SERVICE MANUAL

SECTION VII

CLUTCH

ELECTROMATIC CLUTCH

TRANSMISSION AND OVERDRIVE

APPROVED
Packard
SERVICE

Packard Motor Car Company

Detroit 32, Michigan

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INTRODUCTION

This section of the Packard Service Manual deals with the maintenance and repair of the clutch, the Electromatic Clutch, the manual-shift transmission and the overdrive.

The description and basic theory included is for the purpose of supplementing the practical knowledge of the Packard mechanic and assisting in the problems of trouble shooting and their correction.

CLUTCH

GENERAL DESCRIPTION

The major function of the clutch is to transfer power from the engine to the transmission shaft while providing the means for its instant disengagement. In addition, the rotating clutch assembly must work along with the flywheel, the crankshaft, and the vibration dampener to smooth out the power impulses of the engine and to insulate these impulses from the transmission shaft.

The Packard clutch (figure 1) is designed to provide a cushioning effect as the clutch is engaged and this feature, along with a reasonably normal release of the clutch pedal, should result in smooth, efficient clutch engagement.

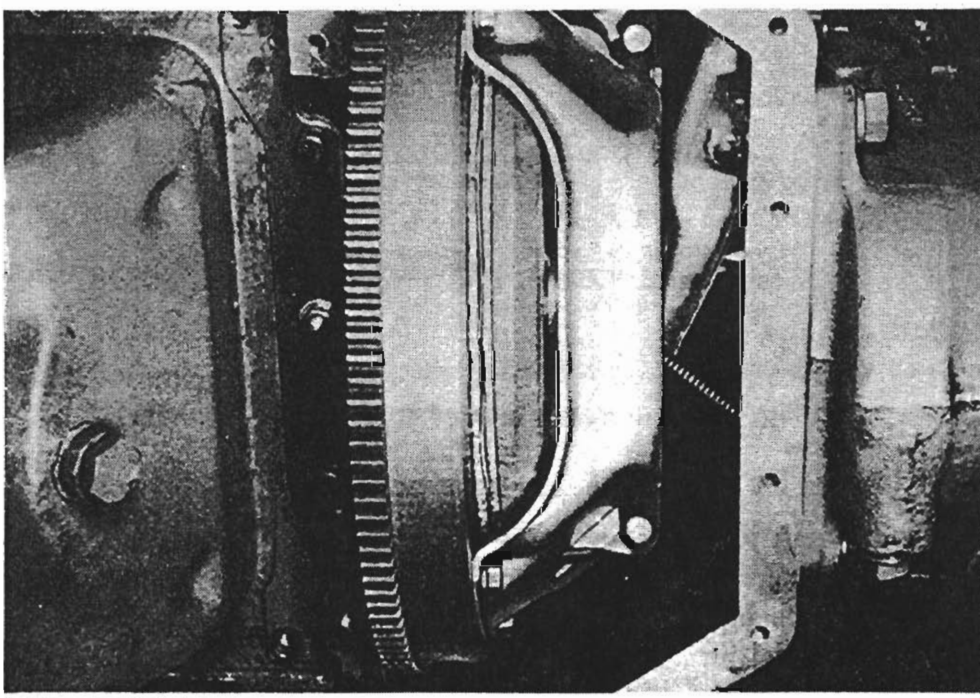


Fig. 1—The Packard Clutch.

The following major assemblies make up the Packard clutch. See figure 2.

1. *The Clutch Pedal and Linkage.* This assembly relays the necessary force for engagement and disengagement of the clutch.
2. *The Flywheel.* This member is attached to the engine crankshaft and rotates when the engine is running. The flywheel face provides one of the two surfaces required to drive the driven plate.
3. *The Driven Plate.* When this member is compressed between the flywheel and the pressure plate, it provides the friction force necessary to transmit torque to the transmission shaft.
4. *The Pressure Plate and Cover Assembly.* The cover is bolted to the flywheel and furnishes the support required for the pressure springs. The pressure plate provides the other driving surface with the flywheel, or the driven plate, which operates between the faces of these two members.

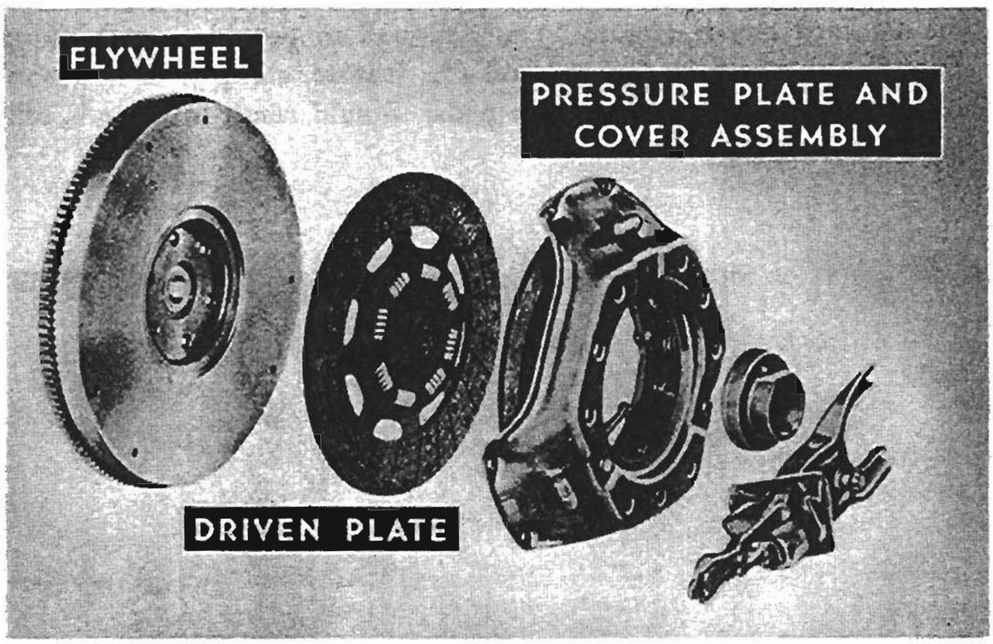


Fig. 2—Exploded View of the Packard Clutch.

1. Clutch Pedal and Linkage

Extremely high pressures are necessary to hold an automotive friction clutch in engagement at high engine speeds without slippage. To overcome these high pressures, when it is desired to disengage the clutch, the pedal arm and linkage are so arranged that they present a considerable mechanical advantage. See figure 3. This advantage is further assisted by a booster spring making engagement and disengagement of the clutch possible with a minimum of physical effort.

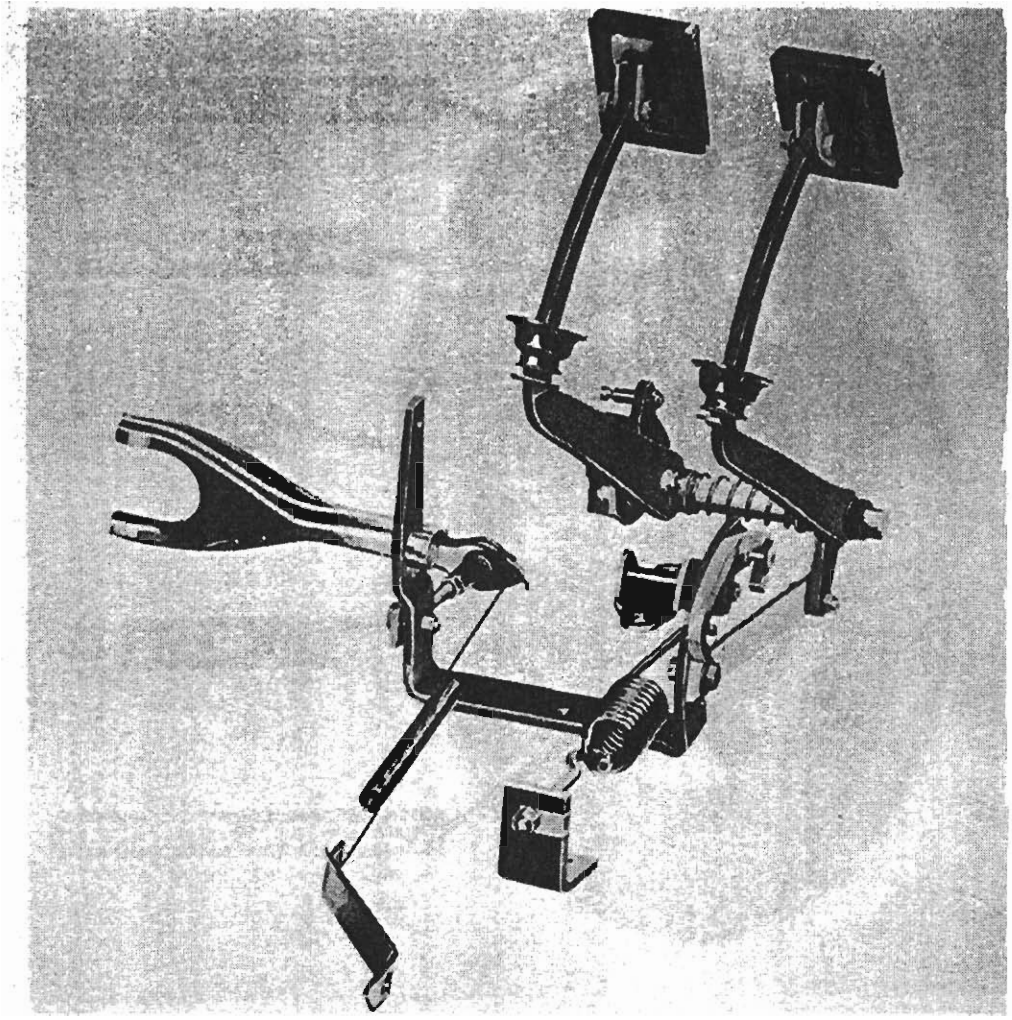


Fig. 3—The Clutch Linkage.

2. Flywheel

The flywheel assembly is machined and balanced to close tolerance, consists of a cast iron disc with a steel ring gear shrunk around its outer circumference. The assembly is bolted to the engine crankshaft and has three major duties to perform: it stores up energy when rotating to help turn the crankshaft between engine power impulses, its ring gear is engaged by the starting motor pinion to start the engine and, finally, it acts with the pressure plate as the driving member when the clutch is engaged.

The rear face of the flywheel is ground thereby ensuring a smooth flat surface to be engaged by the front facing of the driven plate.

3. Driven Plate

The driven plate assembly (figure 4) is splined to the clutch shaft. When it is compressed tightly between the flywheel and the pressure plate, it provides the friction necessary to transfer power from the engine to the transmission shaft.

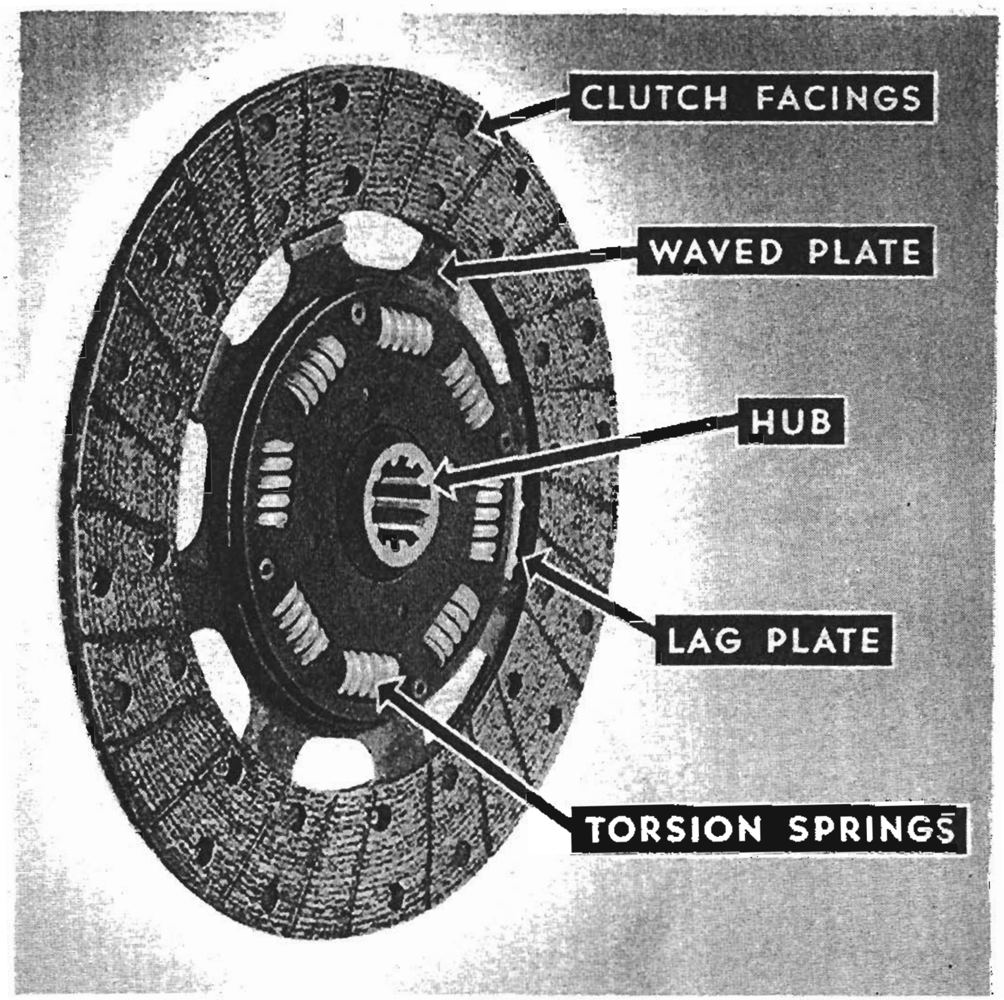


Fig. 4—The Clutch Driven Plate Assembly.

The driven plate is made up of the following parts: the hub, the waved plate, the lag plate and lag facings, the torsion springs, and the clutch facings.

The hub is a steel forging. Splined to match the transmission shaft, it permits very little lash while allowing the fore and aft travel necessary for the engagement and release of the driven plate. Eight radial windows of a size a little greater than that of the torque springs are forged in the hub. Their purpose is to provide an edge for the springs to butt against in the transfer of torque from the waved plate.

The waved plate is formed to a "wavy" contour. Eight radial windows in the stamping match those in the hub for location. Since they are a little longer and somewhat narrower than the torsion springs, they provide an edge for the torque springs to butt against in torque transfer while serving as retainers for one side of the springs.

The lag plate is a heavy steel stamping. Its eight radial windows, like those of the waved plate, are longer and narrower than the torque springs. These also furnish a driving edge and are the retainers for the torsion springs.

The lag plate is riveted through spacers to the waved plate, this arrangement insuring the correct pressure on the lag facings which float between the hub flange and the two plates.

The two lag facings are in the form of flat rings molded of an asbestos-filled compound. They float under firm pressure on each side of the hub flange between the flange and each plate.

Eight torque springs float in the radial windows of the hub. They are retained on one side by the undersized windows of the waved plate, on the other side by those of the lag plate.

The two clutch facings are stamped from woven asbestos-filled stock and are in the form of flat rings. They are tightly riveted independently of one another to the high spots on either side of the waved plate.

At the beginning of clutch engagement, the waved plate is only partially compressed between the flywheel and the pressure plate. At full clutch engagement, the waves in the plate are flattened so that the facings are solidly engaged when the pedal is fully released. The flattening process of the waved plate provides a cushioning effect by its gradual increase of facing contact area, this feature being largely responsible for smooth clutch engagement.

As torque from the engine is picked up by the driven plate, it must first go through the torque springs which butt against the windows in the waved plate, the hub flange, and the lag plate. The torque springs dampen engine impulses while the lag facings act as their shock absorbers.

The degree of resistance of the lag facings to the movement of the springs is called "friction lag" and the function of friction lag is to dampen torsional vibration or "clutch jazz."

4. Pressure Plate and Cover Assembly

The pressure plate and cover assembly (figure 5) is composed of the following parts: the pressure plate, nine heavy compression springs, the pressure plate cover, the three release levers or "fingers."

The pressure plate is an iron casting in the form of a semi-flat ring. Its face is ground flat to close tolerance and bears against the rear facing of the driven plate when the clutch is engaged. The back of the casting has an unfinished surface which incorporates three sets of ears to mount the release levers and nine radial lugs for the purpose of locating and retaining the pressure springs.

The pressure springs seat on the previously mentioned pressure plate lugs forward and butt against the pressure plate cover at the rear,

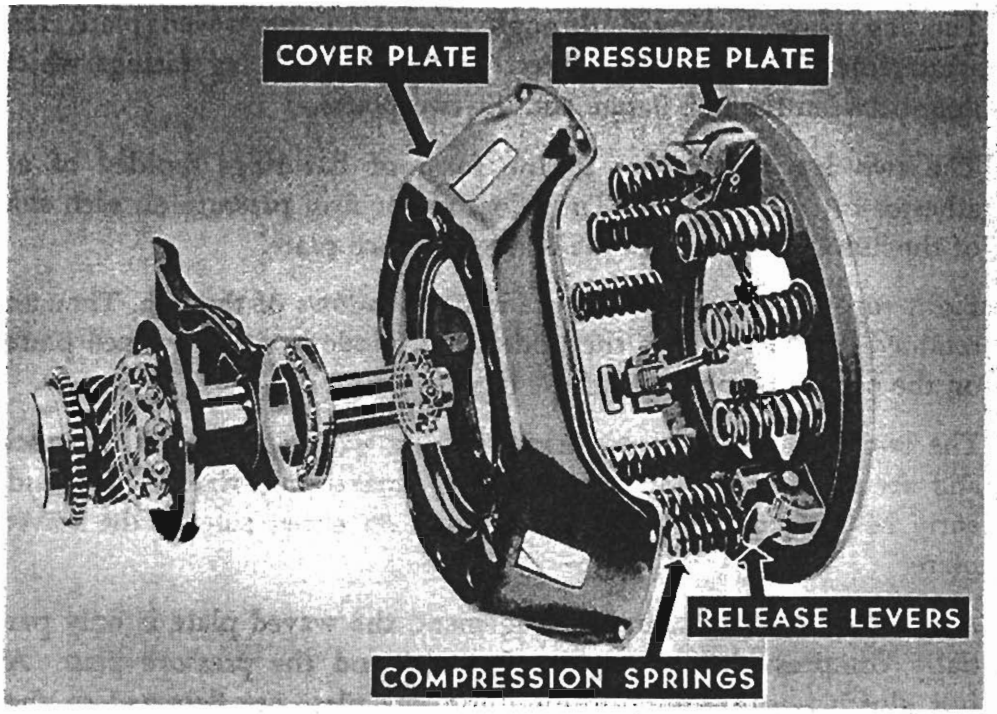


Fig. 5—The Pressure Plate and Cover Assembly.

thus providing sufficient pressure to hold the driven plate tightly against the flywheel at low engine speeds. As engine speeds increase, additional pressure aids the pressure springs. The action of centrifugal force upon the weighted ends of the release levers does this.

The pressure plate cover is a heavy steel stamping and is bolted to the flywheel, setting up the necessary preload in the pressure springs. The release lever brackets which act as fulcrums for the release levers are bolted to this member.

The release levers are one piece steel forgings, threaded for adjusting screws at their inner ends. They are pivoted at the release lever brackets on the cover and again at the pressure plate ears for a lever and fulcrum effect. Each incorporates a heavy "slug" of metal at the end of a short curved arm extending beyond the outermost pivot.

OPERATION OF THE CLUTCH

To disengage the clutch, a force is applied to the clutch pedal (A, figure 6). This force is transmitted through the linkage (B) helped along by the booster spring (C), to the relay lever (D). The throwout lever (E) ball pivoted at the end of the throwout lever rod (F) and again at a fitting on the bell housing, pushes forward on the release bearing.

The release bearing pushes simultaneously on the ends of all three release levers compressing the pressure springs still further while pulling the pressure plate away from the driven plate.

The clutch shaft is installed at the same angle as the center line of the crankshaft which slopes downward toward the rear so the natural tendency of the driven plate, when the car is level and the clutch released, is to move away from the flywheel. Engine vibration assists the driven plate in this tendency as, to a slight extent, does the waved plate in the process of assuming its normal shape. After the driver's foot has been removed from the pedal pad, the clutch pedal is returned

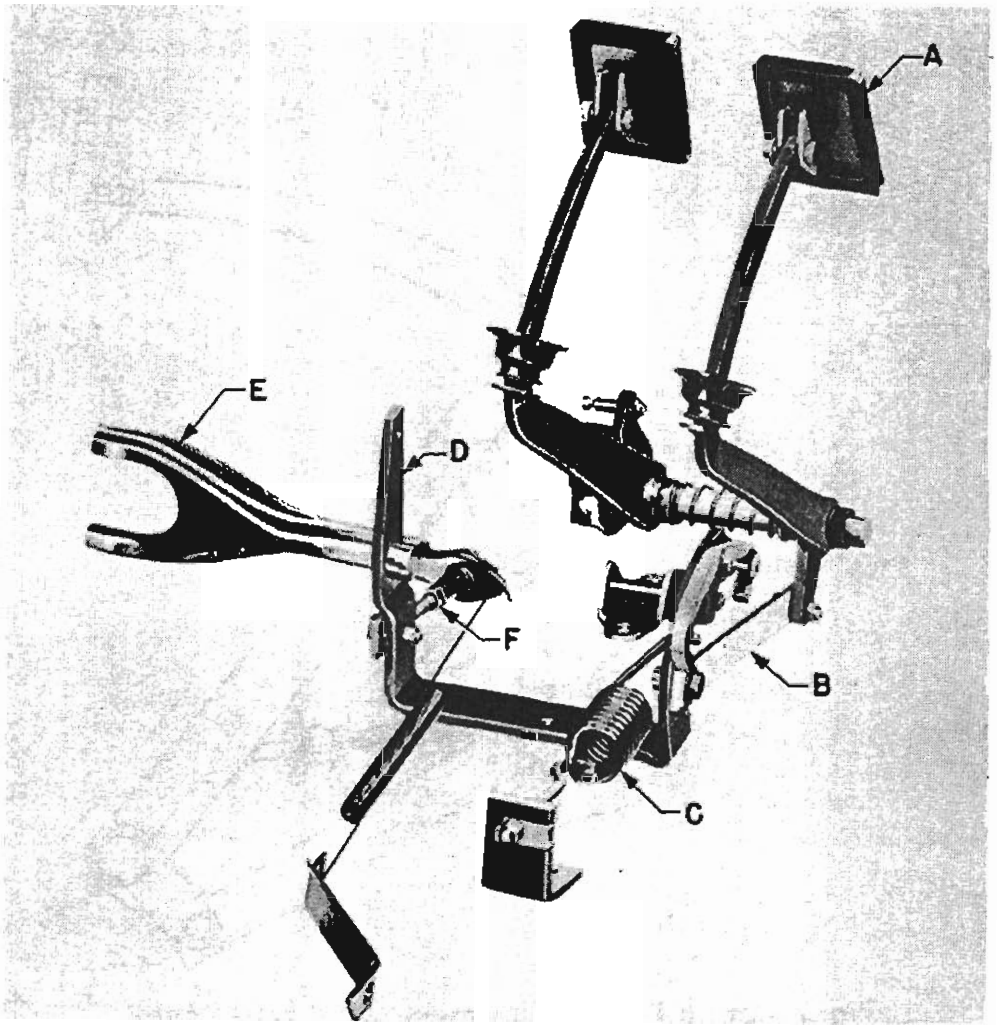


Fig. 6—Operation of the Clutch Linkage.

to normal position by the booster spring which is hooked slightly below center on the booster link.

At the beginning of clutch engagement the pressure springs compress the waved driven plate between the flywheel, forward, and the pressure plate, aft. As the pedal continues its backward travel the pressure of the springs gradually flattens the waved plate and increases the friction until the driven plate is finally compressed tightly between the flywheel and the pressure plate and the clutch is in full engagement. As engine r.p.m. increases, centrifugal force on the "slugs" of the release levers greatly increases the compression force on the driven plate until, at full engine r.p.m., the pressure is more than twice as great as that provided by the springs alone.

CLUTCH SERVICING PROCEDURES

1. Clutch Pedal Adjusting Procedures

For 22nd Series Eight

Adjust nuts (1, figure 7) to obtain $1\frac{1}{4}$ to $1\frac{1}{2}$ inches of free travel at clutch pedal pad.

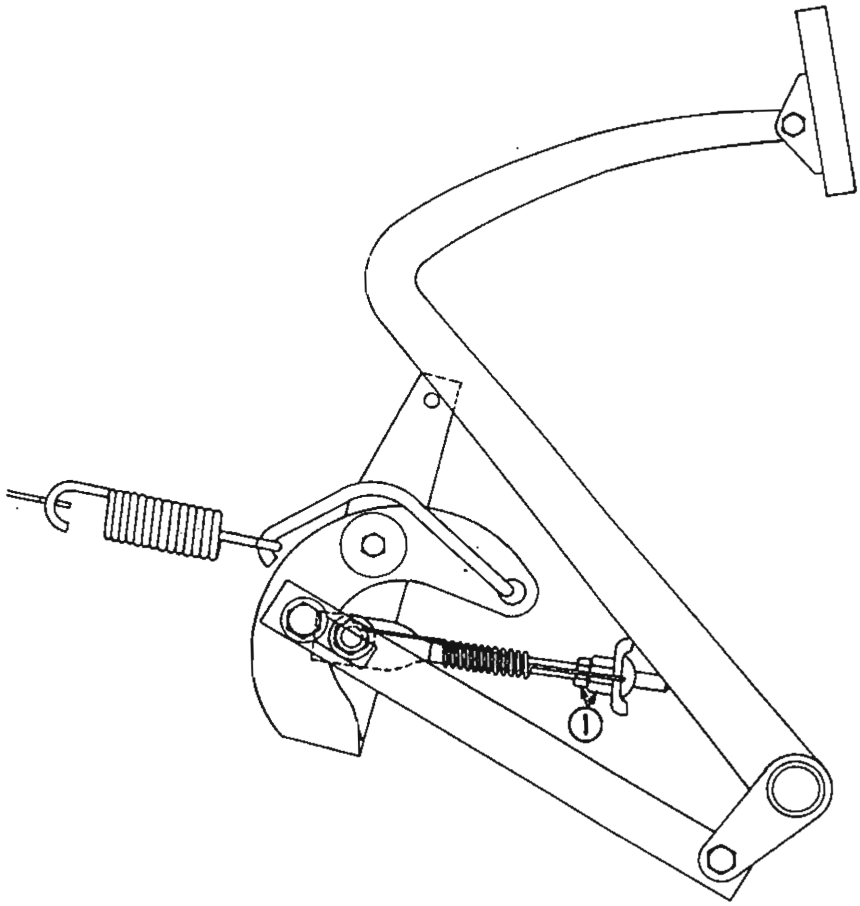


Fig. 7—Clutch Pedal Adjustment, 22nd Series Eight.

For 22nd Series Super Eight and Custom Eight

A. Adjust nuts (1, figure 8) to obtain $1\frac{1}{4}$ to $1\frac{1}{2}$ inches of free travel at clutch pedal pad.

B. Take up nut (2) on booster spring eyebolt (3) until about two inches of thread extends beyond bracket (4). By running nut (2) a few turns in the required direction, the correct adjustment for maximum "boost" and pedal return may be effected.

For 23rd Series Cars

A. Check and, if necessary, adjust nut (5) to obtain the $1\frac{5}{8}$ (approximate) dimension as shown in figure 9.

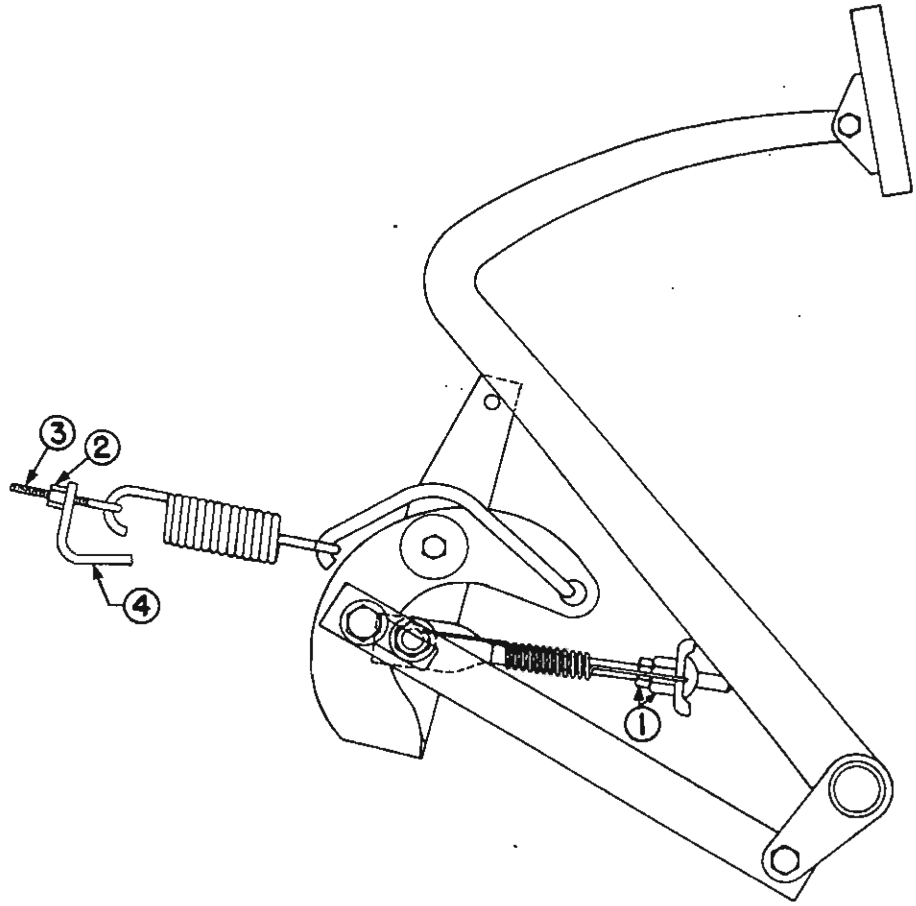


Fig. 8—Clutch Pedal Adjustment, 22nd Series Super and Custom.

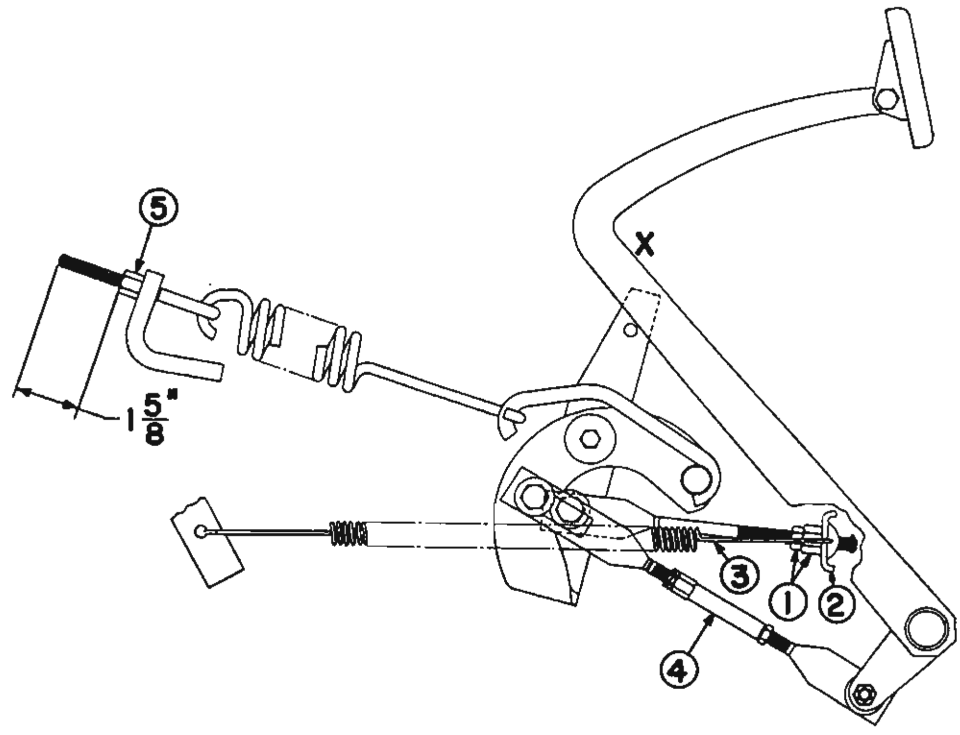


Fig. 9—Clutch Pedal Adjustment, 23rd Series Cars.

B. Run nuts (1) back far enough to make sure that they will not interfere with the throwout lever (2) while performing operation D.

C. Unhook the retracting spring (3) from throwout lever (2).

D. Adjust link (4) so that when the clutch pedal is raised one inch from the toe board, the tension in the booster spring (5) will cause the clutch pedal to continue to move away from the toe board.

NOTE

Adjusting nut (1) should not contact throwout lever (2) when this operation is performed.

E. Hook up retracting spring (3) to throwout lever (2).

F. Adjust nuts (1) to obtain 1¼ to 1½ inches free play at pedal pad.

G. Pull the pedal down so that the pedal pad contacts the toe board and hook a spring scale to the pedal arm at the point marked "X." Adjust nut (5) so that the pedal will be held in this position when the scale registers a pull of seven pounds.

2. Removing, Inspecting and Reconditioning the Clutch

Except for adjustment or lubrication, any repair job on a clutch means removal of the assembly from the car and, this in turn, will require removal of the transmission.

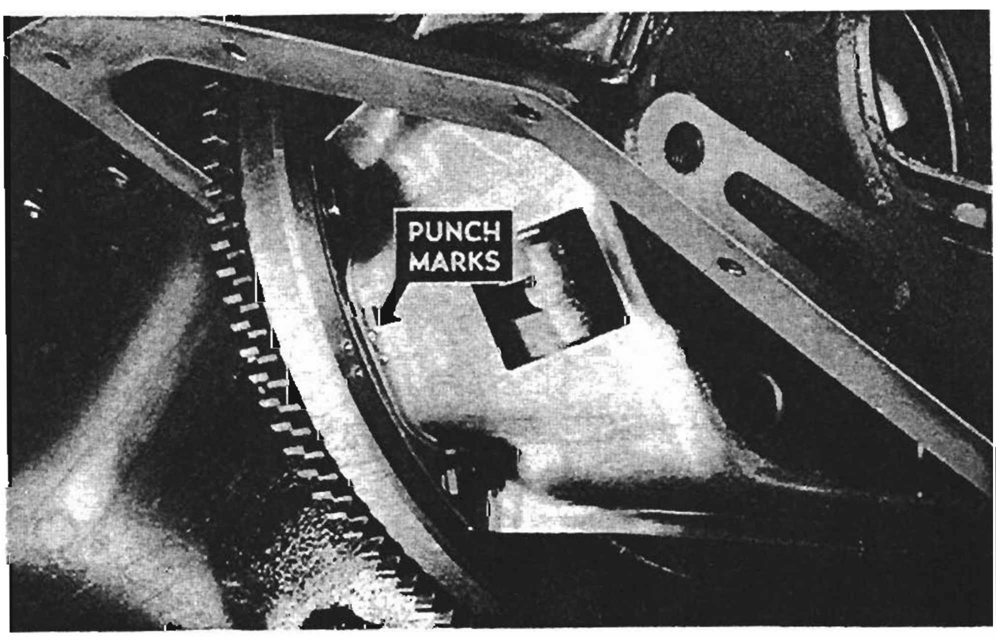


Fig. 10—Be Sure the Flywheel and Clutch Cover are Marked Before Disassembly.

After removing the transmission take off the lower flywheel housing, exposing the bottom part of the flywheel and the clutch cover. Since clutch and flywheel are balanced as an assembly, it is important that they be reassembled in the same relative position so, before disassembly, if they do not already carry a mark, mark the two units with a center punch as shown in figure 10.

Six cap screws hold the pressure plate and cover assembly to the flywheel. Block off the clutch release levers with three ⅜-inch nuts, so that the levers will remain in their engaged position, then take out the six cap screws and remove the pressure plate and cover from the flywheel as an assembly.

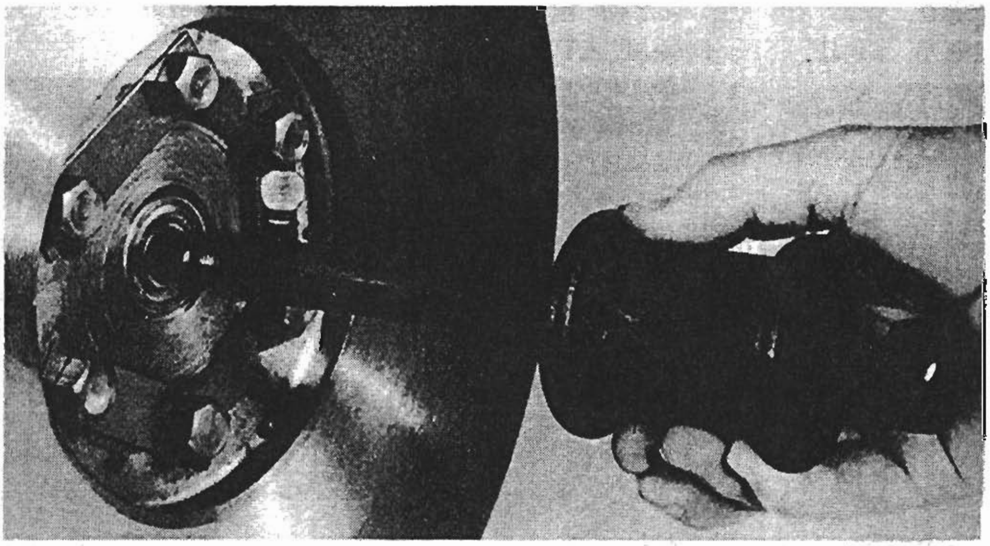


Fig. 11—Removing the Clutch Shaft Pilot Bearing from the Flywheel.

Using tool J-164 or J-489 (figure 11) remove the clutch shaft pilot bearing from the flywheel. Inspect the pilot bearing and the clutch release bearing by hand. If the rotation is not smooth or if the races bind at any position replace the defective bearing or bearings.

Clean the pressure plate and cover assembly with a stiff brush, then dry them with compressed air. Scrub the contact surfaces of the flywheel and pressure plate with a clean cloth moistened with cleaning solvent and inspect these surfaces for scoring and heat checks. If deep scores and/or heat checks are discovered, replace the flywheel or pressure plate as necessary. If the clutch release levers are worn or if the pressure springs have become weak, damaged, or overheated, replace the entire assembly.

Inspect the clutch driven plate and facings. If the waved plate has lost its resilience, if the facings are worn, broken, or grease soaked, the plate should be replaced.

Replace any worn or damaged parts in the clutch linkage and lubricate.

3. Installing the Clutch

Pack the clutch shaft pilot bearing with wheel bearing grease, then install the pilot bearing in the flywheel with the open side of the bearing toward the front of the engine, the shielded side toward the rear.

Install the driven plate on the clutch shaft. Check the fit of the hub splines. If the lash is very slight, remove the driven plate, coat the clutch shaft splines with a thin but thorough coating of lubriplate. It will be noticed that the torque springs of the driven plate are almost flush with the surface of the waved plate on one side. The facing on this side must engage the flywheel. Match the punch marks on the cover assembly with those on the flywheel and, holding the pressure plate and cover assembly in position along with the driven plate, start the cap screws holding the cover to the flywheel. DO NOT TIGHTEN THEM AT THIS TIME.

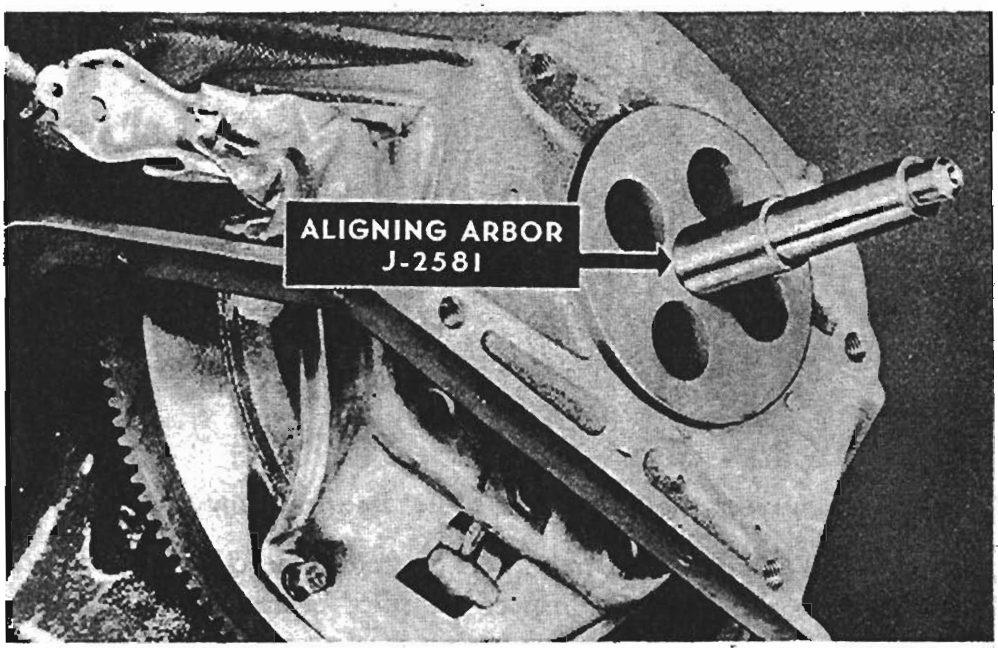


Fig. 12—Insert Aligning Arbor Through Driven Plate, into Pilot Bearing as Shown.

Insert the clutch aligning arbor V-2581 through the clutch driven plate and into the clutch shaft pilot bearing as shown in figure 12. Take up on the cap screws to 25 to 28 foot pounds with a torque wrench. Now install the clutch release bearing and sleeve in the yoke end of the release lever, secure the lower flywheel housing into position, and install the transmission.

4. Alignment

Correct alignment of the flywheel, clutch, and transmission assemblies is by far the most important factor to consider for troublefree clutch performance. Misalignment can ruin bearings, shafts, gears, and clutch parts. It can cause or contribute to all of the major clutch troubles—

drag, slip, and chatter, and will usually promote the conditions of hard shifting and jumping out of gear as well. Procedures for aligning these assemblies are covered in "Clutch Servicing Procedures," of this manual.

CLUTCH TROUBLES AND CORRECTIONS

The most common clutch service problems are "drag," "slip," and "chatter." Some typical problems and their possible corrections follow.

1. Clutch Drag

A dragging clutch can only be caused by failure of the driven plate to completely disengage from the face of the flywheel when the clutch pedal is depressed. This condition contributes to excessive wear of the driven plate facings, to overheating of the clutch assembly, and to clutch spin and gear clash. Following are a number of possible causes of clutch drag and their corrections.

A. Clutch Pedal Improperly Adjusted for Free Play

Adjust clutch pedal to $1\frac{1}{4}$ to $1\frac{1}{2}$ inches free play. (See "Clutch Pedal Adjusting Procedures.")

B. Driven Plate Hub Binding on Transmission Clutch Shaft

If the clutch still drags after adjusting the pedal to the required free play limits, the shaft splines and the internal splines of the driven plate hub should be checked for burrs and/or rust. To do this it will be necessary to remove the transmission. If burrs are apparent on the shaft splines, remove the burrs with a file. If the splines have become rusted, first remove surface rust with a wire brush, then work over the rusted areas with a knife-edged stone. See figure 13. The corners of each spline should be stoned to smooth out any roughness, and if the corners are chamfered only slightly, or show no chamfer, they should be stoned to a chamfer approximately .015 inch wide. The internal splines of the driven plate hub may be cleaned by inserting a long, cloth wrapped screw driver through the pilot hole in the bell housing. After the parts have been cleaned, apply a *thin* but thorough coat of lubriplate to the clutch shaft and reinstall the transmission.

C. Worn Release Levers

Clearance between the flywheel and the driven plate is normally about .030 inch. If the release levers were to become worn at the pivot pin holes, and this wear added to that of the pivot pins, the total might add up to the amount of slack in the mechanism to be taken up before the driven plate could start to back off from the flywheel.

Clutch drag trouble sometimes results when a new driven plate has been installed in a car which has seen a great deal of service without renewing the clutch pressure plate and cover assembly. The clutch pressure plate and cover assembly should be a closely balanced mechanism and replacement of parts would very likely throw it out of static and dynamic balance. In addition, if the release levers and pivot pins are worn, probably the pressure springs have weakened too. Therefore, a complete new, balanced, pressure plate and cover assembly should be installed when release levers and pins have become excessively worn.

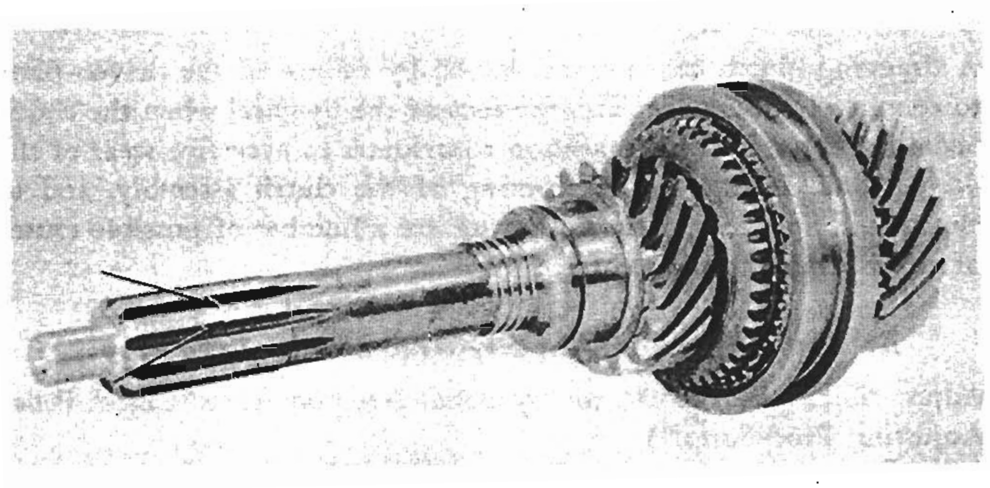


Fig. 13—Stone the Corners of Each Spline to Smooth Out Any Roughness.

D. Loose or Broken Driven Plate Facings

Install new driven plate.

E. Misalignment of Clutch Shaft

The following conditions may cause clutch shaft misalignment:

(1) Worn pilot bearing in flywheel.

(2) Dirt or chips between the bell housing and engine block faces.

If a clutch assembly has been disassembled for repair and either of these conditions is discovered, check the installation thoroughly for alignment. (See "Clutch Servicing Procedures.")

2. Clutch Slip

A slipping clutch is readily recognized by the apparent lack of power when accelerating and climbing grades. A slipping clutch will overheat rapidly and the consequences can be serious since the pressure plate and flywheel may become weakened from overheating to the extent that they will fail at high r.p.m.

The following conditions can cause a slipping clutch:

A. Insufficient Clutch Pedal Free Play

Adjust clutch pedal for 1¼ to 1½ inch free play. (See "Clutch Pedal Adjusting Procedures.")

B. Worn Driven Plate Facings

Replace clutch driven plate.

C. Weak Pressure Springs

Replace pressure plate and cover assembly.

D. Clutch Throwout Linkage Worn, Damaged, or Needs Lubrication

Replace worn or damaged parts, free up, clean and lubricate.

E. Badly Scored Flywheel and/or Pressure Plate

Replace flywheel and/or pressure plate. Never turn down a flywheel or pressure plate without first warning the owner that these two parts have been carefully designed to perform their specific jobs. The weights of both of these members have been held to a minimum so that the quickest acceleration possible is realized from the engine. Further removal of metal from the faces of the flywheel or the pressure plate may weaken them to the point of failure during a severe clutch application or high engine r.p.m.

3. Clutch Chatter

Chatter is readily recognized by severe vibration, usually at the time of clutch engagement. This condition should be corrected as quickly as possible since prolonged chatter can damage gears and shafts in the transmission and differential. Chatter has been known to tear the hub from the driven plate, cause failure of the universals and break axle shafts.

The following conditions may cause clutch chatter:

A. Incorrect Pedal Adjustment

Adjust clutch pedal free play. (See "Clutch Pedal Adjusting Procedure.")

B. Clutch Misalignment

(See "Clutch Servicing Procedures.")

C. Damaged or Flattened Driven Plate

A driven plate may be bent or damaged to the extent that it cannot contact the flywheel and pressure plate with the full area of its facings. This concentrates the engaged pressure on an area which is too small to provide the required friction surface and results in rapid and repeated "grabbing" and release.

If the driven plate has become flattened, that is, if the waved arrangement has lost its resilience or "spring," the cushioning effect will be gone. Without cushioning, the driven plate would be, in effect, a flat plate.

If a driven plate is damaged or flattened, replace it with a new one.

D. Oil or Grease on Driven Plate Facings

Replace clutch driven plate.

E. Deeply Scored Flywheel and/or Pressure Plate

Replace flywheel and/or pressure plate.

F. Loose or Worn Engine and Transmission Mounting Screws

Tighten and replace where necessary.

G. Non-Uniform Pressure Springs

Replace pressure plate and cover assembly.

H. Driven Plate Hub Binding on Transmission Clutch Shaft

See "Clutch Drag."

THE ELECTROMATIC CLUTCH

GENERAL DESCRIPTION

The Electromatic Clutch, when in operation, is a device which automatically operates the clutch. See figure 14. It is optional equipment and its presence on all models up to and including those of the early 22nd Series is indicated by a red clutch pedal pad. On later 22nd and 23rd Series models, the pedal pad has no color identification.

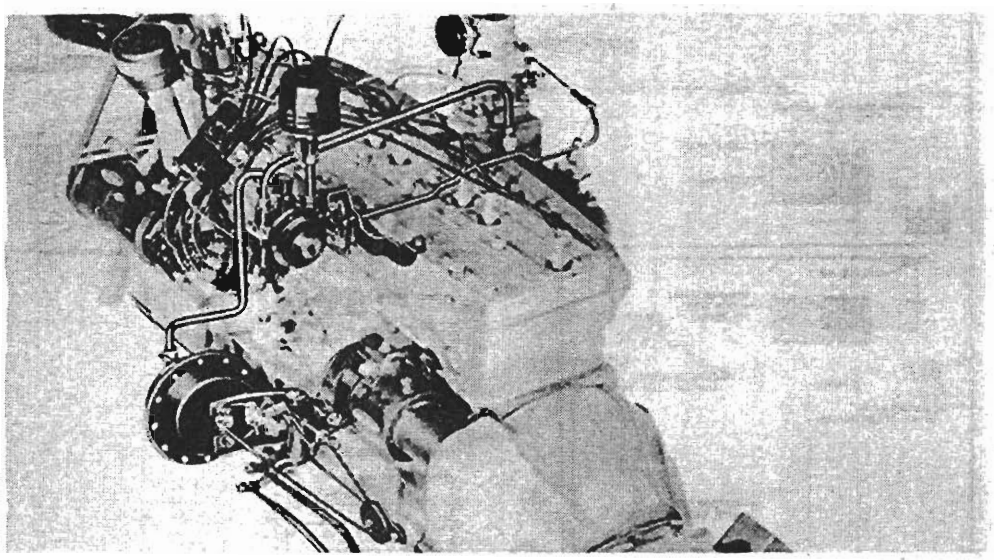


Fig. 14—The Electromatic Clutch.

The Electromatic Clutch is automatically locked out when the ignition switch is off and also when speeds are reached which are greater than governed speeds. The conventional clutch is, of course, in full operation when the Electromatic is locked out.

NOTE

> "Governed speeds" as referred to in the previous and following paragraphs embrace a speed range of approximately 5 miles per hour. Governed speed, when the car is accelerating occurs at about 22 miles per hour and, when the car is decelerating, at approximately 17 miles per hour.

Properly adjusted, the Electromatic engages the clutch with a degree of smoothness that never varies and, by eliminating the human element, it eliminates most instances of clutch abuse. The clutch booster spring is eliminated in all Electromatic installations, and except for a "stiffer" clutch pedal when the Electromatic is locked out, it does not affect the operation of the conventional clutch system in any way.

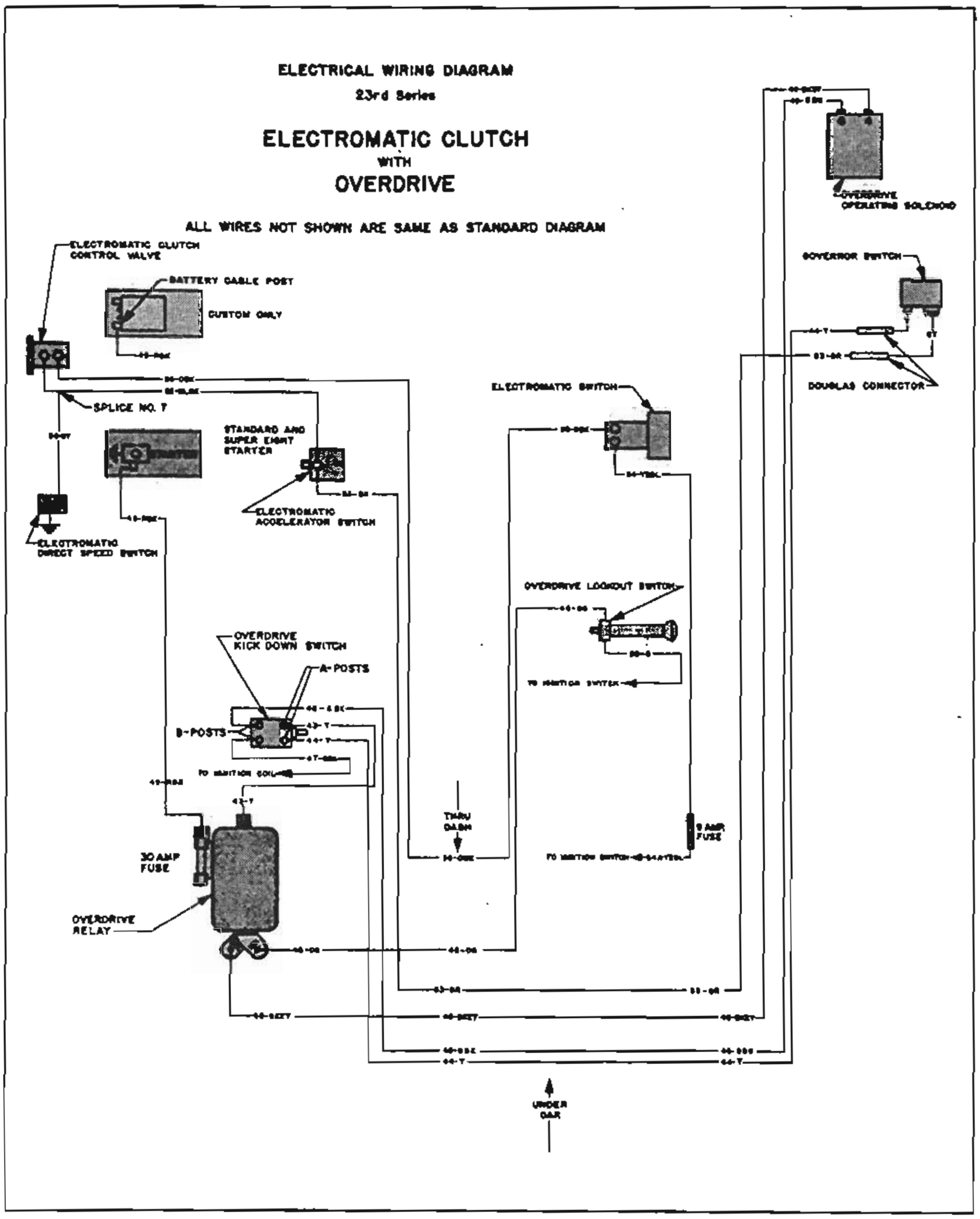


Fig. 15—Electromatic Clutch Wiring Diagram.

The Electromatic Clutch consists of the following major parts: See figure 15.

1. *The lockout switch,* located in the instrument panel, enables the driver to select the Electromatic Clutch or lock it out at will.
2. *The lockout solenoid valve* located in the clutch control valve is energized and de-energized manually by the lockout switch and automatically by other switches. It locks in and locks out the Electromatic Clutch when desired by the driver, or automatically when driving conditions require it.
3. *The clutch control valve* regulates the partial vacuum by metering the amount of air admitted to the power cylinder and supplies the varying pressures required for smooth clutch engagement.
4. *The power cylinder.* This device provides the force required for the degree of engagement and disengagement of the clutch as directed by the clutch control valve. The power cylinder diaphragm is connected to the clutch relay lever by means of a cable-pulley system.
5. *The governor switch* prevents disengagement of the clutch when the accelerator is released at speeds greater than governed speed.
6. *The direct speed switch* is operated by the direct and second idler lever and permits shifting from high gear above governed speeds. The direct and second idler lever mechanically closes the direct speed switch at the first movement of the shifting lever out of high gear and insures that the direct speed switch is open *only* when the car is in direct drive and overdrive.
7. *The accelerator switch* locks in the Electromatic, releasing the clutch *only* when the accelerator pedal is fully released below governed speed.

1. Lockout Switch

The lockout switch is marked "TRANS" in early 22nd Series and "CLUTCH" in later 22nd Series models at the instrument panel. By pushing in the knob of this two-way switch the Electromatic Clutch is made available or is locked out at will. If the Electromatic Clutch is in operation and it is desired to lock it out, push the switch knob in. This breaks the circuit and affords a positive lockout, bringing the conventional pedal operated clutch linkage into full operation. If the conventional clutch is in operation and it is desired to bring the Electromatic Clutch into operation, push the switch knob in. This closes the lockout switch, makes the circuit operative, and permits the circuit to make or break automatically as required by the action of the remaining switches.

2. The Lockout Solenoid Valve

Consisting of one winding and a core with a rubber tipped plunger which acts as a valve, this device affords a positive lockout of the control valve. A compression spring holds the core and valve in a normally closed position, shutting off the partial vacuum which exists in the clutch control valve vacuum passage and completely locking out the Electromatic Clutch. See figure 16. When the solenoid coil is energized, the core and valve plunger are pulled down. This action compresses the seating spring, opens the valve, and subjects the power cylinder diaphragm to partial vacuum.

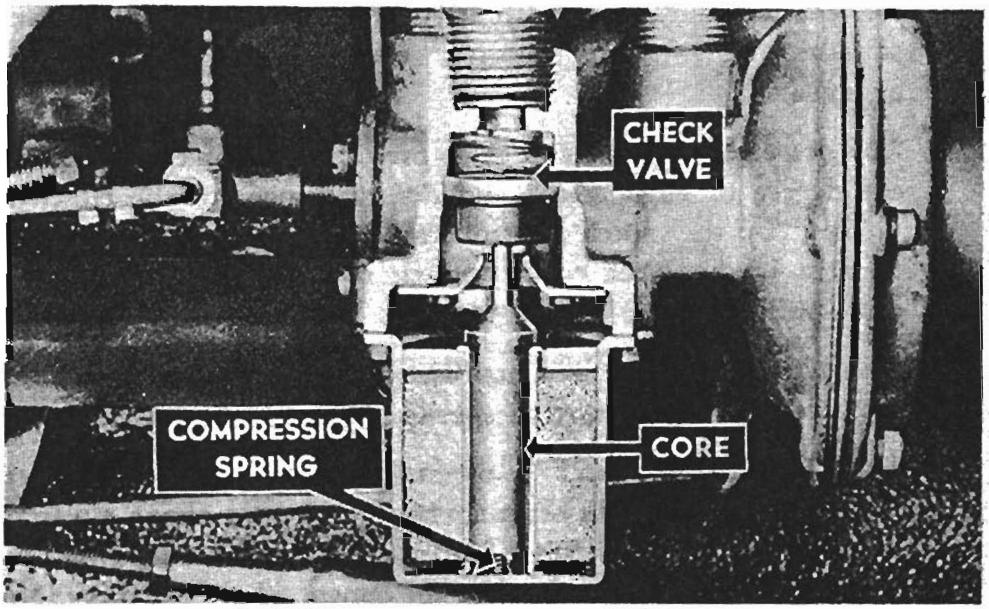


Fig. 16—The Electromatic Lockout Solenoid.

3. The Clutch Control Valve

To create a "vacuum" it would be necessary to pump *absolutely all the air* from an enclosed vessel. So far no one has ever been able to do this—so when the word "vacuum" is used in the paragraphs following, actually what is meant is "partial vacuum."

The intensity of the vacuum in the engine intake manifold varies as the engine speed varies. At low engine speeds, the vacuum intensity is high and at high engine speeds the vacuum intensity is low. This variation goes to work in the operation of the Electromatic Clutch and its control is the responsibility of the clutch control valve.

The clutch control valve assembly consists of the valve body, the diaphragm, the spool valve and sleeve, and the accelerator linkage and fulcrum lever.

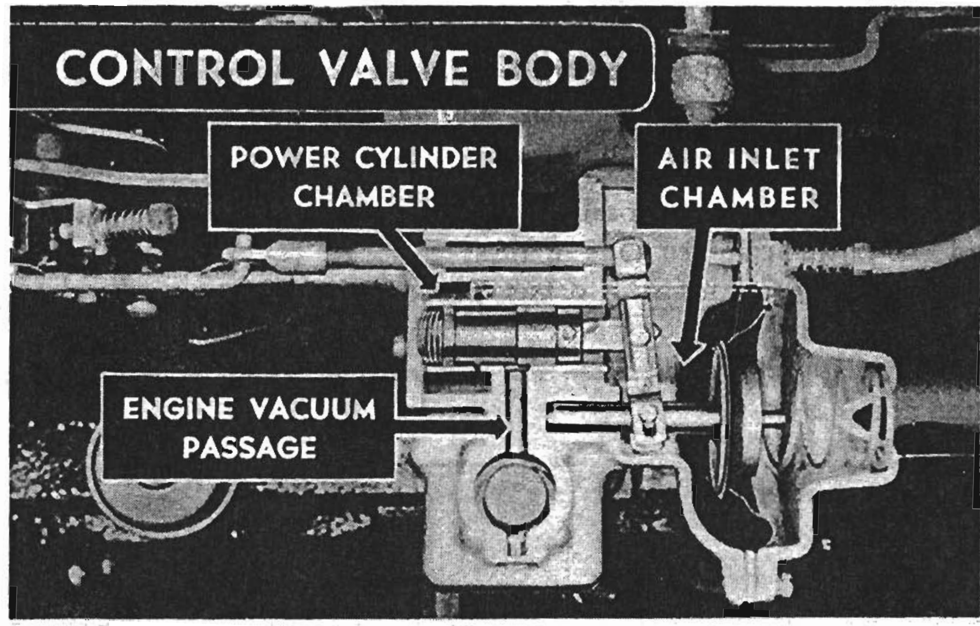


Fig. 17—The Control Valve Body.

The valve body (figure 17) is a die casting. It supports the moving parts of the valve and contains three chambers: the vacuum passage, the air inlet chamber, and the power cylinder chamber.

The vacuum passage is connected to the intake manifold by tubing. This passage contains the lockout solenoid valve previously described, which when actuated, stops off the vacuum passage and renders the control valve inoperative.

The air inlet chamber contains the valve rod and fulcrum lever (part of the linkage operating from the throttle) and the diaphragm and shaft. It is vented to the atmosphere.

The power cylinder chamber serves to subject the power cylinder either to atmospheric pressure or to vacuum, depending upon whether the valve sleeve ports are open or closed.

The diaphragm is connected to the spool valve by the fulcrum lever, pinned to the diaphragm shaft. One side of the diaphragm is always at the same vacuum intensity as the power cylinder and this side is spring loaded. The opposite (forward) side of the diaphragm makes up the rear wall of the air inlet chamber and is exposed only to atmospheric pressure. Thus, the engine vacuum controls the position of the diaphragm shaft and the position of the spool valve in the sleeve.

A hollow, piston type valve (called the spool valve) is free to slide fore and aft in the valve sleeve. Its forward movement is controlled by the linkage from the accelerator and its movement to the rear is controlled by the diaphragm, both working through the fulcrum lever. Its purpose is to block off or open the sleeve ports admitting either atmospheric pressure to the power cylinder, or subjecting it to vacuum.

4. The Power Cylinder

The diaphragm type power cylinder (figure 18) provides the force required for the disengagement and the degree of engagement of the clutch.

A steel reinforced rubber-fabric diaphragm separates the two chambers of the power cylinder. One of these chambers connects to the clutch control valve by means of a metal tube and is always at the degree of vacuum supplied by the control valve. The chamber on the side of the diaphragm away from the vacuum line, however, is vented to the atmosphere.

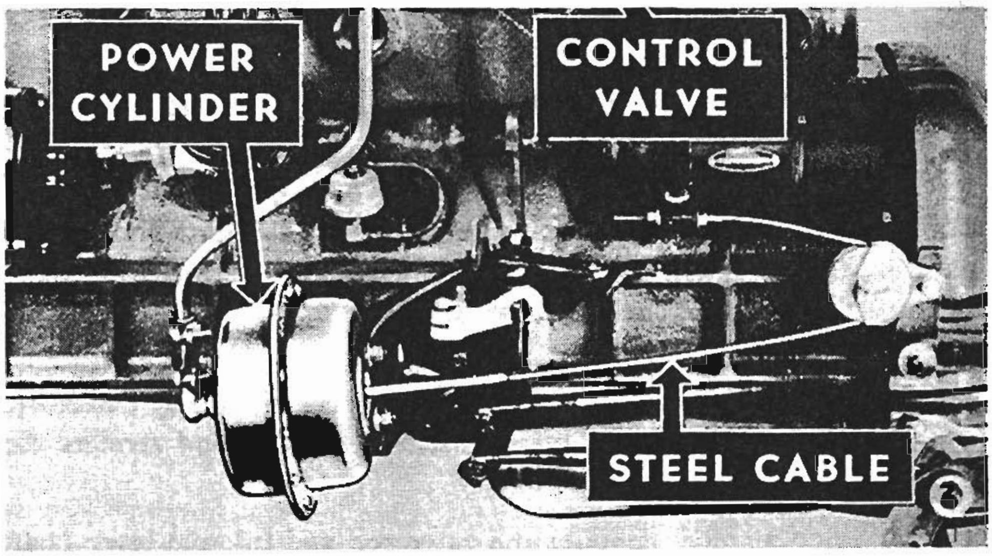


Fig. 18—Showing the Electromatic Power Cylinder.

A flexible steel cable, attached to the center of the diaphragm, travels around a pulley bolted to the clutch relay lever and is secured at the

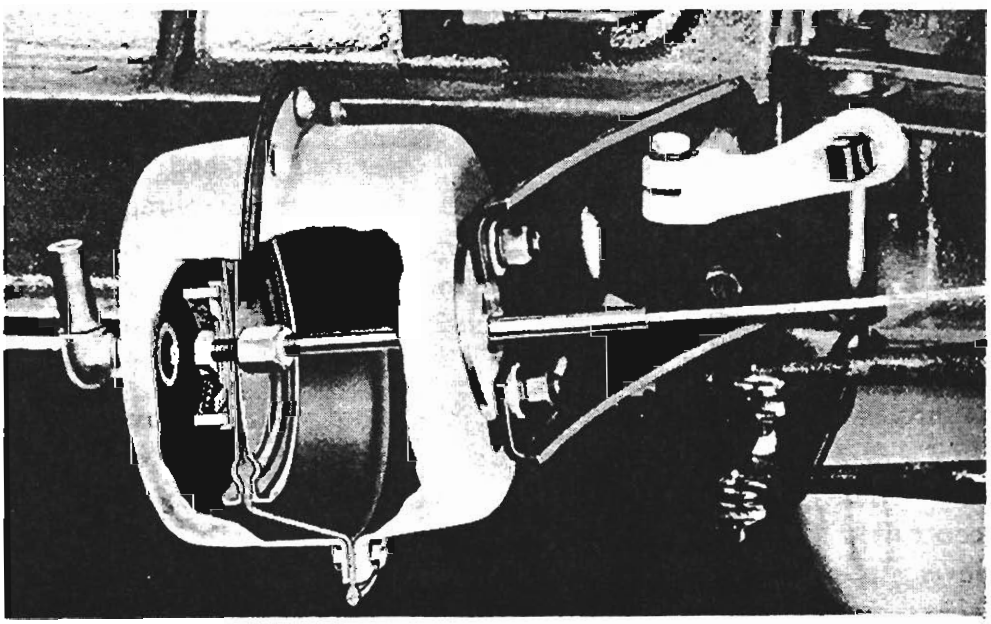


Fig. 19—The Power Cylinder (Clutch Disengaged).

opposite end to a bracket on the starter motor. For clutch *disengagement* (figure 19) the control valve subjects the power cylinder to the full vacuum intensity of the intake manifold. The diaphragm, through the cable-pulley system, exerts upon the clutch relay lever the pull necessary to disengage the clutch. For clutch *engagement* (figure 20) (the diaphragm being in disengaged position) the control valve bleeds atmospheric pressure to the power cylinder. This allows the diaphragm to uniformly assume its relaxed position until all tension has been relieved from the cable and relay lever and the clutch is in full engagement.

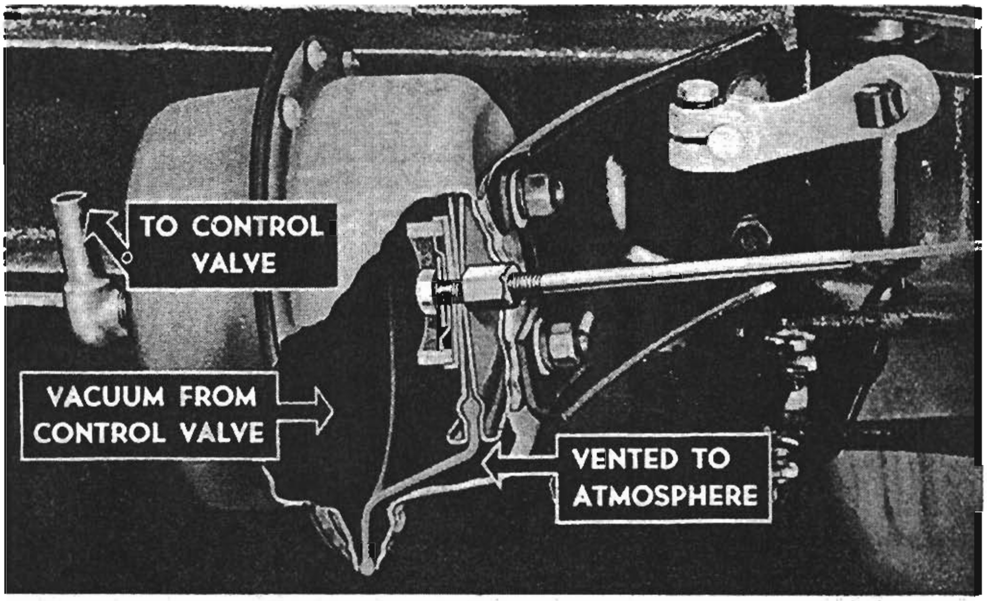


Fig. 20—The Power Cylinder (Clutch Engaged).

5. The Governor Switch

With only the controls described so far the clutch would be disengaged, allowing the car to free wheel every time the accelerator pedal was released. The centrifugally operated governor switch is provided to prevent clutch disengagement at speeds greater than governed speed. It contains two sets of contacts, one marked "EC" (Electromatic Clutch), the other, "AD" (formerly "Aerodrive," now Overdrive). The "AD" contacts are normally open below governed speeds, and control the engaging mechanism of the overdrive.

Both sets of contacts are operated by centrifugal force (set up by rotating flyweights) which opens the "EC" contacts and closes the "AD" contacts when the car is moving above governed speeds. Opening the "EC" contacts breaks the lockout solenoid ground circuit, de-energizing the solenoid, and stops off the vacuum from the power cylinder thereby preventing clutch disengagement above governed speeds.

6. The Direct Speed Switch

While the governor switch is necessary to lock out the Electromatic above governed speed, it is important to have a means of overriding this switch in order to shift gears above governed speeds. Because of this, the plunger type direct speed switch (figure 21) has been provided. It is bracket-mounted to the engine crankcase and is operated by the direct and second idler lever. Connected in parallel with the governor switch, it closes the Electromatic circuit at the first movement of the gearshift lever and, consequently, the first movement of the direct and second idler lever.

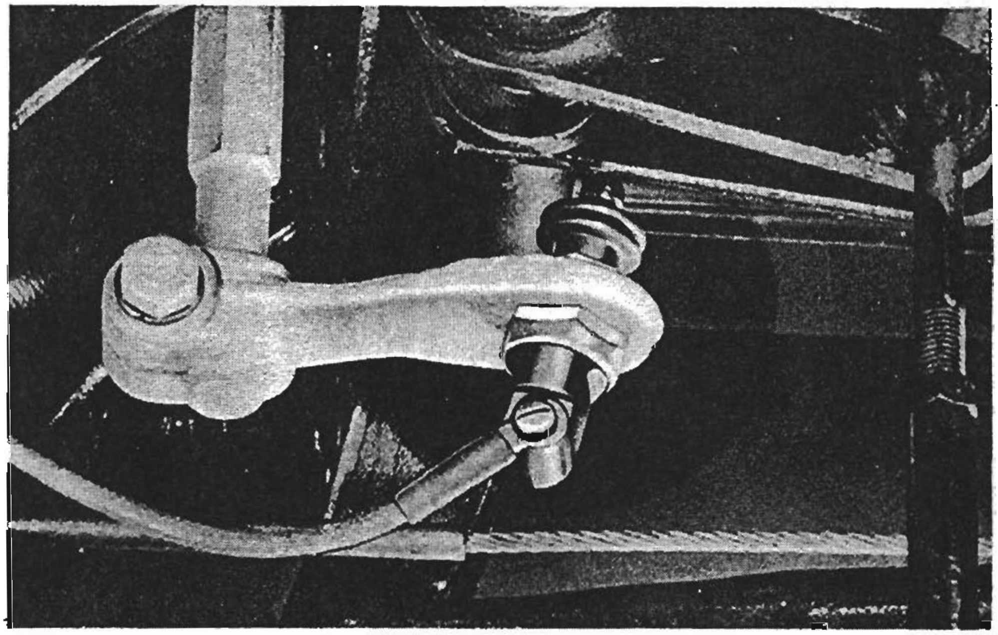


Fig. 21—The Direct Speed Switch.

When the shifting lever is moved to high gear position, the idler lever is pulled outward by the shifter linkage. This outward movement pushes in the plunger of the direct speed switch, opening its contacts and locking out the Electromatic. Any movement of the shifting lever out of high gear position moves the idler lever inward, instantly closing the direct speed contacts and making the Electromatic operative before any movement of the high gear synchronizer takes place. Thus, the direct and second idler lever allows the Electromatic to operate when the shifting lever is moved out of high gear position at speeds above governed speed.

7. The Accelerator Switch

With only the controls previously described, the clutch would be disengaged each time the accelerator pedal was released below governed speed. To prevent this, the accelerator switch has been provided.

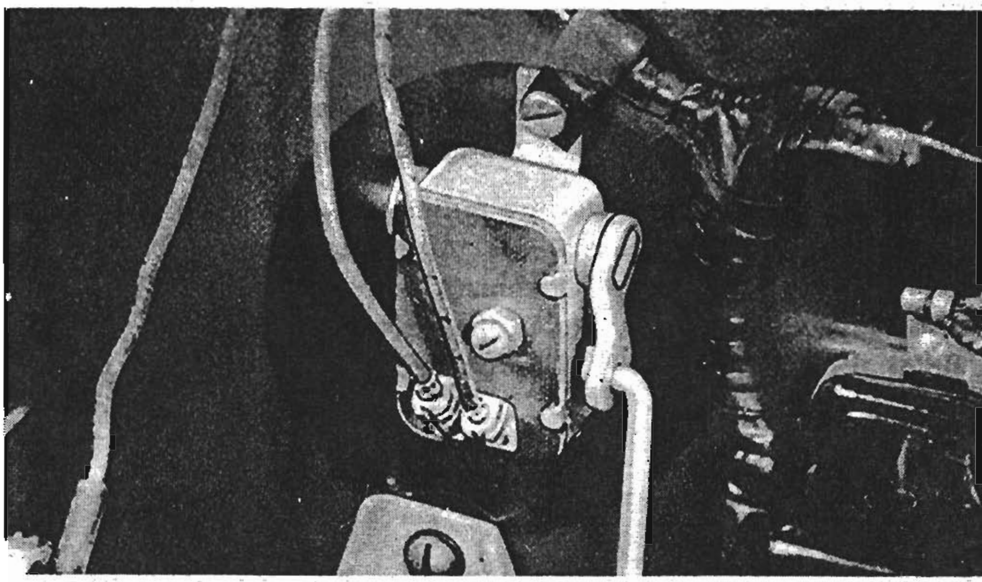


Fig. 22—The Accelerator Switch.

The accelerator switch is operated by a linkage secondary to the throttle linkage. See figure 22. It is connected in series with the governor "EC" contacts and is so adjusted that the switch contacts open just as the slack in the linkage has been taken up when the accelerator is depressed. This breaks the circuit and locks out the Electromatic. When the accelerator pedal is *fully released* below governed speed, the adjustment of the switch is such that its contacts are closed, and this of course "makes" the circuit and the Electromatic can operate.

ADJUSTING THE ELECTROMATIC CLUTCH

In some instances a car may be shipped from the Factory with a rather rough Electromatic adjustment, traceable to normal new car stiffness. Normal wear of mechanical parts may affect Electromatic Clutch action after some thousands of miles of use.

Misadjustment at the Factory is not as serious as it might seem, since the device must normally be adjusted to suit the individual owner. Even at delivery, if the Electromatic functions properly, and does not drag or slip, it is well to postpone the fine adjustment of the device until the 1000 mile inspection. By this time the owner should know the clutch "feel" he prefers, and the Electromatic may be adjusted accordingly.

Any linkage will wear if put to repeated use and, since the Electromatic tolerances must be held closely for efficient operation, adjustments have been provided which will compensate for any reasonable slack in the linkages. The amount of linkage wear will, of course, depend upon how many times the Electromatic has functioned. Normally, a car which has been used mostly in city driving will need adjustment for wear or replacement of mechanical parts before one that has operated mainly under country driving conditions.

Before making any Electromatic adjustment, first check the clutch pedal free play. (See "Clutch Pedal Adjusting Procedures.") It should be kept in mind that the Electromatic is in effect an automatic clutch pedal and that ideal operation of the Electromatic Clutch is impossible unless all troubles of the clutch proper have been eliminated.

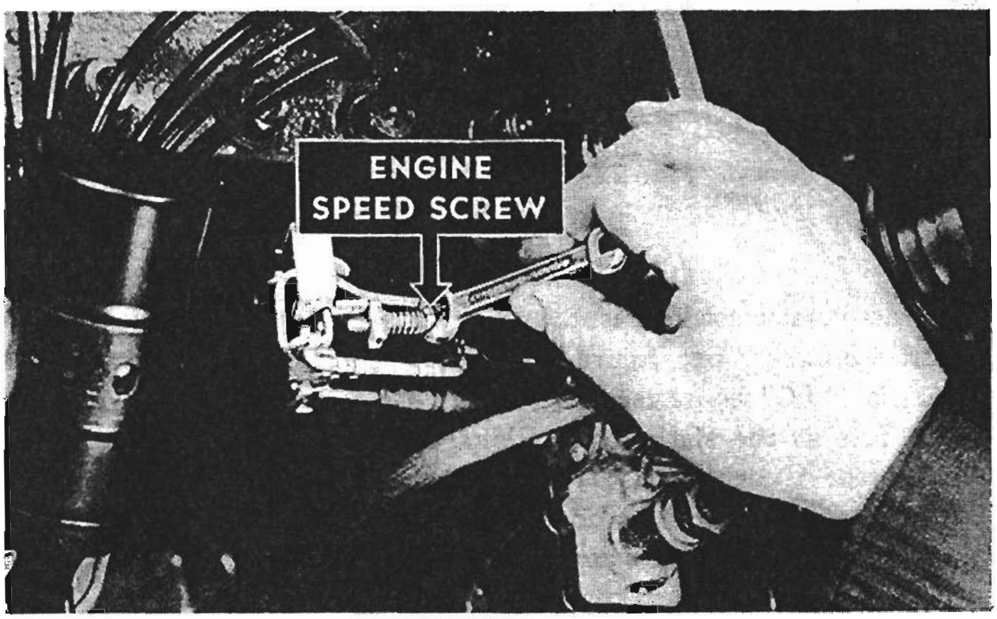


Fig. 23—Adjusting the Engine Speed Screw.

1. The Engine Speed Screw

PURPOSE: To advance or retard the "clutch cushion point" (that is, the r.p.m. of the engine at which the clutch starts to engage) with respect to throttle opening.

EFFECT: Regulates the distance the control valve piston travels before the throttle opens.

PROCEDURE: (a) To make this adjustment, the engine should be warm and at low idle, the transmission in second gear.

(b) Adjust the engine speed screw, as shown in figure 23, so that the car will just move on a level floor when the operating lever is brought up against the engine speed screw. The normal gap between the engine speed screw and the operating lever should be about $\frac{7}{32}$ inch.

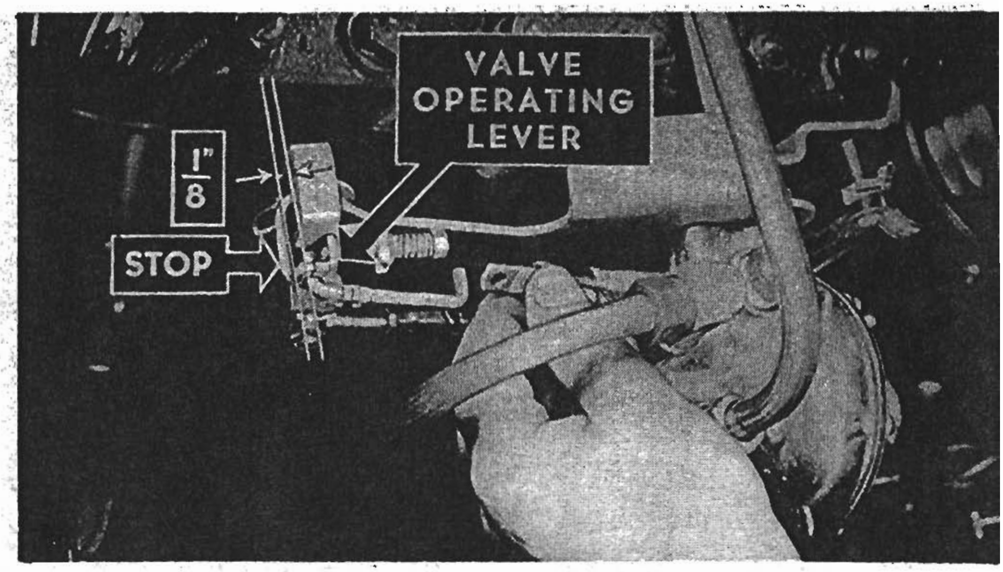


Fig. 24—Adjusting the Valve Rod Clevis.

2. Valve Operating Rod

PURPOSE: To provide additional adjustment if necessary after the engine speed screw has been turned in or out to its limit. This adjustment should not be made unless the adjustment available on the engine speed screw is not adequate.

EFFECT: When engine speed screw travel is not sufficient, the valve operating rod regulates the distance the control valve piston travels before the throttle opens.

PROCEDURE: (a) Make this adjustment with the engine warm and at low idle, the transmission in neutral.

(b) Hold the throttle operating lever against the bracket stop. Move the valve operating lever until there is 1/8 inch gap between the lever and the stop and hold the lever in this position.

(c) Move the valve rod in slowly until the power cylinder operating cable just starts to move on the clutch release stroke. Hold the valve rod at this point and adjust the valve rod clevis (figure 24) until the valve operating link will go into position. Connect the valve operating link and fasten it with the spring clip lock.

ELECTROMATIC ELECTRICAL TESTS

The best way to locate a faulty switch or a faulty solenoid is to use a six volt test lamp. Any electrical test would be worthless if the circuit were dead in the first place, so before starting be sure to check the fuse located between the ignition switch and the Electromatic lockout switch in the main feed cable.

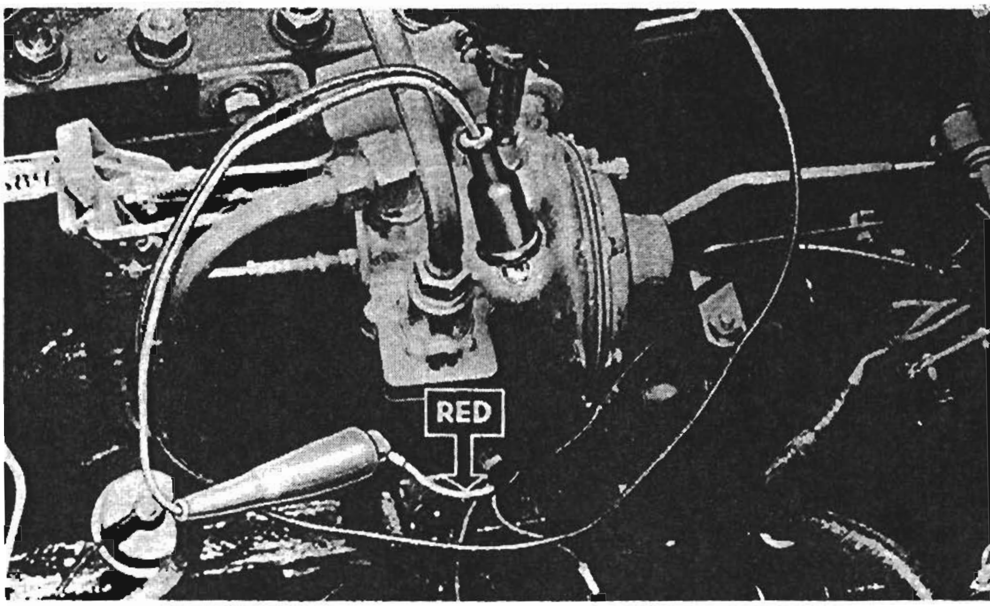


Fig. 25—Lockout Switch Test.

1. Lockout Switch

Disconnect the red lead from the lockout solenoid, clip one test lamp lead to this disconnected wire, then ground the other test lamp lead. See figure 25. When the ignition switch and the lockout switch are both closed, the test bulb should be lighted.

2. Lockout Solenoid

Disconnect both leads from the lockout solenoid terminal and ground one terminal with a jumper lead. Clip one test lamp lead to the remaining terminal, the other to the ungrounded (negative) battery post as shown in figure 26. If the test bulb lights, the solenoid is operating properly.

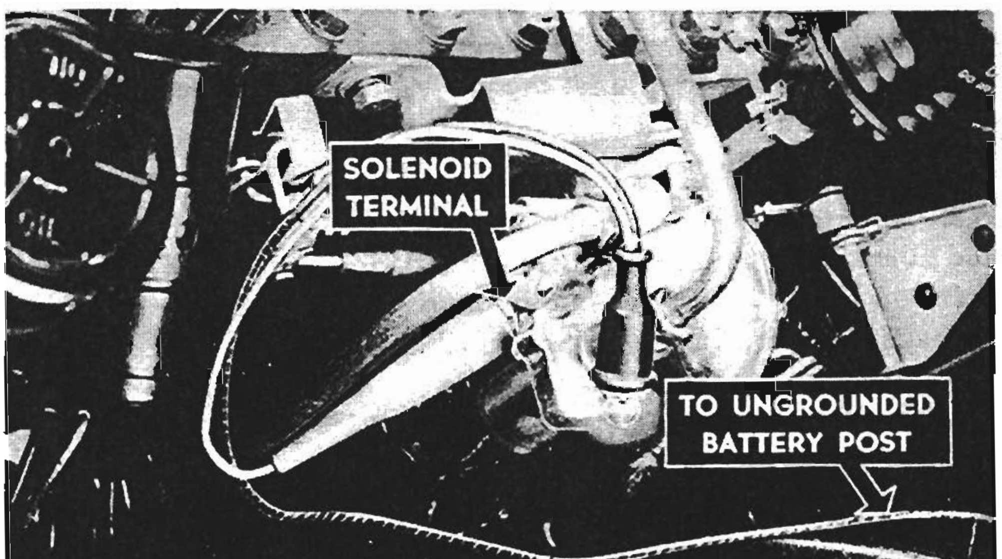


Fig. 26—Lockout Solenoid Test.

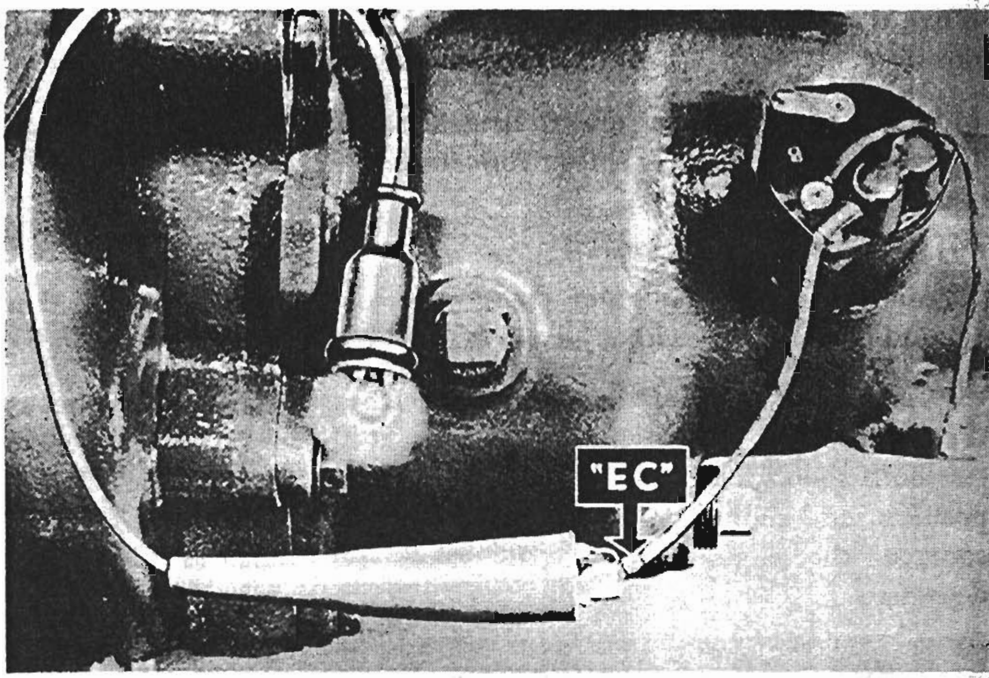


Fig. 27—Governor Switch Test.

3. Governor Switch

Disconnect both the "EC" and the "AD" wires at their connectors. Clip one test lamp lead to the ungrounded (negative) battery post, the other in turn to either of the two disconnected wires. See figure 27.

The test bulb should light when contact is made with the "EC" line, and should not light when the "AD" line is contacted.

4. Direct Speed Switch

Disconnect the lead from the direct speed switch terminal, then clip one test lamp lead to this terminal, the other to the ungrounded (negative) battery post. See figure 28.

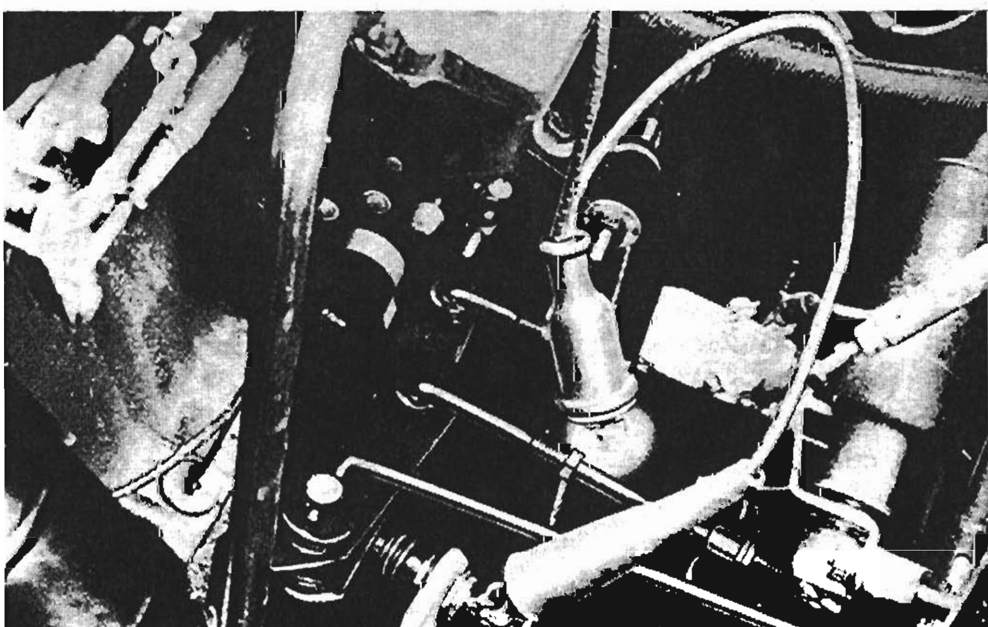


Fig. 28—Direct Speed Switch Test.

Move the gearshift lever into high gear position. The test bulb should not light.

Move the gearshift lever toward neutral position. The test bulb should light just before the gear shifter fork starts out of its detent.

5. Accelerator Switch

Disconnect both leads from the accelerator switch terminals, then ground one terminal with a jumper lead.

Clip one lead of the test lamp to the remaining terminal, the other to the ungrounded (negative) battery post, as shown in figure 29. The test bulb should be lighted with the accelerator pedal in the released position, and should go out just as the control valve operating lever contacts the engine speed screw when the accelerator pedal is depressed.

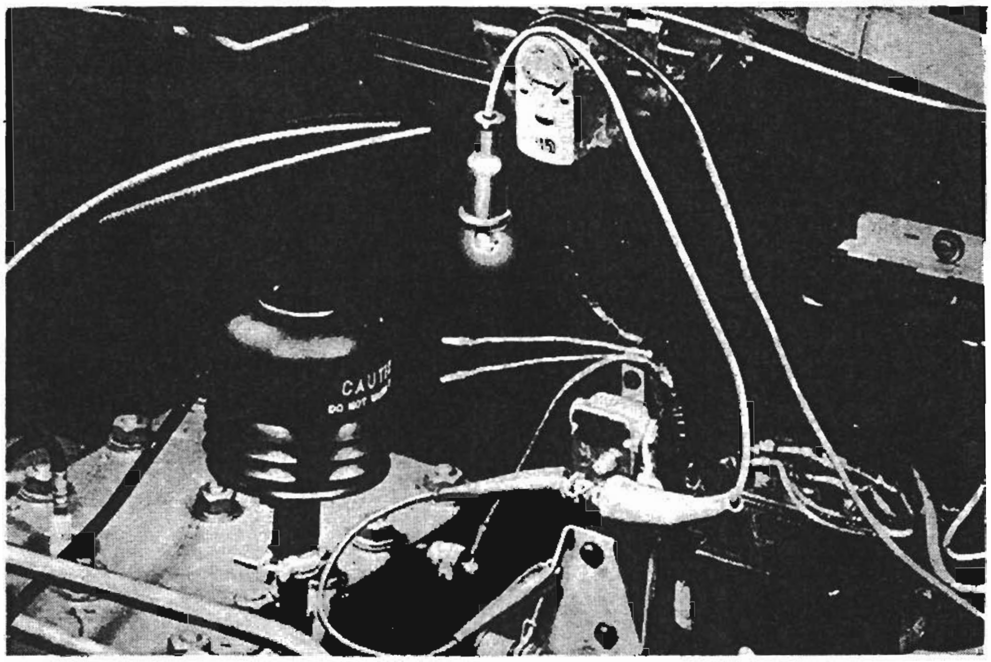


Fig. 29—Accelerator Switch Test.

ELECTROMATIC CLUTCH SERVICING PROCEDURES

1. Accelerator and Throttle Linkage

Satisfactory operation of the Electromatic Clutch demands that the accelerator linkage return to its closed throttle position as quickly as possible after release of the accelerator pedal. This means that the linkage must operate with a minimum of friction so, after cleaning and inspecting for worn parts, apply lubriplate to all friction surfaces *except the valve operating rod.* Any lubricant on the valve operating rod would tend to accumulate particles of dust and dirt, finally "gumming up" between the rod and its valve guide sleeves, so this part must be kept clean and dry of lubricant.

2. Control Valve Air Cleaner

This unit filters air to the clutch control valve through cotton waste and should not be oiled or washed. Since the cotton element is not replaceable, discard the entire unit and replace it if it should become clogged with an accumulation of dirt.

3. Hose and Steel Lines

Replace any deteriorated, collapsed, or damaged rubber hose and make sure all connections are tight. Check all tubing connections for tightness and inspect the lines for kinks or breaks. Replace damaged tubing.

4. Power Cylinder

Check to see that the joint between the two shells of the power cylinder is tight and that the cable connection threads are not stripped. If the diaphragm has been damaged, replace it.

5. Clutch Control Valve

CAUTION

> Clutch control valves are carefully calibrated for the particular models on which they are installed. Never install a clutch control valve on a model other than that for which it was intended.

If Electromatic Clutch performance remains rough and erratic after all adjustments have been properly made, it is probable that the control valve is at fault. It should be removed, cleaned, inspected and serviced.

To remove the clutch control valve from 22nd Series cars, first disconnect the vacuum lines to the intake manifold and the power cylinder (figure 30) remove the air cleaner and air inlet line, and disconnect the electrical leads at the lockout solenoid. The valve may then be removed, leaving the bracket installed on the cylinder head.

To remove the clutch control valve from 21st Series cars, the following procedure is recommended:

Disconnect the accelerator rod from the valve operating lever, and disconnect the throttle rod on the manifold side of the engine. After removing the cap screws, which attach the control valve bracket to the cylinder head, lift off the control valve and bracket assembly. Take off the retaining clips and disconnect the control valve operating link rod at the valve operating lever. Now remove the two cap screws holding the control valve to the bracket and lift off the valve.

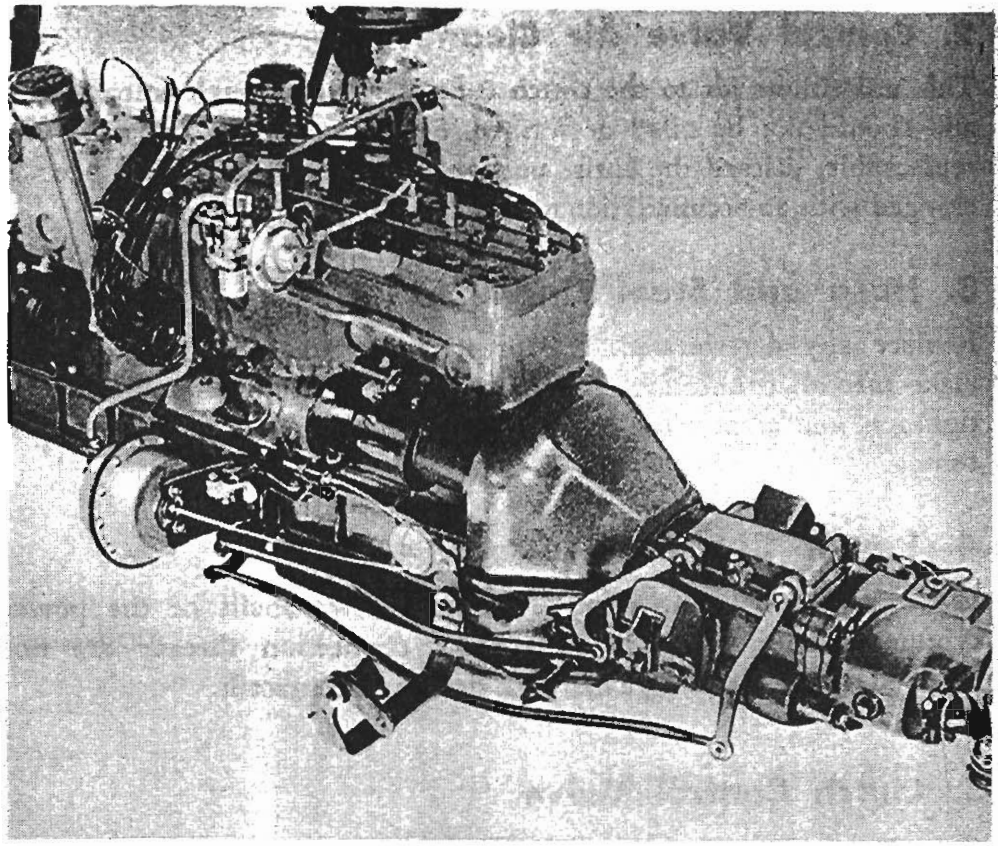


Fig. 30—Disconnect Vacuum Lines to Intake Manifold and Power Cylinder.

To disassemble the valve, remove the valve operating clevis, remembering to count the number of turns required so that it may be reinstalled to approximately the same position. Remove the body end cover plate and spring.

Depress the valve piston latch lever and disconnect the slotted link from the fulcrum lever, then remove the valve piston and the slotted link.

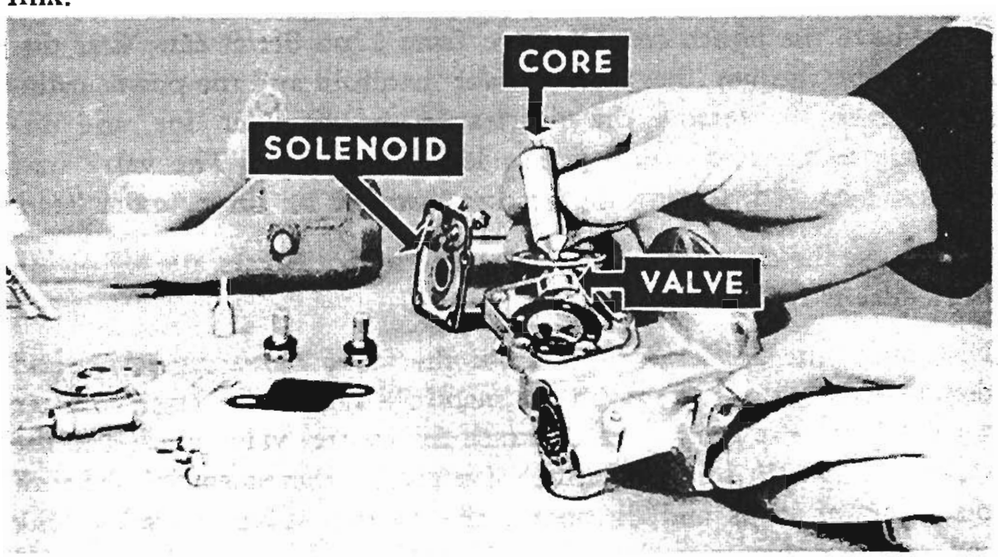


Fig. 31—Remove the Lockout Valve and the Solenoid Core.

Remove the regulating diaphragm cover and spring, take out the diaphragm, fulcrum lever, and valve operating rod as an assembly and remove the gasket and spacer.

Remove the lockout solenoid, being careful not to lose the solenoid spring at the bottom of the core. Remove the lockout valve and the solenoid core. See figure 31. If it is necessary to remove the poppet check valve because of damage to or malfunctioning of this unit, heat the control valve body to a temperature of about 200°F in hot water, then bump the valve body on a wooden block until the poppet valve jars free of the body.

Clean the control valve body, diaphragm, solenoid core, valve piston, valve operating rod, and fulcrum lever with cleaning solvent.

Wipe the solenoid terminal plate and the diaphragm with a clean, solvent-moistened cloth. *Do not dip the solenoid nor the diaphragm in cleaning solvent.* Inspect the rubber solenoid valve disc for wear, damage, and distortion, and if any of these failures have occurred the valve should be discarded and replaced.

Check the spool valve piston spring, the regulating diaphragm, and replace them if necessary. Inspect the control valve body and working parts for general condition, replacing any parts which have become worn or damaged. Test the solenoid as recommended under "Electromatic Electrical Tests."

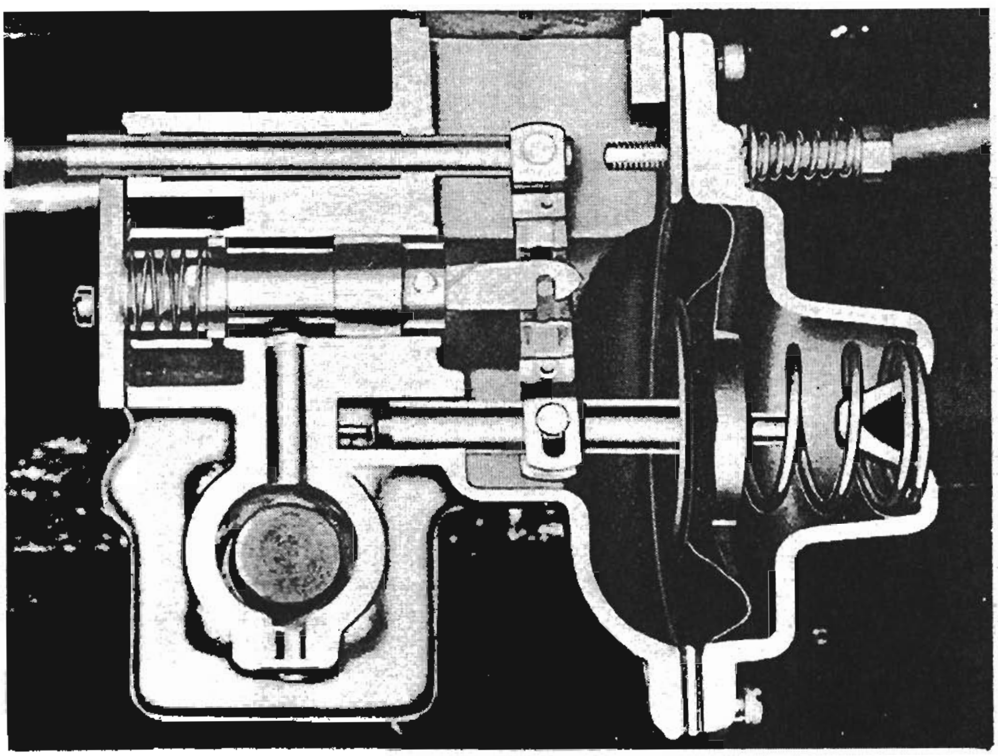


Fig. 32—Showing Slotted Link in Position Over Center Pin in Fulcrum Lever.

To reassemble the clutch control valve after the parts have been cleaned and inspected, proceed as follows:

If the poppet check valve has been removed or is to be replaced, heat the valve body to about 200°F by dipping it in hot water, and push the poppet valve into position. Install the solenoid valve and the solenoid core, then install the core spring and the solenoid, tightening all screws evenly.

Reassemble the diaphragm shaft, fulcrum lever and valve operating rod, and slide this assembly into position in the valve body as a unit. *(Do not lubricate this internal linkage.)* Now install the diaphragm spring and cover, tightening all screws evenly.

Slide the piston-latch lever assembly into position and, holding the latch lever down, snap the slotted link over the center pin in the fulcrum lever. See figure 32. Using a new gasket, install the body end cover plate and spring. Install the valve operating rod clevis, using the same number of turns to reassemble the unit as those previously noted when removing it. Making sure to use a new gasket, install the assembled control valve on the mounting bracket, then connect the valve operating rod link to the clevis and snap the retaining clip into position.

ELECTROMATIC TROUBLES AND CORRECTIONS

Misadjustment is the cause of most Electromatic Clutch troubles. It may be caused by road and engine vibration or by wear of mechanical parts. Other troubles may be bad electrical connections, failure of electrical units, and faulty operation of the control valve. A number of typical troubles and their probable corrections follow.

1. Engine Speed too High and Excessive Clutch Slippage when Making a Part Throttle Start in Low or Reverse

A. Adjust engine speed screw.
(See "Adjusting the Electromatic Clutch.")

B. If this does not correct the trouble, adjust the valve operating rod according to instructions.
(See "Adjusting the Electromatic Clutch.")

2. Engine Speed too Low, Clutch Grabs and Engine Tends to Stall when Making a Part Throttle Start in Low or Reverse

A. Adjust engine speed screw.
(See "Adjusting the Electromatic Clutch.")

B. If this does not correct the trouble, adjust the valve operating rod according to instructions.
(See "Adjusting the Electromatic Clutch.")

3. Excessive Clutch Slippage After Shift Has Been Made Into Second or Direct Speed. Engine Races Immediately After Gears Have Been Shifted Before Clutch Engages

A. Insufficient clutch pedal free play.
(See "Adjusting the Electromatic Clutch.")

B. Power cylinder operating cable out of adjustment.
(See "Adjusting the Electromatic Clutch.")

C. Control valve incorrectly adjusted.
(See "Electromatic Clutch Servicing Procedures.")

4. Clutch Engagement too Rapid After Shift Has Been Made Into Second or Direct Drive

A. Excessive clutch pedal free play.
(See "Clutch Servicing Procedures.")

B. Valve operating screw out too far.
(See "Adjusting the Electromatic Clutch.")

5. Car "Free Wheels" Above Governed Speeds in Direct Drive when Accelerator Pedal Is Released

A. Direct speed switch grounded.
(See "Electromatic Electrical Tests.")

B. Direct speed switch out of adjustment.
(See "Adjusting the Electromatic Clutch.")

C. Faulty governor switch, "EC" contacts fused together or grounded.
(See "Electromatic Electrical Tests.")

6. Clutch Disengages when Driving in High Gear with Very Small Throttle Opening Below Governed Speeds

A. Accelerator switch out of adjustment.
(See "Adjusting the Electromatic Clutch.")

B. Accelerator switch operating rod disconnected. Connect rod and adjust accelerator switch.
(See "Adjusting the Electromatic Clutch.")

C. Faulty accelerator switch.
(See "Electromatic Electrical Tests.")

Replace the accelerator switch if necessary and adjust.
(See "Adjusting the Electromatic Clutch.")

7. Clutch Disengages when Accelerator Is Released While Driving in High Gear Above Governed Speeds

A. Direct speed switch grounded. Test direct speed switch. Replace if necessary.
(See "Electromatic Electrical Tests.")

B. Direct speed switch out of adjustment. Adjust direct speed switch.
(See "Adjusting the Electromatic Clutch.")

C. Faulty governor switch, "EC" contacts fused together or grounded. Test governor switch. Replace if necessary.
(See "Electromatic Electrical Tests.")

8. **Electromatic Will Not Disengage Clutch when Attempting to Shift from Direct to Second Speed While Driving Above Governed Speed. Electromatic Operation Otherwise Satisfactory**

A. Direct speed switch faulty or out of adjustment. Adjust direct speed switch.
(See "Adjusting the Electromatic Clutch.")

B. Direct speed switch lead wire disconnected. Connect lead wire.

9. **Car "Lurches" Above Governed Speed when Accelerator Is Released, then Depressed Again**

A. Faulty or burned "AD" governor switch contacts. Check governor switch. Check "AD" contacts, clean and adjust if necessary.
(See "Electromatic Electrical Tests.")

10. **Excessive Clutch Slippage in Fast Starts**

A. Valve operating rod stop screw out of adjustment. Adjust valve operating rod stop screw.
(See "Adjusting the Electromatic Clutch.")

B. Insufficient clutch pedal free play. Adjust free play.
(See "Clutch Servicing Procedures.")

11. **Clutch Engagement too Severe on Fast Starts But Otherwise Satisfactory**

A. Valve operating rod stop screw out of adjustment. Adjust valve operating stop screw.
(See "Adjusting the Electromatic Clutch.")

12. **Excessive Accelerator Pedal Movement Before Clutch Starts to Engage**

A. Engine speed screw out of adjustment. Adjust engine speed screw.
(See "Adjusting the Electromatic Clutch.")

13. **Inconsistent Operation of Electromatic Clutch**

A. Loose Electromatic wiring connections. Defective wiring. Examine and tighten all electrical connections in the Electromatic circuit, especially the cable connectors at the governor switch. Be sure to check the fuse in the main cable.

14. Overdrive Engages as the Gearshift Lever Is Placed in Low or Reverse Gear on Cars Equipped with Both Electromatic Clutch and Overdrive

A. Blown fuse in Electromatic main feed cable. A broken or disconnected Electromatic main feed cable would also cause this condition. A blown fuse will permit a current reversal through the governor switch "AD" terminal, causing the overdrive solenoid to be energized and engage the overdrive.

15. Clutch Does Not Disengage Fully. Gears Clash in Low or Reverse Gear. Severe Operation

A. Clutch control valve linkage out of adjustment.
(See "Adjusting the Electromatic Clutch.")

B. Power cylinder operating cable out of adjustment.
(See "Adjusting the Electromatic Clutch.")

C. Distorted clutch driven plate.
(See "Clutch Troubles and Corrections.")

D. Grease on clutch driven plate facings.
(See "Clutch Troubles and Corrections.")

16. Electromatic Clutch Totally Inoperative

A. Lockout solenoid wire disconnected. Connect solenoid wire.

B. Faulty lockout switch. Test lockout switch. Install new switch if necessary.
(See "Electromatic Electrical Tests.")

C. Rubber lockout solenoid valve swelled from contact with oil, stuck in control valve vacuum passage. Disassemble, clean and reassemble the control valve. Replace rubber lockout valve. Completely readjust Electromatic.

D. Control valve operating rod clevis disconnected. Adjust operating rod clevis and connect. Completely readjust Electromatic.

E. Control valve piston link disconnected. Disassemble, clean, and reassemble control valve. Be sure valve piston link is properly connected.

F. Broken diaphragm in power cylinder. Usually indicated by racing engine when accelerator is released (air leak into intake manifold).

THE PACKARD MANUAL-SHIFT TRANSMISSION

GENERAL DESCRIPTION

An automotive transmission provides the means of changing the speed, torque, and direction of rotation of the propeller shaft with respect to that of the engine.

The Packard transmission (figure 33) may be described as the "three-speed, manually shifted, constant mesh type." It contains both helical and spur gears and may be divided, for descriptive purposes, into several major working assemblies and parts; these follow. See figure 34.

1. The Clutch Shaft

Its function is to transfer torque from the clutch assembly to the transmission. Splined at the forward end to fit the clutch driven plate hub, it incorporates a combined helical gear and splined flange at the rearward end. See figure 35. The helical gear is in constant mesh with the front helical gear on the countershaft, while the splined flange is engaged by the direct drive and second speed clutch gear when direct drive speed is selected. The clutch shaft is supported at the forward end by a ball bearing in the flywheel and, just ahead of the helical gear, by the clutch shaft rear bearing mounted in the transmission case.

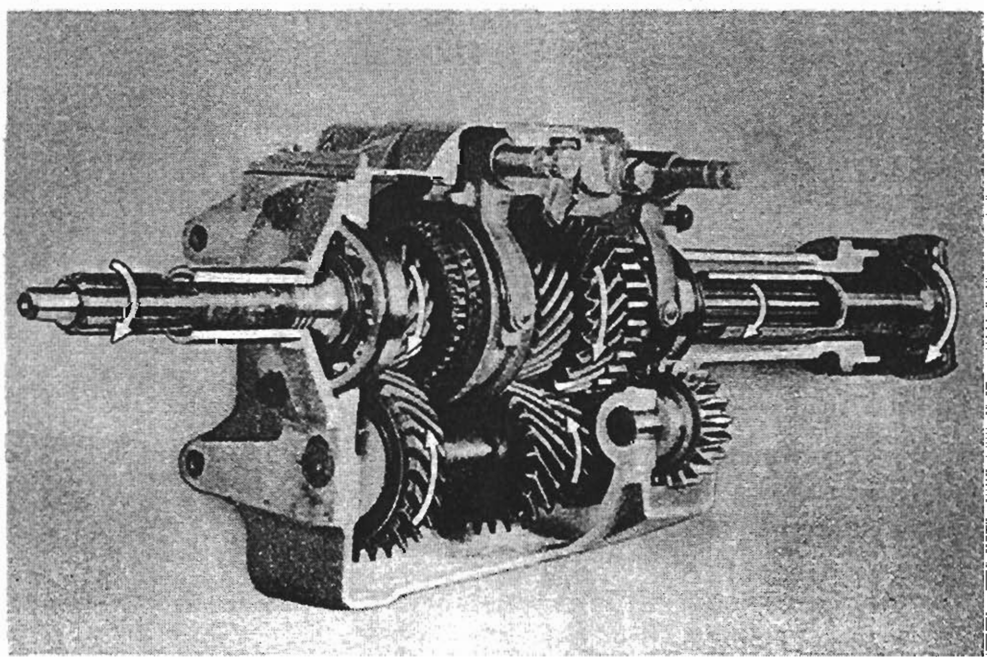


Fig. 33—The Packard Manual Shift Transmission.

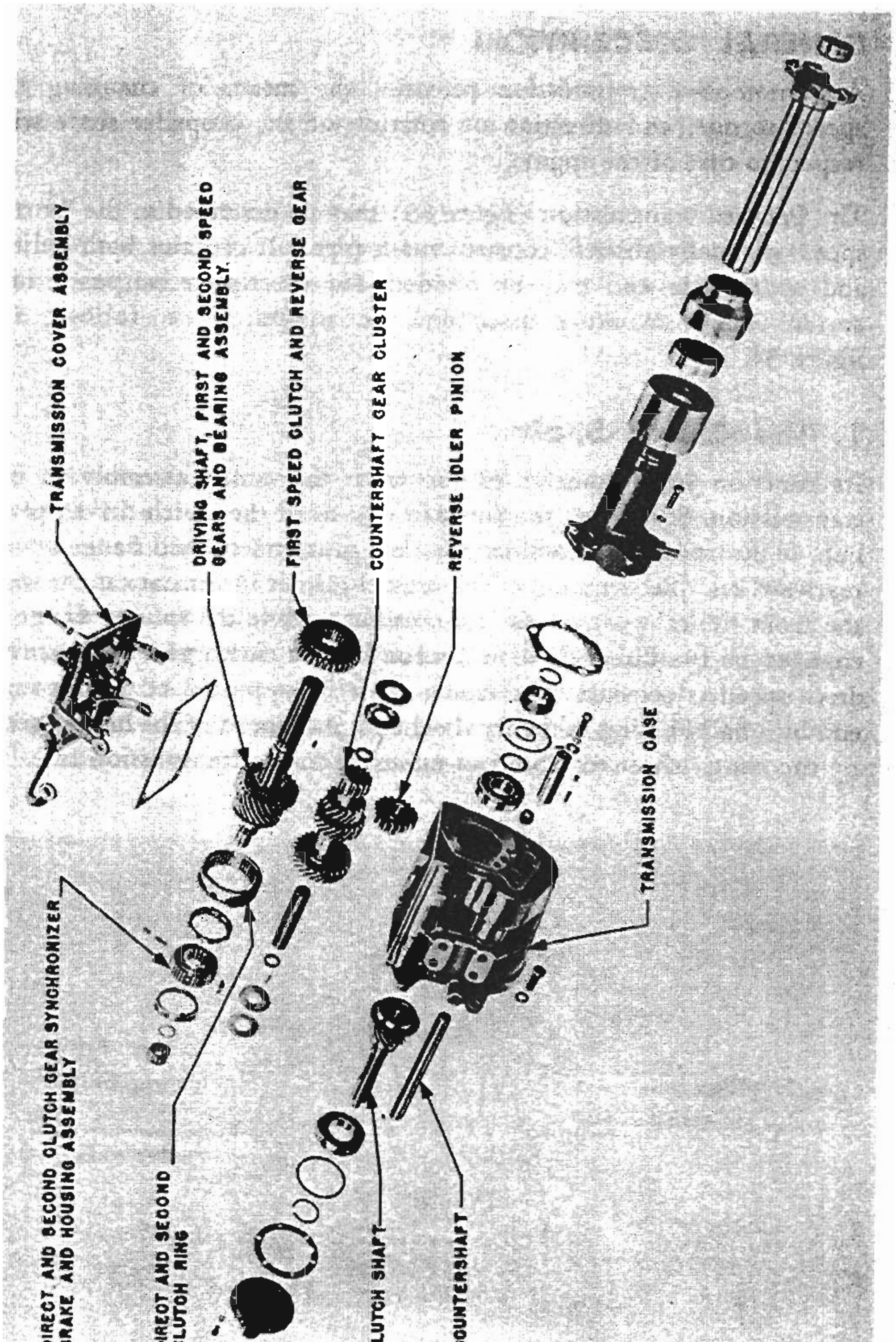


Fig. 34—Exploded View of the Manual Shift Transmission.

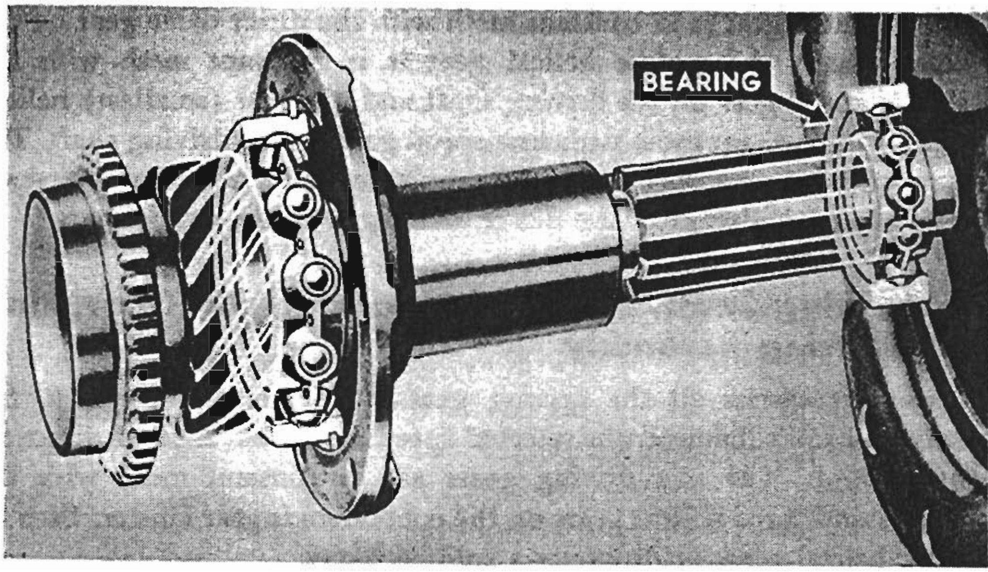


Fig. 35—The Clutch Shaft Incorporates a Combined Helical Gear and Splined Flange.

2. The Transmission Case

It supports all shafts and gears in the transmission. In conjunction with the transmission cover (to be described later), it also acts as the reservoir for transmission lubricant and, of course, seals these parts off from outside dust and dirt. For rigid support, it is bolted to the flywheel housing and, through mounting brackets, to the frame.

3. The Countershaft

This shaft is mounted in the transmission case and supports the countershaft gear cluster.

4. The Countershaft Gear Cluster

Rotating on roller bearings on the countershaft, this idler gear unit consists of three helical gears and a spur gear. See figure 36. The

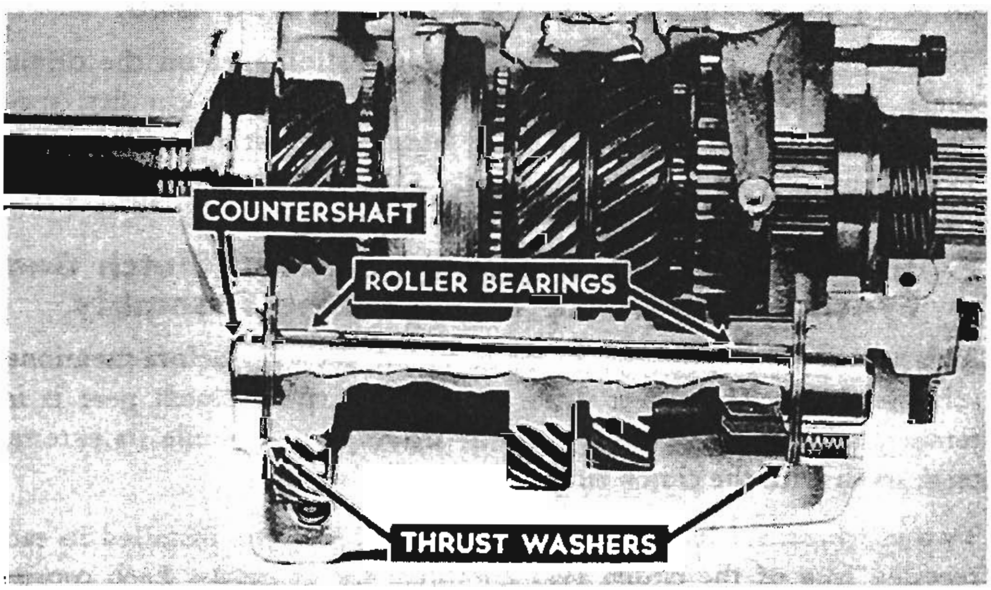


Fig. 36—The Countershaft Gear Cluster.

front helical gear is in constant mesh with the direct drive gear on the clutch shaft, the middle helical gear is in constant mesh with the second speed gear on the driving shaft and, the rear (smallest) helical gear is in constant mesh with first speed gear on the driving shaft. The spur gear is in constant mesh with the reverse idler. The countershaft gear cluster is driven by the direct drive gear on the clutch shaft.

5. Driving Shaft, First and Second Speed Gears and Bearing Assembly

This unit carries all the driving gears and transfers torque to the universal joint flange at the selected speed and in the desired direction of rotation. The two driving gears are in constant mesh with the second and third helical gears on the countershaft gear cluster. Each of these helical gears incorporates a splined flange.

The driving shaft is splined at three places. The forward position is splined to fit the direct drive and second speed clutch gear, the middle portion for the first speed and reverse clutch gear, and the rear portion for the universal driving flange and the speedometer driving gear. The driving shaft is supported at the forward end by roller bearings contained inside the clutch shaft direct drive gear and at the middle section by a ball bearing assembly mounted at the rear of the transmission case.

The speed of the driving shaft (in relation to engine r.p.m.) is selected by moving the splined gears to mesh with the splined bosses on the first speed, second speed, and direct drive gears. Reverse gear is effected by meshing the splined flange of the first speed gear with the reverse idler pinion. The selected speed and rotation is passed on to the driving flange, which is splined to the rear end of the shaft.

6. The First Speed Clutch and Reverse Gear

This spur gear is splined at its hub for a sliding fit on the driving shaft. Its inner teeth mesh with the splined flange on the first speed gear when first speed is selected, the outer teeth with the reverse idler pinion upon selection of reverse gear.

7. The Direct Drive and Second Speed Clutch Gear Synchronizer Brake and Housing Assembly

This assembly (figure 37) is made up of the two before-mentioned sub-assemblies. The direct drive and second speed clutch gear is internally splined at the hub to fit the driving shaft, while its external teeth mesh with the clutch ring.

Two synchronizer brake and housing assemblies, one installed in each recessed face of the clutch gear complete the assembly. Each consists of a stamped housing and bronze ring called a synchronizer brake.

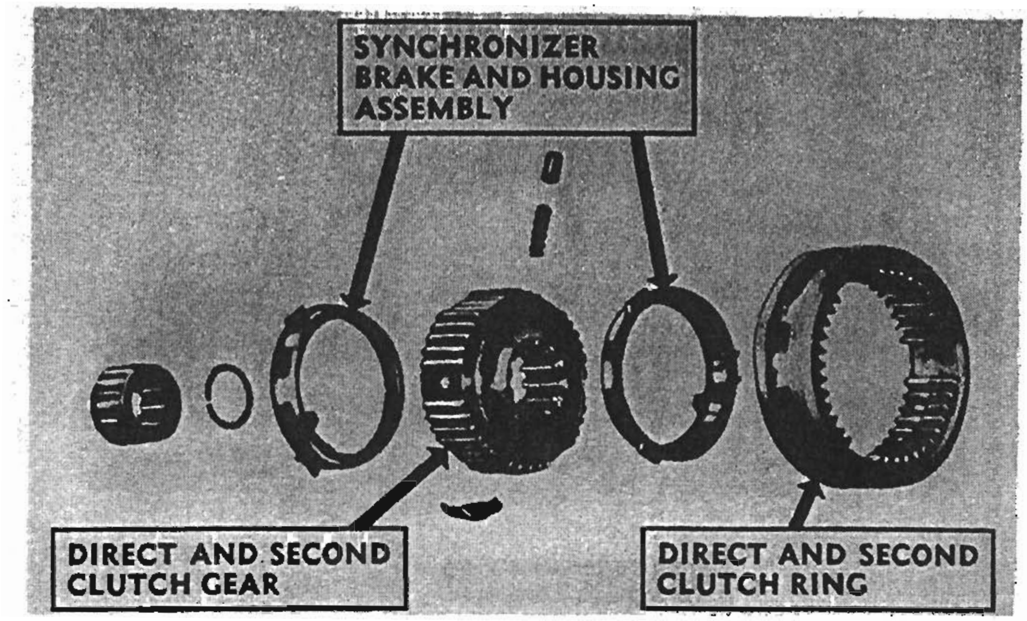


Fig. 37—Exploded View of Clutch Gear and Synchronizer.

8. The Direct Drive and Second Speed Clutch Ring

This part is an annular gear and is engaged with the splined flange of either the direct drive gear, or that of the second speed gear as selected by the shifter fork. Three of its internally cut teeth are milled off at three evenly spaced positions, providing a nest for the brake retaining springs, while a groove which acts as a detent for the plungers in the clutch gear is cut across the middle of all teeth.

9. The Reverse Idler Shaft and Pinion

The reverse idler shaft is a stationary shaft since it is keyed in the transmission case. It supports the reverse idler pinion which is free to turn on the shaft on a bronze bushing.

10. The Transmission Cover Assembly

The major parts of this assembly are the cover, two shift lever and shifter fork assemblies, and the shifter fork interlock bracket. See figure 38.

The transmission cover supports the shafts for the lever and shifter fork assemblies and is secured to the transmission case by cap screws. It works with the transmission case both to hold the transmission lubricant and to seal the transmission from outside dust and dirt.

The shifter forks have shoes pinned to each arm in such a manner that engagement of the shoes in the grooves of both movable gears will remain the same, regardless of the position of the fork arms. A detent arm extends at right angles from each fork, each arm containing three detents. The two forks are pinned through the shafts and are so installed that their detent arms both extend inboard in the cover.

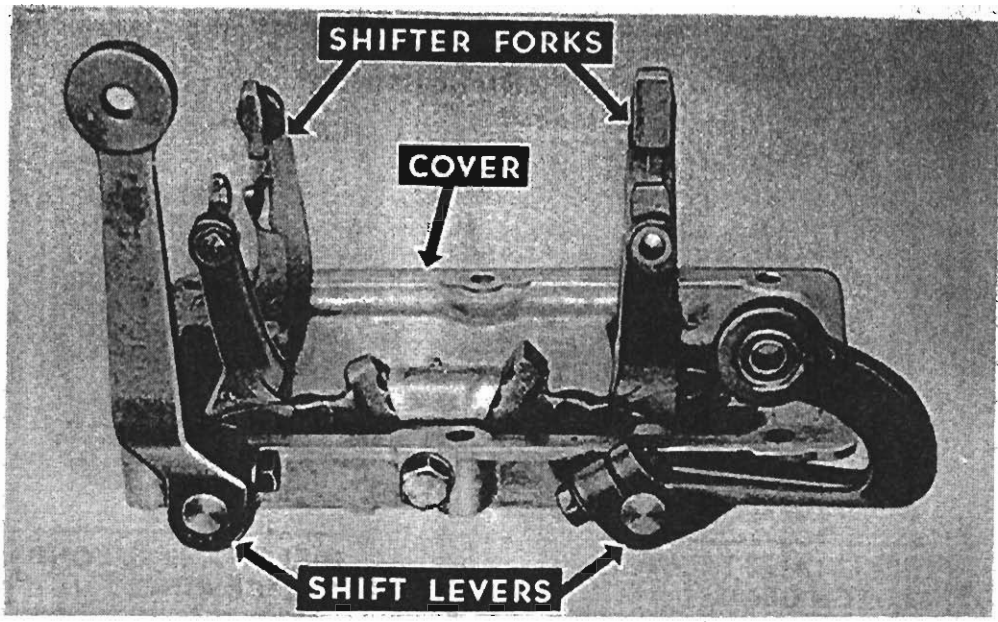


Fig. 38—The Transmission Cover Assembly.

The shifter forks interlock bracket contains two spring-loaded steel balls and is held in position by a slot which fits over a web in the cover, and by the ball detents on the fork detent arms.

The shifter fork shafts are serrated for the shifter levers at one end and contain two serrated holes for the fork connecting pins.

The shifter fork levers are bored and serrated to match the shafts at one end, and are drilled to afford a pin connection to the shifter linkage at the other.

11. The Transmission Gearshift Linkage

The major parts of this linkage are: the gearshift lever, the selector rod assembly, the shaft levers and housing assembly, the selector, the selector rod spring, the shaft lever to idler lever rods, the idler levers, and the lever to transmission rods. See figure 39.

The gearshift lever is pivoted near the end away from the knob, the extreme end beyond the pivot being formed to a ball. This ball is contained in a fitting at the end of the selector rod assembly, allowing pull and push forces to be imparted to the selector rod by the gearshift lever.

The housing is a hollow tube, carries a bracket at the upper end for the gearshift lever pivot, is supported at each end by bearings and is splined at the lower portion for the selector. The selector rod is installed inside this unit.

The two shaft levers (the first and reverse, the second and direct drive) are assembled free to turn on the housing. These levers are each recessed to engage the selector, depending upon the direction of movement of the selector rod.

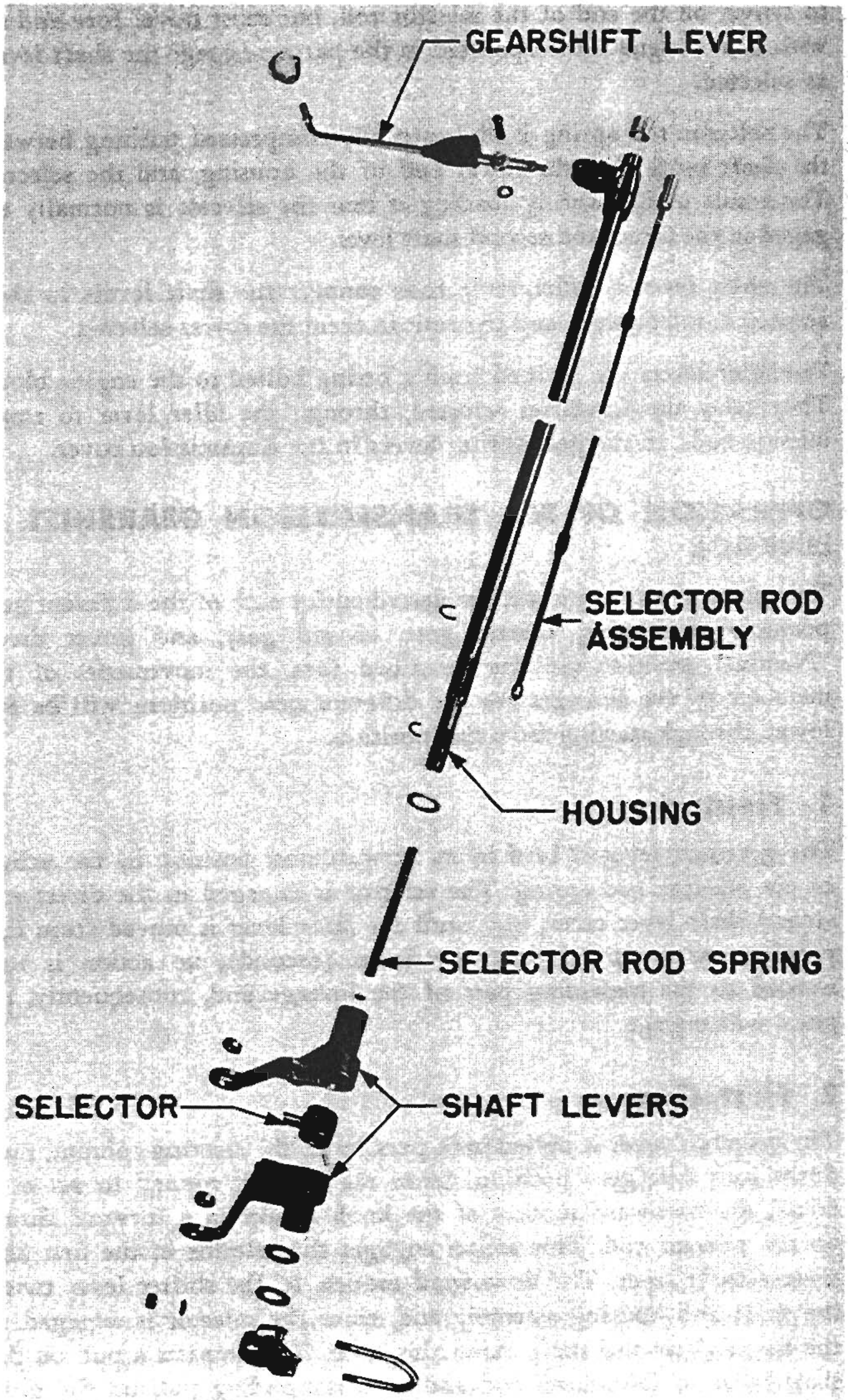


Fig. 39—The Transmission Gearshift Linkage.

The selector is splined to fit the splined portion of the housing and is secured to the lower end of the rod in such a manner that it is free to swivel on the end of the selector rod, but must travel fore and aft with it. A tongue is incorporated in the part to engage the shaft levers as selected.

The selector rod spring is always partly compressed pushing between the shaft bracket at the lower end of the housing, and the selector. The result of this spring loading is that the selector is normally engaged in the direct and second shaft lever.

The shaft lever to idler lever rods connect the shaft levers to their respective idler levers, and transmit to them the forces selected.

The idler levers are pivoted from a fitting bolted to the engine block. They relay the forces, as selected, through the idler lever to transmission rods, to the gear shifter levers in the transmission cover.

OPERATION OF THE TRANSMISSION GEARSHIFT LINKAGE

This phase of operation will be described for each of the different gear positions, first gear, reverse gear, second gear, and direct drive. "Neutral" position will be described first, the movements of the members of the linkages for the different gear positions will be followed through starting from this position.

1. Neutral

The gearshift lever is held in its forwardmost position by the action of the selector rod spring. The selector is engaged in the direct and second shaft lever recess but, until the shift lever is moved from this position either up (reverse) or down (second), no action is forwarded to the remaining part of the linkage and, consequently, no gears will engage.

2. First Gear

The gearshift lever is pulled back parallel to the steering column, then down into first gear position. Since the lever is pinned to act as a crank, the backward motion of the knob results in a forward thrust on the selector rod. This action engages the selector in the first and reverse shaft lever. The downward motion of the shifter lever twists the shaft and housing assembly and, since the selector is engaged in the first and reverse shaft, raises this lever. This imparts a pull on the shaft lever to idler lever rod and a corresponding pull on the idler lever which is transferred through the idler lever to transmission rod, thence to the first speed and reverse shifter lever.

3. Reverse Gear

The gearshift lever is pulled back parallel to the steering column resulting in a forward thrust on the selector rod. This engages the selector in the first and reverse shaft lever. So far the action has been the same as for the first gear; however, at this time the shifter lever is raised and the resulting twist on the shaft and housing is in the opposite direction to that of first gear. This, as far as the remaining linkage is concerned, results in movement of the parts in the direction directly opposite those followed in the coverage of "First Gear."

4. Second Gear

The gearshift lever is already in its forward position, held there by the selector rod spring, and consequently, the selector is engaged in the direct and second shaft lever recess. Raising the gearshift lever twists the housing assembly and raises the direct and second shaft lever which imparts a thrust on the shift lever to idler lever rod and a corresponding thrust on the direct and second idler lever. This thrust is transferred through the idler lever to the direct and second transmission rod, thence to the direct and second shifter lever.

5. Direct Drive

The shifter lever is already forward, the selector rod spring holding the selector engaged in the direct and second shaft lever. The position of the linkage is the same, so far, as that for second gear before the twist is imparted to the housing. As the lever is lowered into direct drive, the housing and the second and direct shaft lever twists in the direction opposite that for second gear, relaying the action through the remaining parts of the linkage in the directions opposite their travel described under "Second Gear."

GEARS R.P.M. AND TORQUE

A spur gear is a disc having teeth cut parallel to the shaft in its outer circumference.

A pinion is actually the same thing as a spur gear except that when the teeth of two spur gears mesh, the smaller of the pair is called the pinion.

A gear and pinion are generally designed so that two teeth on each are in contact at the same time and the teeth of the gear *roll* on the surface of the pinion teeth as the two rotate in opposite directions. If it is desired that the driven gear in a train turn in the same direction as the driving gear, it is necessary that an idler pinion be meshed between them. The size or number of teeth of the idler will have no effect upon the r.p.m. of the driven gear. As long as the teeth of the idler are designed to mesh with those of both gears, the idler merely changes the direction of rotation of the driven gear.

A helical gear is a disc with teeth cut *at an angle* to the shaft. This makes the teeth considerably longer than the teeth in a spur gear and, since they are cut at an angle to the shaft, they twist a little as they pick up the circumference of the disc. This twist, if projected all the way around, would develop a spiral or helix, and this is how a helical gear gets its name. The main reason for using helical gears in an automotive transmission is that they are quieter in operation than spur gears.

A gear ratio means the proportion in speed between the first or *driving* gear of a train to that of the last or *driven* gear and this proportion or ratio is directly proportional to the number of teeth in each gear as well as to their diameter. Usually, gear ratios are calculated using the number of teeth in each gear.

If we had two gears in a train and wanted to find their ratio, we would divide the number of teeth in the driving gear by the number of teeth in the driven gear. It we wanted to figure the r.p.m. of the driven gear we would multiply the r.p.m. of the driving gear by the ratio to get the answer.

If the ratio is greater than one, we gain speed but lose in foot pounds torque and, if the ratio is less than one, we lose in speed but gain in foot pounds torque. You can't gain both speed and torque in a train of gears—you have to settle for one or the other.

OPERATION OF THE TRANSMISSION

As in the operation of the transmission linkage, the position of the gears and shifter forks will be covered for neutral position first, then the different positions will be covered assuming each to be starting from the position of neutral.

1. Neutral

When the engine is running, with the clutch engaged and the transmission in neutral, the clutch shaft (A, figure 40) is turning over at the same r.p.m. as the engine flywheel as, in fact, it will regardless of the gear position selected. Since the clutch shaft gear (B) is in constant mesh with its mating gear (C) on the countershaft gear cluster, the cluster also turns at this time but, as the mating gear on the cluster is the larger of the two, the r.p.m. of the cluster is always *lower* than that of the clutch shaft. The middle helical gear (D) on the countershaft is in constant mesh with the second speed gear (E) on the driving shaft, the last helical gear (F) is in constant mesh with the first speed gear (G) on the driving shaft, and the spur gear (H) is constantly in mesh with the reverse idler pinion. Thus, *with the exception of the*

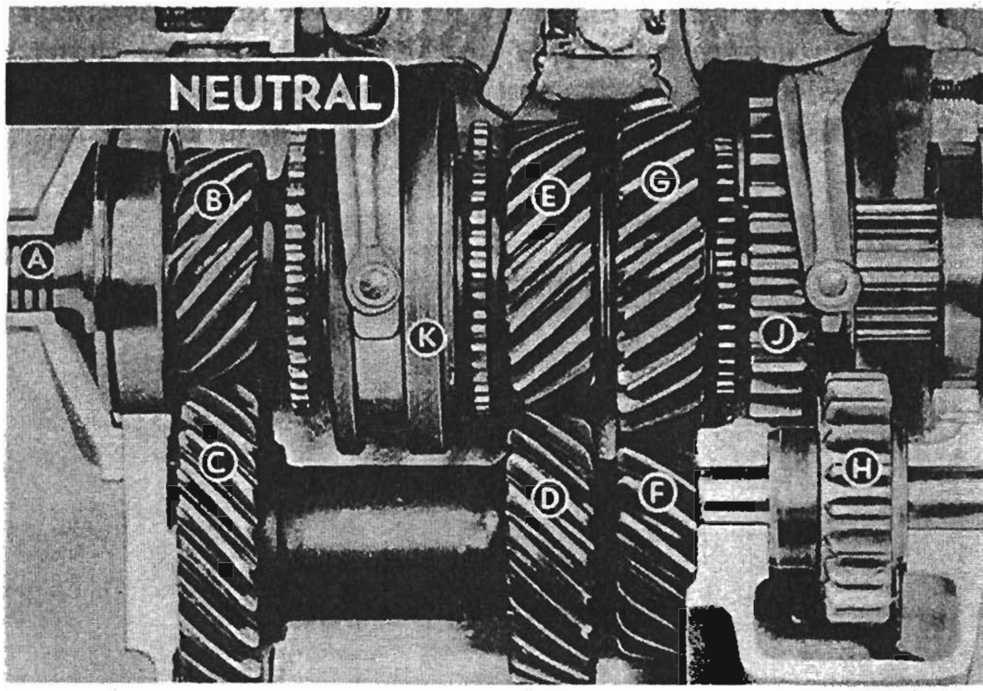


Fig. 40—The Transmission in Neutral.

first speed clutch and reverse gear, and the second and direct speed clutch gear (K), all the gears in the transmission are in mesh and are rotating. That is the reason this transmission is called a "constant mesh transmission."

As long as the direct and second and first and reverse clutch gears are not engaged, the transmission is in neutral and no power can be transferred through the driving shaft and flange to the propeller shaft.

2. First Gear

The thrust imparted to the first and reverse shifter lever by the transmission rod when "first gear" (low speed) is selected, rotates the first and reverse shifter fork shaft along with its shifter fork. The fork shoes push forward on the grooves in the first and reverse clutch gear moving it forward along the splined driving shaft until this gear fully engages with the splined flange of the first speed gear. See figure 41.

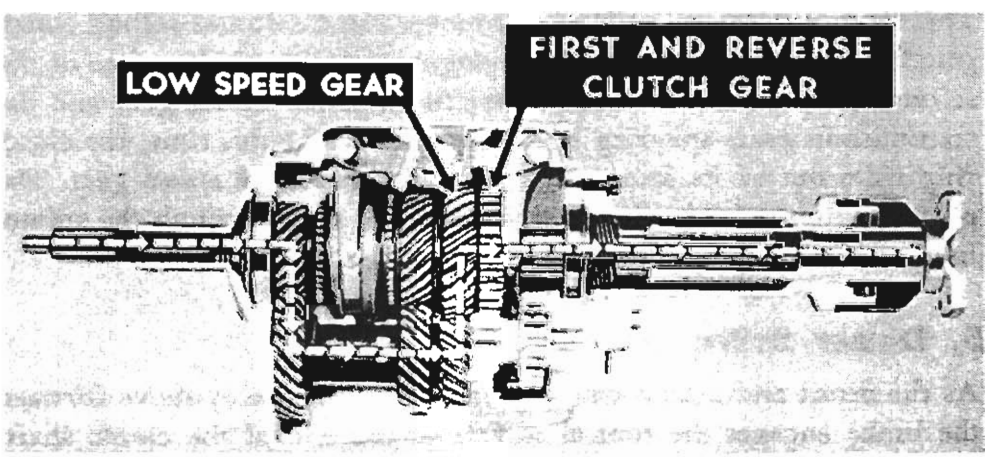


Fig. 41—The Transmission in First Gear.

The first speed gear is constantly turning over since it is always in mesh with the last helical gear on the countershaft gear cluster so, when it is engaged with the first and reverse clutch gear, it transfers the resulting torque through its splined hub to the driving shaft.

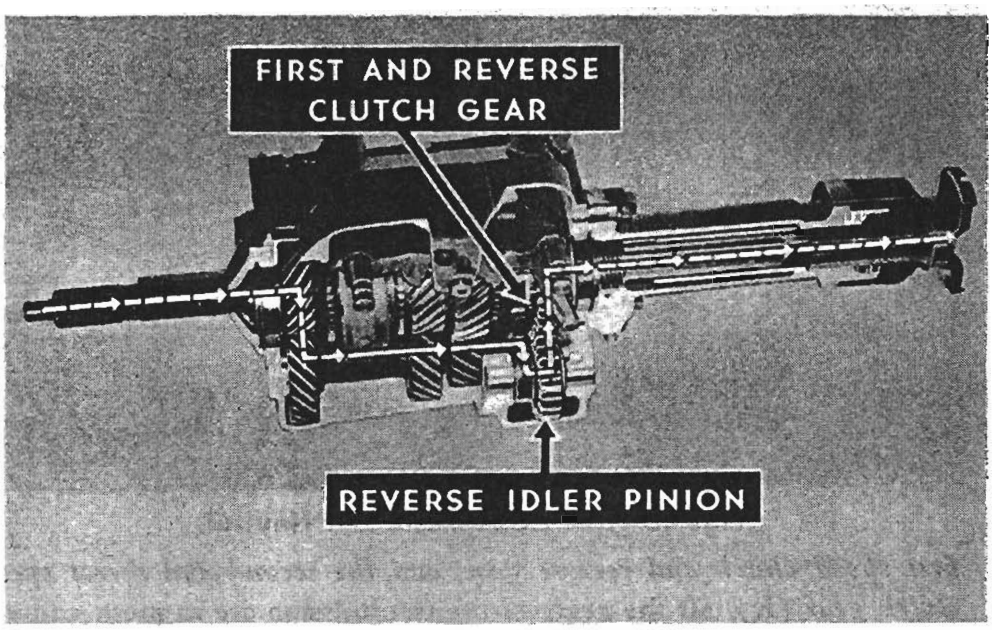


Fig. 42—The Transmission in Reverse Gear.

3. Reverse Gear

The first and reverse shifter fork is moved by the action of the gear-shift linkage in the direction opposite that for first gear. This action pushes the first and reverse clutch gear rearward along the driving shaft to engage with the reverse idler pinion. The pinion is in constant mesh with the spur on the countershaft gear cluster so, when the clutch gear engages the pinion, it completes the train and rotates the driving shaft in the direction opposite that of the forward speeds. See figure 42.

4. Second Gear

The direct and second shifter fork moves the direct and second clutch gear and ring rearward, the brake engaging the conical surface of the second speed gear. The resulting friction sets the clutch gear and the transmission gears spinning at the same speed. At this time, the clutch ring rides out of its detents and engages the second speed gear. The resulting torque is transferred to the driving shaft through the splines in the hub of the clutch gear. See figure 43.

5. Direct Drive

As the direct and second clutch gear and ring assembly move forward the brake engages the conical surface at the end of the clutch shaft. This synchronizes the speed of the transmission with that of the

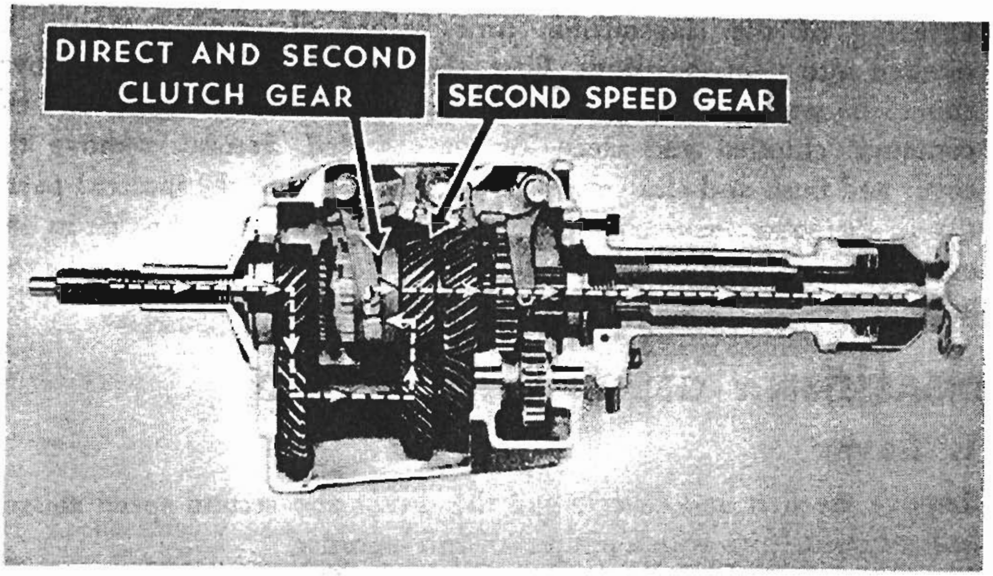


Fig. 43—The Transmission in Second Gear.

clutch shaft and allows the ring to ride out of its detents and engage the direct drive gear. Thus the same torque and r.p.m. of the clutch is transferred to the driving shaft. See figure 44.

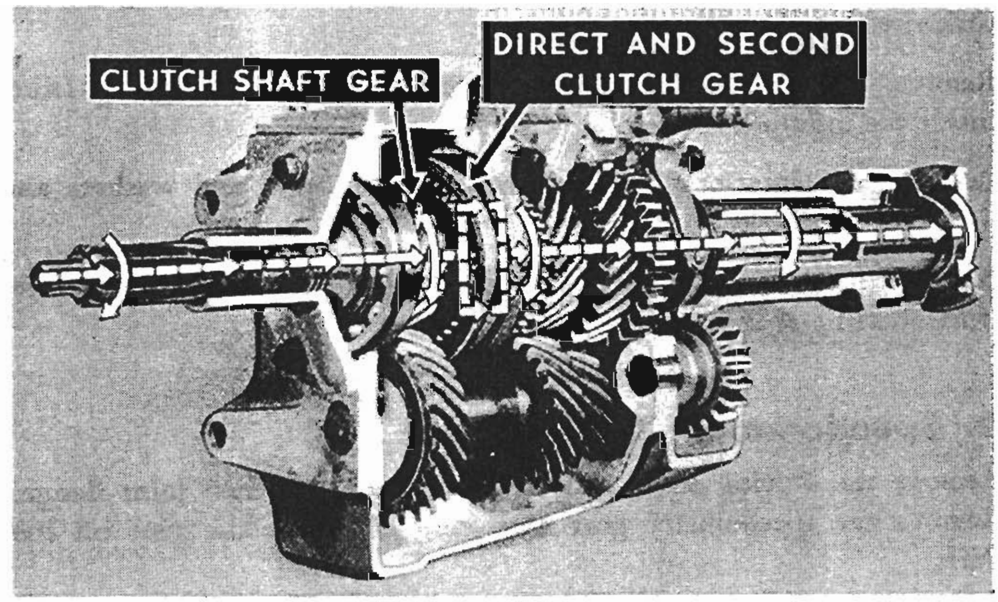


Fig. 44—The Transmission in Direct Drive.

TRANSMISSION SERVICING PROCEDURES

The surest way to obtain consistently good results when overhauling major units of the car is to adopt a uniform procedure to be used every time a like unit is reconditioned.

When a uniform procedure is followed, the customer benefits by having a thorough job done. The dealer and mechanic benefit in the time saved by doing the job systematically.

The following procedure for overhauling the transmission will, if followed, result in increased customer satisfaction and less corrective labor in the shop.

Cleaning of the transmission unit before disassembly should be divided into two operations. First, the outside of the case and cover should be washed with kerosene to remove all dirt and grit, and the container emptied and clean kerosene added. Second, remove the cover and flush and clean the inside of the case and the internal parts. (With the cover removed, cleaning both the inside and outside in one operation may result in dirt and grit getting into the transmission bearings.)

DISASSEMBLY OF THE TRANSMISSION

1. Cover

Remove the first and reverse and the direct and second speed shifter fork retaining pins with a pin punch and hammer.

Pull each shifter lever and shifter fork shaft from the cover with care to prevent losing the detent or interlock balls when the forks are free to drop out of the cover.

Remove the shifter lever lock screws and tap the levers off the shifter fork shafts.

Remove the interlock ball spacer and the detent ball spring from inside the interlock bracket.

Remove the interlock bracket retaining bolt, nut, and washers and lift out the bracket.

Extract the shifter fork shaft seals and seal retainers from the shifter fork shaft holes in the cover.

2. Speedometer Driving Gear

Remove the driving shaft rear cover and the universal joint flange. Remove the speedometer gear snap ring and slide the gear off the shaft.

NOTE

On models which have an intermediate driveshaft bearing assembly, loosen and remove the universal joint flange retaining nut and washer, using Socket J-2571A, and pull off the flange, using Puller J-2576.

3. Countershaft—Clutch Shaft—Driving Shaft Front Bearing

Drive the countershaft out of the case from the rear using Countershaft Assembly Bar J-2559 and a soft hammer. See figure 45. This will allow the gear cluster to drop to the bottom of the case when the ends of the tool are flush with the ends of the gear cluster assembly.

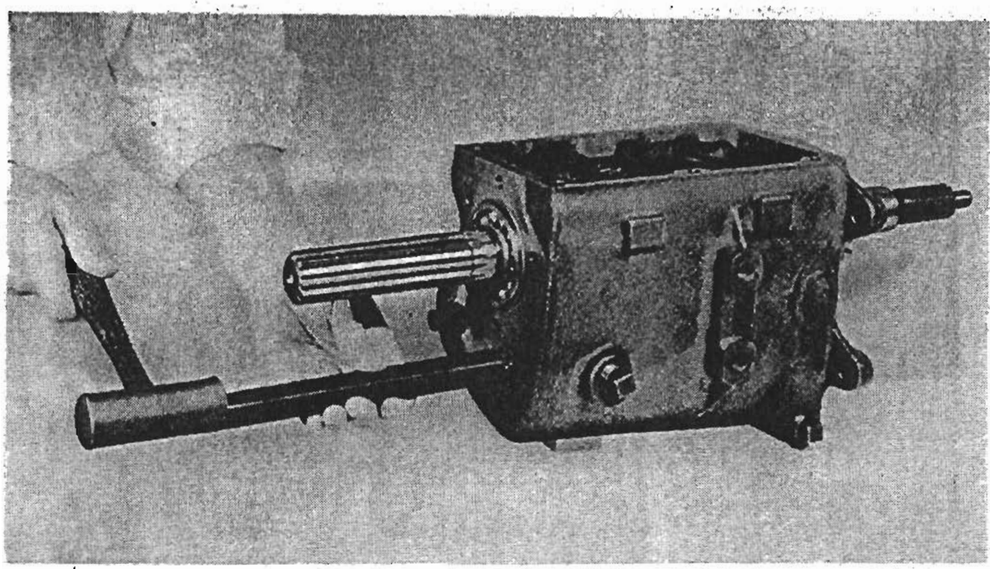


Fig. 45—Drive the Countershaft Out of the Case from the Rear.

Remove the clutch shaft rear bearing cover and pull out the clutch shaft and rear bearing.

NOTE

> The clutch shaft *cannot* be removed until the countershaft has been removed and the gear cluster lowered to the bottom of the case.

Lift the driving shaft front roller bearing from inside the gear end of the clutch shaft or from the front end of the driving shaft. Remove the spacer from the front end of the driving shaft.

Remove the clutch shaft rear bearing snap ring from the clutch shaft using Snap Ring Pliers KMO-410. Place the assembly in an arbor press and press the shaft out of the rear bearing and retaining ring assembly.

4. Driving Shaft Rear Bearing—Driving Shaft—Gear Cluster

Remove the driving shaft rear bearing snap ring.

Extend one hand through the opening in the top of the case to support the driving shaft gear and bearing assembly. With the other hand tap the rear end of the driving shaft with a soft hammer (figure 46) until the driving shaft rear bearing is free and can be removed.

Tilt the front end of the driving shaft upward and lift the shaft and gear assembly out of the case.

Remove the countershaft gear cluster, end plates, and thrust washers from the bottom of the case.

Remove the assembly bar, both sets of bearing rollers, the two bearing rings, and the long bearing spacer from inside the gear cluster.

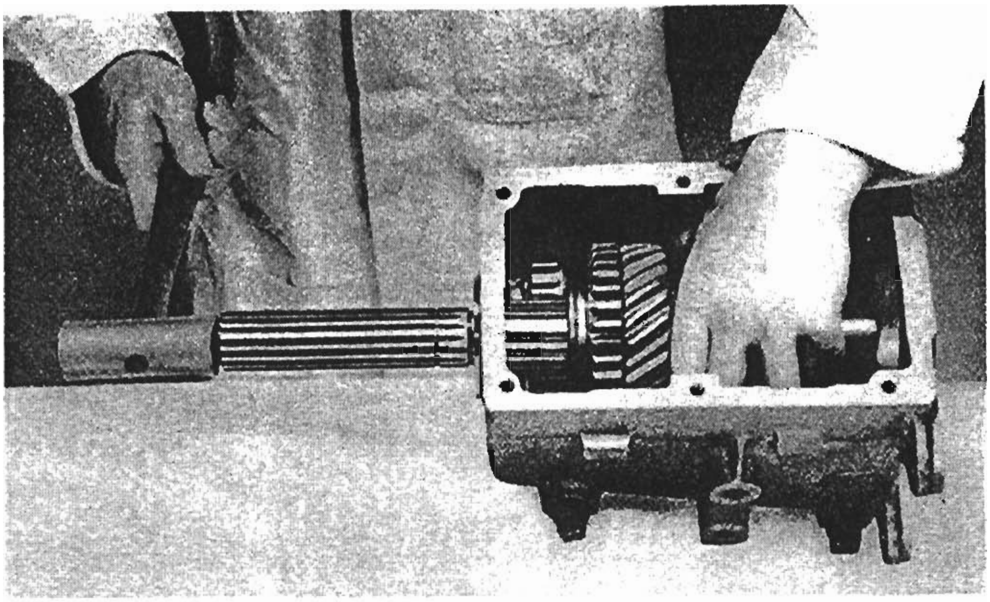


Fig. 46—Tap the Rear End of the Driving Shaft with a Soft Hammer.

5. First and Reverse, Second and Direct Speed Clutch Gears—Synchronizer Brake

Slide the low speed sliding gear off the driving shaft and, from the opposite end of the shaft, remove the synchronizer assembly.

Separate the second and direct speed clutch ring from the synchronizer brake and clutch gear assembly, pressing them apart by hand.

NOTE

When separating these parts, care should be taken to avoid the loss of any of the detent springs or plungers.

Remove the three brake retainer springs and separate the brake and housing assemblies.

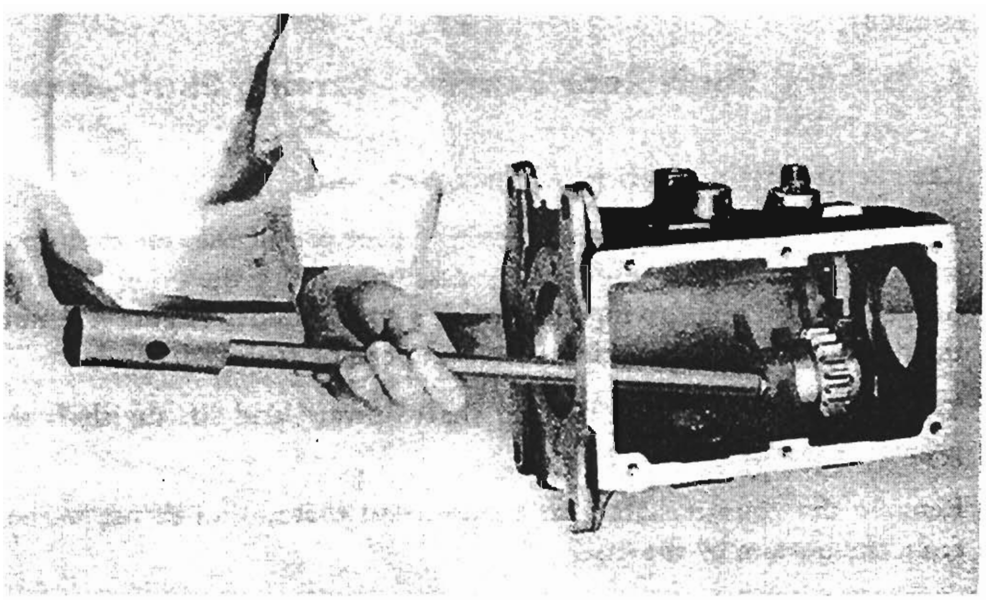


Fig. 47—Drive the Shaft Out of the Case from the Front.

6. Reversing Pinion—Countershaft Thrust Spring Plugs

Remove the reversing pinion shaft retaining cap screw and washers.

Drive the shaft out of the case from the front using a long drift through the large bearing opening in the front end of the case, as shown in figure 47, and lift out the pinion.

Remove the two countershaft thrust springs from the inside of the case and, using a small punch, drive out the thrust spring plugs.

INSPECTION OF THE TRANSMISSION

1. Cover

Inspect the shifter fork shaft holes for wear. If the wear is excessive, it will be necessary to replace the complete cover assembly since the cover alone cannot be replaced.

Check all other parts for wear or defects and replace if necessary.

2. Gears and Shafts

Examine all gears for chipped or scored teth.

3. Bearings

Inspect all bearings for scores, flat spots, or looseness caused by wear.

NOTE

> To check open type or roller bearings, first wash them clean in clean kerosene, then blow dry with compressed air and, while drying, hold the races firmly to prevent spinning and possible scoring. After the bearings have been cleaned and dried, apply a very light oil until all parts are thoroughly coated, and then check the bearing for roughness or flat spots.

ASSEMBLY OF THE TRANSMISSION

1. Cover

Place new shifter fork shaft seals and the seal retainers into the shaft openings in the cover and start the shafts into the openings.

Position the direct drive and second speed shifter fork (the fork with the wide shoes attached) in the forward end of the cover with the hole in the fork in line with the shaft. Push the shaft into place.

Rotate the shaft until the retaining pin holes in the shaft and the fork are in register and drive new retaining pins into the holes.

Install the first and reverse shifter fork in the rear end of the cover following the same procedure as outlined for the direct drive and second speed fork.

Place the interlock ball spacer and the detent ball spring in the interlock bracket. When the bracket is in its normal position the interlock spacer should be toward the center of the cover and the detent ball spring toward the outer edge of the cover.

Place the cover on the bench, top side down, and position the forks so that the center or neutral position grooves of the forks are opposite each other.

While holding the interlock and detent balls in the interlock bracket with one hand, pull the shoe ends of the forks toward each other with the other hand until the balls rest in the center grooves. See figure 48. Continue to pull the forks toward each other, and, at the same time, push the bracket down into position.

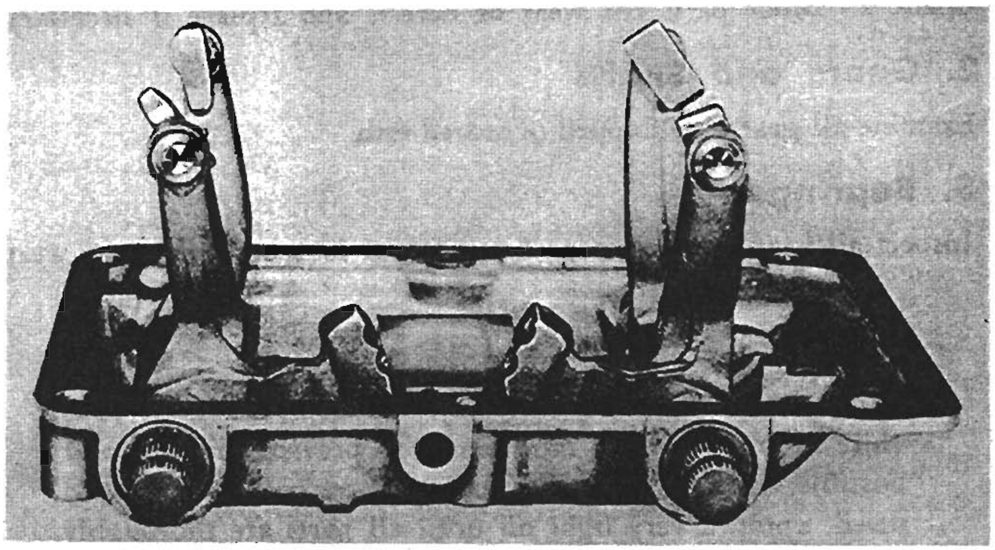


Fig. 48—Correct Position of Detent Balls in Interlock Bracket.

Install the bracket retaining screw, plain washers, nut, and cotter pin placing the smaller washer under the head of the screw and the larger washer under the nut.

Move the direct and second speed shifter fork to the second speed position, then, to the direct speed position checking the clearance between the stops on the fork and the stop pads in the cover. When the ball is properly seated in the detent, in each position, the clearance at the stop should not be less than .002 inch. If the clearance is less than .002 inch, additional clearance may be obtained by filing or scraping the stop pads in the cover.

Install the curved direct and second speed shifter lever on the forward shaft in the cover and the straight first and reverse lever on the rear shaft.

NOTE

> Since the serrations in the lever match those on the shaft, it is possible to install the lever in four different positions. Install them so that they point downward when the cover is in its normal position.

Lock the levers in position with the lock screws.

2. Reversing Pinion

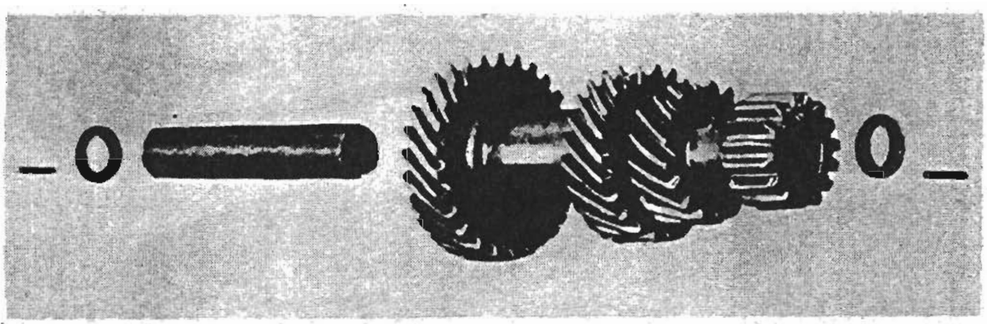
Place the reversing pinion in the case. Position the pinion shaft so that the Woodruff key is in alignment with the recess in the case, then tap the shaft into the case far enough to start the pinion on the shaft.

Install the pinion and drive the shaft into the case until the Woodruff key is seated in the recess. Secure with the plain washer, lockwasher, and cap screw.

3. Gear Cluster

Place the countershaft Assembly Bar J-2559 in the gear cluster and slide the long bearing spacer over the bar to the approximate center of the gear cluster.

Install one bearing ring and 25 bearing rollers in each end of the gear cluster using a heavy grease to hold the rollers in place. See figure 49.



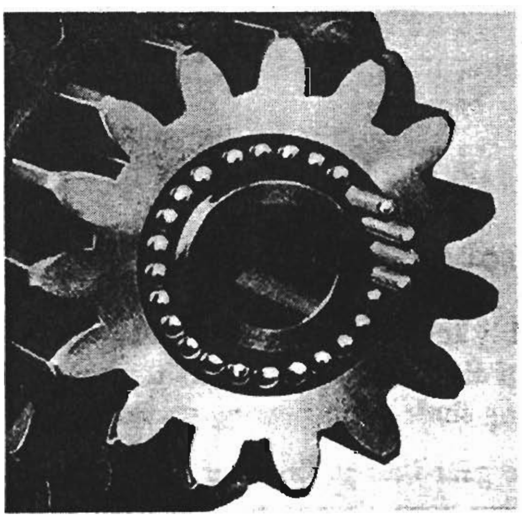


Fig. 49—Bearing Rollers Installed Between Cluster and Countershaft.

Add an end plate and then a thrust washer coated with heavy grease to each end of the cluster. Position the thrust washers so the lips of the washers are up and point away from the gear cluster.

Place the entire assembly in the bottom of the case but do not install the countershaft at this time.

4. Synchronizer Brake—Driving Shaft

Place a synchronizer brake and housing assembly into each end of the direct drive and second speed clutch gear and add the three retainer springs.

Set the assembly on the bench with the extended hub end up and a block under the opposite end, then install the synchronizer brake springs and plunger. Hold them in place with Clutch Gear Clamp J-2563.

With the wide shoulder of the external groove facing downward or toward the bench (figure 50), line up the clutch ring with the clutch gear and press into place.

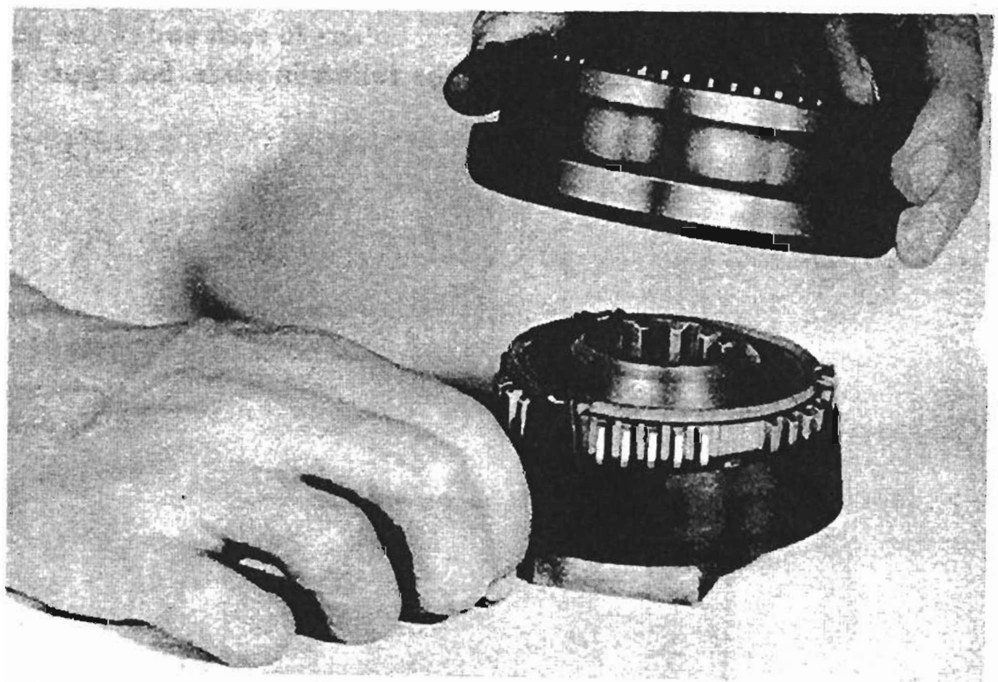


Fig. 50—Assembling the Clutch Gear and Ring.

Slide the assembly into position on the main driving shaft so that the wide shoulder of the external groove is toward the second speed gear. Install the driving shaft front bearing spacer.

Slide the reverse gear into position on the opposite end of the driving shaft with shifting fork groove toward the rear of the case or away from the first speed gear.

5. Clutch Shaft—Driving Shaft Front Bearing

Position the clutch shaft rear bearing and retaining ring assembly on the clutch shaft and install the snap ring.

Place the driving shaft front bearing into the gear end of the clutch shaft and slide the bearing spacer to the front end of the driving shaft.

Place the driving shaft assembly in the case with the long end of the shaft extending through the rear bearing opening.

Slide the driving shaft rear bearing and retaining ring assembly onto the rear end of the driving shaft and, while supporting the front end of the shaft, tap the bearing into place in the case.

Install the clutch shaft assembly while supporting and guiding the front end of the driving shaft into the bearing in the clutch shaft.

Install the clutch shaft rear bearing cover with a new gasket, keeping the drain passage in the cover in line with the drain hole in the case. Add cover retaining cap screws and gaskets.

Install the rear bearing plain washer and the rear bearing snap ring.

Install the speedometer driving gear Woodruff key, gear, and snap ring.

NOTE

The driving shaft rear bearing and the speedometer gear snap rings are available in various thicknesses and should be selected to eliminate end play of the bearing or gear.

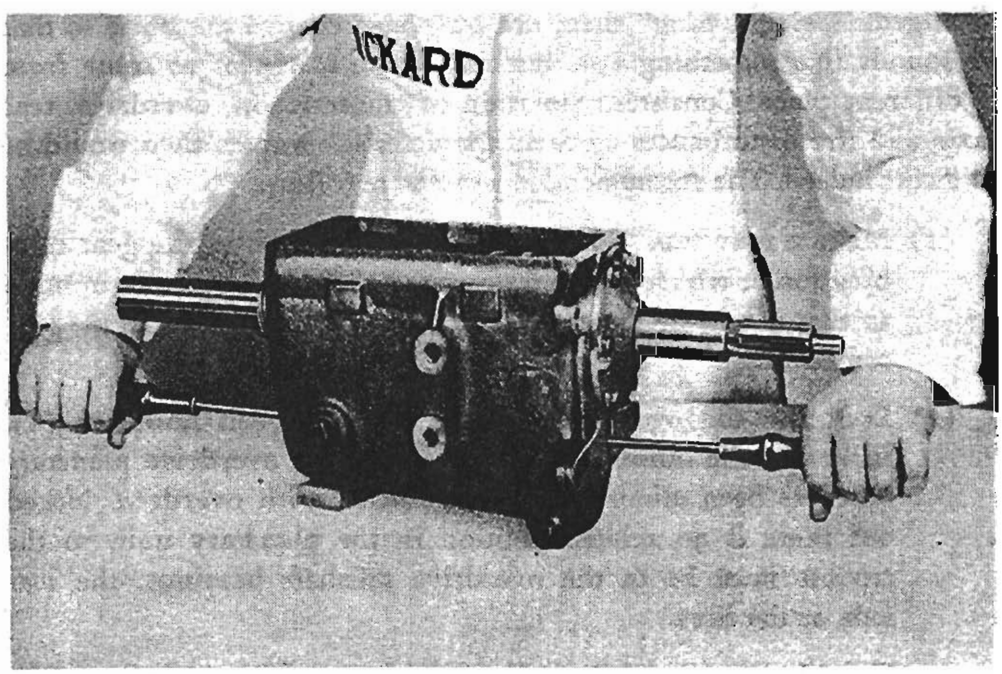


Fig. 51—Raise the Gear Cluster into Position as Shown.

6. Countershaft

Raise the gear cluster into position by inserting drifts or screw drivers through the holes in the case and into each end of the aligning bar. See figure 51.

NOTE

> When raising the gear cluster, it may be necessary to turn the thrust washers to either side to line up the lips of the washers with the machined grooves in the case.

Support the aligning bar in this position with the drift or screw driver through the hole in the rear of the case.

Start the countershaft through the hole in the front of the case so that the Woodruff key aligns with the recess in the case.

Drive the countershaft into the case while holding and guiding the aligning bar out through the hole in the rear of the case.

Place the two countershaft thrust springs into the openings in the case and install the thrust spring plugs.

Install the driving shaft rear bearing cover with a new gasket, then secure the cover with cap screws and lockwashers.

TRANSMISSION NOISE DIAGNOSIS

Gear, bearing and tire noises may "telegraph" through the steel body structure to make themselves audible at locations far removed from the actual point of origin. A sympathetic vibration may even be set up in another part so that the audible pitch of the disturbance is changed. "Telegraphing" then, not only may change the noise so that it sounds like something else, but may make it appear to come from a different place. Consistent isolation of transmission, overdrive, rear axle and tire disturbances by their characteristic sounds then would be difficult indeed. The recommended procedure follows.

(1) Make a road test. Note the speed of the car and the gear combination at which the hum occurs. Fix the sound firmly in mind so that it will be recognized if it recurs during a different gear combination.

(2) Lock out the overdrive and, at the car speed noted in (1), listen for the noise. If it is still there, the overdrive planetary unit has been eliminated as the cause. With overdrive locked out there is no relative motion in the planetary unit, so the trouble must be in the overdrive tailshaft bearings, the rear axle or the tires.

Should the noise fail to occur with overdrive locked out the planetary unit is the offender.

(3) Lock in the overdrive. In overdrive second gear (or in conventional second gear if car speed is not too high), check to see if the noise is still there. If it is, you have now eliminated the transmission as the source. If the disturbance had been the fault of the transmission, it would have occurred at a lower car speed, or would have disappeared, since the gear combination at which the noise originally occurred was not then in use.

If the noise does not occur under these conditions, you have eliminated as offenders the rear axle and tires, and have pinned the trouble down to the transmission, or to the overdrive tail-shaft bearings.

(4) Next, run the car at the speed at which the disturbance occurs and swerve it a little from side to side. If the noise level changes or stops altogether when the thrust is on one side or the other, the offending unit is the side gear or bearing in the differential.

If the noise still remains constant, the trouble may be either the differential ring gear and pinion, pinion shaft bearings, or the tires.

(5) Run the car on a smooth asphalt or blacktop surface, then on a rougher surface—say a brick pavement. If the noise disappears on one or the other, it is, of course, tire noise that caused the trouble. If the noise is still there regardless of the type of road surface under the car, look to the differential ring gear for the trouble.

(See Transmission Noise Diagnosis Chart on page 89.)

THE TRANSMISSION OVERDRIVE

GENERAL DESCRIPTION

Two overdrive installations (designated R-11 and R-9) are currently in service on Packard cars. Late 22nd Series and 23rd Series vehicles incorporate the R-11 unit as optional equipment, while earlier models carry the R-9 installation.

The Packard R-11 Overdrive consists primarily of a planetary gear system and an overrunning clutch. These two assemblies combine to transmit either of two speeds to the propeller shaft, selection of either speed being made semi-automatically by a combination of electrical controls. The overdrive is made up of the following assemblies:

1. *The planetary unit,* which provides a means of increasing the speed of the tail shaft over that of the transmission driving unit.
2. *The overrunning clutch* which provides the two-speed driving connection to drive the tail shaft at engine speed or at increased speed as desired.

3. *The electrical controls* which control the engagement and disengagement of the overdrive.

4. *The engaging mechanism* which, when actuated by the electrical controls, mechanically selects engine speed or increased speed as desired.

1. The Planetary Unit

This unit (figure 52) composed of the following parts:

A. The stationary gear and hub.

B. The pinion and cage assembly.

C. The ring gear.

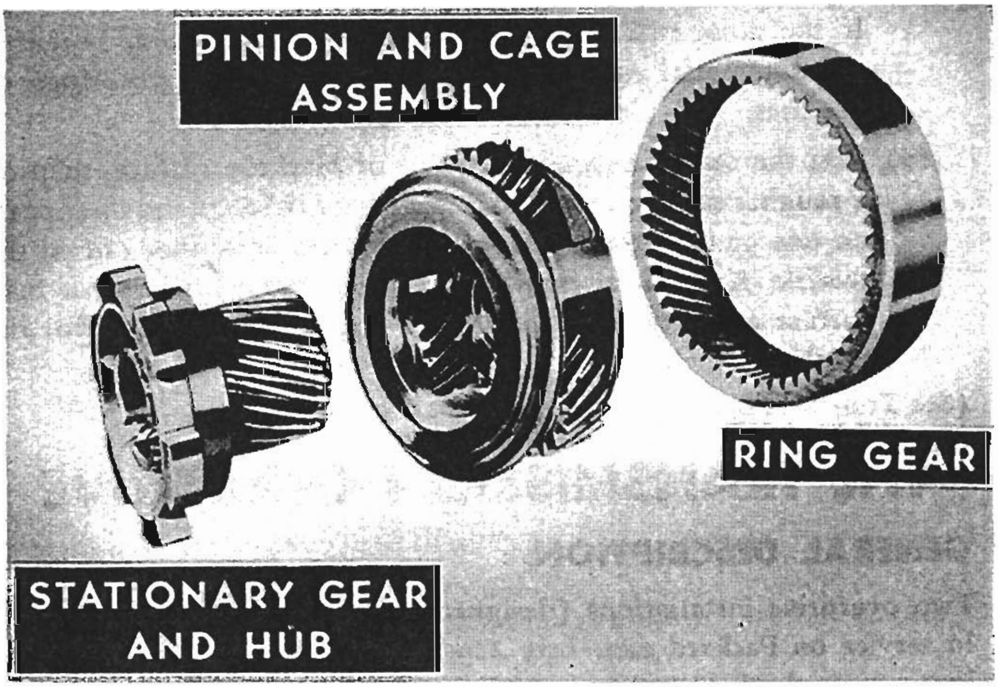


Fig. 52—The Overdrive Planetary Unit.

2. The Overrunning Clutch

This assembly (figure 53) is made up of the following parts:

A. A cam with 12 ramps, which is splined to the transmission shaft.

B. 12 rollers which operate on ramps.

C. A cage—its function is to hold the rollers in place on the cam.

D. A race, formed by the inner bore of the tail shaft.

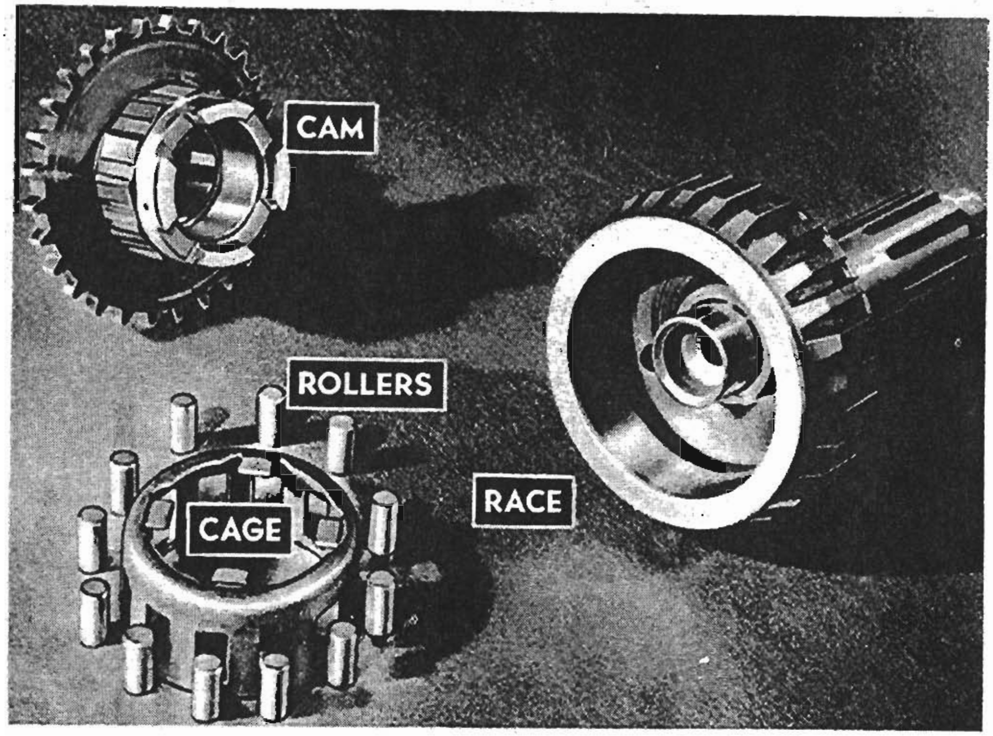


Fig. 53—The Overdrive Overrunning Clutch.

3. The Electrical Controls

The following electrical units (figure 54) control the engagement and disengagement of the overdrive:

A. The Governor. This is the same unit used to control the Electromatic Clutch. (Refer to "Electromatic Clutch, 5. Governor Switch." this manual.)

B. The Kickdown Switch (figure 55). This unit is located on the forward side of the dash panel, is operated by the accelerator bell crank. Its function is to disengage the overdrive when direct drive is desired at above governed speeds.

C. The Lockout Switch. Located on the lockout control it is actuated by this member and locks in and locks out the overdrive as selected manually.

D. The Overdrive Relay. This unit is secured to the front side of the dash panel, contains an actuating relay and a ground out relay.

The actuating relay incorporates two sets of contacts, the lower set making and breaking for the overdrive solenoid, the upper contacts being connected in series with other contacts to complete the ignition ground-out circuit.

The ground out relay contains one set of contacts only and these are used in series with other contacts to complete the ignition ground-out circuit.

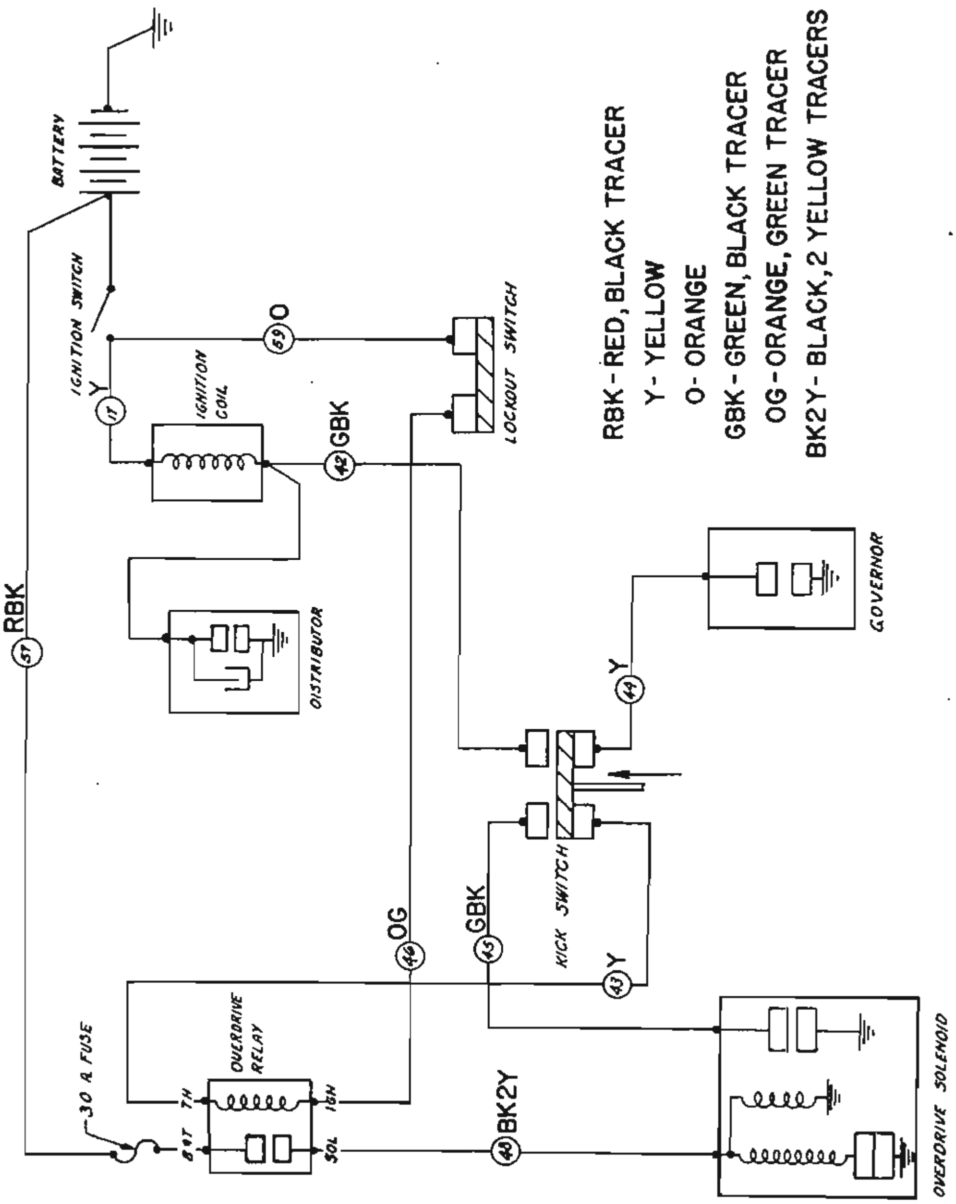


Fig. 54—R-11 Overdrive Wiring Diagram.

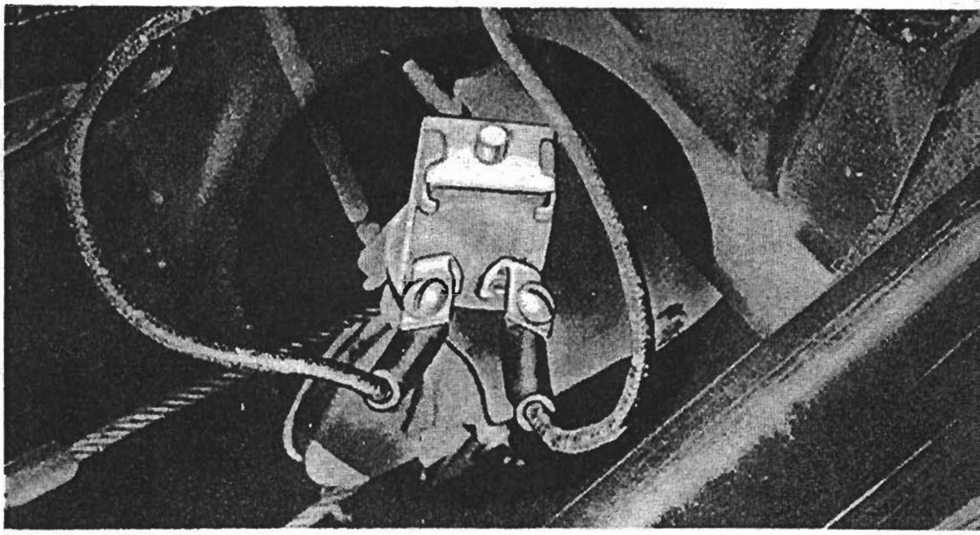


Fig. 55—Overdrive Kickdown Switch.

E. The Solenoid (figure 56). This solenoid contains two windings, a heavily wound "pull-in" coil, and a "hold-in" coil which is more lightly wound. The "pull-in" coil is grounded through the "pull-in" circuit contacts, and is energized only when the solenoid is moving the pawl into the stationary gear plate. It assists the "hold-in" coil while the solenoid is engaging.

The "hold-in" coil is grounded to the solenoid case, and its function is to hold the pawl engaged in the stationary gear plate. The hold-in coil remains energized until it is desired to go back into direct drive.

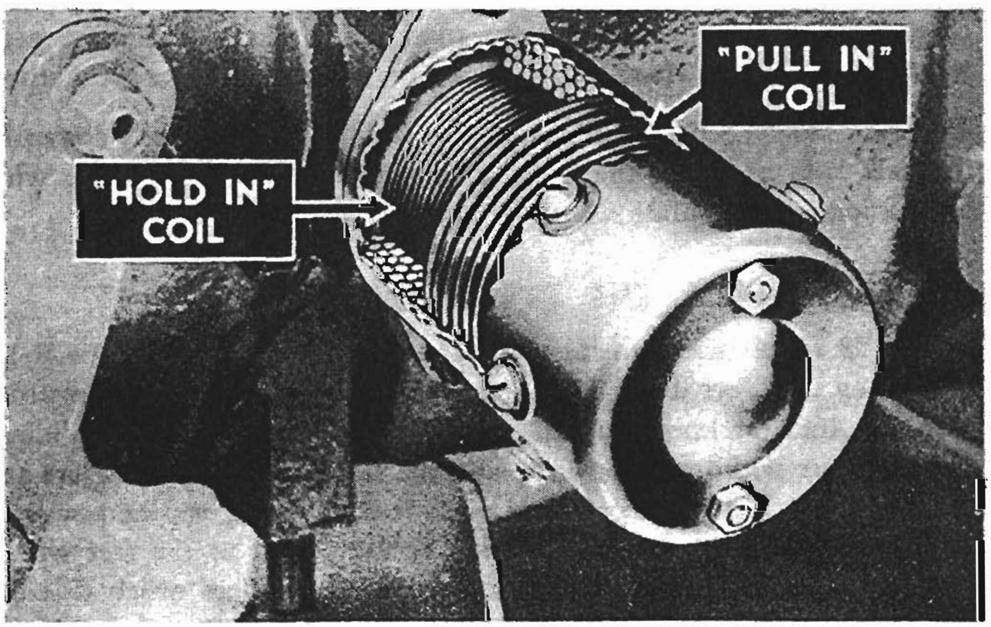


Fig. 56—Overdrive Solenoid.

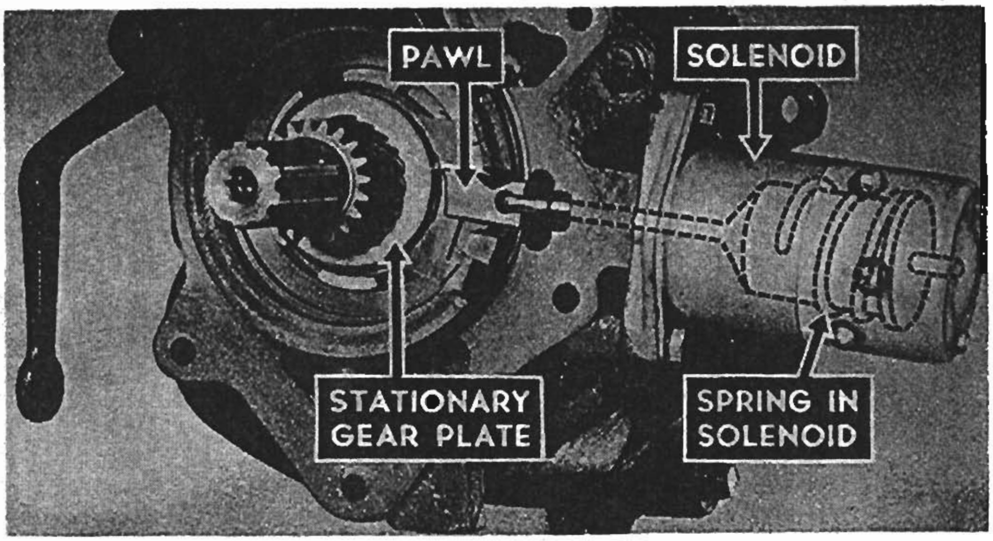


Fig. 57—Overdrive Engaging Mechanism.

4. Engaging Mechanism

The engaging mechanism (figure 57) consists of the following parts: the sliding pawl, the stationary gear plate and the balk ring.

The pawl engages the notches in the stationary gear plate during the time the solenoid is energized after its release by the balk ring and disengages with this member when the solenoid is de-energized.

The stationary gear plate carries notches in its circumference, one of which must be engaged by the sliding pawl after it leaves the step of the balk ring. Internal teeth which match the teeth of the helical stationary gear are cut in the hub of the stationary gear plate. The result is a splined fit between the plate hub and the stationary gear which causes them always to turn or to remain stationary together.

The balk ring fits over the hub of the stationary gear plate, a step in the balk ring receiving the locking pawl prior to its engagement with the stationary gear plate when the accelerator pedal is released.

OPERATION OF THE R-11 OVERDRIVE

Figure 58 shows the transmission of engine power through the R-11 unit when in direct drive with overdrive available or, in other words, with the lockout knob pushed in. It will be noted that the sliding pawl is in its withdrawn position and the stationary gear and plate are free to rotate. With the gear and plate free to rotate, engine power is transmitted through the transmission driving shaft to the free wheel cam which is splined to the driving shaft. The rollers which ride on the ramps of the cam act as wedges between the cam and the inner race of the main shaft and both the transmission driving shaft and the main shaft rotate at the same speed.

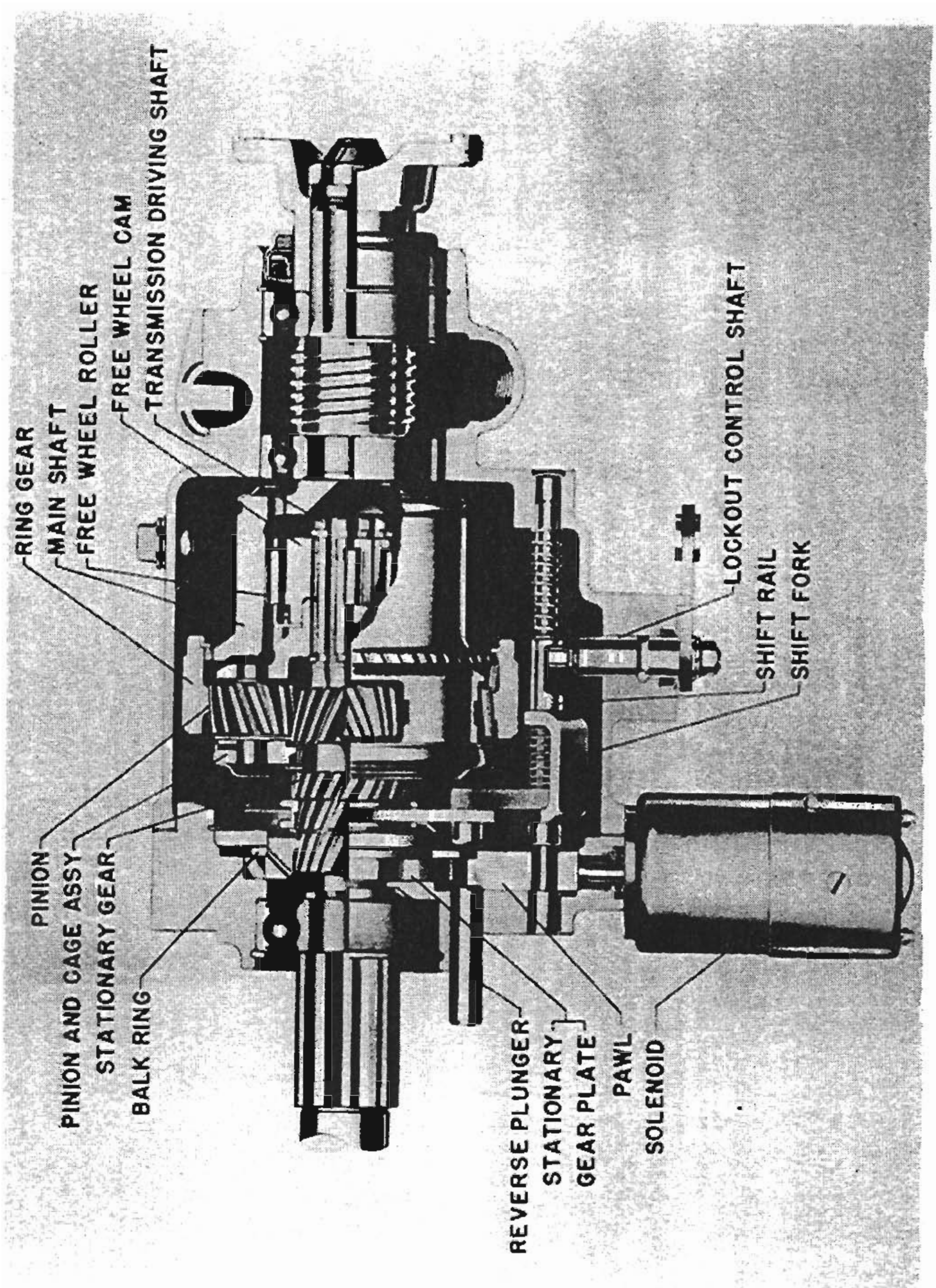


Fig. 58—Overdrive Available.

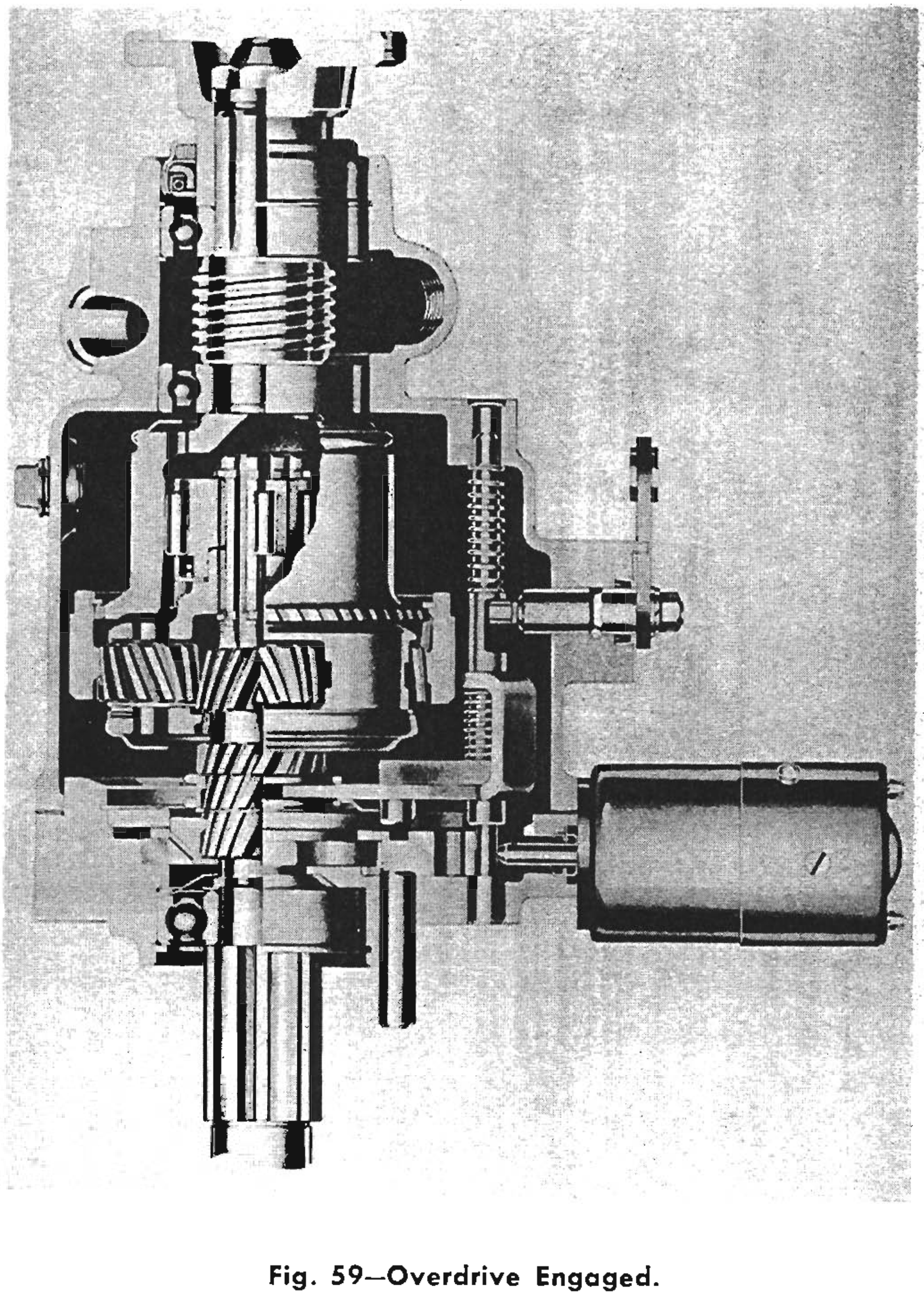


Fig. 59—Overdrive Engaged.

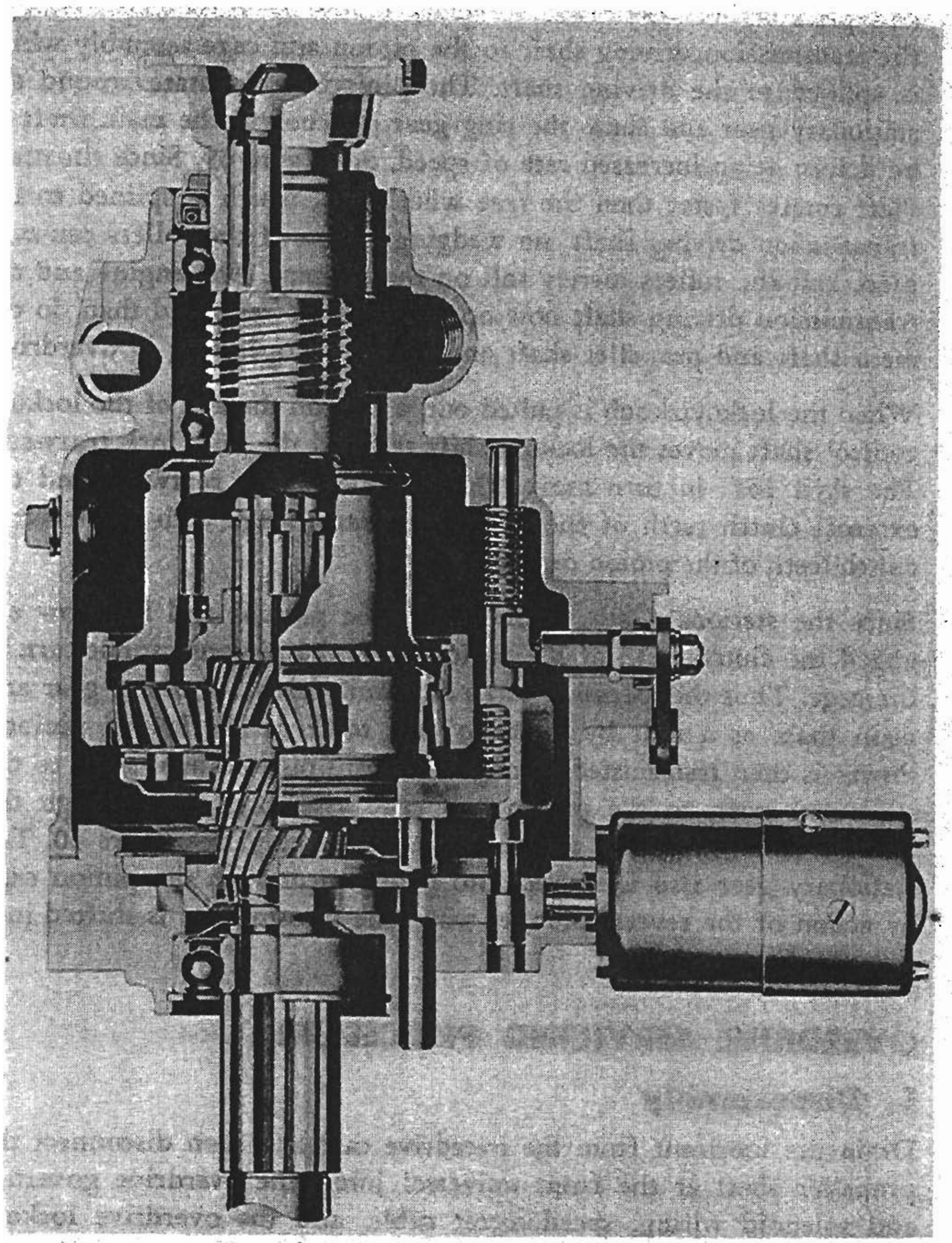


Fig. 60—Overdrive Locked Out.

When governed speed is reached, the solenoid becomes energized and will remain so until the car drops below governed speed or until the lockout knob is pulled out. At this time the sliding pawl is pushed inward onto its step on the balk ring.

To shift into overdrive, the accelerator pedal is released momentarily. This allows reverse torque to turn the balk ring and permits the pawl to enter a slot in the stationary gear plate. When the stationary gear and plate are not permitted to rotate, power is transmitted through the transmission driving shaft to the pinion and cage assembly which is splined to the driving shaft. The pinions now rotate around the stationary gear and cause the ring gear attached to the main shaft to be driven at an increased rate of speed. See figure 59. Since the main shaft rotates faster than the free wheel cam, which is splined to the transmission driving shaft, no wedging action of the rollers can take place and the rollers merely roll on their ramps. The engine and the transmission driving shaft now operate at a slower speed than do the main shaft and propeller shaft and the car is operating in overdrive.

When the lockout knob is pulled out, a cam on the end of the lockout control shaft moves the lockout shift rail and the shift fork rearward. The shift fork in turn moves the stationary gear rearward and the external clutch teeth of the stationary gear engage with the internal clutch teeth of the pinion cage assembly.

Since the stationary gear meshes with the pinions and has now engaged the clutch teeth of the pinion cage, the pinions cannot turn in the cage. Thus the assembly turns as a unit driving the ring gear and main shaft as a unit by means of the teeth of the locked pinions. Power is then transmitted through the transmission main shaft to the stationary gear, to the pinion and cage assembly, and through the pinions to the ring gear and main shaft assembly. See figure 60. The stationary gear also is moved into engagement with the pinion cage by action of the reverse plunger when the transmission is shifted into reverse gear.

OVERDRIVE SERVICING PROCEDURES

1. Disassembly

Drain the lubricant from the overdrive case and then disconnect the propeller shaft at the front universal joint, the overdrive governor and solenoid wiring, speedometer cable, and the overdrive lockout cable. Remove the governor using the Overdrive Governor Wrench J-3227.

Remove the solenoid retaining screws, rotate the solenoid to the right (clockwise) approximately 1/4 turn, and withdraw the solenoid from the adapter.

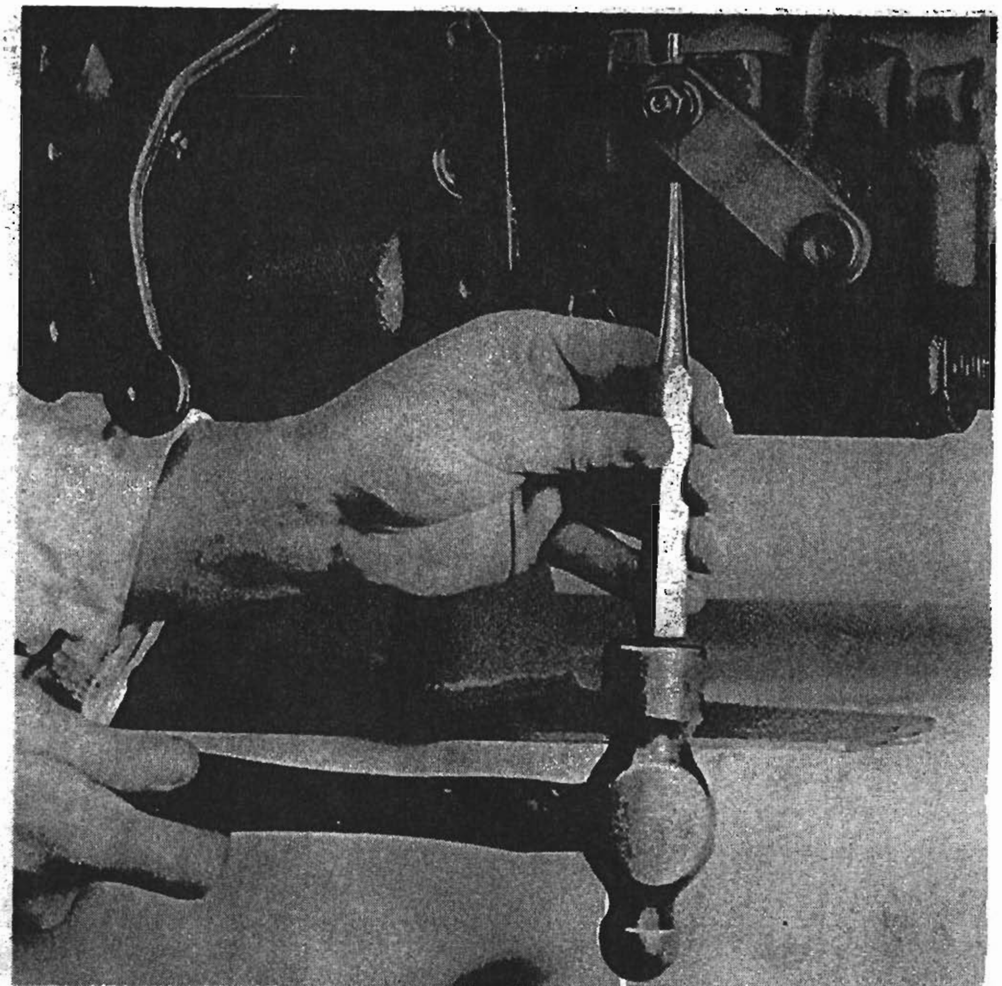


Fig. 61—Drive Out the Retaining Pin from the Bottom.

Drive out the lockout control shaft tapered retaining pin from the bottom as shown in figure 61. Work the lever and shaft outward as far as possible to disengage the cam on the end of the shaft from the shifter rail. See figure 62.

Fig. 62—To Engage the Cam, Work the Lever and Shaft Outward as Far as Possible.

Remove the overdrive case to adapter retaining screws and pull the case and main shaft to the rear and away from the adapter. Do not remove the two screws which hold the adapter to the transmission case. When the overdrive case is pulled rearward, the shift rail retractor spring may drop into the case. Some of the free wheel rollers also will drop into the case and some will remain in the cam and roller retainer assembly on the end of the transmission driving shaft. Be careful not to lose the retractor spring or any of the 12 rollers.

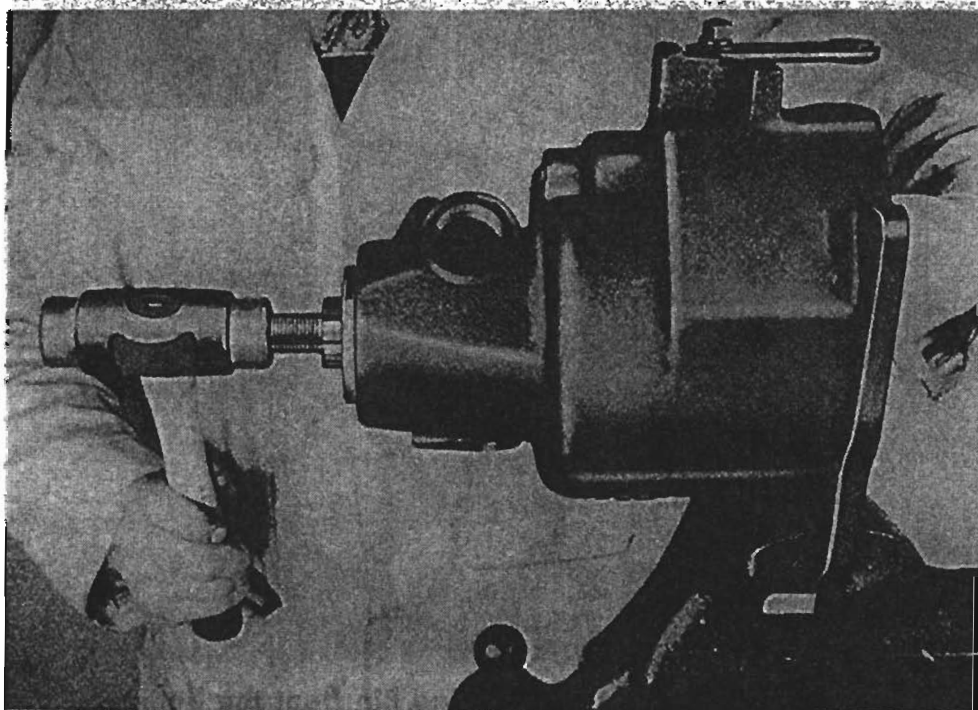


Fig. 63—Tap on the End of the Main Shaft with a Soft Hammer.

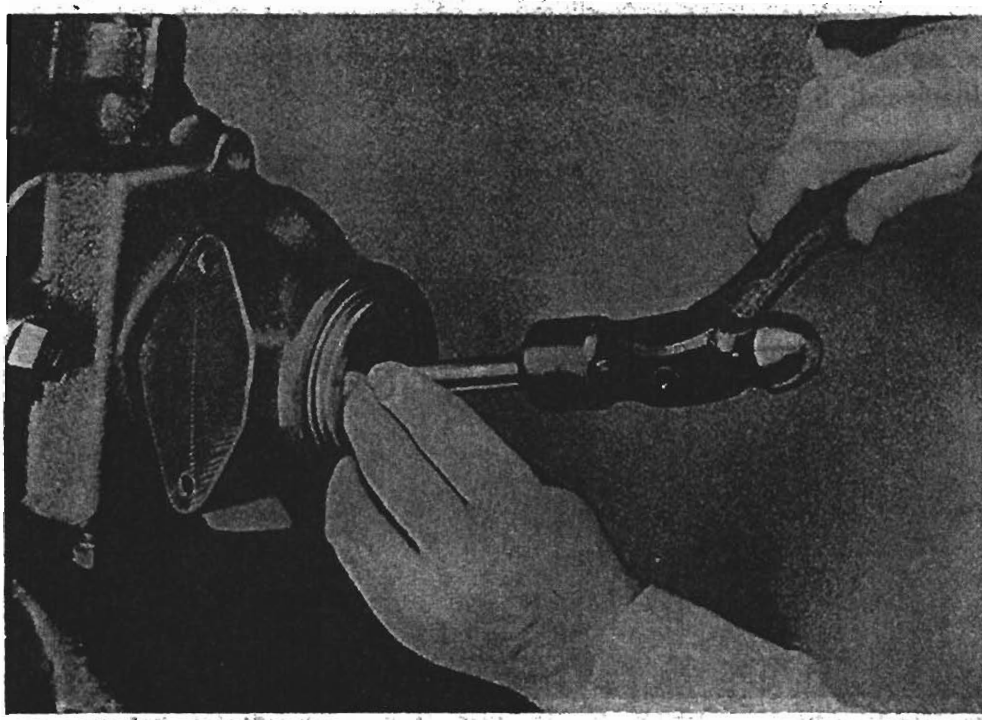


Fig. 64—Driving Out the Main Shaft Front Bearing.

Remove the universal joint flange retaining nut using the Flange Holding Tool J-2659 and the Flange Nut Socket Wrench J-2571A. Remove the flange using the Flange Puller J-2576.

Tap on the end of the main shaft with a soft hammer while pulling it out of the case. See figure 63.

Drive the main shaft front bearing out of the case using a brass drift inserted through the rear bearing and a small hammer as shown in figure 64. Lift the speedometer driving gear out of the case.

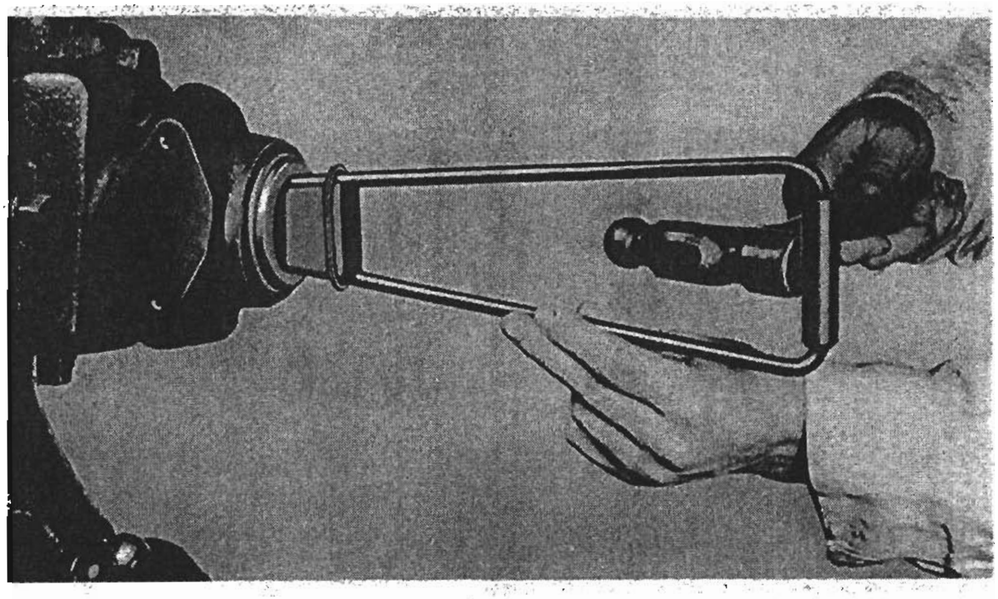


Fig. 65—Pull the Main Shaft Oil Seal.

Pull the main shaft oil seal. The Axle Shaft Oil Seal Remover J-943B may be used for this operation as shown in figure 65. It may be necessary to grind down the legs of the tool to engage the seal retainer. This seal seldom can be removed without mutilation and a new seal should be installed when the unit is assembled. Remove the rear bearing rear snap ring and tap the rear bearing out of the case.

Remove the lockout control lever retaining nut and the lever and work the lever shaft out from inside the case.

Remove the large snap ring from the ring gear, as shown in figure 66, and separate the ring gear from the main shaft.

Remove the free wheel cam retaining snap ring using the Snap Ring Pliers KMO-410 as shown in figure 67. Slide the roller retainer and cam assembly and the pinion and cage assembly off the transmission driving shaft.

Remove the pinion cage assembly retaining snap ring from the driving shaft and mark or tag the ring so that it may be distinguished from the free wheel cam retaining ring when the unit is assembled. Some-

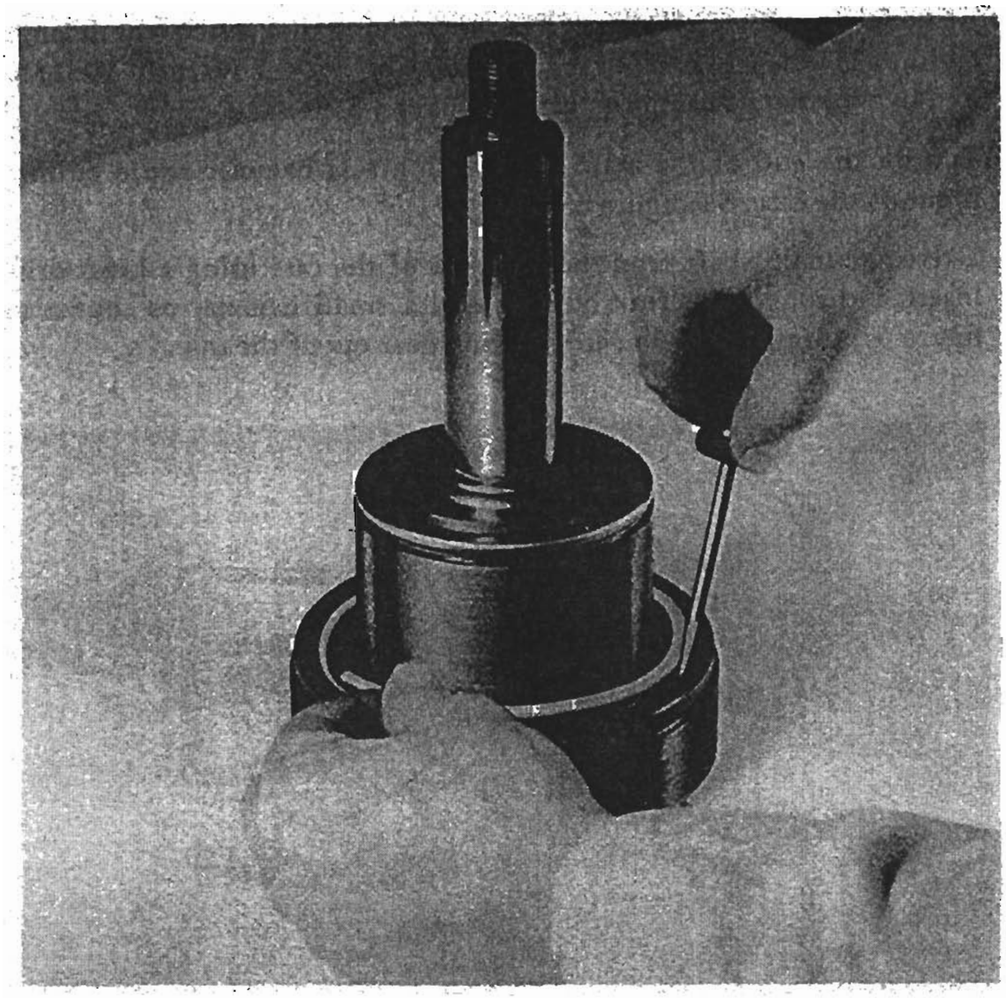


Fig. 66—Remove the Large Snap Ring from the Ring Gear.

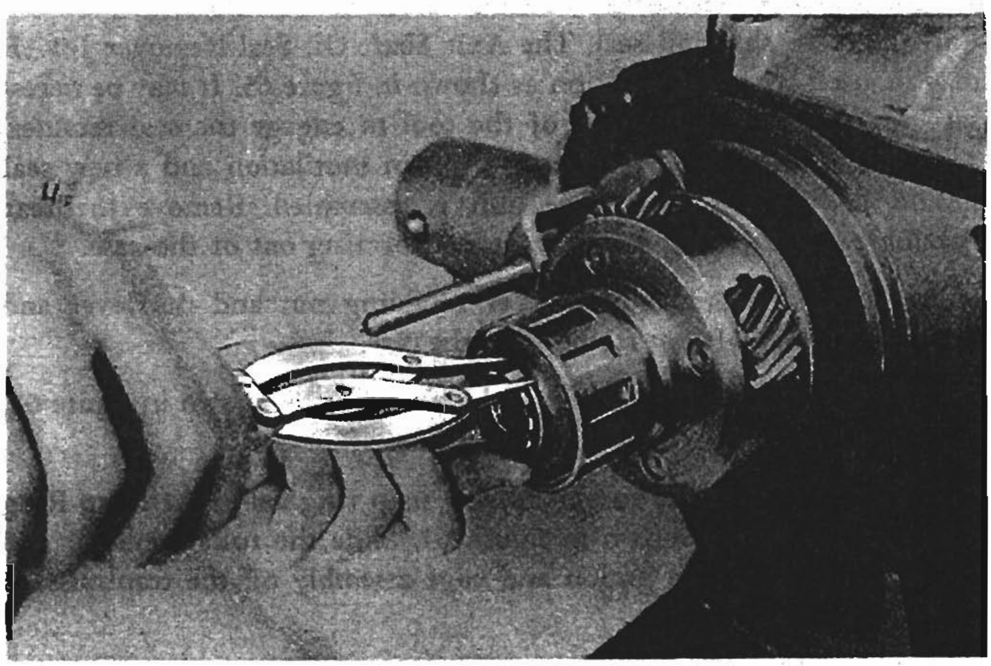


Fig. 67—Remove the Free Wheel Cam Retaining Snap Ring.

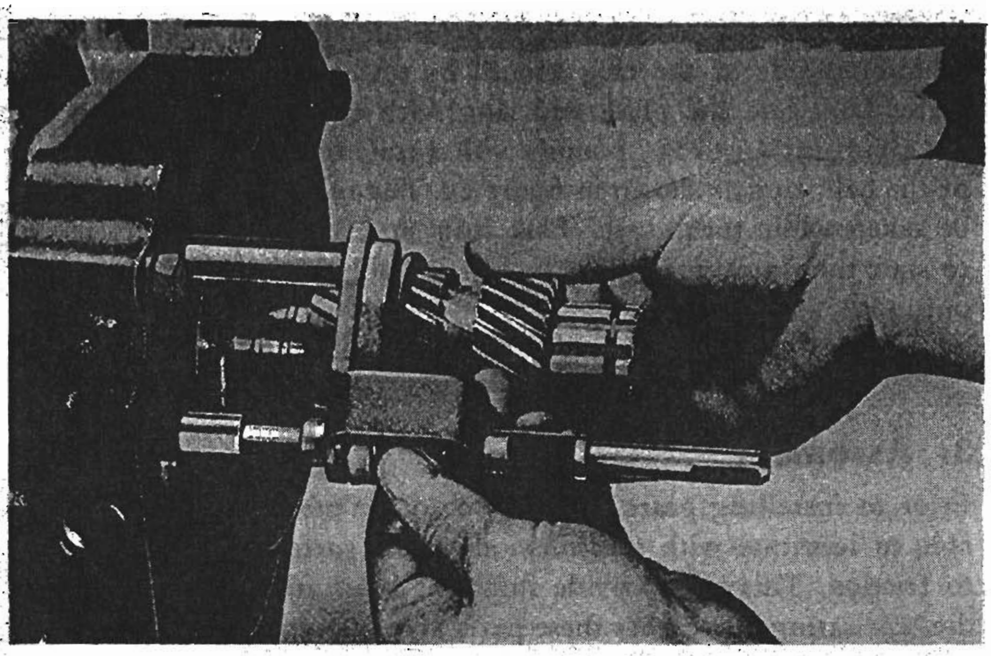


Fig. 68—Remove the Reverse Plunger, Shift Rail and Shift Fork Assembly.

times the two rings may be of the same thickness. In other instances, however, the free wheel cam retaining ring is the thicker of the two. It is supplied in various thicknesses in order to eliminate any end play of the free wheel cam assembly and the pinion cage assembly on the transmission driving shaft.

Pull the reverse plunger, shift rail, and shift fork assembly out of the adapter while sliding the stationary gear rearward and off the driving shaft. These parts are removed together and in one operation as shown in figure 68.

Remove the stationary gear plate cover retaining snap ring and remove the cover, the gear plate, and the sliding pawl.

2. Inspection

Wash all parts thoroughly in a clean container filled with kerosene. It is good practice to wash the bearings before washing other parts to keep dirt or grit from getting into the bearings.

Inspect all gears for broken, chipped, or scored teeth and all internally and externally splined parts for nicked or burred splines.

Apply a light oil to the bearings and check for roughness or flat spots. Check the free wheel rollers for roughness or flat spots. Replace if necessary.

Examine the oil seals and the surfaces of those parts which are in contact with the seals. Replace where necessary.

Check the tension of the balk ring on the stationary gear plate. The chamfered side of the ring should be toward the slotted hub of the plate. Lubricate the plate and ring with transmission oil and check for a pull of 3½ to 5½ pounds with a scale held parallel with the step of the balk ring as shown in figure 69. The reading on the scale should be taken while turning the balk ring since the initial effort required to start the ring turning may be considerably higher than the specified pull.

Check all retaining snap rings for being sprung or distorted.

3. Assembly

Prior to installing gears, bearings or other moving parts, it is advisable to lubricate with transmission oil all surfaces which are subject to friction. This will provide sufficient lubrication until such time as the lubricating oil reaches these parts after the unit is placed in service.

Place the balk ring on the stationary gear plate with the chamfered side of the ring toward the slotted hub of the plate. Place the gear plate in the adapter and then install the sliding pawl, groove upward, in the adapter.

Install the stationary gear plate cover and the cover retaining ring. Rings are available in thicknesses of .062, .066, and .070 each. The cover should be held tightly against its seat in the adapter when the ring is in its groove.

Install the solenoid so that the two terminal screws are toward the rear or toward the overdrive case when it is installed. To install the

Fig. 69—Check the Balk Ring Tension as Shown.

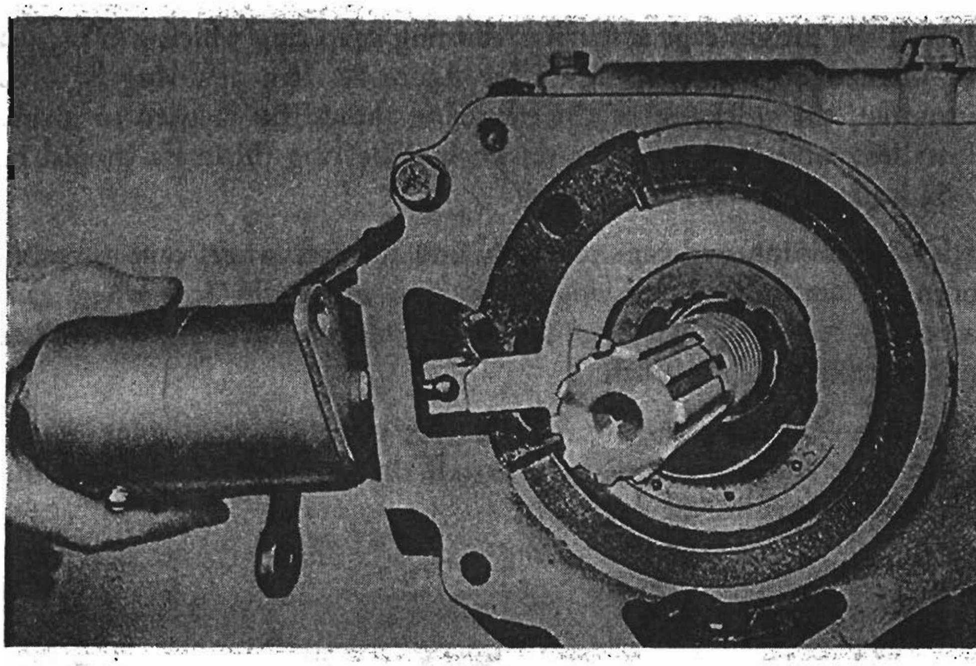


Fig. 70—Installing the Solenoid.

solenoid, turn it approximately ¼ turn to the right (clockwise) from its normal position when installed (figure 70), push inward to engage the plunger with the pawl, and then rotate the solenoid ¼ turn to the left (counterclockwise) to lock the plunger into the pawl. Install and tighten the solenoid retaining screws.

Install the reverse plunger, shift rail, and shift fork assembly and the stationary gear together and in one operation as shown in figure 71.

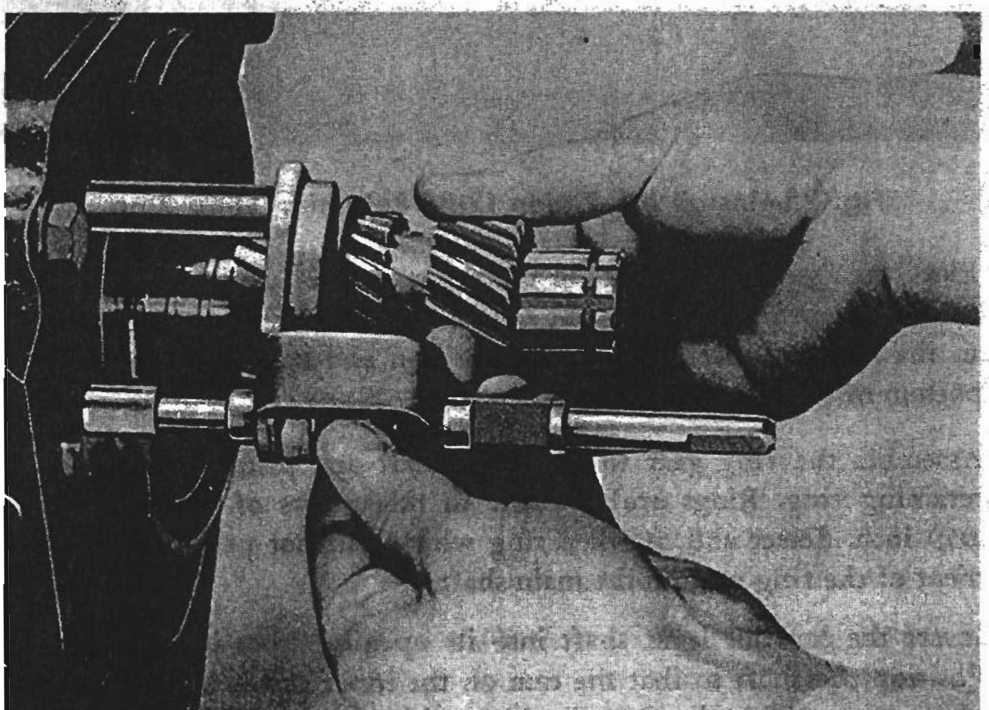


Fig. 71—Install the Reverse Plunger, Shift Rail and Shift Fork Assembly.

Install the pinion cage assembly retaining snap ring which was tagged or marked during disassembly. See figure 72. If a new ring is to be installed, the thickness of the new ring should be checked to insure installing one of the proper thickness. The ring thickness should be .062 inch, plus or minus .002 inch.

Slide the pinion and cage assembly and the free wheel cam assembly onto the transmission driving shaft, then install the free wheel cam assembly retaining snap ring. This snap ring is available in thicknesses of .062, .068, and .074 inch.

Select and install a ring which will not permit any end play of the pinion and cage assembly, then install the free wheel cam assembly on the transmission driving shaft.

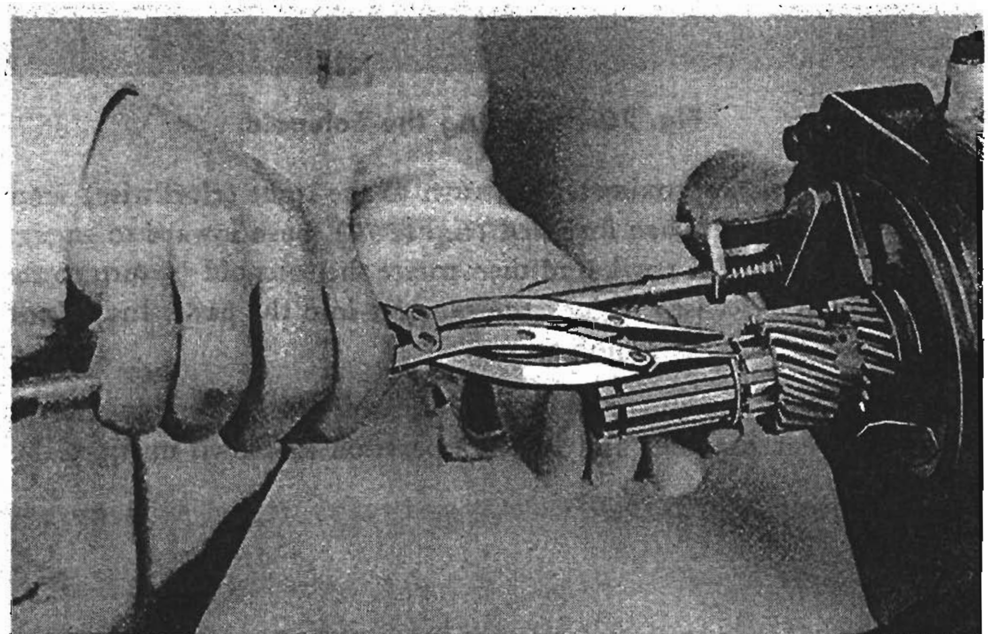


Fig. 72—Install the Pinion Cage Retaining Snap Ring.

Place the free wheel rollers in the roller retainer using a rubber band to hold them in the retainer as shown in figure 73. Rotate the retainer to the left (counterclockwise) to position and hold the rollers at the bottom of their ramps on the cam.

Assemble the ring gear to the main shaft and install the ring gear retaining ring. Rings are available in thicknesses of .055, .057, and .059 inch. Select and install a ring which will not permit end movement of the ring gear on the main shaft.

Insert the lockout lever shaft into its opening from inside the case. Position the shaft so that the cam on the inner end is toward the top of the case. With the shaft in this position, install the lockout lever so it is in the overdrive position or nearly against the bottom of the stop on the case.

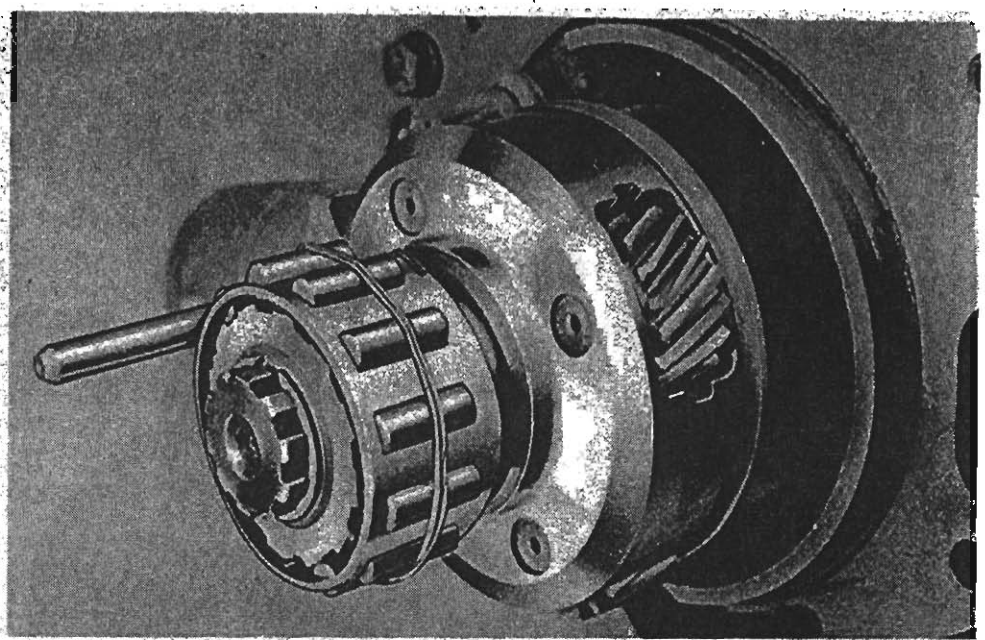


Fig. 73—Use a Rubber Band to Hold the Rollers in the Retainer.

Press the main shaft rear bearing into the case using an arbor press. If an arbor press is not available, tap the bearing into the case using a fiber block or a brass drift and small hammer. The rear bearing front retaining ring was not removed from the case during disassembly of the unit since this ring seldom requires replacement. However, if a new ring is to be installed before seating the rear bearing, the thickness of the new ring should be .087 inch, plus or minus .002 inch.

Install the rear bearing rear retaining ring. This ring is available in thicknesses of .087, .090, .093, and .096 inch. Select a ring to hold the bearing tightly against the front retaining ring.

Press or tap a new main shaft oil seal into the case. The seal is properly positioned when the shoulder of the seal retainer is flush with the end of the case as shown in figure 74.

Place the speedometer driving gear in the rear of the case and then press or tap the main shaft front bearing into place.

Coat the bearing and seal contact surfaces of the main shaft with lubriplate, and install the main shaft and ring gear assembly in the case. To install the assembly, start the end of the main shaft into the front bearing. With a finger inserted through the oil seal and the rear bearing, hold the speedometer driving gear up in position and guide the end of the shaft through the gear and the rear bearing while pushing the assembly toward the rear of the case.

Install the universal joint flange, washer, and the retaining nut. The specified torque for tightening the retaining nut is 200 to 225 foot

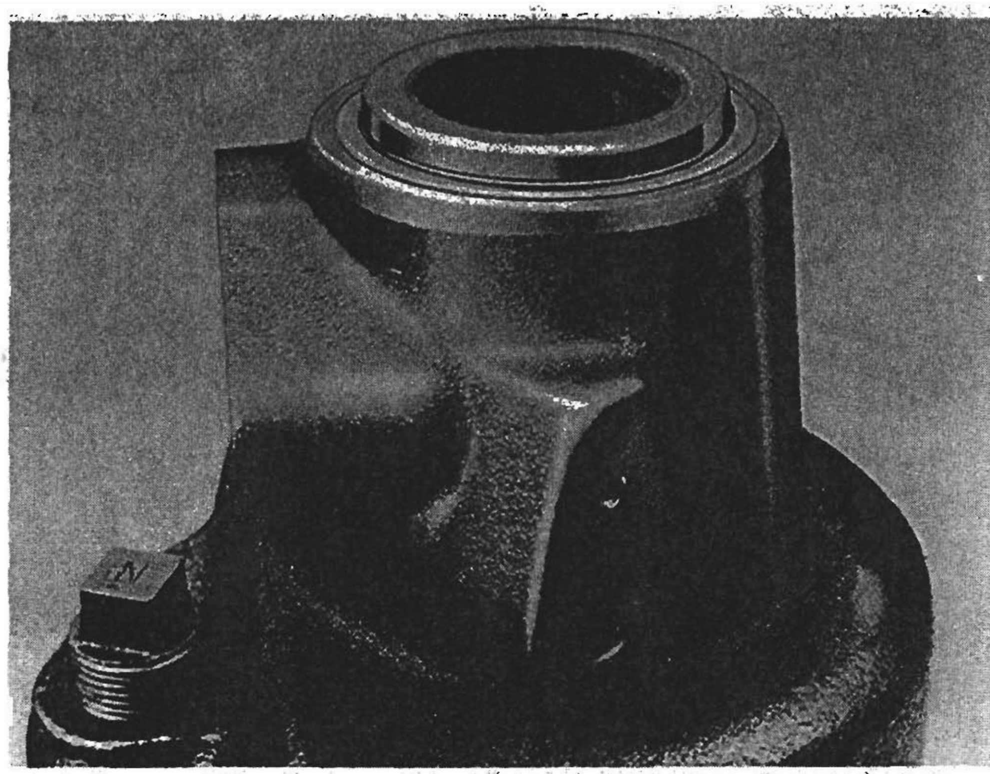


Fig. 74—Main Shaft Oil Seal Properly Positioned.

pounds. The nut must be tightened securely, otherwise the speedometer driving gear may not turn with the main shaft at all times. This results in speedometer fluctuation and faulty governor operation.

Install the governor and place the speedometer pinion and shaft in the case. Work the lockout lever and shaft outward as far as possible so the inner end of the shaft will not interfere with the shift rail when the case is being assembled to the adapter.

Place the shift rail retractor spring on the rail, as shown in figure 75, and place a new gasket on the face of the adapter.

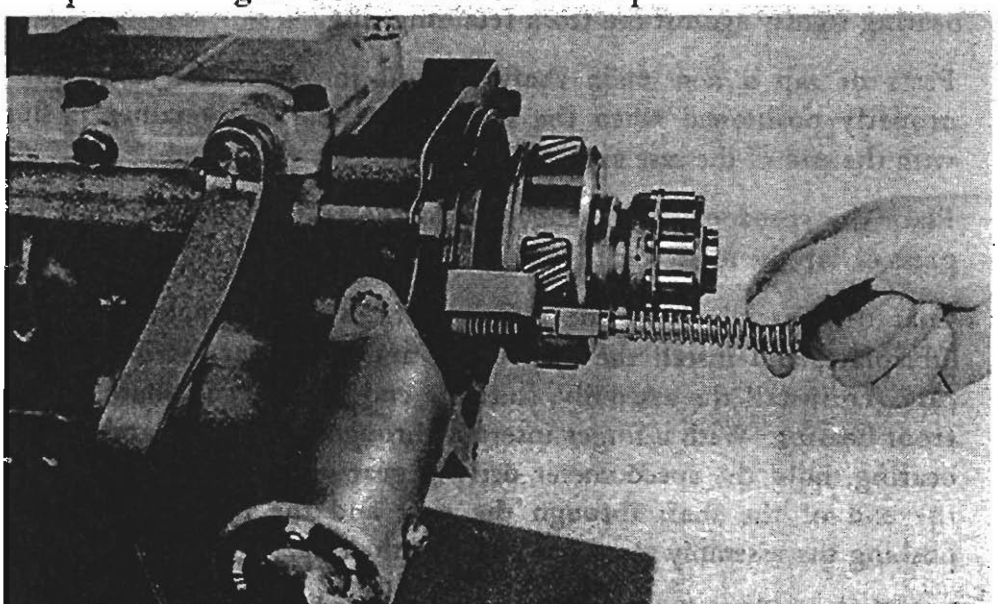


Fig. 75—Install the Shift Rail Retractor Spring.

Support the case assembly and move it toward the adapter while turning the main shaft to line up the pinions so they can enter the ring gear. Do not attempt to remove the rubber band which is holding the free wheel rollers in the roller retainer. The roller race inside the main shaft will push the rubber band off the rollers and the lubricant wil dissolve it. When the shift rail retractor spring is in its free position it extends beyond the end of the rail. It is necessary to compress the spring and to overcome a slight amount of spring tension while pushing the case toward the adapter. It also may be necessary to rotate the case slightly to the right or left or to tilt it upward or downward to permit the end of the shift rail to enter the pilot hole in the case.

Install the case to adapter retaining screws using a copper gasket between the case and washer of the screws having drilled heads for lock-wiring.

Tighten the retaining screws and then push the lockout lever and shaft inward to engage the cam on the end of the shaft with the shift rail. Install the lever shaft tapered retaining pin.

Connect the overdrive governor and the solenoid wiring, speedometer cable, lockout cable, and the propeller shaft. Fill the unit to the filler plug level using S.A.E. 90 transmission oil.

THE R-9 OVERDRIVE

Vehicles equipped with the R-9 unit may be identified by (1) presence of the overdrive indicator light in the instrument panel, (2) the six-terminal overdrive relay on the dash panel as against the four-terminal relay used on the R-11, and (3) the overdrive solenoid and lockout lever located on the right side of the overdrive case instead of on the left.

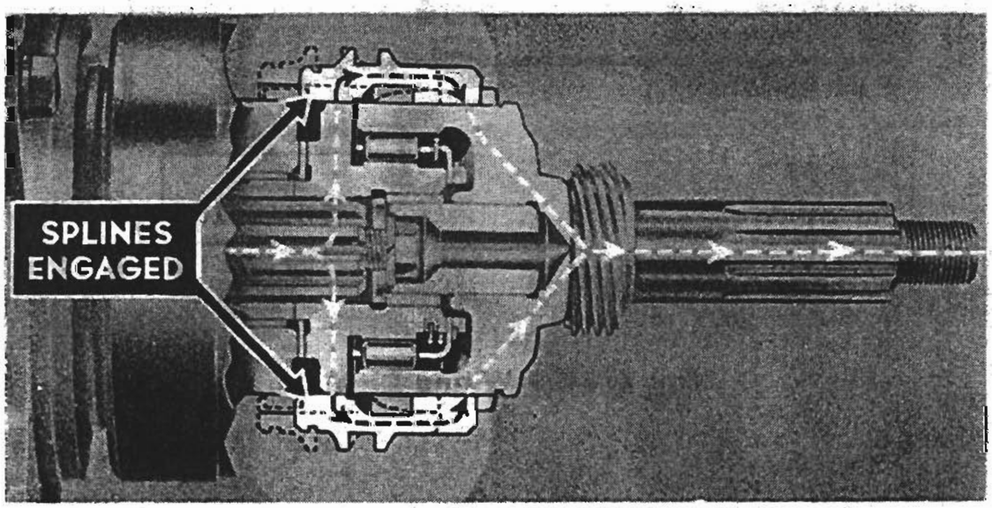


Fig. 76—R-9 Power Transfer.

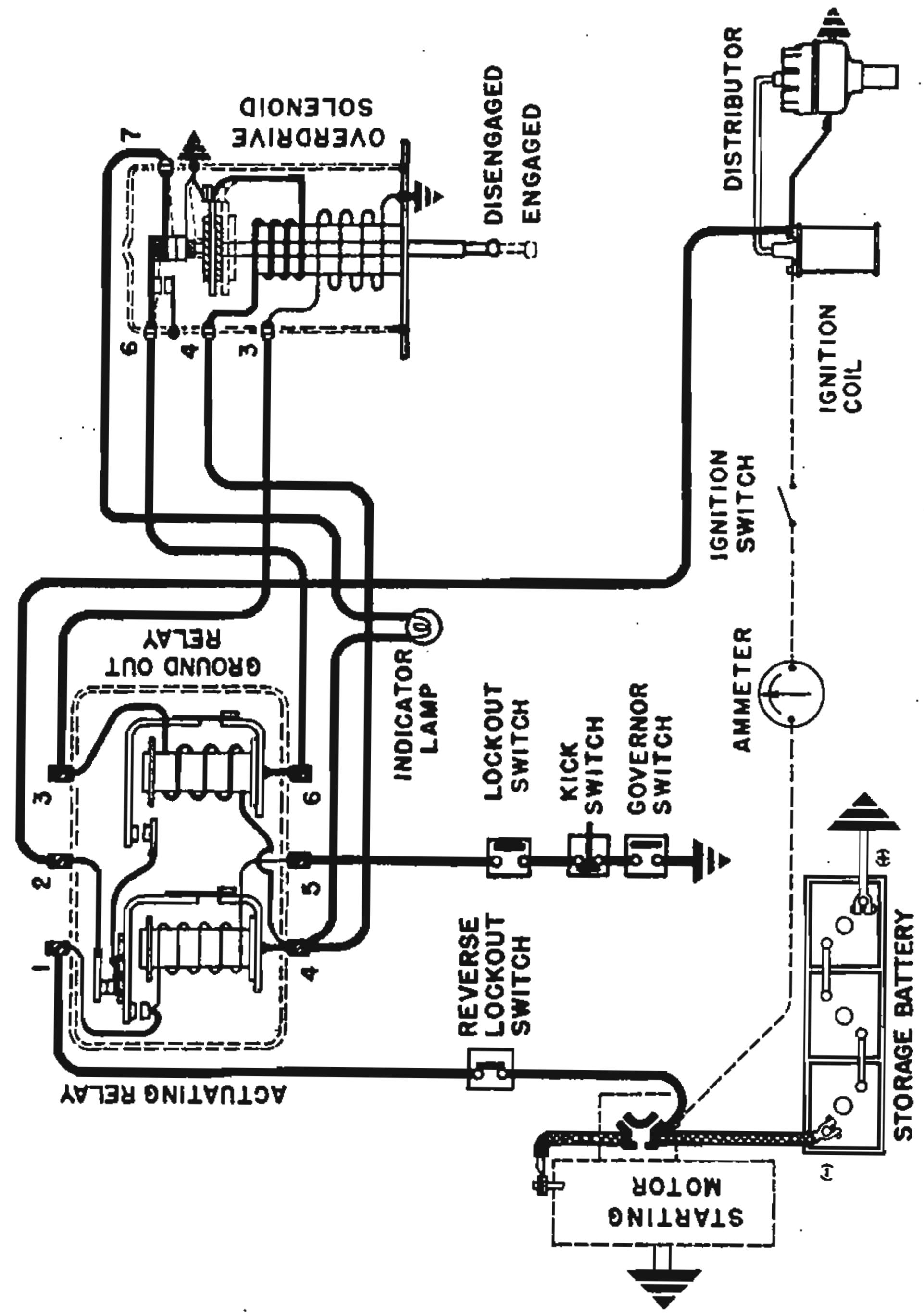


Fig. 77—R-9 Wiring Diagram.

The R-9 overdrive incorporates a planetary gear system similar to that of the R-11, although the two units differ in construction. The most prominent differences between the two units are in the transmission of power through the ring gear, and in the lockout mechanism. In the R-9 unit, the ring gear is splined to a clutch hub which transmits engine power through a clutch sleeve to the main shaft. See figure 76. (In the R-11 overdrive, the ring gear is splined directly to the main shaft.)

Overdrive lockout, in the R-9 unit, is accomplished by locking the overrunning clutch (free wheel cam and main shaft) into a single unit by means of the internally splined clutch sleeve. In the R-11 unit, the clutch sleeve has been eliminated and lockout is accomplished by moving the stationary gear rearward and locking the pinions and the ring gear and main shaft assembly into a single unit.

Among its electrical controls, the R-9 unit incorporates a reverse lockout switch, which member has been eliminated in the R-11. The R-9 wiring diagram is shown in figure 77.

Servicing procedures for the R-9 overdrive may be considered the same as for the R-11, as may operation, with the exception of those points brought out in the preceding paragraphs as to their differences.

1. Replacing the R-9 Overdrive

A service kit and various modifications are required to install an R-11 overdrive in a vehicle which previously was equipped with an R-9 unit. The kit contains an R-11 assembly, all electrical units required, an auxiliary wiring harness, and a wiring diagram. The recommended installation procedure follows:

NOTE

> When this change is incorporated on a 21st Series car, the transmission cover must be replaced with the cover included in the kit, since the lockout solenoid will be mounted on the opposite side to that of the old installation. Remove the direct and second speed shifter fork shaft from the old cover and reinstall it in the new one or, if desired, install a new shaft, part number 379004.

A. Remove the overdrive relay and cut off the six wires close to the harness, tape.

B. Measure 1½ inches from the outer relay attaching screw hole toward the center of the car and drill a 9-64 inch hole.

C. Install the new relay using the rubber spacer at the mounting hole just drilled.

D. Remove kickdown switch and cut off wires, tape.

E. Install new kickdown switch.

F. String wiring harness along main harness and attach with the eight strap clamps provided.

G. Connect wires to relay, starting motor, ignition coil, kickdown switch, ignition switch and lockout switch as shown on wiring diagram included in kit.

H. All service assemblies are supplied with the Mechanics type universal joint flange. If the car is equipped with Spicer universal joints it will be necessary to install a new flange.

I. Install R-11 transmission and overdrive assembly. When reinstalling the rear engine support channel it should be turned end for end to bring the overdrive lockout cable bracket holes on the left side.

J. Cut the solenoid wires from the old harness and tape the ends. Connect the auxiliary harness to the solenoid.

K. Cut the overdrive governor wire at the harness and connect the auxiliary harness wire. Do not cut the Electromatic Clutch wire from the harness as this lead must be used.

L. The speedometer pinion in the R-11 overdrive is of a different type and the original pinion must be replaced. The part numbers of the new pinions are as follows: 412442 – 17 tooth; 412443–18 tooth; 412444–19 tooth.

M. The overdrive lockout cable is moved to the left side of the engine and is held in place by a clamp attached to the Electromatic Clutch control valve rear attaching screw hole. A second clamp is attached to a lower flywheel cover attaching screw. The new bracket and clamp should be attached to the mounting holes in the support channel.

N. Attach the operating instruction tag to the lockout knob and, in addition, advise the customer of the proper method of operation of the R-11 overdrive.

SLUGGISH OVERDRIVE ENGAGEMENT

Sluggish engagement can be expected in cold weather if a car is driven only short distances. Cold, thick oil will retard the shift into overdrive and this condition usually clears up as the temperature of the oil rises and the oil becomes less viscous.

Another contributing factor toward sluggish engagement is an unusually high engine idle. A high idle slows down the reversal of the direction of rotation of the sun gear and plate when the accelerator pedal is released.

If sluggish engagement exists after the lubricating oil has reached its normal operating temperature and if the engine idle is normal (approximately 450 rpm), the sluggishness may be caused by an insufficient amount of drag or friction between the overdrive stationary gear balk ring and the stationary gear plate. Insufficient friction between these two parts will delay the engagement of the overdrive.

When operating the car at speeds below the governor cut-in speed, the transmission of engine power is through the overrunning clutch and tail shaft. On the R-9 overdrive, at this time, the sun gear is free to turn and is rotated by the pinion gears which are being rotated in turn by the ring gear, the clutch sleeve and the tail shaft. On the R-11, which has no clutch sleeve, the pinions are being rotated by the ring gear which is splined to the tail shaft.

The sun gear and the tail shaft then are rotating at the same speed. As long as the sun gear is free to turn, the overdrive cannot function and the car free wheels when the accelerator pedal is released.

When the car speed reaches the cut-in speed of the governor, the solenoid is energized and the sliding pawl is moved inward toward the sun gear until the pawl comes to rest on the balk ring step where it will remain until the shift into overdrive is completed.

To complete the shift into overdrive, the accelerator pedal is released which causes a reversal of the direction of rotation of the sun gear and plate. The friction or drag of the balk ring on the plate causes the balk ring to turn with the plate and the step of the balk ring slides from under the sliding pawl. The energized solenoid then moves the pawl inward into one of the openings in the stationary gear plate and both the plate and the sun gear are held stationary. Engine power then is transmitted through the planetary gear train and the overdrive is engaged.

Insufficient friction between the balk ring and the stationary gear plate will prevent the movement of the balk ring with the plate. The sliding pawl then will remain on the step of the balk ring while the stationary gear plate is rotating with a gradual increase in speed. When the pawl finally is released by the balk ring, the stationary gear plate is rotating too fast for the pawl to enter one of the openings in the plate and the pawl just skips over these openings. When the speed of the stationary gear plate has decreased to a point which will permit the pawl to enter one of the openings in the plate, the plate will be stopped so abruptly that a harsh "clunk" will be felt when the shift into overdrive is completed.

When a new balk ring is installed the tension or torque load should be checked as shown in figure 69. The stationary gear plate and the balk ring should be lubricated with transmission oil and checked for a torque load of $3\frac{1}{2}$ to 5 pounds with a scale held parallel with the step of the balk ring. The reading on the scale should be taken while turning the balk ring since the initial effort required to start the ring turning may be considerably higher than the specified torque.

If a balk ring is to be installed in an overdrive which has seen a great deal of service, the gear plate should be checked for being excessively worn or grooved. If the plate is grooved, the stationary gear and plate should be replaced.

OVERDRIVE TROUBLES AND CORRECTIONS

1. Failure of Overdrive to Engage (General Electrical Causes)

A. Examine the fuse and replace if necessary.

B. Test the governor and replace if necessary.

C. After the fuse and governor have been found to operate satisfactorily, if the circuit is "dead," it is possible that the overdrive relay is at fault. Replace the relay.

D. Test the solenoid with a test lamp. If the test lamp lights and the solenoid does not operate, replace the solenoid.

2. Failure of Overdrive to Engage (General Mechanical Causes)

A. Sticking locking pawl. Remove the solenoid and check the pawl for free movement. If the pawl sticks, disassemble the overdrive and free up the pawl.

B. Solenoid plunger sticking. This might be caused by the spacer having been installed in the wrong position which would cause the plunger to bind. Remove the solenoid and check the position of the spacer. Install the spacer in the correct position if improperly set.

C. Faulty balk ring. This is generally indicated by spasmodic engagement of the overdrive and by very harsh engagement at times. Disassemble the overdrive and check the torque load on the balk ring. (See "Sluggish Overdrive Engagement.") Install a new balk ring if the torque load is not up to $3\frac{1}{2}$ to 5 pounds.

3. Failure of Overdrive to Disengage

A. Faulty governor. Test the governor and, if necessary, replace it.

B. Sticking engaging pawl. Remove the solenoid and check the pawl for free movement. If the pawl sticks, disassemble the overdrive and free up the pawl.

C. Faulty kickdown switch. Test the kickdown switch with a test lamp. Install a new switch if necessary.

D. "Ground out" lead disconnected at the distributor or coil. Connect the "ground out" lead at the distributor or coil primary terminal.

E. Faulty overdrive relay. Check operation of the relay and, if necessary, replace the relay.

4. Overdrive Will Not Lock Out

A. Lockout cable disconnected or out of adjustment. Connect and properly adjust the overdrive lockout cable.

B. Failure of electrical units to lock out after overdrive has been mechanically locked out is generally caused by a shorted lockout switch. Install a new lockout switch.

5. Failure of Overdrive to Lock Out When Shifting Lever Is Placed in Reverse Gear Position

A. Overdrive lockout collar sticking, possibly caused in cold weather by congealed lubricant. Drain the transmission and overdrive, refill with correct grade lubricant.

B. Burred or worn splines on the overrunning clutch cam, tail shaft or lockout collar. To check for free movement of the lockout collar, pull out the control knob on the instrument panel. This should move the lockout collar to the locked out position. To make a further check, the control cable may be disconnected at the lockout lever on the overdrive case. Then, operating the lever by hand, it is possible to feel whether the lockout collar is sliding freely and is travelling the full distance. If the lockout collar cannot be shifted easily, disassemble the overdrive and replace any worn or burred parts.

6. Lockout of Transmission in Reverse Gear. Shifting Lever Won't Go Into Reverse Gear Position

On the R-9 overdrive, because of faulty operation of electrical or mechanical parts, it is possible for the transmission to be in both overdrive and reverse gear at the same time. The result of this is obviously a gear lockup which (if enough engine power is applied) can cause failure of the tail shaft.

On the R-11 overdrive, this lockup can't happen. Because of the different construction of the unit, it is not possible to force the gear-shift lever into reverse gear position.

A. Governor contact points closed or sticking. Test the governor. Install a new governor if necessary.

B. Lockout switch grounded. Test for grounds with a test lamp. Install a new switch if necessary.

C. Kickdown switch grounded. Check to see if kickdown switch grounded. If necessary, install new switch.

D. Overdrive relay contacts closed or sticking. Relay terminals grounded. Test relay, check to see if terminals grounded. Install a new relay if necessary.

E. Overdrive electrical wiring grounded. Test the wiring for grounds with a test lamp. Repair or replace faulty wiring.

F. Locking pawl sticking. Remove the solenoid and check the pawl for free movement. If the pawl sticks, disassemble the overdrive and free up the pawl.

G. Solenoid spacer installed in wrong position (R-9 only). This would cause the plunger to bind. Remove the solenoid and check the position of the spacer. Install the spacer in the correct position if improperly set.

H. Broken engaging pawl. Remove the solenoid and check the engaging pawl. If the pawl is broken, disassemble the overdrive and replace the pawl.

J. Locking pawl disengaged from solenoid plunger. Remove the solenoid and check to see that the ball on the end of the plunger is engaged in the pawl slot.

TRANSMISSION NOISE DIAGNOSIS

PART AFFECTED	WHEN HEARD						
	Clutch	1st Speed	2nd Speed	3rd Speed	All Speeds	Reverse	Neutral
BEARINGS							
Clutch Throwout	LPP				X		X
Clutch Pilot	D						X
Clutch Shaft Rear	E				X		X
Driving Shaft Front	E	XX	XX				X
1st Speed Gear	E		XX				X
2nd Speed Gear	E	XX					X
Driving Shaft Rear	E				X		
Countershaft	E	X	XX				
Reversing Pinion	E					X	
GEARS							
Countershaft—1st Speed	E	XX					X
Countershaft—2nd Speed	E	XX					X
Clutch Shaft Rear	E			X	XX		
Countershaft	E			X	XX		
Reversing Pinion	E				X	XX	
1st and Reverse Sliding	E	X				X	
Clutch Shaft—Mating Crankshaft	E				X		
Clutch Shaft—Countershaft	E						X

LEGEND

LPP—Light Pedal Pressure
D—Disengaged
E—Engaged
X—Noise Audible
XX—Noise More Audible than "X"

CLUTCH AND TRANSMISSION SPECIFICATIONS—20th and 21st SERIES

	EIGHT		SUPER EIGHT		CUSTOM EIGHT	
CLUTCH						
Type	Single Dry Plate		Single Dry Plate		Single Dry Plate	
Pedal Free Play	1½″ to 2″		1½″ to 2″		1¾″ to 2¼″	
Facing Material	U.S. Asbestos, Woven		U.S. Asbestos, Woven		U.S. Asbestos, Woven	
Size Facing	6″ x 9½″ x .125″		6″ x 10″ x .125″		6⅝″ x 11″ x .125″	
Throwout Bearing	Prelubricated Ball		Prelubricated Ball		Prelubricated Ball	
Clutch Spring Pressure	163 lb. at 1⁹⁄₁₆″		127½ lb. at 1⁹⁄₁₆″		163 lb. at 1⁹⁄₁₆″	
Number of Springs	6		9		9	
Vibration Neutralizer	Springs		Springs		Springs	
TRANSMISSION						
Type	Selective—Silent—Synchronized		Selective—Silent—Synchronized		Selective—Silent—Synchronized	
Number of Forward Speeds	3		3		3	
Engine to Rear Wheel Ratio	Std. Trans.	O.D.	Std. Trans.	O.D.	Std. Trans.	O.D.
Overdrive		3.28		3.10		2.95
Direct	4.3	4.55	4.1	4.3	3.92	4.09
Second	6.57	6.96	6.27	6.57	5.99	6.25
First	10.44	11.04	9.95	10.44	9.51	9.93
Reverse	13.6	14.40	12.97	13.6	12.4	12.94
Oil Capacity—Std. Trans.	2 pt.		2 pt.		2 pt.	
Oil Capacity—O.D. Unit	1¼ pt.		1¼ pt.		1¼ pt.	
Oil Level Plugs	½″—14 Pipe		½″—14 Pipe		½″—14 Pipe	
Gear Teeth	Helical		Helical		Helical	
Steering Post Shift	Mechanical Type Std. Equipment		Mechanical Type Std. Equipment		Mechanical Type Std. Equipment	

CLUTCH AND TRANSMISSION SPECIFICATIONS—22nd AND 23rd SERIES

	EIGHT		SUPER EIGHT		CUSTOM EIGHT	
CLUTCH						
Type	Single Dry Plate		Single Dry Plate		Single Dry Plate *	
Pedal Free Play	1¼" to 1½"		1¼" to 1½"		1¼" to 1½"	
Facing Material	U.S. Asbestos, Woven		U.S. Asbestos, Woven		U.S. Asbestos, Woven	
Size Facing	6¾" x 10" x .125"		7" x 10½" x .125"		7" x 11" x .125"	
Throwout Bearing	Prelubricated Ball		Prelubricated Ball		Prelubricated Ball	
Clutch Spring Pressure	154 lb. at 1.566"		163 lb. at 1.632"		175 lb. at 1.562"	
Number of Springs	9		9		9	
Vibration Neutralizer	Yes		Yes		Yes	
TRANSMISSION						
Type	Selective—Silent Synchronized		Selective—Silent Synchronized		Selective—Silent Synchronized	
Number of Forward Speeds	3		3		3	
Engine to Rear Wheel Ratio	Std. Trans.	O.D.	Std. Trans.	O.D.	Std. Trans.	O.D.
Overdrive		2.96		2.96		2.95
Direct	3.9	4.1	3.9	4.1	3.92	4.09
Second	5.96	6.27	5.96	6.27	5.99	6.25
First	9.47	9.96	9.47	9.96	9.52	9.93
Reverse	12.34	12.97	12.34	12.97	12.4	12.94
Oil Capacity—Std. Trans.	2 pt.		2 pt.		2 pt.	
Oil Capacity—O.D. Unit	1¼ pt.		1¼ pt.		1¼ pt.	
Oil Level Plugs	½"—14 Pipe		½"—14 Pipe		½"—14 Pipe	
Gear Teeth	Helical		Helical		Helical	

*Custom Eight data does not apply to 23rd Series. These models equipped with Ultramatic Drive.

REAR AXLE AND SPEEDOMETER RATIOS—20th AND 21st SERIES

MODEL	AXLE RATIOS STD.	AXLE RATIOS OPT.	AXLE RATIOS OVERDRIVE	TIRE SIZE	NO. OF TEETH SPEEDOMETER GEARS	SPEEDOMETER PINION
2000	4.3			15x6.50	19—6	347537
2010		4.55		15x6.50	20—6	347538
			4.55	15x6.50	20—6	347538
2030	4.54			15x7.00	19—6	347537
2001	4.1			15x6.50	18—6	347536
2011		4.3		15x6.50	19—6	347537
			4.3	15x6.50	19—6	347537
2003	3.92			15x7.00	17—6	354976
2006		4.09		15x7.00	17—6	354976
		(4.36)		15x7.00	18—6	347536
			4.09	15x7.00	17—6	354976
			(4.36)	15x7.00	18—6	347536
2100	10-43 4.3			15x6.50 4 Ply	19—6	347537
		9-41 4.55	9-41 4.55	15x6.50 4 Ply	20—6	347538
2100 Spec. 16″ Wheel	10-43 4.3			16x6.50 4 Ply	18—6	347536
		9-41 4.55	9-41 4.55	16x6.50 4 Ply	19—6	347537

REAR AXLE AND SPEEDOMETER RATIOS—21st SERIES—(continued)

MODEL	AXLE RATIOS STD.	 OPT.	 OVERDRIVE	TIRE SIZE	NO. OF TEETH SPEEDOMETER GEARS	SPEEDOMETER PINION
2130	11-50 4.54			15x7.00 6 Ply	19—6	347537
2101 2111	10-41 4.1			15x6.50 4 Ply	18—6	347536
		10-43 4.3	10-43 4.3	15x6.50 4 Ply	19—6	347537
2101-11 Spec. 16" Wheel	10-41 4.1			16x6.50 4 Ply	17—6	354976
		10-43 4.3	10-43 4.3	16x6.50 4 Ply	18—6	347536
2103 2106	12-47 3.92			15x7.00 4 Ply	17—6	354976
		11-45 4.09	11-45 4.09	15x7.00 4 Ply	17—6	354976
2103-06 Spec. 16" Wheel	12-47 3.92			16x7.00 4 Ply	16—6	367650
		11-45 4.09	11-45 4.09	16x7.00 4 Ply	17—6	354976
2126	11-45 4.09			16x7.00 6 Ply	17—6	354976
			11-48 4.36	16x7.00 6 Ply	18—6	347536
2126 Spec. Tires	11-45 4.09			16x7.50 6 Ply	16—6	367650
			11-48 4.36	16x7.50 6 Ply	17—6	354976

REAR AXLE AND SPEEDOMETER RATIOS—22nd SERIES

MODEL	AXLE RATIOS				TIRE SIZE	NO. OF TEETH SPEEDOMETER GEARS	SPEEDOMETER PINION
	WITHOUT OVERDRIVE		WITH OVERDRIVE				
	STD.	OPT.	STD.	OPT.			
2201-11	10-39				15x7.60	17—6	354976
2201R-11R	3.9				4 Ply		
2201-11		10-41			15x7.60		
2201R-11R		4.1			4 Ply	17—6	354976
			10-41		15x7.60		
2201R-11R			4.1		4 Ply	17—6	354976
			10-41		15x7.60		
			4.1		4 Ply	17—6	412442
				10-43	15x7.60		
2201R-11R				4.3	4 Ply	18—6	347536
				10-43	15x7.60		
2201-11				4.3	4 Ply	18—6	412443
2202-32	10-39				15x7.60		
2202R-32R	3.9				4 Ply	17—6	354976
2202R		10-41	10-41		15x7.60		
2232R		4.1	4.1		4 Ply	17—6	354976
2202-32			10-41		15x7.60		
			4.1		4 Ply	17—6	412442
		10-41			15x7.60		
2202-32		4.1			4 Ply	17—6	354976
	12-47				15x8.20		
2206-33	3.92				4 Ply	16—6	367650
		11-45			15x8.20		
2206-33		4.09			4 Ply	17—6	354976
			11-45		15x8.20		

REAR AXLE AND SPEEDOMETER RATIOS—22nd SERIES—(continued)

MODEL	AXLE RATIOS WITHOUT OVERDRIVE STD.	AXLE RATIOS WITHOUT OVERDRIVE OPT.	AXLE RATIOS WITH OVERDRIVE STD.	AXLE RATIOS WITH OVERDRIVE OPT.	TIRE SIZE	NO. OF TEETH SPEEDOMETER GEARS	SPEEDOMETER PINION
			11-45		15x8.20		
2206-33			4.09		4 Ply	17—6	412442
2213			10-47		16x7.50		
Spec. 16" Wheel			4.7		6 Ply	19—6	347537
	11-50				16x7.50		
2213	4.54				6 Ply	18—6	347536
	11-45				15x7.00		
2222-22R	4.09				6 Ply	17—6	354976
			11-48		15x7.00		
2222R			4.36		6 Ply	19—6	347537
			11-48		15x7.00		
2222			4.36		6 Ply	19—6	412444
2226	11-45				16x7.00		
16" Wheel	4.09				6 Ply	17—6	354976
			11-48		16x7.00		
2226			4.36		6 Ply	18—6	412443
2240—16" Wheel	9-41				16x6.50		
Body 2286	4.55				4 Ply	19—6	347537
2240—16" Wheel	10-43				16x6.50		
Body 2282	4.3				4 Ply	18—6	347536
2220	11-50				15x7.00		
15" Wheel	4.54				6 Ply	19—6	347537

REAR AXLE AND SPEEDOMETER RATIOS—22nd SERIES—(continued)

MODEL	AXLE RATIOS WITHOUT OVERDRIVE STD.	WITHOUT OVERDRIVE OPT.	WITH OVERDRIVE STD.	WITH OVERDRIVE OPT.	TIRE SIZE	NO. OF TEETH SPEEDOMETER GEARS	SPEEDOMETER PINION
2222-22R Spec. 16″ Wheel	11-45 4.09				16x7.00 6 Ply	17—6	354976
2222R			11-48 4.36		16x7.00 6 Ply	18—6	347536
2222			11-48 4.36		16x7.00 6 Ply	18—6	412443

REAR AXLE AND SPEEDOMETER RATIOS—23rd SERIES

Model	Ratios	AXLE Ultra-matic	AXLE Std. Trans.	AXLE Over-drive	Pinion No.	ULTRAMATIC Adapter No.	ULTRAMATIC Gov. Assem. No.	ULTRAMATIC Teeth in Gears	SPEEDOMETER STD. TRANS. Pinion No.	SPEEDOMETER STD. TRANS. Teeth in Gears	OVERDRIVE Pinion No.	OVERDRIVE Teeth in Gears	Tire Size
	3.9 10-39	Std.	Std.		421222	421049	423223	22-8	354976	17-6			
2301	4.1 10-41	Opt.	Opt.	Std.	423225	421049	423224	23-8	354976	17-6	412442	17-6	7.60-15 4 Ply
	4.3 10-43	Opt.		Opt.	423226	423216	423224	24-8			412443	18-6	
2302 Std.	3.54 11-39	Std.			421220	421049	421834	20-8					
	3.9 10-39	Opt.	Std.		421222	421049	423223	22-8	354976	17-6			7.60-15 4 Ply
2382-85	4.1												

REAR AXLE AND SPEEDOMETER RATIOS—23rd SERIES—(continued)

		AXLE				ULTRAMATIC			SPEEDOMETER STD. TRANS.		OVERDRIVE		
Model	Ratios	Ultra-matic	Std. Trans.	Over-drive	Pinion No.	Adapter No.	Gov. Assem. No.	Teeth in Gears	Pinion No.	Teeth in Gears	Pinion No.	Teeth in Gears	Tire Size
Bodies	10-41	Opt.	Opt.	Std.	423225	421049	423224	23-8	354976	17-6	412442	17-6	
2302-32	3.54												
Deluxe	11-39	Std.			421220	421049	421834	20-8					
	3.9												8.00-15
2372-73	10-39	Opt.	Std.		421222	421049	423223	22-8	367650	16-6			4 Ply
2375-79	4.1												
Bodies	10-41	Opt.	Opt.	Std.	423225	421049	423224	23-8	354976	17-6	412442	17-6	
	3.54												
	11-39	Std.			421220	421049	421834	20-8					
2306	3.92												8.20-15
2333	12-47	Opt.	Std.		421222	421049	423223	22-8	367650	16-6			4 Ply
	4.09												
	11-45		Opt.	Std.					354976	17-6	412442	17-6	
	4.54												
	11-50		Std.						347536	18-6			7.50-16
2313	4.7												6 Ply
	10-47			Std.							412444	19-6	
	3.92												
	12-47	Std.			421221	421049	423223	21-8					
	4.09												8.20-15
2322	11-45		Std.						354976	17-6			6 Ply
	4.36												
	11-48			Std.							412443	18-6	