

Section 10

CRANKSHAFTS & CAM GEARS

REMOVAL

Aluminum Cylinder Engines

To remove the crankshaft from aluminum alloy engines, remove rust or burrs from the power take-off end of the crankshaft. Remove crankcase cover or sump. If sump or cover sticks, tap lightly with soft hammer on alternate sides near dowel. Turn crankshaft to align the crankshaft and cam gear timing marks, lift out the cam gear, then remove the crankshaft. On ball bearing models, the crankshaft and cam gear must be removed together. Fig. 1.

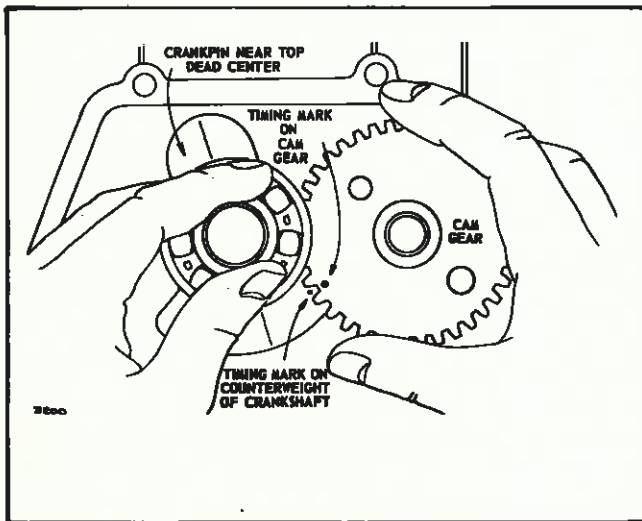


Fig. 1 — Ball Bearing Engines

Cast Iron Cylinder Engines

Model Series 5, 6, 8, N Plain Bearings

Remove magneto. Remove burrs and rust from P.T.O. end of crankshaft. Remove crankshaft, Fig. 2.

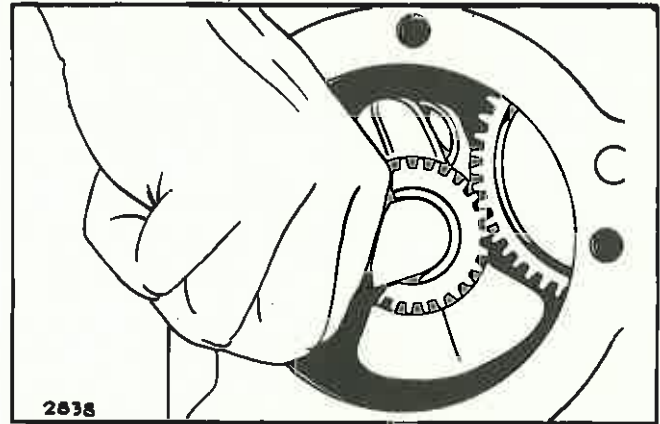


Fig. 2 — Remove or Install Crankshaft

Model Series 6FB, 6FBC, 6SFB, 8FB, 8FBC, 8FBP — Ball Bearings

Remove magneto. Drive out cam gear shaft while holding cam gear to prevent dropping, Fig. 3. Push cam gear into recess, Fig. 4. Pull crankshaft out from magneto side.

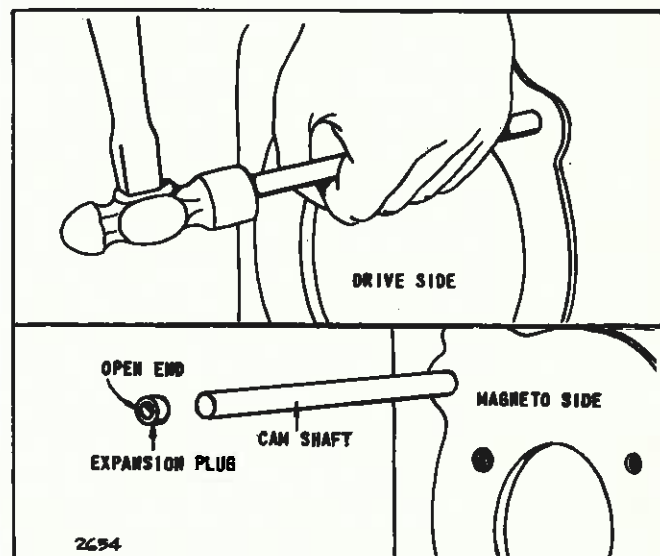


Fig. 3 — Remove Camshaft

CRANKSHAFTS & CAM GEARS

Removal

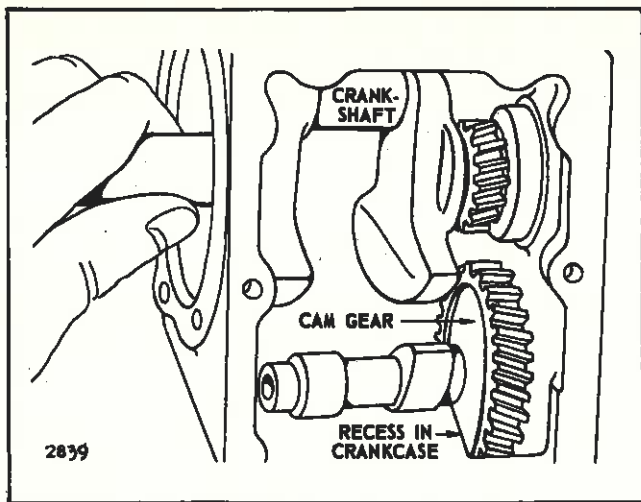


Fig. 4 — Remove or Install Crankshaft

Model Series 9, 14, 19, 23, 200000, 230000 Plain Bearings

Remove crankshaft cover. Rotate crankshaft to approximate position shown in Fig. 2. Pull out crankshaft from P.T.O. side, twisting slightly, if necessary, to clear cam gear.

Model Series 9, 14, 19, 23, 190000, 200000, 230000, 240000, 300000, 320000 Ball Bearings

NOTE: On 240000, 300000, 320000, piston and rod must be removed from engine.

Remove crankcase cover and bearing support. Rotate crankshaft to position shown, Fig. 2. On some models, it may be necessary to position crankshaft approximately 180° from position shown in Fig. 2. Pull crankshaft out, turning as needed to remove crankshaft.

To remove cam gear from all cast iron models, except the 300000 and 320000, use a long punch to drive the cam gear shaft out toward the magneto side. (Save plug.) Fig. 3. Do not burr or peen end of shaft while driving out. Hold cam gear while removing punch so gear does not drop and nick.

Model Series 300400, 320400

Remove short bolt and Belleville washer from P.T.O. drive gear, Fig. 5. Loosen long bolt and Belleville washer two (2) turns on magneto side and tap head of bolt with hammer to loosen cam gear shaft. Turn bolt out while pushing out cam gear shaft. Remove bolts from cam gear bearing, Fig. 6. While holding cam gear, remove cam gear bearing and remove cam gear, Fig. 7.

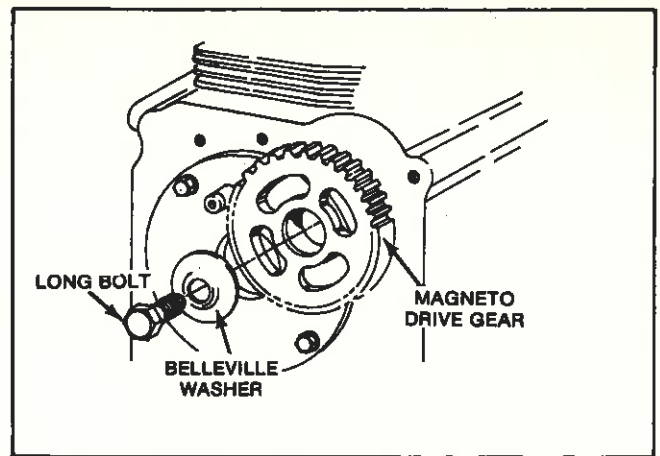


Fig. 5 — Remove Short Bolt

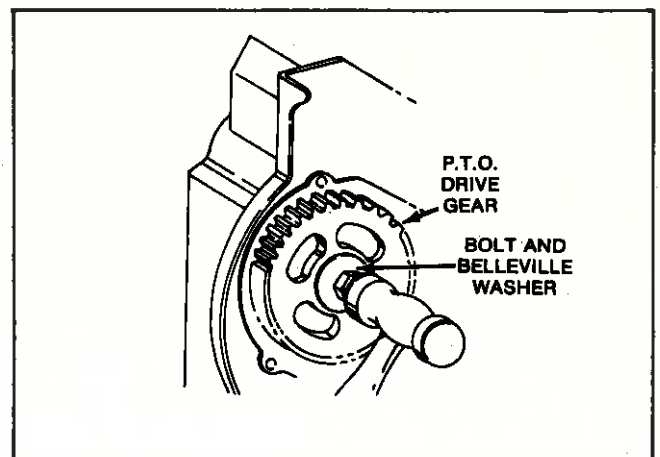


Fig. 6 — Remove Long Bolt

Model Series 301400, 302400, 325400, 326400

Loosen long bolt two (2) turns. Use hammer to drive out cam gear shaft and cam gear plug. Loosen bolt while pushing out cam gear shaft and plug. Remove bolts and cam gear bearing, Fig. 6. Remove cam gear, Fig. 7.

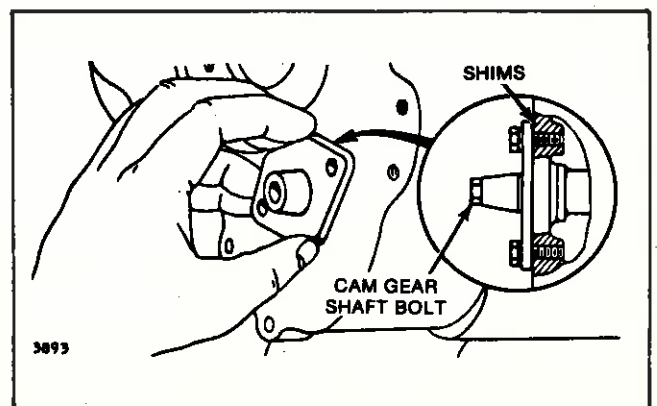


Fig. 7 — Removing Cam Gear Bearing

CRANKSHAFTS & CAM GEARS Checking

CHECKING CRANKSHAFT

All Engines

Table No. 1 shows the rejection sizes of the various wear points of the crankshaft. Discard crankshaft if worn smaller than the size shown. Keyways should be checked to be sure they are not worn or spread. Remove burrs from keyway edges to prevent scratching the bearing. Fig. 8 shows the various points to be checked on the crankshaft.

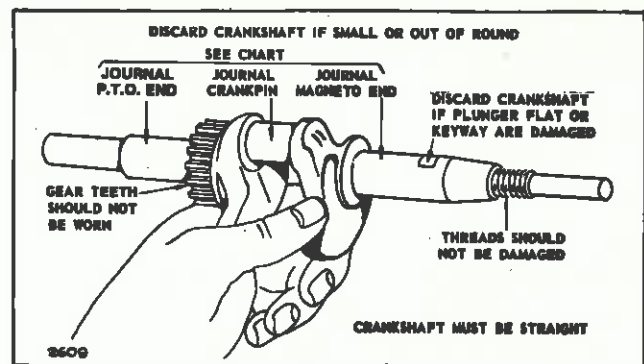


Fig. 8 — Crankshaft Check Points

NOTE: .020" undersize connecting rods may be obtained for use on reground crankpin bearings. Complete instructions are included with the undersize rod. (See Service Bulletin #480 or Illustrated Parts List to find appropriate undersize rod.)

TABLE NO. 1
CRANKSHAFT REJECT SIZES

MODEL SERIES	P.T.O. JOURNAL		MAGNETO JOURNAL		CRANKPIN JOURNAL	
	Inches	Millimeter	Inches	Millimeter	Inches	Millimeter
ALUMINUM CYLINDER						
6B, 60000	.873	22.17	.873	22.17	.870	22.10
8B, 80000*	.873	22.17	.873	22.17	.996	25.30
82000, 92000*, 94000, 110900*, 111200, 111900*	.873	22.17	.873	22.17	.996	25.30
100000, 130000	.998	25.35	.873	22.17	.996	25.30
140000, 170000	1.179	29.95	.997#	25.32#	1.090	27.69
190000	1.179	29.95	.997#	25.32#	1.122	28.50
220000, 250000	1.376	34.95	1.376	34.95	1.247	31.67
CAST IRON CYLINDER						
5, 6, 8, N	.873	22.17	.873	22.17	.743	18.87
9	.983	24.97	.983	24.97	.873	22.17
14, 19, 190000	1.179	29.95	1.179	29.95	.996	25.30
200000	1.197	29.95	1.179	29.95	1.122	28.50
23, 230000†	1.376	34.95	1.376	34.95	1.184	30.07
240000	Ball	Ball	Ball	Ball	1.309	33.25
300000, 320000	Ball	Ball	Ball	Ball	1.309	33.25

*Auxiliary drive models P.T.O. Bearing Reject Size — 1.003 in. (25.48 mm).

#Synchro-Balance Magneto Bearing Reject Size — 1.179 in. (29.95 mm)

†Gear Reduction P.T.O. — 1.179 in. (29.95 mm)

CRANKSHAFTS & CAM GEARS

Checking

CHECKING CAM GEAR

All Engines

Inspect gear teeth for wear and nicks. Cam shaft and cam gear journals and lobe rejection sizes are shown in Table No. 2.

Check automatic spark advance on models equipped with "Magna-Matic." Fig. 9. Place cam gear in normal operating position with the movable weight down. Press the weight down. Release. The spring should lift the weight. If not, the spring is stretched or the weight is binding. Repair or replace.

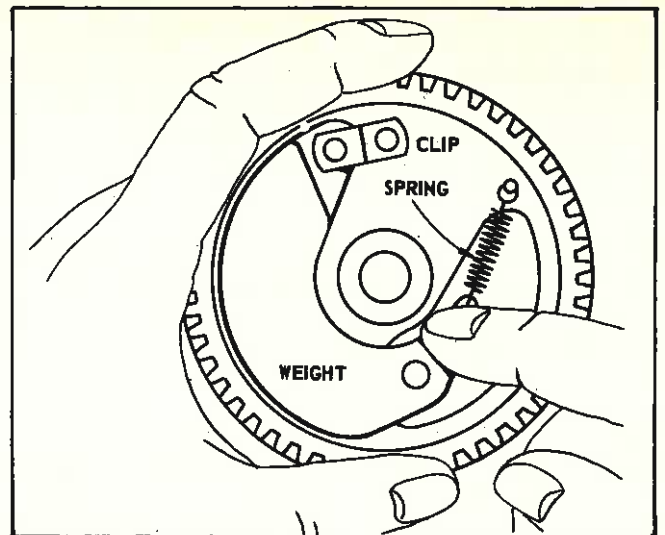


Fig. 9 — Checking Automatic Spark Advance

TABLE NO. 2
CAM GEAR REJECT SIZES

MODEL SERIES	CAM GEAR OR SHAFT JOURNAL		CAM LOBE	
	Inches	Millimeter	Inches	Millimeter
ALUMINUM CYLINDER				
6B, 60000	.498	12.65	.883	22.43
8B, 80000*	.498	12.65	.883	22.43
82000, 92000, 94000	.498	12.65	.883	22.43
110900, 111200, 111900	.436 Mag. .498 PTO	11.07 Mag. 12.65 PTO	.870	22.10
100000, 130000	.498	12.65	.950	24.13
140000, 170000, 190000	.498	12.65	.977	24.82
220000, 250000	.498	12.65	1.184	30.07
CAST IRON CYLINDER				
5, 6, 8, N	.372	9.45	.875	22.23
9	.372	9.45	1.124	28.55
14, 19, 190000	.497	12.62	1.115	28.32
200000	.497	12.62	1.115	28.32
23, 230000	.497	12.62	1.184	30.07
240000	.497	12.62	1.184	30.07
300000	#	#	1.184	30.07
320000	#	#	1.215	30.86

*Auxiliary Drive Models P.T.O. — .751 in. (19.08 mm)

#Magneto Side — .8105 in. (20.59 mm)

P.T.O. — .6145 in. (15.61 mm)

Checking Compression Release Cam

Model Series 111200, 111900

This cam gear has Easy-Spin® plus a compression release on the exhaust cam. In the starting position, the actuator cam moves the rocker cam so it will open the exhaust valve at the same time as the Easy-Spin® lobe. When the engine starts, the actuator cam moves out and lets the rocker cam move down and the exhaust valve operates normally.

To check, move actuator cam to the running position, Fig. 10. Push rocker cam against the actuator cam. Release the actuator cam. Actuator cam spring should pull actuator cam against the shoulder pin causing rocker cam to raise up to starting position, Fig. 11. There should be no binding. Replace if binding exists.

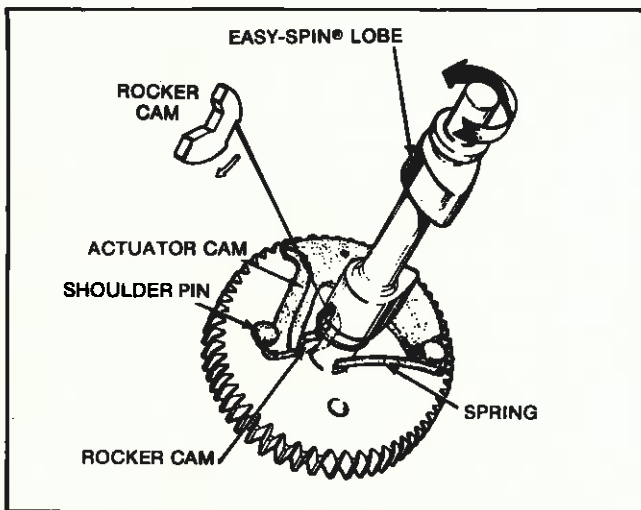


Fig. 10 — Running Position

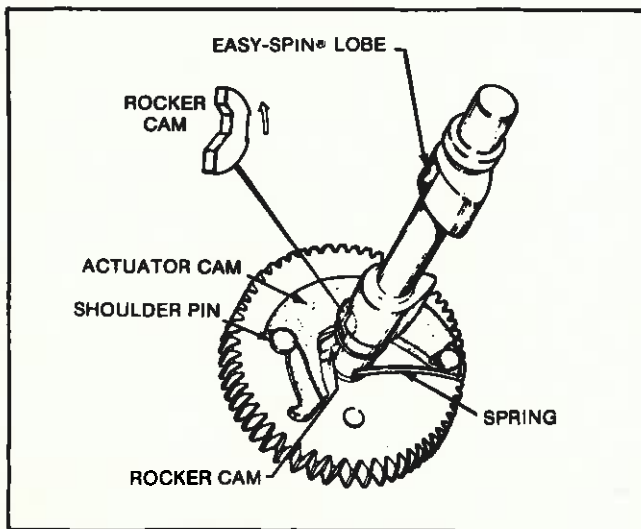


Fig. 11 — Start Position

BALL BEARINGS

Remove

The ball bearing is a press fit on the crankshaft. If either bearing or crankshaft is to be removed, use an arbor press, as shown in Fig. 12.

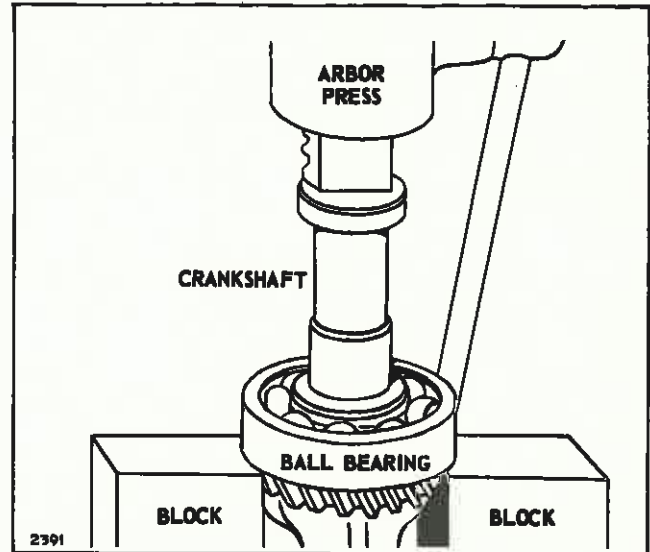


Fig. 12 — Removing Ball Bearing

Install

Heat bearing in hot oil [250° F max. (120° C)]; bearing must not rest on the bottom of the pan in which it is heated. Place crankshaft in vise with bearing side up. When bearing is quite hot it will become a slip fit on the bearing journal. Grasp bearing with the shield down and thrust it down on the crankshaft, Fig. 13. The bearing will tighten on the shaft while cooling. **DO NOT QUENCH.**

NOTE: Bearing shield faces crankshaft crankpin.

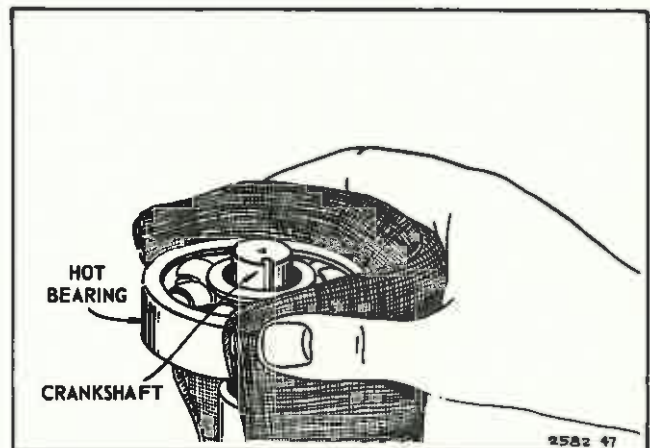


Fig. 13 — Installing Ball Bearing

CRANKSHAFTS & CAM GEARS

Installing

INSTALL CRANKSHAFT AND CAM GEAR

Aluminum Alloy Engines — Plain Bearing

In aluminum alloy models the tappets are inserted first, the crankshaft next, and then the cam gear. When inserting the cam gear, turn the crankshaft and cam gear so that the timing marks on the gears align. Fig. 14.

NOTE: Model series 94000, 171700, 191700, 251700, and 252700 have a removable timing gear. When installing timing gear, have inner chamfer toward crankpin. This assures that timing mark will be visible.

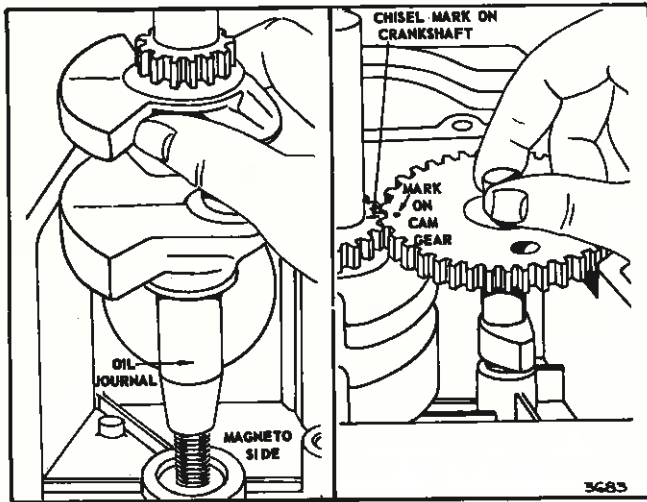


Fig. 14 — Aligning Timing Marks

Aluminum Alloy Engines — Ball Bearing

On crankshafts with ball bearings, the gear teeth are not visible for alignment of the timing marks, therefore, the timing mark is on the counterweight. Fig. 15. On ball bearing equipped models the tappets are installed first. The crankshaft and cam gear must be inserted together; align timing marks as shown in Fig. 15, and insert crankshaft and cam gear.

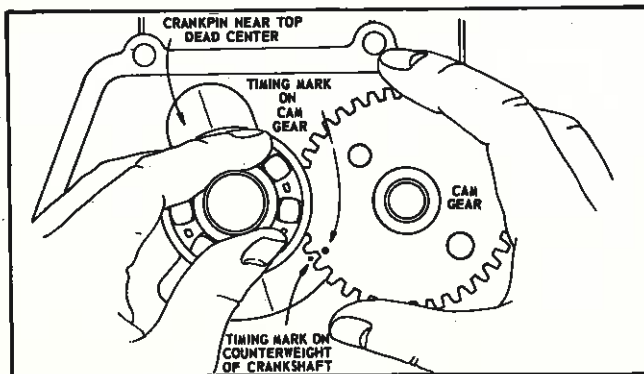


Fig. 15 — Ball Bearing Engines

CRANKCASE COVER and CRANKSHAFT END PLAY

All Models

The crankshaft end play on all models, plain and ball bearing, should be .002" (.05 mm) to .008" (.20 mm). The method of obtaining the correct end play varies, however, between cast iron, aluminum, plain and ball bearing models. New gasket sets include three crankcase cover or bearing support gaskets — .005" (.13 mm), .009" (.23 mm) and .015" (.38 mm).

Aluminum Engines — Plain Bearing

The end play should be .002" (.05 mm) to .008" (.20 mm) with one .015" (.38 mm) gasket in place. If the end play is less than .002" (.05 mm), which would be the case if a new crankcase or sump cover is used, additional gaskets of .005" (.13 mm), .009" (.23 mm) or .015" (.38 mm) may be added in various combinations to attain the proper end play.

If the end play is more than .008" (.20 mm) with one .015" (.38 mm) gasket in place, a thrust washer is available and to be placed on the crankshaft power take-off end, between the gear and crankcase cover or sump. Additional gaskets .005" (.13 mm) or .009" (.23 mm) will then have to be added to the .015" (.38 mm) gasket for proper end play. NOTE: On aluminum models never use less than .015" (.38 mm) gasket. Fig. 16.

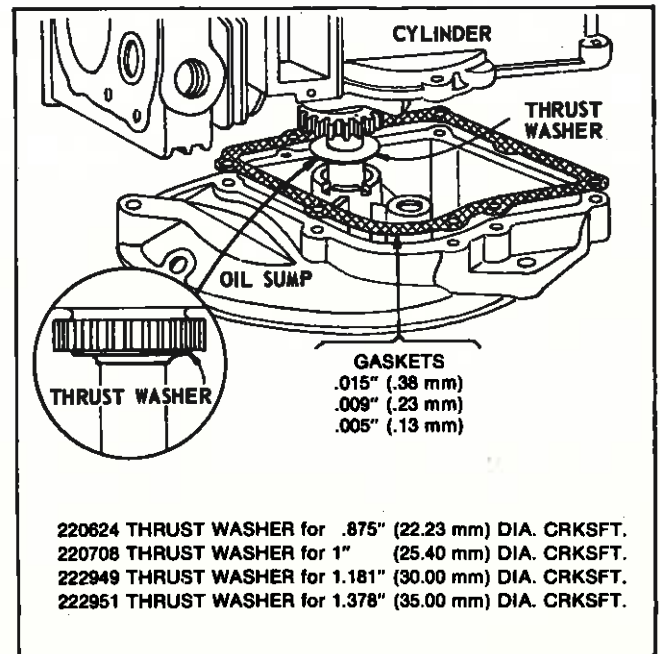


Fig. 16 — Correcting Crankshaft End Play

Aluminum Engines — Ball Bearing

Proceed as in aluminum plain bearings, except the thrust washer is added to the magneto end of the crankshaft instead of the power take-off end. Thrust washer cannot be used on engines with two (2) ball bearings.

Sump Installation

Model 100900 and 130900 Series

On these models use spring washer on cam gear as shown in Fig. 17.

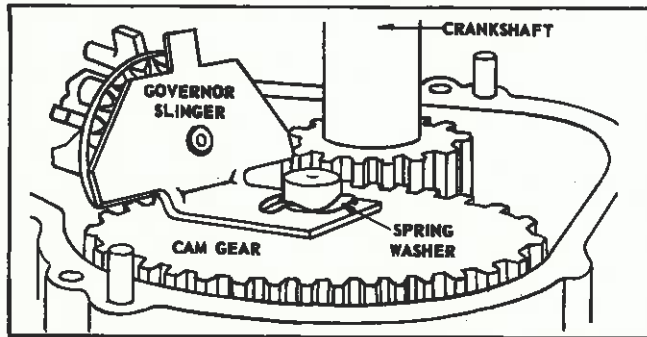


Fig. 17 — Sump Installation —
Model Series 100900 and 130900

To protect the oil seal while assembling the crankcase cover, put oil or grease on the sealing edge of the oil seal. Wrap a piece of thin cardboard around the crankshaft so the seal will slide easily over the shoulder of crankshaft. If the sharp edge of the oil seal is cut or bent under, the seal may leak.

Checking End Play

The end play may be checked by assembling a dial indicator on the crankshaft with the pointer against the crankcase. Move the crankshaft in and out. The indicator will show the end play. Fig. 18. The other method is to assemble a pulley to the crankshaft and measure the end play with a feeler gauge. Fig. 18. End play should be .002-.008" (.05-.20 mm).

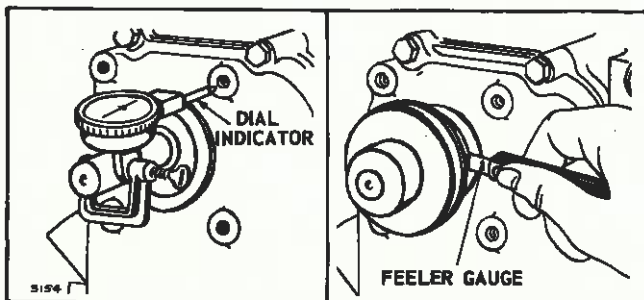


Fig. 18 — Checking Crankshaft End Play

INSTALL CRANKSHAFT AND CAM GEAR

Cast Iron Engines — Plain Bearing

Assemble the tappets to the cylinder, then insert the cam gear. Push the camshaft into the camshaft hole in the cylinder from the flywheel side through the cam gear. With a blunt punch, press or hammer the camshaft until the end is flush with the outside of the cylinder on the power take-off side. Place a small amount of sealer on the camshaft plug, then press or hammer it into the camshaft hole in the cylinder at the flywheel side. Install crankshaft so timing marks on teeth and cam gear align.

All Cast Iron Engines — Ball Bearing

Except Models 300000 and 320000

Assemble the tappets, then insert cam gear into the cylinder, pushing the cam gear forward into the recess in front of the cylinder. Insert crankshaft into cylinder. Turn camshaft and crankshaft until timing marks align, then push cam gear back until it engages the gear on the crankshaft with timing marks together. Insert camshaft. Fig. 19. Place a small amount of sealer on the camshaft plug, then press or hammer it into the camshaft hole in the cylinder at the flywheel side.

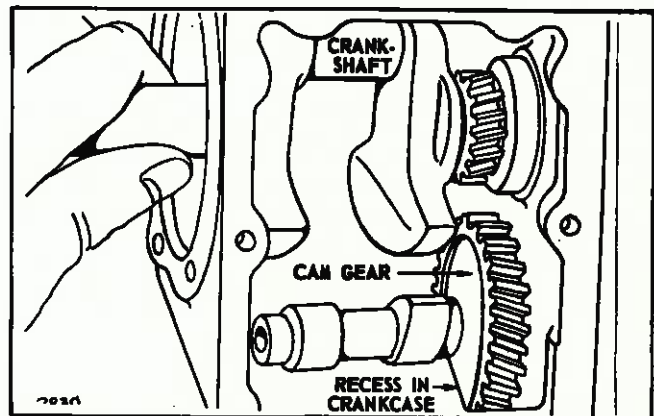


Fig. 19 — Install Crankshaft

Cast Iron Engines — End Play Plain Bearing and Ball Bearing

The crankshaft end play should be .002" (.05 mm) to .008" (.20 mm) with one .015" (.38 mm) gasket in place. If the end play is less than .002" (.05 mm), additional gaskets of .005" (.13 mm) or .009" (.23 mm) may be added to the .015" (.38 mm) gasket in various combinations to attain proper end play. If the end play is more than .008" (.20 mm) with one .015" (.38 mm) gasket in place, a .009" (.23 mm) or .005" (.13 mm) gasket may be used. Fig. 20.

CRANKSHAFTS & CAM GEARS

End Play

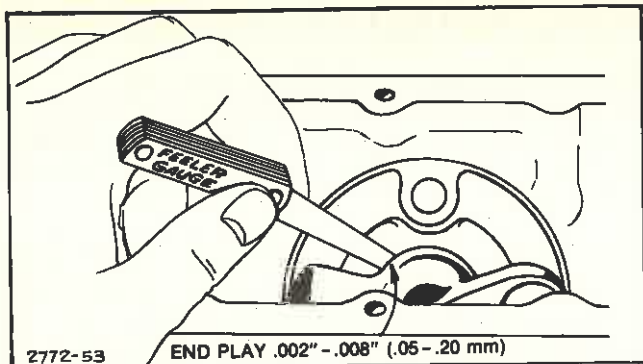


Fig. 20 — Checking Crankshaft End Play

If the end play is more than .008" (.20 mm) with one .015" (.38 mm) gasket in place, a .009" (.23 mm) or .005" (.13 mm) gasket may be used. Fig. 20.

If the end play is more than .008" (.20 mm) with one .005" (.13 mm) gasket in place, a thrust washer is available and is placed on the crankshaft power take-off end. Fig. 20.

222949 Thrust Washer for 1.181" (30 mm) diameter crankshaft.

222951 Thrust Washer for 1.378" (35 mm) diameter crankshaft.

NOTE: Thrust washer cannot be used on ball bearing engines.

Checking End Play

On models with a removable base, the end play can be checked with a feeler gauge between the crankshaft thrust face and the bearing support on plain bearing engines. Fig. 20.

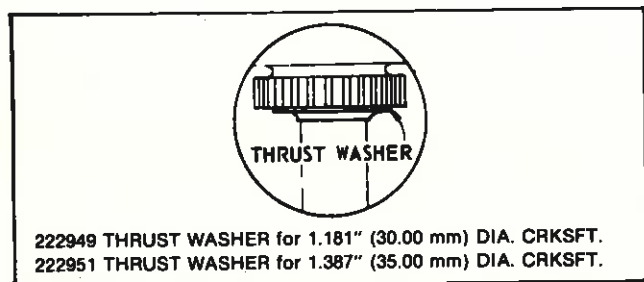


Fig. 21 — Correcting Crankshaft End Play

SERVICE PROCEDURE FOR ENGINE MODEL SERIES 300400 and 320400

Install breaker plunger and tappets, then insert cam gear from power take-off side of cylinder. See Fig. 22.

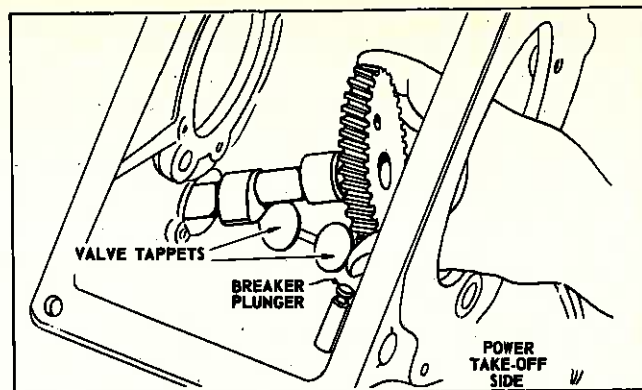


Fig. 22 — Inserting Cam Gear

Slide cam gear shaft through power take-off bearing and into cam gear. See Fig. 23.

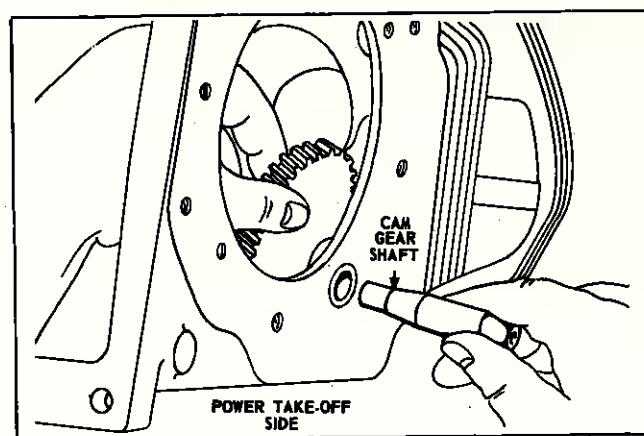


Fig. 23 — Sliding Cam Gear Shaft

Insert magneto side cam gear bearing on cylinder. Torque cam gear bearing screws to 85 inch pounds (1.0 mkp, 9.6 Nm). Install long cam gear shaft bolt (5½") (14 cm) to prevent loss of shaft. See Fig. 24.

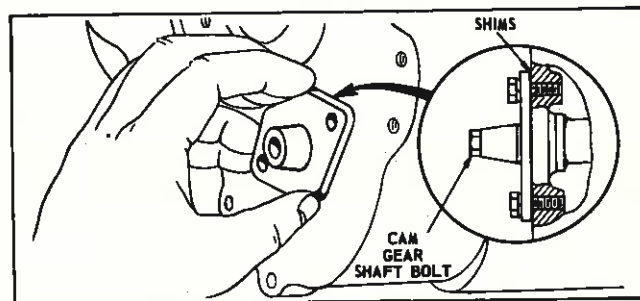


Fig. 24 — Inserting Cam Gear

CHECKING AND CORRECTING CAM GEAR END PLAY

Cam gear end play tolerance is machined at the factory and normally requires no adjustment, unless the magneto side cam gear bearing or cam gear is replaced.

CRANKSHAFTS & CAM GEARS

Auxiliary Drive

Cam gear end play is checked in the same manner as crankshaft end play.

Cam shaft end play must be .002" (.05 mm) to .008" (.20 mm). If end play is less than .002" (.05 mm), add service shims (#270516-.009" (.23 mm); #270517-.007" (.18 mm); or #270518-.005" (.13 mm) to obtain proper end play. If end play is more than .008" (.20 mm), use service bearing assembly kit #299706, which includes above shims to obtain proper end play.

Use chalk or crayon to mark the top of crankshaft gear tooth, whose inner end is directly in line with the notch of the timing mark. See Fig. 25.

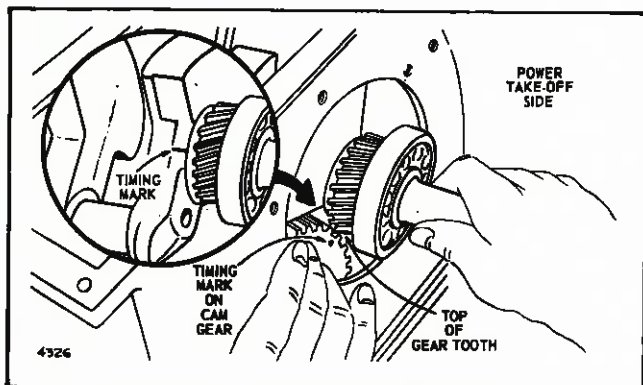


Fig. 25 — Aligning Timing Marks

Align timing marks on crankshaft and cam gear, and install crankshaft. Install crankshaft carefully so crankpin is not damaged.

Install power take-off and magneto side bearing supports. Torque power take-off support screws to 185 inch-pounds (2.2 mkp, 20.9 Nm). Torque magneto side support screw to 85 inch-pounds (1.0 mkp, 9.6 Nm). See Fig. 26.

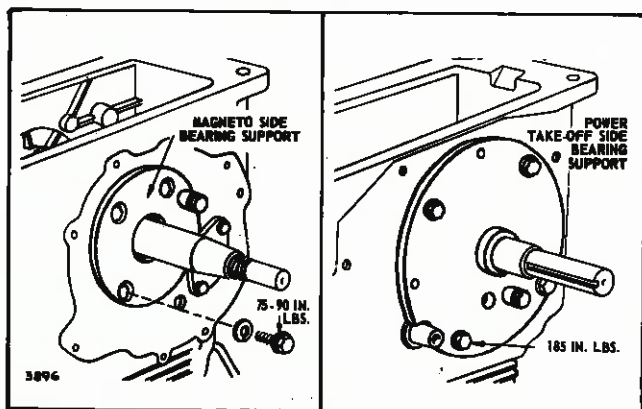


Fig. 26 — Installing Bearing Supports

See Section 12 for timing of synchro-balance timing gears.

CHECKING AND CORRECTING CRANKSHAFT END PLAY

Crankshaft end play tolerance is machined at the factory and normally requires no adjustment, unless the bearing supports or crankshaft is replaced.

Crankshaft end play must be .002" (.05 mm) to .008" (.20 mm). If end play is less than .002" (.05 mm), add service shims (#270513-.015" (.38 mm); #270514-.010" (.25 mm); or #270515-.005" (.13 mm) to obtain proper end play. If end play is more than .008" (.20 mm), use service bearing support assembly kit #299705, which includes the above shims, to obtain proper end play.

Auxiliary P.T.O. — Model Series 92580, 92980, 94580, 94980, 110980, 111980

This auxiliary power take-off shaft is perpendicular to the crankshaft. It rotates at the rate of one revolution for every 8½ revolutions of the crankshaft. On these models, the cam gear, worm gear and oil slinger are a Factory assembly and are not available as separate pieces. See Fig. 27.

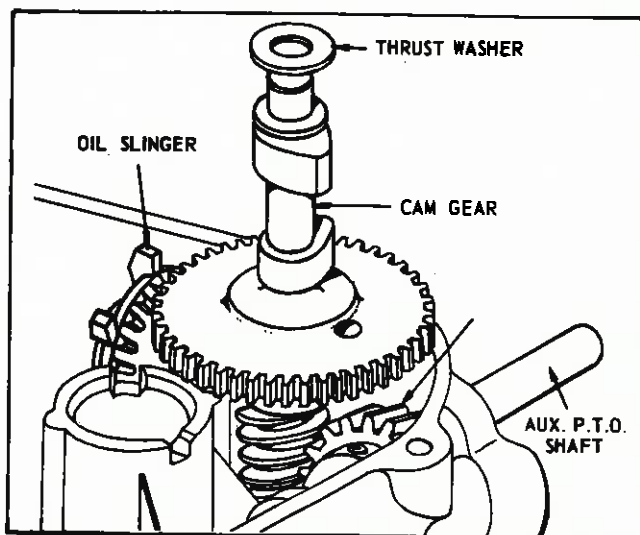


Fig. 27 — Remove and Install Sump Screw

NOTE: If rotation is counterclockwise, the thrust washer is placed next to the worm gear on camshaft.

To remove the sump: One of the six sump mounting screws is located under the auxiliary drive cover. Remove the cover. Lift out shaft stop. See Fig. 28. Slide gear and shaft sideways to expose head of sump mounting screw. Use 7/16" socket to remove screw.

CRANKSHAFTS & CAM GEARS

Auxiliary Drive with Clutch

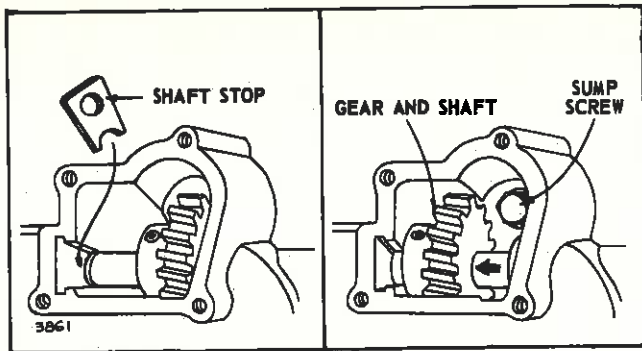


Fig. 28 — Auxillary P.T.O.

When installing cover, Fig. 29, put non-hardening sealant on cover screws.

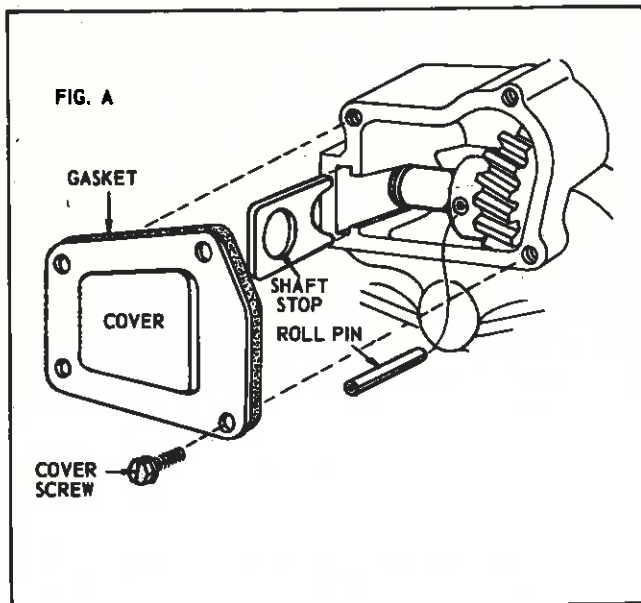


Fig. 29 — Installing Cover

AUXILIARY P.T.O. — With Clutch — Model Series 110980

This auxiliary power take-off shaft is perpendicular to the crankshaft. It rotates at the rate of one revolution for every 8-1/2 revolutions of the crankshaft. Rotation of the shaft is controlled by a clutch on the cam gear. The clutch is engaged or disengaged by a control lever mounted on the oil sump.

Early production cam gears, Fig. 30, are serviced as an assembly consisting of cam gear oil slinger, clutch hub, clutch spring and clutch sleeve assembly. Later production cam gears are serviced as individual parts except for the cam gear which consists of cam gear, oil slinger and clutch hub.

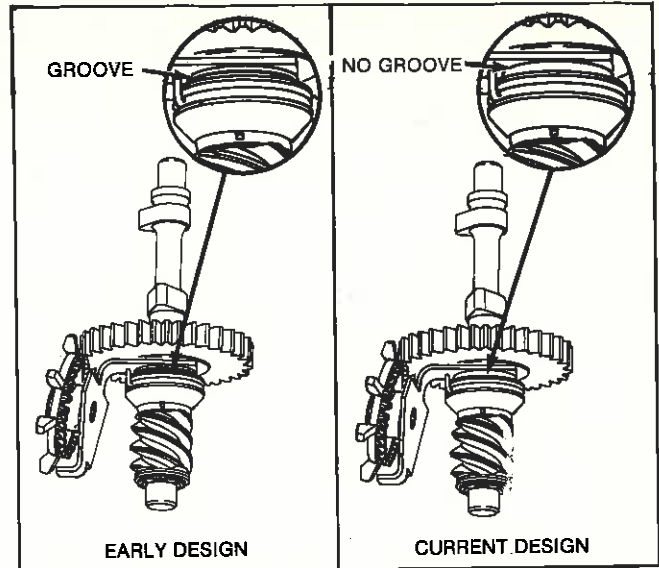


Fig. 30 — Cam Gear and Clutch

To remove sump: Sump is held on by six screws. Five screws are exposed. The sixth screw is under the auxiliary drive cover, Fig. 28. Remove cover and lift out shaft stop, Fig. 28. Slide drive-shaft and gear over to expose head of cap screw. Cap screw can be removed with 7/16" socket.

INSPECT CLUTCH OPERATION

Push on spring tang, "A," Fig. 31, turning spring and clutch sleeve in a counterclockwise direction. Spring and sleeve should rotate approximately 1/8" turn. Worm gear should not rotate in the same direction. With clutch released, worm gear should rotate freely in both directions.

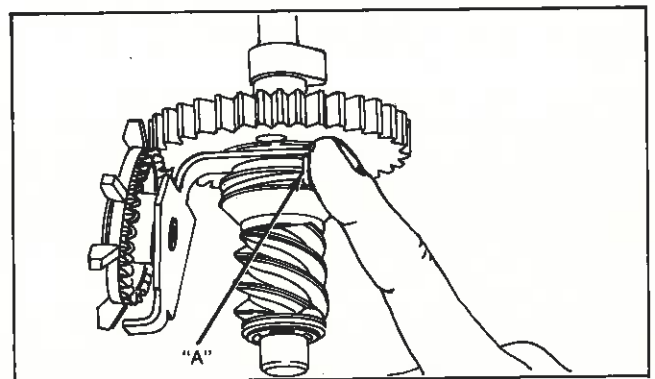


Fig. 31 — Inspect Clutch

CHECK CAM GEAR

Check worm gear end play using feeler gauges at point "A," Fig. 32. End play should not be less than .004", (.10 mm) or more than .017" (.43 mm).

CRANKSHAFTS & CAM GEARS

Auxiliary Drive with Clutch

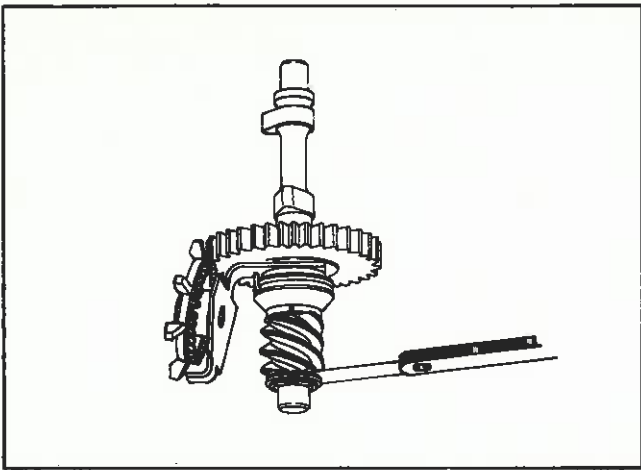


Fig. 32 — Check Cam Gear

CAM GEAR DISASSEMBLY — EARLY DESIGN

Remove "E" ring retainer. Slide off copper washer, thick thrust washer, worm and thin thrust washer. Cam gear, oil slinger, clutch sleeve and springs are serviced with a current production assembly.

INSPECT PARTS

Inspect for worn, burred or broken parts and replace as required.

ASSEMBLE CAM GEAR — EARLY DESIGN

Slide worm gear with thin thrust washer on cam gear. Slide on thick thrust washer. Slide on copper colored washer with gray coated side toward thick thrust washer. Install "E" ring retainer and check worm end play as described in "Check Cam Gear" section above. Inspect cam gear assembly as outlined in in "Inspect Clutch Operation" section above.

DISASSEMBLY CAM GEAR — CURRENT DESIGN

Remove "E" ring. Slide off thrust washers and worm gear. Use thin blade screwdriver or similar tool to pry lower clutch spring tab out of hole in clutch sleeve, Fig. 33. Remove clutch sleeve. Slide clutch spring down, Fig. 34 and lift out upper spring tab to remove spring. Cam gear, oil slinger and clutch drive hub are serviced as an assembly.

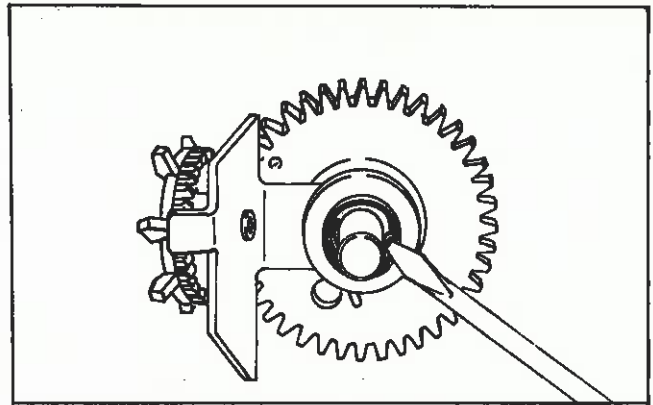


Fig. 33 — Remove Clutch Sleeve

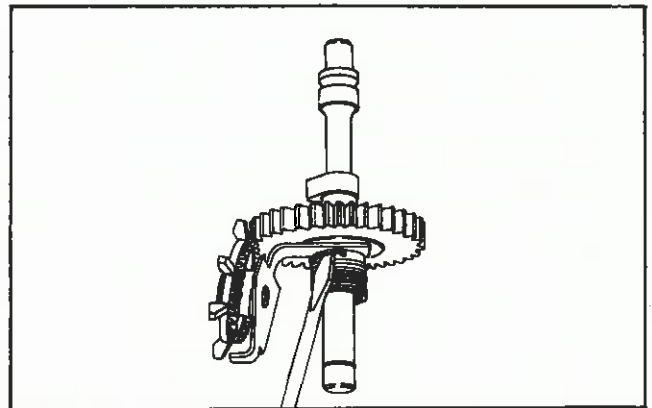


Fig. 34 — Remove Clutch Spring

INSPECT PARTS

Inspect for worn, broken or burred parts. Replace as required.

ASSEMBLE CAM GEAR — CURRENT DESIGN

Assemble clutch spring as shown in Fig. 35. Align hole in clutch sleeve with tab or spring and slide on. Depress spring tab, if required. When clutch sleeve is in place, spring tab should be in sleeve hole, Fig. 36.

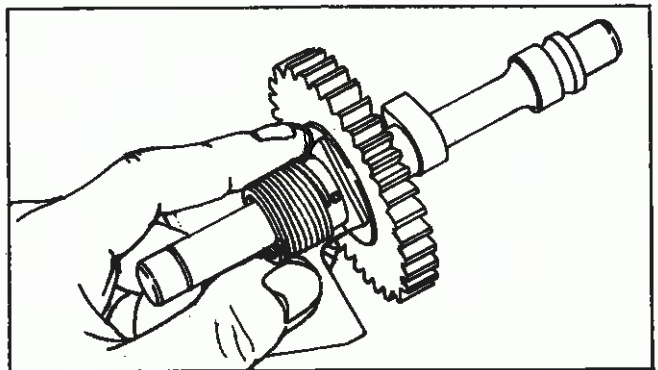


Fig. 35 — Assemble Clutch Spring

10

CRANKSHAFTS & CAM GEARS

Auxiliary Drive with Clutch

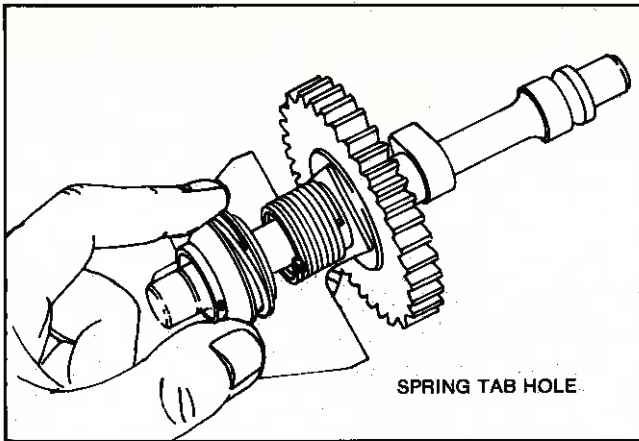


Fig. 36 — Install Clutch Sleeve

Slide thin thrust washer and worm on cam gear. Slide in thick thrust washer. Slide on copper washer with gray coated side toward thrust washer. Install "E" ring and check worm gear end play as described in "Check Cam Gear" section, page 10. Inspect cam gear assembly as outlined in "Inspect Clutch Operation" section, page 10.

REMOVE CONTROL LEVER SHAFT

Remove "E" ring, Fig. 37. Slide control lever and shaft out slowly until lever clears boss on sump. Slowly release spring tension and then remove shaft, spring and "O" ring seal.

Inspect shaft assembly for loose lever, worn or broken parts. Replace as needed.

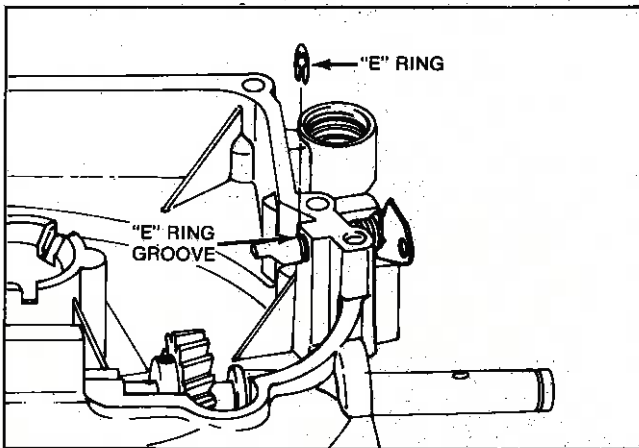


Fig. 37 — Remove "E" Ring

ASSEMBLE CONTROL LEVER AND SHAFT ASSEMBLY

Install return spring on shaft and lever assembly as shown in Fig. 38. Then install "O" ring seal on shaft. Lubricate "O" ring and shaft lightly with engine oil.

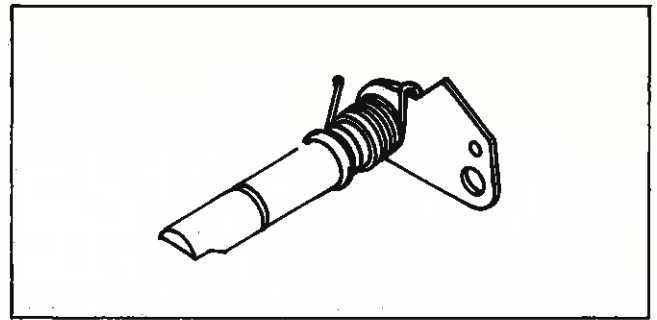


Fig. 38 — Assemble Spring

Slide control lever assembly into shaft bore, Fig. 39, as far as it will go. Rotate lever clockwise to put tension on return spring. When lever clears stop boss, push lever and spring in until lever stops. Install "E" ring. Leg of spring may need to be pushed against sump, Fig. 40.

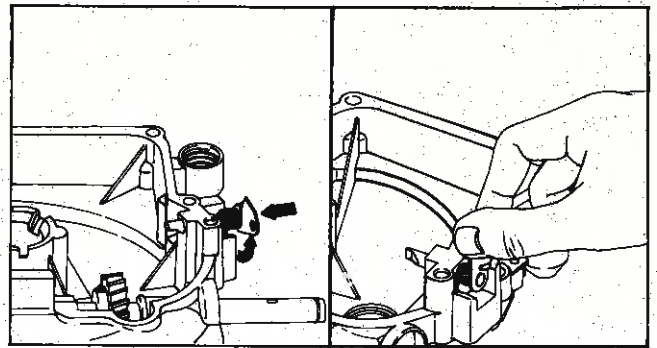


Fig. 39 — Lever Installation

Fig. 40 — Spring Installation

CYLINDER CLIP WASHER

Should clip washer in cylinder require replacing, be sure flat on clip washer is in line with flat on cam bearing boss and spring tabs are on both sides of cam bearing web, Fig. 41.

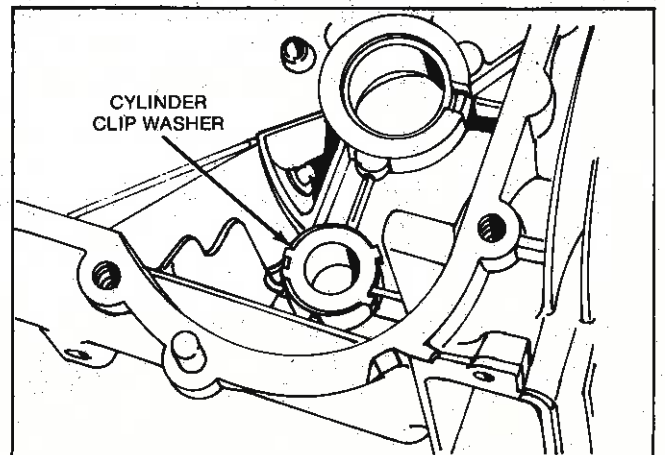


Fig. 41 — Cylinder Clip Washer