TM 9-1728

WAR DEPARTMENT

TECHNICAL MANUAL

ORDNANCE MAINTENANCE

POWER TRAIN FOR LIGHT TANKS M3 AND M3A1

APRIL 8, 1942

Ord. Officer
Asst. Ord. Officer
Maint. Officer
Prop. Officer
Shop Officer

TECHNICAL MANUAL
No. 9-1728

WAR DEPARTMENT,
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POWER TRAIN FOR LIGHT TANKS M3 AND M3A1

Prepared under the direction of the
Chief of Ordnance

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SECTION I

INTRODUCTION

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1. Scope.—This manual is published to provide information and guidance for ordnance personnel. It contains detailed instructions for disassembly, inspection, assembly, maintenance, and repair of the transmission and final drives used at present in the light tank M3. The information and instruction in this manual is supplementary to that to be found in the Field and Technical Manuals prepared for the personnel of the using arms.

2. Illustrative material.—Illustrations of specific operations are included to support and clarify the descriptive matter in the text. Exploded views of sub-assemblies are shown in the sections devoted to the inspection and repair of the different components. This is done to show graphically the correct relation of related parts and to aid in identification. The line drawings in Section VIII are provided in order that the special tools, which are not available, may be made up by the ordnance personnel.

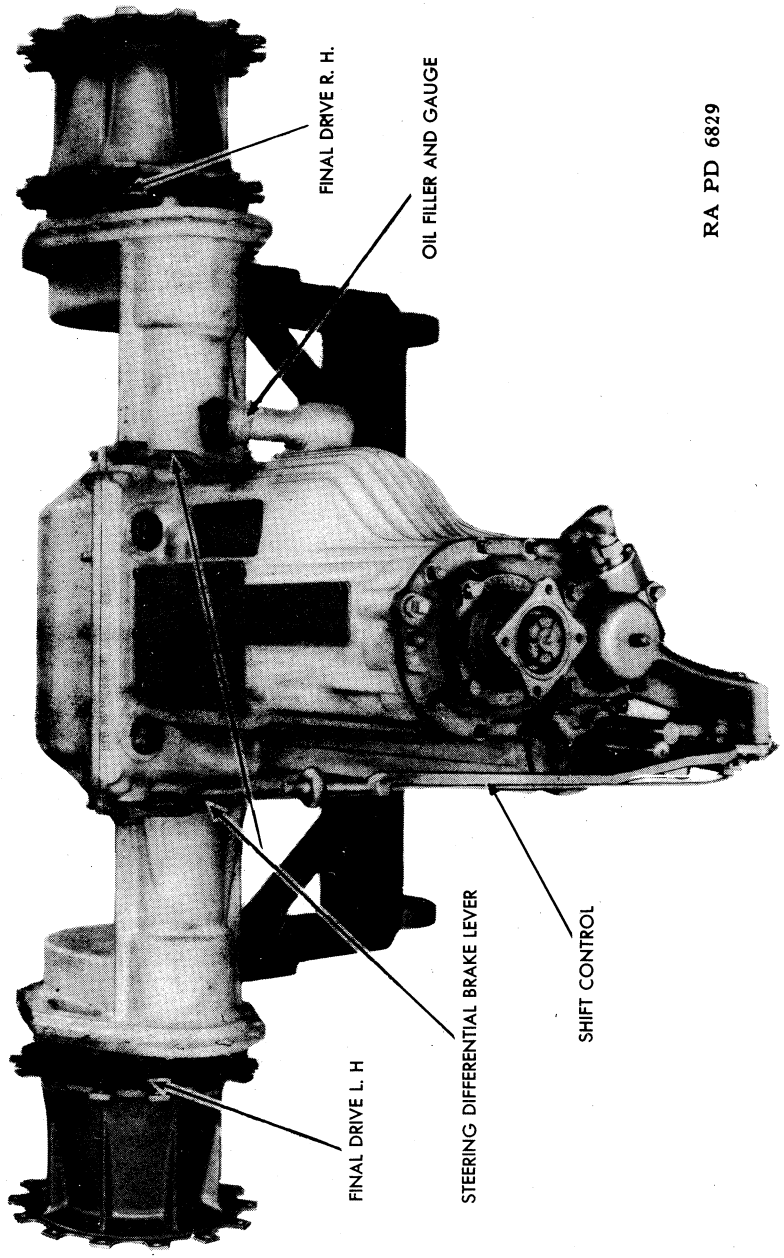

FIGURE 1—Power train—rear view.

SECTION II

DESCRIPTION

Paragraph

Description 3
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Allocation of maintenance operations 6

3. Description.—The transmission used in the light tank M3 has five forward speeds and one reverse. First speed and reverse are through sliding gears. Second, third, fourth and fifth speeds are synchromesh. Synchromesh is the name given to a type of transmission in which, by various means, the two members (or gears) to be engaged are brought to the same surface speed before actual engagement can be completed. The transmission case houses the bevel gear set and the controlled differential as well as the transmission proper. On the outer ends of the transmission case are carried the final drive housings which enclose the final drive gears and shafts through which the drive to the track is taken.

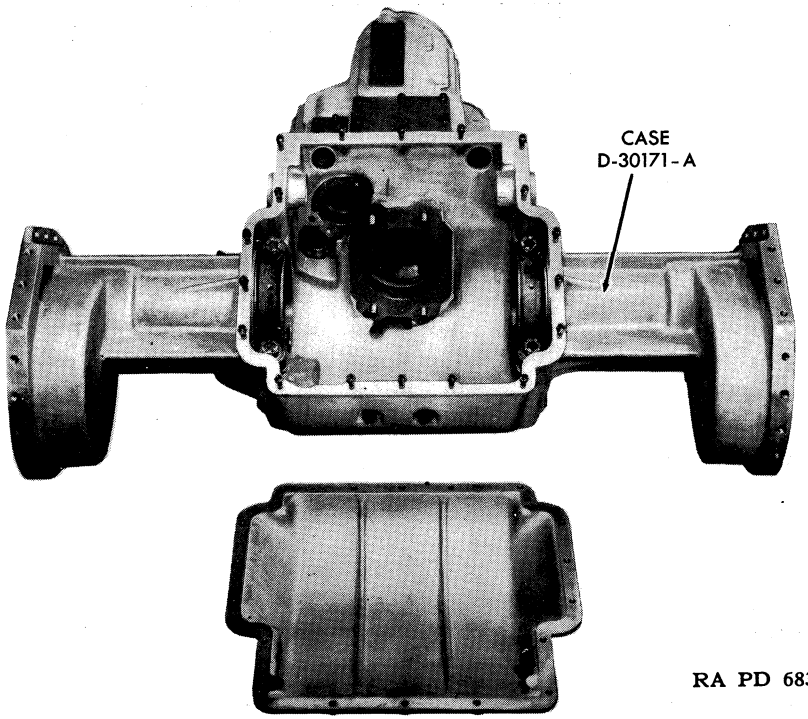

FIGURE 2—Transmission case and cover.

4. Construction.—The transmission case is an aluminum alloy casting with cast iron inserts or steel sleeves at all points where bearings are located. The final drive housings and final drive sprocket hubs are

steel castings. The bevel gear set and differential unit are located in the front chamber of the transmission case; the input and output shafts are located in the rear chamber. The differential chamber and transmission proper are open to each other so that oil from the slightly elevated transmission flows to the differential chamber, lubricating the bevel and differential gears and bearings. Here the oil is picked up by two suction lines from the transmission oil pump, recirculated through the transmission oil cooler and returned to the gears and needle bearings of the transmission.

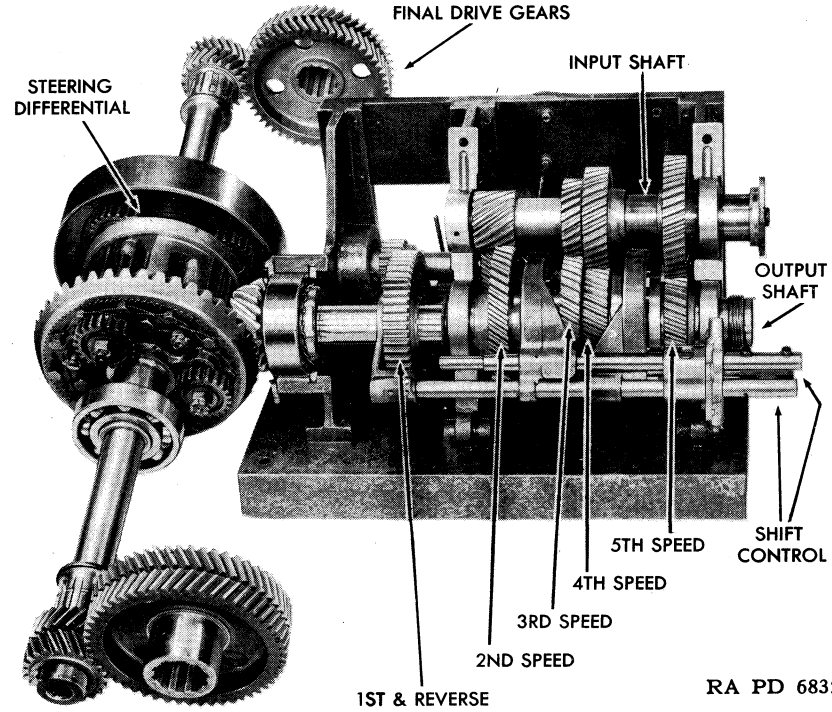

FIGURE 3—Complete transmission gearing.

5. Characteristics.—The transmission used in the light tank M3 differs from the transmissions used in light tank M2A4 and earlier vehicles in that the earlier vehicles used conventional sliding gears throughout. The capacity of the transmission oil pump has been increased to give better distribution of oil and to provide a supply of oil to the needle bearings used on the output shaft of the synchromesh transmission and some of the later sliding gear transmissions.

6. Allocation of maintenance operations. — *a. General.* — The chart shown below in this paragraph, *c.*, covers the allocation of maintenance operations on the M3 light tank transmission, and will be used as a guide in maintaining this unit. The using arms or combat troops are authorized to remove and reinstall a transmission. However, *replacement*

of a transmission with another transmission must not be done by combat troops unless authorization is received by ordnance personnel. Also shown in the chart below are several operations, usually done by the using arms, which must sometimes be done by ordnance personnel.

b. Definitions. — (1) *Service.* — Consists of cleaning, lubricating, tightening bolts and nuts, and making external adjustments of sub-assemblies or assemblies and controls.

(2) *Repair.* — Consists of making repairs to, or replacement of such parts, sub-assemblies or assemblies that can be accomplished without completely disassembling the sub-assembly or assemblies and does not require heavy welding or riveting, machining, fitting, and/or alining.

(3) *Replace.* — Consists of removing a part, sub-assembly or assembly from the vehicle and replacing it with a new, reconditioned or rebuilt part, sub-assembly or assembly, whichever the case may be.

(4) *Rebuild.* — Consists of completely reconditioning and placing in serviceable condition any unserviceable part, sub-assembly or assembly of the motor vehicle including welding, riveting, machining, fitting, alining, assembling, and testing.

c. Chart. —

Operations	Using arm	Ordnance personnel
Final drive assembly — REPLACE	X	—
Final drive assembly — REPAIR	—	X
Final drive assembly — REBUILD	—	X
Gear shift hand lever — REPLACE	X	—
Gear shift hand lever — REPAIR	—	X
Sprockets — REPLACE	X	—
Sprockets — REBUILD, ALINE	—	X
Steering brake band — ADJUST	X	—
Steering brake band — REPAIR, RELINE	—	X
Steering brake band assembly — REPLACE	X	—
Steering hand lever — REPLACE	X	—
Steering hand lever — REPAIR	—	X
Transmission — REPLACE	—	X
Transmission — REPAIR	—	X
Transmission — REBUILD	—	X

SECTION III

TROUBLE SHOOTING

Paragraph
Inspection of transmission in vehicle 7
Trouble shooting 8

7. Inspection of transmission in vehicle.—If the transmission trouble is such that the vehicle may be driven without danger of further damage to the transmission, carefully inspect the unit in motion to predetermine the trouble and its probable cause. If the vehicle cannot be moved, disengage the engine clutch and determine whether the propeller shaft can be turned freely. Remove propeller shaft housing (par. 10) and use a wrench on input shaft flange. If the propeller shaft turns freely and without unusual noise, start the engine with the clutch disengaged and carefully check all gear shift positions, noting any unusual condition which should be corrected. A loose or badly balanced propeller shaft or a defective clutch can be responsible for much noise and vibration. This, unless carefully checked, might be mistaken for transmission trouble and result in the needless removal and overhaul of a good transmission.

8. Trouble shooting.—*a. Trouble Chart.*—The following chart is provided as a guide to common troubles, their causes, and a recommended procedure for inspection to locate the cause.

TRANSMISSION TROUBLES

Trouble	Cause	Inspection
Shifts two rails at once or can't shift either rail.	Interlock ball lost.	Check ball.
	Interlock ball retaining screw loose or lost.	Check security of screw.
Won't stay in gear.	Interlock housing poppets loose or lost.	Inspect poppets.
		Check for weak springs.
Difficult to shift.	Interlock trouble listed above.	Check interlock parts.
	Bent shifter rails.	Inspect rails, rail movement.
	Shifter lever selector finger broken.	Inspect shifter lever.
	Pivot block and quadrant bolts loose or lost.	Check security of bolts.
	Plate B157706 assembled backward.	Check plate.
	Synchromesh clutch worn.	Overhaul transmission.
	Clutch dragging or not fully disengaged.	Check clutch action and adjustment.
Jumps into first or reverse.	Shifter lever safety lock broken.	Check shifter lever.
Excessive heat.	Low oil level.	Check oil level.
	Poor oil circulation, pump broken, stopped lines, valves in cooler inoperative.	Check oil circulation, petcock.

TROUBLE	CAUSE	INSPECTION
Excessive heat (cont.)	Covered or damaged cooler.	Inspect cooler and bypass valve.
	Steering brakes dragging.	Check brake adjustment.
	Bad bearings.	Listen for sound of worn-out bearings or gears.
	Worn gears.	Check magnetic plug for metal particles.
Oil leaks.	Damaged oil lines.	Inspect lines, fittings.
	Poor fittings.	Inspect floor and exterior of tank.
	Cracked housing.	Inspect housings, covers.
	Loose cover bolts, bad gaskets.	Check bolts for security.
	Interlock ball pipe plug loose or lost.	Check pipe plug for security.
Unusual noises.	Worn gears.	Check oil level.
	Worn bearings.	Check magnetic plug for metal particles.
	Low oil.	
	Translated troubles of propeller shaft.	Check transmission in all gears.
	Translated troubles of clutch.	Check propeller shaft for excessive vibration, loose bolts, worn parts.
		Check clutch — out of balance.
	Translated troubles of engine.	Check engine for smooth operation.
Faulty steering.	Brakes out of adjustment.	Check adjustment of brakes.
	Jammed linkage.	Check action of levers.
	Lining worn, torn.	Inspect linkage.
		Check brake action.

b. Needle bearing failure. — Needle bearing failure usually results in the transmission being locked in the speed in which the failure occurs. The cause can generally be traced to a lack of lubrication. The excessive heat, generated by the metal-to-metal contact of the poorly lubricated bearing causes the bearing to weld itself to the gear and to the output shaft. Remove the transmission from the vehicle (par. 10) and proceed with disassembly (par. 14) through step (18).

(1) *Failure in fifth speed.* — Use a puller and remove fifth speed gear. If the gear pulls easily the collar will probably remain on the shaft and it will then be necessary to use pry bars or puller to remove the collar. If these methods fail, split the collar with an oxyacetylene torch or by grinding. Proceed with the removal of the output shaft as described in paragraph 14, if the shaft cannot be cleaned up and made serviceable. Do not hesitate to replace an output shaft which has been badly scored or mutilated due to needle bearing failure.

(2) *Failure in fourth speed.* — Failure of needle bearings at fourth speed does not necessitate a special procedure, since the output shaft may be removed as in the normal disassembly, described in paragraph 14.

(3) *Failure in second or third speed.* — Use standard disassembly procedure described in paragraph 14 through step number (21). Since second and third gears have to be tilted to affect their removal from the case and since second gear is now welded to the shaft, the shaft cannot be removed without cutting. Proceed as follows: Use a soft drift and drive fourth speed gear forward or away from its snap ring. Remove the snap ring. Remove fourth speed gear and needle bearing collar. Remove second-third shift rod from its fork and from the case. Protect the inside of the case and second and third gears by using asbestos board and paper as extensively as possible around the area at third speed gear where the shaft is to be cut. Using an acetylene torch, cut the shaft about ½-in. in back of third speed gear. Make the cut as clean as possible. After cutting use a file and chisel and clean up the shaft spline so that third gear and collar and splined spacer can be driven off. Use a brass bar through the input shaft front bearing bore and drive against third speed gear. A second man will rotate the shaft to prevent binding of the gear on the spline. Remove second-third synchronizer and sleeve. Remove oil pump. Remove nut and washer from reverse gear shaft. Remove bevel pinion assembly. Slide low-reverse gear forward as far as possible. Cut shaft as close as possible to output shaft center bearing protecting all other parts, as before, with asbestos board or paper. Drive reverse gear shaft and the center section of the output shaft to the rear and out of the case. Complete the disassembly and very carefully clean and inspect the case. Clean all bearings as directed in paragraph 25. Make needed replacements and reassemble as in paragraph 32.

SECTION IV

REMOVAL OF TRANSMISSION AND FINAL DRIVE FROM VEHICLE

Paragraph
General 9
Transmission removal 10

9. General.—Before attempting to remove the transmission of the light tank M3 certain physical requirements must be considered. Ample working space around the vehicle is very important since hoisting equipment has to be used at both final drive units and over the center of the transmission. Assemble all of the tools necessary to the transmission removal before the job is started. Trays must be supplied to receive small parts such as nuts, bolts and cap screws as they are removed. Keep all related parts in the same tray to aid in reassembly.

10. Transmission removal.—Before proceeding check to see that the battery switch is open and that the fuel valves are closed. *a. Equipment.* — Tools to be used in each operation are shown in that step. A list comprising all tools needed to complete the transmission removal is shown below:

Bolt, 5/8-in. x 3-in., No. 12 thread	Wrench, 7/16-in., square stock
Chains	Wrench, two, 1/2-in., open end
Drag link	Wrench, 1/2-in., socket, 12 in. or longer extension with universal
Drain pan	Wrench, 9/16-in. open end
Drift, 12-in.	Wrench, 9/16-in., socket, w/ratchet handle
Drift, 24-in. long with pointed driven end	Wrench, 5/8-in., socket
Hammer	Wrench, 3/4-in., open end
Hoist	Wrench, two, 3/4-in., box
Pinch bar, 24-in.	Wrench, two, 3/4-in., socket
Pinch bars, two, 5-ft. long	Wrench, 7/8-in., socket
Pliers	Wrench, 15/16-in., box
Screwdriver	Wrench, 15/16-in., socket
Soft hammer	Wrench, 1-in., open end
Soft sledge hammer	Wrench, 1 1/16-in., socket
Square stock, 3/8 in.	Wrench, 1 1/8-in., open end
Hexagonal stock, 3/8-in.	Wrench, 1 1/4-in., open end
Square stock, 3/4-in.	Wrench, 3 3/4-in., open end
Hexagonal stock, 3/4-in.	Wrench, long socket extension
Wrench, two, 7/16-in., open end	

b. Procedure.

(1) Remove siren lead. Pliers

Disconnect lead at front armor plate end.

(2) Remove light leads. Pliers

Disconnect lead at front armor plate end. (One lead for each headlight.)

(3) Remove fenders. Wrench, 9/16-in., open end, box or socket
Wrench, 15/16-in., socket

The quantities in the following refer to one fender only. Use a 9/16-in. socket wrench and remove seven 3/8-in. hex-hd. bolts and nuts from front sloping armor plate. Remove three 5/8-in. hex-hd. cap screws (15/16-in. wrench) from front sloping armor plate. Remove five 3/8-in. hex-hd. bolts and nuts from side armor plate. Remove four 3/8-in. hex-hd. bolts and nuts from sponson. Lift fenders off.

(4) Disconnect tracks.

If necessary refer to TM 9-726, paragraph 113.

(5) Remove sprockets *(fig. 4).* Wrench, 1 1/16-in., socket
Pinch bar

Lock steering levers in full stop position. Remove eight 7/8-in. hex nuts from studs on each final drive shaft flange (1 1/16-in. socket wrench). Insert pinch bar between hull and sprocket to loosen sprocket hub on studs, and remove sprocket.

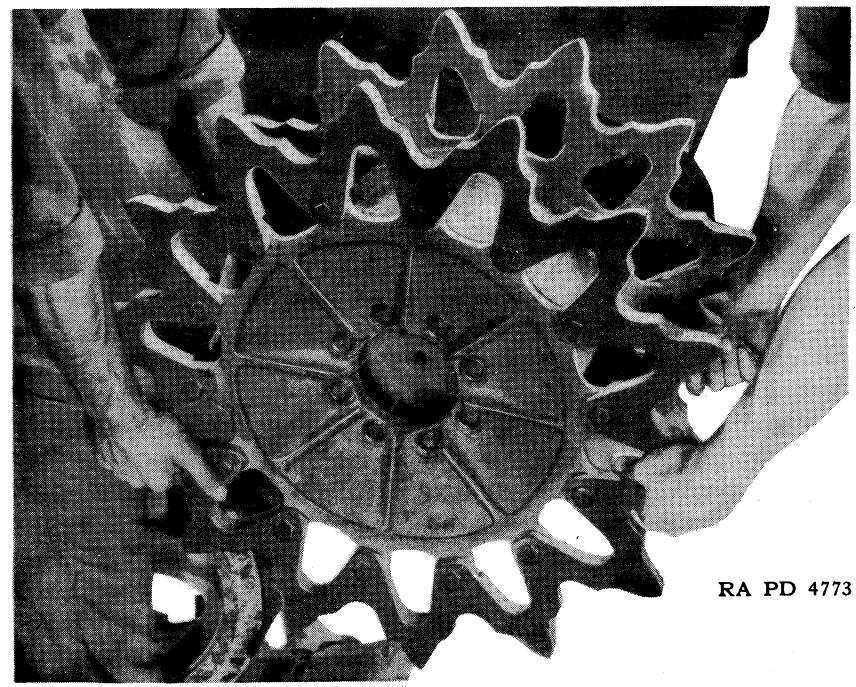

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FIGURE 4—Removal of drive sprocket.

(6) Drain oil from final drive. Square stock, 3/8-in.
Hexagonal stock, 3/8-in.
Wrench, 7/16-in., square socket
Drain pan

Remove two ½-in. recessed head pipe plugs on bottom of differential case near the right and left final drive housing (⅜-in. square stock, and $\frac{7}{16}$-in. square socket wrench or ⅜-in. hexagonal stock). Replace plugs after draining.

(7) Drain oil from transmission.

Wrench, $\frac{9}{16}$-in. box, socket or open end
Square stock, ¾-in.
Hexagonal stock, ¾-in.
Wrench, ¾-in., open end
Drain pan

Remove four ⅜-in. hex-hd. nuts from studs on either plate underneath differential ($\frac{9}{16}$-in. socket wrench). Remove plate. Remove 1¼-in. magnetic pipe plug by means of ¾-in. square rod inserted in recessed head of plug (¾-in. open end wrench). Replace plug after draining (*fig. 4*).

(8) Disconnect final drives.

Wrench, ⅞-in., socket

Remove locking wire. Remove seventeen ⅝-in. hex-hd. cap screws (BANX5BD) holding each final drive housing to differential case (⅞-in. socket wrench).

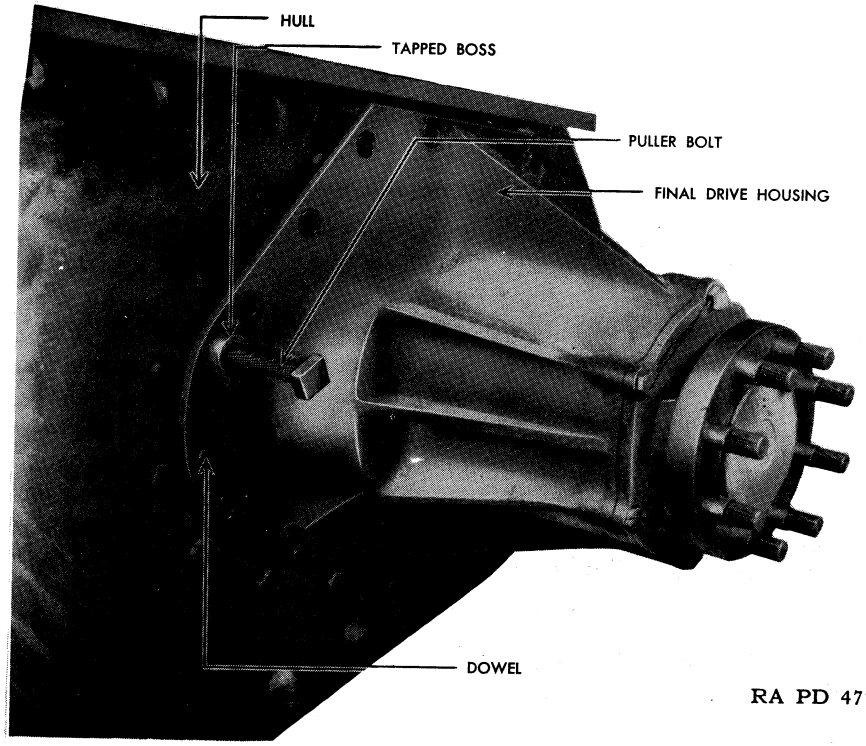

FIGURE 5—Method of separating final drive from differential housing.

(9) Remove final drive *(figs. 5, 6 and 7).*

Two bolts, ⅝-in. x 3-in., thread
Wrench, to fit bolt

Screw bolt in tapped bosses in flange of final drive contacting differential case. Turn puller bolts evenly and rock final drive by hand until it is free. Unless a hoist is used as shown in figure 6, two men are needed to lift final drive away.

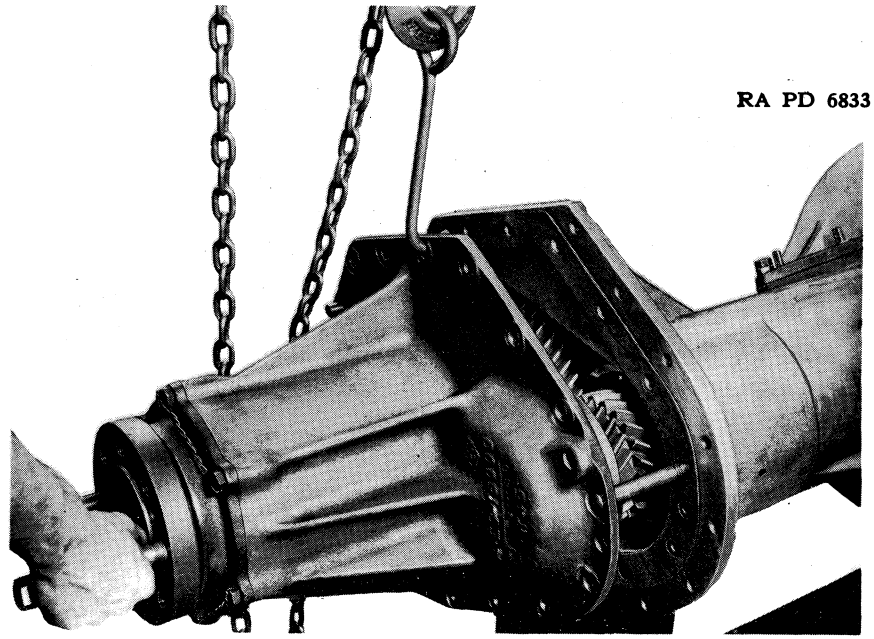

FIGURE 6—Method of supporting final drive assembly.

(10) Remove conduit elbows in front sloping armor plate.

Wrench, $\frac{15}{16}$-in., open end, box or socket

Remove hexagon nut holding conduit elbows for head lamps and siren. From inside tank pull elbows away from front sloping armor plate.

(11) Remove front sloping armor plate *(fig. 8).*

Screwdriver, heavy duty
Drag link
Wrench, $\frac{15}{16}$-in., open end, box or socket
Wrench, ⅝-in.

Remove the following bolts, nuts, and cap screws that hold the front sloping armor plate to hull. Four ⅝-in. slotted head cap screws (screwdriver). Twelve ⅝-in. slotted head bolts and hex-hd. nut ($\frac{15}{16}$-in. socket wrench and screwdriver). One ⅜-in. slotted head bolt and hex-hd. nut supporting compass (⅝-in. wrench). Remove plate.

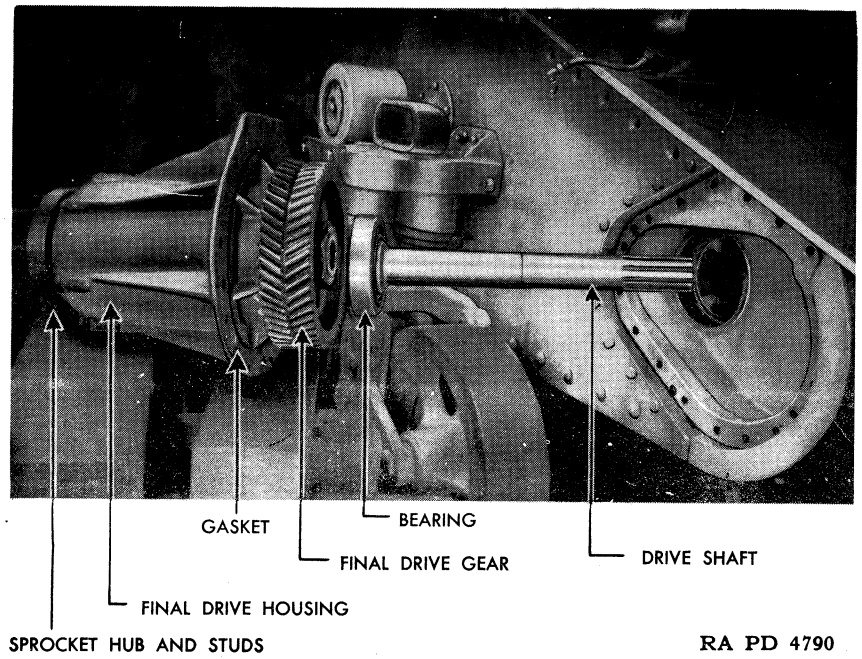

FIGURE 7—Final drive.

(12) Remove stop light switch support brackets from transmission. Wrench, ½-in., open end

Remove four ¼-in. bolts holding switch brackets to transmission case (one on each side).

(13) Disconnect oil pressure gage line. Wrench, $\frac{9}{16}$-in., open end

Disconnect line at gage. Close end of line with cloth.

(14) Disconnect hand throttle cable. Pliers
Wrench, two, $\frac{7}{16}$-in., open end
Wrench, 1-in., open end

Remove cotter and clevis pins from accelerator shaft lever near clutch pedal. Loosen lock nuts holding adjustable clevis. Remove adjustable clevis. Remove 1-in. hex-hd. nut holding cable to support bracket. Remove cable.

(15) Remove leg shield in bow gunner's compartment. Wrench, two, ½-in., open end

Remove three $\frac{5}{16}$-in. hex-hd. bolts and nuts holding leg guard and speedometer shield together. Remove one $\frac{5}{16}$-in. hex-hd. cap screw holding forward end of leg shield to transmission. Remove shield.

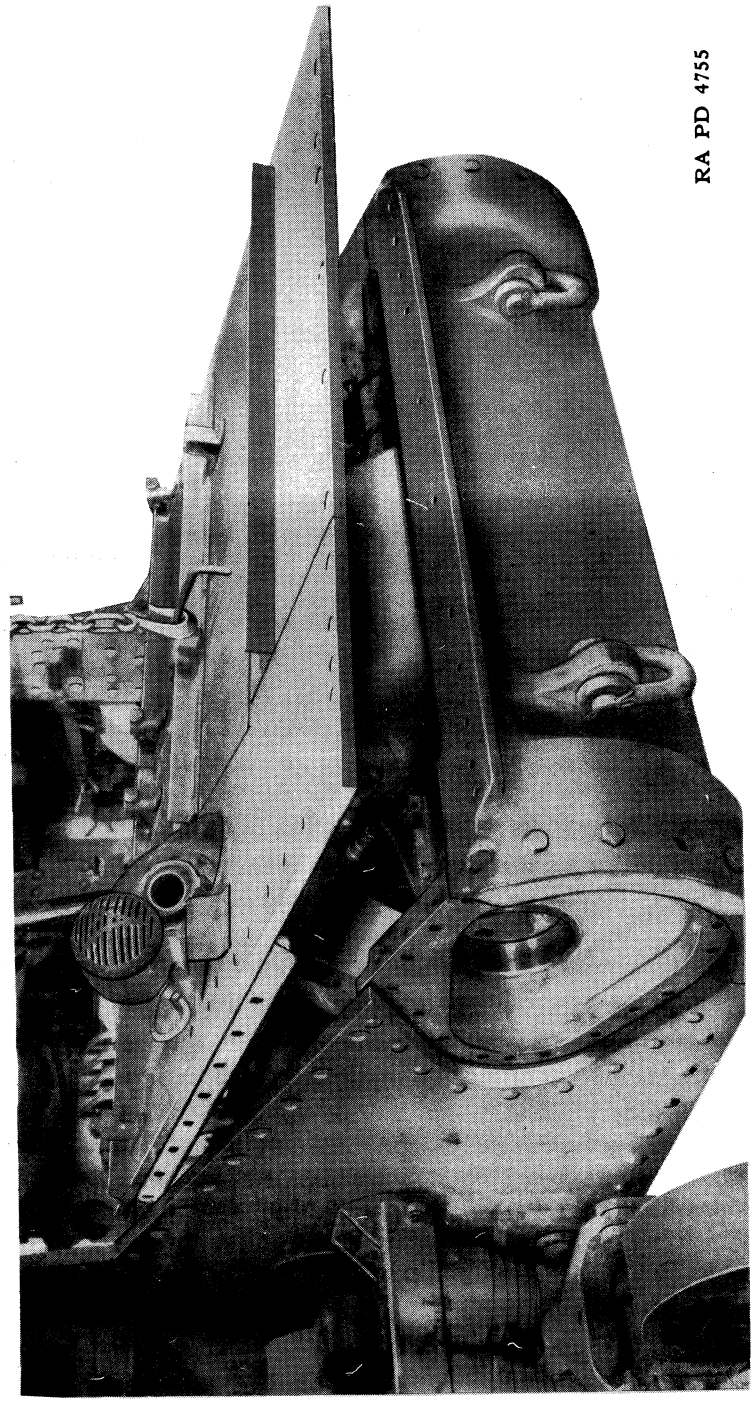

FIGURE 8—Removal of sloping armor.

(16) Remove propeller shaft housing cover. Wrench, 5/8-in., socket

Remove eight 7/16-in. hex-hd. acorn nuts from cover. Remove cover.

(17) Remove windshield fans. Screwdriver

Loosen screws holding mounting sockets together until ball slips from socket. Permit both fans to be supported from their motor leads.

(18) Remove speedometer housing. Wrench, 1/2-in., open end
Pliers

Open inspection cover on speedometer housing. Remove two 5/16-in. hex-hd. cap screws attaching housing to transmission case. Disconnect speedometer cable at transmission. Lay speedometer housing carefully to one side on floor of bow gunner's compartment.

(19) Remove instrument panel rear cover. Wrench, 7/16-in., open end

Remove four 1/4-in. nuts holding cover to instrument panel. Remove cover.

(20) Remove instrument panel from transmission case. Wrench, 9/16-in., open end
Wrench, 9/16-in., socket
Extension with universal joint and ratchet handle, 12-in. or longer.

Use a 9/16-in. open end wrench and remove four 5/16-in. hex-hd. nuts from studs in transmission case holding instrument panel in place. Remove 3/8-in. hex-hd. cap screws holding stop light switch cable clamps to hand hole covers of transmission case (9/16-in. socket wrench). Lay instrument panel carefully on floor of bow gunner's compartment *(fig. 9)*.

(21) Remove ammunition box on floor of bow gunner's compartment. Wrench, 9/16-in., socket
Long extension

Remove two 3/8-in. hex-hd. cap screws and nuts holding ammunition box to hull. Remove two 3/8-in. bolts and spacers through bottom of ammunition box at front and remove ammunition box.

(22) Remove siren switch. Wrench, 3/4-in., open end or socket

Remove 1/2-in. hex-hd. nuts on switch support bracket. Lay on floor of gunner's compartment.

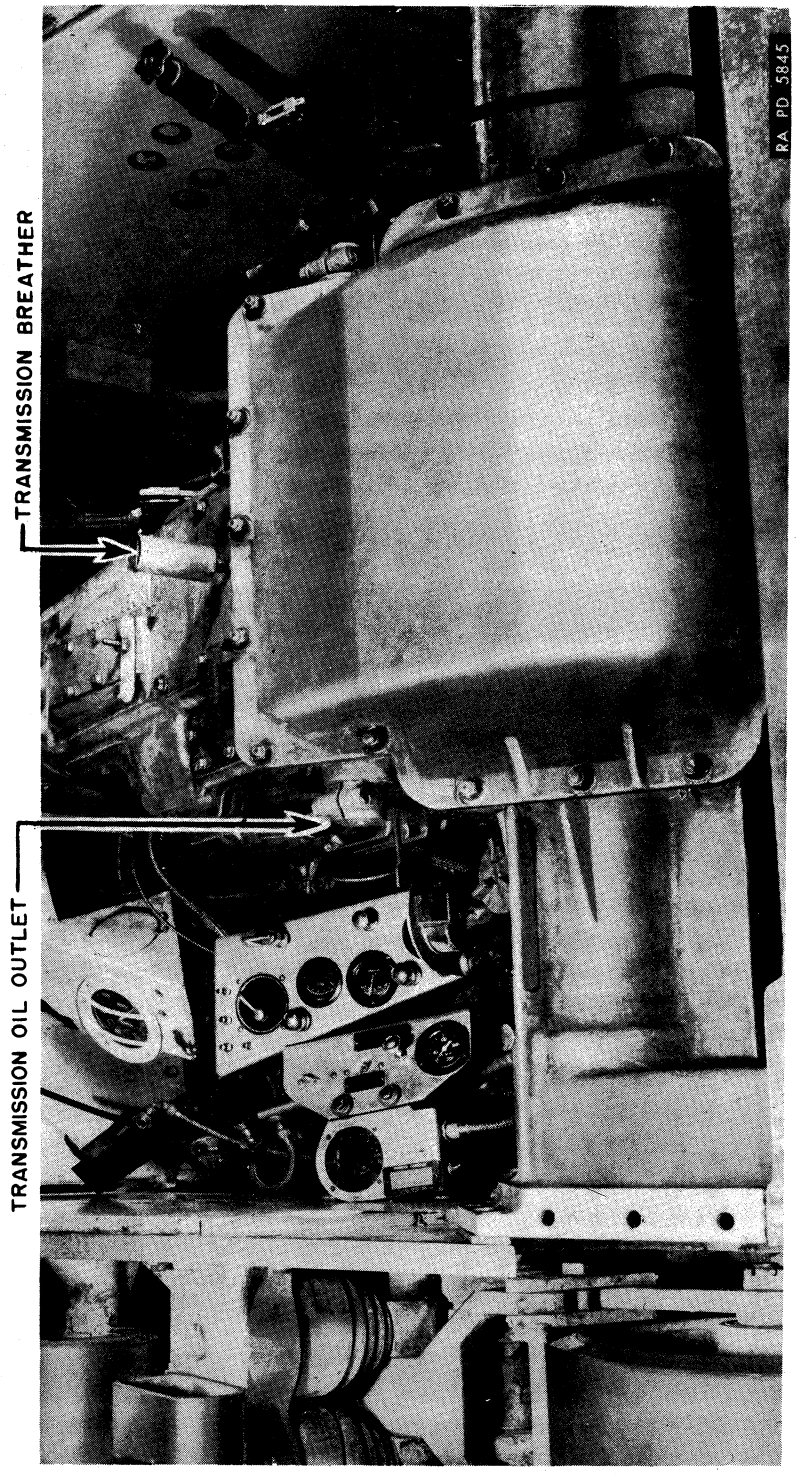

FIGURE 9—Disposition of instruments before transmission removal.

(23) Disconnect steering lever linkage. — Pliers

Remove cotter and clevis pins from adjustable clevis on each steering lever.

(24) Disconnect clutch linkage. — Pliers

Remove cotter and clevis pins from pedal shaft lever located underneath transmission case.

(25) Disconnect transmission oil pump discharge line. — Wrench, 1⅛-in., open end; Wrench, 1¼-in., open end

Disconnect line at fitting on discharge side of pressure relief valve. Close end of line with cloth.

(26) Disconnect needle bearing oil line. — Wrench, ¾-in., open end

Disconnect line at elbow near pressure relief valve. Close ends of line with cloth.

(27) Remove propeller shaft guard straps. — Wrench, ¾-in., open end

Remove four ½-in. hex-hd. cap screws holding guard straps to brackets inside propeller shaft housing. Remove guard straps.

(28) Disconnect propeller shaft. — Wrench, two, ¾-in., box

Remove four ½-in. bolts and nuts which hold propeller and input shaft companion flanges together. Propeller shaft may be held out of the way by means of a block inserted between the shaft and propeller shaft housing.

(29) Remove right and left propeller shaft housing brackets. — Wrench, ¾-in., open end; Wrench, $\frac{9}{16}$-in., open end; Screwdriver

From each bracket remove four ½-in. hex-hd. cap screws holding bracket to transmission (¾-in. open end wrench). Remove three ⅜-in. slotted head bolts and nuts from left side of propeller shaft housing bracket supports ($\frac{9}{16}$-in. open end wrench). Remove five ⅜-in. bolts and nuts from right side of propeller shaft housing bracket supports.

(30) Disconnect transmission inlet oil line. — Wrench, 1⅛-in., open end; Wrench, 1¼-in., open end

Disconnect at fitting on copper tubing nearest transmission. Close ends of line with cloth.

(31) Remove clamps holding oil line to propeller shaft housing. — Wrench, two, $\frac{7}{16}$-in., open end

From each clamp remove a ¼-in. bolt and nut that fastens clamp to propeller shaft housing. Support line to clear transmission by inserting block between line and propeller shaft housing.

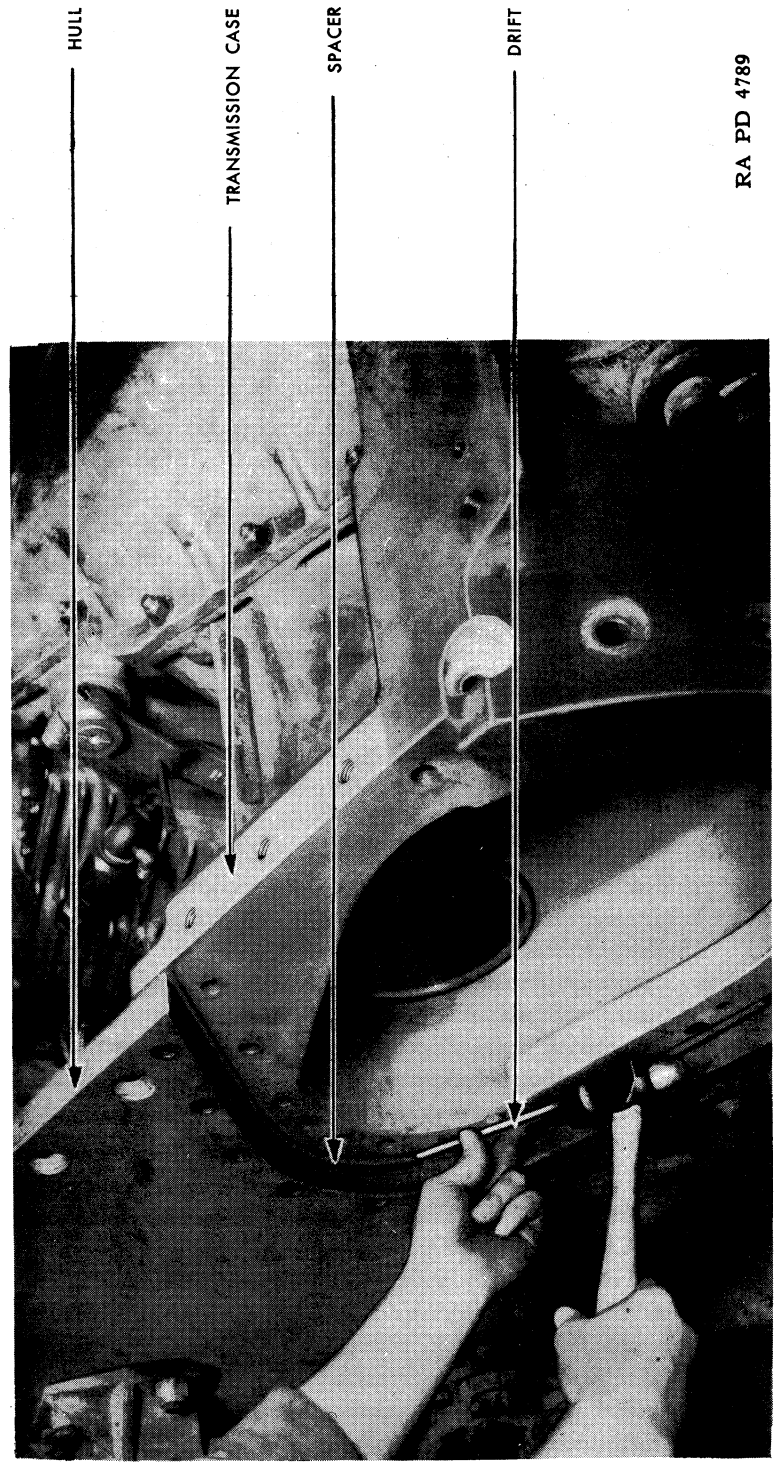

FIGURE 10—Method of removing spacers.

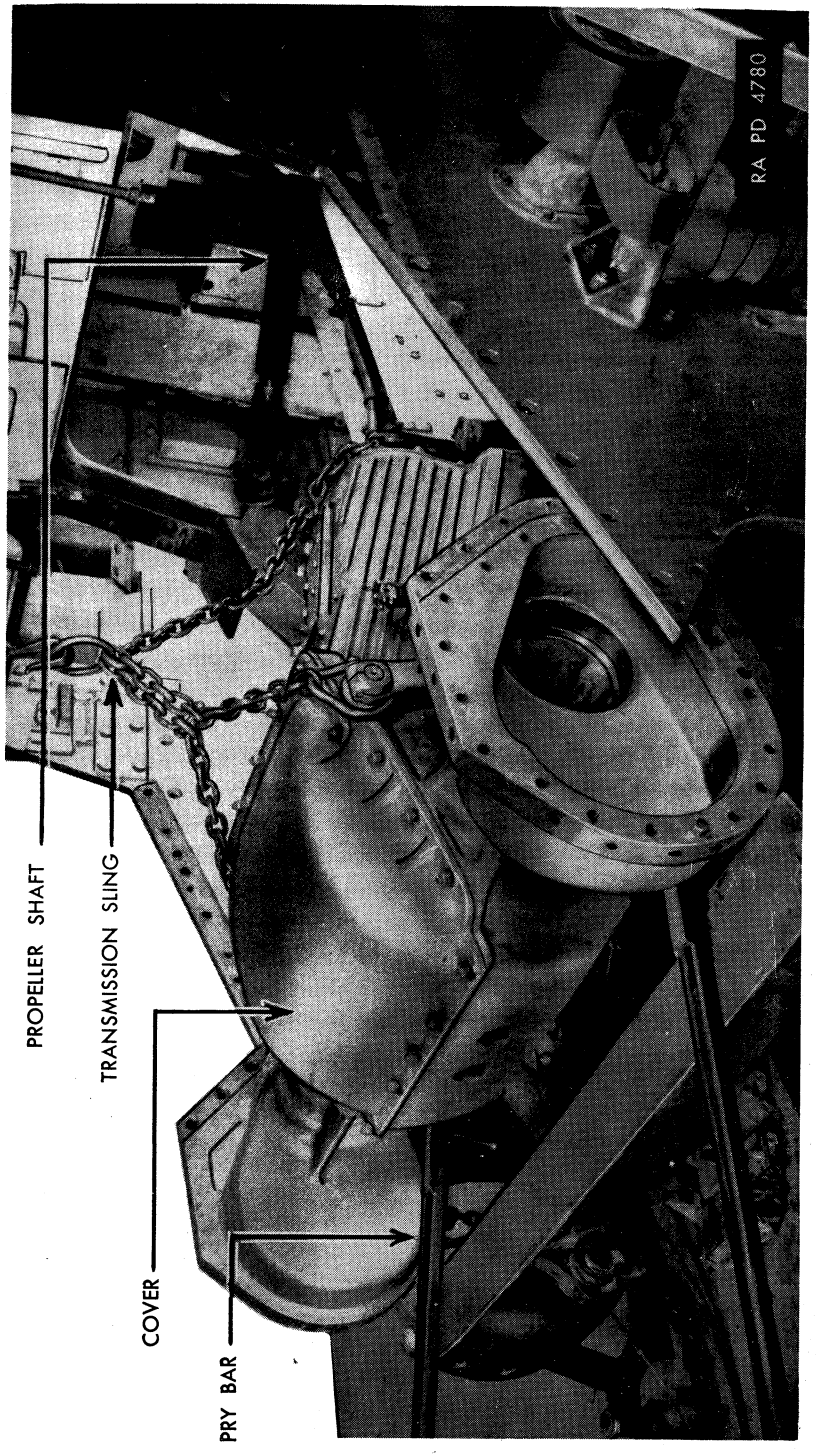

FIGURE 11—Removing the transmission.

(32) Remove bolts and cap screws holding transmission to hull.

Wrench, two, 3/4-in., open end, box or socket
Wrench, 15/16-in., socket

Use a 15/16-in. socket wrench to remove ten 5/8-in. cap screws from front of hull which attach the transmission final drive flanges to hull (five on each side). From each side of hull remove nine 1/2-in. hex-hd. bolts and nuts which attach the transmission final drive flange to hull (3/4-in. socket wrench).

(33) Remove spacers between hull and transmission final drive flanges *(fig. 10).*

Drift
Hammer

With a suitable drift and hammer, drive spacers toward rear of tank. (One spacer on each side.)

(34) Attach chains *(fig. 11).*

Chains

Place the hook or ring of hoist directly above the transmission breather and about six inches from it *(fig. 11)*. Loop a chain around the input shaft, and right and left transmission brake band shafts. Adjust length of chains so that center of lift is directly above breather and about 10 inches from it.

(35) Remove transmission from hull of tank *(fig. 11).*

Chains
Hoist
Pinch bars, two, 5-ft. long

Place one man in driver's seat to see that no parts interfere with removal of transmission. Insert pinch bars between transmission case and front of hull and on each side of differential case so that transmission may be moved toward rear of tank. Lift and pry at the same time until transmission is raised far enough to clear front of hull. If the transmission is placed on a level surface, rest it on three 6-in. by 6-in. blocks, one under each final drive flange and one under the transmission case. Use a supporting cradle as shown in figure 12, if one is available.

SECTION V

INSPECTION AFTER REMOVAL

	Paragraph
Cleaning	11
Inspection	12

11. Cleaning.—After its removal from the vehicle the outside of the transmission case and final drive brackets must be thoroughly cleaned of all mud, grease or other foreign matter. This can best be done when the unit to be cleaned is placed on a cradle or stand *(fig. 12)*. Use a steam jenny, if available, to insure a thorough cleaning. If a steam jenny is not available, hose the case off with water under pressure to loosen and remove as much foreign matter as possible. Use a stiff brush and SOLVENT, dry-cleaning, to remove the remaining grease and dirt. Exercise extreme care to see that the case covers and the areas around the covers and case openings are free of all foreign matter.

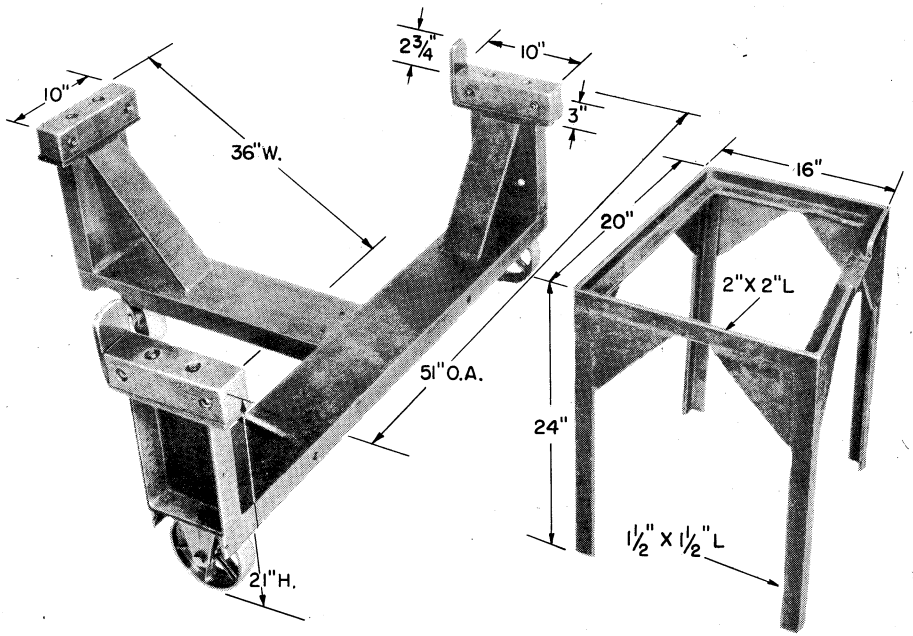

FIGURE 12—Transmission and final drive supporting cradle.

12. Inspection.—When it is cleaned, inspect the outside of the transmission case carefully to detect cracks, oil seepage, or any damage or defect which might be present.

SECTION VI

DISASSEMBLY OF TRANSMISSION

	Paragraph
General	13
Transmission disassembly	14

13. General.—The disassembly of the transmission must not be started without first preparing carefully for the job to be done. The unit should be placed on an assembly cradle similar to the one shown in figure 12, to permit easy access to all transmission and final drive chambers or openings. The floor area around the disassembly must be clean, and bench areas must be clean and of sufficient size to accommodate all the parts removed from the transmission. A good supply of wiping cloths must be available and at least eight small parts trays will be needed. Cleanliness is of extreme importance and great care must be exercised to keep dirt or foreign matter away from the parts as they are removed. This is especially true in the case of anti-friction bearings.

14. Transmission disassembly.—*a. Equipment.*—Tools needed in each specific step are shown in that step. A list, comprising all tools necessary for the complete disassembly of the transmission, is shown below.

- Brass rod, 1½-in., 3 ft. long
- Extension, 12-in., with ratchet handle
- Gear block *(fig. 14)*
- Hammer, 1-1½ lb.
- Hammer, ½-in. slide
- Hammer, 3-lb. or 4-lb.
- Hammer, rawhide
- Hoist
- Pliers, side cutting
- Pliers, snap ring
- Screwdriver
- Soft bar with one tongued end, 4 ft.
- Soft drift
- Spacers *(fig. 13)*
- Special bearing puller *(fig. 13)*
- Wrench, 1¼-in., socket
- Wrench, 2-in., socket with 3-ft. handle
- Wrench, 2⅛-in., socket, 3-ft. handle
- Special center bearing block *(fig. 14)*
- Special input shaft puller *(fig. 13)*
- Special puller, two *(fig. 13)*
- Square rod, ¼-in.
- Small pry bar, two
- Wrench, ½-in., socket
- Wrench, $\frac{9}{16}$-in., socket
- Wrench, ⅝-in., box
- Wrench, ⅝-in., socket with speed wrench
- Wrench, ¾-in., socket with handle
- Wrench, ¾-in., open end
- Wrench, ⅞-in., open end
- Wrench, $\frac{15}{16}$-in., open end
- Wrench, $\frac{15}{16}$-in., socket
- Wrench, 1⅛-in., open end
- Wrench, adjustable spanner *(fig. 14)*
- Wrench, special 3$\frac{9}{16}$-in., open end *(fig. 14)*
- Wrench, special socket *(fig. 14)*

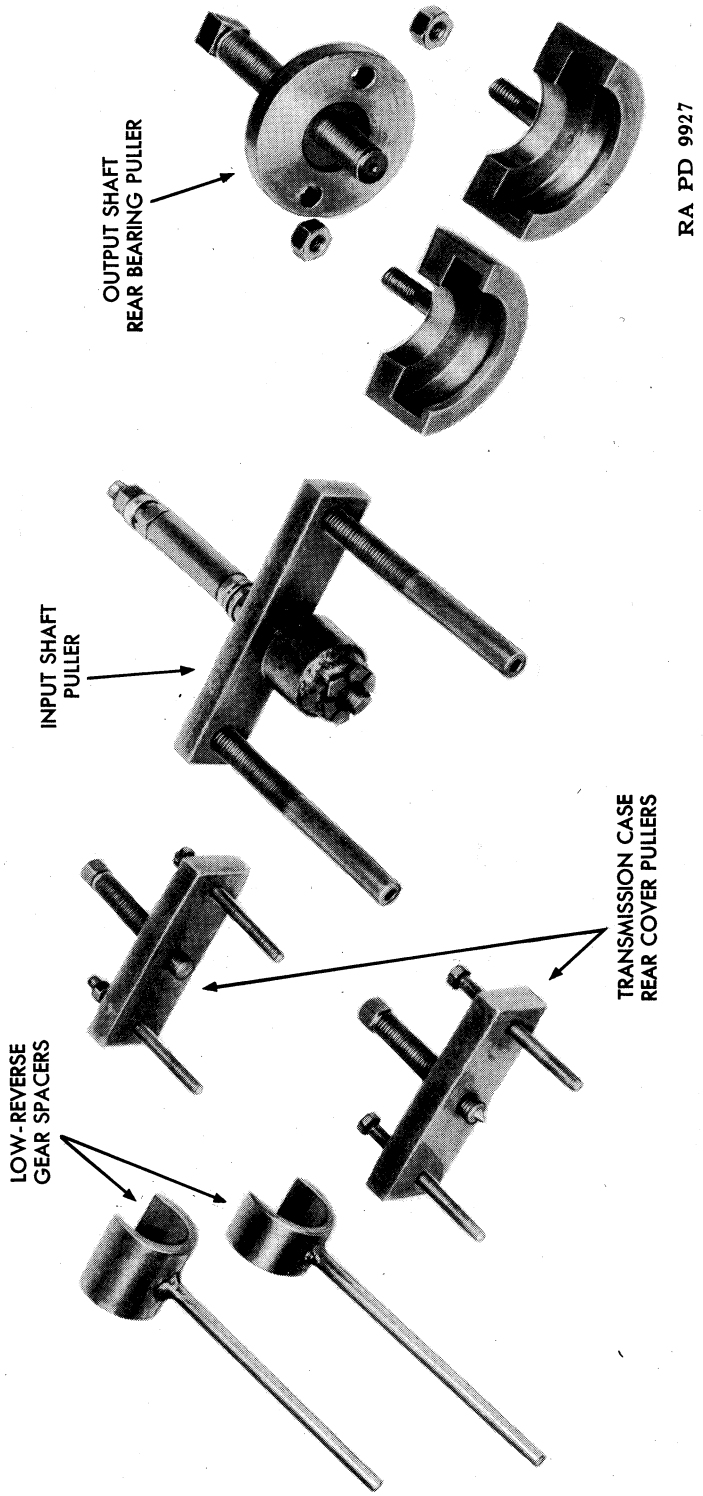

FIGURE 13—Transmission overhaul tools.

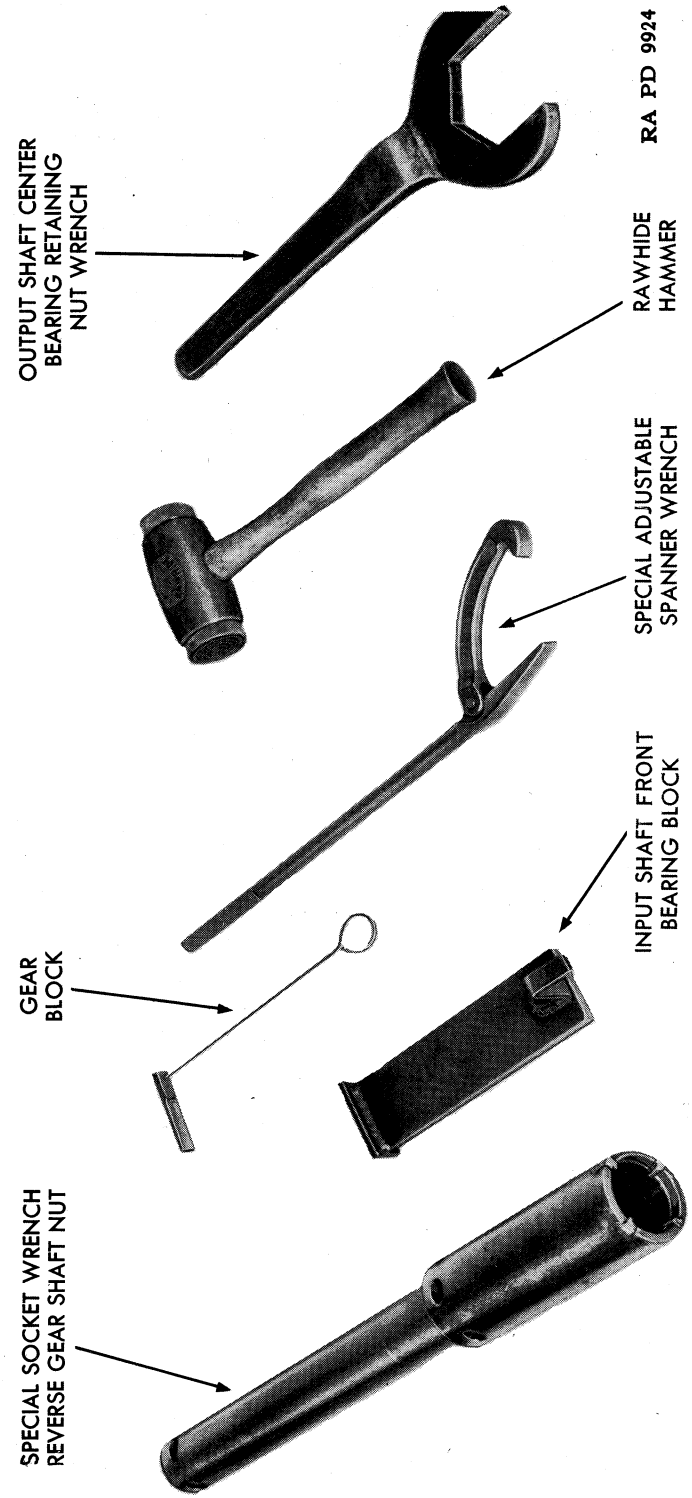

FIGURE 14—Transmission overhaul tools.

b. Procedure.—

(1) Remove steering differential cover *(fig. 80).*

Wrench, 5/8-in., socket with speed wrench
Small pry bars, two

Remove locking NUTS (BB5X4AD) from STUDS (A172140) holding steering differential COVER (C60945) (wrench, 5/8 in. socket with speed wrench). Pry cover up and off the studs using two small pry bars. Remove GASKET (C60938). CAUTION: Be careful not to damage the aluminum cover when prying.

(2) Remove brake shoe assemblies *(figs. 15 and 39).*

Drift
Hammer
Pliers, side cutting

Remove cotter PIN (BFAX1DG) from brake shoe PIN (A143800). Remove cotter PIN (BFAX2AK) from link PIN (A143802). Remove link pins (use small drift) and lift out brake shoe assembly by pulling it around the brake drum.

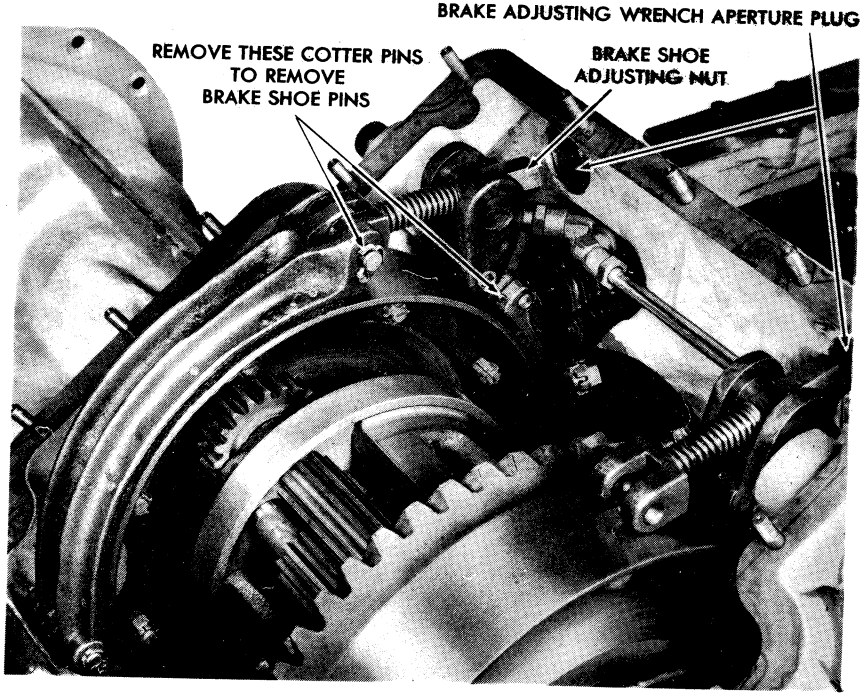

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FIGURE 15—Controlled differential (one brake shoe removed).

(3) Remove brake cam shafts.

Wrench, 3/4-in., socket
Hammer
Soft drift

Remove cap SCREWS (BCAX1EX) and lock WASHERS (BECX1M) in brake LEVERS (C60948) and (C62973) (wrench, 3/4 in., socket). Drive LEVERS (C62973) and (C60948) *(fig. 1)* off shafts (hammer). Remove brake cam SHAFTS (B141514) and (B145583) *(fig. 39).*

(4) Remove steering differential assembly *(figs. 16, 17 and 41).*

Pliers, side cutting
Wrench, 1 1/4-in., socket
Hammer, slide, 1/2 in.
Hoist
Special hook

Remove safety wire at differential bearing support COVERS (C60593). Remove NUTS (BBFX2D) (1 1/4-in. socket wrench) from four STUDS (A143755). Remove bearing support covers (slide hammer, 1/2-in.). Lower hoist hook and insert it through one of the holes in the center of the compensating CASE (C60917) *(figs. 17 and 41)*. Lift differential out of case.

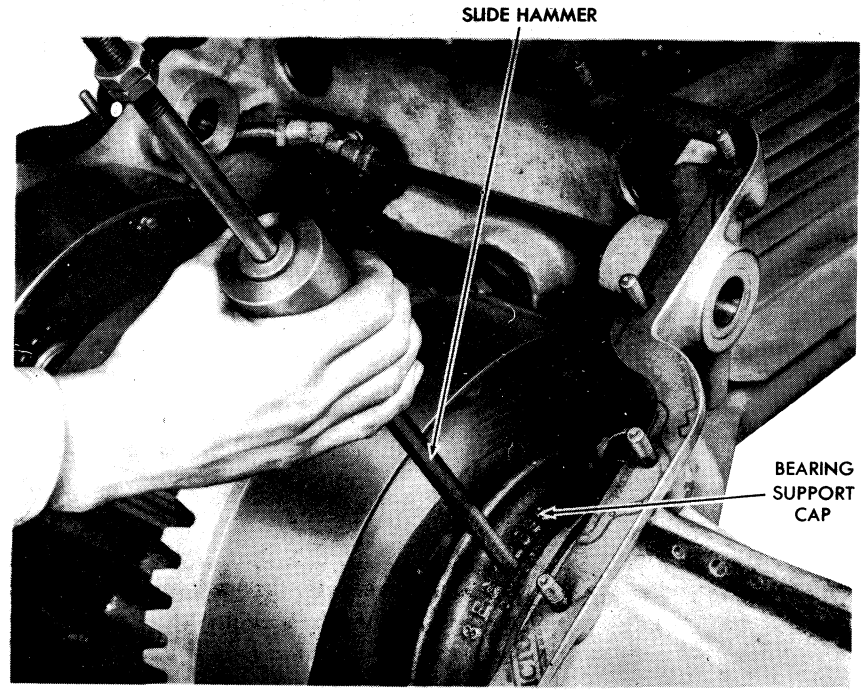

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FIGURE 16—Removal of differential bearing support cap.

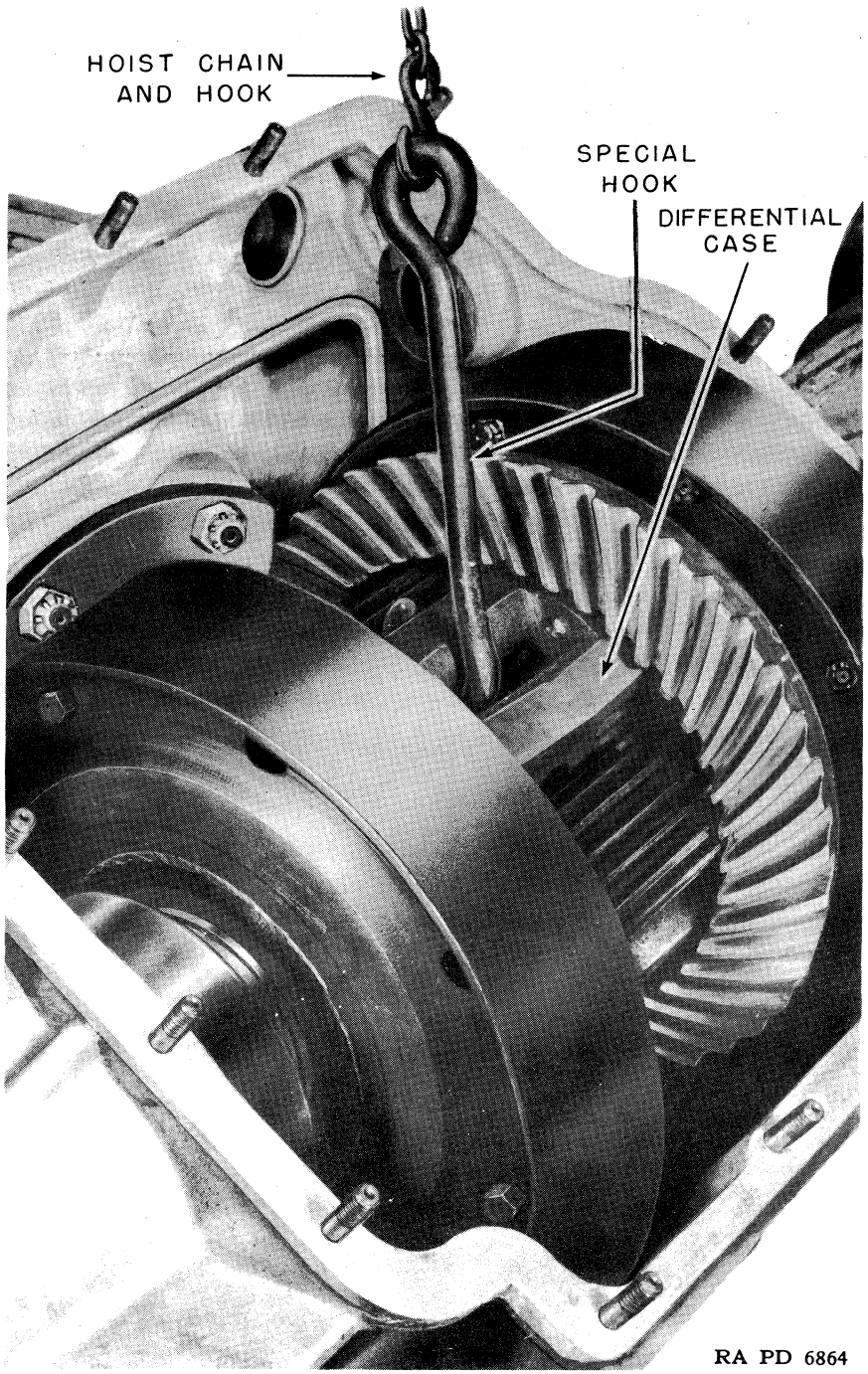

FIGURE 17—Use of hoist for removal of differential assembly.

(5) Remove oil pump *(figs. 18, 19, 36 and 44).*

Pliers, side cutting
Wrench, 7/8-in., open end
Wrench, 9/16-in., socket
Wrench, 3/4-in., open end and socket
Puller No. C62522
Small bar

Remove locking wire from three cap screws on pump cover and two cap screws on pump base. Disconnect oil TUBES (C61347) and (C61346) *(fig. 36)* at pump (7/8-in. open end wrench). Using small bar, pry fittings in such a way that oil tubes can be removed. Remove cap SCREW (A161965) (9/16-in. socket wrench) and two cap SCREWS (BCAX1ED) (3/4-in. socket wrench) *(fig. 44)*. Use Puller No. C62522 and remove oil pump. If puller is not available pry oil pump out, using small bar and screwdriver *(fig. 19)*.

(6) Remove gear shift lever assembly *(figs. 20, 21 and 58).*

Wrench, 3/4-in., socket with handle
Wrench, 15/16-in., open end
Wrench, 1 1/8-in., open end

Remove two cap SCREWS (BCAXIEE) (3/4-in. socket wrench) from fulcrum PLATE (B157706). Depress button in

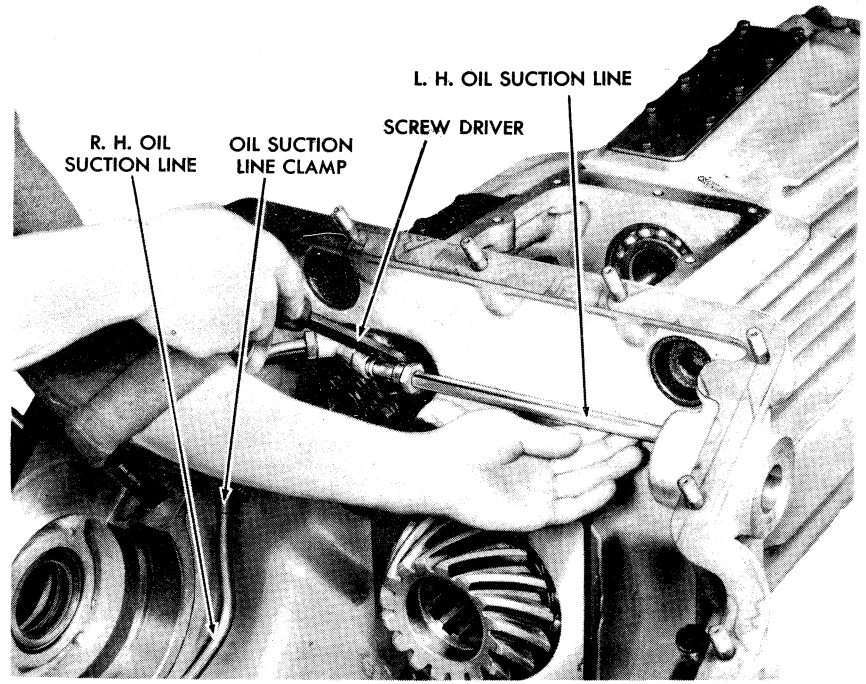

FIGURE 18—Prying oil lines away for oil pump removal.

gear shift lever handle and remove fulcrum plate. Remove BOLT (A143739) ($1\frac{5}{16}$-in. and $1\frac{1}{8}$-in open end wrenches) securing pivot BLOCK (A143741) *(fig. 58)* to output shaft rear CAP (C68508) *(fig. 21)*. Remove lever assembly.

(7) Remove output shaft rear cap *(fig. 21).*

Pliers, side cutting
Wrench, ¾-in., socket

Remove locking wire and with a ¾-in. socket wrench remove four cap SCREWS (three BCAX4S and one BCAX4AD) with WASHERS (BECX1M). Remove CAP (C68508) and gasket. (This may have been done when transmission was removed.)

(8) Drop interlock ball *(figs. 63, 20, 22 and 23).*

Wrench, $\frac{9}{16}$-in., socket
Wrench, ¾-in., socket
Screwdriver
"L" shaped piece of ¼-in. square rod

Remove locking wire. Using a $\frac{9}{16}$-in. socket wrench, remove two cap SCREWS (BAOX7CD) and lock WASHERS (BECX1K). Remove shift rod LUG (B157704) *(fig. 20)*. Using a ¾-in. socket wrench remove three shift rod spring retaining PLUGS (A143749). Remove two lower shift rod SPRINGS

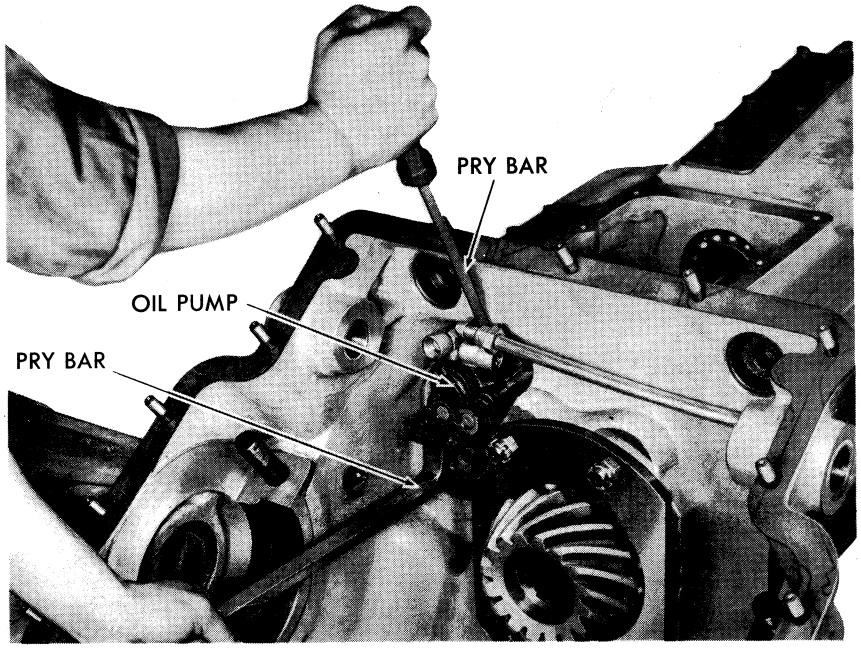

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FIGURE 19—Removal of transmission oil pump

(A143725), two lower PLUNGERS (A143782) and two lower BALLS (CCAX1F) *(fig. 63)*. Since it is difficult to remove the upper ball and plunger with the SUPPORT (C60934) in its normal position, wait until the support is removed and can be turned. With a screwdriver remove interlock ball retaining SCREW (A143761) *(figs. 22 and 63)* from shift rod SUPPORT (C60934). Using a ¼-in. square rod, with a 90° bend in one end to form a handle, remove ¼-in. pipe PLUG (A143863) as shown in figure 23. With all shift rods in neutral, interlock BALL (CCAX1M) *(fig. 63)* should drop. Check this through pipe plug hole below ball. If the ball has not dropped, tap the low-reverse and fourth-fifth shift rods or use a small screwdriver inserted upward through the pipe plug hole, to loosen the ball. *Do not attempt to remove the shift rod support until the interlock ball has dropped.*

(9) Remove hand hole cover over low speed gears *(fig. 80).*

Wrench, $\frac{9}{16}$-in., socket with speed wrench

With a $\frac{9}{16}$-in. socket and speed wrench remove cap SCREWS (BCAX1CC) with lock WASHERS (BECX1K) and remove COVER (C60949) and GASKET (C60950).

A. LOW -- REVERSE SHIFT FORK
B. 2ND - 3RD SHIFT FORK
C. 4TH - 5TH SHIFT FORK
D. OUTPUT SHAFT AND REAR BEARING CAP
E. SPEEDOMETER ADAPTER
F. GEAR SHIFT LEVER
G. OUTPUT SHAFT OIL LINE CONNECTOR—A155920
H. SCREW – BAOX7CD; WASHER – BECX1K
I. 2ND - 3RD SHIFT ROD LUG – B-157704
J. SCREW – BCAX1EE
K. PLATE – B-157706
L. BOLT – A-143739; NUT – BBFX2B; PIN – BFAX1DH
M. SHIFT ROD SUPPORT – C60934

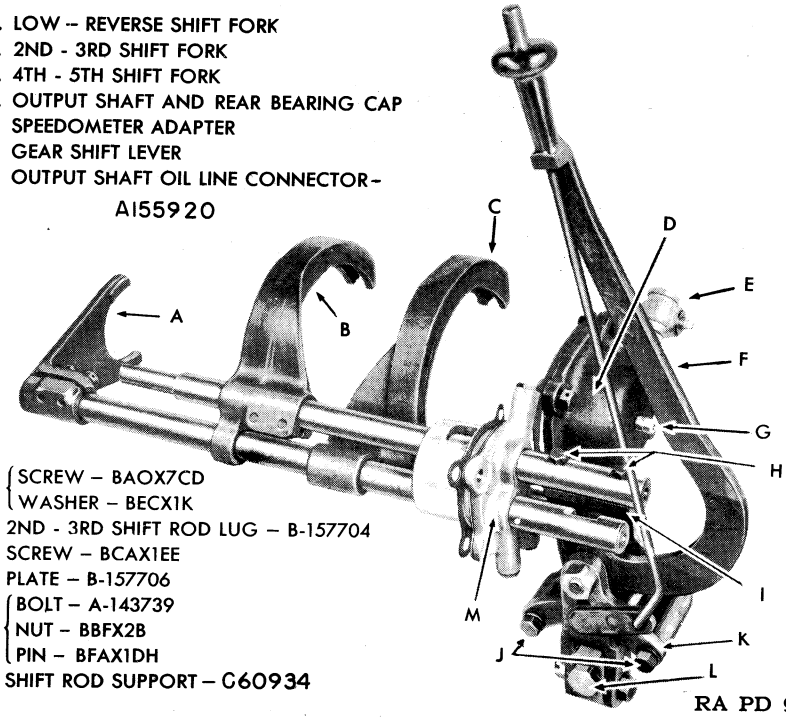

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FIGURE 20—Shift rod group assembly.

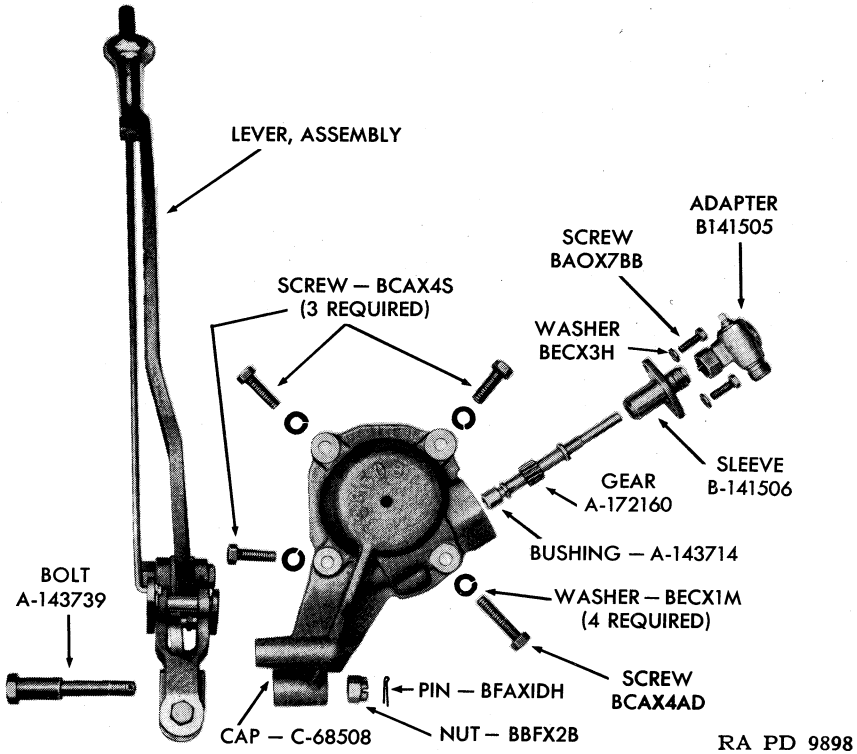

FIGURE 21—Parts of gear shift lever and output shaft rear bearing cap—exploded view.

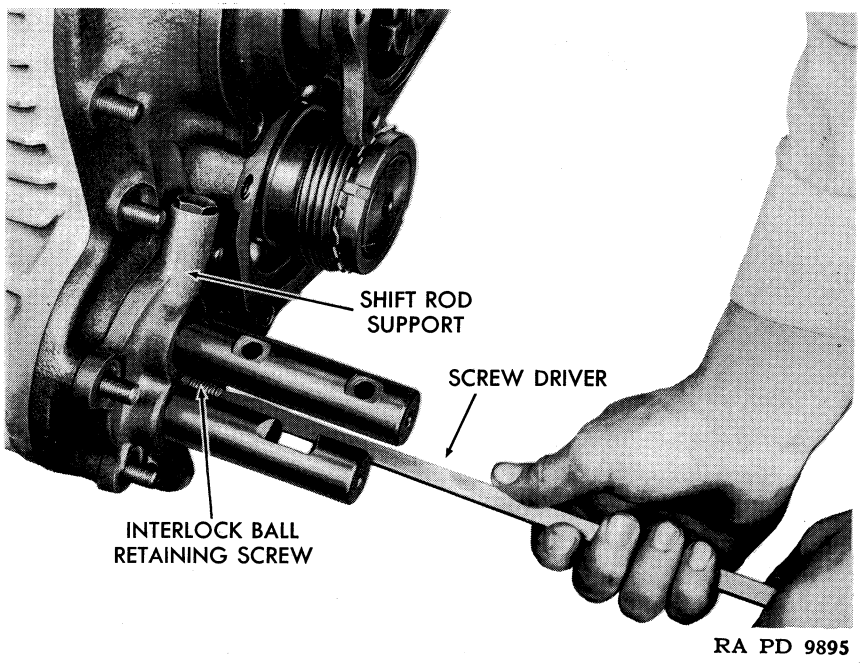

FIGURE 22—Removal of interlock ball retaining screw.

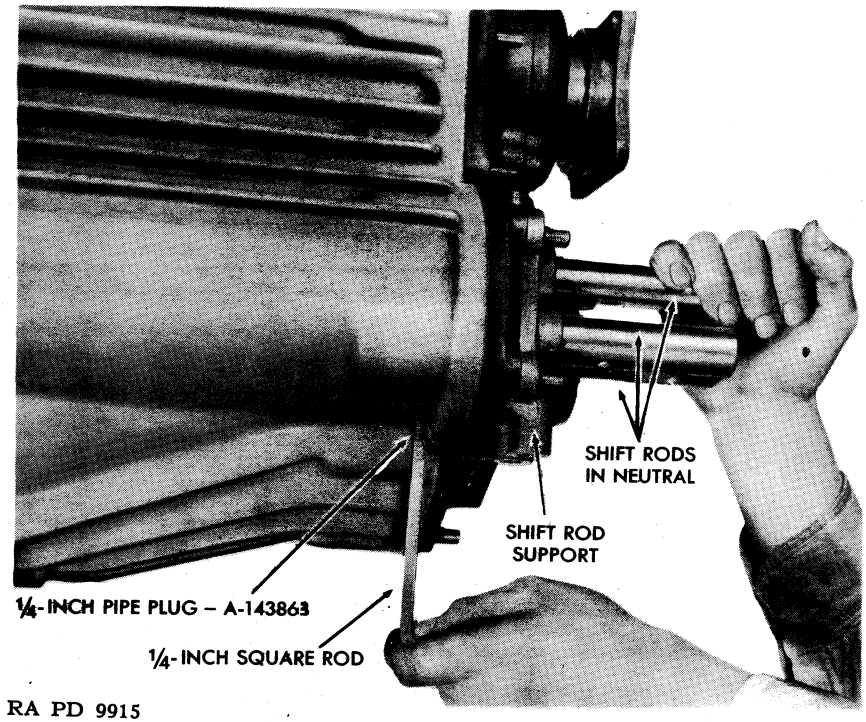

FIGURE 23—Removal of plug for release of interlock ball.

(10) Remove oil passage covers *(fig. 80).*

Wrench, ½-in., socket with speed wrench

Using a ½-in. socket and speed wrench remove cap SCREWS (BCAX1BA) and remove covers. This is done only for the purpose of flushing and cleaning the oil passages.

(11) Remove output shaft center bearing retaining nut *(figs. 24, 46, and 72).*

Screwdriver
Pliers
Wrench, $3\frac{7}{16}$-in., special, open end

Straighten locking WASHER (A188188) at points where output shaft center bearing retaining NUT (A170352) is locked *(fig. 46)*. On older models, the snap ring used in place of the locking washer must be removed. Place transmission in reverse gear by pushing forward on low-reverse shift rod. Using a special $3\frac{7}{16}$-in. open end wrench on the retaining nut *(fig. 72)* and a $2\frac{1}{8}$-in. socket wrench with at least a 3-ft. handle on input flange NUT (A143813) *(fig. 50)*, turn input shaft clockwise to loosen output shaft center bearing retaining nut *(fig. 24)*.

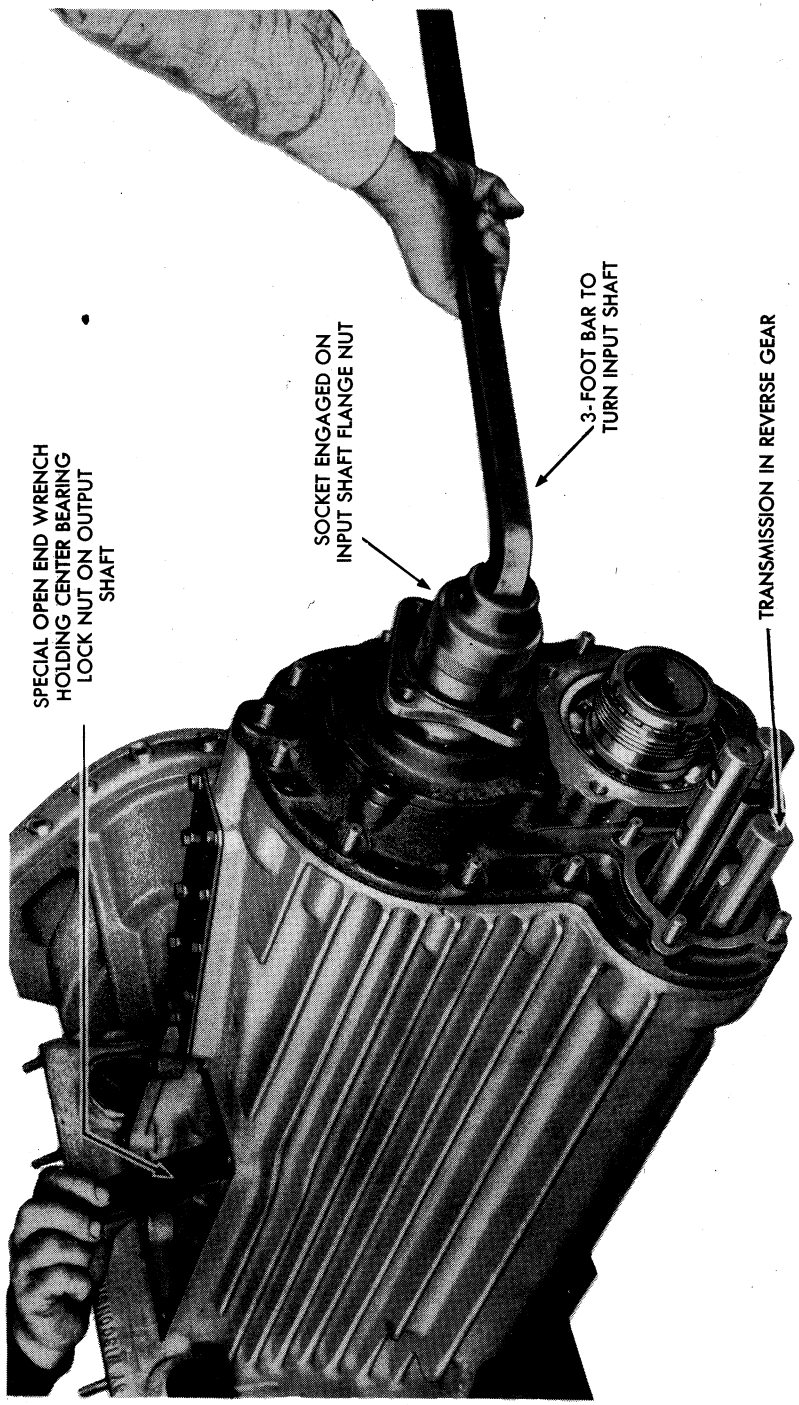

FIGURE 24—Loosening of output shaft center bearing lock nut.

(12) Remove retaining nut at rearward end of output shaft *(figs. 25, 46, and 72).*

Screwdriver
Gear block
Wrench, adjustable spanner

Straighten ears on locking WASHER (BEFX1AP). With transmission gears in reverse place gear block *(fig. 14)* between low-reverse sliding GEAR (C60958) *(fig. 46)* and reverse GEAR (B141510) *(fig. 52)*. Using an adjustable spanner wrench turn retaining NUT (A143724) anticlockwise and remove nut locking washer and speedometer GEAR (A158377) *(fig. 46)*.

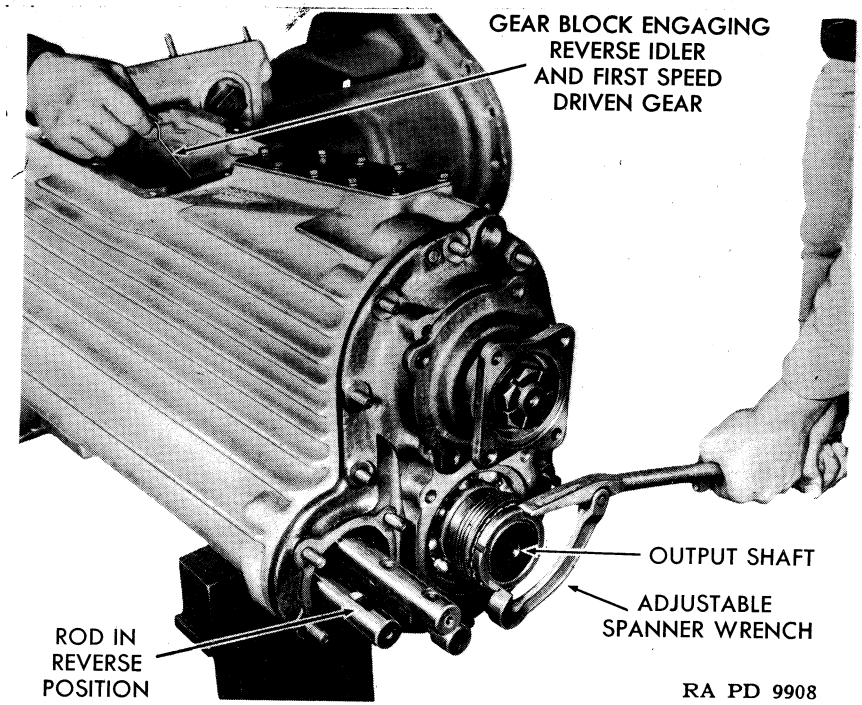

FIGURE 25—Removal of output shaft rear nut.

(13) Remove input shaft drive flange *(figs. 26 and 50).*

Wrench, 2⅛-in., socket with 3-ft. handle
Gear block
Pliers, side cutting
Drift, 16-in.
Hammer

Remove cotter PIN (BFAX1DM). Place transmission in reverse gear and insert gear block between reverse idler and first speed gear. Using a 2⅛-in. socket with a three-foot handle, turn drive flange NUT (A143813) *(fig. 50)* anticlockwise to remove *(fig. 26)*. Use a drift and hammer, tap lightly and drive FLANGE (B141515) rearward and off input shaft.

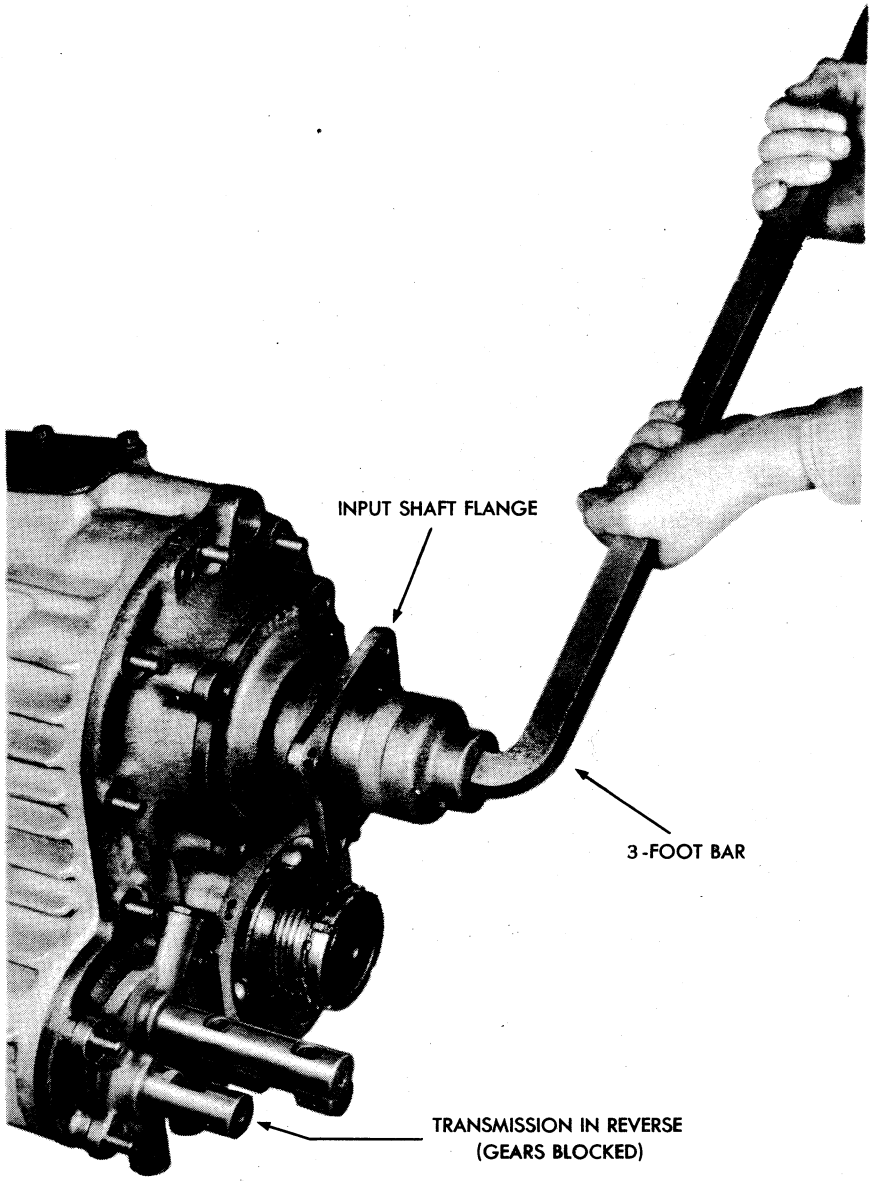

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FIGURE 26—Removal of input shaft flange nut.

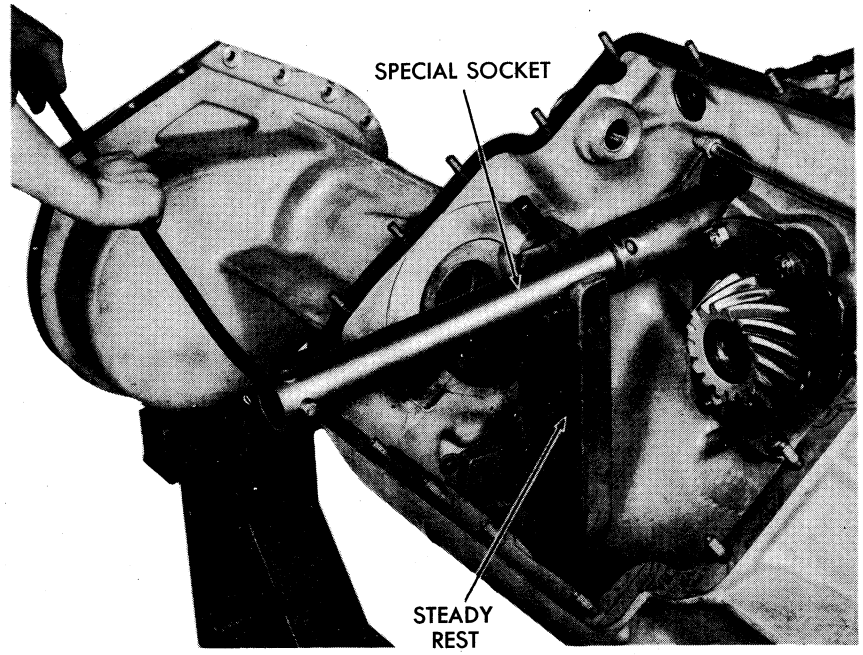

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FIGURE 27—Removal of reverse gear shaft front bearing retaining nut.

(14) Remove reverse gear shaft front bearing retaining nut *(figs. 27 and 52).*

Screwdriver
Wrench, special socket
Gear block

Straighten ear of lock WASHER (A143745). Place transmission in reverse gear and use block between reverse idler and low speed gear. Use special socket wrench *(fig. 14)* supported as shown in figure 27 and remove NUT (A143726) *(fig. 52).*

(15) Remove input shaft rear bearing cap *(fig. 50).*

Pliers, side cutting
Wrench, 3/4-in., socket
Hammer, light

Remove safety wire. Remove four cap SCREWS (BCAX4AC) securing COVER (C60931) *(fig. 50).* Tap cover off.

(16) Remove shift rod support *(fig. 28).*

Wrench, 5/8-in., socket
Wrench, 9/16-in., socket
Small bar

Remove two blocking NUTS (BBSX4AD) and two NUTS (BBSX4AC) from STUDS (A172138) and (A172139). Use a

pry bar as shown in figure 28, and carefully remove support. Remove 1-in. interlock ball. The third shift rod ball, spring and plunger, left in the support in Step (8), may now be removed.

(17) Remove transmission rear cover *(fig. 29).*

Wrench, 5/8-in., socket, with extension and handle
Pullers, special, two

Remove eleven locking NUTS (BBSX4AD) from case to cover STUDS (A172135) using a 5/8-in. socket wrench with a ratchet handle. Locate special pullers as shown in figure 29, so that upper and lower puller jackscrews are in line with the centers of the input and output shafts respectively. If the inner end of the jackscrew, to be used against the center of the output shaft is concave, use the one inch shift rod interlock ball between the screw and the shaft to prevent damage to the oil line aperture in the shaft end. If the jackscrew is flat on the inner end, use a disk instead of a ball. After carefully centering jackscrews of both pullers, operate them alternately to insure against undue binding and the possibility of cracking the cover. When the cover is off, tap, or press the input shaft rear bearing out of the cover. Wrap the bearing to exclude dirt and store for inspection and cleaning.

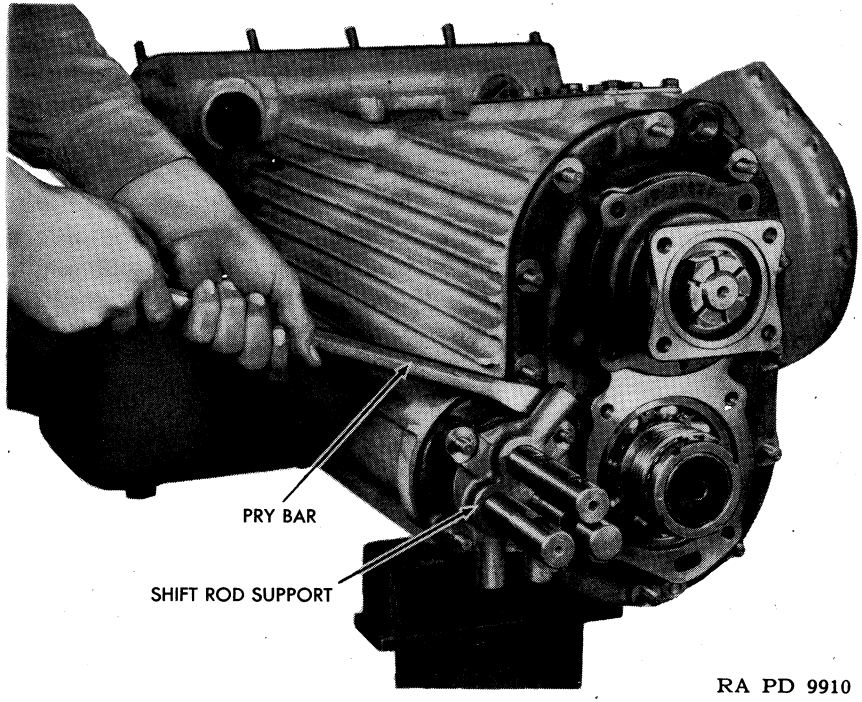


FIGURE 28—Removal of shift rod support.

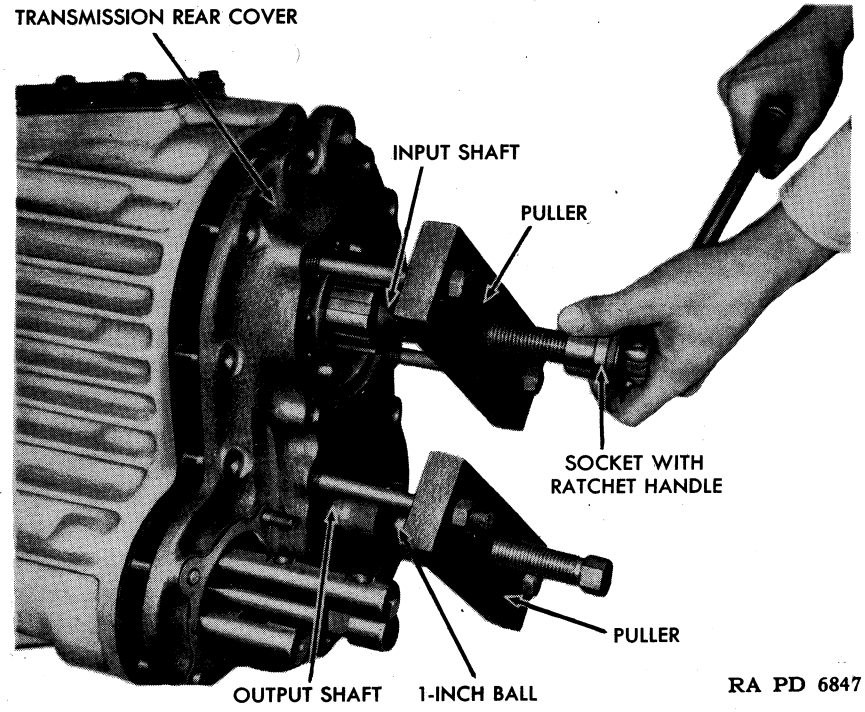


FIGURE 29—Removal of transmission case rear cover.

(18) Remove output shaft rear bearing *(figs. 13, 30, and 46).*

Wrench, special puller with adjustable spanner

Install special puller on output shaft rear BEARING (CAAX3AP) *(fig. 46)* as shown in figure 30. Engage adjustable spanner on puller bolts as shown and turn output shaft until spanner handle contacts spline of input shaft. Operate puller screw and remove bearing.

(19) Remove fifth speed driven gear from output shaft *(fig. 47).*

Bars, small pry, two
Wiping cloths

Place one or two wiping cloths under fifth speed driven GEAR (C68511) *(fig. 47)* to catch the needle BEARINGS (A164557) which will fall. Use two small pry bars and remove gear. Remove COLLAR (B157711) using the same bars.

(20) Remove snap ring at front end of input shaft *(figs. 50 and 72).*

Snap ring pliers
Screwdriver
Hammer, rawhide

With a rawhide hammer, strike rear end of input shaft two or three sharp blows. Use snap ring pliers and remove snap

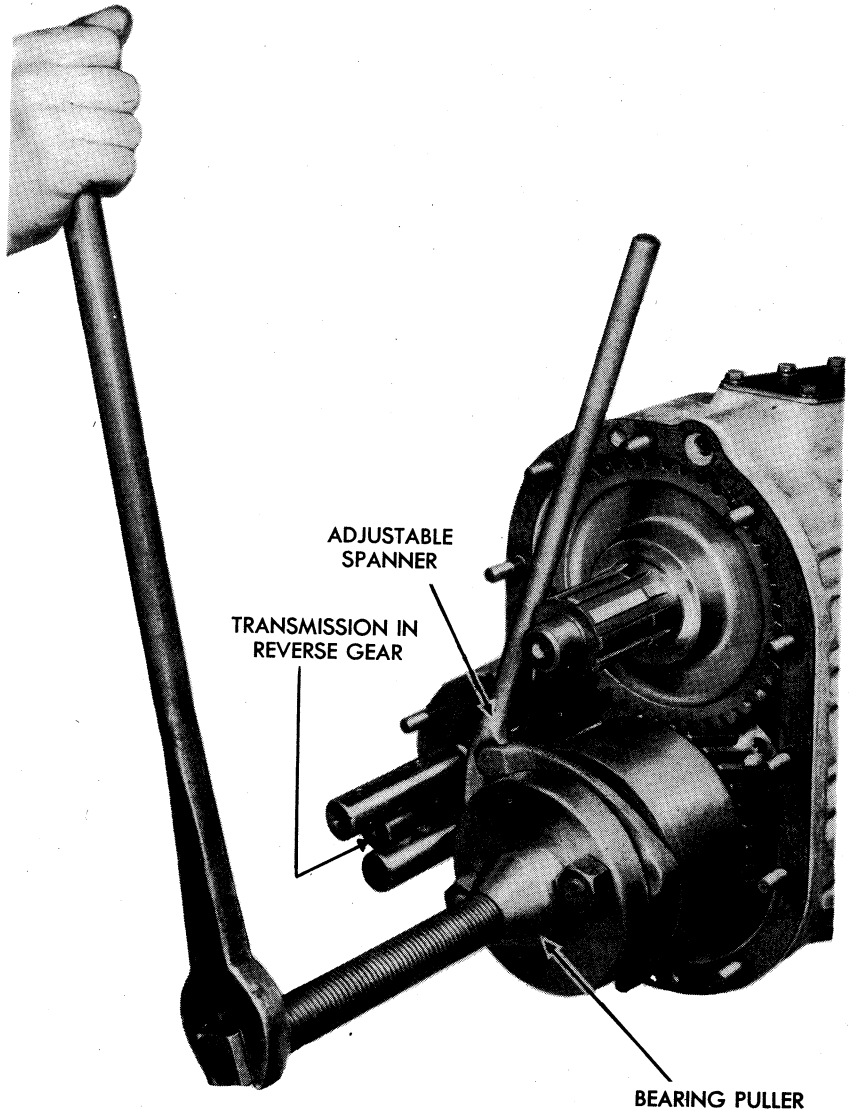


FIGURE 30—Removal of output shaft rear bearing.

RING (A143795) *(fig. 50)* from groove at front end of input shaft. Figure 72 shows the reverse gear chamber and the handhole through which this work is done. This figure also shows the snap ring and its relationship to the input shaft front BEARING (CABX3AL).

(21) Remove input shaft and fourth-fifth shift rod, fork and synchronizer *(fig. 31).*

Special puller *(fig. 13).*

Place legs of special puller over studs (rear cover to case) and screw puller nut on rear end of input shaft as shown in figure 31. Engage third speed gears by pulling to the rear on second-third shift rod and operate puller. As the input shaft is pulled rearward the fourth speed gear on the input shaft will push the fourth-fifth speed synchronizer off of the output shaft, carrying with it, the fourth-fifth shift FORK (C73338) and shift ROD (C68500). *Keep the synchronizer from binding on the output shaft by shaking the fourth-fifth shift rod constantly while the puller is in use.* As soon as the input shaft is pulled clear of its front bearing, remove the puller. Lift the shaft to clear the rest of the gearing, synchronizer assembly and shift fork, and remove the shaft from the case. Remove fourth-fifth synchronizer, shift fork and rod. CAUTION: This whole operation must be done with great care, since the binding of the synchronizer on the output shaft will effectively block the removal of the input shaft.

(22) Remove output shaft *(figs. 32, 33, 46 and 54).*

Pliers, side cutting
Gear block
Wrench, 2-in., socket with 3-ft. handle
Brass rod, 1½-in., 36-in. long
Puller—B144436

Remove cotter PIN (BFAX2BD) from output shaft front retaining NUT (A143742) *(fig. 46).* Place transmission gears in reverse and insert gear block between low-reverse sliding gear and reverse idler. Use a 2-in. socket with a 3-ft. handle as shown in figure 32. Turn nut anticlockwise and remove nut and washer. To remove the output shaft, use PULLER (B144436) with a hydraulic JACK (D34371) *(fig. 46).* If the puller is not available, drive the shaft through the bevel pinion and follow it through the low-reverse sliding gear and the output shaft center bearing. From this point the shaft with fourth speed gear in place may be drawn rearward through second-third gears and synchronizer and out of the case. Use a 1½-in. brass bar at least 36 in. long *(fig. 33)* and drive output shaft out of bevel PINION

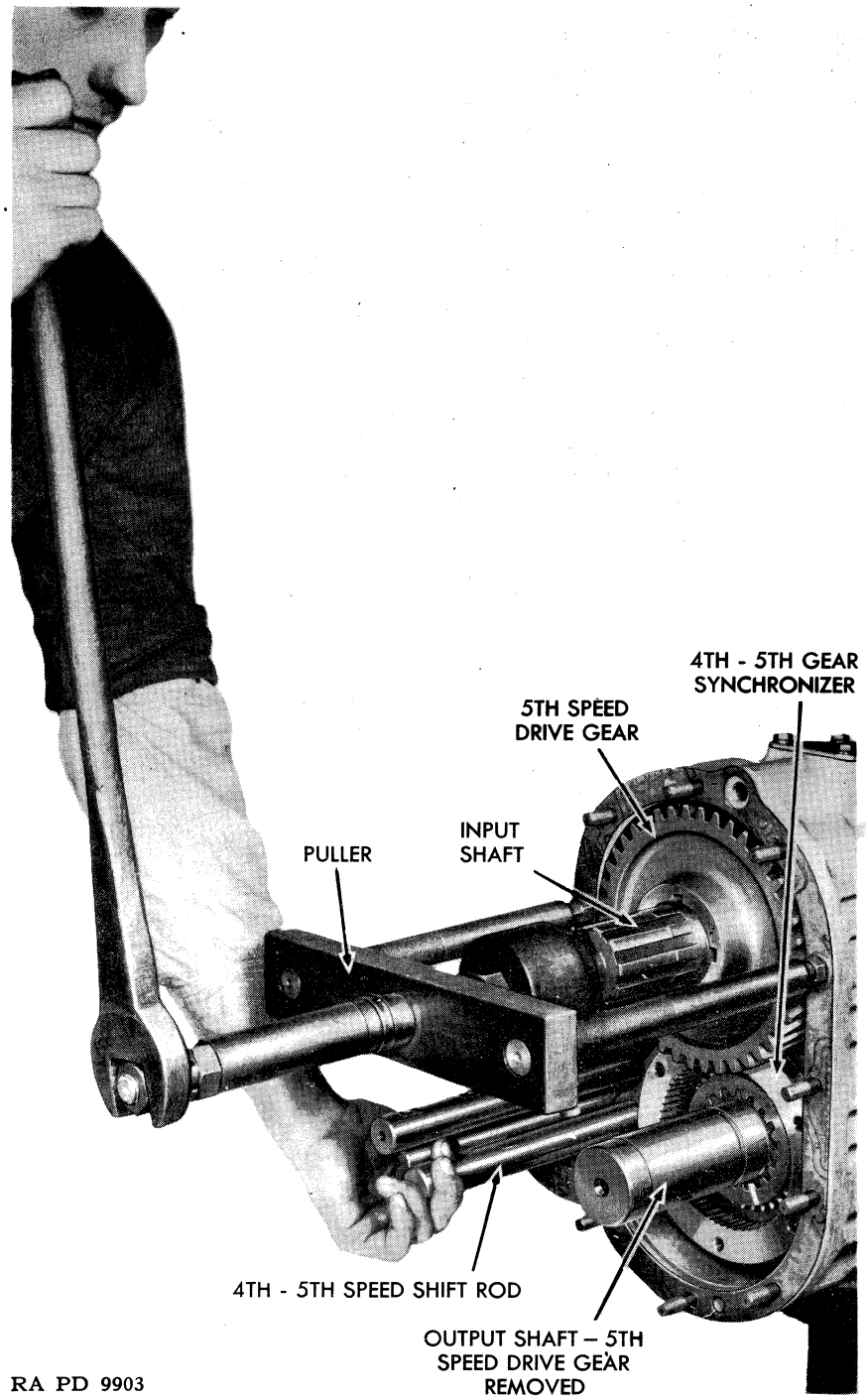


FIGURE 31—Removal of input shaft with fourth-fifth speed shaft rod and synchronizer.

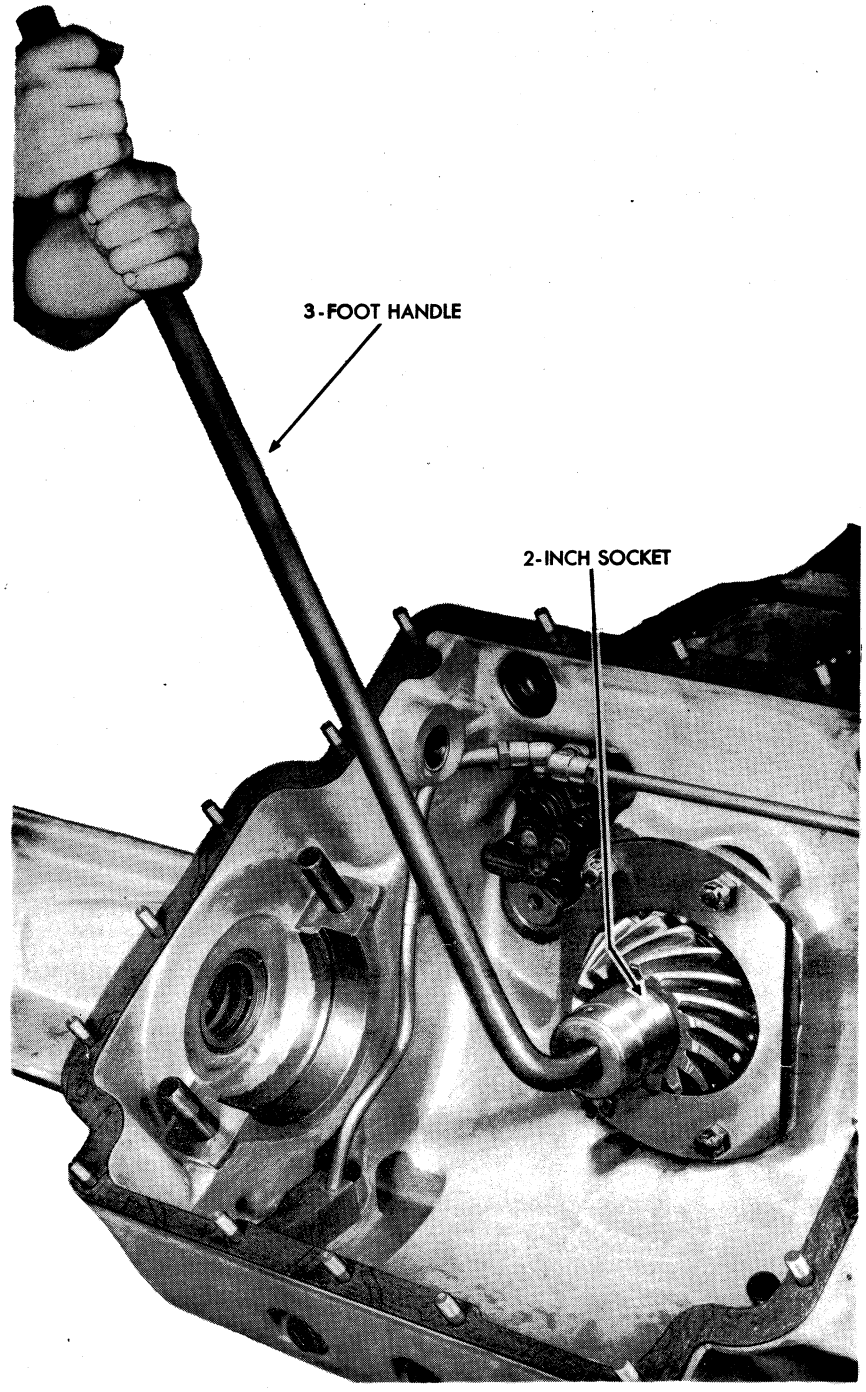


FIGURE 32—Removal of output shaft nut at bevel pinion.

(C60939) *(fig. 54)*. A second man, working through the rear of the case, holds second-third gears and synchronizer in the case and maintains fourth speed gear in position on the shaft, while the shaft is driven out. If necessary, follow the shaft through the center bearing with the brass rod. The shaft may then be pulled through second-third gears and synchronizer and removed from the case.

(23) Remove third speed gear, second-third synchronizer with fork and second speed gear *(figs. 47 and 63)*.

Lift out third speed GEAR (C68499) in such a way that the needle bearing COLLAR (B157939) is held in place, retaining the needle BEARINGS (A170349) *(fig. 47)*. Remove second-third shift FORK (C73337) and ROD (C68502) by sliding rod to the rear and over low-reverse ROD (C60960) *(fig. 63)* while pulling second-third synchronizer from case. Tilt second speed gear assembly, holding needle bearing collar to retain needles, and remove gear from case.

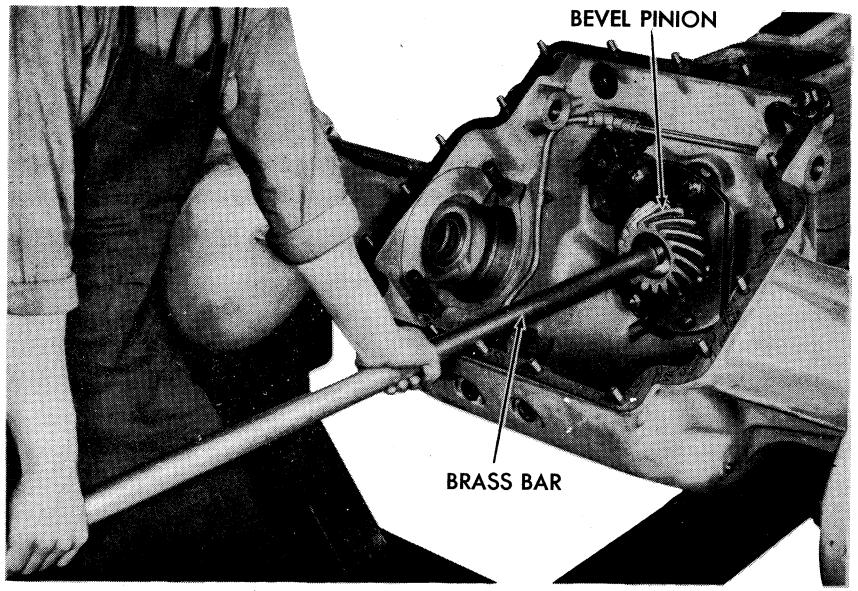


FIGURE 33—Driving output shaft out of pinion.

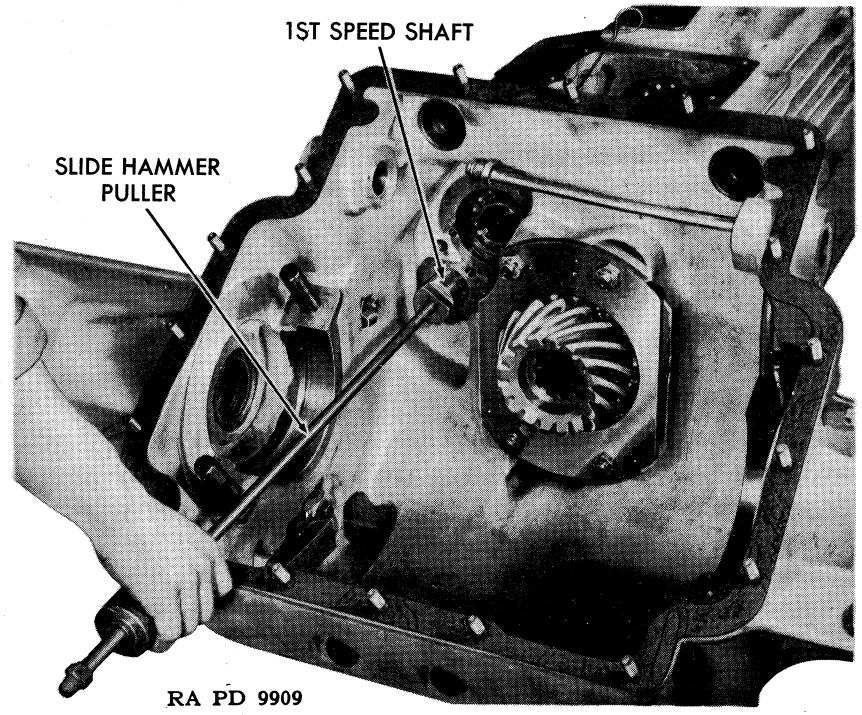


FIGURE 34—Removal of first speed shaft.

(24) Remove first speed shaft *(figs. 34 and 53)*.

Hammer, slide, ½-in.

Screw threaded end of ½-in. slide hammer *(fig. 34)*, into tapped hole in front end of first speed SHAFT (A143744) *(fig. 53)* and pull shaft letting first speed drive GEAR (C60954) drop.

(25) Remove reverse gear shaft *(figs. 35 and 52)*.

Puller—C62522 or
Soft rod, 1-in., with one end tongued to fit slot in front of shaft.

With tongued end of a soft rod in slot in front end of reverse gear SHAFT (C60955) *(fig. 52)* drive shaft out of front bearing *(fig. 35)*. Tilt the shaft as necessary and remove with reverse idler GEAR (B141510) remaining on the shaft. Use PULLER (C62522) if available and pull the shaft rather than use the above procedure.

(26) Remove low-reverse sliding gear.

Lift low-reverse sliding GEAR (C60958) *(fig. 46)* up out of low-reverse shifting FORK (C60919) *(fig. 63)* and out of case.

(27) Remove first speed drive gear.

Lift GEAR (C60954) *(fig. 53)* up and out of case.

(28) Remove low-reverse shift rod and fork.

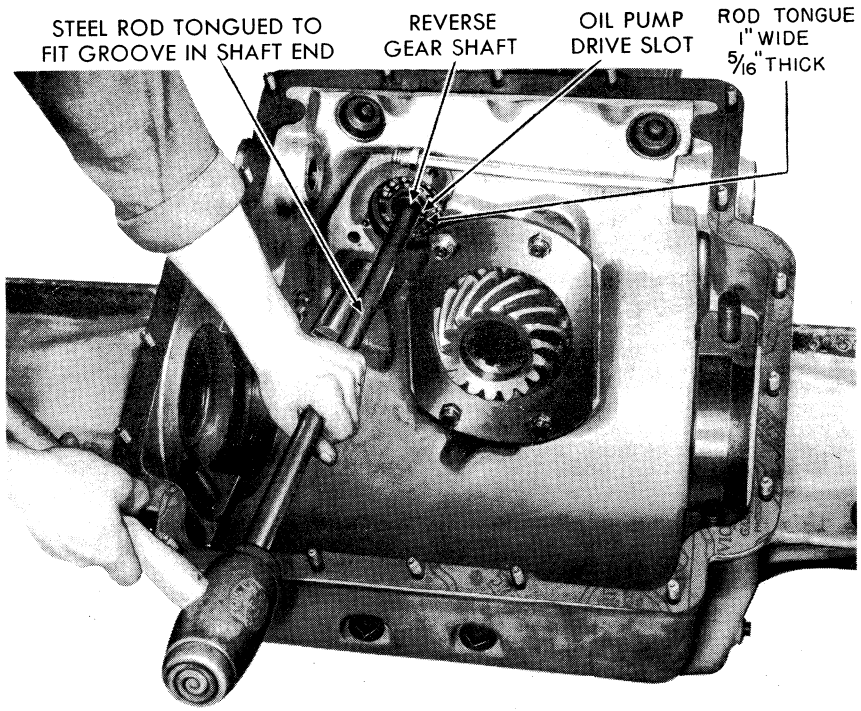
Wrench, $\frac{5}{8}$-in., box
Pliers, side cutting

Remove safety wire. Remove two cap SCREWS (A143772), slide shift ROD (C60960) out of case, and lift out FORK (C60919) *(fig. 63)*.

(29) Remove bevel pinion assembly. *(figs. 36 and 54).*

Pliers, side cutting
Wrench, $\frac{15}{16}$-in., socket with handle
Brass rod or soft hammer

Remove safety wire. Use a $\frac{15}{16}$-in. socket wrench and remove four NUTS (BBFX2B) from STUDS (A143746) and remove pinion bearing retaining PLATE (C60952) *(fig. 36)*. Working from the low-reverse chamber, use a brass rod or a soft hammer and drive the pinion assembly forward and out of the case.



RA PD 9902

FIGURE 35—Driving reverse gear shaft out of front bearing.

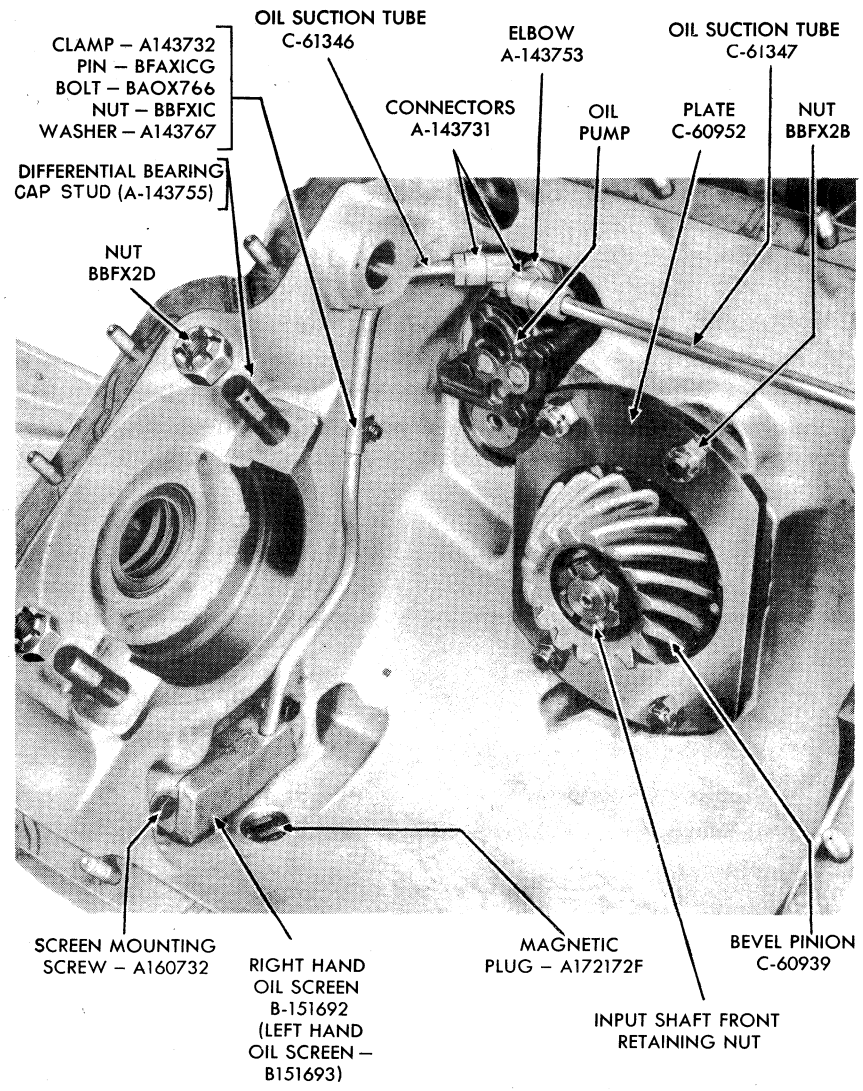


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FIGURE 36—Differential chamber with differential removed.

(30) Bevel pinion removal —transmission in vehicle *(figs. 32, 36, 37, 38 and 46).*

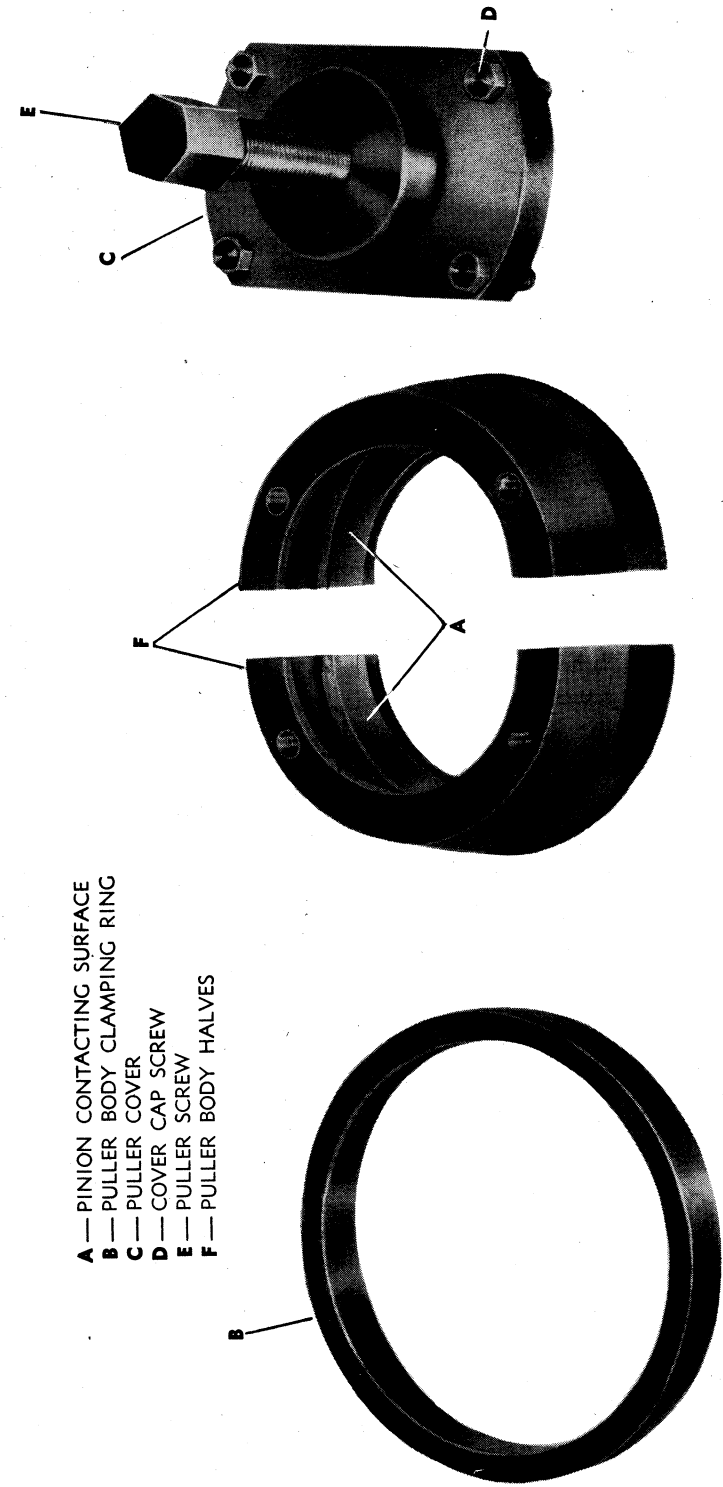
Wrench, 2-in., socket with a 3- or 4-ft. handle
Wrench, $\frac{15}{16}$-in., socket
Wrench, $1\frac{1}{4}$-in., open end

If bevels require adjustment or replacement, or if it is desired to examine or replace the bevel pinion bearing, then either operation can be done in the field or shop without removal of the transmission from the vehicle. Remove hull front cover plate, tracks, and final drive, as directed in paragraph 10. Disassemble brakes, brake camshafts, differential bearing support covers, and remove differential as directed in paragraph 14. Then proceed as follows: Cut and remove wire locking four NUTS (BBFX2B) on STUDS (A143746) *(fig. 36)*. Use a $\frac{15}{16}$-in. socket wrench and remove nuts securing pinion assembly retaining PLATE (C60952) and remove plate. Remove cotter PIN (BFAX2BD). Use a 2-in. socket wrench with a 3-ft. handle *(fig. 32)* and remove NUT (A143742) and WASHER (A143743) *(fig. 46)* from front end of output shaft. Install bevel pinion puller *(figs. 37 and 106)* as shown in figure 38. This is done as follows: Place the two halves of the puller body so that, when assembled surface "G" *(fig. 37)* will be in back of the bevel pinion. Install retaining ring "B" *(fig. 38)* to retain two halves in position. Install cover "D" and tighten four screws "A." Turn screw "F" ($1\frac{1}{4}$-in. open end wrench) in against center of output shaft and remove pinion. Refer to paragraph 24 for disassembly of the bevel pinion with bearings assembly.

(31) Remove reverse gear shaft front bearing, input shaft front bearing and output shaft center bearing from transmission case *(figs. 46, 50, and 52).*

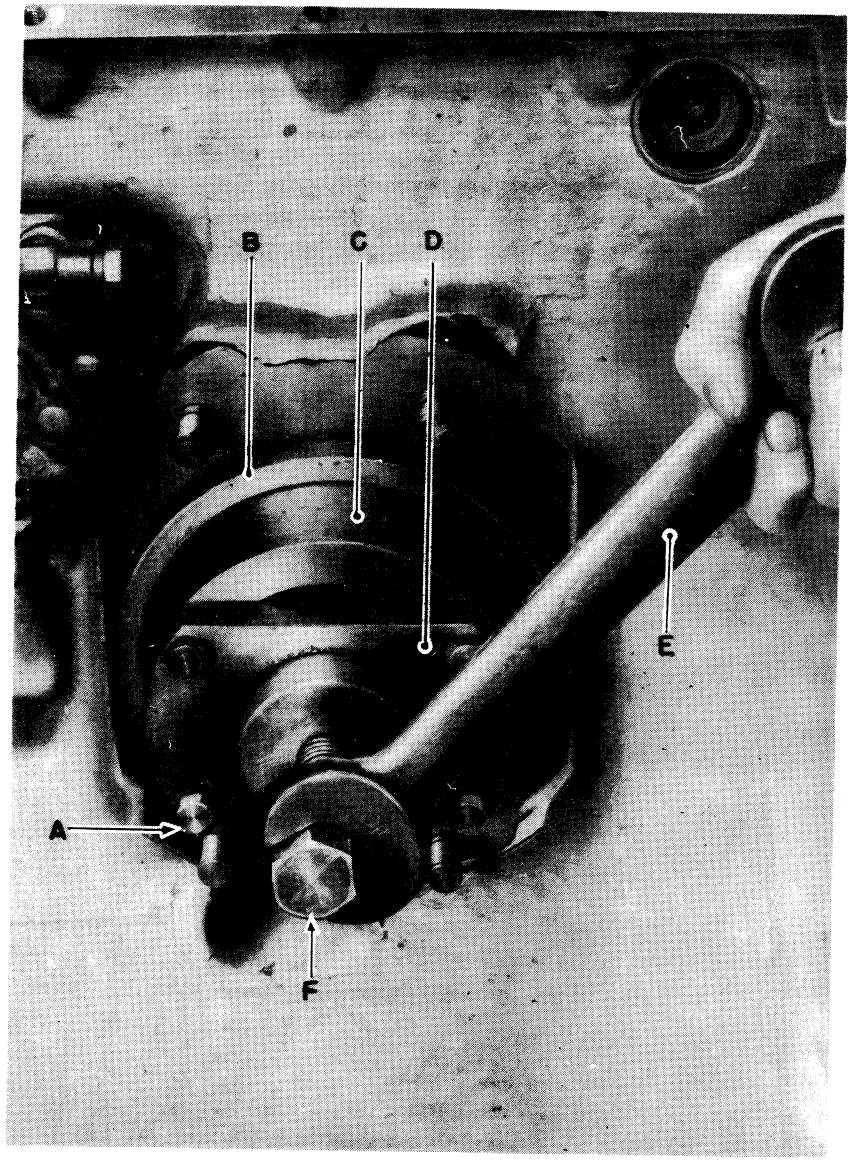
Brass bar
Soft drift
Hammer
Bearing drivers

Use a brass bar and drive reverse gear shaft front BEARING (CABX3AK) *(fig. 52)* rearward into low reverse chamber. Work through aperture left by pinion shaft removal and using bearing driver *(fig. 99)* drive output shaft center BEARING (CAAX3AQ) *(fig. 46)* out of case. Use a bearing driver *(fig. 99A)* or soft drift and hammer and drive input shaft front BEARING (CABX3AL) *(fig. 50)* rearward out of case. CAUTION: Wrap each bearing in a clean wiping cloth or waxed paper as soon as it is removed from the case.



A — PINION CONTACTING SURFACE
B — PULLER BODY CLAMPING RING
C — PULLER COVER
D — COVER CAP SCREW
E — PULLER SCREW
F — PULLER BODY HALVES

FIGURE 37—Bevel pinion puller.



A — COVER SCREW (7/16")
B — PULLER BODY RETAINING RING
C — PULLER BODY - UPPER HALF
D — PULLER COVER
E — 1¼ IN. WRENCH
F — PULLER SCREW

RA PD 9937

FIGURE 38—Use of special puller to remove bevel pinion.

(32) Remove oil lines and screens from case *(fig. 36)*.

Pliers
Wrench, 5/8-in. socket

Remove two cotter PINS (BFAX1CG) *(fig. 36)*. Use a 5/8-in. socket wrench and remove two BOLTS (BAOX7CC) and two NUTS (BBFX1C) with two WASHERS (A143767) and remove two CLAMPS (A143732) from oil TUBES (C61347 and C61346). Lift out oil tubes. Remove four screen mounting SCREWS (A160732) and remove SCREENS (B151692 and B151693). Wash screens in dry cleaning solvent. Replace screens if punctured or badly mutilated.

SECTION VII

DISASSEMBLY, INSPECTION, REPAIR AND ASSEMBLY OF TRANSMISSION COMPONENTS

	Paragraph
Introduction	15
Brake shoe assembly	16
Controlled differential assembly	17
Oil pump assembly	18
Output shaft	19
Output shaft, gears and needle bearings	20
Input shaft with gears	21
Reverse gear shaft with bearings	22
First speed shaft with gear and roller bearings	23
Bevel pinion with bearing	24
Ball and roller bearings	25
Synchronizers	26
Gear shift lever	27
Steering brake levers	28
Transmission case	29
Transmission case repairs	30

15. Introduction.—The disassembly, cleaning, inspection and repair of the following sub-assemblies must be attended with great care and extreme cleanliness. Each sub-assembly has its component parts and to avoid confusion or error should be completely overhauled as a unit. Whenever necessary or helpful, mark related parts for reassembly before disassembling. Clean all sub-assemblies before disassembly. After disassembly carefully clean each component. The inspection which follows will vary, depending upon the nature and use of the part itself. *Be careful to keep all needle bearings with their related gears and collars throughout the overhaul procedure.*

16. Brake Shoe Assembly.—*a. General (fig. 39).*—The brake shoe assemblies are removed as described in paragraph 14 *b.* (2). At the time of transmission overhaul or whenever the brake shoes require relining, all parts must be carefully inspected for wear or malfunction.

b. Inspection (fig. 39).—Clean each part with dry SOLVENT, cleaning, before inspection. Check shoe LININGS (B141519) for wear and notice whether rivet heads are flush, or nearly flush with surface of lining. Reline shoes (par. 16 c.) if necessary. Check shoe connecting PINS (A143800 and A144984) for ridges or wear. If pins are worn .010 in. or more, replace. If new pins are .010-in. loose in SHOES (C60925, C60926

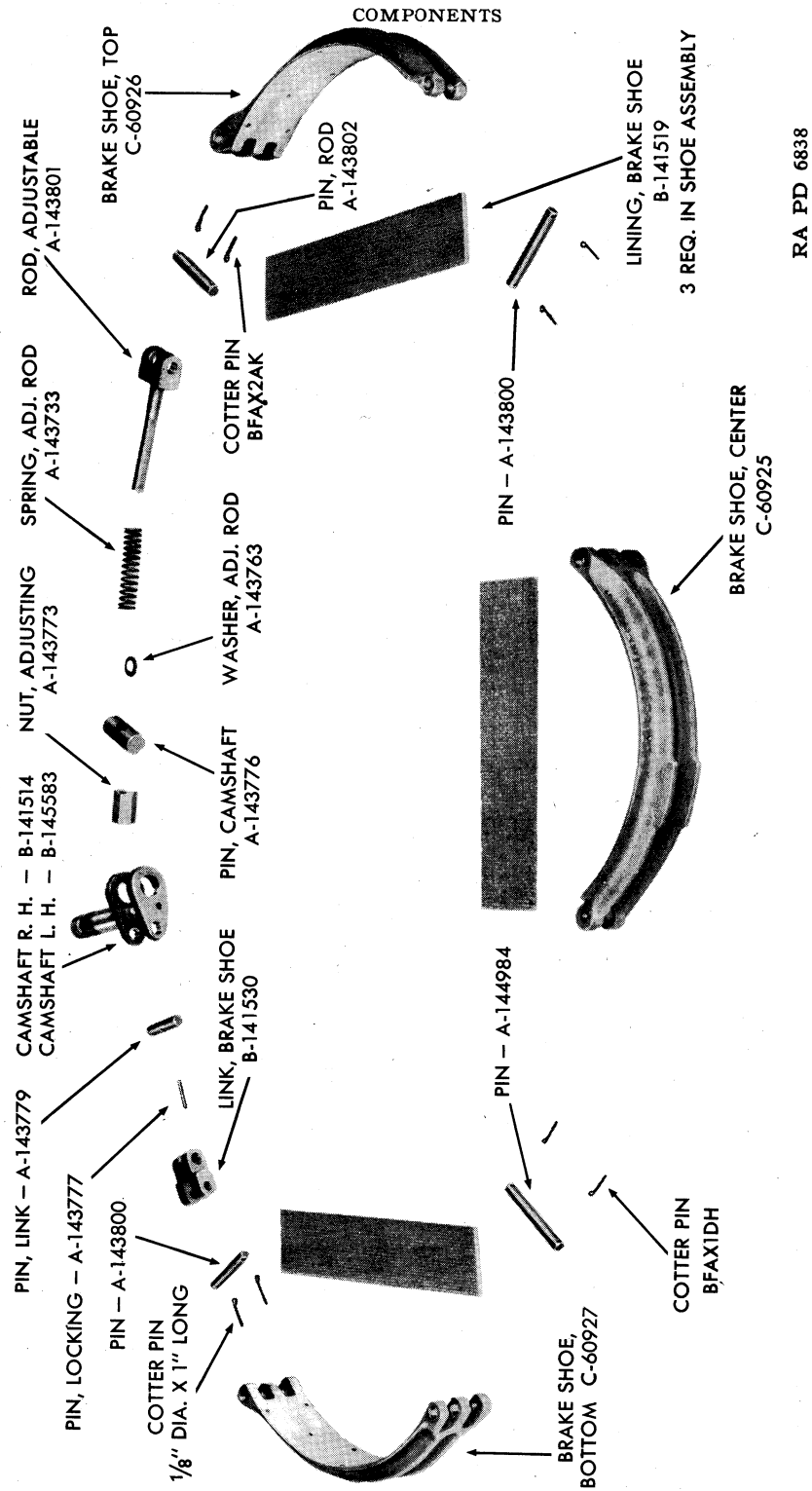


FIGURE 39—Parts of steering brake shoe assembly.

and C60927) replace shoes. Check rod PIN (A143802) in adjustable ROD (A143801) and brake SHOE (C60926) using above tolerances and replace parts as needed. Inspect threaded end of adjustable rod and screw on adjusting NUT (A143773). If thread fit is loose replace both nut and adjustable rod. Check for wear on camshaft and camshaft pin and replace as necessary. Inspection of brake drums and rims is covered in paragraph 17 *b*.

c. Reline brakes.—Use a $\frac{5}{32}$-in. punch and drive out RIVETS ($\frac{3}{16}$ in. OD x $\frac{1}{2}$ in.) from outside of shoe inward, and remove old lining. Clamp new lining to shoe using three or more clamps. Use a $\frac{3}{16}$-in. drill through the rivet holes in the shoe and drill the required number of holes. Remove lining from shoes and counterbore all drilled holes in lining to a depth of $\frac{1}{8}$ in. using a $\frac{5}{16}$-in. counterbore. Rivet lining to shoe, starting at the center and working toward the ends of the shoes. When shoe is lined check clearance between lining and shoe. Clearance of more than .005-in. will cause chatter and loosening of the lining. Install the two pins connecting the three brake shoes and carefully install cotter pins in both ends of connecting pins. Store the assembled shoes in a clean place until needed for reassembly.

17. Controlled differential assembly *(figs. 40, 41 and 43).—a. General.*—This assembly must have a thorough cleaning to remove the heavier accumulation of grease before disassembly. *Remove the two support BEARINGS (CAAX3AT) (par. 17b) before cleaning* and put aside to be cleaned and inspected. This is done to preclude the possibility of foreign material being washed *into* the bearing.

b. Disassembly, inspection and repair (fig. 40).—(1) *Support bearings.*—Remove two support BEARINGS (CAAX3AT) from the hubs of COVERS (C60920 and C61410) using PULLER (B144441). If this puller is not available use puller and jack as shown in figure 40. A spacer slightly smaller in diameter than the hub is used between the hub and the hydraulic jack. Be certain that the puller jaws are equally spaced and that the jack will exert pressure at the center of the puller. Clean the balance of the assembly as well as possible before proceeding with the disassembly.

(2) *Steering brake drums (figs. 41 and 42).*—Lift off brake drum assemblies. If RIMS (C60924) are smooth and show only normal wear and if the wear on BUSHING (A143803) in the GEAR and FLANGE assembly (C60918) is less than .012-in. the drum and rim assembly need not be disassembled. If the rim is grooved or rough it may be turned in a lathe. To make the diameter of the brake conform as nearly as possible to the new diameter of a reconditioned brake drum, use brass shim stock between the lining and the shoe. Under no circumstances will a brake drum rim be used when the rim thickness, through reconditioning, has been reduced to less than $\frac{1}{4}$-in. If the flange-to-hub bushing is worn beyond the acceptable .012-in. clearance, use an arbor press and replace

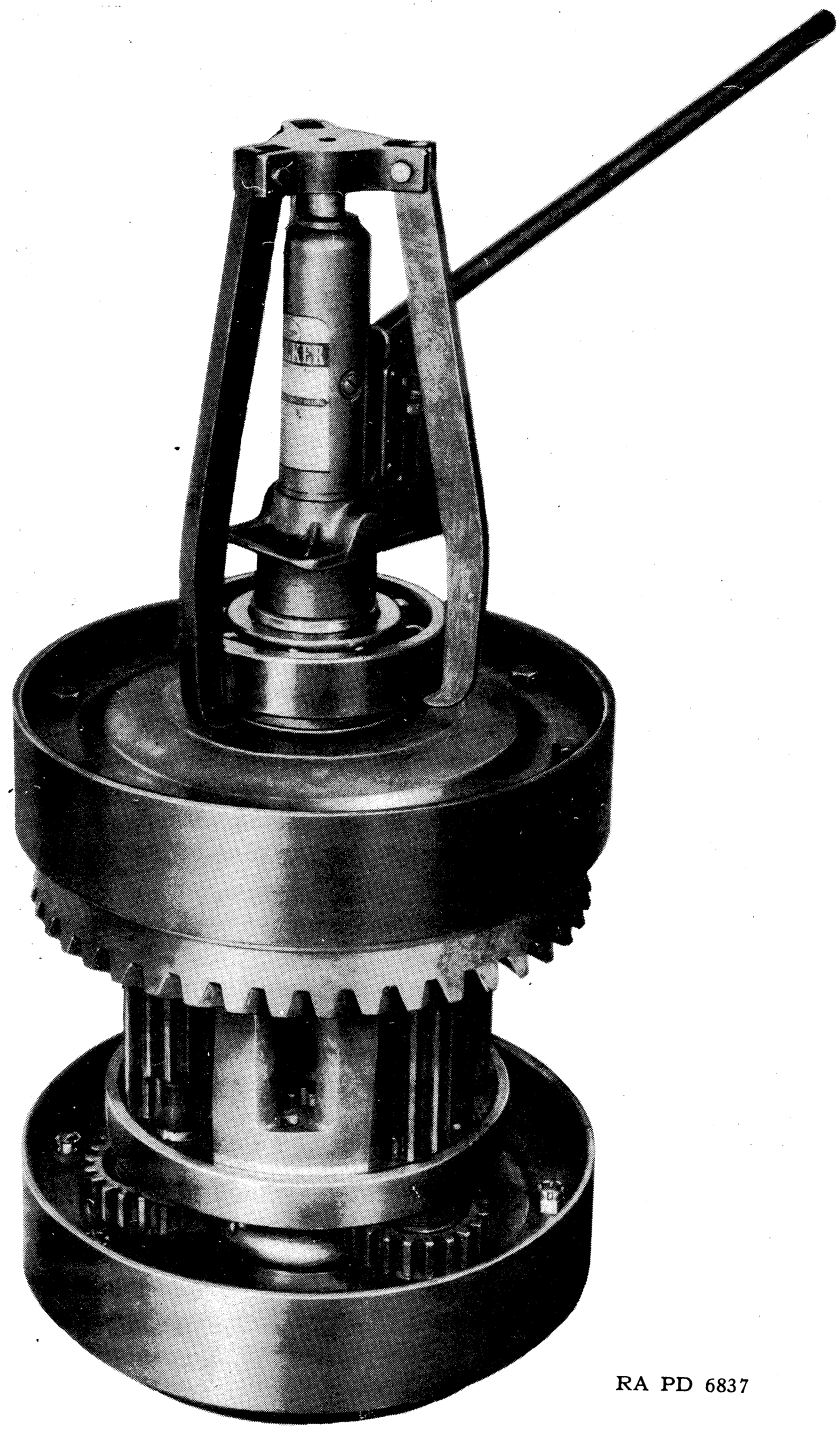


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FIGURE 40—Removal of differential bearing.

the bushing. Do this with care to avoid distortion of the new bushing. When assembled check the new bushing on the hub and, if necessary, carefully ream to size. To replace the brake drum rims, remove eight cotter PINS (BFAX1CR) and NUTS (BBFX1E) and remove rim. Install new or reconditioned rim on flange and when securely bolted set on hub of cover and check for run-out. If run-out exceeds .005-in., true up in lathe.

(3) *Differential case pinions and covers (figs. 41, 42 and 43).* — Remove six cotter PINS (BFAX2AA) and using a $1\frac{1}{16}$-in. socket wrench remove six NUTS (A143797) from six through BOLTS (A143765) (three on each cover). Remove bolts. With a soft hammer, drive alternately on the inside of the two end covers so that the covers are removed from the compensating CASE (C60917). Carefully clean six external PINIONS (B141509), six internal PINIONS (B141508), two differential GEARS (C60923) and bevel GEAR (C61407). Inspect all gears and pinions. If abnormally worn or if teeth are broken or chipped replace the defective gear or pinion and all related or meshing gears or pinions. If the pinions are in serviceable condition note the clearance of each internal pinion in its BUSHING (A143804). If over .005-in. clearance is noted, replace all bushings as follows: Remove six cotter PINS (BFAX2AK) and using a 1¼-in. socket remove six NUTS (A143798) which secure external pinions to internal pinions. Apply pressure under external pinion with a short bar, and using a soft hammer, drive on threaded end of internal pinion to loosen. Remove external pinion. Remove Woodruff key and remove internal pinion. Place external pinion and nut on internal pinion and start retaining nut to insure the correct mating of these parts in reassembly. When all pinions have been removed, press out and replace unserviceable bushings. To remove bevel gear remove locking wire and twelve cap SCREWS (A144527). Use a soft hammer and tap gear off cover. Check teeth and bearing surfaces of two differential GEARS (C60923). Check the fits of these gears in their respective bearings in the covers and in the compensating case. If clearances in excess of .012-in. are noted, replace the worn bushing case or gear as necessary.

(4) *Assembly of differential bevel gear, pinions, case and covers.* — Do not assemble a differential with the old bevel gear without first ascertaining that the mating bevel pinion will also be used. That is, if a new bevel gear is used, a new matched bevel pinion must also be used and vice versa. If bevel gear was removed for any reason, install the same gear or a new one at this time. Install twelve retaining screws and secure with locking wire. Place internal pinions in covers, install Woodruff keys and drive external pinions onto internal pinions. NOTE: Viewed from the outside of each cover, the internal pinion is installed in the right hand hole of each pair of bushings. Install external pinion retaining nuts and cotter pins. Time the pinions as follows: Set the differential gear on the

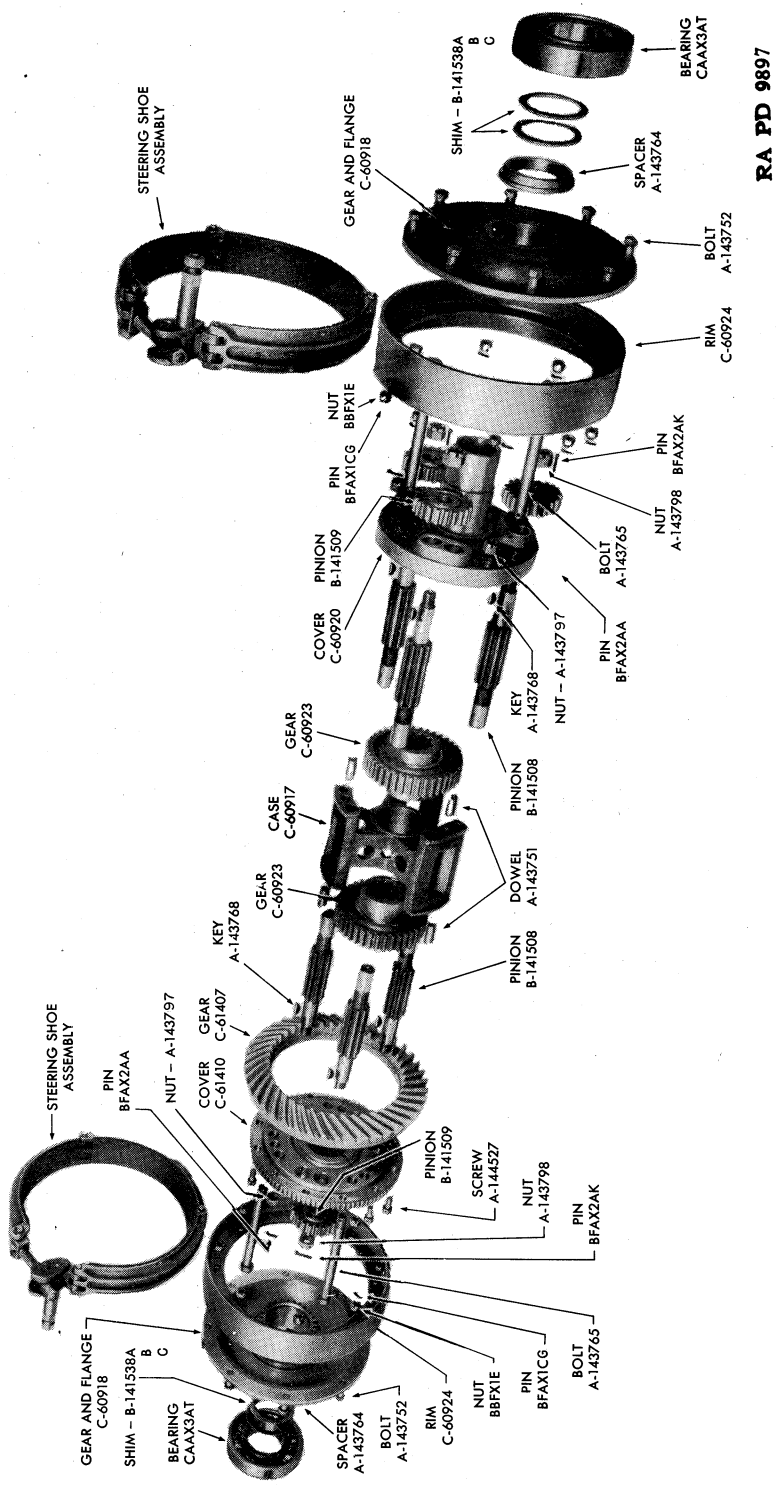


FIGURE 41—Parts of controlled differential.

bench with the shorter hub up. Set the related cover over the differential gear. Set all three internal pinions so that their keyways face the hub of the cover and so that each keyway is in line with the center of the hub. Keeping the pinions in this relationship lift the differential gear up and into mesh with the three internal pinions. Repeat the above procedure with the second cover, pinion and gear. Place six DOWELS (A143751) in compensating case and install case on one cover. Maintaining all the gears in their correct relationship, place the other cover over and into the spider and cover assembly. Replace the through bolts and nuts and install cotter pin securely. Three bolts are entered through each cover. Bolts must be placed in the holes that bring the bolt heads closest to the external pinion. When completely bolted up, install one brake drum and gear and check the assembly for freedom of turn.

18. Oil pump assembly *(figs. 44 and 108).—a. Disassembly.*—Remove two cap SCREWS (BCAX4R) securing pump COVER (A143717) and BODY (C60915) to BASE (C60941). Tap with a soft hammer on the inner end of the pump drive SHAFT (A143723) and with a soft punch on the inner end of the idler SHAFT (A143722). This will separate the body and cover from the base of the pump. Tie the base-to-body SHIMS (A143718) together and tag for identification. Holding the pump body,

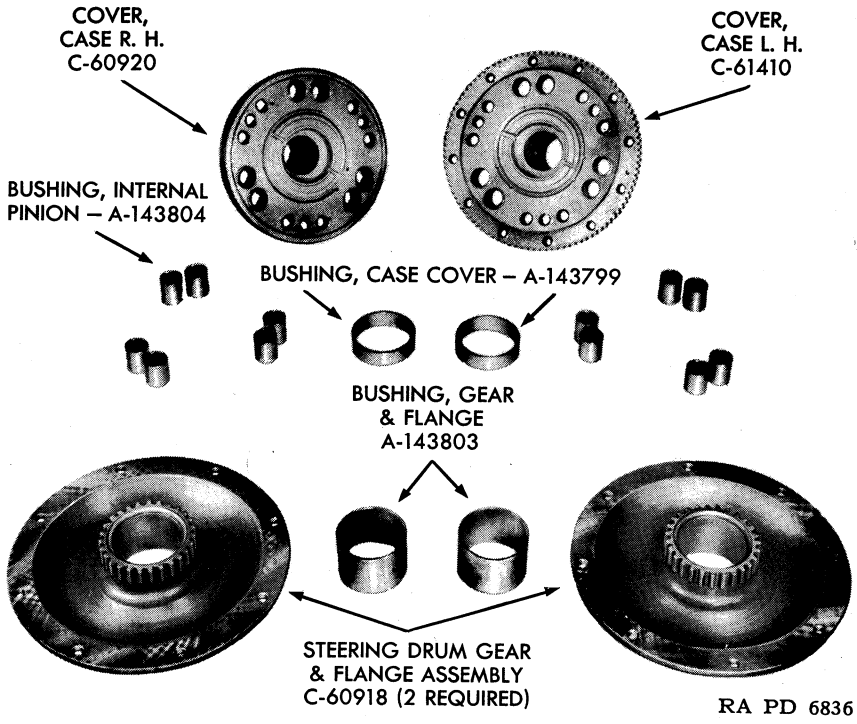


FIGURE 42—Parts of differential covers and flanges.

tap on the two shafts as before, driving them out of their respective gears and, at the same time, separating the pump cover from the body. The idler shaft, with the outside gear in place, will remain in the cover. Remove cover-to-body shim and tag.

b. Inspection. — Carefully clean all parts with dry cleaning solvent. Be certain that all surfaces and passages in the base, body and cover are cleaned down to the metal. Carefully clean and dry shims. Check all gears for tooth wear and fracture, and replace any found defective. Check idler GEARS (A143720) on shaft. If the clearance between the BUSHING (A143719) and the shaft, exceeds .005 in. replace the bushing. Try the drive shaft in base and cover BUSHINGS (A172336) and, if over .005 in. loose, replace bushings.

c. Repair and assembly. — Replace bushings. Drive or press drive shaft bushings out of pump base and cover. Install new bushings and ream to an inside diameter of .4995-in. Press idler gear bushings out. Install new bushings and ream to an inside diameter of .5020-in. Faces of cover, body, and base must be well cleaned with solvent and smoothed as necessary. This can be done by light filing all the way across the face or faces of each part. Assemble the pump by reversing the sequence of disassembly steps. If oil pump test equipment is available similar to that shown in figure 110, the pump should be bolted to it and allowed to run for at least 30 minutes at about 800 rpm. At or above 620 rpm. the pump should deliver 2 gpm. against 30 psi. with oil at 200°F. This will insure against the possible necessity of a second removal and installation due to malfunction after overhaul of the pump.

19. Output shaft *(figs. 45 and 46).—a. Disassembly.*—Except for the removal of fourth speed gear and snap ring this disassembly is done as the output shaft was removed from the transmission case. Use snap ring pliers and remove snap RING (A170341). Remove fourth speed GEAR (C68503) with needle BEARINGS (A170349) and COLLAR (B157703), keeping gear, collar and bearings together as an assembly and place with second, third and fifth speed gears.

b. Inspection. — Clean shaft well and very carefully brush out threaded portions. Clean oil holes and clear with compressed air. Examine shaft at points where second and fifth gears run. If mutilated or scored replace shaft.

20. Output shaft gears and needle bearings *(figs. 46, 47 and 48).* — *a. Disassembly and inspection.* Second, third, fourth and fifth speed gears must each be treated as a separate assembly in order that each gear may be kept with its related collar and needle bearings. Remove collar and needles. Wash gear, collar and needles in clean dry cleaning solvent. Examine bore of gear, needles, and bearing surface of collar

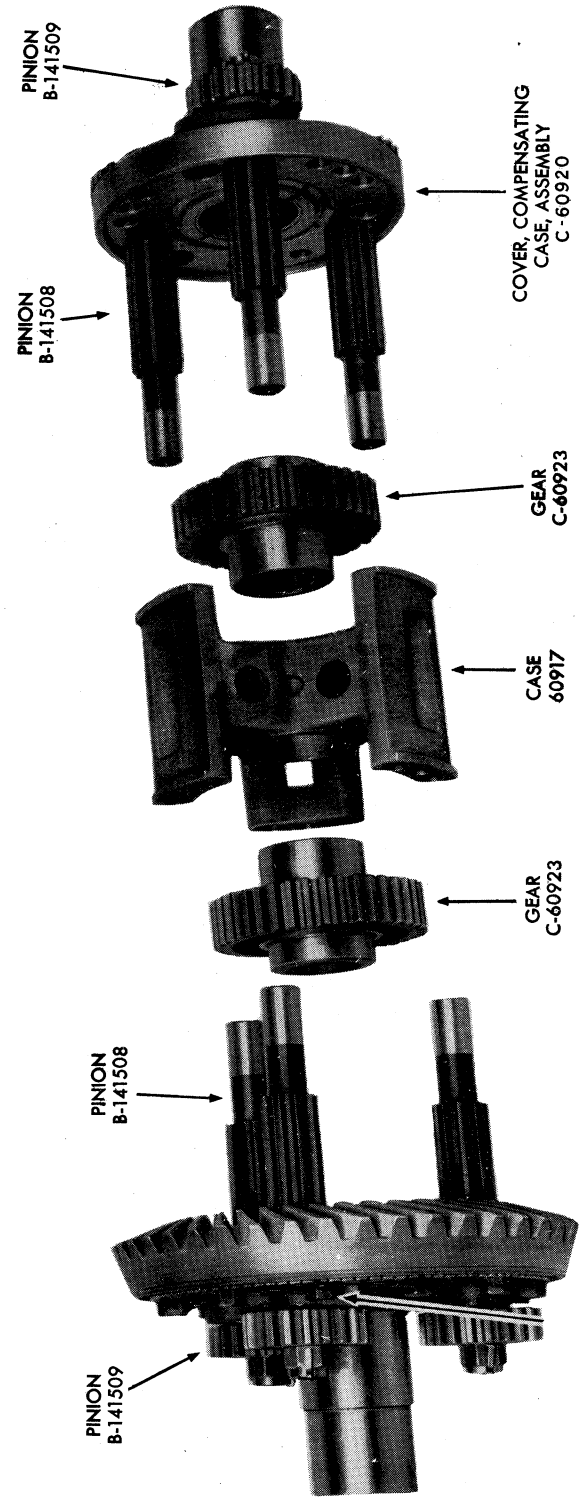


FIGURE 43—Differential and bevel gear assembly—partially exploded.

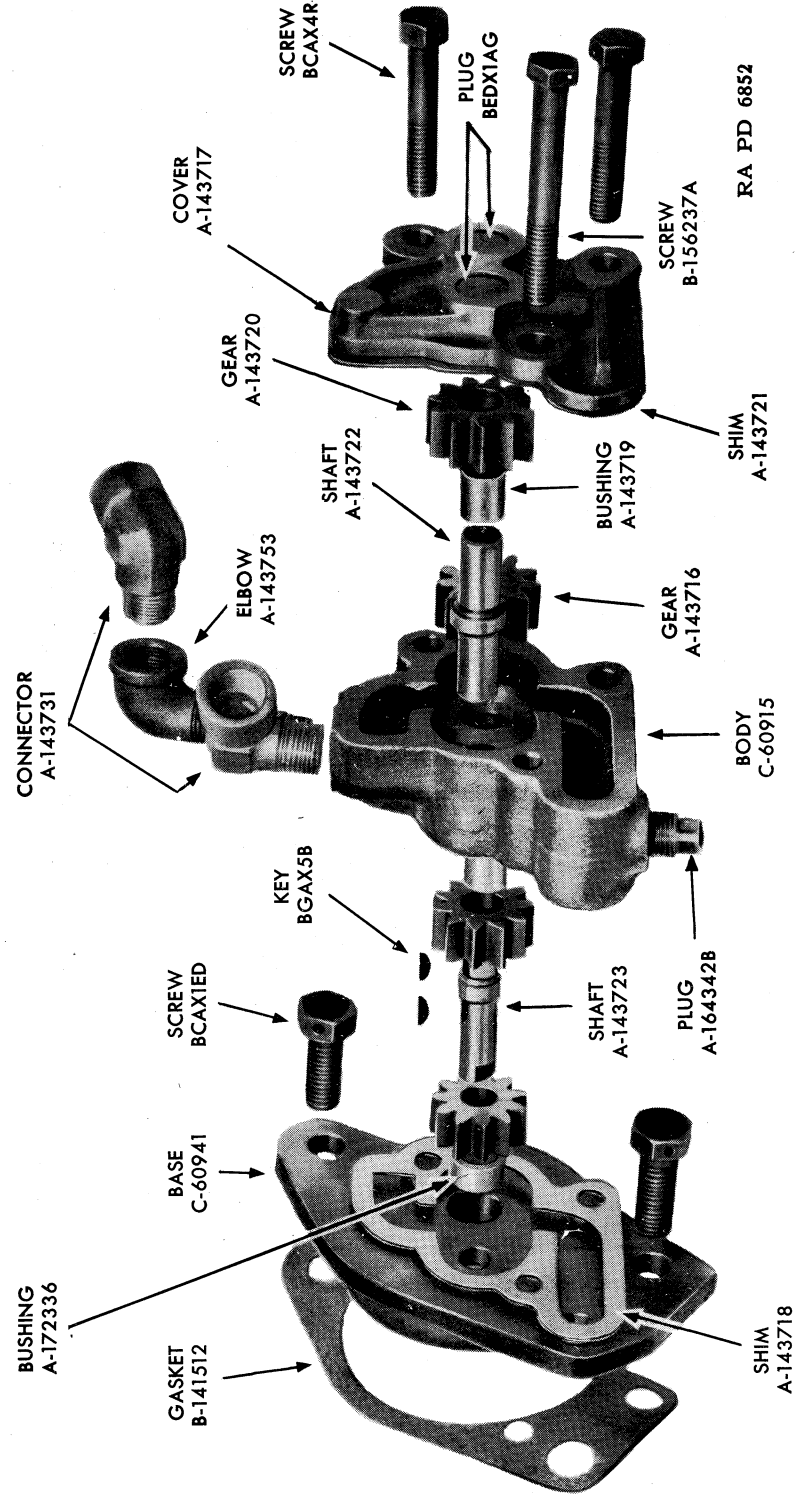


FIGURE 44—Parts of oil pump assembly.

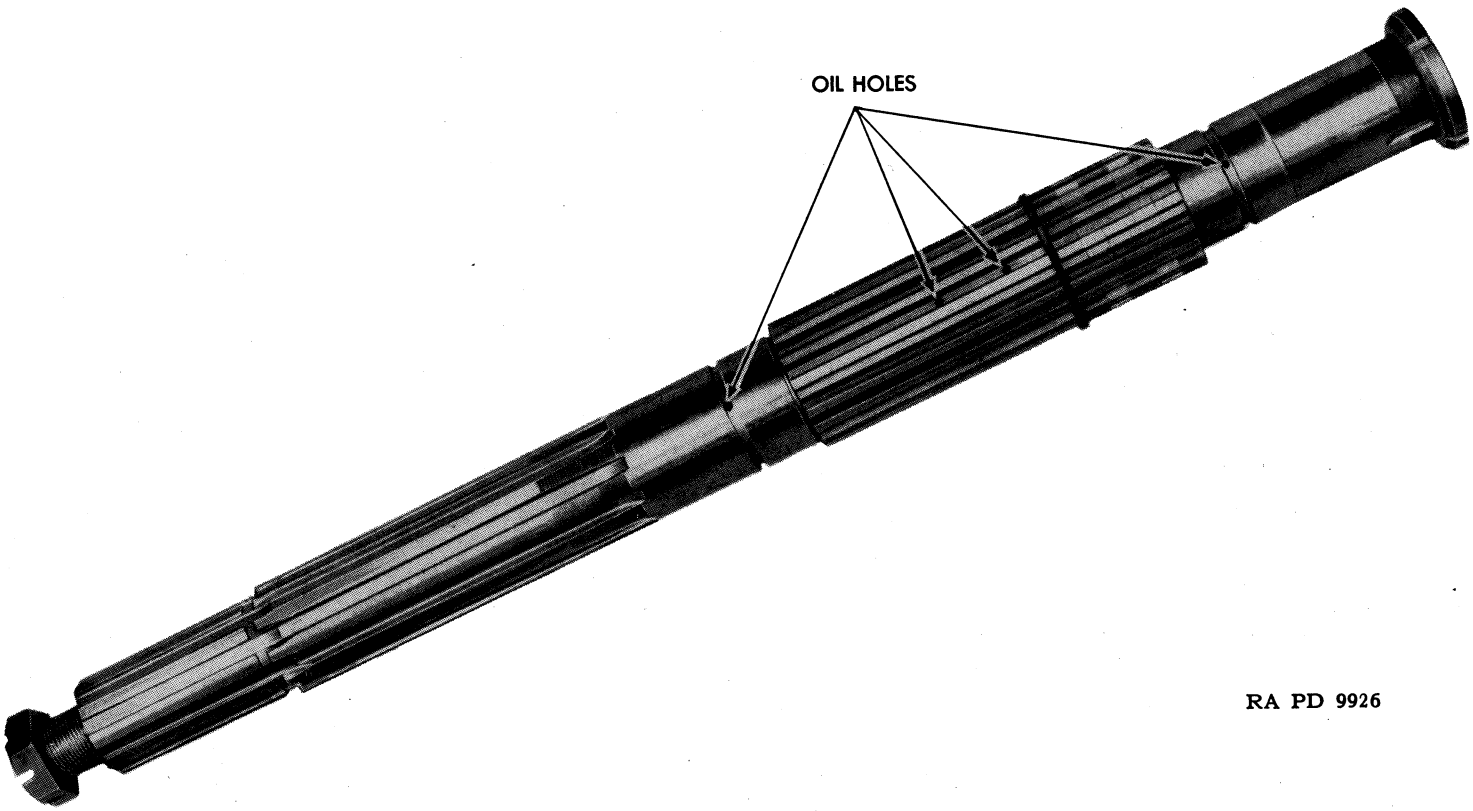


FIGURE 45—Output shaft showing needle bearing oil hole.

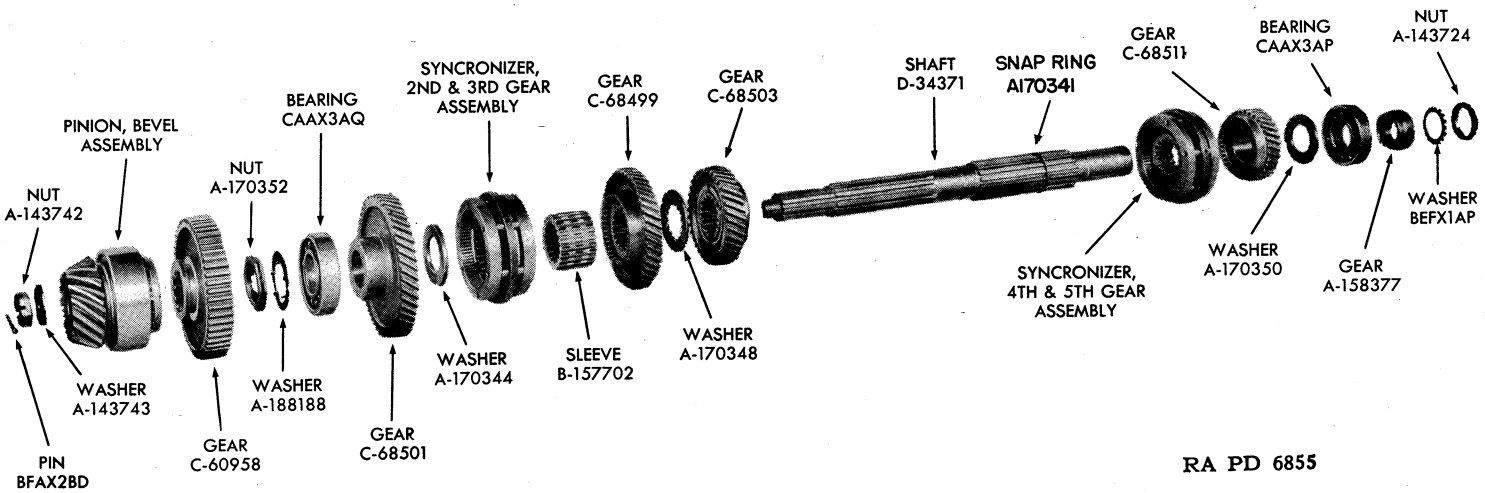


FIGURE 46—Parts of output shaft assembly.

for signs of scuff. Replace gear, bearings and collar if damaged or imperfect due to wear or scuff. Examine each gear. If teeth are chipped or broken, replace gear. Try each gear in all positions on its synchronizer clutch. If there is binding at any point due to a bur on a tooth, remove bur with a file or fine hand grinder. If any synchronizer clutch teeth or gear clutch teeth are broken, replace clutch or gear or both as necessary. Examine the teeth on low-reverse gear. Since this is a sliding gear its teeth are more liable to fracture and chipping. Try the gear on the splined area of the output shaft in the normal neutral position. The longitudinal motion of the face of the gear, with the hub held in a fixed position on the shaft, must not exceed .015-in. If 2nd, 3rd, 4th or 5th gear is replaced only because of broken or chipped teeth and an examination of the bore of the gear has disclosed no defect, the needle bearings and collar may be used in a new gear. If this is done all parts must be carefully measured to insure a correct over-all clearance between the collar with needles and the bore of the new gear. Twice the diameter of one of the needles added to the outside diameter of the collar must be .003-in. to .004-in. less than the diameter of the bore of the gear. Tolerances are such that micrometers must be used which are graduated to read in tenths of a thousandth. When using a new gear and the old needles and collars, check the overall length of the hub of the gear and the bearing length of the collar. The collar should be a minimum of .005-in. longer than the gear. Place the collar flange end down on a support and place the gear on it. With a straightedge across the face of the collar, check the clearance to the gear, using thickness gage.

b. Assembly of needle bearings, collar and gear (figs. 47 and 48). — Since the assembly procedures for the different gears and bearings are substantially similar and differ only in the size of the parts and the number of rows of needles used, the procedure which follows will deal with only fifth speed gear *(fig. 48)*. Cover the bench area to be used for the needle bearing assembly with a clean cloth. Set fifth speed GEAR (C68511) "B" in figure 48, on the bench with the cone side of the gear out as in step (1) in the illustration, so that the first row of needles will be placed in cone side "I" of the gear bore. Place the number of NEEDLES (A164557) required for the complete bearing "D" step (1) on the cloth in front of the gear. Install approximately one-half row of needles in the bore of the gear as shown at "C" in step (1) of figure 48. Set collar "A" in bore of gear on needles *with the shoulder of the collar on the cone side of the gear*. Holding the collar in place turn the gear so that it rests on the bench with cone "I" side down with the collar supported by a wood block *(step 2, fig. 48)*. Drop in the balance of the first row of needle bearings. Use one less needle than is required to fill the row. To determine the right quantity of needles use a $\frac{3}{16}$-in. rod "J" as shown in step (3), and fill the row until there is just sufficient space for the rod to be inserted. Oil the completed row of needles. Use the rod now to rotate the row of

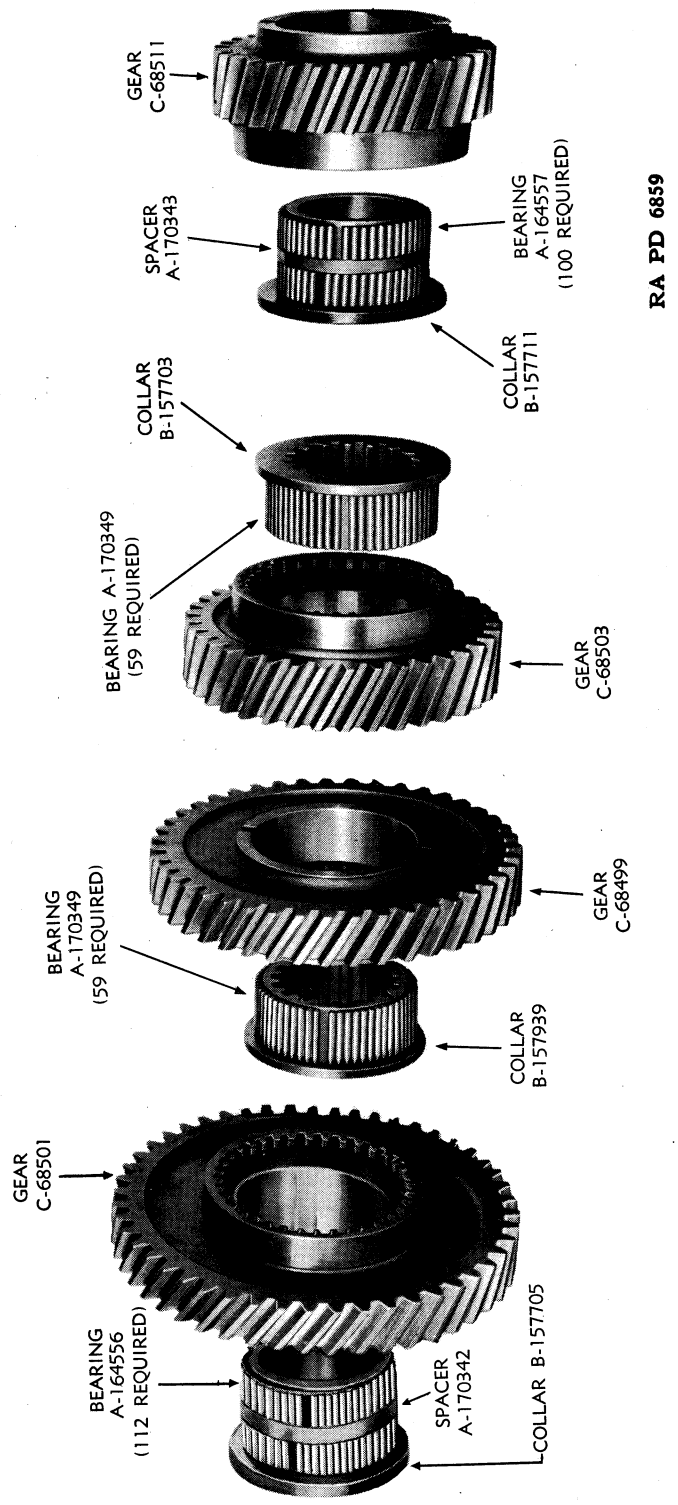
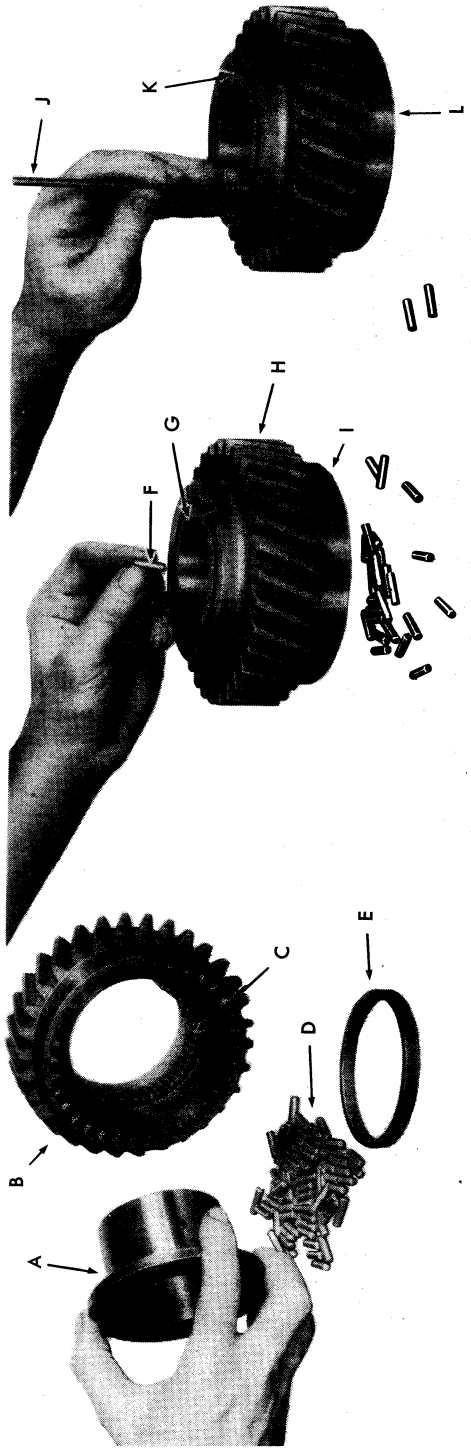


FIGURE 47—Output shaft gears with related bearings and collars.



STEP 1 — INSTALLATION OF NEEDLE BEARING COLLAR
A. NEEDLE BEARING COLLAR
B. 5TH SPEED DRIVEN GEAR
C. HALF ROW OF NEEDLES INSTALLED
D. BALANCE OF NEEDLES TO COMPLETE BEARING
E. SPACER

STEP 2 — GEAR, CONE SIDE DOWN, SPACER PLACED, BALANCE OF NEEDLES BEING DROPPED INTO PLACE.
F. NEEDLE BEARING
G. COLLAR
H. 5TH SPEED GEAR
I. GEAR CONE

STEP 3 — ALINING NEEDLE BEARINGS W/3/16-INCH ROD
J. 3/16-INCH ROD
K. NEEDLES IN PLACE
L. GEAR CONE

RA PD 7200

FIGURE 48—Installation of needle bearings.

needles to assure that all are in place. Remove rod and install spacer (*"E", step 1, fig. 48*). Drop in the second row of needles and again check with the rod to ascertain the correctness of the bearing. If a complete row of needles cannot be rotated easily the bearing lacks adequate clearance and must be remeasured and reassembled. With the bearing assembled, raise one side of the gear sufficiently to allow access to the shoulder of the needle bearing collar. Support the collar to retain the needles and raise the gear to a vertical position. Oil completed needle bearing thoroughly with a light oil. Cover each gear, when fully assembled, to exclude dust and store it so that it cannot be accidentally disassembled prior to assembly in the transmission.

21. Input shaft with gears *(figs. 49, 50 and 51).*—*a. Disassembly.* — Clean shaft and gears with dry cleaning solvent and wipe dry. Examine gears and shaft ends carefully before disassembly. If gears and shaft are in good condition there will be no need to disassemble. If fourth or fifth gears are damaged or a closer examination of the shaft appears to be necessary, proceed as follows. Place input SHAFT (D32707) with gears in hydraulic press with fifth gear supported by press bars as shown in figure 49. Press shaft out of fifth speed GEAR (C60944) while a second man supports the shaft from below to avoid damage to the shaft through falling. Remove two Woodruff KEYS (BGAX3H) and lift off SPACER (A143794). Replace shaft in press and remove fourth speed GEAR (C68506) as described above. Remove remaining two Woodruff keys. If the replacement of fifth gear only is in question, fourth gear need not be disturbed.

b. Inspection. — Carefully clean shaft with gears and fourth and fifth speed gears with dry cleaning solvent. Examine all gears for signs of fracture and all gear teeth for breakage or chipping. Check keyways and keys for fit. Check shaft ends where they ride in front and rear bearings *(fig. 50).*

c. Assemble (figs. 50 and 51). — Install Woodruff keys in shaft for fourth speed gear. Support fourth speed gear in a hydraulic press with the longer hub down. Start shaft down through gear with keys in shaft alined with keyways in gear. Press shaft into gear all the way. Install spacer. Install keys as for fourth speed gear and press shaft into fifth speed gear, also with longer hub down.

22. Reverse gear shaft with bearings *(fig. 52).*—This SHAFT (C60955) was removed from the transmission with BEARING (CABX1AP), snap RING (A143734) and reverse idler GEAR (B141510) in their respective positions on the shaft.

a. Disassembly. — Tap reverse idler gear off shaft spline. If necessary support the smaller gear in a press and press the threaded end of the

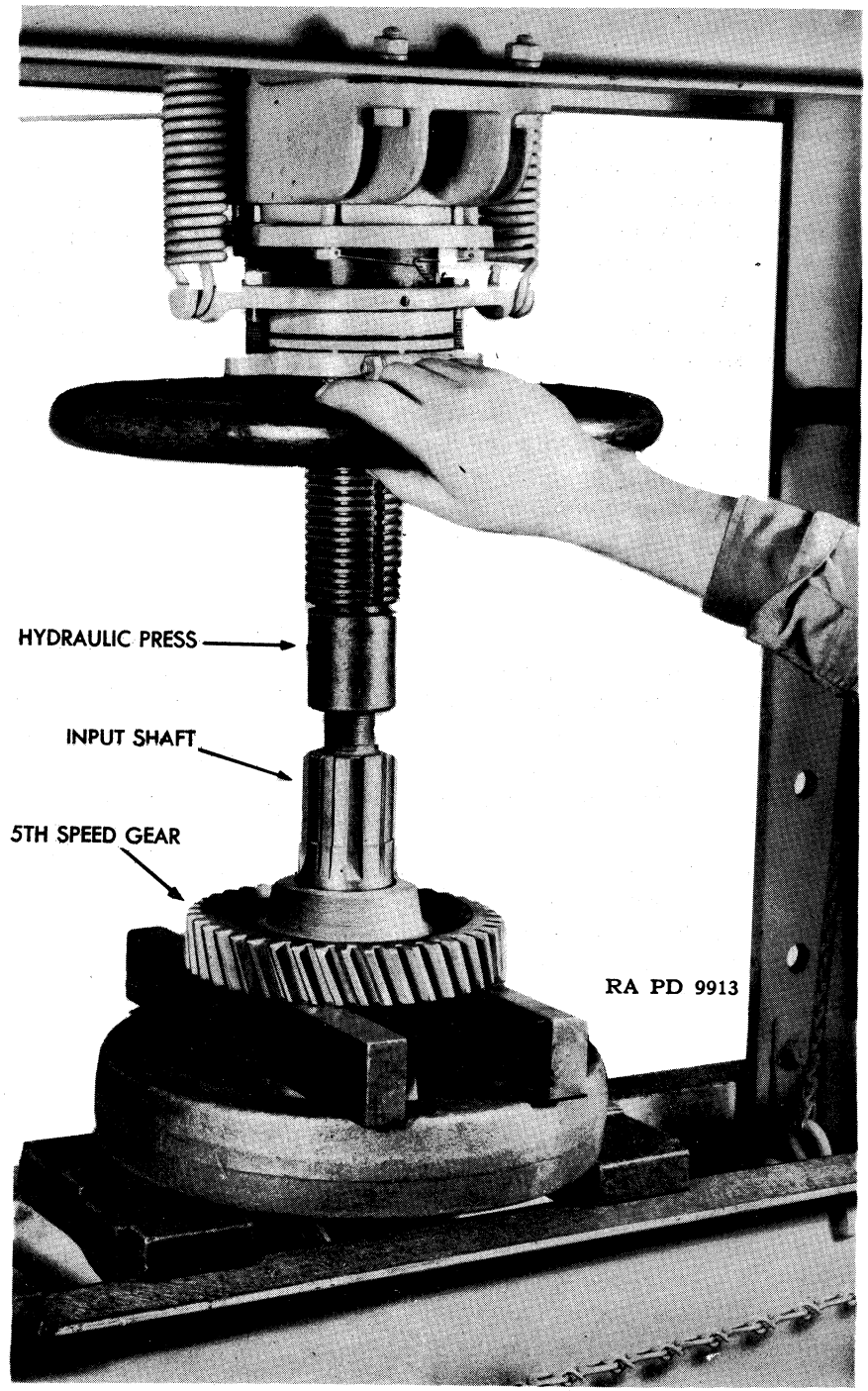


FIGURE 49—Removal of fifth speed gear from input shaft.

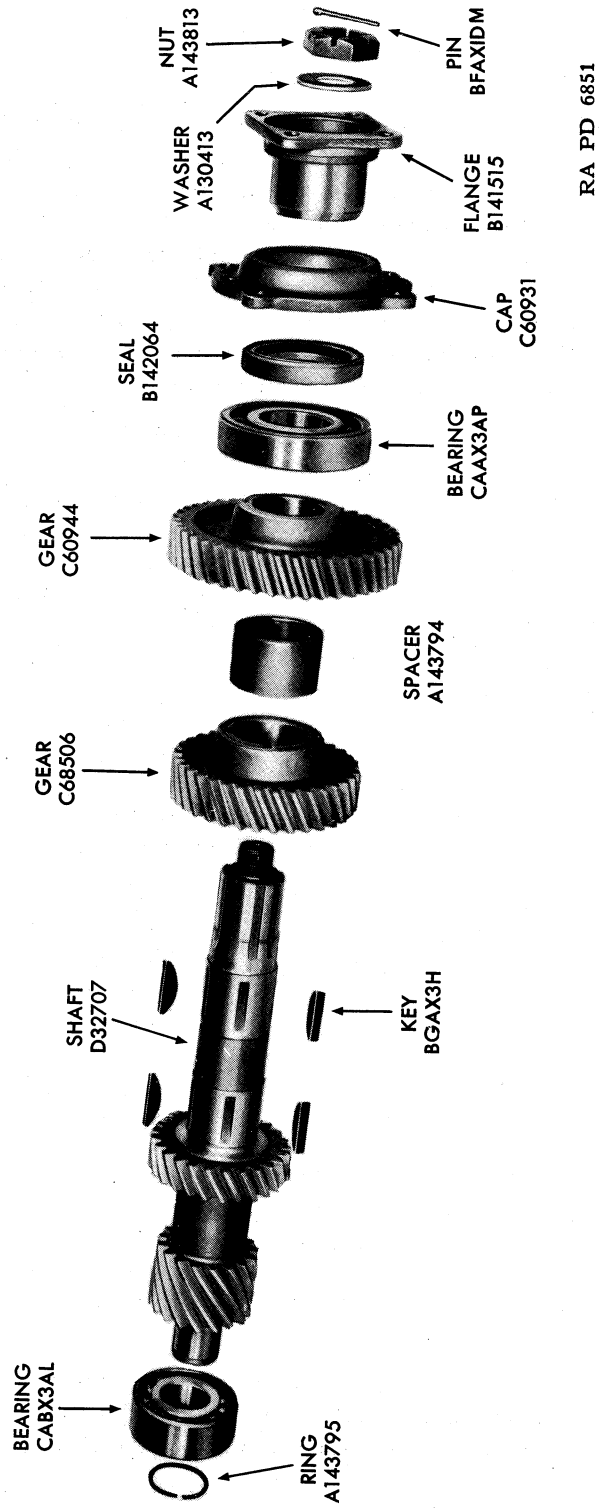


FIGURE 50—Parts of input shaft assembly.

shaft out of the gear. Use snap ring pliers and remove the snap ring in front of the rear bearing. Using a soft drift through the three ¾-in. holes in the large gear, tap bearing off shaft.

b. Inspection (fig. 52). — Clean gears and shaft carefully with clean solvent. Wash and inspect bearing as described in paragraph 25. Examine gear teeth for signs of fracture or actual breaks, or chipping. Check the reverse idler on the shaft spline and note whether it is a tight fit. If loose on the spline replace the gear or shaft or both as needed. Check the bearing seats on the shaft for signs of abrading. If shaft is roughened at these points replace shaft and examine bores of bearings to insure that the inner rings of the bearings are not abraded and have not been turning on the shaft. If abrasions are present replace the bearing.

c. Assemble. — Place shaft on bench, splined end up. Make sure that rear bearing seat is clean and be very sure that fillet is free of foreign material. Coat bearing seat lightly with oil. Place bearing in press with support under inner ring of bearing. Press shaft into bearing until shoulder comes up solidly against inner ring of bearing. If no press is available set bearing in place and using an iron pipe of the correct size over the shaft against the inner ring of the bearing, drive bearing on shaft until up against shoulder. Install snap ring. Use a soft hammer and drive the reverse idler gear onto the spline and up to the shoulder. The reverse gear shaft is now ready for assembly in the transmission.

23. First speed shaft with gear and roller bearings.—*a. Disassembly.* — Slide roller BEARINGS (A143821) out of first speed drive GEAR (C60954) and wash in clean solvent (par. 25).

b. Inspection (fig. 53). — Inspect all rollers for abrasions or other imperfections. Clean gear and inspect the bore for wear or roughness. Examine gear teeth carefully on the meshing side and if broken or chipped, replace the gear. Inspect shaft for worn bearing seats. After the shaft is cleaned and after the bearings and gear have been inspected, oil all parts lightly and assemble the bearings and gear on the shaft. Check for wear, or roughness of the bearings and gear by rotating them on the shaft. Replace unserviceable parts.

24. Bevel pinion with bearing *(fig. 54).*—*a. Disassembly.*—Hold PINION (C60939) in a vise equipped with copper jaws. Unlock lock WASHER (BEFX1AX). Use an adjustable spanner *(fig. 14)* and remove retaining NUT (B141513). Remove pinion from vise and tap threaded end on a face plate to remove BEARING (CABX1AX). Remove SHIMS (B141531) and tie and tag for assembly.

b. Inspection. — Wash and inspect bearing as described in paragraph 25. Clean shaft and pinion teeth and carefully examine pinion for tooth wear, tooth contact and for fracture or chipping of teeth. If the pinion

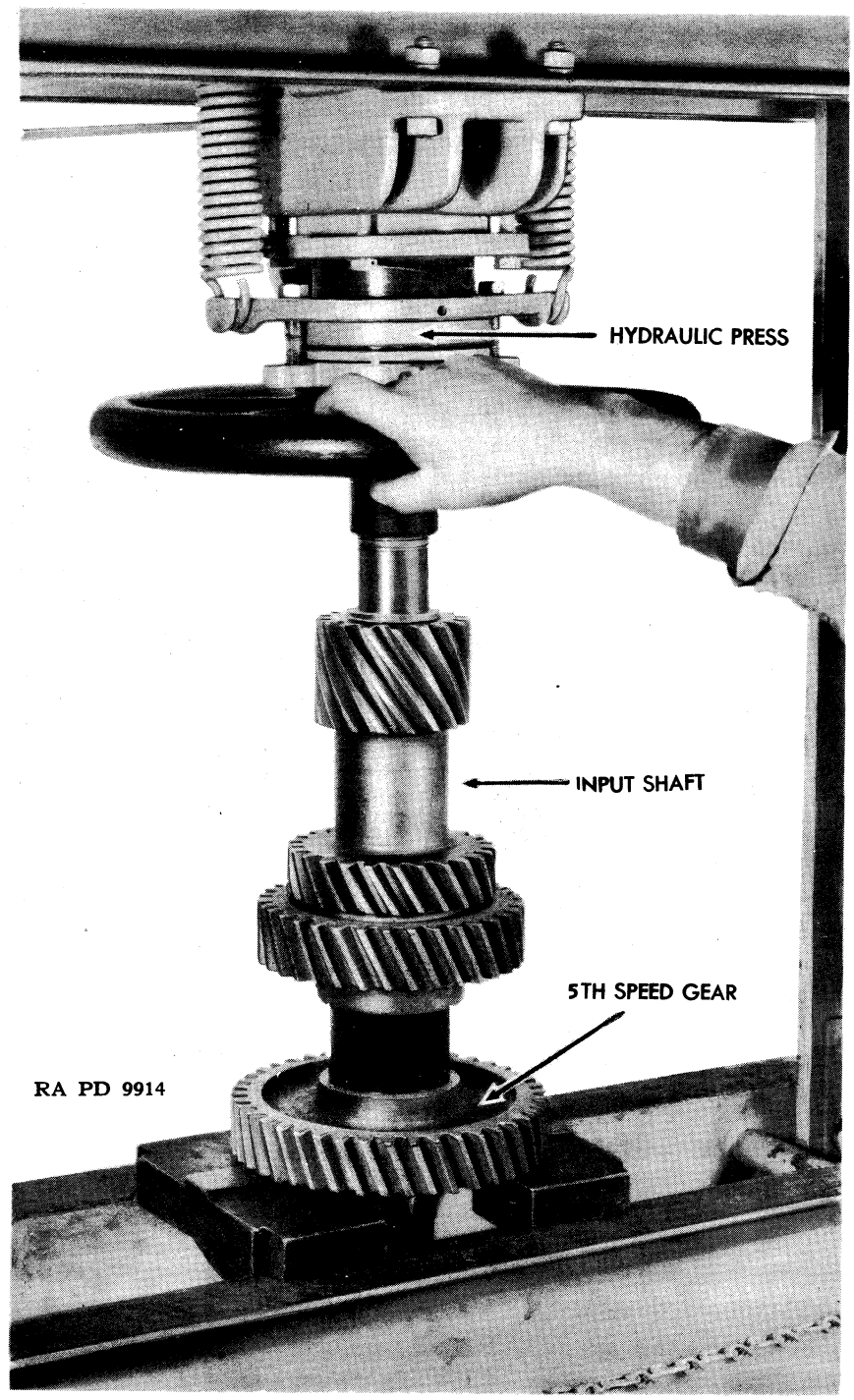


FIGURE 51—Installation of fourth speed gear on input shaft.

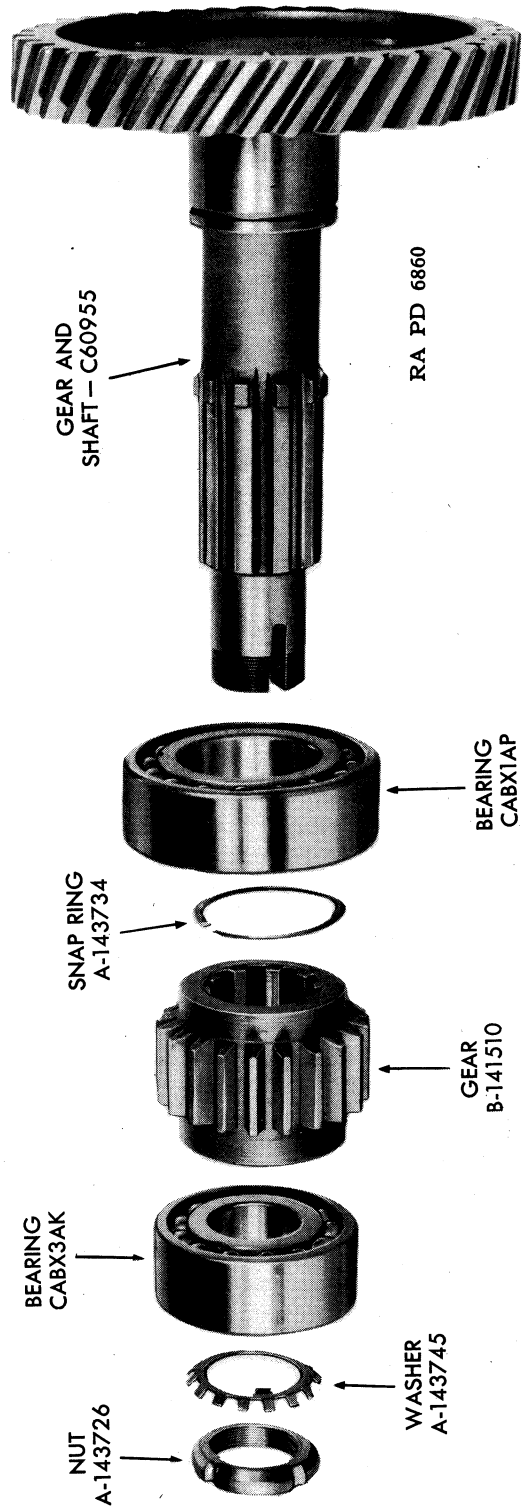


FIGURE 52—Parts of reverse gear shaft assembly.

teeth show abnormal wear due to improper tooth contact or inadequate lubrication, replace pinion and bevel gear (par. 14 *b* [29]). Never attempt to use or to readjust a bevel pinion or a bevel gear that shows any appreciable wear due to an earlier maladjustment.

c. Assemble. — Secure pinion in a copper jawed vise as in the disassembly. *Wipe shims carefully with a clean cloth* and place them on the pinion shaft against the shoulder. Start pinion bearing on shaft and tap lightly until the bearing comes up solidly against the shims. Put washer in place so that the key of the washer rides the groove in the shaft. Install retaining nut and tighten with an adjustable spanner having an 18-in. to 24-in. handle. Lock retaining nut by bending ear of washer so that it engages one of the slots in the nut. Wrap the assembly in a clean cloth or paper until it is to be installed in the transmission.

25. Ball and roller bearings.—*a. General.*—The operation of the transmission as a whole may well depend on the condition of all or any one of the bearings which supports the different shafts and carry the total power load. Very few bearings removed in the course of service work are entirely free from all traces of dirt or foreign matter. In a large number of cases there is enough dirt present to affect the "feel" of the bearings. After demounting, the inner rings, which were press fitted, contract slightly; the bearing will be looser and dirt can more readily work between balls and raceways. Wrap bearings in any dry, clean paper until they can be washed and relubricated, ready for inspection as to fitness for reinstallation. Use the following cleaning, inspection and assembly procedure in connection with all anti-friction bearings:

b. Cleaning. — Wash bearings in clean dry cleaning solvent. The bearings may be strung on a wire and sloshed in the solvent to remove oil or soft grease. Afterward they may be rotated by hand in solvent to complete the removal of old lubricant and dirt. Bearings that are especially dirty or filled with hardened grease may require a thorough soaking in order to loosen it to a point where it may be washed out. A light oil (SAE 10 or lighter) if heated to approximately 170°F makes a good bath for soaking and working out hardened grease. The lighter the oil, the better it will penetrate. If an air hose is used in cleaning bearings, the air must be free from dirt and contain no moisture.

(1) Before a bearing has been cleaned or while it is being cleaned, a certain amount of abrasive matter is very nearly always present. If an air hose is so directed as to spin a bearing, a very high speed can be attained and considerable scratching or scoring be done before the dirt is blown out. The correct method is to hold both rings against rotation while the air is directed squarely at the side or face of the bearing; that is, so that the hose is parallel with the bearing bore. When thoroughly cleansed, oil each bearing with clean new engine oil, and rotate

so as to distribute the lubricant to all surfaces. Following this, each bearing may be examined as to fitness for reinstallation.

(2) Sludge from transmission or rear axle oil forms a hard deposit in the bearings and requires a thorough soaking and washing in solvent to remove. This deposit makes a bearing feel rough because it clings tenaciously to the ball and race surfaces.

c. *Inspection.* — For some applications where especially heavy press fits are employed, single row bearings are furnished extra loose to accommodate the greater expansion which takes place in mounting. Therefore, because an unmounted bearing may feel quite loose it does not necessarily indicate that the bearing is unsuitable for remounting. Single row angular contact bearings are normally very loose when unmounted. The inner and outer rings of these bearings should be pressed toward each other when rotated, so as to bring balls and raceways into definite contact. Double row bearings should have no end play when the rings are rotated by hand and examined for condition. Looseness in this type is evidence of wear from abrasive dirt and such bearings should not be reinstalled. Owing to their greater width, double row bearings require especially thorough washing to remove dirt. In reoiling, work lubricant entirely through the bearings.

d. *Installation.* — Before pressing a bearing on a shaft that has been in service, always inspect the bearing seat for condition. If it shows evidence of scuffing or burnishing from the original bearing having turned, it should be checked for roundness and size. If a bearing has turned on a shaft enough to cause scoring, the metal from the bearing seat usually builds up a high spot which can cause trouble. Such high spots or abraded places must be trued up and if this reduces the diameter so as to give less than a light press fit, the shaft should be replaced. Before pressing a bearing on a shaft, wipe any grease from the bore and face of the inner ring. Clean the bearing seat on the shaft and be sure to remove grease or grit from the corner fillet and shoulder. Otherwise, grease and grit may be trapped, and prevent the bearing from making a perfect contact with the shoulder. An extremely light film of oil on the shaft will help in mounting. An arbor press should always be used if available. Start the bearing slowly to avoid cocking. In finishing, be sure that the inner ring is tight against the shaft shoulder. Tight or press fits on a revolving shaft are absolutely necessary to prevent bearing rings from turning. A clamping nut will not keep a loose fitting race from rotating, because in such a case the shaft acts as an internal gear inside the ring and drives it around. Slippage causes wear of both bearing bore and shaft with abrading or scuffing likely to take place.

26. Synchronizers *(figs. 55, 56 and 57).*—*a. General.*—The two synchronizer assemblies are similar in appearance and action but differ in that the second-third gear synchronizer is larger and rides on a sleeve

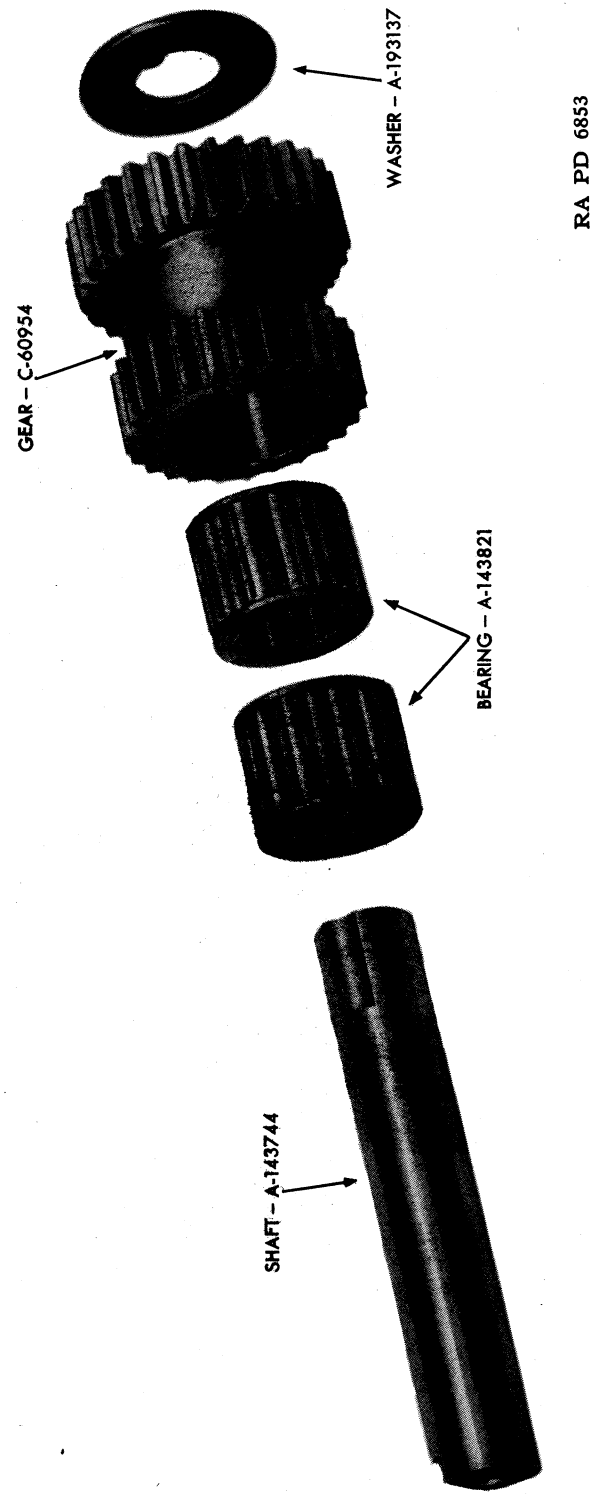


FIGURE 53—Parts of first speed shaft assembly.

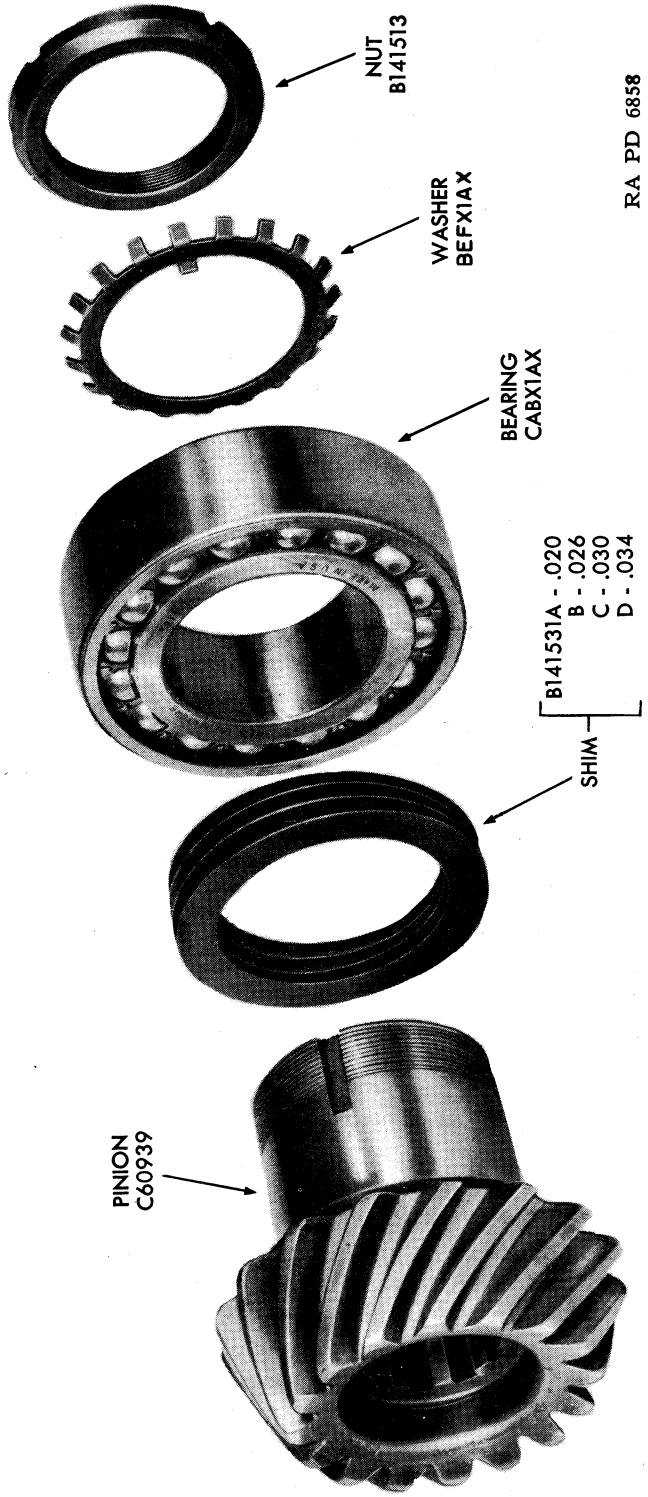


FIGURE 54—Parts of bevel pinion assembly.

which in turn is splined to and driven by the output shaft. The fourth-fifth synchronizer is carried directly on the spline of the output shaft. It is made up of a geared clutch PLATE (C73099) which, actuated by a shift rod fork, exerts pressure, forward or rearward through six cross PINS (A170333) on the bronze CONE (B157707). The cone is thus forced to contact the cone of the desired gear bringing that gear to a synchronous speed with the output shaft. The moment the speed of the two units is equalized the drag, or block, on the crosspin shoulders is released and the clutch gear rides across the pins and engages the geared portion of the gear cone, thus completing gear engagement.

b. Inspection (fig. 55). — The nature of the assembly makes it possible and important that the synchronizer be examined before disassembly. Wash thoroughly in clean solvent. Try the bronze plates on the cone of the related gear. If the gear cone is flush with, or extends beyond, the inner side of the bronze plate, replace the synchronizer. If the bronze plates show only slight scoring, and are otherwise serviceable remove the scoring with emery cloth and again check the plate for wear against the gear cone. Check action of poppet PINS (A170338) against cross pins. If the total assembly appears to be in serviceable condition, support it on first one plate and then the other and snap the clutch plate back and forth several times as a check against any roughness or malfunction that may have been overlooked in the first part of the inspection.

c. Disassembly (figs. 56 and 57). — If the inspection has shown the synchronizer to be unserviceable for any reason, replace the whole assembly. If a new assembly is not available proceed as follows with the disassembly of the old one and replace necessary parts. Place synchronizer in a drill press so that it rests on one of the bronze cone plates. Use a $\frac{3}{8}$-in. drill in each of the six holes in each bronze cone plate drilling to a depth of 3/64 in. to remove that portion of the cross pin which is riveted over. Run drill slowly to compensate for the semi-hardness of the cross pin. Drill all holes to the same depth. Remove from press and support the central portion of the synchronizer clutch on a metal block. Use a $\frac{5}{16}$-in. punch and, driving each pin a little at a time, remove all cross pins from plate. Remove the other plate with the cross pins from the clutch plate being careful not to lose poppet pins or springs which will then be released. Use a $\frac{5}{16}$-in. punch and drive the cross pins from the second plate.

d. Assemble (figs. 56 and 57). — Carefully examine clutch plate, poppet springs and pins before assembly. Clean out poppet spring holes and carefully inspect the polished surfaces of the holes where the cross pins ride. Be sure, if any parts are to be reused, that all such parts are serviceable. Place new bronze cone plate on a flat surface with the larger diameter of the cone surface of the plate down. Drive new cross pins into cone plate so that the flats on each cross pin will be perpen-

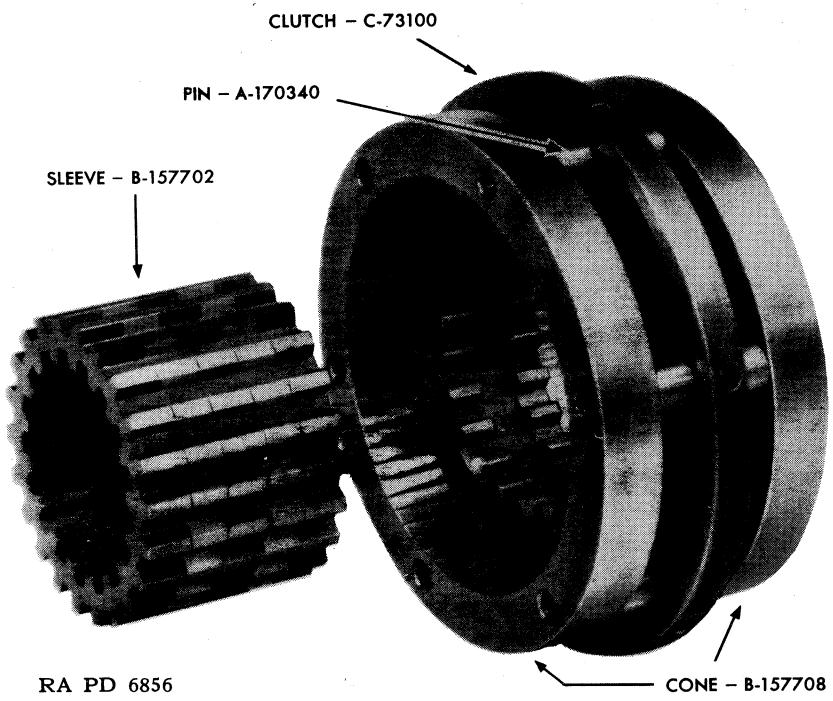


FIGURE 55—Second and third gear synchronizer and sleeve.

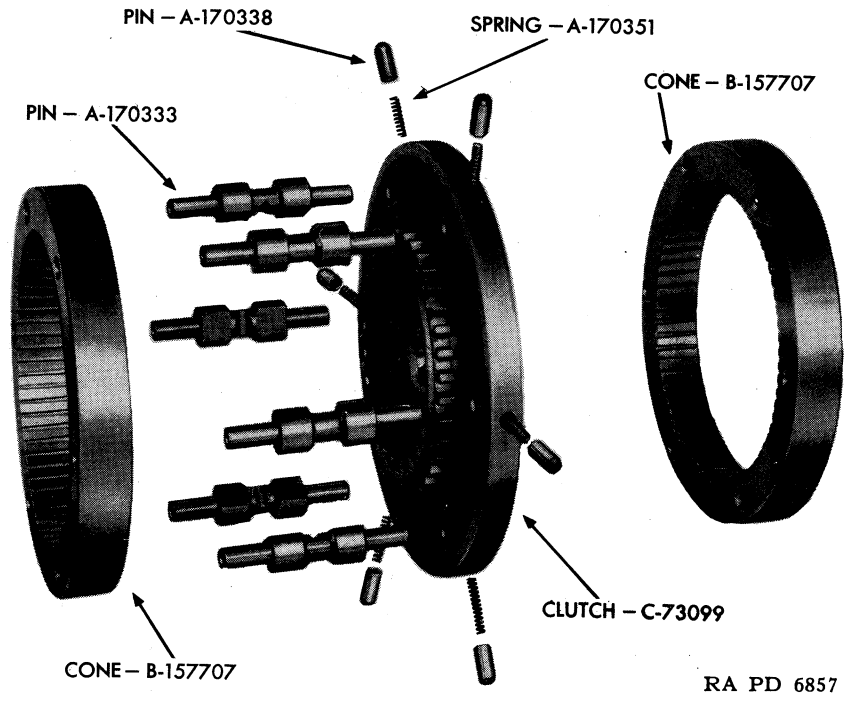


FIGURE 56—Parts of fourth and fifth gear synchronizer assembly.

dicular to a line drawn from the center line of the bronze plate to the center line of the cross pin. This may be easily checked as follows: with all pins in place, lay a steel scale, 1 in. wide, against the circular surface of the two pins on either side of pin being checked. The flat on the pin being checked, must be parallel with the edge of the scale. Holding the scale in position, turn the pin as needed to bring the flat to the desired attitude. Assemble all poppet springs and pins in clutch plate. Place clutch plate on newly assembled pins of bronze cone plate. Assemble other bronze plate over cross pins with large diameter of cone surface up. Rivet cross pins in plates using a $\frac{3}{8}$-in. steel ball. (One sharp blow with a 1-lb. hammer is sufficient.) Lubricate cross pins and poppet pins and snap clutch plate back and forth five or six times to check action.

27. Gear shift lever *(fig. 58).*—If it is desired to replace the gear shift LEVER (D37150) with ROD (B159987) assembly proceed as follows: Remove cotter PIN (BFAX1CC). Use a 1-in. socket and remove NUT (BBAX2B) from pivot BOLT (A170346). Remove lever with rod assembly. Replace bolt if worn more than .020-in. Reverse the sequence of the disassembly procedure to install the new assembly. If necessary to remove ROD (B159987) push the rod through the handle until PIN (A143737) is exposed. Use a $\frac{1}{16}$-in. pin punch and drive pin out of BUT-

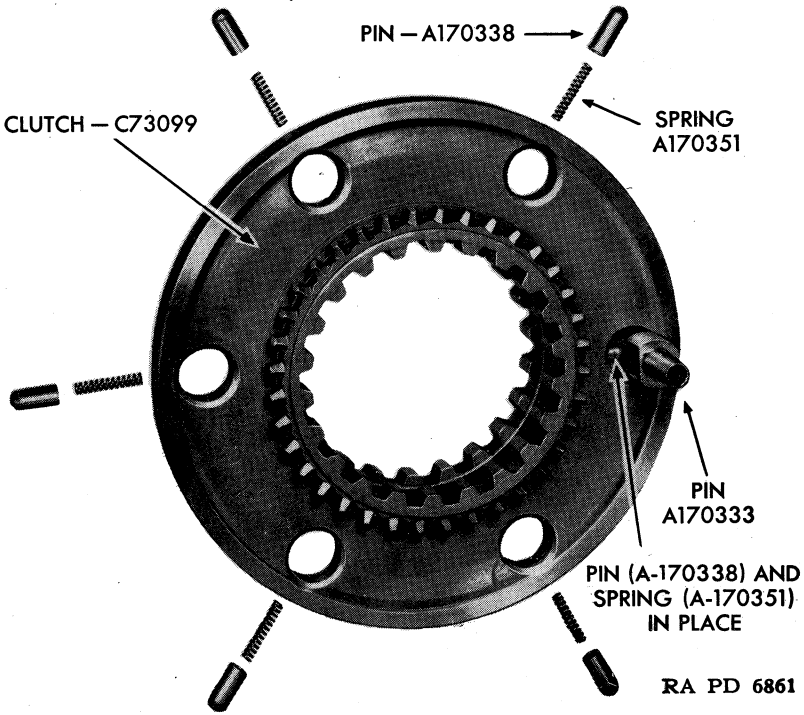


FIGURE 57—Parts of fourth and fifth gear clutch with pins and springs

TON (A170335) and rod. Remove button WASHER (A143758) and SPRING (A170328). Remove rod. Reverse sequence to reassemble. Do not disassemble the lever to remove the fulcrum PLATE (B157706) for examination or replacement. Depress the button in the lever and remove plate through the throat of the fulcrum block assembly (C90147). If the edges of the notch in the fulcrum plate are worn or rounded over in excess of 3/32 of an inch replace the plate.

28. **Steering brake hand levers** *(fig. 59)*.—Replacement of steering brake hand levers will usually be done by the using arm. However, the replacement and repair may at some time have to be done by ordnance personnel. Instructions given in this paragraph deal with replacement, disassembly, repair and reassembly of the steering brake hand levers.

a. Replacement of left steering brake hand lever.—When bent or broken the lever will be replaced as follows:

(1) Open battery switch.

(2) Remove gun firing switch clamp screw and loosen conduit retaining clips.

(3) Lay firing mechanism on vehicle floor.

(4) Remove steering lever clamping bolt.

(5) Remove lever.

(6) Install steering lever by reversing removal procedure.

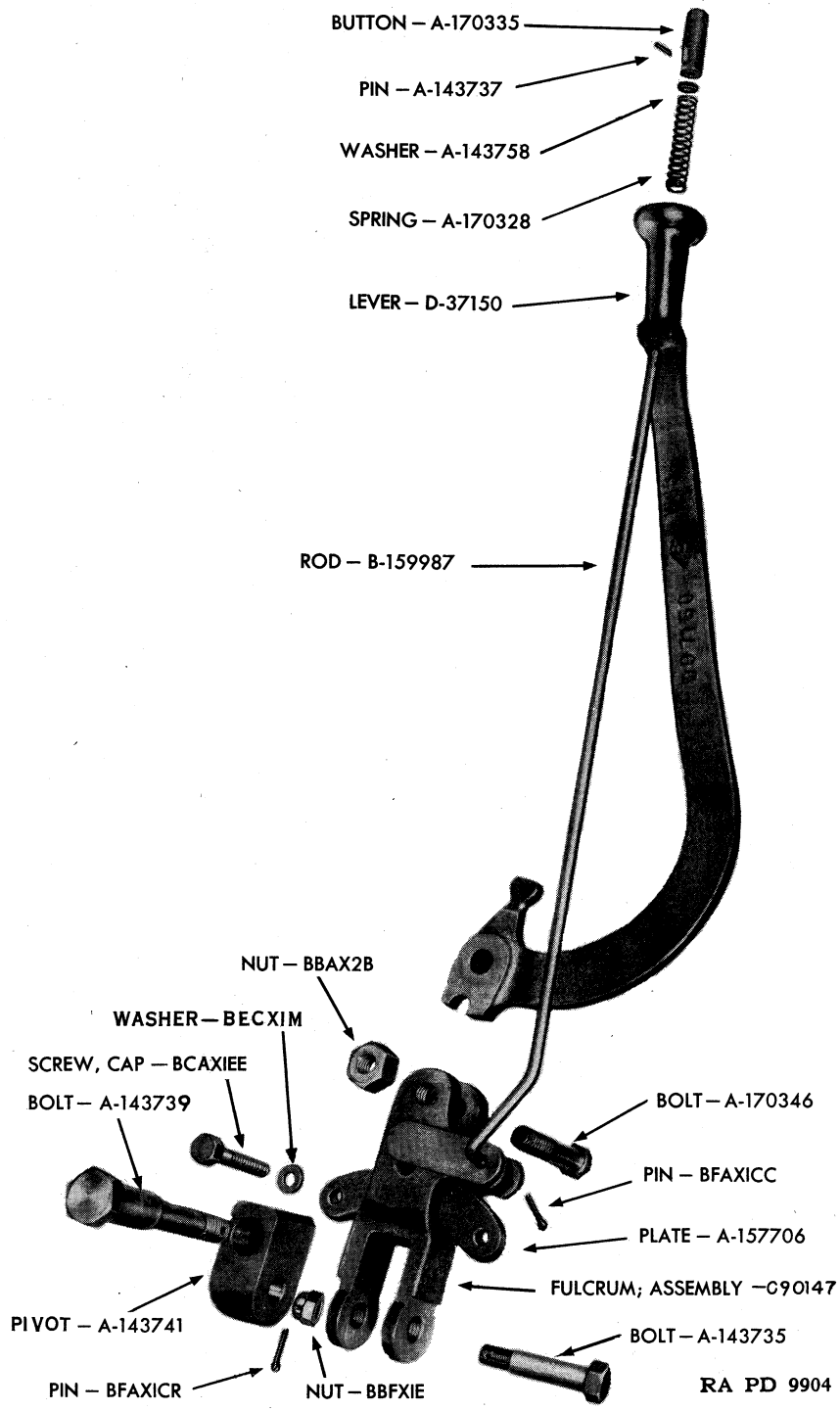


FIGURE 58—Parts of gear shift lever.

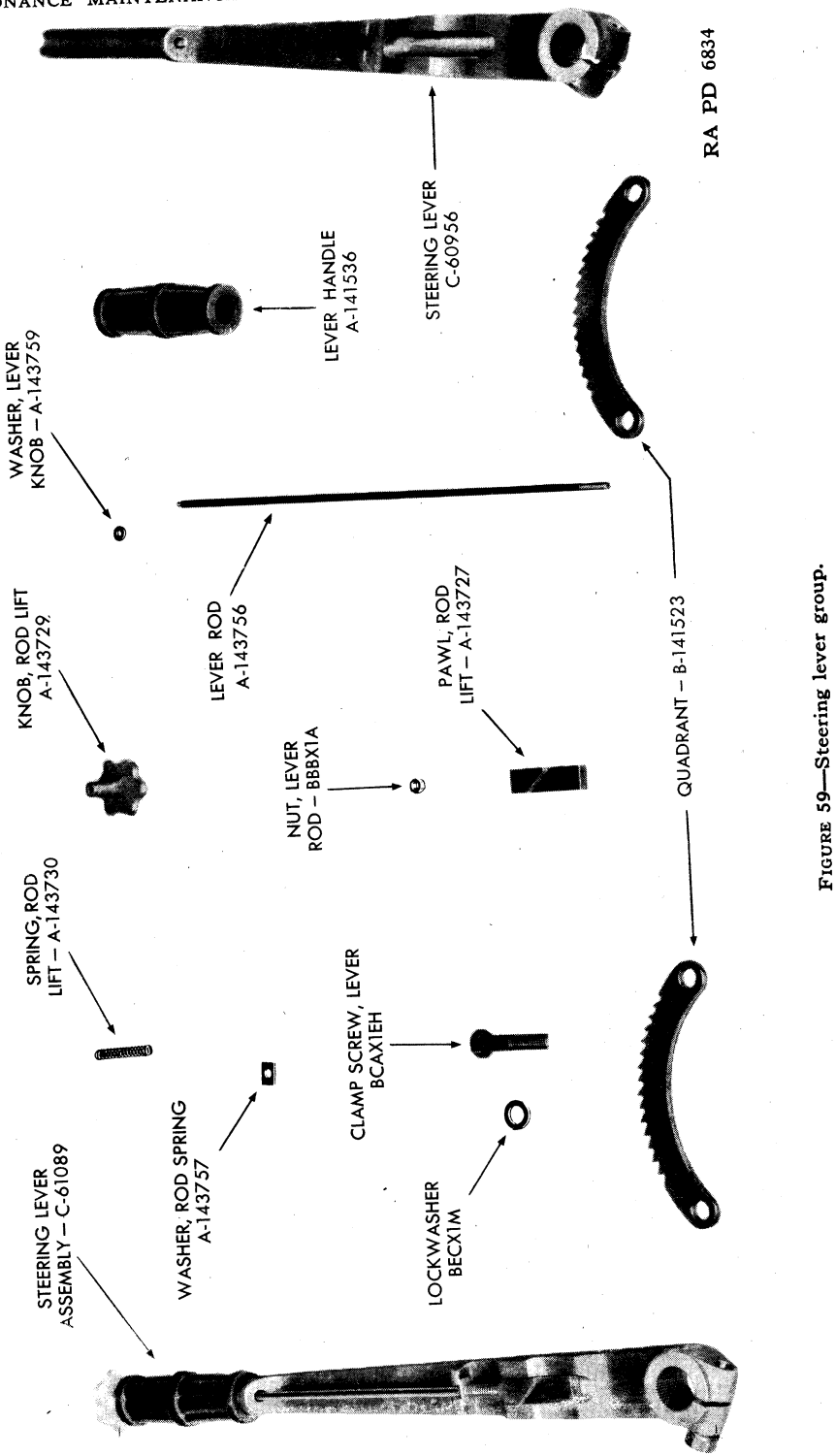


FIGURE 59—Steering lever group.

b. Replacement of right steering brake hand lever.—For removal proceed as in *a.* above, steps (1) through (4). Then disconnect brake lever connecting link in bow gunner's compartment and drive or pry shaft out of steering brake hand lever. Install right steering lever by reversing removal procedure.

c. Disassembly (fig. 59).—Press brake lever rod PAWL (A143727) toward HANDLE (A141536) compressing SPRING (A143730). Maintain pawl and rod in this position. Loosen lock NUT (BBBX1A) (5/8-in. wrench, open end). Screw lever rod out of pawl using a pair of pliers. Remove ROD (A143756) with KNOB (A143729) and WASHER (A143759). Clean all parts using dry cleaning solvent. Carefully check condition of pawl and the milled section of the lever where the pawl rides. If the pawl shows wear in excess of .020-in., replace pawl. Slight wear, or a slightly rounded edge at the point where the pawl engages the QUADRANT (B141523) can be cleaned up and made serviceable by grinding. Any excessive wear is sufficient reason to replace pawl. Examine quadrant and if broken or rounded teeth are noted quadrant must be replaced. Replace rod spring if spring is weak or broken. If the rod or knob alone is to be replaced, it is necessary to remove the headed-over portion of the rod where it secures the knob retaining washer. When the necessary parts have been repaired or replaced reverse the disassembly procedure for assembly.

29. Transmission case *(fig. 2).*—*a. Cleaning.*—Use live steam and clean inside of case thoroughly. Special attention should be given to the removal of hardened grease and scale which forms around bearing inserts and the various compartment openings. If necessary, scrub the stubborn portions of the case with a stiff brush and dry cleaning solvent, finishing the cleaning with live steam. Dry the inside of the case, bearing bores, and inserts for inspection.

b. Inspection.—Examine tapped holes at case ends where final drives are supported. Try a new cap screw of the correct size in each hole as a guide to condition of threads. All holes, where stripped or loose threads are found must be reconditioned as described in paragraph 30. Inspect oil seals at differential bearing bores. If damaged or if leathers are turned, replace seals. Examine outboard bearing insert SLEEVES (B141520) by trying a new drive shaft bearing in the bore of the sleeve. If a tolerance in excess of .004-in. is noted between the bearing and the sleeve, replace the sleeve.

30. Transmission case repairs.—*a.* Tapped holes *(fig. 60).*—A method of replacing cap screws in the transmissions of tanks, when the cap screws are found to be an excessively loose fit in the aluminum case, is available. A screw having a special thread form and used with a metal insert, is employed.

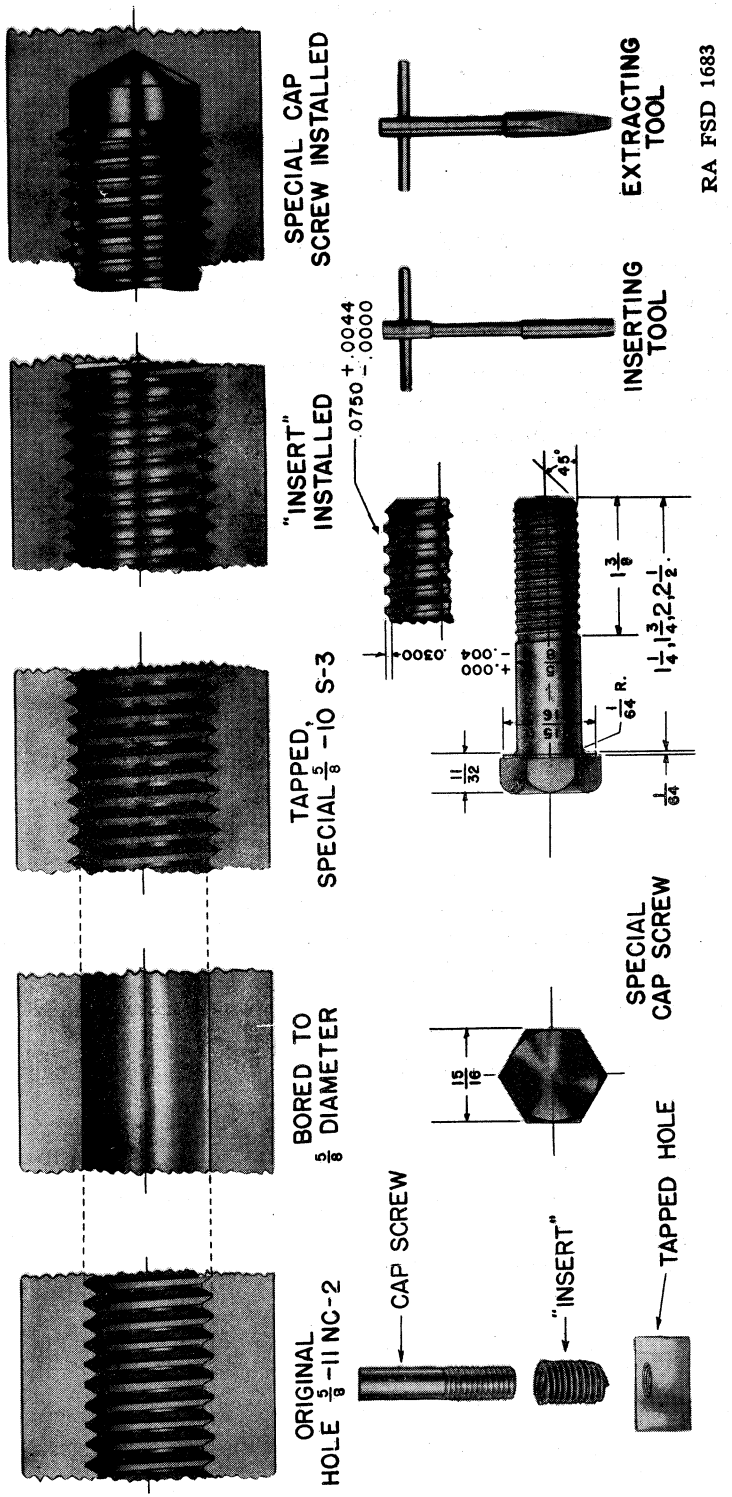


FIGURE 60—Aero-thread cap screws, inserts and installation tools.

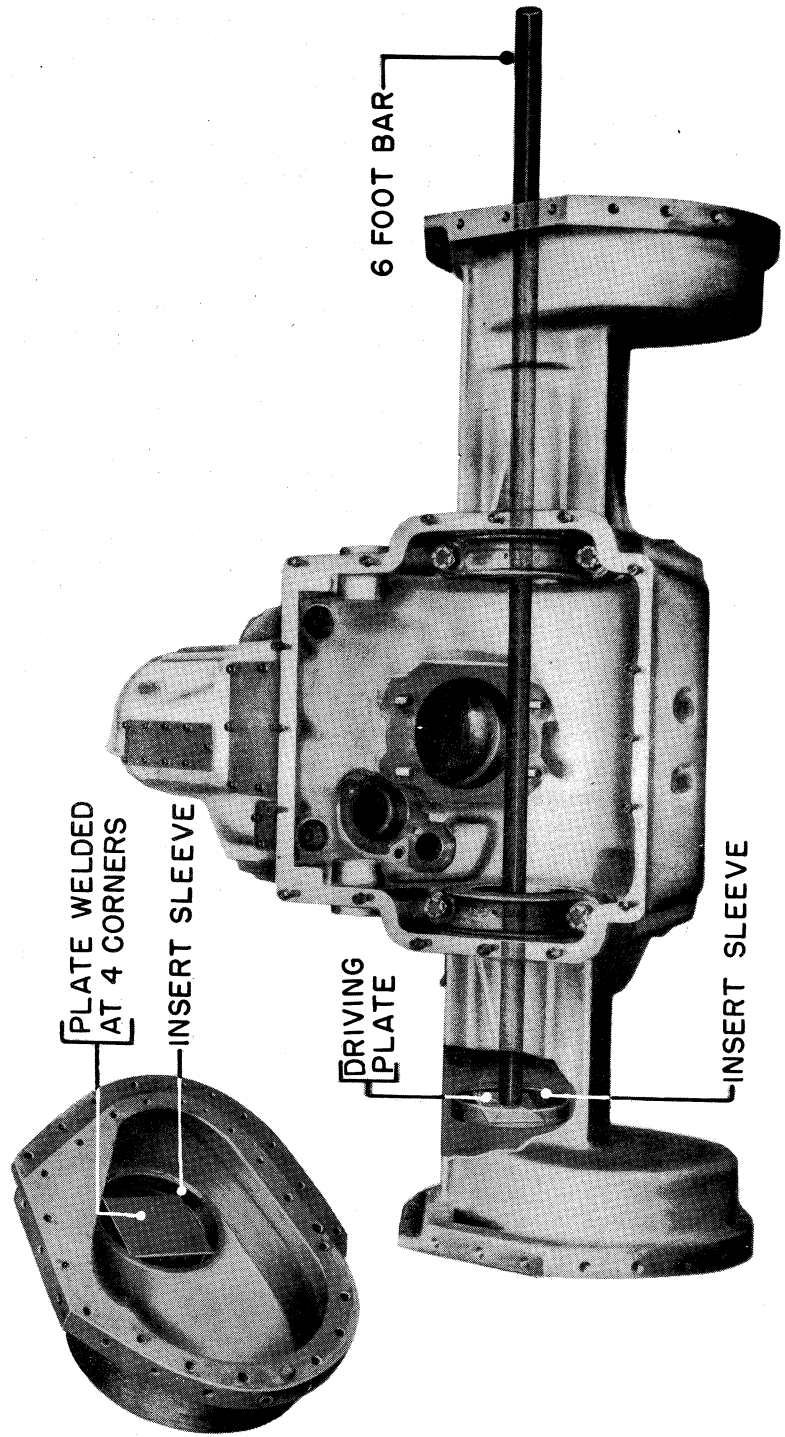


FIGURE 61—Removal of drive shaft bearing insert sleeve.

(1) When any cap screws fastening the final drive cases to the transmission case are found to be stripped, or considerably less than a "No. 2 fit", the hole will be bored to a 5/8-in. diameter and tapped with the special tap available for this purpose.

(2) Tap the 5/8-in. hole, full depth, using the special tap.

(3) Use the inserting tool, and screw the insert into the tapped hole, flush with outer edge of hole. The driving "lip" may be allowed to remain, but can be sheared off by a simple unscrewing movement of the inserting tool.

(4) Install the special cap screw in a normal manner, tightly.

(5) An extracting tool is available for use in removing insert. These inserts cannot be reused after removal.

(6) If not marked for ready identification when received, the head of each special cap screw should be marked by a series of center-punch marks, in order that this nonstandard condition may be readily noted upon subsequent overhauls.

b. Insert sleeve replacement.—Unserviceable outboard bearing insert sleeves are most easily removed when the following procedure is used. Cut a plate out of 1/4-in. stock to a dimension of (4 7/8 in. L. x 4 7/8 in. W. x 1/4 in. T.). Fit the square plate inside the sleeve bore so that each of the four corners contact, and are square with the bearing surface of the sleeve *(fig. 61)*. Arc weld plate at contact corners to sleeve and allow to cool. Use a 1 1/2- or 2-in. bar between 6 and 7 ft. long and, from the opposite side of the transmission, drive through the other sleeve, through the differential bearing bores against the plate *(fig. 61)*. Remove the insert sleeve. To prevent cocking of the sleeve being removed, one man, by tapping the high side with a hammer can keep the sleeve in alinement throughout the removal. CAUTION: Remove differential oil seals to avoid damage which might be done by the driving bar. To install a new sleeve use a soft drift and hammer and drive against the shoulder of the sleeve being very careful to keep the sleeve in proper alinement with the machined recess in the case. Insert sleeve must be driven in until it bottoms against the shoulder in the case. Installation of the sleeve by shrinking is preferred to the above method and should be used whenever the necessary materials (dry ice and alcohol) are available.

SECTION VIII

ASSEMBLY OF TRANSMISSION

Paragraph

Preassembly procedure 31
Assembly procedure 32

31. Preassembly procedure.—It is presumed that all transmission bearings and sub-assemblies have been inspected and that replacements have been made where needed. It is important now that each part or sub-assembly be re-examined before it is installed in the transmission case. Extreme care must be exercised in the handling of all parts and assemblies in order that they may take their respective positions in the total assembly clean and undamaged. Place a supply of clean lintless wiping cloths where they can be conveniently reached. Hands doing the work cannot be kept clean but they must be kept free of grit, sand or any foreign material that could damage a bearing or any of the closely fitted parts in the transmission. Use the list given in paragraph 32 and assemble all tools needed for the complete job. Tools required for any specific step are shown in that step. See that all tools are clean before the assembly is started. Keep the tools clean throughout the procedure.

32. Assembly procedure.—*a. Tool list.*

Block, wood
Bearing drivers, three
Brass bar, 4-ft. (1 1/2-in.)
Drift, flat soft, one
Drifts, soft, two
Driving sleeve
Gear block
Hammer, 1-lb.
Hammer, 3-lb.
Hammer, rawhide
Hammer, soft
Hoist
Pliers
Pliers, snap ring
Protractor
Rod, 1/4-in., 10-in. long
Scale, 12-in.
Screwdriver
Screwdriver, heavy, 16-in.
Special bearing block *(fig. 14)*
Special clamps
Special lifting hooks
Special spacers *(fig. 13)*
Square bar, 1-in., 3-ft. long bent to use as socket handle
Square rod, 1/4-in., with 90° angle
Wrench, 1/2-in., socket
Wrench, 9/16-in., socket
Wrench, 5/8-in., box
Wrench, 5/8-in., socket
Wrench, 3/4-in., open end
Wrench, 3/4-in., socket
Wrench, 7/8-in., open end
Wrench, 15/16-in., socket
Wrench, 15/16-in., open end
Wrench, 1 1/16-in., open end
Wrench, 1 1/4-in., socket
Wrench, 2-in., socket with 3-ft. handle
Wrench, 2 1/8-in., socket with long handle
Wrench, 2 3/8-in., special open end
Wrench, adjustable spanner
Wrench, special socket *(fig. 14)*
Wrench, first speed shaft socket

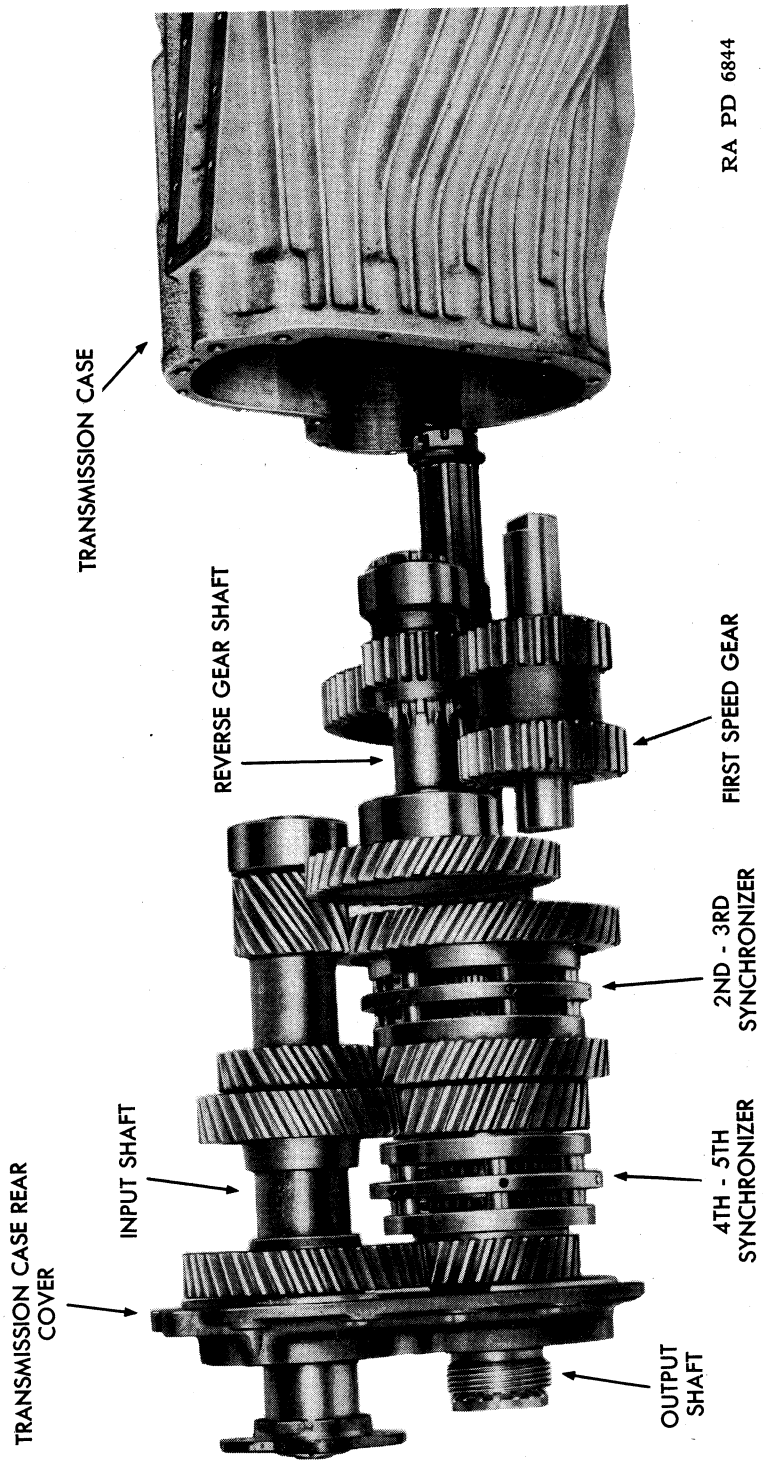


FIGURE 62—Transmission assembled out of case.

b. Assembly of transmission (fig. 62).—

(1) Install low-reverse shift rod and fork *(fig. 63).* — Pliers; Wrench, 5/8-in., box

Slide shift rod into case and into long boss of fork. Use a 5/8-in. box wrench to install and tighten two cap screws. Secure cap screws with locking wire.

(2) Install first speed drive gear.

Put first speed drive gear, with roller bearings installed, in place in case with smaller toothed portion toward the front. Place spacing washer between large portion of gear and case division. Do not put shaft in place yet.

(3) Install low-reverse sliding gear.

Lift fork as high as possible and place gear in fork. Shift fork groove, in gear, faces front of case *(fig. 72)*.

(4) Install reverse gear shaft front bearing. — Bearing driver; Hammer, 3-lb.

Use bearing driver and drive bearing into upper left hand bore as viewed from the front of the case.

(5) Install first speed shaft. — Hammer, rawhide; Wrench, first speed shaft socket

Support first speed gear so that bearing bores are alined to receive shaft. With a rawhide hammer tap shaft through from the front of the case until it is flush with the rear end of the first speed drive gear. Aline thrust washer tongue with groove in shaft. Drive shaft in. Note that the flat on the front end of the shaft must be turned to the correct angle to receive and be secured by the base of the oil pump *(fig. 36)*. To turn the shaft, use the special socket shown in figure 97.

(6) Install reverse gear shaft. — Brass bar; Hammer

Insert shaft assembly through rear bearing bore, meshing the reverse idler with the smaller toothed portion of the first speed gear. Drive the rear bearing into its bore and the shaft into the front bearing. With the shaft held at the rear, drive the front bearing in against shoulder on shaft *(fig. 52)*.

(7) Install lock washer and nut on reverse gear shaft. — Gear block; Wrench, special socket *(fig. 14)*

Block gears, placing block between idler gear and low-reverse sliding gear. Install washer and start nut on. Use special socket to tighten nut. Bend ear of lock washer to lock in slot of nut.

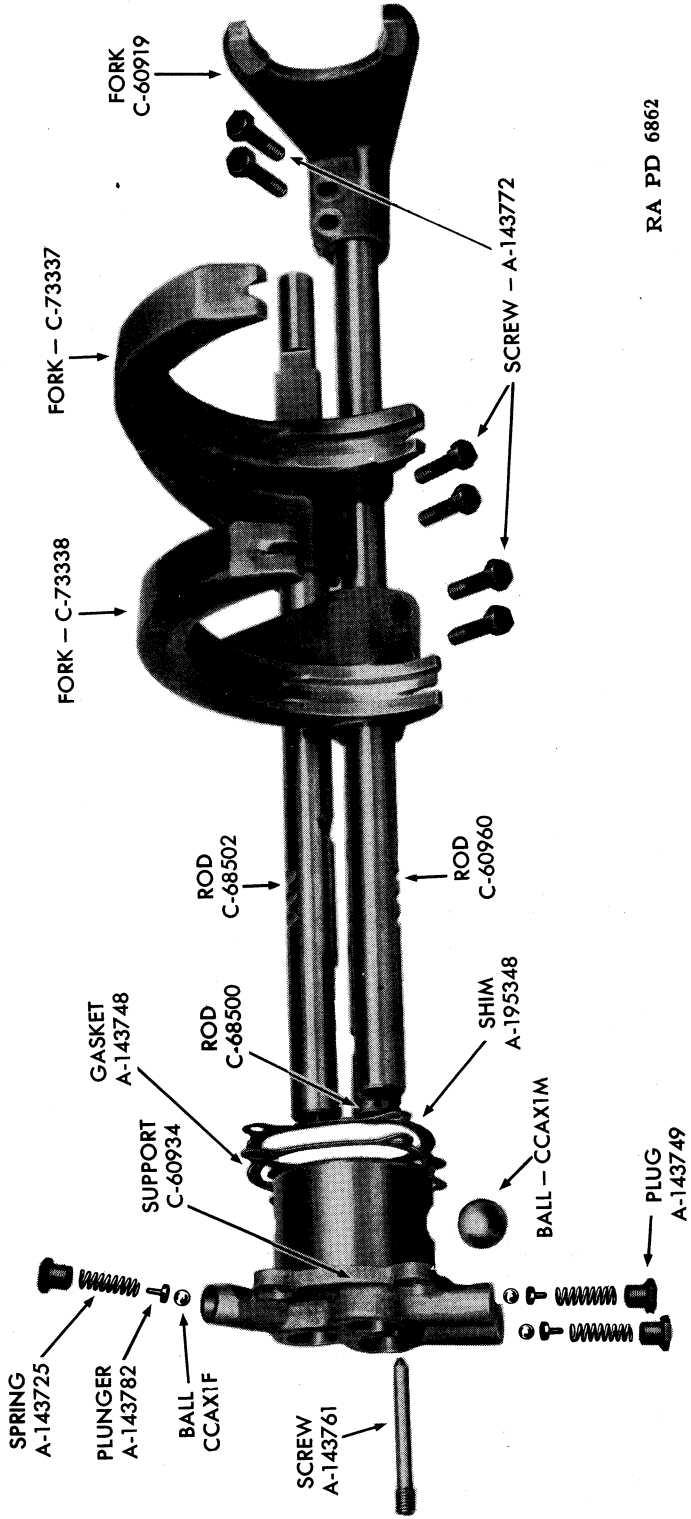


FIGURE 63—Shift rods, forks and support assembly.

(8) Replace oil screens and suction tubes *(fig. 36).*

Square rod, ¼-in., with 90° bend
Wrench, ⅝-in., socket

Place screens in proper place. Install cap screws (⅝-in. socket wrench) and secure with locking wire. Put tubes in place but do not secure clips until oil pump is installed. Use ¼-in. square rod (bent on one end to 90° for a handle) and install plugs in outer ends of cap screw holes.

(9) Install oil pump *(fig. 36).*

Wrench, $\frac{9}{16}$-in., socket
Wrench, ¾-in., open end
Wrench, ¾-in., socket
Wrench, ⅞-in., open end
Pliers

Install new gasket, cemented on both sides, on pump base. Turn first speed shaft so that side of oil pump base fits the flat on the first speed shaft. Install pump. Put two ½-in. cap screws in base and one ⅜-in. cap screw through cover and tighten (¾-in. open end, ¾-in. socket, and $\frac{9}{16}$-in. socket). Wire two ½-in. cap screws together and three ⅜-in. cap screws together using No. 16 wire. Pry fittings around as necessary and connect oil suction tubes. (⅞-in. open end wrench.)

(10) Install bevel pinion.

Brass bar or soft hammer
Wrench, $\frac{15}{16}$-in., socket

Start bevel pinion assembly into bore and tap into place with brass bar or soft hammer. Install bearing retainer plate over studs and secure with four nuts using a $\frac{15}{16}$-in. socket wrench. Safety four nuts with No. 16 locking wire by wiring two top nuts together and two bottom nuts together.

(11) Install input shaft front bearing.

Bearing driver *(fig. 100)*
Hammer

Tap input shaft front bearing in place from front of bore using bearing driver *(fig. 99A).*

(12) Replace output shaft center bearing.

Bearing driver
Hammer

Tap bearing in place from front of bore using bearing driver *(fig. 99).*

(13) Set in and block second speed gear assembly *(fig. 64).*

Block, wood

Tilt gear assembly, supporting needle bearing collar to avoid disassembly, and set it, gear cone to the rear, in transmission case against the output shaft center bearing. Support the assembly on a block of wood of a thickness to aline the bore of the gear assembly exactly with the bore of the output shaft center bearing *(fig. 64).*

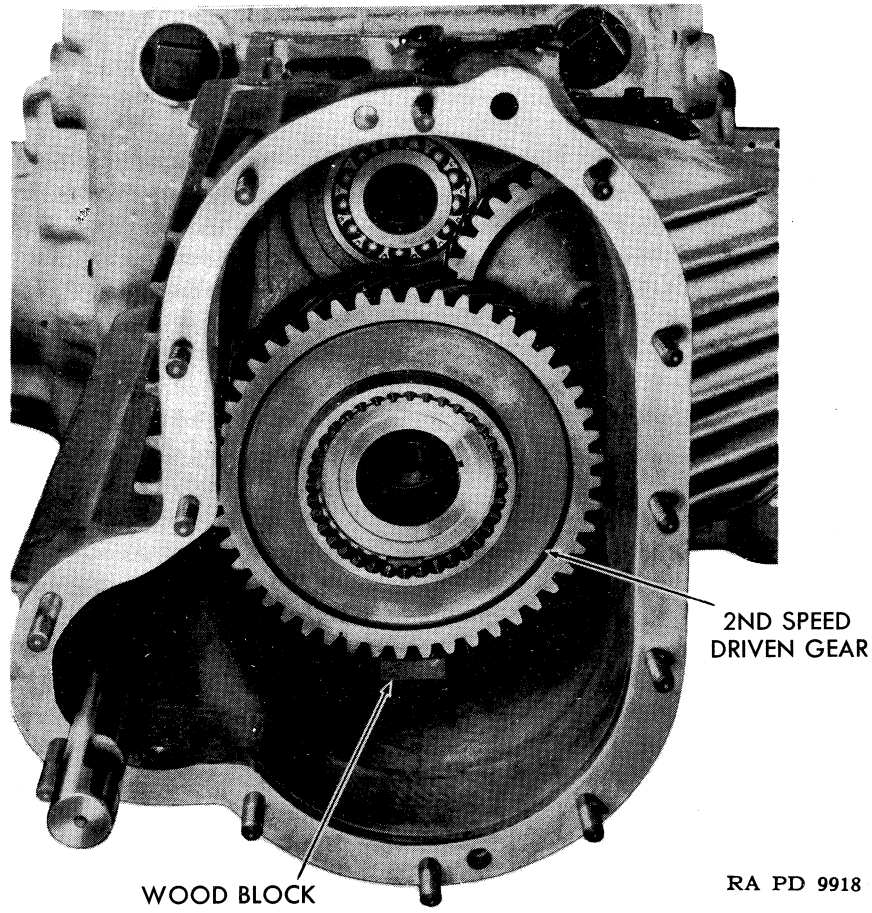


FIGURE 64—Second speed gear blocked to aline bore with shaft center bearing.

(14) Install second-third shift rod fork and synchronizer.

Place second-third fork and rod on low-reverse shift rod; put second-third synchronizer clutch plate into groove in fork and slide shift rod, fork and synchronizer into place on the cone of second speed gear. NOTE: The second-third synchronizer clutch plate and sleeve are marked for assembly. The ground marking on the involute spline of the clutch plate must aline with a similar mark on the sleeve. Both marks should be at the top of the synchronizer assembly facing the rear of the case.

(15) Install third speed gear assembly *(fig. 66)*.

Special clamp *(fig. 65)*

With the gear supported to retain needle bearings, set it in place so that the cone of the gear is in the cone plate of the synchronizer. (The prick punch mark on the splined needle bearing collar indicates the oil hole in the collar and must be placed at the top and be visible from the rear.) Install special clamp to hold second-third gears and synchronizer in position.

(16) Install output shaft with fourth speed gear and snap ring *(figs. 45 and 67)*.

Wrench, 2-in., socket with 3-ft. handle
Pliers, snap ring
Pliers
Special spacers

If fourth speed gear was removed from the shaft it should now be replaced. Be sure that the oil hole punch mark on the needle bearing collar lines up with the punch mark at the end of the output shaft spline and that the cone of the gear faces rearward *(fig. 67)*. Along the output shaft will be noted oil holes and grooves *(fig. 45)*. The oil holes at second speed gear position are in a groove so that the oil can get around to a corresponding hole in the needle bearing collar. This is also the case with the hole at fifth speed gear position. The holes for the third and fourth speed gears are in between keys of the spline and cannot be grooved as are the second and fifth speed holes. Therefore, the shaft *must* be put into the third and fourth speed needle bearing collars so that the holes will line up. In (15) above note was made that the oil hole location of the third speed collar was marked with a prick punch mark and that this was to be placed to the top to be visible from the rear. The location of the third-fourth oil holes in the output shaft is marked with a prick punch mark at the end of the spline and this was taken into account when the fourth speed gear was assembled on the shaft. The holes in the shaft must line up with marks on the splined sleeve at the synchronizer clutch and with the oil holes at third and

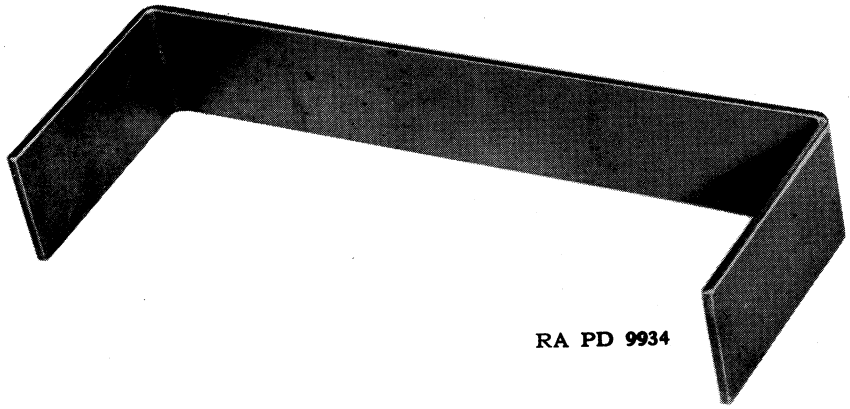


FIGURE 65—Clamp used to secure second-third gears and second-third synchronizer during output shaft installation.

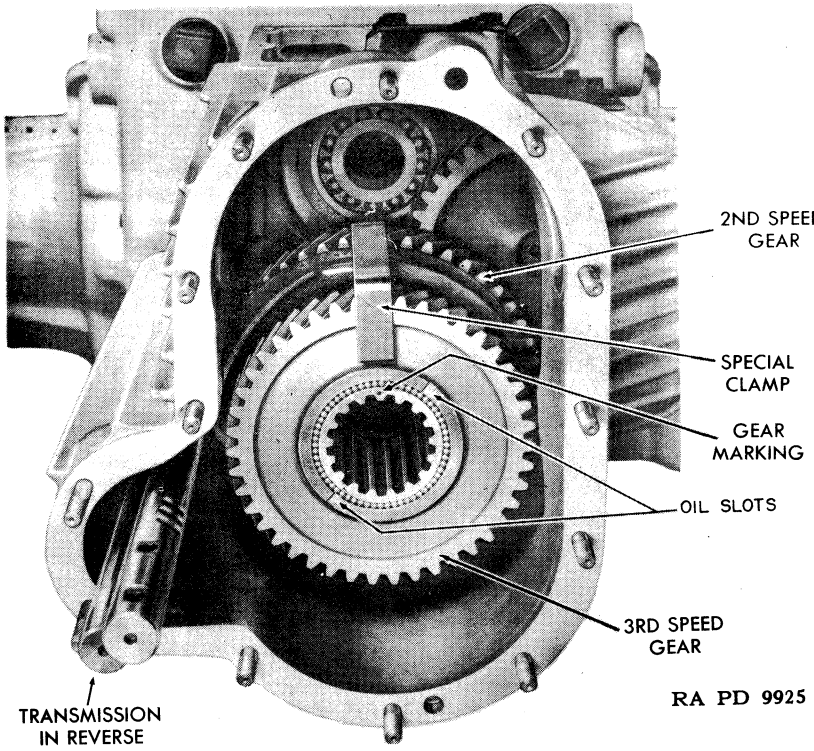


FIGURE 66—Second-third speed gears and synchronizer in position to receive output shaft.

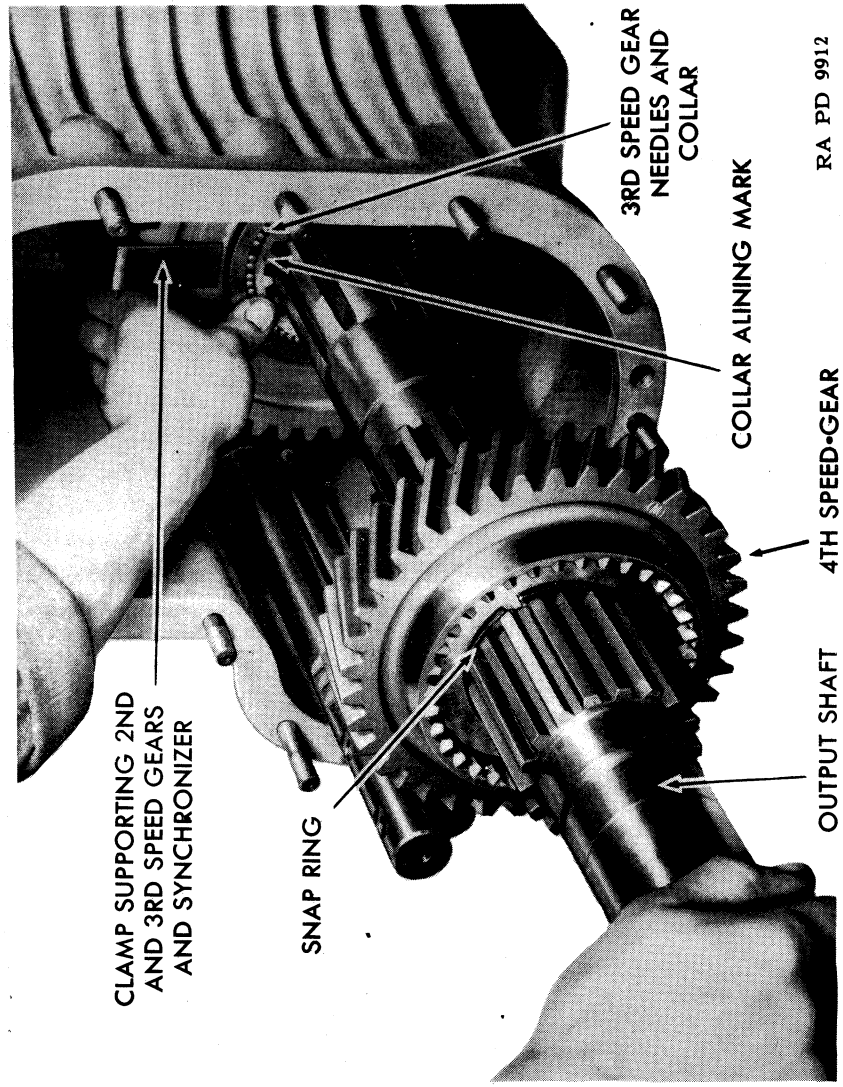


FIGURE 67—Installation of output shaft with fourth speed gear in place.

fourth speed gears. This is why the markings of the clutch sleeve and the marking for the third speed hole are all placed at the top. Place a touch of red lead in the end of the spline which has the oil holes. Sight through splined third speed collar to be sure this lines up with splines of the synchronizer sleeve. Thread output shaft through third speed gear, synchronizer and second speed gear into and through center bearing *(fig. 67)*. Before front end of shaft gets to low-reverse sliding gear, put on center bearing lock and nut. Then advance shaft until low-reverse gear can be put on shaft. Keep on advancing shaft, tapping on the end with a soft hammer if necessary. Be sure spline of shaft has entered splined collar and sleeve in the proper marked position. Keep moving center bearing lock and nut on shaft so that it does not bind. Enter shaft into spline of bevel pinion. After shaft spline enters splined sleeve of second-third synchronizer progress may be stopped. This will be caused by washer at second speed gear dropping into the second speed needle bearing oil groove. This can be overcome by turning the shaft and tapping it ahead at the same time. After the shaft has been started into low-reverse sliding gear, this gear should be kept at the neutral position. Place spacers *(figs. 13, 96)* on output shaft, one between pinion bearing and low-reverse gear, and the other between low-reverse gear and output shaft center bearing to retain center bearing in position and low-reverse sliding gear in neutral. When the shaft is into the bevel pinion, it may be driven home by driving with a brass bar on the end of the shaft. Put washer and nut on bevel pinion end of shaft, partially tighten nut, putting low-reverse gear in mesh and blocking the gears. *Do not forget to remove the wood block and special clamp used to support and hold second and third speed gears in place.*

(17) Install input shaft and fourth and fifth speed synchronizer *(figs. 68, 69 and 70).*

Hammer, soft
Block, bearing

Put fourth-fifth speed synchronizer into groove of fourth-fifth shift rod fork and start fork assembly onto other shift rods and onto output shaft but not into the case. Lift input shaft into transmission over output shaft so that the fourth and fifth speed gears straddle the fourth-fifth synchronizer *(fig. 68)*. Shift second-third synchronizer into third speed engagement. Advance input shaft into front bearing, moving synchronizer ahead with input shaft. When synchronizer starts onto involute spline, see that it lines up properly *(fig. 69)*. NOTE: There is a difference in length of the hubs which carry the clutch teeth on the clutch plate; the long hub is the one which goes to fifth speed and which should be out or facing rearward when assembled.

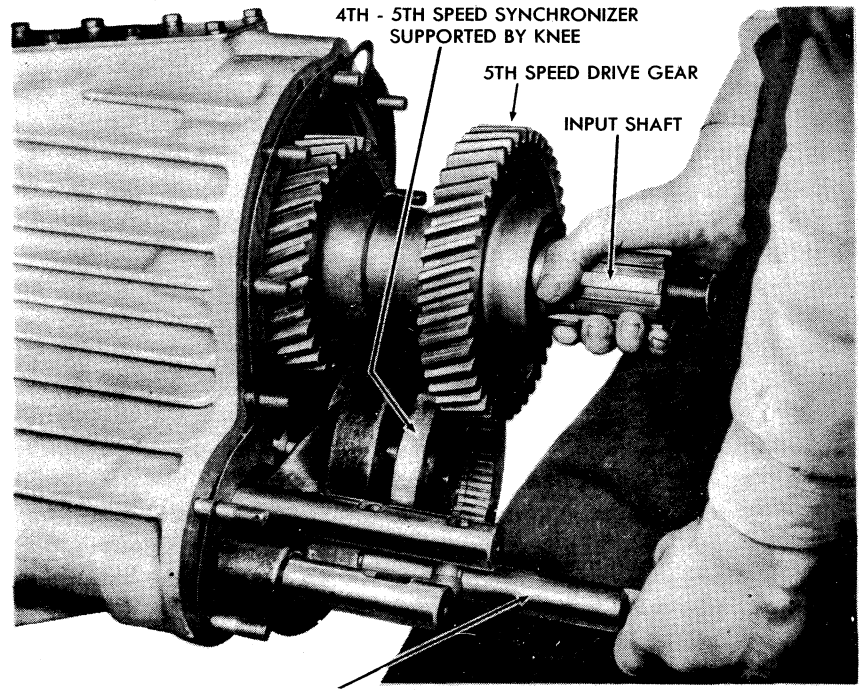


FIGURE 68—Installation of input shaft with fourth-fifth speed synchronizer.

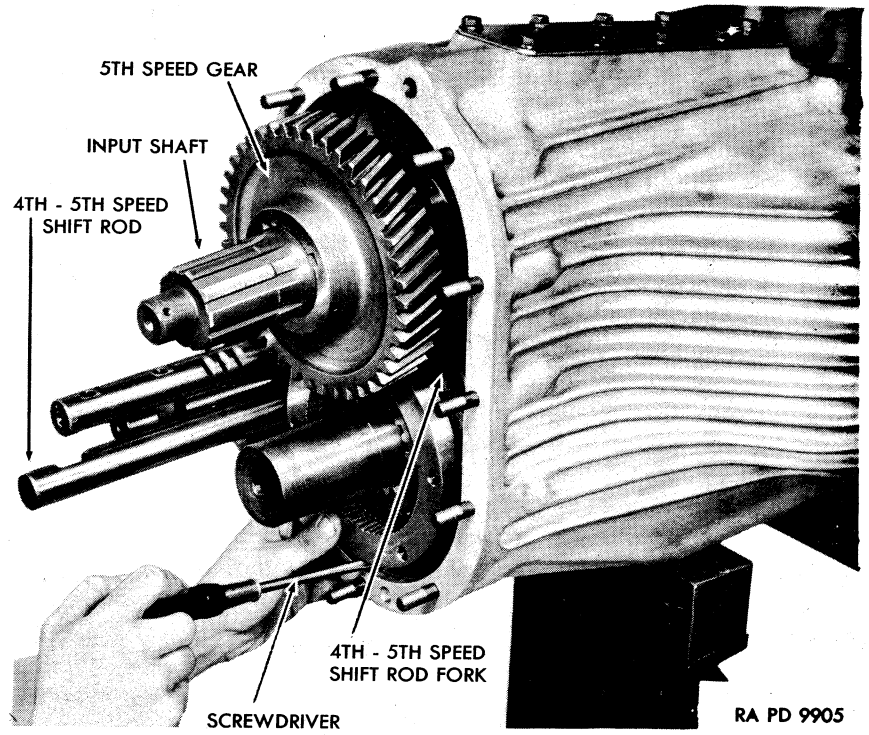
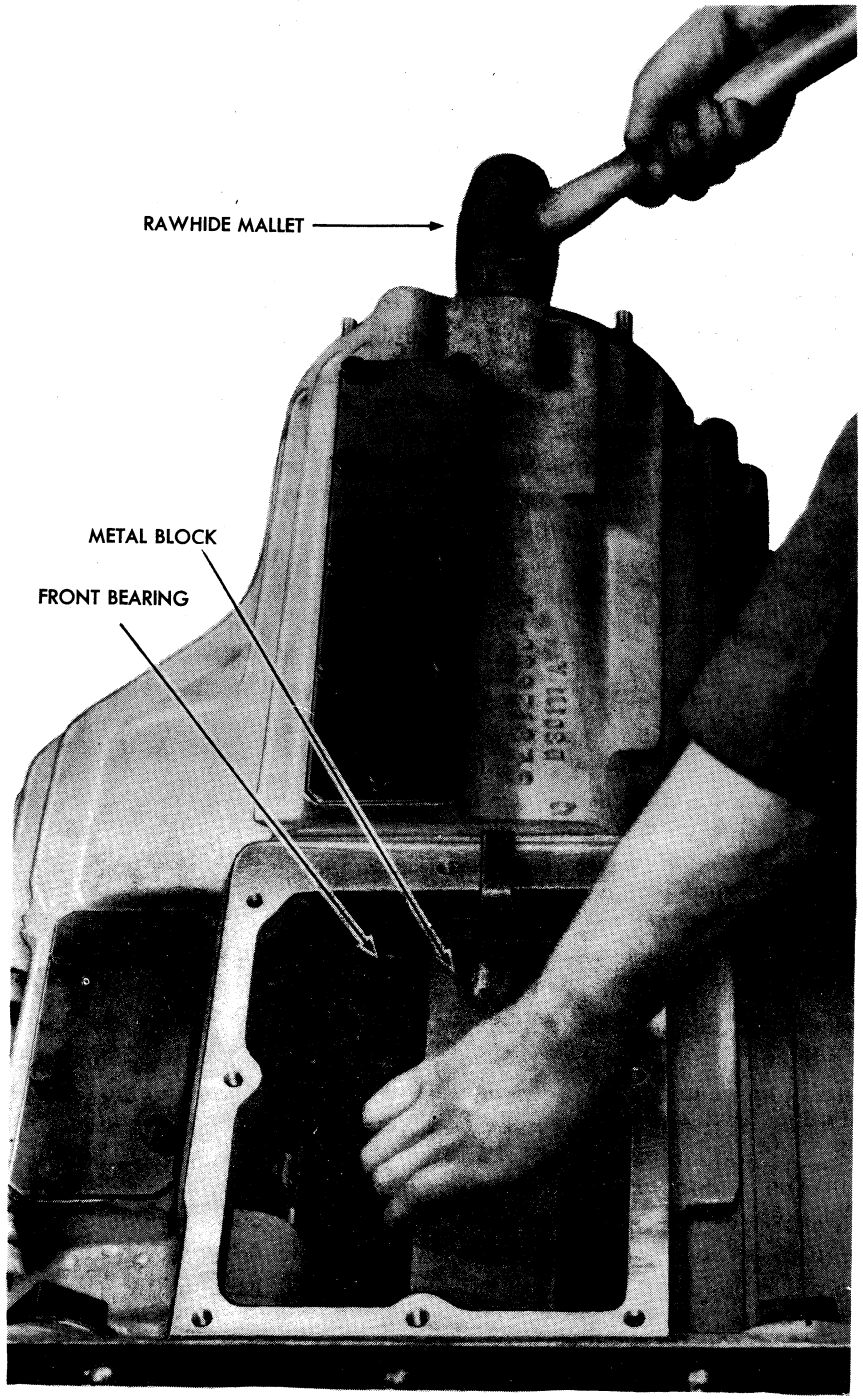


FIGURE 69—Alinement of fourth-fifth gear synchronizer with spline of output shaft.



RA PD 6849

FIGURE 70—Driving input shaft into front bearing.

Drive shaft into bearing. Use a special block *(figs. 14 and 104)* between bearing and wall at front of case to hold bearing in place and slowly *(fig. 70)* revolve shaft as it goes in so that the teeth will enter the teeth of their mating parts instead of butting the ends. After shaft is through bearing, put snap ring in place on shaft. Put all shifts in neutral and turn input shaft to be sure everything is free.

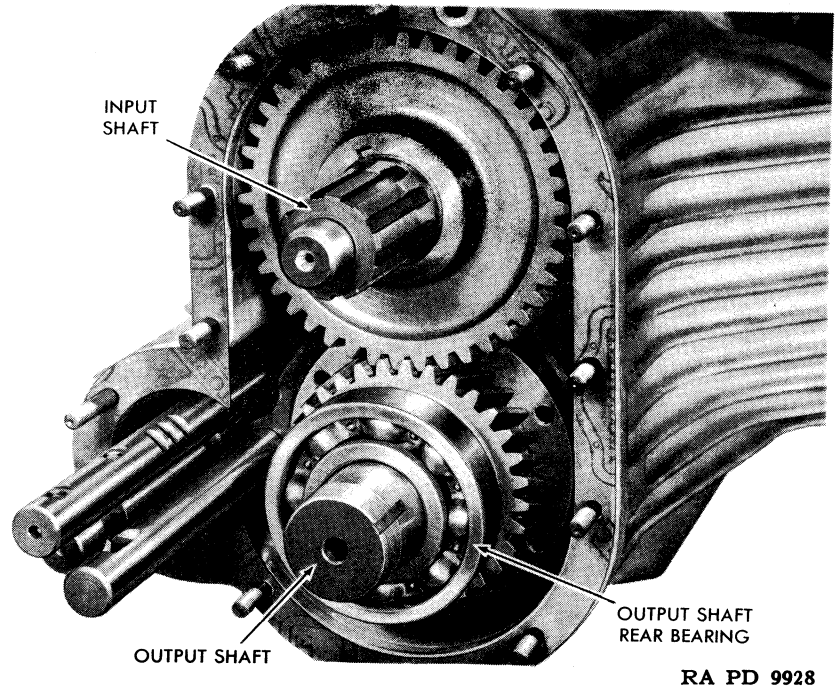
(18) Install fifth speed driven gear assembly.

Put washer against shoulder of shaft formed by end of involute spline. Install fifth speed gear assembly on shaft against washer with cone of gear entering fourth-fifth synchronizer cone plate. (The bearing collar is a slip fit to shaft.)

(19) Install output shaft rear bearing, speedometer gear, washer and retaining nut *(fig. 71)*.

Driving sleeve or soft drift
Wrench, adjustable spanner
Wrench, 2-in., socket with 3-ft. handle
Pliers
Hammer
Gear block

Install output shaft rear bearing and drive home with driving sleeve or soft drift *(fig. 71)*. Install speedometer gear on



RA PD 9928

FIGURE 71—Rear of transmission (cover with input shaft bearing removed).

output shaft with geared portion to the rear. Put locking washer in place and screw on nut. Put gears in reverse speed and block gears between low-reverse sliding gear and reverse idler. Use the adjustable spanner wrench and tighten output shaft rear nut. Engage ear of locking washer with slot in nut. Block gears between reverse idler and first speed gear and tighten nut on front end of output shaft at bevel pinion. Secure nut with cotter pin.

(20) Install transmission case rear cover.

Hammer, rawhide

Put new gasket in place on cover studs. Put cover onto and over output shaft rear bearing. Use a rawhide hammer and drive cover home over studs and insert dowels.

(21) Install input shaft rear bearing, cover with oil seal, drive flange, washer and nut.

Driving sleeve
Hammer, soft
Wrench, 3/4-in., socket
Wrench, 2 1/8-in., socket with long handle
Pliers
Hammer

Slide rear bearing onto input shaft and into rear cover. Drive home, using a driving sleeve and soft hammer. Set new gasket in place on bearing cover and see that oil seals are in place. Install bearing cover and secure with four 1/2-in. cap screws (3/4-in. socket wrench). Install drive flange. Put on washer and nut. Block gears as in (19) above and tighten nut (2 1/8-in. socket wrench with long handle). Secure nut with cotter pin.

(22) Tighten output shaft center bearing retaining nut *(fig. 72)*.

Wrench, 2 3/8-in., special open end
Drift, flat
Hammer

Place special 2 3/8-in. open end wrench *(fig. 103)* on center bearing retaining nut as shown in figure 72. With transmission in reverse and gears blocked, as in (21) above, turn input shaft flange clockwise (as viewed from the rear of the transmission) to tighten retaining nut. CAUTION: *Because of the multiplication of effort through the reverse gearing, care must be exercised in the application of leverage in turning the input shaft flange.* To lock nut bend a section of washer over flat of nut.

(23) Install output shaft rear bearing cover.

Wrench, 3/4-in., socket

Put new gasket on cover. Install cover *(fig. 21)* using two short and two long 1/2-in. cap screws and lock washers (3/4-in. socket wrench).

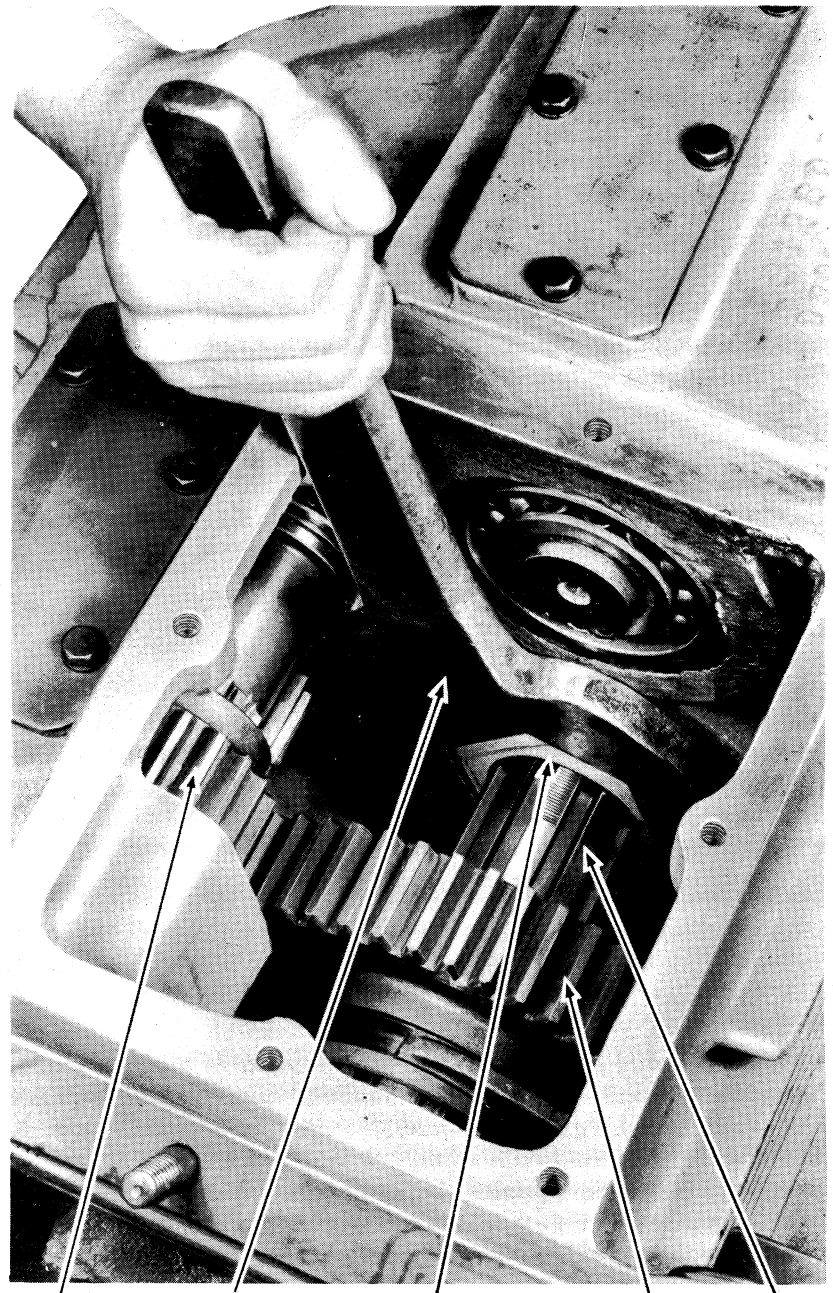


FIGURE 72—Tightening output center bearing lock nut.

(24) Install shift rod support *(fig. 63).*

Rod, 1/4-in.
Square rod 1/4-in., with 90° bend
Screwdriver
Wrench, 3/4-in., socket
Wrench, 5/8-in., socket
Wrench, 9/16-in., socket

Put new gasket over four studs. Start support over three shift rods and advance until support is about to enter the hole in the cover. Put balls, plungers, springs, and plugs into the three poppet holes and tighten plugs. Put interlock ball in place through large hole in bottom of support and hold in this position while support is driven into cover (soft hammer). Use a 1/4-in. round rod through the pipe tap hole in the bottom of the case to lift interlock ball up into place. Hold ball in position while the retaining screw is screwed all the way in to support the ball. (Low-reverse and fourth-fifth shift rods must be in neutral position to lift ball into place. If ball does not go up easily continue to support the ball with the 1/4-in. rod and tap lightly on the ends of the two shift rods.) Install pipe plug under ball (1/4-in. square rod, bent 90°). Install and tighten all nuts on shift rod support and on transmission rear cover (5/8-in. socket and 9/16-in. socket wrenches).

(25) Install controlled differential.

Hoist
Special lifting hook
Hammer, soft
Pliers
Wrench, 1 1/4-in., socket

Engage the special lifting hook as in the removal of the assembly *(fig. 17)*. Lift differential and lower into place in bearing bores. If necessary tap bearings into place with a soft hammer. Facing the differential compartment the bevel gear goes to the right hand side. *Be sure the bevel is in this position.* (A wrong installation is possible and will result in the vehicle running backward.) Install bearing support covers. The machined side of the cover must go against the machined side of the case. The punch marks on the covers must be toward a similar marking on top of the case. Place nuts on support studs. Tighten nuts, using a 1 1/4-in. socket wrench and secure with safety wire.

(26) Install brake camshafts *(figs. 15 and 39).*

Place the two brake camshafts into their respective bushed holes in the case so that the camshaft pins are at the top of the cam plates and so that the adjustable rod and spring extend to the rear and rest on the brake drum as shown in figure 15.

(27) Install brake shoe assemblies.

Pliers

Viewing one of the brake shoe assemblies (3 shoes) note that the open link pin holes at the assembly ends are of different size. Facing into the differential chamber, start the shoe having the small link pin hole down around the brake drum and up the back side of the drum into place. Line up cotter pin hole in connecting pin with cotter pin hole in brake shoe end and install connecting pin. Install cotter pin from front and lock. Loosen brake shoe adjusting nut to give necessary length to adjustable rod. Connect other end of shoe assembly and cotter pin both ends of connecting pin.

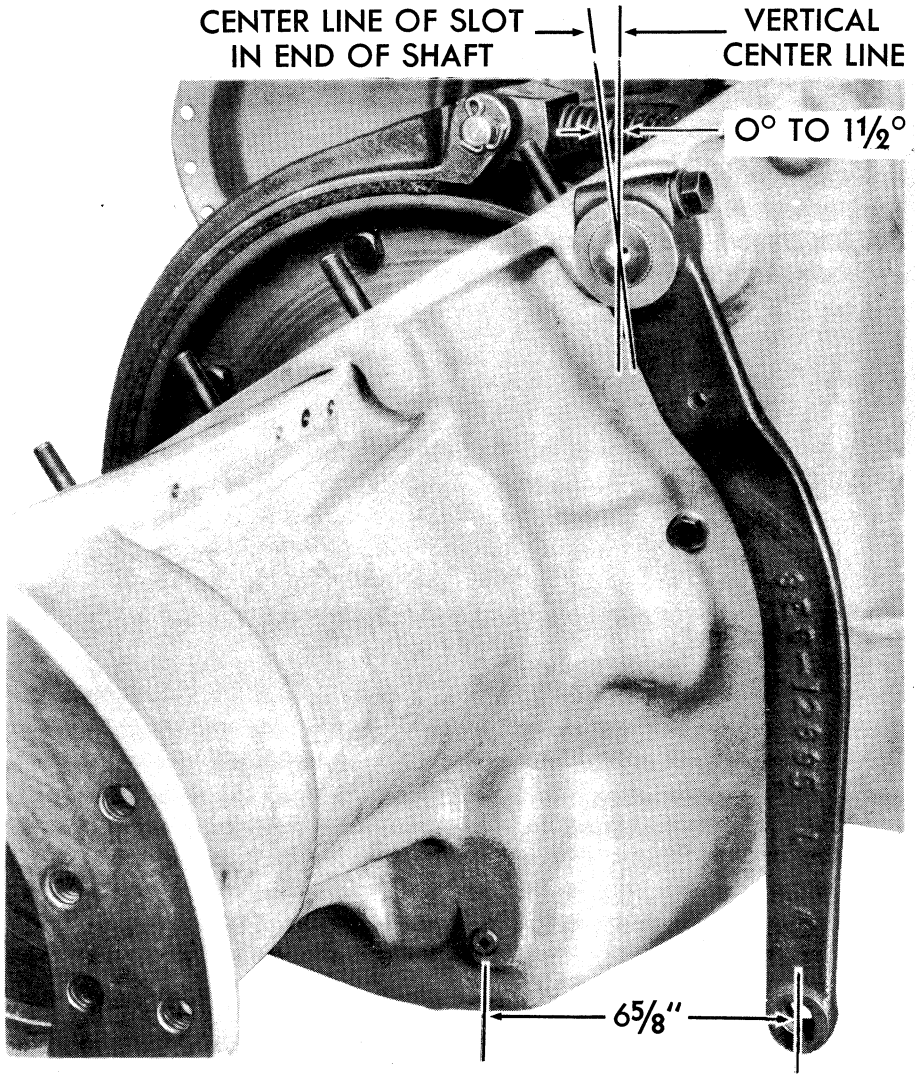
(28) Adjust brakes *(fig. 73).*

Wrench, 1 1/16-in., open end
Wrench, 3/4-in., socket
Straightedge
Scale, 12-in.

CAUTION: Before the brakes are adjusted check to see that the transmission case is level. This may be done by using a level on the machined surface to which the handhole cover (C60949) is attached. Put brake lever on camshaft spline with the smaller end of the lever up. Pull lever forward and at the same time push brake shoe against spring while a second man tightens adjusting nut to eliminate the slack between the nut and the camshaft pin. With the brake applied, the correct adjustment will be reached when the slot in the brake camshaft *(fig. 73)* is vertical or from 0° to 1 1/2° ahead of vertical. (Measure from the shaft center to the top of the shaft.) Remove lever and reinstall on spline of camshaft so that the long, straight, lower section of the lever is approximately parallel to the slot in the end of the camshaft. As a check, measure the distance between centers of the hole in the lever end to the center of the plug in back of the rear oil screen screw *(fig. 73)*. 6 5/8 in. is the correct distance with the brake applied. Use a 3/4-in. socket wrench and tighten brake lever locking screw.

(29) Adjustment of bevel gearing in regard to correct tooth contact.—*(a)* To obtain the maximum life from bevel gearing, it is necessary that the gears be adjusted correctly in regard to tooth contact. If this contact is not correct excessive loads will be concentrated on small areas of the teeth and breakage or rapid wear will result. Figures 74, 75, 76, 77 and 78 shown in this paragraph illustrate the various possible contacts and an explanation of each is given. Figure 79 is included to show all bearing surfaces and to contrast the undesirable tooth contacts with the correct tooth bearing shown in figure 74.

1. Figure 74 shows what is considered a desirable tooth contact. Area of contact starting at toe and extending about 80 percent of tooth length



RA PD 6839

FIGURE 73—Method of adjusting brake.

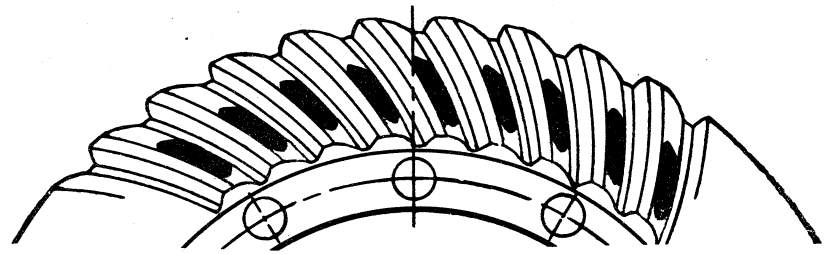


FIGURE 74—Correct tooth contact. RA PD 4881A

toward heel. When making adjustment use drive side of tooth, because when drive side is correct, coast side of tooth will automatically be in correct adjustment. Powdered red lead mixed with any light machine oil can be spread over gear tooth surfaces with a brush to show clearly the tooth contact obtained.

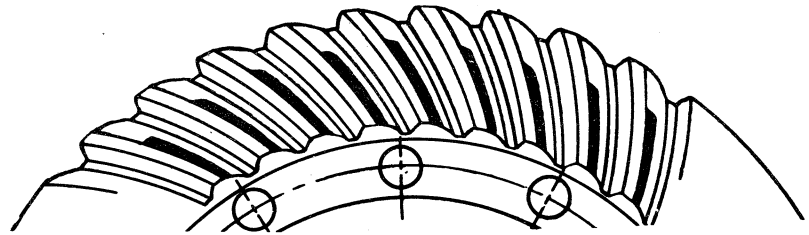


FIGURE 75—High, narrow tooth contact. RA PD 4881B

2. Figure 75 shows a high narrow contact on gear tooth which is not desirable. If gears are allowed to operate with an adjustment of this kind, noise, galling, and rolling over at the top edges of the teeth will result. To obtain correct contact move pinion in toward gear enough to lower contact area to its proper place. This adjustment will decrease backlash between pinion and gear teeth, which can be corrected by moving gear away from pinion. Backlash should be approximately .005-in. to .010-in. Several adjustments of both pinion and gear may be necessary before correct contact and backlash are obtained. For correct contact see figure 74.

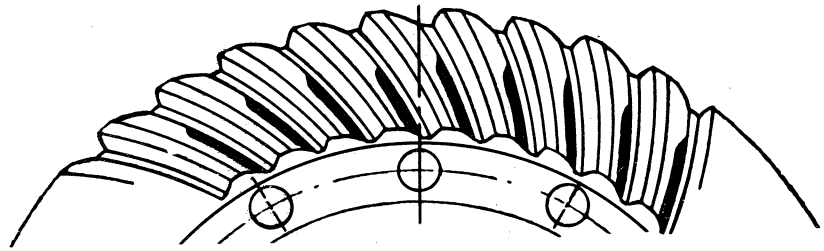


FIGURE 76—Low, narrow contact. RA PD 4881C

3. Figure 76 shows a long narrow contact on gear tooth, which is not desirable. If gears are allowed to operate with an adjustment of this kind, galling, noise, and grooving of teeth will result. To obtain correct contact move pinion out from gear a sufficient amount to move contact to its proper place on tooth. To maintain correct backlash gear should be moved in toward pinion. For correct contact see figure 74.

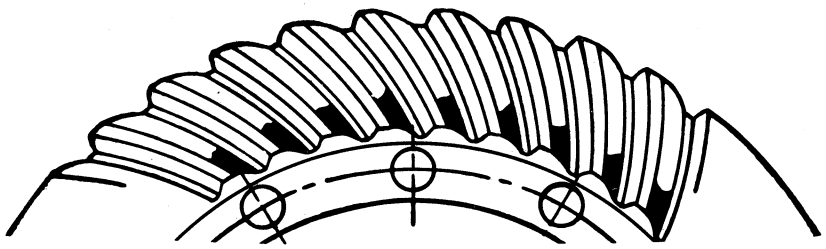


FIGURE 77—Short toe contact.

RA PD 4881D

4. Figure 77 shows a short toe contact which is not desirable. If gears are allowed to operate with an adjustment of this kind, chipping at tooth edges and excessive wear due to small contact area will result. To obtain correct contact move gear away from pinion. This will increase the lengthwise contact, moving contact toward heel of tooth. Correct backlash can be obtained by moving pinion in toward gear. For correct tooth contact see figure 74.

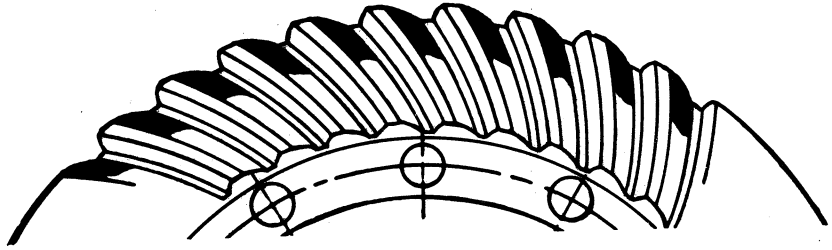
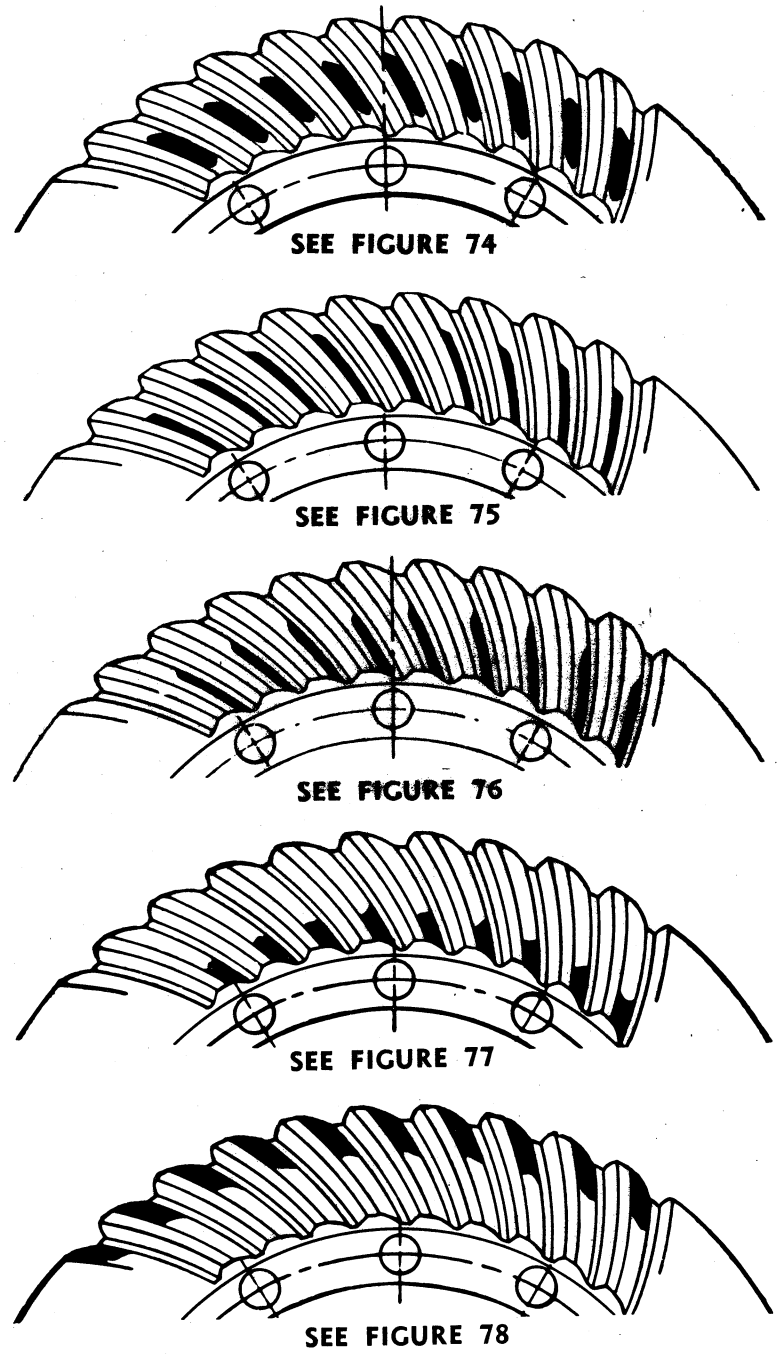


FIGURE 78—Short heel contact.

RA PD 4881E

5. Figure 78 shows a short heel tooth contact which is not desirable. If gears are allowed to operate with an adjustment of this kind, chipping, excessive wear and noise will result. To obtain correct contact the gear must be moved toward pinion to increase the lengthwise contact and move contact area toward toe. Correct backlash can be obtained by moving pinion away from gear. For correct tooth contact see figure 74.

(*b*) Any change in the adjustment of the pinion necessitates the removal of the differential assembly and the pinion assembly and the subsequent disassembly of the pinion assembly. To move the bevel pinion toward gear the total existing shim thickness *(fig. 54)* must be increased.



RA PD 4881

FIGURE 79—Bearing surfaces on bevel gear.

Movement of the pinion away from the gear requires that the shim thickness be decreased. Any adjustment of the bevel gear requires that the differential assembly be removed and that the support bearings be pulled to make possible the addition or removal of shims as needed in the repositioning of the gear. Often an adjustment of the bevel gearing will necessitate several changes in both the gear and pinion before the correct tooth contact is reached. To move the gear away from the pinion, remove a shim from the bevel gear side of the differential and add it to the existing shim on the opposite side of the unit. Reverse the procedure to move the gear toward or into the pinion.

(*c*) CAUTIONS:

1. Use a dial indicator for checking backlash. Don't guess.

2. Bear in mind that all adjustments necessary to obtain correct tooth contact should be moderate.

3. Make sure all adjustments are securely locked.

4. Excessive pinion end play will cause noisy gears, and fast wear of gear teeth.

5. Do not fail to lubricate.

(*d*) The four steps used when adjusting bevel gearing are:

1. Move pinion in toward gear to lower contact area.

2. Move pinion out from gear to raise contact area.

3. Move gear away from pinion to lengthen contact from toe toward heel.

4. Move gear in toward pinion to lengthen contact from heel toward toe.

(30) Replace differential cover. Wrench, 5/8-in., socket

Before replacing cover observe the following: that there is backlash between bevel gear and pinion; that the bevel pinion retainer plate is properly in place; that the nuts are tight and safety wired. Check to see that the oil pump is safety wired; that the two 1/2-in. cap screws are wired to each other and that the three 3/8-in. cap screws with one continuous wire are twisted together at the ends; that the differential bearing cover nuts are tight and wired together; that the oil screens are in place and wired, and that the oil tubes at the pump connections are tight; that all the pins and cotter pins in the brake assembly are in place and locked; that the chamber is clean. Install new gasket. Put on cover and install all nuts and tighten, using a 5/8-in. socket wrench.

(31) Install shift control *(fig. 20).* Wrench, 9/16-in., socket
Wrench, 3/4-in., socket
Wrench, 15/16-in., open end

Put shift lug in place on second-third shift rod and secure with two cap screws using a 9/16-in. socket wrench *(fig. 20)*. Put

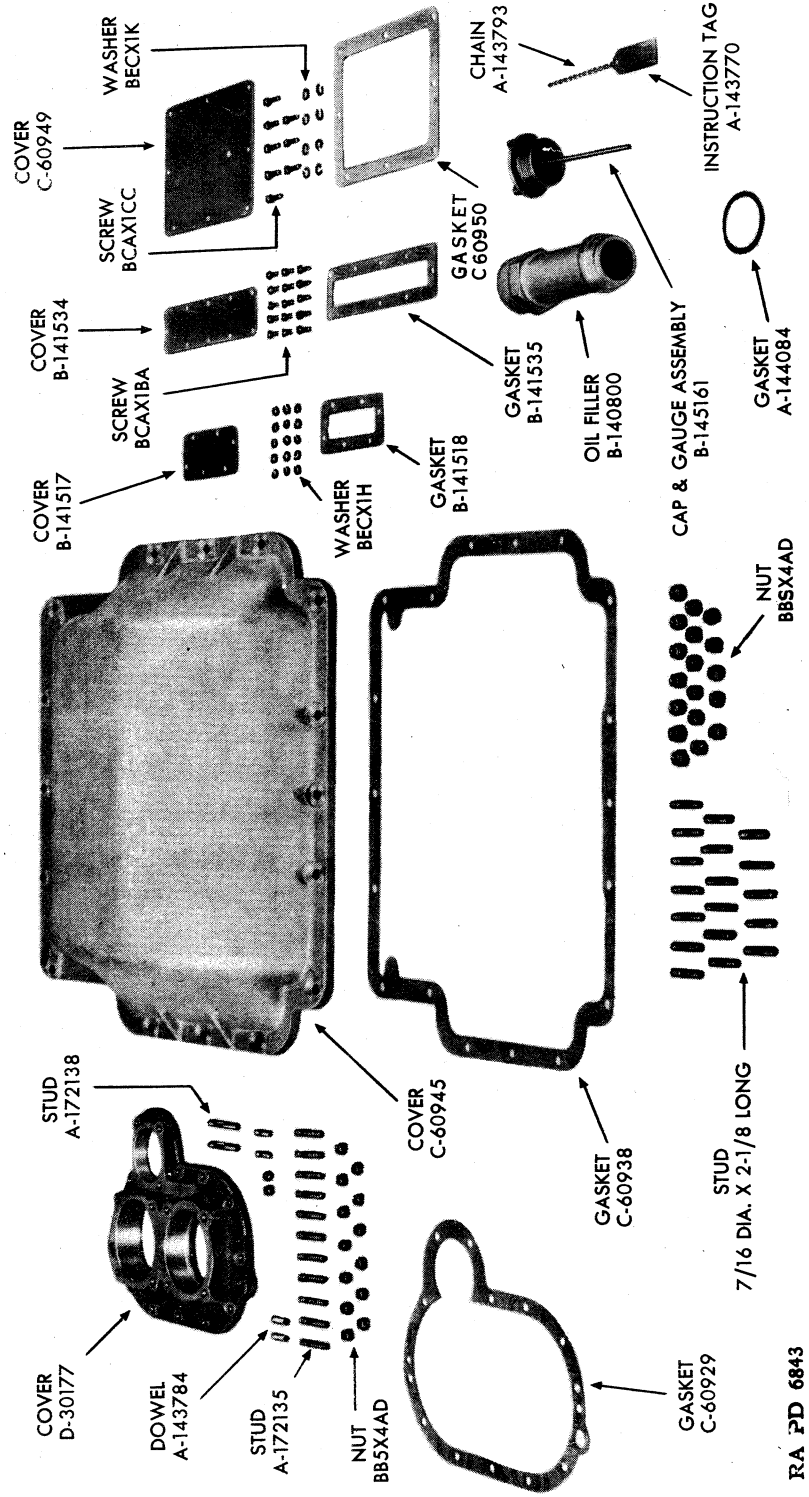


FIGURE 80—Transmission case covers and gaskets.

shifter end of lever into place in rods, put long bolt through pivot block and into extension of speedometer cover and secure nut ($1\frac{5}{16}$-in. open end wrench) with cotter pin. Depress button on shift lever handle so that fulcrum plate can be introduced into throat of lever and secure in place on the two bosses provided, with two cap screws and lock washers (¾-in. socket wrench). Note on this fulcrum plate the notch into which the pin drops. *This notch is on an angle and must be placed so that it slopes to the rear at the bottom.*

(32) Secure cap screws, bearing cover and speedometer cover.

Safety wire four cap screws on input shaft bearing cover, wiring left top to left bottom and right top to right bottom. Secure four cap screws at speedometer cover with safety wire as above.

(33) Replace oil groove covers, if they have been removed, and handhole cover *(fig. 80).*

Wrench, ½-in., socket
Wrench, $\frac{9}{16}$-in., socket

Replace gaskets. Put covers in place and fasten with cap screws and lock washers. Before putting handhole cover on over low speed gear chamber observe: that center bearing retainer nut on output shaft is tightened and locked; that snap ring is on reverse gear shaft to hold bearing; that bevel pinion nut is in place and locked; that the chamber is clean.

(34) Final inspection.—Try shifts one by one, observing that shift travels far enough so that detent ball drops into groove; turn input shaft in each shift to see that everything is free. Look over rear end of case and see that all nuts are on and tightened, that cotter pins and safety wire are in place and that the ¼-in. pipe plug is in beneath the shift support. Put tape over the output shaft needle bearing oil connection to protect threads. Put ¾-in. pipe plug in hole at top of rear cover to keep out dirt. See that oil level gage is in place, and that all cap screws on top covers are in place and tightened. See that brake adjusting hole plugs are in and are tightened. Check brake levers; see that cap screws are tightened and that adjustment is correct. At the front see that all nuts are on and tightened. Remove the two magnetic drain plugs on bottom of case, clean them off and replace them. If plug has been removed at oil pump discharge or if none is there, replace with ½-in. pipe plug. Equipment for a transmission running test is shown in figure 113. If this or similar equipment is available, it should be used to provide a running test with and without load before the transmission is placed in vehicle.

SECTION IX

DISASSEMBLY OF FINAL DRIVE

Paragraph
General 33
Disassembly 34

33. General.—Clean the outside surfaces of the final drive bracket, the bracket cover and around the flanged end of the driven shaft using the procedure described in paragraph 11. Place the bracket, after cleaning, on an area of floor that has been well cleaned and proceed with the disassembly.

34. Disassembly *(figs. 83 and 85).* — *a. Equipment.* — Equipment needed for any single step is listed in that step. Equipment required for the total disassembly is listed below.

Arbor press
Arbor press plate or bars
Drift, soft
Hammer
Hammer, soft
Hydraulic jack
Pliers, side cutting
Pry bars, two
Puller, special
Spacer
Stand
Vise, with copper jaws
Wrench, ¾-in., socket
Wrench, $3\frac{9}{16}$-in., open end

b. Procedure.—

(1) Remove nut from final drive driven shaft.

Pliers, side cutting
Bar
Drift
Hammer
Wrench, special
Wrench, $3\frac{9}{16}$-in., open end

Remove cotter PIN (BFAX2CN) from final drive driven shaft retaining NUT (B132938). Use a $3\frac{9}{16}$-in. open end wrench or special wrench *(fig. 109)* to remove nut. To prevent turning of the SHAFT (D27406) while the nut is being loosened, place a bar between the studs on the flanged end of the shaft and turn the shaft until the bar contacts the floor. If necessary use a soft drift and hammer to loosen nut.

(2) Remove final drive gears and shaft.

Pry bars, two
Stand

Support the final drive bracket on a stand with the geared end up *(fig. 12)*. While one man, using two pry bars, lifts large GEAR (D32854) and BEARING (CABX1CZ) off the driven shaft spline, a second man removes drive SHAFT (D27413) with PINION (C66710) and BEARINGS (3AAX3AT, CAAX3CS and A130733).

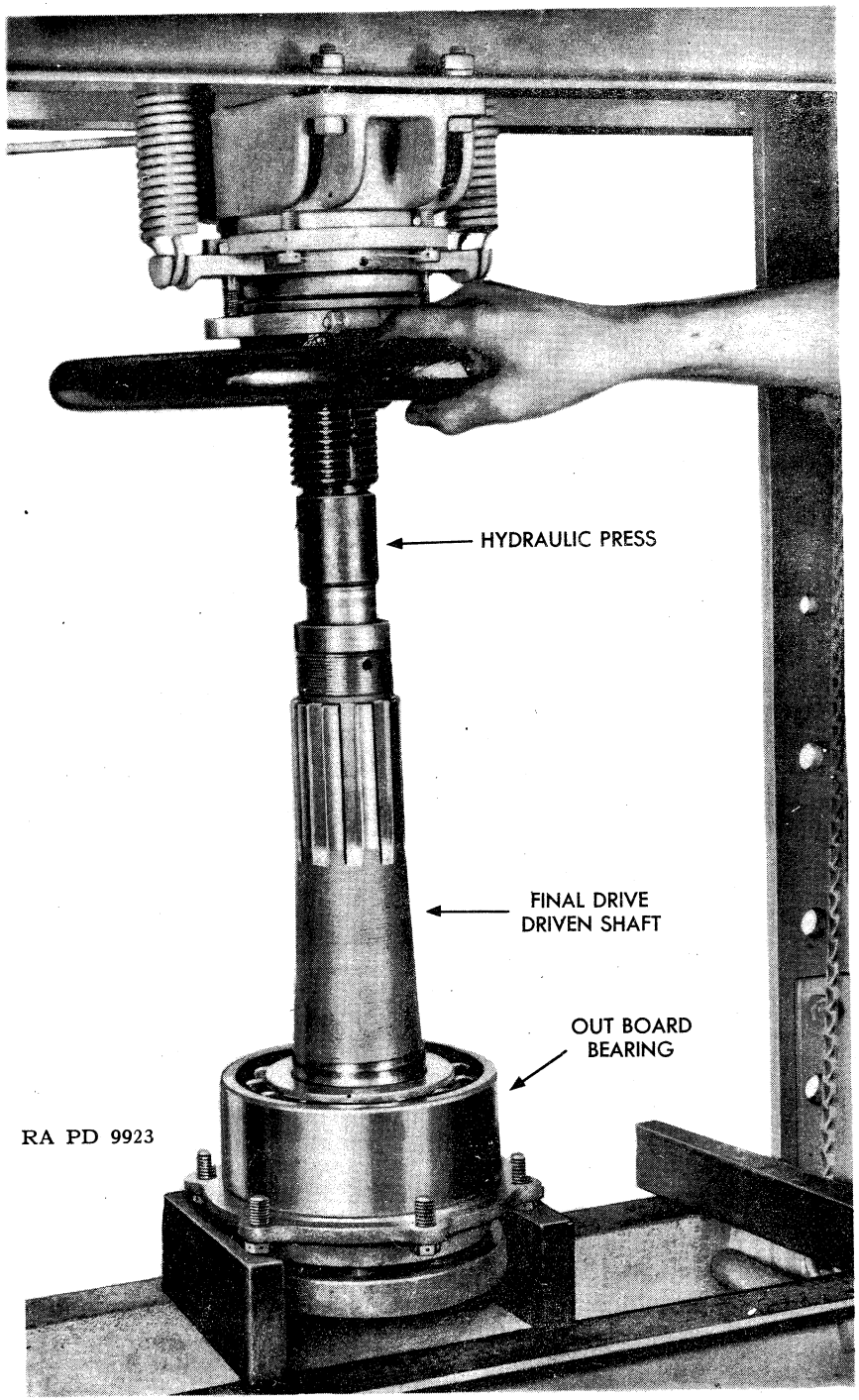


FIGURE 81—Removal of outboard bearing—final drive driven shaft.

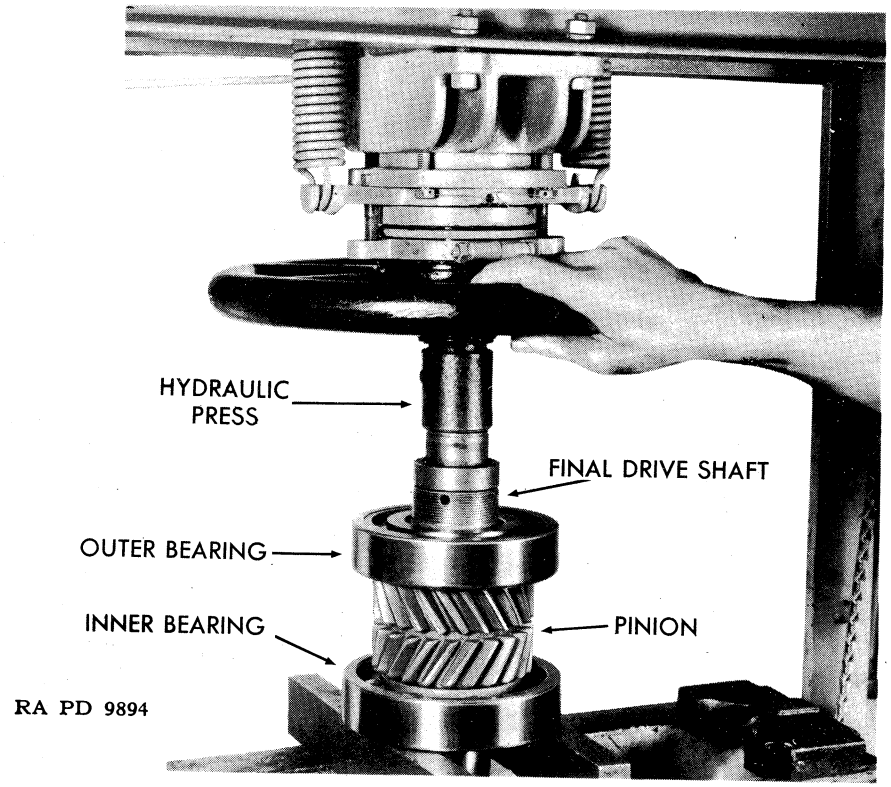


FIGURE 82—Removal of bearings and pinion from drive shaft.

(3) Remove driven shaft.

Brass bar or soft hammer
Pliers, side cutting
Wrench, ¾-in., socket

Turn the bracket in the stand so that the flanged end of the driven shaft is up as in figure 90. Remove safety wire securing six cap SCREWS (A144777). Use a ¾-in. socket wrench and remove the cap screws from the bracket. They cannot be removed from the COVER (B132935) while the cover is in place on the driven shaft. Turn the bracket on its side and using a brass bar drive on the splined end of the driven shaft to remove the shaft assembly from the bracket.

(4) Remove outer bearing and cover from driven shaft *(fig. 81).*

Arbor press
Arbor press plate or bars

Lift off SPACER (C63229). Place shaft assembly in arbor press with cover supported by bars as shown in figure 81. Press shaft out of BEARING (A167432) and COVER (B132935).

(5) Remove bearings and pinion from drive shaft *(fig. 82).*

Arbor press
Arbor press bars
Pliers, side cutting
Vise, with copper jaws
Wrench, $3\frac{9}{16}$-in., open end

Secure drive SHAFT (D27413) in vise equipped with copper jaws. Remove cotter PIN (9/32 x $4\frac{1}{2}$ in.). Use a $3\frac{9}{16}$-in. open end wrench and remove NUT (B132938). Remove shaft from vise and place in arbor press as shown in figure 82 with the bars, under the inner bearing, placed as closely as possible to the drive shaft. Press shaft out of outer BEARING (A130733), PINION (C66170) and inner BEARING (A143816).

(6) Remove driven shaft inner bearing from final drive gear.

Hydraulic jack
Spacer
Special puller

It is not often necessary to remove this BEARING (A130734) from the final drive GEAR (D32854). When necessary proceed as in the removal of differential bearings shown in figure 40, using a three-pronged puller, a spacer, and a hydraulic jack.

SECTION X

INSPECTION, REPAIR AND ASSEMBLY OF FINAL DRIVE COMPONENTS

Paragraph
Final drive bracket 35
Final drive driven shaft assembly 36
Drive shaft assembly 37
Driven gear and bearing 38

35. Final drive bracket *(figs. 83 and 85).—a. Cleaning.*—Use live steam and clean inside of bracket thoroughly. (If steam is not available use SOLVENT, dry-cleaning.) It is especially important that all bearing recesses or bores be cleaned well to aid inspection.

b. Inspection.—Check mating faces of bracket and COVER (B132935). Surfaces must be flat. Replace cover if it is warped. Carefully examine bearing bores for cracks or signs of abrading. If any of these surfaces are rough replace the bracket.

36. Final drive driven shaft assembly *(fig. 83).—a. Inspection.*—Carefully clean all parts in dry-cleaning solvent. Clean the outboard BEARING (A167432) as directed in paragraph 25. Examine the inner ring of the bearing and the bearing seat on the shaft for signs of scratching or abrading. Check the two oil seals for worn, mutilated or turned-over leathers. Replace the seals if they are imperfect. Inspect cover cap SCREWS (A144777). Try them in the tapped holes in the bracket and replace if less than No. 2 fit. Check driven shaft flange to hub STUDS (D27406) and safety NUTS (BBSX4AH). Replace all worn or unserviceable studs or nuts.

b. Assembly.—Place oil seals in cover so that lips of leathers are toward bracket. Place six cap screws in cover. Put cover in place on shoulder of driven shaft. Set bearing in an arbor press supported *at the inner ring* by press bars. Lower the shaft through the bore of the bearing and press the shaft into the bearing until the bearing is solidly against the shoulder on the shaft *(fig. 84).*

37. Drive shaft assembly *(fig. 85). — a. Inspection.* — Clean and inspect inner and outer BEARING (A143816 and A130733) as described in paragraph 25. Inspect PINION (C66170) for fit on spline and for worn, chipped or broken teeth. Replace pinion if unserviceable. Examine both splined ends of drive SHAFT (D27413). If any signs of twisting are present in any part of the shaft, replace the shaft. Slight burs or roughness on the splines can be cleaned up with a small hand grinder. Examine NUT (B132938) and the threaded end of the drive shaft and be sure that threads are clean and in good condition.

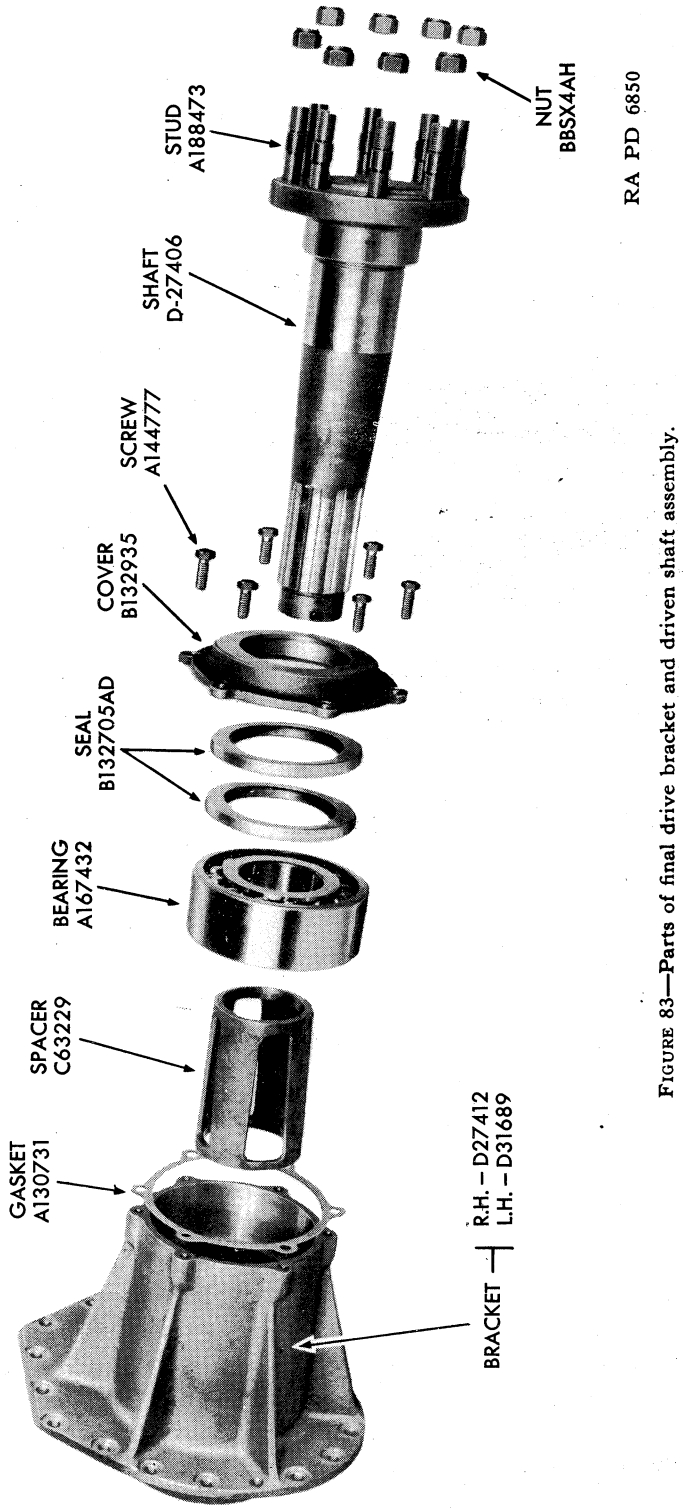


FIGURE 83—Parts of final drive bracket and driven shaft assembly.

b. Assembly (fig. 86).—Place inner BEARING (A143816) in an arbor press supported *at the inner ring* by the press bars. Start drive shaft into the bearing and operate press until bearing is solidly against the shoulder on the shaft. Press shaft with bearing into the splined pinion in the same manner. Press shaft with inner bearing and pinion into outer bearing *(fig. 86)*. Remove shaft from the press and secure in a vise equipped with copper jaws. Put on nut and tighten ($3\frac{9}{16}$-in. open end wrench). Lock with cotter pin. NOTE: If a press is not available for the above assembly operations, an assembly stand with a lead base may be used as shown in figures 87 and 88. Be sure, when driving bearings on, that a

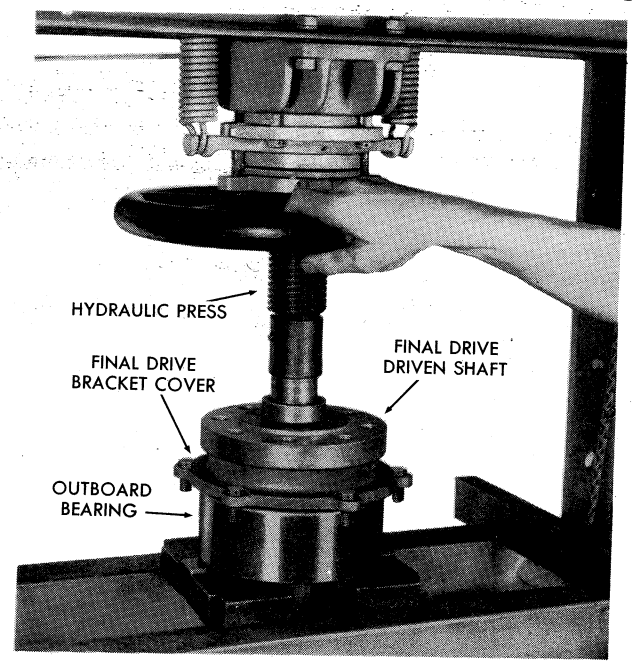


FIGURE 84—Installation of final drive driven shaft outboard bearing.

driver is used which will contact and drive against *the inner ring of the bearing*.

38. Driven gear and bearing.—*a. Inspection.*—Carefully clean and inspect bearing as described in paragraph 25. If the bearing was not removed it may be washed with the gear using dry-cleaning solvent. Clean the assembly, keeping the bearing above the gear at all times to avoid washing foreign material from the gear into the bearing. Inspect gear for chipped or broken teeth. Examine the bearing seat on the gear hub for signs of abrading or scratching. If the gear requires replacement, replace the mated pinion also.

b. Assembly.—Place the bearing in an arbor press with the press bars supporting the inner ring of the bearing. Press the gear hub into the bearing bore as far as the shoulder on the hub will permit.

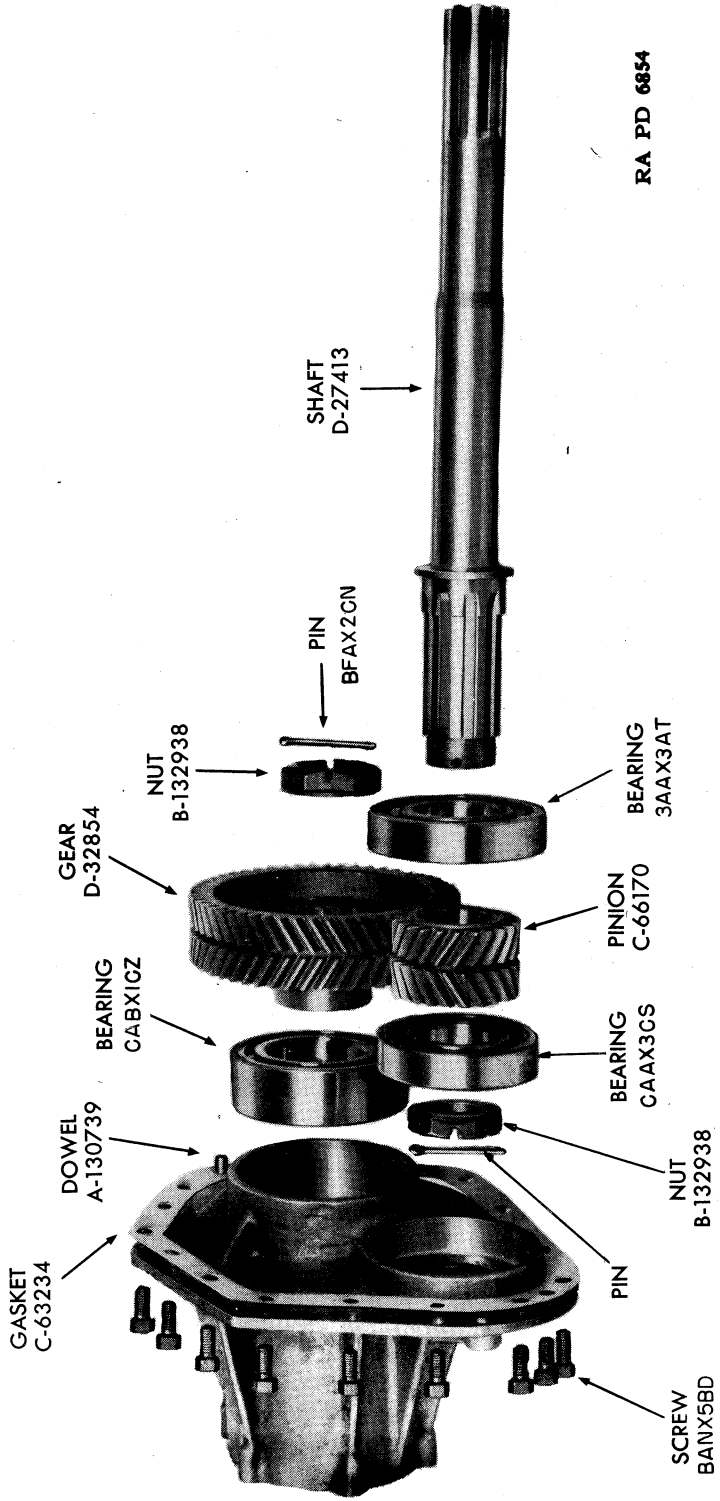


FIGURE 85—Final drive bracket, gears, bearings and pinion shaft.

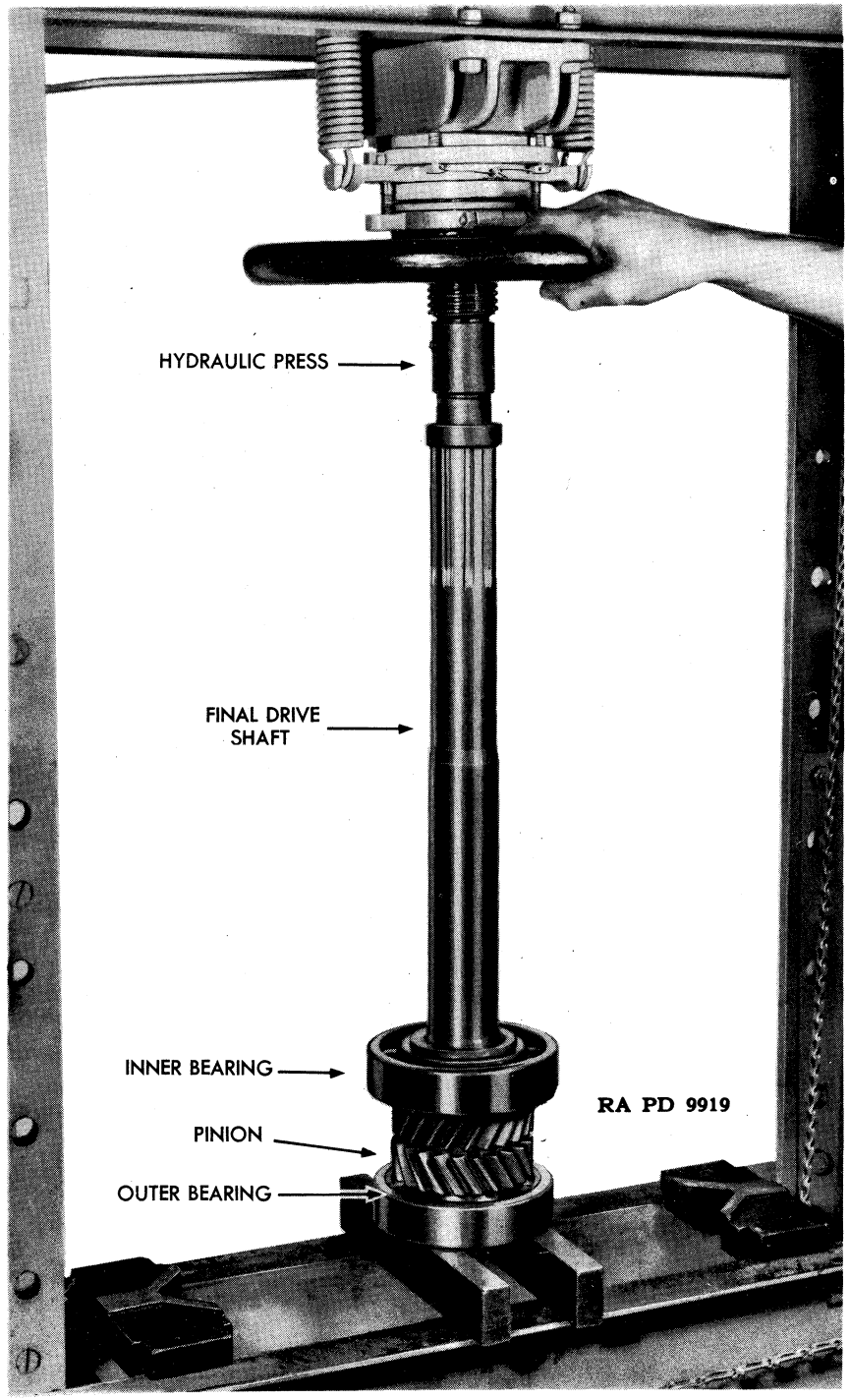


FIGURE 86—Installation of final drive shaft outer bearing.

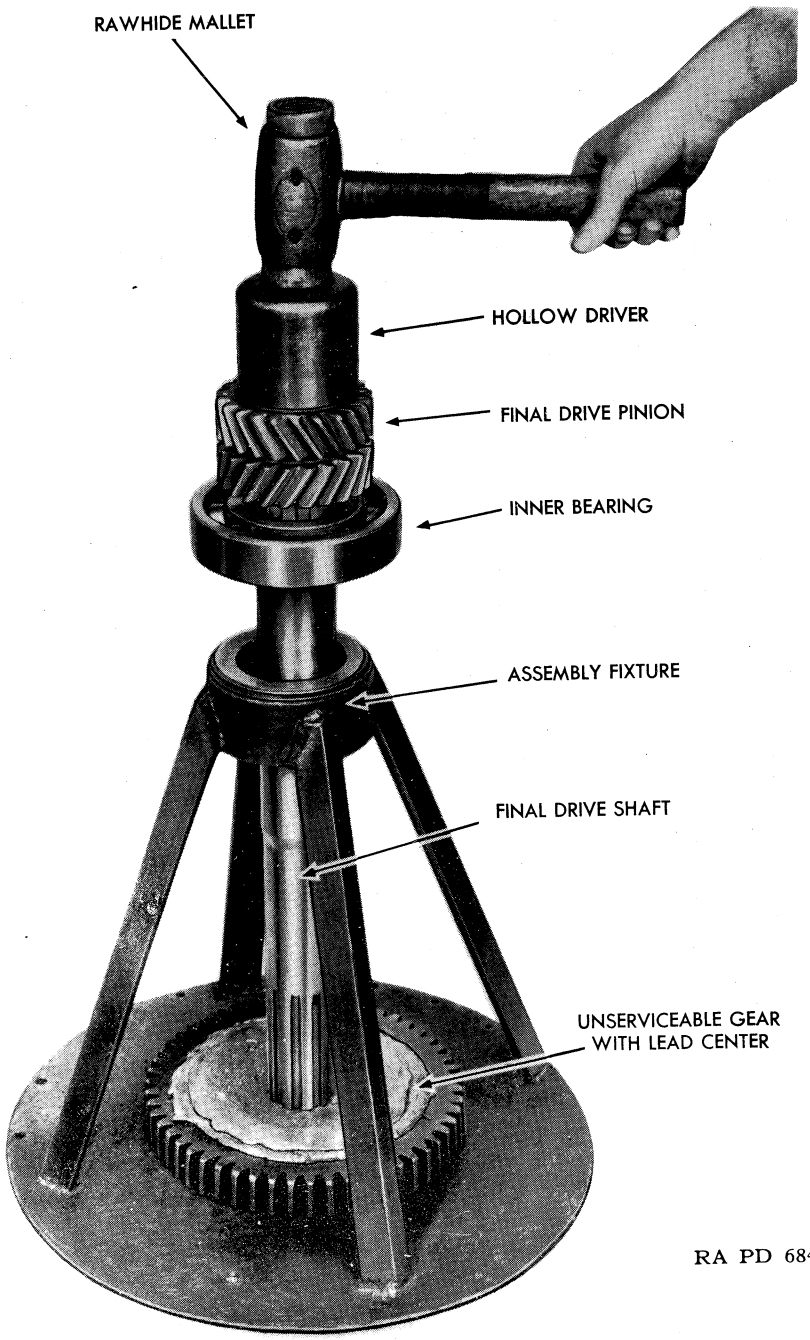


FIGURE 87—Driving pinion onto final drive shaft.

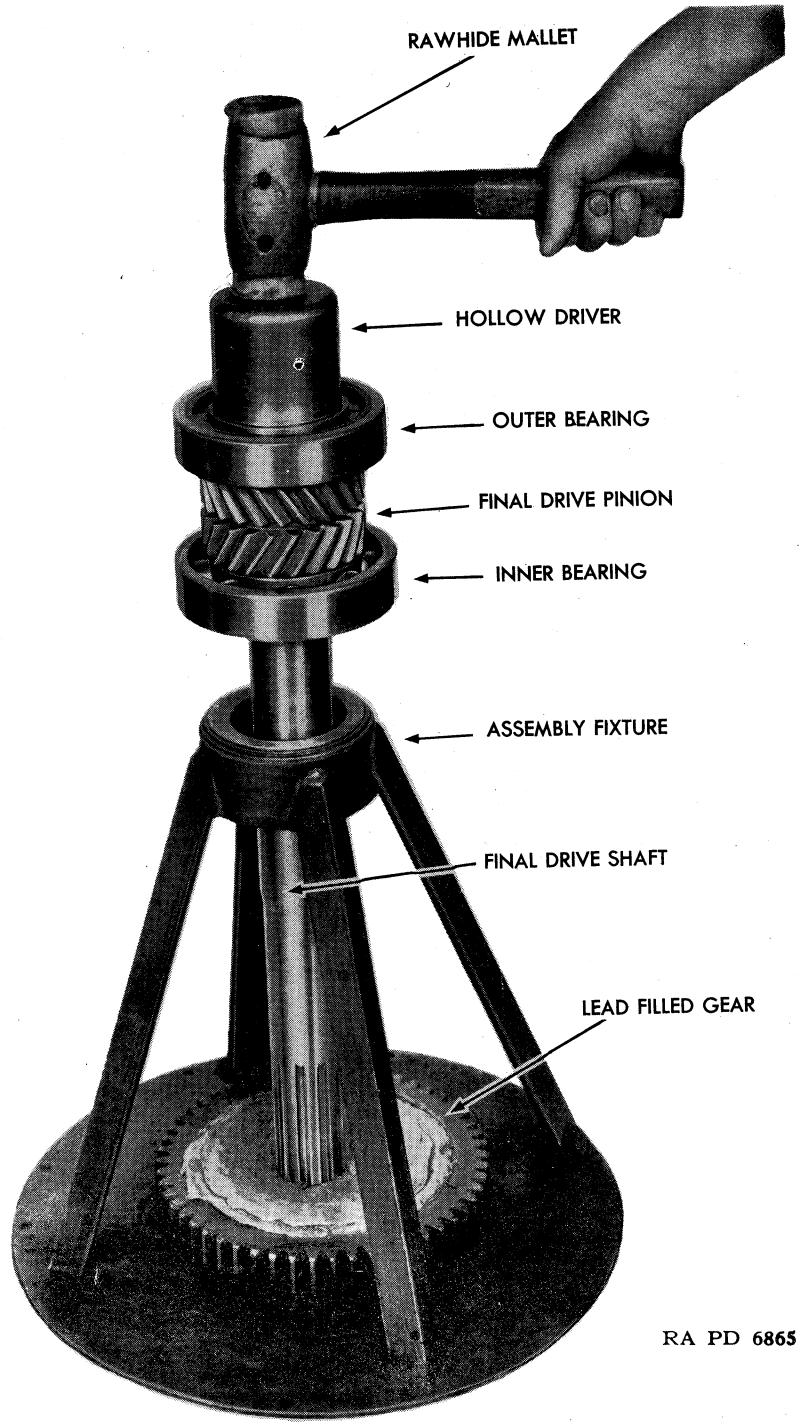


FIGURE 88—Driving outer bearing into final drive shaft.

SECTION XI

FINAL DRIVE ASSEMBLY

	Paragraph
Final inspection	39
Assembly	40

39. Final inspection.—Inspect all of the sub-assemblies that comprise the final drive before starting the final assembly. Make sure that the shaft splines are clean and smooth and that all bearings are clean, lubricated and serviceable. Examine bearing recesses in final drive bracket for the presence of foreign material or imperfections.

40. Assembly *(figs. 89, 90 and 91).*—Support final drive bracket as shown in figure 89. Place a new cover gasket over driven shaft and allow it to remain on the outer bearing *(fig. 89)*. Install shaft in bracket and tap bearing into recess by driving on the flanged end of shaft. Aline cover and gasket with holes in bracket and install six cap screws (¾-in.

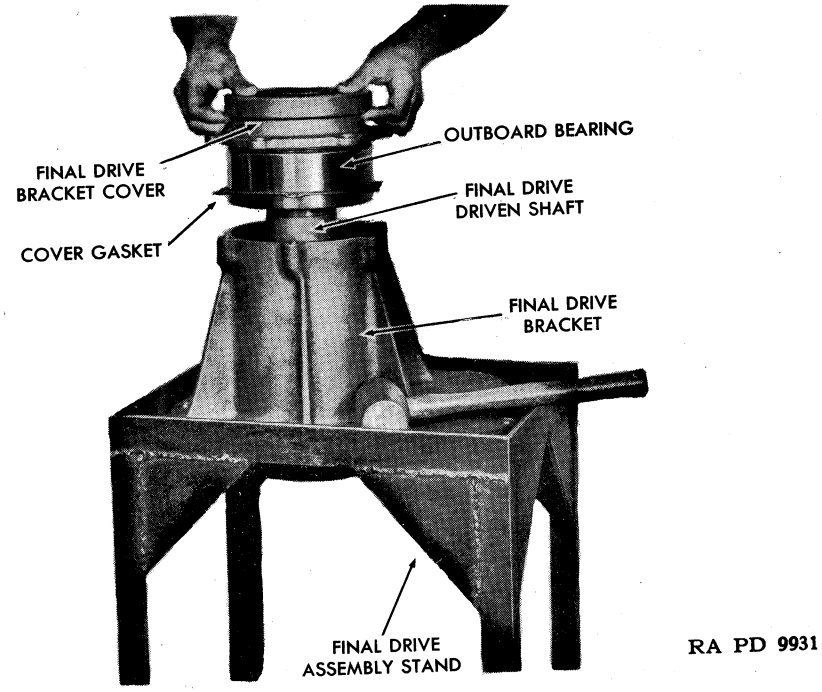


FIGURE 89—Installation of driven shaft and bearing in final drive bracket.

socket wrench). Secure with safety wire. Remove bracket from stand and turn it so that it rests on the flanged end of the driven shaft *(fig. 90)*. Start driven gear and bearing onto spline of driven shaft and into bearing recess.

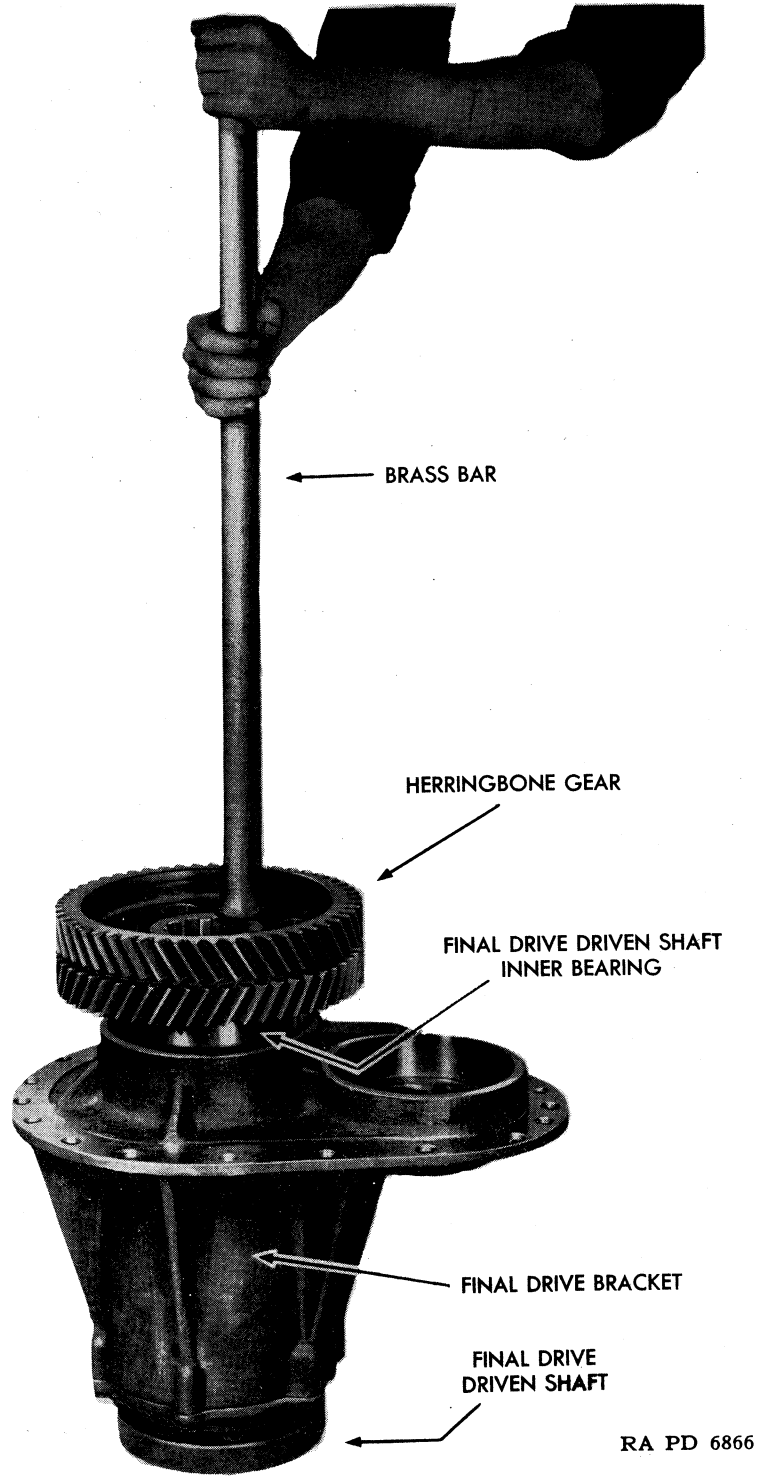


FIGURE 90—Installation of herringbone gear and bearings in final drive bracket.

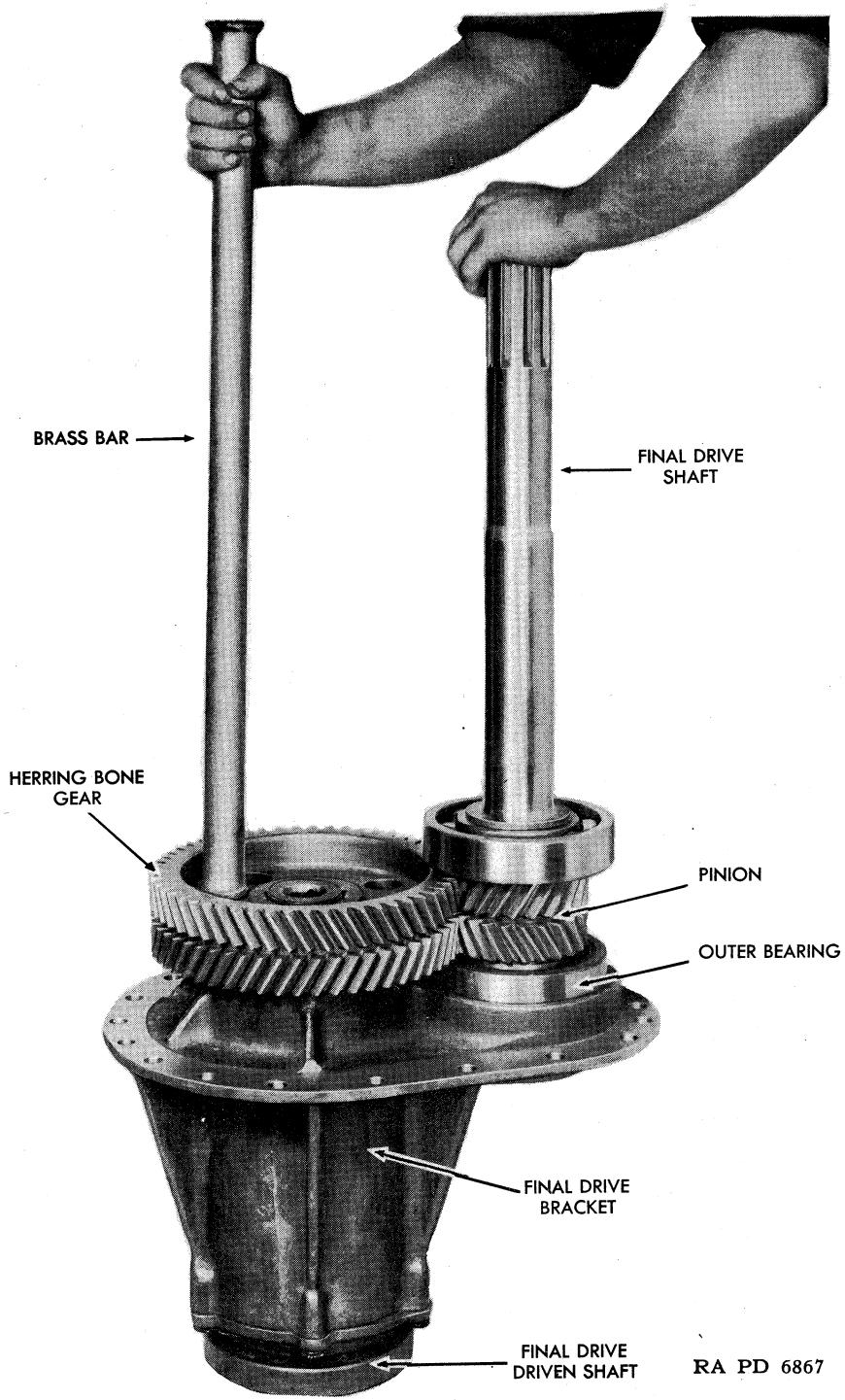


FIGURE 91—Assembly of gears and bearings in final drive bracket.

Use a $1\frac{1}{2}$-in. brass bar and drive on outside of gear to advance bearing into recess approximately one-half inch. Mesh drive shaft pinion with gear and start outer drive shaft bearing into its recess in the bracket at the same time driving on large gear to advance both assemblies until the bearing on the large, or driven gear, bottoms in its recess. (If the drive shaft outer bearing is properly alined with its recess and the pinion is correctly meshed with the larger gear, the drive shaft bearing will be moved into place without driving.) Tap the splined end of the drive shaft to insure that the outer bearing is seated. If a new driven shaft was used install studs in flange. Use an impact type stud driver or a stud driving hex cap with a socket and 30-in. handle. Install nut on end of driven shaft. Insert a bar between studs to prevent shaft rotation, and with a heavy $3\frac{9}{16}$-in. open end wrench tighten nut. Secure nut with cotter pin.

SECTION XII

INSTALLATION OF TRANSMISSION AND FINAL DRIVES IN VEHICLE

	Paragraph
Precautions	41
Installation of transmission and final drives	42
Road test	43

41. Precautions.—As in the removal of the transmission, check to see that all tools needed for the installation are conveniently at hand. Clean all oil, dirt or other foreign material from the floor and the inside of the armored sides of the hull. If the instruments or drive shaft have been disturbed, place them so that they will not be damaged when the transmission is set in place. *Work with clean tools and keep them clean.* Keep a good supply of clean wiping cloths close to the job and use them.

42. Installation of transmission and final drives.—*a. Equipment.*

Chains
Drag link
Drain pan
Hoist
Jack
Pinch bar, two, 5-ft. long
Pliers
Screwdriver
Square stock, 3/8-in.
Hexagon stock, 3/8-in.
Square stock, 3/4-in.
Hexagon stock, 3/4-in.
Wrench, 5/16-in., box, open end or socket
Wrench, two, 7/16-in., open end
Wrench, 7/16-in., box, open end or socket
Wrench, 7/16-in., square socket
Wrench, two, 1/2-in., open end
Wrench, 1/2-in., socket, 12-in., or longer extension with universal
Wrench, 1 1/4-in., open end
Wrench, 9/16-in., socket, long extension
Wrench, 9/16-in., open end
Wrench, 9/16-in., open end, ratchet handle
Wrench, 9/16-in., box, open end or socket
Wrench, 5/8-in., socket
Wrench, two, 3/4-in., box, open end or socket
Wrench, 3/4-in., open end
Wrench, two, 3/4-in., box
Wrench, 3/4-in., open end or socket
Wrench, 7/8-in., socket
Wrench, 1 5/16-in., socket
Wrench, 1-in., open end
Wrench, 1 1/16-in., socket
Wrench, 1 1/8-in., open end
Wrench, 1 5/16-in., box, open end or socket

b. Procedure.—(1) Clean interior of tank, particularly the floor.

(2) Place one man in driver's compartment to prevent injury to the accessories laying on floor.

(3) Make sure rubber pads are on brackets attached to floor of tank beneath transmission case.

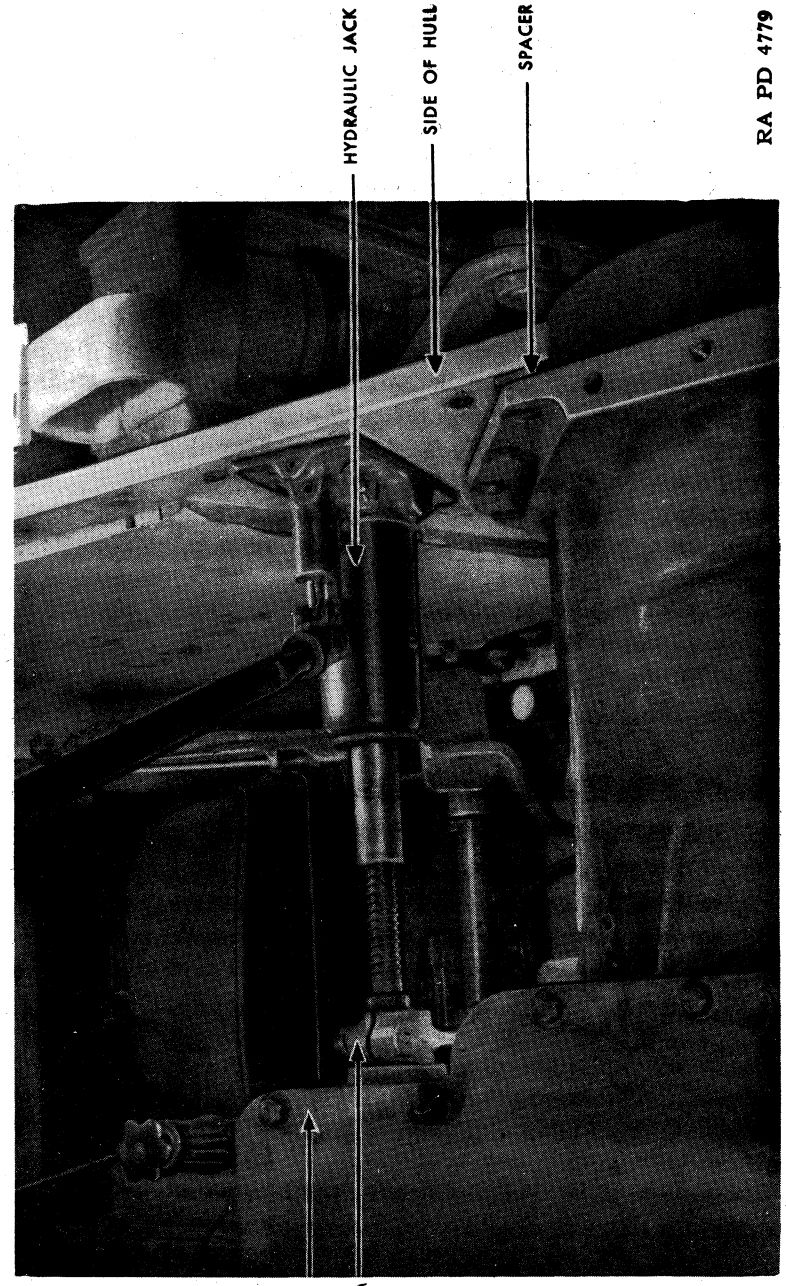


FIGURE 92—Second spacer installation.

(4) Install transmission in hull of tank *(fig. 11).* — Chains; Hoist; Two pinch bars, 5-ft. long

To attach chain to transmission, place the hook or ring of hoist directly above transmission breather and about 6 in. from it. Loop a chain around the input shaft, and right and left transmission brake band shafts. Adjust length of chains so that center of lift is directly above breather and about 10 in. from it as shown in figure 11.

(5) Install first spacer.

Insert spacer, making certain that it does not overlap the final drive aperture inside of hull at any point. Any overlap will cause oil to leak from the transmission in the final drive in a few miles of operation. Hold first spacer firmly by at least three bolts before installing the second spacer.

(6) Install second spacer *(fig. 92).* — Jack

Place a jack between transmission steering brake band shaft and hull in such a manner as to spread hull slightly to permit installation of second spacer. Make certain spacer does not overlap final drive aperture in hull.

(7) Install bolts and cap screws holding transmission to hull. — Wrench, two, 3/4-in., open end, box or socket; Wrench, 15/16-in., socket

Use a 15/16-in. socket wrench and install ten 5/8-in. cap screws in front of hull attaching transmission final drive flanges to hull (five on each side). On each side install nine 1/2-in. hex-hd. bolts (two 3/4-in. wrenches) and nuts attaching transmission final drive flange to hull.

(8) Install speedometer drive, gear housing. — Wrench, 3/4-in., open end

Install four 1/2-in. hex-hd. cap screws holding housing to rear of transmission case *(fig. 92).*

(9) Install right and left propeller shaft housing brackets. — Screwdriver; Wrench, 3/4-in., open end; Wrench, 9/16-in., open end

Install three 3/8-in. slotted head bolts, (screwdriver) and nuts and five hex-hd. bolts (9/16-in. open end wrench) attaching brackets to propeller shaft housing. Install two 1/2-in. hex-hd. cap screws holding bracket to transmission (3/4-in. open end wrench).

(10) Install clamps holding oil line to propeller shaft housing. — Wrench, two, 7/16-in., open end

Attach clamps to propeller shaft housing by installing 1/4-in. bolts and nuts.

(11) Install propeller shaft. — Wrench, two, 3/4-in., box

Install four 1/2-in. bolts and nuts which hold propeller and input shaft companion flanges together.

(12) Connect transmission inlet oil line. — Wrench, 1 1/8-in., open end; Wrench, 1 1/4-in., open end

Connect at fitting on copper tubing nearest transmission.

(13) Install propeller shaft guard straps. — Wrench, 3/4-in., open end

Install four 1/2-in. hex-hd. cap screws holding guard straps to brackets inside propeller shaft housing.

(14) Install needle bearing oil line. — Wrench, 3/4-in., open end

Connect line at elbow near pressure relief valve.

(15) Connect transmission oil pump discharge line. — Wrench, 1 1/8-in., open end; Wrench, 1 1/4-in., open end

Connect line at fitting on discharge side of pressure relief valve.

(16) Connect clutch linkage. — Pliers

Install clevis and cotter pins connecting clutch pedal shaft and linkage underneath transmission case.

(17) Connect steering lever linkage. — Pliers

Install clevis and cotter pins attaching adjustable clevis to each steering lever.

(18) Install siren switch. — Wrench, 3/4-in., open end or socket

Attach switch to bracket with 1/2-in., hex-hd. nuts.

(19) Install ammunition box on floor of bow gunner's compartment. — Wrench, 9/16-in., socket, long extension

Install two 3/8-in. hex-hd. cap screws and nuts holding ammunition box to hull.

(20) Install instrument panel on transmission case.

Wrench, 9/16-in., open end
Wrench, 1/2-in., socket
Extension with universal joint and ratchet handle 12-in. or longer

Use a 9/16-in. open end wrench and install four 5/16-in. hex-hd. nuts on studs in transmission case holding instrument panel in place. Install 3/8-in. hex-hd. cap screws holding stop light switch cable clamps to handhole covers of transmission case (1/2-in. socket wrench).

(21) Install instrument panel rear cover.

Wrench, 7/16-in., open end

Secure cover to instrument panel with four 1/4-in. nuts.

(22) Install speedometer housing.

Wrench, 1/2-in., open end
Pliers

Working through inspection cover on speedometer housing install two 5/16-in. hex-hd. cap screws attaching housing to transmission case.

(23) Install windshield fans.

Screwdriver

Install ball mounting in socket. Hold in position by tightening socket clamping screw to clamp socket.

(24) Install propeller shaft housing cover.

Wrench, 5/8-in., socket

Install eight 7/16-in. hex-hd. acorn nuts holding cover to housing.

(25) Install leg shield in bow gunner's compartment.

Wrench, two, 1/2-in., open end

Hold leg guard and speedometer shield together by installing three 5/16-in. hex-hd. bolts and nuts. Hold forward end of leg shield to transmission case by installing 5/16-in. cap screw to transmission.

(26) Connect hand throttle cable.

Pliers
Wrench, two, 7/16-in., open end
Wrench, 1-in., open end

Install adjustable clevis and hold in position by tightening lock nuts. Install clevis pin and cotter pin connecting accelerator shaft lever near clutch pedal to adjustable clevis. Hold cable to support bracket by installing hex-hd. nut.

(27) Connect oil pressure gage line.

Wrench, 9/16-in., open end

Connect line at gage.

(28) Install stop light switch support brackets on transmission.

Wrench, 1/2-in., open end
Wrench, 9/16-in., open end

Install four 1/4-in. bolts holding switch brackets to transmission case (one on each side).

(29) Install front sloping armor plate.

Drag link
Screwdriver
Wrench, 5/16-in., open end, box or socket

Install the following bolts, nuts and cap screws holding the front sloping armor plate to hull. Four 5/8-in. slotted-hd. cap screws (drag link, screwdriver). Twelve 5/8-in. slotted bolts and hex-hd. nuts. One 3/8-in. slotted-hd. bolt and hex-hd. nut supporting compass (5/16-in. socket wrench).

(30) Install conduit elbows in front sloping armor plate.

Wrench, 15/16-in., open end, box or socket

Install hexagon nut holding conduit elbows in front sloping armor plate for headlamps and siren.

(31) Install final drive.

Wrench, 7/8-in., socket

Using two men, place final drive in position. Start four equally spaced cap screws holding final drive to flange of transmission case. Rock final drive to make certain that dowel pins enter final drive flange holes before cap screws are tightened. Tighten evenly so as to keep final drive in alinement. Install remaining thirteen 5/8-in. hex-hd. cap screws.

(32) Install sprockets.

Wrench, 1 1/16-in., socket

Using two men, mount sprocket on final drive shaft flange. Install eight 7/8-in. hex-hd. nuts holding each final drive to final drive shaft flange.

(33) Install fenders.

Wrench, 9/16-in., open end, box or socket
Wrench, 15/16-in., open end, box or socket

Quantities in the following refer to one fender only. Install seven 3/8-in. hex-hd. bolts and nuts holding fender to front sloping armor plate (9/16-in. socket wrench). Install three 5/8-in. hex-hd. cap screws holding fender to front sloping armor plate (15/16-in. socket wrench). Install five 3/8-in. hex-hd. bolts and nuts holding fender to side armor plate. Install four 3/8-in. hex-hd. bolts and nuts holding fender to sponson.

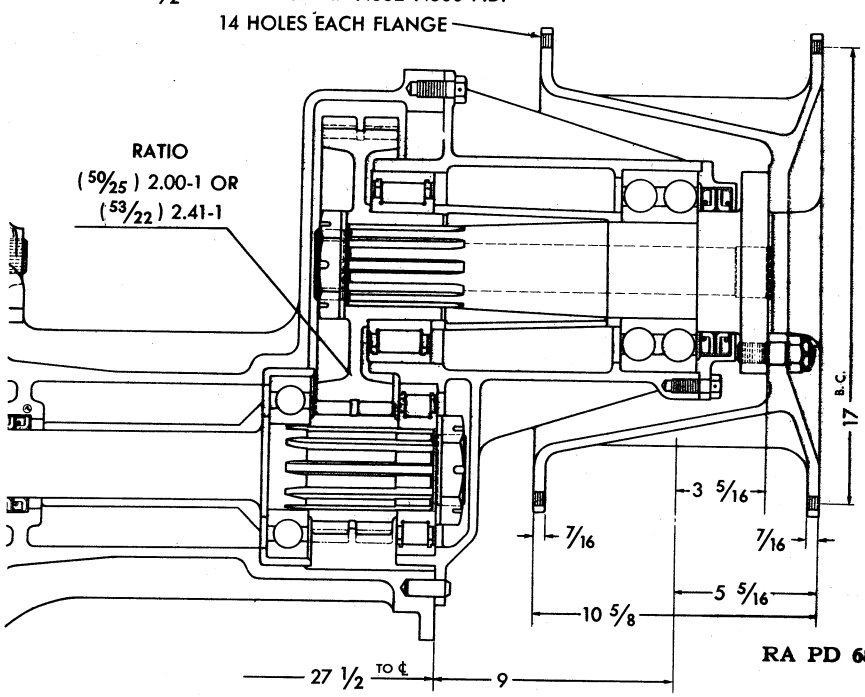


FIGURE 93—Final drive end assembly.

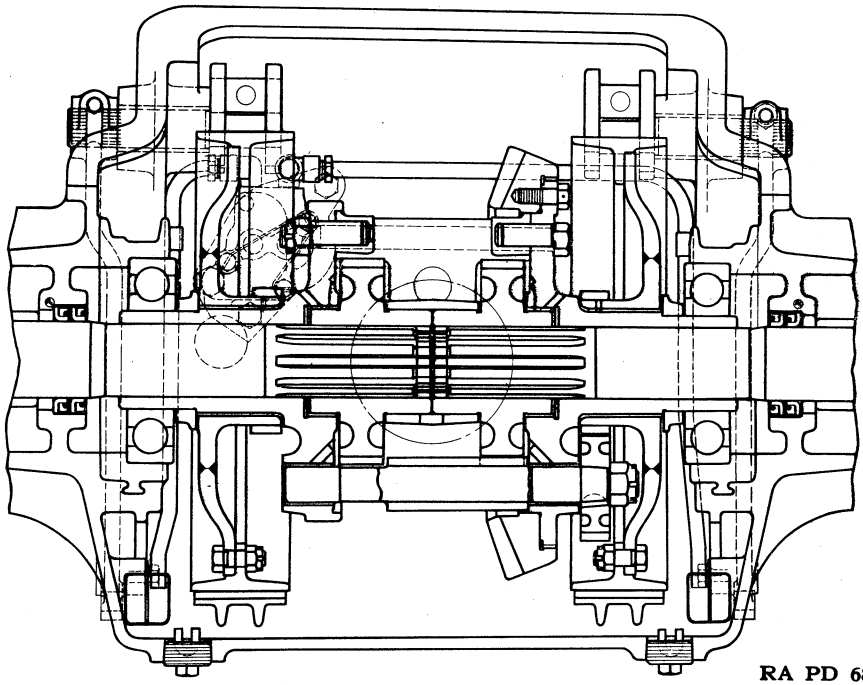


FIGURE 94—Controlled differential assembly.

(34) Install light leads. — Pliers

Connect leads at front sloping armor plate.

(35) Install siren lead. — Pliers

Connect lead at front sloping armor plate.

(36) Fill transmission with oil.

Wrench, 9/16-in., box, socket or open end
Square stock, 3/4-in.
Hexagonal stock, 3/4-in.
Wrench, 3/4-in., open end
Drain pan

After cleaning, install 1¼-in. magnetic pipe plug using 3/4-in. square stock and 3/4-in. open end wrench. Hold pipe plug cover plate to hull by installing four 3/8-in. hex-hd. nuts on studs in hull (9/16-in. socket wrench). NOTE: Follow lubrication chart, paragraph 18 TM 9-726, and quantity of lubricants used in filling transmission.

(37) Install oil drain plugs of final drive.

Square stock, 3/8-in.
Hexagonal stock, 3/8-in.
Wrench, 7/16-in., square socket
Drain pan

Use 3/8-in. square stock and 7/16-in. square socket wrench and install two ½-in. recessed head pipe plugs on bottom of flanged right and left final drive housing near the right and left final drive housing. NOTE: See lubrication chart, TM 9-726, paragraph 18. Put in oil.

43. Road Test.—Whether or not the reconditioned transmission is given a running test on the test stand, it must receive a road test on the vehicle. Watch the transmission oil pressure gage and be sure the oil pump is functioning properly and that the oil is being properly cooled. When the vehicle is first put into operation and the oil is cool, the gage should register about 30 psi, but as the oil heats up, the pressure will gradually fall toward 0, due to the foaming of the oil. Proper functioning of the oil pump is then ascertained by opening the petcock on the back side of the gage to see if any oil is pumped out. The gage must be watched through the road test. *Do not operate the transmission without adequate oil pressure.* Carefully check all shifts. In the gears engaged through the synchronizers, note whether the final engagement is natural and noiseless when the first step in the shift, or the gear "blocking," is completed. See that the engine clutch linkage is properly adjusted and that at least ½-inch free pedal play is present between the clutch pedal and the stop.

SECTION XIII

SPECIAL TOOLS AND EQUIPMENT

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44. Introduction.—*a.* The overhaul of the transmission in light tank M3 can be accomplished faster and in a more satisfactory manner if the tools specified in each operation are used. Some of the tools used are not standard and will have to be made up in the ordnance shop. To simplify this procedure, paragraph 45 provides sketches of all of the special tools important to the overhaul procedure.

b. Figures 112 and 113 show test equipment for the oil pump assembly and the complete transmission assembly, respectively. These test set-ups are important not only to check performance after overhaul, but also for inspection and diagnosis of trouble before disassembly. Similar equipment when made up will be found to be helpful and will contribute much to both the saving of time and the quality of the job done. The test cradle and motor shown in figure 114 will provide a satisfactory "no load" running test for the gearing of the transmission proper.

45. Special Tools. — The following list of tools and related figure numbers are shown in the detailed sketches which follow:

Tool	*Fig. No.*
Clamp to hold second and third speed gears during assembly	95
Spacers — an input shaft between bevel pinion and sliding gear, and bearing nut during assembly	96
Wrench for idler shaft	97
Differential bearing puller	98
Bearing drivers input and output shaft bearings	99
Puller for rear cover	101
Wrench output shaft center bearing retainer nut	103
Bearing block used when driving input shaft into front bearing	104
Socket wrench reverse gear shaft front bearing retaining nut	105
Puller input shaft	106
Bearing puller output shaft rear bearing	107
Puller for bevel pinion	108
Driver differential bearing	109

46. Test Equipment. — Figures 112, 113 and 114 show sample groups of test equipment. As long as the important factors remain similar either group may be built up from available components as long as the desired performance is realized in the final group assembly.

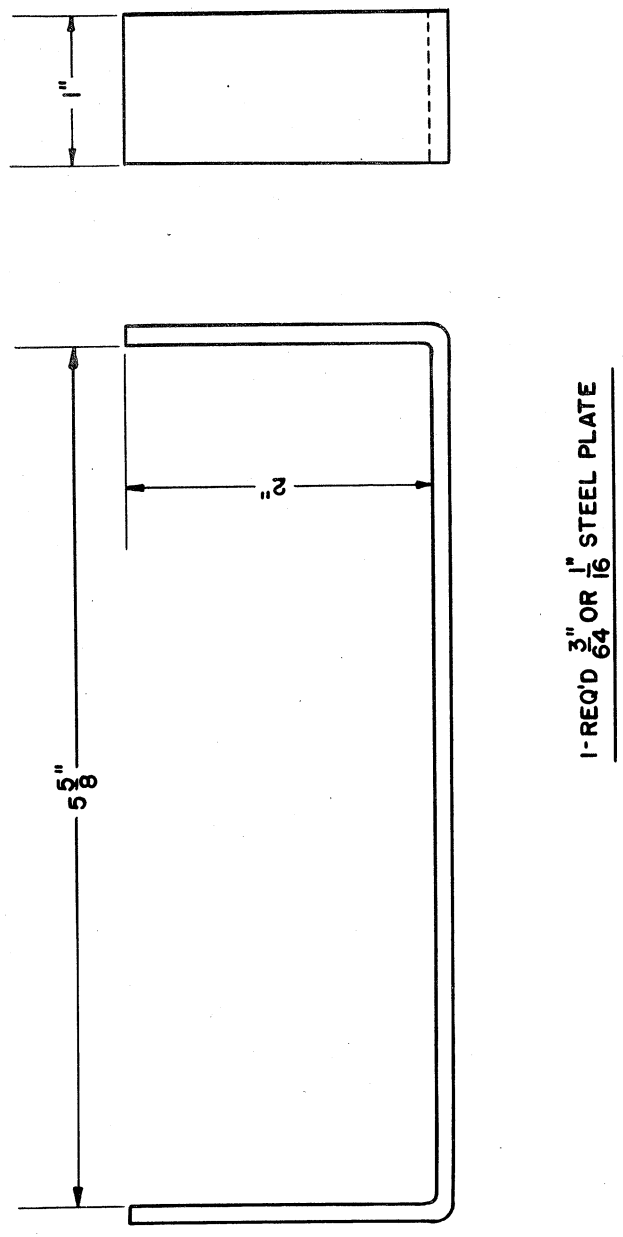


FIGURE 95—Clamp to hold second and third speed gears during assembly.

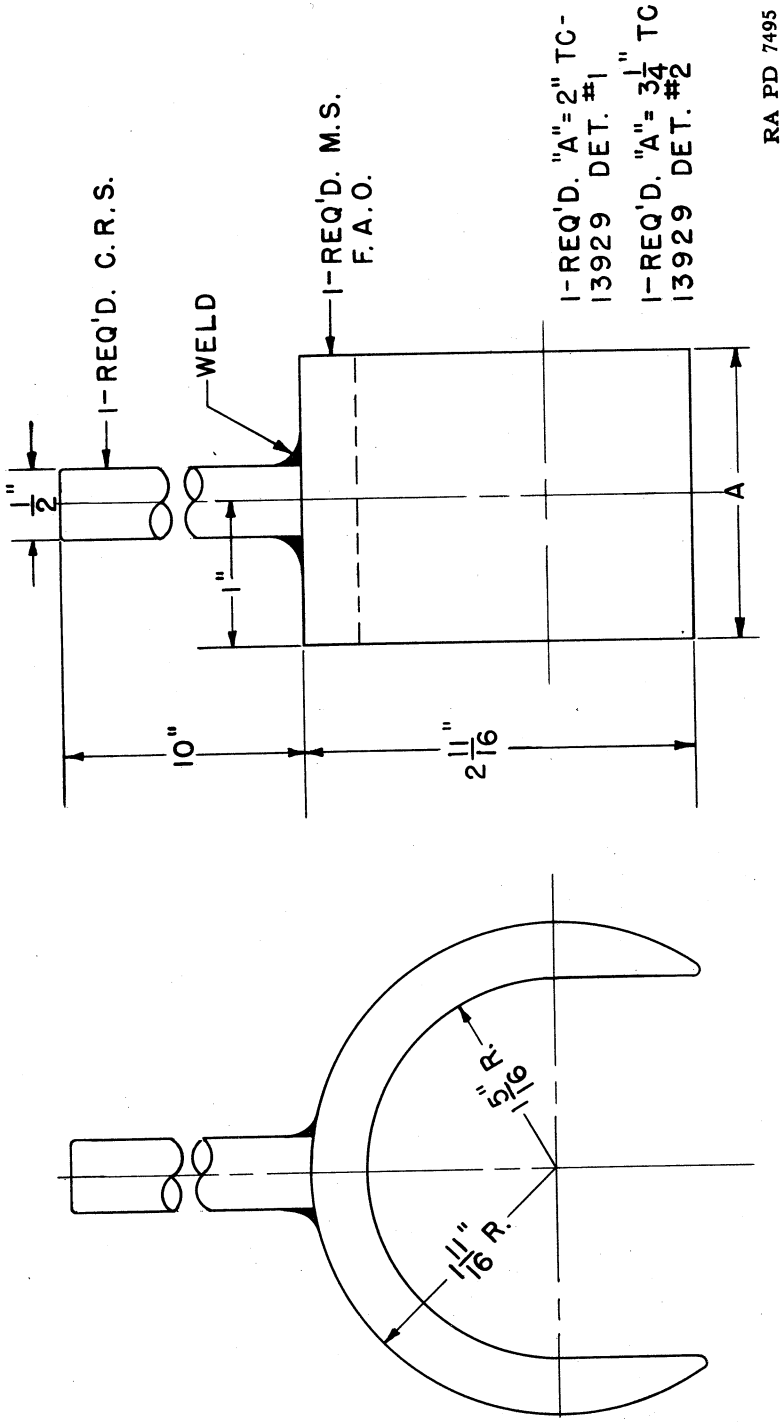


FIGURE 96—Sliding gear locating spacers—output shaft installation.

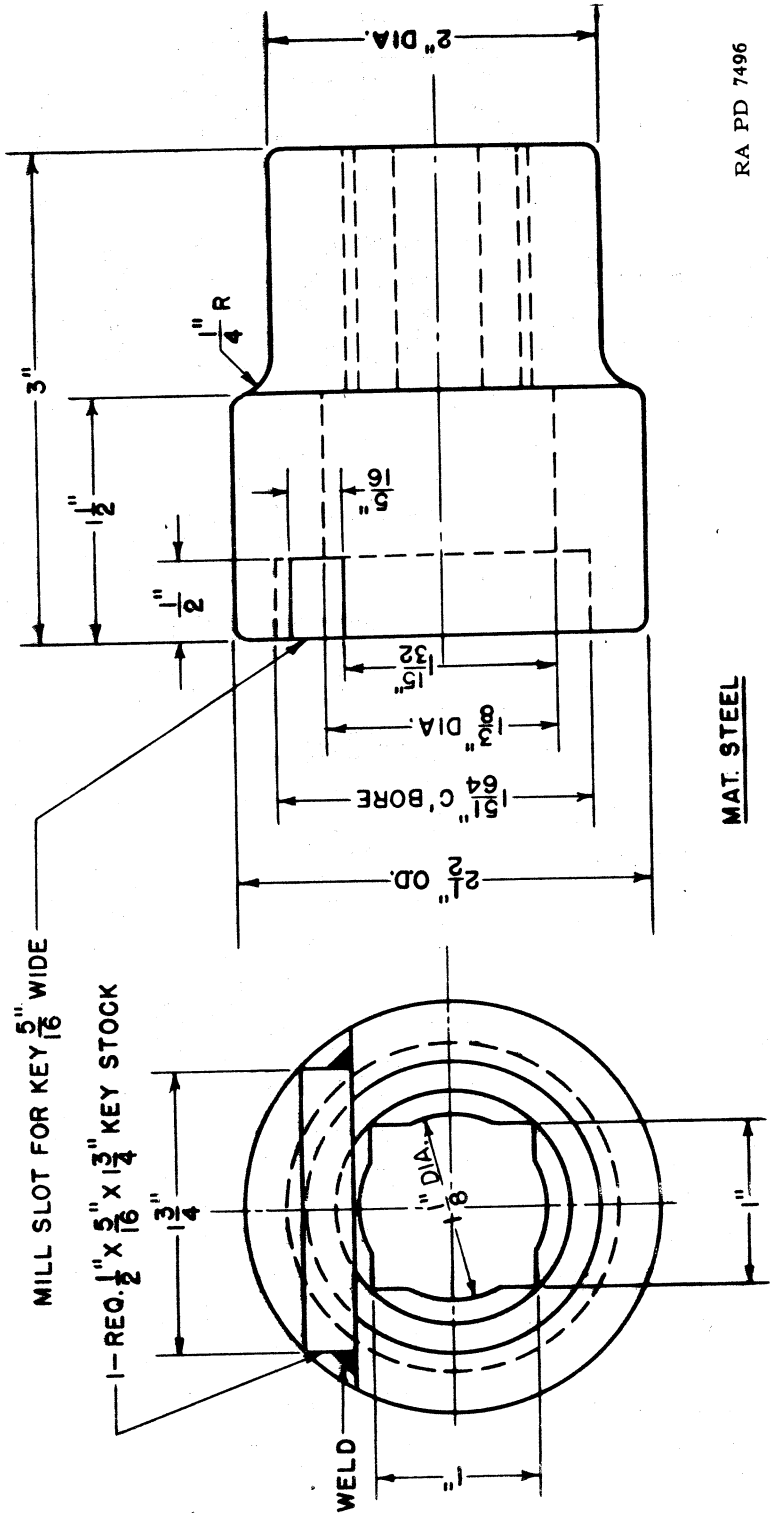


FIGURE 97—Wrench for first speed shaft.

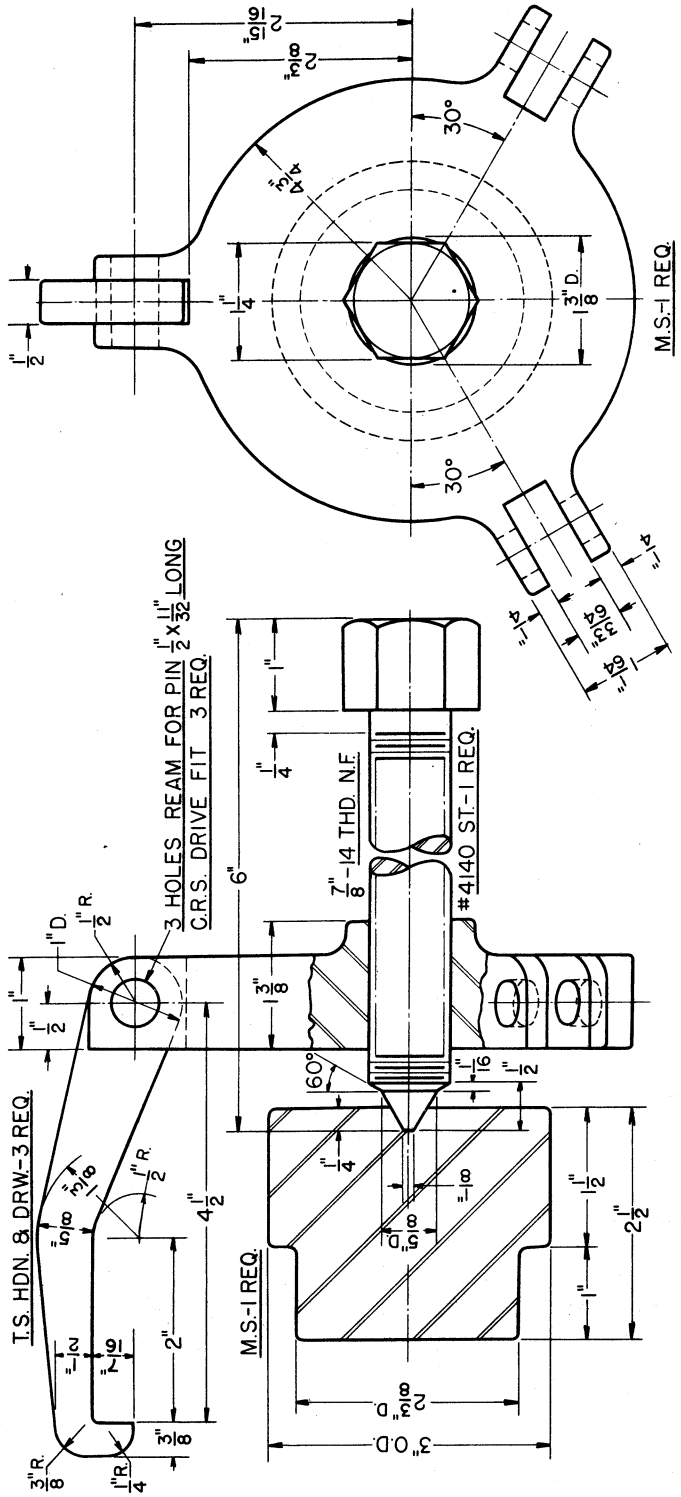


FIGURE 98—Differential bearing puller.

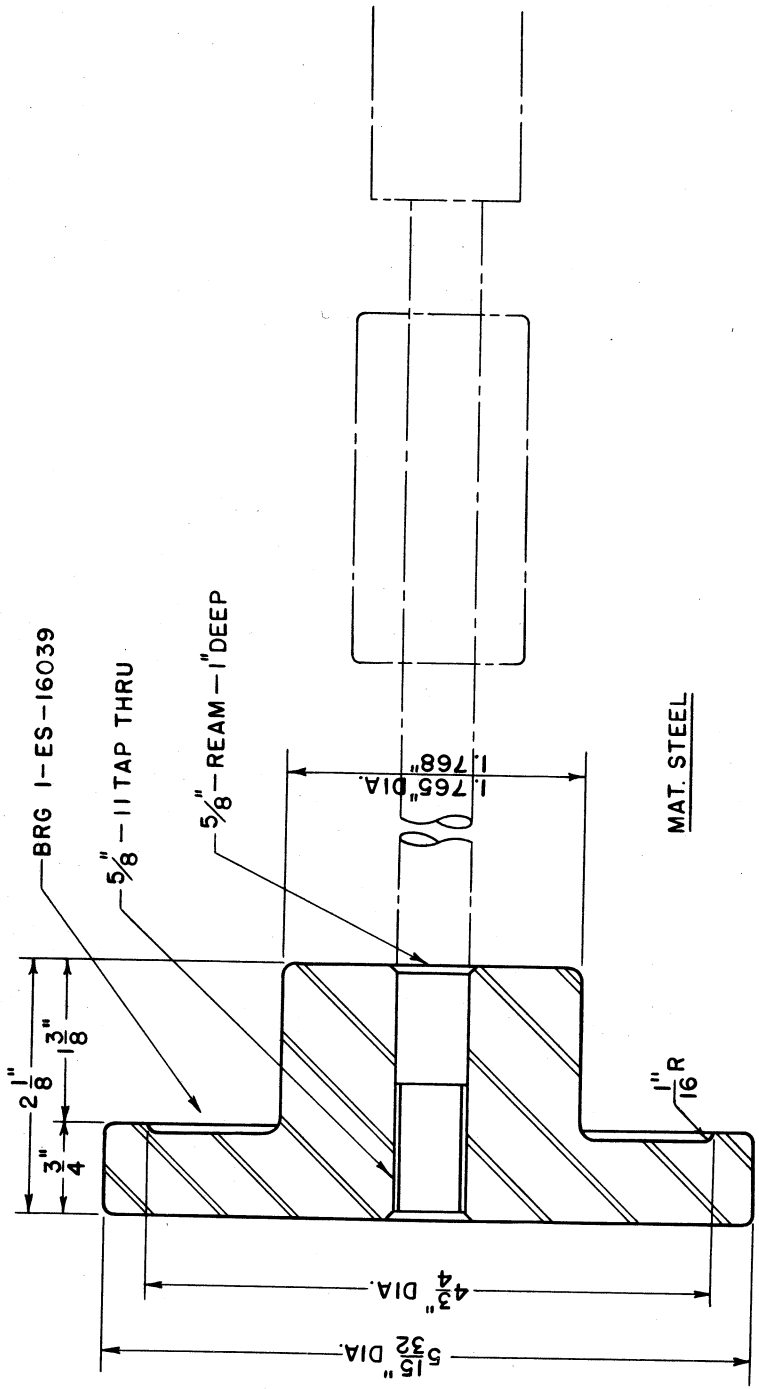
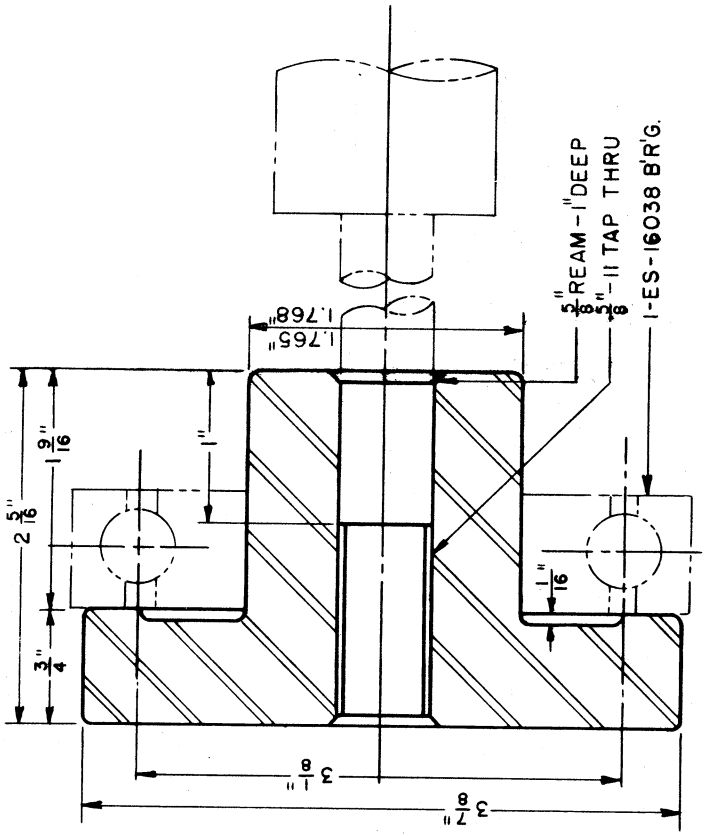
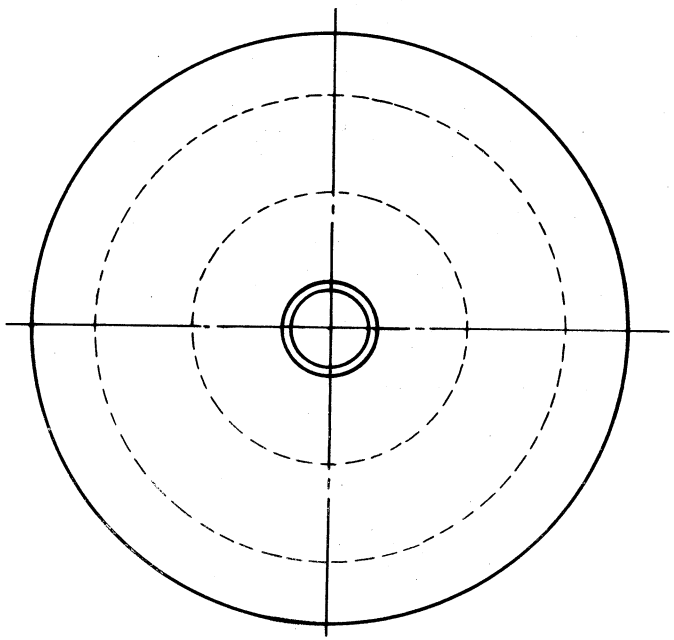


FIGURE 99—Bearing driver-output shaft center bearing.

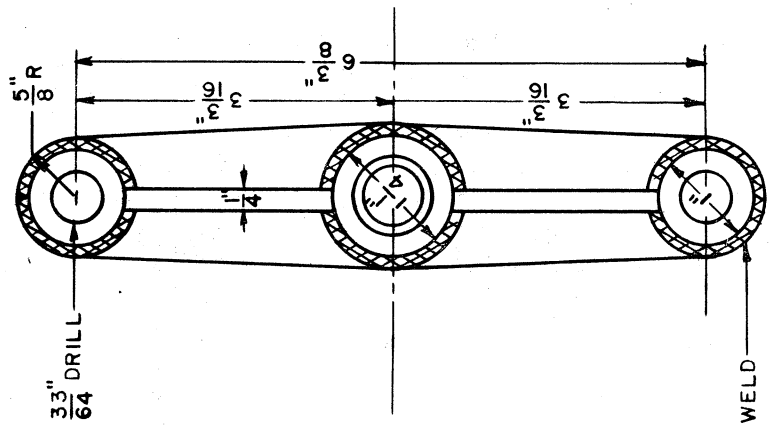


RA PD 7498A



MAT. STEEL

FIGURE 100—Bearing driver-input shaft front bearing.



RA PD 7499

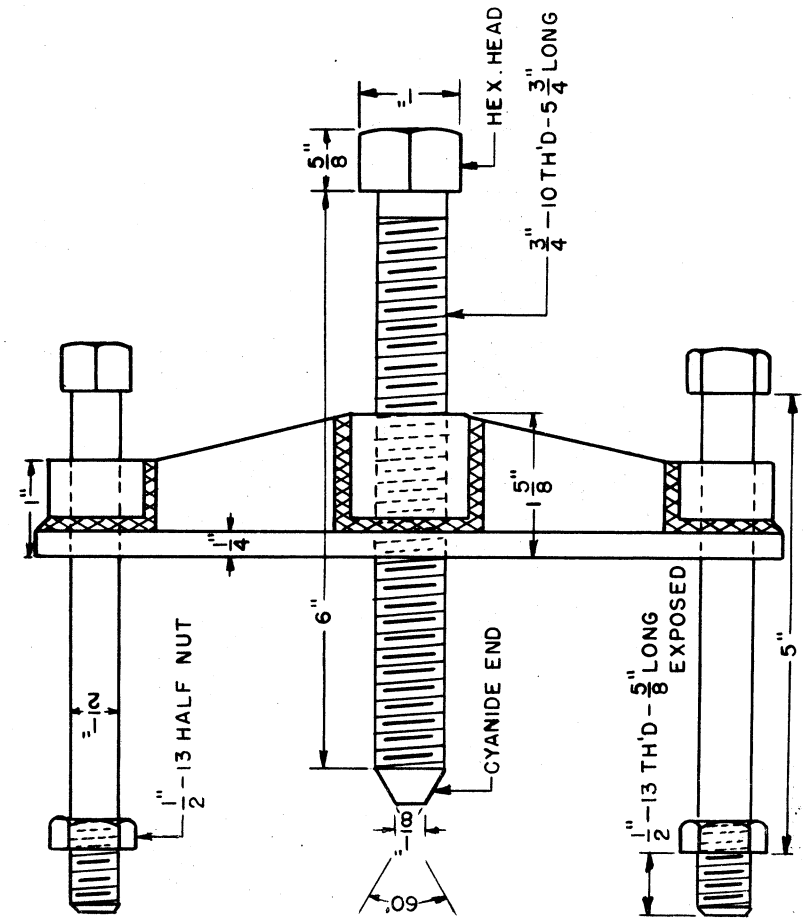


FIGURE 101—Puller for rear cover used on input shaft.

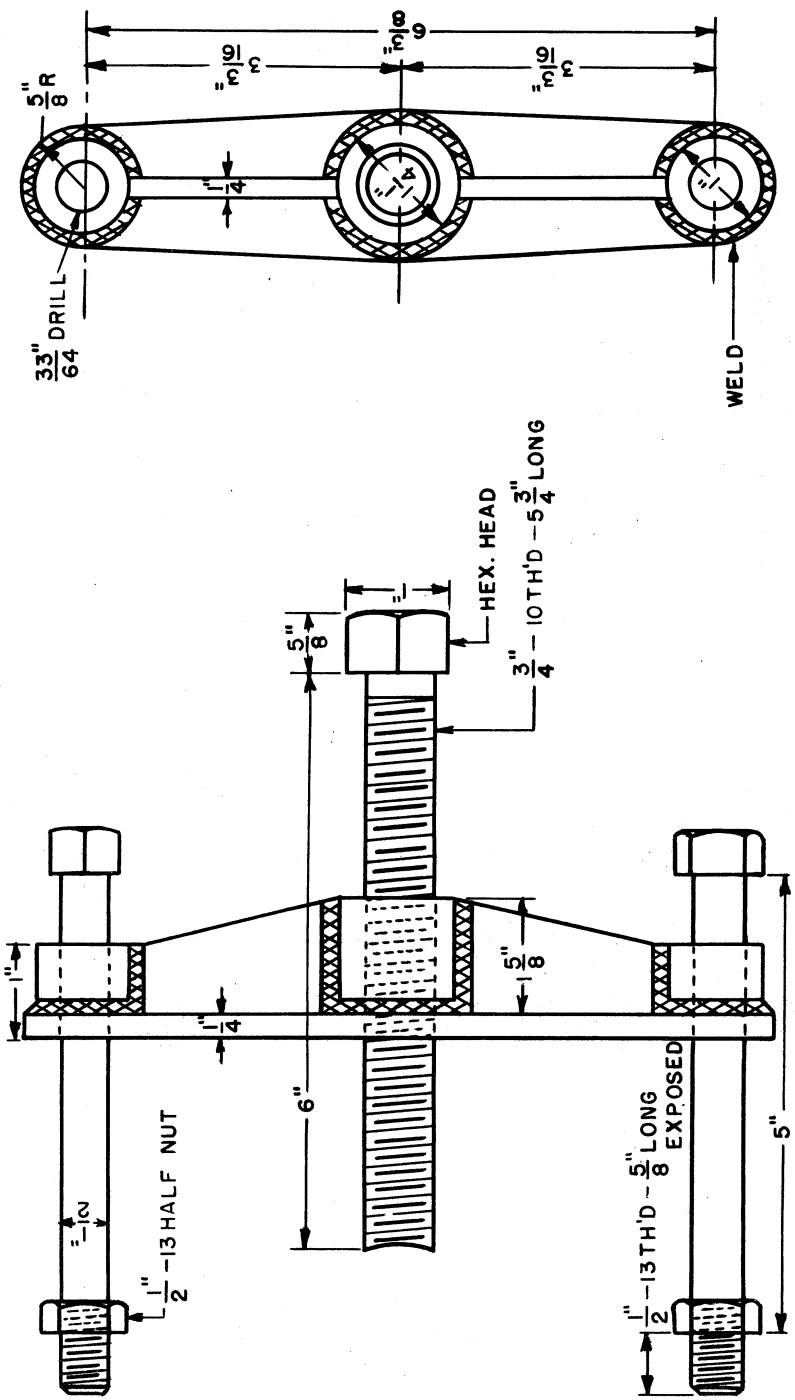


FIGURE 102—Puller for rear cover used on output shaft.

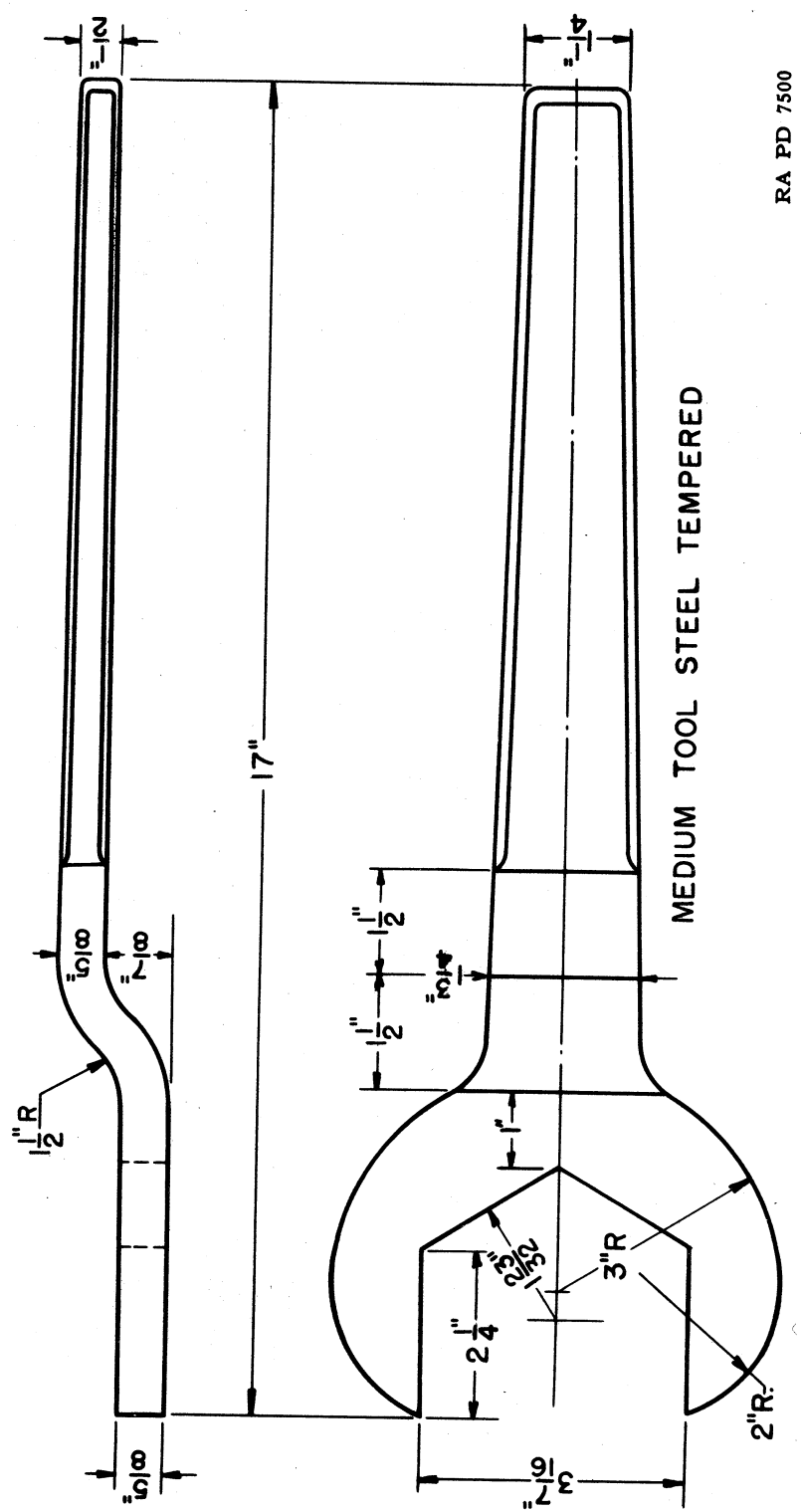


FIGURE 103—Wrench for output shaft center bearing retainer nut.

RA PD 7501

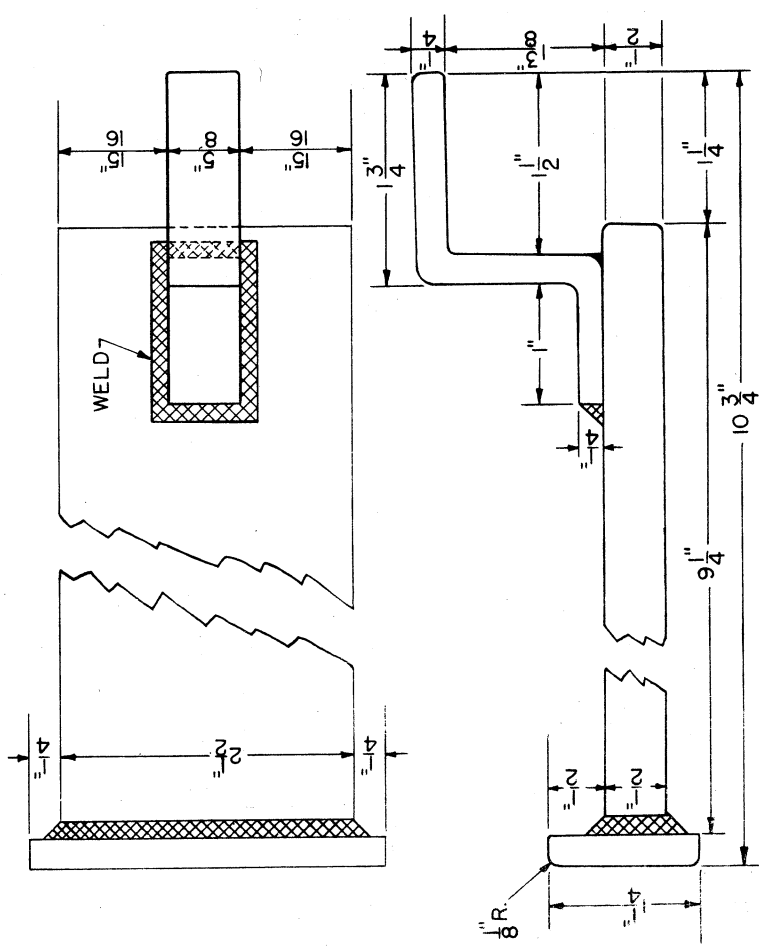


FIGURE 104—Bearing block used when driving input shaft into front bearing.

RA PD 7502

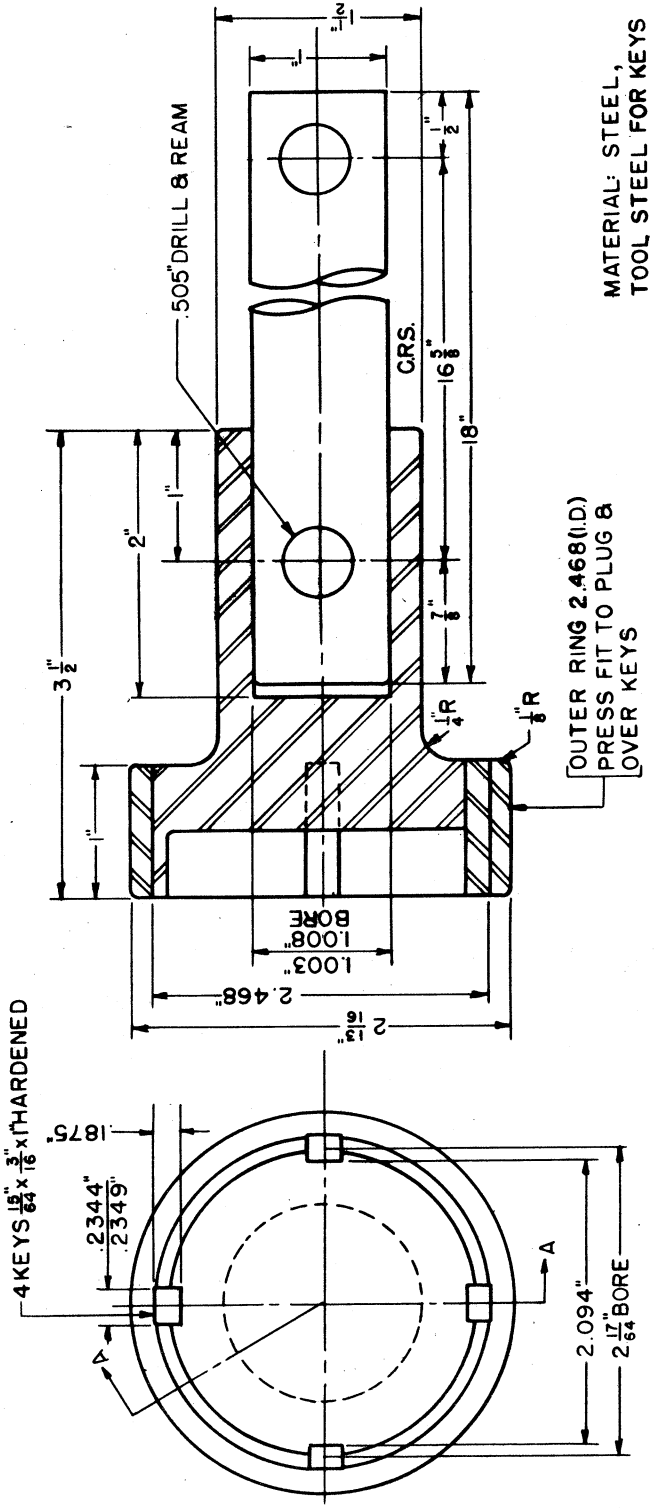


FIGURE 105—Socket wrench for reverse gear shaft front bearing retaining nut.

RA PD 7503

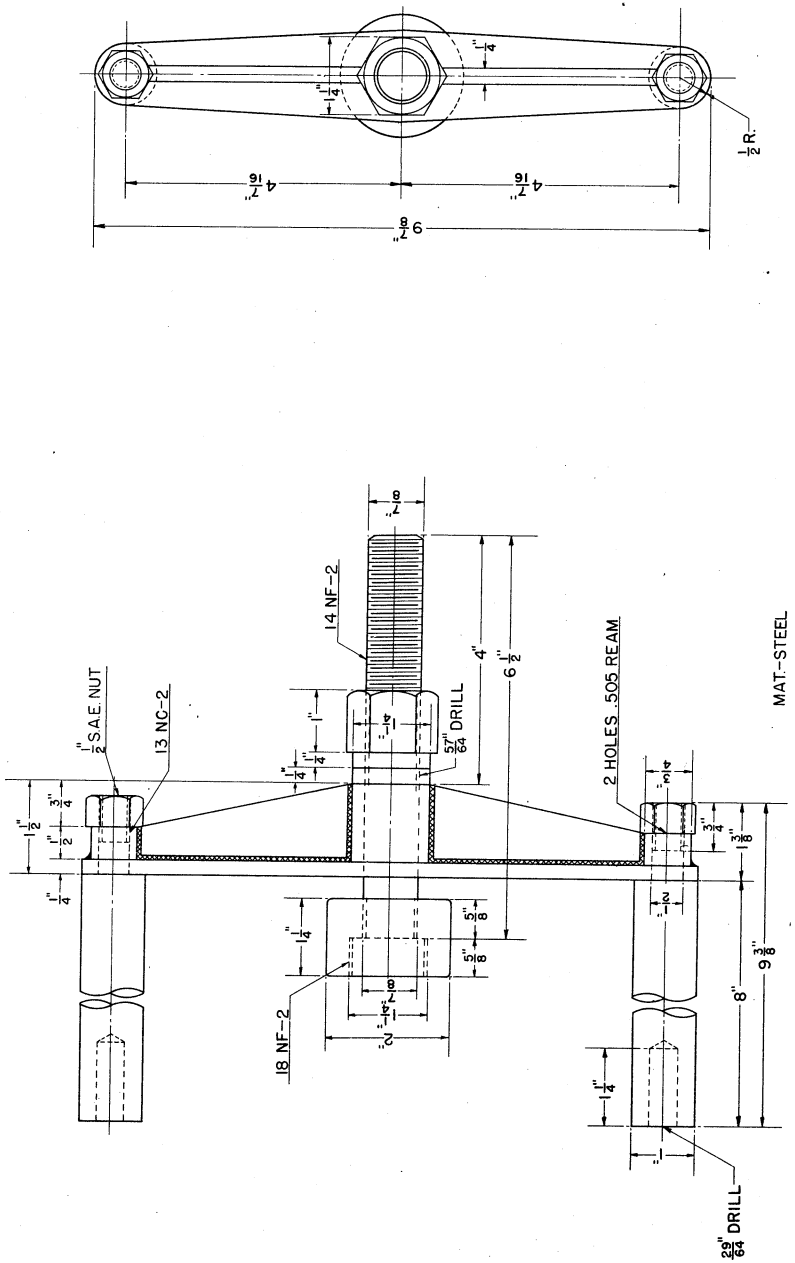


FIGURE 106—Input shaft puller.

RA PD 7504

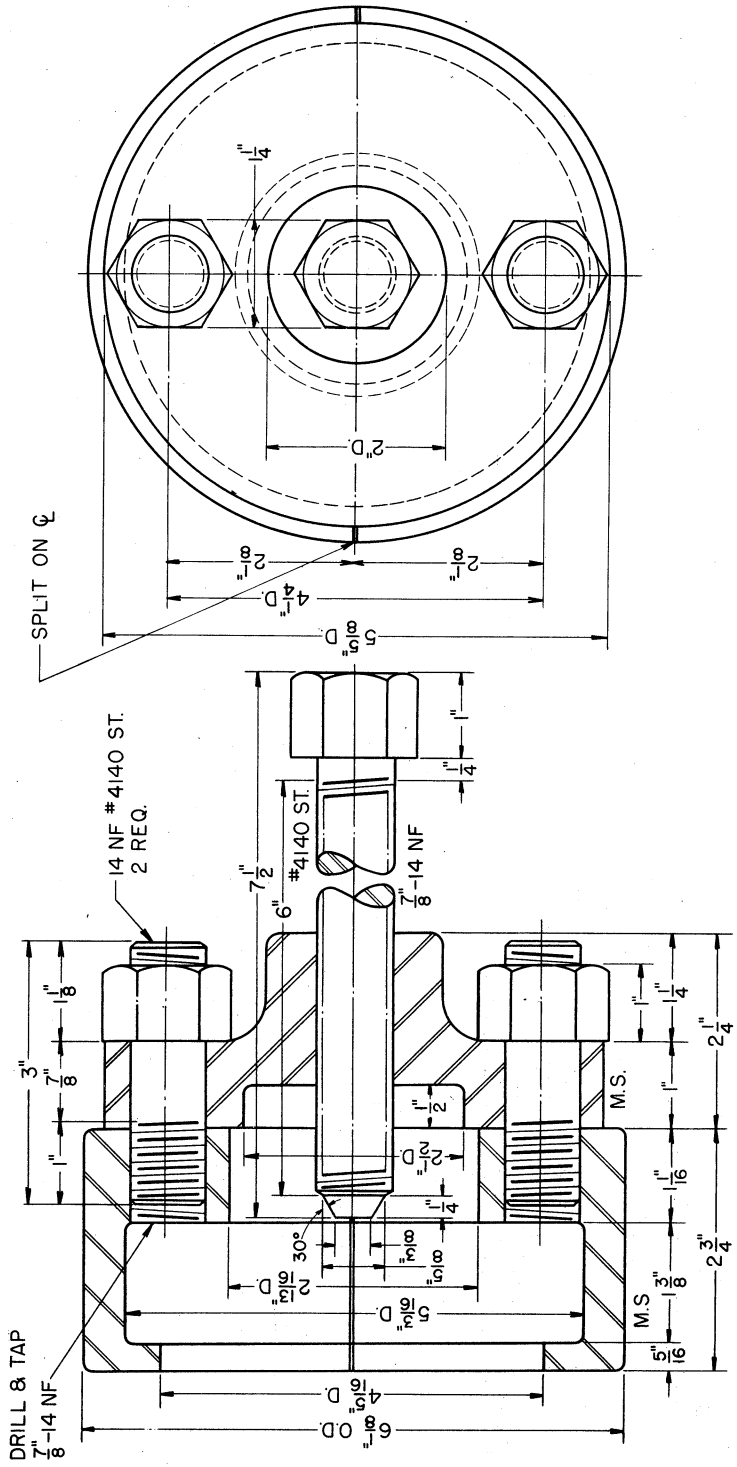


FIGURE 107—Bearing puller for output shaft rear bearing.

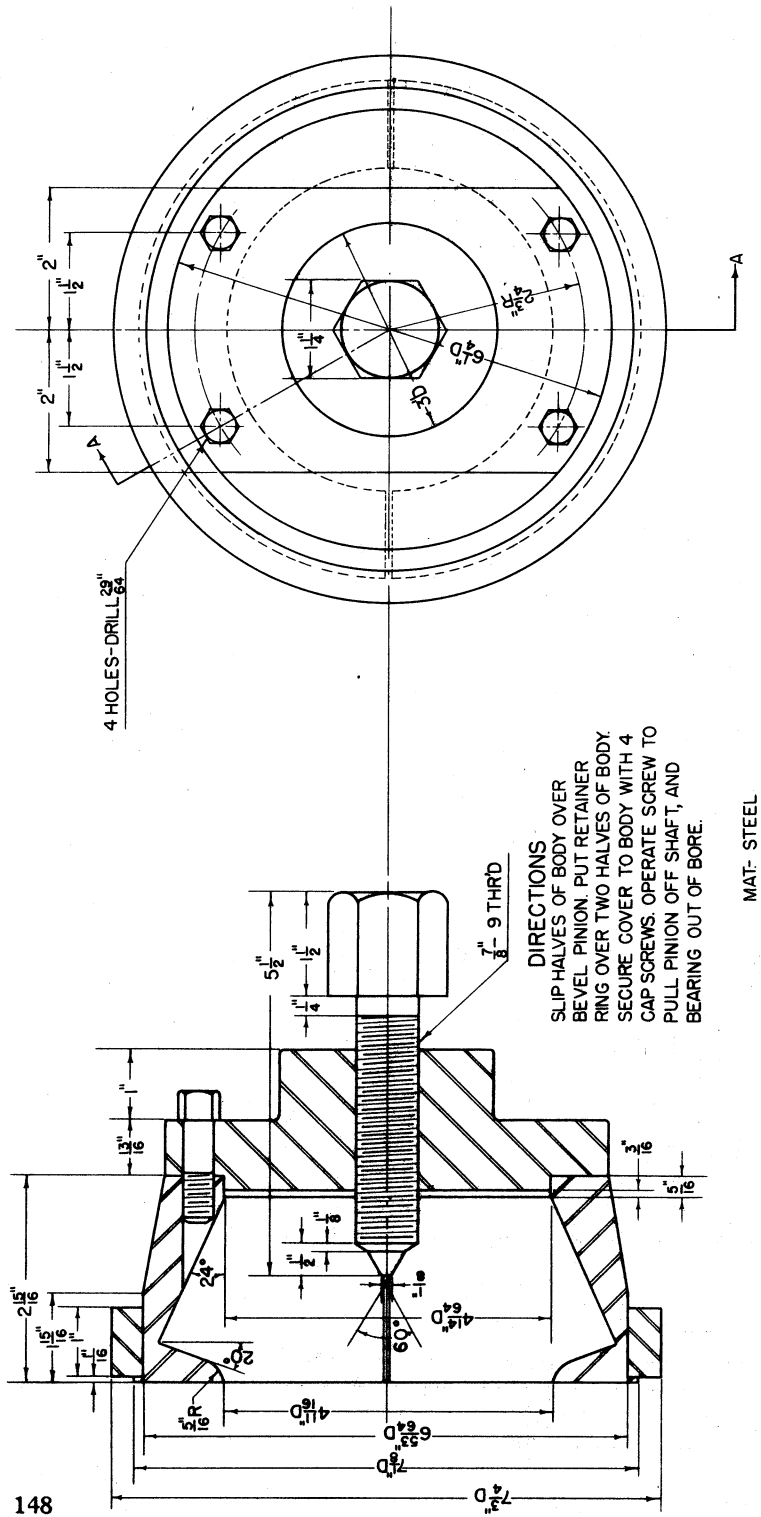


FIGURE 108—Puller for bevel pinion.

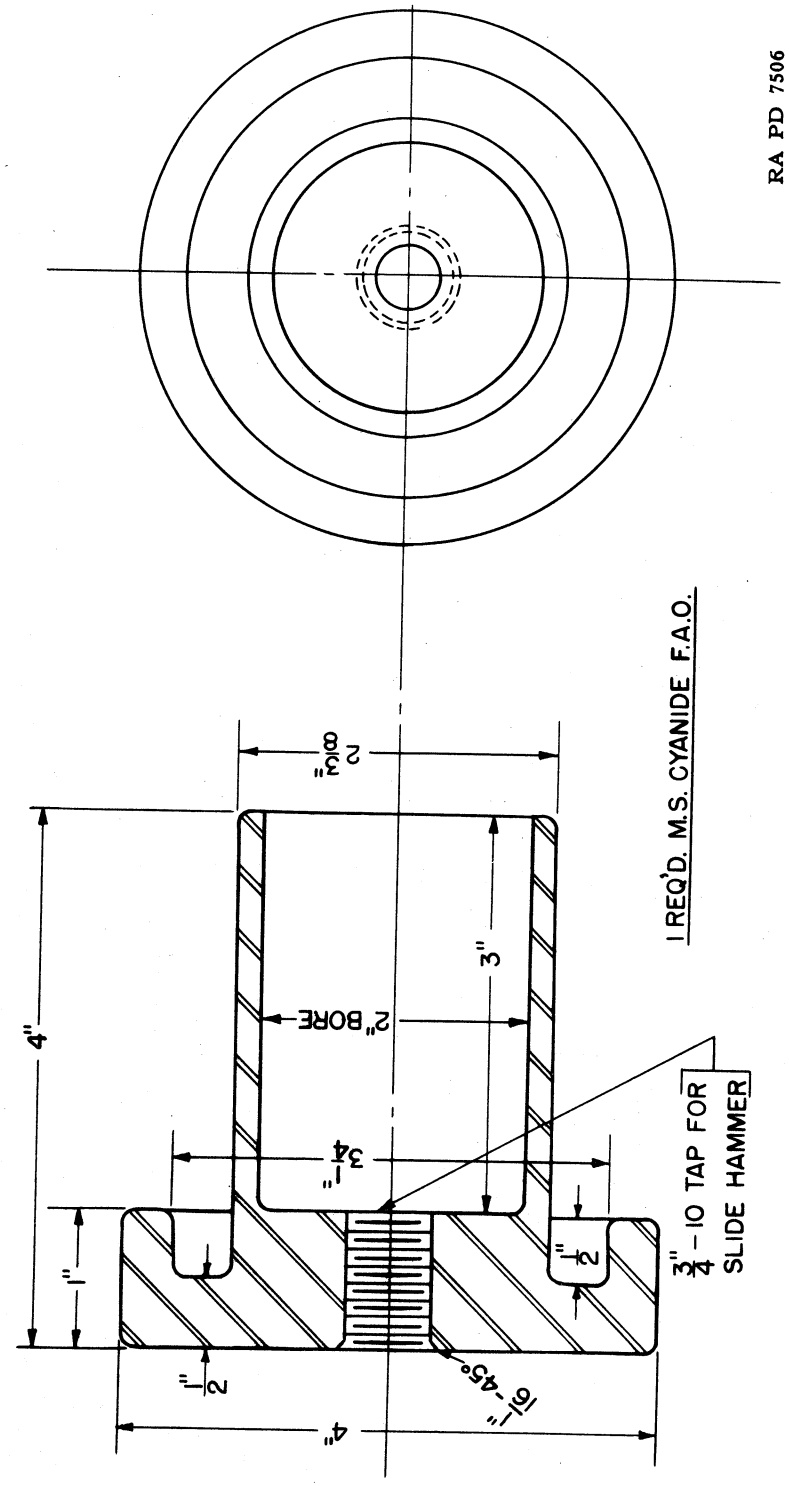


FIGURE 109—Driver for differential bearing.

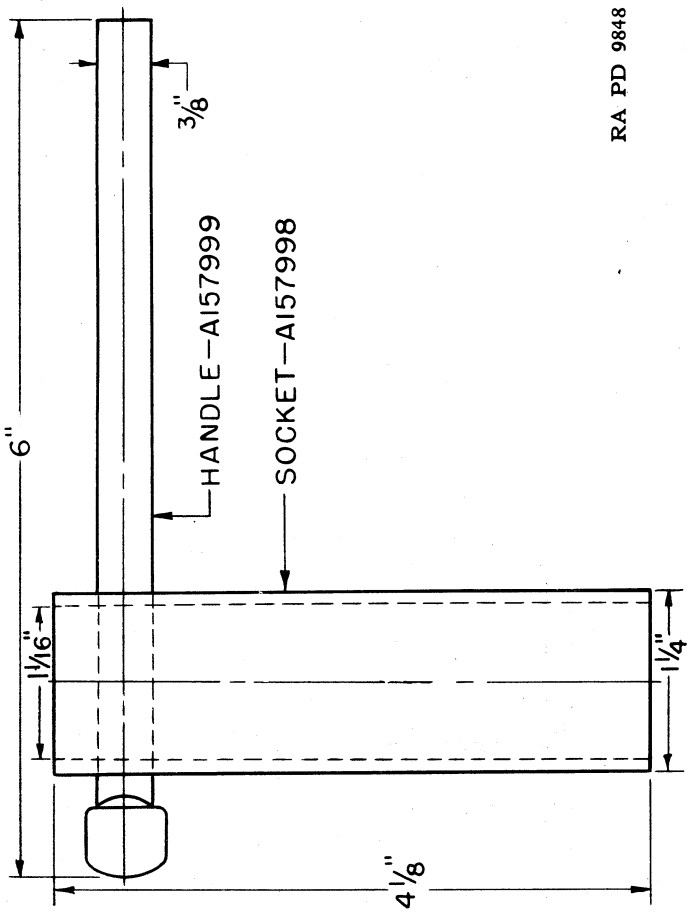


FIGURE 110—Brake adjusting wrench

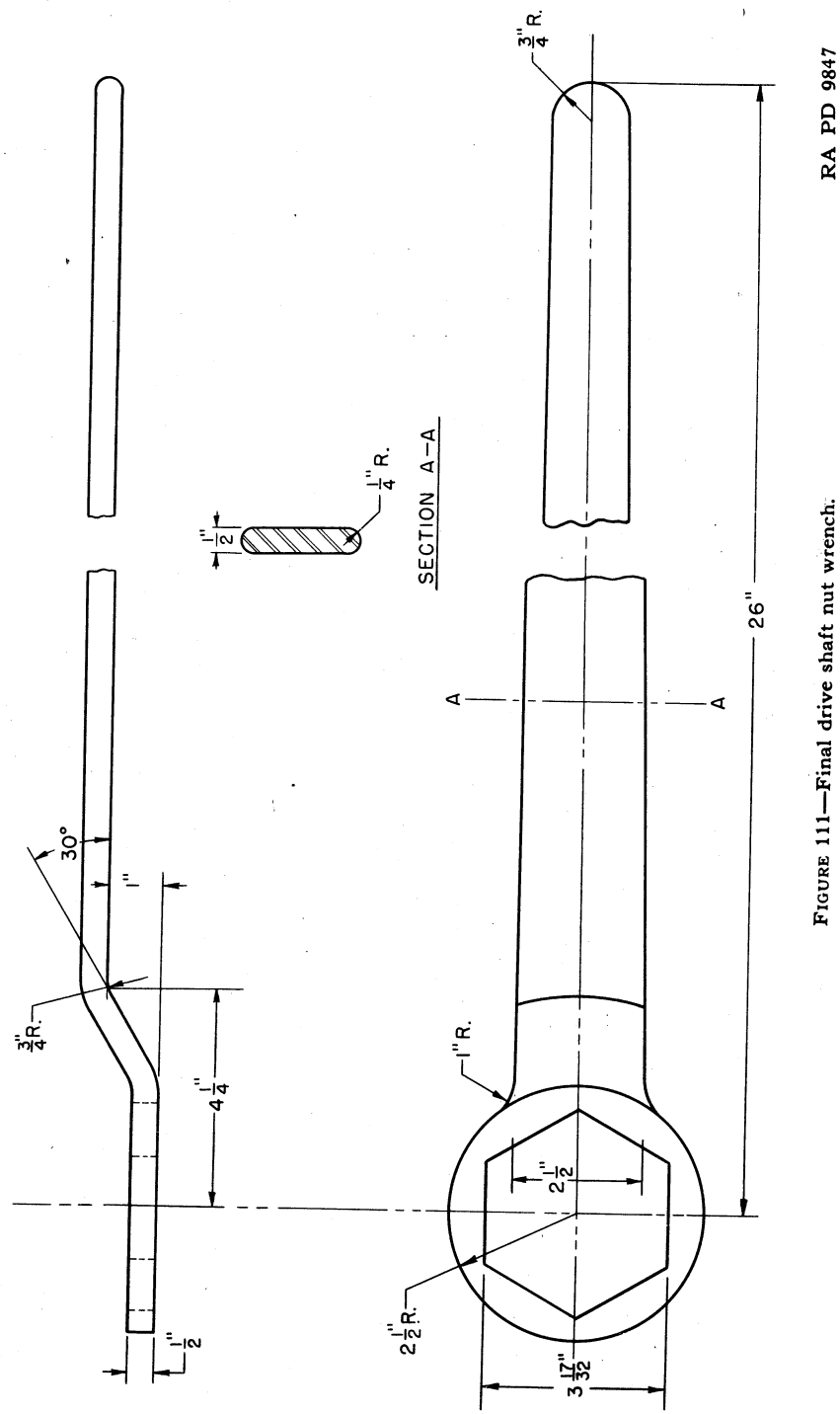
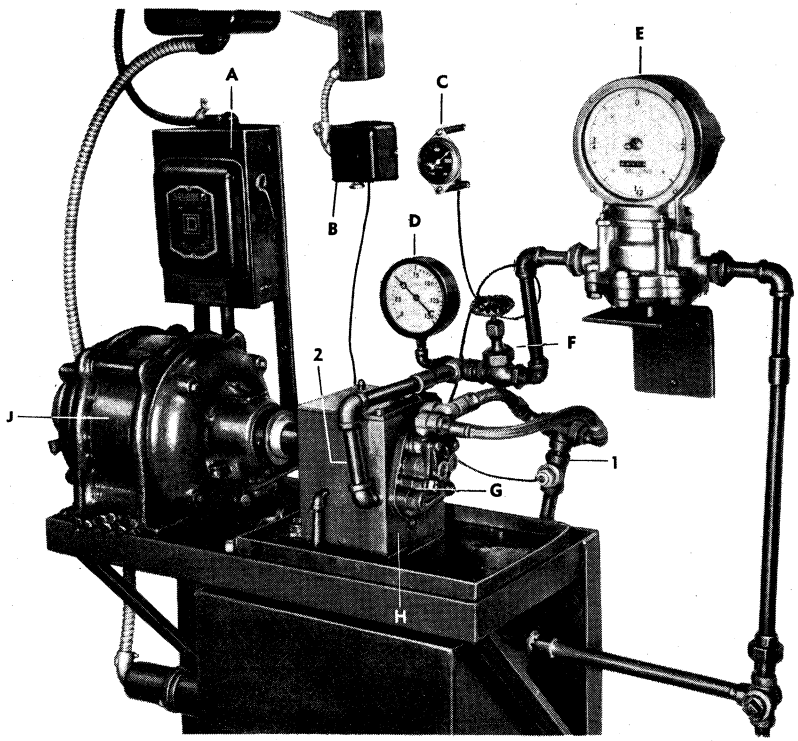


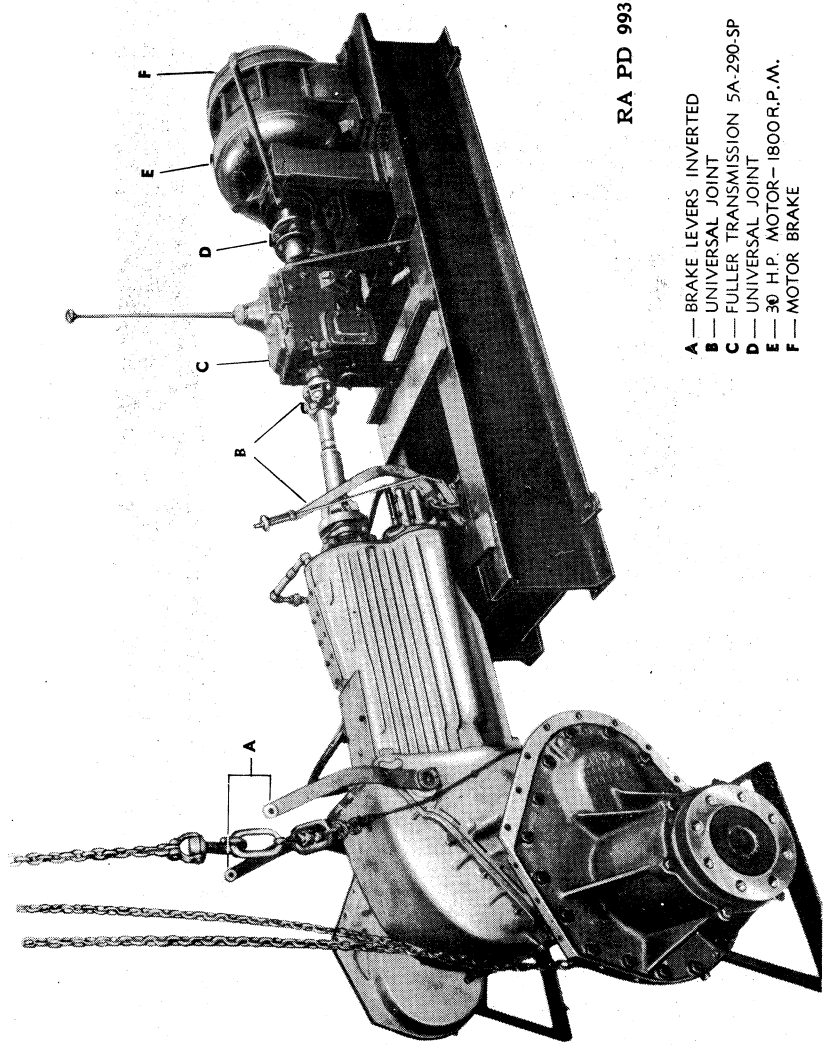
FIGURE 111—Final drive shaft nut wrench.



A — MOTOR SWITCH
B — HEAT CONTROL
C — OIL TEMPERATURE
D — PRESSURE GAUGE
E — FLOW METER
F — PRESSURE REG. VALVE
G — OIL PUMP - 1 OIL "IN" - 2 OIL "OUT"
H — FACE OF GEAR BOX MACHINED TO TAKE PUMP BASE
J — MOTOR 1800 R.P.M. 3 H.P.–FINAL SPEED AT PUMP 618 R.P.M.

RA PD 9932

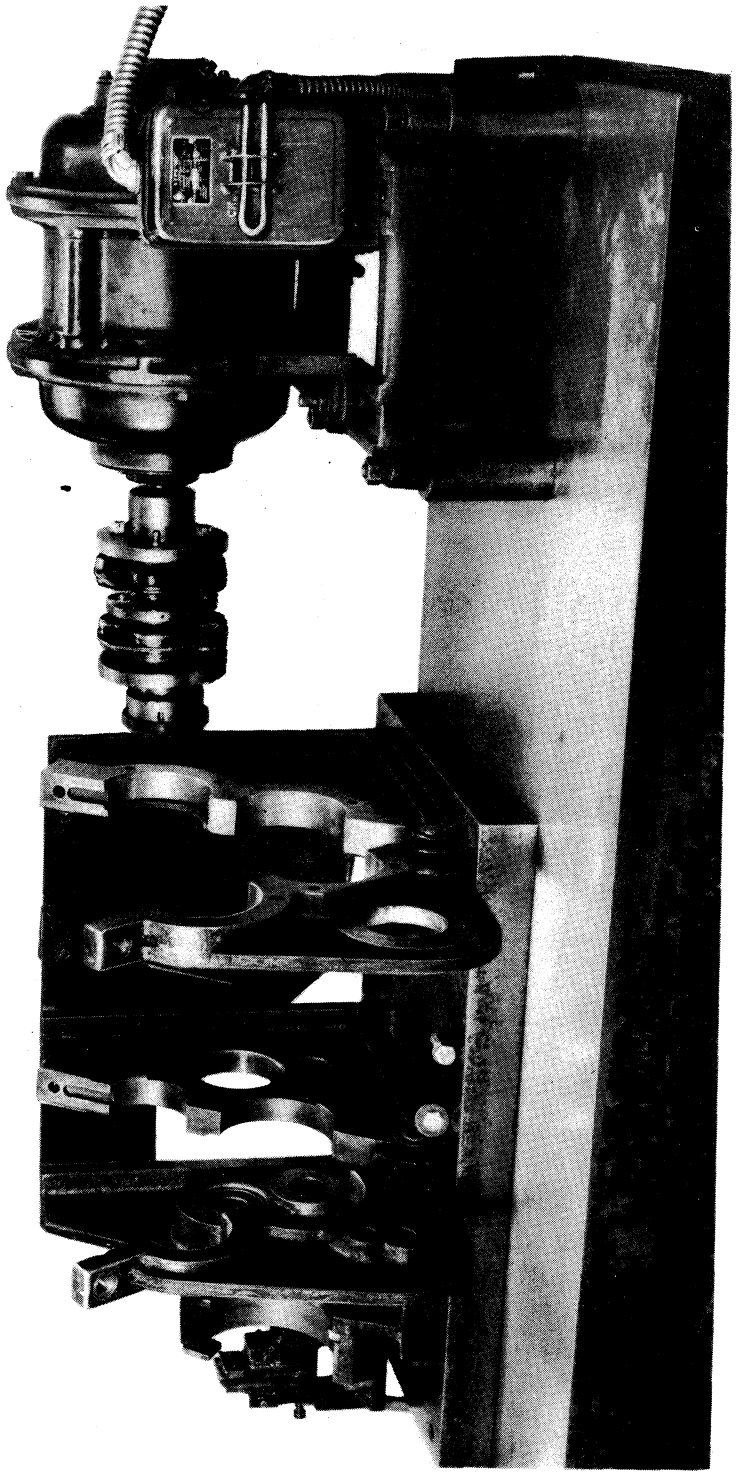
FIGURE 112—Oil pump test equipment.



RA PD 9935

A — BRAKE LEVERS INVERTED
B — UNIVERSAL JOINT
C — FULLER TRANSMISSION 5A-290-SP
D — UNIVERSAL JOINT
E — 30 H.P. MOTOR– 1800 R.P.M.
F — MOTOR BRAKE

FIGURE 113—Power train final test equipment.



RA PD 6840

FIGURE 114—Test cradle for gears.

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47. Standard nomenclature lists —

a. Cleaning, preserving, and lubricating materials ..... SNL K-1

b. Tank, light, M3 ..... SNL G-103

Current Standard Nomenclature Lists are as tabulated here.

An up-to-date list of SNL's is maintained as "Ordnance Publications for Supply Index".. OPSI

48. Explanatory publications —

a. Cleaning, preserving, and lubricating materials ..... TM 9-850

b. Maintenance and inspection

Echelon system of maintenance ..... TM 10-525

Fire prevention, safety precautions, accidents ..... TM 10-360

Motor transport inspection ..... TM 10-545

Sheet metal work, body, fender and radiator repairs ..... TM 10-450

c. Light tank M3 ..... TM 9-726

d. Ordnance maintenance manuals

Accessories for light tank engines ..... TM 9-1730

Continental engine, model W670-9A ..... TM 9-1726

Guiberson Diesel engine, model T-1020, series 4 ..... TM 9-1727

e. Lubrication

Automotive lubrication ..... TM 10-540

Lubrication instructions for tank, light, M3.. OFSB 6-G-103

f. Storage and shipment

Loading of mechanized and motorized army equipment on open top railroad equipment — Association of American Railroads

Storage of military motor vehicles ..... AR 850-18

g. Miscellaneous

Defense against chemical attack ..... FM 21-40
Hand, measuring, and power tools ..... TM 10-590
Military motor transportation ..... TM 10-505
Military motor vehicles ..... AR 850-15
Motor transport ..... FM 25-10

49. Training films and film strips —

a. Maintenance

Third echelon of maintenance ..... FS 10-55
Fourth echelon of maintenance ..... FS 10-56

b. Lubrication ..... FS 10-39

c. Engine

Gasoline motors ..... TF 10-166
Ignition and a spark plug ..... TF 25-152
Internal combustion engines ..... FS 1-15
The internal combustion engine ..... FS 10-42

d. Storage ..... FS 10-61

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