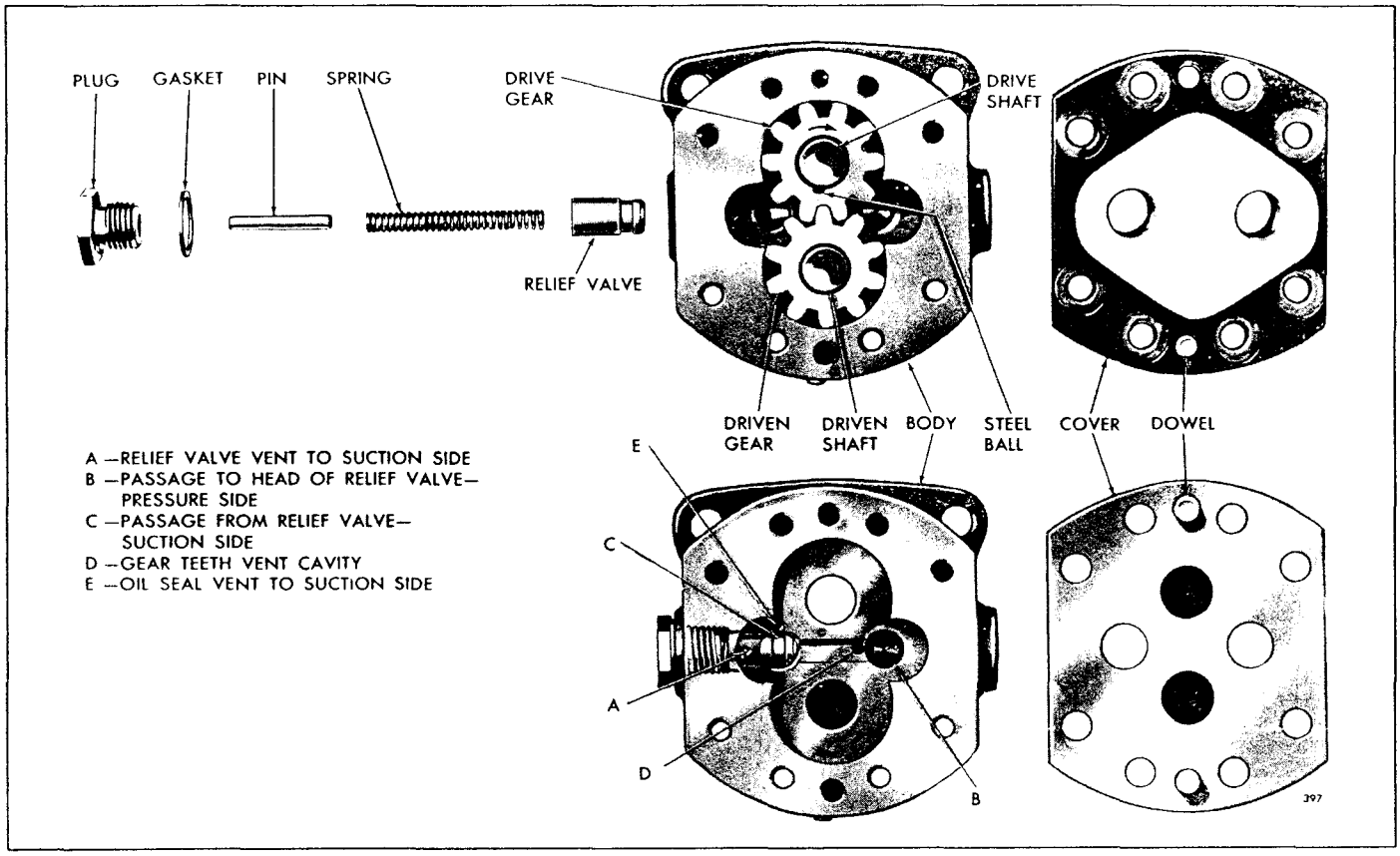


Fig. 2 – Fuel Pump Valving and Rotation (Right Hand Pump Shown)

The drive and driven gears are a line–to–line to a .001" press fit on their shafts. The drive gear is provided with a gear retaining ball to locate the gear on the shaft.

A spring–loaded relief valve incorporated in the pump body normally remains in the closed position, operating only when pressure on the outlet side (to the fuel filter) reaches approximately 65 psi (448 kPa).

Operation

In operation, fuel enters the pump on the suction side and fills the space between the gear teeth which are exposed at that instant. The gear teeth then carry the fuel oil to the discharge side of the pump and, as the gear teeth mesh in the center of the pump, the fuel is forced out into the outlet cavity. Since this is a continuous cycle and fuel is continually being forced into the outlet cavity, the fuel flows from the outlet cavity into the fuel lines and through the engine fuel system under pressure.

The pressure relief valve relieves the discharge pressure by by–passing the fuel from the outlet side of the pump to the inlet side when the discharge pressure reaches approximately 65 to 75 psi (448 to 517 kPa).

The fuel pump should maintain the fuel pressure at the fuel inlet manifold (see Section 13.2).

Remove Fuel Pump

1. Disconnect the fuel lines from the inlet and outlet openings of the fuel pump.
2. Disconnect the drain tube, if used, from the fuel pump.
3. Remove the three pump attaching bolts and withdraw the pump.
4. Check the drive coupling fork and, if broken or worn, replace it with a new coupling.

Disassemble Fuel Pump

With the fuel pump removed from the engine and mounted in holding fixture J 1508–10 as shown in Fig. 4, refer to Figs. 1 and 6 and disassemble the pump as follows:

1. Remove the eight cover bolts and withdraw the pump cover from the pump body. Use care not to damage the finished faces of the pump body and cover.
2. Withdraw the drive shaft, drive gear and gear retaining ball as an assembly from the pump body.

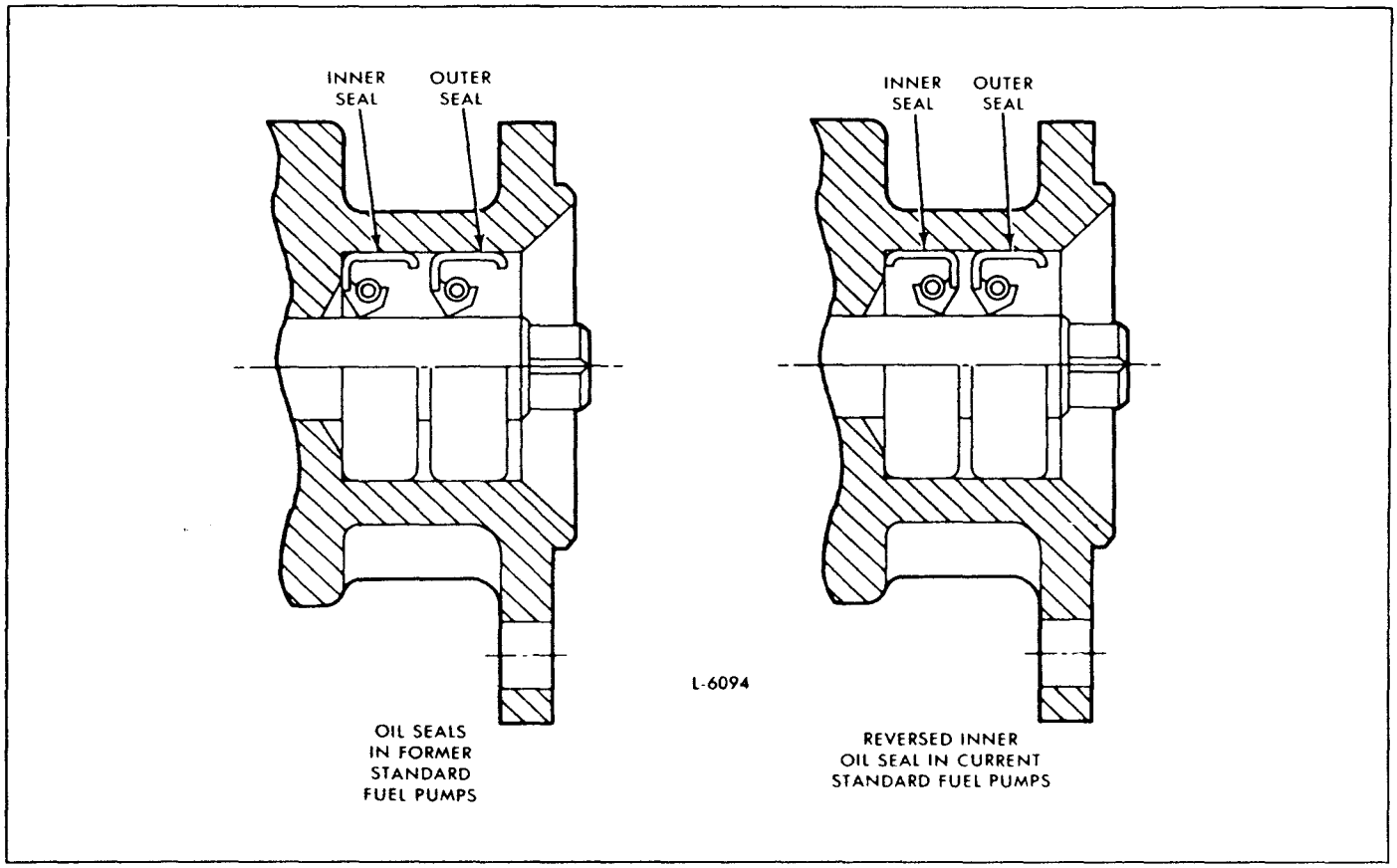


Fig. 3 – Fuel Pump Oil Seal Arrangements

3. Press the drive shaft just far enough to remove the steel locking ball. Then invert the shaft and gear assembly and press the shaft from the gear. *Do not misplace the steel ball.* Do not press the squared end of the shaft through the gear as slight score marks will damage the oil seal contact surface.

4. Remove the driven shaft and gear as an assembly from the pump body. *Do not remove the gear from the shaft.* The driven gear and shaft are serviced only as an assembly.

5. Remove the relief valve plug and copper gasket.

6. Remove the valve spring, pin and relief valve from the valve cavity in the pump body.

7. If the oil seals need replacing, remove them with oil seal remover J 1508–13 (Fig. 5). Clamp the pump body in a bench vise and tap the end of the tool with a hammer to remove the outer and inner seals.

NOTICE: Observe the position of the oil seal lips before removing the old seals to permit installation of the new seals in the same position (Fig. 3).

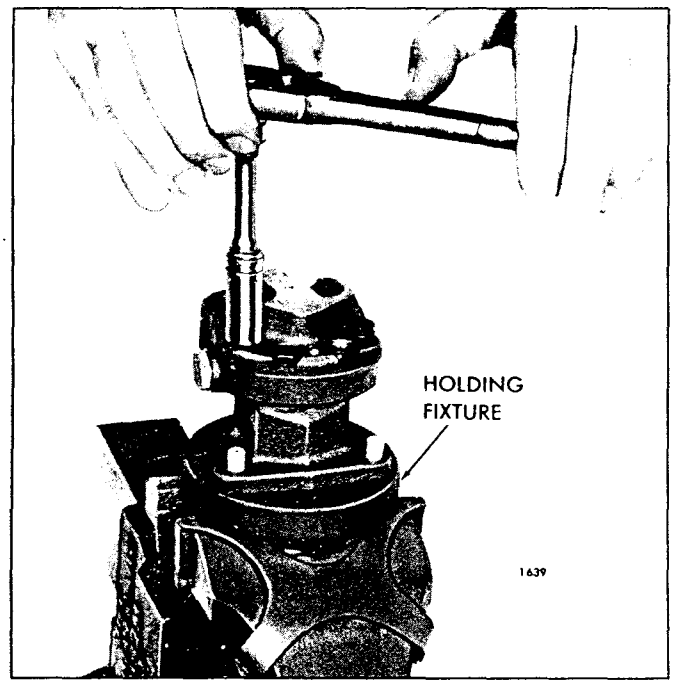


Fig. 4 – Removing Fuel Pump Cover

Inspection

Clean all of the parts in clean fuel oil and dry them with compressed air.

- **CAUTION: To prevent possible personal injury, wear adequate eye protection and do not exceed 40 psi (276 kPa) air pressure.**

Oil seals, once removed from the pump body, must be discarded and replaced with new seals.

Check the pump gear teeth for scoring, chipping or wear. Check the ball slot in the drive gear for wear. If necessary, replace the gear.

Inspect the drive and driven shafts for scoring or wear. Replace the shafts if necessary. The driven shaft is serviced as a gear and shaft assembly only.

The mating faces of the pump body and cover must be flat and smooth and fit tightly together. Any scratches or slight damage may result in pressure leaks. Also, check for wear at areas contacted by the gears and shafts. Replace the pump cover or body, if necessary.

The relief valve must be free from score marks and burrs and fit its seat in the pump body. If the valve is scored and cannot be cleaned up with fine emery cloth or crocus cloth, it must be replaced.

Current standard fuel pumps (with 1/4" wide gears) incorporate a 1/8" shorter pump body with three drain holes, a 1/8" shorter drive shaft and a cover with a 3/8" inlet opening. When replacing a former pump, a 3/8" x 1/4" reducing bushing is required for the inlet opening and the unused drain holes must be plugged.

Assemble Fuel Pump

Refer to Figs. 1, 2, 3 and 6 and assemble the pump as follows:

1. Lubricate the lips of the oil seals with a light coat of vegetable shortening, then install the oil seal in the pump body as follows:

   a. Place the inner oil seal on the pilot of the installer handle J 1508–8 so that the lip of the seal will face toward the shoulder on the tool.

      When replacing the former nitrile fuel pump seals with the current polyacrylate seals, install them with the seal lips facing each other (Fig. 3).

   b. With the pump body supported on wood blocks (Fig. 7), insert the pilot of the installer handle in the pump body so the seal starts straight into the pump flange. Then drive the seal in until it bottoms.

   c. Place the shorter end of the adaptor J 1508–9 over the pilot and against the shoulder of the installer handle. Place the outer oil seal on the pilot of the installer handle with the lip of the seal facing the adaptor. Then insert the pilot of the installer handle into the pump body and drive the seal in (Fig. 8) until the shoulder of the adaptor contacts the pump body. Thus the oil seals will be positioned so that the space between them will correspond with the drain holes located in the bottom of the pump body.

2. Clamp the pump body in a bench vise (equipped with soft jaws) with the valve cavity up. Lubricate the outside diameter of the valve and place it in the cavity with the hollow end up. Insert the spring inside of the valve and the pin inside of the spring. With a new gasket in place next to the head of the valve plug, place the plug over the spring and thread it into the pump body. Tighten the 1/2"–20 plug to 18–22 lb–ft (24–30 N·m) torque.

3. Install the pump drive gear over the end of the drive shaft which is not squared (so the slot in the gear will face the plain end of the shaft). This operation is very important, otherwise fine score marks caused by pressing the gear into position from the square end of the shaft may cause rapid wear of the oil seals. Press the gear beyond the gear retaining ball detent. Then place the ball in the detent and press the gear back until the end of the slot contacts the ball.

4. Lubricate the pump shaft and insert the square end of the shaft into the opening at the gear side of the pump body and through the oil seals as shown in Fig. 9.

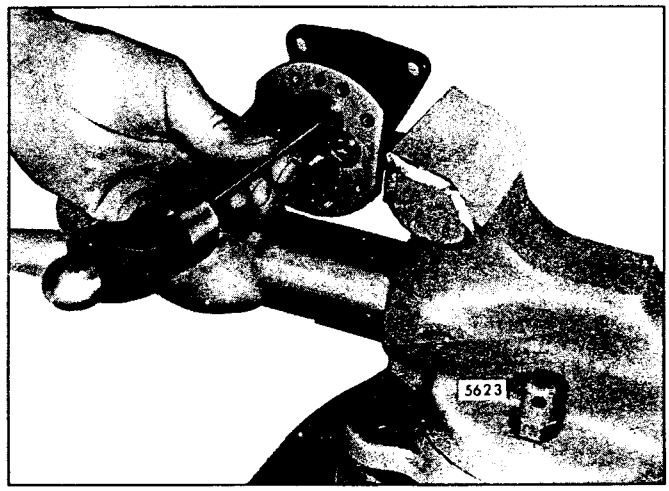


Fig. 5 – Removing Oil Seals Using Tool J 1508–13

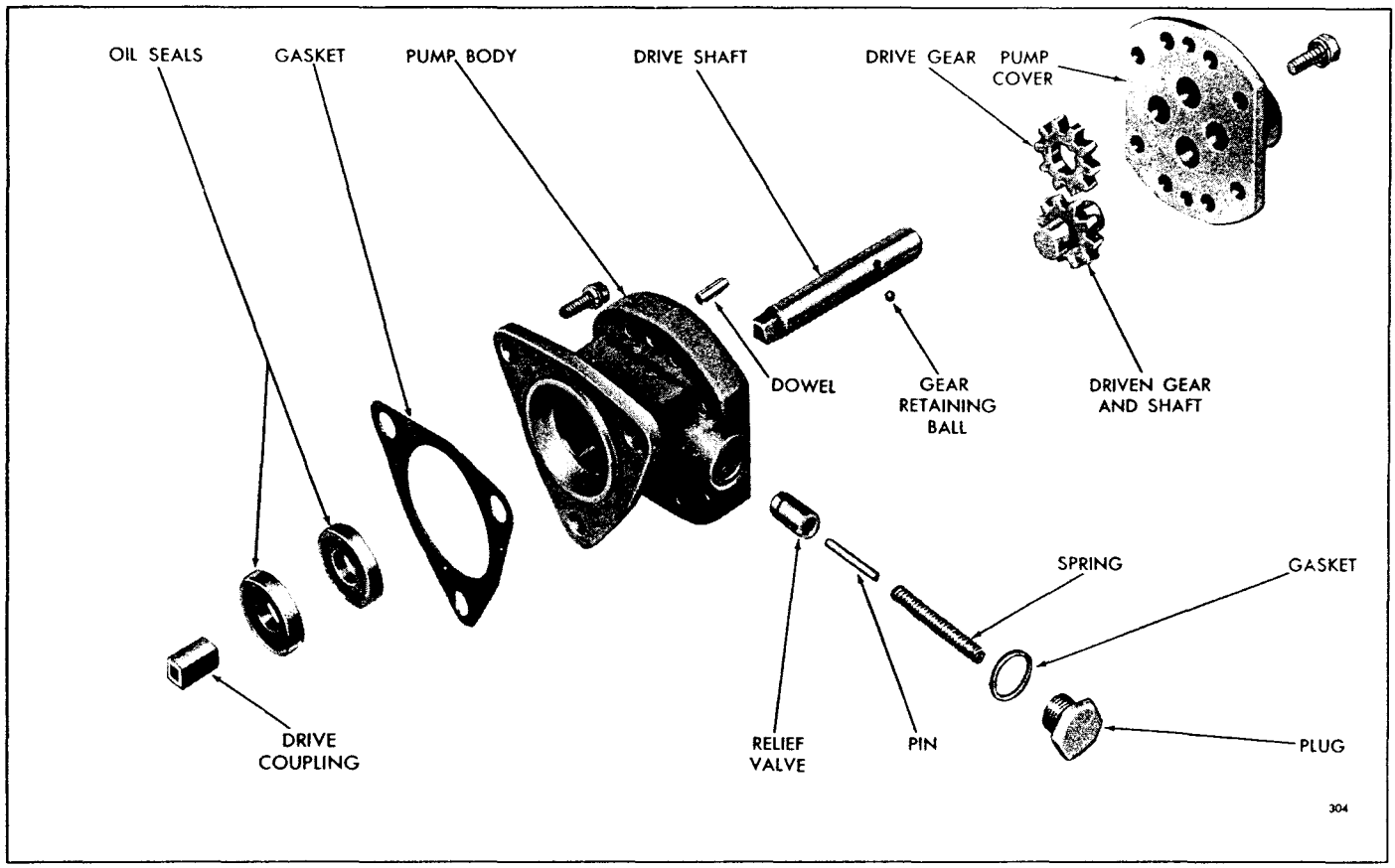


Fig. 6 – Fuel Pump Details and Relative Location of Parts (Right Hand Pump Shown)

5. Place the driven shaft and gear assembly in the pump body.

   NOTICE: The driven gear must be centered on the shaft to give proper end clearance. Also, the chamfered end of the gear teeth of the production gear must face the pump body. If a service replacement gear with a slot is used, the slot must face toward the pump cover.

6. Lubricate the gears and shafts with clean engine oil.

7. Apply a thin coat of quality sealant on the face of the pump cover outside of the gear pocket area.

   Then place the cover against the pump body with the two dowel pins in the cover entering the holes in the pump body. The cover can be installed in only one position over the two shafts.

   NOTICE: The coating of sealant must be extremely thin since the pump clearances have been set up on the basis of metal–to–metal contact. Too much sealant could increase the clearances and affect the efficiency of the pump. Use care that sealant is not squeezed into the gear compartment, otherwise damage to the gears and shafts may result.

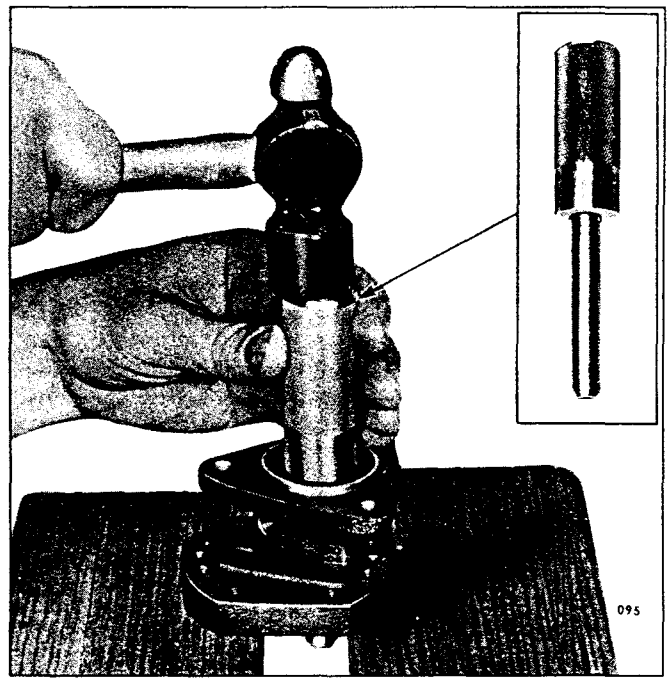


Fig. 7 – Installing Inner Oil Seal Using Tool J 1508–8

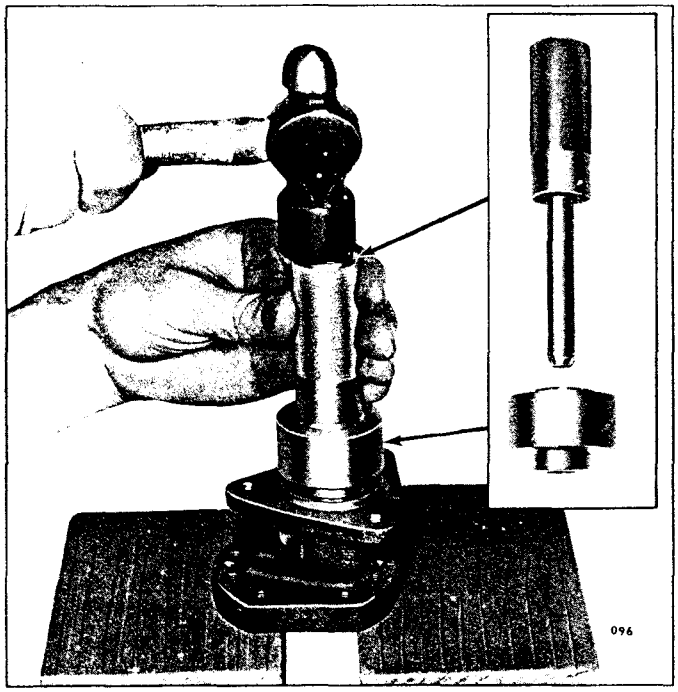


Fig. 8 – Installing Outer Oil Seal Using Tools J 1508-8 and J 1508-9

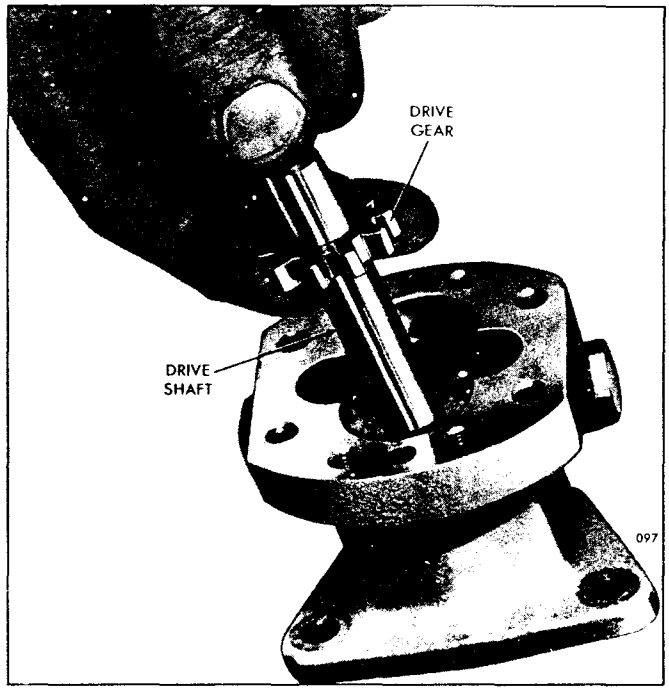


Fig. 9 – Installing Fuel Pump Drive Shaft and Gear Assembly

8. Secure the cover in place with eight bolts and lock washers, tightening the bolts alternately and evenly.

9. After assembly, rotate the pump shaft by hand to make certain that the parts rotate freely. If the shaft does not rotate freely, attempt to free it by tapping a corner of the pump.

10. Install 1/8" pipe plugs in the upper unused drain holes.

11. If the pump is not to be installed immediately, place plastic shipping plugs in the inlet and outlet openings to prevent dirt or other foreign material from entering the pump.

Install Fuel Pump

1. Affix a new gasket to the pump body mounting flange and locate the pump drive coupling over the square end of the fuel pump drive shaft.

2. Install the fuel pump on the engine and secure it with three nylon patch bolts.

   To provide improved sealing against leakage, nylon patch bolts are used in place of the former bolt and seal assemblies.

• 3. If removed, install the inlet and outlet elbows in the pump cover. Before installing, coat the threads lightly with Gasoila, Permatex 2, or an equivalent non-hardening sealant.

• **NOTICE:** Do not use Teflon tape or paste on fittings, since this can result in fuel pump cover damage (cracking) before the required torque is reached.

• To prevent sealant from entering the fuel system, do not apply it to the first two (2) threads of the fittings. Tighten fittings to the low end of the torque. If necessary, continue tightening until alignment is achieved, but do not exceed maximum torque. Tighten fittings to the following values:

Fitting Size	Torque
1/4"	14-16 lb-ft. (19-22 N·m)
3/8"	18-22 lb-ft. (24-30 N·m)
1/2"	20-25 lb-ft. (27-34 N·m)

4. Connect the inlet and outlet fuel lines to the fuel pump.

5. Connect the fuel pump drain tube, if used, to the pump body.

6. If the fuel pump is replaced or rebuilt, prime the fuel system before starting the engine using Primer J 5956. This will prevent the possibility of pump seizure upon initial starting.

FUEL PUMP DRIVE

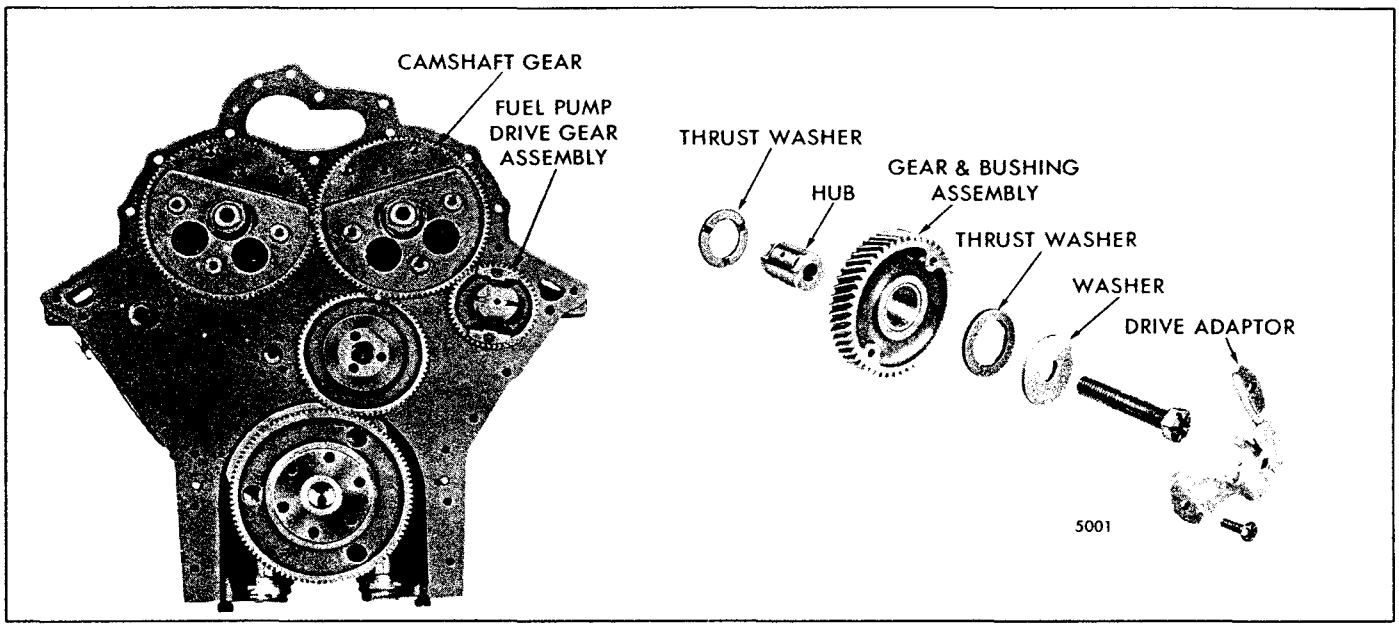


Fig. 1 – Typical Fuel Pump Drive Gear Mounting and Details (V–Type Engine)

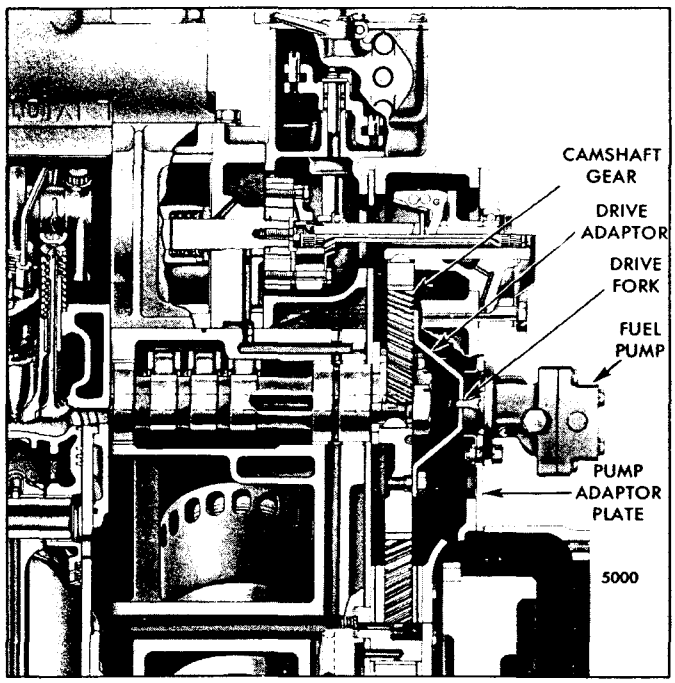


Fig. 2 – Camshaft Drive for Fuel Pump (6V Engine Shown)

On some V–type engines, the fuel pump is mounted on the flywheel housing and is driven by an accessory drive gear. The fuel pump drive consists of a gear, stationary hub and drive adaptor (Fig. 1). The fuel pump drive gear rotates on the stationary hub attached to the cylinder block and is driven at approximately twice the engine speed by the camshaft gear. On other V–type engines, the fuel pump may be driven by either camshaft by means of a drive fork and drive adaptor (Fig. 2), in the same manner as the pump mounted on the flywheel housing of the In–line engines.

The fuel pump on In–line engines is driven by the governor weight shaft by means of a drive coupling. On some engines, the fuel pump is mounted on an adaptor plate attached to the flywheel housing. A drive adaptor attached to the balance shaft gear registers with a drive fork on the fuel pump shaft to provide a drive for the pump. Servicing of the fuel pump and drive on an In–line engine is covered in Section 2.2; the following applies only to a V–type engine.

To reduce the level of engine noise in the Series 53 engines, the pitch and pressure angle of the gear train and accessory drive gears has been changed. Refer to Section 1.7.1.

Lubrication

The fuel pump drive gear bearing (bushing type) is pressure lubricated. Lubricating oil from the oil gallery in the cylinder block flows through a drilled passage in the block, around the gear retaining bolt, and through another drilled hole in the gear hub to the bearing.

Remove Fuel Pump Drive Gear (V-Type Engine)

With the flywheel housing removed, remove the fuel pump drive gear as follows:

1. Remove the bolts and detach the fuel pump drive adaptor from the gear.
2. Loosen the fuel pump drive gear retaining bolt and remove the bolt and washer, gear, thrust washers and hub from the engine.

Inspection

Wash the drive gear and its related parts with fuel oil and dry them with compressed air.

- **CAUTION: To prevent possible personal injury, wear adequate eye protection and do not exceed 40 psi (276 kPa) air pressure.**

Inspect the thrust washers, hub and drive gear bearing for wear or scoring. Parts which are excessively worn or scored must be replaced. A pre-finished drive gear bearing (bushing type) is available for service. A new bushing should be pressed in flush to .010" below the gear face (both sides). Examine the gear teeth and, if they are excessively worn, scored or pitted, replace the gear and bushing assembly.

Install Fuel Pump Drive Gear (V-Type Engine)

Install the fuel pump drive gear and its related parts on the engine as outlined below:

1. Lubricate the drive gear bearing, thrust washers and hub with engine oil.
2. Assemble the fuel pump drive gear and thrust washers on the hub. The oil grooves in the thrust washers *must face toward the gear.* Note the position of the oil hole in the hub.

   Do not mix the former and the current hardened gears on the same engine. Mixing the gears will result in the excessive gear wear and may lead to serious engine damage.

   - **NOTICE:** The hardened gears are used on 6V turbocharged automotive engines. This change became effective with engine serial number 6D-229616.
3. Install the hub and gear assembly on the engine with the small diameter of the hub entering the rear end plate and the counterbore in the cylinder block, and the fuel pump drive gear teeth in mesh with the camshaft gear teeth. The oil hole in the hub should be toward the bottom of the engine.
4. Secure the gear and hub assembly in place with the gear retaining bolt and washer. Tighten the 1/2"-13 bolt to 71-75 lb-ft (96-102 N·m) torque.
5. Check the clearance between the gear and the thrust washer. The specified clearance between new parts is between .005" and .018". The maximum clearance between used parts must not exceed .022".
6. Attach the fuel pump drive adaptor to the gear with the two bolts.

FUEL STRAINER AND FUEL FILTER

(BOLT-ON TYPE)

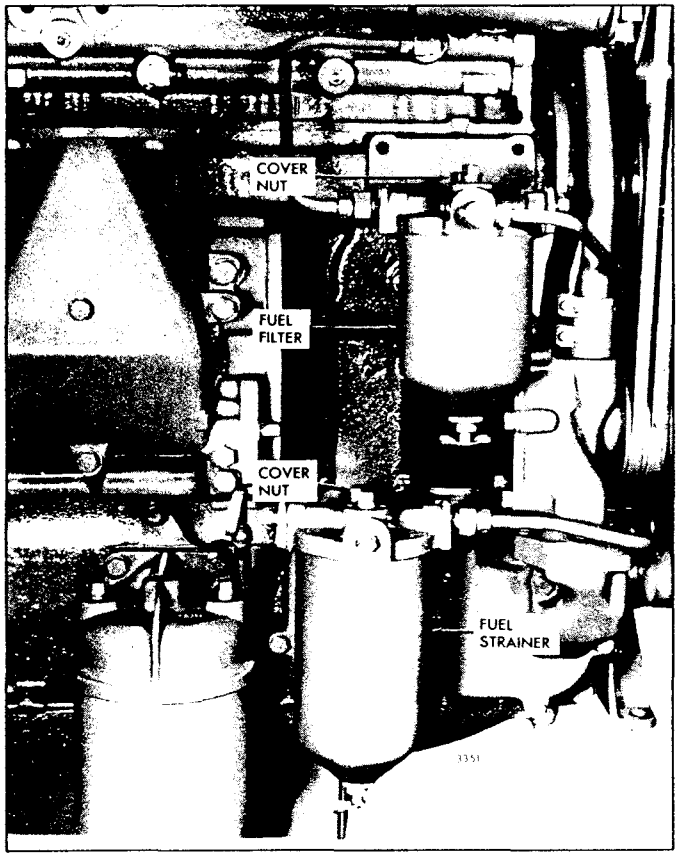


Fig. 1 – Typical Fuel Strainer and Fuel Filter Mounting

• A fuel strainer (primary) and fuel filter (secondary), Fig. 1, are used to remove impurities from the fuel. The fuel strainer is located between the fuel tank and the fuel pump. The replaceable density–type element is capable of filtering out particles of 30 microns (a micron is approximately .00004"). The fuel filter is installed between the fuel pump and the fuel inlet manifold. The replaceable paper–type (cellulose) element (Fig. 2) can remove particles as small as 10 microns. Fiberglass elements can remove particles as small as 5 microns.

> **NOTICE:** A fuel tank of galvanized steel should never be used for fuel storage, as the fuel oil reacts chemically with the zinc coating to form powdery flakes which quickly clog the fuel filter and cause damage to the fuel pump and the fuel injectors.

The fuel strainer and fuel filter are essentially the same in construction and operation, and they will be treated as one in this section.

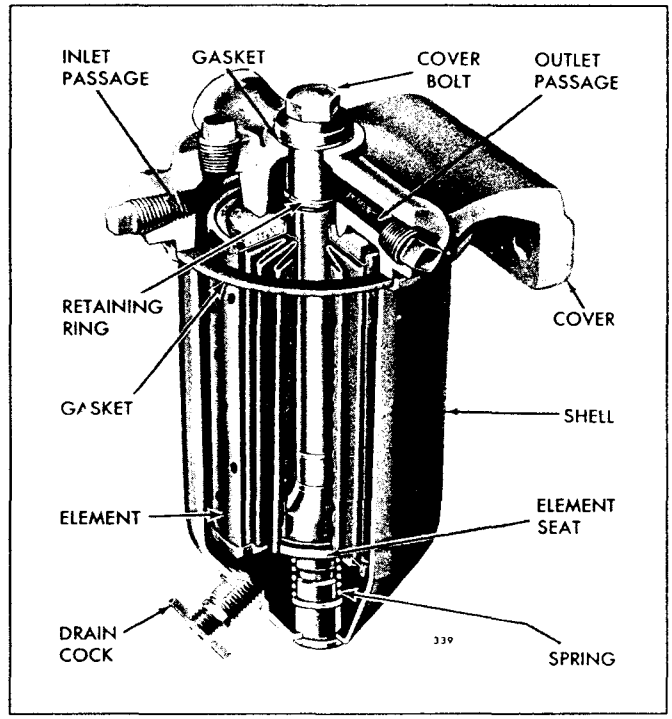


Fig. 2 – Fuel Filter Assembly

The filter and strainer, illustrated in Figs. 3 and 4, consist basically of a shell, a cover, and a replaceable filtering element. The assembly is made oil tight by a shell gasket, a cover nut or bolt, and a cover nut or bolt gasket.

The central stud is a permanent part of the shell and, when the unit is assembled, extends up through the cover where the nut or bolt holds the assembly together.

A filter element sets over the central stud inside the shell and is centered in the shell by the stud.

The former and current cover assemblies are visibly different. The cast letter "P" (primary) has been added to the top of the strainer cover and the letter "S" (secondary) has been added to the top of the filter cover.

Operation

Since the fuel strainer is between the fuel supply tank and the fuel pump, it functions under suction. The fuel filter, placed between the fuel pump and the fuel inlet manifold in the cylinder head, operates under pressure. Fuel enters through the inlet passage in the cover and into the shell surrounding the filter element. Pressure or suction created by the pump causes the fuel to flow through the filter element where dirt particles are removed. Clean fuel flows to the

interior of the filter element, up through the central passage in the cover and into the outlet passage, then to the fuel inlet manifold in the cylinder head.

If engine operation is erratic, indicating shortage of fuel or flow obstructions, refer to *Troubleshooting* in Section 15.2 for corrective measures.

Replace Fuel Strainer Or Filter Element

The procedure for replacing an element is the same for the fuel strainer or fuel filter. Refer to Figs. 3 and 4 and replace the element as follows:

NOTICE: Only filter elements designed for fuel oil filtration should be used to filter the fuel.

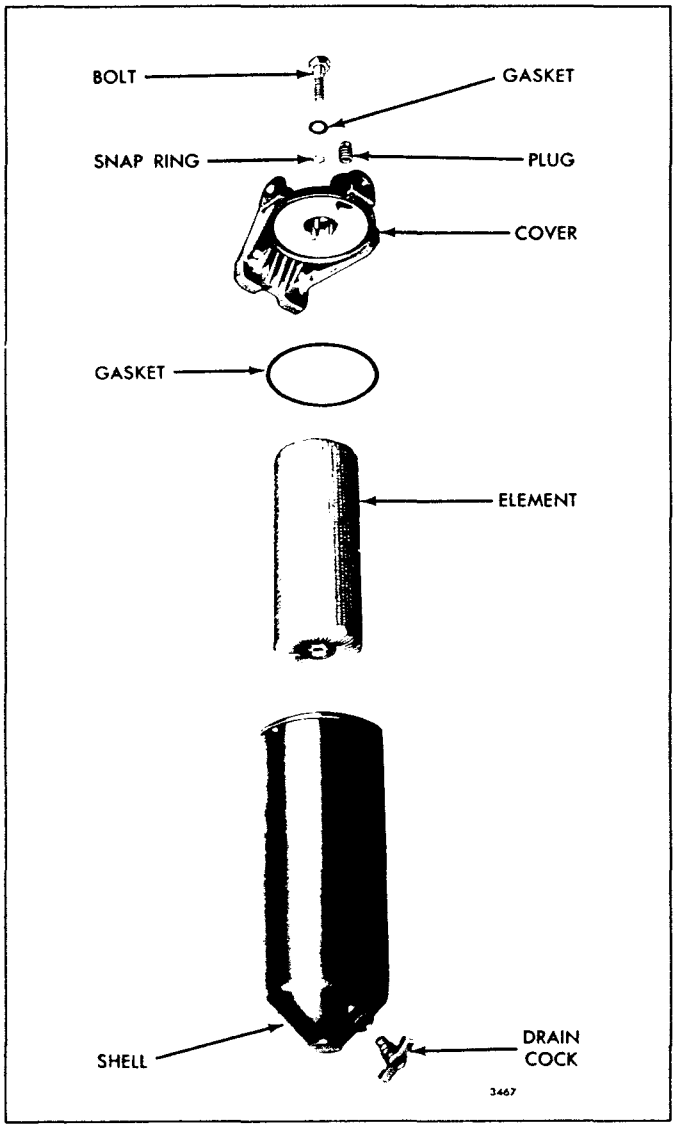


Fig. 3 – Fuel Strainer Details and Relative Location of Parts

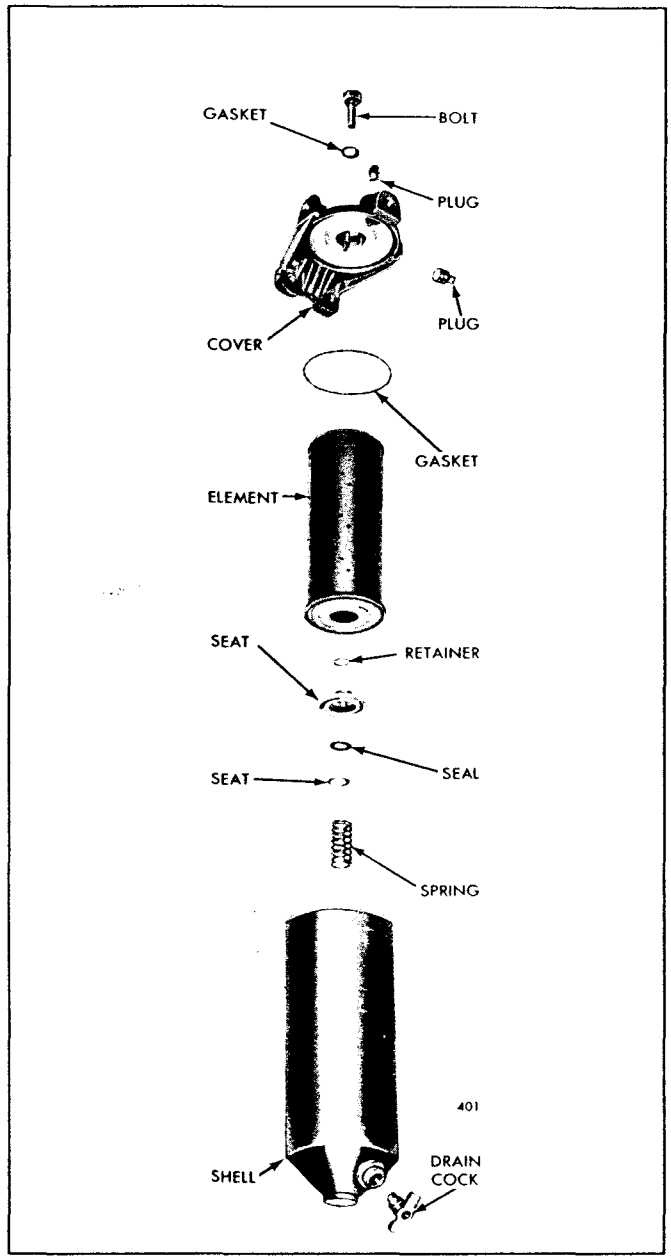


Fig. 4 – Fuel Filter Details and Relative Location of Parts

1. With the engine stopped, place a container under the strainer or filter and open the drain cock. Loosen the cover nut or bolt just enough to allow the fuel oil to drain out freely. Then close the drain cock.

   NOTICE: The wiring harness, starting motor or other electrical equipment must be shielded during the filter change, since fuel oil can permanently damage the electrical insulation.

2. While supporting the shell, unscrew the cover nut or bolt and remove the shell and element. Also remove and discard the cover nut retaining ring, if used.

3. Remove and discard the filter element and shell gasket, the cover nut or bolt gasket, and, if used, the cover bolt snap ring.

   Current strainers and filters do not incorporate the cover bolt snap ring. This was eliminated to facilitate replacement of the bolt gasket with each element replacement.

4. Wash the shell thoroughly with clean fuel oil and dry it with compressed air.

   CAUTION: To prevent possible personal injury, wear adequate eye protection and do not exceed 40 psi (276 kPa) air pressure.

5. Examine the element seat and the retaining ring to make sure they have not slipped out of place. Check the spring by pressing on the element seat. When released, the seat must return against the retaining ring.

   The element seat, spring, washer and seal can not be removed from the strainer shell. If necessary, the shell assembly must be replaced. However, the components of the filter shell are serviced. Examine the filter retainer seal for cracks or hardening. If necessary, replace the seal.

   The current strainer and filter elements include the element, the cover gasket and cover bolt gasket. The strainer element also includes both the former and current bolt gaskets.

6. Place a new element over the center stud and push it down against the element seat. Make sure the drain cock is closed, then fill the shell about two–thirds full with clean fuel oil.

   Thoroughly soak the density–type *strainer* element in clean fuel oil before installing it. This will expel any air entrapped in the element and is conducive to a faster initial start.

7. Place a new shell gasket in the recess of the shell; also place a new gasket on the cover nut or bolt.

8. Place the shell and element in position under the cover. Then thread the cover bolt (or nut) in the center stud.

9. With the shell and the gasket properly positioned, tighten the cover bolt or nut just enough to prevent fuel leakage.

10. Remove the pipe plug at the top of the cover and complete filling of the shell with fuel. Fuel system primer J 5956 may be used to prime the entire fuel system.

11. Start the engine and check the fuel system for leaks.

FUEL STRAINER AND FUEL FILTER

(SPIN–ON TYPE)

A spin–on type fuel strainer and fuel filter (Fig. 5) is used on certain engines. The spin–on filter cartridge consists of a shell, element and gasket combined into a unitized replacement assembly (Fig. 6). No separate springs or seats are required to support the filters.

• Replaceable paper type (cellulose) elements can remove particles as small as 10 microns. Fiberglass elements can remove particles as small as 5 microns.

The filter covers incorporate a threaded sleeve to accept the spin–on filter cartridges. The word "Primary" is cast on the fuel strainer cover and the word "Secondary" is cast on the fuel filter cover for identification.

No drain cocks are provided on the spin–on filters. Where water is a problem, it is recommended that a water separator be installed. Otherwise, residue may be drained by removing and inverting the filter. Refill the filter with clean fuel oil before reinstalling it.

Filter Replacement

A 1" diameter twelve–point nut on the bottom of the filter is provided to facilitate removal and installation.

Replace the filter as follows:

1. Unscrew the filter (or strainer) and discard it.

2. Fill a new filter replacement cartridge about two–thirds full with clean fuel oil. Coat the seal gasket lightly with clean fuel oil.

3. Install the new filter assembly and tighten it to one–half of a turn beyond gasket contact.

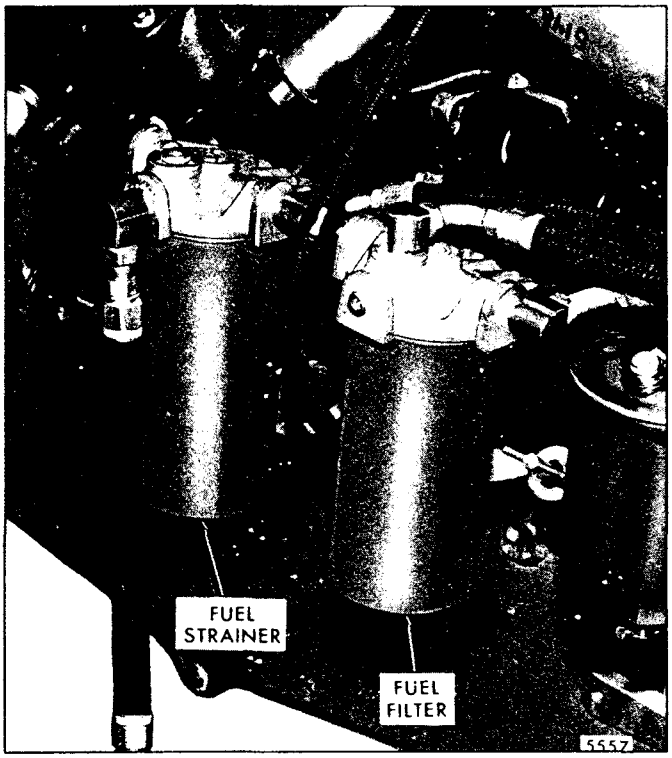


Fig. 5 – Typical Spin–On Filter Mounting

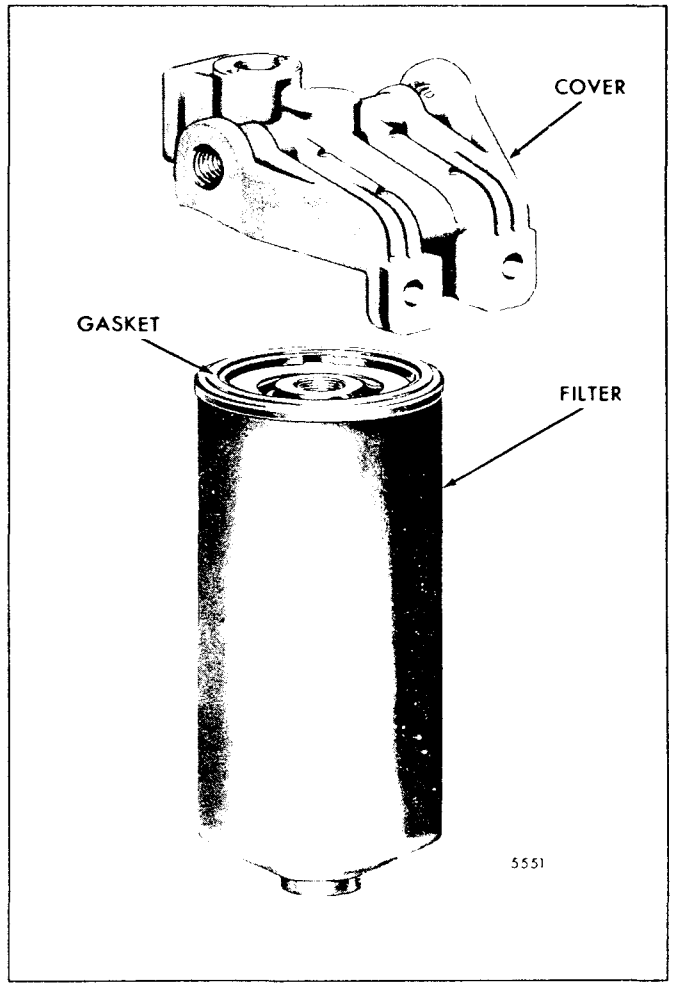


Fig. 6 – Spin–On Filter Details

FUEL COOLER (V Engines)

A fuel cooler may be mounted in the raw water system, between the heat exchanger and the raw water pump, so that the fuel leaving the engine is cooled before it returns to the fuel tank.

Fuel continually cycling through an engine causes the fuel in the tank to become heated after extended operation. Excessive fuel temperatures can affect engine operation. An increase in the fuel inlet temperature above 90°F (32°C) will result in a brake horsepower loss of approximately 2% per 20°F (11°C) increment fuel temperature increase.

Remove Fuel Cooler

1. Disconnect the flexible hoses at the fuel cooler.

2. Loosen the hose clamps and slide the hoses back on the raw water pump tubes.

Clean Fuel Cooler

Clean the oil side of the cooler core first, then immerse it in the following solution: Add 1/2 pound of oxalic acid to each 2–1/2 gallons (9.5 liters) of a solution composed of 1/3 muriatic acid and 2/3 water. The cleaning action is evident by the bubbling and foaming.

Watch the process carefully. When bubbling stops (this usually takes from 30 to 60 seconds), remove the core from the cleaning solution and thoroughly flush it with clean, hot water. After cleaning, dip the core in light oil.

Pressure Test Fuel Cooler

After the fuel cooler has been cleaned, check it for leaks by plugging one of the fuel openings with a 1/4" pipe plug and attaching an air hose to the other opening. Apply approximately 100 psi (689 kPa) air pressure and submerge the cooler in a container of heated water (180°F or 82°C). A leak will be indicated by air bubbles in the water. If leaks are indicated, replace the cooler.

- **CAUTION: To avoid personal injury when making this pressure test, be sure that personnel are adequately protected against any stream of pressurized water from a leak or rupture of the cooler core.**

Install Fuel Cooler

Reverse the procedure for removing the fuel cooler.

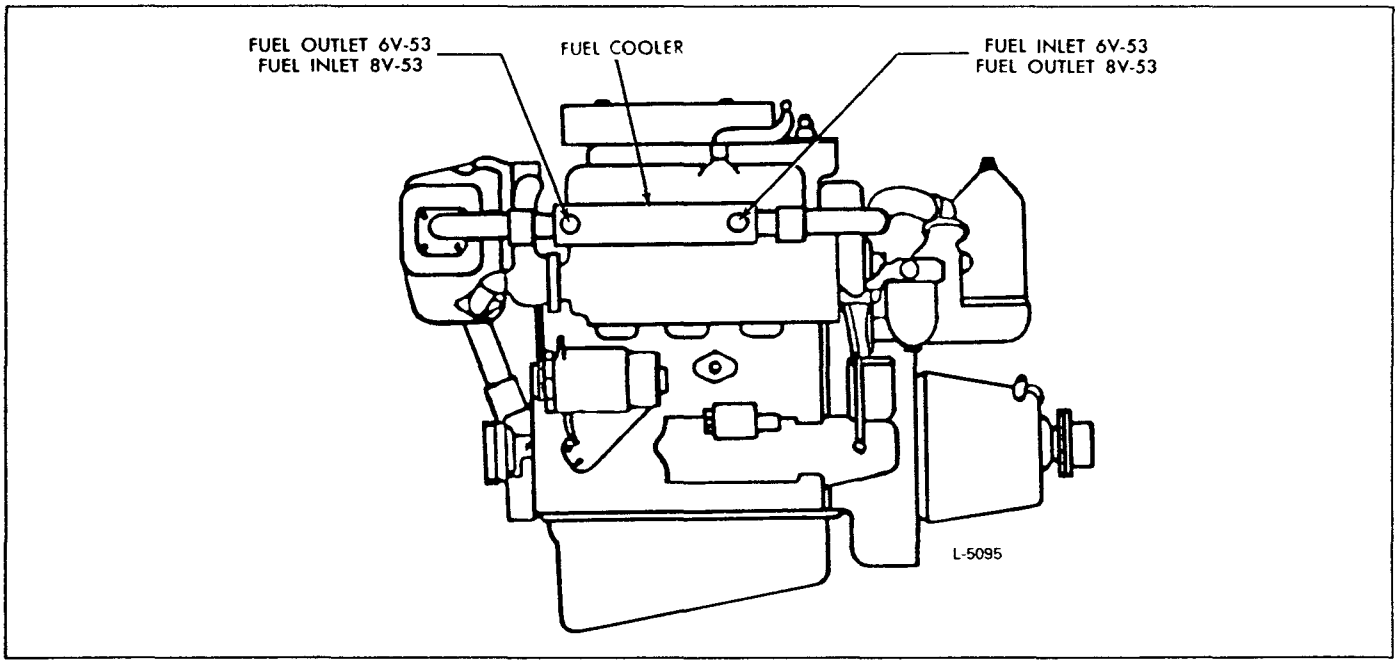


Fig. 1 – Fuel Cooler Mounting (V Engines)

MECHANICAL GOVERNORS

Horsepower requirements on an engine may vary due to fluctuating loads. Therefore, some method must be provided to control the amount of fuel required to hold the engine speed reasonably constant during load fluctuations. To accomplish this control, a governor is introduced in the linkage between the throttle control and the fuel injectors. The following types of mechanical governors are used:

1. Limiting Speed Mechanical Governor.

2. Variable Speed Mechanical Governor.

Engines requiring a minimum and maximum speed control, together with manually controlled intermediate speeds, are equipped with a limiting speed mechanical governor.

Engines subjected to varying load conditions that require an automatic fuel compensation to maintain a near constant engine speed, which may be changed manually by the operator, are equipped with a variable speed mechanical governor. However, a variable speed governor cannot be used on an engine equipped with an Allison vehicle transmission. Each type of governor has an identification plate located on the control housing, containing the governor assembly number, type, idle speed range and drive ratio. The maximum engine speed, not shown on the identification plate, is stamped on the option plate attached to the valve rocker cover.

Check Governor Operation

Governor difficulties are usually indicated by speed variations of the engine. However, it does not necessarily mean that all such speed fluctuations are caused by the governor. Therefore, when improper speed variations are present, check the engine as follows:

1. Make sure the speed changes are not the result of excessive load fluctuations.

2. Check the engine to be sure that all of the cylinders are firing properly (refer to Section 15.2). If any cylinder is not firing properly, remove the injector, test it and, if necessary, recondition it as outlined in Section 2.1 or 2.1.1.

3. Check for bind that may exist in the governor operating mechanism or in the linkage between the governor and the injector control tube.

With the fuel rod connected to the injector control tube lever, the mechanism should be free from bind throughout the entire travel of the injector racks. If friction exists in the mechanism, it may be located and corrected as follows:

1. If an injector rack sticks or moves too hard, it may be due to the injector hold–down clamp being too tight or improperly positioned. To correct this condition, loosen the injector clamp, reposition it and tighten the clamp bolt to 20–25 lb–ft (27–34 N·m) torque.

2. An injector which is not functioning properly may have a defective plunger and bushing or a bent injector rack. Recondition a faulty injector as outlined in Section 2.1 or 2.1.1.

3. An injector rack may bind as the result of an improperly positioned rack control lever. Loosen the rack control lever adjusting screws. If this relieves the bind, relocate the lever on the control tube and position the rack as outlined in Section 14.

4. The injector control tube may bind in its support brackets, thus preventing free movement of the injector racks to their no–fuel position due to tension of the return spring. This condition may be corrected by loosening and realigning the control tube supporting brackets. If the control tube support brackets were loosened, realigned and tightened, the injector racks must be repositioned as outlined in Section 14.

5. A bent injector control tube return spring may cause friction in the operation of the injector control tube. If the spring has been bent or otherwise distorted, install a new spring.

6. Check for bind at the pin which connects the fuel rod to the injector control tube lever; replace the pin, if necessary.

If, after making these checks, the governor fails to control the engine properly, remove and recondition the governor.

LIMITING SPEED MECHANICAL GOVERNOR

In-Line Engine

The limiting speed mechanical governor performs the following functions (Fig. 1):

1. Controls the engine idle speed.
2. Limits the maximum operating speed of the engine.

The mechanical engine governors are identified by a name plate attached to the governor housing. The letters D.W.–L.S. stamped on the name plate denote a double–weight limiting speed governor.

The governor is mounted on the rear end plate of the engine and is driven by a gear that extends through the end plate and meshes with either the camshaft gear or the balance shaft gear, depending upon the engine model.

Operation

The governor holds the injector racks in the advanced fuel position for starting when the throttle control lever is in the idle position. Immediately after starting, the governor moves the injector racks to the position required for idling.

The centrifugal force of the revolving governor low and high speed weights is converted into linear motion which is transmitted through the riser and operating shaft to the operating shaft lever. One end of this lever operates against the high and low speed springs through the spring cap, while the other end provides a moving fulcrum on which the differential lever pivots.

When the centrifugal force of the revolving governor weights balances out the tension on the high or low speed spring (depending on the speed range), the governor stabilizes the engine speed for a given setting of the speed control lever.

In the low speed range, the centrifugal force of the low and high speed weights together operate against the low speed spring. As the engine speed increases, the centrifugal force of the low and high speed weights together compresses the low speed spring until the low speed weights are against their stops, thus limiting their travel, at which time the low speed spring is fully compressed and the low speed spring cap is within .0015" of the high speed spring plunger.

Throughout the intermediate speed range the operator has complete control of the engine because the low speed gap is closed and the low speed weights are against their stops, and the high speed weights are not exerting enough force to overcome the high speed spring. As the speed continues to increase, the centrifugal force of the high speed weights increases until this force can overcome the high speed spring and the governor again takes control of the engine, limiting the maximum engine speed.

A fuel rod, connected to the differential lever and the injector control tube lever, provides a means for the governor to change the fuel settings of the injector rack control levers.

The engine idle speed is determined by the force exerted by the governor low speed spring. When the governor speed control lever is placed in the idle position, the engine will operate at the speed where the force exerted by the governor low speed weights will equal the force exerted by the governor low speed spring.

Adjustment of the engine idle speed is accomplished by changing the force on the low speed spring by means of the idle speed adjusting screw. Refer to the tune–up section for idle speed adjustment.

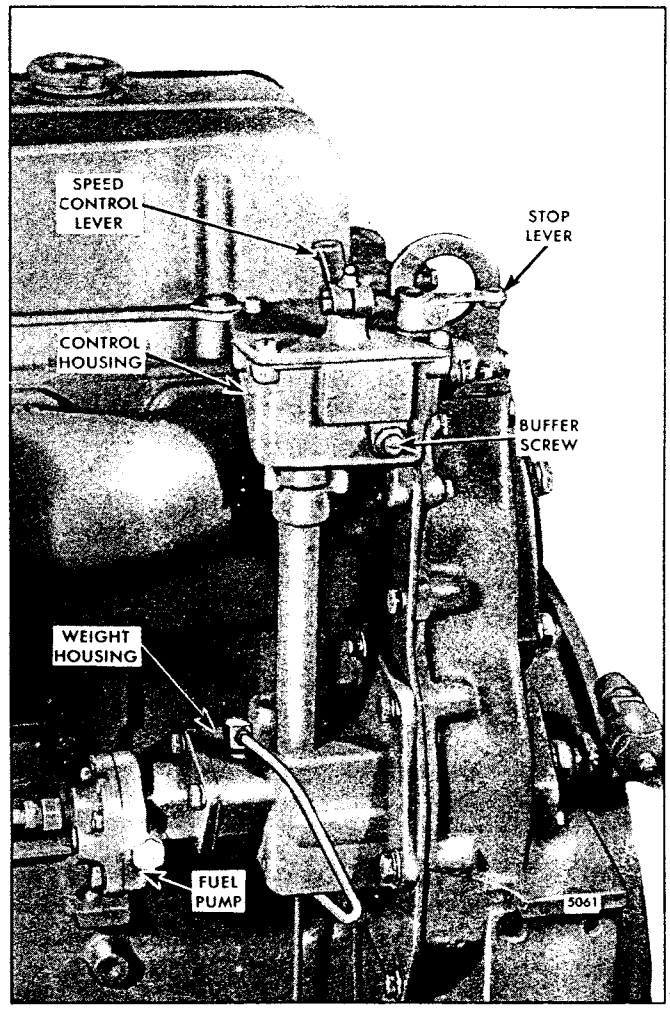


Fig. 1 – Governor Mounting

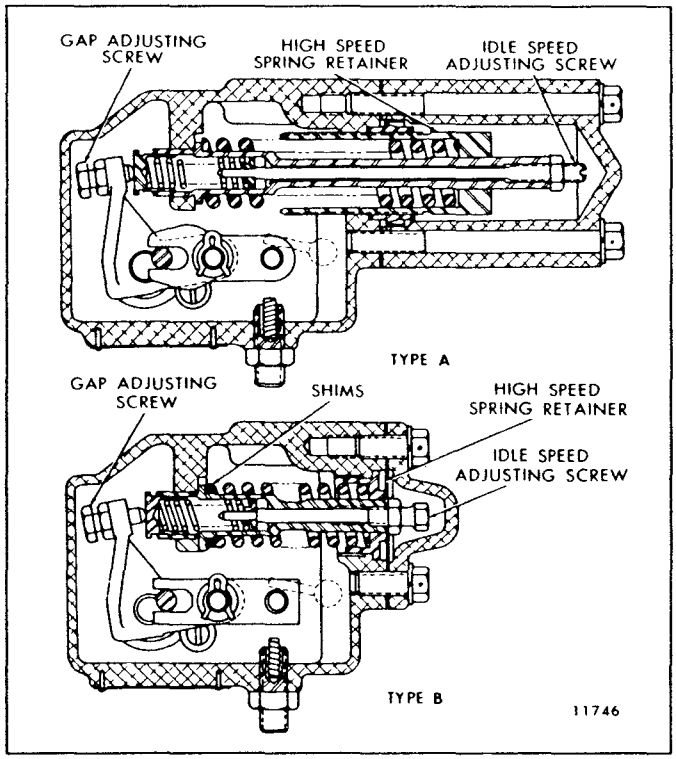


Fig. 2 – Differences Between Industrial and Vehicle Type Governor Assemblies

The engine maximum no–load speed is determined by the force exerted by the high speed spring. When the throttle control lever is placed in the maximum speed position, the engine will operate at a speed where the force exerted by the governor high speed weights will equal the force exerted by the governor high speed spring.

Adjustment of the maximum no–load speed is accomplished by changing the tension on the high speed spring. Refer to the tune–up section for the maximum no–load speed adjustment.

Lubrication

The governor is lubricated by oil splash from the engine gear train and by a pressure line on current engine models. The oil passes through the governor weight housing on to the shaft and weight assemblies. The oil is distributed to the various moving parts within the governor by the revolving weights. Surplus oil drains from the governor through holes in the governor bearing retainer back to the engine gear train.

Remove Governor from Engine

Before removing the governor from the engine, the operation should be checked as outlined in Section 2.7. If the governor fails to control the engine properly after performing these checks, remove and recondition it.

1. Disconnect the linkage to the governor control levers.
2. Remove the governor cover and gasket.
3. Detach the spring housing from the governor housing by removing the two bolts and lock washers.
4. Loosen the high speed spring retainer locknut with spanner wrench J 5895 and remove the spring assembly (Fig. 2).
5. Loosen the fuel rod cover hose clamps.
6. Clean and remove the rocker cover from the cylinder head.
7. Disconnect the fuel rod from the injector control tube lever. Remove the clip that holds the fuel rod to the differential lever and lift the fuel rod from the lever.
8. Detach the fuel pump by disconnecting the fuel lines and removing the three bolts. Also, disconnect the lubricating oil line, if used.
9. Remove the five bolts from the governor weight housing and the two bolts from the governor control housing.
10. Detach the governor and gasket from the engine.

Disassemble Governor Cover

1. Remove the return spring and clip from a single lever cover only, then loosen the governor speed control lever retaining bolt and lift the control lever from the speed control shaft (Fig. 3).
2. Remove the retaining ring and washer. Withdraw the speed control shaft from the cover.
3. Remove the seal ring from the cover. The single lever cover has the seal ring at the top of the cover. The double lever cover has the seal ring at the bottom of the cover.
4. Loosen the governor stop lever retaining bolt and lift the lever from the stop lever shaft.
5. Remove the retaining ring and washers and withdraw the stop lever shaft from the cover.
6. Remove the seal ring from the top of the cover.

Disassemble Governor Weight Housing

1. Remove the gear retaining nut from the shaft, then remove the gear, key and spacer from the shaft.
2. Remove the small screw holding the bearing retainer in place.
3. Turn the bearing support until the large opening is centered over the fork on the operating shaft.

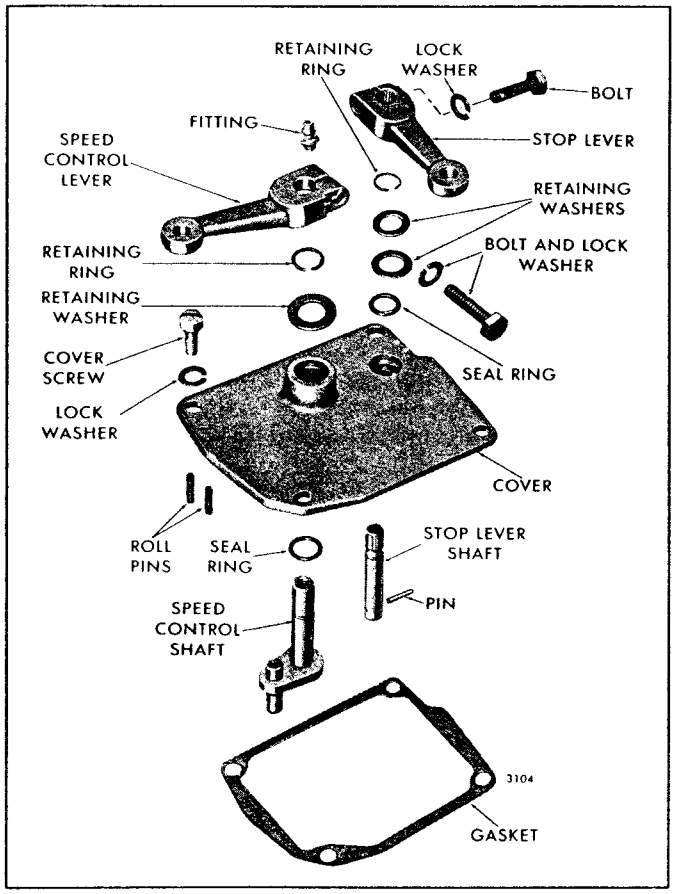


Fig.3 – Governor Cover Details and Relative Location of Parts

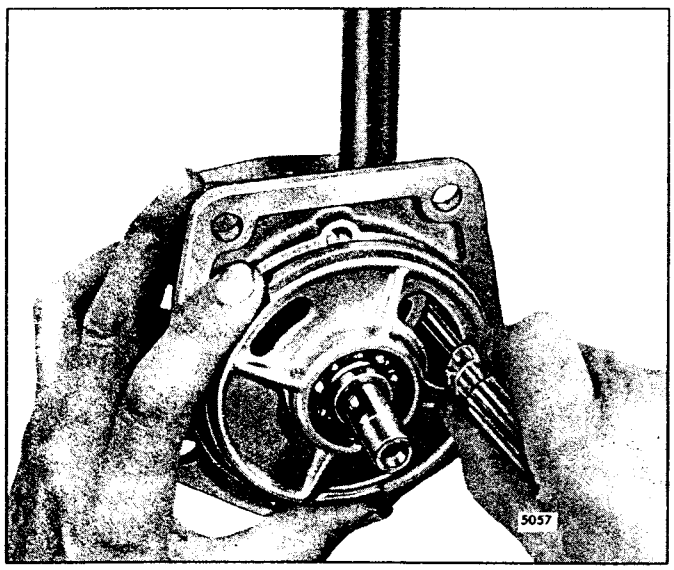


Fig. 4 – Removing Fork from Operating Shaft

4. Lift up on the weight shaft until there is enough clearance for a 5/16" socket wrench to be placed on the screws that hold the fork to the operating shaft (Fig. 4). Then remove the two screws and washers.
5. Lift the shaft and weight assembly out of the governor weight housing.
6. Remove the screw and washers holding the bearing in the control housing and lift the shaft assembly out of the housing.
7. Place a rod approximately 18" long through the control housing and knock the plug out of the bottom of the weight housing.
8. Remove the snap ring and press the bearing from the weight housing.
9. Remove the spring clip and washer from the governor operating shaft lever and remove the governor differential lever.
10. Press the bearing and operating shaft lever from the operating shaft, if necessary.
11. If necessary, disassemble the control housing from the weight housing.

Disassemble Weight Shaft Assembly

1. Press the bearing retainer from the weight shaft.
2. If necessary, remove the snap ring and press the bearing from the bearing retainer.
3. Remove the weight pin retainers from the governor weight pins, then drive the pins out of the carrier and weights. *Drive the pins out of the carrier from the weight pin retainer end.*

   Remove the governor weights. Punch mark the carrier at the retainer end of the weight pins so the pins may be placed in the proper position when reinstalling the weights in the carrier.
4. Slide the riser and bearing assembly from the shaft. Do not disassemble the bearing since the riser and bearing are serviced only as an assembly.

Inspection

Immerse all of the governor parts in a suitable cleaning fluid to loosen and remove all foreign material. Use a bristle brush and compressed air as necessary to ensure cleanliness of all parts.

- **CAUTION: To prevent possible personal injury, wear adequate eye protection and do not exceed 40 psi (276 kPa) air pressure.**

Examine the bearings for any indications of corrosion or pitting. Lubricate each bearing with light engine oil; then, while holding the bearing inner race from turning, revolve the outer race slowly by hand and check for rough spots. Replace the bearings if rough or tight spots are detected.

The lower governor drive components have been revised to reduce the clearance between the riser and the

weight shaft. With this change, additional lubrication is provided to the governor by an oil line connected between the oil gallery in the cylinder block and the governor weight housing. When replacing the riser assembly, shaft and carrier assemblly, or the complete governor assembly, the new oil line must be installed to provide adequate lubrication.

Examine the riser thrust bearing for excessive wear, flat spots or corrosion. If any of these conditions exist, install a new riser and bearing assembly. Examine the weight carrier pins for wear and replace them if necessary.

Inspect the weight carrier, weights and retaining pins for wear. The current single-weight carrier replaces the former double-weight carrier.

Inspect the fuel pump drive end of the weight shaft. Replace the shaft if the end is worn or rounded.

Inspect the bushing in the weight housing. Replace the bushing if it is worn excessively.

Inspect the spring seats, plungers, adjusting screws, lock nuts and other parts of the control housing for defects that might affect governor operation.

Assemble Governor Cover

New mechanical governor cover assemblies with serrated shafts are being used on In-line 53 engines.

The limiting speed governor cover assemblies include a new, longer 7/16" diameter speed control shaft and a new 3/8" diameter serrated stop lever shaft (Fig. 3). The serrations on the shafts ensure positive clamping between the serrated levers and the shafts and prevent any slippage. Four serrations on the stop lever shaft of the limiting speed governor are eliminated. This allows certain customers to design a mating lever with missing serrations which will provide a *fixed position* for particular requirements. Levers with missing serrations are not provided. The former and new cover and shaft assemblies are interchangeable on a governor, and only the new assemblies will be serviced. Since the new serrated shafts can be used with the former covers, only the new serrated shafts will be serviced.

1. Place a new seal ring in the counterbore of the cover (Fig. 2). The single lever cover has the seal ring at the top of the cover. The double lever cover has the seal ring at the bottom of the cover.
2. Lubricate the speed control shaft with engine oil, then slide the shaft through the cover. Install the washer and retaining ring on the shaft.
3. Place the speed control lever over the shaft and secure it with the bolt and lock washer.
4. On double lever covers, lubricate the stop lever shaft with engine oil, then slide the shaft through the cover.
5. Place the seal ring in the counterbore of the shaft opening, then install the washers over the shaft. Lock the shaft in place with the retaining ring.
6. Place the stop lever on the shaft and secure it with the bolt and lock washer.

Assemble Control Housing

1. Install a 1/8" pipe plug in the tapped hole in the side of the control housing.
2. If necessary, assemble the control housing to the weight housing, using a good quality sealant between the tube and the housings.
3. Install the governor operating shaft lower bearing, numbered side out, in the weight housing. Install the snap ring to secure the bearing (Fig. 5).
4. Apply a quality sealant around the edge of a new plug and tap it in place.
5. Start the governor operating shaft upper bearing over the upper end of the operating shaft. Support the lower end of the shaft on the bed of an arbor press. Use a sleeve and press down on the inner race of the bearing until it contacts the shoulder of the operating shaft.
6. Place the operating lever on the shaft with the flat surface on the shaft registering with the flat surface on the lever. Press the lever tight against the bearing on the shaft.
7. Lubricate both bearings with engine lubricating oil. Insert the lever and operating shaft assembly in the control housing. Guide the lower end into the bearing.
8. Secure the upper operating shaft bearing with the round head retaining screw and washers.
9. Place the fork on the operating shaft with the two cam faces facing the fuel pump.
10. Secure the fork to the operating shaft with two screws and lock washers.
11. Place the differential lever over the operating shaft lever pin and secure it in place with a washer and spring pin.

Assemble Governor Weight and Shaft Assembly

1. If the carrier was removed from the weight shaft, press the carrier on the shaft so as to allow a clearance of .001" to .006" between the shaft shoulder and the rear face of the carrier.
2. Press the governor weight shaft bearing into the bearing retainer by pressing on the outer race of the bearing (Fig. 6).

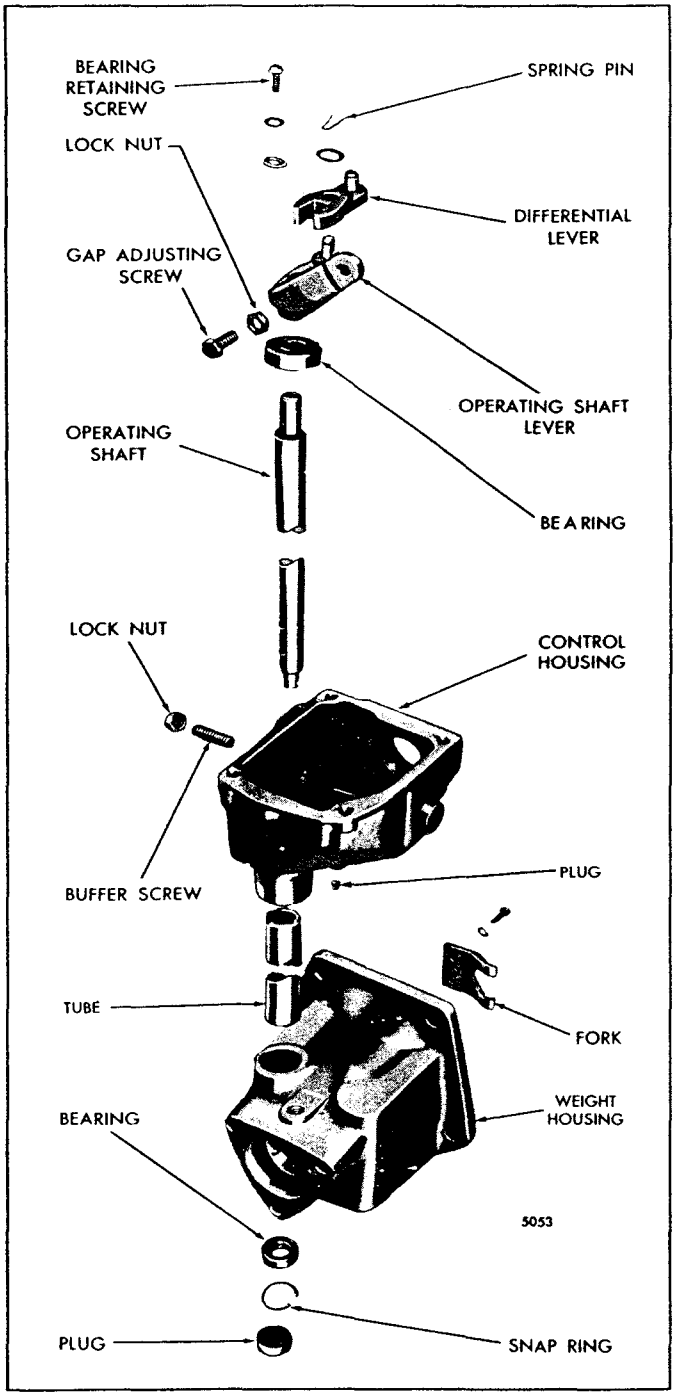


Fig. 5 – Governor Housings and Relative Location of Parts

3. Install the snap ring in the retainer with the flat side of the ring facing the bearing.

4. Press the bearing retainer on the weight shaft until the bearing is against the shoulder on the shaft.

   NOTICE: To prevent any damage, press only on the inner race of the bearing.

5. Place the riser on the weight shaft.

6. Position the low speed weights, identified by the short cam arm and three center laminations, each approximately 9/64" thick, on the weight carrier. Drive the weight pins in place and install the weight pin retainers.

7. Install the high speed weights in the same way. The high speed weights are identified by the long cam arm and three center laminations; the middle lamination is 3/16" thick and the outer ones are 1/8" thick.

   The weight pins must be reinstalled in the same positions from which they were removed.

8. Slide the shaft and weight assembly into the weight housing with the riser bearing placed behind the fork.

9. Turn the bearing retainer until the large opening is over the fork on the operating shaft. Tighten the two screws holding the fork to the operating shaft with a 5/16" socket wrench.

10. Turn the bearing retainer until the counterbored hole in the retainer and housing line up. Install the screw to secure the bearing retainer to the weight housing.

11. Place the drive gear spacer on the shaft. Install the key in the keyway and place the gear on the shaft.

12. Tap the gear until the spacer is against the bearing. Install the drive gear retaining nut and tighten it to 125–135 lb–ft (170–183 N·m) torque.

13. Check the backlash between the governor drive gear and the camshaft or balance shaft gear. The backlash should be .0030" to .0050" between new gears and should not exceed .0070" between used gears. If necessary, loosen and readjust the rear end plate to bring gear lash within specifications.

Install Governor

Refer to Fig. 1 and install the governor on the engine as follows:

1. Attach the fuel rod to the differential lever and secure it in place with a washer and spring pin.

2. Attach a new gasket to the governor weight housing.

3. Insert the end of the fuel rod through the hose and clamps and into the opening in the cylinder head and position the governor weight housing against the engine rear end plate; the teeth on the governor drive gear must mesh with the teeth on the camshaft gear or balance shaft gear. Refer to Section 1.0 for allowable backlash.

4. Install the three 12–point head bolts with copper washers in the governor weight housing next to the

cylinder block. Install the two remaining bolts with steel washers and lock washers. Tighten the bolts to 35 lb–ft (47 N·m) torque.

5. Install the two governor control housing attaching bolts and lock washers. Tighten the bolts to 10–12 lb–ft (14–16 N·m) torque.

6. On current engines, install the lubricating oil line and fittings to the weight housing and the cylinder block.

7. Align and tighten the hose clamps on the fuel rod covers.

8. Attach the fuel rod to the injector control tube lever with a pin and cotter pin.

9. Assemble the industrial governor spring mechanism as follows:

   a. Thread the spring retainer locknut on the retainer.

   b. Thread the idle speed adjusting screw on the governor spring plunger.

   c. Place the high speed spring over the governor spring plunger.

   d. Lubricate and install the spring plunger assembly in the spring retainer and secure it with a locknut so that approximately 1/4" of the idle speed adjusting screw extends beyond the nut.

   e. Lubricate and insert the spring seat, low speed spring and the spring cap in the open end of the spring plunger.

10. Thread the spring retainer and spring assembly into the governor housing and tighten the locknut finger tight until an engine tune–up is performed.

11. Assemble the vehicle governor spring mechanism as follows:

   a. Back off the locknut at the outer end of the adjusting screw to within 1/16" of the slotted end of the screw.

   b. Slip the shims, if used, and the high speed spring over the plunger. Position the retainer over the high speed spring and insert the adjusting screw into the plunger.

   c. Position the seat and cap on the ends of the low speed spring and insert the assembly into the hollow end of the plunger.

   d. Insert the spring and plunger assembly into the control housing and tighten the retainer nut with spanner wrench J 5895.

12. Thread the spring retainer and spring assembly into the governor; the locknut should be finger tight until an engine tune–up is performed.

13. Use a new gasket when installing the governor cover and lever assembly. Be sure the speed control shaft pin engages the slot in the differential lever and the stop lever is in the correct position. Secure the cover with four screws and lock washers.

- **CAUTION: Before starting an engine after an engine speed control adjustment or after removal of the engine governor cover and lever assembly, the technician must determine that the injector racks move to the *no–fuel* position when the governor stop lever is placed in the stop position. Engine overspeed will result if the injector racks cannot be positioned at no fuel with the governor stop lever. An overspeeding engine can result in engine damage which could cause personal injury.**

14. Install the return spring and spring clip (single lever cover only).

15. Add all purpose grease to the speed control shaft through the grease fitting on top of the shaft. *At temperatures above 30°F (1°C) use a No. 2 grade grease and a No. 1 grade grease below this temperature.*

16. Connect the linkage to the governor control levers.

17. Install the fuel pump and fuel lines.

18. Perform an engine tune–up as outlined in Section 14.

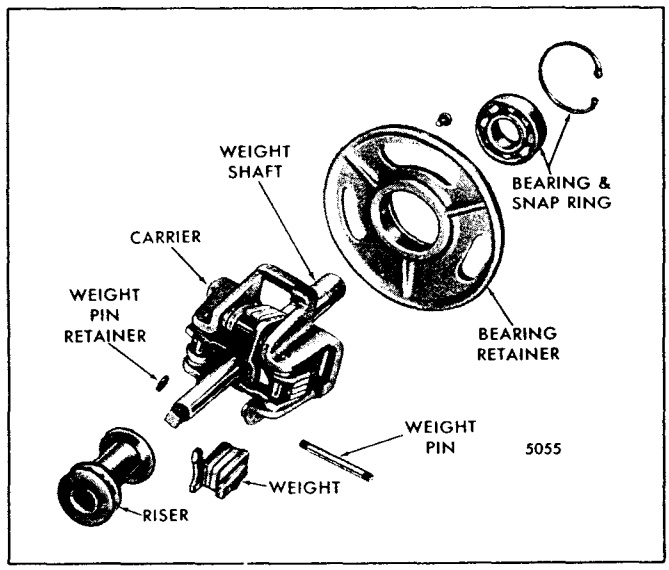


Fig. 6 – Governor Weight Details and Relative Location of Parts

LIMITING SPEED MECHANICAL GOVERNOR

6V Engine

The limiting speed mechanical governor, illustrated in Fig. 1, performs the following functions:

1. Controls the engine idle speed.

2. Limits the maximum operating speed of the engine.

The double-weight governor, identified by the letters D.W.-L.S. stamped on the governor name plate, is mounted between the engine blower and the flywheel housing (Fig. 2). One end of the governor weight shaft is splined to a drive plate attached to the driven blower timing gear to provide a means of driving the governor. The other end of the shaft is supported by a bearing in the blower drive support (Fig. 1).

The governor consists of four basic sub-assemblies: a cover and lever assembly, governor housing, spring housing, and a weight and shaft assembly.

Operation

Two manual controls are provided on the governor: a stop lever and a speed control lever. In the RUN position, the stop lever holds the fuel injector racks near the full-fuel position. When the engine is started, the governor moves the injector racks toward the idle speed position. The engine speed is then controlled manually by moving the speed control lever.

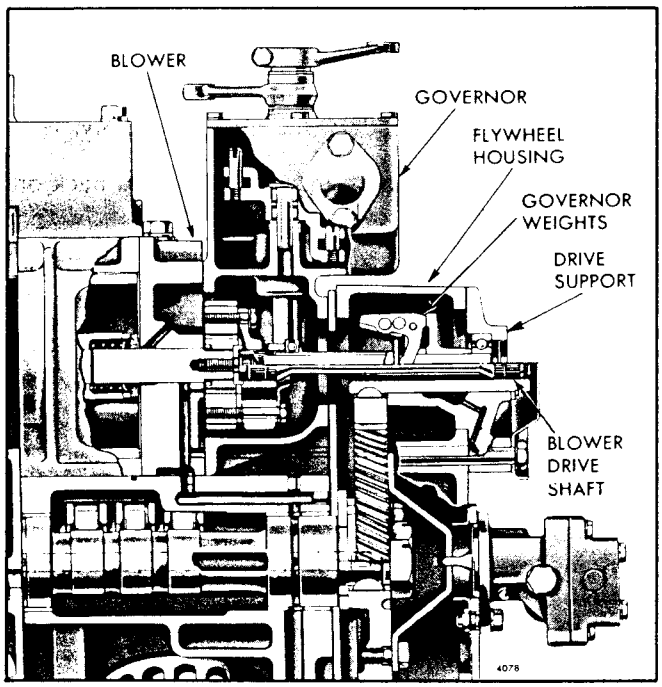


Fig. 1 - Limiting Speed Governor and Drive on 6V-53 Engine

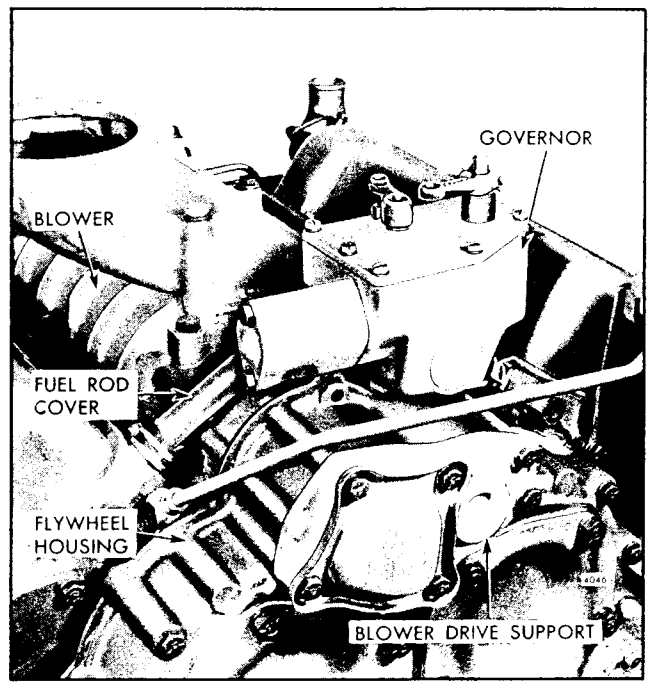


Fig. 2 - Governor Mounting on 6V-53 Engine

The centrifugal force of the revolving governor weights is converted into linear motion which is transmitted through the riser and operating shaft to the operating shaft lever. One end of this lever bears against the governor spring cap while the other end provides a moving fulcrum on which the differential lever pivots.

The centrifugal force of the governor weights is opposed by the governor springs. Load changes or movement of the speed control lever momentarily creates an unbalanced force between the revolving weights and the tension on the high speed spring or low speed spring (depending on the speed range). When the forces reach a balanced condition again, the engine speed will be stabilized for the new speed setting or new load.

In the low speed range, the centrifugal force of the low speed weights and the high speed weights operates against the low speed spring. As the engine speed increases, the centrifugal force of both pairs of weights compresses the low speed spring until the low speed weights have reached the limit of their travel, at which time the low speed spring is fully compressed

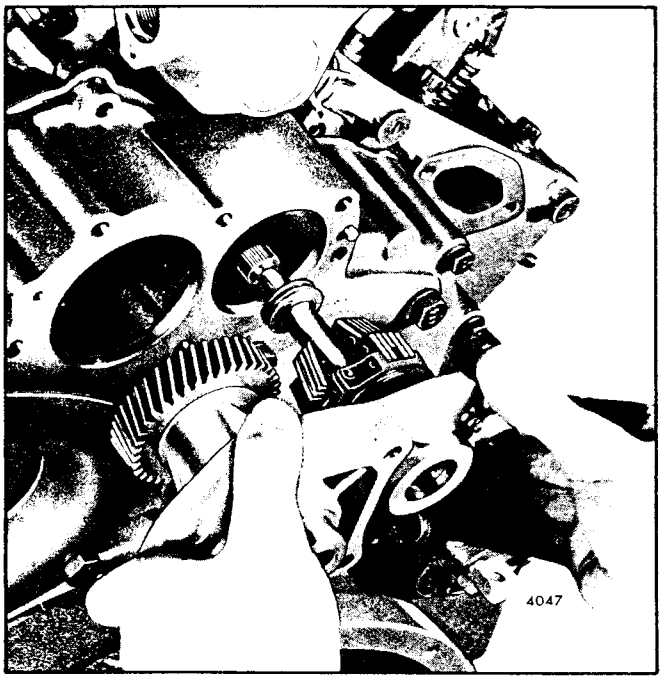


Fig. 3 - Removing or Installing Blower Drive Support

and the spring cap is within .0015" of the high speed spring plunger.

Throughout the intermediate speed range, the operator has complete control of the engine because both the low speed spring and the low speed weights are against their stops, and the high speed weights are not exerting enough force to overcome the high speed spring.

As the engine speed continues to increase, the centrifugal force of the high speed weights increases until this force overcomes the high speed spring and the governor again takes control of the engine, limiting the maximum engine speed.

Fuel rods are connected to the differential lever and the injector control tube levers through the control link lever. This arrangement provides a means for the governor to change the fuel settings of the injector control racks.

To stop the engine, the speed control lever is moved to the idle speed position and the stop lever is moved to the no-fuel position and held there until the engine stops.

Adjustment of the governor is covered in Section 14.

Lubrication

The governor is lubricated by a spray of pressurized lubricating oil from the blower rear end plate to the blower timing gears which distribute this oil to various parts of the governor. Oil splash from the gear train provides lubrication for the governor weights and shaft. Excess oil overflows into the gear train compartment and returns to the crankcase.

Remove Governor From Engine

Check the governor as outlined in Section 2.7 and, if it fails to control the engine properly, remove and disassemble it for further inspection.

Since the governor is mounted between the blower and the flywheel housing, the blower and blower drive support assemblies must also be removed. Remove the governor as follows:

1. Disconnect the linkage to the governor control levers.

2. Remove the seven attaching screws and lock washers and detach the governor cover and lever assembly from the governor housing. Remove the cover gasket.

3. Take out the two bolts and copper washers and remove the spring housing (or cover) and gasket from the governor housing.

4. Loosen the high speed spring retainer lock nut (type "A" governor, Fig. 6) with a spanner wrench. Remove the spring retainer and withdraw the spring retainer, idle speed adjusting screw, high speed spring, spring plunger, low speed spring, spring seat and spring cap as a unit.

On engines equipped with the type "B" governor (Fig. 6), remove the spring retainer with spanner wrench J 5895 and withdraw the spring assembly.

5. Loosen the hose clamps and slide the hoses back on the fuel rod covers.

6. Remove the valve rocker covers from the cylinder heads.

7. Disconnect the lower fuel rods from the injector control tube levers and from the lower (threaded) ends of the upper fuel rods.

8. Remove the threaded pins that connect the fuel rods to the control link lever and remove the upper fuel rods.

9. Remove the blower drive support (Fig. 3) as outlined in Section 3.4. The governor weight and shaft assembly will be removed with the blower drive support.

10. Check the clearance between the gear and each of the fully extended weights (Fig. 18). If this clearance

is less than .100" , the weights or carrier are worn and must be replaced.

NOTE: The current weight carrier is hardened in the weight stop areas and the stop area on the low speed weights has been increased with the use of new center laminations to prevent wear which could allow the weights to open beyond limits and strike the blower drive gear.

11. Remove the governor weight shaft and carrier assembly from the blower drive support, using pry bars if necessary.

12. Remove the blower and governor housing assembly as outlined in Section 3.4.

13. Remove the six attaching bolts and lock washers and detach the governor housing from the blower rear end plate. Remove the gasket.

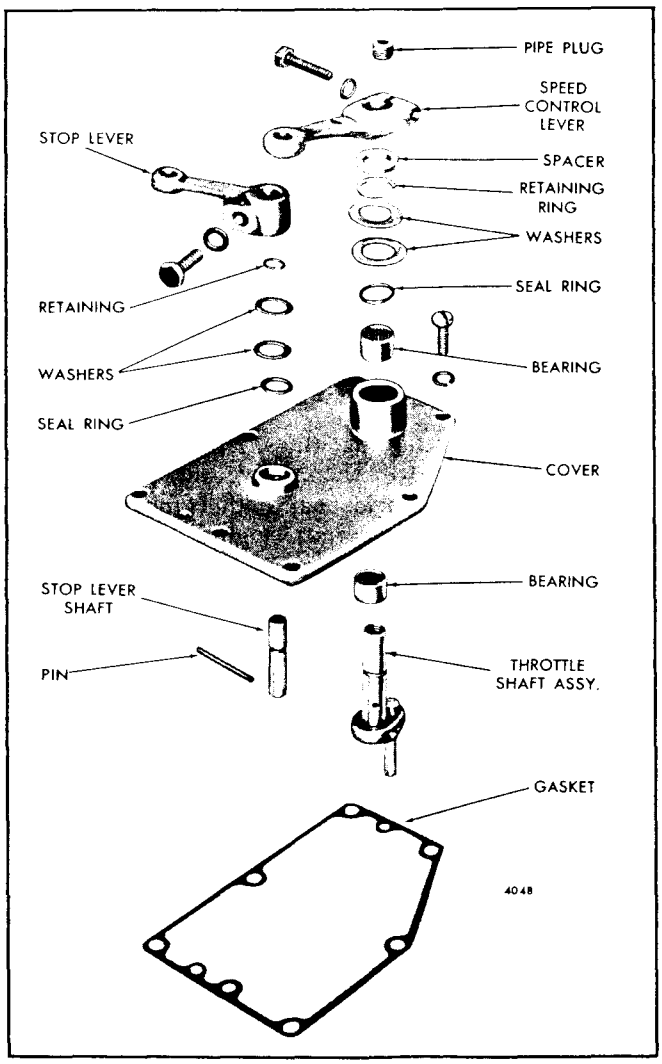


Fig. 4 - Governor Cover Details and Relative Location of Parts

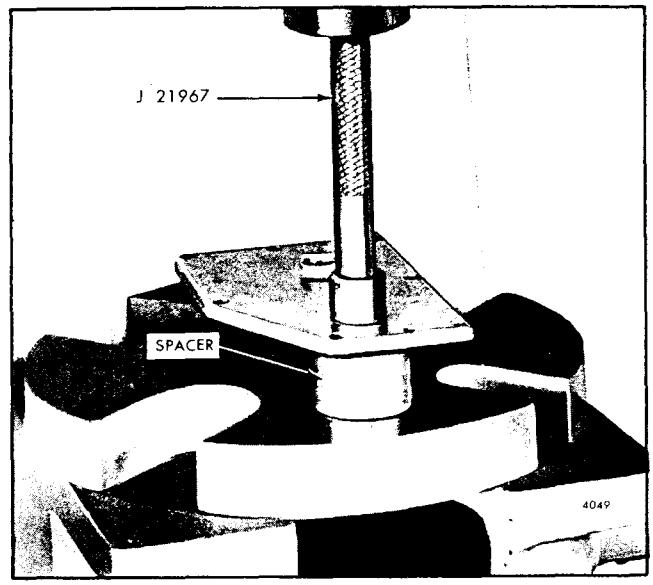


Fig. 5 - Removing Governor Cover Bearing

Disassemble Governor Cover

Refer to Fig. 4 and disassemble the governor cover as follows:

1. Remove the pipe plug from the throttle shaft.

2. Loosen the clamping bolt and remove the speed control lever.

3. Remove the spacer from the throttle shaft.

4. Remove the retaining ring and two seal retaining washers and withdraw the throttle shaft assembly from the cover.

5. Remove the seal ring from the cover.

6. Loosen the clamping bolt and remove the stop lever.

7. Remove the retaining ring and two seal retaining washers and withdraw the stop lever shaft from the cover.

8. Remove the seal ring from the cover.

9. Wash the governor cover with clean fuel oil and inspect the needle bearings for wear or damage. If the bearings are satisfactory, removal is unnecessary.

10. If the bearings are to be removed, place the governor cover on an arbor press and press them out with bearing remover J 21967 (Fig. 5).

Disassemble Governor Springs

Refer to Fig. 6 and disassemble the governor spring assembly as follows:

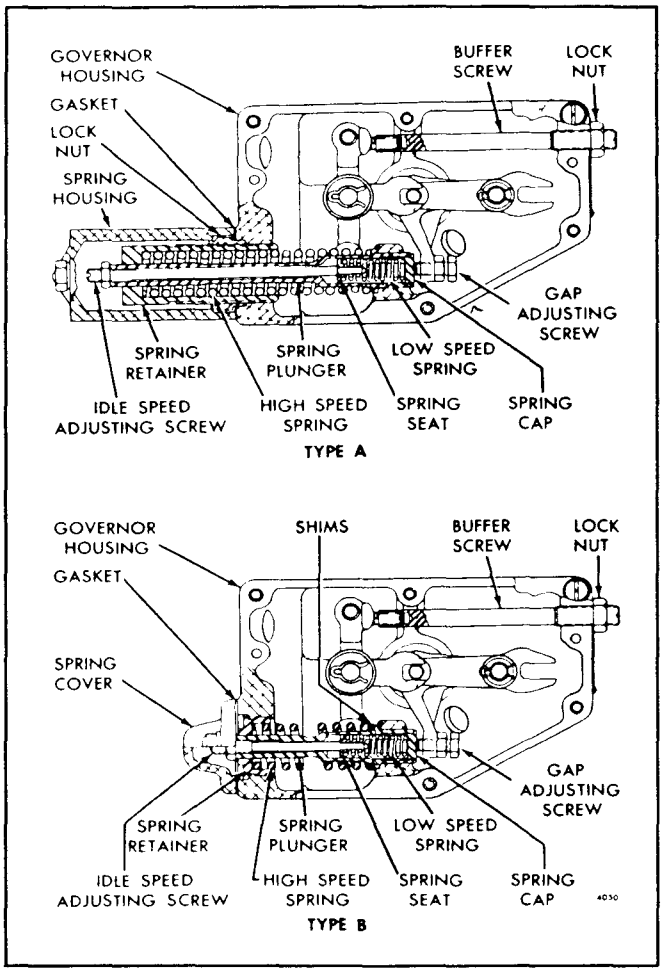


Fig. 6 - Governor Spring Assemblies

1. Remove the low speed spring cap, spring, and spring seat from the spring plunger.

2. Depress the high speed spring by hand and remove the idle speed adjusting screw lock nut. The spring retainer and high speed spring (and shims) may then be withdrawn. Remove the idle speed adjusting screw from the spring plunger.

Disassemble Governor Housing

1. Remove the governor buffer screw and spring.

2. Remove the spring pin and washer from the control link lever pin (Fig. 7) and withdraw the control link lever and washer.

3. If the bearings require replacement, support the control link lever on a sleeve placed on the bed of an arbor press. Then, press the bearings out of the lever with tool J 8985 (Fig. 8).

4. Remove the spring pin and washer from the pin in the operating shaft lever and remove the differential lever.

5. Remove the plug at the bottom of the governor housing.

6. Remove the set screws, if used, from the governor operating fork.

7. Remove the operating shaft upper bearing retaining screw and washer.

8. Remove the operating shaft lower bearing by placing the inverted governor housing on the bed of an arbor press; use wood block(s) to prevent damage to the dowel pins in the housing. Press on the shaft, using a rod small enough to pass through the bearing, until the bearing is free of the shaft. Then, withdraw the bearing.

9. Place an end wrench between the operating fork and the governor housing; also place a rod on the end of the operating shaft and press the shaft out of the fork (Fig. 9).

10. Withdraw the operating shaft, operating shaft lever and bearings.

11. Press the shaft from the operating shaft lever and the upper bearing.

Disassemble Governor Weights and Shaft

1. Remove the retaining rings from the governor weight pins (Fig. 10). Then, drive the pins out by tapping on a punch held against the grooved end of the pins. Remove the governor weights.

2. Press the shaft from the governor weight carrier (Fig. 11).

3. Slide the governor riser and bearing assembly from the shaft. Do not remove the bearing since the bearing and riser are serviced only as an assembly.

Disassemble Blower Drive

1. Remove the snap ring and the thrust washer from the blower drive gear shaft (Fig. 12). Slide the shaft and gear from the blower drive support.

2. Press the drive gear from the shaft and remove the key.

3. Tap the governor weight shaft bearing from the blower drive support. If the bearing is a tight fit, drive

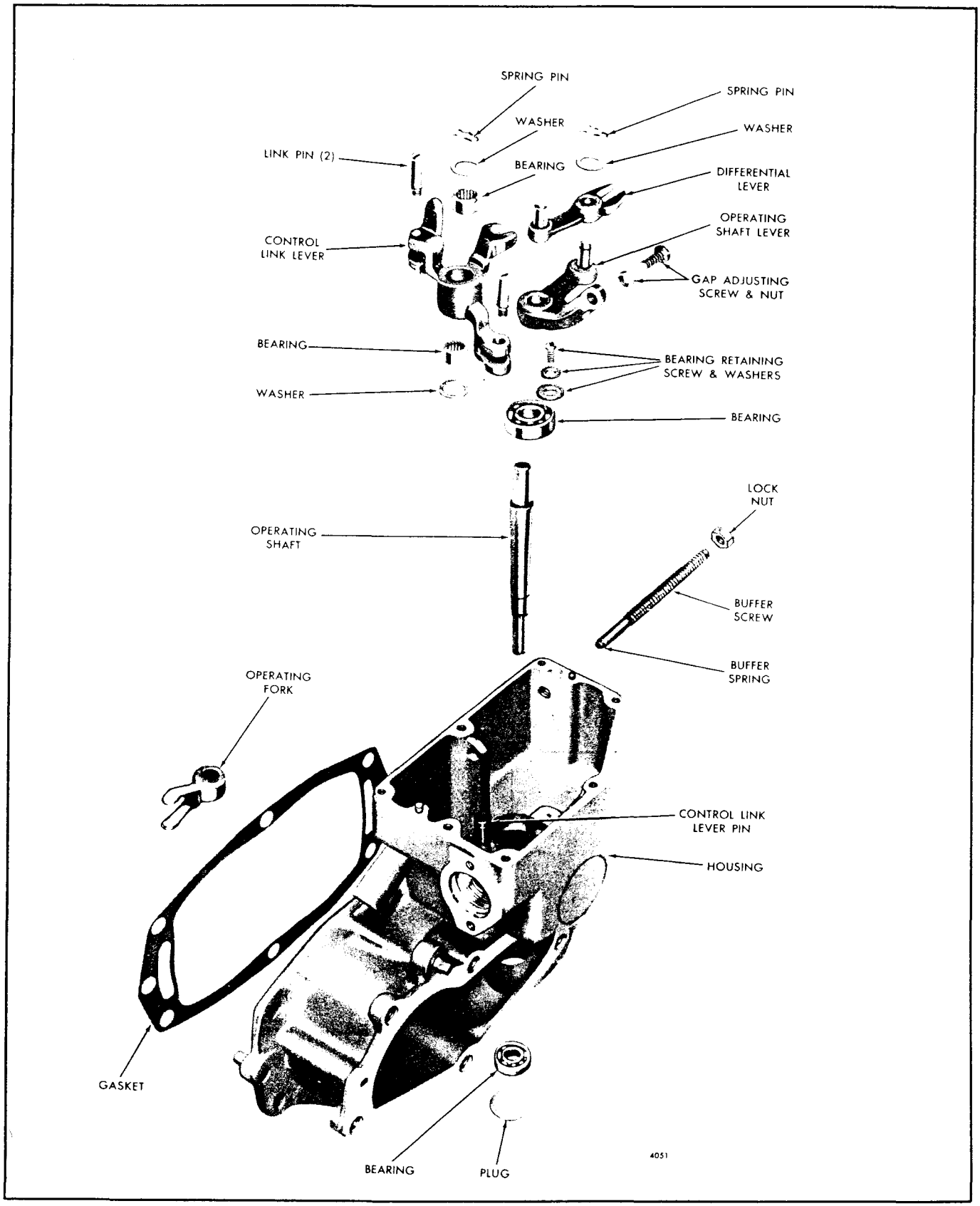


Fig. 7 - Governor Housing Details and Relative Location of Parts

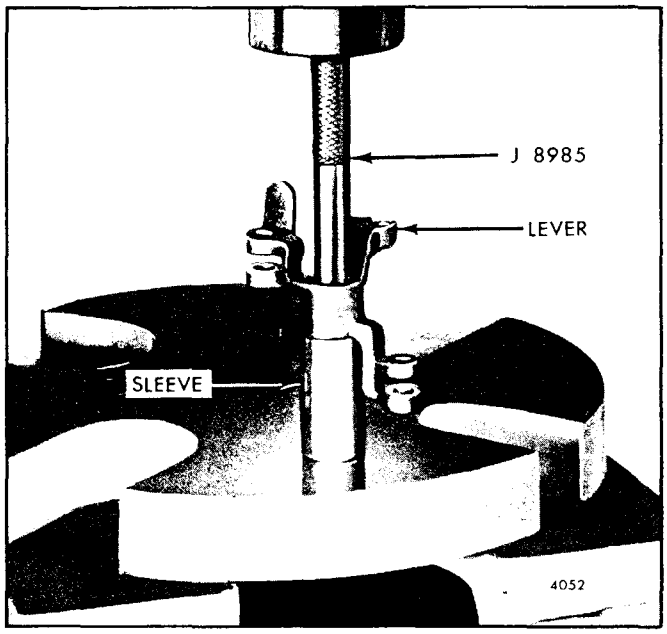


Fig. 8 - Removing Bearings from Control Link Lever

the plug from the support and, using a spacer against the outer race of the bearing, press or tap the bearing from the support.

Inspection

Clean all of the parts with fuel oil and dry them with compressed air.

Inspect all of the bearings. Replace corroded or pitted bearings. Revolve ball bearings slowly by hand. Replace bearings which indicate rough or tight spots.

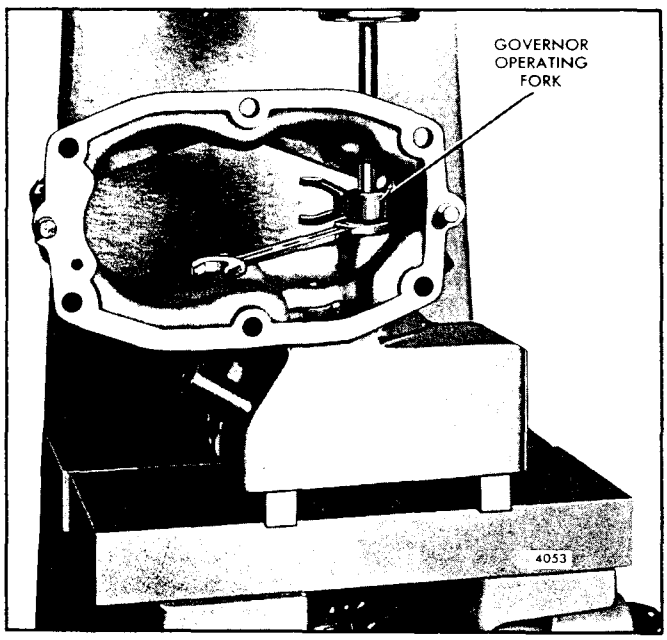


Fig. 9 - Removing Governor Operating Fork

Examine the riser thrust bearing for excessive wear, flat spots or corrosion. If any of these conditions exist, install a new riser and thrust bearing assembly.

Inspect the control link lever, needle bearings and control link lever pin for wear. Replace worn parts. If a new control link lever pin is required, remove the old pin and press the new pin in the governor housing; the pin must project 1.055" to 1.060" above the boss in the housing.

Examine the weight carrier, weights and pins. Replace worn parts. The current weight carrier is hardened in the weight stop areas and the stop area on the low speed weights has been increased with the use of new center laminations.

Inspect the governor springs, spring seat, spring cap, plunger, spring retainer, adjusting screws and other parts of the governor housing for wear.

Check the serrations on the governor weight shaft and the drive plate on the blower timing gear for wear. Replace worn parts.

Assemble Governor Cover

Refer to Fig. 4 and assemble the governor cover as follows:

1. Place the cover, with the inner face down, on the bed of an arbor press. Start a needle bearing straight into the bearing bore of the cover, with the number side of the bearing up. Then, insert bearing installer J 21068 in the bearing and press the bearing in until the shoulder on the tool contacts the cover (Fig. 13).

2. Turn the cover over and start the second bearing, number side up, in the bearing bore. Press the bearing in flush with the cover with tool J 21068.

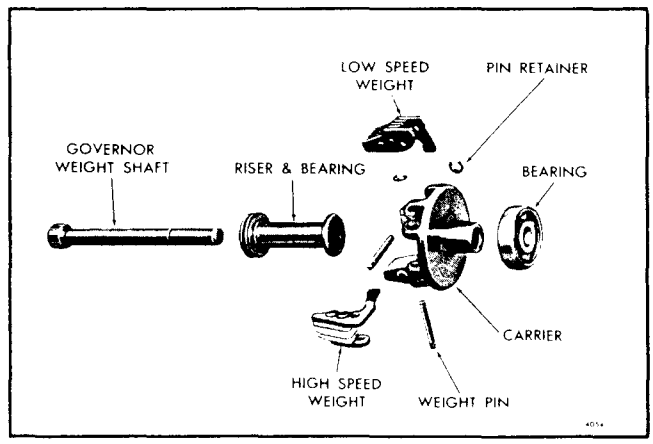


Fig. 10 - Governor Weight Details and Relative Location of Parts

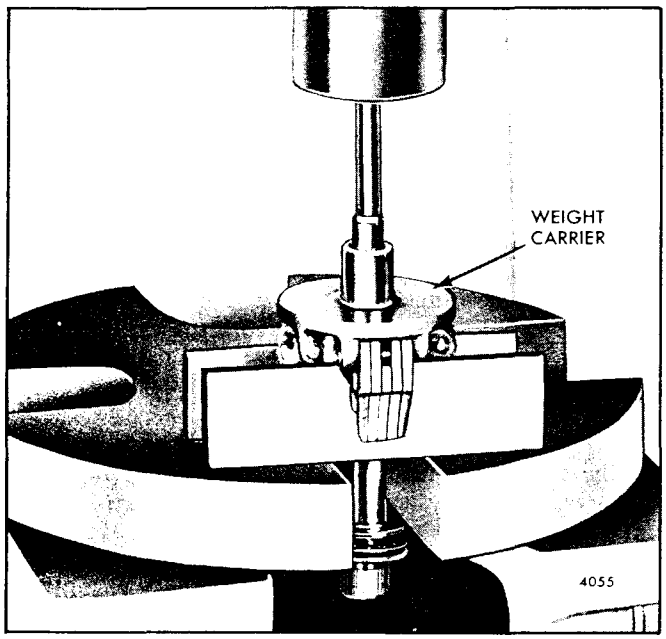


Fig. 11 - Removing Shaft from Weight Carrier

NOTE: Do not use impact tools to install needle bearings.

3. Install the pipe plug in the tapped hole in the throttle shaft.

4. Pack the needle bearings with grease. Then, slide the throttle shaft assembly through the bearings, with the fulcrum lever pin seated in the slot on the underside of the cover.

5. Install a new seal ring on top of the upper bearing. Then, install the two seal retaining washers and the retaining ring.

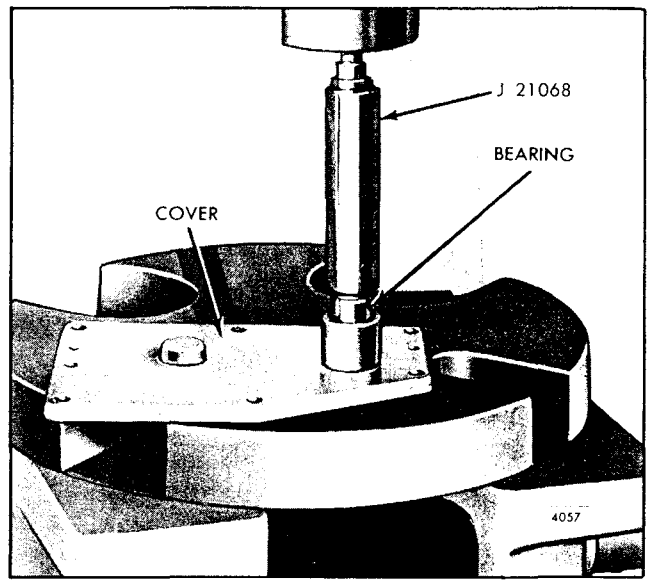


Fig. 13 - Installing Governor Cover Bearings

NOTE: A .0329" thick, 33/64" I.D. x 43/64" O.D. seal ring back-up washer is used in place of the lower washer on certain governor covers.

6. Lubricate the stop lever shaft with engine oil. Then, slide the shaft through the cover.

7. Install a new seal ring over the shaft. Then, install the two seal retaining washers and the retaining ring.

NOTE: A .0329" thick, 25/64" I.D. x 17/32" O.D. seal ring back-up washer is used in place of the lower washer on certain governor covers.

8. Install the .078" thick spacer over the speed control shaft and against the retaining ring.

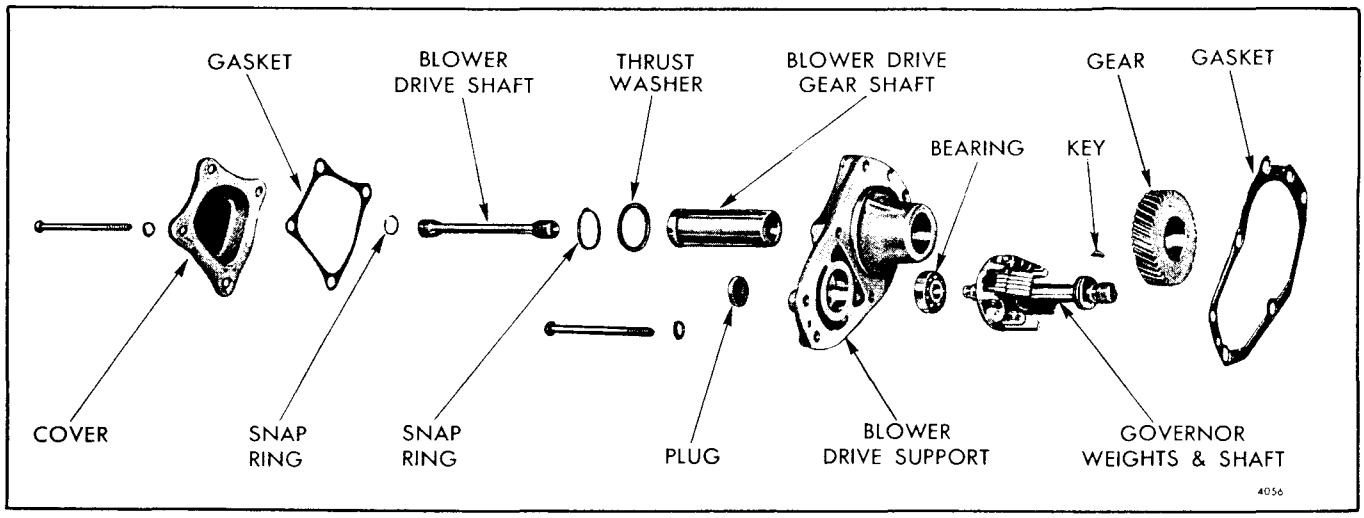


Fig. 12 - Blower Drive Support Assembly Details and Relative Location of Parts

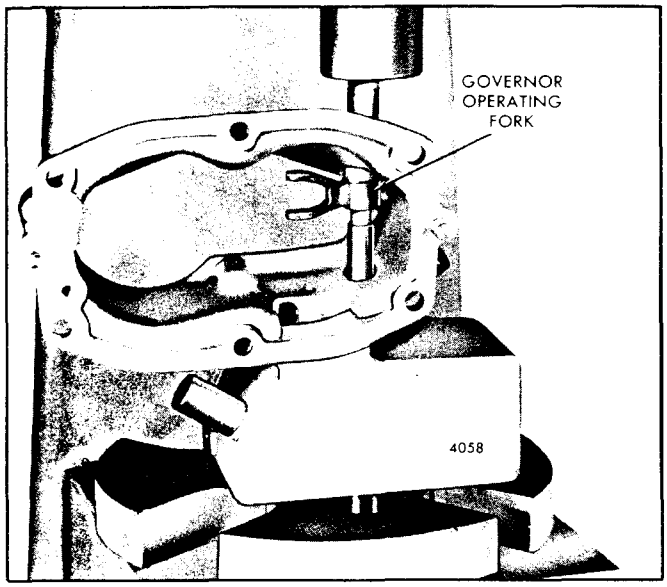


Fig. 14 - Installing Governor Operating Fork on Shaft

9. Install the stop lever and speed control lever, then tighten the clamping bolts. Be sure the speed control lever contacts the spacer.

Assemble Governor Housing

Refer to Fig. 7 and assemble the governor housing as follows:

1. Start the upper operating shaft bearing, number side up, on the end of the shaft. Support the lower end of the shaft on an arbor press. Place a sleeve on the inner race and press the bearing against the shoulder on the shaft.

2. Start the operating shaft lever, with the pivot pin up, on the end of the shaft with the flat on the shaft registering with the flat in the lever bore. Use a sleeve to press the lever tight against the bearing.

3. Insert the lever and shaft assembly through the top of the governor housing. Position the operating fork over the lower end of the shaft, with the finished cam surfaces facing toward the rear of the governor (toward the governor drive).

4. Support the operating shaft and governor housing on the bed of an arbor press with the upper end of the shaft resting on a steel block (Fig. 14). Align the flat in the fork with the flat on the shaft, then place a sleeve over the shaft and against the fork. Press the fork tight against the shoulder on the shaft. Install the set screw and lock screw, if used, in the fork.

5. Start the lower operating shaft bearing, number side up, on the end of the shaft. Place a sleeve on the inner race and press the bearing against the shoulder in the housing.

6. Lubricate both bearings with engine oil.

7. Apply a good quality sealant around the edge of a new expansion plug and tap it in place in the housing.

8. Secure the upper operating shaft bearing in place with a retaining screw and flat washer.

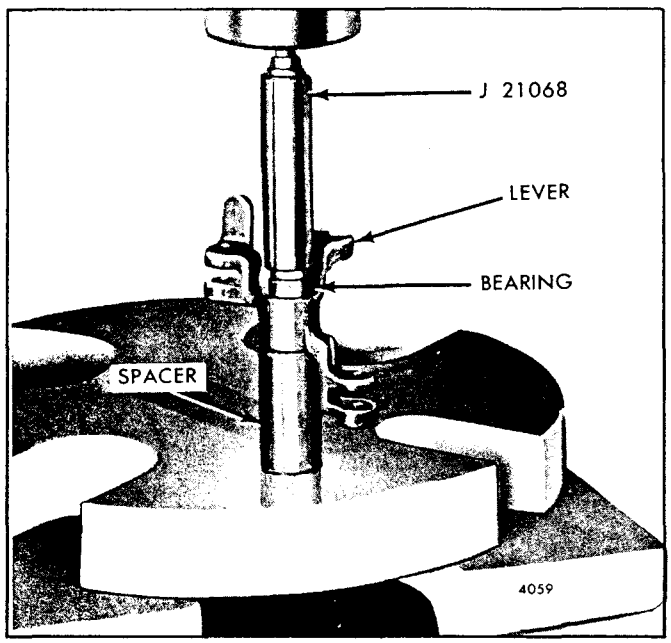


Fig. 15 - Installing Bearings in Control Link Lever

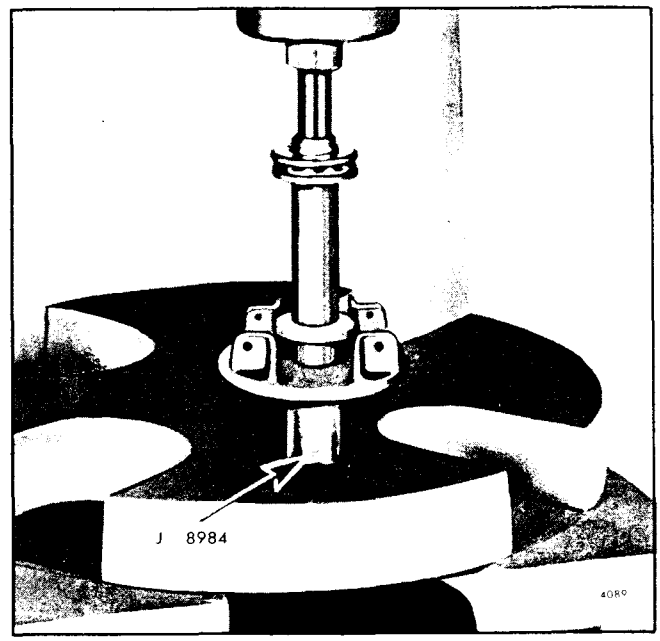


Fig. 16 - Installing Weight Carrier on Shaft

9. Place the differential lever (Fig. 7) over the pivot pin in the operating shaft lever. Secure the lever with a washer and spring pin.

10. If previously removed, install the gap adjusting screw and lock nut in the tapped hole in the operating shaft lever.

11. Support the control link lever on a steel spacer on the bed of an arbor press. Start one bearing, number side up, in the lever and press it flush with the lever with tool J 21068 (Fig. 15). Invert the lever and install the second bearing in the same manner.

12. Place the washer on the control link lever pin in the housing. Pack the needle bearings with grease and install the lever, with the tapped end of the link pin holes down, over the pin in the governor housing (Fig. 7). Secure the lever with the washer and spring pin.

13. Thread the buffer screw into the governor housing until it extends 9/16" to 5/8" beyond the governor housing and install the lock nut.

> **NOTE:** The buffer screw on early governors threaded into a splined lock nut which was installed (inside the housing) in a drilled hole in the governor housing. The current buffer screw threads into a tapped hole in the housing and is secured with a lock nut which is installed from the outer side of the housing.

Assemble Governor Weights and Shaft

Refer to Fig. 10 and assemble the governor weights and shaft as follows:

1. Lubricate the governor weight shaft with clean engine oil and slide the riser assembly over the shaft, with the bearing end toward the serrated end of the shaft. Pack the bearing with grease.

2. Use installer J 8984 as illustrated in Fig. 16 and press the shaft into the weight carrier. The tool will properly position the carrier on the shaft.

3. Position the low speed weights, identified by the long cam arm, on opposite sides of the weight carrier. Drive the weight pins in place and install the retaining rings. To install a weight pin correctly, push the grooved end through the smaller hole in the carrier and through the weight. Then, drive the knurled end in just enough so the retaining ring can be installed on the pin.

4. Install the high speed weights in a similar manner. The high speed weights are identified by the short cam arm.

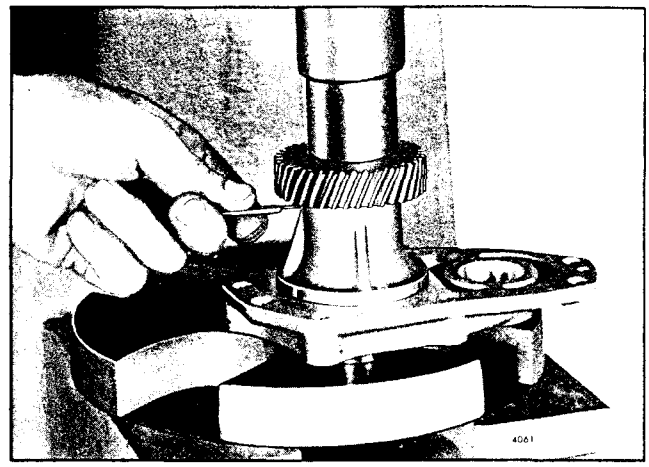


Fig. 17 - Installing Blower Drive Gear on Shaft

Assemble Blower Drive

Refer to Fig. 12 and assemble the blower drive as follows:

1. Place the blower drive support, with the inner face up, on the bed of an arbor press. Start the governor weight shaft bearing, numbered side up, into the bore of the support. Place a suitable sleeve against the outer race and press the bearing against the shoulder of the blower drive support.

2. Place the steel thrust washer on the end of the blower drive gear shaft and secure it in place with the snap ring.

3. Lubricate the blower drive gear shaft with engine oil and install it in the blower drive support.

4. Install the key in the shaft, then place the blower drive support on an arbor press. Lubricate the inner diameter of the blower drive gear and start it straight on the shaft, with the keyway in the gear aligned with the key in the shaft. Place a spacer over the gear and press the gear on the shaft until a .005" feeler gage may just be withdrawn (Fig. 17).

5. Place a support under the inner race of the bearing in the blower drive support and start the weight end of the governor weight shaft into the bearing. Press the shaft in until the shoulder on the shaft contacts the inner race of the bearing. Press the shaft in straight to avoid brinelling the bearing.

6. Apply a good quality sealant on the edge of the cup plug and press the plug in flush with the blower drive support.

7. Check the clearance between the fully extended governor weights and the blower drive gear. This clearance must not be less than .100" (Fig. 18).

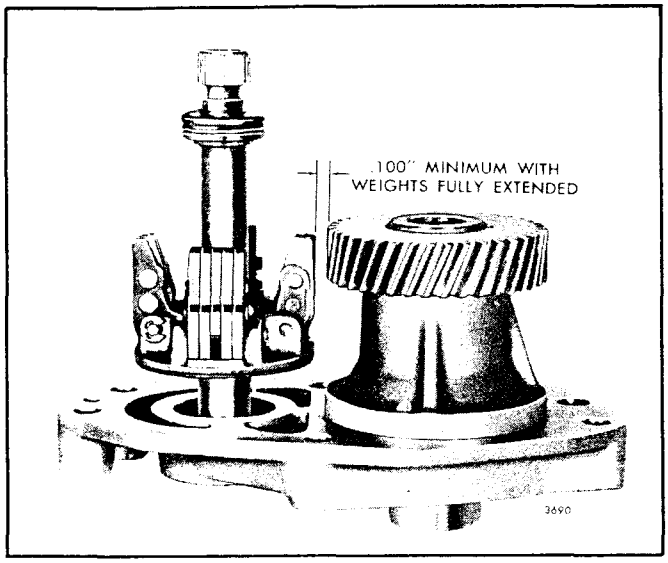


Fig. 18 - Minimum Clearance Between Blower Drive Gear and Governor Weights

Install Governor

Install the governor on the engine as follows:

1. Attach a new gasket to the governor housing and place the housing against the blower rear end plate. Secure the governor housing to the blower with six bolts and lock washers.

2. Install the blower and governor assembly on the engine as outlined in Section 3.4.

3. Install the blower drive support assembly as outlined in Section 3.4 under *Install Blower in 6V Engine.*

4. Insert the upper fuel rods through the fuel rod covers, hoses and clamps and attach the fuel rods to the governor control link lever. Then, thread the link pins into the lever.

5. Attach the lower fuel rods to the injector control tube levers and to the upper fuel rods.

6. Slide the fuel rod cover hoses in place and secure them with the hose clamps.

7. Assemble the governor springs as follows:

TYPE A (Fig. 6):

a. Thread the lock nut on the spring retainer.

b. Thread the idle speed adjusting screw into the spring plunger.

c. Place the high speed spring over the spring plunger (with the close wound coils toward the idle screw end of the plunger).

d. Lubricate the spring and plunger assembly with engine oil. Then, install the spring and plunger assembly in the spring retainer and secure it in place with a lock nut. Approximately 1/4" of the idle speed adjusting screw should extend beyond the lock nut.

e. Lubricate and insert the spring seat, low speed spring, and spring cap in the open end of the spring plunger.

f. Place a new gasket over the spring retainer and thread the retainer and spring assembly into the governor housing. Tighten the lock nut finger-tight until the engine tune-up is performed.

TYPE B (Fig. 6):

a. Thread the idle speed adjusting screw into the spring plunger.

b. Reinstall the original shims over the spring plunger.

c. Place the high speed spring over the spring plunger.

d. Lubricate the spring and plunger assembly with engine oil. Then, place the spring retainer over the plunger and secure it with a lock nut. Approximately 1/4" of the idle speed adjusting screw should extend beyond the lock nut.

e. Lubricate and insert the spring seat, low speed spring and spring cap in the open end of the spring plunger.

f. Thread the retainer and spring assembly into the governor housing. The cover and gasket are to be installed after the engine tune-up is performed.

8. Place a new gasket on the governor housing and install the cover and lever assembly. Make sure the control link lever engages the pin on the differential lever. Also, be sure the pin in the speed control shaft enters the slot in the differential lever and that the pin in the stop lever shaft is engaged between the stop on the underside of the cover and the vertical extension of the control link lever. Then, secure the cover with seven screws and lock washers.

9. Connect the linkage to the governor control levers after the engine tune-up is performed.

10. Perform an engine tune-up as outlined in Section 14.

LIMITING SPEED MECHANICAL GOVERNOR

8V ENGINE

The limiting speed mechanical governor, illustrated in Fig. 1, performs the following functions:

1. Controls the engine idling speed.

2. Limits the maximum operating speed of the engine.

The double-weight governor, identified by the letters D.W.-L.S. stamped on the governor name plate, is mounted on the front end of the blower and is driven by the left-hand helix blower rotor shaft (Fig. 2).

The governor consists of four basic sub-assemblies: a cover and lever assembly, governor housing, spring housing, and a weight and shaft assembly.

Operation

Two manual controls are provided on the governor: a stop lever and a speed control lever. In the RUN position, the stop lever holds the fuel injector racks near the full-fuel position. When the engine is started, the governor moves the injector racks toward the idle speed position. The engine speed is then controlled manually by moving the speed control lever.

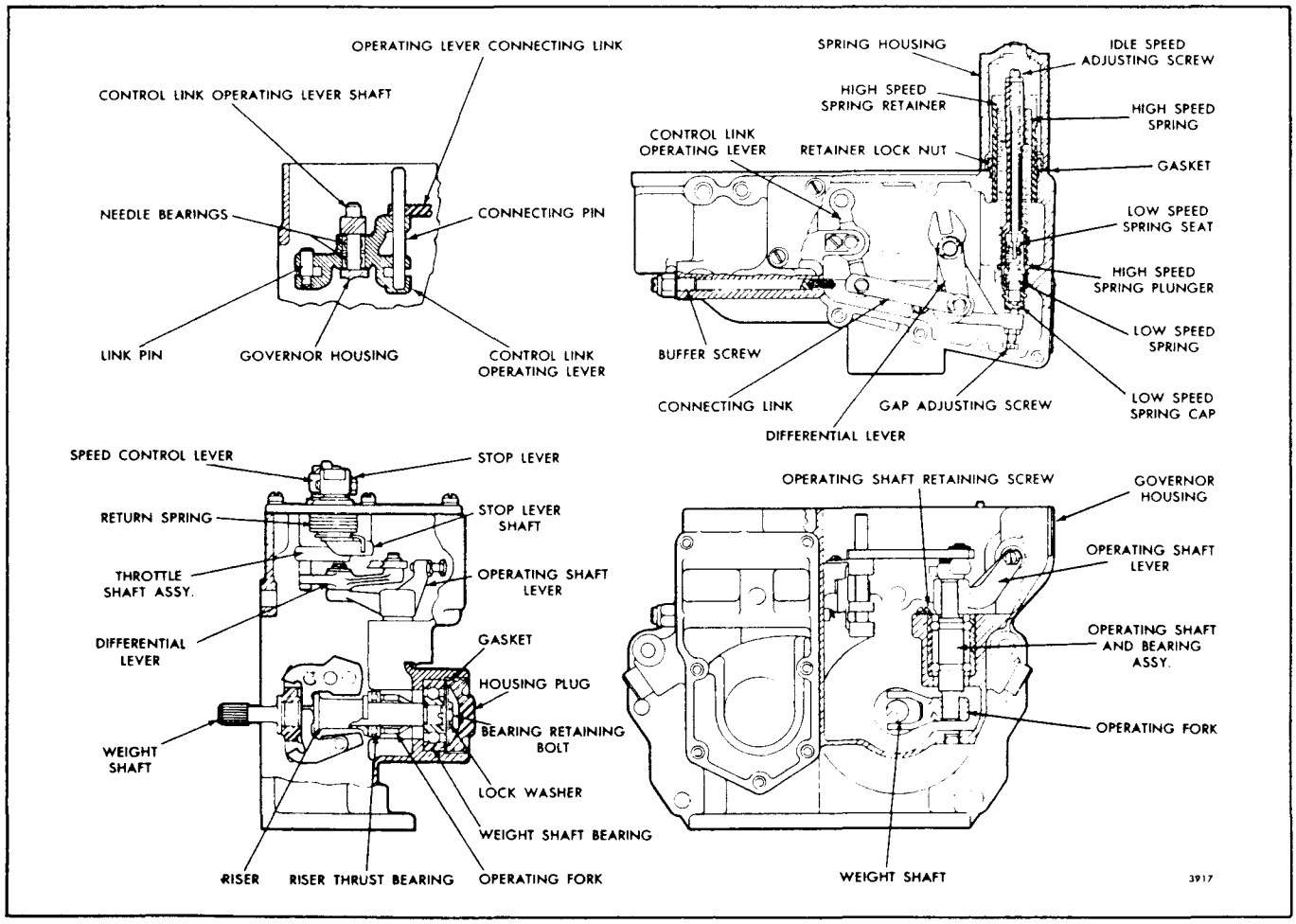


Fig. 1 - Limiting Speed Governor for 8V-53 Engine

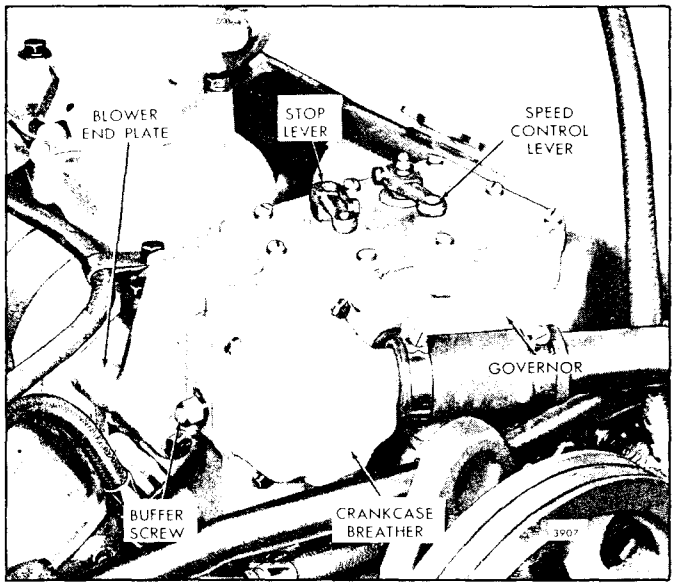


Fig. 2 - Governor Mounting

The centrifugal force of the revolving governor weights is converted into linear motion which is transmitted through the riser and operating shaft to the operating shaft lever. One end of this lever bears against the governor spring cap while the other end provides a moving fulcrum on which the differential lever pivots.

The centrifugal force of the governor weights is opposed by the governor springs. Load changes or movement of the speed control lever momentarily creates an unbalanced force between the revolving weights and the tension on the high speed spring or low speed spring (depending on the speed range). When the forces reach a balanced condition again, the engine speed will be stabilized for the new speed setting or new load.

In the low speed range, the centrifugal force of the low speed weights and the high speed weights operates against the low speed spring. As the engine speed increases, the centrifugal force of both pairs of weights compresses the low speed spring until the low speed weights have reached the limit of their travel at which time the low speed spring is fully compressed and the spring cap is within .0015 " of the high speed spring plunger.

Throughout the intermediate speed range, the operator has complete control of the engine because both the low speed spring and the low speed weights are against their stops, and the high speed weights are not exerting enough force to overcome the high speed spring.

As the engine speed continues to increase, the centrifugal force of the high speed weights increases until this force overcomes the high speed spring and the governor again takes control of the engine, limiting the maximum engine speed.

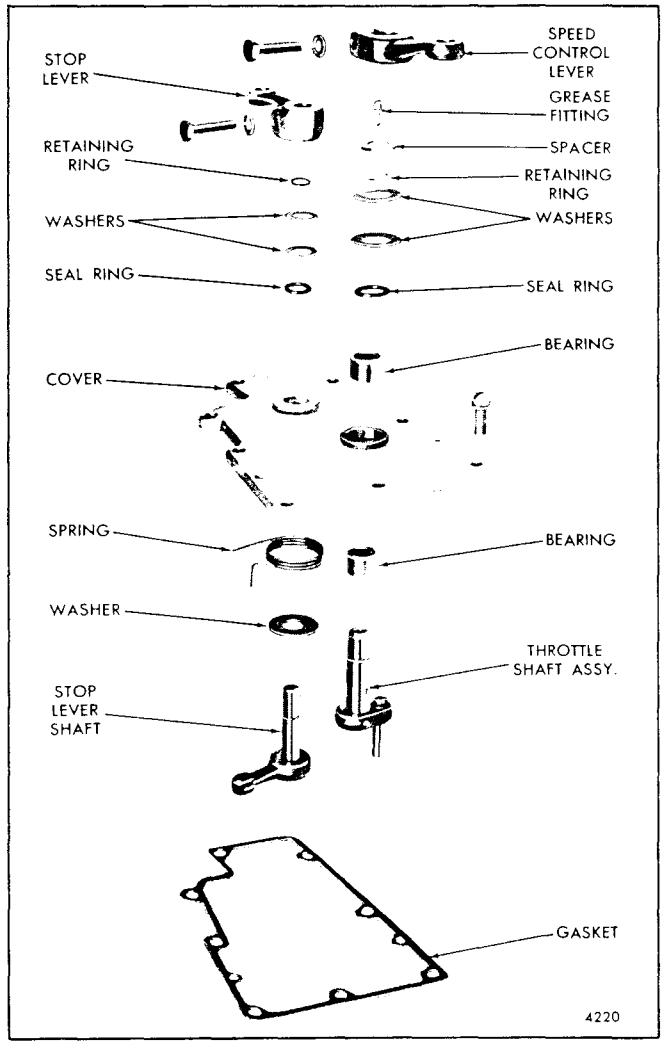


Fig. 3 - Governor Cover Details and Relative Location of Parts

Fuel rods are connected to the differential lever and the injector control tube levers through the control link operating lever and the connecting link (Fig. 1). This arrangement provides a means for the governor to change the fuel settings of the injector control racks.

To stop the engine, the speed control lever is moved to the idle speed position and the stop lever is moved to the no-fuel position and held there until the engine stops.

Adjustment of the governor is covered in Section 14.

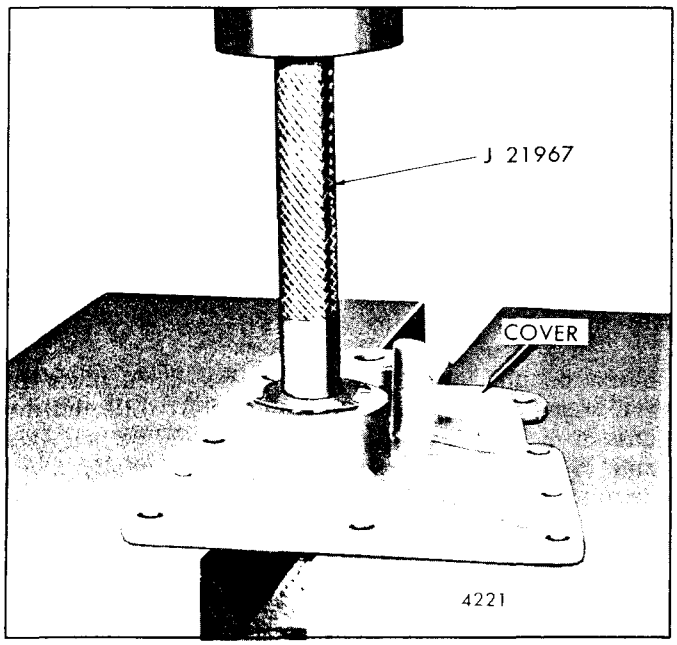


Fig. 4 - Removing Governor Cover Bearings

Lubrication

The governor is lubricated by a spray of oil from a passage in the blower end plate. The revolving governor weights distribute this oil to all parts of the governor which require lubrication. Excess oil returns to the engine crankcase through passages in the blower end plate and the cylinder block.

Remove Governor From Engine

Check the operation of the governor as outlined in Section 2.7 and if it fails to control the engine properly, remove and disassemble it for further inspection.

The blower and governor must be removed together as outlined under *Remove Blower (8V-53)* in Section 3.4.1. Then remove the governor from the blower as outlined under *Remove Accessories from Blower (8V-53)* in Section 3.4.1.

Disassemble Governor

Before removing any parts from the governor, wash the entire unit in clean fuel oil, dry it with compressed air and inspect for worn or damaged parts which may be repaired or replaced without complete disassembly.

Disassemble Governor Cover

Refer to Fig. 3 and disassemble the governor cover as follows:

1. Loosen the clamping bolt and remove the stop lever.

2. Remove the retaining ring and withdraw the two washers from the stop lever shaft assembly.

3. Note the position of the stop lever shaft assembly and the lever return spring. Then withdraw the shaft, washer and spring.

4. Remove the seal ring.

5. Loosen the clamping bolt and remove the speed control lever.

6. Remove the spacer from the throttle shaft.

7. Remove the retaining ring and withdraw the two washers from the throttle shaft assembly.

8. Withdraw the throttle shaft assembly. Remove the grease fitting from the shaft.

9. Remove the seal ring.

10. Wash the governor cover with clean fuel oil and inspect the needle bearings for wear or damage. If the bearings are satisfactory, removal is unnecessary.

11. If the bearings are to be removed, place the governor cover on an arbor press and press them out with bearing remover J 21967 (Fig. 4).

Disassemble Governor Springs

Refer to Fig. 5 and disassemble the governor spring housing as follows:

1. Remove the two retaining bolts and copper washers and withdraw the spring housing from the governor.

2. Loosen the spring retainer lock nut with a spanner wrench. Remove the spring and retainer assembly from the governor. Remove the gasket.

3. Remove the spring cap and low speed spring.

4. Loosen the lock nut and remove the idle speed adjusting screw. Then withdraw the high speed spring and plunger from the spring retainer.

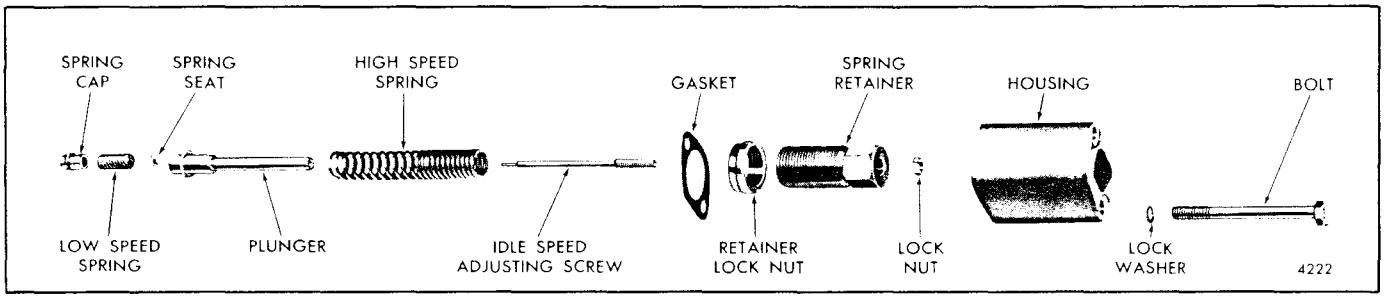


Fig. 5 - Governor Spring Assembly Details and Relative Location of Parts

Disassemble Governor Housing

Refer to Figs. 6 and 9 and disassemble the governor housing as follows:

1. Remove the large plug and gasket from the governor housing to provide access to the weight shaft bearing.

2. Straighten the tang on the lock washer and remove the weight shaft bearing retaining bolt, washer and lock washer.

3. Withdraw the weight, riser and shaft assembly.

4. Remove the weight shaft bearing from the governor housing.

5. Loosen the lock nut and remove the buffer screw.

6. Remove the two link pins from the control link lever.

7. Remove the spring pin and washer and remove the connecting link.

8. Remove the spring pin and washer and remove the differential lever.

9. Remove the control link lever shaft retainer and screw. Then withdraw the control link lever, shaft and two washers from the governor housing.

10. Examine the needle bearings. If they are satisfactory for further use, removal is unnecessary.

11. If the bearings require replacement, support the control link lever on a sleeve placed on the bed of an arbor press. Then press the bearings out of the lever with bearing remover J 8985 (Fig. 7).

12. Remove the operating shaft bearing retaining screw and washer.

13. Tap the small cup plug out of the housing.

14. Place the governor housing, upside down, on wood blocks on the bed of an arbor press. Then place an end wrench between the operating shaft fork and the boss in the housing. Insert a rod through the cup plug hole in the housing and against the end of the shaft, then press the shaft out of the fork (Fig. 8).

15. Withdraw the operating shaft, bearing and lever assembly.

16. If the operating shaft bearing requires replacement, use a small puller to remove the lever from the shaft.

Disassemble Governor Weights and Shaft

Refer to Fig. 9 and disassemble the governor weights as follows:

1. Remove the riser thrust bearing and riser tube from the weight shaft.

2. Remove the retaining rings from the weight pins. Then drive the pins out of the carrier and the weights by tapping on the grooved end of the pins. Remove the governor weights.

Inspection

Clean all of the parts (except the operating shaft bearing) with fuel oil and dry them with compressed air.

> **NOTE:** The operating shaft bearing is sealed and must not be cleaned with fuel oil or other cleaning agent.

Inspect all bearings. Replace corroded or pitted bearings. Revolve ball bearings slowly by hand; replace bearings which indicate rough or tight spots. The operating shaft and bearing are serviced only as an assembly.

Examine the riser thrust bearing for excessive wear, flat spots or corrosion.

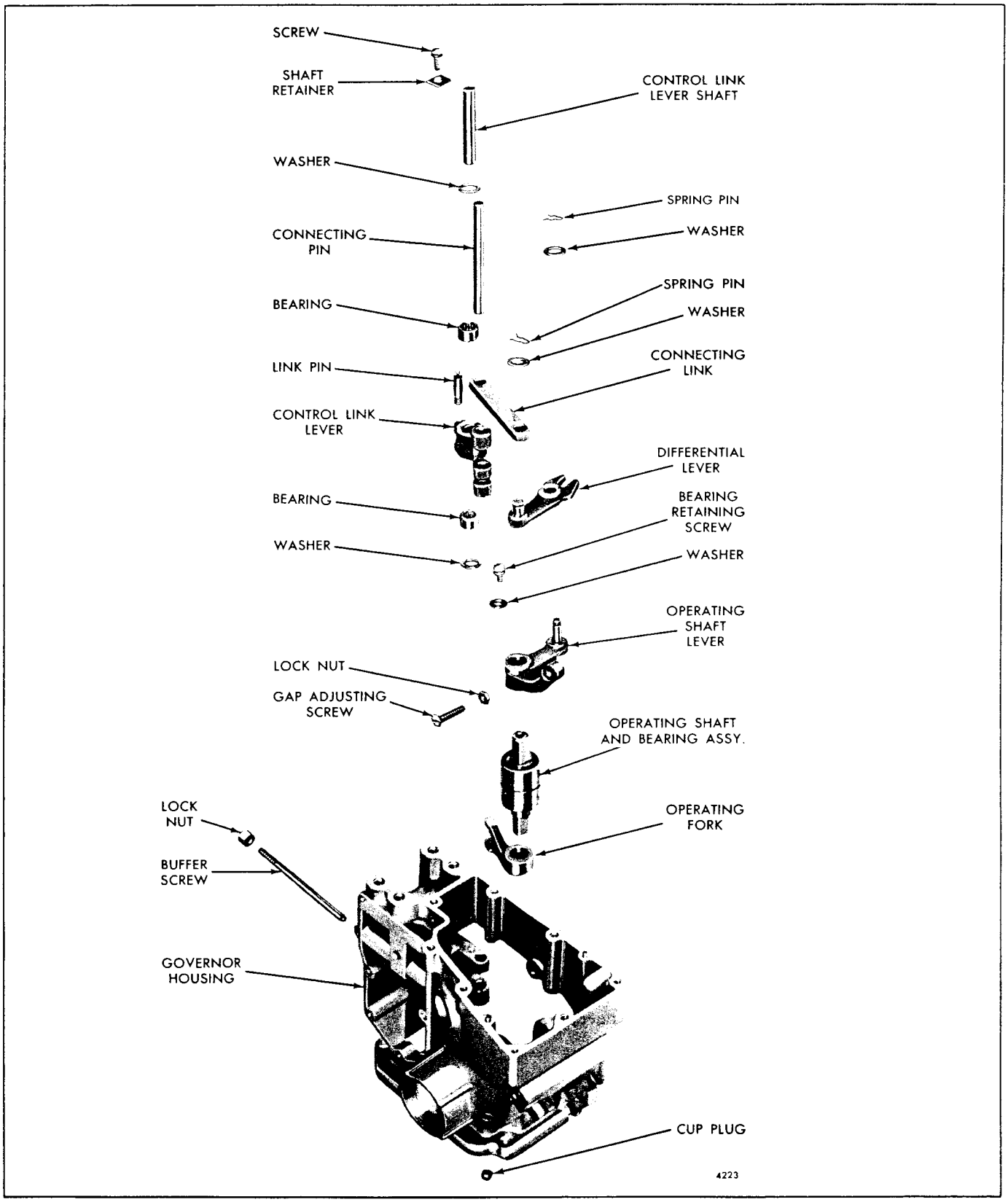


Fig. 6 - Governor Housing Details and Relative Location of Parts

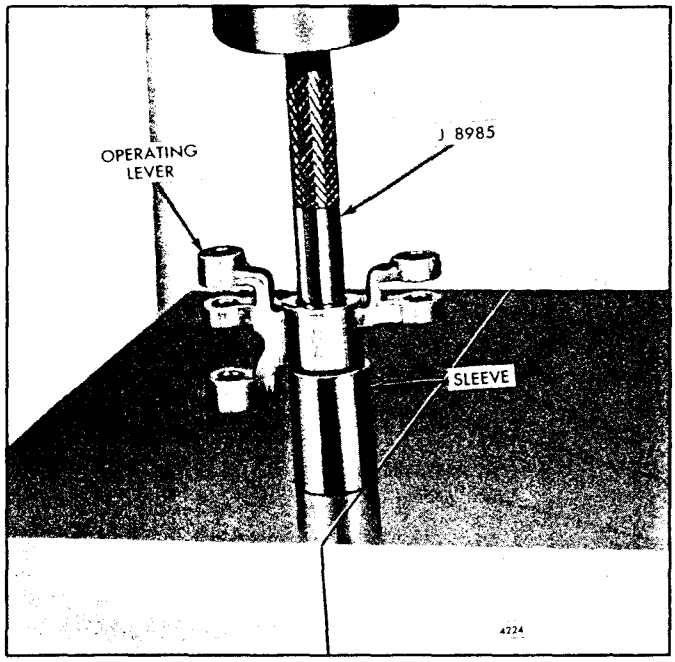


Fig. 7 - Removing Control Link Lever Bearings

Inspect all of the levers, pins, shafts, governor weights and springs. Replace worn or damaged parts.

Assemble Governor Cover

Refer to Fig. 3 and assemble the governor cover as follows:

1. Place the cover, with the inner face down, on a spacer on the bed of an arbor press. Start a needle bearing straight into the bearing bore of the cover, with the number side of the bearing up. Then insert bearing installer J 21068 in the bearing and press the bearing in until the shoulder on the tool contacts the cover (Fig. 10).

2. Turn the cover over and start the second bearing, number side up, in the bearing bore. Press the bearing in flush with the cover with tool J 21068.

NOTE: Do not use impact tools to install needle bearings.

3. Install the grease fitting in the throttle shaft.

4. Pack the needle bearings with grease. Then slide the throttle shaft assembly through the bearings, with the fulcrum lever pin seated in the slot on the underside of the cover.

5. Install a new seal ring on top of the upper bearing.

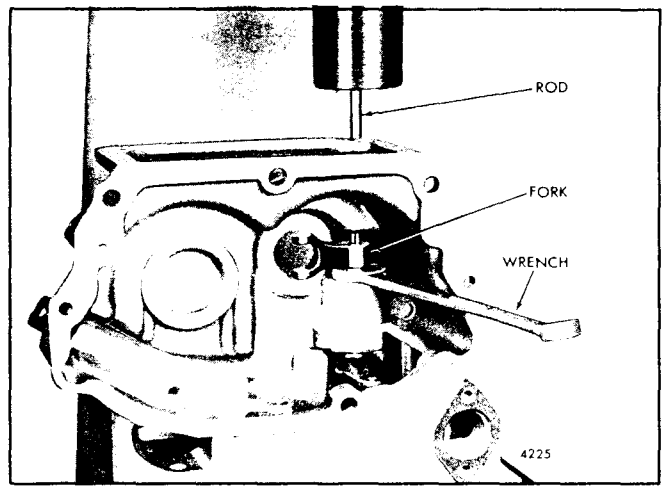


Fig. 8 - Removing Governor Operating Fork

Then install the two seal retaining washers and the retaining ring.

6. Place the large washer over the stop lever shaft. Then place the spring, with the hook end down, over the shaft. Insert the shaft in the cover with the lever against the stop in the cover; position the spring with the hook behind the lever and the upper extended end of the spring located between the lever stop and the shaft boss in the cover.

7. Install a new seal ring over the shaft. Then install the two seal retaining washers and the retaining ring.

8. Install the .078 " thick spacer over the speed control shaft and against the retaining ring.

9. Install the stop lever and the speed control lever; tighten the clamping bolts. Be sure the speed control lever contacts the spacer.

Assemble Governor Housing

Refer to Fig. 6 and assemble the governor housing as follows:

1. Start the operating shaft lever on the shaft with the flat surfaces aligned and press the lever flush with the top of the shaft.

2. Insert the shaft, bearing and lever assembly in the governor housing.

3. Place the housing right side up on the bed of an arbor press.

4. Align the flat surfaces and start the operating shaft fork on the shaft with the finished cam surfaces of the fork facing toward the rear of the governor. Insert the

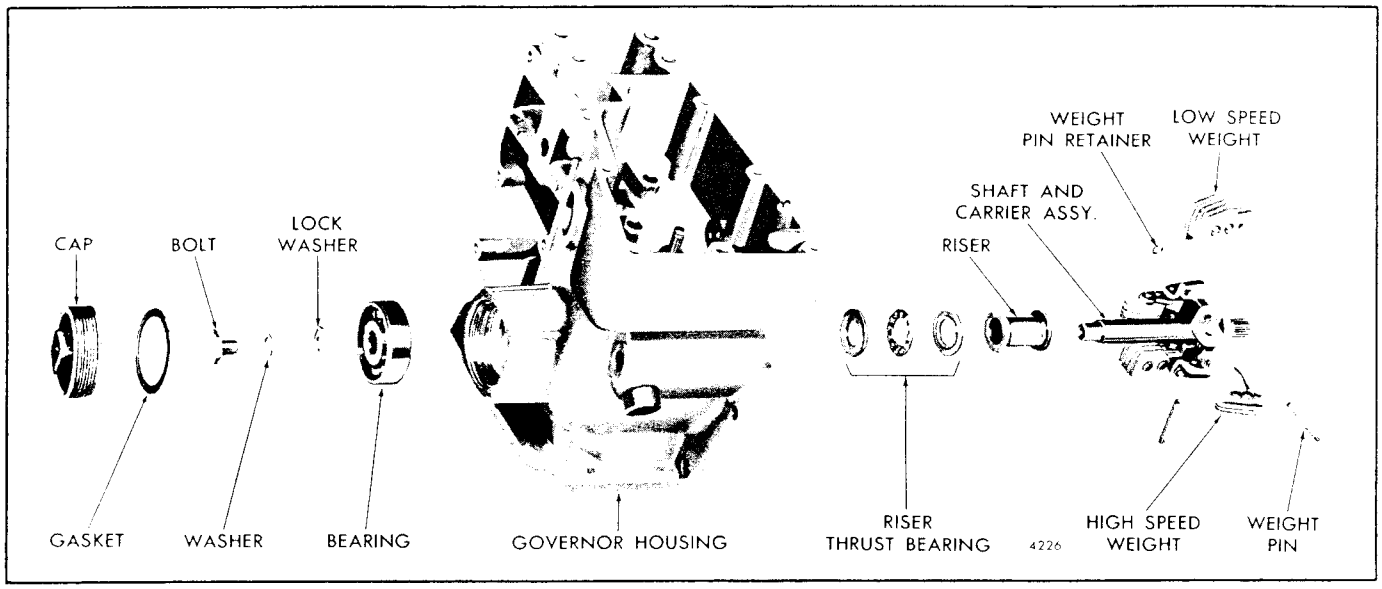


Fig. 9 - Governor Weight Details and Relative Location of Parts

threaded end of tool J 21995-2 through the cup plug hole in the housing. Then thread the knurled nut J 21995-1 on the end of the tool so the fork rests on the nut. Use a rod of suitable length and diameter and press the shaft into the fork until the fork is flush with the end of the shaft (Fig. 11). Remove the tools.

5. Install the operating shaft bearing retaining screw and washer.

6. Apply a good quality sealant to a new cup plug and press the plug in the governor housing.

7. Place the differential lever over the pin in the operating shaft lever and secure it with a washer and spring pin.

8. If previously removed, install the gap adjusting screw and lock nut in the tapped hole in the operating shaft lever.

9. Support the control link lever on a steel spacer on

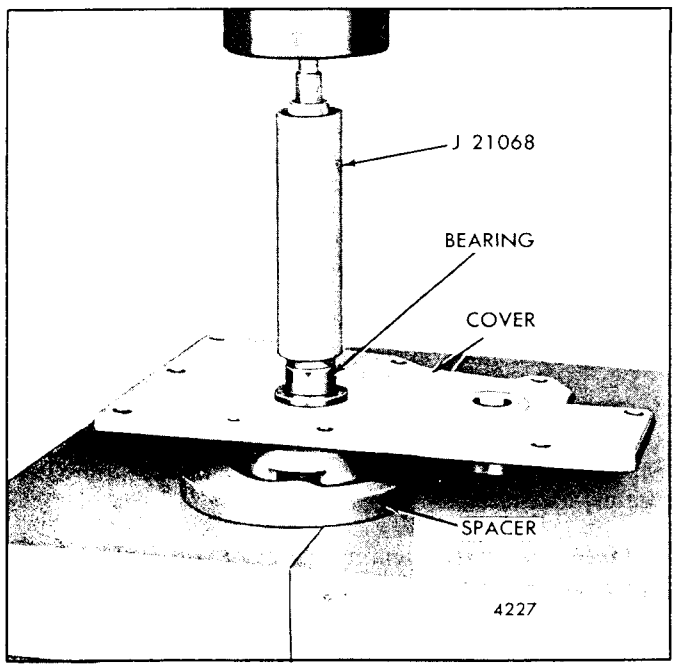


Fig. 10 - Installing Governor Cover Bearings

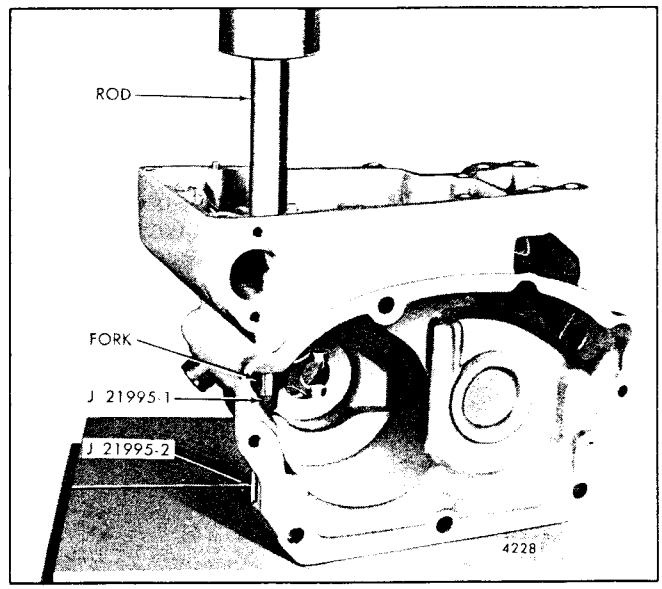


Fig. 11 - Installing Governor Operating Fork

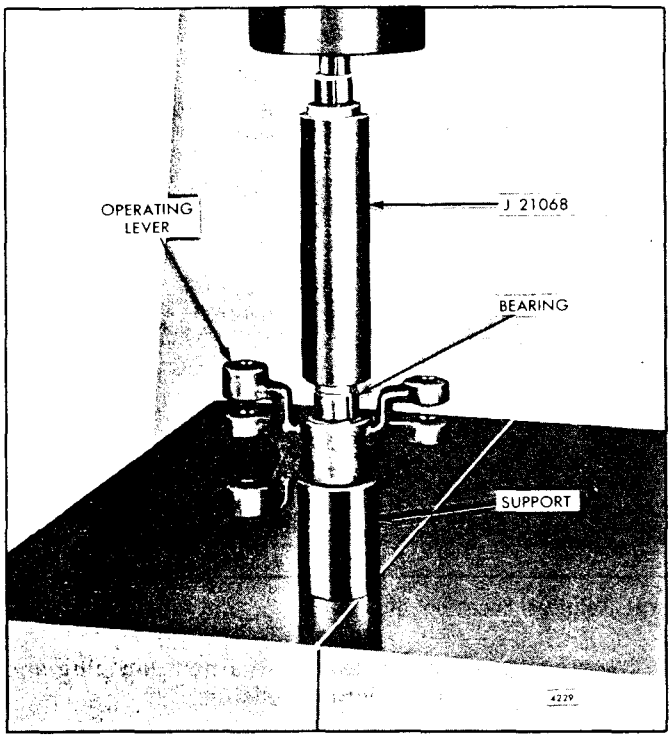


Fig. 12 - Installing Control Link Lever Bearings

the bed of an arbor press. Start one bearing, number side up, in the lever and press it flush with the lever with tool J 21068 (Fig. 12). Invert the lever and install the second bearing in the same manner.

NOTE: Do not use impact tools to install needle bearings.

10. Pack the needle bearings with grease, place a washer over each bearing and insert the control link lever between the two bosses in the housing (Fig. 1). Insert the control link lever shaft, then insert the shaft retainer in the notch of the shaft and fasten it to the housing with the retaining screw.

11. Place the connecting pin in the control link lever, then place the connecting link over the connecting pin and the pin in the differential lever. Secure the link to the differential lever with a washer and spring pin.

12. Thread the short link pin into the control link lever.

13. Install the buffer screw and lock nut.

Assemble Governor Springs

Refer to Fig. 5 and assemble the governor springs as follows:

1. Thread the lock nut on the high speed spring retainer approximately 1-1/2 ". Place the high speed spring over the spring plunger with the loosely wound end of the spring against the shoulder of the plunger.

2. Insert the plunger and spring assembly in the spring retainer. Thread the idle speed adjusting screw approximately 1/2 " into the tapped end of the plunger. Thread the lock nut on the idle speed adjusting screw.

3. Insert the spring cap in one end of the low speed spring and the small end of the spring seat in the other end of the spring.

4. Insert the spring seat end of the spring, cap and seat assembly in the spring plunger, with the spring seat against the shoulder on the idle screw.

5. Place the spring housing gasket over the springs and against the shoulder on the spring retainer lock nut. Then thread the spring retainer in the governor housing, with the spring cap against the gap adjusting screw in the operating shaft lever. Tighten the lock nut.

6. The spring housing may be installed after the engine tune-up (Section 14) is performed.

Assemble Governor Weights

Refer to Fig. 9 and assemble the weights, shaft and riser as follows:

1. Position the low speed weights, identified by the short cam arm, on opposite sides of the weight carrier. Drive the weight pins in place and install the retaining rings. To install a weight pin correctly, push the grooved end through the smaller hole in the carrier and through the weight. Then drive the knurled end in just enough so the retaining ring can be installed on the pin.

2. Install the high speed weights in a similar manner.

3. Lubricate the weight shaft with clean engine oil and slide the riser tube on the shaft.

4. Pack the riser thrust bearing with grease. Then assemble the bearing on the weight shaft, with the bearing race having the smaller inside diameter against the riser.

5. Insert the shaft, weight and riser assembly in the governor housing.

6. Support the splined end of the shaft on the bed of an arbor press. Start the weight shaft bearing in the governor housing and over the end of the shaft. Place

a sleeve against the inner race and press the bearing in the housing and against the shoulder on the shaft.

7. Place a flat washer and lock washer over the bearing retainer bolt. Thread the bolt into the tapped end of the shaft and tighten it. Bend the tang on the lock washer against the flat on the head of the bolt.

8. Place a gasket against the weight shaft bearing. Apply a sealant such as Loctite grade H, HV or HVW, or equivalent on the threads of the governor housing and the plug and thread the plug into the housing. Clean the plug with solvent to remove any oil or grease before applying the sealant. Tighten the plug to 45 lb-ft torque.

Install Governor

1. Refer to Section 3.4.1 and attach the governor to the blower as outlined under *Attach Accessories to Blower (8V-53).*

2. Install the blower and governor assembly as outlined under *Install Blower (8V-53)* in Section 3.4.1.

3. Install the crankcase breather assembly as outlined in *Ventilating System,* Section 4.8.

4. Perform an engine tune-up as outlined in Section 14.

LIMITING SPEED MECHANICAL GOVERNOR

(Variable Low-Speed)

The variable low-speed limiting speed mechanical governor used on highway vehicle engines is of the double-weight type and is used where the same engine powers both the vehicle and auxiliary equipment and a 500 to 1200 rpm idle speed range is desired during the auxiliary operation.

Governor identification is provided by a name plate attached to the governor housing. The letters V.L.S.L.S. stamped on the name plate denote a variable low-speed limiting speed mechanical governor.

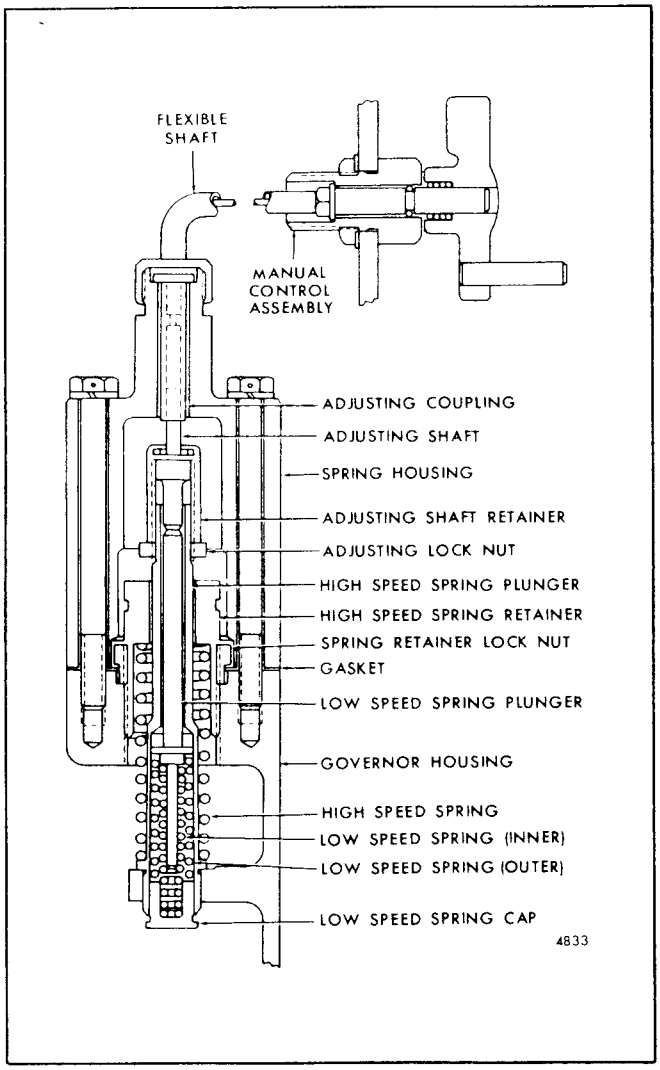


Fig. 1 - Governor Spring Housing and Components

Operation

During highway operation the governor functions as a limiting speed governor, controlling the engine idling speed and limiting the maximum operating speed. At the unloading area, the throttle is left in the idle speed position and the remote control knob is turned to the speed required within the above range to operate the auxiliary equipment. The governor then functions as a variable speed governor, maintaining a constant speed when the load is continuously changing during the unloading operation. Before resuming highway operation, the remote control knob must be turned all the way back.

Lubrication

The governor is lubricated in the same manner as the limiting speed governor (Section 2.7.1.1).

Check Governor Operation

Governor difficulties should be checked out in the same manner as outlined in Section 2.7. If, after making the checks, the governor fails to control the engine or auxiliary equipment properly, it should be removed and reconditioned.

Remove Governor From Engine

1. Disconnect the manual control flexible shaft from the governor spring housing.

2. Remove the governor following the same procedures outlined in Section 2.7.1.1.

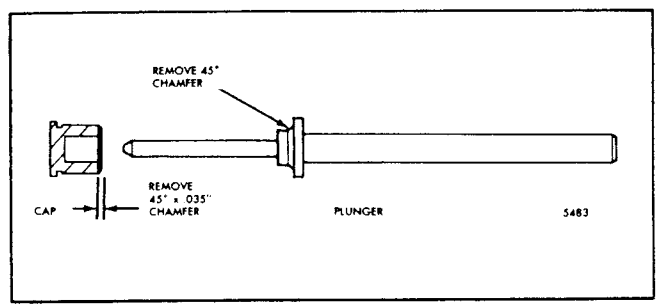


Fig. 2 - Rework Former Plunger and Cap

Disassemble Governor

The variable low-speed limiting speed governor is similar to the limiting speed governor with the exception of the spring housing and its components. Therefore, disassemble the governor as outlined in Section 2.7.1.1, then disassemble the spring housing and its components (Fig. 1) as follows:

1. Clamp the flange of the governor housing in a vise equipped with soft jaws.

2. Remove the two bolts and lock washers securing the spring housing to the governor housing and withdraw the spring housing and gasket.

3. Remove the adjusting coupling from the adjusting shaft.

4. Hold the adjusting lock nut with a wrench and back off the retainer and adjusting shaft.

5. Unscrew the adjusting shaft from the retainer.

6. Unscrew the idle adjusting lock nut from the end of the high-speed spring plunger.

7. Unscrew the high-speed spring retainer lock nut and remove the high-speed spring retainer, plunger and spring along with the low-speed spring plunger, inner and outer springs and low-speed spring cap as an assembly from the governor housing.

8. Remove the high-speed spring retainer and spacer assembly and spring from the high-speed spring plunger. Remove the low-speed spring cap from the opposite end of the high-speed spring plunger and remove the low-speed spring plunger along with the inner and outer low-speed springs.

> **NOTE:** The high-speed spring retainer on early engines did not include a spacer. If the shaft sticks in the retainer, replace it with the current retainer and spacer assembly.

Inspect Governor Parts

Wash all of the parts in clean fuel oil and dry them with compressed air, then inspect them as outlined in Section 2.7.1.1.

Assemble Governor

> **NOTE:** During assembly, lubricate all spring housing components and needle bearing assemblies with MIL. G3278A, Aero Shell 7A grease, or equivalent (special grease for high and low temperature operations).

Assemble the governor as outlined in Section 2.7.1.1, then assemble the spring housing and components (Fig. 1).

To assure a 500 rpm idle speed, the spring seat chamfer has been removed from the low low-speed spring plunger and cap. The internal chamfer has been removed from both ends of the coil of the outer low-speed spring. A high idle condition could be the result if an unchamfered spring did not seat properly due to the chamfer on the former plunger and cap. To correct this condition, install a current (modified) plunger and cap, or remove the 45° chamfer from the spring seat area of the plunger and also the 45° x .035" chamfer on the cap (shaded area, Fig. 2).

> **CAUTION:** A chamfered spring should not be used with an unchamfered plunger and cap, because a severe wear condition will result.

1. Thread the spring retainer lock nut on the high-speed spring retainer approximately 1-1/2".

2. Place the high-speed spring on the high-speed spring plunger.

3. Insert the high-speed spring and plunger assembly in the high-speed spring retainer.

4. Insert the low-speed spring plunger into the high-speed spring plunger.

5. Place the inner and outer springs in the lower end of the high-speed spring plunger, over the low-speed spring plunger.

6. Install the low-speed spring cap over the end of the inner low-speed spring and into the end of the high-speed spring plunger and install the assembly in the governor housing.

> **CAUTION:** Place the spring housing gasket in position before installing the assembly.

7. Thread the idle speed adjusting lock nut on the threaded end of the high-speed spring plunger approximately 1/2".

8. Screw the adjusting shaft into the adjusting shaft retainer all the way in as shown in Fig. 1.

9. Install the adjusting retainer and shaft onto the high-speed spring plunger. Turn down the adjusting retainer against the idle speed adjusting lock nut.

10. Install the adjusting coupling and spring housing

after the governor adjustments (Section 14.3.3) have been performed.

Install Governor

Install the governor as outlined in Section 2.7.1.1. then connect the manual control flexible shaft to the governor spring housing (Fig. 1).

Adjust the governor as outlined in Section 14.3.3.

LIMITING SPEED MECHANICAL GOVERNOR

(FAST IDLE CYLINDER)

6V-53 VEHICLE ENGINE

The double-weight limiting speed governor equipped with a fast idle air cylinder is used on vehicle engines where the engine powers both the vehicle and auxiliary equipment.

The fast idle system consists of a fast idle air cylinder installed in place of the buffer screw and a throttle locking air cylinder mounted on a bracket fastened to the governor cover (Fig. 1). An engine shutdown air

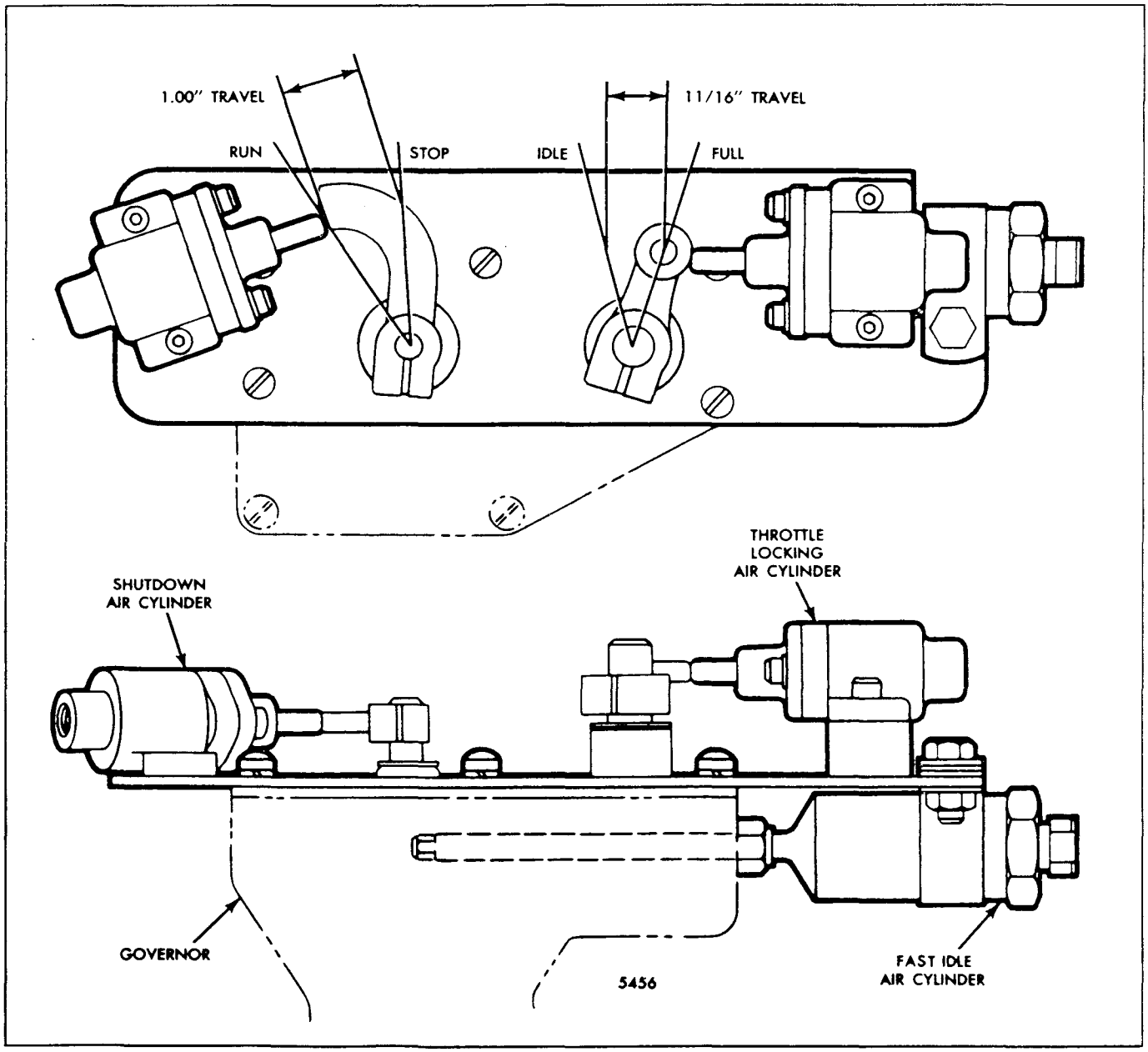


Fig. 1 - Governor with Fast Idle Cylinder

cylinder, if used, is also mounted on the governor cover.

For operation and adjustment of the fast idle air cylinder, refer to Section 14.3.4.

Lubrication

The governor is lubricated in the same manner as the limiting speed governor (Section 2.7.1.1).

Check Governor Operation

Governor difficulties should be checked in the manner outlined in Section 2.7. If, after making the checks, the governor fails to control the engine or auxiliary equipment properly, it should be removed and reconditioned.

Remove Governor

1. Release any air in the system and disconnect the air hoses from the air cylinders.

2. Remove the governor by following the procedure outlined in Section 2.7.1.1.

Disassemble Governor

1. Disassemble the governor as outlined in Section 2.7.1.1.

2. Refer to Fig. 2 and disassemble the fast idle cylinder as follows:

a. Pull the plunger out of the buffer spring and cylinder.

b. Clamp the air cylinder in a vise equipped with soft jaws.

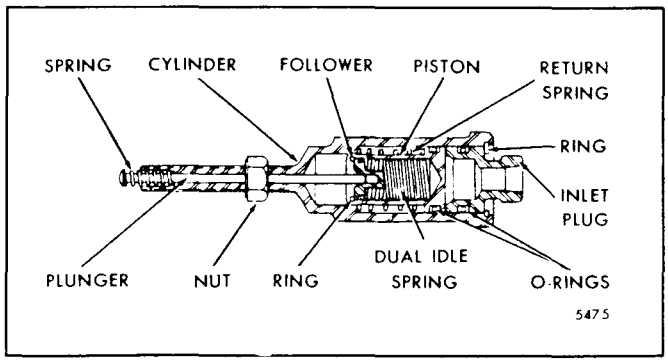


Fig. 2 - Fast Idle Air Cylinder

c. Apply pressure on the end of the air inlet plug and remove the plug retaining ring from the groove in the air cylinder.

d. Pull the air inlet plug and seal ring assembly from the air cylinder. Remove the seal ring from the groove in the plug.

e. Insert a 3/32 " diameter steel rod in the plunger opening in the air cylinder and push the piston, seal ring, dual idle spring and spring follower out of the air cylinder as an assembly. Then remove the air cylinder spring from the cylinder.

f. Remove the seal ring from the groove in the piston. Apply pressure on the spring follower and remove the follower retaining ring from the groove in the piston. Remove the follower and spring.

Inspection

Wash all of the governor components in clean fuel oil and dry them with compressed air. Then inspect them as outlined in Section 2.7.1.1.

Examine the fast idle air cylinder components for wear or any defects. Replace worn or damaged parts.

Assemble Governor

1. Assemble the governor as outlined in Section 2.7.1.1.

2. Assemble the fast idle cylinder as follows:

a. Refer to Fig. 2 and insert the dual idle spring inside of the fast idle air cylinder. Place the spring follower, with the small diameter end down, inside of the spring. Apply pressure on the spring follower and compress the spring enough to expose the retaining groove. Then install the retaining ring in the groove.

b. Install a new seal ring in the groove in the piston. Then install the air cylinder spring over the small diameter end of the piston.

c. Lubricate the seal ring on the piston with engine oil. Then insert the piston and spring assembly, with the small diameter end of the piston first, straight into the air cylinder spring seats on the shoulder in the cylinder.

d. Install a new seal ring in the groove of the air cylinder air inlet plug.

e. Lubricate the seal ring with engine oil. Then insert

the air inlet plug straight into the air cylinder and against the piston.

f. Clamp the air cylinder in a vise equipped with soft jaws. Apply pressure on the end of the air inlet plug and compress the spring enough to expose the retaining ring groove. Then install the retaining ring.

g. If removed, thread the lock nut on the air cylinder. Then insert the plunger through the buffer spring and into the air cylinder.

3. Install the fast idle air cylinder assembly in the governor housing buffer screw hole.

Install Governor

1. Install the governor on the engine as outlined in Section 2.7.1.1.

2. Install the throttle locking and engine shutdown air cylinders.

3. Connect the air hoses to the air cylinders.

4. Adjust the governor as outlined in Section 14.3.4.

VARIABLE SPEED MECHANICAL GOVERNOR (PIERCE)

In-Line Fan-To-Flywheel Industrial Engines

The variable speed mechanical governor, illustrated in Fig. 1, performs three functions:

1. Controls the engine idle speed.

2. Limits the maximum no-load speed.

3. Holds the engine at any constant speed, between idle and maximum, as desired by the operator.

The governor is mounted on the rear end plate of the engine and is driven by a gear that extends through the end plate and meshes with either the camshaft gear or balance shaft gear, depending upon the engine model.

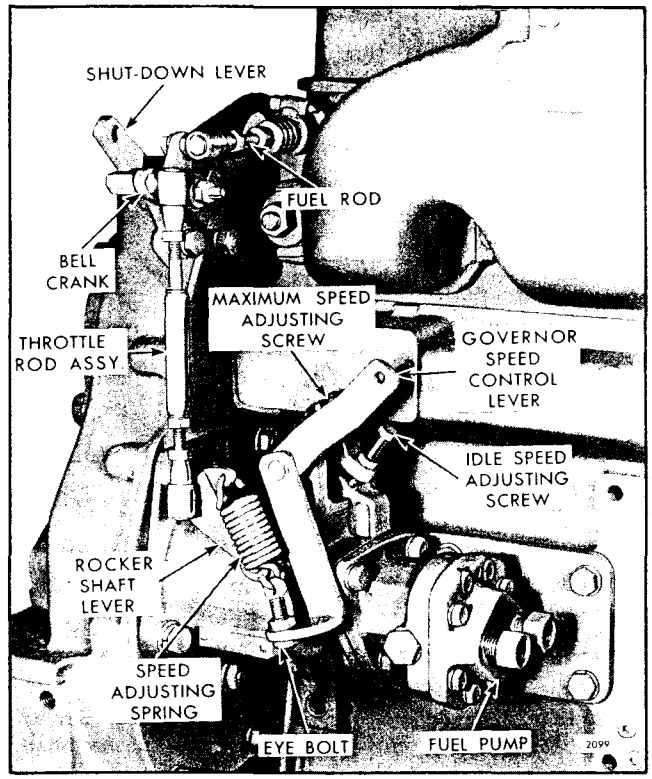


Fig. 1 - Governor Mounting

Lubrication

The governor is lubricated by oil splash, from the engine gear train, that passes through the bearing housing to the governor flyweight assembly. The oil is distributed to the various moving parts within the governor by the revolving flyweights.

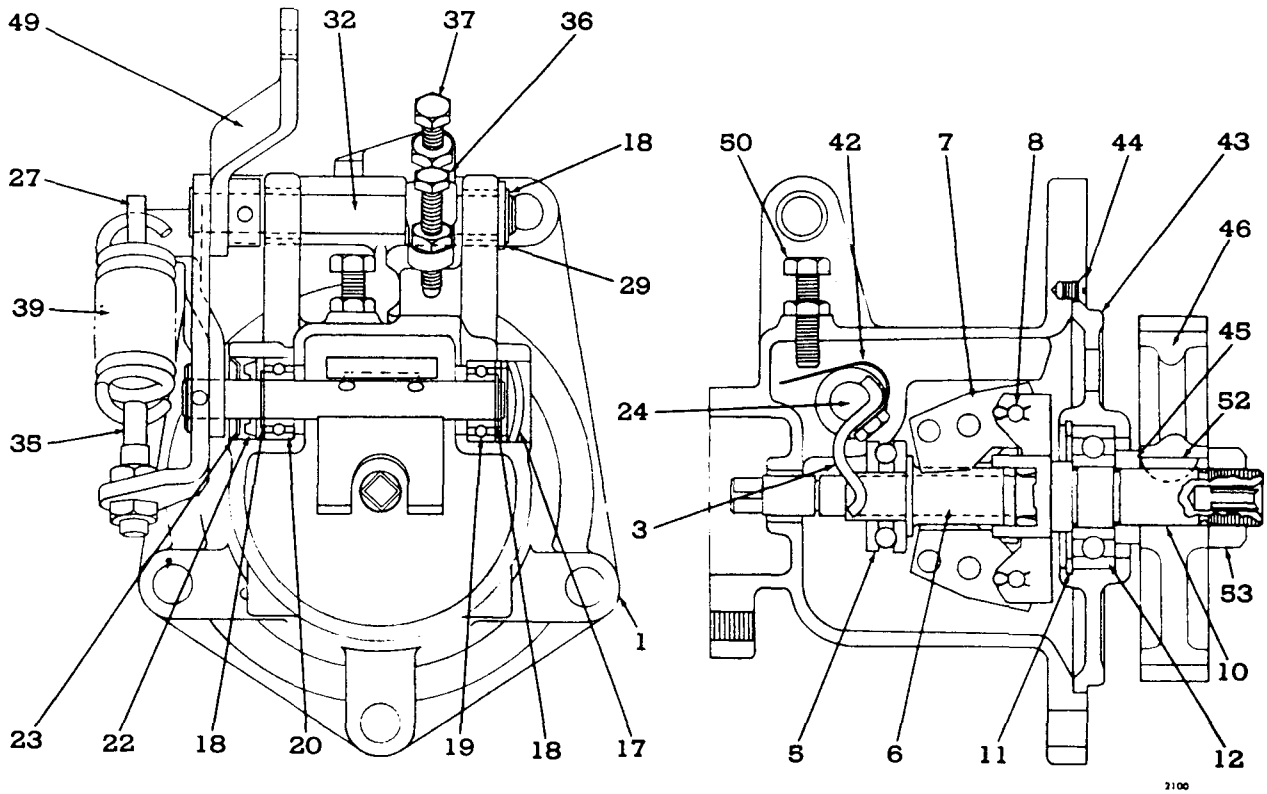
Surplus oil drains from the governor through holes in the governor bearing housing back to the engine crankcase.

Operation

The governor flyweights (7), shown in Fig. 2, are mounted on the spider and shaft assembly (10) and driven by the governor drive gear (46). This gear is pressed on the spider and shaft assembly and is driven by the engine gear train. A shoulder on the flyweights bears against the riser (6) that transmits the motion of the flyweights through the riser thrust bearing (5) to the operating fork (3). The operating fork is attached to the rocker shaft (24) that rides in ball bearings (19 and 20), and transmits the motion of the flyweights to the rocker shaft lever (27). The rocker shaft lever is pinned to the rocker shaft. The rocker shaft lever is connected to the speed adjusting spring (39) that is, in turn, connected through an eyebolt (35) to the governor speed control lever (49). The governor speed control lever is mounted on the speed adjusting shaft (32) and is controlled by the engine operator when establishing the desired speed of the unit. The idle (36) and maximum (37) speed adjusting screws limit the travel of the governor speed adjusting shaft and thus the minimum and maximum engine speed settings. The linkage operating the injector fuel racks is attached to the rocker shaft lever. Movement of the rocker shaft lever increases or decreases the amount of fuel delivered by the injectors to the engine. A governor buffer spring (42) is mounted, with the operating fork, on the rocker shaft. The spring bears against the screw (50), extending inside the governor body, that is used to stablize the engine operation at idle speed.

When the governor speed control lever is moved to an increased speed position, the tension on the speed adjusting spring is increased. The force resulting from the increased spring tension is transmitted to the rocker shaft lever and control linkage which advances the injector racks. Engine speed increases, as a result of the increased fuel, until the governor flyweight force is sufficient to balance the increased spring tension. The flyweights then move against the spring and reduce the injector rack fuel setting to an amount sufficient to maintain the higher engine speed setting.

If the governor speed control lever is moved to a decreased speed position, the tension on the speed



1. Body--Governor
3. Fork--Operating
5. Bearing--Riser Thrust
6. Riser
7. Flyweights
8. Pins--Weight Supporting
10. Spider and Shaft Assembly--Operating
11. Ring--Snap (Internal)
12. Bearing--Shaft
17. Plug--Oil Seal
18. Ring--Snap (External)
19. Bearing--Rocker Shaft (Inner)
20. Bearing--Rocker Shaft (Outer)
22. Seal--Rubber Oil
23. Retainer--Oil
24. Shaft--Rocker
27. Lever--Rocker Shaft
29. Washer
32. Shaft--Speed Adjusting
35. Eyebolt
36. Screw--Idle Speed Adjusting
37. Screw--Maximum Speed Adjusting
39. Spring--Speed Adjusting
42. Spring--Buffer
43. Housing--Bearing
44. Screw--Bearing Housing Retaining
45. Spacer--Drive Gear
46. Gear--Drive
49. Lever--Governor Speed Control
50. Screw--Buffer
52. Key--Drive
53. Nut--Drive Gear Retaining

Fig. 2 - Governor Cross-Section

adjusting spring will decrease and the governor flyweights will overcome the spring tension and move the rocker shaft lever to a decreased fuel position. The engine speed will be reduced until the force of the governor flyweights equals the tension of the speed adjusting spring. The engine will then operate at the desired reduced speed.

Remove Governor from Engine

The governor is mounted on the engine rear end plate and is retained by five bolts. The engine fuel pump is driven by the governor. After removing the dirt from around the governor and engine end plate, remove the governor as follows:

1. Disconnect the linkage to the governor speed control lever.

2. Disconnect the throttle rod assembly from the rocker shaft lever.

3. Disconnect the fuel lines from the fuel pump.

4. Remove the fuel pump from the governor.

5. Remove the fuel pump gasket and the pump drive coupling.

6. Remove the attaching bolts and withdraw the governor from the engine.

7. Remove the end plate-to-governor gasket.

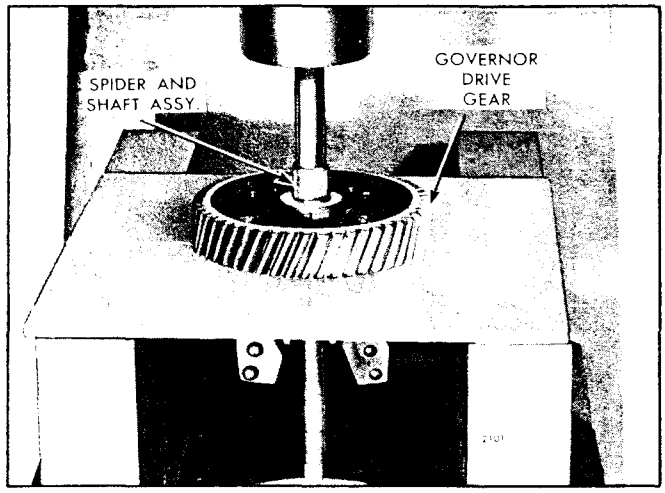


Fig. 3 - Removing Drive Gear from Spider and Shaft Assembly

Disassemble Governor

Before removing any parts from the governor, wash the entire unit in clean fuel oil and dry it with compressed air. Then inspect for worn or damaged parts that can be repaired or replaced without complete disassembly. Refer to Figs. 2 and 4 and disassemble the governor as follows:

1. Remove the countersunk screw (44) retaining the bearing housing (43) to the governor body (1) and withdraw the bearing housing from the governor. The governor drive gear (46), spider and shaft assembly (10), riser (6) and three piece thrust bearing (5) will be removed with the bearing housing.

2. Remove the outer race and the ball assembly (5) from the riser (6).

3. Remove the riser (6) from the spider and shaft assembly (10).

4. If necessary, carefully support the lower side of the inner race of the thrust bearing (5) in an arbor press and gently press the riser (6) from the inner race.

5. If required, remove the hair pin clips or retainer rings (9) that secure the flyweights (7) on the supporting pins (8). Then gently tap out the supporting pins with a 1/8" punch and remove the flyweights.

6. Remove the drive gear retaining nut (53) from the shaft and place the drive gear (46), bearing housing (43), and spider and shaft assembly (10) in an arbor press, using split plates as illustrated in Fig. 3. Then press the drive gear from the shaft with a brass rod. Remove the drive key (52) from the shaft.

7. Remove the gear spacer (45) from the shaft (10).

8. Remove the internal snap ring (11) which retains the bearing (12) in the bearing housing (43). Then separate the bearing housing from the bearing.

9. Support the inner race of the bearing (12) on split plates in an arbor press, with the drive gear end of the spider and shaft assembly (10) up. Then press the shaft from the bearing.

10. Remove the speed adjusting spring (39) by removing the eyebolt (35) from the governor speed control lever (49). The spring can then be slipped from the eyebolt and the rocker shaft lever (27).

11. Remove the roll pin (25) retaining the speed adjusting bracket (30) to the governor speed adjusting shaft (32).

12. Remove the snap ring (18) retaining the speed adjusting shaft (32) to the governor body. Then remove the speed adjusting shaft, tapping the shaft, if necessary, to remove it from the speed adjusting bracket (30).

13. If desired, remove the idle (36) and maximum (37) speed adjusting screws from the speed adjusting bracket.

14. Remove the speed control lever (49) by driving out the roll pin and tapping the shaft from the lever.

15. If desired, remove the buffer screw (50) from the governor body.

16. Remove the operating fork (3) and the buffer spring (42) by removing the two retaining bolts (4) and lock washers.

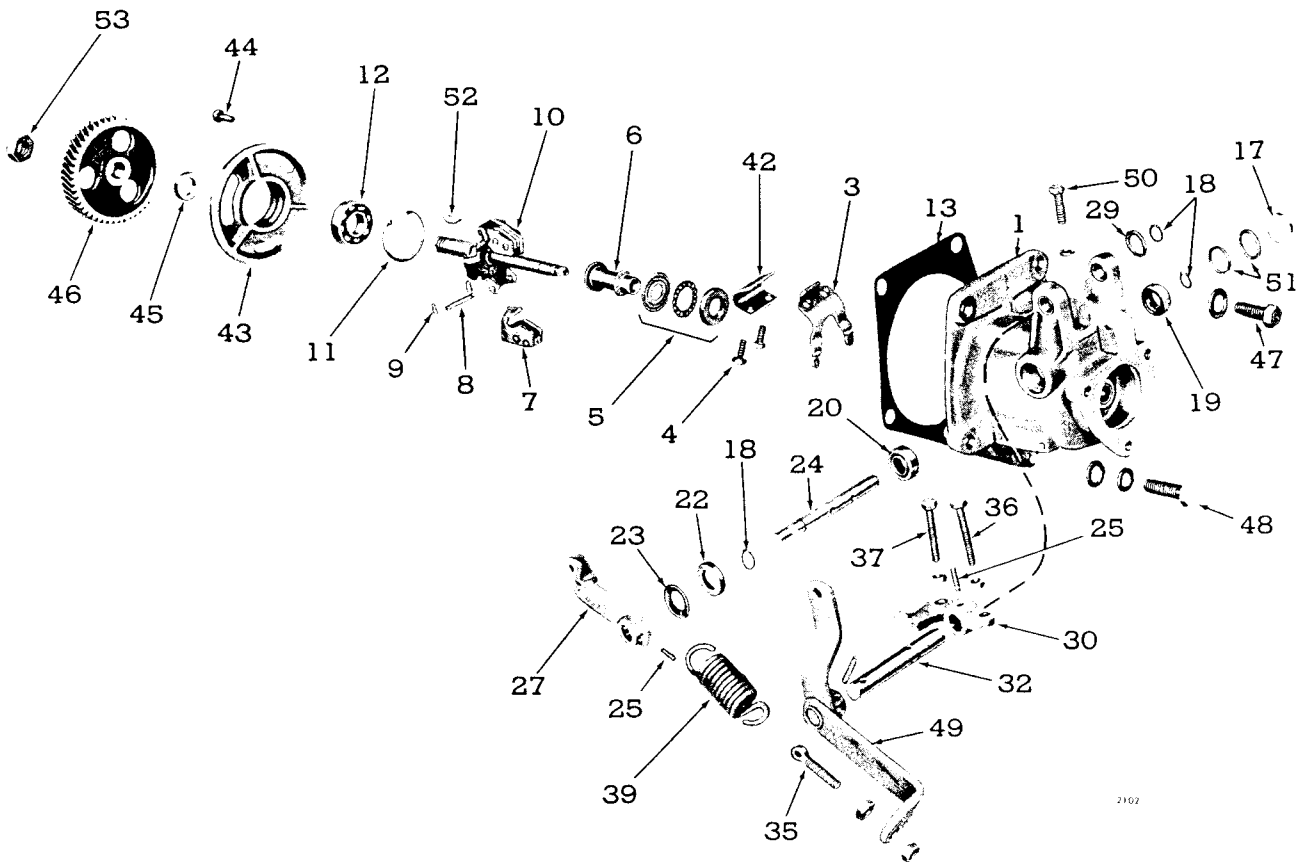
17. Remove the oil seal plug (17) by driving lightly with a small punch at the lower edge of the plug, thus forcing the upper edge outward. Then place a screw driver behind the plug and remove it from the governor body. Remove the gaskets (51).

18. Remove the bearing retaining snap ring (18) from the rocker shaft (24). Then tap the rocker shaft lightly to withdraw it from the governor body.

19. Remove the bearing (19) from the governor body.

20. Remove the oil seal retainer (23) and the oil seal (22) from the rocker shaft (24).

21. Remove the rocker shaft lever (27) from the rocker shaft (24) by driving out the roll pin (25) and tapping the shaft gently to facilitate removal.



1. Body--Governor
3. Fork--Operating
4. Bolts--Operating Fork
5. Bearing--Riser Thrust
6. Riser
7. Flyweights
8. Pins--Weight Supporting
9. Ring--Retainer
10. Spider and Shaft Assy.--Operating
11. Ring--Snap (Internal)
12. Bearing--Shaft
13. Gasket--Body Mounting
17. Plug--Oil Seal
18. Ring--Snap (External)
19. Bearing--Rocker Shaft (Inner)
20. Bearing--Rocker Shaft (Outer)
22. Seal--Rubber Oil
23. Retainer--Oil
24. Shaft--Rocker
25. Pin--Roll (5/32")
27. Lever--Rocker Shaft
29. Washer
30. Bracket--Speed Adjusting Shaft
32. Shaft--Speed Adjusting
35. Eyebolt
36. Screw--Idle Speed Adjusting
37. Screw--Maximum Speed Adjusting
39. Spring--Speed Adjusting
42. Spring--Buffer
43. Housing--Bearing
44. Screw--Bearing Housing Retaining
45. Spacer--Drive Gear
46. Gear--Drive
47. Bolt--Body Mounting (3/8"-24 x 1")
48. Bolt--Body Mounting (3/8"-16 x 1-1/4")
49. Lever--Governor Speed Control
50. Screw--Buffer
51. Gasket--Oil Seal Plug
52. Key--Drive
53. Nut--Drive Gear Retaining

Fig. 4 - Governor Details and Relative Location of Parts

Inspection

After the governor has been disassembled, clean the parts thoroughly with fuel oil and dry them with compressed air.

Inspect the rocker shaft bearings for excessive wear. Replace the bearings, if necessary.

Inspect the bushings in the governor housing for wear. If badly worn, replace the bushings.

Inspect the rubber oil seal on the rocker shaft. The slightest wear on this part can cause oil leakage. When overhauling a governor, it is recommended that a new oil seal be installed.

Inspect all of the retaining snap rings to determine if they have been damaged at time of disassembly. Replace them if necessary.

Inspect the riser bearing surface of the flyweights for excessive wear or flat spots. If either condition exists, new flyweights must be installed. The flyweights must work freely on the supporting pins for satisfactory governor operation.

Inspect the governor operating fork and the buffer spring for excessive wear or distortion. If either condition exists, replace the defective part.

Inspect the teeth of the governor drive gear for wear. Also examine the engine gear train. Replace any defective gears.

Inspect the spider and shaft assembly at the bushing and bearing surfaces and at the drive gear surface. Replace the shaft if it is damaged or worn.

Assemble Governor

After all of the parts have been cleaned and inspected, refer to Figs. 2 and 4 and assembly the governor as follows:

1. Install the outer bearing (20) on the rocker shaft (24) and retain it in place with a snap ring (18).

2. Slide the rocker shaft and bearing into the governor body.

3. Support the lever end of the rocker shaft and install the inner bearing (19) in the governor body and on the rocker shaft. Retain the bearing and shaft with a snap ring (18).

4. Install two new gaskets (51) and the oil retaining plug (17) in the rocker shaft bore.

5. Install the rocker shaft oil seal (22), with the lip of the seal facing the bearing, and the oil seal retainer (23).

6. Install the operating fork (3) and the buffer spring (42) on the rocker shaft (24) with two bolts (4) and lock washers. Tighten the bolts.

7. Install the rocker shaft lever (27) on the rocker shaft (24) and secure it with a roll pin (25).

8. Install the buffer screw (50) and the lock nut.

9. Install the governor speed control lever (49) on the speed adjusting shaft (32) and secure it with a roll pin (25).

10. Slide the speed adjusting shaft (32) through one governor body bushing and the speed adjusting bracket (30), and then through the opposite body bushing. The shaft is secured to the governor body, after installing a flat washer (29), by a snap ring (18) inserted into the groove in the shaft.

11. Position the speed adjusting bracket (30) on the speed adjusting shaft (32) and secure it with a roll pin (25).

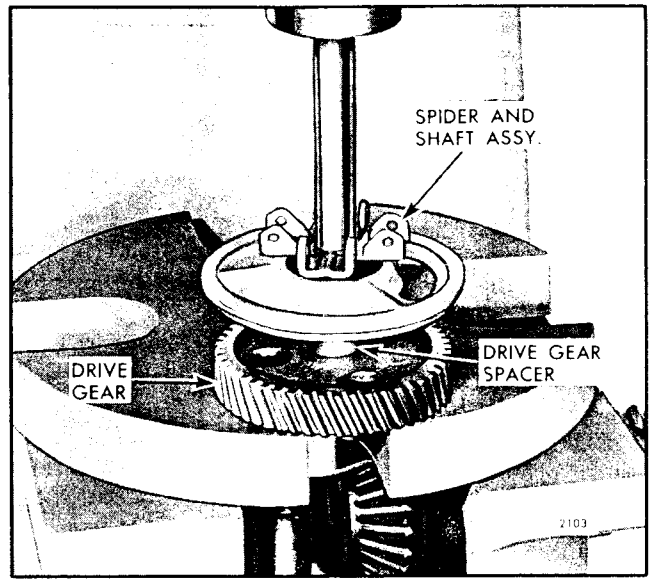


Fig. 5 - Installing Drive Gear on Spider and Shaft Assembly

12. Install the speed adjusting spring (39) on the rocker shaft lever (27) and then, using eyebolt (35), attach the spring to the governor speed control lever (49).

13. Install the idle (36) and maximum (37) speed adjusting screws and lock nuts.

14. If the spider was removed from the weight shaft, press the spider on the shaft so as to allow a clearance of .001" to .006" between the shaft shoulder and the rear face of the spider.

15. Support the inner race of the shaft bearing (12) on an arbor press. Then press the gear end of the spider and shaft assembly (10) through the bearing until the bearing seats on the shoulder of the shaft.

16. Install the bearing housing (43) on the bearing (12) and retain it with an internal snap ring (11).

17. Support the governor drive gear on an arbor press. Then, with the drive gear spacer (45) on the shaft and the key (52) installed in the keyway, press the spider and shaft assembly (10) into the gear (46) until the gear bottoms against the spacer and bearing (12), as shown in Fig. 5. Install the drive gear retaining nut (53) and tighten it to 125-135 lb-ft torque.

18. Install the flyweights (7) on the spider and shaft assembly with supporting pins (8). Retain the pins in place with hair pin clips or retainer rings (9) at the unknurled ends.

19. Support the inner race of the three-piece thrust bearing (5) on an arbor press and press the riser (6)

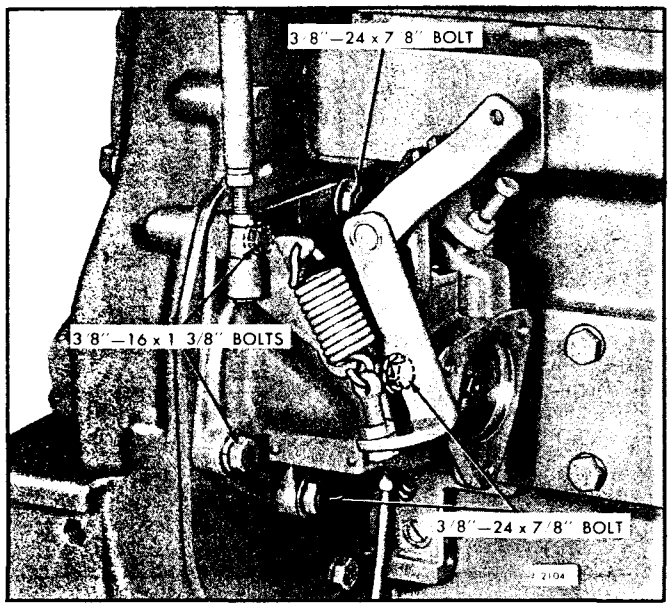


Fig. 6 - Location of Governor Retaining Bolts

into the bearing race until the shoulder on the riser contacts the bearing race.

20. Slide the riser (6) on the spider and shaft assembly (10).

21. Install the ball assembly and outer race of the three-piece bearing (5) on the riser (6).

22. Turn the bearing housing (48) around to align the attaching screw hole with the tapped hole in the governor housing. Then slide the shaft and bearing housing assembly into the governor body. The fuel pump end of the shaft extends through the bushing in the governor body. Install the countersunk screw (44) to retain the bearing housing to the governor body.

Install Governor on Engine

Mount the governor on the engine rear end plate as follows:

1. Attach a new governor-to-end plate gasket on the governor body mounting flange.

2. Install the governor against the engine end plate, so the teeth of the governor drive gear mesh with the teeth of the balance shaft gear or camshaft gear. Install and tighten the three bolts with plain copper washers (only) and two bolts with plain steel washers and lock washers (Fig. 6).

3. Install the fuel pump drive coupling and a new gasket on the fuel pump.

4. Mount the fuel pump, coupling and gasket on the governor housing (Fig. 1), turning the pump shaft until the coupling engages the drive end of the governor operating shaft. Secure the pump to the governor with three 5/16" - 18 x 7/8" bolts.

5. Reconnect the fuel lines to the fuel pump.

6. Reconnect the throttle rod assembly to the rocker shaft lever.

7. Perform an engine tune-up as outlined in Section 14.4.1.

VARIABLE SPEED MECHANICAL GOVERNOR

6V ENGINE

The variable speed mechanical governor, illustrated in Fig. 1, performs the following functions:

1. Controls the engine idling speed.

2. Limits the maximum no-load speed.

3. Holds the engine at any constant speed, between idle and maximum, as desired by the operator.

The governor is mounted between the engine blower and the flywheel housing. One end of the governor weight shaft is splined to a drive plate attached to the driven blower timing gear to provide a means of driving the governor. The other end of the governor weight shaft is supported on a bearing in the blower drive support (Fig. 2).

The governor consists of a cover and lever assembly, governor control housing, variable speed spring housing and shaft, and governor weight and shaft assembly with a single pair of weights.

For certain applications, a heavy-duty governor is provided. This governor has two pair of weights, one high speed spring (former governor has two high speed springs), a heavier operating shaft and related components, larger bearings and a blower drive support which has a larger bore to admit the larger weight shaft bearing.

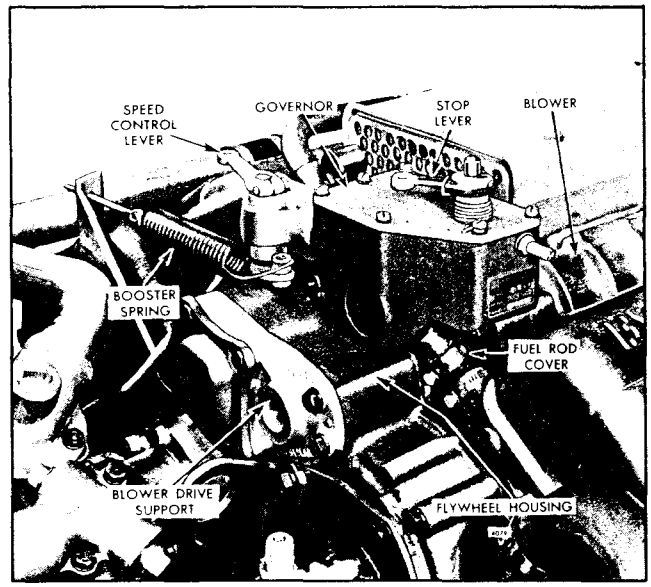


Fig. 1 - Governor Mounting

Operation

Two manual controls are provided on the governor; a stop lever and a speed control lever. In its normal position, the stop lever holds the fuel injector racks near the full-fuel position. When the engine is started, the governor moves the injector racks toward the idle speed position. The engine speed is then controlled manually by moving the speed control lever.

The centrifugal force of the revolving governor weights is converted into linear motion which is transmitted through the riser and operating shaft to the operating shaft lever. One end of this lever bears against the variable speed spring plunger, while the other end provides a moving fulcrum on which the differential lever pivots.

The centrifugal force of the governor weights is opposed by the variable speed spring. Load changes or movement of the speed control lever momentarily creates an unbalanced force between the revolving weights and the tension on the spring. When the forces reach a balanced condition again, the engine speed will be stabilized for the new speed setting or new load.

Fuel rods are connected between the control link operating lever and each injector control tube lever. A vertical pin in the differential lever engages the slot in

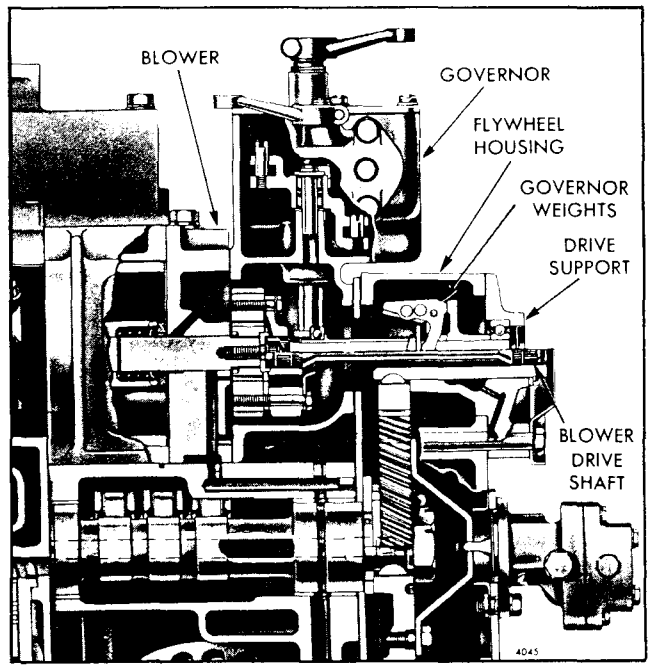


Fig. 2 - Governor and Drive

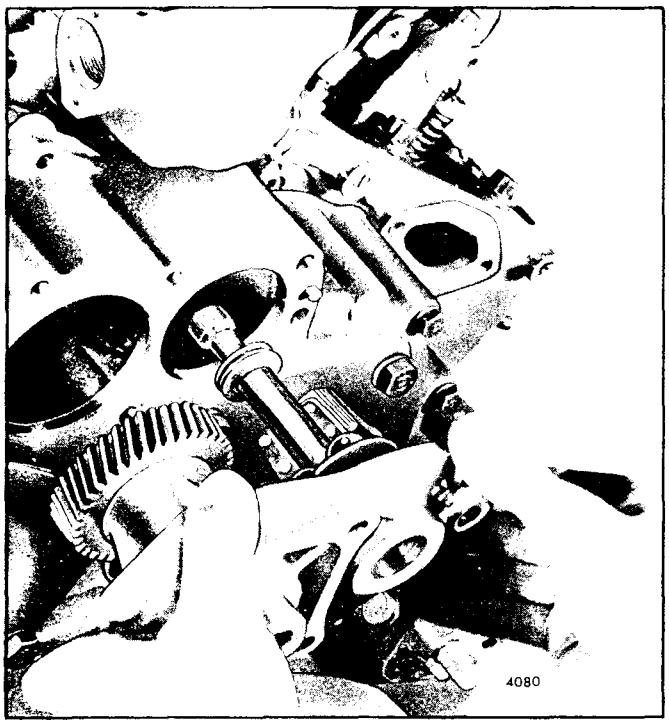


Fig. 3 - Removing or Installing Blower Drive Support

the control link lever fork. This arrangement provides a means for the governor to change the fuel settings of the injector control racks.

The engine idle speed is determined by the centrifugal force required to balance out the tension on the variable speed spring in the low speed range.

To stop the engine, the speed control lever is moved to the idle speed position and the stop lever is moved to the no-fuel position and held there until the engine stops.

Adjustment of the governor is covered in the *Engine Tune-Up* Section.

Lubrication

The governor is lubricated by a spray of pressurized lubricating oil from the blower rear end plate to the blower timing gears which distribute this oil to various parts of the governor. Oil splash from the gear train provides lubrication of the governor weights and shaft. Excess oil overflows into the gear train compartment and returns to the crankcase.

The governor weight shaft bearing, in the heavy-duty governor, is lubricated by oil flowing under pressure through a drilled passage from the cavity surrounding the blower gear drive shaft to the bearing bore in the blower drive support.

Remove Governor From Engine

Governor operation should be checked as outlined in Section 2.7 before the governor is removed from the engine. If, after performing these checks, the governor fails to control the engine properly, it should be removed and reconditioned.

Since the governor is mounted between the blower and the flywheel housing, it must be removed along with the blower as outlined below.

1. Disconnect the throttle control rod and the booster spring (Fig. 1) from the speed control lever.

2. Disconnect the retracting spring from the stop lever or cover screw.

3. Remove the attaching screws and lock washers and lift the cover and lever assembly and the gasket from the governor housing.

4. Loosen the two attaching bolts and lock washers and withdraw the variable speed spring housing and lever assembly and gasket from the governor.

5. Remove the spring retainer, shims, variable speed spring(s), stops and spring plunger.

6. Loosen the hose clamps and slide the hoses back on the fuel rod covers.

7. Remove the valve rocker cover from each cylinder head.

8. Disconnect the lower fuel rod from each injector control tube lever and also from each upper fuel rod.

9. Remove the threaded pins which connect the upper fuel rods to the control link lever. Remove the fuel rods.

10. Remove the blower drive support assembly (Fig. 3) and the blower drive shaft as outlined in Section 3.4. The governor weights, carrier, riser tube and bearing assembly, and weight shaft will be removed with the blower drive support.

11. Remove the governor weight shaft and carrier assembly from the blower drive support, using pry bars if necessary.

12. Remove the blower and governor housing assembly as outlined in Section 3.4.

13. Remove the six bolts and lock washers which attach the governor housing to the blower rear end plate. Studs and nuts were used in place of one or two of the bolts on early units. Remove the governor housing and gasket.

Disassemble Governor Cover

1. Loosen the governor stop lever retaining bolt and remove the lever from the shaft. Remove the lever retracting spring.

2. Remove the retaining ring and the two seal retaining washers. Withdraw the throttle shaft from the cover (Fig. 4).

3. Remove the seal ring from the cover.

4. At this stage of disassembly, wash the cover assembly thoroughly in clean fuel oil and inspect the bearings or bushing for wear or damage. If the bearings (or bushing) are satisfactory for further use, removal is unnecessary.

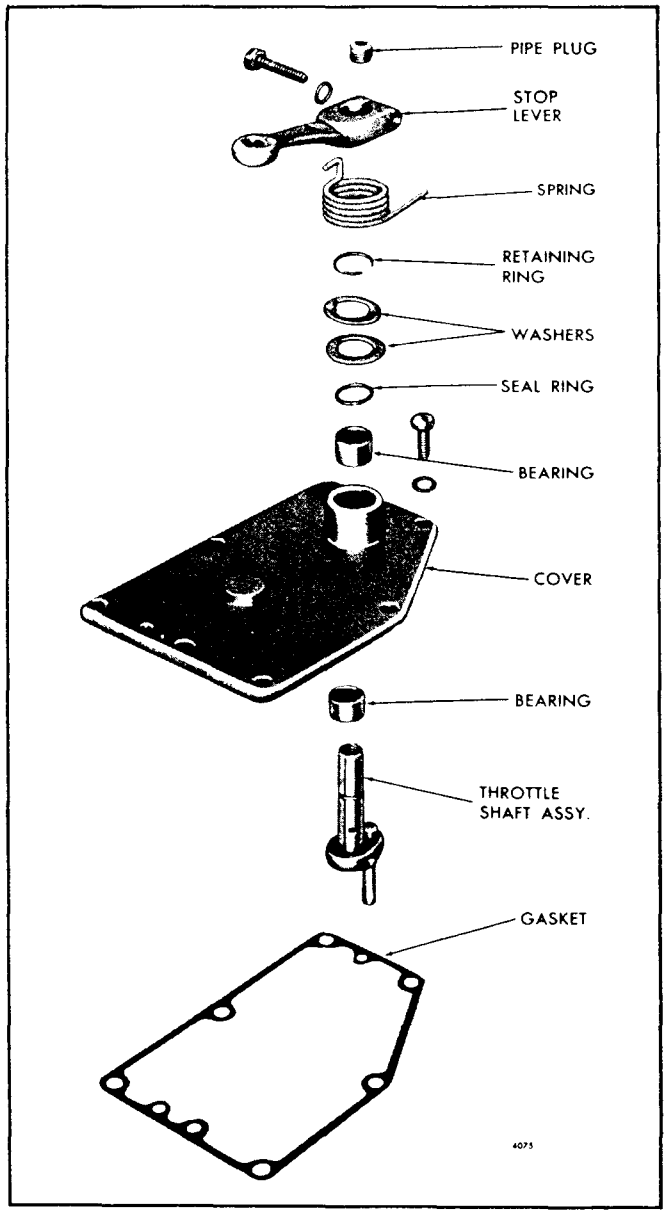


Fig. 4 - Governor Cover Details and Relative Location of Parts

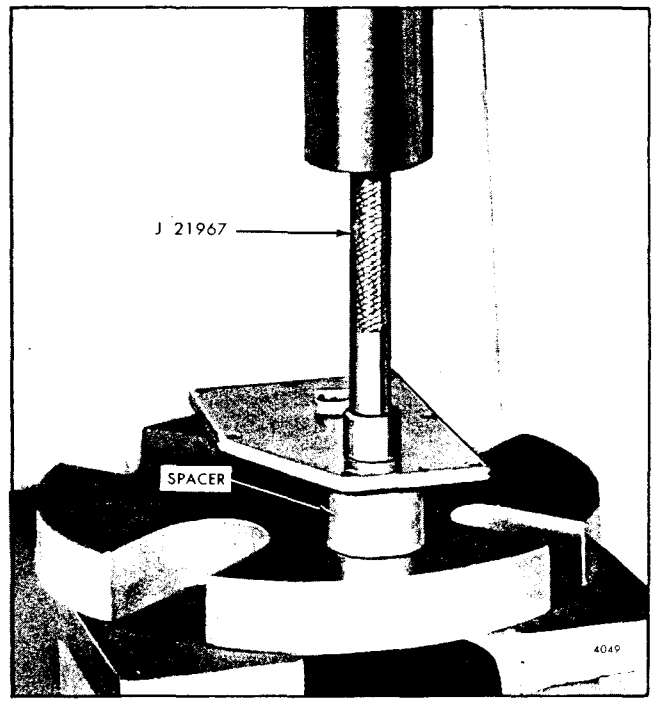


Fig. 5 - Removing Governor Cover Bearings

5. If the bearings (or bushing) are to be removed, place the governor cover with the inner face down on an arbor press. Place a hollow spacer between the cover and the bed of the press (Fig. 5). Place the bearing remover J 21967 on top of the upper bearing (or bushing) and press both bearings (or bushing) out of the cover.

Disassemble Governor Spring Housing

If the bearings or lever require replacement, disassemble the spring housing as follows:

1. Loosen the clamp bolt and remove the speed control lever from the shaft. Remove the Woodruff key.

2. Loosen the clamp bolt and remove the booster spring lever, if used. Remove the Woodruff key.

3. Remove the plain washer and seal ring. If a booster spring lever is used, a washer and seal ring is used at each end of the shaft (Fig. 6).

4. On current governors, remove one screw and lock washer and remove the spring housing cover and gasket. Then remove the set screw from the spring lever.

On former governors, remove the pipe plug from the housing and, working through the opening, remove the set screw from the spring lever.

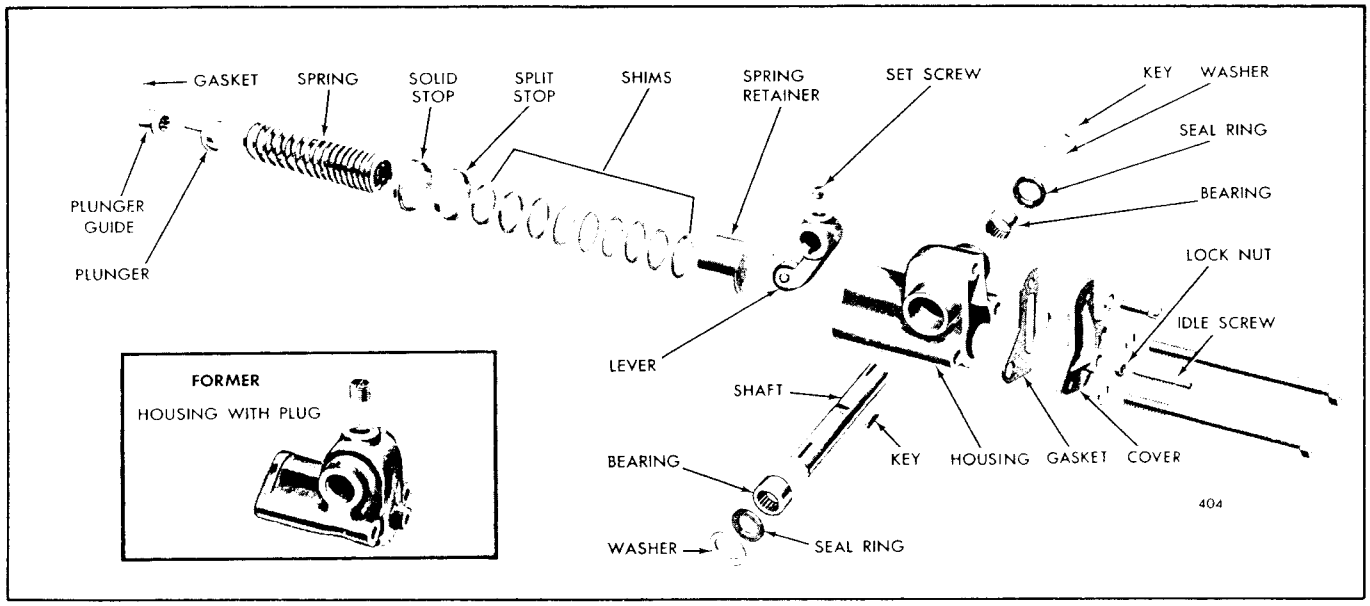


Fig. 6 - Variable Speed Spring Housing Assembly

5. Support the spring housing in an arbor press. Use a brass rod to press the shaft, bearing and plug (if used) from the housing.

6. Remove the spring lever assembly.

7. Press the second bearing from the housing.

Disassemble Governor Housing

1. Remove the governor buffer screw and spring.

2. Remove the spring pin and washer from the control link lever pin (Fig. 7) and withdraw the control link lever and washer.

3. If the bearings require replacement, support the control link lever on a sleeve placed on the bed of an arbor press. Then press the bearings out of the lever with tool J 8985 (Fig. 8).

4. Remove the spring pin and washer from the pin in the operating shaft lever and remove the differential lever.

5. Remove the plug at the bottom of the governor housing.

6. Remove the set screws, if used, from the governor operating fork.

7. Remove the operating shaft upper bearing retaining screw and washer.

8. Remove the operating shaft lower bearing by placing the inverted governor housing on the bed of an arbor press; use wood blocks to prevent damage to the dowel pins in the housing. Press on the shaft, using a rod small enough to pass through the bearing, until the bearing is free of the shaft. Then withdraw the bearing.

9. Place an end wrench between the operating fork and the governor housing and a rod on the end of the operating shaft. Then press the shaft out of the fork (Fig. 9).

10. Withdraw the operating shaft, operating shaft lever and bearings. Also withdraw the fork spacer, if a heavy-duty governor is being disassembled.

11. Press the upper bearing and operating shaft lever from the shaft.

Disassemble Governor Weights and Shaft

1. Remove the retaining rings from the governor weight pins (Fig. 10). Then drive the pins out of the carrier and the weights. Remove the governor weights.

2. Press the governor weight carrier from the shaft (Fig. 11).

3. Slide the governor riser and bearing assembly from the shaft. Do not remove the bearing since the bearing and riser are serviced only as an assembly.

Disassemble Blower Drive

1. Remove the snap ring and the thrust washer from the blower drive gear shaft (Fig. 12). Slide the shaft and gear from the blower drive support.

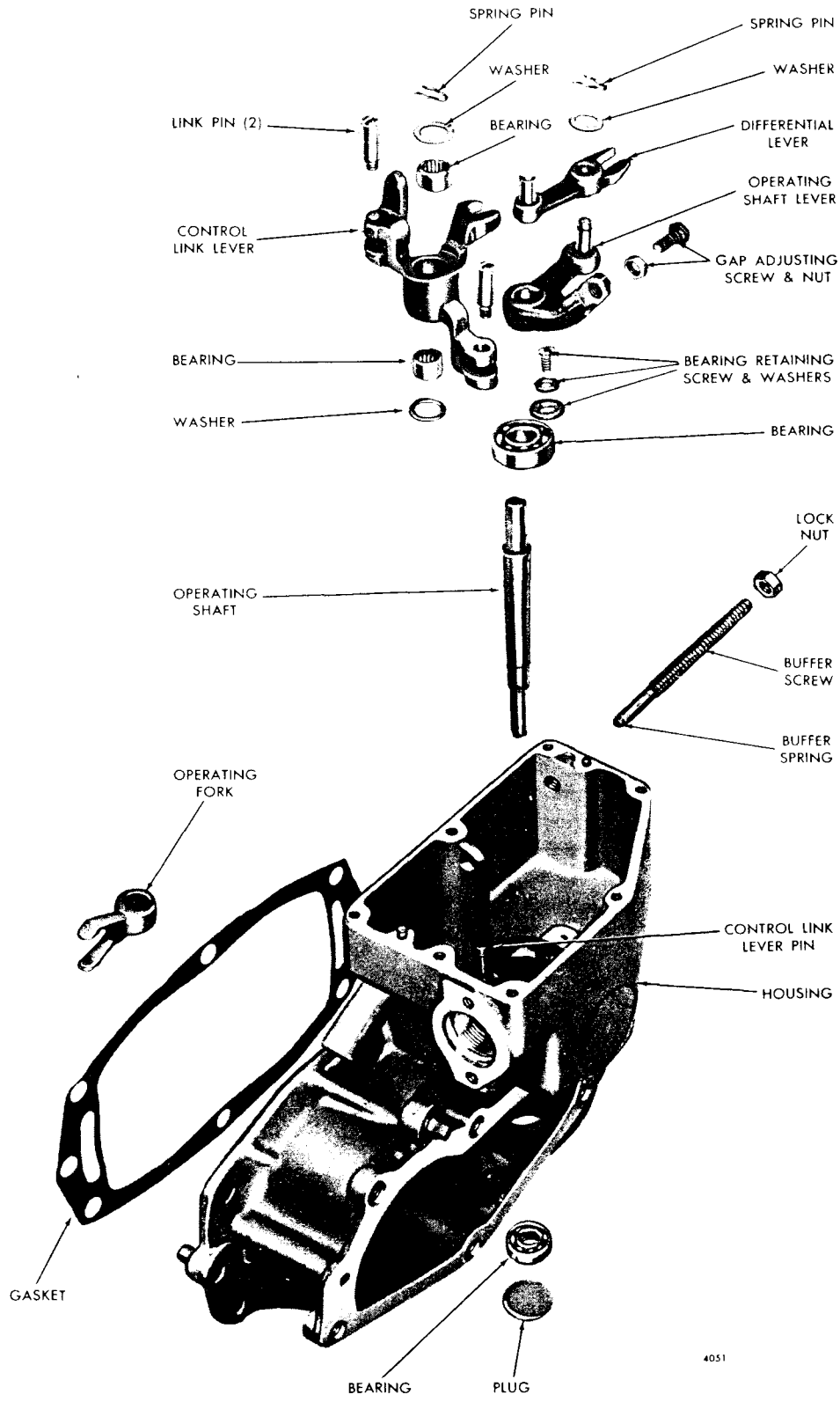


Fig. 7 - Governor Housing Details and Relative Location of Parts

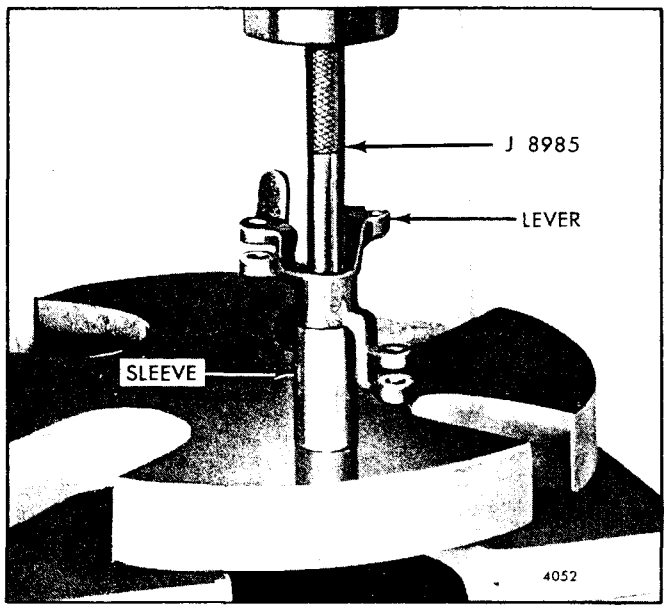


Fig. 8 - Removing or Installing Control Link Lever Bearings

2. Press the drive gear from the shaft and remove the key.

3. Tap the governor weight shaft bearing from the blower drive support. If the bearing is a tight fit, drive the plug from the support and, using a spacer against the outer race of the bearing, press or tap the bearing from the support.

Inspection

Clean all of the parts with fuel oil and dry them with compressed air.

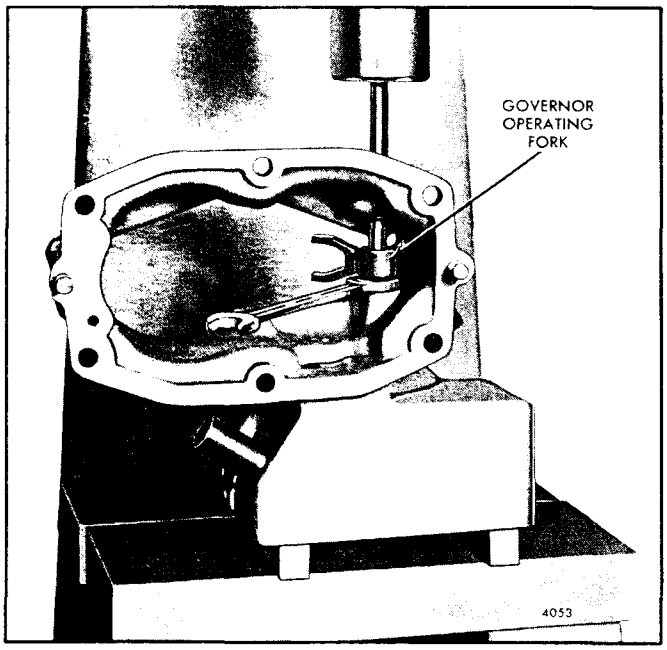


Fig. 9 - Removing Governor Operating Fork

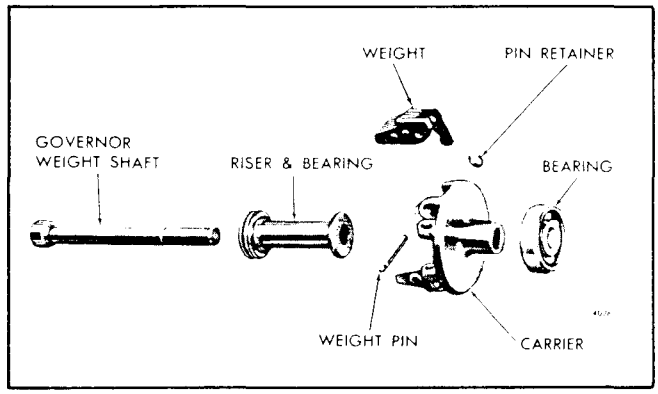


Fig. 10 - Governor Weight Details and Relative Location of Parts

Inspect all bearings. Replace corroded or pitted bearings. Revolve ball bearings slowly by hand. Replace bearings which indicate rough or tight spots.

Examine the riser thrust bearing for excessive wear, flat spots or corrosion. If any of these conditions exist, install a new riser and thrust bearing assembly.

Inspect the control link lever, needle bearings and control link lever pin for wear. Replace worn parts. If a new control link lever pin is required, remove the old pin and press the new pin in the governor housing; the pin must project 1.055" to 1.060" above the boss in the housing.

Examine the governor weight carrier pins for wear.

Examine the variable speed spring lever roller and pin for excessive wear. The current roller type bearing rides on a hardened bearing pin which is a press fit in the spring lever and is staked at three places on both

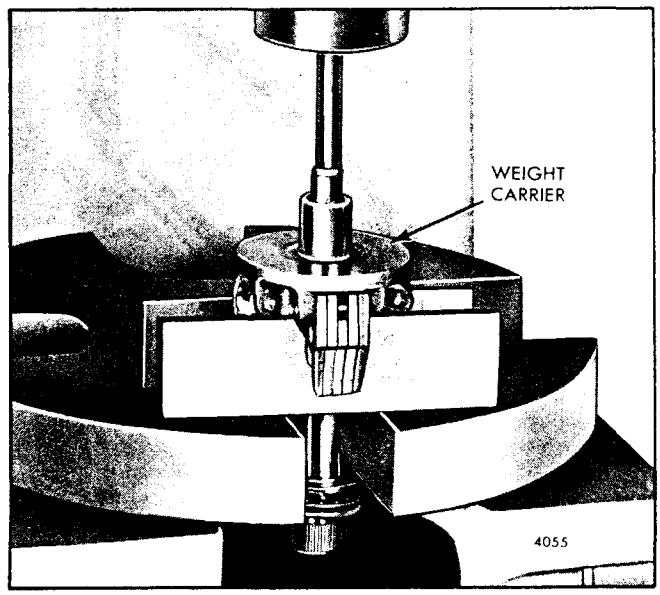


Fig. 11 - Removing Shaft from Weight Carrier

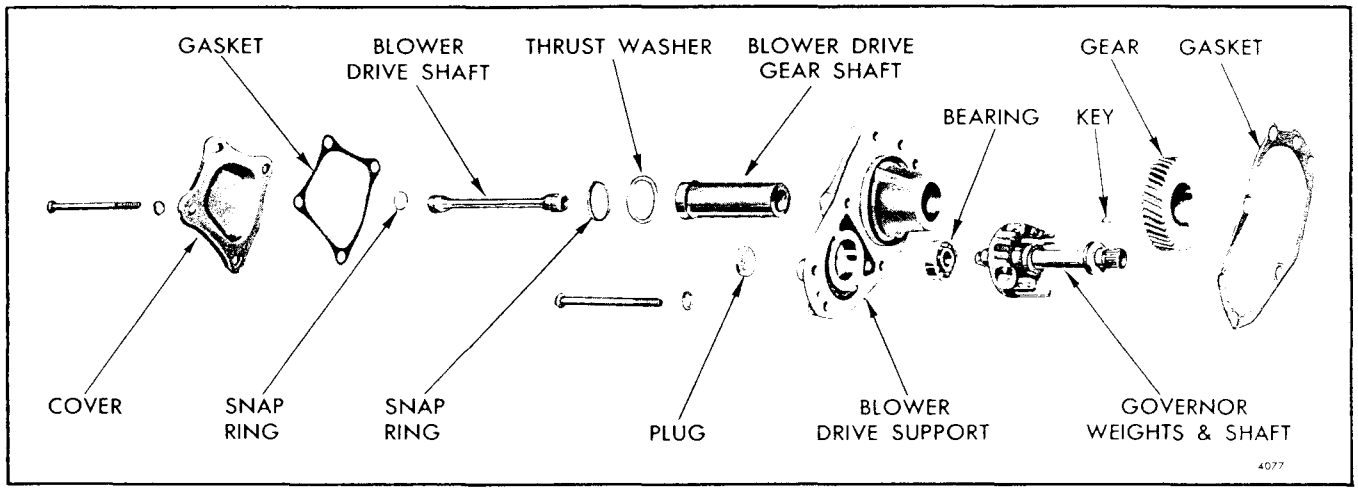


Fig. 12 - Blower Drive Support Details and Relative Location of Parts

sides. The former ball type bearing (with two washers) rides on a soft bearing pin that is swagged at both ends to retain the bearing in the spring lever.

Examine the variable speed spring plunger, guide and spring retainer for wear or score marks. If the retainer or plunger are scored slightly, clean them up with crocus cloth. Replace the retainer, plunger and guide if scored excessively.

Check the serrations on the governor weight shaft and the drive plate on the blower timing gear for wear. Replace worn parts.

Assemble Governor Cover

Refer to Figs. 4 and 13 and assemble the governor cover as follows:

1. Place the cover, with the inner face down, on the bed of an arbor press. Start a needle bearing straight into the bearing bore of the cover, with the number side of the bearing up. Then insert the installer J 21068 in the bearing and press the bearing in until the shoulder on the tool contacts the cover.

2. Turn the cover over and start the second bearing, number side up, in the bearing bore. Place a flat washer over the pilot end of tool J 4647 and insert the tool in the bearing. Press the bearing in until the washer contacts the cover.

> **NOTE:** The bushing, used in certain governor covers, is not serviced. For service, install two needle bearings. Do not use impact tools to install needle bearings.

3. Pack the needle bearings with grease. Then slide the governor throttle shaft assembly through the bearings, with the fulcrum lever pin seated in the slot on the underside of the cover.

4. Install a new seal ring on top of the upper bearing. Then install two seal retaining washers and lock them in place with the retaining ring.

> **NOTE:** A .0329" thick, .312" I.D. x .672" O.D. seal ring back-up washer is used in place of the lower washer on certain governor covers.

5. If a torsion-type stop lever retracting spring (Fig. 4) is used, place it over the cover hub with the hooked end up. Then place the governor stop lever on the shaft and secure it with a bolt and lock washer.

Assemble Governor Spring Housing

1. Lubricate the speed control lever shaft needle bearings with Shell Alvania No. 2 grease, or equivalent. Then start one of the bearings, numbered end up, straight in the bearing bore in the right hand side of the spring housing as viewed in Fig. 6.

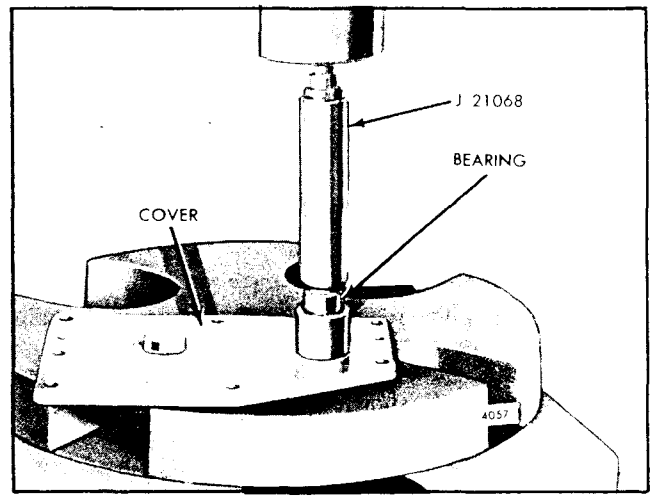


Fig. 13 - Installing Governor Cover Bearings

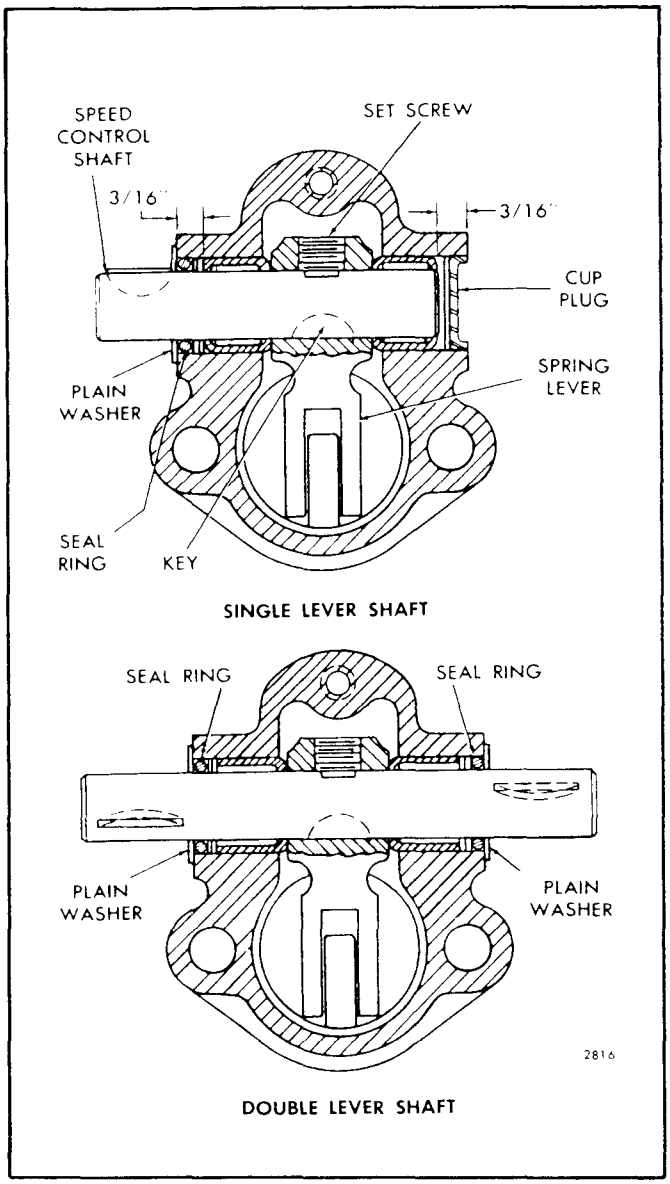


Fig. 14 - Governor Variable Speed Spring Housing

2. Install the needle bearing pilot rod J 9196-2 in the installer body J 9196-1 and secure it in place with the retaining screw.

NOTE: Do not use impact tools to install needle bearings.

3. Place the pilot rod end of the bearing installer assembly in the bearing. Support the spring housing, bearing and installer on a short sleeve on the bed of an arbor press as shown in Fig. 15, then press the bearing in the housing until the shoulder on the installer contacts the housing.

NOTE: When the shoulder on the installer body contacts the housing, the bearing will be properly positioned in the housing.

4. Install the current roller type bearing and pin in the spring lever. Press the pin below the surface of the lever and stake at three places on both sides of the lever. The former ball type bearing (with two washers) is swagged at both ends to retain the bearing in the spring lever.

5. If removed, install the spring lever Woodruff key in the center keyway in the speed control lever shaft.

6. Place the spring lever assembly between the bearing bores inside the spring housing with the arm (roller end) of the lever facing out.

7. Insert the correct end of the (single or double lever type) speed control lever shaft, Fig. 6, through the bearing bore in the side of the spring housing, opposite the bearing previously installed. Align the key in the shaft with the keyway in the spring lever and push the shaft through the lever and in the bearing until the flat on the top of the shaft is centered under the set screw hole in the lever.

8. Thread the set screw into the spring lever, making sure the point of the screw is seated in the flat on the shaft.

9. Place the second shaft needle bearing, numbered end up, over the protruding end of the shaft and start it straight in the bore of the housing.

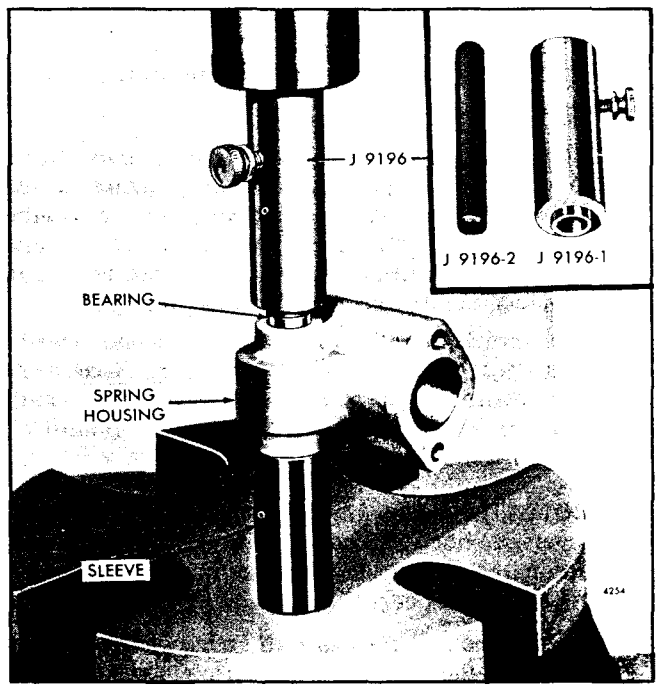


Fig. 15 - Installing Speed Control Shaft Bearings In Spring Housing

10. Remove the bearing pilot rod J 9196-2 from the installer body J 9196-1 and place the installer body over the end of the shaft and against the bearing. Support the spring housing, bearings and installer on a short sleeve on the bed of an arbor press as shown in Fig. 15, then press the bearing in the housing until the shoulder on the installer contacts the housing.

11. If a single lever shaft was installed in the spring housing, apply a thin coat of sealing compound to the outside diameter of the cup plug. Start the cup plug straight in the bearing bore in the housing, then support the spring housing, bearings and shaft assembly on a sleeve on the bed of an arbor press and press the cup plug in flush with the outside face of the housing.

12. Clamp the spring housing assembly in a bench vise equipped with soft jaws. Then tighten the spring lever retaining set screw to 12-15 lb-ft torque.

13. Stake the edge of the set screw hole with a small center punch and hammer to retain the set screw in the lever. Then install the plug in the spring housing.

14. On a single lever shaft, place a seal ring over the end of the shaft and push it into the bearing bore and against the bearing. Place the plain washer over the shaft and against the housing, then install the Woodruff key in the keyway in the shaft.

15. On a double lever shaft, place a seal ring over each end of the shaft and push them into the bearing bores and against the bearings. Place a plain washer over each end of the shaft and against the housing, then install a Woodruff key in the keyway at each end of the shaft.

16. Place the speed control lever(s) on the shaft in its original position. Align the keyway in the lever with the key in the shaft and push the lever in against the plain washer and secure it in place with the retaining bolt and lock washer.

Assemble Governor Housing

Refer to Fig. 7 and assemble the governor housing as follows:

1. Start the upper operating shaft bearing, number side up, on the end of the shaft. Support the lower end of the shaft on an arbor press. Place a sleeve on the inner race and press the bearing against the shoulder on the shaft. The shaft on the heavy-duty governor has no shoulder; press the bearing approximately .562" from the end of the shaft.

2. Start the operating shaft lever, with the pivot pin up, on the end of the shaft with the flat on the shaft registering with the flat in the lever bore. Use a sleeve to press the lever tight against the bearing. On the heavy-duty shaft, use a rod to press the lever against the bearing until the lever is flush with the end of the shaft.

3. Insert the lever and shaft assembly through the top of the governor housing. On the heavy-duty governor, slide the 2.50" long governor fork spacer on the shaft. Position the operating fork over the lower end of the shaft, with the finished cam surfaces facing toward the rear of the governor (toward the governor drive).

4. Support the operating shaft and governor housing on the bed of an arbor press with the upper end of the shaft resting on a steel block (Fig. 16). Align the flat in the fork with the flat on the shaft, then place a sleeve over the shaft and against the fork. Press the fork tight against the shoulder on the shaft or against the fork spacer. Install the set screw and lock screw, if used, in the fork.

5. Start the lower operating shaft bearing, number side up, on the end of the shaft. Place a sleeve on the outer race and press the bearing against the shoulder in the housing.

6. Lubricate both bearings with engine oil.

7. Apply a good quality sealant around the edge of a new expansion plug and drive it securely in place in the housing.

CAUTION: Do not break the housing.

8. Secure the upper operating shaft bearing in place with a retaining screw and flat washer.

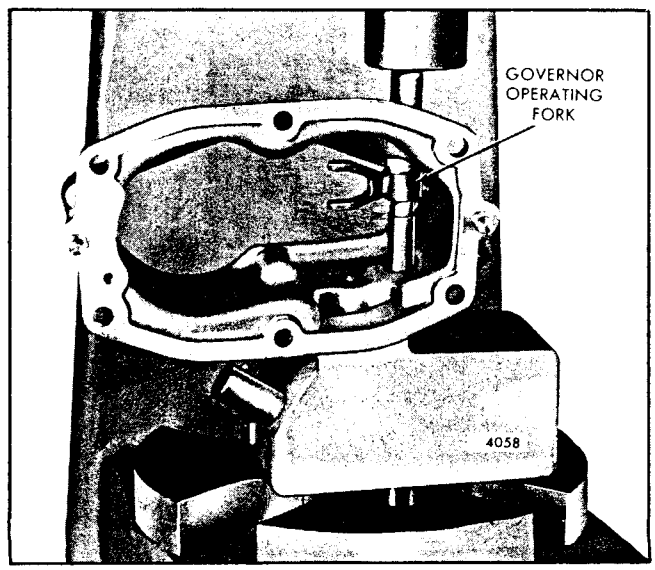


Fig. 16 - Installing Governor Operating Fork on Shaft

9. Place the differential lever (Fig. 7) over the pivot pin in the operating shaft lever. Secure the lever with a washer and spring pin.

10. If previously removed, install the gap adjusting screw and lock nut in the tapped hole in the operating shaft lever.

11. Support the control link lever on a steel spacer as shown in Fig. 8. Start one bearing, number side up, in the lever. Insert the pilot end of installer J 8985 in the bearing and press the bearing in the lever. Reverse the lever and install the second bearing in the same manner.

12. Place a washer over the end of the control link lever pin in the governor housing. Pack the needle bearings with grease and place the lever, with the tapped ends of the link pin holes down, over the pin in the housing. Secure the lever with a washer and spring pin.

13. Install the buffer screw and lock nut, leaving approximately .750" of the screw extending from the governor housing.

NOTE: The buffer screw lock nut on some earlier governors was an integral part of the governor housing.

Assemble Governor Weights and Shaft

1. Lubricate the governor weight shaft with engine oil, then slide the riser assembly over the shaft with the bearing end toward the serrated end of the shaft. Pack the bearing with grease.

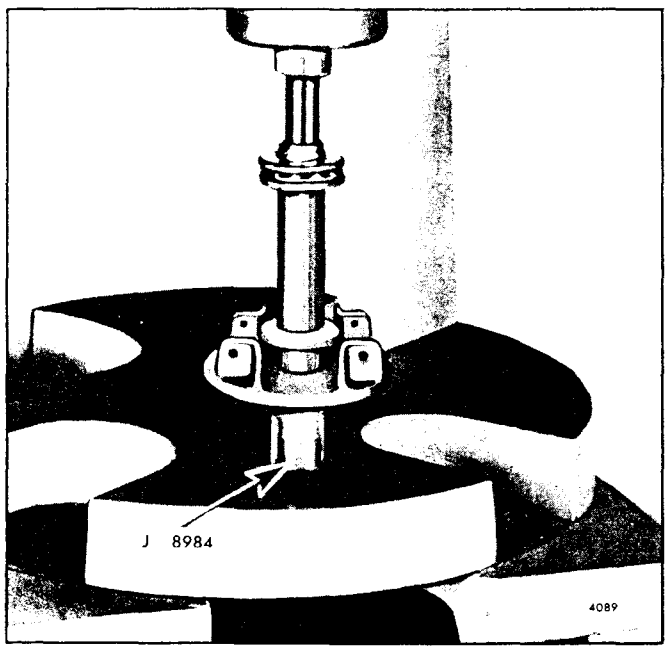


Fig. 17 - Installing Weight Carrier on Shaft

2. Press the shaft into the weight carrier, using tool J 8984 as illustrated in Fig. 17. The tool will properly position the weight carrier on the shaft. However, if a four-weight assembly is used, press the shaft in until it extends .555" to .559" from the weight carrier.

3. Position the weights on the carrier and drive the weight pins in place. Install the retaining rings.

Assemble Blower Drive Support

1. Place the blower drive support, with the inner face up, on the bed of an arbor press. Start the governor weight shaft bearing, number side up, in the bearing bore of the support. Place a sleeve against the outer race and press the bearing firmly against the shoulder in the bearing bore. Attach the bearing retainer (four-weight governor only) with two bolts, nuts and copper washers.

2. Place the steel thrust washer on the end of the blower drive shaft and secure it in place with a snap ring.

3. Lubricate the shaft with engine oil and install it in the drive support.

4. Install the key in the shaft, then place the blower drive support on an arbor press. Lubricate the inner diameter of the blower drive gear and start it straight on the shaft, with the keyway in the gear aligned with the key in the shaft. Place a spacer over the gear and press the gear on the shaft until a .005" feeler gage may just be withdrawn (Fig. 18).

5. Place a support under the inner race of the bearing in the blower drive support and start the weight end of the governor weight shaft into the bearing. Press the shaft in until the shoulder on the shaft contacts the inner race of the bearing. Press the shaft in straight to avoid brinelling the bearing.

6. Apply a good quality sealant on the edge of the cup plug and press the plug in flush with the blower drive support.

7. Check the clearance between the fully extended governor weights and the blower drive gear. This clearance must not be less than .100" (Fig. 19).

Install Governor

Install the governor on the engine as follows:

1. Attach a new gasket to the governor housing and place the housing against the blower rear end plate. Secure the governor housing to the blower with six bolts and lock washers.

2. Install the blower and governor assembly on the engine as outlined in Section 3.4.

3. Install the blower drive support assembly as outlined in Section 3.4 under *Install Blower on 6V Engine.*

4. Insert the upper fuel rods through the fuel rod covers and hoses and attach the rods to the governor control link lever with link pins which thread into the lever.

5. Attach the lower fuel rods to the injector control tube levers and to the upper fuel rods.

6. Slide the fuel rod cover hoses in place and secure them with hose clamps.

7. Refer to Fig. 6 and install the variable speed spring and housing to the governor as follows:

a. On current governors, use a new gasket and attach the spring housing cover to the spring housing with a screw and lock washer.

b. Install the spring plunger guide in the governor housing.

c. Insert the spring plunger in the plunger guide.

d. Insert the solid stop in the governor housing.

e. Place the spring retainer in the spring housing, with the closed end of the retainer against the spring lever. If shims were used, place them inside of the spring retainer. Insert the split stop in the housing and against the spring retainer.

NOTE: Be sure to use shims with a .343" inside diameter and a spring retainer with three bleed holes when a two-spring assembly is used. On the one-spring assembly, either spring retainer may be used with shims which have a .750" I.D. However, do not use the .343" I.D. shims with a spring retainer which has only one air bleed hole.

f. Insert the variable speed spring in the spring retainer with the tightly wound end of the spring against the shims. If a two-spring assembly is used, insert the inner spring inside of the outer spring.

g. On former governors, insert two bolts with lock washers through the spring housing (through the spring housing cover and spring housing on current governors) and place a new gasket over the bolts and against the housing. On current governors, use copper washers with the two attaching bolts.

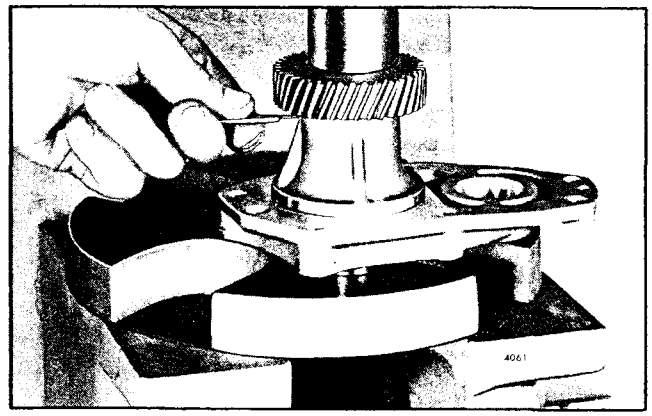


Fig. 18 - Installing Blower Drive Gear on Shaft

h. Place the spring housing in position against the governor housing, with the spring plunger engaged in the end of the spring (inner spring of the two-spring assembly). Thread the bolts into the governor housing and tighten them.

i. Install the idle speed adjusting screw and lock nut in the spring housing (former governors) and in the spring housing cover (current governors).

8. Place a new gasket on the governor, then install the governor cover and lever assembly. Be sure the governor control lever assembly enters the slot in the

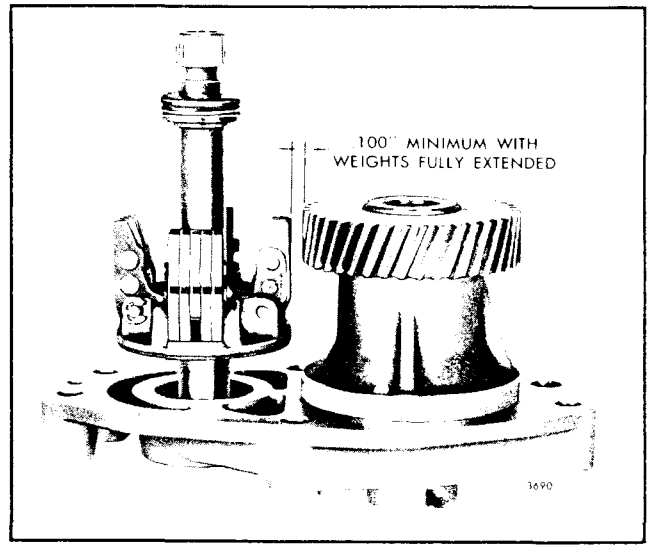


Fig. 19 - Minimum Clearance Between Blower Drive Gear and Governor Weights

differential lever. Secure the cover to the governor with seven screws and lock washers.

NOTE: If a torsion-type stop lever spring is used, a special cover screw is used to hold the spring in place. If a long coil spring is used, the spring retaining bracket is held in place by one of the standard cover retaining screws.

9. Hook the stop lever spring to the lever and to the spring retaining bracket or the special cover screw.

10. Perform an engine tune-up as outlined in Section 14.