

SECTION 12**GOVERNOR**

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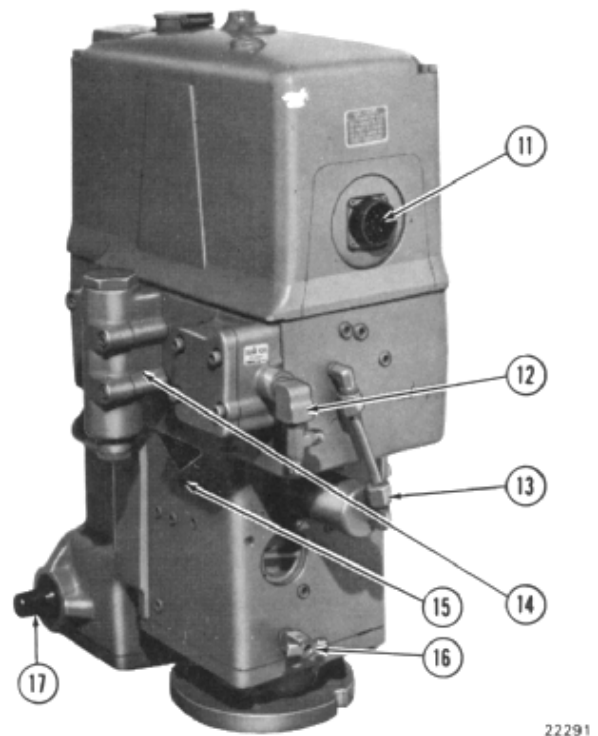
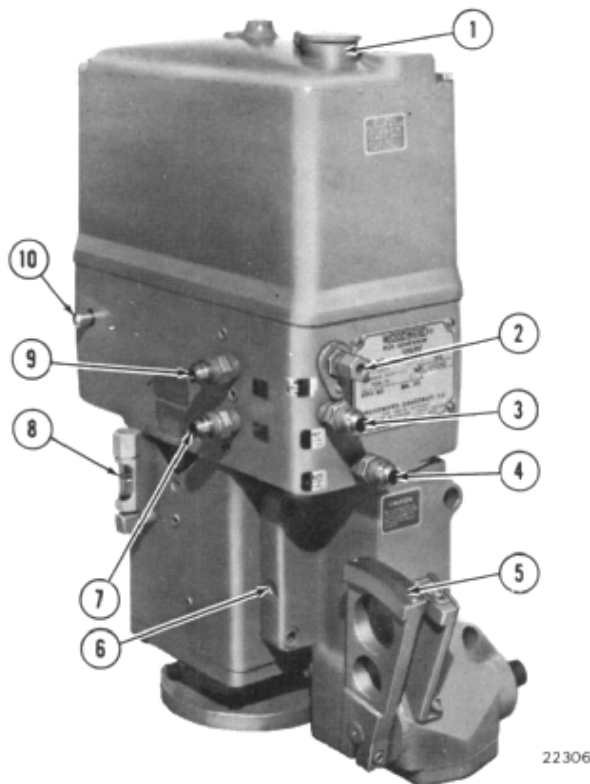
ENGINE MAINTENANCE MANUAL

GOVERNOR

DESCRIPTION

The limiting and rebalancing type PGR governor, Fig. 12-1, is used on the turbocharged engine. An electro-hydraulic speed control maintains the engine speed selected by the engine operator. The governor is provided with a sensor assembly, sensitive to absolute air pressure, which operates to adjust the engine load in proportion to the air supply, within the range of the load regulator, to ensure correct air-fuel ratio. In addition, a rocker arm and lever arrangement is provided on the governor to stop upward movement of the power piston through the action of the fuel limiter.

The governor incorporates an engine protective device, Fig. 12-2, which shuts the engine down when actuated by low engine oil pressure, high oil temperature, or as a result of the operation of the low water and crankcase pressure detector. A visual indication and an alarm is actuated in the event of an engine protection shutdown. A normal engine shutdown is obtained by actuating one of the speed solenoids with the stop button. Other auxiliary devices which are a part of the governor include the load regulator pilot valve, which controls oil to the load regulator, and the ORS solenoid which when energized raises the load regulator pilot valve to the minimum field position.

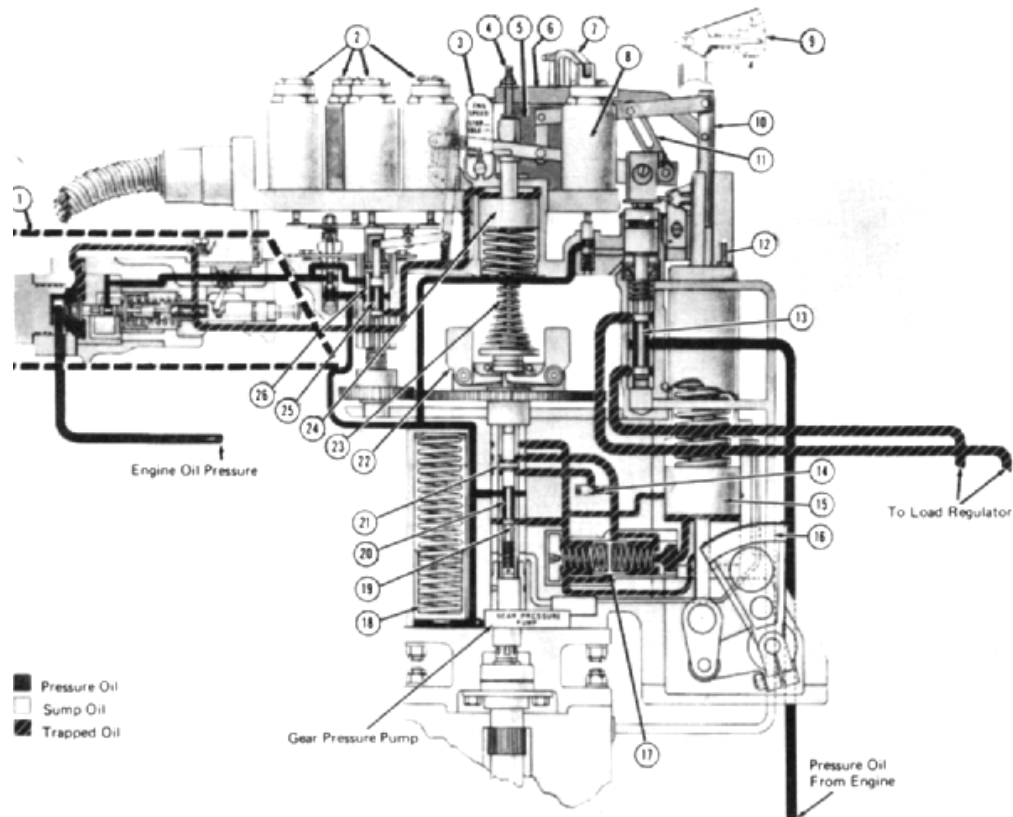


- 1 Oil Filler
- 2 Air Box Pressure Connection
- 3 Pilot Valve Engine Oil Supply
- 4 Pilot Valve Oil Drain
- 5 Terminal Shah Scale
- 6 Compensating Needle Valve

7. Vane Motor Oil Line Connection; Increase Excitation .
8. Oil Level Sight Glass
9. Vane Motor Oil Line Connection; Decrease Excitation
10. Low Oil Pressure Shutdown Plunger
11. Electrical Receptacle

12. Engine Oil Pressure Connection
13. Time Delay Accumulator
14. Rebalancing Servo Oil Filter
15. Vent Plug
18. Oil Drain Cods
17. Terminal Shaft Control

Fig. 12-1 - Electro-Hydraulic Governor



- | | | |
|---------------------------------|---------------------------------------|------------------------------------|
| 1. Low Oil Pressure Shutdown | 10. Power Piston Tail Rod | 19. Regulating Port |
| 2. Speed Control Solenoids | 11. Plot Valve Linkage And Eccentric | 20. Power Piston Plot Valve |
| 3. Speed Scale | 12. Power Piston Stop Screw | 21. Compensating Receiving Piston |
| 4. Shutdown Rod | 13. Load Regulator Pilot Valve | 22. Ballhead Assembly |
| 5. Air Pressure Sensor Assembly | 14. Compensating Needle Valve | 23. Speeder Spring |
| 6. Fuel Limit Lever | 15. Power Piston | 24. Speed Setting Piston |
| 7. Rebalancing Rocker Arm | 16. Terminal Shaft Scale | 25. Speed Control Pilot Valve |
| 8. Overriding Solenoid | 17. Buffer Piston | 26. Speed Control Rotating Bushing |
| 9. Pilot Valve Scale | 18. Governor Oil Pressure Accumulator | |

Fig. 12-2 - Governor Schematic Diagram

The main parts of the speed and fuel control portions of the governor are: a speed sensing arrangement (speeder spring and flyweights), fuel adjustment control (power piston), compensating mechanism (compensating land integral on power piston pilot valve and buffer piston and springs), and an independent oil system (oil sump, oil pump, accumulators, external filter, and connecting passages).

The governor has a self-contained hydraulic oil system, consisting of storage sump, rotary gear pump, and accumulators. The oil lubricates the moving parts and provides force necessary to operate various parts of the governor.

To vary the speed of the engine with throttle changes, or to maintain a constant engine speed with load changes, the amount of fuel injected into the cylinder must be varied. This is determined by the position of the power piston. To move the power piston, the ten-

sion on the speeder spring is varied. Whether the throttle changes or the engine speed changes (due to a load change), the flyweights will move. This changes the position of the pilot valve plunger and controls the supply of oil to the power piston.

The power piston moves the injector control rack through the governor rotary shaft and injector linkage. The upward motion of the power piston results from oil under pressure, controlled by the power piston pilot valve plunger, raising the piston against the pressure of the power piston spring.

The compensating mechanism prevents the engine from racing or hunting by arresting the movement of the power piston after it has traveled an amount sufficient to give the desired speed. The compensating mechanism includes the integral receiving compensating piston, buffer piston and springs, and compensating needle valve.

The governor drive shaft, pump gears, rotating bushing and flyweights rotate together. Two accumulators provide for the storage of governor oil under pressure, and the maximum pressure of this governor oil is regulated by a bypass in one of the accumulators. A buffer piston centered by springs is located between the pilot valve plunger and the power piston. This piston is bypassed by the needle valve, and also by passages which are uncovered when it moves a certain distance away from its central position. The small difference in oil pressure on the two sides of the buffer piston is transmitted to the receiving compensating piston on the pilot valve plunger.

OPERATION

Fig. 12-3 illustrates the operation of the fuel control portion of the governor. The power piston spring acts to shut off fuel to the engine. Oil under pressure is used only to raise the power piston and increase the supply of fuel to the engine. The following paragraphs describe the sequence of events under different operational conditions.

LOAD DECREASED OR THROTTLE DECREASED

As shown in Fig. 12-3, the engine is running normally under steady load and at constant speed. The flyweights, pilot valve plunger, and buffer piston are in normal position. The control land on the pilot valve plunger covers the regulating port holes in the rotating bushing. The power piston is stationary.

Assume that the engine load is decreased, thus increasing the speed. As the speed increases, the flyweights move out, raising the control land of the pilot valve plunger and uncovering the regulating ports in the rotating bushing. Uncovering the regulating ports in this direction permits oil to escape from the area to the right of the buffer piston; it then moves to the right, as spring pressure forces the power piston down. It is apparent that since this compresses the right-hand buffer spring, the oil pressure on the left of the buffer piston is a little higher than that on the right. These pressures are connected to the areas above and below the receiving compensating piston on the pilot valve

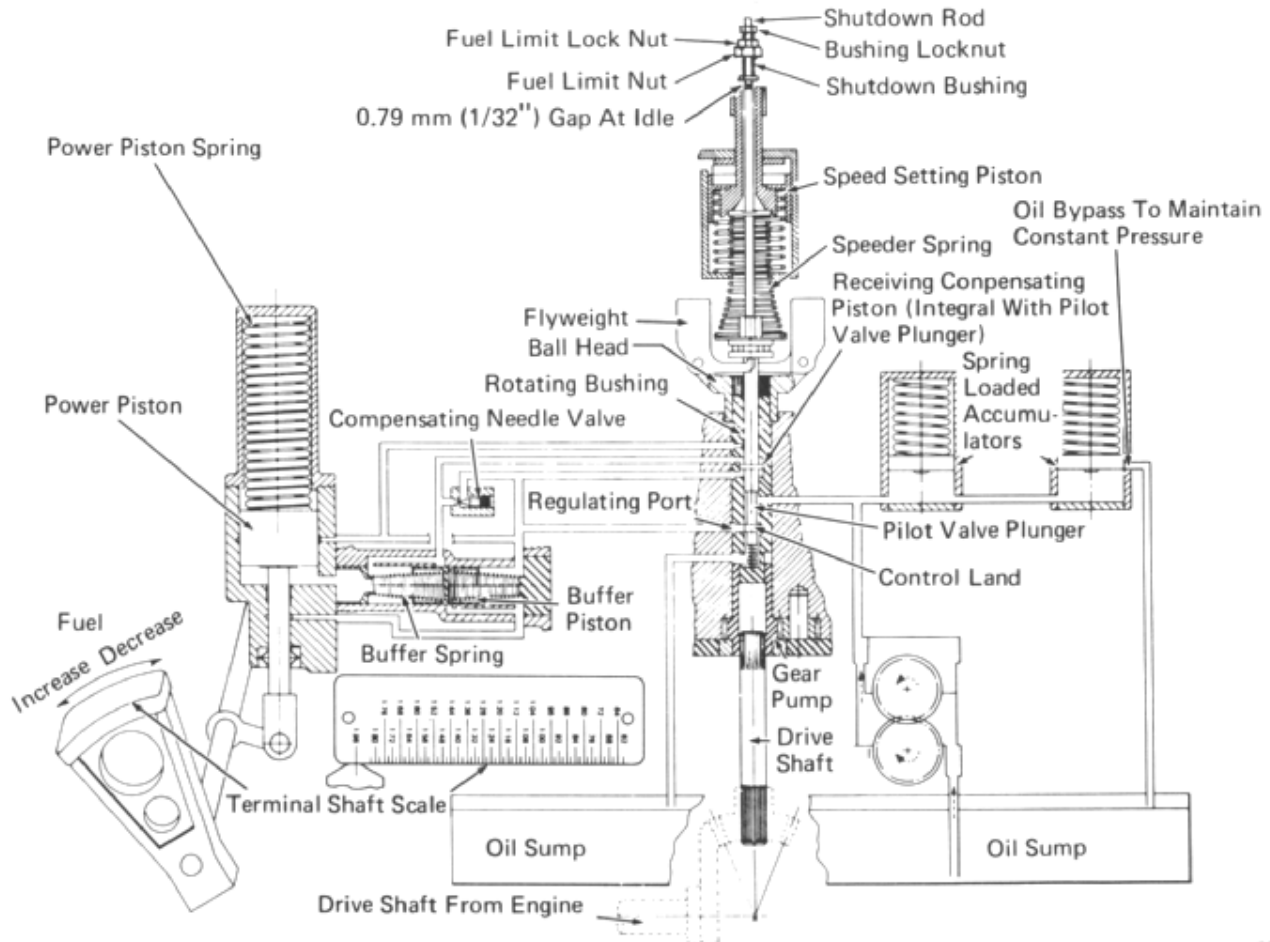


Fig. 12-3 - Fuel Control Schematic Diagram

plunger, and since the higher pressure is above this it is forced downward so that the land of the pilot valve plunger starts to close the ports and stop the power piston movement. If the governor is properly adjusted, this action will stop the movement of power piston when it has moved far enough to correct for the load change that started the action.

Oil leaking through the compensating needle valve then allows the buffer piston to return to center, which gradually releases the force on top of the receiving compensating piston. This force is no longer needed to hold the pilot valve plunger in its central position, because during this time the engine speed has been returning to normal, and the outward force of the flyweights has been reduced until it is balanced by the speeder springs.

It is apparent that the compensating mechanism described above produces stable operation by permitting the governor to move rapidly in response to a speed change, and then wait for the speed to return to normal.

LOAD INCREASED OR THROTTLE INCREASED

As before, all parts of the governor are centered, and there is no power piston movement. Assume that the engine load is increased, resulting in a decrease in speed. The governor will go through a cycle of operations as follows: The decrease in speed will cause the flyweights to move inward, which lowers the pilot valve plunger and opens the port. Oil from the accumulators passes through the pilot valve, forces the buffer piston to the left, and moves the power piston upward to give the engine more fuel. The compression of the left-hand buffer spring is a result of a higher pressure on the right-hand side of the buffer plunger and on the underside of the receiving compensating piston. This pressure moves the pilot valve plunger upward and stops the movement of the power piston when it has moved far enough to correct for the load change that started the action.

Oil leaking through the compensating needle valve gradually releases the force under the receiving compensating piston, allowing the buffer piston to return to center. This force is no longer needed to hold the pilot valve plunger in its central position, because during this time the engine speed has been returning to normal.

In the preceding description of operation, speed changes as a result of load changes have been consid-

ered. Similar governor movements occur when a difference between actual governor speed and governor speed setting is produced by changing speeder spring tension through the speed adjusting control used on the governor. With large speed changes the buffer piston travel is much greater, to the left or right, depending on increase or decrease in speed, opening a passage for the flow of oil to or from the power piston.

Under normal operation, the air pressure sensor assembly and rebalancing arrangement will automatically adjust itself to provide correct operation. However, if air box pressure or fuel demand is not normal during operation, the rebalancing and fuel limit arrangement, explained in the following pages, will automatically make an adjustment to compensate for the condition.

MAINTENANCE

GOVERNOR REMOVAL

Remove the governor from the engine as follows:

1. Open drain cock on side of governor and drain oil into suitable container.
2. Remove right and left bank control rods from governor to control rod lever.
3. Disconnect electrical connector and all external lines and hoses.
4. Remove the four stud nuts securing governor to mounting surface, and lift governor off of studs. Remove the gasket from between the governor and the mounting surface.

CAUTION: Use care when handling governor and avoid striking the end of the drive shaft or the terminal shaft. Damage can be done to the shafts, bearings, and governor oil pump gears.

5. Remove governor to control rod lever from governor terminal shaft.

GOVERNOR INSTALLATION

Install governor on engine as follows:

1. Apply governor to control rod lever to governor terminal shaft.

CAUTION: Ensure that unsplined area of the lever I.D. is properly aligned to the keyway (missing spline) on the terminal shaft.

2. Install gasket on governor mounting surface. 3. Install governor on mounting surface with terminal shaft pointing toward engine.
4. Apply four stud nuts and torque to specified value.
5. Connect electrical connector and all external lines and hoses.
6. Connect right and left bank control rods to governor to control rod lever.

NOTE: Every time a governor is installed on an engine the injector rack setting should be checked. Due to manufacturing tolerances in governor mounting bolt holes, the position of the governor in relation to the injector linkage can change the rack setting.

GOVERNOR COMPENSATION

DESCRIPTION

The compensating mechanism prevents the engine from racing or hunting by arresting the movement of the power piston after it has traveled a sufficient amount to give the desired speed. The compensating mechanism includes the integral compensating receiving piston, buffer piston and springs, and compensating needle valve.

When the engine is started the first time or after installation of a new or reconditioned governor or one that has been drained and cleaned and new oil added, the governor will require compensation adjustment. This is necessary to purge the governor oil system of trapped air.

MAINTENANCE

COMPENSATION ADJUSTMENT

1. See that the governor oil is at the proper level in the sight glass. Then operate the governor at idle speed.
2. Open the compensating needle valve, Fig. 12-1, several turns. Loosen the vent plug, Fig. 12-1, several turns, but do not remove the plug.
3. The governor will hunt and surge, and air will bleed from the system at the vent plug. When only oil flows from the vent plug, the system is free of air, and the compensating needle valve should be closed slowly until the hunting condition stops or is lessened. Allow the governor to run until normal operating temperature is reached. Tighten the vent plug to prevent oil leakage, and add the oil necessary to obtain the proper level in the governor.
4. After normal temperature has been reached, again open the compensating needle valve and allow the governor to hunt. Then close the needle valve until hunting stops. The needle valve will be open approximately one-quarter to three turns depending upon the engine characteristics.
5. Test the governor stability by manually changing the speed to observe governor recovery. If the governor returns to a steady speed, the compensating adjustment is satisfactory. If hunting is resumed, close the compensating needle valve slightly and test again.
6. Keep the compensating needle valve open as far as possible to prevent sluggishness and still maintain even governor operation. After compensation is made, it should not require another adjustment, unless a permanent temperature change effects the viscosity of the governor oil.

ENGINE SPEED CONTROL

DESCRIPTION

Speed setting with the electro-hydraulic governor is accomplished in steps by energizing different combinations of the "A," "B," "C," and "D" solenoids, Fig. 12-4. Solenoids "A," "B," and "C" have plungers bearing on a triangular fulcrum plate at varying distances from a set fulcrum point. The triangular plate fulcrum bears on a lever which is connected to the speed control pilot valve inside a rotating bushing. The "D" solenoid plunger bears on the rotating bushing through its cap and bearing.

To increase engine speed, the speeder spring must be compressed; or compression lessened to decrease speed. The speed setting piston position must be changed to satisfy these conditions. This is accomplished by admitting or releasing governor oil above the speed setting piston. Admission or release of oil to or from the speed setting piston is controlled by the solenoids through the speed pilot valve and rotating bushing.

When a solenoid or different combinations of "A," "B," or "C" solenoids are energized, the triangular

MAINTENANCE

It is recommended that a suitable test stand be used when making engine speed settings.

NOTE: Test stand must have provision to energize A and D solenoids simultaneously for setting low idle speed.

When setting engine speeds, the governor solenoids are adjusted to provide specified speeds at idle, intermediate, and full speed throttle positions. For applicable speeds at each throttle setting refer to Table A in the Service Data at the end of this section.

In addition to the other information on the governor name plate each name plate has an insert, Fig. 12-5, which shows the full speed of the engine and the full load injector rack length (BAL. PT.) for the engine speed given in the insert. If the governor is reset to a different full load injector rack length or engine speed, a new insert should be applied having the correct information.

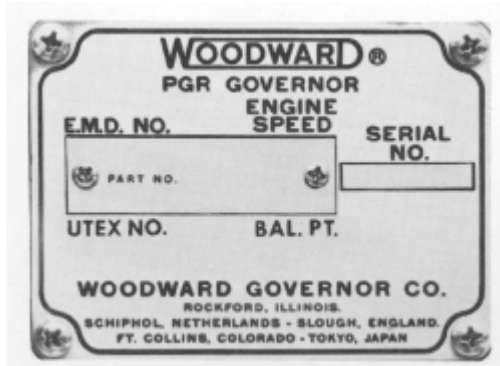


Fig. 12-5 - Governor Nameplate

Everytime a governor is installed on an engine the injector rack length settings should be checked. Before attempting to set speeds, the governor should be operated with the heated test stand oil 82°-93° C (180°-200° F) for a sufficient length of time to allow the temperature to equalize.

To facilitate setting speeds, the solenoid adjustment wrench may be used. This tool provides a means for holding the solenoid case while making locknut and stop screw adjustments.

Establish absolute air pressure to bellows, as given in Table B. Adjust the solenoids to obtain the speeds given in Table A as described below.

1. Place the throttle in No. 6 position and bring speed to specified RPM by adjusting fulcrum nut, Fig. 12-6, at the end of the linkage. Raising the fulcrum nut increases speed.

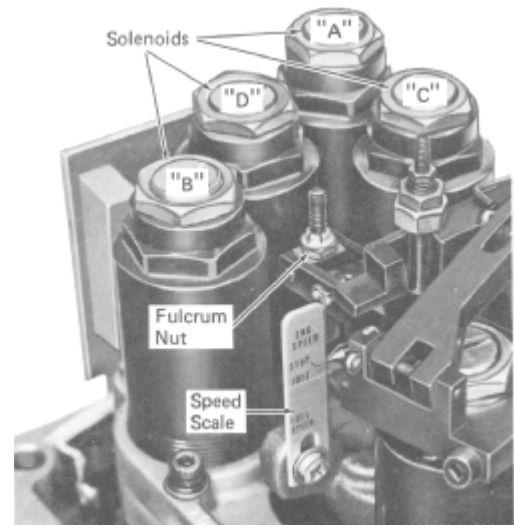


Fig. 12-6 - Speed Control Adjustment Points

2. Move the throttle to No. 8 position and set speed by adjusting the "D" solenoid stop screw. Back off stop screw to increase speed.
3. With the throttle in No. 4 position, adjust the "B" solenoid stop screw to set speed. Turn stop screw in to increase speed.
4. Place throttle in low idle position. and set speed by adjusting "C" solenoid stop screw. Turning stop screw in, increases speed.
5. With throttle in idle position adjust "A" solenoid to set speed. Turn screw in to increase speed.
6. Check above settings and, readjust for proper speeds, if required.
7. Check engine speed at all throttle positions. All speeds must be within limits shown in Table A.
8. Adjust speeder servo scale as follows:

- a. With governor operating at low idle speed, loosen scale locking screw and locate scale so stamped IDLE mark is aligned with pointer. Tighten locking screw.
- b. With governor at idle speed, scribe a line on scale opposite pointer.
- c. With governor at throttle 8 position, scribe a line on scale opposite pointer.

ENGINE SHUTDOWN

DESCRIPTION

Engine shutdown can normally be accomplished by depressing the STOP button or placing the throttle in the STOP position. Either action will energize the "D" solenoid, Fig. 12-4. This action depresses the speed control rotating bushing so its port is below the land of the speed control pilot valve. This allows the trapped oil above the governor speeder spring piston to drain. The spring under the piston forces the speeder spring piston upward and the piston extension contacts the shutdown bushing on the shutdown rod. Raising the shutdown rod also lifts the power piston pilot valve. Oil will then be released from under the power piston through the associated linkage to bring the injectors to the "no fuel" position.

MAINTENANCE

SOLENOID ADJUSTMENT

No additional adjustment is required on the governor solenoids. The "D" solenoid which causes engine shutdown is adjusted at the time of speed adjustment.

SHUTDOWN ADJUSTMENT

CAUTION: Shutdown adjustment must be made on governor test stand, since this adjustment establishes the basis for fuel limit settings.

1. Operate governor at low idle speed.
2. Loosen shutdown bushing locknut, Fig. 12-7, and adjust shutdown bushing by turning the fuel limit nut until there is 0.79 mm (1/32") clearance between the bottom of the shutdown bushing and of the speed setting piston fulcrum assembly.

3. Tighten bushing locknut.

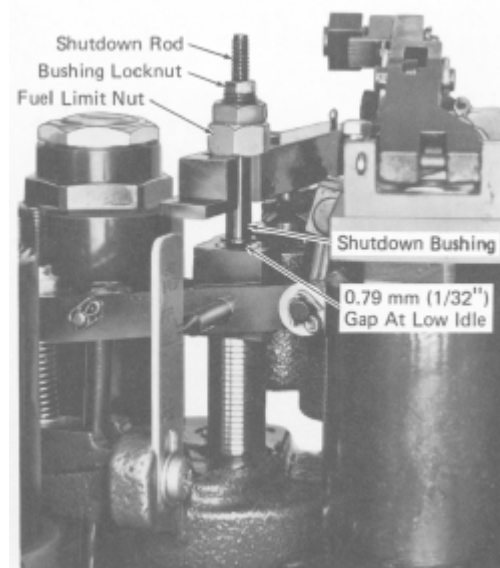


Fig. 12-7 - Shutdown Adjustment Location

4. Turn test stand selector switch to OFF position and loosen speed setting piston stop screw locknut.
5. Adjust speed setting piston stop screw, Fig. 12-8, to position the speed indicator pointer at or slightly above the STOP mark on the speed scale.
6. Tighten stop screw locknut.

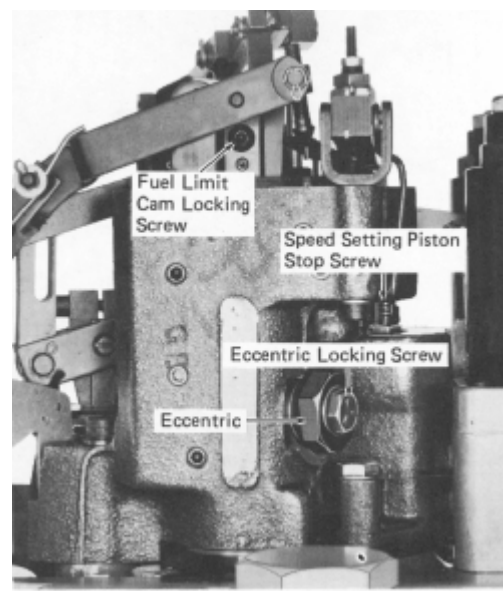


Fig. 12-8 - Speed Setting Piston Stop Screw

AIR PRESSURE SENSOR ASSEMBLY

DESCRIPTION

The purpose of the sensor assembly, Fig. 12-9, is to adjust the fuel limiter and pilot valve rebalancer arrangement in accordance with the absolute air pressure. The automatic positioning of these two controls is dependent upon engine air box pressure and atmospheric pressure.

The pressure sensor is a force-balance device consisting of an inlet check valve, an orifice pack restriction, a piston and cam assembly, a restoring spring, a bleed valve, an absolute pressure bellows arrangement, and a hydraulic amplifier.

Pressured oil enters the sensor through the inlet check valve, and is directed to the upper side of the sensor piston and through the orifice pack restriction to the under side of the sensor piston. The inlet check valve prevents siphoning of the oil from the limiter housing during shutdown periods.

The bleed valve regulates the rate of oil flow from the area under the sensor piston to the sump as a function of manifold air pressure. When the bleed valve bypasses a greater flow of oil from this area than is admitted through the orifice pack, the sensor piston moves downward. Conversely, reducing the bypass oil flow to less than that admitted causes the sensor piston to rise. When the inflow and outflow of oil are equal, the piston remains stationary.

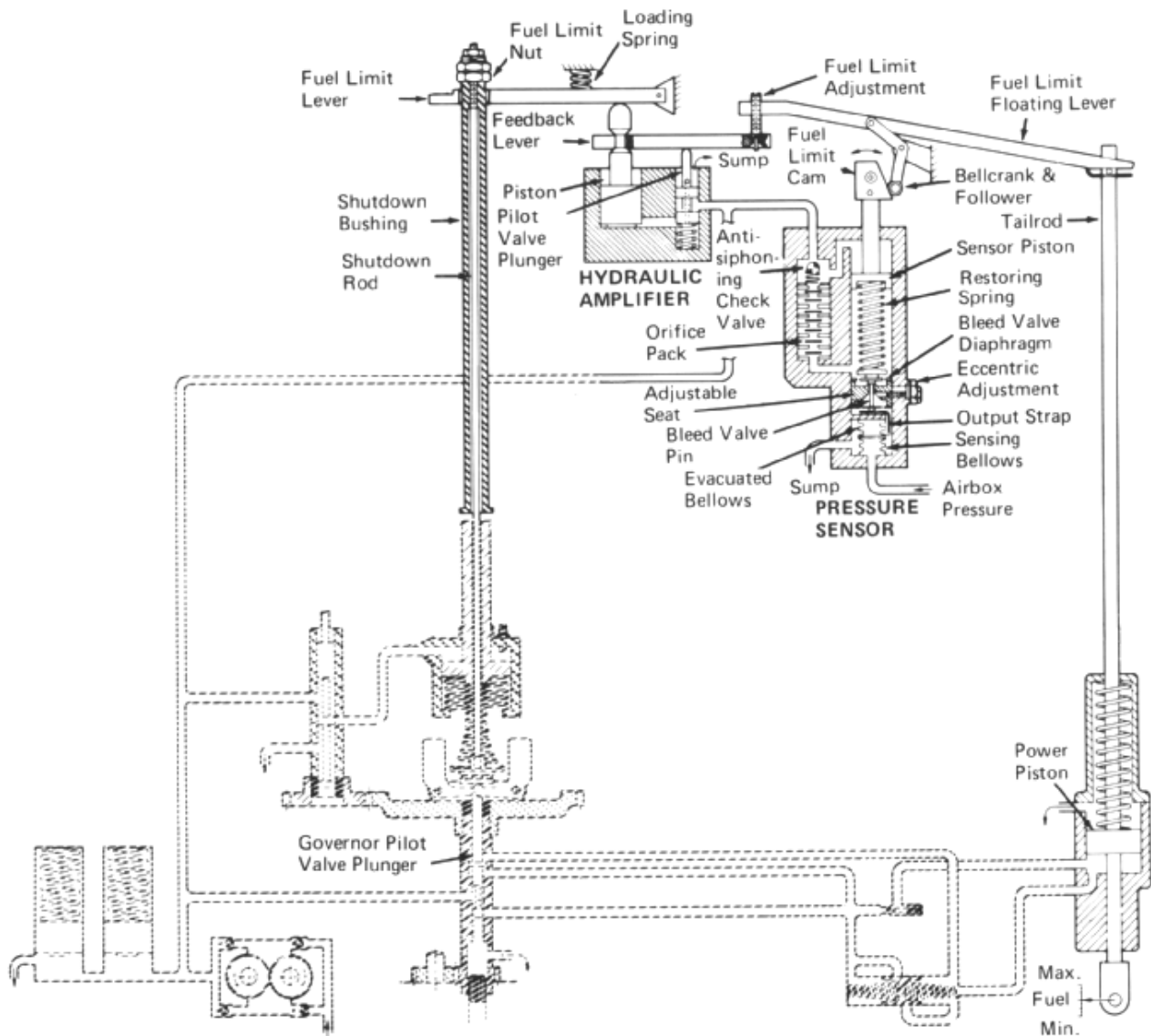


Fig. 12-9 - Air Pressure Sensor Assembly Schematic

The sensing element consists of two opposed, flexible, metallic bellows. The upper bellows is evacuated, and the lower bellows senses air box pressure. A spacer joins the bellows at the center while the outer end of each bellows is restrained to prevent movement. Air box pressure acting internally on the sensing bellows produces a force causing the spacer to move towards the evacuated bellows. The evacuated bellows provides an absolute reference, therefore the sensing bellows force is directly proportional to the absolute air box pressure. Movement of the bellows spacer is transmitted through an output strap and a bleed valve pin to the bleed valve diaphragm.

When the governor speed setting is advanced, the governor power piston moves upward supplying additional fuel. Since air box pressure lags engine acceleration, the fuel limiter cam and bellcrank initially remain stationary until air box pressure rises. As the governor power piston moves upward increasing fuel, the fuel limit floating lever depresses the right end of the feedback lever on the hydraulic amplifier. This pushes the amplifier pilot valve plunger below center, allowing pressured oil to flow into the area under the amplifier piston, causing the piston to rise. As the piston rises, it lifts the fuel limit lever. When the fuel limit lever contacts the fuel limit nut on the shutdown bushing it begins lifting the shutdown rod to recenter the governor pilot valve plunger. The upward movements of the fuel limit and feedback levers continue until the left end of the feedback lever raises far enough to recenter the amplifier pilot valve plunger and stop the flow of oil to the amplifier piston. At this point, the fuel limit lever recenters the governor pilot valve plunger, stopping the upward movement of the governor power piston. Although the governor flyweights are in an underspeed condition at this time, the power piston remains stationary until air box pressure rises.

As engine speed and load increases, air box pressure begins to rise after a short time lag. The increase in air box pressure produces an increase in the sensing bellows force. The bellows force, causes the bleed valve diaphragm to move further off its seat. This allows a greater flow of oil to the sump than is admitted through the orifice pack. Governor oil pressure acting on the upper side of the sensor piston forces the piston downward and further compresses the restoring spring. The piston continues its downward movement until the net increase in restoring spring force equals the bellows force. This restores the bellows and bleed valve diaphragm to their original positions. At this point, the outflow of oil is again equal to the inflow and movement of the piston is halted.

As the sensor piston and cam move downward in response to a rise in air box pressure, the bellcrank rotates in a clockwise direction. This allows the floating lever pivot point, the left end of the lever, and in turn the hydraulic amplifier pilot valve plunger to rise.

When the pilot valve plunger rises above center, the oil under the amplifier piston bleeds to sump through a drilled passage in the center of the plunger. The passage in the plunger restricts the rate of oil flow to sump and decreases the rate of movement of the amplifier piston to minimize hunting. As the amplifier piston moves downward, the left end of the fuel limit lever also moves downward. This lowers the shutdown rod which in turn lowers the governor pilot valve plunger and increases engine fuel.

The sequence of events described above occurs in a continuous and rapid sequence. Normal governor operation is overridden during an acceleration transient and engine fuel is scheduled as a function of air box pressure, regardless of governor speed setting. During steady state operation, air box pressure is normally greater than that at which fuel limiting occurs, and the sensor piston and cam will be positioned below the effective limiting point.

MAINTENANCE

1. Operate governor at idle speed.
2. Connect air line to AIR PRESSURE TO LIMITER fitting on governor.
3. Adjust air pressure to 36" Hg Abs.

NOTE: If test stand is equipped with an absolute pressure manometer, read inches of mercury absolute directly from manometer. If test stand is equipped with a mercury column and a barometer, subtract barometric pressure from absolute pressures given in this instruction and establish pressure difference as inches of mercury on the mercury column.

4. Loosen eccentric locking screw, Fig. 12-8, and turn eccentric clockwise until sensor piston travels to the top of its stroke.
5. Measure and record the height of the fuel limiter cam, Fig. 12-10, from a convenient reference surface.

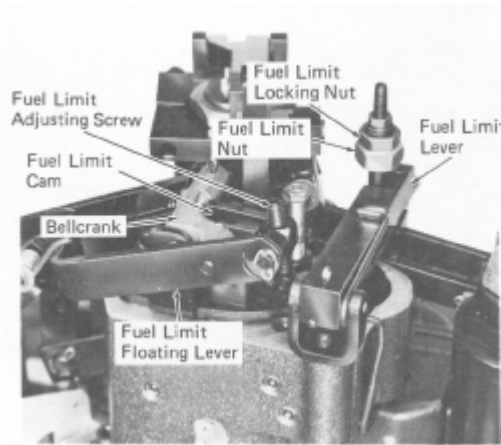


Fig. 12-10 -Fuel Limit Adjustments

6. Tighten eccentric locking screw slightly and turn eccentric counterclockwise until fuel limit cam travels downward $2.36 \text{ mm} \pm 0.38 \text{ mm}$ ($3/32'' \pm 1/64''$). Tighten locking screw.
7. Rapidly increase and decrease the air box pressure to the bellows. (This may be done by application of a vent valve between the mercury column and the governor air connection.) Observe the limiter cam motion. This should follow the pressure changes closely. If the limiter cam does not follow a decreasing air pressure, check the limiter oil supply filter and orifice stack for plugging.
8. Adjust air pressure to 36" Hg Abs., and check for fuel limit cam position obtained in Step 5.

FUEL LIMITER

DESCRIPTION

The purpose of the fuel limiter is to prevent supplying fuel to the engine in excess of that which can be properly consumed with the available air supply.

In response to a demand for fuel, the governor pilot valve is lowered to permit governor oil to raise the power piston. The power piston upon being raised will also lift the fuel limit floating lever, Fig. 12-10. If sufficient air is not available for proper combustion, the hydraulic amplifier piston, contacts the fuel limit lever which will raise the shutdown bushing and governor power piston pilot valve. The governor oil port to the power piston will then be closed and the upward or increase fuel movement of the power piston will be stopped.

Since the limiter floating lever has a movable fulcrum, the fulcrum position is automatically varied to correspond to air box pressure. This will adjust the limiter action in proportion to the available air box pressure.

MAINTENANCE

1. With the governor operating at full speed, establish the absolute pressure to the sensor assembly bellows specified in Table C 1 in the Service Data at the end of the section.
2. Adjust test stand air valve linkage to position the power piston at the rack length specified in Table C 1.
3. Loosen and back off the fuel limit locking nut and the fuel limit nut to the top of shutdown bushing threads.
4. Adjust fuel limit adjusting screw until fuel limit lever is in the horizontal position (determined visually).
5. Adjust fuel limit nut until it just contacts the fuel limit lever.
6. Tighten fuel limit locking nut.
7. Back off fuel limit adjusting screw until fuel limit lever loses contact with the fuel limit nut.
8. Adjust fuel limit adjusting screw until fuel limit lever contacts limit nut and limiter reduces speed 10 to 15 rpm.
9. Slowly adjust test stand air valve linkage to reduce governor speed by 100 rpm.
10. Observe terminal shaft scale. Rack length must be specific value of Table C1 $+0.00'' -0.02''$. If rack length is not within specified tolerance, inspect fuel limiter amplifier piston for leakage.
11. Reduce absolute pressure to 42" Hg.
12. Adjust test stand air valve linkage until full governor speed is obtained.
13. Very slowly adjust test stand air valve linkage to decrease rack length until 10 to 15 rpm speed reduction occurs.
14. Injector rack length must be as specified in Table C2.

If rack is not as specified, loosen fuel limit cam locking screw, Fig. 12-8, slightly, and tilt top of cam toward bellcrank to increase rack length, or away from bellcrank to decrease rack length. Tighten locking screw and repeat Steps 12 and 13.

15. Repeat steps I through 14 until all conditions of Table C I and C2 are met.

SETTING REBALANCER ROCKER ARM STOP SCREW

DESCRIPTION

The rebalancer rocker arm, Fig. 12-11, adjusts the load to the air available for combustion. The setting of the rebalancer rocker arm stop screw determines the balanced injector rack position at the minimum air box pressure required for full load. At air box pressures below that required for full load, the rebalancer rocker arm positions the pilot valve to limit the load in proportion to the available air pressure.

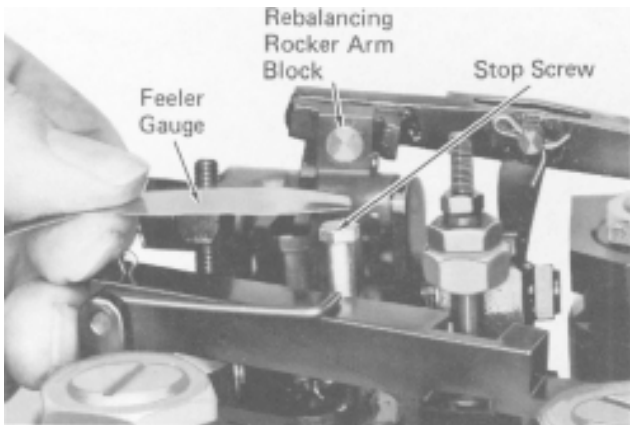


Fig. 12-11 - Rebalancing Stop Screw Adjustment

MAINTENANCE

It is recommended that the governor be placed on a suitable test stand to perform the following maintenance.

1. Loosen the locknut and screw down the rebalancer rocker arm stop screw, Fig. 12-11, to ensure no interference during loading of the governor on the test stand.
2. Operate governor at injector rack length, engine speed, and pressure as shown in Table B. 3. Using a 0.001"-0.002" feeler gauge under the rebalancer rocker arm block, Fig. 12-11, run the

screw up until a drag is felt on the gauge as it is pulled from under the block. Tighten locknut. 4. Check the above setting by reducing the absolute pressure on the sensor assembly bellows by 5" to 6" Hg and then re-establishing the pressure shown in Table B, as in Step

2. Again using 0.001 "-0.002" feeler gauge under the rebalancer rocker arm block, check to see that the same drag is felt on the gauge as in Step 3.

LOAD REGULATOR PILOT VALVE AND ASSOCIATED LINKAGE

DESCRIPTION

The load regulator pilot valve, Fig. 12-12, is a device in the governor for controlling the oil to the vane motor of the load regulator. In addition to this, the load control is also made dependent upon absolute air pressure, since the rebalancer will vary the position of the load control pilot valve in response to variations in engine air box and barometric pressures.

The pilot valve linkage, Fig. 12-12, consists of the rebalancer rocker arm, horizontal floating link, slotted link, eccentric and clevis, the latter being threaded on the pilot valve plunger.

The pilot valve in conjunction with the load regulator requires the engine to assume a predetermined load for each throttle position by controlling the loading of the main generator through the battery field.

The action of the rebalancing linkage is such that the lower set of predetermined load valves is established when the air box pressure falls below the minimum that has been established for full load operation.

Fig. 12-12 shows a partial governor section through the pilot valve and associated parts. When engine output is correct for a certain throttle position, the lands of the pilot valve plunger close ports "B" and "C" in the pilot valve bushing. In this plunger position no oil can flow through the ports to or from the load regulator vane motor. This position is the balanced position of the pilot valve. As shown, lubricating oil under pressure enters the valve at a point between the lands of the plunger and is trapped when the pilot valve is balanced.

When the horsepower demand on the engine is greater or less than the engine is adjusted to develop at a given

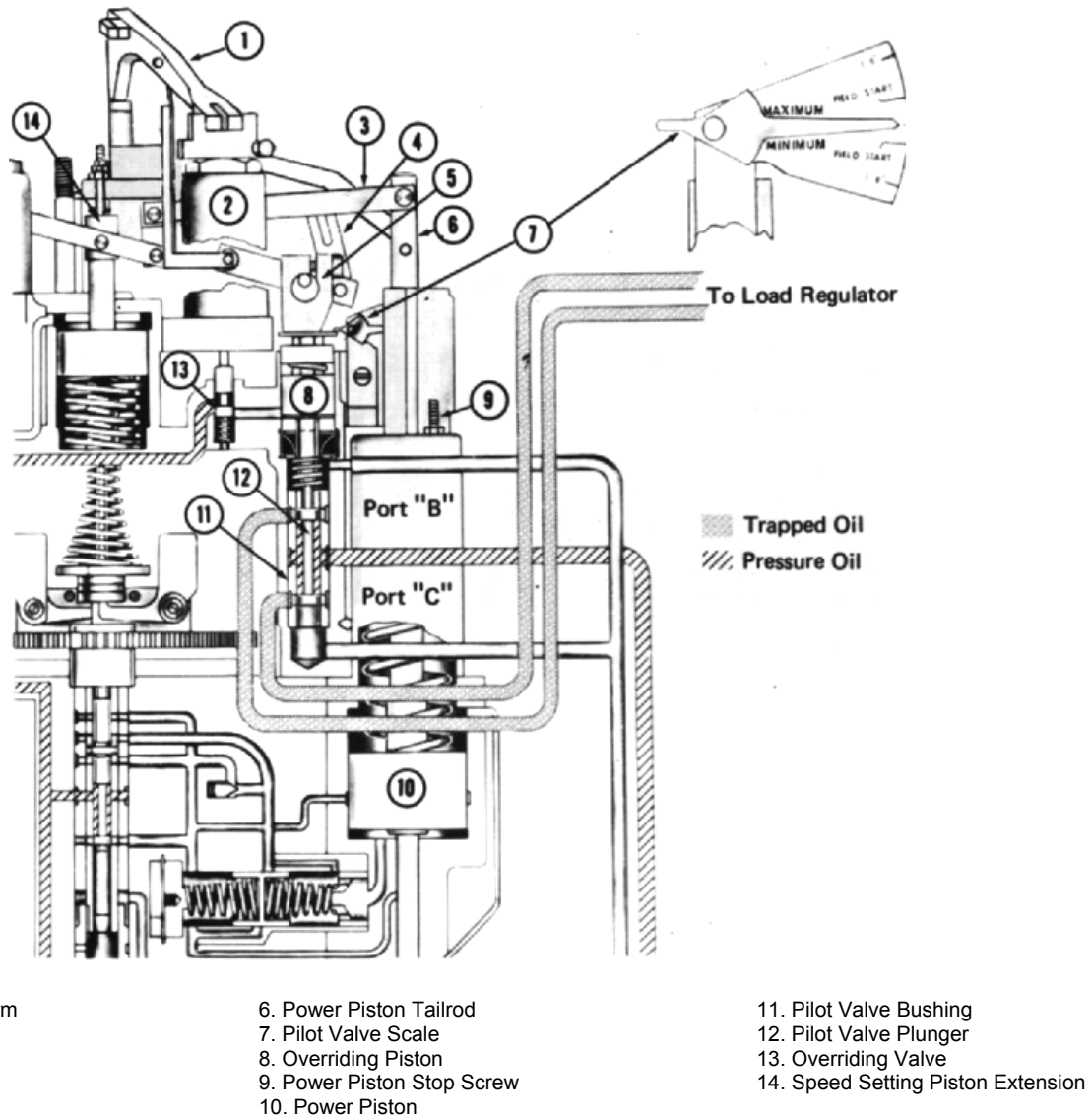


Fig. 12-12 - Load Regulator Pilot Valve, Schematic Diagram

throttle position, a change will be made in the position of the governor power piston to meet the changed horsepower demand. Since the throttle position has not changed, the pilot valve plunger will either be raised or lowered through the movement of the power piston and linkage. This action unbalances the pilot valve and the oil thus permitted to flow causes the load regulator to adjust the generator load to the desired engine output.

If a more than proper load is placed on the engine, the piston will move upward to increase fuel. This action raises the pilot valve plunger, Fig. 12-12, opening port "B" with its upper land. Oil under pressure can then flow through port "B" to the vane motor of the load regulator. This causes the load regulator movement to reduce main generator output. As the vane rotates it pushes oil ahead of it through oil line port "C" of the pilot valve and then

to the engine oil sump. As the load on the engine is reduced, the power piston and pilot valve plunger move down to normal position. The pilot valve plunger again closes both ports "B" and "C."

The operation of the pilot valve for less than proper load on the engine is opposite that given for an overload, again adjusting generator load to permit the engine to assume its proper load for a certain throttle position.

The rate of movement of the vane or brush holder of the load regulator is automatically controlled by orifices and slots in port "C," or lower port of the pilot valve bushings, as oil from the load regulator must return through port "C" when oil to the load regulator leaves through port "B" or when oil to regulator passes through port "C." The slot and orifices in the pilot valve bushing lower port are designed to provide for a

definite rate of load regulator movement.

Normal action of the load regulator pilot valve, as previously described, can be nullified or overridden by energizing the overriding solenoid. This action raises the pilot valve above the normal range of travel determined by the mechanical linkage, causing the load regulator to move toward the minimum field position. When the solenoid is deenergized the pilot valve and load regulator position is again determined by the mechanical linkage. See "Overriding Solenoid."

MAINTENANCE

Is it recommended that the governor be placed on a suitable test stand to perform the following maintenance.

SETTING PILOT VALVE LINKAGE

PREPARATION

Before setting the pilot valve, the speeds, the air pressure sensor assembly, and the rebalancer rocker arm stop screw must be correctly set as previously outlined.

Ensure that terminal shaft scale can travel from 1.96" to .62". If not, loosen rack stop screw locknut and adjust rack stop screw until full range of travel is obtained.

SETTING PROCEDURE

1. Operate the governor on the test stand at full load rack length, engine speed, and pressure on the sensor assembly 1"-2" Hg above that shown in Table B in Service Data at end of section.
2. Pointer on the test stand servo indicator should be balanced at some point well away from either end of its travel with the settings as given in Step 1. If not, loosen the eccentric clevis lock-screw, Fig. 12-13, and using a screwdriver, adjust the eccentric to bring the pilot valve to the balance position. Then tighten the clevis lock-screw. The pointer of the pilot valve scale should be at "0" with pilot valve balanced. If necessary, relocate the scale to position the pointer at "0".
3. Operate the governor test stand to simulate idle engine speed, so that the terminal shaft pointer and the pressure on the sensor assembly are as shown in Table B.

4. Pilot valve scale pointer should be at MAXIMUM FIELD START position. If the pointer is

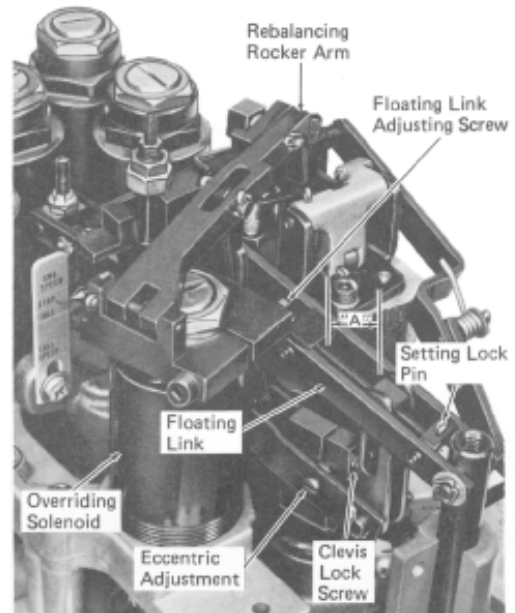


Fig. 12-13 - Pilot Valve Linkage

below the MAXIMUM FIELD START position, remove setting lock pin, Fig. 12-13, and turn floating link adjusting screw to lengthen dimension "A." If above, dimension "A" should be shortened. On this correction, adjust dimension "A" $I / 2$ required, then return to the conditions to set "0" or balance as outlined under Step I.

5. Recheck the settings to conform to conditions given in Steps 1, 2, 3, and 4 to obtain the correct adjustment for full speed conditions and idle speed conditions or readjust the linkage as outlined until correct positions are obtained.
6. Install new setting lock pin.

Once the pilot valve is properly set, it should not be changed to correct engine output until all other conditions are investigated.

OVERRIDING SOLENOID

DESCRIPTION

The overriding solenoid "O", Fig. 12-12, is employed on the governor to override normal action of the pilot valve linkage and move the load regulator in the direction of minimum field. The solenoid is energized by external circuits which may be determined by consulting the specific wiring diagram covering the particular

governor application. When the overriding solenoid is energized, it moves a small cylindrical valve downward, permitting governor accumulator oil pressure to flow under the overriding cylinder piston. This piston moves up carrying the load regulator pilot valve plunger with it. When the solenoid is de-energized, a spring moves the pilot valve back to normal position.

MAINTENANCE

SOLENOID ADJUSTMENT

1. With governor operating at IDLE speed, loosen locknut on overriding solenoid and run the screw down until the load control pilot valve moves up.
2. Carefully back off the screw until pilot valve starts down, then back off screw a full quarter turn more, and lock it.

Improper adjustment of the overriding solenoid may result in a loss of governor accumulator oil pressure. This is caused by the overriding solenoid adjusting screw being backed off too far, allowing its valve to open the supply port, permitting governor oil pressure to be bypassed directly back to the governor oil sump.

In cases where the engine dies in the lower throttle positions, the adjustment of the overriding solenoid should be one of the checks made.

LOW OIL PRESSURE SHUTDOWN

DESCRIPTION

The low oil pressure shutdown device, Fig. 12-14, is an integral part of the governor. The device will respond, by shutting the engine down, when a low oil condition is created. This can be caused by any of the following:

1. A true system low oil pressure.
2. A positive crankcase pressure or a low water supply which, through the low water and crankcase pressure detector, will relieve pressure from the oil pressure line to the governor.
3. Overheated lube oil, which will also relieve oil pressure from the line to the governor through the hot oil detector.

A time delay of approximately 50-60 seconds at idle engine speed is provided before the alarm switch trips and the engine shuts down. This allows operating pressures to be reached after starting engine, and to provide time to locate trouble spot in the event of malfunction. Repeated engine starting to locate cause of shutdown should not be attempted. The time delay is voided above third throttle, and shutdown will occur in approximately two seconds.

Since oil pressure is the lowest at the rear of the engine, an oil line runs from this point to the shutdown device in the governor.

The shutdown device in the governor, Fig. 12-14, consists of an oil failure diaphragm and plunger, time delay accumulator, oil failure piston, ball valve, shutdown rod, and an alarm switch.

Engine pressure oil is admitted to the left of the oil failure diaphragm. A spring also exerts pressure on the left side of the diaphragm. Pressure oil from the governor speed setting piston pushes against the right side of the oil failure diaphragm. The pressure of the oil from the speed setting piston varies with engine speed. The highest pressure is at full engine speed and the lowest is at idle engine speed. If engine oil pressure is reduced below a safe level, the speed setting piston oil pressure will become greater than engine oil pressure and move the oil failure diaphragm and plunger to the left. This permits governor oil pressure to move the shutdown plunger to the right, releasing the trapped oil above the speed setting piston allowing the piston to travel upward. When the piston extension contacts and lifts the shutdown bushing on the governor pilot valve shutdown rod, resultant movement of other governor components places the terminal shaft, injector control lever, and the injector racks in a no fuel position and the engine will shut down.

When the shutdown plunger moves out, an alarm switch is actuated and a colored band is visible on the plunger indicating that the device has been tripped. After being tripped, the plunger must be manually reset to permit the governor to control engine operation. If conditions warrant the engine being shutdown, the action will occur even though the plunger were to be held in manually. When the oil failure piston moves to the right, it contacts the valve pin and unseats a ball valve releasing speed setting piston oil pressure through the ball valve.

The time delay feature of the device is controlled by engine speed. When engine speed is below fourth throttle position, governor pressure oil must pass through a time delay device before reaching the oil

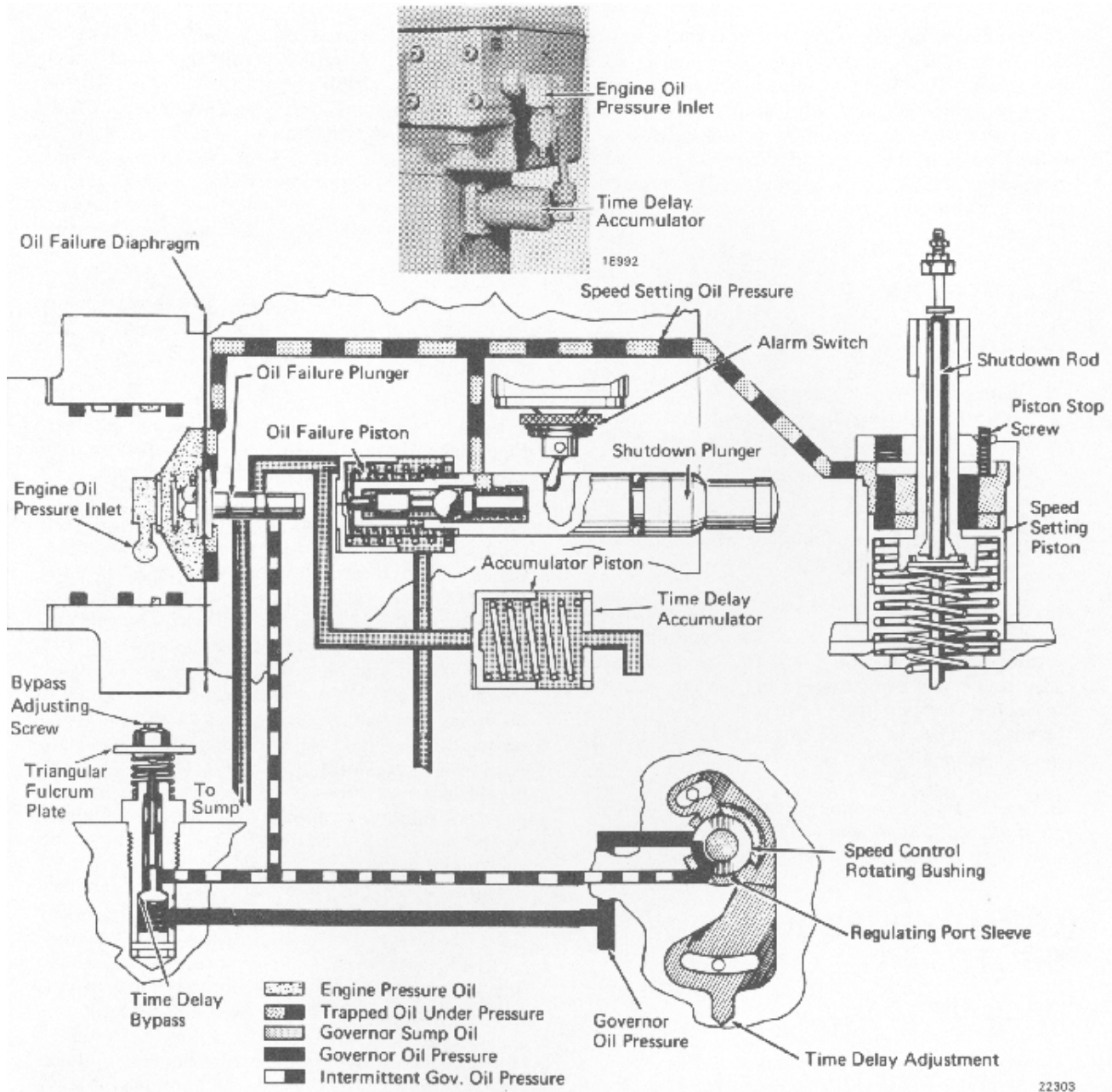


Fig. 12-14 -- Low Oil Pressure Shutdown Device

failure piston. The time delay is brought about by the governor oil passing through an intermittent flow orifice toward the top of the speed control rotating bushing. At each revolution of the bushing, a slot in the bushing aligns with the oil line to the oil failure piston. The amount of oil discharge through the slot is regulated by adjusting the port sleeve. The amount of oil discharged determines the time required to admit a sufficient amount of oil to move the accumulator piston through its full travel and operate the oil failure piston. When engine speed is above third throttle position, the speed solenoids

bearing on the triangular fulcrum plate of the governor, opens the time delay bypass. When the bypass is open, governor oil goes directly to the oil failure piston, and shutdown will occur in about two seconds.

MAINTENANCE

SETTING TIME DELAY BYPASS

1. Operate governor at throttle 2 position with normal oil pressure to governor.

2. Back off several turns on the bypass adjusting screw, Fig. 12-14, located in the triangular plate between the "A," "C," and "D" solenoids.
3. Open lube oil pressure bleed valve and close lube oil pressure supply valve to drop oil pressure to zero as rapidly as possible.

The shutdown plunger should not trip in less than 30 seconds.

4. Turn the bypass adjusting screw in slightly, and repeat steps 1 and 3 until the shutdown plunger trips in 2 seconds or less, after the oil pressure is rapidly dropped to zero.
5. Back out bypass adjusting screw 1/4 to 3/8 of a turn.
6. Repeat step 3 for low idle, idle, and throttle 2 positions. Shutdown should not occur in less than 30 seconds.
7. Repeat step 3 for throttle 4 position. Shutdown must occur within 2 seconds.

SETTING TIME DELAY

1. Operate the governor at idle speed.
2. Open lube oil pressure bleed valve and close lube oil pressure supply valve to drop the oil pressure to zero as rapidly as possible. This should cause the shutdown plunger to trip within 50-60 seconds.
3. If the time delay is not within the 50-60 second limit, adjust the time delay adjustment, Fig. 1214, located under the "A" and "C" solenoids. Movement of the adjustment in the counterclockwise direction increases the time delay.

OIL FILTER

DESCRIPTION

The oil filter, Fig. 12-15, is used on the governor to protect the servo bellows assembly screen and orifice stack. The filter is contained in a housing that is mounted on the side plate.

MAINTENANCE

The design of this filter is such that under normal service it is expected to stay in service without cleaning or other attention. Maintenance may be done at the

annual inspection with other governor work. However, if the sensor assembly bellows operation does not follow air pressure changes

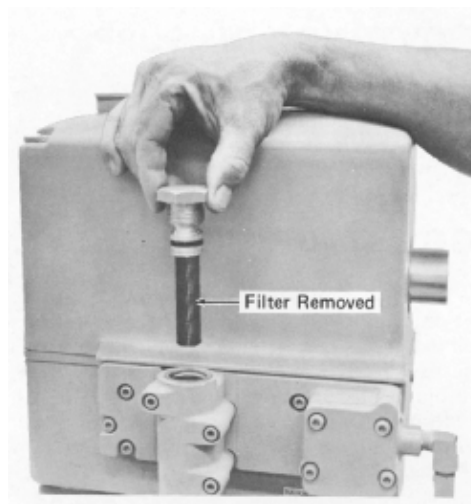


Fig. 12-15 -Oil Filter

closely, the filter should be checked for cleanliness. If required, the filter may be cleaned by washing in solvent.

FLUSHING GOVERNOR

Governor flushing is not recommended as a regular maintenance item. Instead, the governor should be disassembled and cleaned if operation is impaired due to dirt or other foreign particles in the governor. In cases of necessity where the governor is suspected of being dirty and it would not be practical to remove the governor from the engine, it may be flushed on the engine as follows:

1. The engine should be shut down and the drain plug removed from the governor case, or petcock opened. Close valve or replace plug and add two pints of filtered kerosene to governor and start engine. Using the injector control lever, vary the speed of the engine from 400 to 500 RPM, for about five minutes. Shut the engine down and drain kerosene from governor. Repeat this operation several times until the kerosene drained from the governor appears clean.
2. Add two pints of recommended oil to the governor and repeat the above procedure and drain. This will remove any kerosene trapped in the governor.
3. Fill the governor with recommended oil to the proper level and start the engine. Adjust the governor compensation as previously described. The oil level should then be checked and oil added, if necessary.

GOVERNOR OIL SUPPLY

With the engine at idle speed, the governor oil should be maintained at proper level in the sight glass. The vent at the top of the sight glass must be open to ensure correct readings. Governor oil specification is listed on Service Data page.

GOVERNOR STORAGE

When a governor is to be stored, governor oil should be drained. If the governor has been operating with oil that meets specifications, no further treatment is necessary. If governor oil does not meet the recommended specifications, drain and fill with the recommended oil and, if possible operate the governor for several minutes, then again drain the oil.

The recommended oil should be used when the governor is returned to service.

GOVERNOR DRIVE ASSEMBLY

DESCRIPTION

The governor drive assembly, Fig. 12-16, is mounted at the front of the engine on the accessory drive cover adjacent to the water pumps. The governor is mounted on the housing and driven through the 90° bevel gear drive. The serrated end of the drive shaft is mated into a drive plate on the governor drive gear in the accessory gear train. Lubrication of the governor drive bearings is provided through drilled passages in the drive housing.

A cover having a removable plug, is provided on the housing so that a tachometer adapter, Fig. 12-16, can be inserted in the drive shaft end. The adapter end is inserted into a reamed hole in the end of the governor drive shaft and has a friction fit.

MAINTENANCE

The governor drive assembly normally does not require servicing except at the time of general engine

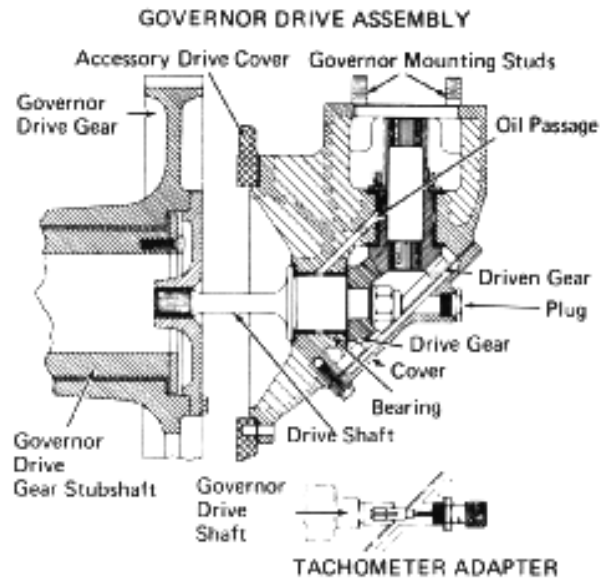


Fig. 12-16 - Governor Drive Application

overhaul or reconditioning. At this time or when conditions warrant, the governor drive assembly should be removed and parts inspected and checked. After removal of the governor, the governor drive assembly can be easily removed. A mounting dowel correctly positions the governor drive housing on the accessory drive cover.

After the governor drive assembly has been removed and disassembled, visually inspect the bushing bores and thrust faces for flaking, imbedded dirt, chipping, or scoring. Bushings that are chipped or flaked or have large quantities of imbedded dirt should be replaced with new bushings. Check oil passages in the housing to be sure they are free of restrictions. Inspect bevel gears for nicks, pitting, or visible wear on the loaded tooth faces. Nicks, burrs, or any high spots should be stoned out or the gears replaced. If it is necessary to replace a gear, it is recommended that both gears be replaced as a set. Check individual parts and assembly to be sure dimensions are within limits given in Service Data.



SERVICE DATA GOVERNOR

PGR GOVERNOR SETTING AND ADJUSTMENT TABLES

SPEED SETTINGS -- TABLE A

Adjustment Sequence	Adjust	Throttle Position	Speed (RPM)		Solenoid Energized			
			Eng.	Gov.	A	B	C	D
14	C	STOP						
5	A	LOW IDLE	255±4	278±4				"
		IDLE	318±4	347±4	*			*
		1	318±4	347±4				
		2	388±15	423±15	*			
		3	497±15	542±15				*
3	B	4	570±4	621±4	*			*
		5	566±15	714±15	*	*	*	
1	FULCRUM NUT	6	730±4	796±4	*	*	*	*
		7	829±15	904±15				* *
2	D	8	904±4	985±4	*	*	*	

+If governor is being adjusted on a locomotive without a low idle panel, place throttle to position 2 and adjust "C" solenoid to obtain throttle 2 engine RPM.

NOTE: Governor PRM is provided for use with test stands calibrated in governor speeds instead of engine speeds.

PILOT VALVE
TABLE B

Governor	Throttle Position	Injector Rack Length In.	Pilot Valve Position	Air Pressure H mm	g Abs. In.
8483536	8 Idle	.83 1.75	Balance Max. Fld.	1460 Atmospheric	57.5 Atmospheric
9322619	8 Idle	.87 1.75	Balance Max. Fld.	1575 Atmospheric	62.0 Atmospheric

**FUEL LIMITER
TABLE C1**

Governor	Throttle Position	Engine Speed	Absolute Pressure		Limiting Point In.
			mm Hg	In. Hg	
8483536	8	904±4	1460	57.5	.75
9322619	8	904±4	1575	62.0	.79

TABLE C2

8483536	8	904±4	1067	42.0	.96±.02
9322619	8	904±4	1067	42.0	1.02±.02

SPECIFICATIONS

Clearance and dimensional limits listed below are defined as follows:

1. New limits are those to which new parts are manufactured. (Drawing tolerances.)
2. Minimum, maximum, and tolerance measurements are provided as service limits. At time of rebuild or any time unscheduled maintenance is performed, the service limits should not be exceeded. Engine components within these limits may be reused with the assurance that they will perform satisfactorily until the next scheduled overhaul.

GOVERNOR DRIVE ASSEMBLY

Bushing bore diameter (as assembled in housing) - Max.	47.739 mm (1.8795")
Distance between bushing thrust faces - Min.	47.42 mm (1.867")
Diameter of drive shaft journal - Min.	47.536 mm (1.8715")
Governor drive shaft thrust face to shoulder - Max.	47.73 mm (1.879")
Driven gear thrust face to shoulder - Max.	47.78 mm (1.881 ")
Diameter of driven shaft journal - Min.	47.536 mm (1.8715")
Bevel gear backlash - Max.	0.33 mm (.013")
Thrust clearance	Limit is governed by gear backlash

EQUIPMENT LIST

	<u>Part No.</u>
Hand tachometer (Mechanical)	8107967
Controller adapter (use with 8227463 and 8469431)	8210156
Tachometer drive adapter	8210556
Rotary shaft bearing remover-installer	8225658
Rotary shaft oil seal driving rod	8225659
Rotary shaft oil seal remover	8225660
Engine speed controller (use with 8210156 and 8469431)	8227463
Solenoid adjustment wrench (PGR)	8343447
Governor adapter (use with 8210156 and 8227463)	8469431
Hand tachometer (Digital)	9319424

MATERIAL SPECIFICATIONS

Governor oil	M.1. 1764
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