust. 1 is a phantom view of the power steering gear assembly. This view shows all of the important parts and their relationship to each other.

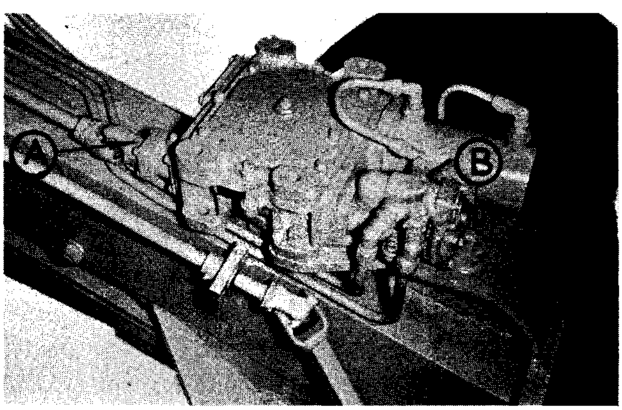
All minor repairs and adjustments to the steering gear can be made without removing it from the grader.

REMOVAL

(Illust. 2). Remove nut, lock washers and arm from end of shaft. IMPORTANT: When driving arm from shaft, the end of shaft must be supported or serious damage to the steering gear will result. Use light hammer blows to remove the arm.

Remove pin "A" in universal joint (Illust. 3) and slide universal joint off shaft. Disconnect all hydraulic lines leading to steering gear. CAUTION: Extreme care must be used to keep all dirt and foreign material out of steering assembly, connections and internal parts. This will cause possible serious damage to the operation of the assembly. Plug all openings, both in the hydraulic lines which are disconnected and fittings in steering gear assembly. Remove torque bolt "B", then remove complete steering gear from grader.

Illust. 2

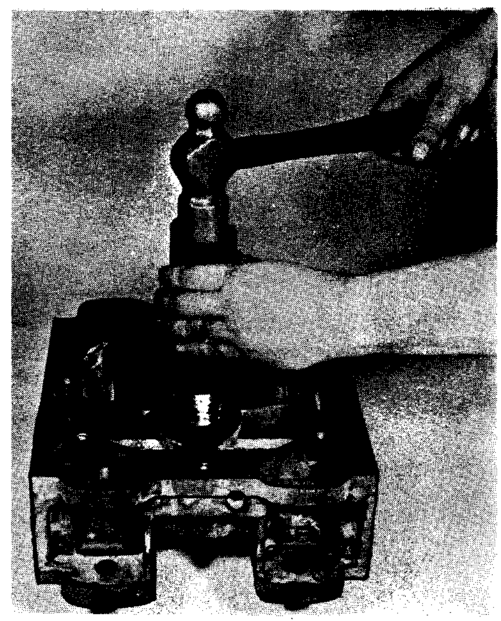


Illust. 3

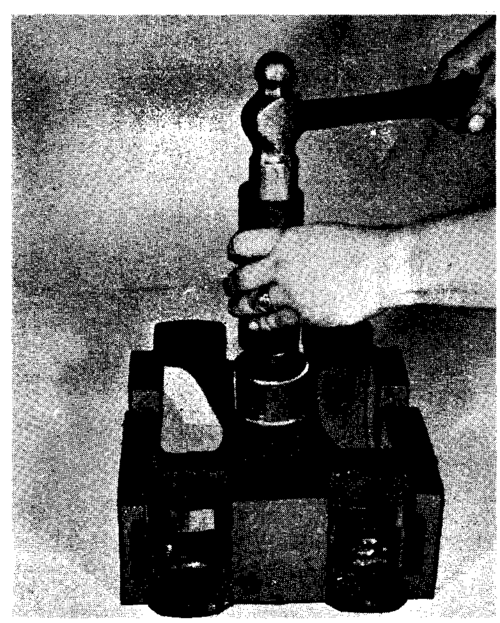
REASSEMBLY

The first step in reassembly is to install bushing into top of gear housing (Illust. 4). When driving bushing into place, use a piece of pipe or similar driver. Install bushing into the bottom of housing (Illust. 5). The grease seal (Illust. 6) should now be installed.

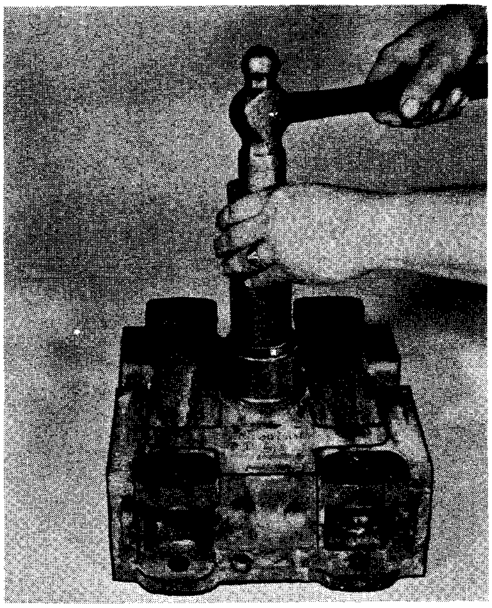
Install cam into gear housing. Assemble first thrust bearing and spring assembly on valve end of cam, small race of thrust bearing against shoulder of cam.



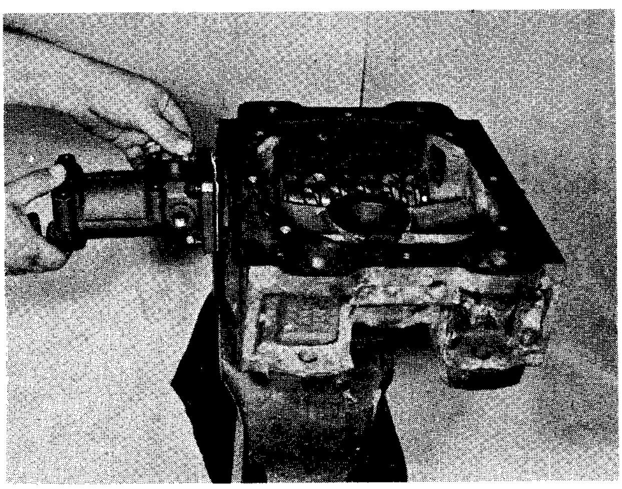
Illust. 4



Illust. 5



Illust. 6

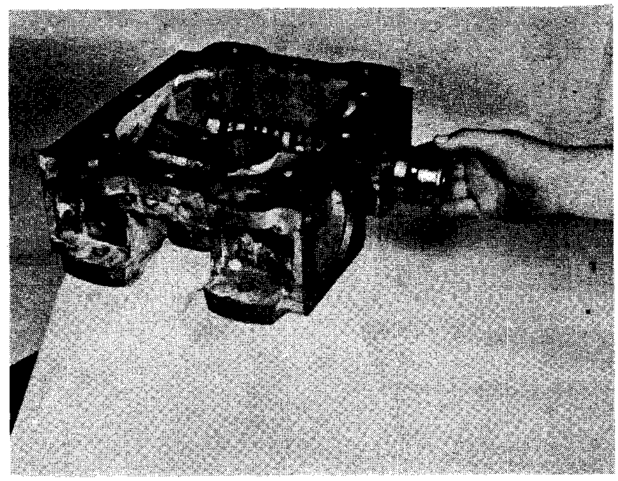


Illust. 7

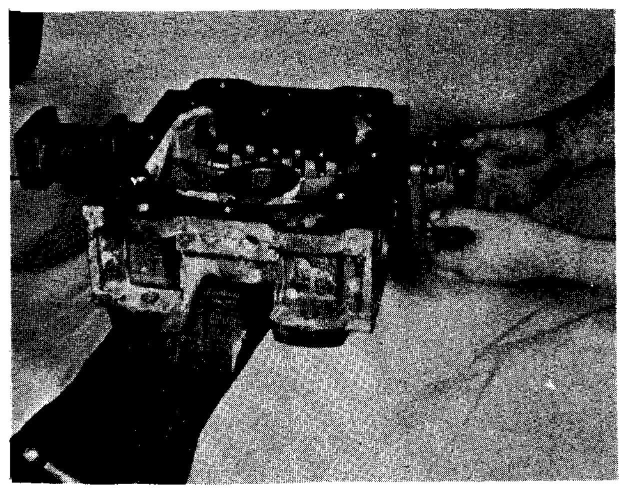
Assemble control housing and vellumoid gasket to housing (Illust. 7). Install cap screws and lock washers and tighten securely.

Assemble second thrust bearing and spring assembly. Install to the other end of cam (the splined end) (Illust. 8).

Install wheel tube bearing housing to gear housing less shims or gaskets.

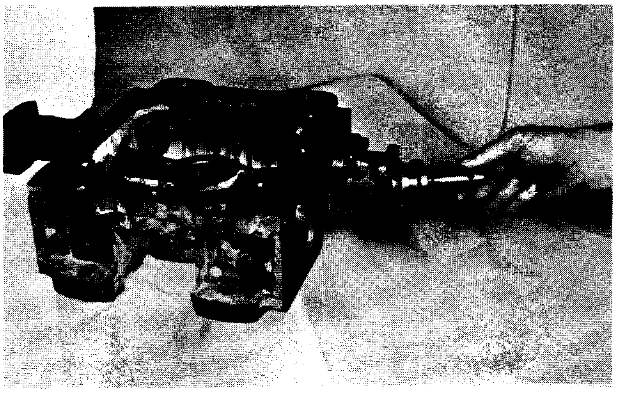


Illust. 8

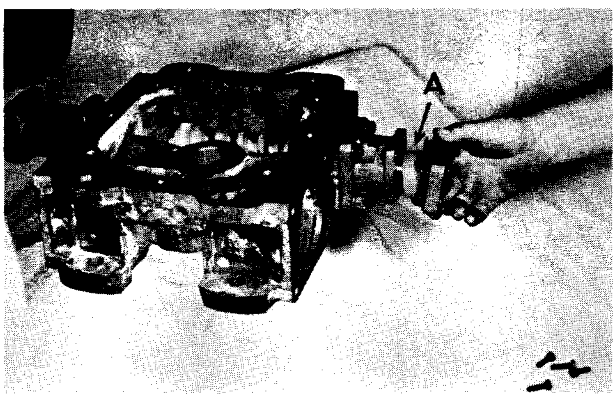


Illust. 9

Measure gap between gear housing and bearing housing with a feeler gauge or shims. This distance will be equal to the amount of shims necessary for proper adjustment. The metal shims are of .002", .003" and .010" thickness. The vellumoid gaskets are of .010" material but are only .006" when compressed. Therefore, they are to be figured at .006" when compressed. Remove the bearing housing and reinstall with the proper amount of shims and gaskets (Illust. 9). In doing this the metal shims are to go between the two vellumoid gaskets.



Illust. 10

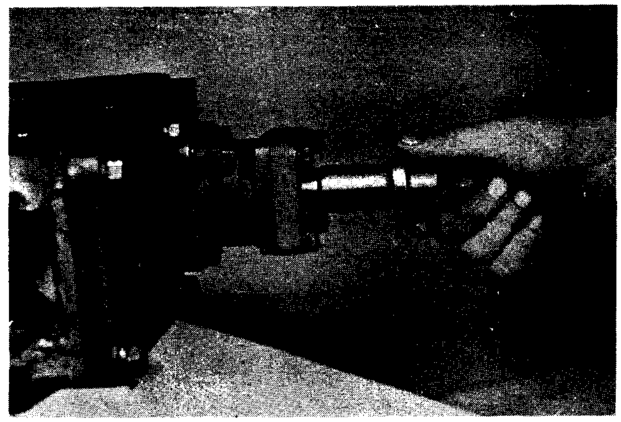


Illust. 11

This will allow the vellumoid gaskets to seat the machine surfaces of the gear housing and bearing housing. Install cap screws and lock washers. Tighten securely.

You should be able to turn the cam freely with your fingers. If cam is hard to turn, not enough shims have been used. If it has end play, too many shims have been used.

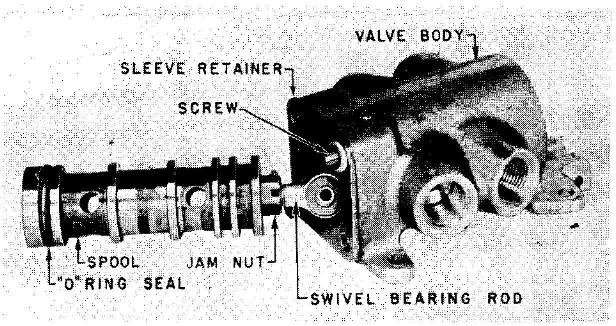
Install bearings to wheel tube and secure them with snap rings (Illust. 10). Coat end of shaft with a light grease and install assembly to splined end of shaft. Install spacer "A" (Illust. 11). Determine the amount of shims necessary to go between bearing housing and end cover by the same procedure as used between gear housing and bearing housing. Install shims and end cover with the metal shims between the vellumoid gaskets. Install lock washers and cap screws and tighten securely. Install grease seal around wheel tube, using care to prevent damaging seal. One way of expanding the leather seal over end of shaft is by wrapping a thin piece of shim stock around shaft in a funnel shape (Illust. 12).



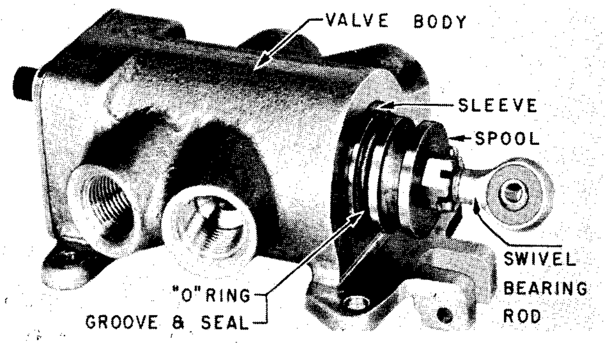
Illust. 12

It should be noted that if either the valve body (Illust. 13), sleeve or spool should require replacement, the entire valve assembly must be replaced. The parts of the valve are not furnished individually for repair. The "O" rings between valve spool and sleeve, swivel rod bearing and nut and the valve spool cover "O" ring are the only internal parts of the valve that can be serviced.

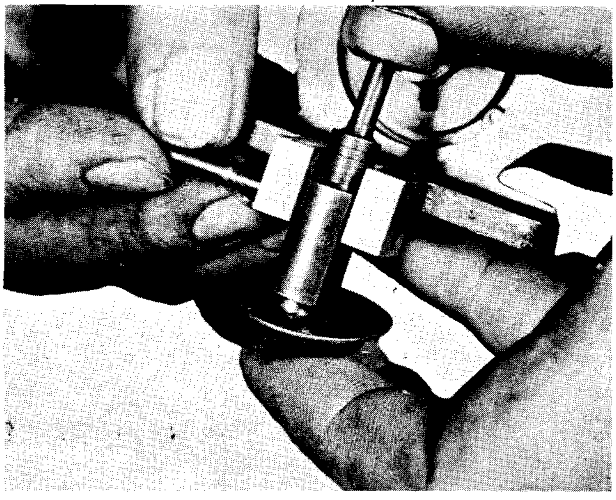
Install "O" ring seal in groove on end of valve spool, opposite swivel bearing rod end (Illust. 13). Push spool through sleeve far enough to uncover second groove in swivel bearing rod end of spool (Illust. 14).



Illust. 13



Illust. 14



Illust. 15

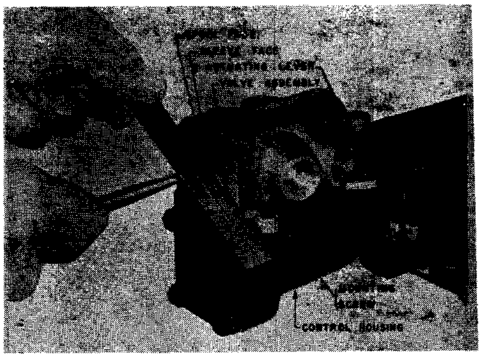
Install "O" ring seal in second groove (Illust. 14) and push this end of spool back into sleeve until "O" ring seal has just entered the sleeve. Install snap ring into first groove in spool and push on spool at the same time, pressing snap ring into groove in valve body. Tighten the two screws holding the sleeve retainer (Illust. 13).

Install swivel bearing rod and jam nut to spool (Illust. 13). Insert actuating lever in swivel bearing, then insert pivotpin through valve body clevis and actuating lever (Illust. 15).

Install the steel washer, then rubber seal over rounded portion of actuating lever (Illust. 15).

Place valve assembly in position on control housing and start the four mounting screws, being sure rounded portion of valve actuating lever fits into its groove in steering gear cam. THIS IS IMPORTANT: If actuating lever has not entered the groove in the steering cam before the mounting screws are tightened, it will result in breaking the swivel bearing rod and lever brackets (Illust. 14). Make sure steel washer is centered over rubber washer (Illust. 15). Tighten mounting screws holding valve body to control housing. With jam nut loose, turn valve spool with screw driver until face of spool is flush with face of sleeve (Illust. 16).

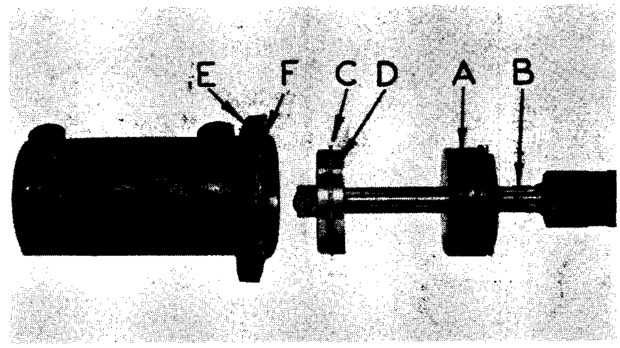
Connect all power steering hydraulic lines and check oil level in power steering supply tank. Start engine and turn steering wheel to right and left several times. This will bleed the air from the hydraulic system and will determine if valve spool is properly adjusted. It may be necessary to change adjustment a little one way or the other to equalize the steering effort. Tighten the jam nut approximately 25 ft. lbs.



Illust. 16

Illust. 17

Illust. 18



Illust. 19

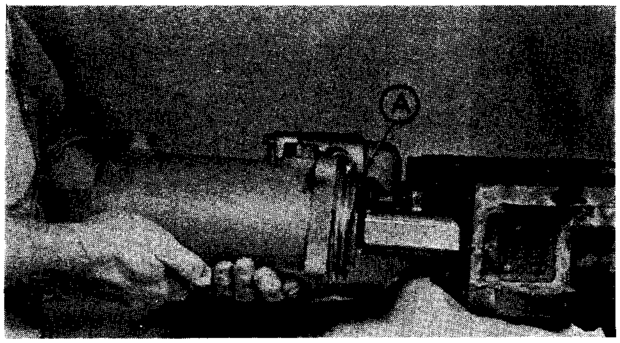
Assemble gasket and dust cover over swivel rod bearing and actuating lever. Install the valve spool cover and "O" ring and secure with Allen head screws and lock washers.

Install rubber seal, vellumoid gasket and steel washer in the order named, into adapter (Illust. 17). Be sure and place seal lip toward inside of adapter. Install snap ring "A" and "O" ring (Illust. 18).

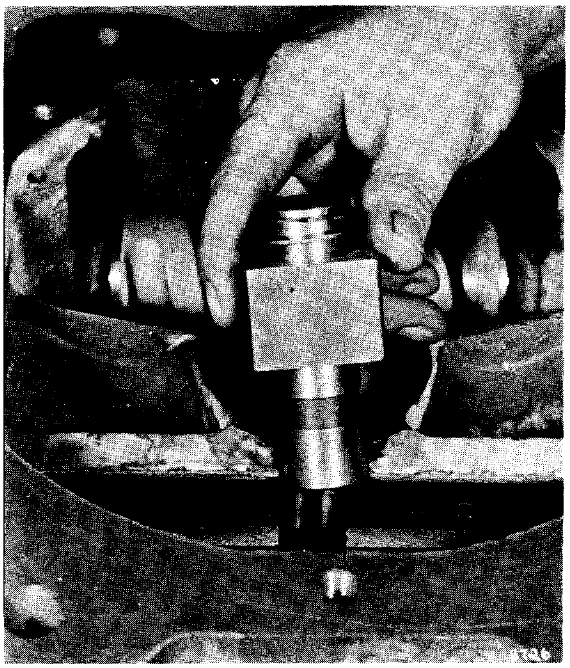
Install adapter "A" (Illust. 19) to slide bar "B" with the end containing seal going on first. Install piston ring "C" to piston "D" and place piston on slide bar. Taper of piston mating with taper of rod. Place washer on threaded end of shaft.

Tighten slotted nut to a torque reading of 200 to 225 foot pounds.

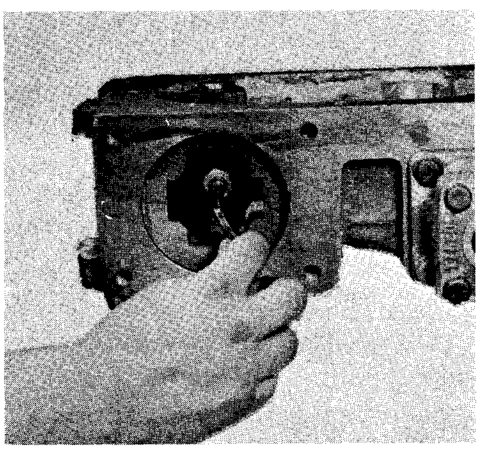
Install cylinder adapter "E" and snap ring "F" to cylinder. Complete the assembly by placing piston and adapter in the cylinder. Use care while installing adapter into cylinder to prevent "O" ring from damage. Slide bar should move freely through cylinder and adapter.



Illust. 20



Illust. 21



Illust. 22

Install gasket "A" then install cylinder assembly to gear housing (Illust. 20). Install hex head cap screws and lock washers and tighten securely.

Install lever block pin, lever block, washer and snap ring (Illust. 21). Install them in slide bar.

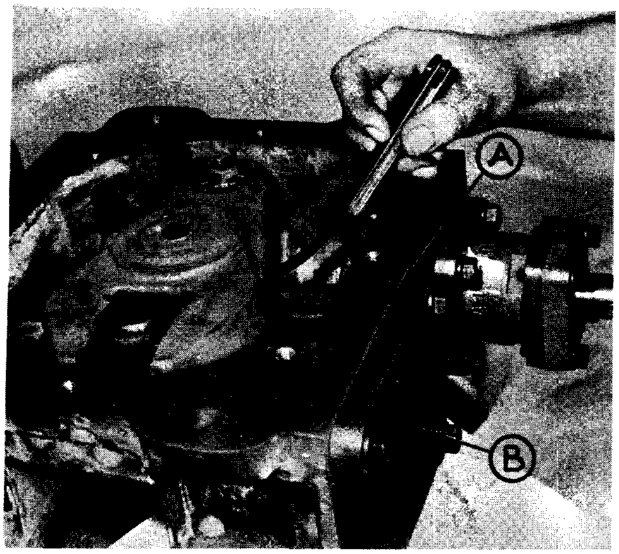
(Illust. 22). Install set screw and lock nut in end of slide bar and tighten securely. Be sure lever block is free to rotate on pin and that slide bar and piston are free to move back and forth in housing and cylinder.

Install gasket "A" and cover "B" (Illust. 23). Install hex head cap screws and lock washers. Tighten securely.

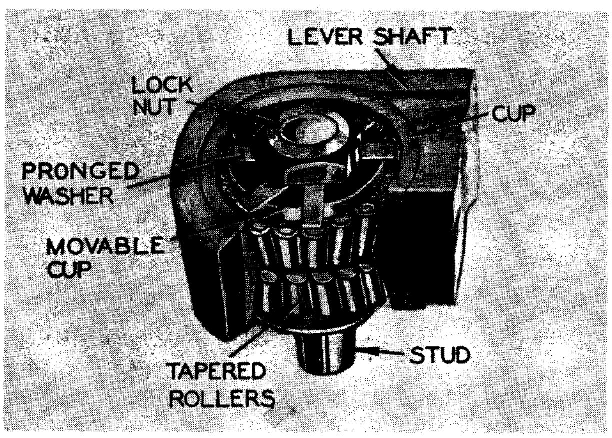
Assemble stud roller bearing unit (Illust. 24), in lever shaft.

The roller bearing should be preloaded at all times. Adjust to a noticeable drag. NOTE: Operation of a correctly adjusted unit may feel rough to the hands but under steering load it will operate smoothly and the load will be properly distributed. The unit should be adjusted to a minimum of three (3) inch lbs. of torque to revolve the stud, never below. Care should be taken not to burr surface of stud. Lock adjustment by bending the washer prong against a side of nut.

Omitting spacer washer, spring washer and shims, install lever shaft in gear housing (Illust. 23). First be sure there are no burrs on the shaft that would damage the bushing. With stud centered on cam as shown in the illustration, measure the distance between the face of the lever and the



Illust. 23



Illust. 24

face of the trunnion. Subtract .280" (which is the thickness of the spacer and 3 spring washers in their compressed state) from the measurement. If there is no difference, no shims are needed. If there is a difference, add the .010" shims as necessary.
NOTE: The shims should be installed to the closest .010". For example, a difference of .024", you should add two shims and for a .026" difference, add three shims.

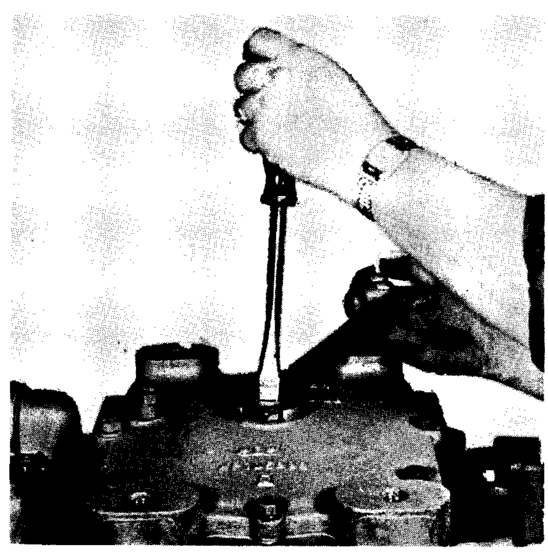
After the necessary shims have been determined, remove lever shaft from housing and install three (3) spring washers, spacer washer and shims, if necessary, to shaft and reinstall shaft to gear housing. Install cover, using a new gasket and fasten securely in place with lock washers and cap screws.

Install adjusting screw and jam nut (Illust. 25). NOTE: The backlash of the stud in the cam groove shows up as backlash at the steering wheel and at ball on steering arm.

The groove in the cam is cut narrower in the mid-position range of stud travel to provide close adjustment where the straight ahead driving takes place.

Adjust through the mid-position. Do not adjust in the end positions. Backlash in the end positions is normal and not objectionable.

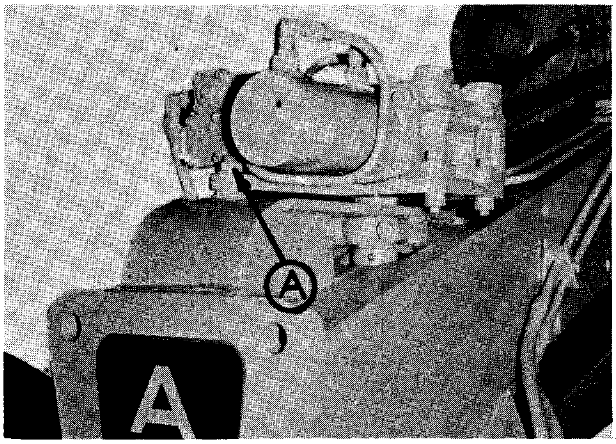
When making the adjustment, tighten adjusting screw until a slight drag is felt when turning gear through mid-position. While holding adjusting screw, tighten lock nut. Recheck drag at wheel through full travel of gear.



Illust. 25

INSTALLATION

The main point to watch when the unit is being installed to the grader is that the vertical lever is not placed in a bind due to tightening down on the torque bolt. The spacer washer should be placed over the lever shaft before lowering the gear in position and then before tightening the torque stud "A" (Illust. 26), check the unit closely to be sure tightening the stud will not draw the plate down, thereby, placing the complete unit in a bind. If necessary use shims to prevent this condition.



Illust. 26

When installing the steering arm on the serrations on the lower end of the lever shaft, it must be mounted so the front spindles will strike the stops before the steering gear reaches its maximum position. This is important as improper mounting of the steering arm may result in a broken steering gear. To determine the proper position for mounting the steering arm, turn the steering gear to the left as far as it will go. Then turn the front wheels to the left until they strike their stop. Turn the steering gear back to the right slowly until the first set of serrations on the lever shaft line up properly to allow the steering arm to become mounted. Install and tighten the lock washer and nut on the end of the lever shaft.

Install the grease tube and fitting for the lower bearing of lever shaft. Remove plugs and reconnect the hydraulic lines. Install universal joint and secure with pin and cotter pins. Lubricate steering gear as described under "Lubricating Instructions".

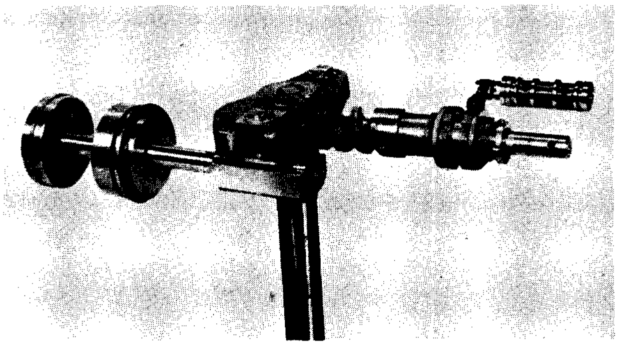
POWER STEERING

STEERING GEAR

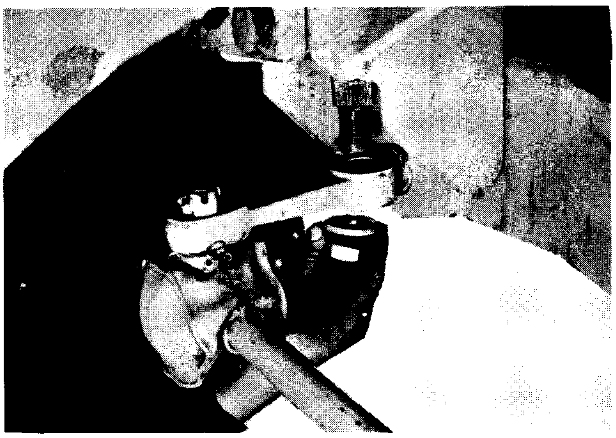
The power steering removal and assembly procedure described here refers to Model 330 motor graders Serial No. 1642 and later. Also, Serial Nos. 1606, 1609, 1627, 1630 and 1636. Model 440 motor graders Serial No. 2706 and later. Also Serial nos. 2622 and 2652.

Illust. 1 is a view of the power steering gear assembly. This view shows all of the important parts and their relationship to each other.

All minor repairs and adjustments to the steering gear may be made without removing it from the grader.



Illust. 1

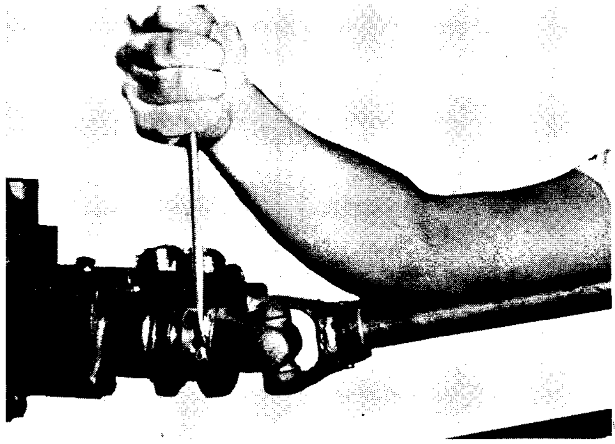


Illust. 2

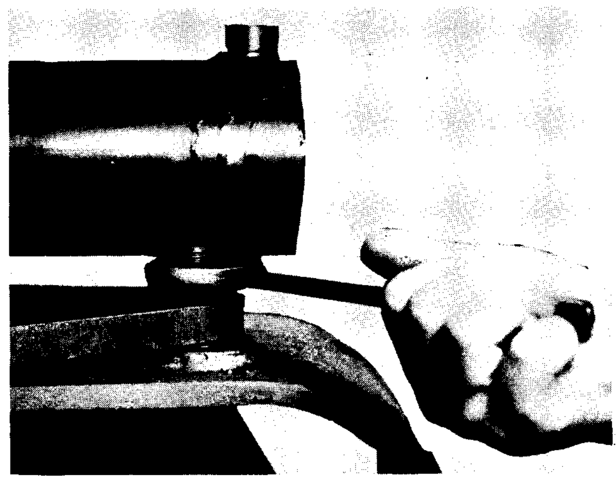
REMOVAL

The first step in the removal procedure is, disconnect hydraulic tubing from steering housing. CAUTION: Extreme care must be used to prevent dirt and foreign matter from steering assembly, connections and internal parts. Plug openings in hydraulic tubes and fittings in steering gear. Next, remove nut and lock washer from end of shaft (Illust. 2). Drive arm from serrations of shaft. IMPORTANT: When driving the arm from shaft, the end of shaft must be supported or serious damage to steering gear will result. Use light hammer blows to remove arm.

Remove cotter pin from drilled pin,



Illust. 3



Illust. 4

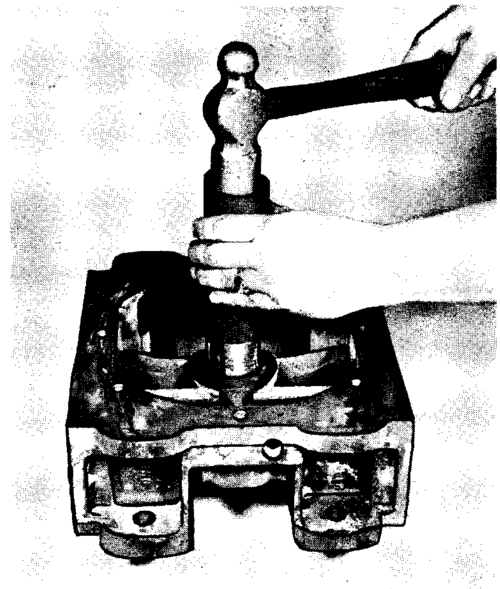
then drive drilled pin from universal joint and shaft (Illust. 3). Remove universal joint from shaft.

Loosen bearing cap bolts and remove torque plate bolt (Illust. 4).

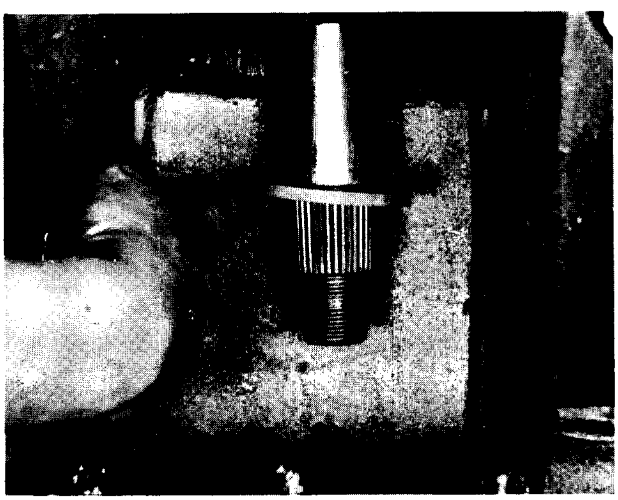
With a chain hoist, raise steering housing assembly (Illust. 5) from bolster until rubber washer can be removed from steering shaft (Illust. 6), then remove steering assembly from frame.

To disassemble the steering housing, reverse the reassembly procedure.

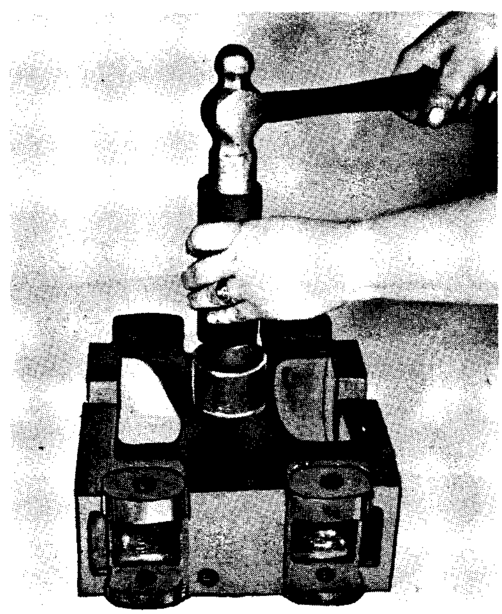
Illust. 5



Illust. 1



Illust. 6



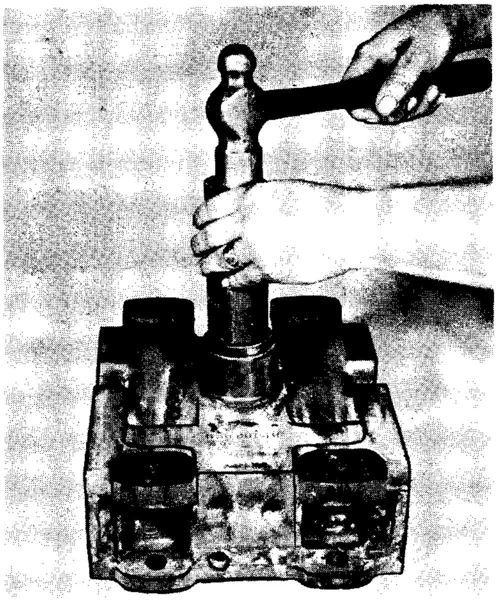
Illust. 2

Inspect all parts of the assembly for wear and damage. Replace defective parts. Clean all parts before assembling. Apply oil to parts before installation.

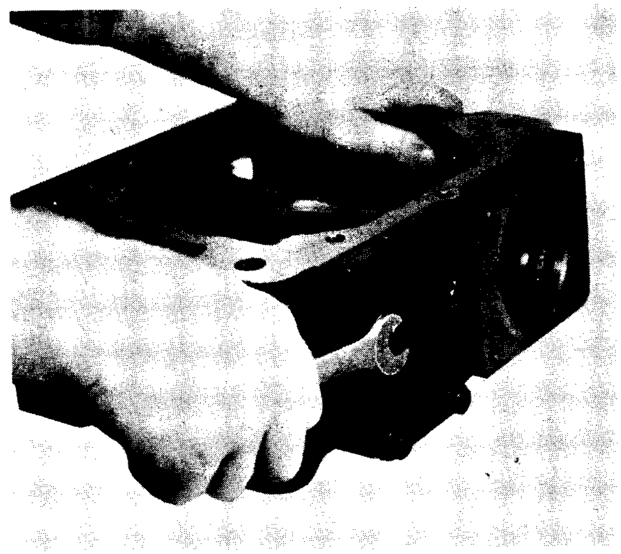
REASSEMBLY

The first step in reassembly is, install bushing into top of gear housing (Illust. 1). When driving bushing into place, use a piece of pipe or similar driver. Install bushing into bottom of housing (Illust. 2). The grease seal (Illust. 3) should now be installed.

Install cam and shaft end cover and gasket on steering housing. Install cap screws and lock washers. Tighten cap screws securely (Illust. 4).



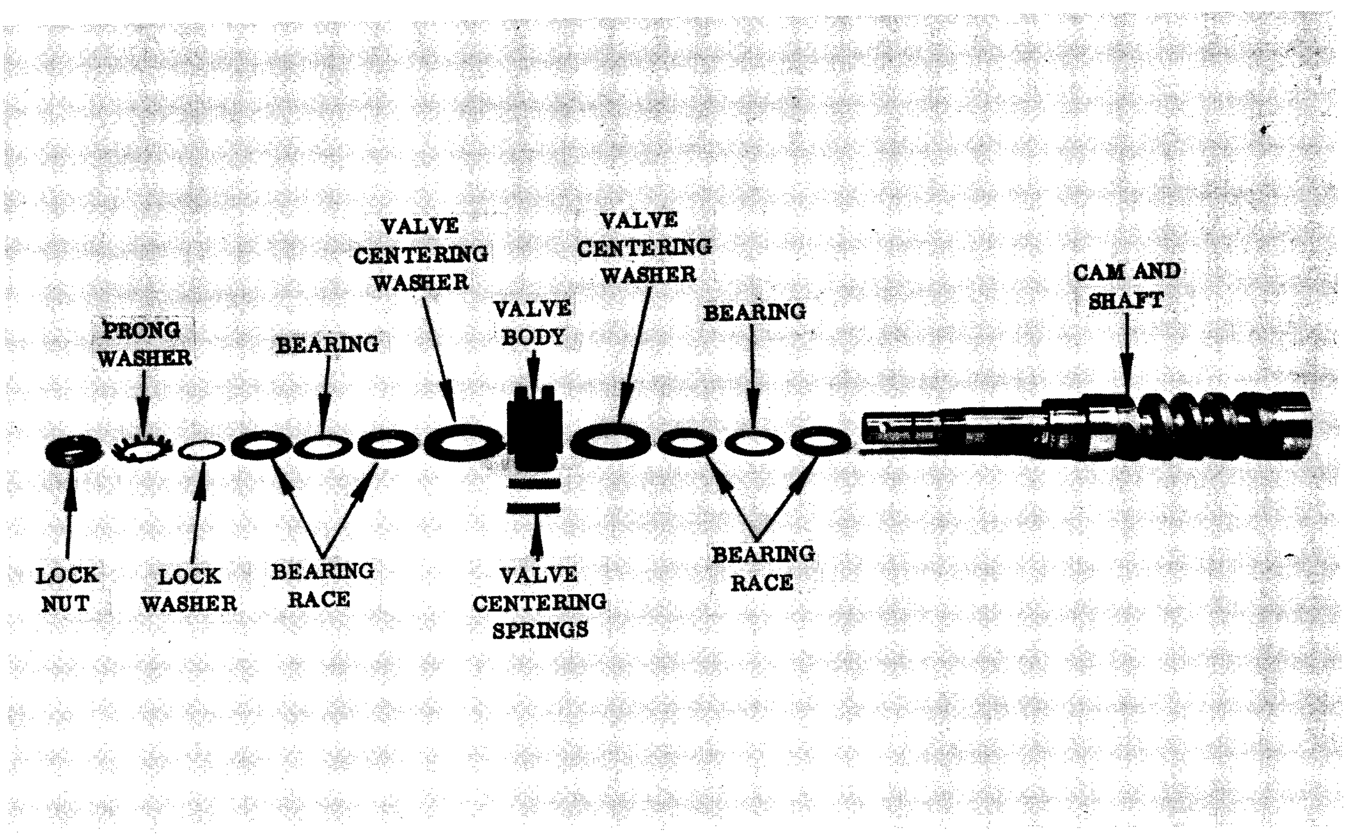
Illust. 3



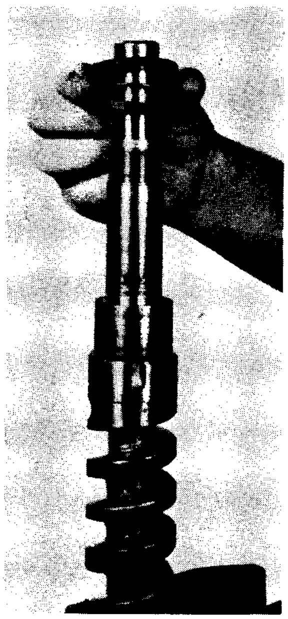
Illust. 4

CAM AND SHAFT

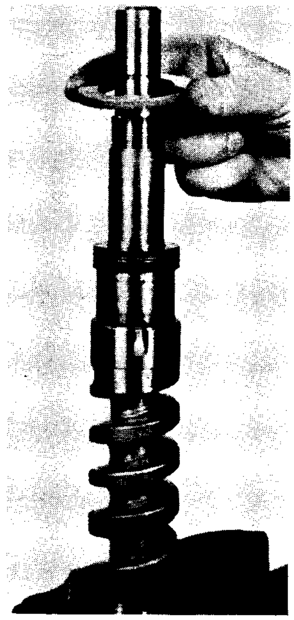
Illust. 1 is an exploded view of the cam and shaft.



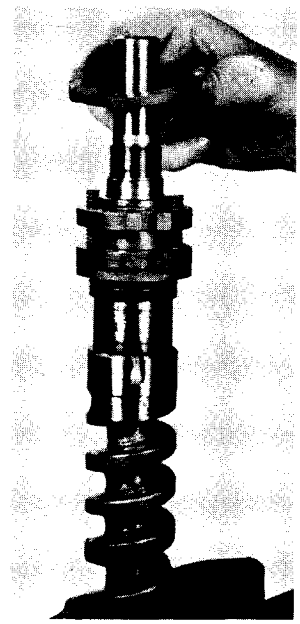
Illust. 1



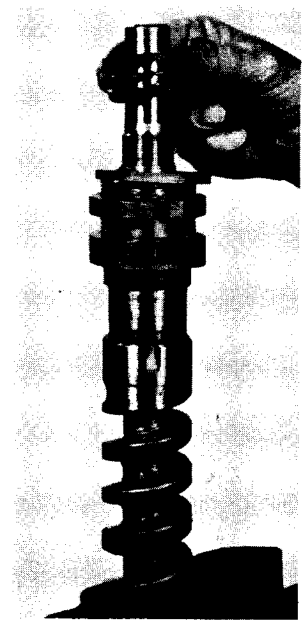
Illust. 2



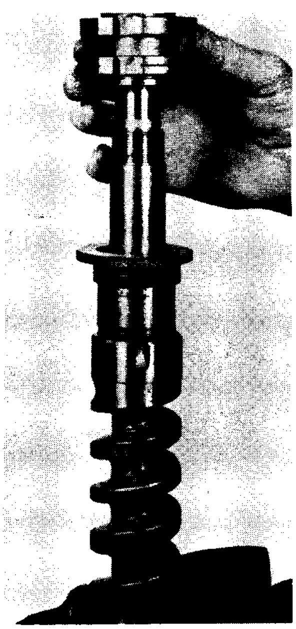
Illust. 3



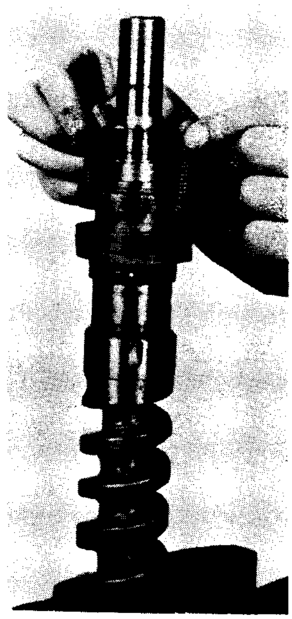
Illust. 6



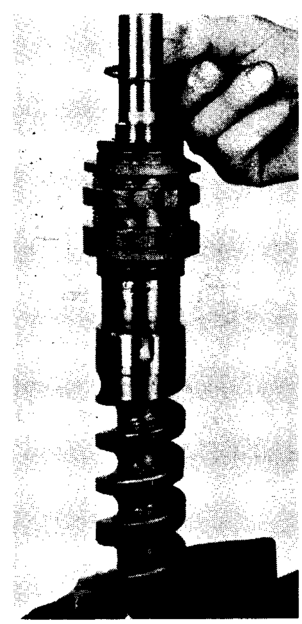
Illust. 7



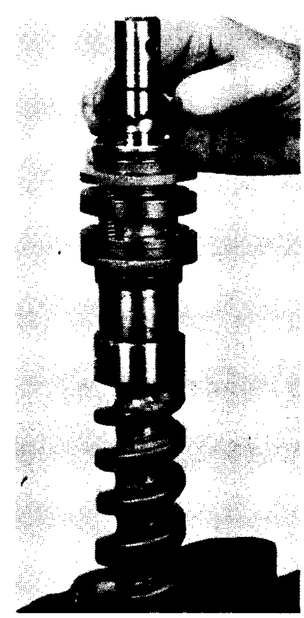
Illust. 4



Illust. 5



Illust. 8

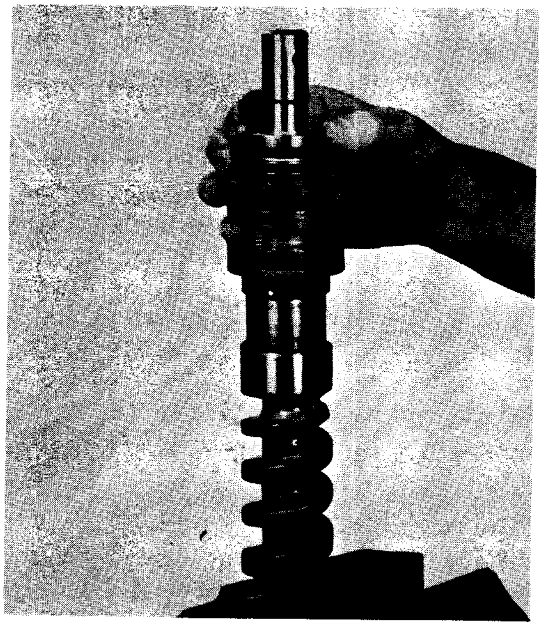


Illust. 9

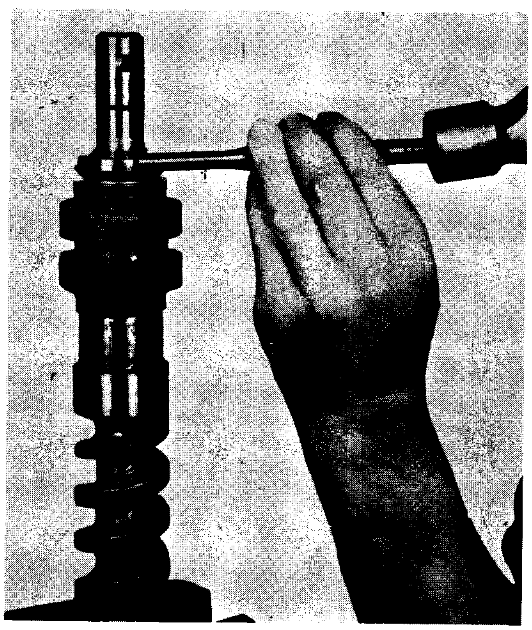
Clamp cam shaft into a vise with brass jaw protectors. Install bearing race, bearing and second bearing race onto cam shaft (Illust. 2). Next, install valve centering washer (Illust. 3).

Install valve body onto cam shaft (Illust. 4). Groove in valve body away from threaded end of cam shaft.

Install two valve centering springs into valve body (Illust. 5). Next, install second valve centering washer onto cam shaft and onto springs (Illust. 6).



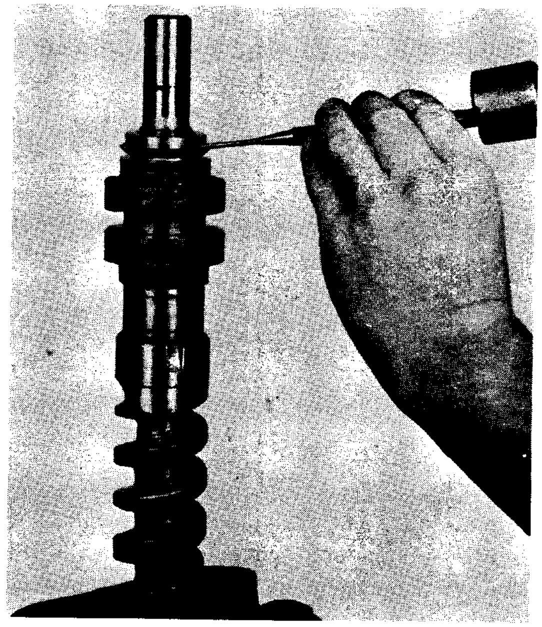
Illust. 10



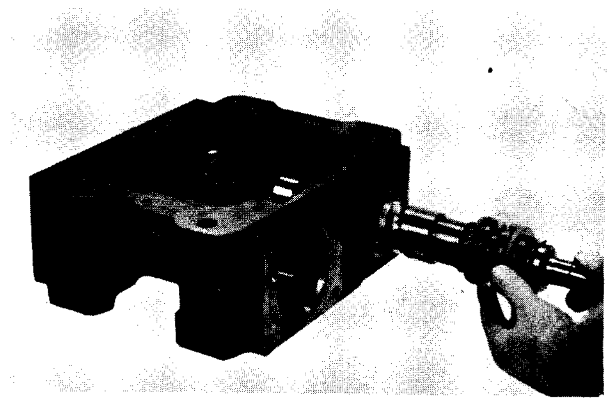
Illust. 11

Install bearing race, bearing and second bearing race onto cam shaft and down onto valve centering washer (Illust. 7).

Install lock washer onto cam shaft (Illust. 8). Locking prong of washer to fit in slot of shaft.



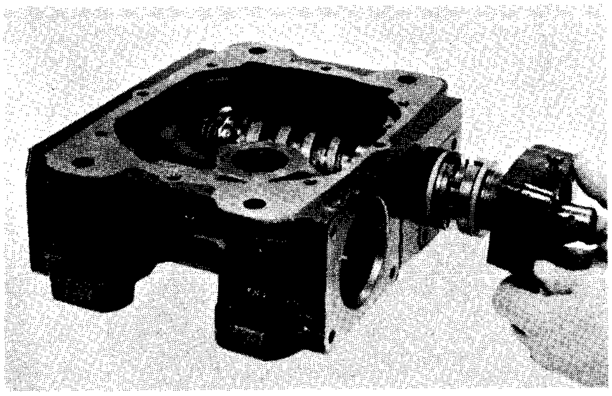
Illust. 12



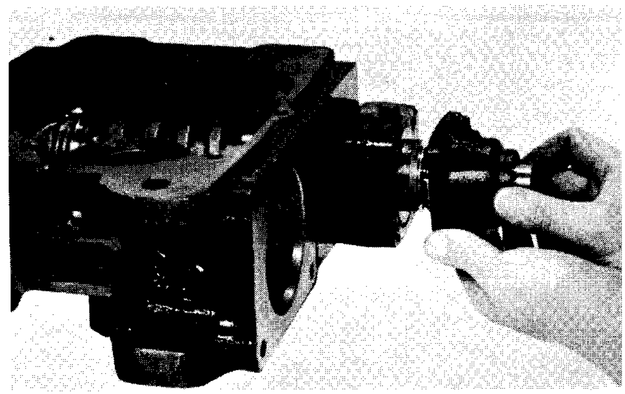
Illust. 13

Install prong washer onto cam shaft (Illust. 9). Prongs of washer away from valve body. Next, install lock nut (Illust. 10). Chamfered end of nut toward valve body.

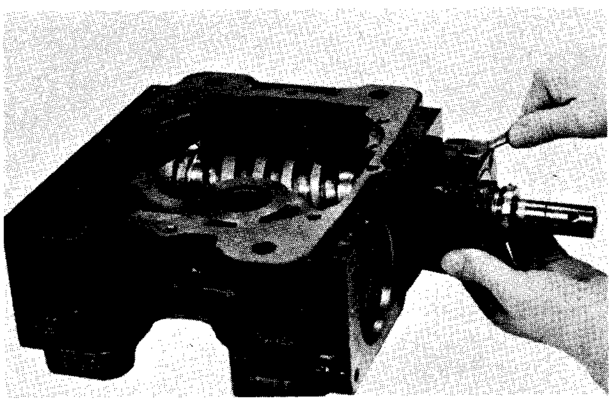
Tighten nut (Illust. 11) until a slight drag is obtained to rotate valve body, then, using a punch and hammer, bend a prong of washer into slot of nut (Illust. 12). NOTE: If washer is reused, break used prong from washer and lock the nut with an unused one.



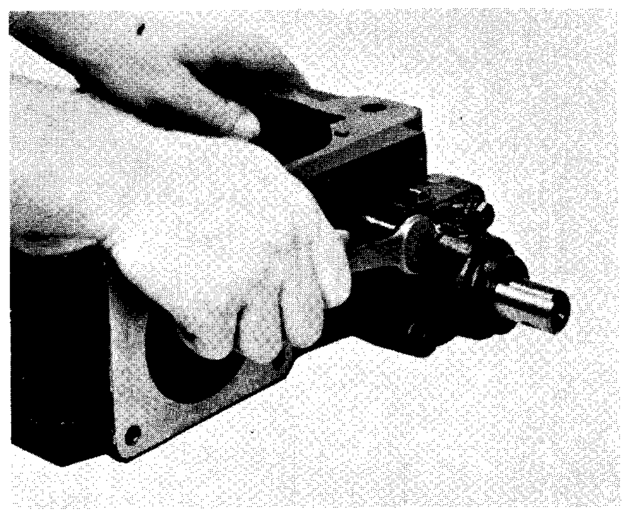
Illust. 14



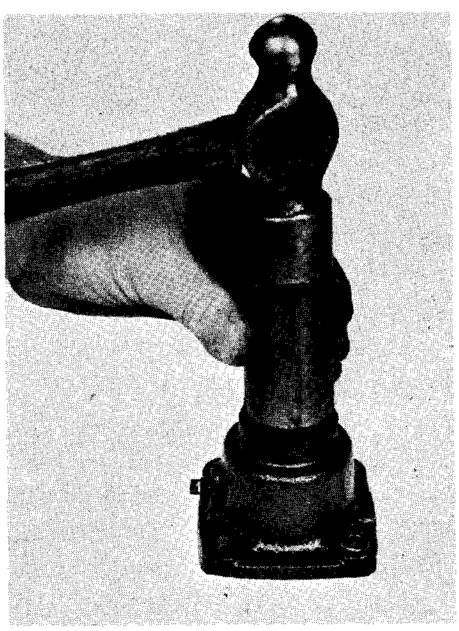
Illust. 17



Illust. 15



Illust. 18



Illust. 16

Install cam shaft into housing (Illust. 13). Slots in valve body in an upward position.

Install actuator housing gasket and housing onto steering housing (Illust. 14). NOTE: Install actuator housing with set screw in an upward position and toward the universal joint end of cam shaft.

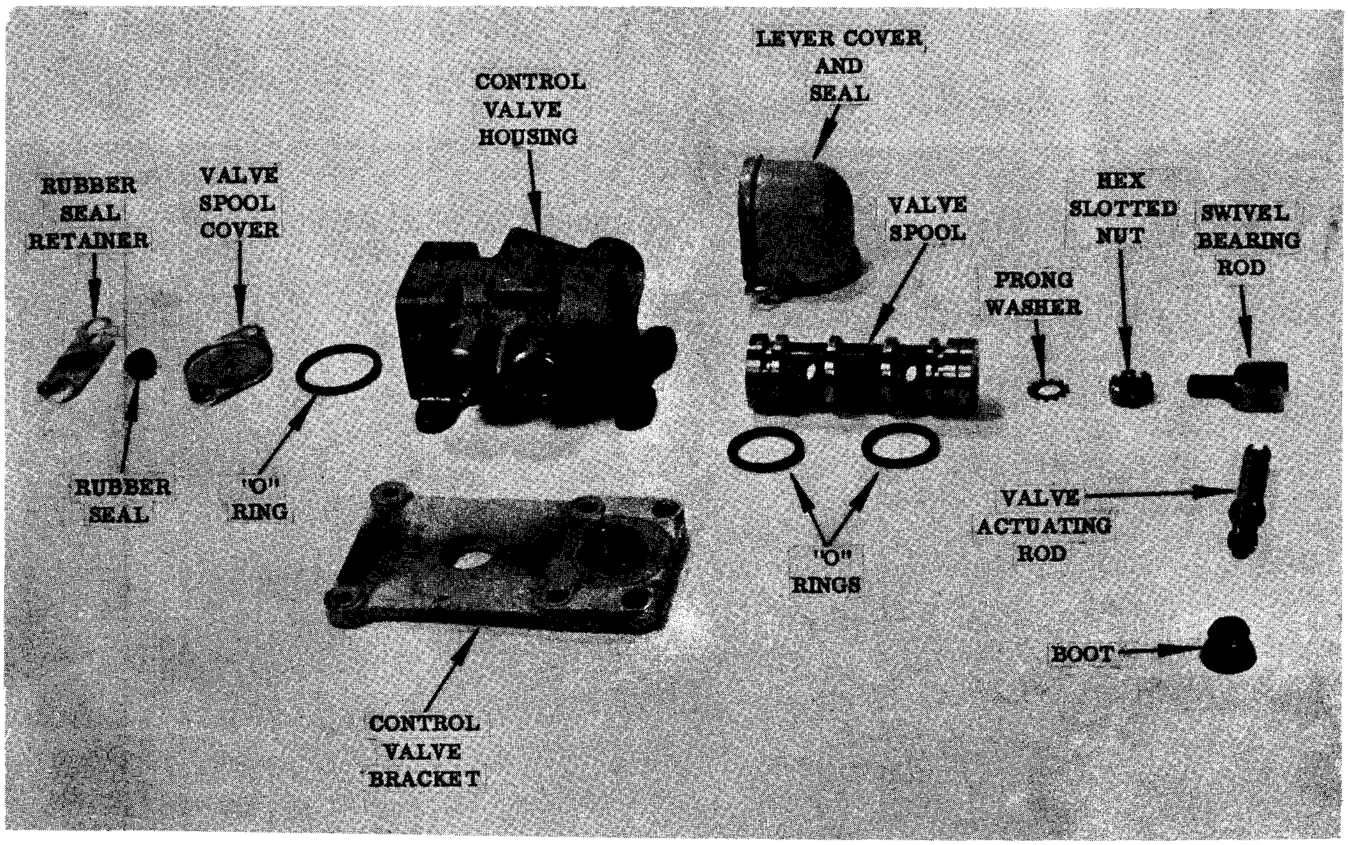
Tighten set screw into slot of valve body (Illust. 15).

Press or drive oil seal into shaft housing (Illust. 16). Lip of oil seal toward inside of housing.

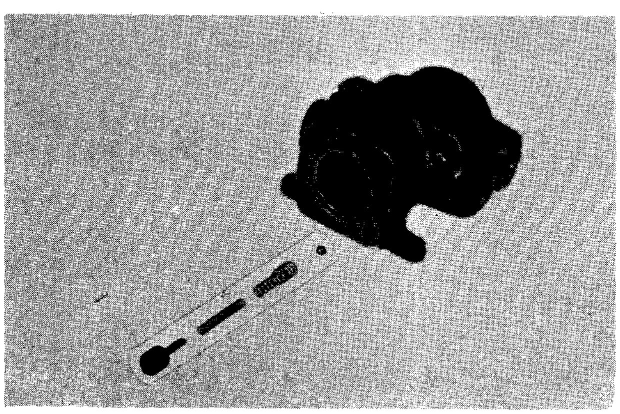
Install gasket and shaft housing onto cam shaft (Illust. 17) and against actuator housing. NOTE: Use a piece of shim stock over shaft to prevent damage to seal.

Install lock washers and cap screws. Tighten cap screws securely (Illust. 18).

CONTROL VALVE



Illust. 1



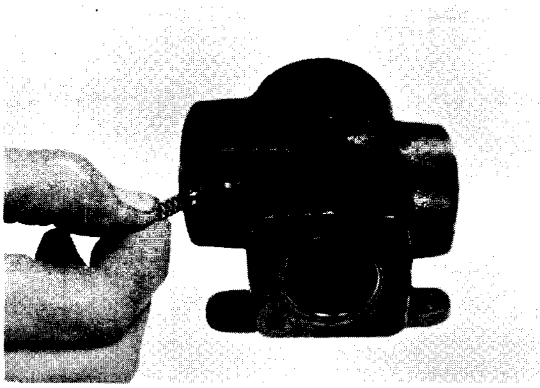
Illust. 2

Illust. 1 is an exploded view of the control valve assembly.

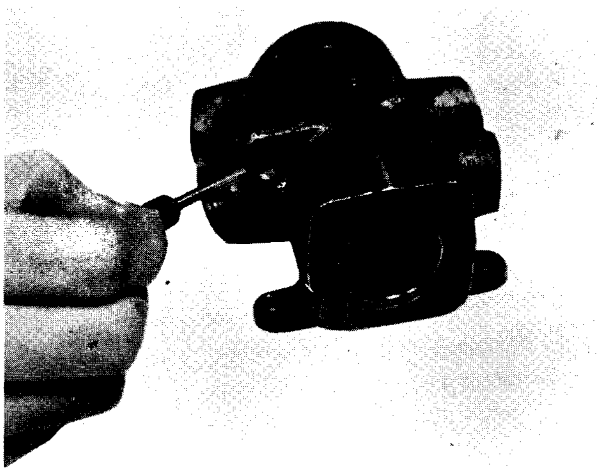
Illust. 2 is a view of the control valve springs and ball.

Insert ball into large end of tapered spring (Illust. 3) and insert into valve housing.

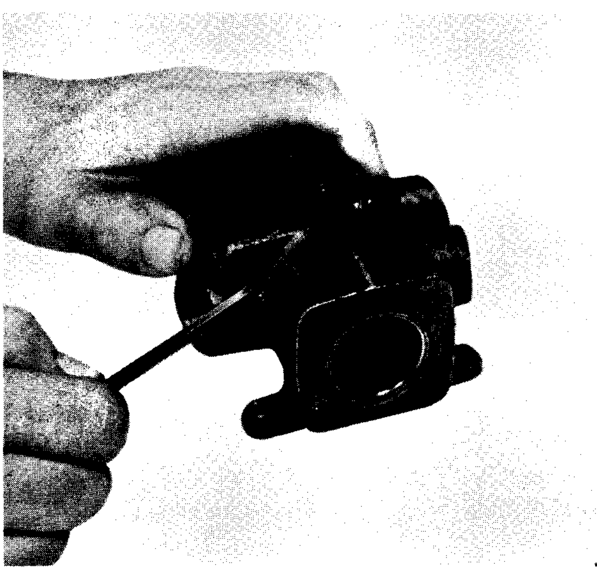
Insert straight spring onto pronged end of Allen head set screw. Now, insert spring into tapered spring (Illust. 4).



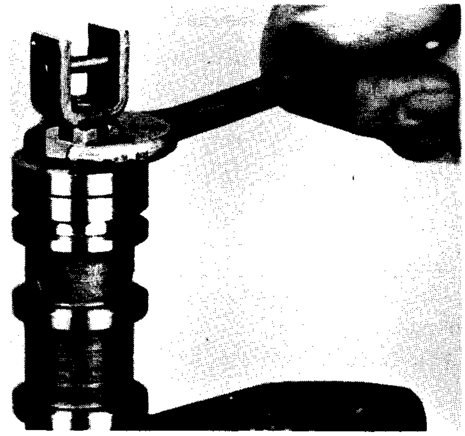
Illust. 3



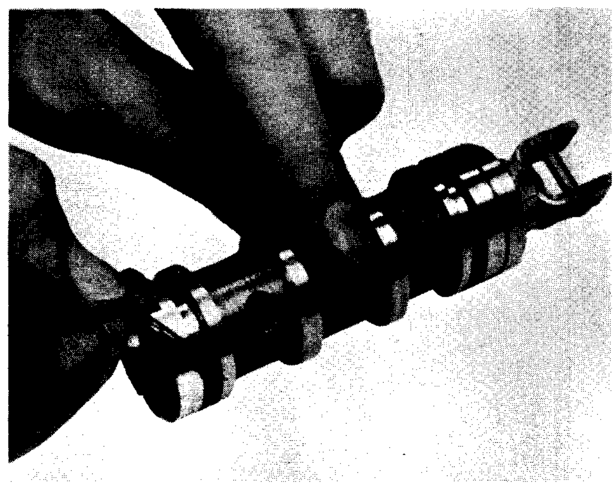
Illust. 4



Illust. 5



Illust. 6



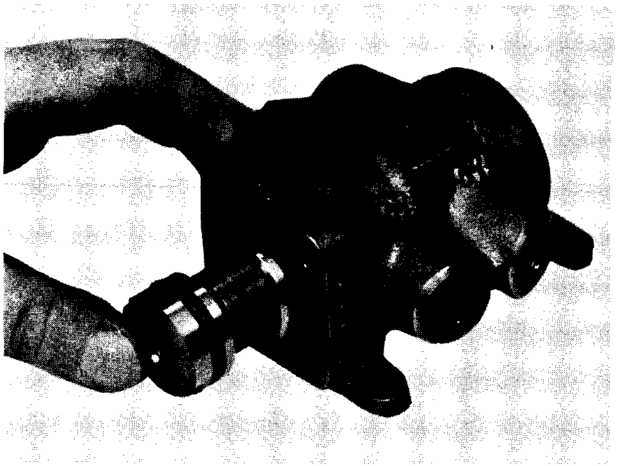
Illust. 7

Tighten Allenhead set screw securely (Illust. 5). Check to see that ball is properly seated.

Clamp valve spool in a vise with brass jaw protectors. Install slotted nut and Shakeproof lock washer onto swivel bearing rod. Slotted nut to be up to yoke in rod (Illust. 6). Do not tighten nut. Next, install swivel bearing rod into valve spool as illustrated.

Install "O" ring into groove of valve spool (Illust. 7).

Apply white lead to "O" ring. Insert valve spool into control valve housing (Illust. 8). Push spool through hous-

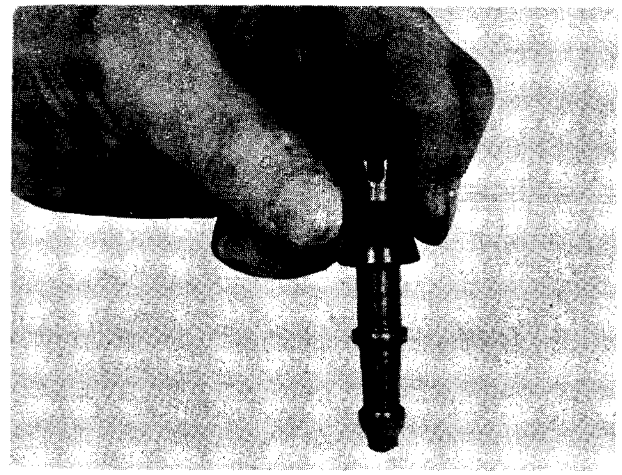


Illust. 8

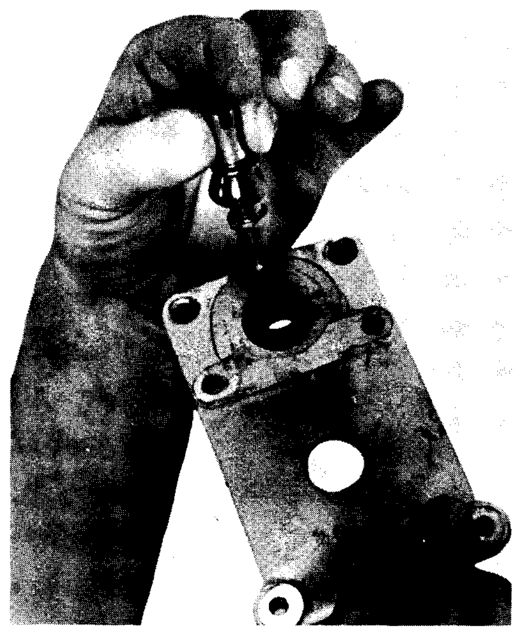
Illust. 9

ing until groove nearest swivel bearing rod appears. Install second "O" ring in groove of spool (Illust. 9). Apply white lead to second "O" ring then push on swivel bearing rod until opposite end of spool is flush with end of control valve housing.

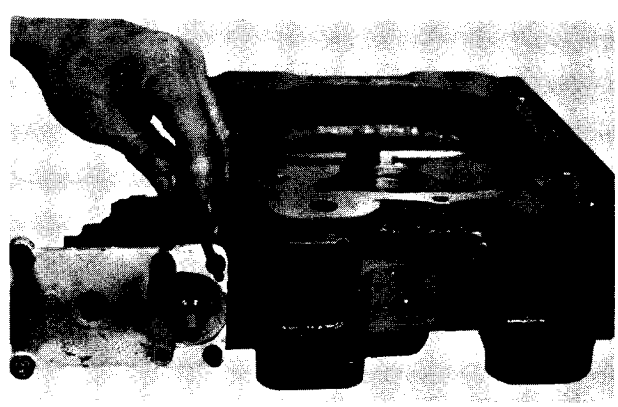
Install rubber boot onto slotted end of actuating rod (Illust. 10). Push boot down to shoulder of rod.



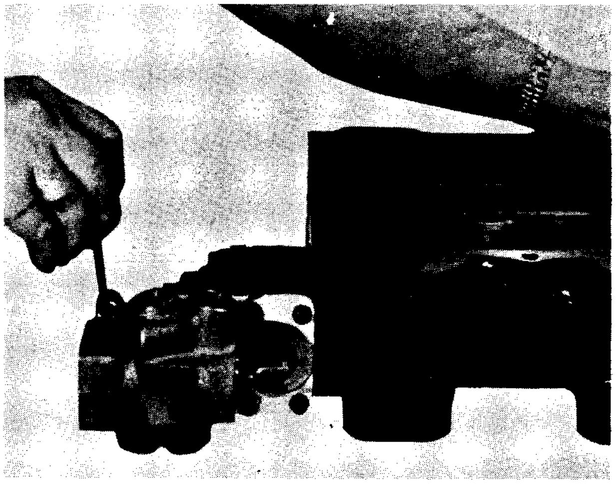
Illust. 10



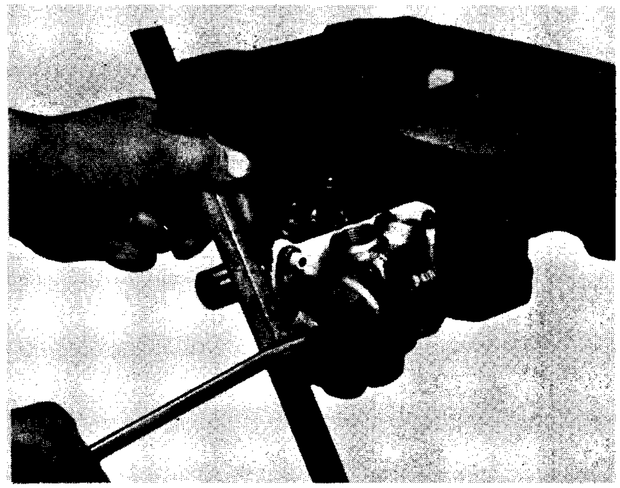
Illust. 11



Illust. 12



Illust. 13



Illust. 14

Insert actuating rod into shouldered end of sleeve (Illust. 11).

Install control valve bracket onto steering housing (Illust. 12). Knob on end of actuating rod to fit in groove of cam shaft valve body. Install Allen head set screws with Shakeproof lock washers. Tighten set screws securely (Illust. 12).

Install control valve housing onto bracket (Illust. 13). Pin in swivel bearing rod to fit in slot of actuating rod. Next, install four Allen head set screws with shakeproof lock washers.

Tighten set screws securely.

PRELIMINARY ADJUSTMENT: Using a screw driver in slot of valve spool, thread spool in or out until slotted end of spool is flush with end of valve body (Illust. 14).

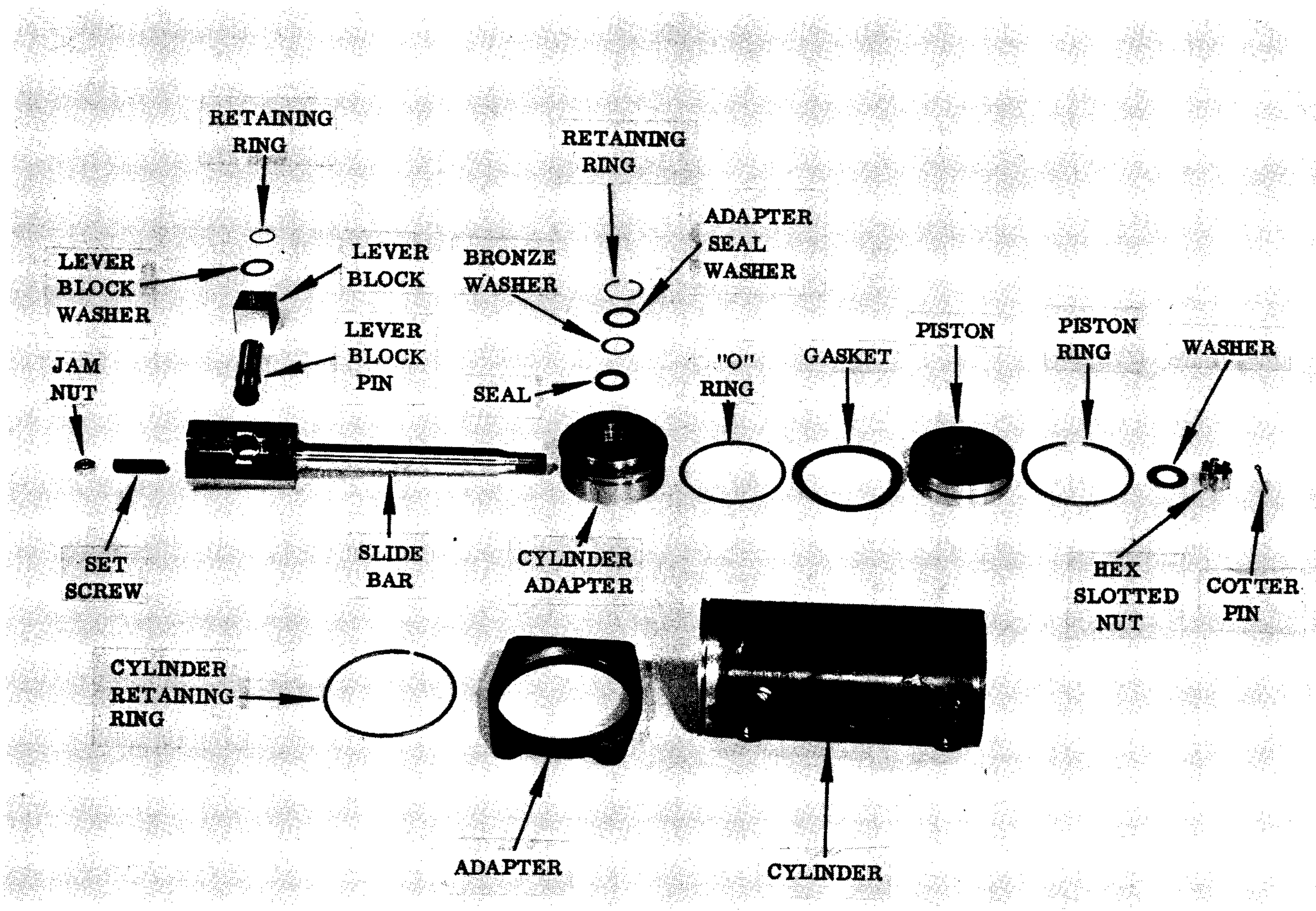
Hold spool in place and carefully tighten slotted nut.

NOTE: A slight change in spool will affect adjustment.

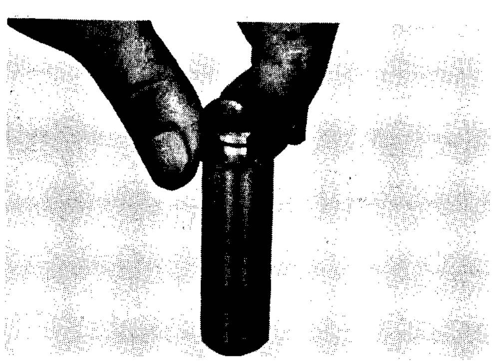
Lock adjustment with cotter pin. Do not install end covers until "Final Adjust ent" is made.

Final Adjustment instructions appear on Page 42 of this Section.

CYLINDER



Illust. 1

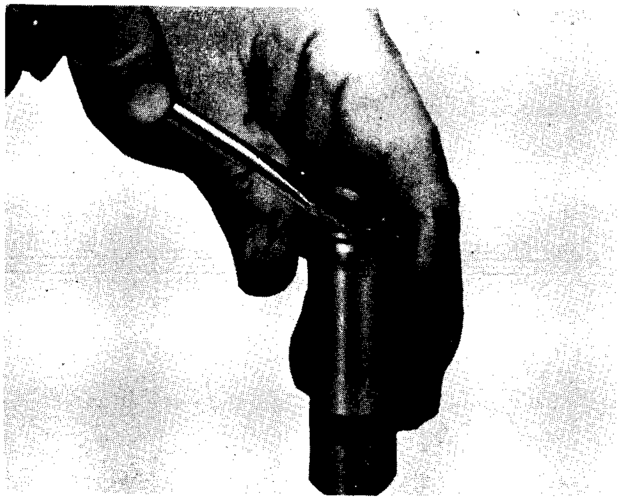


Illust. 2

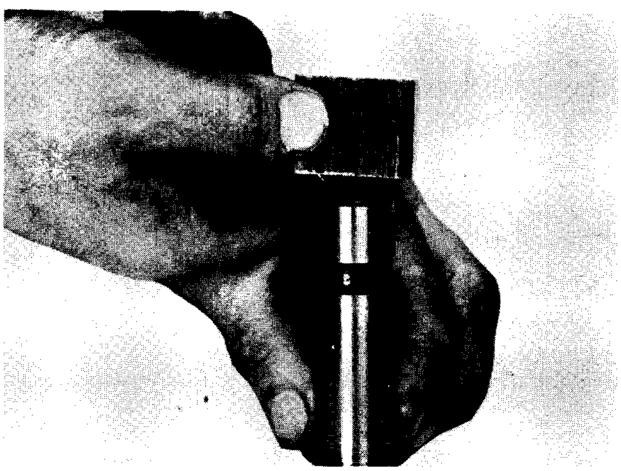
Illust. 1 is an exploded view of the cylinder.

Install lever block washer onto lever block pin (Illust. 2). Flat on washer to fit flat of pin.

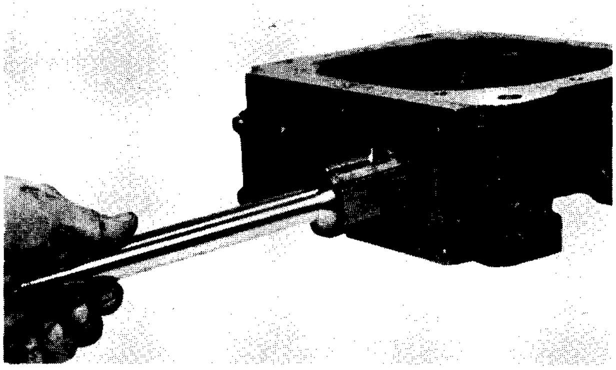
Install lever block retaining ring in groove of lever block pin (Illust. 3). Next, install lever block (Illust. 4).



Illust. 3

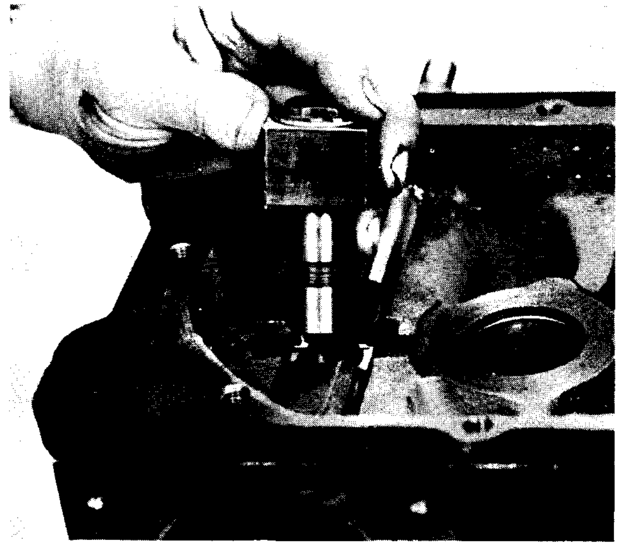


Illust. 4

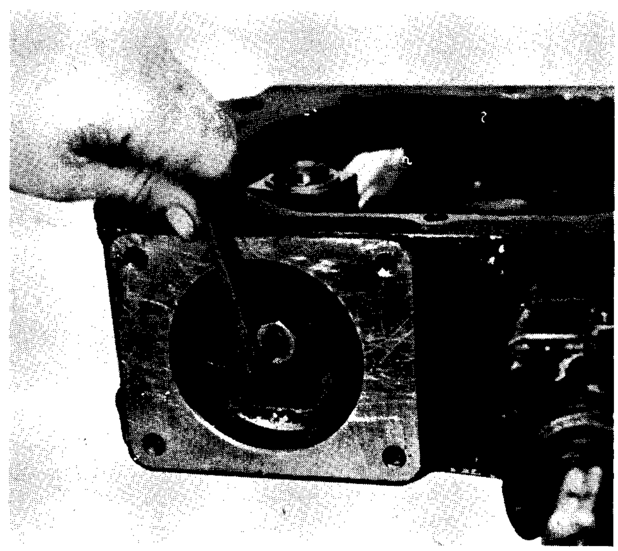


Illust. 5

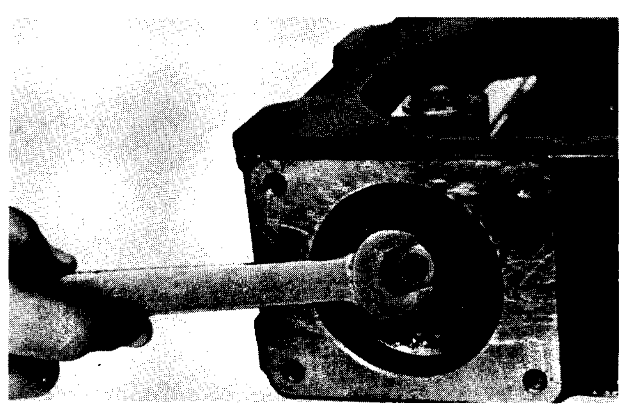
Install slide bar into steering housing (Illust. 5).



Illust. 6



Illust. 7

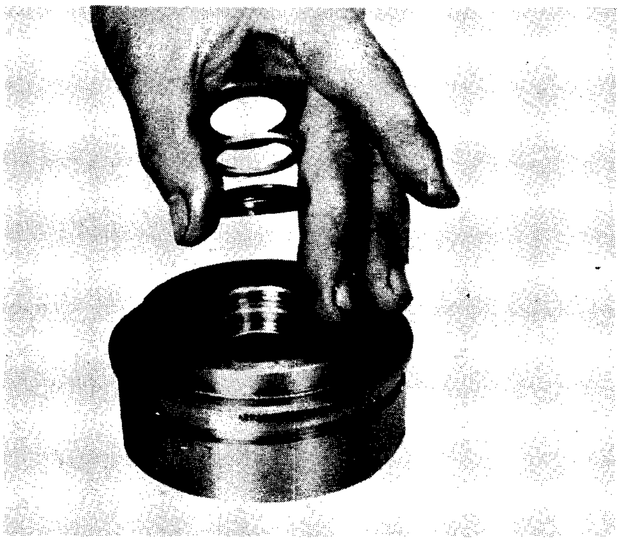


Illust. 8

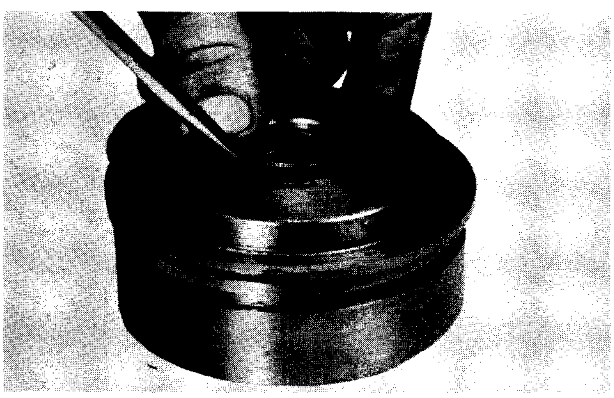
Install lever block pin assembly into bore of slide bar (Illust. 6).

Install set screw and jam nut in end of slide bar and tighten securely (Illust. 7). Be sure lever block is free to rotate on lever block pin and that slide bar is free to move back and forth in steering housing. Tighten jam nut securely (Illust. 8).

Install slide bar seal, bronze washer and adapter washer seal into cylinder adapter in the order named (Illust. 9). Be sure to place lip of slide bar seal toward the inside of adapter.

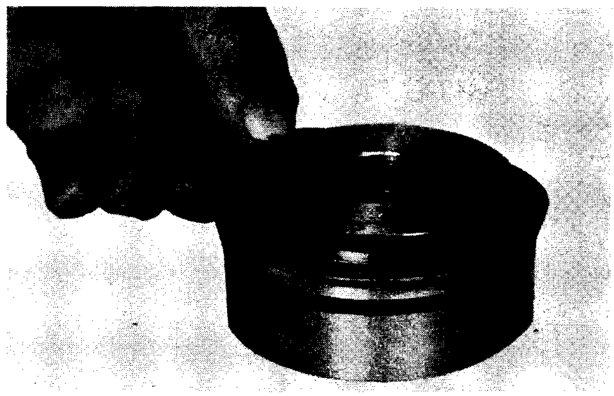


Illust. 9



Illust. 10

Illust. 11

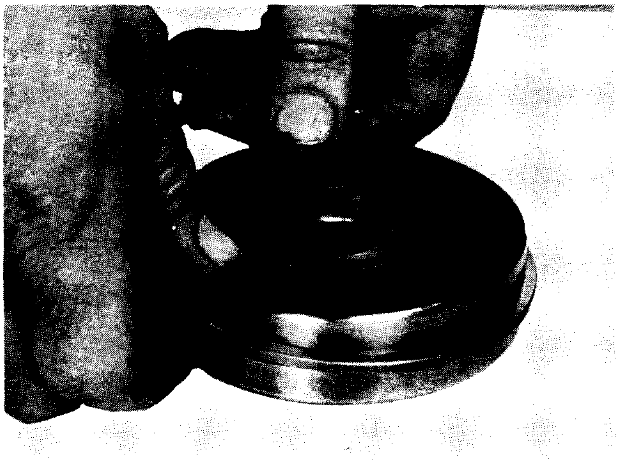


Illust. 12

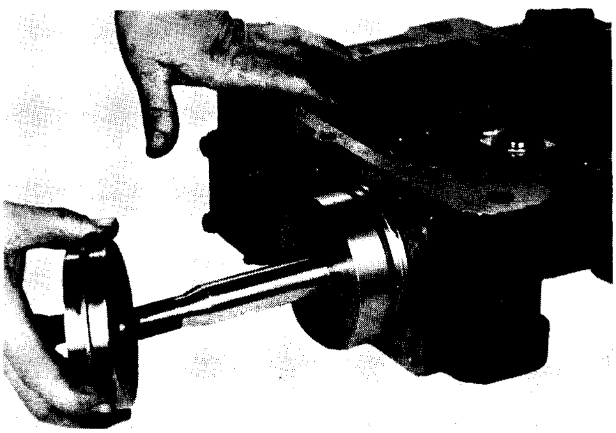
Illust. 13

Next, install retaining ring in groove of cylinder adapter (Illust. 10).

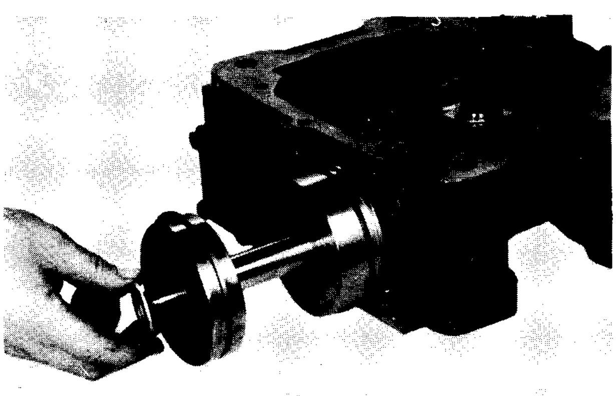
Install "O" ring into groove of cylinder adapter (Illust. 11).



Illust. 14

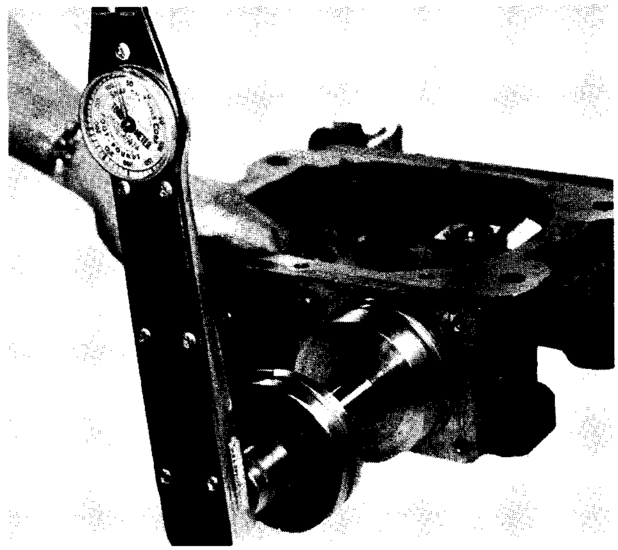


Illust. 15

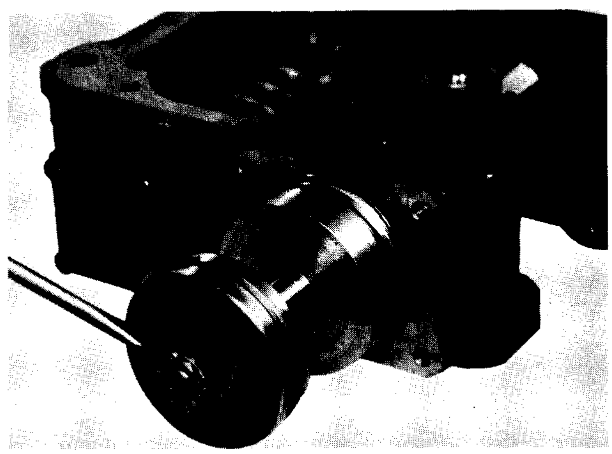


Illust. 16

Install gasket onto cylinder adapter (Illust. 12).



Illust. 17



Illust. 18

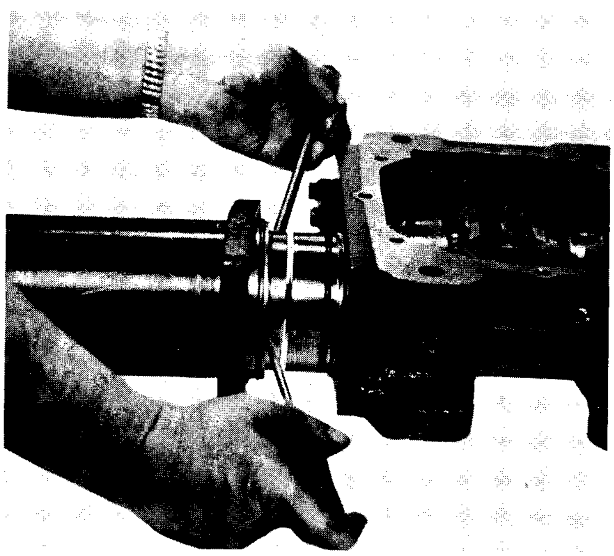
Install cylinder adapter onto slide bar (Illust. 13). End containing gasket and seal going on first.

Install piston ring into groove of piston (Illust. 14).

Install piston onto slide bar (Illust. 15) with taper of bore in piston mating with taper of slide bar. Next, install washer and hex slotted nut (Illust. 16) onto slide bar.

Tighten slotted nut to a torque reading of 200 to 225 foot pounds (Illust. 17).

Illust. 19

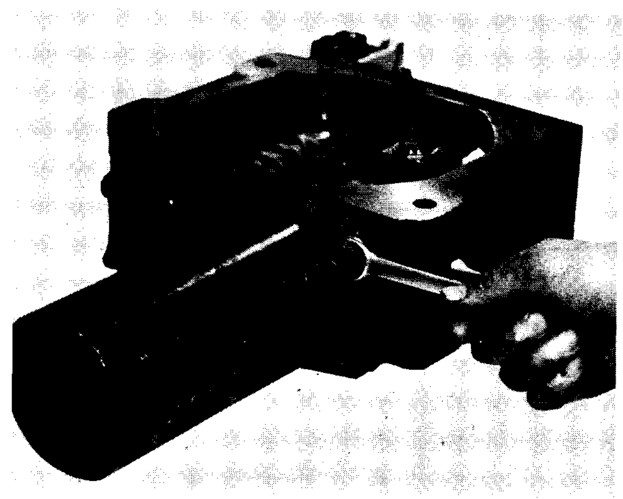


Illust. 20

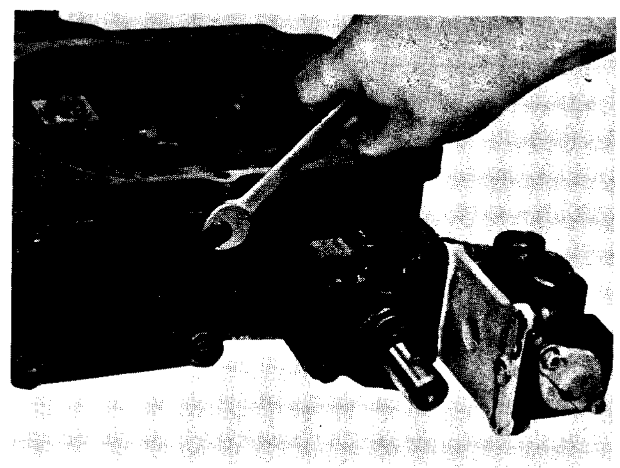
Install cotter pin and spread (Illust. 18).

Install adapter onto cylinder (Illust. 19). Next, install cylinder retaining ring into groove of cylinder.

Compress piston ring, then slide cylinder over piston and cylinder adapter (Illust. 20). Cylinder to fit flush with



Illust. 21



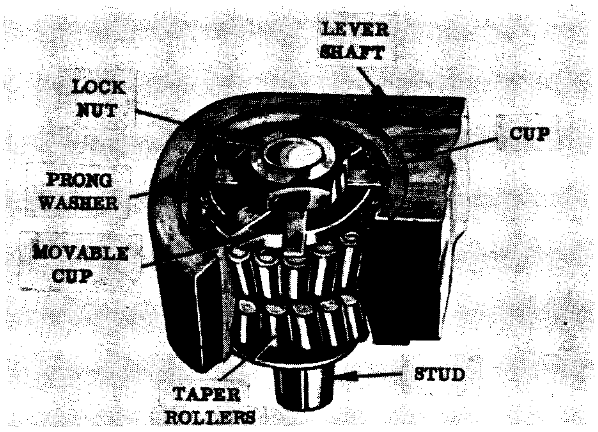
Illust. 22

shoulder of cylinder adapter. NOTE: Apply white lead to "O" ring to prevent damage.

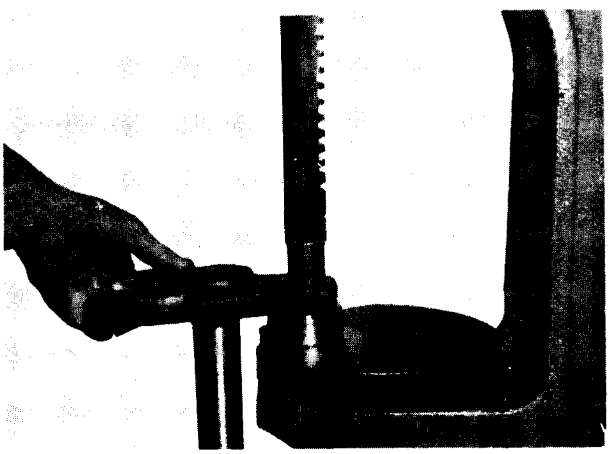
Install four adapter cap screws with lock washers. Tighten cap screws equal to prevent placing cylinder in a bind (Illust. 21). NOTE: Slide bar assembly should move freely through cylinder.

Install end cover and gasket. Install cap screws and lock washers. Tighten cap screws securely (Illust. 22).

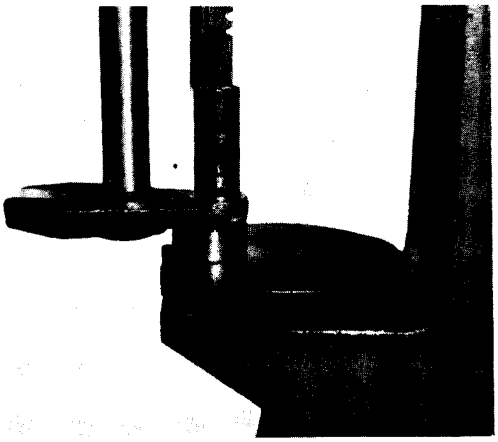
STUD ROLLER BEARING UNIT



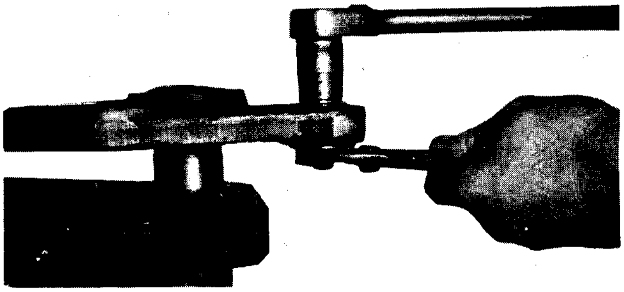
Illust. 1



Illust. 2



Illust. 3



Illust. 4

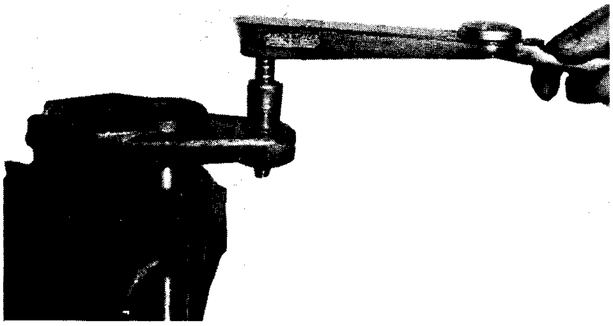
Illust. 1 is a cut away view of the stud roller bearing unit.

To remove the stud roller bearing unit from the lever shaft, use a piece of pipe the same diameter as bearing cup. Press or drive unit from shaft (Illust. 2). NOTE: When removing stud bearing unit from lever shaft, be sure lever shaft is in a downward position as illustrated.

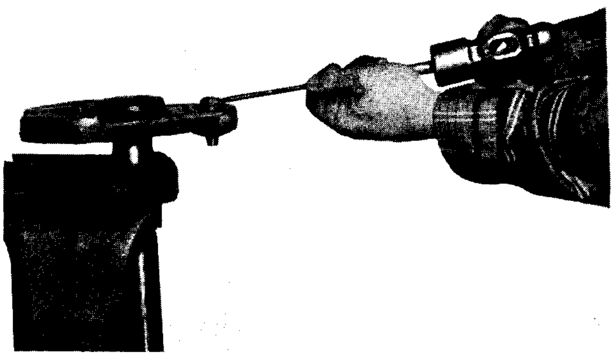
Press or drive stud bearing unit into lever shaft (Illust. 3) until shoulder of unit is flush against lever shaft.

To pre-load the bearings, clamp stud with a pair of pliers, using care not to burr or nick stud. Tighten nut (Illust. 4) until a noticeable drag is obtained. Rotate unit, using a torque wrench (Illust. 5). Torque reading should be minimum of three inch pounds, never below. If reading is below three inch pounds, tighten nut still tighter.

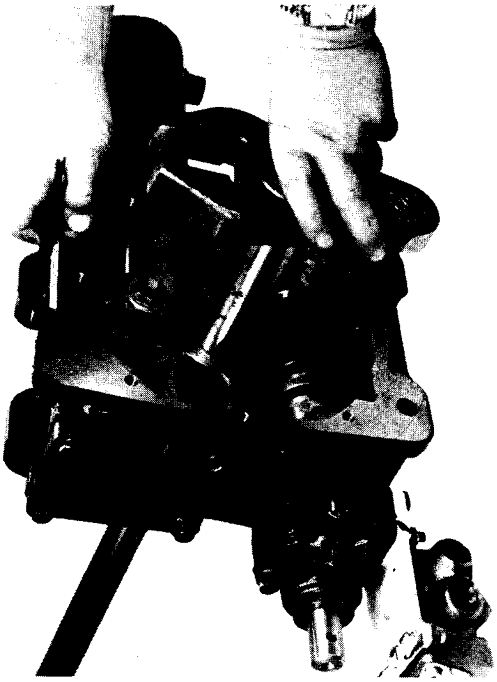
Lock the nut by bending a prong of washer against a side of the nut (Illust. 6). NOTE: Bend a prong that is at right angles to a side of nut. If old pronged washer is used, break off bent prong to prevent reusing.



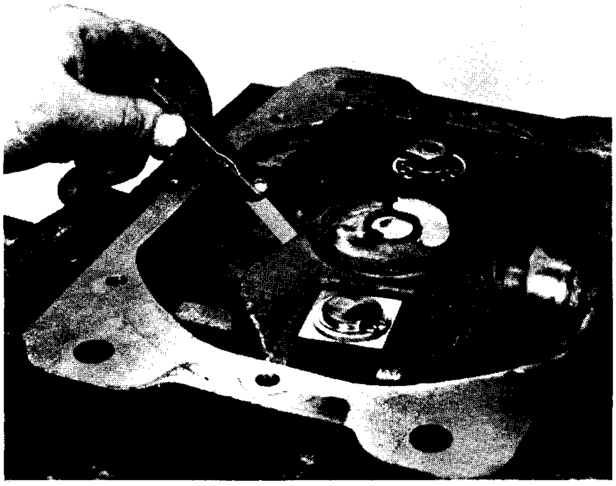
Illust. 5



Illust. 6



Illust. 7

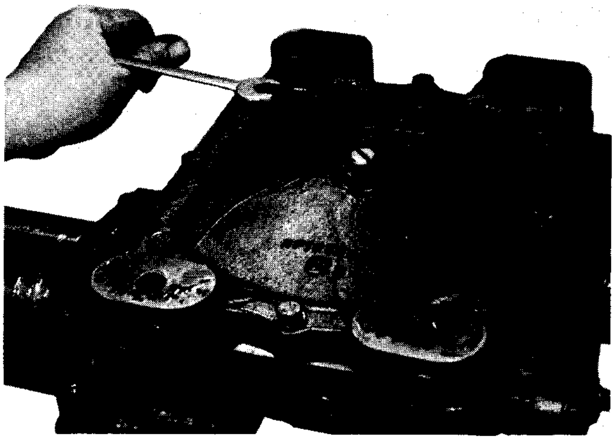


Illust. 8

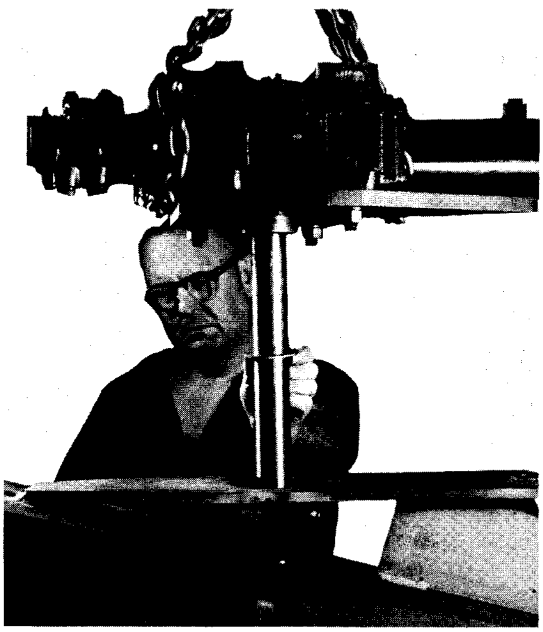
Install lever shaft into steering housing less shims (Illust. 7). With the stud centered in the cam shaft, measure the distance between the face of the lever shaft and face of the center bore of steering housing (Illust. 8). Subtract .280 of an inch (which is the thickness of the support washer and 3 spring washers in its compressed state) from the measurement.

If there is no difference, no shims are required. If there is a difference, add .010 of an inch shims as necessary.
NOTE: The shims should be installed to the closest .010 of an inch. For example, a difference of .024 of an inch, you should add two shims and for a .026 of an inch difference, add three shims.

When the required amount of shims have been determined, remove lever shaft from housing and install 3 spring washers, support washer and shims, if necessary, onto lever shaft. Rounded portion of spring washers toward forked end of lever shaft. Reinstall lever shaft into steering housing.
IMPORTANT: Center the lever shaft with stud bearing unit in cam shaft between lever stops in housing.



Illust. 9

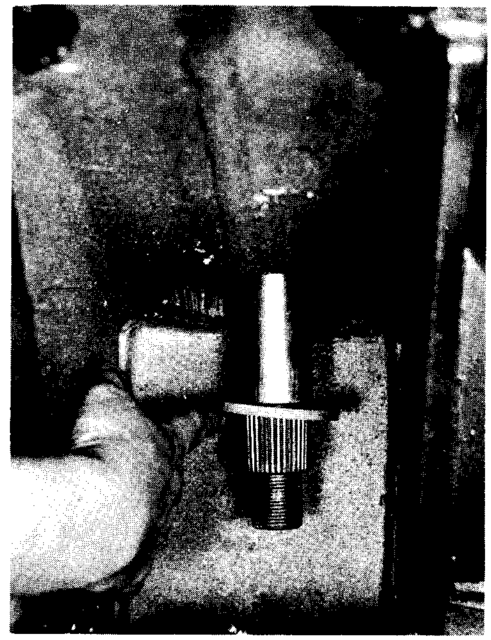


Illust. 10

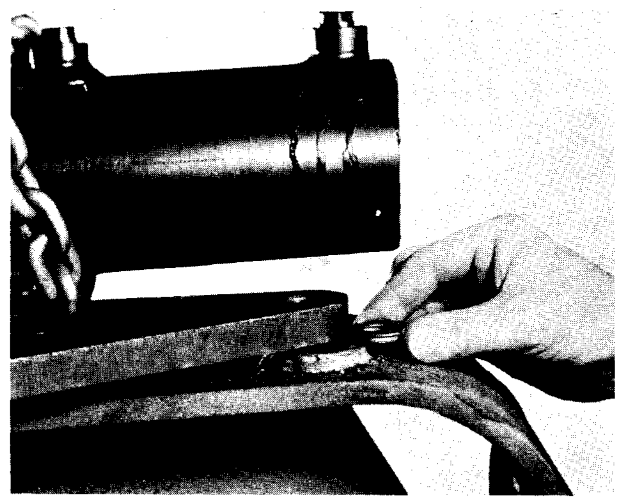
Install steering housing cover gasket, cover and cap screws with lock washers. Tighten cap screws securely (Illust. 9).

Install washer onto steering shaft and insert steering housing assembly into frame (Illust. 10).

Lower steering housing through frame until end of lever shaft is well extended through bottom of frame, then install rubber washer (Illust. 11).

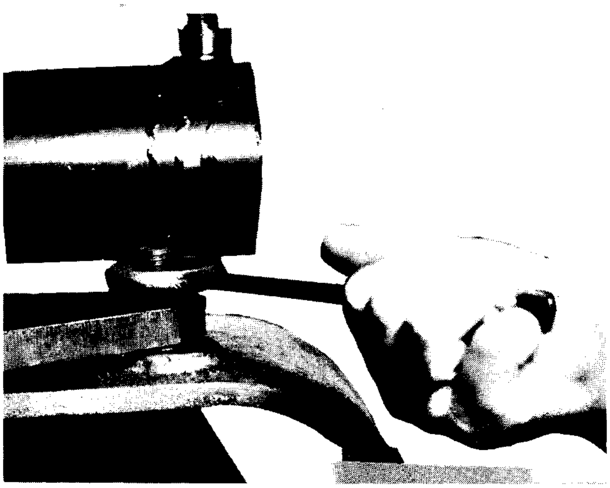


Illust. 11

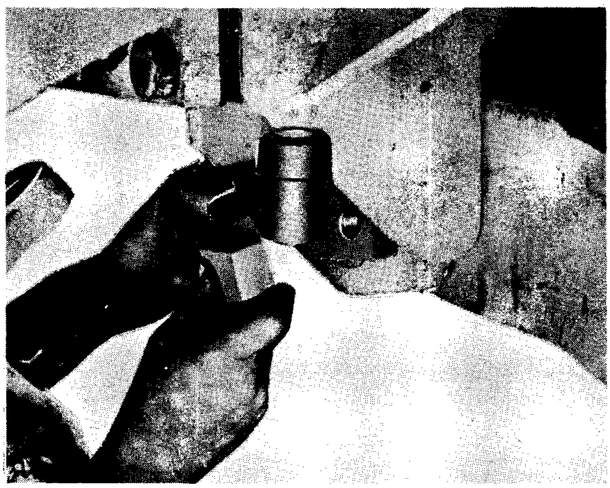


Illust. 12

Continue lowering steering housing until housing rests on bolster. Measure the gap between torque plate and bolster and insert the required amount of shims (Illust. 12). Next, insert torque plate bolt through bolster and torque plate. Install lock washer and nut. Tighten nut securely (Illust. 13). Next, tighten self aligning bearing cap cap screws.

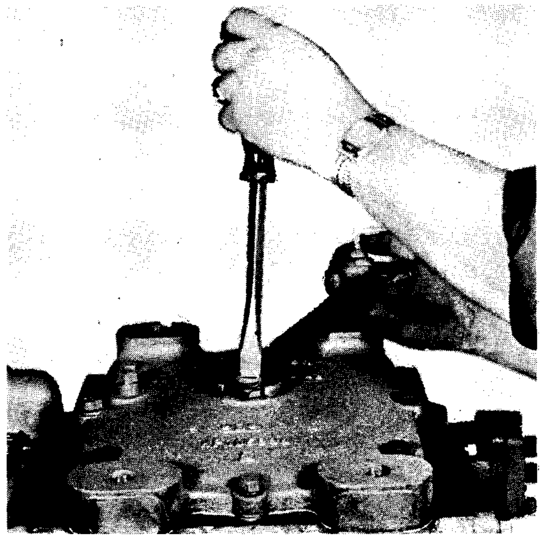


Illust. 13

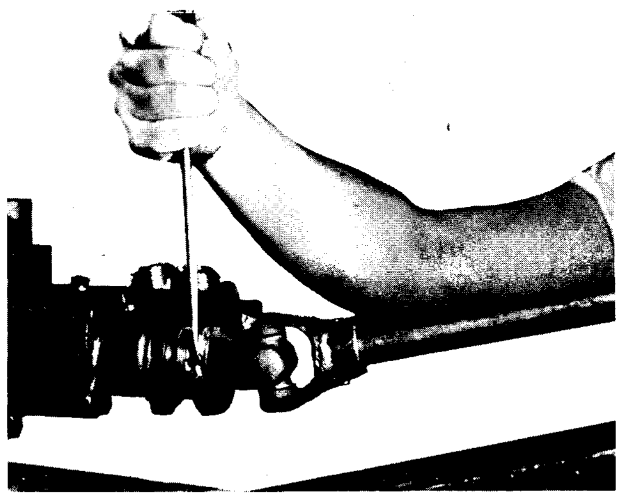


Illust. 14

Illust. 15



Illust. 16



Illust. 17

It is not necessary to remove the lower self-aligning bearing (Illust. 14) when removing the steering gear. However, if it is removed for any reason, be sure to reinstall the bearing with the longest end turned up. Install the grease fitting before tightening the cap screws in the bearing cap. The two lower cap screws in the drawbar bearing hold the self aligning bearing in position.

Install steering arm onto lever shaft (Illust. 15). IMPORTANT: Be sure to install steering arm onto shaft parallel with the center line of main frame.

To adjust backlash between stud bearing unit and cam, tighten set screw while at the same time slightly turn shaft clockwise and counterclockwise until a slight drag is obtained (Illust. 16). Tighten set screw jam nut securely.

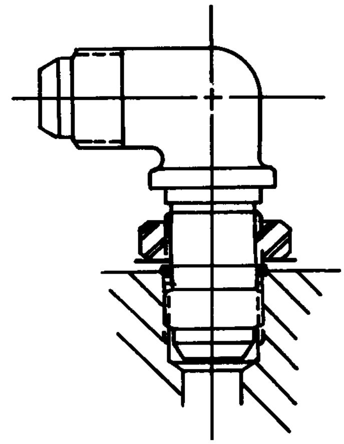
Align pin hole in universal joint with pin hole in cam shaft. Install universal joint onto cam shaft. Install pin and cotter pin. Spread cotter pin (Illust. 17).

Should it become necessary to remove steering arm for repair, be sure before installing arm, center lever shaft in housing.

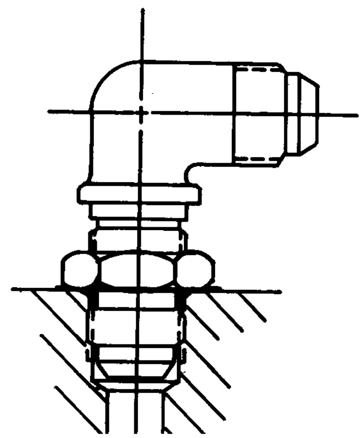
To center lever shaft in housing, count the number of turns required to turn steering wheel from one extreme to the other. Turn steering wheel in the opposite direction one half the total number of turns. Install arm to lever shaft parallel with the center line of the main frame. IMPORTANT: Fill steering housing with correct lubricant. See "Lubricating Instructions".

INSTALLATION OF HYDRAULIC LINES

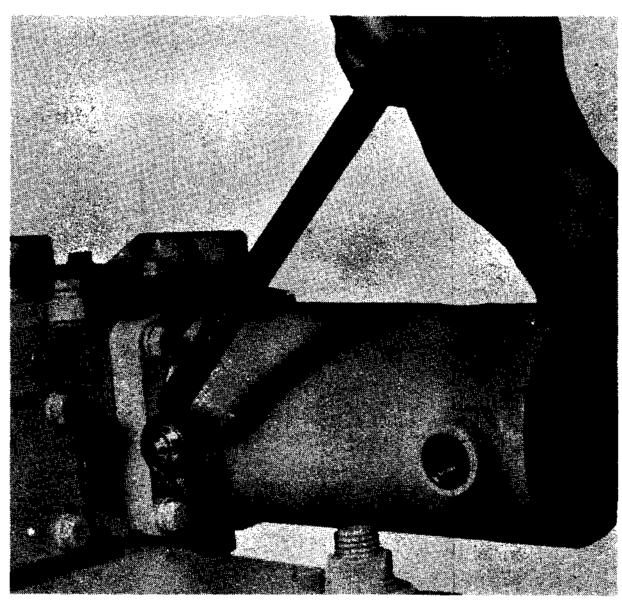
To install an elbow fitting, run nut and washer on fitting to clear gasket groove. Install gasket in groove, then screw fitting into boss until gasket contacts boss (Illust. 1). Unscrew fitting, not more than one turn, to desired position, then tighten lock nut (Illust. 2).



Illust. 1



Illust. 2



Illust. 3

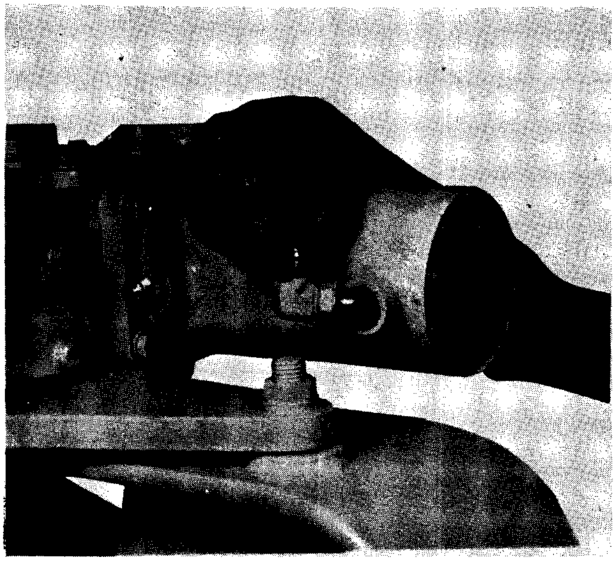
Straight fittings do not require positioning. To install straight fitting, install gasket in groove. Screw fitting tight against boss.

Install and tighten straight fitting into rear bore of cylinder (Illust. 3).

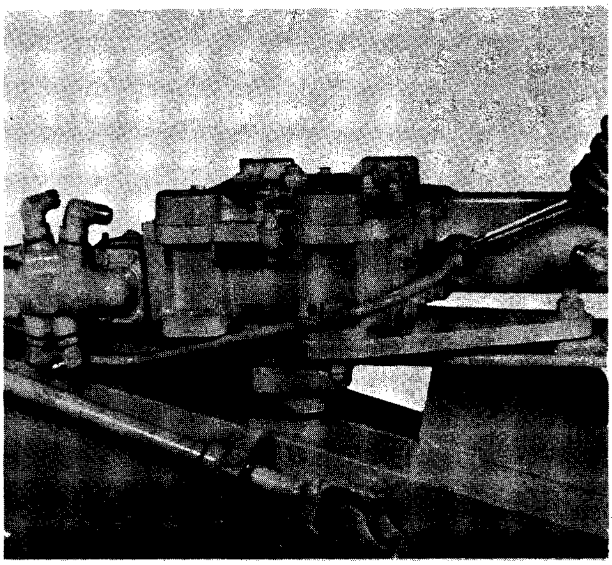
Install elbow fitting into front bore of cylinder (Illust. 4). NOTE Do not tighten nut until fitting is positioned.

Install elbow fittings into control valve (Illust. 5). Large diameter fittings into top bores of valve housing. NOTE: Do not tighten nuts until fittings are positioned.

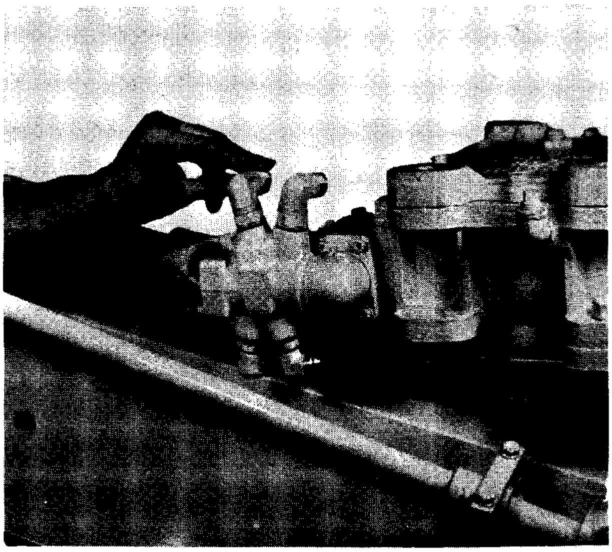
Install pressure line from straight fitting in cylinder to lower elbow in valve. Tighten line fittings securely (Illust. 6). Tighten elbow fitting nut securely (Illust. 7).



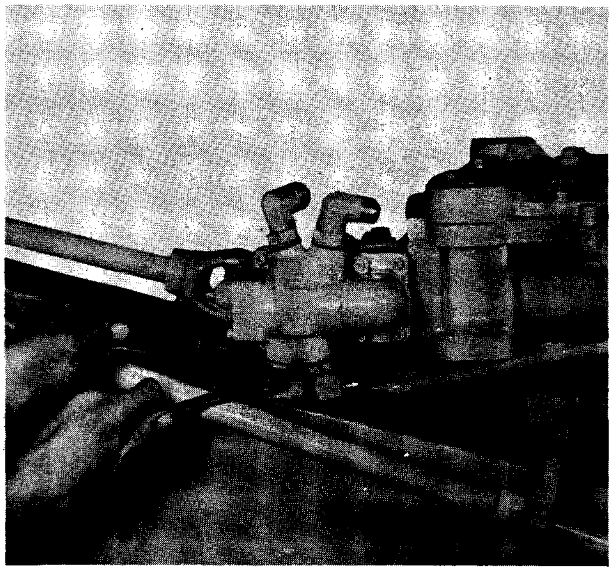
Illust. 4



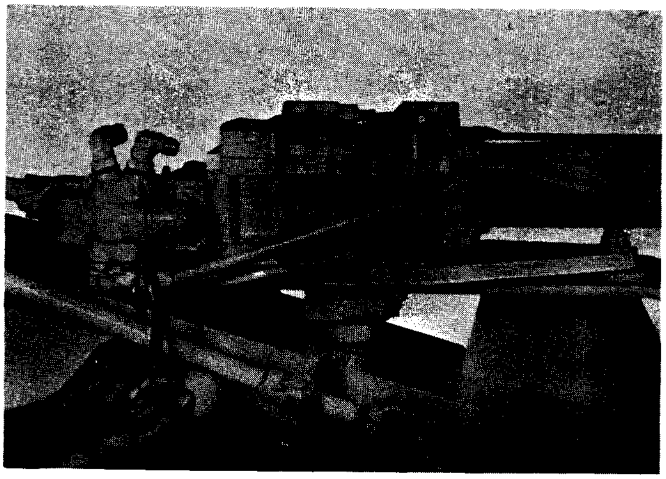
Illust. 6



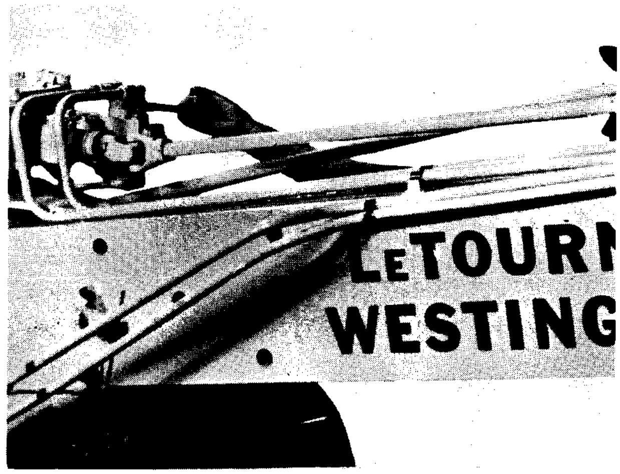
Illust. 5



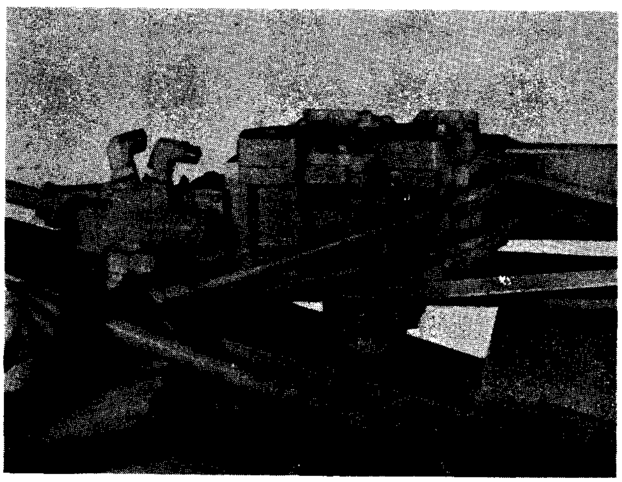
Illust. 7



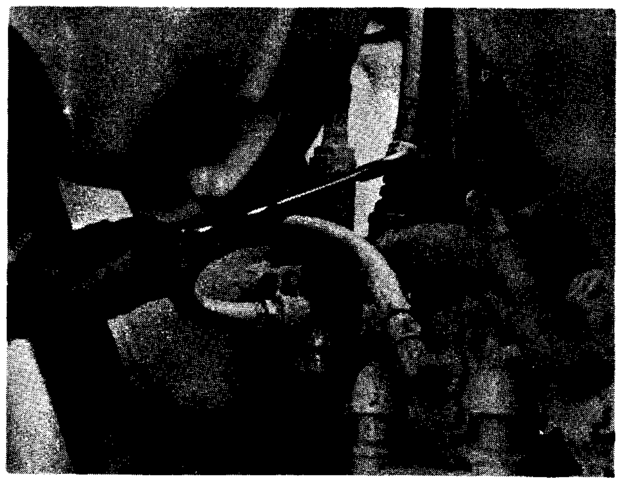
Illust. 8



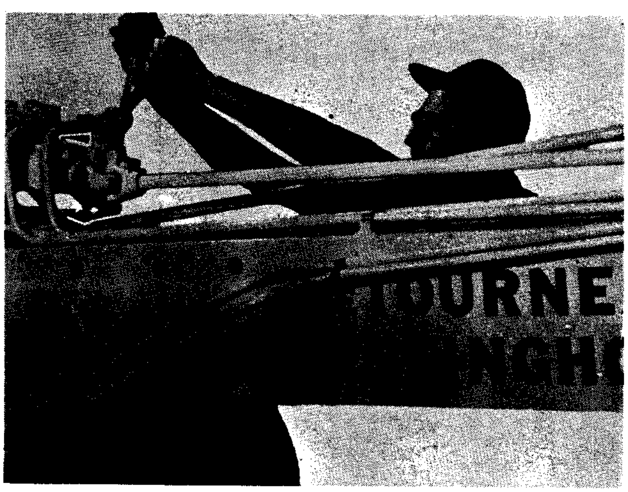
Illust. 11



Illust. 9



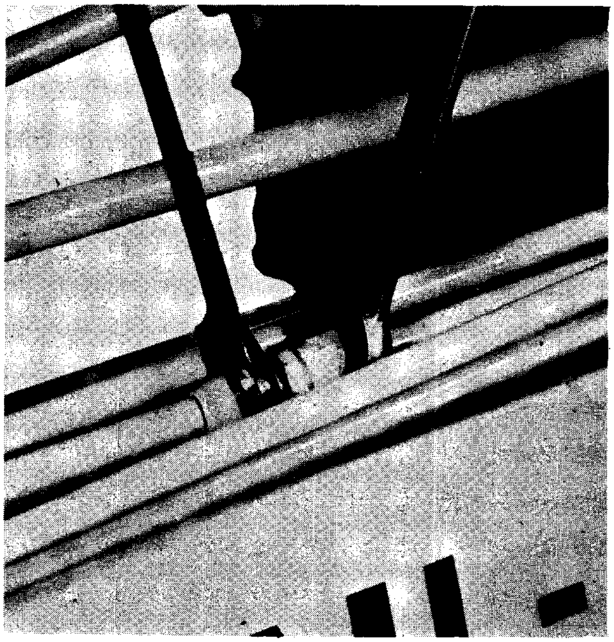
Illust. 12



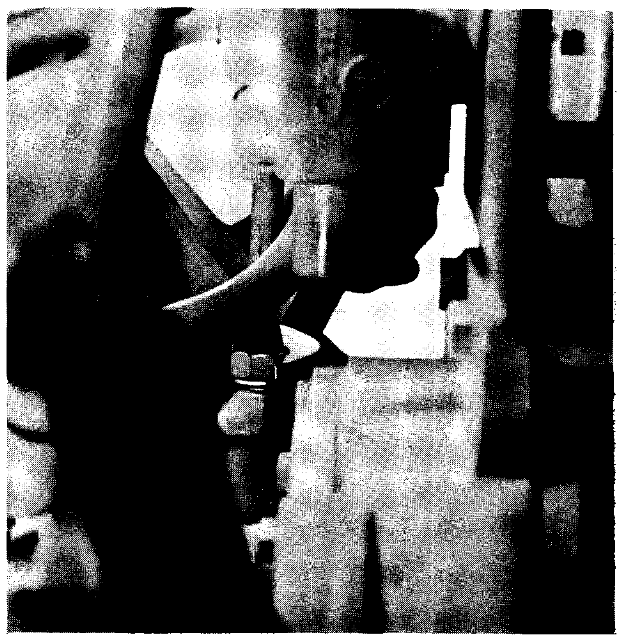
Illust. 10

Install second pressure line from elbow fitting in cylinder to lower elbow fitting in control valve. Tighten line fittings securely (Illust. 8). Tighten both elbow fitting nuts securely (Illust. 9).

Install both return and pressure lines to elbow fittings in top of valve and tighten securely (Illust. 10). The short return line nearest the edge of frame. The long pressure line toward center of frame. Tighten elbow fitting nuts securely (Illust. 11).



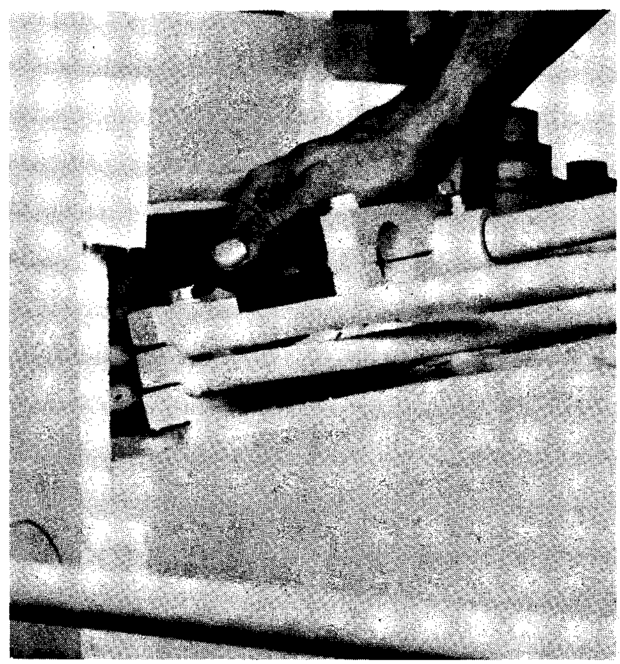
Illust. 13



Illust. 14

Install both rear sections of return and pressure line. The long rear section (return) nearest the edge of frame. The short rear section (pressure) toward the center of frame. Screw both line fittings into straight fittings of front sections, but do not tighten.

Illust. 15



Illust. 16

Install rear section of return line fitting to the straight fitting of tee at relief valve and tighten securely (Illust. 12). Now, tighten return line fittings on top of frame (Illust. 13).

NOTE: When installing hydraulic lines to fittings, be sure not to damage threads, also be sure lines are properly seated in clamps before tightening.

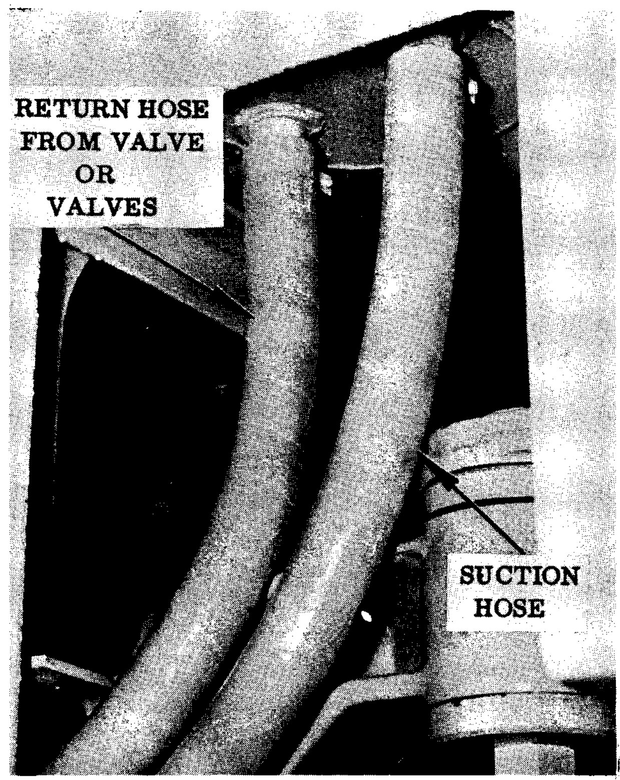
Illust. 17 is a view of the hydraulic hoses as they connect to the reservoir. This view will aid in the identification of the hoses. IMPORTANT: Fill reservoir with correct lubricant. See "Lubricating Instructions".

Install rear section of pressure line fitting to relief valve elbow and tighten securely (Illust. 14). Tighten pressure line fittings on top of frame (Illust. 15).

Install all hydraulic lines in clamp bases on frame. Install clamp, cap screws and lock washers. Tighten cap screws securely (Illust. 16).

FINAL ADJUSTMENT: Valve spool must actuate (moves axially in both directions). Center steering. Rotate steering wheel to move steering against stop. Apply sufficient effort to actuate spool.

Reverse steering against opposite stop to actuate spool in other direction.

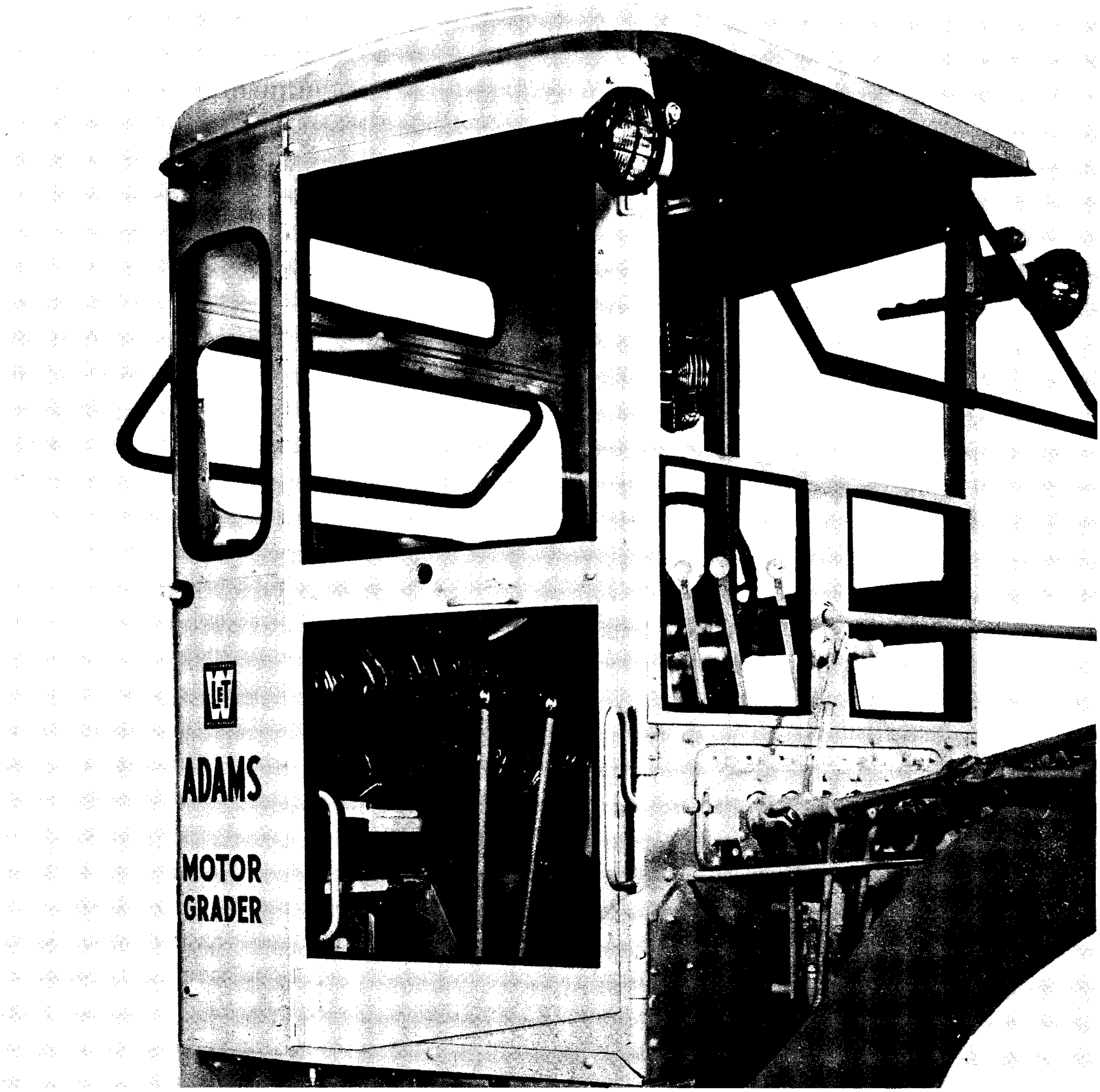


Illust. 17

Spool travel in each direction from center or neutral must be equal.

Recheck "Preliminary Adjustment" Page 28 in this Section, if travel is not equal.

Install end covers to spool body.



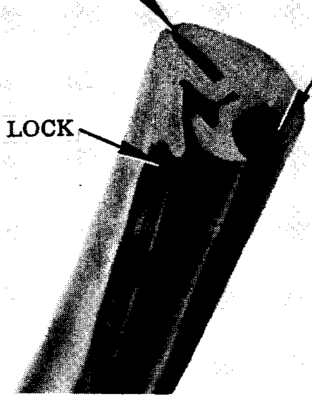
Illust. 1

Illust. 1 is a view of the operator's cab. Some machines are equipped with the "roadster" type cab but maintenance is very much the same. When installing a cab, install shims where needed and as needed between the cab and the mounting brackets on the frame to prevent the cab from being pulled out of shape when the mounting bolts are tightened. Also check to be sure there is no interference between any of the controls and the frame or lower side of the cab.

GLASS INSTALLATION

When installing glass, care must be taken not to crack glass or damage rubber channel.

There are two types of rubber channel used for installing glass in the cab. One type is the locking type (Illust. 1) and the other is the box type (Illust. 2).



Illust. 1

The locking type channel is used when installing the side glass and upper rear glass. A special tool (Illust. 3) is recommended for locking the channel. This tool is not listed in the tool kit, but may be ordered. The tool consists of a Filler Strip Handle (Adams part number 474414), Curled Bit (Adams part number 474415) and Straight Bit (Adams part number 474416).

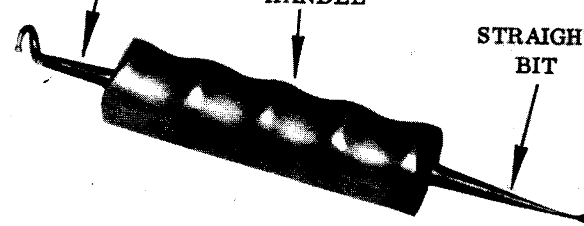
The box type channel is used when installing door glass and lower windshield glass. All that is needed to install this type channel is a piece of rope approximately 3/16" in diameter and 12 feet long.

Illust. 2

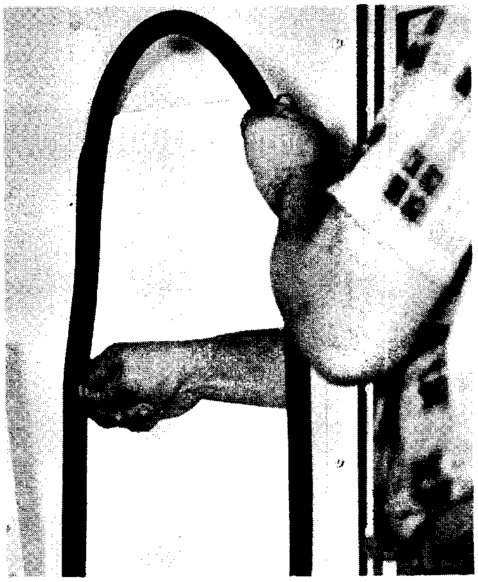
SIDE GLASS

Insert small groove of channel (Illust. 1) over edge of side opening in cab (Illust. 4). Lock of channel toward inside of cab. Channel to fit snug around opening.

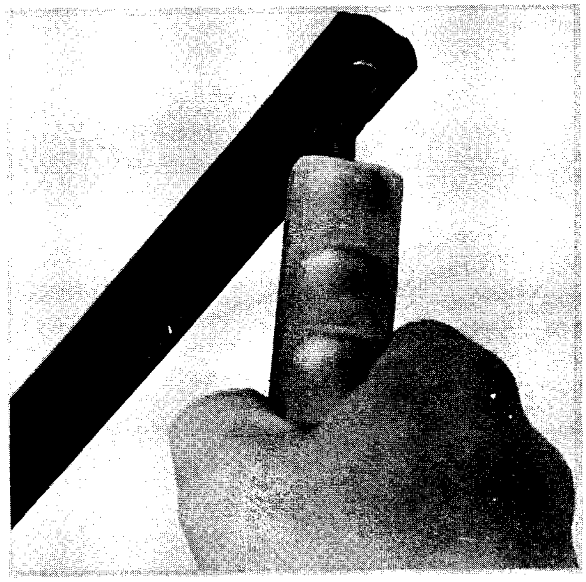
Insert one edge of glass into large groove of channel (Illust. 1). Using the straight bit of tool (Illust. 3), work channel around glass (Illust. 5). Care must be taken to prevent chipping or cracking of glass.



Illust. 3

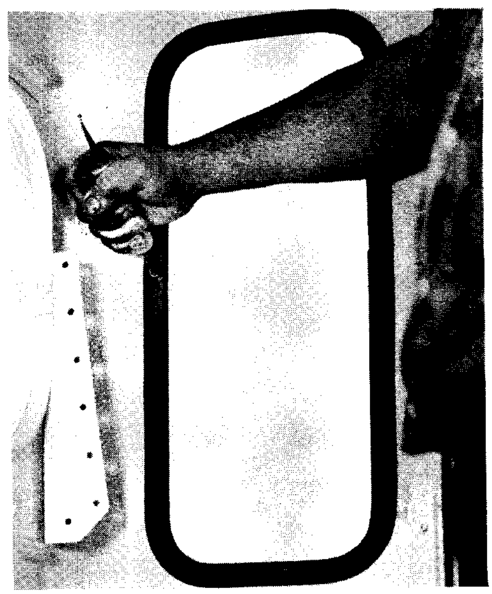


Illust. 4



Illust. 6

Illust. 5



Illust. 7

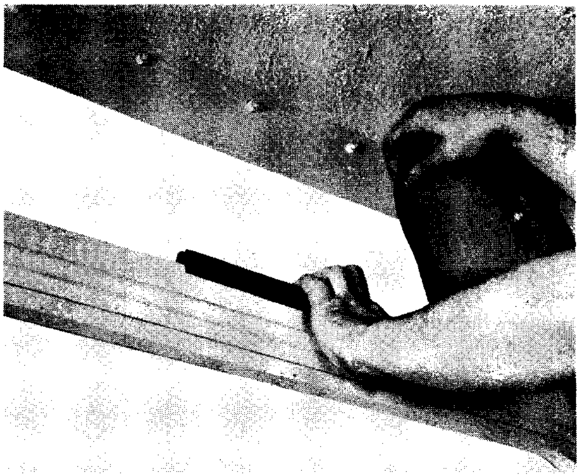
Insert curled bit of tool over lock (Illust. 3). Push knob of bit into locking groove (Illust. 6). By slightly

twisting tool clockwise and counterclockwise, work tool around channel (Illust. 7). This procedure will lock channel to glass and cab.

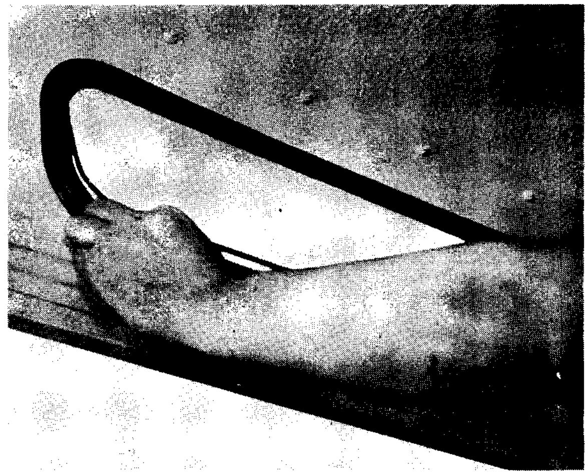
UPPER REAR GLASS

Insert small groove (Illust, 1) of channel over edge of upper rear opening of cab (Illust. 8). Lock of channel toward inside of cab. Channel to fit snug around opening.

Insert one edge of glass into large



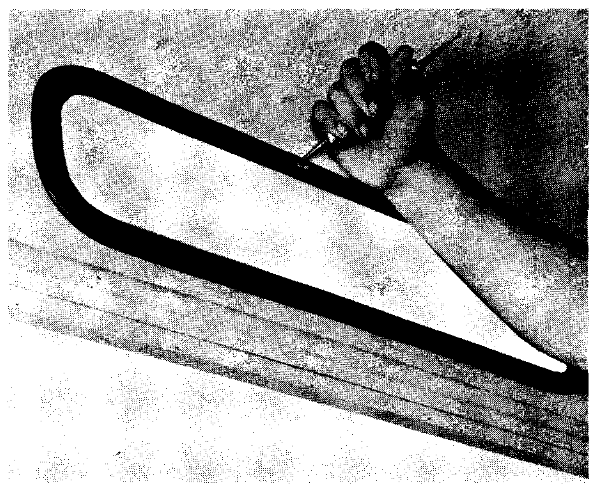
Illust. 8



Illust. 9

groove (Illust. 1) of channel (Illust. 9). Using the straight bit of tool (Illust. 3) work channel around glass. Care must be taken to prevent chipping or cracking of glass.

Insert curled bit of tool over lock (Illust. 3). Push knob of bit into locking groove of channel (Illust. 6). By slightly twisting tool clockwise and counterclockwise, work tool around channel (Illust. 10). This procedure will lock channel to glass and cab.

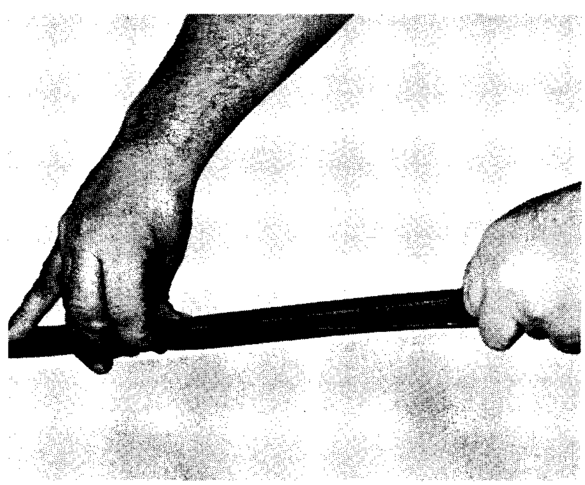


Illust. 10

CAB DOOR GLASS

As you will note, the box type channel has a rounded side and a straight side. The rounded side of channel is to fit over the outside of door opening (Illust. 2).

Starting at one corner of glass, install groove of channel over glass (Illust. 11). Care must be taken to prevent tearing corners of channel.



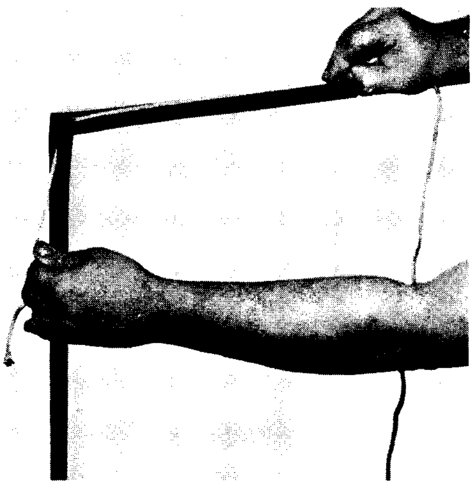
Illust. 11

Insert a piece of rope 3/16" in diameter by 12 feet long) into outside groove of channel (Illust. 12). Start rope at one corner. Using a small screw driver, push rope to bottom of groove around channel ending at starting corner. Let ends overlap at starting corner (Illust. 13).

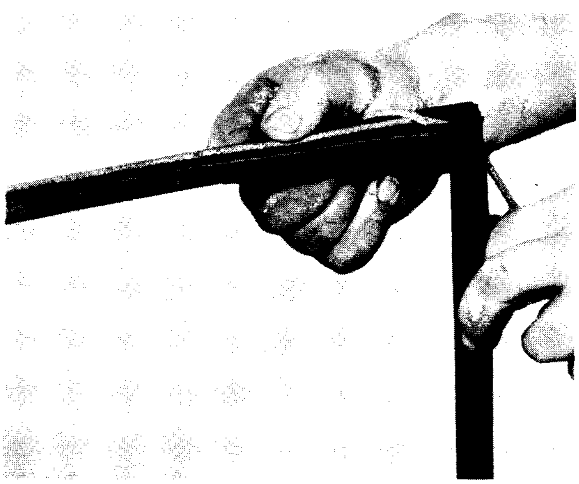
Place glass with channel against inside opening in door, straight side of channel (Illust. 2), toward inside of cab. Carefully, pull one end of rope until corner of channel starts over door opening edge. Next, pull on the other end of rope to bring corner completely over door opening edge (Illust. 14). Continue pulling each end of rope until rounded side of channel is locked over edge of opening (Illust. 15). Care must be taken when pulling rope around corners to prevent tearing of channel. Install the lower door glass in the same manner.

LOWER FRONT WINDSHIELD GLASS

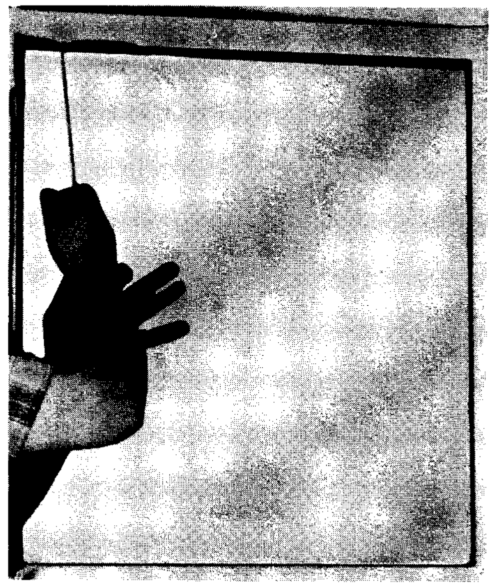
Installation of the lower front windshield glass to cab is the same as installation of the door glass.



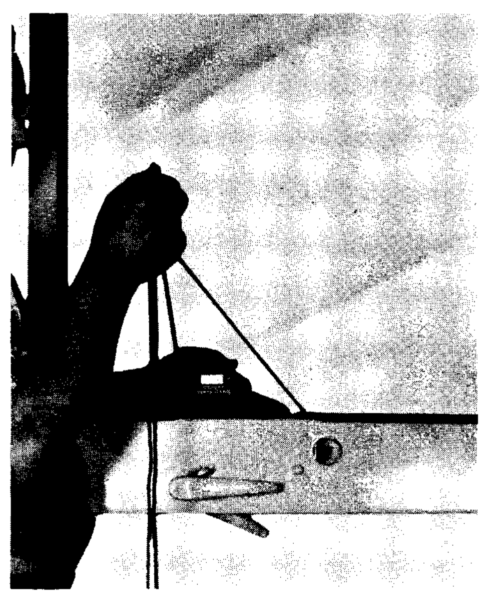
Illust. 12



Illust. 13



Illust. 14



Illust. 15

Starting at one corner of glass, install groove of channel over glass (Illust. 16). Care must be taken to prevent tearing corners of channel.

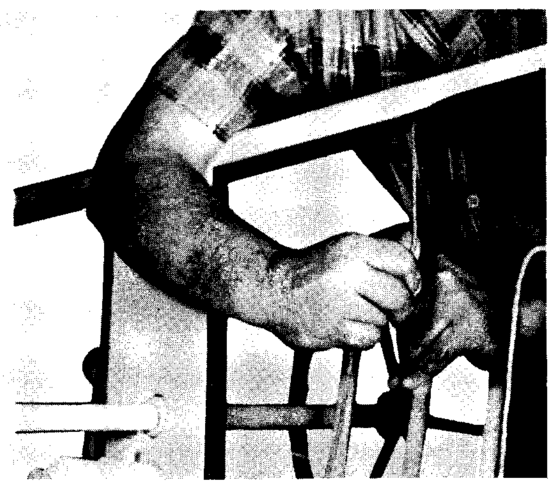
Insert a piece of rope (3/16" in diameter by 12 feet long) into outside groove of channel. Start rope at one corner. Using a small screw driver, push rope to bottom of groove and around channel, ending at starting corner. Overlap ends of rope at starting corner (Illust. 17).

Place glass with channel against opening in lower windshield frame. Straight side of channel toward inside of cab. Carefully, pull one end of rope until corner of channel starts over opening edge (Illust. 18). Pull the other end of rope to bring corner completely over opening edge. Continue pulling each end of rope until channel is locked over edge of opening. Care must be taken when pulling rope around corners to prevent tearing of channel.

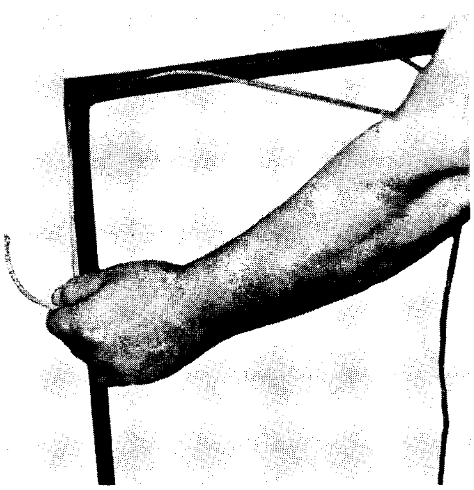
REAR WINDSHIELD

Position rear windshield to rear opening of cab. Align holes in hinge with

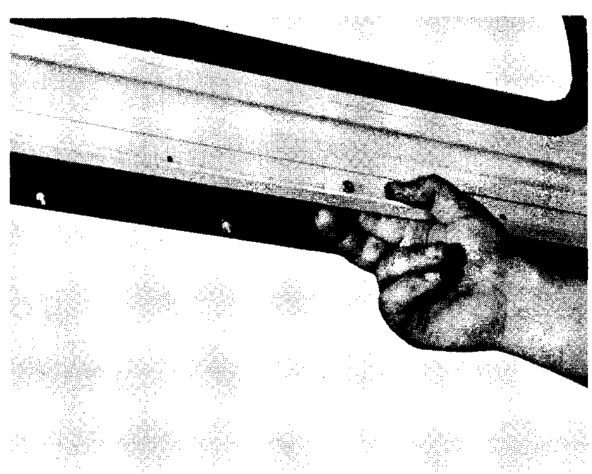
Illust. 16



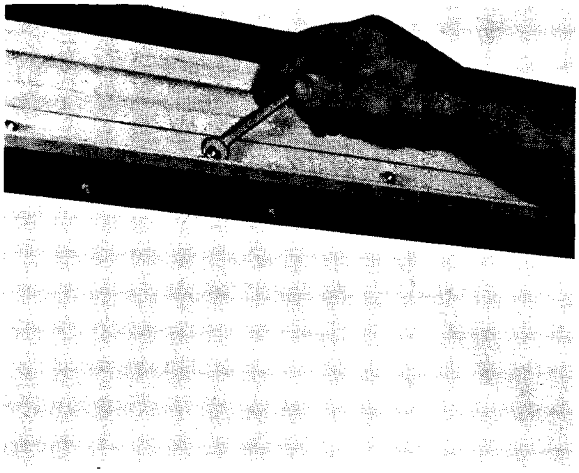
Illust. 18



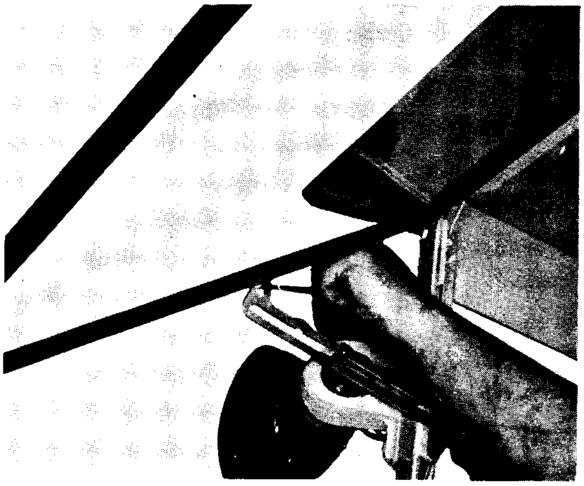
Illust. 17



Illust. 19

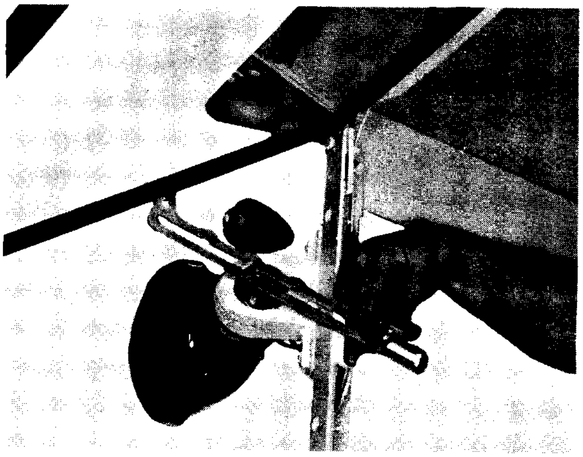


Illust. 20



Illust. 22

Illust. 21



Illust. 23

holes in cab. Insert cap screws, lock washers and nuts. Insert stay bars in ears of cab to hold rear windshield in place (Illust. 19). Tighten nuts securely (Illust. 20).

FRONT WINDSHIELD

Insert lip of windshield into lip of hinge (Illust. 21). Using a slight upward and downward movement, push windshield lip through lip of hinge until windshield is centered in opening.

Install windshield stay bars. Install stay bar pivot cap screws and tighten (Illust. 22).

Install adjusting wing nuts through slot in stay bars and through brackets (Illust. 23).

— NOTES —

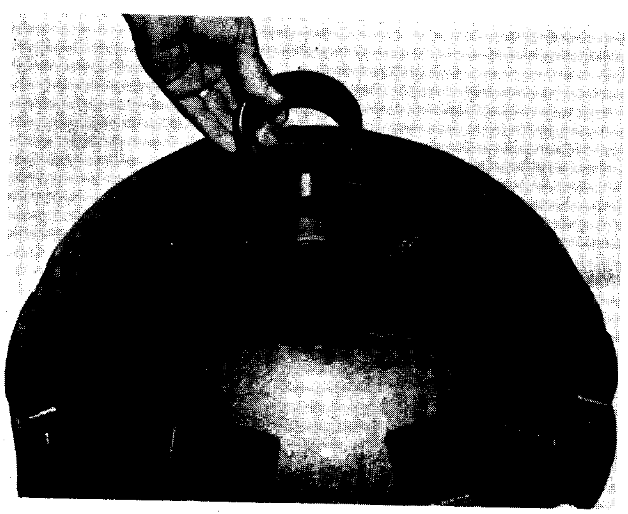
WHEELS

The wheels of a motor grader require very infrequent repair, due to their design and construction. Front wheels require more attention than rear, due to the necessity of cleaning, repacking and readjusting front wheel bearings at regular intervals. The frequency with which these operations are carried out depends upon the working conditions.

When it becomes necessary to clean, repack and adjust front wheel bearings, front wheels must be completely removed from the spindles. To remove the wheels, remove the hub caps, drilled bolt through wheel nut, wheel bearing nut and outer wheel bearing.

Instructions and illustrations described in this section outlines the reassembly procedure. To disassemble, reverse reassembly procedure.

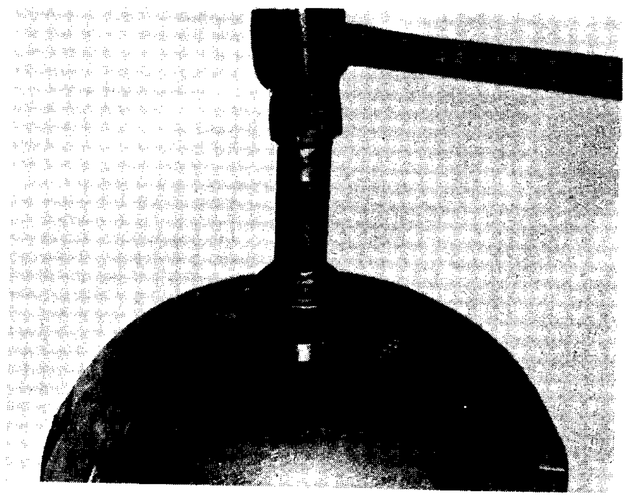
Inspect all parts for excessive wear, chipping or other damage.



Illust. 1

Install front wheel outer cup into wheel (Illust. 1). Thin edge of cup toward outside of wheel. Next, drive cup into wheel until cup strikes snap ring (Illust. 2).

Turn wheel over and install inner front wheel cup (Illust. 3). Thin edge of cup away from snap ring. Drive cup into wheel until cup strikes snap ring (Illust. 4).



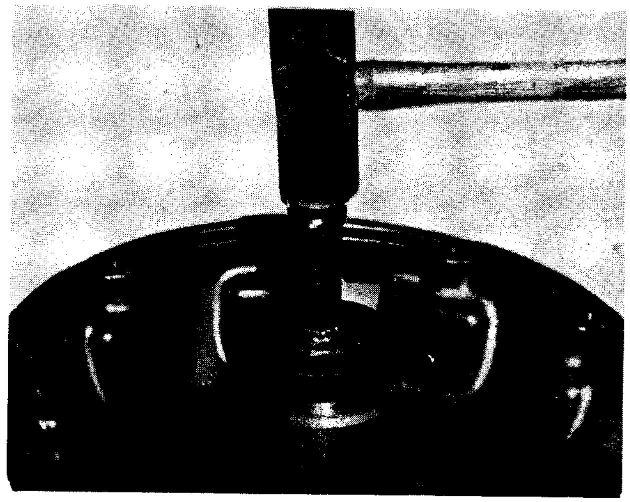
Illust. 2

Illust. 3

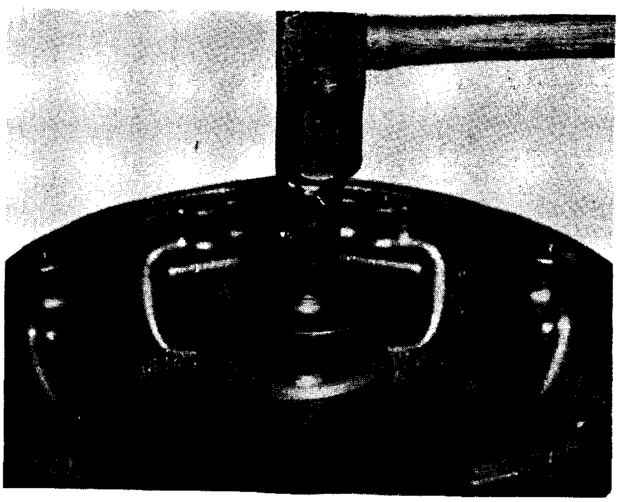
Install felt retainer into wheel (Illust. 5). Drive retainer into wheel, using care to prevent damaging edge of retainer (Illust. 6).

Install felt washer and spacer onto spindle (Illust. 7). IMPORTANT: Be sure felt washer fits over shoulder of spacer. Also, dowel pin hole in spacer to fit on dowel pin in spindle.

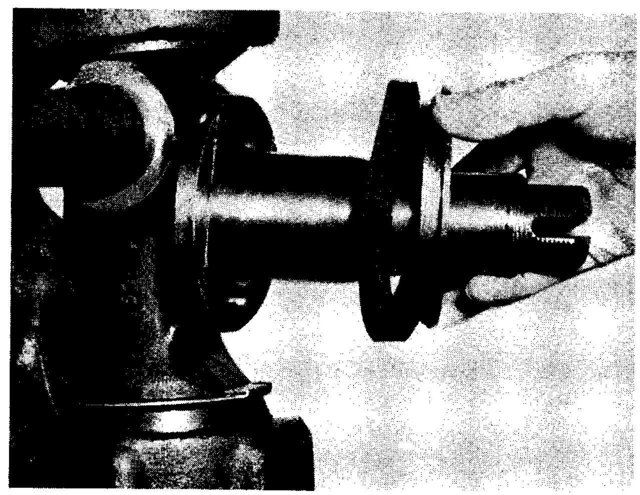
Drive inner bearing onto spindle until bearing is against spacer (Illust. 8). Tapered end of bearing toward threaded end of spindle.



Illust. 6

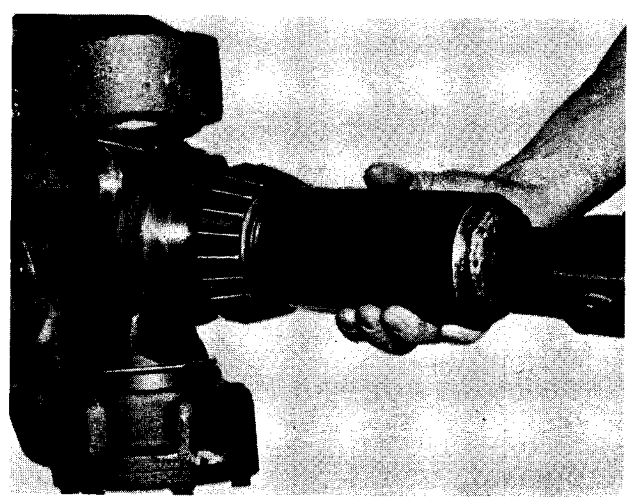


Illust. 4

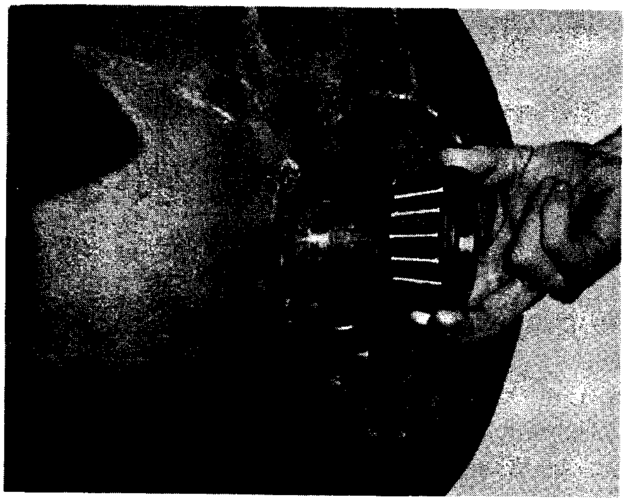


Illust. 7

Illust. 5



Illust. 8

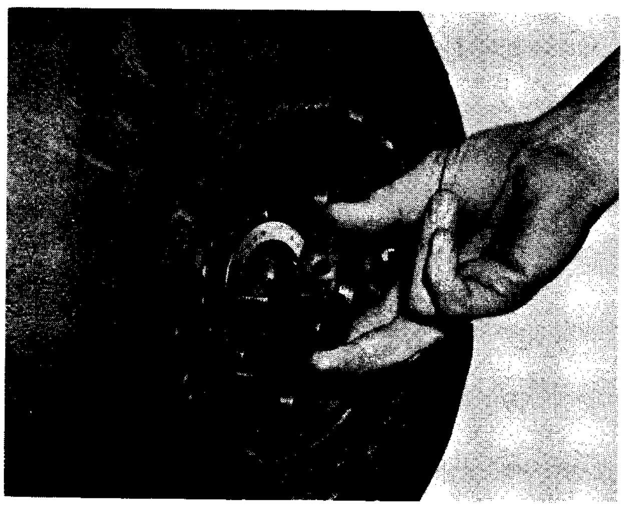


Illust. 9

Install wheel onto spindle and install outer bearing onto spindle and into wheel (Illust. 9). Drive bearing into place.

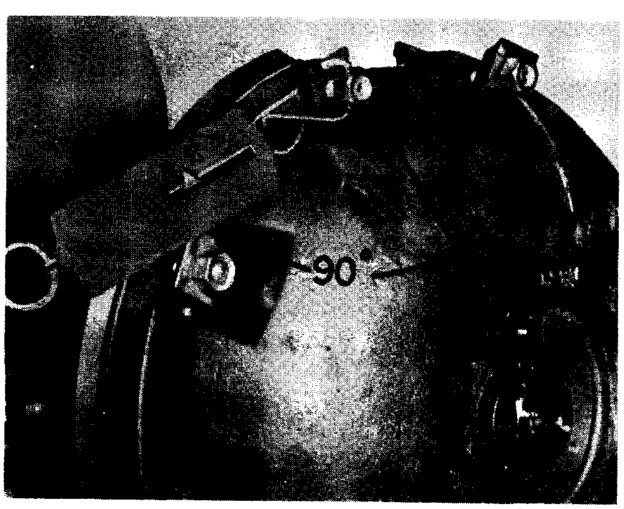
Install wheel bearing nut (Illust. 10). Install a fish scale on a stud (Illust. 11). Pull on fish scale, while at the same time, tighten nut until a 10 to 20 pull poundage is obtained. NOTE: Fish scale should always be pulled in a line 90 degrees to center line of wheel.

When pull poundage is obtained, install drilled bolt through nut (Illust. 12).
NOTE: If hole in nut is not in line with slot in spindle, loosen nut to nearest hole.

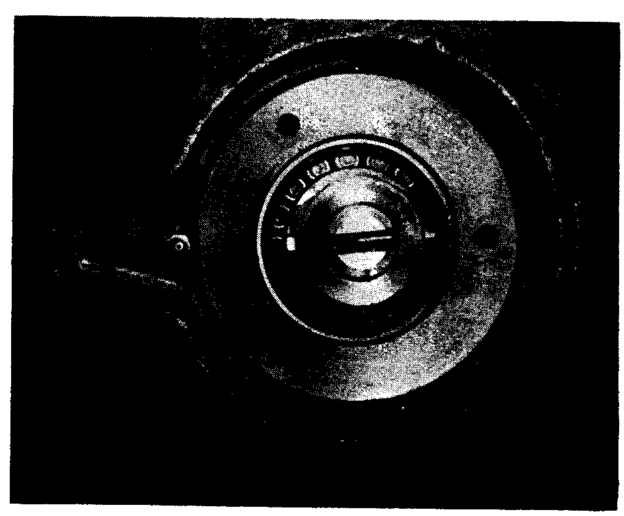


Illust. 10

Illust. 12



Illust. 11



Illust. 13

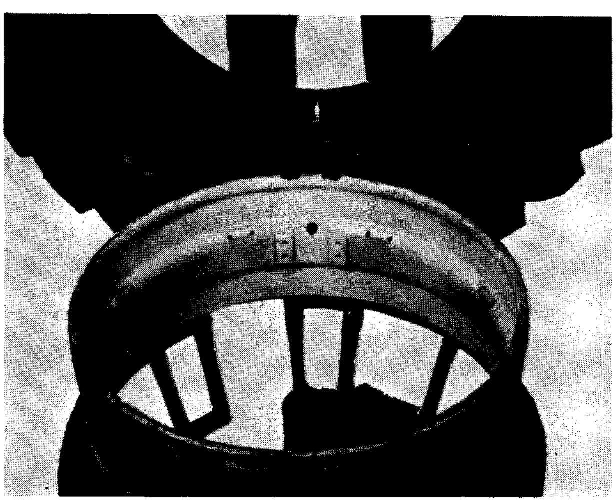
Install slotted nut on drilled bolt. Tighten nut securely. Install cotter pin and spread (Illust. 13).

TIRE MOUNTING

Installation of a front tire is similar to that of the rear. In the following instructions and illustrations, a tire is shown being mounted on a rim.

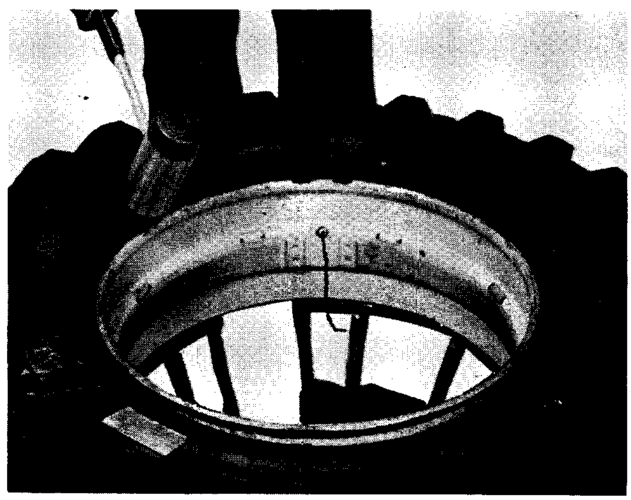
Note and follow any mounting instructions molded onto the side wall of tire, Most "tractor type" treads must be mounted to run one way for traction or driving and the opposite way for free rolling wheels. Be sure to mount each tire to run in the proper direction for the individual wheel on which tire will be used.

Install inner tube with valve stem off center (Illust. 1). The tube is molded and the valve stem mounted to one side. Be sure the tube and stem are not placed in a strain by pulling the valve into place on the wrong side. Lay rim on a frame or blocks and lower tire onto rim. Rim must be supported high enough to prevent tire from resting on ground.

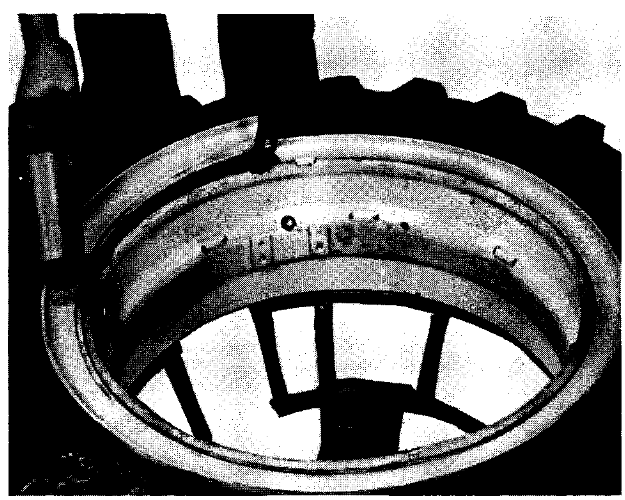


Illust. 1

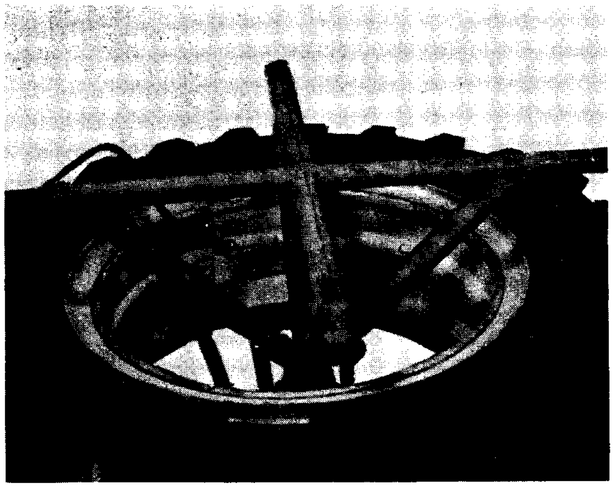
As tire is lowered onto rim, it will be necessary to draw valve stem into valve hole in rim. A variety of tools are available for this purpose, the usual one being a chain and cap which screws onto end of valve stem. This type of tool is shown being used in Illust. 2.



Illust. 2



Illust. 3



Illust. 4

To prevent loosing valve stem back through hole in rim, slide outside bead of tire over rim. It will be found much easier if bead is pressed down to the center of rim on one side, while it is being worked over rim on opposite side. Install lock ring (Illust. 3). Care should be taken when installing lock ring not to spring it more than necessary to install it. Be sure lock ring is properly seated and that lugs on ring enter into notches in rim.

Inflate the tire (Illust. 4) to pressure specified in tire inflation chart. When inflating tire, always take precautions against possible injury by the lock ring snapping off due to pressure. If lock ring has been properly installed, it should not snap off. However, to prevent any danger of possible serious injury, roll tire and rim into a frame before inflating. NOTE: Do not over inflate.

When mounting tires and wheels on grader, be sure that they run true within 1/4" on front wheels and 1/2" on rear wheels. If tires run out of true (wobble) more than this maximum, it will cause excessive tire wear. This dimension should not be confused with camber or toe-in which is described under front axle. "Wobble" of wheels can be corrected by proper tightening of lug nuts.

Always keep valve caps on valve stems. If a tire is operated without the valve cap installed, dirt and water will enter valve, causing it to leak.

When operating the grader on black top work, clean all oil and dirt from tire daily. Oil will cause rubber to become spongy and will bring about short tire life. For proper method of removing oil from tires, see your local authorized dealer for the tires which are being used.

Keep tires properly inflated at all times. Over inflation will cause excessive wear in the center of the tread, while under inflation will break down the side walls and cause tread separation.

TIRE INFLATION CHART

7.50 x 24	(10 Ply)	60 Lbs.
9.00 x 24	(10 Ply)	50 Lbs.
10.00 x 24	(10 Ply)	45 Lbs.
12.00 x 24	(8 Ply)	30 Lbs.
13.00 x 24	(8 Ply)	25 Lbs.
13.00 x 24	(10 Ply)	30 Lbs.
13.00 x 24	(12 Ply)	35 Lbs.
14.00 x 24	(8 Ply)	25 Lbs.

NOTE: For maintenance work on established highways, inflation pressure may be increased 25% if desired.

— NOTES —

FUEL CONSUMPTION IN RELATION TO MAINTENANCE INTERVALS

A periodic maintenance schedule based on hours of operation cannot be established for these machines unless all machines are working under the same conditions.

The motor grader's use varies widely as to rate and type of work being done. A grader mixing surfacing material for a road may use from 20% to 35% of its power, while a grader doing ditching or grading on rough terrain may use from 50% to 75% of its power.

With other things being equal, the amount of wear should be proportional to the amount of work. Work is measured in horsepower hours and is obtainable from the fuel that is burned. Therefore, it is evident that a periodic maintenance schedule for the engine should be based on the gallons of fuel consumed.

The intervals for engine maintenance is given in gallons of fuel consumed. To convert this to an hourly interval it is necessary for the operator to determine his average fuel consumption per hour and convert the fuel consumed intervals to hourly intervals.

LUBRICATION

Correct lubrication of any machine is of prime importance in prolonging its life. Fuels, oil and greases should be of good quality and kept free of dirt, water or other foreign matter.

The proper S. A. E. weights of oil should be stocked and readily available for the prevailing operating temperatures. The S. A. E. viscosity numbering system classes as to its viscosity of fluidity only and has nothing to do with any other characteristic or property of the oil. The higher number denotes a thicker, heavier oil and the lower number denotes a lighter oil. All oil companies have adapted this standard of viscosity.

Use only high quality lubricating oils and greases. Select only those of recognized manufacturer.

Gear housings should be drained when they are warm. The oil will be thinner and will drain more completely, carrying any dirt that might be in suspension with it before it has a chance to settle.

In the following instructions and illustrations, cleaning operations are shown along with lubricating procedures because they are to be performed at the same time.

CRANKCASE LUBRICATING OIL SPECIFICATIONS

Engine is filled with a break-in oil suitable for "running-in" a new engine. Before operating under load, the crankcase should be drained completely and filled with oil specified in the "Lubricating Instructions" of the Engine Manufacturer's Operators and Maintenance Manual.

S.A.E. NUMBERS OR VISCOSITY OF OIL RECOMMENDED

Use Engine Manufacturer's Operators and Maintenance Manual for recommended S.A.E. number or viscosity of oil for engine. For air cleaner, use same S.A.E. number or viscosity of oil that is used in the engine.

HYDRAULIC SYSTEM

The capacity of tank does not represent the quantity of oil required to operate the Hydraulic System. Oil requirement varies according to machine's hydraulic equipment.

Never start engine if in doubt regarding oil in Hydraulic System. Check oil level, add oil if necessary. Start engine, operate hydraulic equipment one (1) time and recheck oil level. Add additional oil if necessary.

AIR TEMPERATURE	RECOMMENDED VISCOSITY OF OIL
Above 32° F.	S.A.E. 20
32° F. to -25° F.	S.A.E. 10W
Below -25° F.	Drain oil out of Hydraulic Reservoir and replace with an equal quantity of fuel oil. Remove diluted oil at end of cold season.

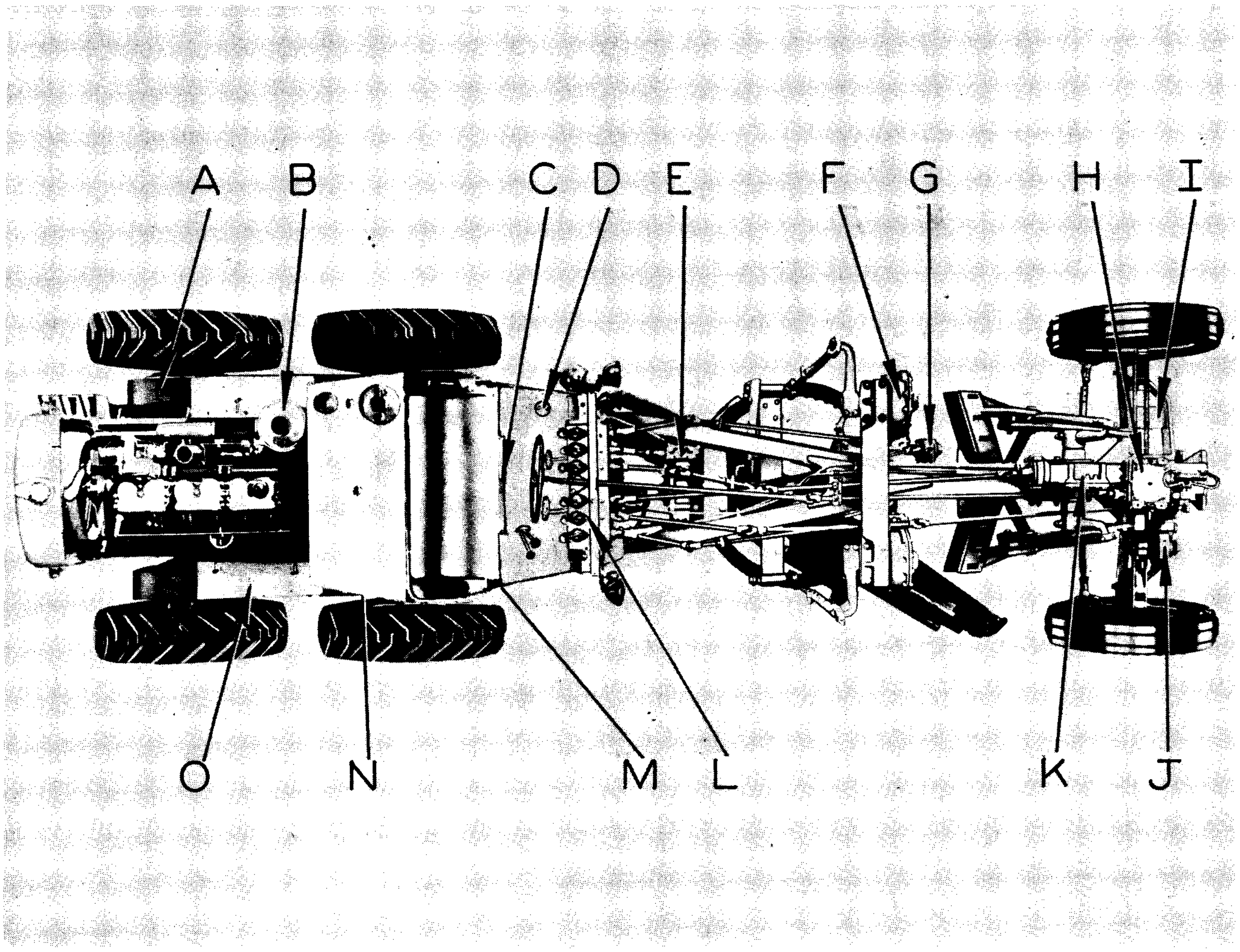
OIL CAN POINTS

Points on the machine that do not have fittings, such as clevis pin and yoke joints, etc., should be lubricated occasionally with a light grade of engine oil applied with a hand oil can. The interval of application should be dependent upon the amount of use the motor grader receives. When oiling such items as starter, linkage, etc., care should be taken to prevent oil from coming in contact with the insulation on wiring. Oil will cause rubber and some types of insulation to deteriorate, making replacement of the wiring necessary.

LUBRICATION FITTING (HAND LUBRICATOR) GREASE

Use pressure gun grease (Lithium-soap base #2 Consistency) for lubricating fittings on which the hand lubricator (pressure gun) is applied.

In the following illustrations, the letter "D" indicates a drain plug. The letter "L" indicates a level plug. The letter "F" indicates a fill plug. The letters "FL" indicates fill and level plug. In each case, they refer to the plug to which the arrow points. All plain arrows refer to pressure gun lubrication points.



LUBRICATION REFERENCE CHART

Familiarize yourself as soon as possible with all points on the grader which should be lubricated. The reference chart above will help you. The letters on the chart indicate general locations of lubrication points -- for detailed instructions, see illustrations on following pages which are identified by corresponding letters. For type of lubricant to be used in each gear housing, refer to "Table of Housing Capacities".

TABLE OF HOUSING CAPACITIES - MODEL 330

Illustration letters refer to lubrication chart and small detailed instructions on the following pages.

Picture Letters	Housings	Capacities U.S. Measure	Lubricant Recommended S.A.E. Weights
A	Tandems	3 Gals.	Engine Crankcase Oil S.A.E. 10
B	Air Cleaner (Oil Bath)	6-1/2 Pts.	Same Weight Oil As In Engine
**C	Upper Transmission & Shifter Housing	3 Gals.	Multi-Purpose Type Gear Lubricant
D	Master Cylinder	2-1/2 Pts.	Lockheed #21
E	Lateral Shift Housing	15-1/2 Pts.	Special Lubricant
E	Lateral Shift Reduction Housing	3-1/2 Pts.	Special Lubricant
F	Lift Housings	3 Pts.	Special Lubricant
F	Lift Reduction Housings	3-1/2 Pts.	Special Lubricant
G	Circle Reverse Housing	2-1/2 Qts.	Special Lubricant
G	Circle Transfer Housing	2/3 Pt.	Multi-Purpose Type Gear Lubricant 90
**H	Steering Gear (Manual)	3-2/3 Pts.	Multi-Purpose Type Gear Lubricant
**H	Steering Gear (Power)	5 Pts.	Multi-Purpose Type Gear Lubricant
J	Front Wheel Lean Housing	2 Qts.	Special Lubricant
K	Scarifier Lift Housing	24-1/2 Pts.	Special Lubricant
K	Scarifier Lift Reduction Housing	1-1/2 Pts.	Special Lubricant
L	Power Box Housing	7 Pts.	Engine Crankcase Oil S.A.E. 30
**L	Power Box Drive Housing	5-1/2 Pts.	Multi-Purpose Type Gear Lubricant
**L	Power Box Drive Housing (With pump adapter)	7-3/4 Pts.	Multi-Purpose Type Gear Lubricant
**M	Lower Transmission	13 Gals.	Multi-Purpose Type Gear Lubricant

KEY: Engine Crankcase Oil - Heavy Duty Service DS - Meet U.S. Army Specifications MIL-L-2104A or equal.
Multi-Purpose Type Gear Lubricant - Meet U.S. Army Specifications MIL-L-2105 or equal.
Special Lubricant - Gallon Size - Adams Part Number 722324
Lubrication Grease - Lithium Soap Base #2 Consistency

**Air Temperature	Transmission	Power Box Drive Housing & Adapter	Steering Gear
Above 30° F.	Multi-Purpose Type Gear Lubricant 90	Multi-Purpose Type Gear Lubricant 90	Multi-Purpose Type Gear Lubricant 140
30° F. to 0° F.	Multi-Purpose Type Gear Lubricant 90	Multi-Purpose Type Gear Lubricant 90	Multi-Purpose Type Gear Lubricant 90
Below 0° F.	4 Parts Multi-Purpose Type Gear Lubricant 90 1 Part Diesel Fuel	4 Parts Multi-Purpose Type Gear Lubricant 90 1 Part Diesel Fuel	4 Parts Multi-Purpose Type Gear Lubricant 90 1 Part Diesel Fuel

TABLE OF HOUSING CAPACITIES - MODEL 440

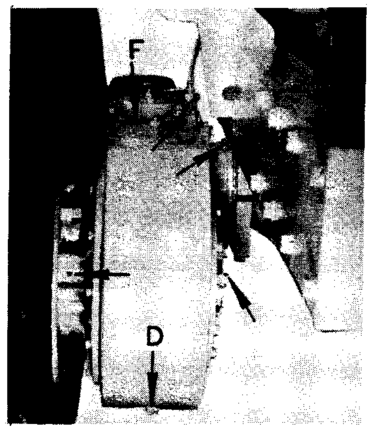
Illustration letters refer to lubrication chart and small detailed instructions on the following pages.

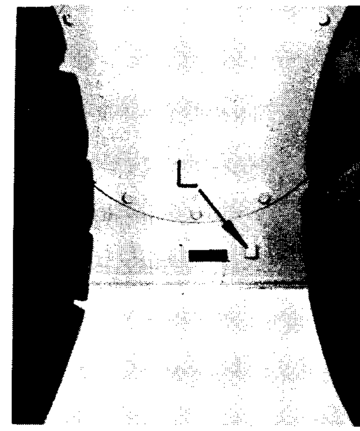
Picture Letters	Housings	Capacities U.S. Measure	Lubricant Recommended S.A.E. Weights
A	Tandems	4 Gals.	Engine Crankcase Oil S.A.E. 10
B	Air Cleaner (Oil Bath)	6-1/2 Pts.	Same Weight Oil As In Engine
**C	Upper Transmission & Shifter Housing	3 Gals.	Multi-Purpose Type Gear Lubricant
D	Master Cylinder	2-1/2 Pts.	Lockheed #21
E	Lateral Shift Housing	15-1/2 Pts.	Special Lubricant
E	Lateral Shift Reduction Housing	3-1/2 Pts.	Special Lubricant
F	Lift Housings	3 Pts.	Special Lubricant
F	Lift Reduction Housings	3-1/2 Pts.	Special Lubricant
G	Circle Reverse Housing	5 Pts.	Special Lubricant
G	Circle Transfer Housing	2/3 Pt.	Multi-Purpose Type Gear Lubricant 90
**H	Steering Gear (Manual)	3-2/3 Pts.	Multi-Purpose Type Gear Lubricant
**H	Steering Gear (Power)	5 Pts.	Multi-Purpose Type Gear Lubricant
J	Front Wheel Lean Housing	2 Qts.	Special Lubricant
K	Scarifier Lift Housing	24-1/2 Pts.	Special Lubricant
K	Scarifier Lift Reduction Housing	1-1/2 Pts.	Special Lubricant
L	Power Box Housing	7 Pts.	Engine Crankcase Oil S.A.E. 30
**L	Power Box Drive Housing	5-1/2 Pts.	Multi-Purpose Type Gear Lubricant
**L	Power Box Drive Housing (With pump adapter)	7-3/4 Pts.	Multi-Purpose Type Gear Lubricant
**M	Lower Transmission	13 Gals.	Multi-Purpose Type Gear Lubricant

<u>KEY</u>: Engine Crankcase Oil - Heavy Duty Service DS - Meet U.S. Army Specifications MIL-L-2104A or equal.
Multi-Purpose Type Gear Lubricant - Meet U.S. Army Specifications MIL-L-2105 or equal.
Special Lubricant - Gallon Size - Adams Part Number 722324
Lubrication Grease - Lithium Soap Base #2 Consistency

**Air Temperature	Transmission	Power Box Drive Housing & Adapter	Steering Gear
Above 30° F.	Multi-Purpose Type Gear Lubricant 90	Multi-Purpose Type Gear Lubricant 90	Multi-Purpose Type Gear Lubricant 140
30° F. to 0° F.	Multi-Purpose Type Gear Lubricant 90	Multi-Purpose Type Gear Lubricant 90	Multi-Purpose Type Gear Lubricant 90
Below 0° F.	4 Parts Multi-Purpose Type Gear Lubricant 90 1 Part Diesel Fuel	4 Parts Multi-Purpose Type Gear Lubricant 90 1 Part Diesel Fuel	4 Parts Multi-Purpose Type Gear Lubricant 90 1 Part Diesel Fuel

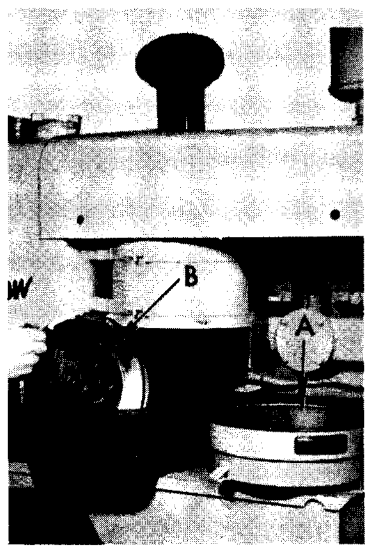
(A) TANDEMS: Drain at (D). Fill at (F) to level (L). Check oil level every 60 hours. NOTE: Tandem housing must be level when checking oil level. Lubricate fitting with five (5) strokes of pressure gun grease every $\boxed{60}$ hours. Change oil every 10,000 hours.

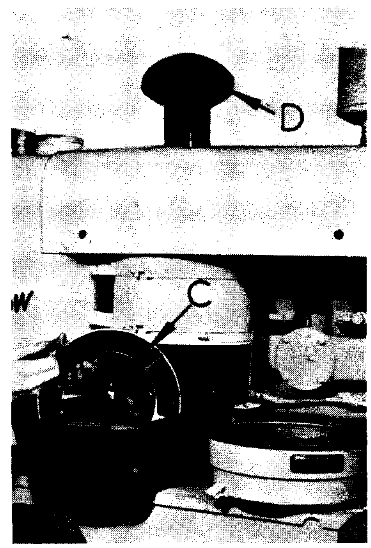


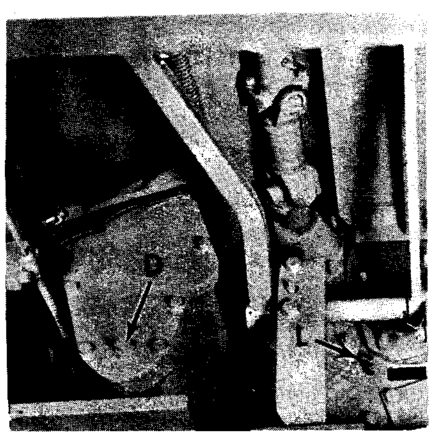


(B) AIR CLEANER: Remove oil cup (A) daily. Clean and refill. Disc (B) pre-filter (C) and air intake cap (D) should be kept clean at all times.

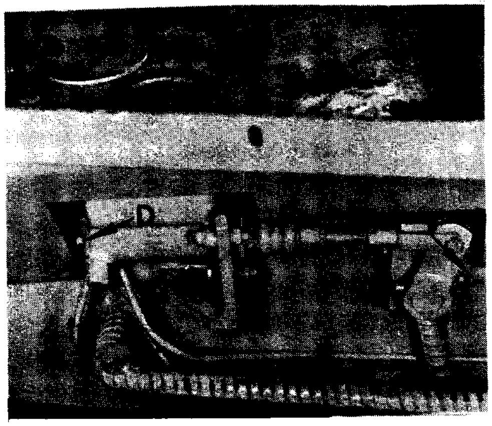
AIR CLEANER (DUO-DRY) (Not illustrated): Remove and empty dust cup daily or more frequently if dust conditions warrant.
WARNING: Do not use oil in dust cup. Air intake cap must be clean at all times.



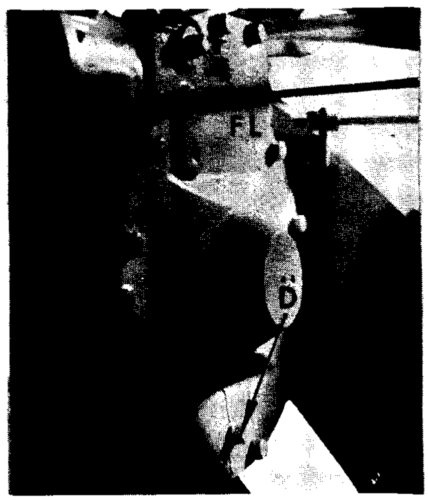




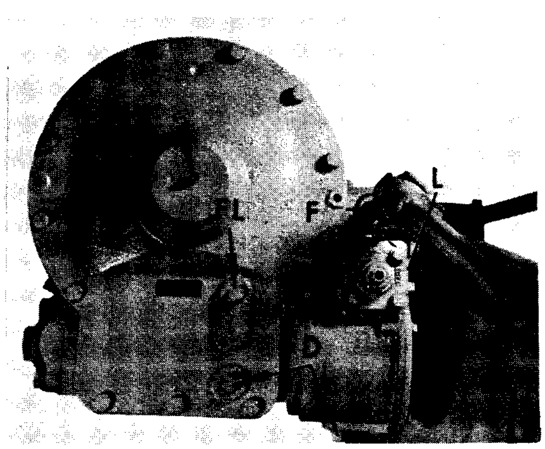
(C) UPPER TRANSMISSION AND SHIFTER HOUSING: Drain at (D). Fill at (F) to level (L). Check level every 60 hours. The shifter housing fills from the Upper Transmission.

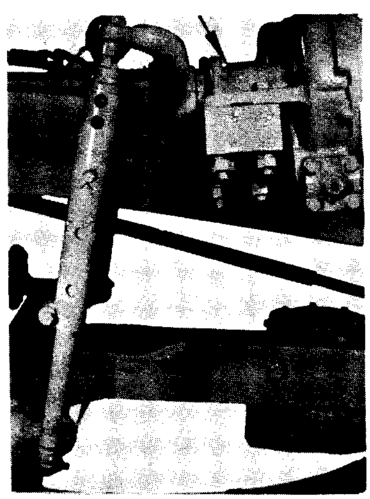


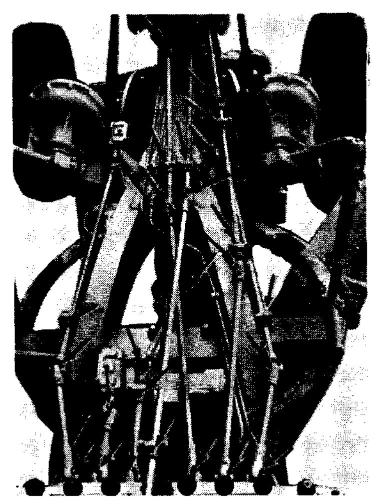
(D) BRAKE CYLINDER: Fill master cylinder at (F) as needed. Drain at (D). Check fluid every 10 hours. Lubricate fittings with five (5) strokes pressure gun grease every 10 hours.



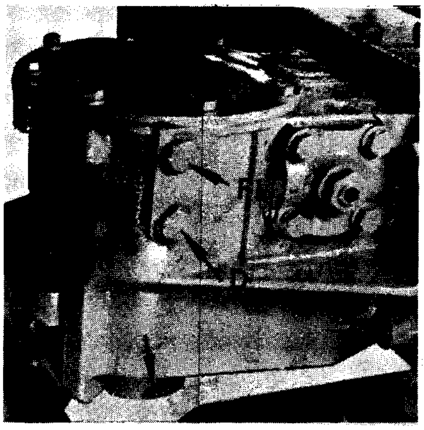
(E) LATERAL SHIFT: Drain housings at (D). Fill at (F) to oil level (L). Check oil level every 60 hours. Lubricate fittings with five (5) strokes pressure gun grease every 10 hours. Not necessary to change oil.

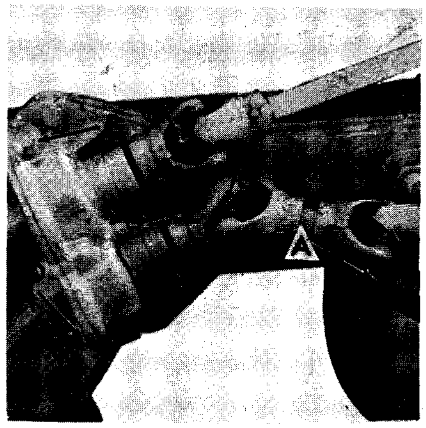


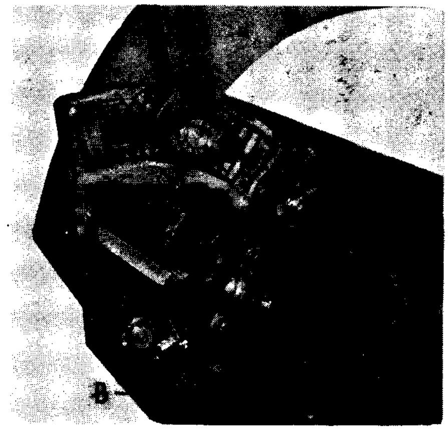


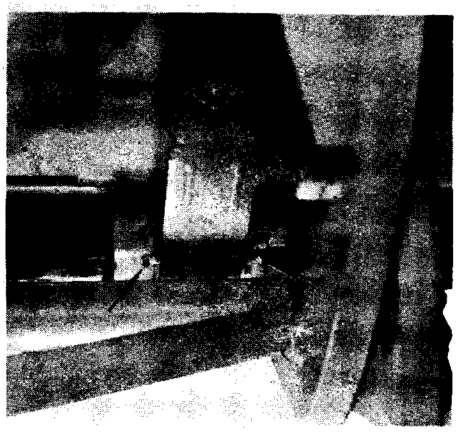


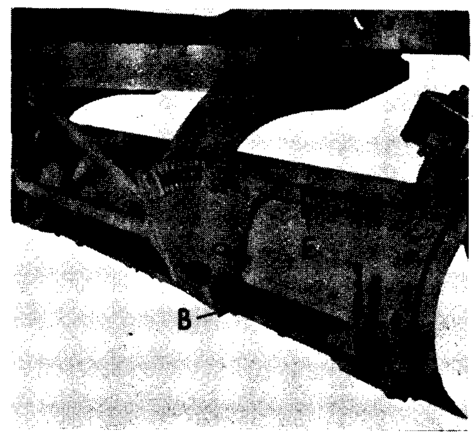
(F) MOLDBOARD LIFTS: Drain housings at (D). Fill at (F) to oil level (L). Check oil levels every 60 hours. Lubricate fittings with five (5) strokes pressure gun grease every 10 hours. Not necessary to change oil.





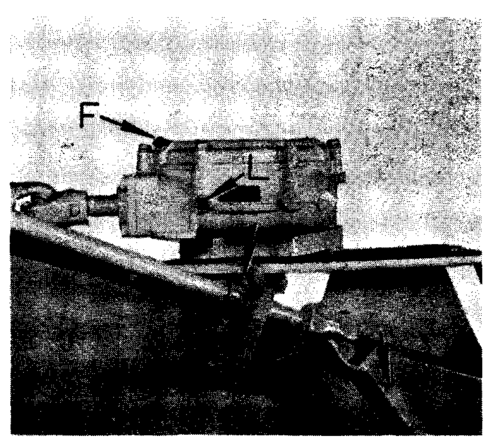


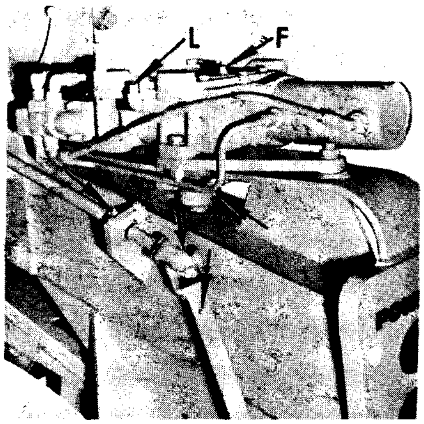


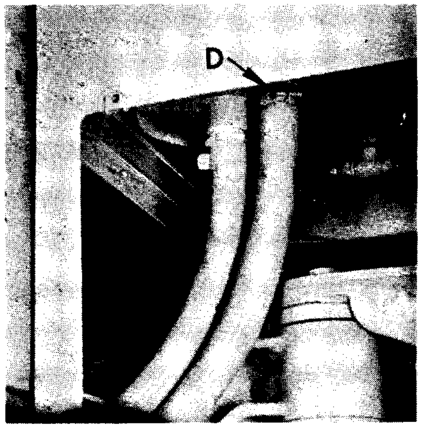


(G) CIRCLE REVERSE AND CIRCLE TRANSFER HOUSINGS: Drain at (D). Fill at (F) to oil levels (L). Check oil levels every 60 hours. Not necessary to change oil in Circle Reverse Housing. Change oil in Circle Transfer Housing every 5000 hours. Flush circle flange (A) and moldboard slide bar or bars (B) and (C) every 10 hours. Apply a coating of transmission oil to circle flange and moldboard slide bar or bars. Apply a coating of lubricating grease under slide angle (E). Lubricate fitting with five (5) strokes pressure gun grease every 10 hours.

(H) MANUAL STEERING GEAR: Fill steering gear at (F) to oil level (L). Lubricate fittings with five (5) strokes pressure gun grease every 10 hours. Check oil level every 60 hours. Change oil every 10,000 hours.

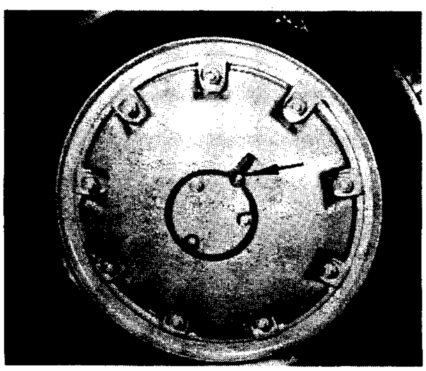


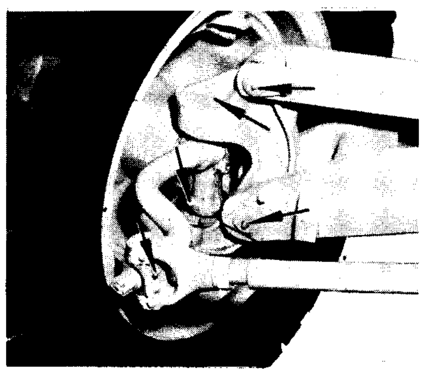


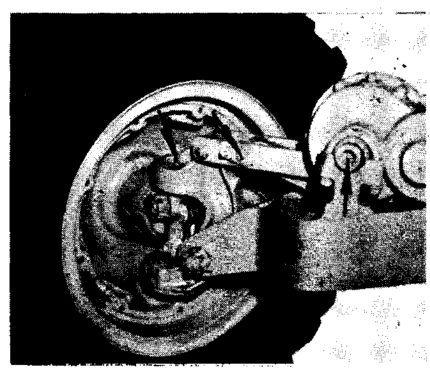


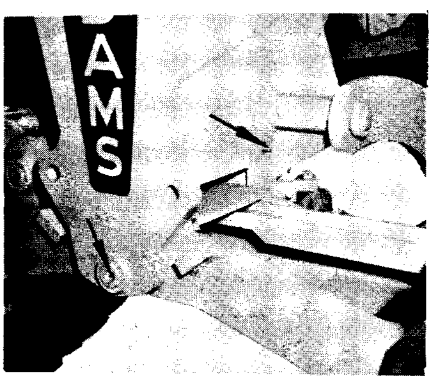
(H) POWER STEERING GEAR: Fill steering gear at (F) to oil level (L). Lubricate fittings with five (5) strokes pressure gun grease every 10 hours. Check oil level every 60 hours. Change oil every 10,000 hours.

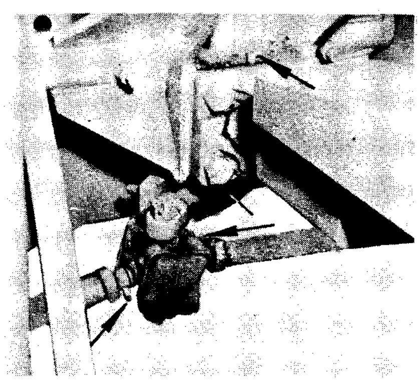
(H) HYDRAULIC RESERVOIR: Fill reservoir at (F) to markings on dip stick. Drain by removing hose as indicated by arrow. IMPORTANT: When installing cover and gasket, be sure that gasket is in recess of cover and that recess is over edge of reservoir.

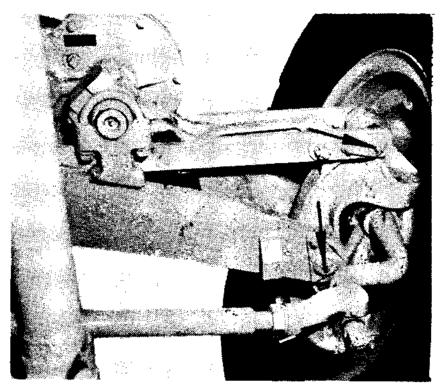






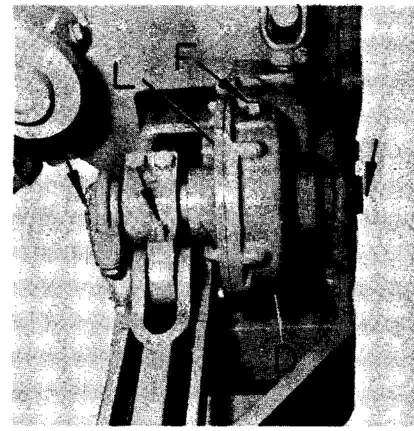




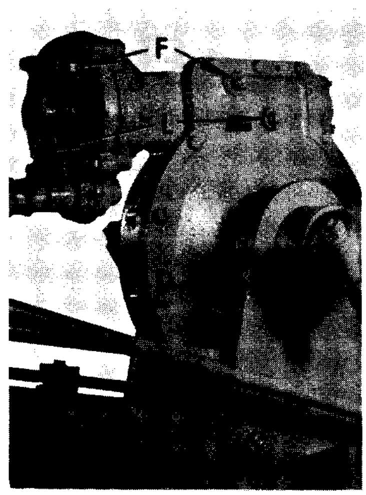


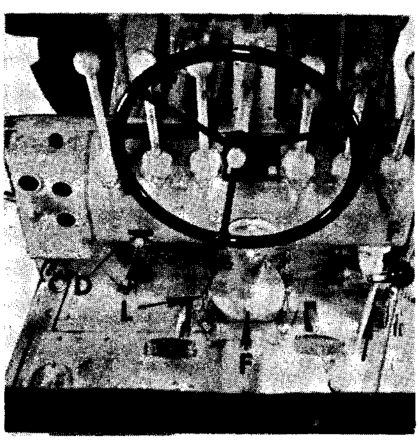
(I) FRONT AXLE: Lubricate fittings with five (5) strokes pressure gun grease every 10 hours.

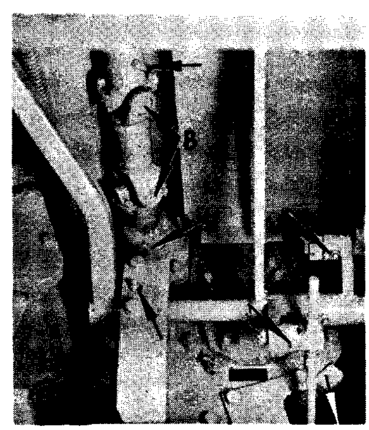
(J) FRONT WHEEL LEAN: Drain at (D). Fill at (F) to oil level (L). Check oil every 60 hours. Lubricate fittings with five (5) strokes pressure gun grease every 10 hours. Not necessary to change oil.



(K) SCARIFIER: Drain at (D). Fill at (F) to oil level (L). Check oil levels every 60 hours. Lubricate fittings with five (5) strokes pressure gun grease every 10 hours. Not necessary to change oil.



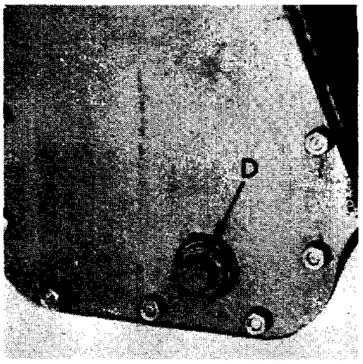


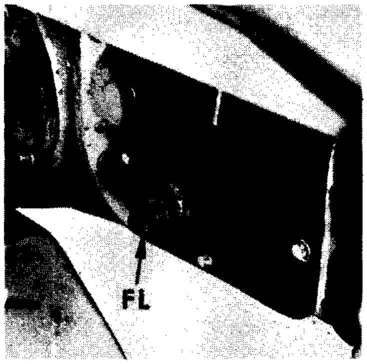


(L) POWER BOX: Drain at (D). Fill at (F) to oil level (L). Check oil level every 60 hours. Change oil every 5000 hours.

(L) POWER BOX DRIVE: Drain at (D). Fill at (F) to oil level (L). Check oil level every 60 hours. Change oil every 5000 hours.

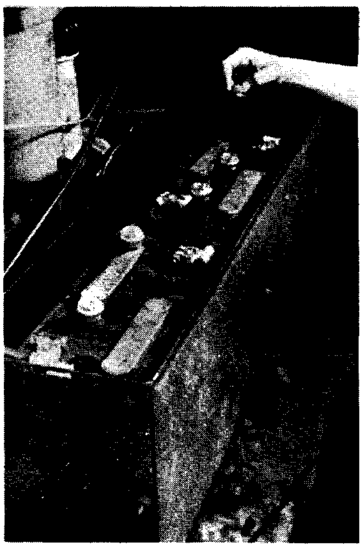
Every 1000 hours, disassemble universal joints (B). Clean and repack with Lithium Soap Base Grease #2 Consistency. Give fittings five (5) strokes pressure gun grease every 10 hours.





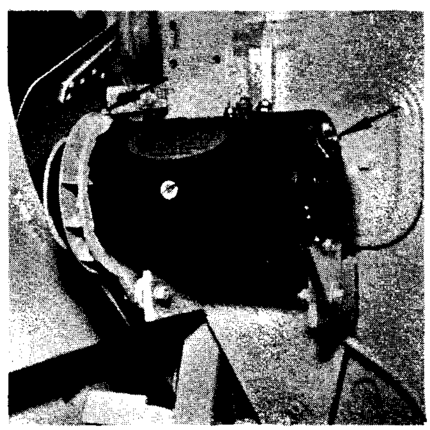
(M) TRANSMISSION: Drain at (D). Fill at (FL). Check oil every 60 hours. Change oil every 5000 hours.

(N) UNIVERSAL JOINT, CLUTCH SHAFT BEARING AND CLUTCH RELEASE BEARING: Give fittings four (4) strokes pressure gun grease every 10 hours.

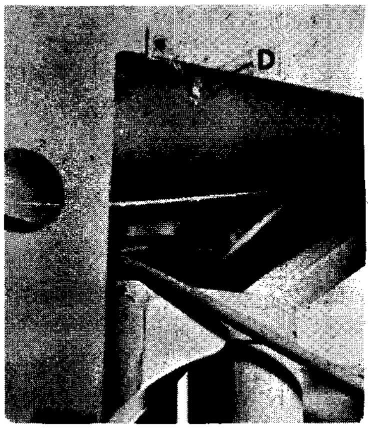


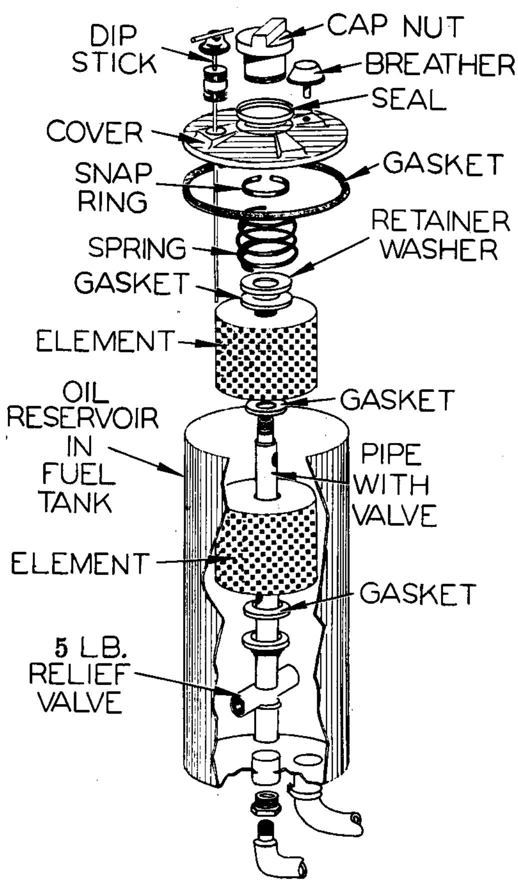
(O) BATTERIES: Keep cells filled with distilled water to 1/2" above plates. Check every 60 hours.

(P) GENERATOR: Add a few drops of SAE 20 engine oil to oil cups after each 1000 gallons of fuel consumed.



(Q) FUEL TANK: Drain at (D). Fill at (F) to desired level on dip stick.





Illust. 1

HYDRAULIC RESERVOIR FILTER ELEMENTS

The hydraulic reservoir filter elements should be changed after 50 to 75 working hours have been accumulated on a new motor grader, then filter elements should be changed every 500 working hours.

Illust. 1 is an exploded view of the hydraulic reservoir tank.

To remove the hydraulic reservoir filter elements, remove dip stick then loosen cover cap nut until cover and gasket can be removed. Remove spring, retainer washer and gasket. Lift first filter element from tank.

Remove gasket and second filter element from tank.

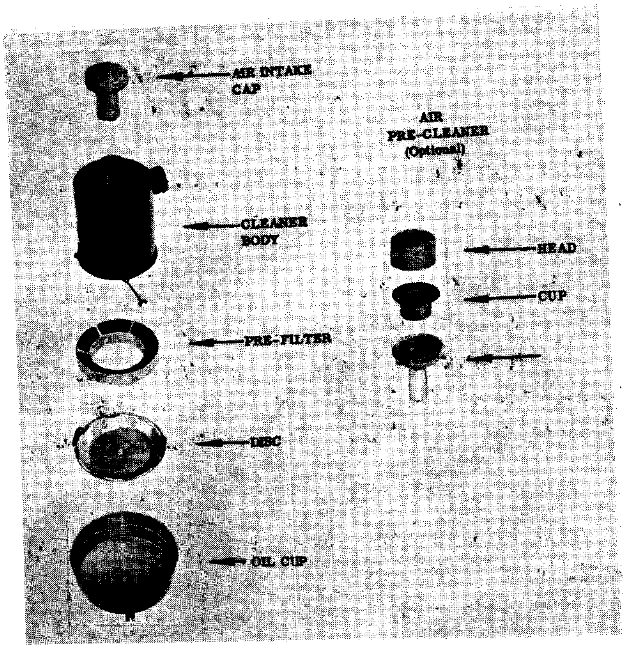
Illust. 2

IMPORTANT: When installing cover and gasket, be sure that gasket is in recess of cover (Illust. 2) and that recess is over edge of hydraulic reservoir.

AIR CLEANING SYSTEMS

OIL BATH AIR CLEANER

Illust. 1 is a view of the oil bath air cleaner. The same illustration is used for the auxiliary air cleaner. Servicing procedure for both are the same.



Illust. 1

AIR INTAKE CAP

The air intake cap screen must be kept clean at all times.

Chaff, leaves, water or oil may collect on the air intake cap screen restricting the flow of air to the engine. Restricted air flow will result in reduced horsepower delivered by the engine.

AIR CLEANER OIL CUP

SERVICE AIR CLEANER OIL CUP DAILY (or oftener when operating under severe dusty conditions). Remove, wash and refill oil cup to the oil level indicated on cup with the same weight oil as used in the engine crankcase.

WARNING: Never use crankcase drainings.

AIR CLEANER CARE

To remove disc and pre-filter, remove oil cup. Lift disc from oil cup, using the handles on disc. Pre-filter may be removed by pressing upward and turning pre-filter to the left until locking tabs align with the vertical slots, then pull downward.

Wash parts in a cleaning solvent and dry with compressed air.

The entire air cleaner must be removed from the grader and cleaned after each 500 gallons of fuel consumed. After removing the air cleaner from the grader, remove the air intake cap or pre-cleaner. Clean the entire cleaner in solvent and dry with compressed air.

When reassembling air cleaner to the machine make sure all connections between the cleaner body and manifold are air tight.

Refill oil cup with proper viscosity of oil and reassemble to air cleaner.

An oil of the same weight used in the engine crankcase should be used in the air cleaner, however, in extremely cold weather, a lighter weight may be necessary. Some detergent or additive oils tend to foam in the air cleaner. The additives are of no advantage and for these reasons it is recommended that a straight mineral oil be used. See "Lubrication Section" in Engine Manufacturer's Operator's and Maintenance Manual.

GENERAL PRECAUTIONS

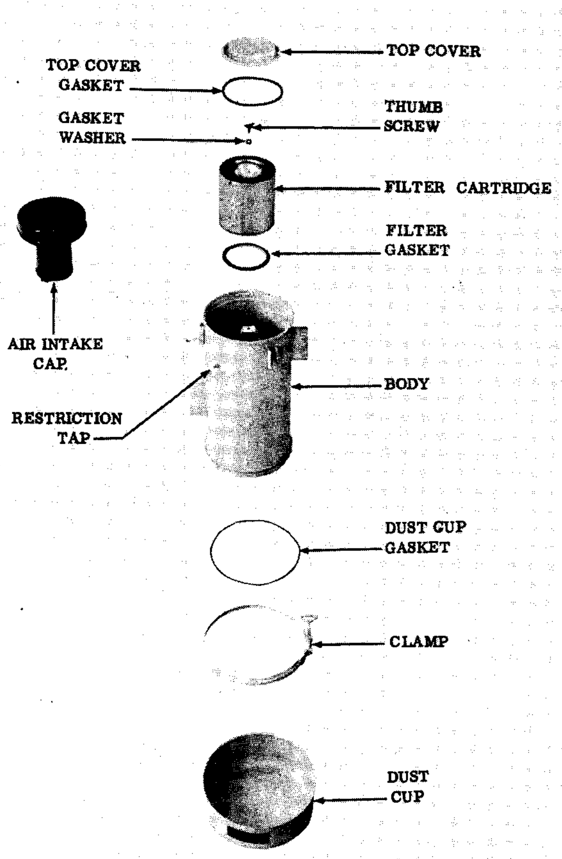
To prevent entrance of dirt into the engine, it is absolutely essential that frequent inspections be made of flexible rubber hose connections between the manifold and air cleaner. Hose connections should be replaced before they deteriorate. To eliminate any undue strain on the connections, make sure all pipes line up. See that all joints between the air cleaner and the cylinder head are air tight. This includes the flexible connections, manifold joints and gaskets. All gaskets must be in good condition and bolts drawn up tight.

DUO-DRY AIR CLEANERS

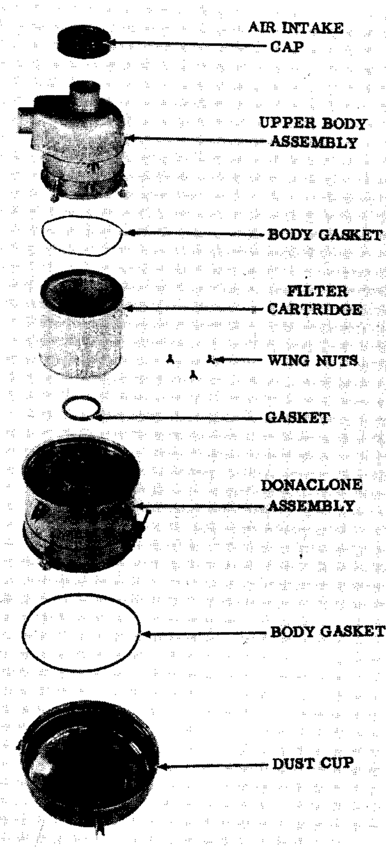
Illust. 2 is a view of the Duo-Dry air cleaner used on Model 330 Motor Graders equipped with Cummins engines. Also, Models 440 Motor Graders equipped with Cummins or General Motors Engines.

Illust. 3 is a view of the Duo-Dry air cleaner used on Model 330 Motor Graders equipped with General Motors Engines.

Servicing procedure of both are the same.



Illust. 2



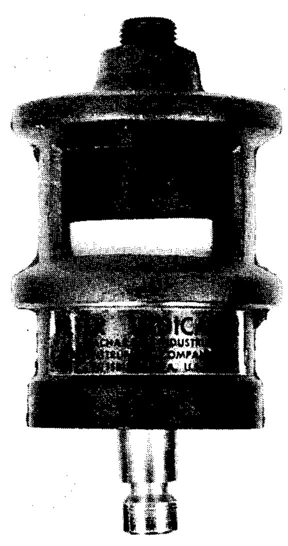
Illust. 3

AIR INTAKE CAP: The air intake cap must be kept clean at all times. A dirty cap will restrict air flow, reducing horsepower delivered by the engine.

DUST CUP: Service dust cup daily (more often if dust conditions warrant). Stop engine. Loosen dust cup clamp or wing nuts and remove cup. Dump out dust and wipe gasket clean before reassembling. Do not use oily waste, gasoline or oil to clean cup. Dust can be dislodged by slapping the side or bottom of cup with palm of hand.

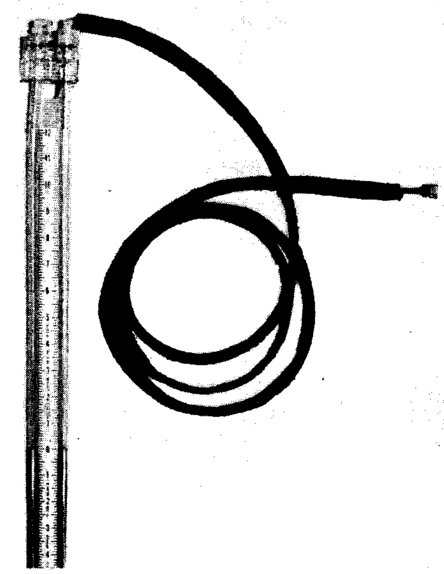
Replace gasket if signs of wear, damage or leakage appears. A tight, positive seal must be made between dust cup and cleaner after each servicing. Leakage will increase dust loading and make it necessary to service filter cartridge more often.

FILTER: Replace filter cartridge after 1000 hours of use. Excessive exhaust smoke, loss of power or excessive fuel consumption may indicate need for filter cartridge service.

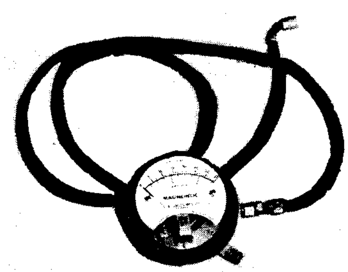


Illust. 4

A vacuum gauge (Illust. 4), water manometer (Illust. 5) or water gauge (Illust. 6)



Illust. 5



Illust. 6

may be used to measure air restriction of air cleaner.

Model 330 Motor Graders equipped with Cummins engines and Model 440 Motor Graders equipped with either Cummins or General Motors engines.

VACUUM GAUGE: Remove restriction tap plug from air cleaner (Illust. 2). Attach gauge with fitting into tap. Rev engine to high idle speed. If red marked piston in gauge raises to top of cylinder, filter cartridge must be cleaned or replaced.

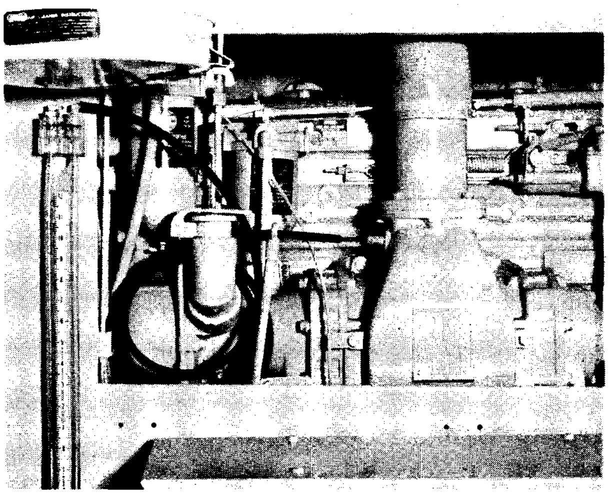
WATER MANOMETER OR WATER GAUGE:

Remove restriction tap plug from air cleaner. Attach gauge with fitting into tap. Rev engine to high idle speed. Filter cartridge must be cleaned or replaced when air restriction has increased to 27" of water for General Motors Engine; 20" of water for Cummins Engine.

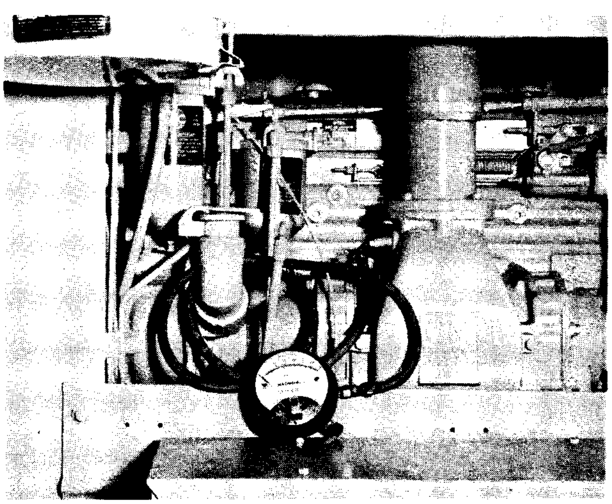
After measuring, replace tap plug securely.

Model 330 Motor Graders equipped with General Motors Engines.

WATER MANOMETER OR WATER GAUGE: Remove plug from engine blower. Attach gauge with fitting into blower (Illusts. 7 and 8). Rev engine to high idle speed. Filter cartridge must be cleaned or replaced when air restriction has reached 27" of water.



Illust. 7



Illust. 8

After measuring, replace plug securely.

SERVICING FILTER CARTRIDGE: Stop engine. Wipe off cover or upper body assembly and loosen cover clamps or upper body wing nuts.

Lift cover or lower upper body from air cleaner. Unscrew wing bolts which hold filter cartridge in position. Remove filter cartridge.

Slap filter cartridge side or bottom rim with palm of hand to remove excess dust. DO NOT STRIKE CARTRIDGE AGAINST ANY HARD SURFACE. This may damage filter cartridge and affect the seal when reassembled.

If dust is blown from filter cartridge by compressed air, blow out cartridge from clean air side.

It is practical to wash filter cartridge in a non-sudsing, household detergent. Warm water (120-140 degrees F.) is recommended. Wash filter cartridge with a gentle water stream until drain water is clear. Air dry thoroughly before using.

Inspect filter cartridge after every cleaning for damage or rupture.

Wipe out any loose dust which may be in cartridge chamber of air cleaner.

When reassembling filter cartridge, tighten wing nuts so cartridge will not rotate.

Inspect all gaskets for damage.

SERVICING OF TUBES: With filter cartridge and dust cup removed, inspect tubes by looking through them with a bright light. Dust can be removed with a stiff brush.

GENERAL PRECAUTIONS

To prevent entrance of dirt into the engine, it is absolutely essential that frequent inspections be made of flexible rubber hose connections between the manifold and air cleaner. Hose connections should be replaced before they deteriorate. To eliminate any undue strain on the connections, make sure all pipes line up. See that all joints between the air cleaner and the cylinder head are air tight. This includes the flexible connections, manifold joints and gaskets. All gaskets must be in good conditions and bolts drawn up tight.

— NOTES —

STARTING AND LIGHTING EQUIPMENT

The following instructions apply to 12 volt and 24 volt electrical systems. Motor graders equipped with General Motors engines have a 12 volt electrical system, whereas, motor graders equipped with Cummins engines have a 24 volt system.

GENERATOR

The only care that is needed in the daily operation of the generator is to keep connections on generator clean and tight, to lubricate and to maintain proper adjustment of generator belt.

If generator belt becomes loose, loosen bolt in adjustment slide bar, pull generator out away from motor until proper belt tension is obtained and retighten bolt in adjustment bar. Do not operate with belt tighter than absolutely necessary to drive generator. Excessive belt tightness will result in rapid belt wear and over-loading of bearings in generator.

Never attempt to adjust or repair generator in the field. If repair or adjustment of generator is needed, remove complete assembly and take it to your LeTourneau-Westinghouse Distributor for service.

VOLTAGE REGULATOR

The only maintenance needed on voltage regulator is to be sure that all connections are clean and tight. Never attempt to adjust or regulate voltage regulator in the field. If repair or adjustment of voltage regulator becomes necessary, remove complete assembly and take it to your LeTourneau-Westinghouse Distributor for service.

STARTER AND SOLENOID

Aside from keeping all connections tight and clean, the only other point which should be watched is proper lubrication of starting motor. If repair to either of these units becomes necessary. remove complete assembly and take it to your LeTourneau-Westinghouse Distributor for service.

BATTERIES

Motor graders equipped with General Motors engines have two 6 volt batteries. These batteries are located in battery box on right side of frame, next to engine.

Motor graders equipped with Cummins engines have four 6 volt batteries. These batteries are located in two battery boxes, one battery box on each side of frame, next to engine. Each lead acid storage battery used with General Motors or Cummins engines are of the 6 volt type, consisting of three cells of two volts each, connected in series. Each cell is composed of two groups of plates, positive and negative, with separators between positive and negative plates. This element is immersed in electrolyte (sulphur acid and water) and sealed in place.

The battery should be checked every two weeks, whether grader is operating or not, using a hydrometer. The hydrometer will determine the specific gravity of the electrolyte, which in turn indicates the condition of the battery. Specific gravity reading 1275 indicates full charge. Specific gravity reading 1225 indicates half charge. Specific gravity reading 1150 indicates complete discharge.

WIRING

Keep all wiring connections tight and clean. Occasionally, inspect wiring for breaks or for worn places which might cause shorts. Defective wiring should be repaired or replaced immediately. Should it be necessary to either reinstall the old wiring, or install new wiring, connect all wires and cables, as shown in the wiring diagrams.

WARNING

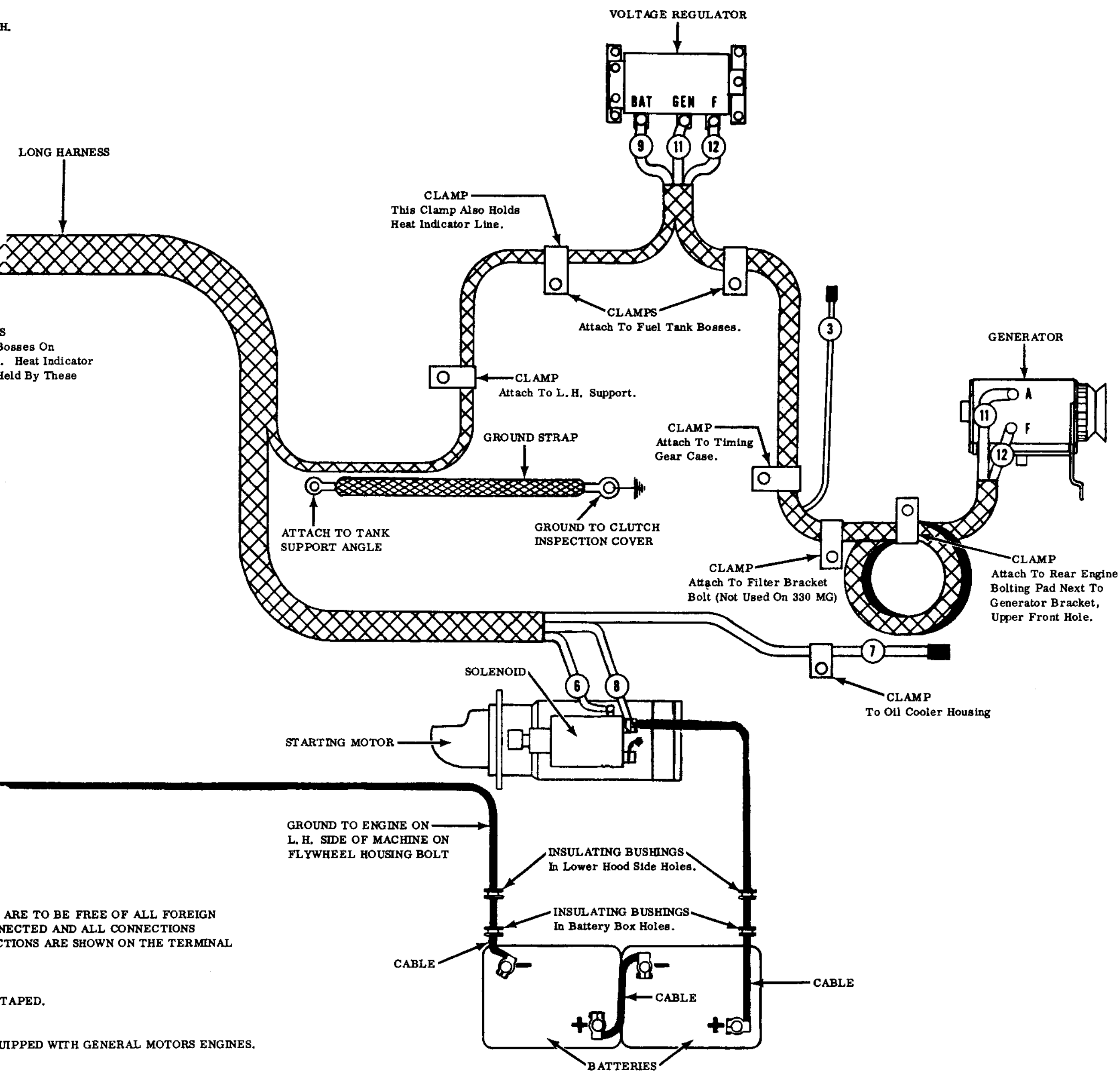
If generator or voltage regulator have been disconnected for any reason, the generator must be correctly polarized again before operating the units. After connecting all wires and before starting engine, always connect momentarily with a bumper lead between generator armature terminal and battery terminal of regulator. This allows a momentary surge of battery current to flow into the generator which correctly polarizes generator with respect to the battery it is to charge.

Illust. 1

WIRING DIAGRAM FOR STARTING - GENERAL MOTORS ENGINE
MODEL 330 MOTOR GRADER - S/N 700 and Later
MODEL 440 MOTOR GRADER - S/N 2400 and Later

H.

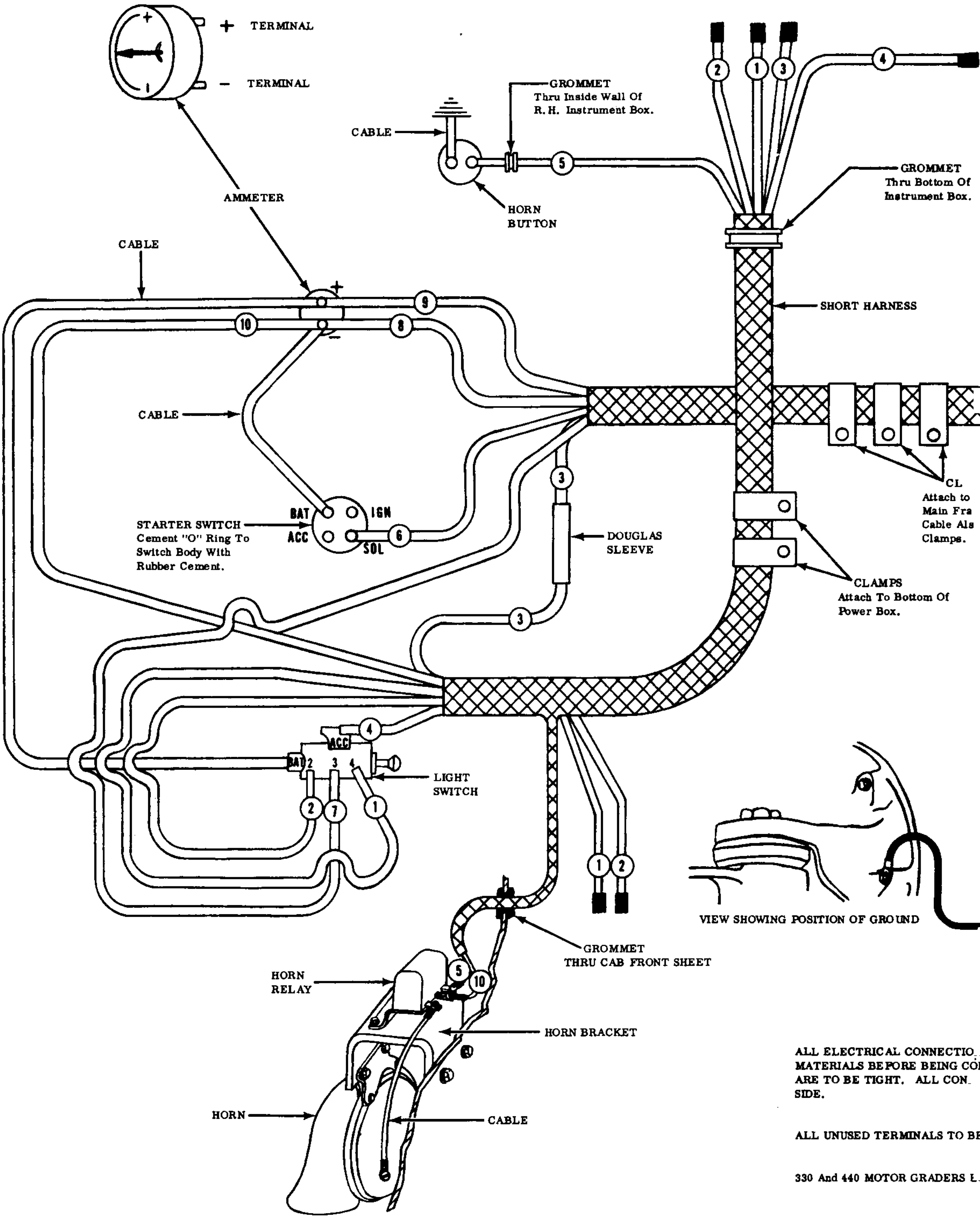
S
Bosses On
. Heat Indicator
Held By These



ARE TO BE FREE OF ALL FOREIGN
NECTED AND ALL CONNECTIONS
CTIONS ARE SHOWN ON THE TERMINAL

TAPED.

UIPPED WITH GENERAL MOTORS ENGINES.



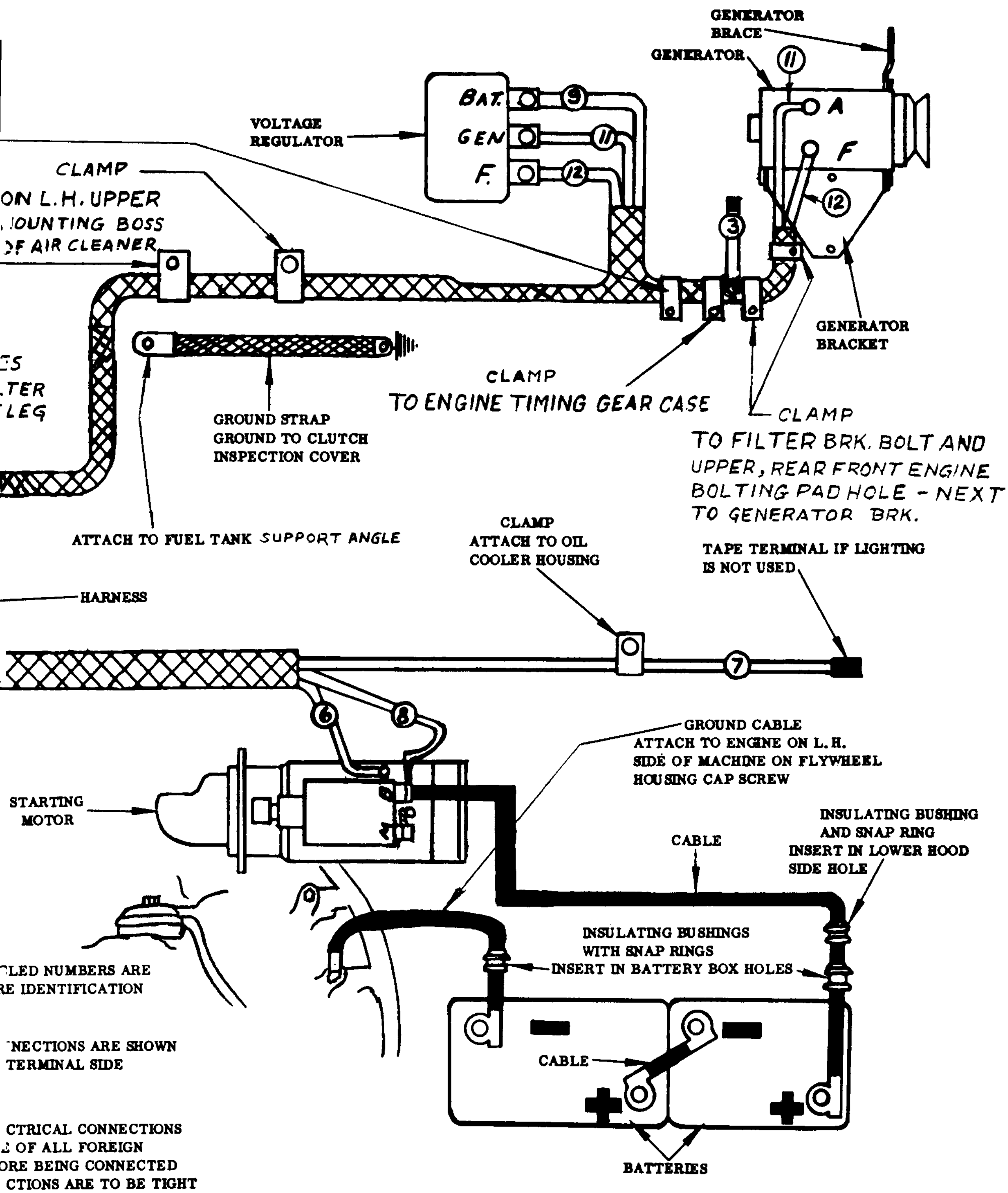
ALL ELECTRICAL CONNECTIO
MATERIALS BEFORE BEING CO
ARE TO BE TIGHT. ALL CON
SIDE.

ALL UNUSED TERMINALS TO B

330 And 440 MOTOR GRADERS L

Illust. 2

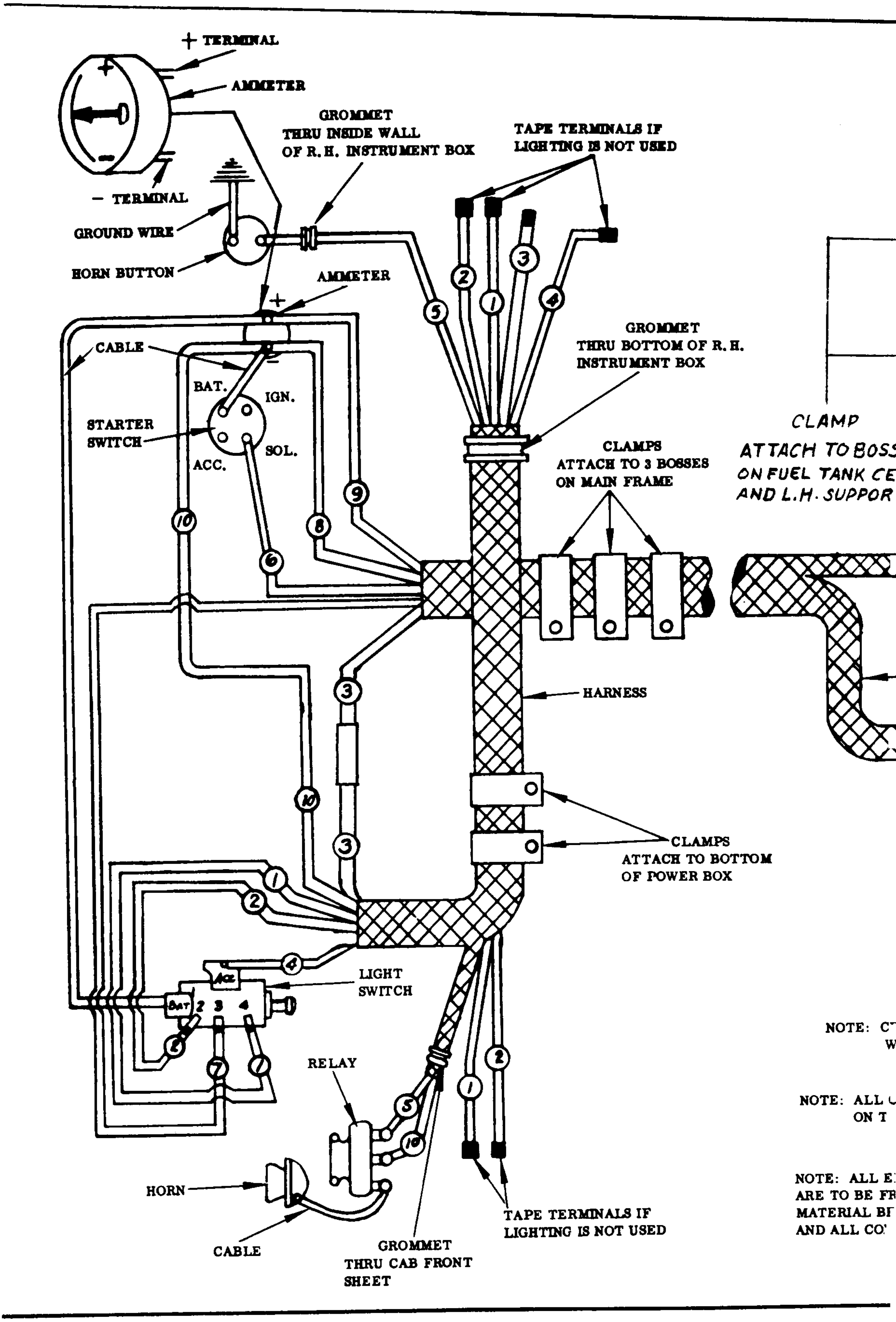
WIRING DIAGRAM FOR STARTING - GENERAL MOTORS ENGINE
MODEL 440 MOTOR GRADER - S/N 1500 thru 2399



CLED NUMBERS ARE
RE IDENTIFICATION

NECTIONS ARE SHOWN
TERMINAL SIDE

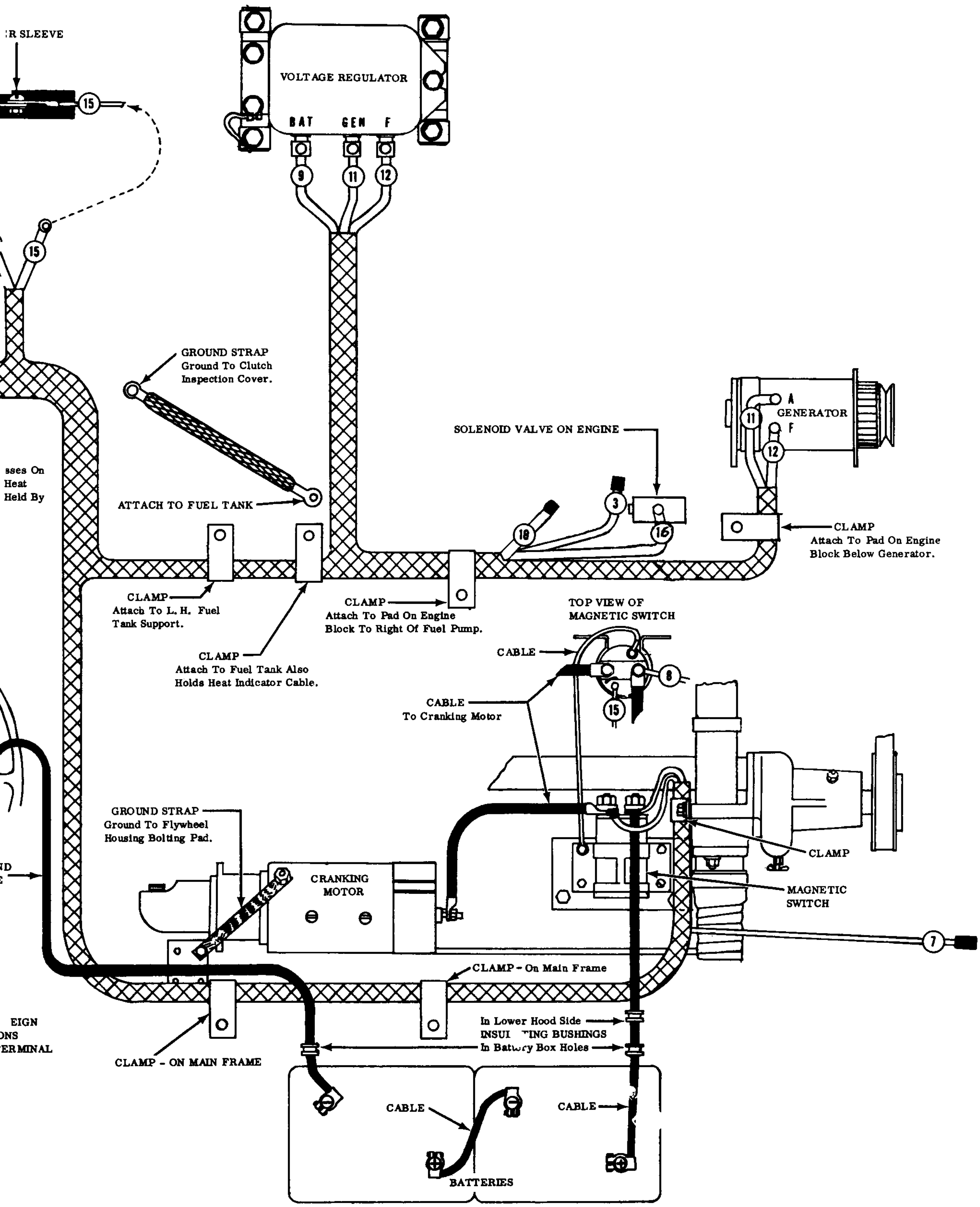
CTRICAL CONNECTIONS
: OF ALL FOREIGN
ORE BEING CONNECTED
CTIONS ARE TO BE TIGHT



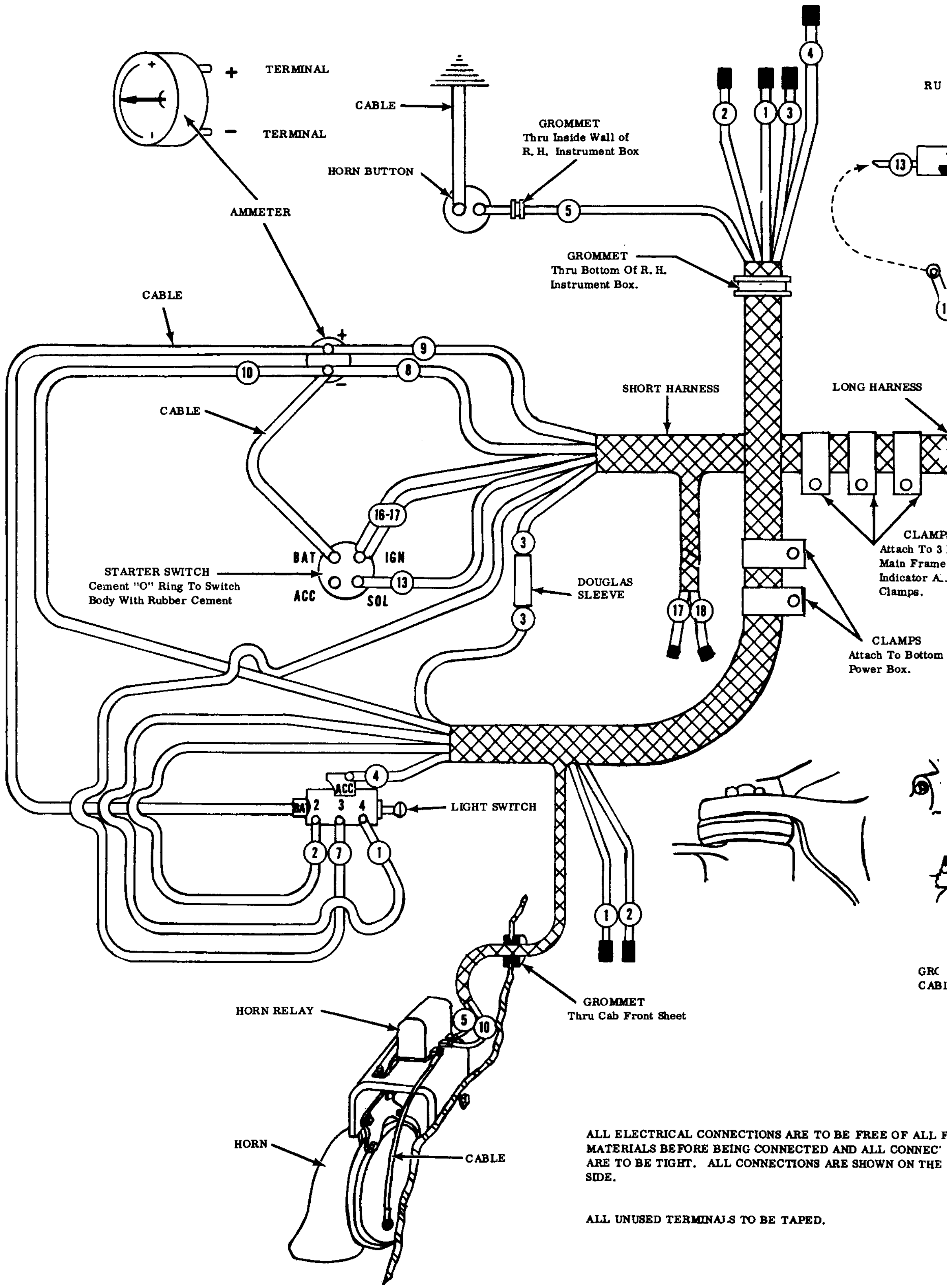
+ TERMINAL
AMMETER
- TERMINAL
GROUND WIRE
HORN BUTTON
GROMMET THRU INSIDE WALL OF R.H. INSTRUMENT BOX
TAPE TERMINALS IF LIGHTING IS NOT USED
AMMETER
GROMMET THRU BOTTOM OF R.H. INSTRUMENT BOX
CABLE
BAT.
IGN.
STARTER SWITCH
ACC.
SOL.
CLAMP
ATTACH TO BOSS
ON FUEL TANK CE
AND L.H. SUPPOR
CLAMPS ATTACH TO 3 BOSSES ON MAIN FRAME
HARNESS
CLAMPS ATTACH TO BOTTOM OF POWER BOX
LIGHT SWITCH
RELAY
HORN
CABLE
GROMMET THRU CAB FRONT SHEET
TAPE TERMINALS IF LIGHTING IS NOT USED
NOTE: C
W
NOTE: ALL
ON T
NOTE: ALL E
ARE TO BE FR
MATERIAL BE
AND ALL CO

Illust. 3

WIRING DIAGRAM FOR STARTING - CUMMINS ENGINE
MODEL 330 MOTOR GRADER - S/N 700 thru 1599
MODEL 440 MOTOR GRADER - S/N 1500 thru 2096



R SLEEVE
VOLTAGE REGULATOR
BAT
GEN
F
9
11
12
15
GROUND STRAP
Ground To Clutch
Inspection Cover.
sses On
Heat
Held By
ATTACH TO FUEL TANK
SOLENOID VALVE ON ENGINE
3
18
16
A
GENERATOR
F
CLAMP
Attach To Pad On Engine
Block Below Generator.
CLAMP
Attach To L. H. Fuel
Tank Support.
CLAMP
Attach To Pad On Engine
Block To Right Of Fuel Pump.
CLAMP
Attach To Fuel Tank Also
Holds Heat Indicator Cable.
TOP VIEW OF
MAGNETIC SWITCH
CABLE
8
CABLE
To Cranking Motor
GROUND STRAP
Ground To Flywheel
Housing Bolting Pad.
CRANKING
MOTOR
CLAMP
MAGNETIC
SWITCH
7
CLAMP - On Main Frame
EIGN
ONS
ERMINAL
CLAMP - ON MAIN FRAME
In Lower Hood Side
In Battery Box Holes
CABLE
CABLE
BATTERIES

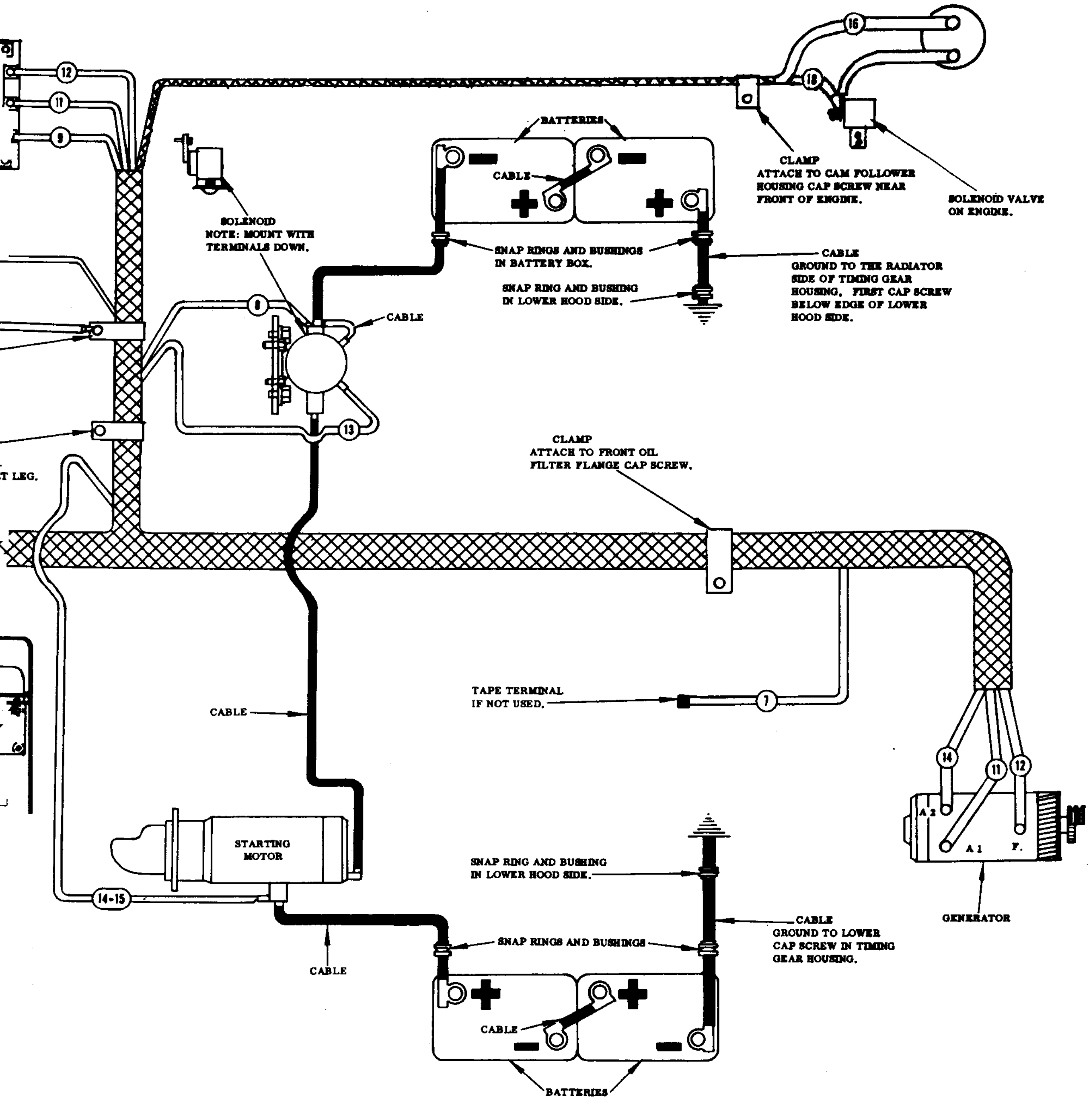


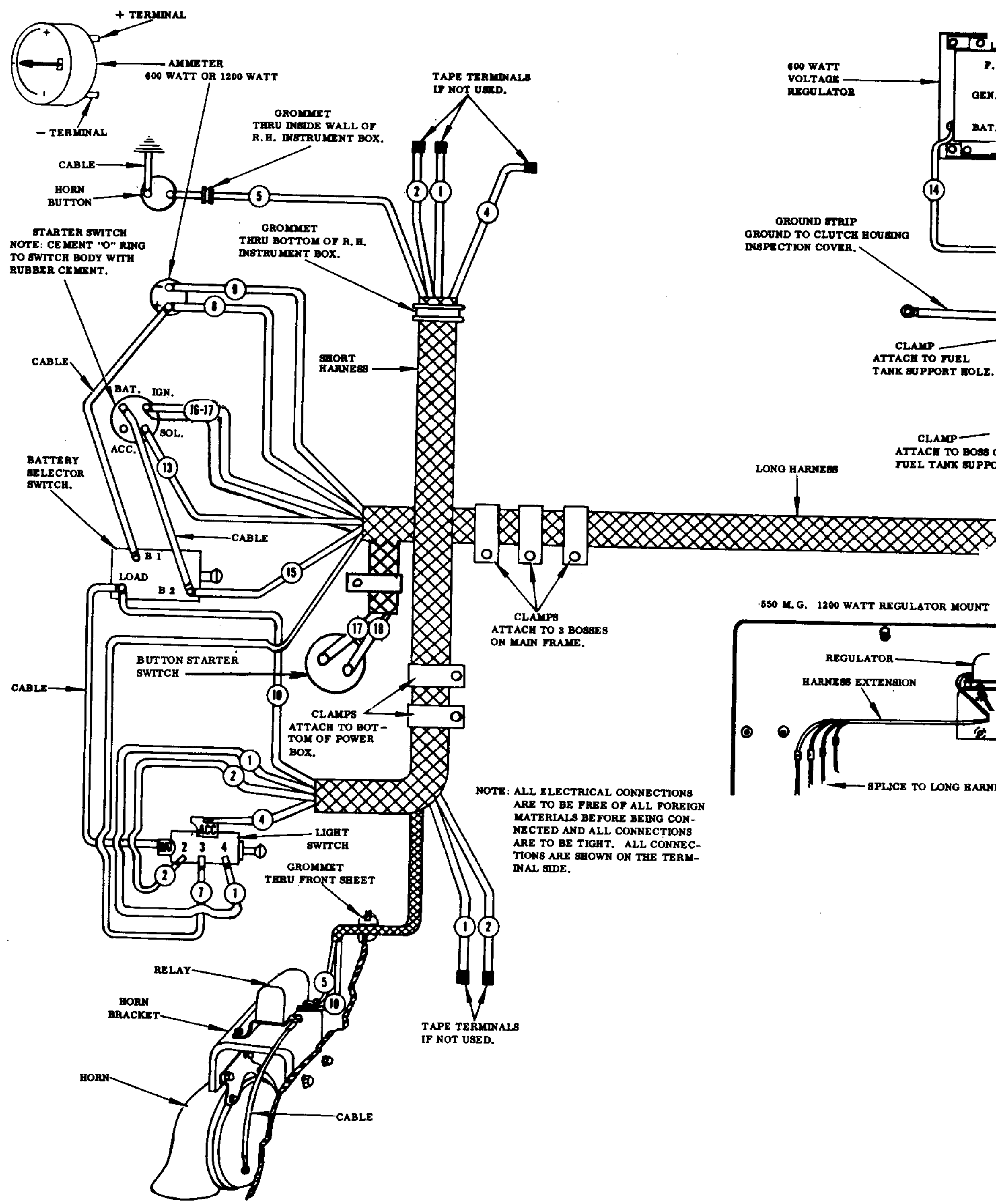
ALL ELECTRICAL CONNECTIONS ARE TO BE FREE OF ALL F
MATERIALS BEFORE BEING CONNECTED AND ALL CONNEC
ARE TO BE TIGHT. ALL CONNECTIONS ARE SHOWN ON THE
SIDE.

ALL UNUSED TERMINALS TO BE TAPED.

Illust. 4

WIRING DIAGRAM FOR STARTING - CUMMINS ENGINE
MODEL 330 MOTOR GRADER - S/N 1600 thru 1999
MODEL 440 MOTOR GRADER - S/N 2097 thru 3199

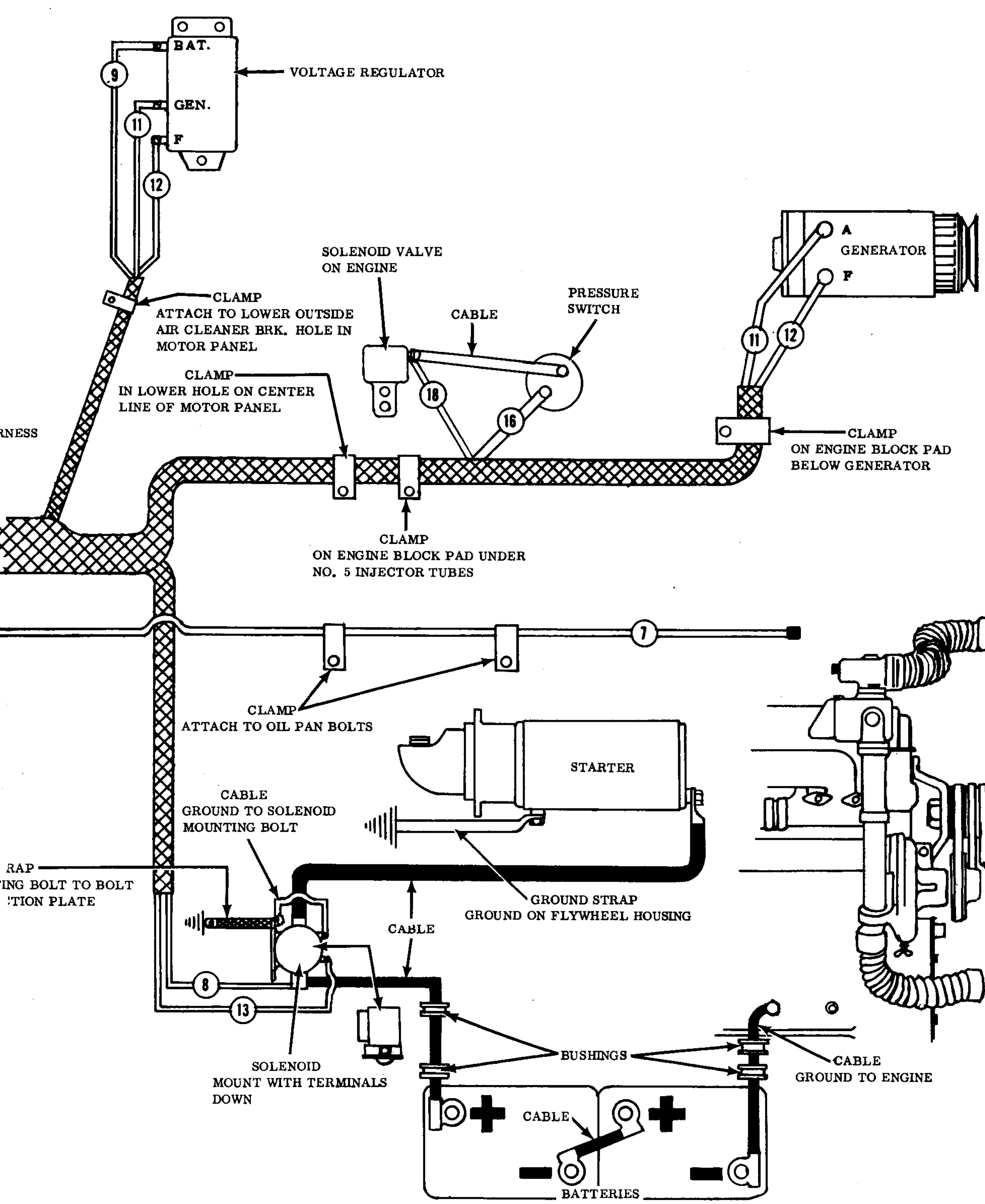

BATTERIES
CABLE
CLAMP
ATTACH TO CAM FOLLOWER HOUSING CAP SCREW NEAR FRONT OF ENGINE.
SOLENOID VALVE ON ENGINE.
SOLENOID
NOTE: MOUNT WITH TERMINALS DOWN.
SNAP RINGS AND BUSHINGS IN BATTERY BOX.
CABLE
GROUND TO THE RADIATOR SIDE OF TIMING GEAR HOUSING. FIRST CAP SCREW BELOW EDGE OF LOWER HOOD SIDE.
SNAP RING AND BUSHING IN LOWER HOOD SIDE.
CABLE
T LEG.
CLAMP
ATTACH TO FRONT OIL FILTER FLANGE CAP SCREW.
TAPE TERMINAL IF NOT USED.
CABLE
STARTING MOTOR
SNAP RING AND BUSHING IN LOWER HOOD SIDE.
SNAP RINGS AND BUSHINGS
CABLE
GROUND TO LOWER CAP SCREW IN TIMING GEAR HOUSING.
CABLE
CABLE
BATTERIES
GENERATOR
A 2
A 1
F.
12
11
9
16
18
8
13
7
14
11
12
14-15



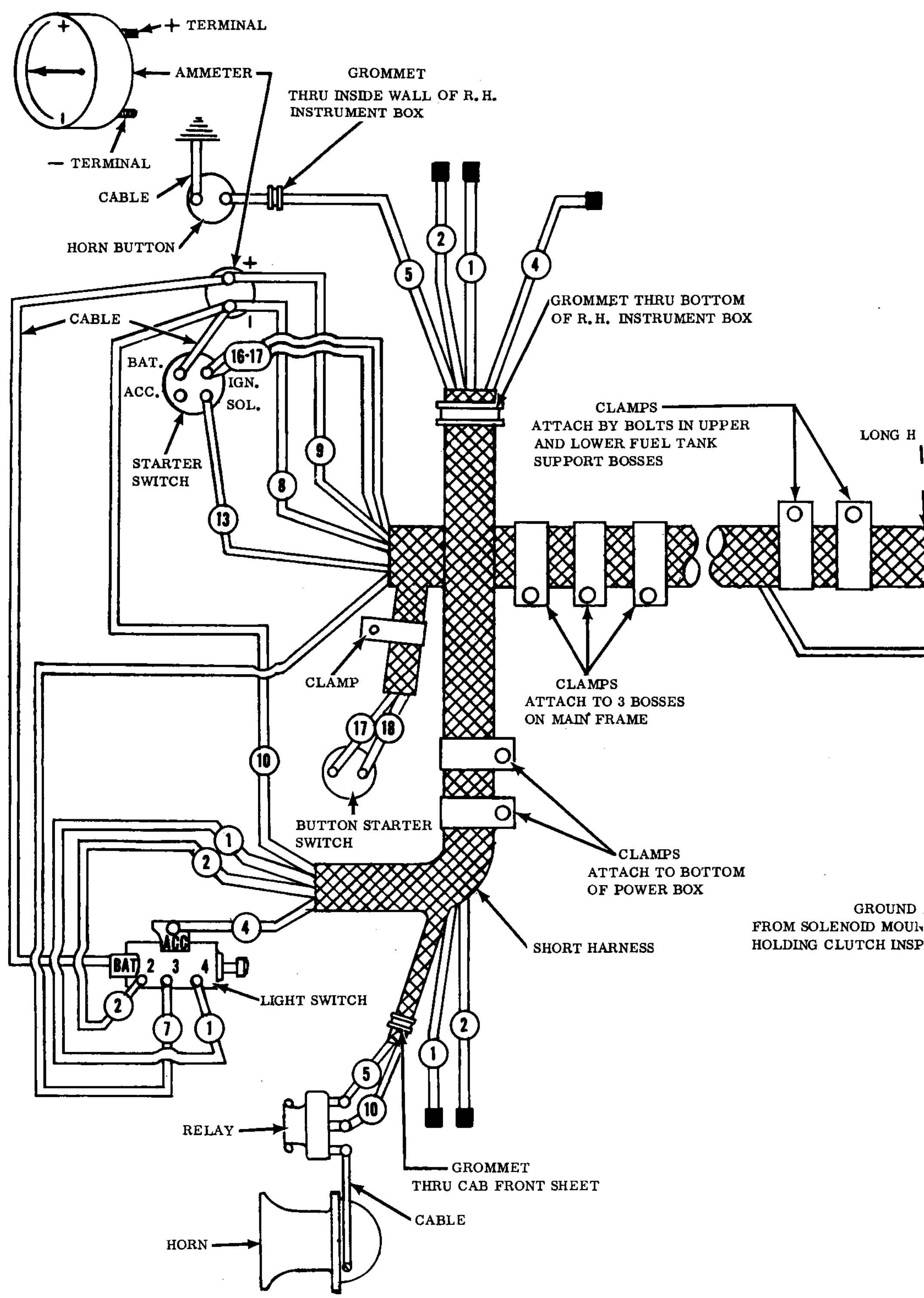
+ TERMINAL
AMMETER
600 WATT OR 1200 WATT
− TERMINAL
CABLE
HORN BUTTON
GROMMET THRU INSIDE WALL OF R.H. INSTRUMENT BOX.
TAPE TERMINALS IF NOT USED.
STARTER SWITCH NOTE: CEMENT "O" RING TO SWITCH BODY WITH RUBBER CEMENT.
GROMMET THRU BOTTOM OF R.H. INSTRUMENT BOX.
SHORT HARNESS
CABLE
BAT.
IGN.
16-17
SOL.
ACC.
BATTERY SELECTOR SWITCH.
B 1
LOAD
B 2
CABLE
CABLE
BUTTON STARTER SWITCH
CLAMPS ATTACH TO BOTTOM OF POWER BOX.
LIGHT SWITCH
GROMMET THRU FRONT SHEET
NOTE: ALL ELECTRICAL CONNECTIONS ARE TO BE FREE OF ALL FOREIGN MATERIALS BEFORE BEING CONNECTED AND ALL CONNECTIONS ARE TO BE TIGHT. ALL CONNECTIONS ARE SHOWN ON THE TERMINAL SIDE.
RELAY
HORN BRACKET
HORN
CABLE
TAPE TERMINALS IF NOT USED.
CLAMPS ATTACH TO 3 BOSSES ON MAIN FRAME.
LONG HARNESS
600 WATT VOLTAGE REGULATOR
GROUND STRIP GROUND TO CLUTCH HOUSING INSPECTION COVER.
CLAMP ATTACH TO FUEL TANK SUPPORT HOLE.
550 M.G. 1200 WATT REGULATOR MOUNT
REGULATOR
HARNESS EXTENSION
SPLICE TO LONG HARN

Illust. 5

WIRING DIAGRAM FOR STARTING - CUMMINS ENGINE
MODEL 330 MOTOR GRADER - S/N 2000 and Later



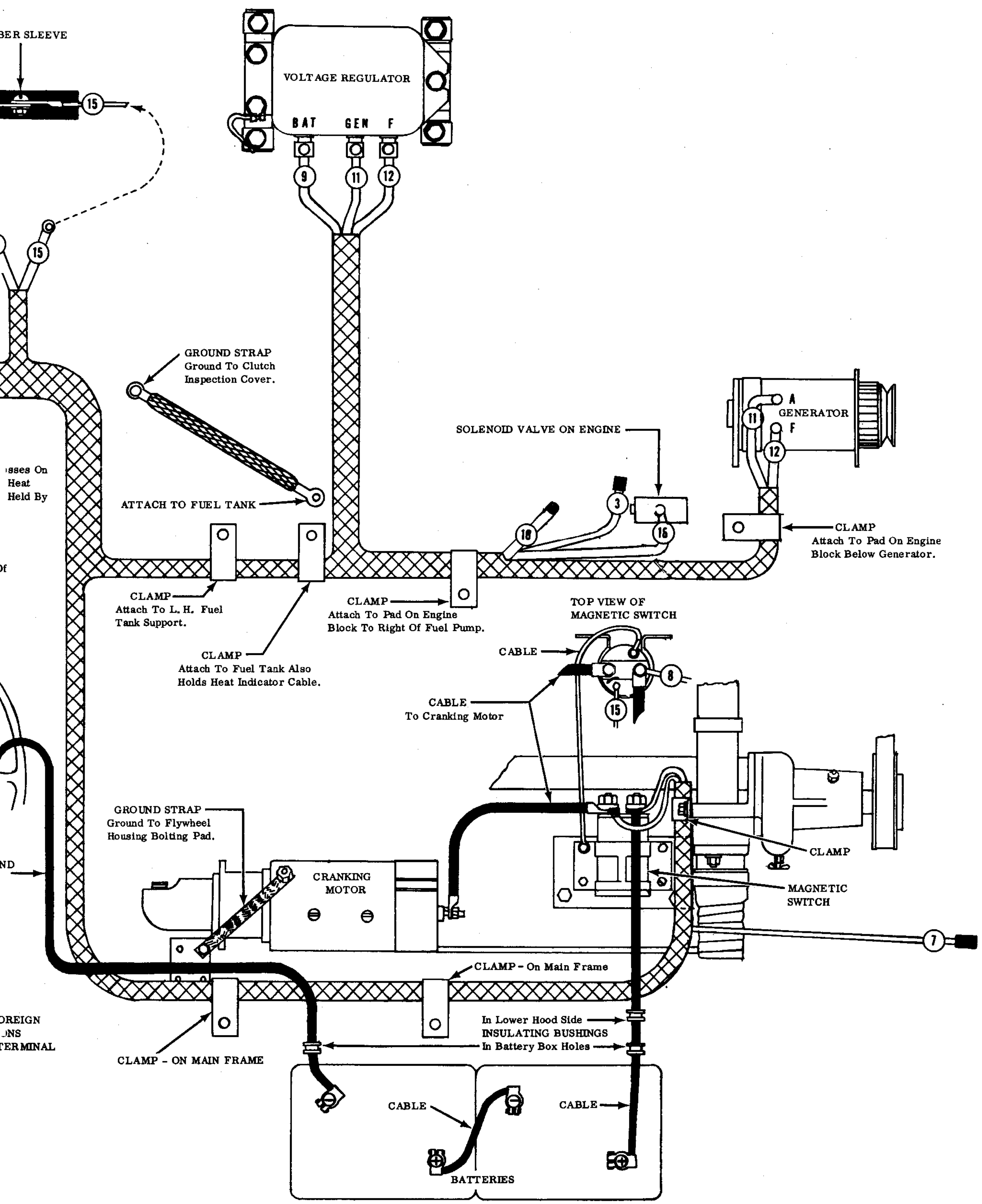
BAT.
GEN.
F
VOLTAGE REGULATOR
9
11
12
SOLENOID VALVE
ON ENGINE
CABLE
PRESSURE
SWITCH
A
GENERATOR
F
CLAMP
ATTACH TO LOWER OUTSIDE
AIR CLEANER BRK. HOLE IN
MOTOR PANEL
CLAMP
IN LOWER HOLE ON CENTER
LINE OF MOTOR PANEL
18
16
11
12
CLAMP
ON ENGINE BLOCK PAD
BELOW GENERATOR
RNESS
CLAMP
ON ENGINE BLOCK PAD UNDER
NO. 5 INJECTOR TUBES
7
CLAMP
ATTACH TO OIL PAN BOLTS
STARTER
CABLE
GROUND TO SOLENOID
MOUNTING BOLT
RAP
ING BOLT TO BOLT
TION PLATE
GROUND STRAP
GROUND ON FLYWHEEL HOUSING
CABLE
8
13
SOLENOID
MOUNT WITH TERMINALS
DOWN
BUSHINGS
CABLE
GROUND TO ENGINE
CABLE
BATTERIES



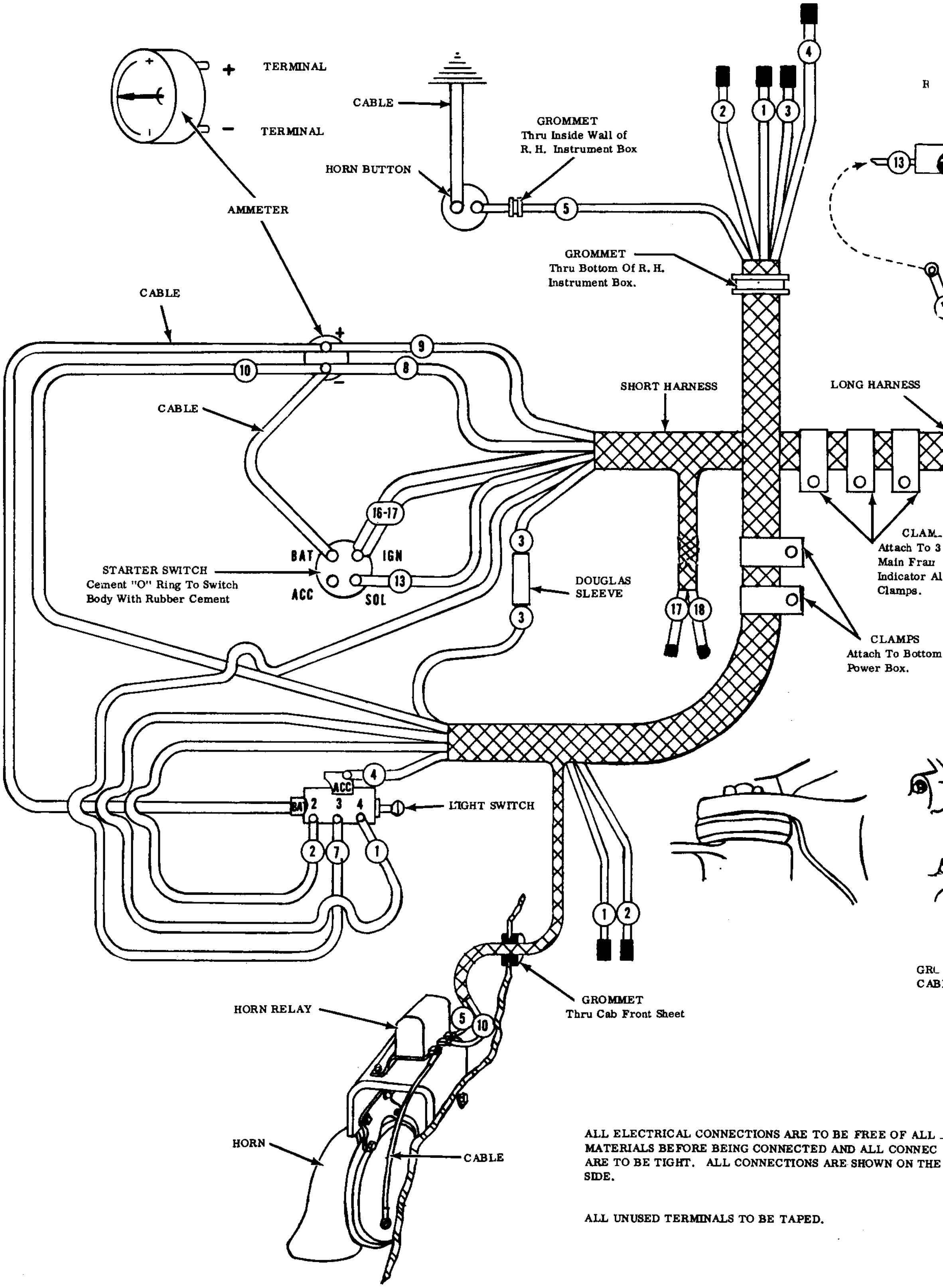
+ TERMINAL
AMMETER
GROMMET
THRU INSIDE WALL OF R. H.
INSTRUMENT BOX
— TERMINAL
CABLE
HORN BUTTON
CABLE
BAT.
ACC.
IGN.
SOL.
16-17
STARTER
SWITCH
GROMMET THRU BOTTOM
OF R. H. INSTRUMENT BOX
CLAMPS
ATTACH BY BOLTS IN UPPER
AND LOWER FUEL TANK
SUPPORT BOSSES
LONG H
CLAMP
CLAMPS
ATTACH TO 3 BOSSES
ON MAIN FRAME
17
18
BUTTON STARTER
SWITCH
CLAMPS
ATTACH TO BOTTOM
OF POWER BOX
GROUND
FROM SOLENOID MOU
HOLDING CLUTCH INSP
SHORT HARNESS
ACC
BAT 2 3 4
LIGHT SWITCH
RELAY
GROMMET
THRU CAB FRONT SHEET
CABLE
HORN

Illust. 6

WIRING DIAGRAM FOR STARTING - CUMMINS ENGINE
MODEL 440 MOTOR GRADER - S/N 3200 and Later

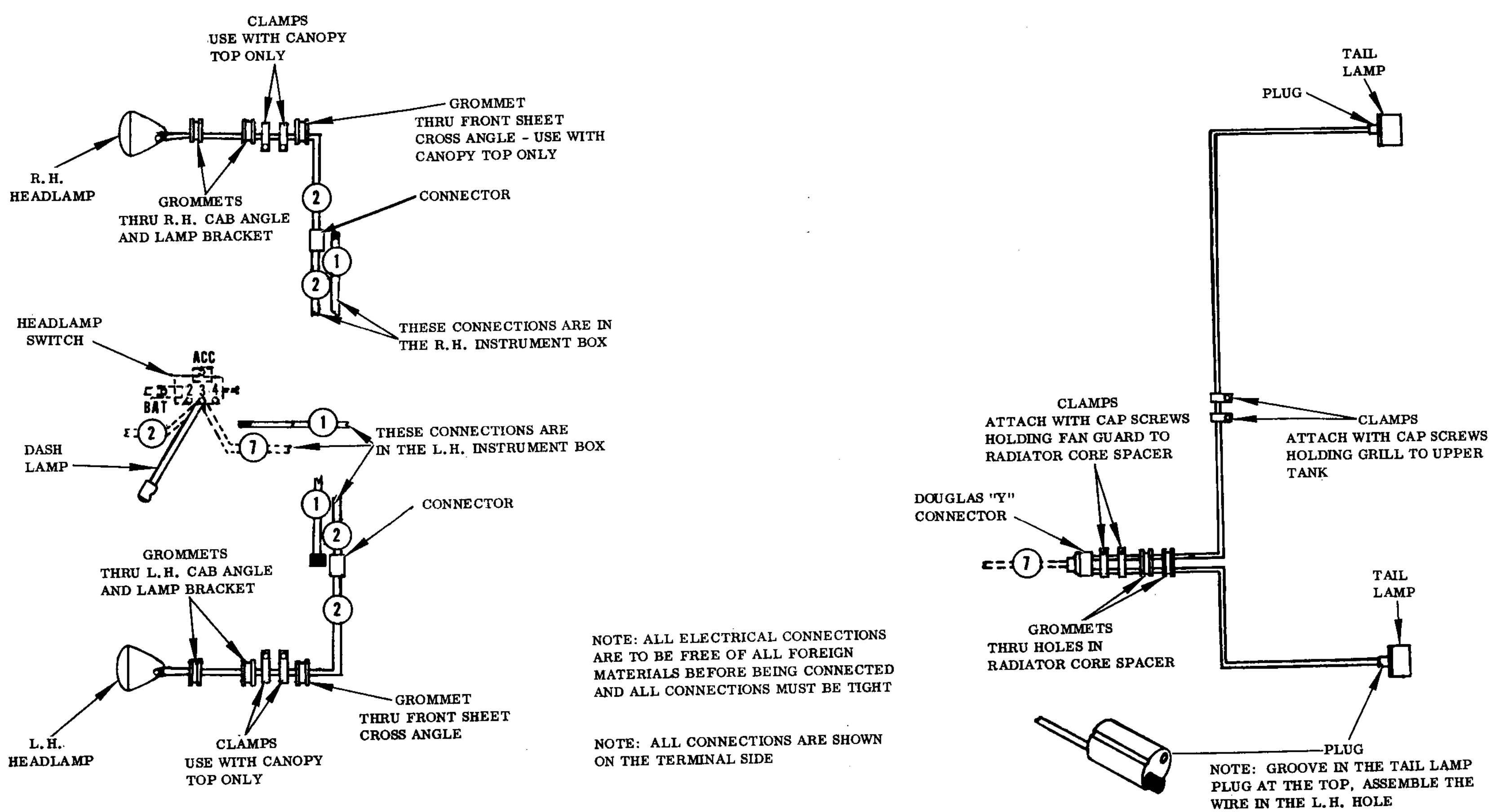


BER SLEEVE
VOLTAGE REGULATOR
BAT
GEN
F
GROUND STRAP
Ground To Clutch
Inspection Cover.
ATTACH TO FUEL TANK
CLAMP
Attach To L. H. Fuel
Tank Support.
CLAMP
Attach To Fuel Tank Also
Holds Heat Indicator Cable.
CLAMP
Attach To Pad On Engine
Block To Right Of Fuel Pump.
SOLENOID VALVE ON ENGINE
GENERATOR
A
F
CLAMP
Attach To Pad On Engine
Block Below Generator.
TOP VIEW OF
MAGNETIC SWITCH
CABLE
CABLE
To Cranking Motor
GROUND STRAP
Ground To Flywheel
Housing Bolting Pad.
CRANKING
MOTOR
CLAMP
MAGNETIC
SWITCH
CLAMP - On Main Frame
In Lower Hood Side
INSULATING BUSHINGS
In Battery Box Holes
CLAMP - ON MAIN FRAME
CABLE
CABLE
BATTERIES



ALL ELECTRICAL CONNECTIONS ARE TO BE FREE OF ALL
MATERIALS BEFORE BEING CONNECTED AND ALL CONNEC
ARE TO BE TIGHT. ALL CONNECTIONS ARE SHOWN ON THE
SIDE.

ALL UNUSED TERMINALS TO BE TAPED.



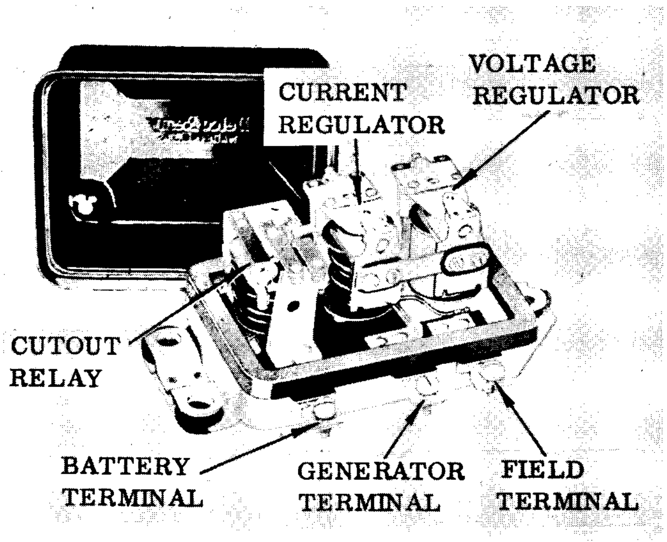
Illust. 7

WIRING DIAGRAM FOR LIGHTS - MODELS 330 AND 440 MOTOR GRADERS - CUMMINS AND GENERAL MOTORS ENGINES

VOLTAGE REGULATOR

(MODELS 330 AND 440 MOTOR GRADERS)
(Delco Remy No. 1118956 - 12 Volt - 35 Amp)
(Delco Remy No. 1119156 - 12 Volt - 50 Amp)

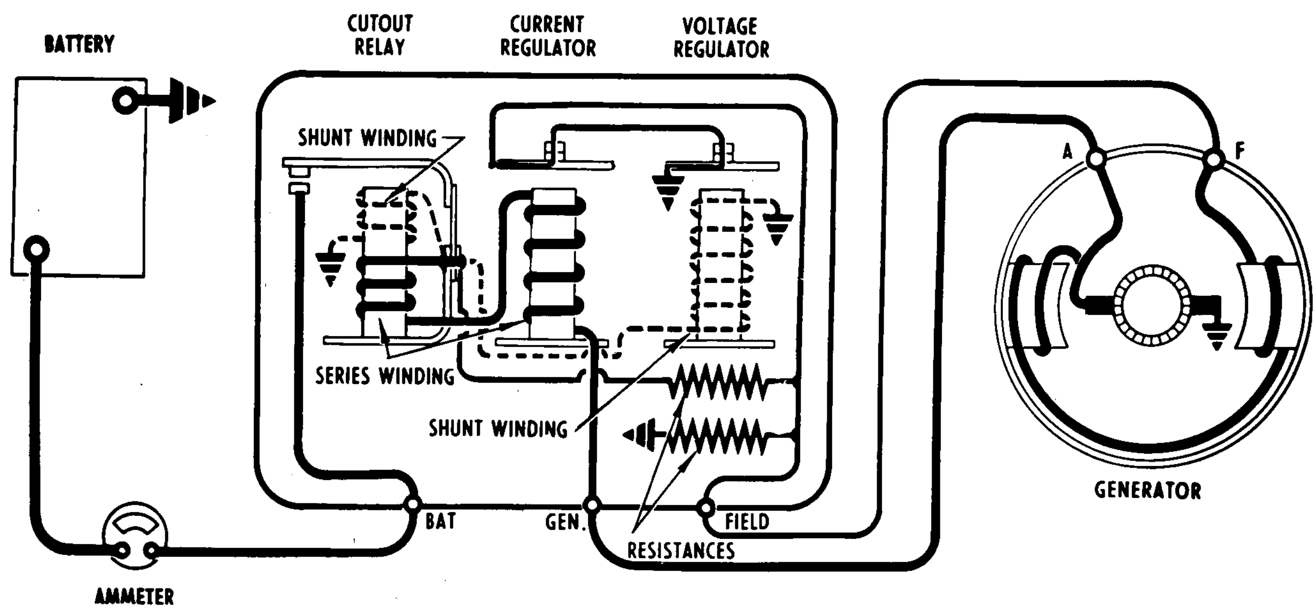
The regulator (Illust. 1) consists of cutout relay, a voltage regulator, and a current regulator unit. The cutout relay closes the generator-to-battery circuit when the generator voltage is sufficient to charge the battery, and it opens the circuit when the generator slows down or stops. The voltage regulator unit is a voltage-limiting device that prevents the system voltage from exceeding a specified maximum and thus protects the battery and other voltage-sensitive equipment. The current regulator unit is a current-limiting device that limits the generator output so as not to exceed its rated maximum.



Illust. 1

CUTOUT RELAY

The cutout relay (Illust. 2) has two windings, a series winding of a few turns of



Illust. 2

heavy wire and a shunt winding of many turns of fine wire. The shunt winding is connected across the generator so that generator voltage is impressed upon it at all times. The series winding is connected in series with the charging circuit so that all generator output passes through it. The relay core and windings are assembled into a frame. A flat steel armature is attached to the frame by a flexible hinge so that it is centered just above the end of the core. The armature contact points are located just above the stationary contact points. When the generator is not operating, the armature contact points are held away from the stationary points by the tension of a flat spring riveted on the side of the armature.

CUTOUT RELAY ACTION

When the generator voltage builds up a value great enough to charge the battery, the magnetism induced by the relay windings is sufficient to pull the armature toward the core so that the contact points close. This completes the circuit between the generator and battery. The current which flows from the generator to the battery passes through the series winding in a direction to add to the magnetism holding the armature down and the contact points closed.

When the generator slows down or stops, current begins to flow from the battery to the generator. This reverse flow of current through the series winding causes a reversal of the series winding magnetic field. The magnetic field of the shunt winding does not reverse. Therefore, instead of helping each other, the two windings now magnetically oppose so that the resultant magnetic field becomes insufficient to hold the armature down. The flat spring pulls the armature away from the core so that the points separate; this opens the circuit between the generator and battery.

VOLTAGE REGULATOR

The voltage regulator unit has a shunt winding consisting of many turns of fine wire (Illust. 2) which is connected across the generator. The winding and core are assembled into a frame. A flat steel armature is attached to the frame by a flexible hinge so that it is just above the end of the core. The armature contains a contact point which is just beneath a stationary contact point. When the voltage regulator unit is not operating, the tension of a spiral spring holds the armature away from the core so that the points are in contact and the generator field circuit is completed to ground through them.

VOLTAGE REGULATOR ACTION

When the generator voltage reaches the value for which the voltage regulator unit is adjusted, the magnetic field produced by the winding overcomes the armature spring tension, pulls the armature down and the contact points separate. This inserts resistance into the generator field circuit. The generator field current and voltage are reduced. Reduction of the generator voltage reduces the magnetic field of the regulator shunt winding. The result is that the magnetic field is weakened enough to allow the spiral spring to pull the armature away from the core, and the contact points again close. This directly grounds the generator field circuit, causing generator voltage and output to increase. The above cycle of action takes place, and the cycle continues at a rate of many times a second, regulating the voltage to a predetermined value.

CURRENT REGULATOR

The current regulator has a series winding of a few turns of heavy wire (Illust. 2) which carries all generator output. The winding and core are assembled into a frame. A flat steel armature is attached to the frame by a flexible hinge so that it is just above the core. The armature has a contact point which is just below a stationary contact point. When the current regulator is not operating, the tension of a spiral spring holds the armature away from the core so that the points are in contact. In this position, the generator field circuit is completed to ground through the current regulator contact points in series with the voltage regulator contact points.

CURRENT REGULATOR ACTION

When the generator output reaches the value for which the current regulator is set, the magnetic pull of the winding overcomes armature spring tension, pulls the armature down and opens the contact points. This inserts a resistance into the generator field circuit. The generator output and field current are reduced. Reduction of the current output reduces the magnetic field of the current regulator winding. The result is that the magnetic field is weakened enough to allow the spiral spring to pull the armature up and the contact points close again. This directly grounds the generator field circuit, causing the generator output to again increase. This cycle is repeated many times a second, limiting the generator output so as not to exceed its rated maximum.

RESISTANCES

The current and voltage regulator unit circuits use two common resistors. One is inserted in the field circuit when either the current or voltage regulator unit operates. The second resistor (Illust. 2) is connected between the regulator FIELD terminal and the cutout relay frame, which places it in parallel electrically with the generator field coils. The sudden reduction in field current occurring when either the current or voltage regulator contact points open, is accompanied by a surge of induced voltage in the field coils as the strength of the magnetic field changes. These surges are partially dissipated by the two resistors, thus preventing excessive arcing at the contact points.

TEMPERATURE COMPENSATION

Voltage regulators are compensated for temperature by means of a bi-metal thermostatic hinge on the armature. This causes the regulator to regulate at a higher voltage when cold which partly compensates for the fact that a higher voltage is required to charge a cold battery. Many current regulators also have a bi-metal thermostatic hinge on the armature. This permits a somewhat higher generator output when the unit is cold, but causes the output to drop off as temperature increases.

REGULATOR POLARITY

Some regulators are designed for use with negative grounded systems, while other regulators are designed for use with positive grounded systems. Using the wrong polarity regulator on an installation will cause the regulator contact points to pit badly and give short life. As a safeguard against installation of the wrong polarity regulator, all regulators of this type have the model number and the polarity clearly stamped on the end of the regulator base.

REGULATOR MAINTENANCE

GENERAL INSTRUCTIONS

1. Mechanical checks and adjustment (air gap, point opening) must be made with battery disconnected and regulator preferably off the vehicle.

CAUTION: The cutout relay contact points must be closed by hand with the battery connected to the regulator. This would cause a high current to flow through the units which would seriously damage them.

2. Electrical checks and adjustments may be made either on or off the vehicle. The regulator must always be operated with the type generator for which it is designed.

3. The regulator must be mounted in the operating position when electrical settings are checked and adjusted and it must be at operating temperature. *

*Operating temperature for voltage regulator checking and adjusting is reached after 15 minutes of continuous operation of the voltage regulator unit, with 1/4 ohm resistance in series with the battery and with regulator cover in place. It is not necessary to measure the amount of current flowing during warm-up or testing of the voltage unit; however, it is important that no electrical load other than ignition be turned on during the test. (If a variable resistor is used, set to 1-10 amperes for warm up period). Operating temperature for temperature-compensated current regulators is reached after 15 minutes of operation with current regulator operating and cover in place.

4. Specified generator speeds for testing and adjusting.

(a) Voltage Regulator
    (1) Governed speed for governed engines.
(b) Current Regulator
    (1) All generators must be operated at a speed sufficient to produce current in excess of specified setting.
    (2) Voltage of the generator must be kept high enough to insure sufficient current output.

5. After any tests or adjustments the generator must be polarized after leads are connected, but before the engine is started as follows:

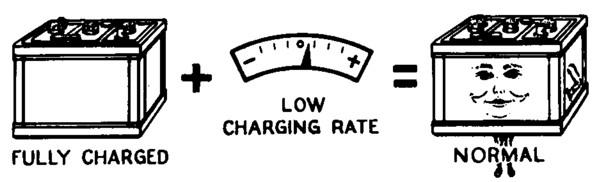
POLARIZING GENERATOR

After reconnecting leads, momentarily concect a jumper lead between the "GEN" and "BAT" terminals of the regulator. This allows a momentary surge of current to flow through the generator which correctly polarizes it. Failure to do this may result in severe damage to the equipment, since reversed polarity causes vibration, arcing and burning of the relay contact points.

QUICK CHECKS OF GENERATOR AND REGULATOR

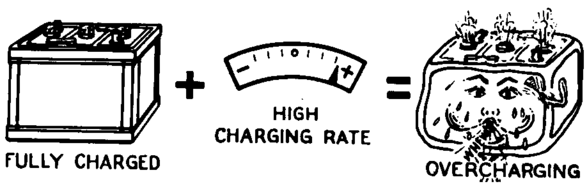
In analyzing complaints of generator-regulator operation, any of several basic conditions may be found.

(1) FULLY CHARGED BATTERY AND LOW CHARGING RATE - (Illust. 1). This indicates normal generator-regulator operation.



Illust. 1

(2) FULLY CHARGED BATTERY AND A HIGH CHARGING RATE - (Illust. 2). This usually indicates that the voltage regulator unit either is not limiting the generator voltage as it should or is set too high. A high charging rate to a fully charged battery will damage the battery and the accompanying high voltage is very injurious to all electrical units.



Illust. 2

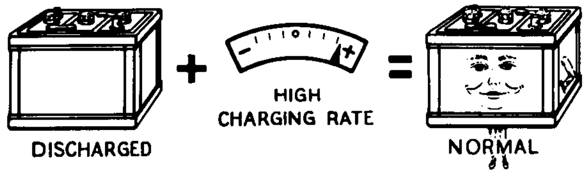
This operating condition may result from:
(a) Improper voltage regulator setting.
(b) Defective voltage regulator unit.
(c) Grounded generator field circuit (in either generator, regulator or wiring).
(d) High temperature which reduces the resistance of the battery to charge so that it will accept a high charging rate even though the voltage regulator setting is normal.

If the trouble is not due to high temperature, determine the cause of trouble by disconnecting the lead from the regulator "F" terminal with the generator operating at medium speed.

If the output remains high, the generator field is grounded either in the generator or in the wiring harness.

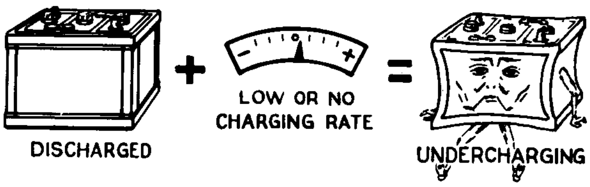
If the output drops off, the regulator is at fault, and it should be checked for a high voltage setting or grounds.

(3) LOW BATTERY AND HIGH CHARGING RATE - (Illust. 3). This is normal generator-regulator action. Regulator setting may be checked as outlined in the following section.



Illust. 3

(4) LOW BATTERY AND LOW OR NO CHARGING RATE - (Illust. 4). This condition could be due to:



Illust. 4

(a) Loose connections, frayed or damaged external wiring.
(b) Defective battery.
(c) High circuit resistance.
(d) Low regulator setting.
(e) Oxidized regulator contact points.
(f) Defects within the generator.
(g) Cutout relay not closing.
(h) Open series circuit within regulator.
(i) Generator not properly polarized.

If the condition is not caused by loose connections, frayed or damaged wires, proceed as follows to locate cause of trouble.

To determine whether the generator or regulator is at fault, momentarily ground the "F" terminal of the regulator and increase generator speed. If the output does not increase, the generator is probably at fault and it should be checked. If the generator output increases, the trouble is due to:

(a) A low voltage (or current) regulator setting.
(b) Oxidized regulator contact points which insert excessive resistance into the generator field circuit so that output remains low.
(c) Generator field circuit open within the regulator at the connections.
(d) Cutout relay not closing.
(e) Open series circuit within regulator.

(5) BURNED RESISTANCES, WINDINGS, OR CONTACTS - These result from open circuit operation, open resistance units, or loose or intermittent connections in the charging circuit. Where burned resistances, windings, or contacts are found, always check wiring before installing a new regulator. Otherwise, the new regulator may also fail in the same way.

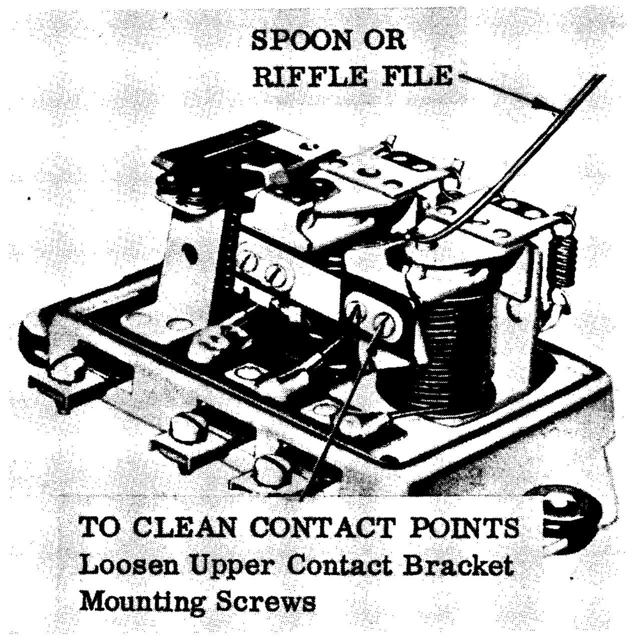
(6) BURNED RELAY CONTACT POINTS - This may be due to reversed generator polarity. Generator polarity must be corrected after any checks of the regulator or generator, or after disconnecting and reconnecting leads.

CLEANING CONTACT POINTS

The contact points of a regulator will not operate indefinitely without some attention. It has been found that a great majority of all regulator trouble can be eliminated by a simple cleaning of the current and voltage regulator contact points, plus some possible readjustment. The large flat points should be cleaned with a spoon or riffler file. On negative grounded regulators which have the flat contact point on the regulator armature, loosen the upper contact bracket mounting screws so that the bracket can be tilted to one side (Illust. 5).

On positive grounded regulators, the flat point is in the upper contact bracket so the bracket must be removed for cleaning the points. A flat file cannot be used successfully to clean the flat contact points since it will not touch the center where wear is most apt to occur. NEVER USE EMERY CLOTH OR SANDPAPER TO CLEAN THE CONTACT POINTS.

Remove all oxides from the contact points but note that it is not necessary to remove any cavity that may have developed.



Illust. 5

CAUTION: File very lightly on the soft (small) contact points to avoid excessive loss of metal.

ADAPTING VOLTAGE REGULATOR SETTING FOR UNUSUAL CONDITIONS

The voltage regulator setting often must be "tailored" to adapt it to the battery and type of service. The ideal setting is that which will keep the battery at or near full charge with the minimum use of water. The "normal" setting (value shown in test specifications) usually will be satisfactory for average service. However, if service is above or below average, the setting must be tailored to fit the job. Either of two conditions which may exist will require tailoring: (1) battery is being overcharged (using too much water), (2) battery remains undercharged (3/4 charge or less). Corrections may be made as follows:

(1) If battery uses too much water at normal setting, reduce voltage setting 0.1 or 0.2 of a volt and check for improved condition over a reasonable service period.

Repeat until battery remains charged with a minimum use of water. It rarely will be necessary to go below 13.8 volts on a 12 volt system.

CAUTION: Whenever the voltage setting is reduced, the cutout relay must also be checked and reduced if necessary. It must be at least 0.5 of a volt less than voltage regulator setting.

(2) If battery is consistently undercharged at normal setting, increase the voltage setting 0.1 of a volt and check for improved condition over a reasonable service period. Repeat until the battery remains charged with a minimum use of water. It rarely will be necessary to increase the voltage above 14.8 on a 12 volt system.

CAUTION: When increasing voltage avoid settings high enough to damage lights or other voltage-sensitive equipment during cold weather operation. Before tailoring the voltage setting for unusual conditions be sure the battery is normal - not sulfated, not permanently damaged due to having been overheated, not operating in too hot a location, and not poorly ventilated.

REGULATOR CHECKS AND ADJUSTMENTS

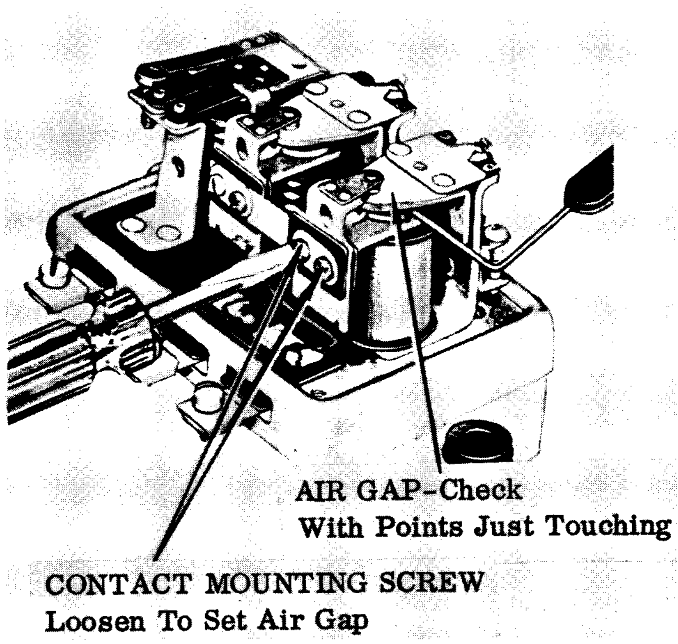
Procedure: For best results the following steps should be taken in the sequence given.

(1) Bring voltage regulator to operating temperature.
(2) Check voltage regulator.
(3) Check cutout relay.
(4) Bring current regulator to operating temperature.
(5) Check current regulator.

VOLTAGE REGULATOR

Two checks and adjustments are required on the voltage regulator: air gap and voltage setting.

AIR GAP - Push down on armature until contact points are just touching. Measure air gap between armature and winding core (Illust. 1). Adjust by loosening contact mounting screws and raising or lowering contact mounting bracket as required. Be sure the contact points are aligned and screws securely tightened after adjustment.



Illust. 1

VOLTAGE SETTING

FIXED 1/4 OHM RESISTANCE METHOD

(1) Connect a 1/4 ohm fixed resistor (not less than 25 watts) into the charging circuit at "BAT" terminal of regulator (in series with battery) (Illust. 2).

(2) Connect a voltmeter from regulator "BAT" terminal to ground (Illust. 2).

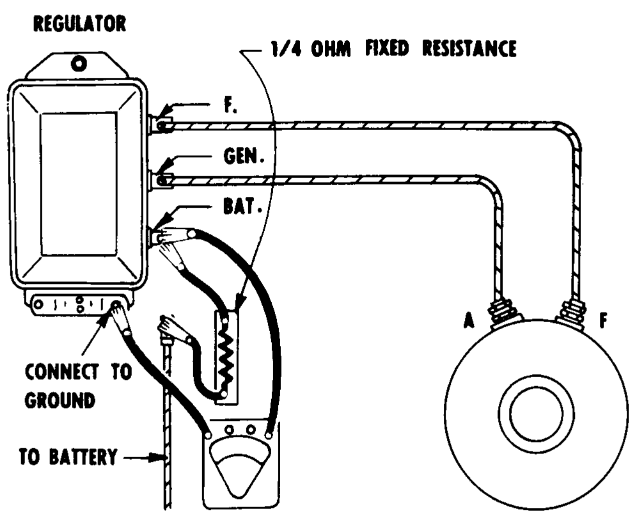
(3) Operate generator at specified speed for 15 minutes. Regulator cover must be in place. (Regulator may now be consid-

ered to be at operating temperature).

NOTE: IT IS NOT NECESSARY TO MEASURE THE AMOUNT OF CURRENT FLOWING DURING TESTING AND ADJUSTING. HOWEVER, IT IS IMPORTANT THAT NO ELECTRICAL LOAD OTHER THAN IGNITION BE TURNED ON DURING TEST.

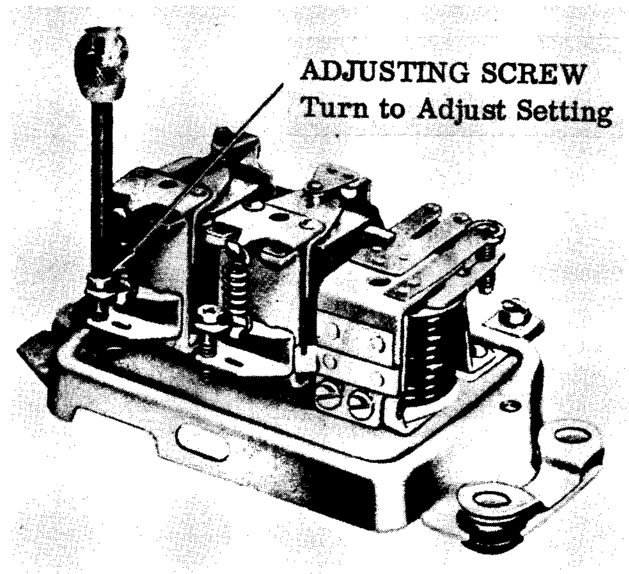
(4) Cycle the generator:

Method A - Move voltmeter lead from "BAT" to "GEN" terminal of regulator. Retard generator speed until generator voltage is reduced to 4 volts on a 12 volt system. Move voltmeter lead back to "BAT" terminal of regulator. Bring generator back to specified speed and note voltage setting.



Method B - Connect a variable resistance into the field circuit (Illust. 7). Turn out all resistance. Operate generator at specified speed. Slowly increase (turn in) resistance until generator voltage is reduced to 4 volts on a 12 volt system. Turn out all resistance again and note voltage setting (with voltmeter connected) (Illust. 2). Regulator cover must be in place.

(5) To adjust voltage setting, turn adjusting screw (Illust. 3). Turn clockwise to increase setting and counter-clockwise to decrease voltage setting.



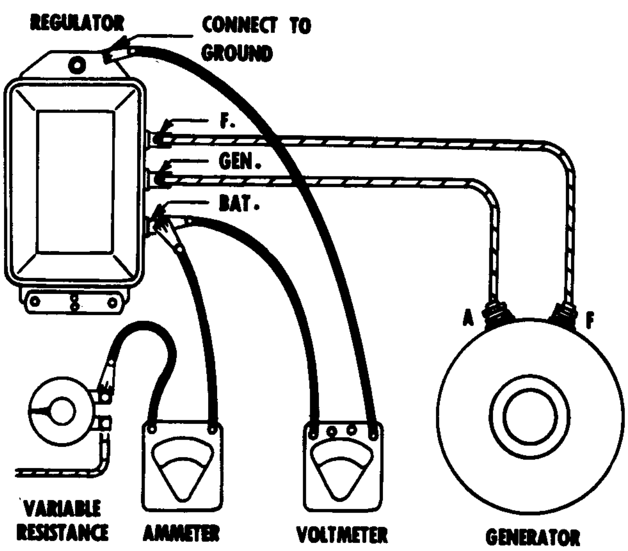
Illust. 3

CAUTION: If adjusting screw is turned down (clockwise) beyond range, spring support may note return when screw is backed off. In such case, turn screw counter-clockwise until there is ample clearance between screw head and spring support. Then, bend spring support up carefully until it touches the screw head. Final setting of the unit should always be made by increasing spring tension, never by reducing it. If setting is too high, adjust unit below required value and then raise to exact setting by increasing spring tension. After each adjustment and before taking reading, replace the regulator cover and cycle the generator

VARIABLE RESISTANCE METHOD

(1) Connect a variable resistance (not less than 25 watts) and an ammeter into the charging circuit (in series with battery) at "BAT" terminal of regulator (Illust. 4).

(2) Connect a voltmeter from regulator "BAT" terminal to ground (Illust. 4).



Illust. 4

(3) Start generator and adjust variable resistance to obtain a current flow of not more than 10 amperes. Operate the generator at specified speed for 15 minutes. Regulator cover must be in place. (Regulator may now be considered to be at operating temperature; see paragraphs 3 and 4 in general instructions).

(4) Cycle the generator as explained in step 4 under "FIXED 1/4 OHM RESISTANCE METHOD".

(5) Adjust voltage setting as necessary, as explained in step 5 under "FIXED 1/4 OHM RESISTANCE METHOD".

CORRECTION FOR TEMPERATURE

It is important to note that the voltage setting shown in Test Specifications is the normal setting at operating temperature when room temperature is 80° F. If regulator is adjusted at room temperature higher than 80°, set voltage 0.1 volt less than specified normal setting for each 10 degrees above 80°. For lower room temperatures, set voltage setting 0.1 volt more for each 10 degrees below 80°.

EXAMPLE 1: Voltage setting of a regulator at operating temperature but with room temperature at 90° F. would be 14.5 minus 0.1 volt or 14.4 for normal setting.

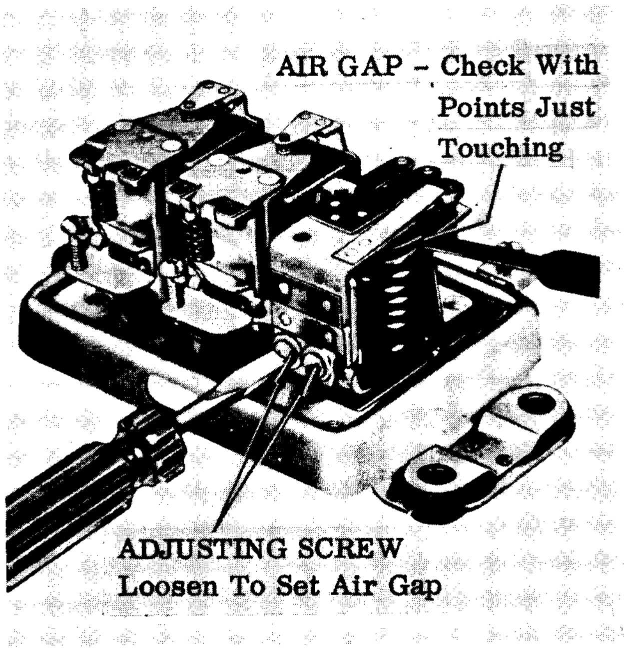
EXAMPLE 2: For a regulator at operating temperature but with room temperature at 60° F., normal setting would be 14.5 plus 0.2 volt or 14.7 volts.

For voltage regulator settings above or below normal, see section "ADAPTING VOLTAGE SETTINGS FOR UNUSUAL CONDITIONS". Extreme or abnormal operating conditions may require tailoring the voltage regulator setting.

CUTOUT RELAY CHECKS AND ADJUSTMENTS

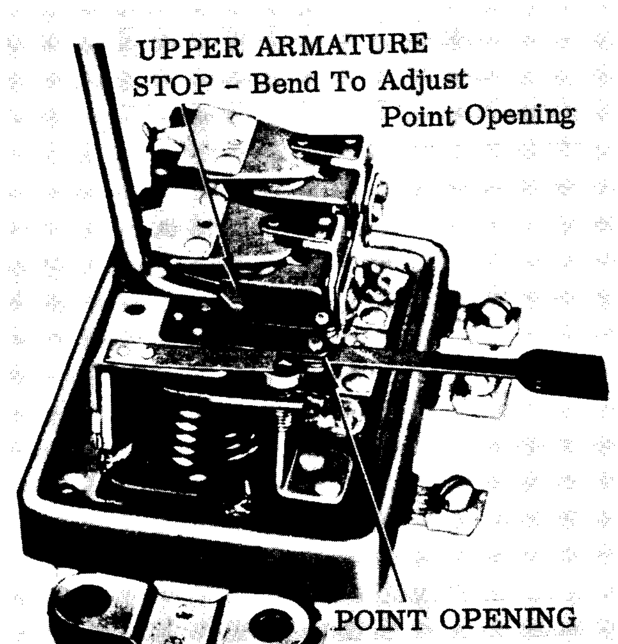
The cutout relay requires three checks and adjustments: air gap, point opening and closing voltage. Air gap and point opening must be must with the battery lead disconnected from the regulator.

AIR GAP - Place fingers on armature directly above core, move armature down until points just close. Measure air gap between armature and center of core (Illust. 5). On multiple contact point relays make sure that all points close simultaneously. Adjust air gap by adjusting two screws in back of relay and raise or lower armature as required. Tighten screws after adjustment.



Illust. 5

POINT OPENING - Check point opening and adjust by bending the upper armature stop (Illust. 6).



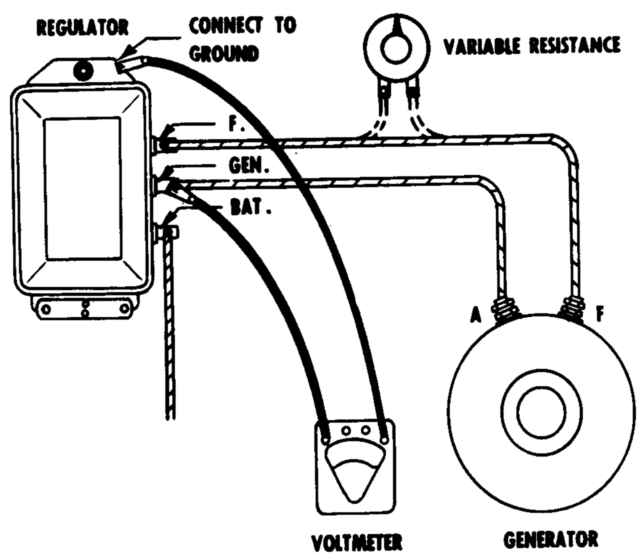
Illust. 6

CLOSING VOLTAGE

(1) Connect regulator to proper generator and battery. Connect voltmeter between the regulator "GEN" terminal and ground (Illust. 7).

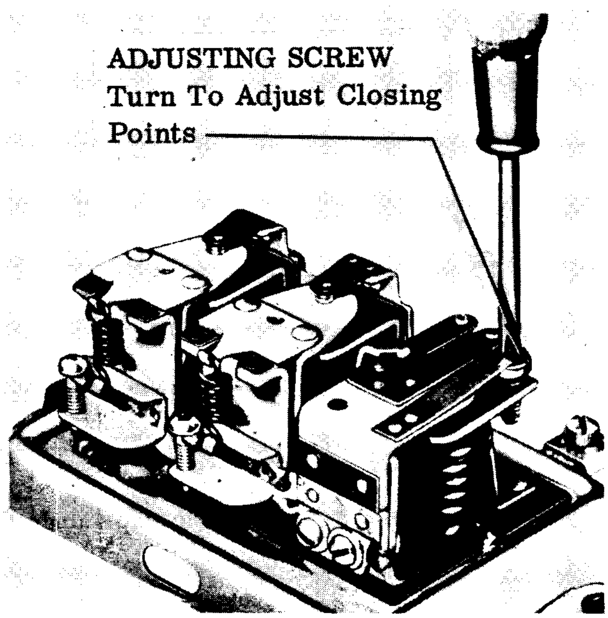
(2) Method A - Slowly increase generator speed and note relay closing voltage. Decrease generator speed and make sure the cutout relay points open.

Method B - Make connections as in Step 1, but in addition, add a variable resistor connected into the field circuit (Illust. 7). Use a 25 ohm - 25 watt for 12 volt systems. Operate generator at medium speed with variable resistance all in. Slowly decrease (turn out) the resistance until cutout relay points close. Note closing voltage. Slowly increase (turn in) resistance to make sure points open.



Illust. 7

(3) Adjust closing voltage (either method) by turning adjusting screw (Illust. 8). Turn screw clockwise to increase setting and counter-clockwise to decrease setting.



Illust. 8

CURRENT REGULATOR

Two checks and adjustments are required on the current regulator: air gap and current setting.

AIR GAP - Check and adjust in exactly the same manner as for the voltage regulator.

CURRENT SETTING - To check current regulator setting, the voltage regulator unit must be prevented from operating. Several methods for preventing the voltage regulator from operating are available. Regardless of the method used, connect an ammeter into the charging circuit at the regulator "BAT" terminal. The first method listed below should be used for preliminary checks wherever possible since it does not require removal of the regulator cover. The various methods are as follows:

(1) QUICK CHECK METHOD - (Do not use for models which include "B" or "C" suffix)

(a) Connect ammeter into charging circuit (Illust. 10).

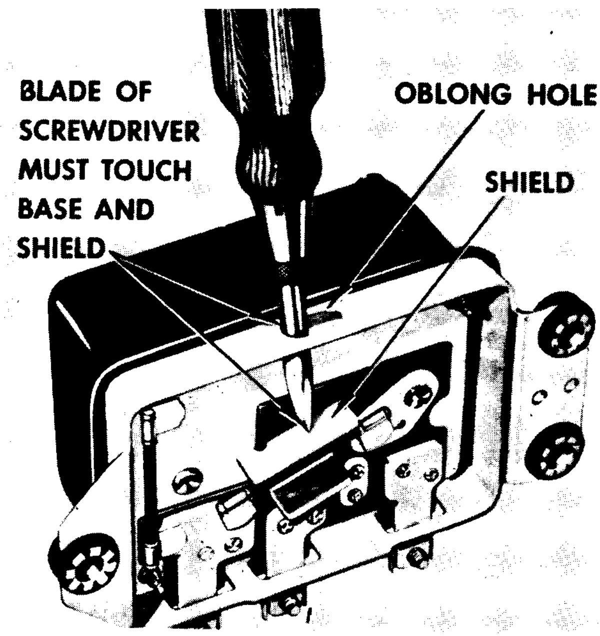
(b) Turn on all lights and accessories.

(c) Operate generator at specified speed for 15 minutes with cover in place. (This establishes operating temperature, see paragraphs 3 and 4 in General Instructions). If current regulator is not temperature-compensated, disregard 15 minute warm-up period.

(d) Insert screw driver blade through hole in regulator base (Illust. 9). This shorts out the voltage regulator. (Hold screw driver firmly with blade touching regulator base and shield at same time).

(e) Cycle generator and note current setting.

(f) Adjust in the same manner described for the voltage regulator (Illust. 3).



Illust. 9

(2) LOAD METHOD

(a) Connect ammeter into charging circuit (Illust. 10).

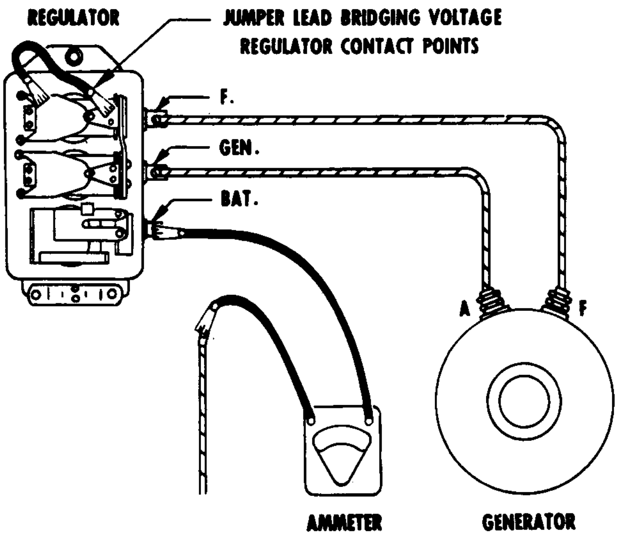
(b) Place load across battery about equal to current regulator setting. Load may be a carbon pile or bank of lights.

(c) Operate generator as in "c" under Quick Check Method.

(d) Cycle generator and note current setting.
(e) Adjust in same manner as described for the voltage regulator (Illust. 3).

(3) JUMPER LEAD METHOD - (Only for current regulators without temperature compensation).

(a) Connect ammeter into charging circuit (Illust. 10).
(b) Connect jumper lead across voltage regulator points (Illust. 10).
(c) Turn on all lights and accessories or load battery as in "b" under Load Method.
(d) Operate generator at specified speed and note current setting.
(e) Adjust in same manner as described for the voltage regulator (Illust. 3).



Illust. 10

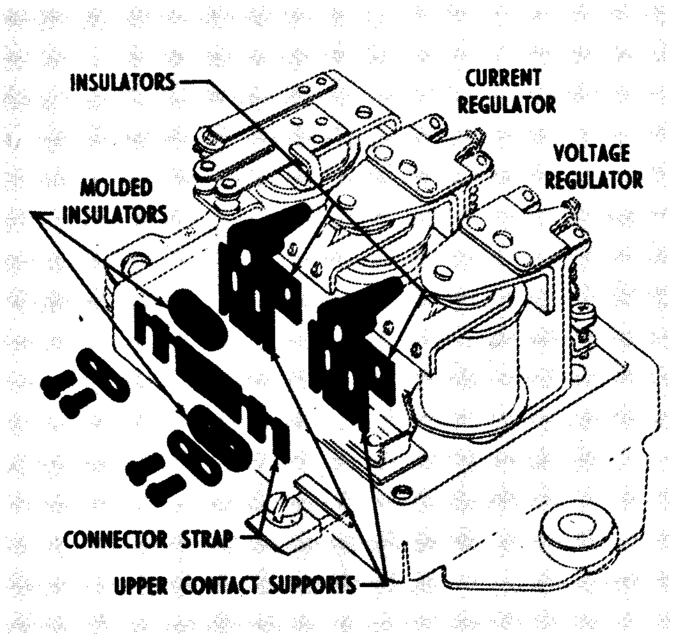
REPAIR SECTION

REGULATOR SPRING REPLACEMENT

If it becomes necessary to replace the spiral spring on either the current or voltage regulator unit, the new spring should first be hooked on the lower spring support and then stretched up until it can be hooked at the upper end. Stretch the spring only by means of a screw driver blade inserted between the turns (or in a similar manner) do not pry the spring into place, as this is likely to bend the spring supports. After installing a new spring, readjust the unit setting as already described.

REPLACING CONTACT SUPPORT BRACKETS

Voltage or current regulator unit contact support brackets can be replaced by following the relationship illustrated in Illust. 11. Note particularly that the connector strap is insulated from the voltage regulator unit contact mounting screws while it is connected to the current regulator unit contact mounting screws.



Illust. 11

VOLTAGE SETTING FOR HIGH TEMPERATURE CONDITIONS WHERE CONTINUOUS BATTERY OVERCHARGE IS EXPERIENCED

Where high battery temperatures are obtained, battery overcharge may be experienced even though the voltage regulator setting is within specifications and correct for all normal operating conditions. This overcharging condition may be relieved by reducing the voltage setting slightly. HOWEVER, THE VOLTAGE REGULATOR SETTING MUST NOT BE REDUCED UNLESS IT IS ACTUALLY NECESSARY. The cutout relay likewise must be reduced so the voltage regulator setting is still safely above the setting of the cutout relay.

If such voltage reductions are made during hot weather, the voltage settings should again be increased to the standard specified settings at the onset of cold weather since the reduced settings, combined with low temperatures, may result in undercharged batteries.

HIGH POINTS ON REGULATOR PERFORMANCE AND CHECKS

1. The voltage regulator unit limits the voltage of the circuit, thus protecting the battery, distributor points, lights and other accessories from high voltage.

2. The current regulator unit provides protection to the generator, preventing it from exceeding its maximum rated output.

3. Never set the current regulator above the maximum specified output of the generator.

4. Many of the regulators are designed to be used with a positive grounded battery only while others are designed to be used with a negative grounded battery only. Never attempt to use the wrong polarity regulator on an application.

5. The majority of reported regulator troubles arise from dirty and oxidized contact points, which cause a reduced generator output. Clean the contact points with a file as explained previously. NEVER USE EMERY CLOTH OR SANDPAPER TO CLEAN POINTS.

6. Always make sure that the rubber gasket is in place between the cover and base before replacing the cover. The gasket prevents entrance of moisture, dust and oil vapors which might damage the regulator.

7. Be sure the battery to which the regulator is connected has the correct terminal grounded or connected to the return circuit, as noted on the regulator name plate.

8. Never connect condensers across the regulator contact points (or from the FIELD terminal to ground or other terminals) unless definitely specified. A special condenser is required for this in order to prevent damage to the regulator contact points.

9. Electrical adjustments should be made with the regulator at operating termperature.

10. The proper testing equipment in the hands of a qualified mechanic is necessary to assure proper and accurate regulator settings. Any attempt on the part of untrained personnel to adjust regulators is apt to lead to serious damage to the electrical equipment and should be discouraged.

11. After any generator or regulator tests or adjustments, the generator must be repolarized as explained previously in order to avoid damage to the equipment.

TEST SPECIFICATIONS			
VOLTAGE REGULATORS (12 Volt Systems)			
Cutout Relay Air Gap ----------------.020 in. Cutout Relay Point Opening -----------.020 in.		Voltage Regulator Air Gap-----------------.075 in. Current Regulator Air Gap-----------------.075 in.	
Delco Remy Regulator Model No.	Cutout Relay Closing Voltage Allowable Limit	Voltage Regulator Setting Normal Range	Current Regulator Setting Allowable Limit
1118956	11.8 - 13.5	13.8 - 14.8	32 - 37*
1119156	11.8 - 13.5	13.8 - 14.7	48 - 52*

*Current regulator must be checked at operating temperature. Operating temperature is assumed to be established after 15 minutes of continuous current regulator operation.

GENERATORS

MODELS 330 AND 440 MOTOR GRADERS

(Delco Remy No. 1105105 - 12 Volt - 35 Amp - 525 Watt)
(Delco Remy No. 1106822 - 12 Volt - 50 Amp - 750 Watt)

The generator is a machine used to convert mechanical energy into electrical energy. The generator is so mounted as to be driven by the engine, and it uses some of the mechanical energy from the engine to create electrical energy. The generator consists of a field frame with field coils which produce a magnetic field and armature to support conductors in and rotate conductors through the magnetic field, a commutator on the armature and secondary brushes on the commutator end heads to carry away current induced in armature conductors, and bearing to support the armature.

The generator has two jobs. It restores to the battery the current withdrawn during cranking, thus maintaining the battery in a charged condition. Secondly, it carries the connected electrical load up to the capacity of the generator, when the generator is operating at speeds at which substantial or maximum generator output is available.

The generators used are of a two (2) brush, shunt type. In shunt type generators the field strength is varied by inserting or removing resistance in the generator field circuit. Inserting resistance reduces field strength, cuts down generator output. Removing the resistance increases the field strength, permits increased generator output.

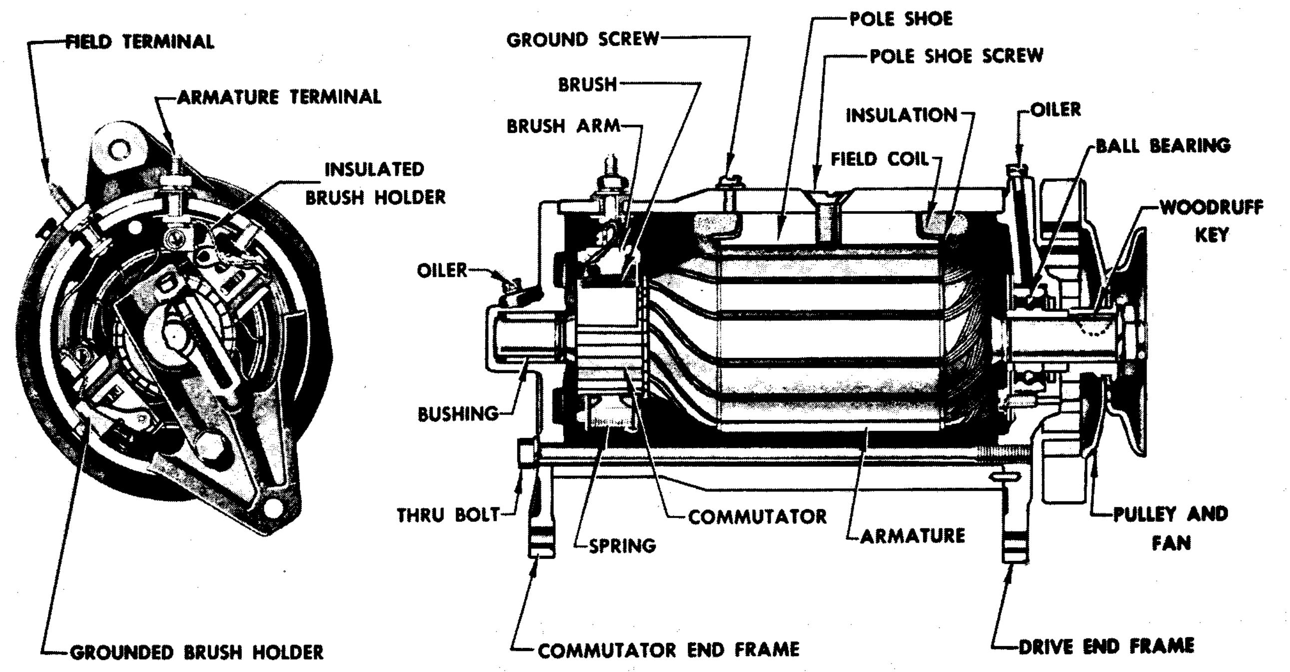
The field circuit is connected inside the generator to the insulated brush. Outside the generator, the field circuit is connected to the voltage regulator. Further details concerning the circuits between generator and voltage regulator, is outlined under "Voltage Regulator".

The brush is a small but very important part of the generator which does not always receive the consideration it requires for good generator operation. Brushes are selected for each type in accordance with the operating characteristics of the generator. Different types of brushes cannot be used indiscriminately, although they may happen to have the same physical dimensions. A generator with a high output at high speeds require a different brush than one operating with a low output at low speeds.

The generator brush holders used on machines equipped with General Motors engines are reaction type, whereas, those used on machines equipped with Cummins engines are reaction box type (Illust. 1).

Illust. 1

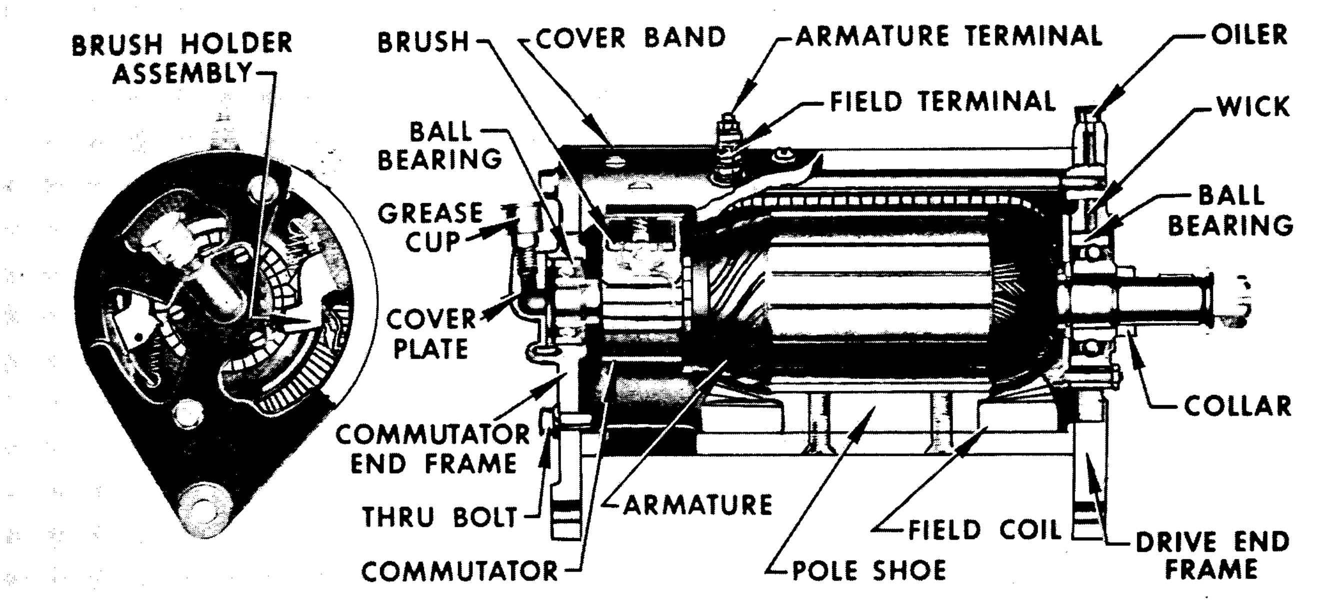
A stop is provided to prevent the brush arm from touching and scoring the commutator. The brush, however, never should be allowed to wear down until the brush arm actually touches the stop. The brush arm stop also protects the commutator bars from being scored by the arm when a brush is removed.



Illust. 2

Illust. 2 is a cut-away view of the generator similar to the one used on motor graders equipped with General Motors engines. These generators are belt driven.

Illust. 3 is a cut-away view of the generator similar to the one used on motor graders equipped with Cummins engines. These generators are driven directly from the gear in the gear housing.



Illust. 3

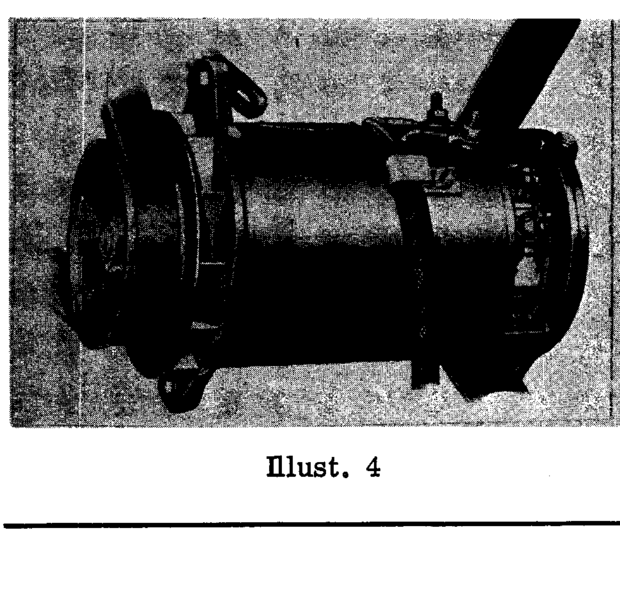
PREVENTATIVE MAINTENANCE

Every 100 hours of operation, a period check should be made to determine the general condition of the generator. First, inspect the terminals, external connections and wiring. Remove cover band (Illust. 4) and inspect the commutator, brushes and external connections. Check belt and belt tension (General Motors engine) or coupling (Cummins engine). If brushes are worn down to 1/2 their original length they must be replaced. Brush spring tension must be sufficient to give good clean contact of the brushes on the commutator. Brushes must be free to slide in their holders.

The commutator must be smooth, round, clean and without gummed or burned areas. The slots between the segments must be open and not filled with brush or copper dust.

The armature leads must be properly soldered to the commutator segments.

If the generator is belt driven, proper tension must be maintained. Excessive belt tension causes rapid belt and bearing wear, while low belt tension causes belt slippage, rapid belt wear and failure of the generator to charge in a normal manner.



Illust. 4

Every 600 hours of service (approximately) the generator should be removed from the grader, disassembled, and all parts cleaned and inspected. Generally speaking, disassembly should be carried only so far as is necessary to adequately inspect and clean all parts. Likewise, the field windings and terminal studs need not be removed from the field frame except for replacement. Indiscriminate disassembly and assembly of such parts may actually damage them since it tends to weaken leads and connections by bending and stressing them.

CLEANING

Wipe off excess grease and dirt with a clean cloth. Do not steam clean or dip clean the generator, and avoid getting any water or dirt in the generator. Handle generators carefully to avoid battering or bending the terminal studs or cover band.

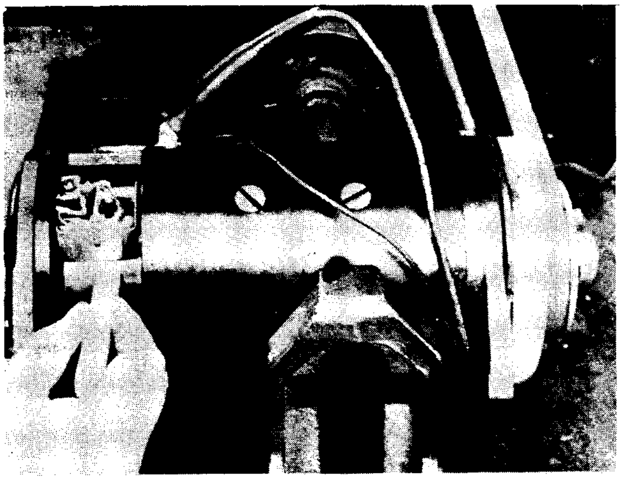
LUBRICATION

Care should be taken to avoid excessive lubrication, since this might cause lubricant to be forced out onto the commutator where it would gum and cause poor commutation. Such a condition results in reduced generator output and increased commutator and brush wear.

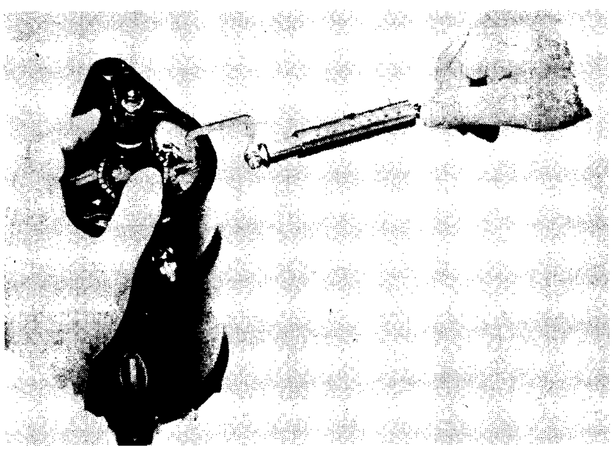
Never lubricate the commutator and do not lubricate the generator while it is in operation. Be sure to keep all lubricants clean and in closed containers. For lubrication procedure, see "Lubrication Section".

ADJUSTMENTS, TESTS AND MAINTENANCE

To clean the commutator, remove cover band (Illust. 1). Clean commutator with a piece of No. 00 sandpaper. Never use emery cloth to clean the commutator.



Illust. 1



Illust. 2

The sandpaper may be used by holding it against the commutator with a wood stick while the generator is in operation, moving it back and forth across the commutator.

Gum and dirt will be sanded off in a few seconds. All dust should be blown from the generator after the commutator has been cleaned. A brush setting stone (Illust. 2) can also be used to clean the commutator.

When new brushes are installed, they should be seated to make sure they are in good contact with the commutator. A convenient tool for seating brushes is a brush seating or bedding stone. This is a soft abrasive material which, when held against a revolving commutator, disintegrates so that particles are carried under the brushes and wear their contact faces to the contour of the commutator in a few seconds. Illust. 2 illustrates the manner in which a brush seating stone is used.

The brush spring tension must be correct since excessive tension will cause rapid brush and commutator wear, while low tension causes arcing and burning of the brushes and commutator. Brush spring tension can be checked with a spring gauge hooked on the brush arm or brush attaching screw. Measure brush spring tension as shown in Illust. 8. (See specification table at the end of section). Correction can be made by bending the brush spring as required. If the brush spring shows evidence of overheating (blue or burned) do not attempt to readjust it but install a new spring. Overheating will cause a spring to lose its temper.

SHUNT GENERATOR OUTPUT

The maximum output of shunt generators is determined by the current setting of the current regulator with which the shunt generator is used. (For specifications of current regulator, see TEST SPECIFICATIONS in Voltage Regulator Section).

NO OUTPUT

If the generator will not produce any output, check the commutator, brushes and internal connections. Sticking brushes, a dirty or gummy commutator (see ARMATURE SERVICE), or poor connections may prevent the generator from producing any output. Thrown solder on the cover band indicates that the generator has been overloaded (allowed to produce excessive output) so it has overheated and melted the solder at the commutator riser bars. The solder has been thrown out: often, this leads to an open circuit and burned commutator bars (see paragraph 4, following). If the brushes are satisfactorily seated and are making good contact with the commutator, and the cause of the trouble is not apparent, use a set of test points and a test lamp as follows to locate the trouble (leads must be disconnected from generator terminals).

1. Raise the grounded brush (or brushes) from the commutator and insulate with a piece of cardboard. Check for grounds with test points from the generator main brush or "A" terminal to the generator frame. If the generator is of the type in which the field is internally grounded to the field frame*, disconnect the field ground lead before making this test. If the lamp lights, it indicates that the generator is internally grounded. Location of the ground can be found by raising and insulating all brushes from commutator and checking the brush holders, armature or commutator, and field separately. Repair or replace parts required.

*If a grounded field is found in the generator of this type, check the regulator contact points since a grounded field may have permitted an excessive field current which will have burned the regulator contact points. Burned regulator points should be cleaned or replaced as required.

2. If the generator is not grounded, check the field for an open circuit with a test lamp. The lamp should light when one test point is placed on the field terminal or grounded field lead and the other is placed on the brush holder to which the field is connected. If it does not light, the circuit is open. If the open is due to a broken lead or bad connection, it can be repaired but if the open is inside one of the field coils, the coil must be replaced.

3. If the field is not open, check for a short circuit in the field by connecting a battery of the specified voltage and an ammeter in series with the field circuit. Proceed with care, since a shorted field may draw excessive current which might damage the ammeter. If the field is not within specifications, new field coils will be required. NOTE: If a shorted field is found, check the regulator contact points, since the shorted field may have permitted excessive field current which would have caused regulator points to burn. Clean or replace points as required.

4. If the trouble has not yet been located, check the armature for open and short circuits. Open circuits in the armature are usually obvious since the open circuit commutator bars will arc every time they pass under the generator brushes so that they will soon become burned. If the bars are not too badly burned and the open circuit can be repaired, the armature can usually be saved. In addition to repairing the armature, generator output must be brought down to specifications to prevent overloading by readjustment of the regulator.

Short circuits in the armature are located by use of a growler. The armature is placed in the growler and slowly rotated (while a thin strip of steel, such as a hacksaw blade, is held above the armature core). The steel strip will vibrate above the area of the armature core in which short circuited armature coils are located. If the short circuit is obvious, it can often be repaired so that the armature can be saved.

UNSTEADY OR LOW OUTPUT

If the generator produces a low or unsteady output, the following factors should be considered:

1. A loose belt will slip and cause a low or unsteady output.

2. Brushes which stick in their holders, or low brush spring tension will prevent good contact between the brushes and commutator so that output will be low and unsteady. This will also cause arcing and burning of the brushes and commutator.

3. If the commutator is dirty, out of round, or has high mica, generator output is apt to be low and unsteady. The remedy here is to turn the commutator down in a lathe and under cut the mica. Burned commutator bars may indicate an open circuit condition in the armature as already stated in paragraph 4, under NO OUTPUT.

EXCESSIVE OUTPUT

When a generator produces excessive output on an application, the procedure for determining whether the trouble is in the generator, voltage regulator or elsewhere, (See "QUICK CHECKS" in Voltage Regulator Section). If the generator output remains high, even with the "F" terminal lead disconnected, then the trouble is in the generator itself and it must be further analysed to locate the source of the trouble. The procedure to follow depends upon the type of generator - regulator circuit the system uses. There are two basic circuits in which the regulator inserts resistance to produce output regulation. In one, the generator field circuit is grounded through the regulator while in the other, the generator field circuit is grounded internally.

In the first system (which has the generator field circuit grounded externally) accidental internal grounding of the field circuit would prevent normal regulation so that excessive output might be produced by the generator. On this type of unit, an internally grounded field circuit which would cause excessive output, may be located by use of test points connected between the "F" terminal and the generator frame. Leads should be disconnected from the "F" terminal and the brush to which the field lead is connected inside the generator should be raised from the commutator before this test is made. If the test lamp lights, the field is internally grounded. If the field has become grounded because the insulation on a field lead has worn away, repair can be made by reinsulating the lead. It is also possible to make repair where the ground has occurred at the pole shoes by removing the field coils and reinsulating them. A ground at "F" terminal stud can be repaired by installing new insulating washers or bushings.

If the generator is of the type which has the field circuit internally grounded, about the only cause of excessive output (with lead disconnected from the generator "F" terminal) would be a short between the field circuit and the insulated main circuit. This can be corrected by relocating and reinstalling the leads.

NOISY GENERATOR

A noisy generator may be caused by a loose mounting, drive pulley or gear, worn or dirty bearings, or improperly seated brushes. Dirty bearings may sometimes be saved by cleaning and relubricating, but worn bearings should be replaced. If the brush holder is bent, it may be difficult to reseat the brush so that it will function properly without excessive noise. Such a brush holder will require replacement.

POLARIZING GENERATOR

After a generator has been repaired and installed on a motor grader, or at any time after the generator has been tested, it must be polarized to make sure that it has the correct polarity with respect to the battery it is to charge. Failure to polarize the generator may result in burned relay contact points, a run-down battery and possibly serious damage to the generator itself. The procedure to follow in correcting generator polarity depends upon the generator regulator wiring circuits - that is, whether the generator field is internally grounded or is grounded through the regulator.

Connect a jumper lead momentarily between the ARMATURE and BATTERY terminals of the regulator after all leads have been connected but before the engine is started. This allows a momentary surge of current to flow through the generator which correctly polarizes it.

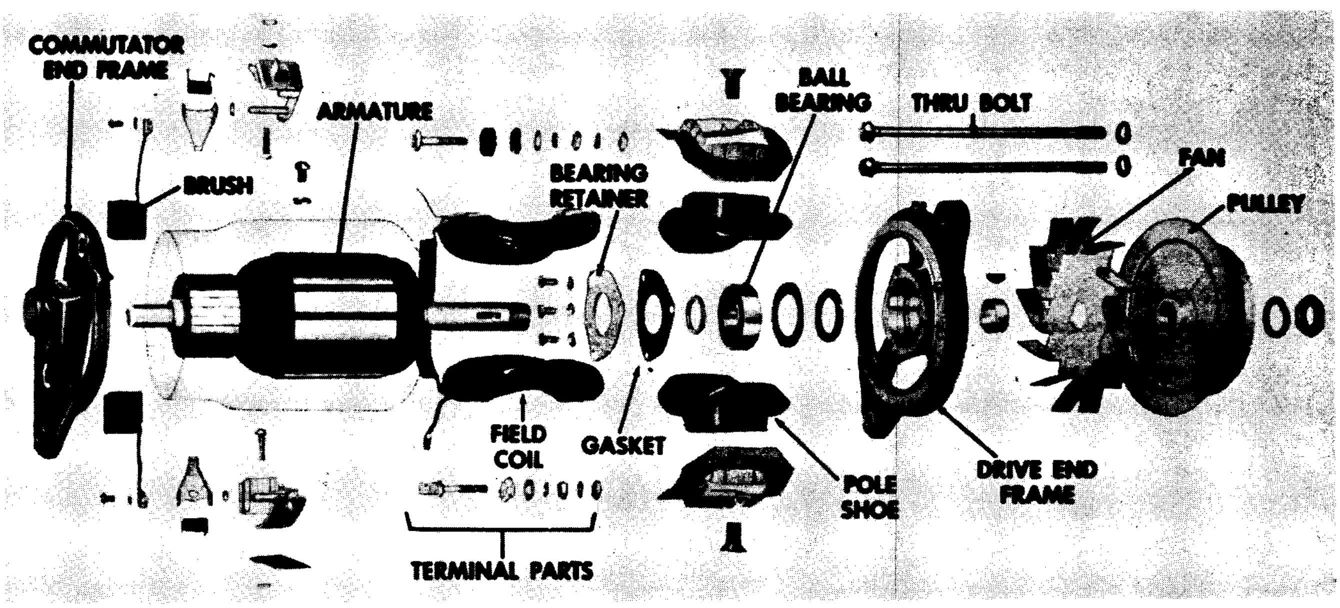
DISASSEMBLE, REPAIR AND REASSEMBLE

Illusts. 1 and 2 are exploded views of the generator similar to the one used on motor graders equipped with General Motors engines.

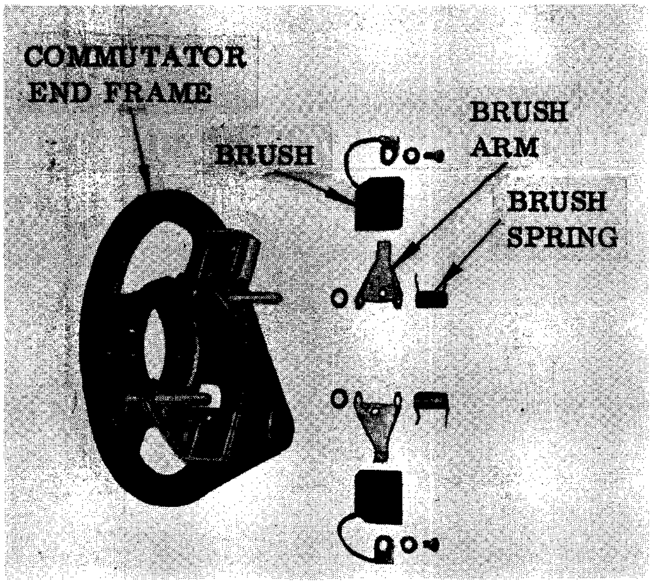
To disassemble this type unit, unscrew the thru bolts and remove the commutator end frame and the field frame. Place the armature in a vise with soft jaws and remove the shaft nut, washer, pulley, fan assembly and drive end frame. If new brush holders are required, a replacement brush holder package is available with instructions for installing (See your Delco Remy Agency). It is necessary only to drill out the rivets holding the present holders and replace with the new holders, securing them to the frame with the screws, nuts and washers provided in the package. The assembly procedure is the reverse of the disassembly for the generator. The end frame assembly (Illust. 2) has the brush holders permanently riveted to the frame, so that the end frame and brush holders serviced together. The brush holders used in this assembly are the reaction type.

Illust. 3 is an exploded view of the generator similar to the one used on motor graders equipped with Cummins engines.

The disassembly procedure is similar to that of the generator used on the General Motors engines. The difference being, by removing the two thru bolts, the end frame, bearings and armature, the generator can be disassembled or replaced without disturbing any electrical connections. Each



Illust. 1



Illust. 2

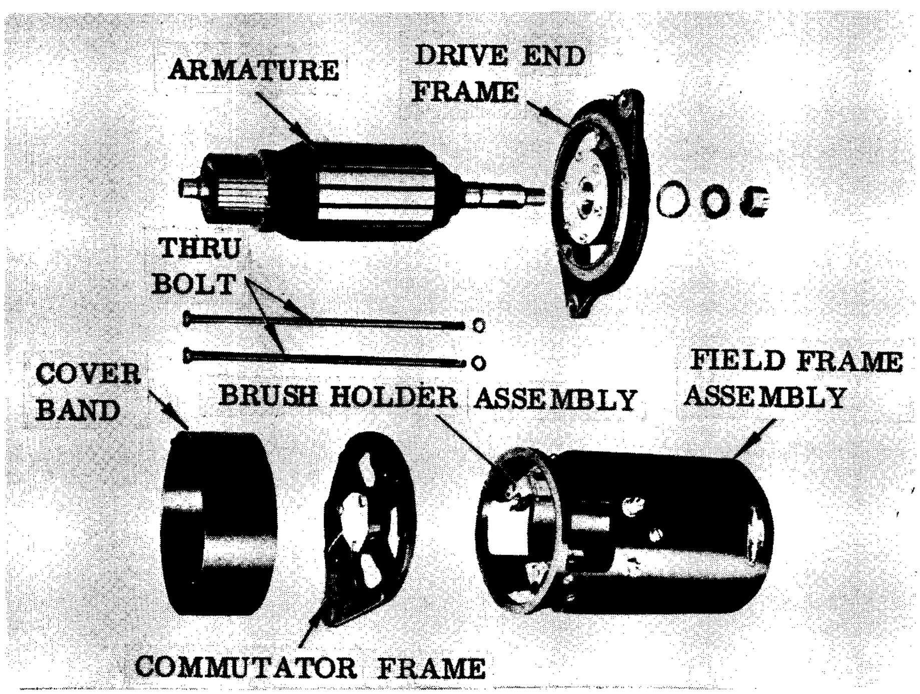
brush holder can be disassembled by removing two attaching set screws and nuts. The brush holders used in this type generator are of the reaction box type.

Do not clean the armature in any degreasing tank or by use of degreasing compounds since this may damage insulation, thus causing shorts or ground. Wipe armature off, using a clean cloth.

Thoroughly clean and repack ball bearings with a high melting point ball bearing grease. Bearings that are sealed require no cleaning or relubricating. Other generator parts should be cleaned and carefully inspected for wear and damage. Any defective parts should be replaced or repaired. On reassembly, all soldered electrical connections should be made with rosin flux. Acid flux must never be used on electrical connections.

FIELD COIL SERVICE

The field coil should be checked for grounds, opens or shorts (See paragraphs 1 to 3 under NO OUTPUT).



Illust. 3

INSPECTION AND REPAIR OF PARTS

Grounded field coils may sometimes be repaired by removing them so they can be reinsulated. Care must be used to avoid excessive bulkiness when applying new insulation, since this might cause the pole shoe to cut through and cause another ground when the coils are reinstalled.

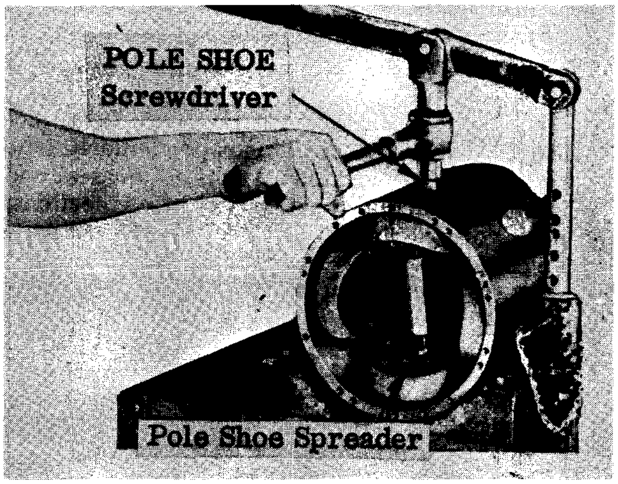
Usually, if a field coil is open or shorted internally, it will require replacement since it is difficult to repair such a defect.

To remove or replace field coils in the frame, use a pole shoe spreader and screw driver (Illust. 4).

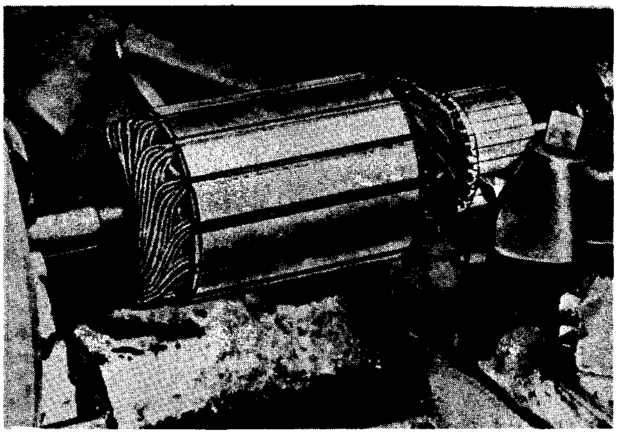
ARMATURE SERVICE

The armature should be checked for opens, shorts and grounds. If the armature commutator is worn, dirty, out of round, or has high mica, the armature should be put in a lathe (Illust. 5) so the commutator can be turned down and the mica undercut. The mica should be undercut 1/32 of an inch and the slots cleaned out carefully to remove any trace of dirt or copper dust. Mica can also be undercut by using a file and hacksaw blade (Illust. 6). As a final step in this procedure, the commutator should be sanded lightly with No. 00 sandpaper to remove any slight burrs that might be left as a result of the undercutting procedure.

Open circuited armatures can often be saved, where the open is obvious and repairable. The most likely place an open will occur is at the commutator riser bars; this usually results from overloading of the generator which causes overheating and melting of solder. Repair can be effected by resoldering the leads in the riser bars (use rosin flux) and turning down the commutator in a lathe to remove the burned spot and then undercutting the mica.



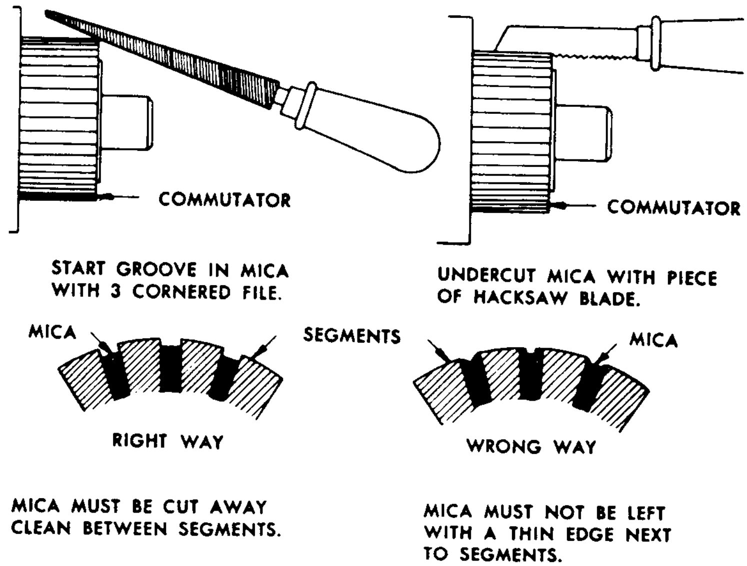
Illust. 4



Illust. 5

Short circuits in the armature are located by use of a growler. When the armature is revolved in the growler, with a steel strip such as a hacksaw blade held above it, the blade will vibrate above the area of the armature core in which the short is located. Copper brush dust in the slots sometimes causes shorts between bars which can be eliminated by cleaning out the slots. Shorts at cross-overs of the coils at the core end can often be eliminated by bending wires slightly and reinsulating the exposed bare wire.

Grounds in the armature are detected by use of a test lamp and test points. If the lamp lights when one test point is placed



UNDERCUTTING MICA

Illust. 6

on the commutator with the other point on the core or shaft, the armature is grounded. Grounds occur as a result of insulation failure which is often brought on by overloading and consequent overheating of the generator. Repairs can sometimes be made, if grounds are at core ends (where coils come out of slots) by placing insulation strips between core and coil which has grounded.

WIRING AND INSULATION

All connections in the charging circuit must be clean and tight. Corroded and loose connections cause high resistance and may result in serious damage to equipment, due to excessive voltage.

All soldered joints should be made with rosin flux. Never use acid flux on electrical connections.

For 24 volt systems, extra heavy insulated wire must be used to protect against the higher voltage. Failure to insulate the wiring properly may result in serious damage due to a great amount of power available from the battery.

Terminals at the ends of the wires must have ample current-carrying capacity and must be sufficiently strong to withstand vibration. Wires should be supported as near to terminals as possible.

Whenever generator wiring is installed, wire of sufficiently large size must be used to carry the maximum current the length of the circuit without excessive voltage drop. In two-wire insulated systems, the total length of wire in the circuit must be taken into account. Smaller wire can be used in the generator field circuit since the current carried is comparatively small, being only about one to three amperes depending upon the voltage of the system.

Due to mechanical reasons, wire smaller than number 14 B. and S. should never be used. Always use stranded wire in all circuits to minimize danger of breakage due to vibration.

TEST SPECIFICATIONS GENERATORS (12 Volt System)								
Delco Remy Generator Model No.	Rotation from D. E.	Brush Spring Tension Oz.	Field Current (80° F.)		Cold Output			Hot Output
			Amps.	Volts	Amps.	Volts	Approx. R. P. M.	
1105105	C*	28	1.54-1.67	12	35	14.0	1950	Max. output controlled by current regulator
1106822	C*	20	1.37-1.50	12	50	13.0	1925	Max. output controlled by current regulator

*C - Clockwise

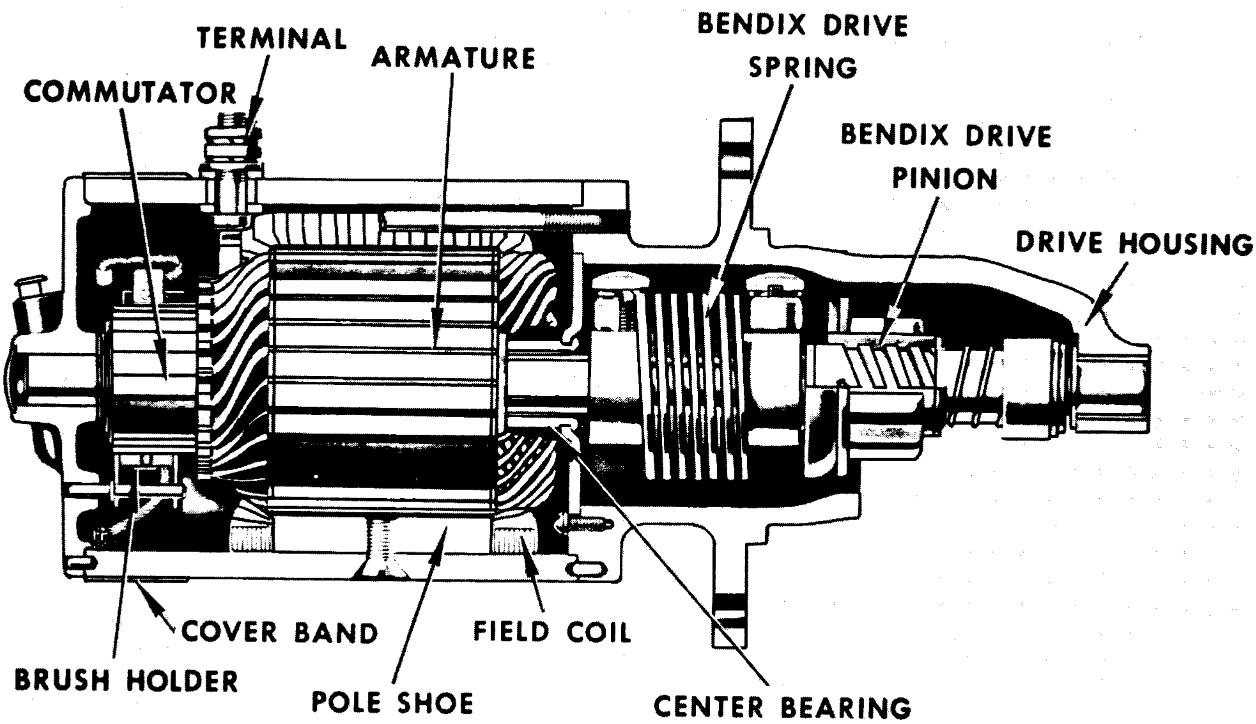
CRANKING MOTOR
(BENDIX DRIVE)
(Model 330 and 440 Motor Graders)
(Delco Remy No. 1114000)

Illust. 1 illustrates a Bendix drive cranking motor while Illust. 2 illustrates an exploded view of the Bendix drive. The Bendix drive provides an automatic means of engaging the drive pinion with engine flywheel ring gear for cranking the engine and for disengaging the drive pinion from the flywheel ring gear after the engine starts.

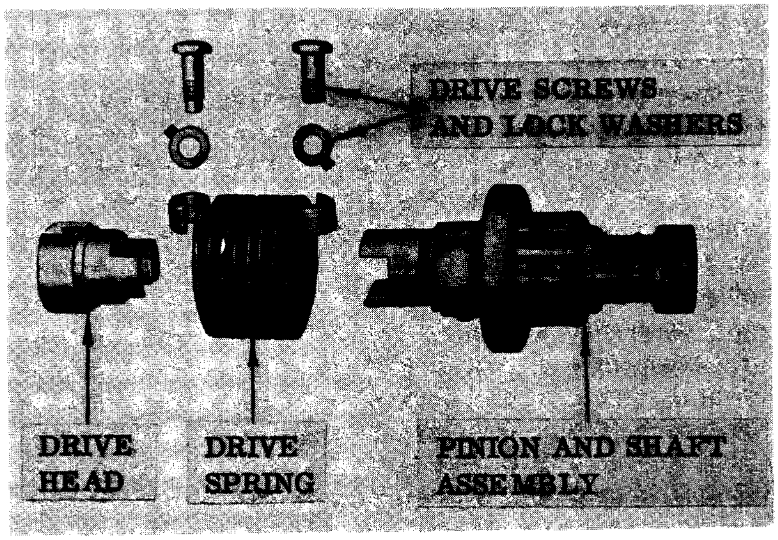
The drive pinion is mounted on a threaded sleeve or hollow shaft which has the spiral threads that match internal threads in the drive pinion. The shaft assembly is a loose fit on the cranking motor armature shaft. One end of the shaft assembly is bolted to the Bendix drive spring; the other end of the drive spring is keyed and bolted to the armature shaft through the drive head.

When the cranking motor is not operating, the pinion is in the position shown in Illust. 1; that is, it is demeshed from the engine flywheel ring gear. As soon as the cranking motor switch is closed, the cranking motor armature begins to rotate, picking up speed rapidly.

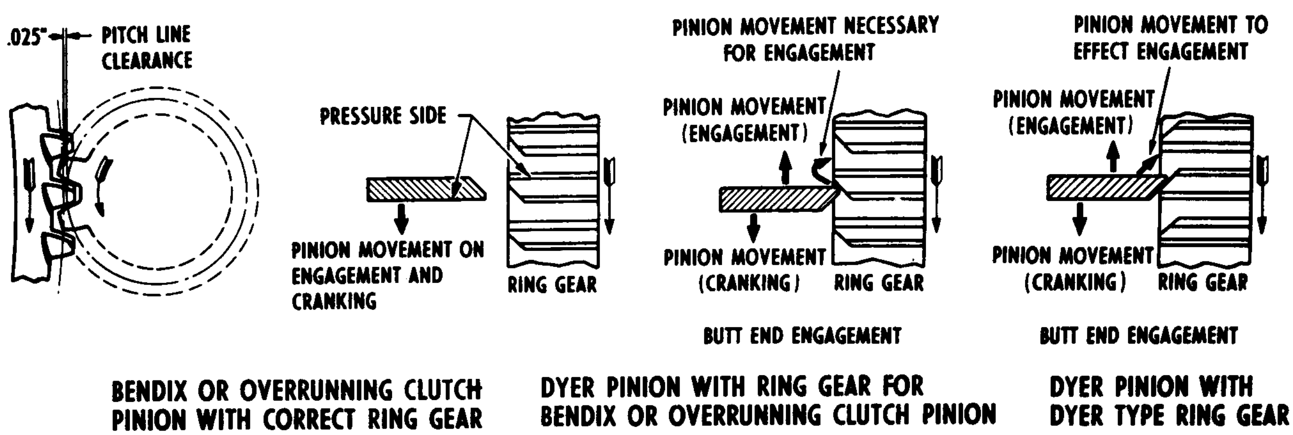
The threaded shaft assembly picks up speed with the armature inasmuch as it is driven through the drive spring. However, the drive pinion, being a loose fit on the shaft assembly, does not pick up speed instantly.



Illust. 1



Illust. 2



Illust. 3

The result is that the shaft assembly turns within the pinion, forcing the pinion endwise along the shaft and into mesh with the flywheel ring gear. This action wouldbe similar to holding a nut and turning a screw in it so that the nut would move from one to the other end of the screw. As the drive pinion reaches the pinion stop on the end of the shaft assembly, it can move out no further and it must then rotate with the shaft assembly and the armature so that the engine flywheel is turned and the engine is cranked. The drive spring compresses slightly to take up the shock of engagement.

After the engine has started, the flywheel spins the drive pinion more rapidly than the armature and shaft assembly are turning, with the result that the pinion is backed out of mesh with the flywheel ring gear.

CHAMFERS OF RING GEAR TEETH

Illust. 3 illustrates the importance of matching drive pinion and flywheel ring gear teeth properly. The left view shows the action of an over-running clutch or Bendix pinion as it engages with the correct type ring gear. The chamfer of the teeth is such that engagement is facilitated. However, if a Dyer drive pinion is used with a ring gear for an over-running clutch or Bendix drive (center view), then difficulty is likely to be encountered in engagement. In this case, when the teeth butt, the pinion must move back and up as shown by the arrows before engagement can take place. It must be remembered that with the Dyer drive cranking motor, pinion movement for engagement is in one direction while pinion movement during cranking is in the opposite direction.

It will be noted that the chamfer on the ring gear teeth used in connection with a Dyer drive cranking motor must be in the reverse of the chamfer on a ring gear used with an over-running clutch or Bendix drive. If the wrong type of ring gear is used, repeated attempts will be required for engagement and burring of the teeth is likely to occur.

ADJUSTMENTS, TESTS AND MAINTENANCE

The best assurance of obtaining maximum service from cranking motors with minimum trouble is to follow a regular inspection and maintenance procedure. Periodic lubrication where required, inspection of the brushes, commutator and drive arrangement are essentials in the inspection procedure. In addition, disassembly and thorough overhauling of the cranking motor at periodic intervals is desirable as a safeguard against road failures resulting from accumulations of dust and grease and from normal wear of parts. This is particularly desirable on motor graders where maintenance of operating schedules is of especial importance. In addition to the cranking motor itself, the external circuit between the cranking motor and the battery must be kept in good condition, since defective wiring or loose or corroded connections will prevent normal cranking action. Also, the solenoid should be periodically checked.

CRANKING MOTOR MAINTENANCE

Bendix drives should be lubricated with a small amount of light engine oil whenever cranking motor is removed from the engine for servicing. Heavy oil or grease must not be used, as this may retard or prevent normal action of the drive mechanism.

INSPECTION

At periodic intervals, the cranking motor should be inspected to determine its condition. The frequency with which this should be done will be determined by the type of service in which it is used. Frequent starts, excessively long cranking periods caused by a hard starting engine condition, excessively dirty or moist operation conditions, heavy vibration, all will make it necessary that the inspection checks be made at more frequent intervals.

INSPECTION PROCEDURE

Cranking motor action is indicative, to some extend, of the cranking motor condition. Thus, a cranking motor that responds normally when the cranking motor switch is closed is usually considered to be in good condition. (Checking a cranking motor that does not operate normally is discussed in the following section). However, the inspection procedure should include more than a mere check of the cranking motor operation; the following items should also be inspected. The mounting, wiring and connections should be tight and in good condition. The solenoid should be firmly mounted and should operate freely and without binding. Next, remove the cover band so the commutator, brushes and internal connections can be checked. Examine the cover band for thrown solder (Illust. 1) which results if the cranking motor is subjected to excessive long cranking periods causing overheating. This overheating causes the solder at the commutator riser bars to melt and be thrown out during cranking. Bad connections consequently develop which in turn result in arcing and burring of the commutator bars and ultimate ruination of the armature. If the bars are not too badly burned, the armature often can be saved by resoldering the connections at the riser bars (using rosin, not acid flux) turning the commutator on a lathe and undercutting the mica between bars.

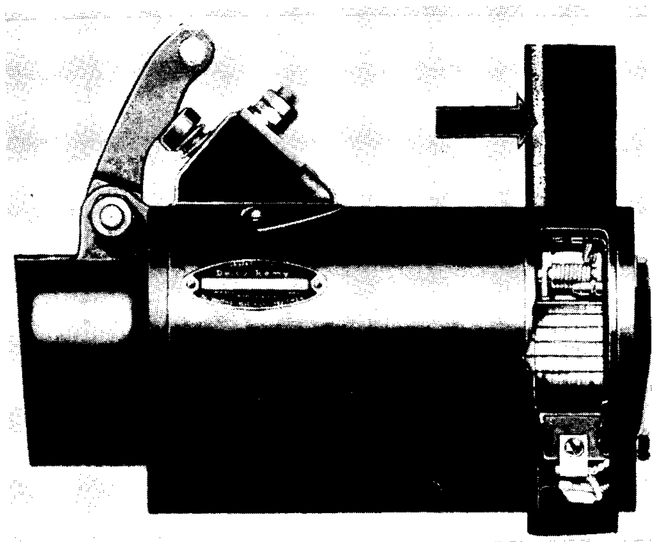
NOTE: NEVER OPERATE THE CRANKING MOTOR MORE THAN 30 SECONDS AT A TIME WITHOUT PAUSING TO ALLOW THE CRANKING MOTOR TO COOL OFF AT LEAST TWO MINUTES. Overheating caused by excessively long cranking periods may seriously damage the cranking motor.

When checking the brushes, make sure they are not binding and that they are resting on the commutator with sufficient tension to give good, firm contact. Brush leads and screws should be tight. If the brushes are worn down to one-half their original length (compare with new brushes), they should be replaced.

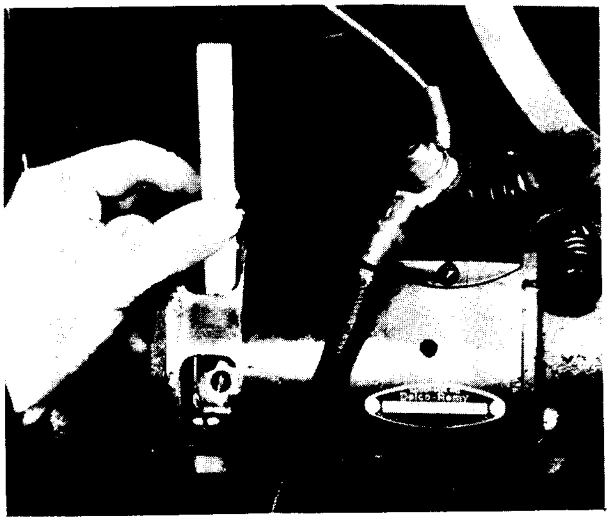
Note the condition of the commutator. If it is glazed or dirty, it can be cleaned in a few seconds by holding a strip of No. 00 sandpaper against it with a piece of wood while the cranking motor is operated (Illust. 2). A brush setting stone can also be used for this purpose. Move the sandpaper or stone back and forth across the commutator while the armature is spinning. Never operate the cranking motor more than 30 seconds at a time without pausing for a few minutes to allow the cranking motor to cool. Blow out all dust after the commutator is cleaned. If the commutator is rough, out of round, has high mica or extremely dirty, it will require turning down in a lathe and undercutting of the mica between the bars.

QUICK CRANKING MOTOR CHECKS

When trouble develops in the cranking motor system, and the cranking motor 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 cranking motor, in the wiring circuit between them or elsewhere. Many conditions besides defects in the cranking motor can result in poor cranking performance.



Illust. 1



Illust. 2

To make a quick check of the cranking motor system, turn on the headlights, if so equipped. They should burn with normal brillance. If they do not, the battery may be run down and it should be checked with a hydrometer. If the battery is in a charged condition, so the lights burn brightly, close the cranking motor circuit. Anyone of three things will happen to the lights: they will go out, dim considerably or stay bright without any cranking action taking place.

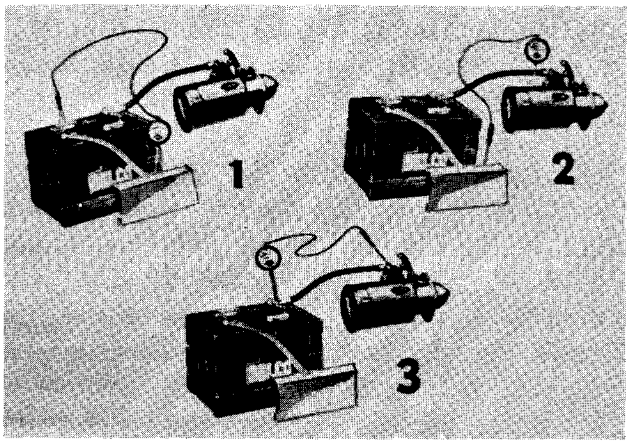
(1) If the lights go out as the cranking motor switch closes, it indicates that there is a poor connection between the battery and the cranking motor. This poor connection most often will be found at the battery terminals and correction is made by removing the cable clamps from the terminals, cleaning 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 formation of corrosion.

(2) If lights dim considerably as the cranking motor switch is closed and the cranking motor operates slowly or not at all, the battery may be run down or there may be some mechanical condition in the engine or the cranking motor that is throwing a heavy burden on the cranking motor. This in turn imposes a high discharge rate on the battery which causes noticeable dimming of the lights. Check the battery with a hydrometer. If it is charged, the trouble probably lies either in the cranking motor or engine itself. In the engine, tight bearings or pistons or heavy oil place an added burden on the cranking motor. Low temperatures also hamper cranking motor performance since cold thickens engine oil and makes engine considerably harder to crank and start. Also, the battery is less efficient at low temperatures. In the cranking motor, a bent armature shaft, loose pole shoe screws or worn bearings, any of which may allow the armature to drag, will reduce cranking performance and increase current draw.

(3) The third condition which may be encountered when the cranking motor switch is closed with the lights turned on is that the lights stay bright, but no cranking action takes place. This indicates an open circuit at some point, either in the cranking motor or in the cranking motor switch or control circuit. Where the application is solenoid operated, the solenoid control circuit can be eliminated momentarily by placing a heavy jumper lead across the solenoid main terminals to see if the cranking motor will operate. This connects the cranking motor directly to the battery and if the cranking motor operates, it indicates that the control circuit is not functioning normally. The wiring and control units then must be checked to locate the trouble. If the cranking motor does not operate, it probably will have to be removed from the engine so that it can be analyzed in detail.

CHECKING BATTERY-TO-CRANKING MOTOR CIRCUIT

Excessive resistance in the circuit between the battery and cranking motor will reduce cranking performance. The resistance can be checked by using a voltmeter to measure the voltage drop in the circuits while the cranking motor is operated (Illust. 3). There are three checks to be made, (1) the voltage drop between the motor grader frame and the grounded battery terminal post (not the terminal cable clamp); (2) the drop between the motor grader frame and the cranking motor field frame, and (3) the drop between the insulated battery terminal post and the cranking motor terminal stud (or the battery terminal stud of the solenoid). Each of these should show no more than 0.2 volt drop for 12 volts with the cranking motor cranking the engine.



Illust. 3

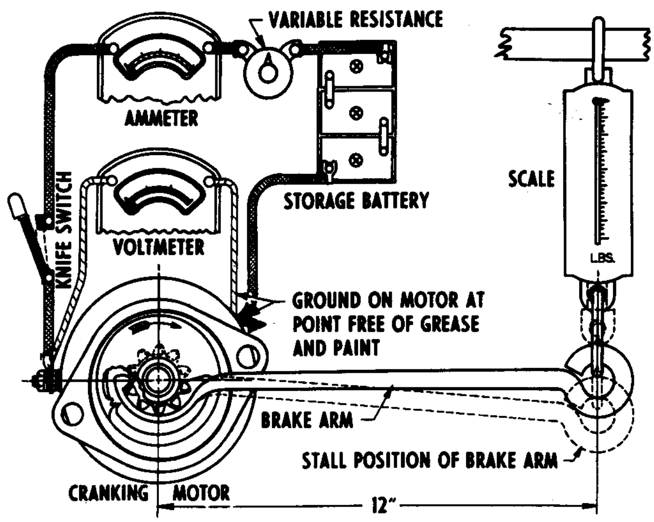
CAUTION: Do not use the cranking motor more than 30 seconds to avoid overheating. If excessive voltage drop is found in any of these circuits, make corrections by disconnecting the cables, cleaning the connections carefully and then reconnecting the cables firmly in place. A coating of corrosion-inhibitor on the battery terminals and cable clamps will retard corrosion.

NO LOAD AND TORQUE TESTS

To obtain full performance data on a cranking motor or to determine the cause of abnormal operations, the cranking motor should be submitted to a no-load and torque test. These tests are performed with the cranking motor removed from the engine.

In the no-load test, the cranking motor is connected in series with batteries of the specified voltage and an ammeter capable of reading several hundred amperes. An r.p.m. indicator should also be used to measure the armature revolutions per minute.

The torque test requires such equipment as illustrated in Illust. 4. The cranking motor is securely mounted and the brake arm hooked to the drive pinion. Then, when the specified voltage is applied, the torque can be computed from the reading on the scale. If the brake arm is one foot long, as shown, the torque will be indicated directly on the scale in pounds feet. A high-current-carrying variable resistance should be used so that the specified voltage can be applied. Many torque testers indicate the developed pounds feet of torque on a dial.



Illust. 4

The specifications are normally given at low voltages so the torque and ammeter readings obtained will be within the range of the testing equipment available in the field.

INTERPRETING RESULTS OF TESTS

1. Rated torque, current draw and no load speed indicated normal condition of cranking motor.

2. Low free speed and high current draw with low developed torque may result from:

(a) Tight, dirty or worn bearings, bent armature shaft or loose field pole screws which would allow the armature to drag.

(b) Shorted armature. Check armature further on growler.

(c) A grounded armature or field. Check by raising the grounded brushes and insulating them from the commutator with cardboard and then checking with a test lamp between the insulated terminal and the frame. If test lamp lights, raise other brushes from commutator and check fields and commutator separately to determine whether it is the field or armature that is grounded.

3. Failure to operate with high current draw:

(a) A direct ground in switch, terminal or fields.

(b) Frozen shaft bearings which prevent the armature from turning.

4. Failure to operate with no current draw:

(a) Open field circuit. Inspect internal connections and trace circuit with test lamp.

(b) Open armature coils. Inspect the commutator for badly burned bars. Running free speed, an open armature will show excessive arcing at the commutator bar which is open.

(c) Broken or weakened brush springs, worn brushes, high mica on the commutator or other causes which would prevent good contact between the brushes and commutator. Any of these conditions will cause burned commutator bars.

5. Low no-load speed with low torque and low current draw indicates:

(a) An open field winding. Raise and insulate ungrounded brushes from commutator and check fields with test lamp.

(b) High internal resistance due to poor connection, defective leads, dirty commutator and causes listed under 4.

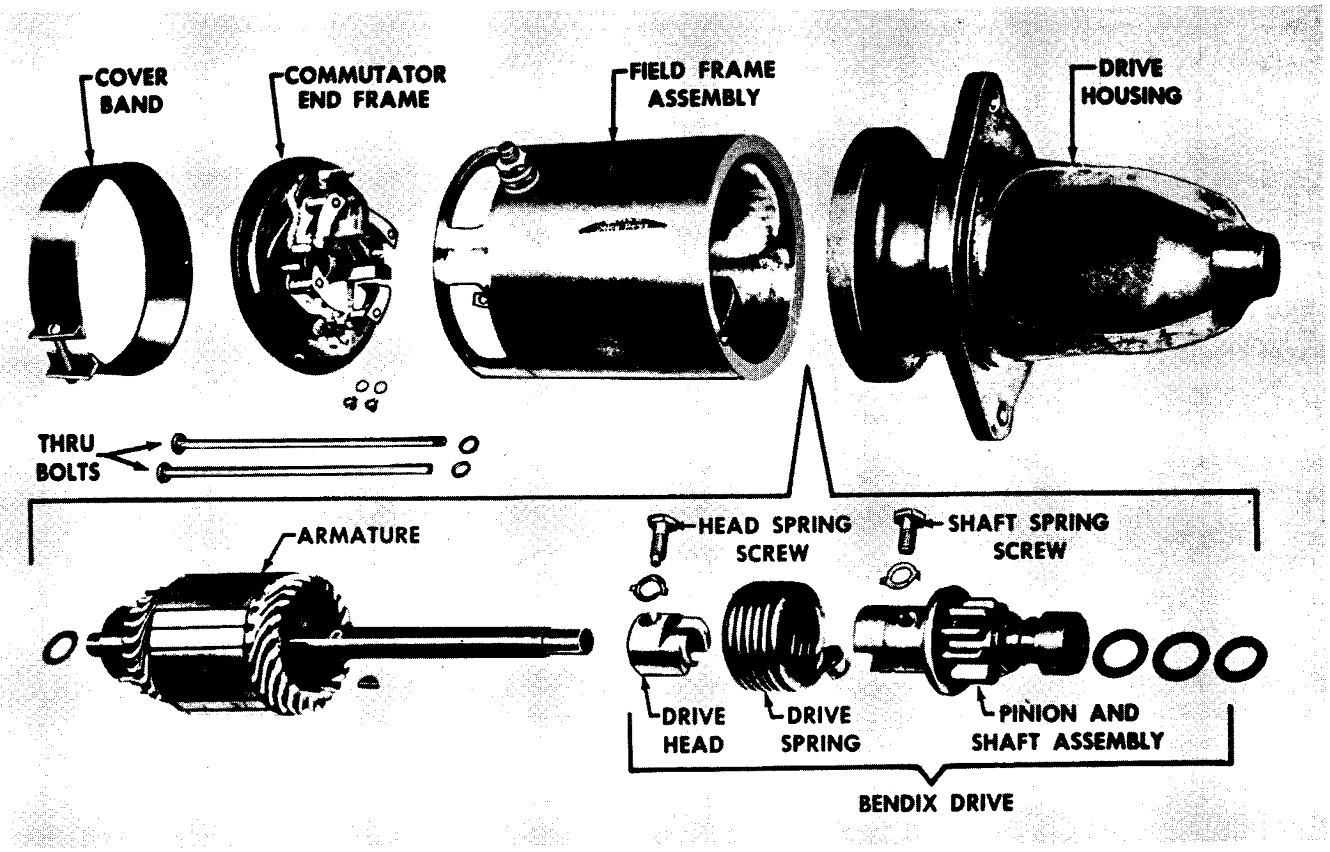
6. High free speed with low developed torque and high current indicates shorted field. There is no easy way to detect shorted fields, since the field resistance is already low. If shorted fields are suspected, replace the fields and check for improvement in performance.

DISASSEMBLY, REPAIR AND REASSEMBLY

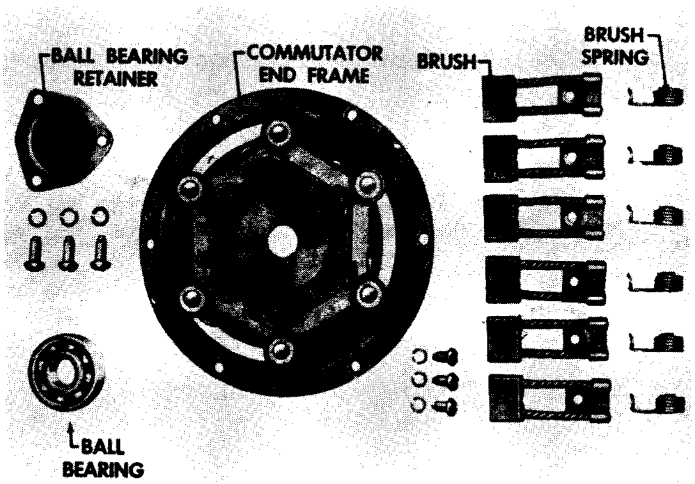
Illust. 1 is an exploded view of a Bendix drive cranking motor. To disassemble the cranking motor, remove the cover band and detach brush leads from field leads. Unscrew thru bolts and take off commutator end frame and field frame assembly. Where there is a center bearing attached to the drive housing, detach it. Now, remove the armature with the Bendix drive assembled on it from the drive housing. Armature service is covered further along in the section "Inspection and Repair of Parts". The Bendix drive can be detached from the armature shaft by removing the head spring screw. Unscrewing the shaft spring screw permits separation of the drive spring from the drive pinion and shaft assembly. Use new tang lock washers on reassembly, since repeated bending of the tang is likely to break it off.

The Bendix drive may be cleaned by washing in kerosene and then relubricated with a trace of light engine oil after reassembly. Do not use heavy oil or grease as this may retard or prevent normal drive action.

Illust. 2 is a view of the commutator end with integral brush holders from which the brushes are shown removed. This illustration can be used as a guide for removal of the brushes or brush holders.



Illust. 1



Illust. 2

To remove the field coils, see paragraph "Field Coil Removal". Field coil service is also covered under "Inspection and Repair of Parts".

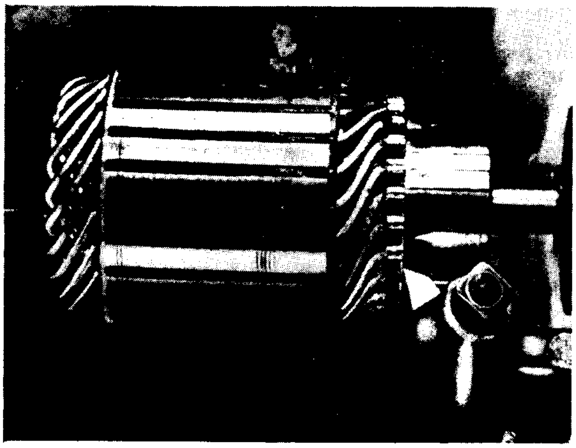
INSPECTION AND REPAIR OF PARTS

The armature and field coils should not be cleaned in any degreasing tank or by use of degreasing compound since this might damage insulation so that a short circuit or ground would consequently develop. Brushing parts with oleum or other neutral spirits, however, is satisfactory. Sealed ball bearings should not be cleaned inasmuch as this would remove the lubricant originally packed in the bearings. On assembly, all soldered electrical connections should be made with rosin flux. Never use acid flux on electrical connections.

ARMATURE SERVICE

The armature should be checked for opens, short circuits or grounds. If the armature commutator is worn, dirty, out of round or high mica, the armature should be put in a lathe (Illust. 3) so the commutator can be turned down. The mica should then be undercut 1/32 of an inch and the slots cleaned out to remove any trace of dirt or copper dust. As a final step in this procedure the commutator should be sanded lightly with No. 00 sandpaper to remove any burrs left as a result of the undercutting procedure.

Open circuit armatures often can be saved where the open is obvious and repairable. The most likely place for an occurance is at the commutator riser bars as a result of excessively long cranking periods. Long cranking periods overheat the cranking motor so that the solder in the connections melt and is thrown out. The consequent poor connections then cause arcing and burning of the commutator bars as the cranking motor is used. If the bars are not too badly burned, repair can often be affected by resoldering the leads in the riser bars (use rosin flux) and turning down the commutator in a lathe (Illust. 3) to remove the burned material. The mica should then be undercut. Some cranking motor armatures are of a welded construction with the armature coil leads welded and not soldered to the commutator bars. This type of armature should not be repaired by ordinary soldering methods.



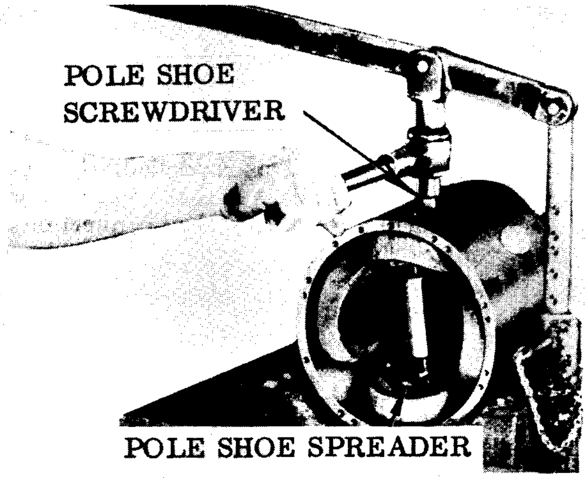
Illust. 3

Short circuits in the armature are located by use of a growler. When the armature is revolved in the growler with a steel strip such as a hacksaw blade held above it, the armature core in which the short circuit is located. Copper or brush dust in the slots between the commutator bars sometimes produces shorts between bars which can be eliminated by cleaning out the slots.

Grounds in the armature can be detected by the use of a test lamp and test points. If the lamp lights when one test point is placed on the commutator with the other point on the case of the shaft, the armature is grounded. Grounds occur as a result of insulation failure which is often brought about by overheating of the cranking motor produced by excessively long cranking periods or by accumulation of brush dirt between the commutator bars and the steel commutator ring.

FIELD COIL REMOVAL AND SERVICE

Field coils can be removed from the field frame assembly most easily by use of a pole shoe screw driver (Illust. 4). A pole shoe spreader should also be used since this prevents distortion of the field frame. Careful installation of the field coils is nec-



Illust. 4

essary to prevent shorting or grounding of the field coils as the pole shoes are tightened into place. On many cranking motors, long and triangular insulating strips are used to protect the field leads from grounding to the frame. These must be replaced on assembly. Where the pole shoe has a long lip on one side and a short lip on the other, the long lip should be assembled in the direction of armature rotation so it becomes the trailing (not leading) edge of the pole shoe. If the varnish coating on the field coils becomes hard and interferes with assembly, they may be heated in an oven to soften sufficiently for easy installation.

Grounded field coils may sometimes be repaired by removing and reinsulating them. Care must be taken in applying new insulation to avoid excessive bulkiness, since this may cause the pole shoe to cut through and produce another ground when the coils are installed.

USE OF INSULATING VARNISH

On installation where excessive moisture conditions are experienced, it may be desirable to treat the field coils as well as the armature windings with one of the insulating varnishes supplied for this purpose. This will provide protection against excessive moisture in the coils or windings.

WIRING INSTALLATION

In installing the wire between the cranking motor and battery every precaution should be taken to guard against the possibility of a short circuit or ground. All wires should be of sufficient size to carry the electrical load without excessive voltage drop. Stranded wire and cable should be used to guard against breakage due to vibration. All joints and connections should be clean and tight. Terminal clips should be soldered to leads with rosin flux. Acid flux must never be used on electrical connections.

All leads and cables should be supported at enough points to prevent them from moving about so that the insulation will not become worn through. On 12 volt systems, extra precaution should be taken to avoid shorts or grounds. On these higher voltage systems, it would be well to insulate all terminals and clips normally left exposed. This can be done with rubber boots, rubber tape or friction tape and shellac. Insulating terminals and clips in this manner will guard against accidental shorting or grounding.

WIRE SIZES

Good cranking performance will not be obtained if the cables between the battery and cranking motor are of inadequate size. With inadequate cables or bad connections, excessive voltage drop between the battery and cranking motor will be obtained with consequent poor cranking performance.

LENGTH OF STARTING CIRCLE

If the engine fails to start after extended cranking, check the cause and do not continue to crank since this will not only run the batteries down but will also overheat and damage the cranking motor.

CAUTION: Never operate the cranking motor for more than 30 seconds at a time without pausing for several minutes to permit the cranking motor to cool off.

CRANKING MOTOR TESTS								
Delco Remy Cranking Motor Model No.	Rotating Viewing D. E.	Min. Brush Tension (Oz.)	No Load Test			Lock Test		
			Volts	Max. Amps.	Min. R. P. M.	Volts	Max. Amps.	Min. Torque Lb. Ft.
1114000	*C	35	11.5	105	6000	2.3	600	19

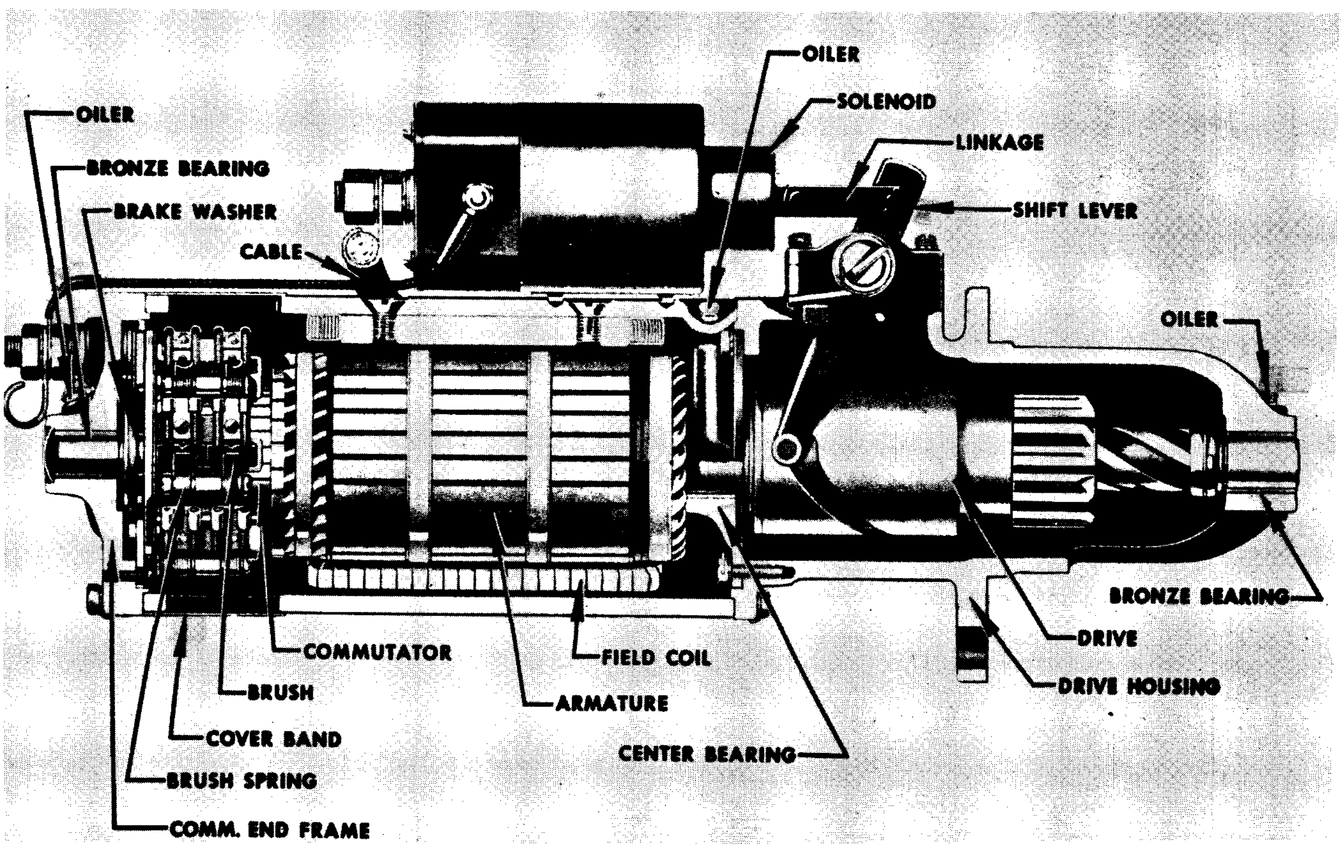
*C - Clockwise

CRANKING MOTOR
(DYER DRIVE)
Models 330 and 440 Motor Graders Equipped with GM Engines
(Delco Remy No. 1114029)

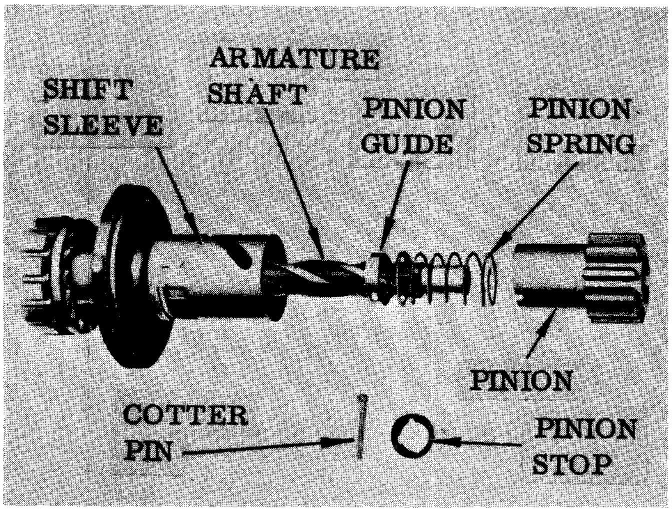
The Dyer drive is a special type of drive mechanism which provides for positive engagement of the cranking motor drive pinion with the engine fly-wheel ring gear before the cranking motor switch is closed and thus before the armature starts to rotate. This eliminates clashing and the possibility of broken or burred teeth on either the drive pinion or the flywheel ring gear. As soon as the engine starts, the pinion is automatically demeshed by the reversal of torque so that the armature will not be subjected to excessive speeds.

The Dyer drive makes use of a shift lever which is solenoid operated (Illust. 1). Illust. 2 is a disassembled view of the Dyer drive parts while Illusts. 3 to 6 illustrate the Dyer drive action.

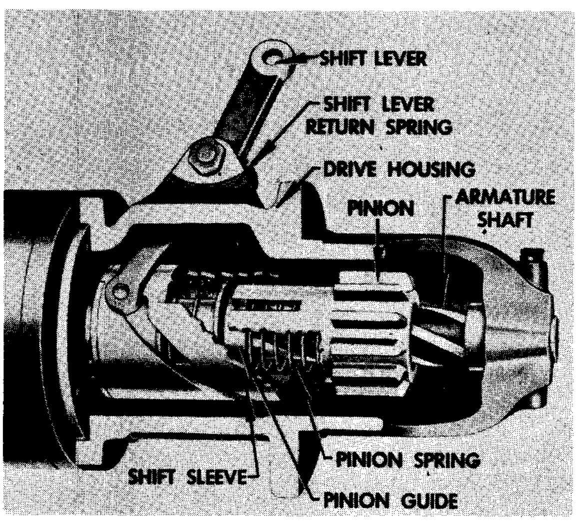
The Dyer drive is assembled on spiral splines on the armature shaft and consists of thrust washers, a shift sleeve assembly, pinion guide, spring, pinion and pinion stop.



Illust. 1



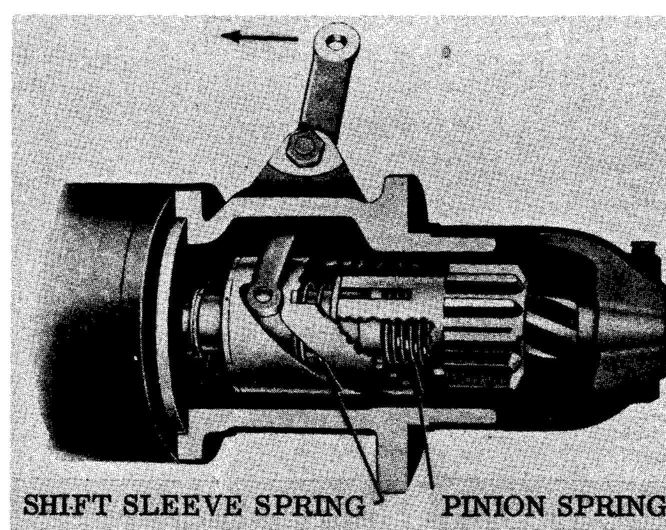
Illust. 2



Illust. 3

Illust. 3 illustrates the relationship of all the Dyer drive parts in the "at rest" position. The pinion is locked in this position when out of mesh.

Illust. 4 illustrates the action of the Dyer drive parts as the shift lever motion begins. This is the first stage of the starting cycle. As the shift lever moves, it begins to force the shift sleeve toward the flywheel. The initial shift sleeve movement unlocks the pinion guide from undercuts in the spiral splines on the armature shaft. During this initial movement, the pinion guide is moved endwise as the inner sleeve of the shift sleeve assembly presses against it. The pinion guide in turn, pushing against the pinion spring, forces the pinion toward the flywheel. This action causes the pinion to reach the flywheel. If the drive pinion and the flywheel ring gear teeth align, meshing takes place immediately. If teeth butt, then meshing cannot immediately take place but further movement of the shift lever causes the drive pinion to rotate so that meshing does take place. The reason that rotation of the pinion takes place is that the pinion guide continues its forward movement as the shift lever travel continues. The guide follows the spiral splines on the armature shaft as it moves forward and the two lugs on the pinion guide transmit the resulting rotary motion to the pinion through the two slots in the pinion skirt. The pinion is a loose fit on the spiral splines so that it can rotate sufficiently without forward motion to permit engagement even under the most adverse conditions.

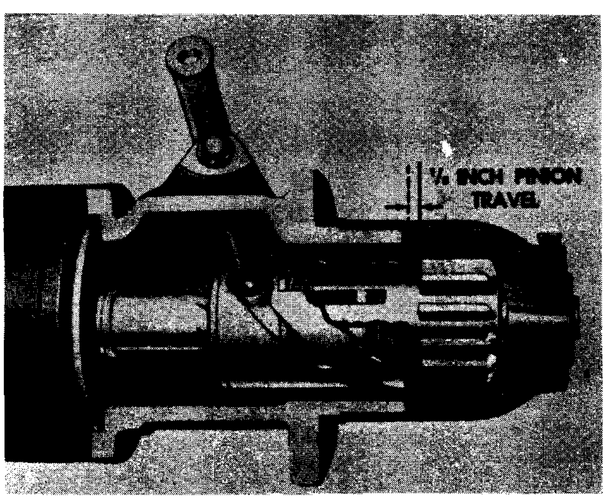


Illust. 4

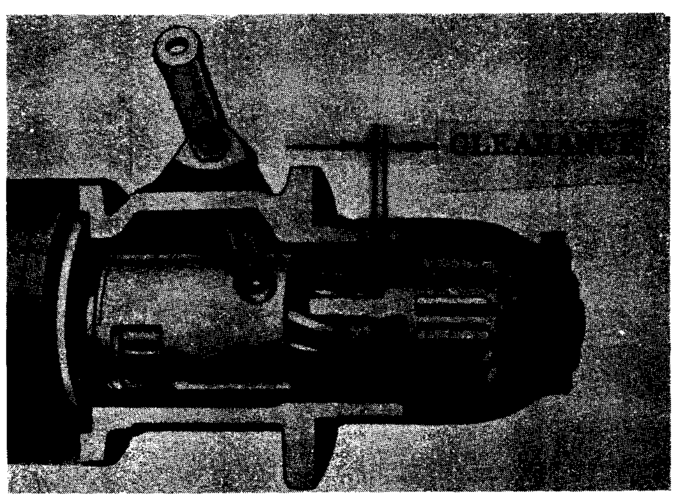
Illust. 5 illustrates the position of the parts at the instant that engagement is completed. Full shift lever movement has been complete so that the pinion has come up against the pinion stop and is then in proper mesh or engagement with the flywheel ring gear. Completion of the shift lever movement not only causes full pinion engagement but also causes the cranking motor switch to close so that the cranking motor armature begins to rotate and cranking takes place. Also at completion of the shift lever movement it is important to have the proper amount of pinion travel (Illust. 5).

Illust. 6 illustrates the operating position of the Dyer drive parts. As soon as the cranking motor armature begins to rotate, the friction of the armature shaft in the shift sleeve causes the sleeve to rotate. The stud on the end of the shift lever is in the slot in the shift sleeve so that rotation of the shift sleeve causes it to move back out of the way from the drive pinion into the position shown in Illust. 6. Cranking takes place as the shaft splines cause the drive pinion to rotate with the armature shaft.

As soon as the engine begins to operate, it spins the drive pinion faster than the armature is rotating, thus causing the drive pinion to be spun back out of the mesh from the flywheel ring gear. As the pinion moves back out of mesh, the pinion guide drops into the undercut section of the spiral splines where it locks to hold the drive pinion in the disengaged position (Illust. 3). It is impossible to re-engage the pinion until the shift lever is returned to the "at rest" position so that the stud can rotate the shift sleeve and re-engage the flat section of the spiral slot in the shift sleeve. Movement of the shift lever will then cause the above cranking cycle to again take place. The drive pinion will not engage with the flywheel ring gear while the engine is running for as soon as the pinion teeth touch the moving flywheel ring gear teeth, the shift sleeve will be rotated and the pinion follows the armature shaft spline back to the locked position (Illust. 3).



Illust. 5


Illust. 6

CHAMFERS OF RING GEAR TEETH

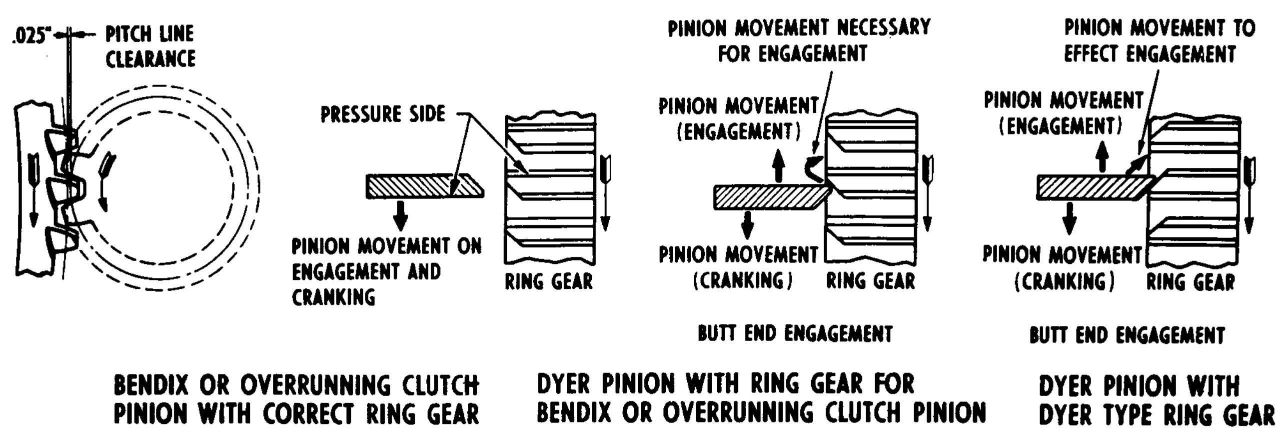
Illust. 7 illustrates the importance of matching drive pinion and flywheel ring gear teeth properly. The left view shows the action of an overrunning clutch or Bendix pinion as it engages with the correct type ring gear. The chamfer on the teeth is such tate engagement is facilitated. However, if a Dyer drive pinion is used with a ring gear for an overrunning clutch or Bendix drive (center view), then difficulty is likely to be encountered in engagement. In this case, when the teeth butt, the pinion must move back and up as shown by the arrows before engagement can take place. It must be remembered that with the Dyer drive cranking motor, pinion movement for engagement is in one direction while pinion movement during cranking is in the opposite direction.

The action of a Dyer drive pinion in engaging with a Dyer drive type ring gear after teeth butt is shown to the right in Illust. 7. It will be noted that the chamfer on the ring gear teeth used in connection with a Dyer drive cranking motor must be the reverse of the chamfer on a ring gear used with an overrunning clutch or Bendix drive. If the wrong type of ring gear is used, repeated attempts will be required for engagement, and burring of the teeth is likely to occur.

NOTE: Recommended hardness for ring gears used in connection with Dyer drive cranking motors is Rockwell "C" scale 40-50.

ADJUSTMENTS, TESTS AND MAINTENANCE

The best assurance of obtaining maximum service from cranking motors with minimum trouble is to follow a regular inspection and maintenance procedure. Periodic lubrication where required, inspection of the brushes, commutator and drive arrangement are essentials in the inspection procedure. In addition, disassembly and thorough overhauling of the cranking motor at periodic intervals is desirable as a safeguard against road failures resulting from accumulations of dust and grease and from normal wear of parts. This is particularly desirable on motor graders where maintenance of operating schedules is of especial importance.



Illust. 7

In addition to the cranking motor itself, the external circuit between the cranking motor and the battery must be kept in good condition, since defective wiring or loose or corroded connections will prevent normal cranking action. Also the solenoid should be periodically checked. On solenoid operated Dyer drive cranking motors the drive pinion clearance or travel must be checked as explained in following paragraphs.

CRANKING MOTOR MAINTENANCE

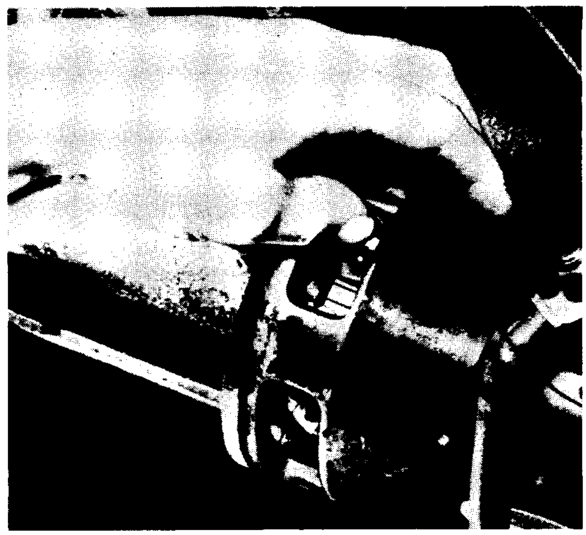
Dyer drives should be lubricated with a small amount of light engine oil whenever cranking motor is removed from the engine for servicing. Heavy oil or grease must not be used as this may retard or prevent normal action of the drive mechanism.

INSPECTION

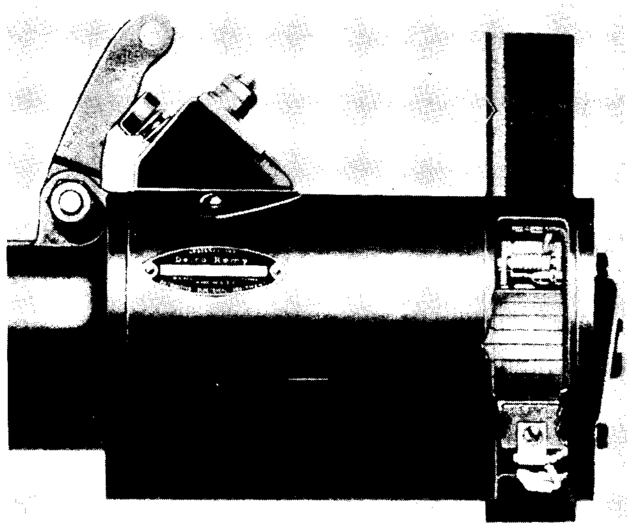
At periodic intervals, the cranking motor should be inspected to determine its condition. The frequency with which this should be done will be determined by the bype of service in which it is used. Frequent starts, excessively long cranking periods caused by a hard starting engine condition, excessively dirty or moist operating conditions, heavy vibration, all will make it necessary that the inspection checks be made at more frequent intervals.

INSPECTION PROCEDURE

Cranking motor action is indicative, to some extent, of the cranking motor condition. Thus, a cranking motor that responds normally when the cranking motor switch is closed is usually considered to be in good condition. (Checking a cranking motor that does not operate normally is discussed in the following section). However, the inspection procedure should include more than a mere check of the cranking motor operation; the following items should also be inspected. The mounting, wiring and connections should be tight and in good condition. The solenoid should be firmly mounted and should operate freely and without binding. Next, remove the cover band (Illust. 1) so the commutator, brushes and internal connections can be checked. Examine the cover band for thrown solder (Illust. 2) which results if the cranking



Illust. 1



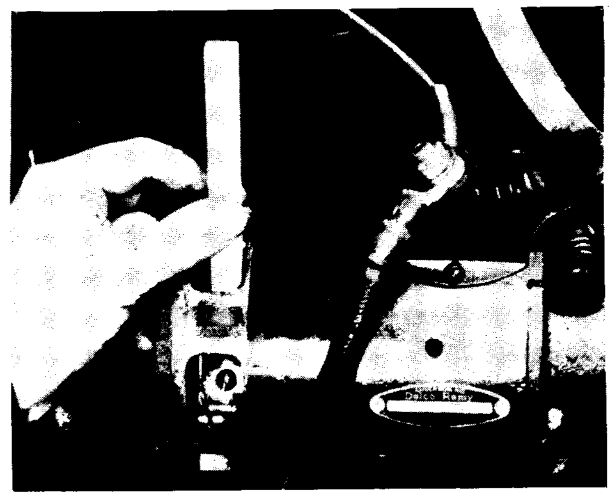
Illust. 2

motor is subjected to excessive long cranking periods so it overheats. This overheating causes the solder at the commutator riser bars to melt and be thrown out during cranking. Bad connections consequently develop which in turn result in arcing and burning of the commutator bars and ultimate ruination of the armature. If the bars are not too badly burned, the armature often can be saved by resoldering the connections at the riser bars (using rosin, not acid flux), turning the commutator on a lathe and undercutting the mica between bars.

NOTE: NEVER OPERATE THE CRANKING MOTOR MORE THAN 30 SECONDS AT A TIME WITHOUT PAUSING TO ALLOW THE CRANKING MOTOR TO COOL OFF AT LEAST TWO MINUTES. Overheating caused by excessively long cranking periods, may seriously damage the cranking motor.

When checking the brushes, make sure they are not binding and that they are resting on the commutator with sufficient tension to give good, firm contact. Brush leads and screws should be tight. If the brushes are worn down to one half their original length (compare with new brushes), they should be replaced.

Note the condition of the commutator. If it is glazed or dirty, it can be cleaned in a few seconds by holding a strip of No. 00 sandpaper against it with a piece of wood while the cranking motor is operated (Illust. 3). A brush setting stone can also be used for this purpose. Move the sandpaper or stone back and forth across the commutator while the armature is spinning. Never operate the cranking motor more than 30 seconds at a time without pausing for a few minutes to allow the cranking motor to cool. Blow out all dust after the commutator is cleaned. If the commutator is rough, out of round, has high mica, or extremely dirty, it will require turning down in a lathe and undercutting of the mica between the bars.



Illust. 3

QUICK CRANKING MOTOR CHECKS

When trouble develops in the cranking motor system and the cranking motor cranks the engine slowly or not at all, several preliminary checks can be made to determine whether the trouble lies ir the battery, in the cranking motor, in the wiring circuit between them or elsewhers. Many conditions besides defects in the cranking motor can result in poor cranking performance.

To make a quick check of the cranking motor system, turn on the headlights, if so equipped. They should burn with normal brilliance. If they do not, the battery may be run down and it should be checked with a hydrometer. If the battery is in a charged condition so the lights burn brightly, close the cranking motor circuit. Anyone of three things will happen to the lights: they will go out, dim considerably or stay bright without any cranking action taking place.

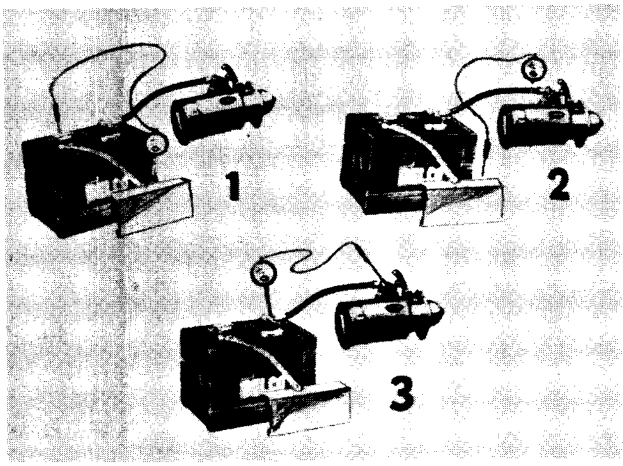
(1) If the lights go out as the cranking motor switch closed, it indicates that there is a poor connection between the battery and the cranking motor. This poor connection most often will be found at the battery terminals and correction is made by removing the cable clamps from the terminals, cleaning 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 formation of corrosion.

(2) If the lights dim considerably as the cranking motor switch is closed and the cranking motor operates slowly or not at all, the battery may be run down. Or, there may be some mechanical condition in the engine or the cranking motor that is throwing a heavy burden on the cranking motor. This in turn imposes a high discharge rate on the battery which causes noticeable dimming of the lights. Check the battery with a hydrometer. If it is charged, the trouble probably lies either in the cranking motor or engine itself. In the engine, tight bearings or pistons or heavy oil place an added burden on the cranking motor. Low temperatures also hamper cranking motor performance since cold thickens engine oil and makes engine considerably harder to crank and start. Also, the battery is less efficient at low temperatures. In the cranking motor, a bent armature shaft, loose pole shoe screws or worn bearings, any of which may allow the armature to drag, will reduce cranking performance and increase current draw.

(3) The third condition which may be encountered when the cranking motor switch is closed with the lights turned on is that the lights stay bright, but no cranking action takes place. This indicates an open circuit at some point, either in the cranking motor or in the cranking motor switch or control circuit. Where the application is solenoid operated, the solenoid control circuit can be eliminated momentarily by placing a heavy jumper lead across the solenoid main terminals to see if the cranking motor will operate. This connects the cranking motor directly to the battery and if the cranking motor operates, it indicates that the control circuit is not functioning normally. The wiring and control units then must be checked to locate the trouble. If the cranking motor does not operate, it probably will have to be removed from the engine so that it can be analyzed in detail.

CHECKING BATTERY-TO-CRANKING MOTOR CIRCUIT

Excessive resistance in the circuit between the battery and cranking motor will reduce cranking performance. The resistance can be checked by using a voltmeter to measure the voltage drop in the circuits while the cranking motor is operated (Illust. 4). There are three checks to be made - (1) the voltage drop between the motor grader frame and the grounded battery terminal post (not the terminal cable clamp); (2) the drop between the motor grader frame and the cranking motor field frame, and (3) the drop between the insulated battery terminal post and the cranking motor terminal stud (or the battery terminal stud of the solenoid). Each of these should show no more than 0.2 volt drop for 12 volts with the cranking motor cranking the engine.



Illust. 4

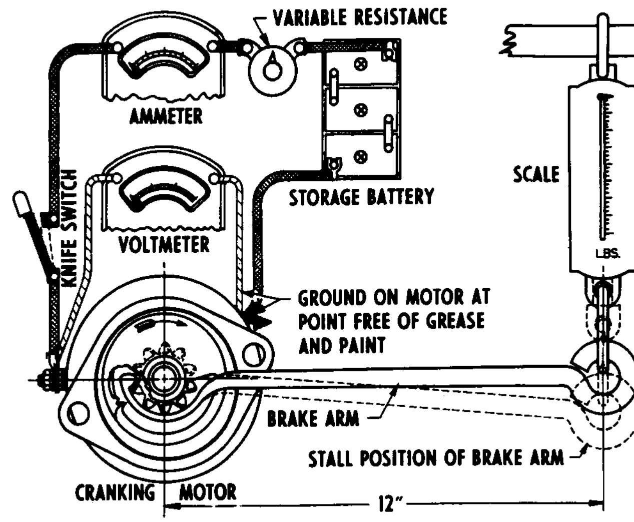
CAUTION Do not use the cranking motor more than 30 seconds to avoid overheating. If excessive voltage is found in any of these circuits, make corrections by disconnecting the cables, cleaning the connections carefully and then reconnecting the cables firmly in place. A coating of corrosion-inhibitor on the battery terminals and cable clamps will retard corrosion.

NO LOAD AND TORQUE TESTS

To obtain full performance data on a cranking motor or to determine the cause of abnormal operations, the cranking motor should be submitted to a no-load and torque test. These tests are performed with the cranking motor removed from the engine.

In the no load test, the cranking motor is connected in series with batteries of the specified voltage and an ammeter capabel of reading several hundred amperes. An r.p.m. indicator should also be used to measure the armature revolutions per minutes.

The torque test requires such equipment as illustrated in Illust. 5. The cranking motor is securely mounted and the brake arm hooked to the drive pinion. Then, when the specified voltage is applied, the torque can be computed from the reading on the scale. If the brake arm is one foot long as shown, the torque will be indicated directly on the scale in pounds feet. A high-current-carrying variable resistance should be used so that the specified voltage can be applied. Many torque testers indicate the developed pounds feet of torque on a dial.



Illust. 5

The specifications are normally given at low voltages so the torque and ammeter readings obtained will be within the range of the testing equipment available in the field.

INTERPRETING RESULTS OF TESTS

1. Rated torque, current draw and no load speed indicated normal condition of cranking motor.

2. Low free speed and high current draw with low developed torque may result from: (a) Tight, dirty or worn bearings, bent armature shaft or loose

field pole screws which would allow the armature to drag. (b) Shorted armature. Check armature further on growler. (c) A ground armature on field. Check by raising the grounded brushes and insulating them from the commutator with cardboard and then checking with a test lamp between the insulated terminal and the frame. If test lamp lights, raise other brushes from commutator and check fields and commutator separately to determine whether it is the field or armature that is grounded.

3. Failure to operate with high current draw: (a) A direct ground in switch, terminal or fields. (b) Frozen shaft bearings which prevent the armature from turning.

4. Failure to operate with no current draw: (a) Open field circuit. Inspect internal connections and trace circuit with test lamp. (b) Open armature coils. Inspect the commutator for badly burned bars. Running free speed, an open armature will show excessive arcing at the commutator bar which is open. (c) Broken or weakened brush springs, worn brushes, high mica on the commutator or other causes which would prevent good contact between the brushes and commutator. Any of these conditions will cause burned commutator bars.

5. Low no-load speed with low torque and low current draw indicates: (a)An open field winding. Raise and insulate ungrounded brushes from commutator and check fields with test lamp. (b) High internal resistance due to poor connection, defective leads, dirty commutator and causes listed under 4.

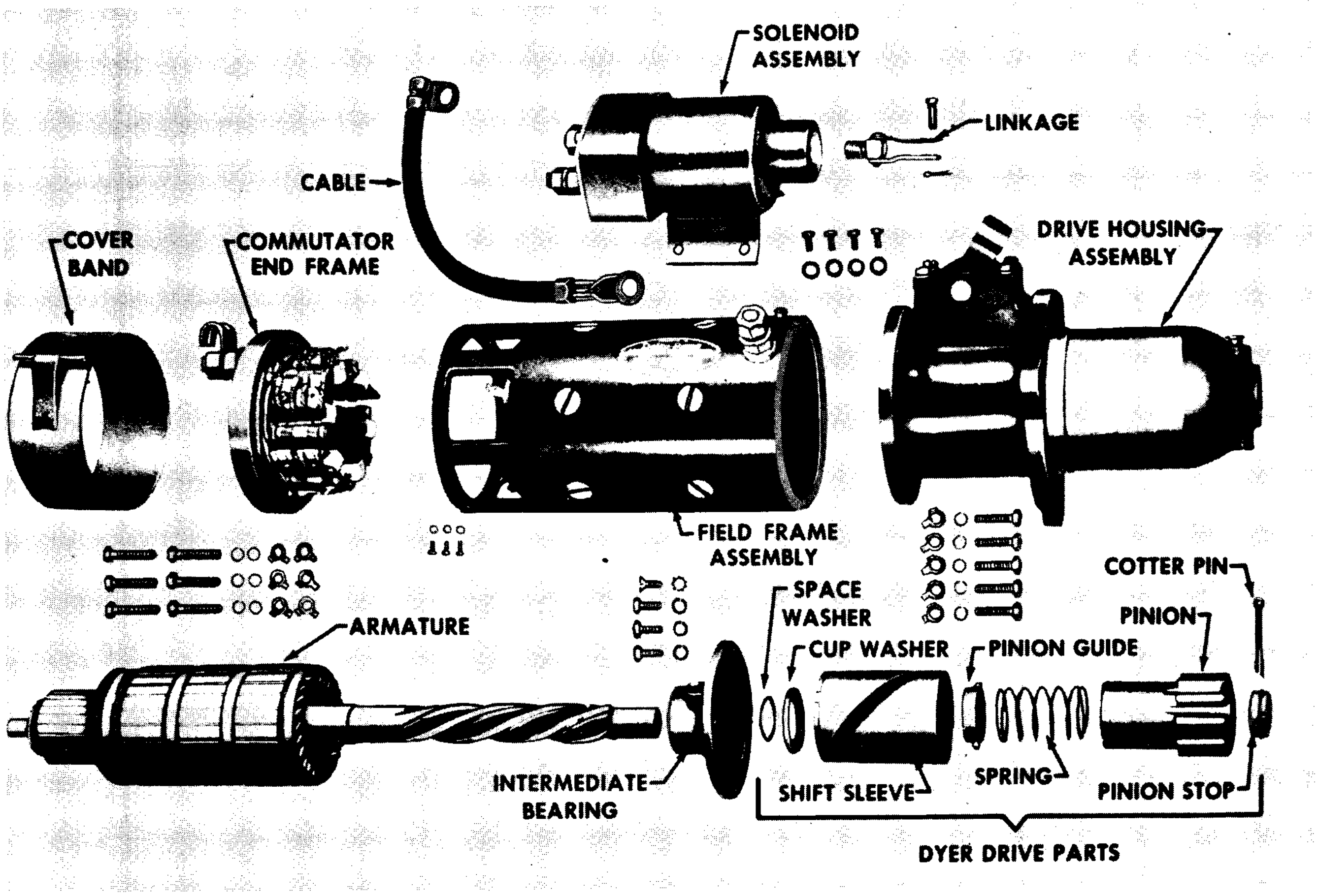
6. High free speed with low developed torque and high current draw indicates shorted field. There is no easy way to detect shorted fields, since the field resistance is already low. If shorted fields are suspected, replace the fields and check for improvement in performance.

DISASSEMBLY, REPAIR AND REASSEMBLY

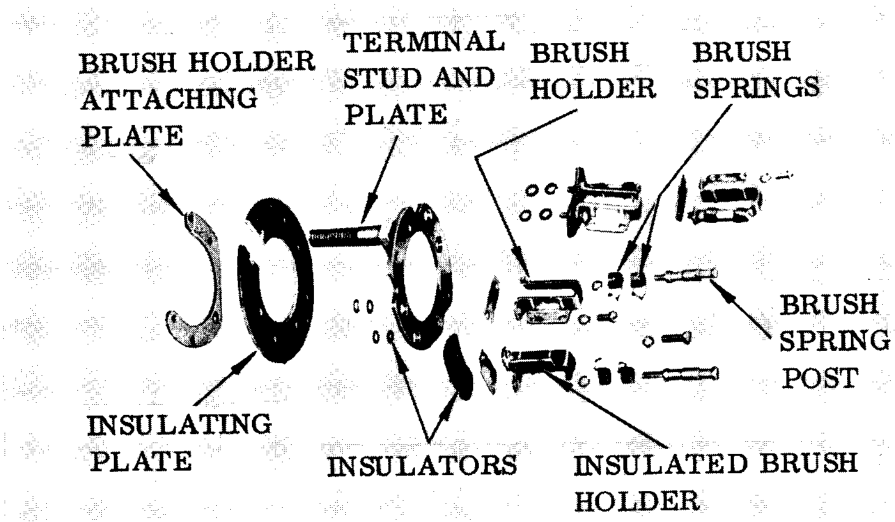
Illust. 1 is an exploded view of the cranking motor, first separate the unit into its main sub-assemblies. Remove the cranking motor solenoid switch, detach drive housing assembly by bending up the tangs on lock washer so screws can be removed. Discard lock washers since it is not safe to use this type lock washer more than once, in as much as repeated bending of the tangs will break them off. Remove armature with intermediate bearing and Dyer drive assembly from the drive-end-frame assembly by unscrewing the bearing attaching screws.

Separate commutator end frame from field frame by removing cover band, detaching brush leads from field leads and unscrewing end-frame attaching screws (discarding tang lock washers).

The brush plate assembly may be removed from the commutator end frame by unscrewing nuts from the terminal and taking out the screw holding the brush plate in place. The brush plate assembly may be disassembled by unscrewing the brush spring posts and brush holder attaching screws. Illust. 2 is an exploded view of a typical brush plate assembly and it may be used as a guide in disassembly and reassembly. On reassembly, pay particular attention to the insulators which insulate the insulated brush holders from brush plate.



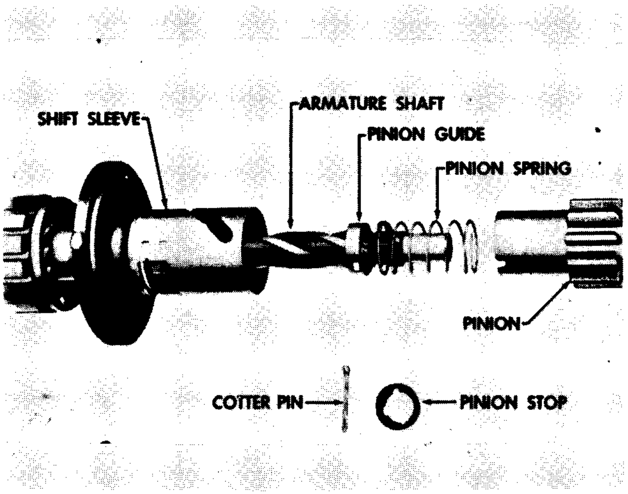
Illust. 1



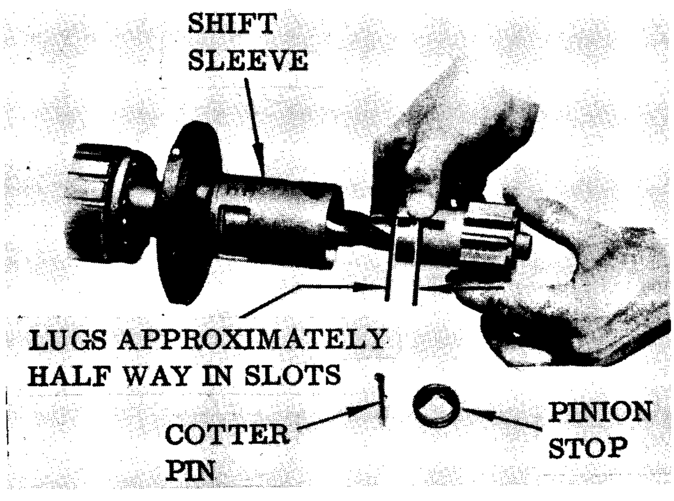
Illust. 2

Removal of the field coils from the frame is explained in the following section under "Field Coil Removal and Service". The Dyer drive is disassembled from the armature shaft by pulling the cotter pin and removing the pin stop, pinion, spring, pinion guide, shift sleeve and two washers. The intermediate bearing may be removed from the armature shaft.

After the cotter pin has been removed the pinion stop must be rotated until the notches register with the shaft splines. The remainder of the assemblies will slip off easily if pressure is applied against the shift sleeve. Armature service is outlined under "Inspection and Repair Parts" in the following section. A special procedure is required to reassemble the Dyer drive assembly into the armature shaft. As a first step, put the intermediate bearing on the armature shaft. Some applications use a collar which is put on the armature shaft before the bearing. Then install the plain washer and cupped thrust washer, cup section facing the shift sleeve. Assemble the shift sleeve, pinion guide and spring on the armature shaft (Illust. 3). Note that in Illusts. 1 and 3 the lugs of the pinion guide are toward the pinion. This is the proper position for most pinion guides with the exception being pinion guides having an identifying "T" stamped on one side. Guides having the "T" identification are heavy parts and are to be assembled with the lugs away from the pinion and are to be used only with pinions having an identification groove cut in the pinion skirt near the pinion teeth. Note that the lugs on the pinion guide are toward the pinion. Do not twist the pinion guide onto the shaft more than approximately 1-3/4 inches from the end of the shaft. Hold the guide in this position and put the pinion on the shaft over the spring, compressing the spring into the pinion skirt (Illust. 4). Align the lugs on the pinion guide with the slots which are cut in the skirt of the pinion. With the thumb and forefinger (Illust. 4) hold the pinion guide stationary while pushing the pinion onto the shaft so the lugs enter the slots in the pinion skirts. Then remove the thumb and forefinger and twist the assembly back onto the armature shaft and into the shift sleeve. As it reaches the extreme position, a click will be heard which indicates that the pinion guide has dropped into the undercut section of the shaft splines so that the assembly is locked in the demeshed position.



Illust. 3



Illust. 4

Replace the pinion stop by aligning it with the spline grooves and turning it on until it hits the undercut. It can then be rotated to align the holes in the shaft and pinion stop. This permits replacement of the cotter pin so that the pinion stop will be held in position.

Lubricate the drive after reassembly with a small amount of light engine oil. Do not use heavy oil or grease. This might retard or prevent normal drive action.

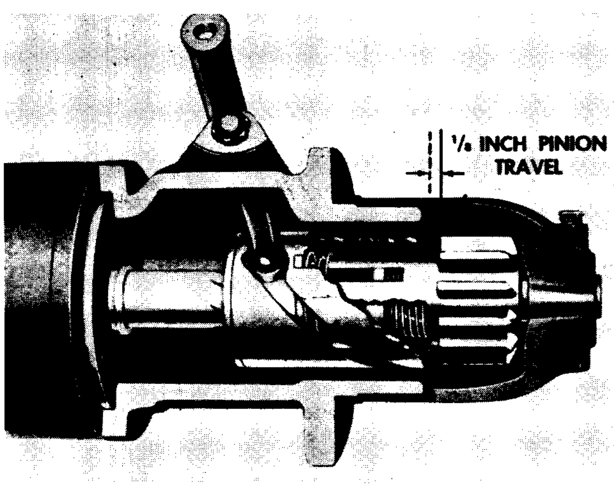
When the shift lever is in the cranking position it should be possible to push the pinion back against spring pressure 1/8 to 3/16 inch (Illust. 5). This free travel adjustment can be checked by disconnecting the lead between the solenoid and cranking motor. Connect a battery of the specified voltage to the two small solenoid terminals. Operate the shift lever by hand until the switch is closed. Battery current will then maintain it in the operating position so that the pinion travel can be checked. Adjustment is made by turning the stud in the plunger in or out as required.

INSPECTION AND REPAIR OF PARTS

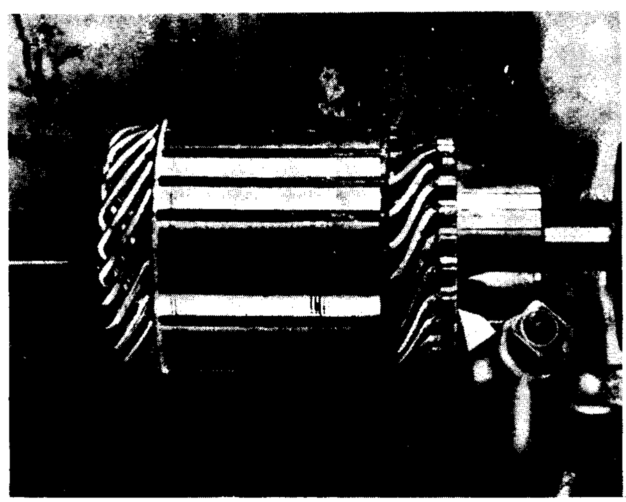
The armature and field coils should not be cleaned in any degreasing tank or by the use of degreasing compound since this might damage insulation so that a short circuit or ground would consequently develop. Brushing parts with oleum or other neutral spirits, however, is satisfactory. Sealed ball bearings should not be cleaned inasmuch as this would remove the lubricant originally packed in the bearings. On assembly, all soldered electrical connections should be made with rosin flux. Never use acid flux on electrical connections.

ARMATURE SERVICING

The armature should be checked for opens, short circuits or grounds. If the armature commutator is worn, dirty, out of round or high mica, the armature should be put in a lathe (Illust. 6) so the commutator can be turned down. The mica should then be undercut 1/32 of an inch wide and 1/32 of an inch deep and the slots cleaned out to remove any trace of dirt or copper dust. As a final step in this procedure, the commutator should be sanded lightly with No. 00 sandpaper to remove any burrs left as a result of the undercutting procedure.



Illust. 5



Illust. 6

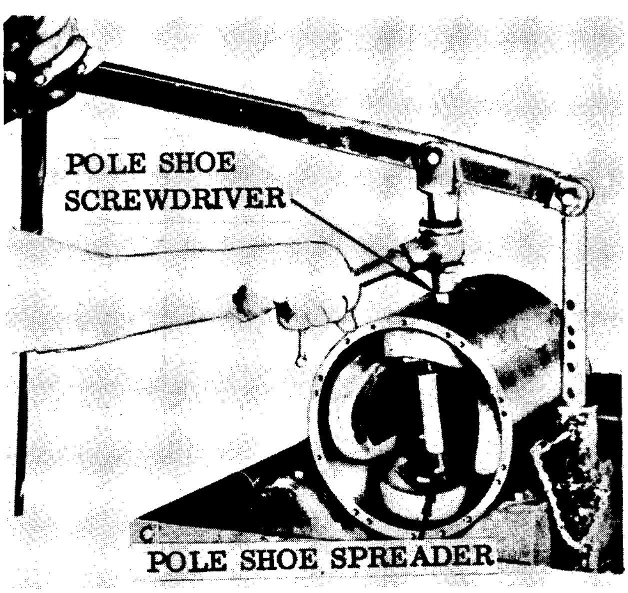
Open circuit armatures often can be saved where the open is obvious and repairable. The most likely place for an occurance is at the commutator riser bars as a result of excessively long cranking periods. Long cranking periods. Long cranking periods overheat the cranking motor so that the solder in the connections melts and is thrown out. The consequent poor connections then cause arcing and burning of the commutator bars as the cranking motor is used. If the bars are not too badly burned, repair can often be affected by resoldering the leads in the riser bars (use rosin flus) and turning down the commutator in a lathe (Illust. 6) to remove the burned material. The mica should then be undercut. Some cranking motor armatures are of a welded construction with the armature coil leads welded and not soldered to the commutator bars. This type of armature should not be repaired by ordinary soldering methods.

Short circuits in the armature are located by use of a growler. When the armature is revolved in the growler with a steel strip such as a hacksaw blade held above it, the blade will vibrate above the area of the armature core in which the short circuit is located. Copper or brush dust in the slots between the commutator bars sometimes produces shorts between bars which can be eliminated by cleaning out the slots.

Grounds in the armature can be detected by the use of a test lamp and test points. If the lamp lights when one test point is placed on the commutator with the other point on the core of the shaft, the armature is grounded. Grounds occur as a result of insulation failure which is often brought about by overheating of the cranking motor produced by excessively long cranking periods or by accumulation of brush dirt between the commutator bars and the steel commutator ring.

FIELD COIL REMOVAL AND SERVICE

Field coils can be removed from the field frame assembly most easily by use of a pole shoe screw driver (Illust. 7). A pole shoe spreader should also be used since this prevents distortion of the field frame. Careful installation of the field coils is necessary to prevent shorting or grounding of the field coils as the pole shoes are tightened into place. On many cranking motors, long and triangular insulating strips are used to protect the field leads from grounding to the frame. These must be replaced on assembly. Where the pole shoe has a long lip on one side and a short lip on the other, the long lip should be assembled in the direction of armature rotation so it becomes the trailing (Not leading) edge of the pole shoe. If the varnish coating on the field coils become hard and interferes with assembly they may be heated in an oven to soften sufficiently for easy installation.



Illust. 7

Grounded field coils may sometimes be repaired by removing and reinsulating them. Care must be taken in applying new insulation to avoid excessive bulkiness, since this may cause the pole shoe to cut through and produce another ground when the coils are installed.

USE OF INSULATING VARNISH

On installation where excessive moisture conditions are experienced, it may be desirable to treat the field coils as well as the armature windings with one of the insulating varnishes supplied for this purpose. This will provide protection against excessive moisture in the coils or windings.

WIRING INSTALLATION

In installing the wire between the cranking motor and battery every precaution should be taken to guard against the possibility of a short circuit or ground. All wires should be of sufficient size to carry the electrical load without excessive voltage drop. Stranded wire and cable should be used to guard breakage due to vibration. All joints and connections should be clean and tight. Terminal clips should be soldered to leads with rosin flux. Acid flux must never be used on electrical connections.

All leads and cables should be supported at enough points to prevent them from moving about so that the insulation will not become worn through. On 12 and 24 volt systems extra precaution should be taken to avoid shorts or grounds. On these higher voltage systems, it would be well to insulate all terminals and clips normally left exposed. This can be done with rubber boots, rubber tape or friction tape and shellac. Insulating terminals and clips in this manner will guard against accidental shorting or grounding.

WIRE SIZES

Good cranking performance will not be obtained if the cables between the battery and cranking motor are of inadequate size. With inadequate cables or bad connections, excessive voltage drop between the battery and cranking motor will be obtained with consequent poor cranking performance.

LENGTH OF STARTING CYCLE

If the engine fails to start after extended cranking check the cause and do not continue to crank since this will not only run the batteries down but will also overheat and damage the cranking motor.

CAUTION: Never operate the cranking motor for more than 30 seconds at a time without pausing for several minutes to permit the cranking motor to cool off.

CRANKING MOTOR TESTS								
Delco Remy Cranking Motor Model No.	Rotating Viewing D. E.	Min. Brush Tension (Oz.)	No Load Test			Lock Test		
			Volts	Max. Amps.	Min. R. P. M.	Volts	Max. Amps.	Min. Torque Lb. Ft.
1114029	*C	35	11.5	105	6000	2.3	600	19

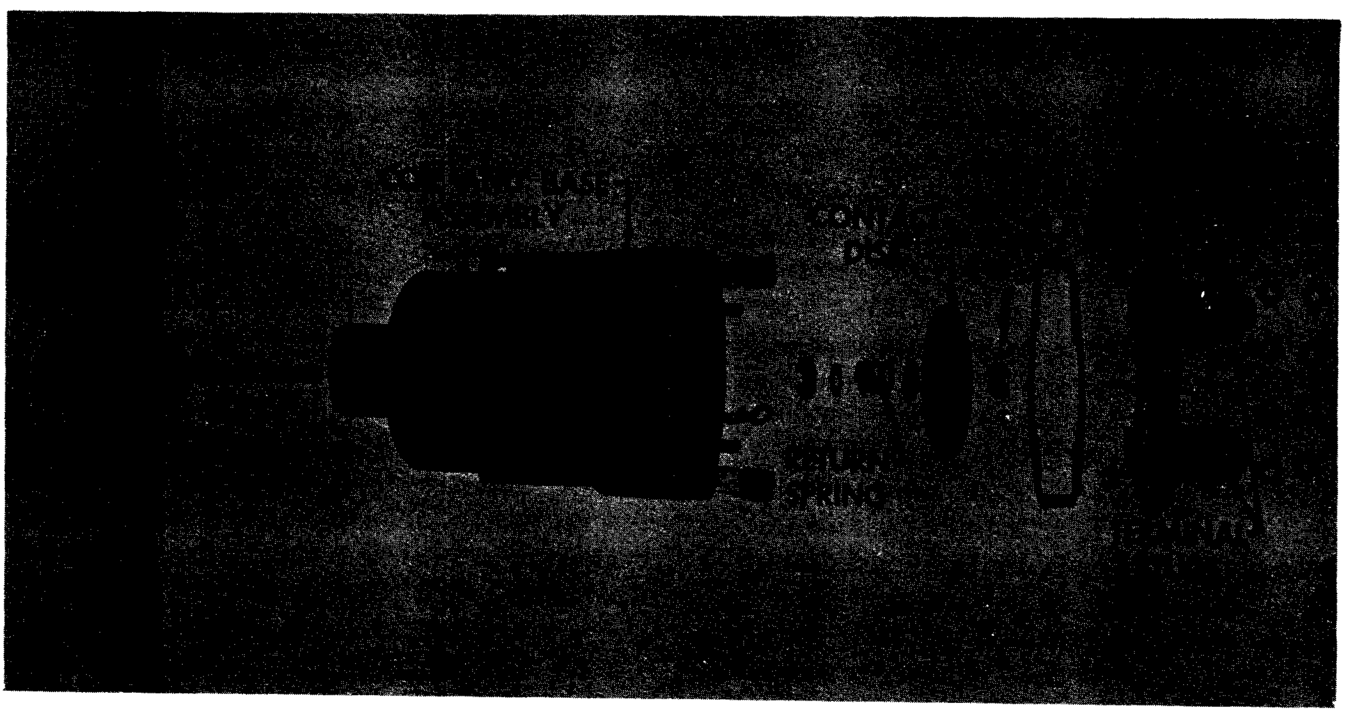
*C – Clockwise

MAGNETIC AND SOLENOID SWITCHES

SOLENOID SWITCH

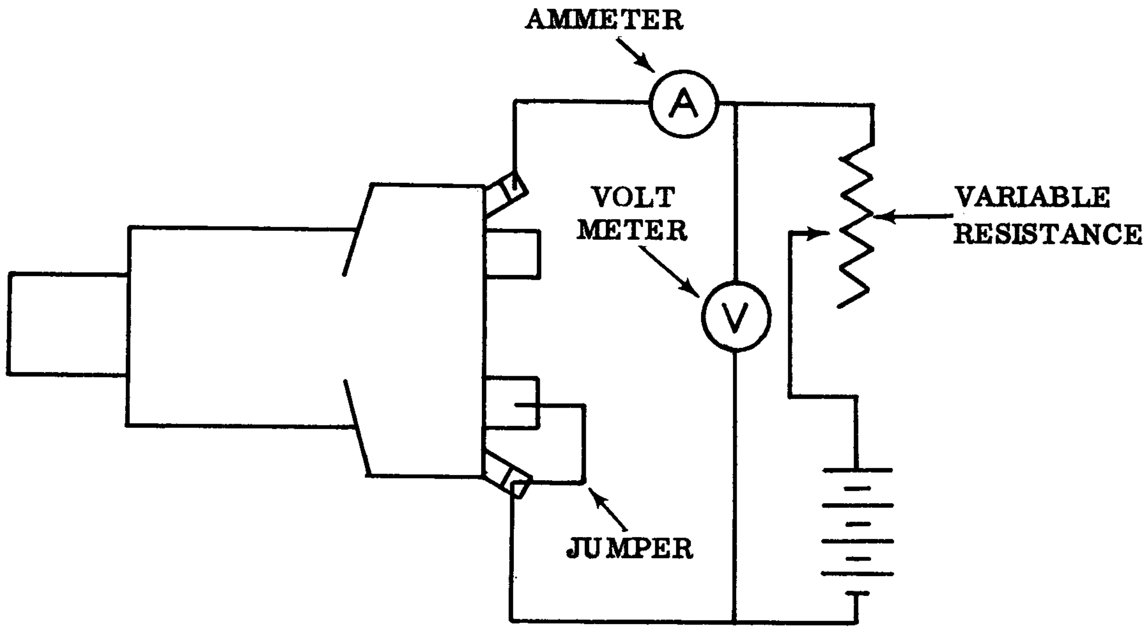
Magnetic and solenoid switches are designed to perform mechanical jobs electromagnetically. The solenoid switches used contains two windings: a pull-in winding and a hold-in winding. When the control switch is closed, current from the battery flows through these windings producing a magnetic field which pulls in the plunger. Movement of the plunger is transmitted to the cranking motor shift lever by means of a linkage and the cranking motor drive pinion is shifted into mesh with the engine flywheel ring gear. Completion of the plunger travel closes the main switch contacts, connecting the cranking motor directly to the battery. Closing of the main switch contacts shunts out the pull-in winding since this winding is connected across the main contacts. The magnetism produced by the hold-in winding is sufficient to hold the plunger in and shunting out of the pull-in winding reduces the drain on the battery. When the control switch is opened, the hold-in winding is disconnected from the battery so that the shift lever spring can withdraw the plunger from the solenoid, opening the solenoid switch contacts and at the same time withdrawing the drive pinion from mesh.

Illust. 1 is an exploded view of the solenoid switch. Disassembly of the switch is made by removing the nuts attaching the terminal plate assembly. The contact disk can be detached from the plunger and rod assembly by removing the cotter pin and unscrewing the castellated nut. On reassembly, the castellated nut should be tightened down so that the face of the disk is 1-1/32 inch below the edge of the housing with the plunger in the retracted position. After assembly is completed, fill the bushing in the terminal plate assembly through which the lead passes with sealing material to prevent entrance of dust.



Illust. 1

PULL IN TEST



Illust. 2

SOLENOID CURRENT CHECK
(See "Test Specifications")

The solenoid can be tested with the solenoid heater off or on the starting motor. All wires or cables should be disconnected from the solenoid. Two tests must be made to determine the current draw of the windings. For the pull-in test (Illust. 2) hook a jumper wire from one of the control circuit terminals to the nearest battery and motor terminal of the solenoid. Hook an ammeter and a variable resistance to the battery from the other control circuit terminals. Run a lead from the control circuit terminal, from which is also hooked the jumper wire, to the battery. A voltmeter should be hooked parallel between the ammeter and the variable resistance and the lead from the battery to the control circuit terminal which is also hooked to the jumper wire. Slowly increase the voltage at the variable resistance and note the current draw.

For the hold-in test (Illust. 3) remove the jumper wire and slowly increase the voltage as before and note the current draw.

IMPORTANT: Whenever the solenoid has been removed or replaced, the clearance of the motor and drive pinion must be readjusted after the solenoid has been remounted on the starting motor. Adjust to motor specifications by adjusting the stud in the solenoid plunger to secure the proper travel of the Dyer pinion.

MAGNETIC SWITCH

Illust. 4 illustrates the end and sectional views of the sealed type magnetic switch used on graders equipped with Cummins Engines.

DISASSEMBLY

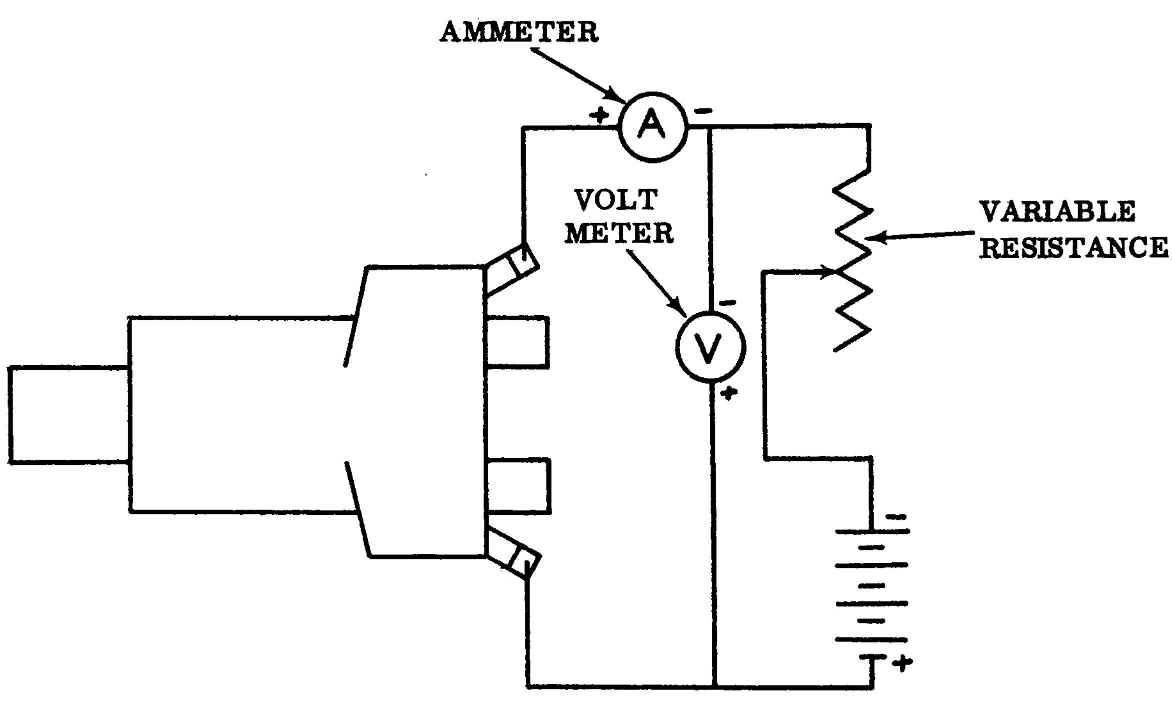
The magnetic switch can be disassembled by unscrewing the three screws attaching the cover to the switch case. This permits removal of the contact disk and the shaft assembly, plunger stop and plunger from the case.

The terminals are assembled (into a molded) terminal ring which is held in place on the switch case by the cover and cover attaching screws. Gaskets on both sides of the ring seal the contact compartment as a protection against moisture or dirt. The winding assembly is not removable from the case.

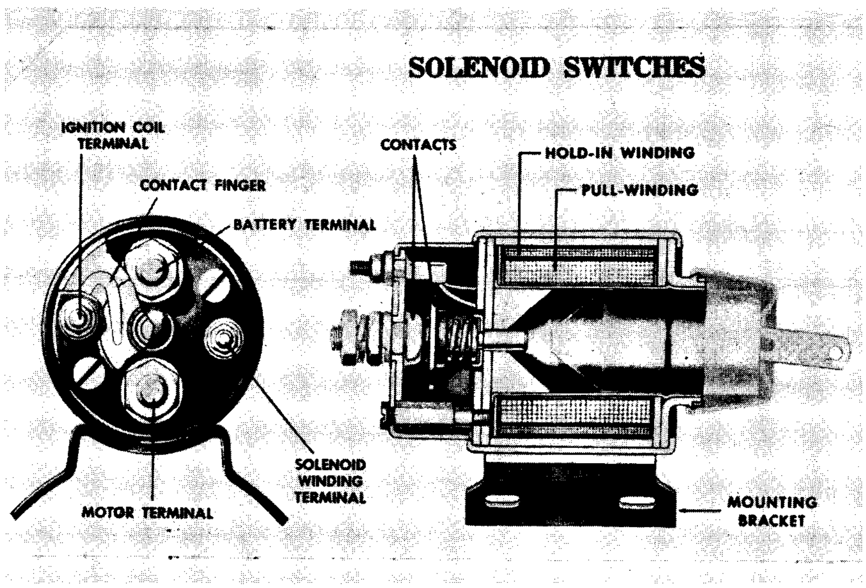
MAGNETIC SWITCH TEST
(See "Test Specifications")

Connect a test voltmeter between the switch control terminal and connect a source of variable voltage to these terminals. A battery and a variable resistance connected in series will be found to be a suitable source of variable voltage. Increase the voltage on the switch slowly and note the voltage required to close the contacts. Closing of the contacts is indicated by a click which can normally be heard. A more accurate way of checking, the instant that the contacts close, is to connect test lamp points between the two main switch terminals. The lamp will light as the contacts close.

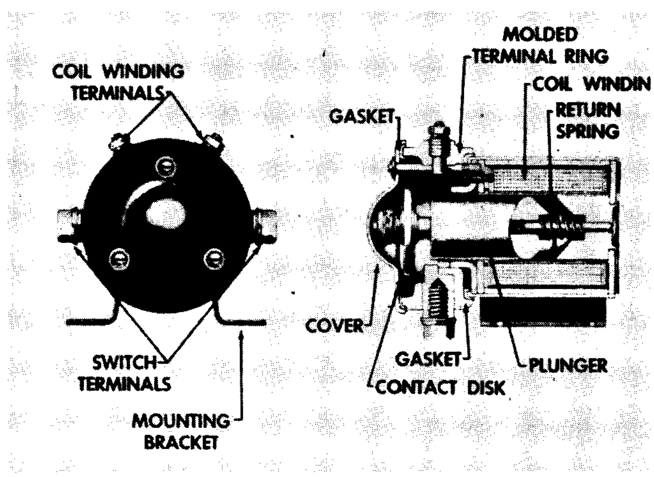
HOLD IN TEST



Illust. 3



Illust. 4



Illust. 5

SOLENOID SWITCHES

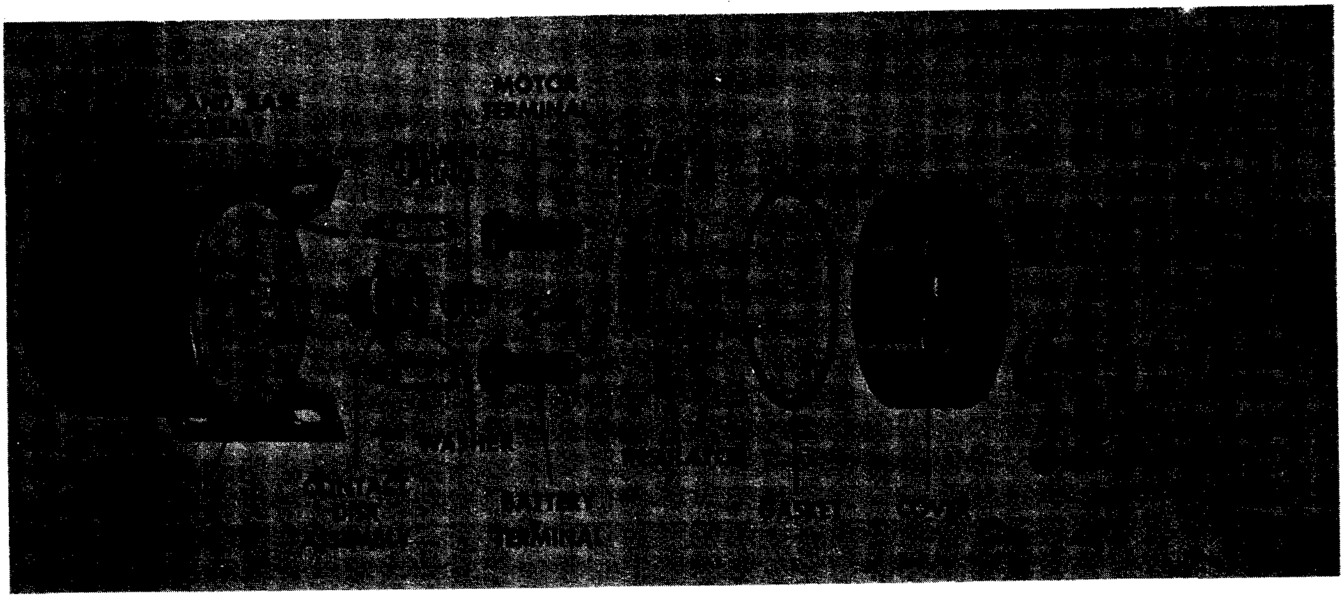
This type of switch is similar to the one used on motor graders equipped with General Motors engines.

Illust. 5 is a sectional view and end view of the solenoid switch. This type is energized by the battery through a separate switch. Note, however, that the switch includes an additional small terminal and contact finger. This terminal has no functional duty in relation to the switch, but is used to complete a special ignition circuit during the cranking cycle only. When the solenoid is in the cranking position, the finger touches the contact disk and provides a direct circuit between the battery and ignition coil.

Illust. 6 is an exploded view of the solenoid switch used on Dyer drive cranking motors. When reassembling the switch, the contact finger should be adjusted to touch the contact disk before the disk makes contact with the main switch terminal. There should be 1/16" to 3/32" clearance between the contact disk and the main terminals when the finger touches.

DISASSEMBLY

To disassemble the solenoid (Illust. 6) remove nuts, washers and insulators from the switch terminal and battery terminal. Unscrew cover screws and remove cover. Take out the contact disk assembly.



Illust. 6

SOLENOID SWITCH TEST
(See "Test Specifications")

Two tests must be made to determine the current draw of (1) both windings in parallel and (2) the hold-in winding alone. The solenoid windings can be tested with the solenoid either off or on the engine. However, when the solenoid is checked on the engine, it is necessary to disconnect both leads at the main solenoid terminals to prevent interference. For the first test, connect a source of variable voltage (battery and a variable resistance) in series with an ammeter between the solenoid base and the solenoid switch terminal. Connect a voltmeter between the same two points. Slowly increase voltage and note the current draw at the voltage specified in the solenoid test specifications. Disconnect the jumper lead grounding the main solenoid terminal and readjust the variable resistance to obtain the specified voltage to check current draw of the hold-in winding.

MAGNETIC SWITCHES AND SOLENOID TEST SPECIFICATIONS				
	CURRENT CONSUMPTION*			
Delco Remy Model Nos.	Both Windings Amps.	Volts	Hold-In Winding Amps.	Volts
1119803	41.6-45.8	24	7.3- 8.3	24
1119819	11.1-12.1	12	--------	--
1119866	4.3- 4.7	24	--------	--
1119948	65.2-79	10	12.7-14.3	10

*Room temperature (80^{o} F.)

HORN

Automotive electrical horns manufactured by Delco-Remy have vibrating type power plants which operate on a magnetic principle to produce sound used as a warning signal (Illust. 1). Current flows from the battery through the field winding within the horn power plant whenever the horn circuit is completed. The resulting magnetic field attracts the movable armature toward the pole. A diaphragm is connected to the armature, and movement of the armature thus causes similar movement of the diaphragm. The contact points, which are normally closed, are connected in series with the horn winding and are opened mechanically as the armature moves toward the pole. When the current is interrupted, the armature returns due to "spring-back" of the diaphragm. The return movement of the armature allows the contact points to close, again completing the circuit (Illust. 1). This cycle is repeated many times per second resulting in a rapid vibration of the diaphragm with the production of sound. The number of vibrations produced per second determines the pitch of the sound - the greater the number of vibrations the higher the pitch.

TYPES OF ELECTRIC HORNS

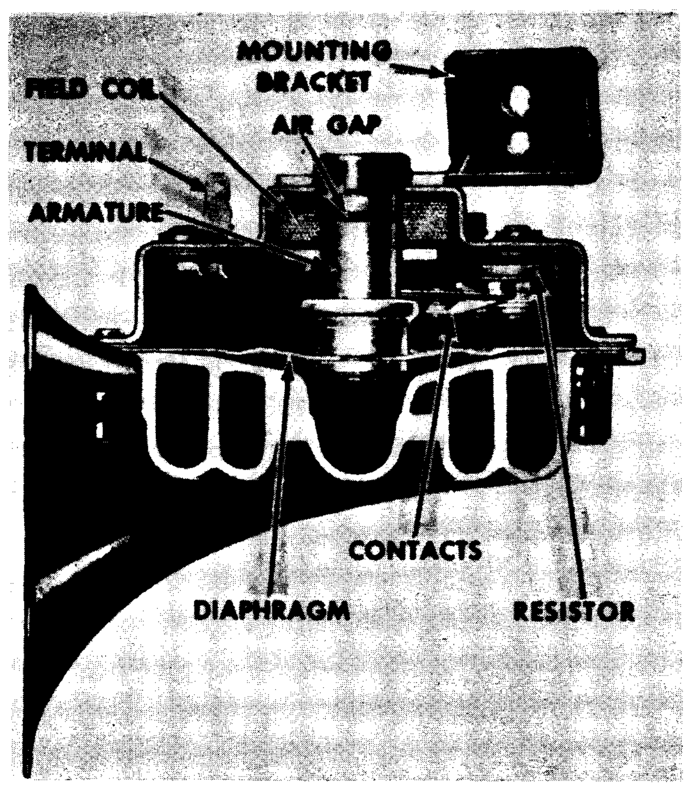
AIR-TONE MODELS

In these units the vibrating diaphragm causes an air column to vibrate. Since the air column for most horns of this type is coiled in a compact form similar to a sea shell, these horns are commonly known as "sea shell" type.

Present air-tone horns have a solenoid-type power plant construction (Illust. 1) and are called "Type S" horns.

Type S horns have the power plant built in the backshell and the armature operates in the center of the coil. The resistor acts as a suppressor for the electric arc which occurs at the contacts when they are opened.

The air columns are designed to produce a trumpet-like sound from the diaphragm vibrations. This sound contains frequencies in the region where the human ear is most sensitive.



Illust. 1

Since horns are designed for intermittent service, serious damage may result if they are operated continuously for prolonged periods. If the horn tone changes after prolonged operation, the horn has overheated and continued operation will result in horn failure. Because of the relatively high operating current of air-tone horns, a relay is used in the power circuit (Illust. 2). The relay reduces the length of heavy gauge wire required by providing a more direct connection between the horns and the battery. Consequently, a greater voltage is available at the horns, and better performance is obtained than would be possible if the horn control wiring were not eliminated from the direct power circuit.

Most horns have two terminals. Two terminals are required at the horn rather than one when a horn relay is omitted from the circuit. The operating current for horns of this type is not great enough to warrant using a relay. Either horn terminal may be connected to the battery. The remaining terminal is connected to ground through the horn button (Illust. 2).

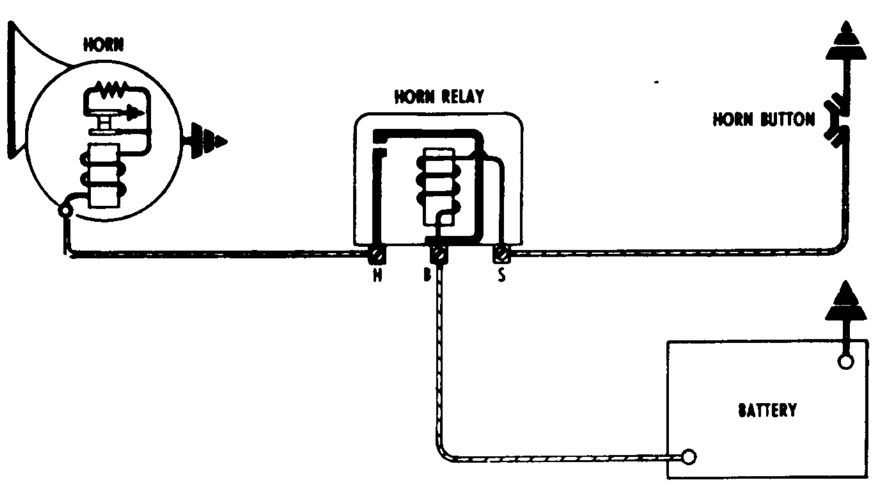
CHECKS AND ADJUSTMENTS

Each horn is carefully adjusted and inspected during manufacture and when used properly should give years of service without further attention. Present Type S horns are assembled with rivets and cannot be adjusted or repaired. If this type horn should become defective, it must be replaced with a complete unit.

Complete failures, of course, may be encountered due to overheating, broken internal leads or similar mechanical causes. If at any time the horns do not give satisfactory performance, first check the battery and wiring circuit, cleaning and tightening connections wherever necessary.

After checks have been made, and it is established that the horn is at fault, the trouble may be that the contacts are held open by a foreign particle. To dislodge the particle in a Type S horn, energize the horn and tap the power plant lightly. If this is the trouble, the horn will start to blow and resume normal operation.

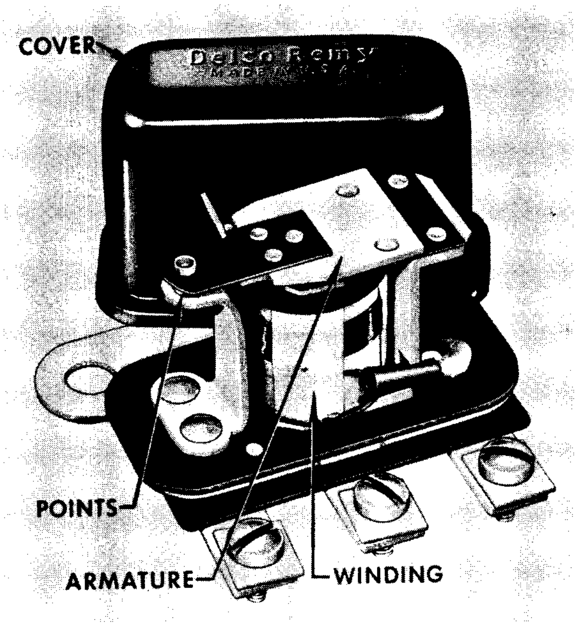
MOUNTING - This type horn is grounded internally and therefore requires that a good ground connection to the frame be maintained through the mounting brackets. Horns also must be fastened securely in position or the tone will be affected.



Illust. 2

HORN RELAY

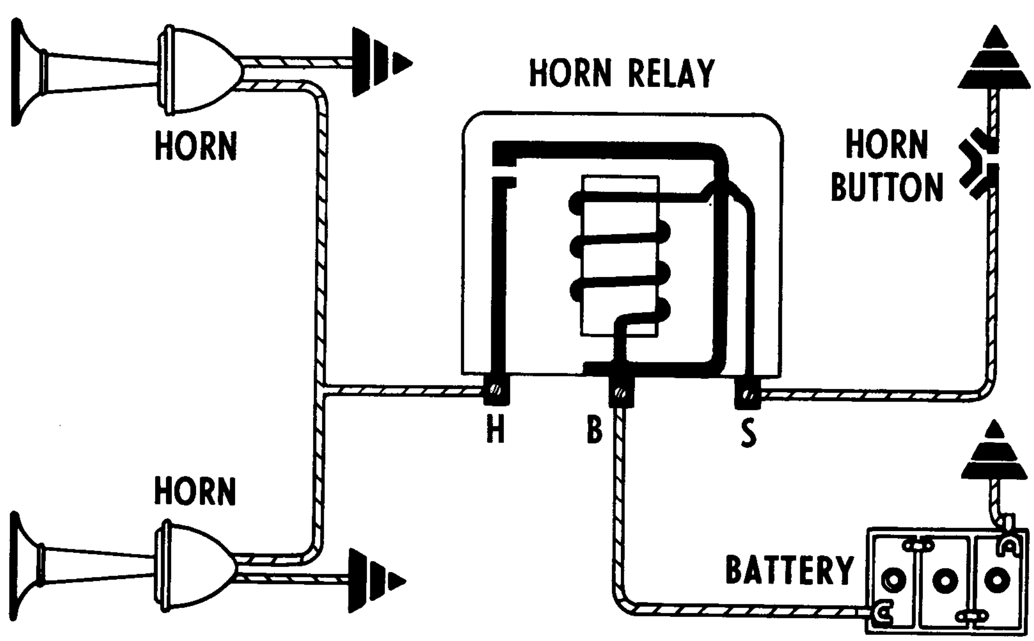
The horn relay (Illust. 1) is connected into the horn and battery circuit to make a more direct connection between the battery and the horn, eliminating the horn button wiring from the horn circuit proper so higher voltage becomes available at the horn and better horn performance is obtained. The horn relay consists of a winding assembled on a core above which an armature is placed. The armature has a point positioned above a stationary point.



Illust. 1

HORN RELAY OPERATION

The horn relay circuit is shown in Illust. 2. When the horn button is closed, the circuit from the battery is completed through the horn relay winding. This causes a magnetic field which pulls the relay armature down so the circuit between the battery and horn is completed. The horn functions and will continue to function as long as the horn button remains in the closed position.



Illust. 2

CHECKS AND ADJUSTMENTS

Three checks and adjustments are required on the horn relay: air gap, point opening and closing voltage. The air gap and contact point opening checks and adjustments should be made with the battery disconnected.

AIR GAP

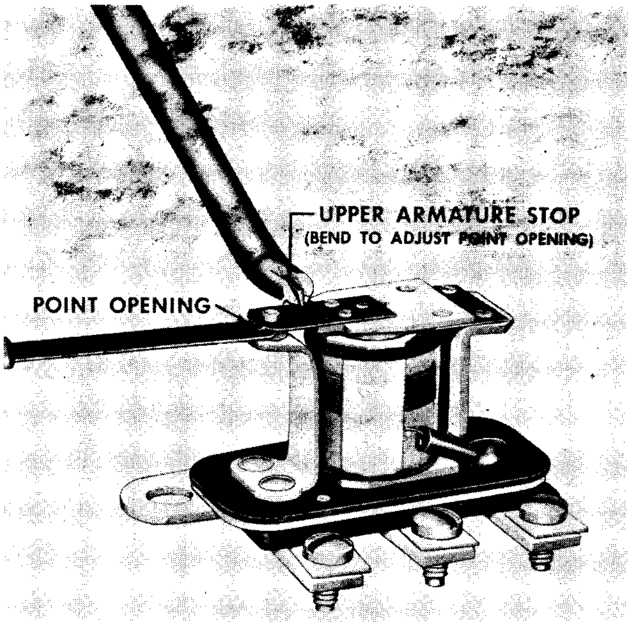
The air gap should not normally require adjustment unless the relay has been misadjusted. Check the air gap with the points barely touching and adjust if necessary by bending the lower point support (Illust. 3).

CONTACT POINT OPENING

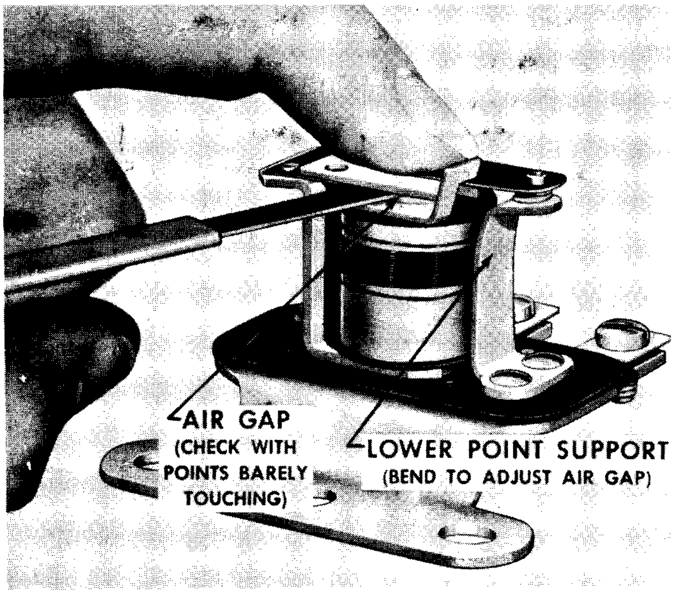
Check the contact point opening and adjust by bending the upper armature stop (Illust. 4).

CLOSING VOLTAGE

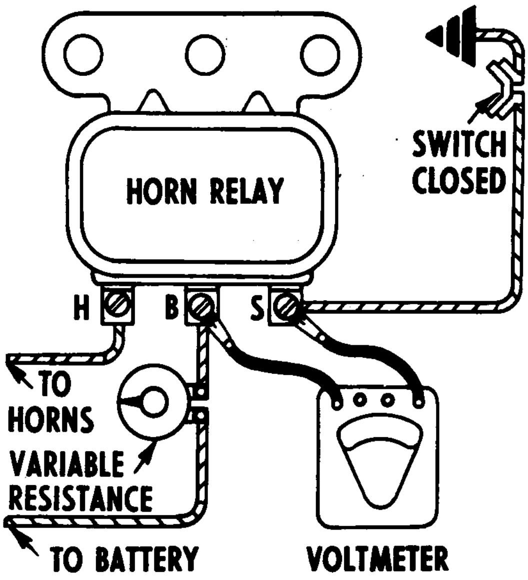
To check the relay closing voltage, connect a variable resistance of 10 ohms in series with the relay "B" terminal and connect a voltmeter between the "S" and the "B" terminals (Illust. 5). With the horn button closed, slowly decrease the amount of resistance in order to check the relay closing voltage. Adjust the closing voltage by



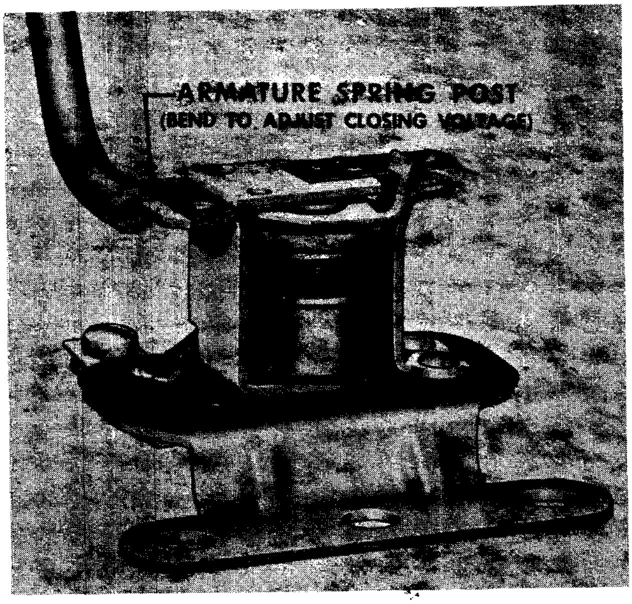
Illust. 4



Illust. 3



Illust. 5



Illust. 6

bending the armature spring post (Illust. 6). Bending down to increase the spring tension increases the closing voltage while bending up decreases the closing voltage.

NOTE: Late type horn relay terminals do not carry any markings but relationship of the terminals is shown in Illust. 5.

RELAY TEST SPECIFICATIONS			
Delco Remy Model No.	Nominal Air Gap At Core With Points Closed (Inches)	Nominal Point Opening (Inches)	Closing Voltage Range (Volts)
1116781	.020	.018	1.5 - 9.5

ROBERT BOSCH WINDSHIELD WIPERS

WINDSHIELD WIPER

Illust. 1 is a view from inside of cab showing location of mounting hole for windshield wiper motor.

Drill a 29/64" diameter hole, 7/16" from top of windshield frame and 19-9/16" from metal edge of frame (Illust. 1).

Illust. 2 shows wiper motor mounted to windshield.

Insert wiper motor shaft through hole in windshield frame. Install lock washer and nut. Tighten nut to a torque reading of 20 foot lbs.

Install and tighten second nut against first nut.

Install cap with gasket onto shaft. Tighten cap finger tight.

Install serrated bushing onto shaft. Pin hole in bushing to align with pin hole in shaft.

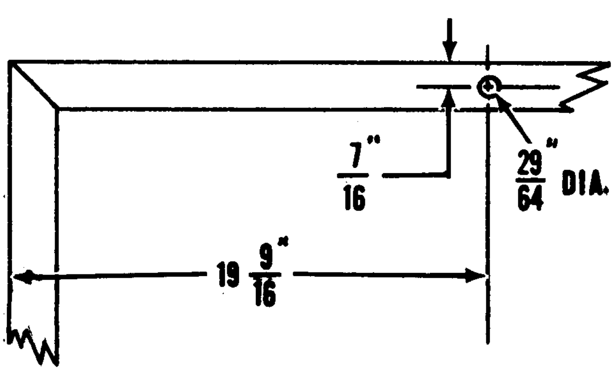
Tap pin through bushing.

Illust. 3 is a view from inside of cab showing installation of wiring, wiper arm and blade.

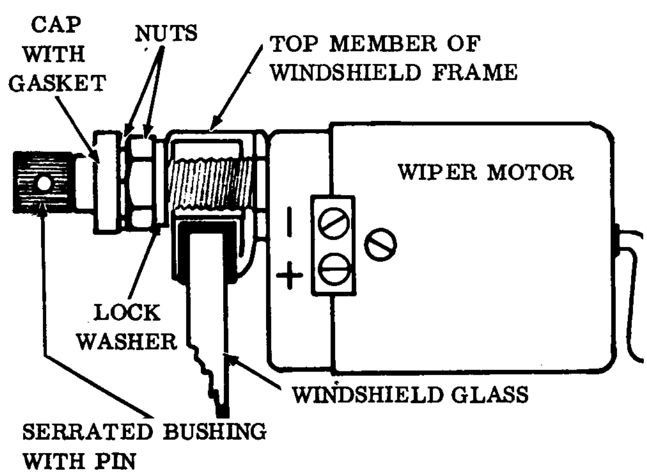
Connect positive cable from No. 4 cable in R.H. instrument box to positive pole of wiper motor. Anchor cable with clips to center and R.H. windshield mounting bolts.

Connect negative cable from negative pole of wiper motor to center windshield mounting bolt.

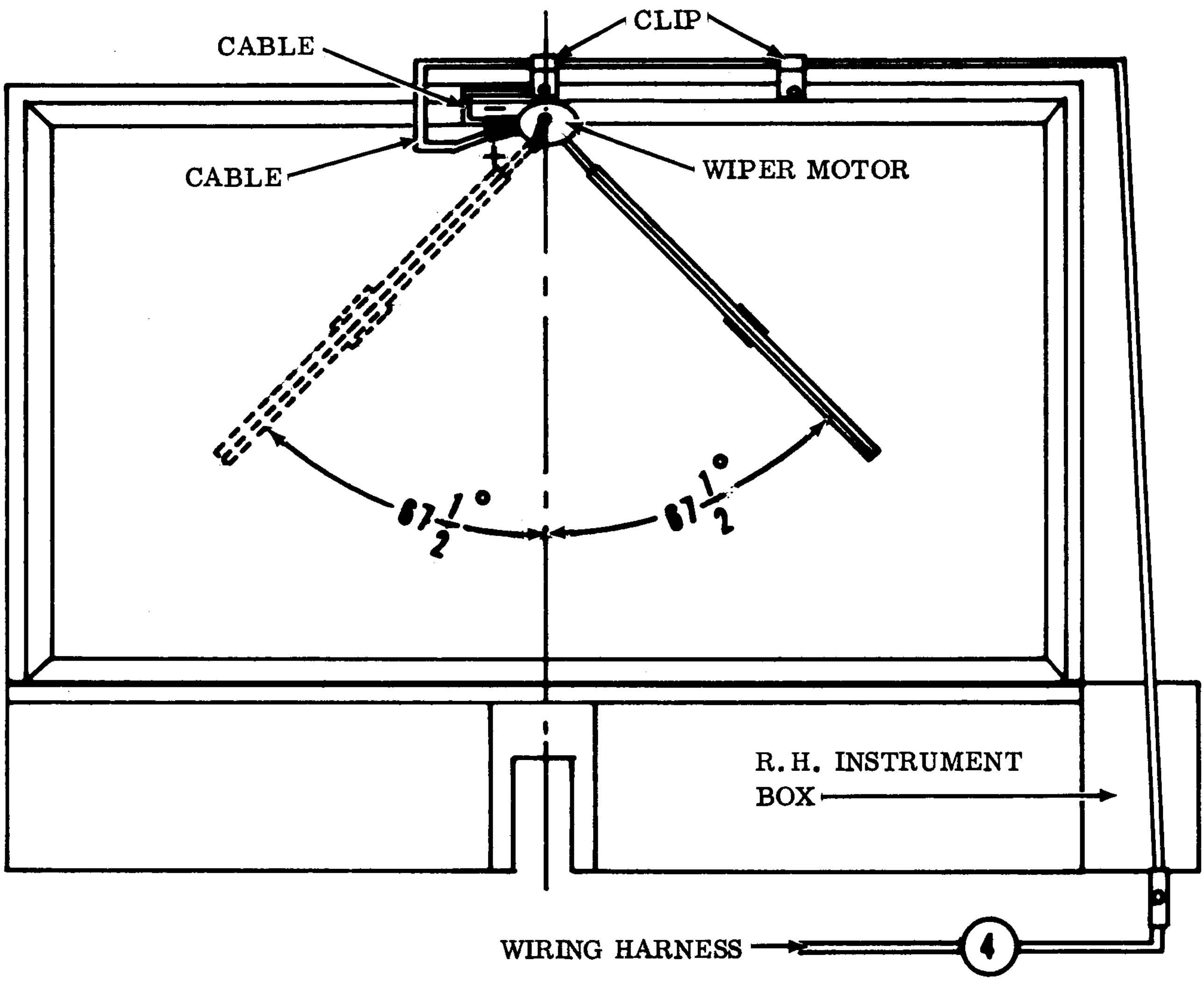
Turn wiper motor switch to "ON" position. Note arc of bushing travel. Stop motor when bushing has reached its highest point of arc then install wiper arm and blade (Illust. 3).



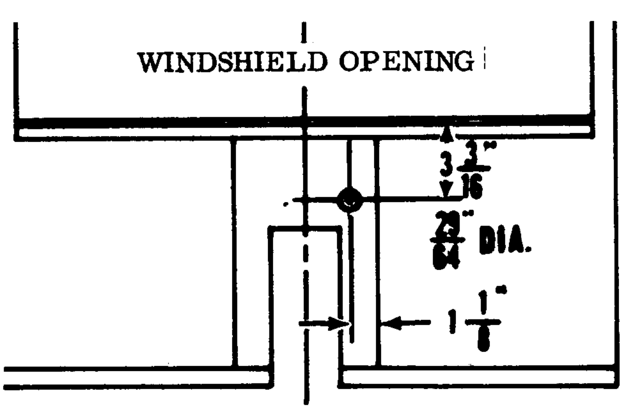
Illust. 1



Illust. 2



Illust. 3



Illust. 4

AUXILIARY WINDSHIELD WIPER

Illust. 4 is a view from inside of cab showing location of mounting hole for auxiliary windshield wiper.

Drill a 29/64" diameter hole, 3-3/16" from lower windshield frame angle and 1-1/8" from right edge of steering post section of windshield frame.

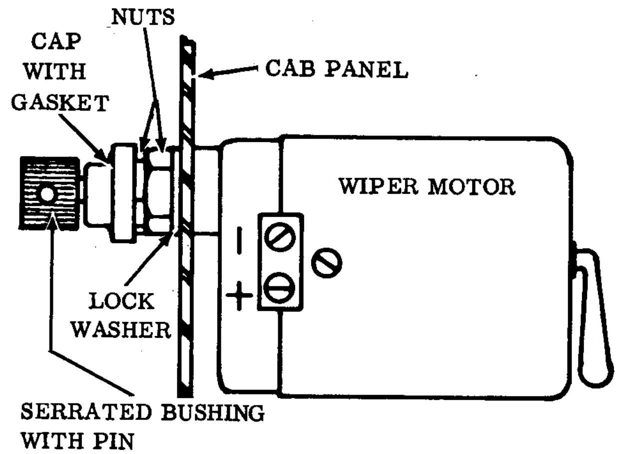
Illust. 5 shows wiper motor mounted to steering post section of windshield frame.

Insert wiper motor shaft through hole in frame. Motor to be at an angle (See Illust. 6). Install lock washer and nut. Tighten nut to a torque reading of 20 foot lbs.

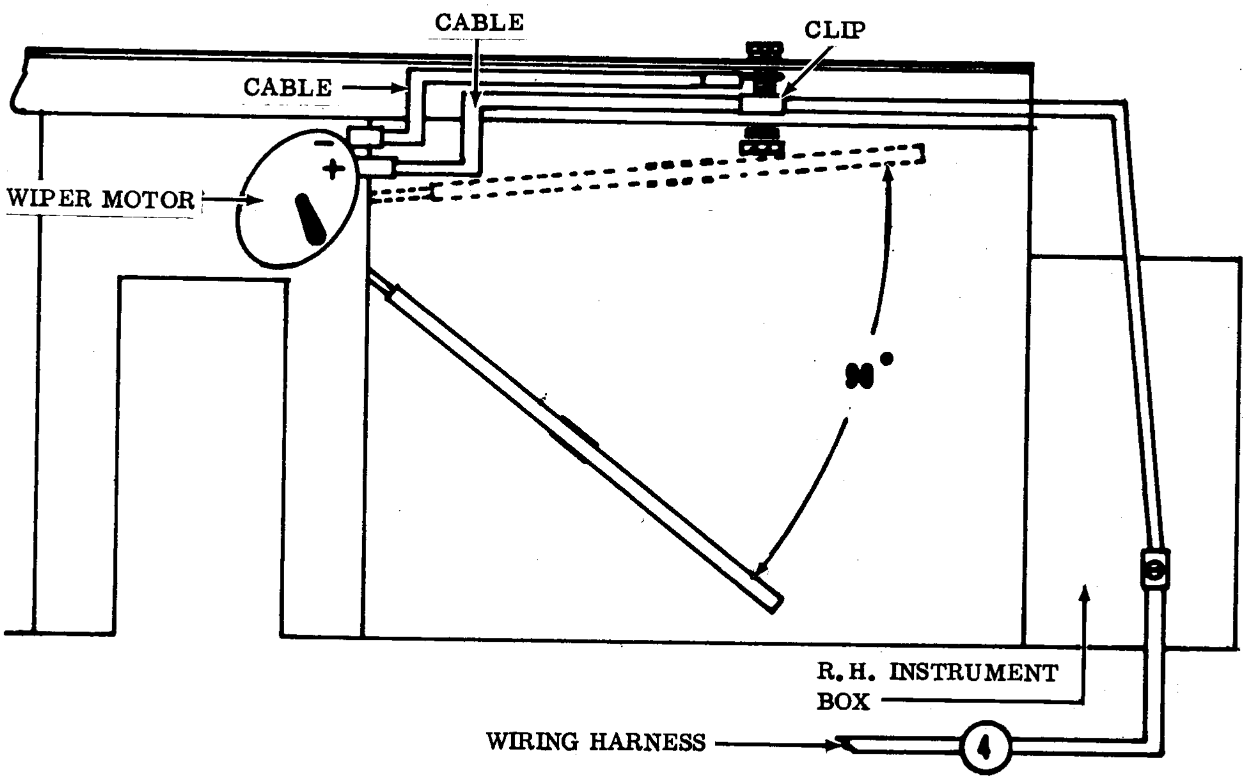
Install and tighten second nut.

Install cap with gasket onto shaft. Tighten cap finger tight.

Install serrated bushing onto shaft. Pin hole in bushing to align with pin hole in shaft.



Illust. 5



Illust. 6

Tap pin through bushing.

Illust. 6 is a view from inside of cab showing installation of wiring, wiper arm and blade.

Connect negative cable from negative pole of wiper motor to defroster fan mounting hole in windshield frame.

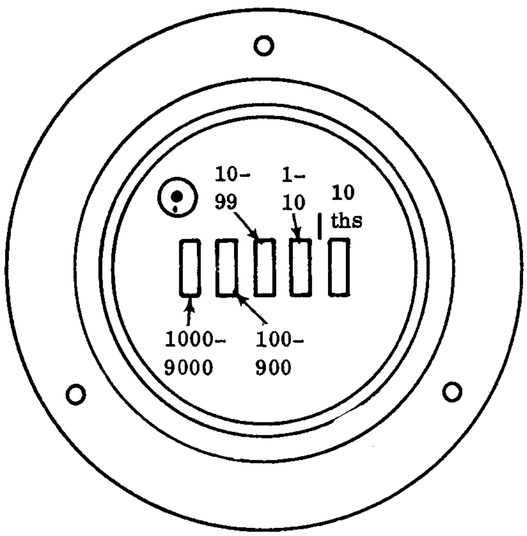
Connect positive cable from No. 4 cable in R.H. instrument box to positive pole of wiper motor.

Clip positive cable to defroster fan hole in windshield frame.

Turn wiper motor switch to "ON" position. Note arc of bushing travel. Stop motor when bushing has reached its highest point of arc then install wiper arm and blade (Illust. 6).

HOUR METER

MODEL 330 MG - S/N 700 thru 1999
MODEL 440 MG - S/N 1500 thru 3199

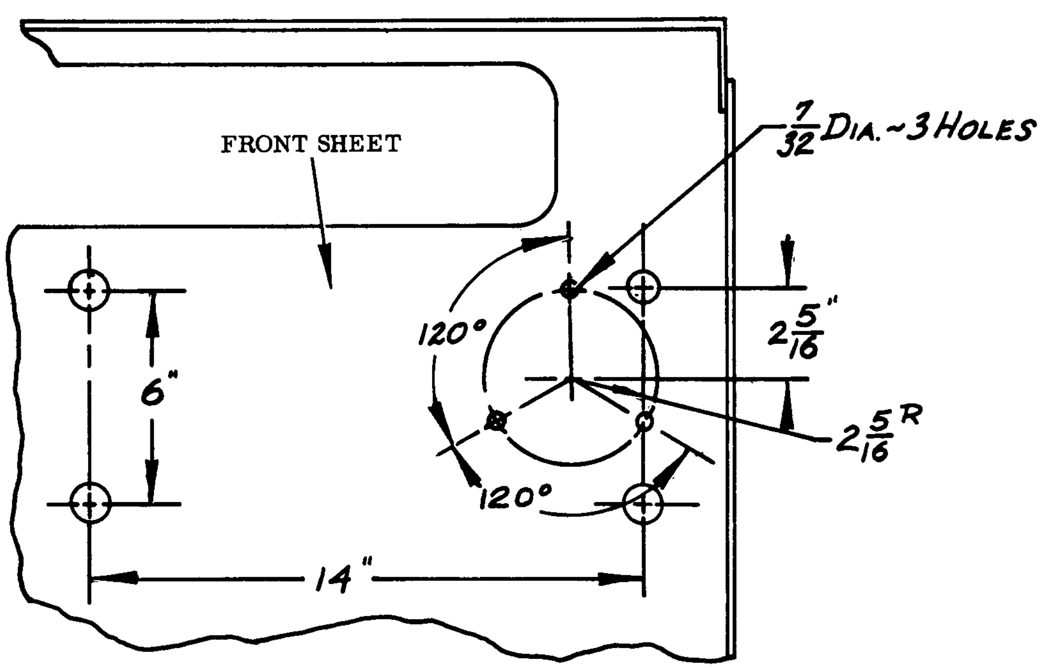


Illust. 1

The hour meter is an instrument operated by a pressure switch located in the engine oil lubricating system to register engine working hours.

The switch has been especially designed for use with the engine hour meter. It has been tested and adjusted to close the electrical circuit at approximately 4 pounds of oil pressure.

Illust. 1 is a view of the hour meter face. As you will note, the hour meter dials are somewhat similar to an automobile mileage dial of a speedometer. The red section registering 10ths; the first white section



HOLE LOCATION

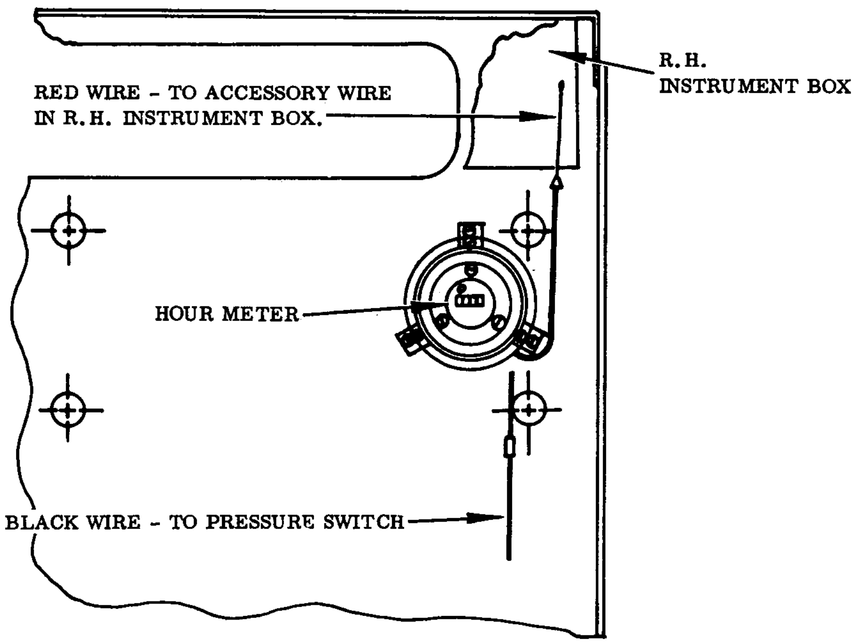
Illust. 2

registering 1-10 hours; second white section registering 10-99 hours; third white section registering 100-900 hours and the fourth white section registering 1000-9000 hours.

The small indicator dial at the upper left of the hour meter face revolves one revolution per minute while engine is running. After engine has been shut down, the indicator dial may continue to operate for a maximum of three minutes.

No resetting mechanism has been provided on the hour meter. The case is sealed against entrance of dust, moisture and tampering.

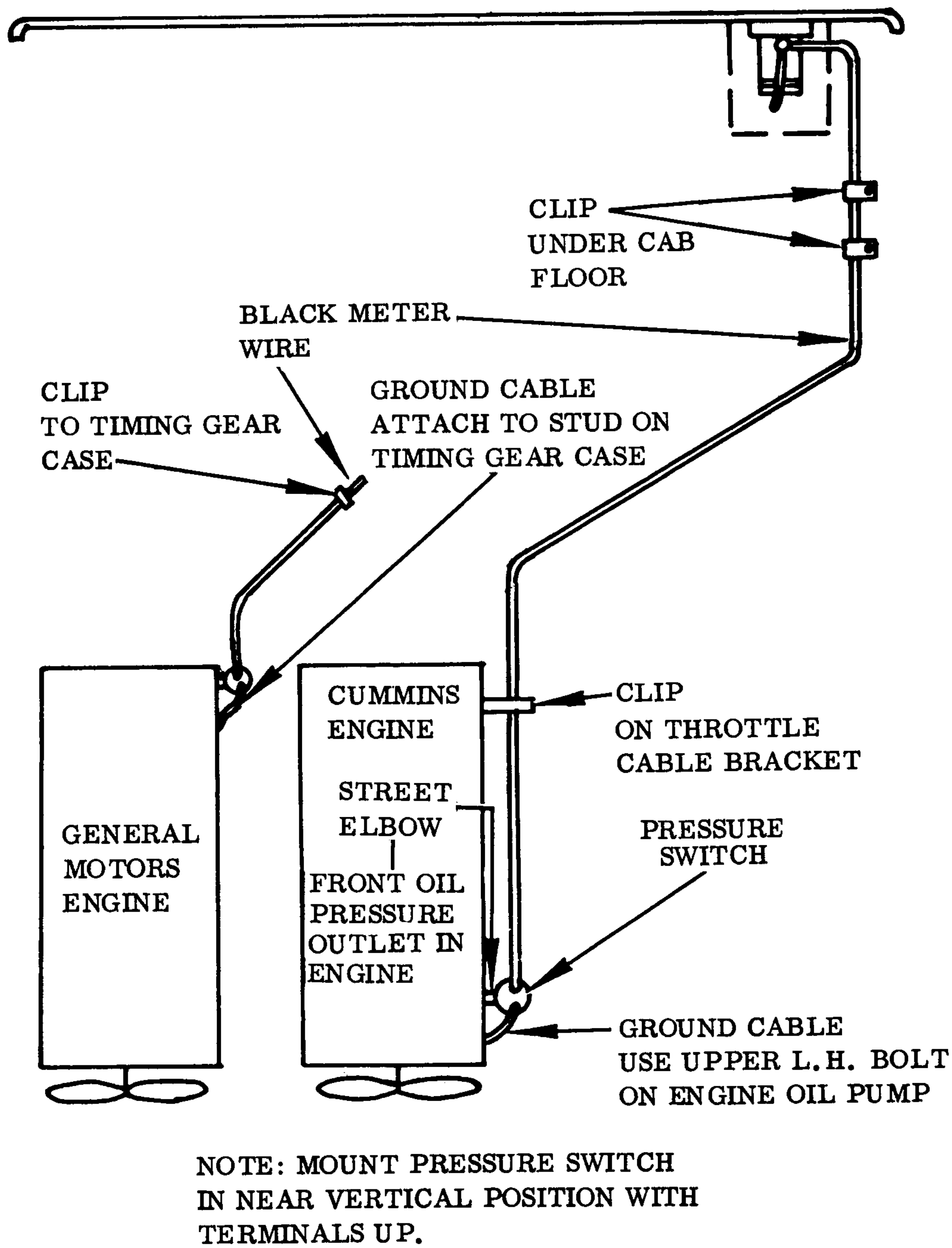
Illusts. 2 and 3 show the installation of the hour meter.



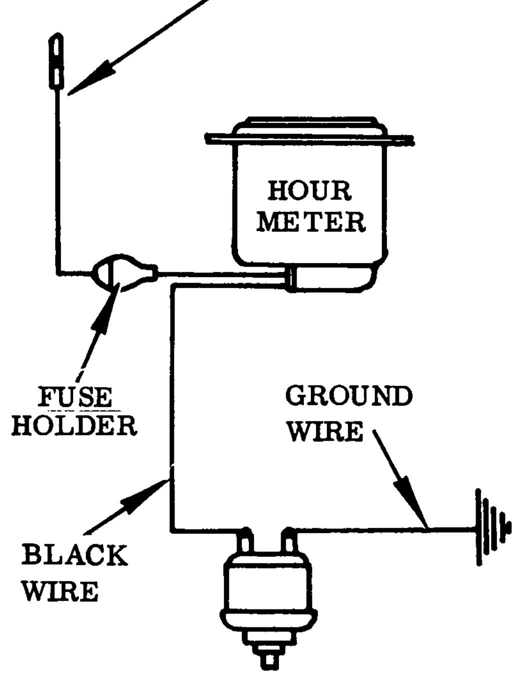
Illust. 3

Illust. 4 shows wiring diagram from engine to hour meter.

Illust. 5 shows hour meter wiring diagram.



Illust. 4

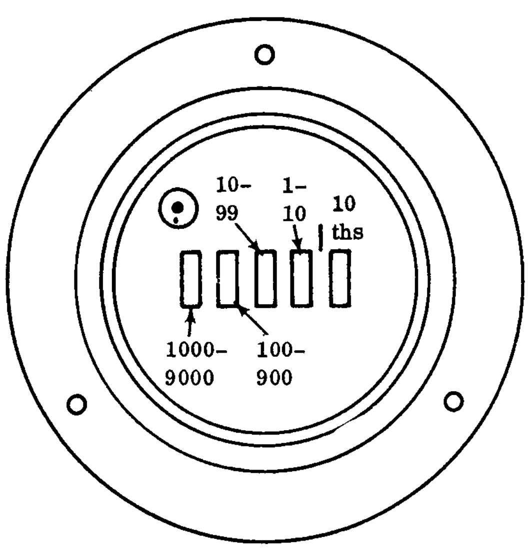


WIRING DIAGRAM

Illust. 5

HOUR METER

MODEL 330 MG - S/N 2000 and Later
MODEL 440 MG - S/N 3200 and Later



Illust. 1

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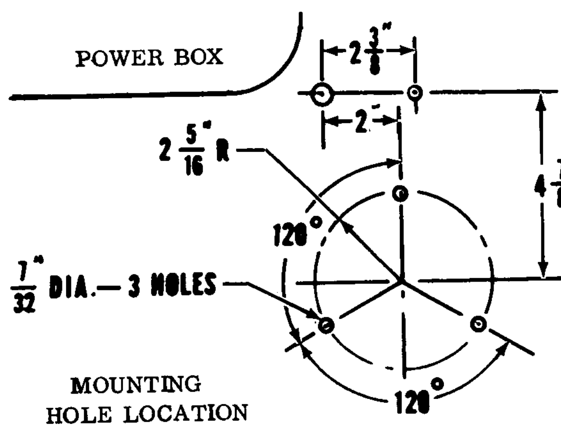
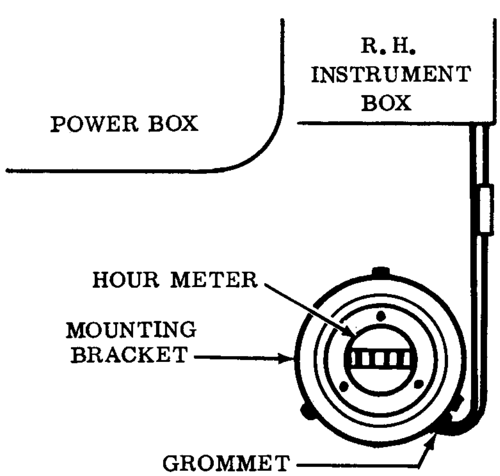
Illusts. 2 and 3 show the installation of the hour meter.

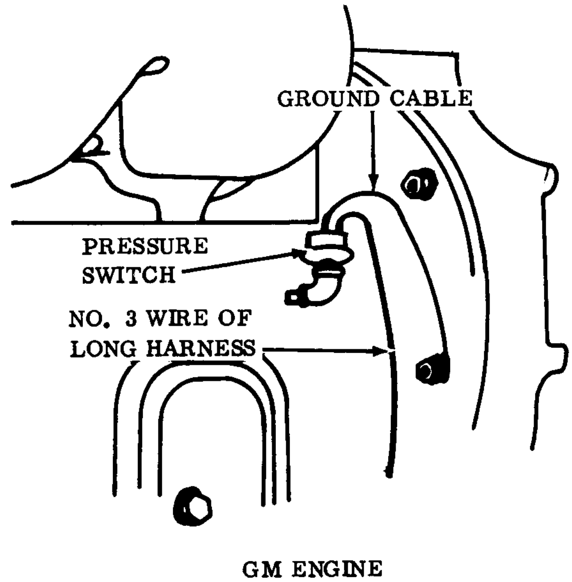
Illusts. 4, 5 and 6 are views of wiring diagrams.



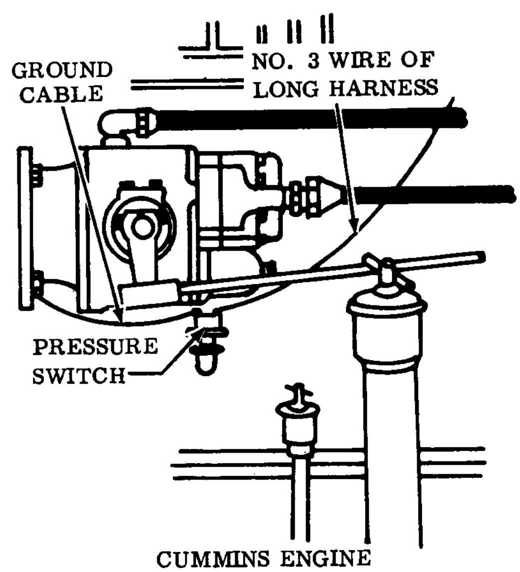
Illust. 2



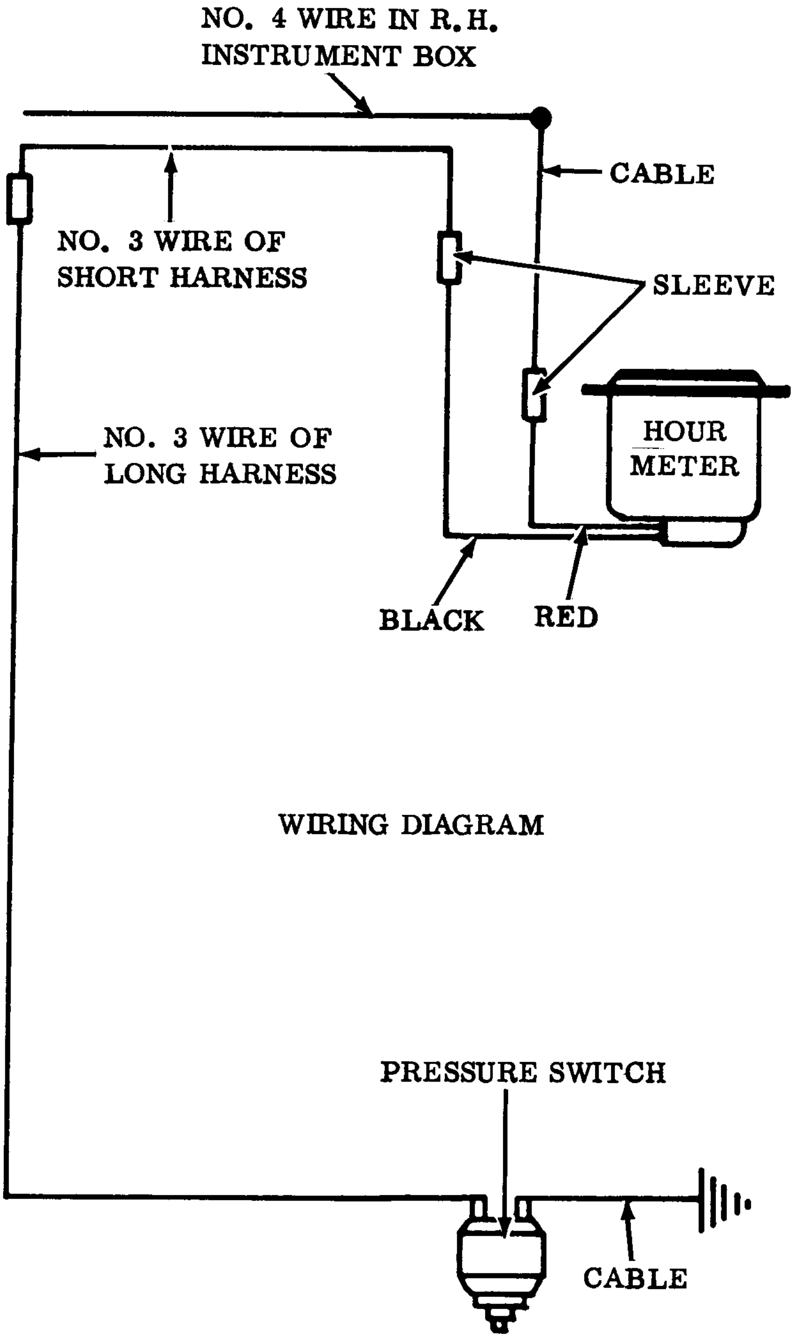
Illust. 3



Illust. 4



Illust. 5


NO. 4 WIRE IN R.H.
INSTRUMENT BOX
CABLE
NO. 3 WIRE OF
SHORT HARNESS
SLEEVE
NO. 3 WIRE OF
LONG HARNESS
HOUR
METER
BLACK
RED
WIRING DIAGRAM
PRESSURE SWITCH
CABLE

Illust. 6

BALL AND SOCKETS

LOOSENESS

The ball and socket joints on all lift links, lateral shift control and power-shift moldboard ram are adjustable for wear. The links are provided with laminated shims to take care of wear at these points. In order to make this adjustment, the two clamp cap screws and cap should be removed. The laminated shims under each cap can be removed from the clamp bolts and layers of shims peeled off with a knife. Do not remove any more shim than necessary to remove the free play in the joint. The joint should never bind but should always work freely. It will be found that these joints wear egg-shaped. Therefore, they should be adjusted in the position in which they will operate.

MOLDBOARD CONTROLS

"COASTING"

If trouble is experienced with "coasting", the worm thrust bearings can be tightened to aid the anti-coast brakes.

When thrust bearing adjustment becomes necessary, first take the load off of gears (such as resting the moldboard on ground). Loosen lock nut and tighten adjusting screw up solid. Next, back the adjusting screw back about 1/16 of a revolution, holding the screw in this position and tighten the locking nut. If the gears still have a tendency to "coast", the adjusting screw must be tightened more. However, the adjustment should never be tightened more than necessary to keep it in the desired position as it will cause excessive wear on the ends of the worm.

BRAKES

PEDAL GOES TO FLOOR

This may be caused by normal wear of the brake lining, a leak in hydraulic system, air in hydraulic system, pedal improperly set for hydraulic system or insufficient fluid in hydraulic fluid supply tank.

ALL BRAKES DRAG

This may be caused by improperly adjusted brakes, mineral oil in hydraulic system or pedal improperly set for hydraulic system.

ONE BRAKE DRAGS

One brake dragging may be caused by weak brake shoe return springs, brakes set too close to drum or distorted cups in hydraulic wheel cylinder.

SPRINGY, SPONGY PEDAL

This trouble is usually caused by brakes being improperly adjusted or air in the hydraulic system. Adjust brakes and "bleed" hydraulic system.

EXCESSIVE PEDAL PRESSURE - POOR STOP

Poor brake action is caused by brakes improperly adjusted, incorrect lining, lining making partial contact, oil or hydraulic fluid on lining or brakes wet (with water). If water on the brake lining has caused trouble, it can be easily corrected by dragging the brakes heavily (usually in low gear) until they are heated to the point of evaporating the water from the lining.

Glazing of the brake lining (usually only found on hydraulic operated brakes) can also cause poor brakes. It has been found that due to the infrequent and usually light use of motor grader brakes, the lining has a tendency to glaze over. When this occurs, the glaze can be removed by operating the grader wide open in 4th gear and applying the brakes as hard as possible, then releasing brakes. Apply this operation several times. If the brakes still do not hold, repeat the operation as stated above, only instead of releasing the brakes, allow the brakes to heat until they smoke. At this point, the machine should be stopped and with the brakes released, allow them to cool until the hand can be held on the brake drum. Now, test the brakes which should have come back to new performance and stop the grader while traveling at its highest speed on level ground within the length of the machine. If it will not stop, repeat the above outlined procedure and test again.

CIRCLE AND DRAWBAR

"MOLDBOARD CHATTER"

Looseness of circle guide plates.
Looseness of ball joints connecting moldboard to circle.
Loose ball and socket joints on lift and lateral linkage.
Looseness of end thrust bearing in lift and lateral housings.

"COASTING" OF THE CIRCLE

If trouble is experienced with "coasting", the end thrust bearing in the circle reverse housing can be tightened to aid the power box anti-coast brake to hold the gears in position against the pressure causing the "coasting".

TIGHT PLACES ON CIRCLE

If the circle tends to bind in one or more positions as it is rotated, the indication is that the circle is bent. To correct bind, straighten or replace circle.

Teeth improperly meshed between circle and pinion.

ELECTRICAL

If the generator or regulator has been disconnected for any reason, the generator must be correctly polarized again before operating the units. After connecting all wires and before starting the engine, always connect momentarily with a jumper lead between the generator armature terminal and the battery terminal of the regulator. This allows a momentary surge of battery current to flow into the generator which correctly polarizes the generator with respect to the battery it is to charge, Never operate the generator with the field circuit terminal lead disconnected (open circuit operation) since this would allow a high voltage to build up within the generator which would damage the fields and armature.

To clean, check or repair electrical units, contact your LeTourneau-Westinghouse Distributor.

FRONT AXLE

HARD STEERING

Front axle which does not have proper Toe-in, Caster or Camber: Check, replace worn parts and set to the proper dimensions.

Failure to use leaning front wheels to aid steering: The use of the leaning front wheels will make steering easier, when used in connection with the steering wheel, whether in making a right angle turn or backing around to make a "Y" turn-around. In making a turn to the right, lean the wheels sharply to the right while making the turn.

'SHIMMY"

Check all steering connections and eliminate all looseness. On high arch axles, tighten spindle thrust bearings. Leaning front wheels slightly on leaning wheel axles also helps.

EXCESSIVE FRONT TIRE WEAR

Check the "Toe-in" and "Camber".

Check lug nuts to see that they are tightened properly to eliminate "wobble" so front tires will run true.

POWER BOX

"COASTING"

"Coasting" of circle reverse, lifts, etc., can be caused by anti-coast brakes being improperly adjusted.

Worm thrust bearings must be in proper adjustment before any attempt is made to adjust anti-coast brakes. Adjust brakes by tightening the bolt that passes through the band on the under side of the outlet shaft until it is tight enough to prevent "coasting". Do not over-tighten bands as this may cause excessive wear on both brakes and power box clutch.

EXCESSIVE KICK BACK OF CLUTCH LEVERS

Worm thrust bearings in control housings adjusted too tight will cause clutch levers to kick excessively. If excessive kicking is encountered, loosen thrust bearings slightly and check for improved performance.

CLUTCHES FAILING TO KICK OUT

If a clutch tends to stick in engagement after the lever is released, it is due to rough splines on the shaft or in the clutch or it may be caused by clutch jaw faces which have not polished in as yet. Smooth and polish all surfaces as necessary. If condition is not too serious, it will correct itself in a short time.

ANTI-COAST BRAKE NOISE

Should anti-coast brake become noisy, apply a liberal amount of Diesel fuel between brake lining and drum.

STEERING GEAR

HARD STEERING

Worm steering gear or gear out of adjustment.

Worn parts in steering gear.

Relief valve out of adjustment.

"CHATTER"

Usually caused by air in the hydraulic lines or low oil level in reservoir. If air continues to enter system, check all connections on suction line leading to pump. If any of these connections are loose, air will be sucked into the system. "Chatter" can also be caused by binding in the control valve on the steering gear assembly.

FOAMING OF THE OIL

This is caused by one of three things:

1. Air entering the suction lines leading to the pump due to a loose connection.
2. Water in the oil.
3. Improper oil.

(Very seldom is improper oil the cause). Occasionally it will be found that one type of oil will foam where another will not, but this is rather uncommon.

TANDEMS

CHAINS BREAKING

Chain breakage can be due to excessive wear due to long use or sprocket teeth being worn into a hook shape which will place excessive strains on the chain. If chains or sprockets are badly worn, replace them.

If any of the cotter keys in the chain links are missing, it will allow the connector bars to work off the ends of the pins and chain breakage will result. Always check all cotter keys in tandem chain when installing on the machine. This is especially important after removing a tandem by pressing with jacks.

BOUNCE OR HOPPING

If the tandems have a tendency to bounce, it is usually due to flat spots on the tires due to sliding the wheels when stopping. This trouble will be encountered only when transporting the grader in one of the higher gears. It may be corrected or at least improved by increasing tire pressure.

Motor graders "shut-down" for any period of time will cause flat spots on tires. After tires have heated, due to motor grader running, flat spots will disappear.

WEAR OF TIRES

Excessive wear of front tires may be due to incorrect camber or toe-in.

Excessive rear tire wear may be due to having two different size tires on the rear. Rear tires must be of the same size and should be in approximately the same condition (with regard to wear).

"Wobble" of front or rear tires can also cause wear which will be spotted. For correction, see below.

"WOBBLE" OF WHEELS

On all wheels where the rim is mounted on a wheel with lugs (either front or rear) "wobble" of the wheel can be corrected by proper tightening of the lug nuts.

— NOTES —

Index

SUBJECT	PAGE
CAB	
Door Glass	8-4
General Information	8-1
Rear Glass	8-3
Side Glass	8-2
Windshield (Front)	8-5, 8-7
Windshield (Rear)	8-6
CLUTCH	
Clutch	1-5
Clutch Brake Adjustment	1-21, 1-22
Clutch Brake Operation	1-21, 1-22
Clutch Pedal Adjustment	1-20, 1-21
Clutch Release Brake Housing	1-9
Engine Mount Gap	1-4
Engine Removal	1-1
P.T.O. Bearing Cages	1-17, 1-18
CONTROLS	
Circle	4-42, 4-43
Adjustments	4-42, 4-44
Circle Reverse Mechanism	4-27
Transfer Housings	4-35, 4-38
Control Valve	4-53
Adjustment	4-57
Center Section	4-55
Inlet Section	4-54
Lever	4-59
Drawbar	4-46
Hydraulic Cylinders	4-60, 4-64
Ball and Socket	4-70
Reassembly	4-66
Removal	4-62, 4-64
Hydraulic Line Installation	4-57
Moldboard (Slide-Shift)	4-47
Removal (Moldboard)	4-47
Removal (Tilt Plate)	4-47
Tilt Plate Assembly	4-48
CONTROLS (Continued)	
Moldboard (Power-Shift)	4-52
Removal (Moldboard)	4-52
Removal (Tilt Plate)	4-53
Power Box	4-9
Power Box Drive	4-1
Rotary Control Valve	4-71
Scarifier Lift Housing	4-75
Installation	4-83
ELECTRICAL	
Cranking Motor	11-33, 11-44
Test Specifications	11-43, 11-58
General Information	11-1
Generator	11-22
Test Specifications	11-32
Horn	11-65
Horn Relay	11-67
Test Specifications	11-69
Hour Meters	11-73, 11-76
Magnetic Switch	11-59
Test Specifications	11-64
Solenoid Switch	11-59
Test Specifications	11-64
Voltage Regulator	11-8
Test Specifications	11-21
Windshield Wipers	11-70, 11-71
Wiring Diagrams	11, 3-11-3A, 11-4, 11-4A, 11-5, 11-6, 11-7
FRONT AXLE	
Adjustment	6-6
Front Lean Housing	6-8
General Information	6-1
Spindles	6-2
HYDRAULIC PUMP	
Hydraulic Pump	5-1

Index

SUBJECT PAGE

HYDRAULIC PUMP (Continued)
Relief Valve ---------------- 5-6
Adjustment -------------- 5-10
Installation -------------- 5-9

LUBRICATING INSTRUCTIONS
Air Cleaner ------------ 10-6, 10-13
Batteries ------------------ 10-11
Brake Cylinder -------------- 10-7
Circle Reverse Housing ------- 10-8
Clutch Release Bearing ------- 10-11
Clutch Shaft Bearing ---------- 10-11
Front Axle ----------------- 10-9
Front Lean Housing ---------- 10-10
Fuel Tank ------------------ 10-12
General Information ---------- 10-1
Generator ------------------ 10-11
Hydraulic Reservoir ---------- 10-9
Hydraulic Reservoir Filters --- 10-12
Hydraulic System Chart ------- 10-2
Lateral Shift Housing --------- 10-7
Lift Housings --------------- 10-7
Lubricating Fittings----------- 10-2
Lubrication Reference Chart --- 10-3
Moldboards ----------------- 10-8
Oil Can Points -------------- 10-2
Power Box Drive Housing ----- 10-10
Power Box Housing ----------- 10-10
P. T. O. Universal Joints ------ 10-10
Scarifier Housing------------- 10-10
Steering (Manual) ------------ 10-8
Steering (Power) ------------- 10-9
Table of Housing Capacities
Capacities ---------- 10-4, 10-5
Tandems-------------------- 10-6
Transmission ------------10-6, 10-11
Universal Joint--------------- 10-11

SUBJECT PAGE

STEERING
Manual Steering
Cam and Shaft -------------- 7-4
Reassembly ---------------- 7-2
Removal ------------------- 7-1
Stud Roller Bearing Units ----- 7-6
Power Steering
Cam and Shaft -------------- 7-21
Control Valve -------------- 7-25
Cylinder ------------------ 7-29
Hydraulic Lines------------- 7-38
Installation ---------------- 7-18
Reassembly ----------- 7-11, 7-20
Removal -------------- 7-10, 7-19
Stud Roller Bearing Unit ------ 7-34

TANDEMS
Foot Brakes (Auto-matic) ----- 3-22
Adjustments-----------3-30, 3-31
Foot Brakes (Hydraulic)------- 3-11
Adjustments---------------- 3-17
Hydraulic Brake System------- 3-18
Bleeding ------------------ 3-20
Master Cylinder-------------- 3-18
Adjustment ---------------- 3-19
Parking Brake -------------- 3-20
Adjustment ---------------- 3-20
Tandem Drive -------------- 3-1
Wheel Cylinders ------------ 3-19

TRANSMISSION
Bearing Cage & Adapter Assy. --- 2-20
Complete Drive Unit Removal --- 2-1
Engine Mount Gap ------------ 2-68
Final Drive ------------------ 2-4
Intermediate Plate ------------ 2-18
Lower Transmission ---------- 2-12

Index

SUBJECT	PAGE
TRANSMISSION (Continued)	
Parking Brake	2-62
Shifter Lever	2-65
Installation	2-67
Shifter Mechanism	2-55
Shifter Rails	2-60
Shifter Rails and Forks	2-25
Spiral Pinion Shaft	2-13
Upper Shaft (Lower Transmission)	2-16
Upper Transmission	2-28
Creeper Gears Installation	2-46
Creeper Gears (Lower)	2-44
Creeper Gears (Upper)	2-42
Lower Shaft	2-28
Shaft Installation	2-33
Upper Shaft	2-32
TROUBLE SHOOTING	
Ball and Sockets	12-1
Brakes	12-1
Circle	12-2
Controls (Moldboard)	12-1
Drawbar	12-2
Electrical	12-3
Front Axle	12-3
Power Box	12-3
Steering Gear	12-4
Tandems	12-4
WHEELS	
Inflation Chart	9-5
Tire Mounting	9-4
Wheels	9-1