SECTION XI

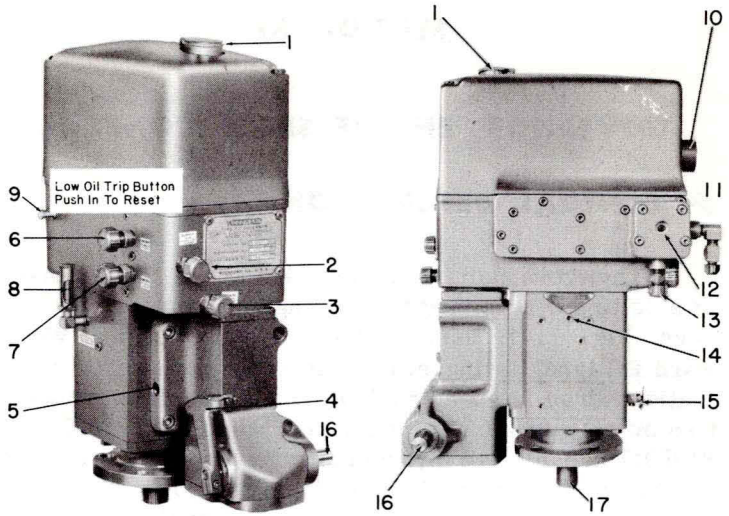
GOVERNOR, ENGINE SPEED CONTROL

A. GENERAL DESCRIPTION

The governor maintains the speed of the engine at a setting determined by the engine operator. Governors, Fig. 11-1, used on the 567C engines are Woodward PG type, having either electro-hydraulic or pneumatic-hydraulic speed control. Each governor is identified by a separate part number. Numbers 8216206 and 8195017 are electro-hydraulic governors while 8200426 is a pneumatic-hydraulic speed control governor. Each governor may be set to maintain the engine speed desired for 800 RPM or 835 RPM full speed. To aid in correct governor installation, separate inserts (see Table B, page 1119) are applied to each governor name plate which identifies the speed setting of the governor and the proper full load injector rack length. Fig. 11-2, shows a cross-section of the electro-hydraulic speed control governor.

Main parts 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, buffer piston and springs), and an independent oil system (oil sump, oil pump, accumulators and connecting passages).

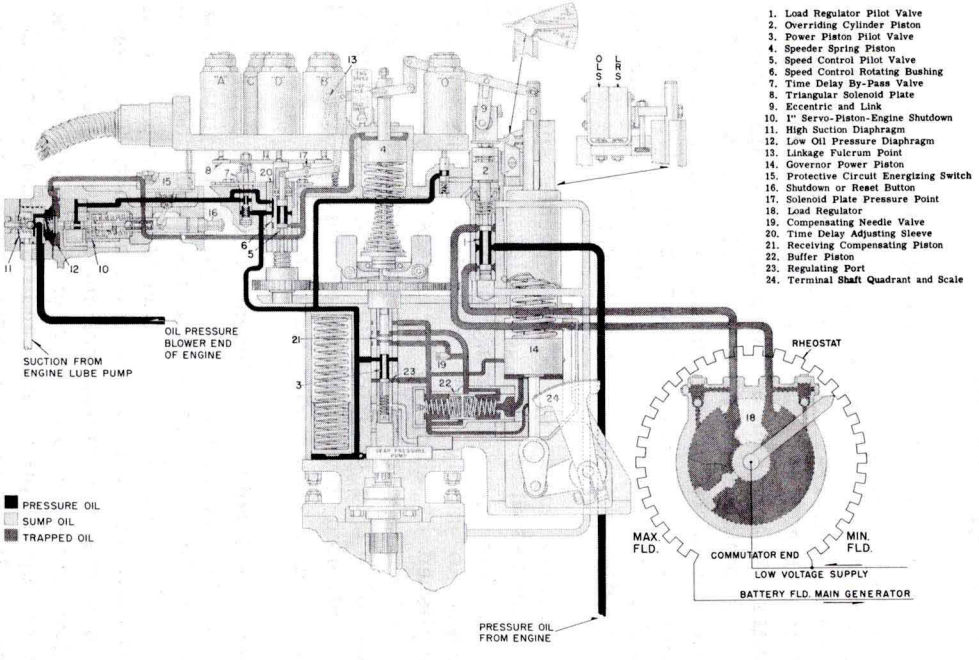
Engine auxiliary devices are a part of the governor, such as: load regulator pilot valve, ORS solenoid used with load regulator pilot valve over-riding piston, LRS and OLS switches, engine low oil pressure and high lube oil pump suction shutdown, as shown in Fig. 11-2.



Front Back

1. Oil filler opening
2. Pilot valve engine oil supply
3. Pilot valve oil drain
4. Injector rack length scale quadrant
5. Compensating adjusting screw location
6. Vane motor oil line connection; decrease exitation
7. Vane motor oil line connection; increase exitation
8. Governor oil level sight glass
9. Low oil pressure and high suction shutdown rod
10. Electrical plug receptacle
11. Engine oil pressure connection
12. Engine oil pump high suction plunger
13. Engine oil pump suction connection
14. Vent plug location
15. Governor oil drain
16. Rotary terminal shaft, fuel control
17. Governor drive shaft

Rotary Shaft Electro-Hydraulic Governor
Fig. 11-1



Schematic of Rotary Shaft PG Governor with Electro-Hydraulic Speed Control
Fig. 11-2

B. DESCRIPTION

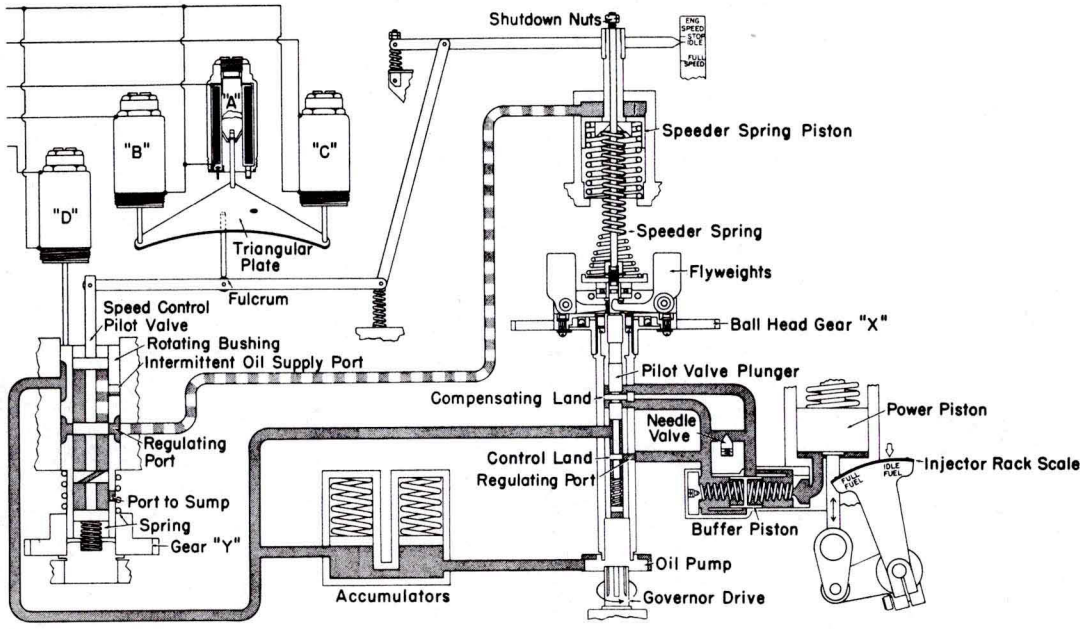
1. Electro-Hydraulic Speed Control

Speed setting with the electro-hydraulic governor is accomplished in steps by energizing different combinations of four solenoids, "A," "B," "C," and "D" shown in Fig. 11-2 and in the schematic operating diagram, Fig. 11-3. 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 speeder spring piston position must be changed to satisfy these conditions. This is accomplished by admitting or releasing governor oil above the speeder spring piston. Admission or release of oil to or from the speeder spring piston is controlled by the solenoids through the speed control pilot valve and rotating bushing.

When a solenoid or different combinations of "A," "B" or "C" solenoids are energized, the triangular plate is forced down a distance depending on the solenoids energized. This causes the speed control pilot valve to go down a certain amount. The regulating port in the rotating bushing is uncovered, permitting governor oil under pressure to force the speeder spring piston down and compress the speeder spring. As the speeder spring piston moves downward, the linkage raises the speed control pilot valve to again close the regulating port when the desired piston position has been reached.

Compression of the speeder spring forces the flyweights in, allowing the governor pilot valve plunger



Schematic Operating Diagram Electro-Hydraulic Governor
Fig. 11-3

to lower and permit oil to raise the power piston to increase fuel to the engine. Unbalanced oil pressure on the compensating land of the pilot valve plunger closes the regulating port when the power piston has been raised enough for the desired speed. When the new engine speed is reached the flyweights will return to balance position against speeder spring pressure.

When a solenoid or a combination of "A," "B" or "C" solenoids are de-energized, the triangular plate will rise, and the speed control pilot valve will also be moved upward. Since the pilot valve is raised, oil above the speeder spring piston drains through the regulating port to the oil sump. The speeder spring piston is raised by its spring. As the piston moves up, the connecting linkage causes the speed control pilot valve to move down and close the regulating port when the desired piston position is reached.

Since the speeder spring piston was raised, speeder spring compression is lessened. The flyweights will move outward under centrifugal force to lift the governor pilot valve. Oil will then be released from under the power piston and it will move downward to decrease fuel supply and engine speed.

Energizing the "D" solenoid in combination with other solenoids lessens their effect on engine speed, since the "D" solenoid pushes down the rotating bushing and lowers the regulating port. When only the "D" solenoid is energized it opens the regulating port in the rotating bushing to sump, permitting oil above the speeder spring piston to be released. The piston then raises and its extension lifts the shutdown nuts and rod, causing the governor to shut off the engine fuel supply.

Note that oil enters the speed control rotating bushing through an intermittant supply port. This port is of such size to allow the speeder spring piston to move full stroke in a specified time. Consequently, speed increase is controlled under all conditions of operation.

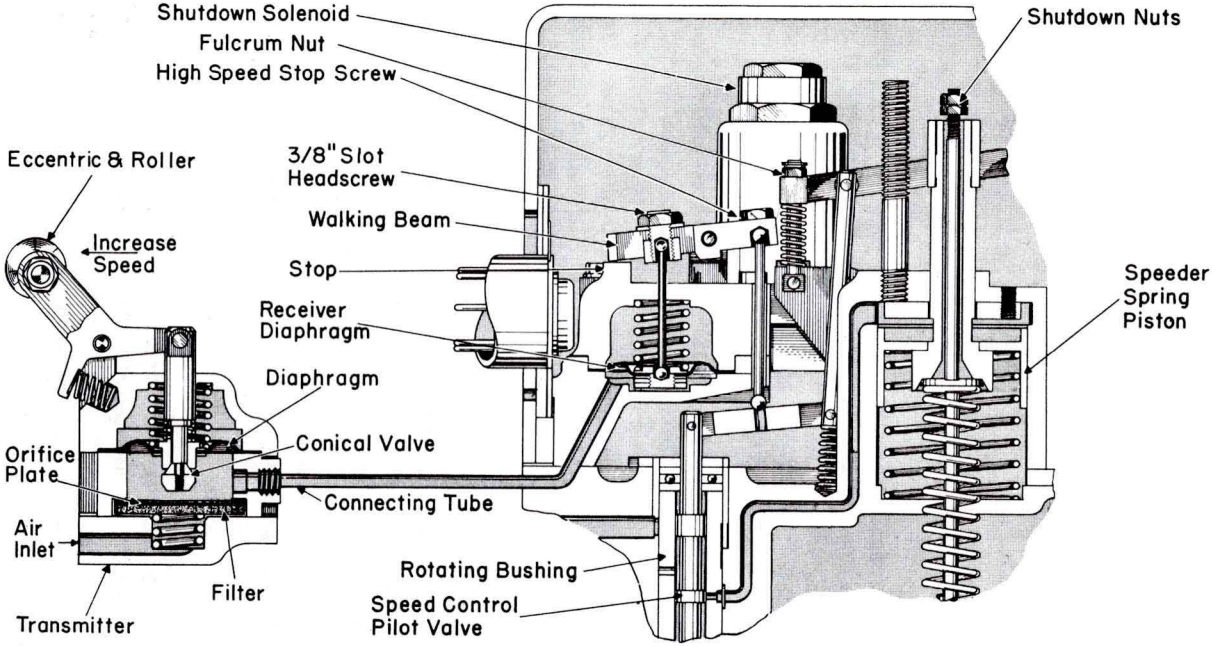
2. Pneumatic-Hydraulic Speed Control

Speed control with the pneumatic-hydraulic governor consists of a transmitter and a receiver which, through linkage, raises or lowers the speed control pilot valve which is identical in operation as used in the electro-hydraulic governor.

The transmitter, Fig. 11-4, is located at the control station. It is actuated through the throttle lever, shaft, and cam. As shown, it consists of a spring loaded diaphragm and tapered seat valve. Inlet air is supplied the transmitter through a sintered filter and inlet orifice to give a constant supply of air.

The air supplied through the orifice causes the pressure to raise until the air pressure against the diaphragm balances spring tension, at which time the conical valve is unseated and the air bleeds off to maintain constant pressure. There should be a continuous discharge of air around the transmitter stem except during an increase in speed. Varying the diaphragm spring tension, through the throttle and cam, varies the air pressure in the transmitter.

The transmitter air pressure is piped directly to the receiver, located in the governor, Fig. 11-4, and exerts its pressure against the receiver diaphragm. As the air pressure is varied in the transmitter, it is also varied in the receiver.



Pneumatic-Hydraulic Speed Control
Fig. 11-4

The diaphragm responds to the varied pressure and moves the speed control pilot valve linkage to raise or lower the speed control pilot valve, operation of of which is identical as in the electro-hydraulic governor.

3. Governor Controls

a. Oil Supply

The governors have a self-contained 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.

b. Speed Control Column

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 cylinders must be varied. This is determined by the position of the power piston. See Fig. 11-5. To move the power piston, the tension 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.

c. Power Piston

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

d. Compensating Mechanism

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 on PG type governors, Fig. 11-5.

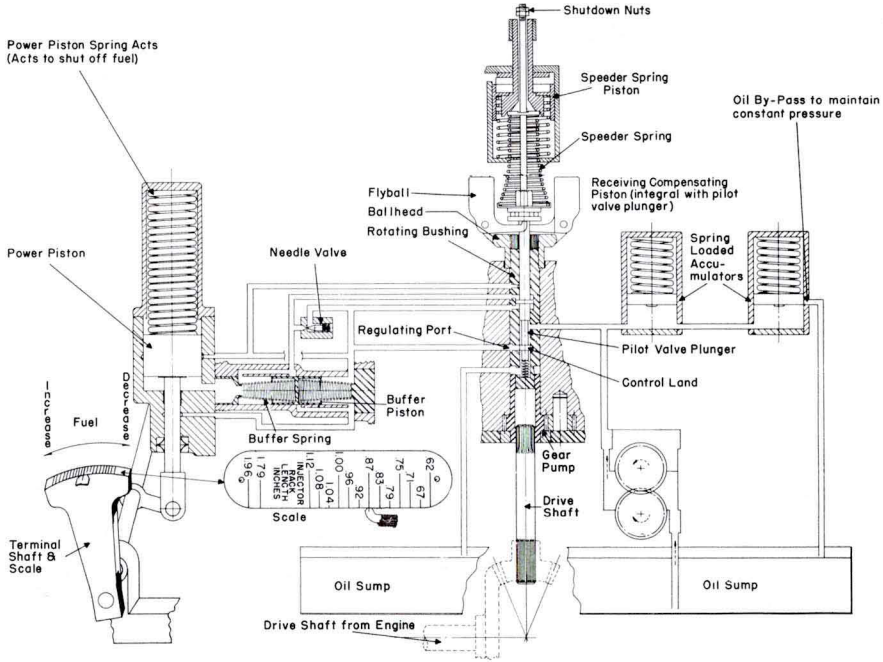
e. Fuel Control

Fig. 11-5 illustrates the operation of the fuel control portion of the PG governor. The power piston spring acts to shut off fuel to the engine. Oil pressure is used only to increase the supply of fuel to the engine.

The governor drive shaft, pump, rotating bushing and flyballs rotate together. Two accumulators are provided for governor pressure oil storage capacity; the maximum pressure of governor oil is regulated by a by-pass in one of them. A buffer piston centered by springs is in the hydraulic circuit between the pilot valve plunger and the power piston. It is by-passed by the needle valve, and also by passages which are uncovered when it moves more than 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.

(1) Load Decreased or Throttle Decreased

As shown in schematic diagram, Fig. 11-5, the engine is running normally under steady load and at constant speed. The flyballs, pilot valve plunger and buffer piston are in normal positions. The control land on pilot valve plunger covers the regulating port holes in the rotating bushing. The power piston is stationary.



Schematic Diagram PG Governor
Fig. 11-5

Assume that the engine load is decreased, thus increasing the speed. As the speed increases, the flyballs 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 right of the buffer piston; it moves to the right, and the power piston moves down. It is apparant 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 plunger, and since the higher pressure is above this piston, it is forced downward, so that the land of the pilot valve plunger starts to close the ports and stop the power piston movement. The governor is so designed that this action will stop 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 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 flyballs has been reduced until it is balanced by the speeder spring.

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.

(2) 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 just the reverse of those described above, as follows: The decrease in speed will cause the fly-balls 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 results in a higher pressure on the right-hand side of the buffer plunger and on the under side 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 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.

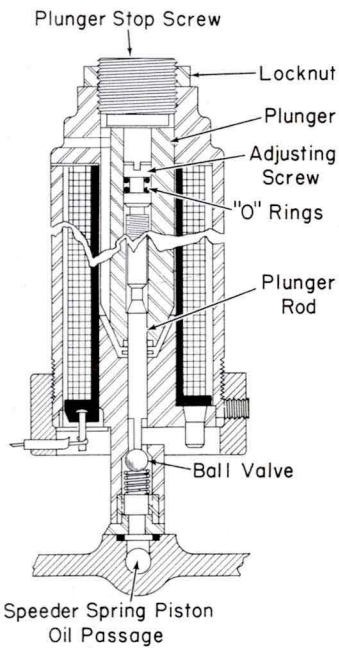
In the foregoing description, speed changes as a result of load changes have been considered. Similar governor movements occur when a difference between actual governor speed and governor speed setting is produced by changing speeder spring tension through the speed adjusting control particular to the type of speed 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.

4. Engine Shutdown (Adjustments Given Under Maintenance)

a. Electro-Hydraulic Governor

Engine shutdown can normally be accomplished by depressing the "STOP" button or by placing the throttle in the "STOP" position. Either action will energize the "D" solenoid. 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 nuts on the shutdown rod, lifting the power piston pilot valve up, which action drains the oil from under the governor power piston, causing the power piston to turn the rotary shaft and bring the injectors to "no fuel" position.



Shutdown Solenoid Pneumatic-Hydraulic Governor
Fig. 11-6

b. Pneumatic-Hydraulic Governor

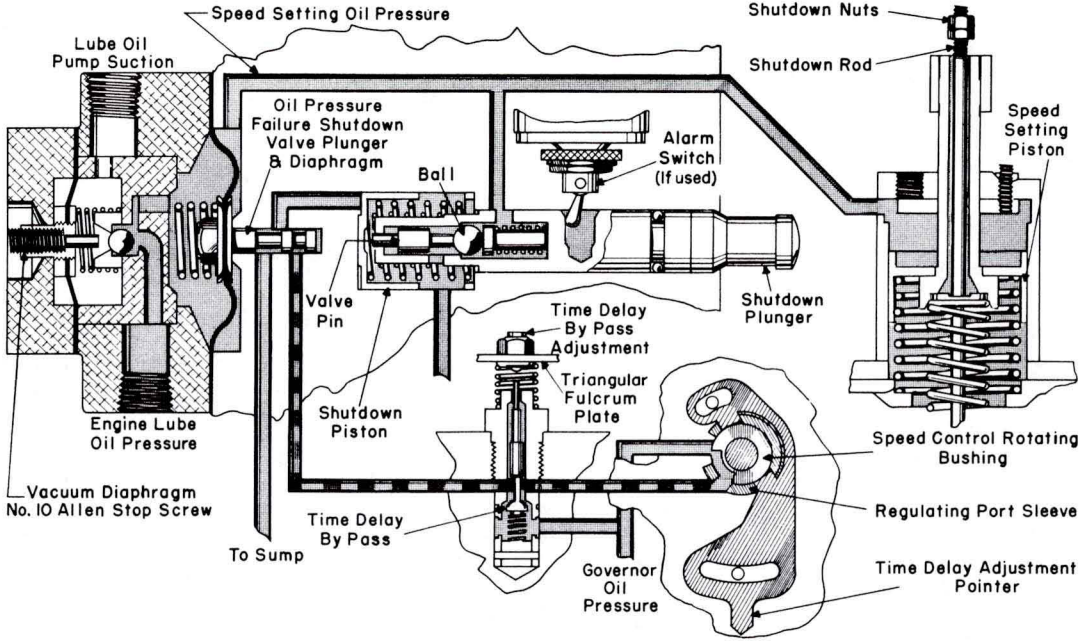
On engines equipped with pneumatic-hydraulic governors, shutdown of the engine is accomplished by releasing the throttle to "Stop" position, which action completes a circuit to the shutdown solenoid shown in Fig. 11-6. Energizing the shutdown solenoid moves its plunger downward to open a valve in the oil line from the speeder spring piston, to the governor sump. The oil released above the speeder spring piston allows the piston to move upward, its extension contacting the shutdown nuts, Fig. 11-4, and bringing about engine shutdown as with the electro-hydraulic governor.

5. Low Oil Pressure and High Oil Pump Suction Shutdown

The electro-hydraulic and pneumatic-hydraulic governors have as a part of each governor an oil failure alarm system which in the event of low oil pressure or high oil pump suction, shuts the engine down and operates the low oil pressure alarm switch. Do not start engine until trouble is corrected, if engine dies on start after resetting governor shutdown rod. See Section 8, Possible Lube Oil Troubles.

As shown in Fig. 11-7, this feature consists of oil pump suction diaphragm, with adjusting screw, lube oil diaphragm and plunger, shutdown piston, two ball check valves, shutdown alarm rod and alarm circuit switch.

The area to the right of the suction diaphragm is connected to the lube oil pump suction. Oil pressure from the blower oil supply is admitted to the left of the lube oil diaphragm. On the right side of the lube oil diaphragm is oil under pressure from the governor speeder spring piston. Governor oil



Low Oil Pressure Shutdown
Fig. 11-7

flowing through a milled passage in the outer circumference of the speed control rotating bushing, every revolution of the bushing, operates the shutdown piston in the event of low oil pressure or high pump suction when the engine is at idle. This oil admittance is adjustable through the speed control rotating bushing ports, by rotating the port sleeve, to give greater or less admittance of oil, thus regulating the time interval until sufficient oil is available to operate the shutdown piston. This gives the time delay necessary for building up oil pressure when starting the engine and is adjusted to operate after approximately 40 seconds with engine at idle position. At the third throttle position or higher, a time delay by-pass is opened to nullify the delay period and the engine will shut down in two seconds, should engine oil pressure fail or high lube oil pump suction exist. This safety feature differs in the electro-hydraulic and pneumatic-hydraulic governors only in the actuation of the time delay by-pass and its setting. The operation is identical for both governors.

6. Overriding Solenoid

The overriding solenoid "O" Fig. 11-2, is employed on the electro-hydraulic and pneumatic-hydraulic governors (if used) to position the load regulator in the minimum field position. 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, Item 2. 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. Adjustment of the ORS solenoid is given under Maintenance, Item 7.

7. LRS and OLS Switches

The twelve point electrical receptacle used on the 567C engine governors, provide for separate circuits to accommodate the LRS (when used) and OLS switches, as well as the low oil pressure switch and governor solenoids. Both the LRS and OLS switches are contained in a bracket mounted on the electrical equipment base near the ORS solenoid and adjacent the power piston tailrod, Fig. 11-12.

Both switches protect against overload and are actuated by a bar with adjusting screw, attached to the upper end of the power piston tailrod. When the injector rack length is one scale dimension ($\pm$ 1/2 division) less than the full load rack setting of the engine the LRS switch is closed. Closing of the LRS switch voids supplemental circuits used in conjunction with the load regulator, permitting full load regulator control. If the injector rack length reaches .67", the OLS switch is closed, which energizes the ORS solenoid, causing the load regulator to move toward minimum field to reduce load on the engine. Setting of these switches is given under Maintenance, Item 6.

C. MAINTENANCE

1. Setting Governer for Engine Speeds

The 567C engine governors, electro-hydraulic or pneumatic-hydraulic, are set for 275 RPM idle engine speed and either 800 RPM or 835 RPM full engine

speed depending on application. Corresponding speeds for each throttle position are shown in Table A, "Engine Governor Speed Setting." (Some conversion engines are set at 300 RPM idle speed and throttle step speeds vary from those shown. Speed settings on these engines are outlined separately under 1-b.)

A system of identification is used on the governors, since their use and settings vary. The type of governor and its part number are located on the name plate. The part number identifies the type of load control pilot valve bushing in the governor as well as the speed control. Governors 8195017 electro-hydraulic and 8200426 pneumatic-hydraulic have a five port wide slot pilot valve bushing, whereas governor 8216206, electro-hydraulic has the conventional five port narrow slot bushing which gives different load regulator timing. (See * under Table B).

In addition each governor has an insert, Fig. 11-8, applied to the name plate. Marked on the insert is the full speed which the governor is set to maintain and the full load injector rack length of the engine on which the governor is to be used. There is one of these inserts for each full load injector rack setting and full engine speed which may be used. If governor is applied to another engine installation and reset to a different full speed or to one which has a

TABLE A

ENGINE GOVERNOR SPEED SETTINGS

Throttle Position	Governor Speed RPM Min.	Max.	Solenoid Energized A	B	C	D	Governor Speed RPM Min.	Max.	Adjustment Solenoid	Sequence
Stop						*				
Idle	275	283					275	283	"C"	5
1	275	283					275	283		
2	344	374	*				339	369		
3	424	454			*		414	444		
4	515	523	*		*		500	508	"B"	4
5	584	614		*	*	*	564	594		
6	675	683	*	*	*	*	650	658	Fulcrum Nut	1
7	755	763		*	*		725	733	"A"	3
8	835	843	*	*	*		800	808	"D"	2

TABLE B

567C Engine Governor Applications

Loco.	Engine HP ø	Full Engine R.P.M.	Full Load Inj. Rack	Current E-H	Gov. No. P-H	Name Plate Insert	Type * Pilot Valve	Fuel ** Injector	Replaces Governor
F9	1750	835	.96	8216206		8218698	NS	HO	8206333 8195017
FP9	1750	835	.96	8216206		8218698	NS	HO	8206333 8195017
GP9	1750	835	.96	8216206		8218698	NS	HO	8206333 8195017
SD9	1750	835	.96	8195017		8218698	WS	HO	8206333
E9	1200	800	.83	8216206		8211843	NS	STD	8208845 8195017
SW1200	1200	800	.83		8200426	8211843	WS	STD	
SW1200-MU	1200	800	.83	8195017		8211843	WS	STD	8208845
SW900	900	835	.92		8200426	8211840	WS	HO	8206334
SW900-MU	900	835	.92	8195017		8211840	WS	HO	8206333
SW600	600	800	.83		8200426	8211843	WS	STD	
SW600-MU	600	800	.83	8195017		8211843	WS	STD	8208845
Conv.	1750	835	.96	8216206		8218698	NS	HO	
Conv.	1600	835	1.00	8216206		8219317	NS	HO	
Conv.	1500	800	.87	8216206		8211841	NS	STD	
Conv.	1500	835	.92	8216206		8211840	NS	STD	
Conv.	660	800	1.00	8200426		8211842	WS	STD	
LWT12	1200	835	.87	8216206		8232688	NS	STD	

Replacement 567C Engines or Governors Operating at Replaced Engine Horsepower

SW	600	800	.83		8200426	8211843	WS	STD	
SW-MU	600	800	.83	8195017		8211843	WS	STD	
SW	1000	800	1.00		8200426	8211842	WS	STD	
SW-MU	1000	800	1.00	8195017		8211842	WS	STD	
Pass.	1000	800	1.00	8216206		8211842	NS	STD	
Pass.	1125	800	.87	8216206		8211841	NS	STD	
SW	1200	800	.83		8200426	8211843	WS	STD	
SW-MU	1200	800	.83	8195017		8211843	WS	STD	
Frt.	1350	800	1.00	8216206		8211842	NS	STD	
Frt.-Pass.	1500	800	.87	8216206		8211841	NS	STD	
BL	1500	800	.87		8200426	8211841	WS	STD	
SD7	1500	800	.87	8195017		8211841	WS	STD	

different full load injector rack length, the insert having the correct information should be applied to the governor. Application of the governors and the respective insert used is shown in Table B.

a. Electro-Hydraulic Governor

Due to the difference in expansion between the metals in the governor, no attempt should be made to accurately set the engine speeds until the temperature of the metal has equalized.

Use a tachometer applied either to governor drive or front camshaft. A special solenoid adjustment

TABLE B (Cont'd)

Export 567C Engines

Engine H.P. ø	Full Engine R.P.M.	Full Load Inj. Rack	Current E-H	Gov. No. P-H	Name Plate Insert	Type * Pilot Valve	Fuel ** Injector	Main Gen.
650	835	.92	8195017		8211840	WS	HO	D15
875	835	.92	8216206		8211840	NS	HO	D15
1125	800	.87	8216206		8211841	NS	STD	D15
1125	835	1.04	8240871		8219318	NSX	HO	D15
1310	835	.92	8240871		8211840	NSX	HO	D12
1500	800	.87	8216206		8211841	NS	STD	D12
1500	835	1.04	8216206		8219318	NS	HO	D12
1600	835	1.00	8216206		8219317	NS	HO	D12
1750	835	.92	8216206		8211840	NS	HO	D12

ø - represents engine horsepower into the main generator.

567C type electro-hydraulic governors ordered separately are set for 835 RPM and .96" injector rack setting and pneumatic-hydraulic governors are set for 800 RPM and .83" injector rack setting unless the purchase order specifically requests a different setting.

*NS - represents pilot valve plunger #8113805 and bushing #8146495 five port (narrow slot) which permits load regulator timing of 23 to 33 seconds from minimum field position to maximum field position and 6 to 10 seconds from maximum to minimum field position. (NSX = Min. to Max. 30 sec., Max. to Min. 15 sec.)

WS - represents pilot valve plunger #8188851 and bushing #8191874 five port (Wide slot) which permits load regulator timing 6 to 10 seconds from minimum field position to maximum field position, and 23 to 33 seconds from maximum to minimum; and approximately 6 seconds from maximum to minimum field position when ORS solenoid is energized.

**HO - represents high output injector #5228230.

STD - represents standard injector #5227852.

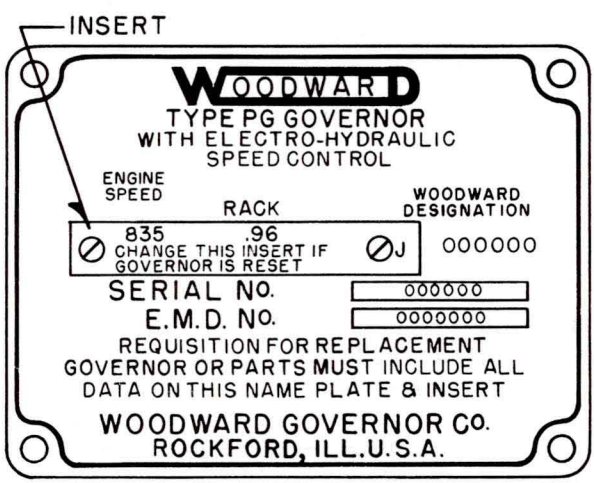
wrench 8174868 is available to facilitate speed setting. This tool provides for holding the solenoid case while making locknut and stop screw adjustments.

Portable engine speed controller 8227463 with plug adapter #8210256 can be used to set engine speeds. This controller can be located close to the governor and current supply taken from a low voltage outlet receptacle. Adapter 8210256 must be used since the 567C engine governor has a 12 point plug, whereas the controller has an 8 point plug. (When a 567C engine is replaced by a 567B engine, permanent governor adapter #8210938

is used to connect the governor to the locomotive governor plug.)

The speeds given in the following Items 2 through 6 cover governors set for full speed of 835-843 RPM. The same procedure is used to set the governor for 800-808 full speed engines except speeds should be, 650-658, 800-808, 725-733, 500-508 and 275-283 RPM for throttle positions #6, 8, 7, 4 and 1 respectively. Speed settings for 300 RPM idle speed engines are given under b, Special Engine Speed Settings.

(1) Be sure necessary precautions are taken so the generator on the unit being worked on will not supply power. The portable controller 8227463 above can be connected directly to the governor, however, if the throttle is used on a multiple engine consist then the isolation switches on the other units must be placed in the "Start" position while the unit worked on is in the "Run" position.

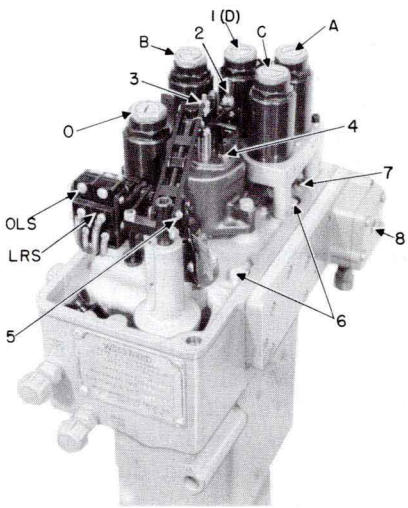


Governor Name Plate Insert
Fig. 11-8

(2) Set the throttle in #6 position and bring engine speed to 675-683 RPM by adjusting fulcrum nut, Fig. 11-9, Item 2, at the end of the linkage. Raising the fulcrum nut increases speed.

(3) Set the throttle to #8 position and bring engine speed to 835-843 RPM by adjusting the "D" solenoid stop screw, Item 1. Back off stop screw to increase speed.

(4) With the throttle in #7 position, adjust the "A" solenoid stop screw for 755-763 RPM. Turn stop screw in to increase speed.



1. D VALVE
2. FULCRUM NUT
3. SHUTDOWN NUTS
4. SPEEDER SPRING PISTON STOP SCREW
5. POWER PISTON TO FLOATING LINK PIN
6. CONTROL COLUMN HOLDING BOLTS
7. TIME DELAY ADJUSTMENT POINTER
8. HIGH LUBE OIL SUCTION

A. A VALVE
B. B VALVE
C. C VALVE
D. D VALVE

0. OVERRIDING SOLENOID

Speed Control - Electro-Hydraulic Governors
Fig. 11-9

(5) Set throttle in #4 position and bring engine speed to 515-523 RPM by adjusting "B" solenoid stop screw. Turning in increases engine speed.

(6) With throttle at idle adjust "C" solenoid to give 275-283 RPM engine speed. Turn screw in to increase speed.

(7) Check above settings and, if correct, all other speeds will be within limits, with all solenoids set. Check engine speed at all throttle positions. Speeds at intermediate throttle positions must be within limits as shown in speed chart.

(8) Also, the speed pointer should be observed to register at correct speed on the speed scale when setting engine speeds at idle and full speed. If not, scale must be relocated or remarked so pointer and scale correspond at idle and full speed. (If speed scale is altered, check pilot valve setting.)

b. Special Engine Speed Settings

Some 567C engines in repowered locomotives other than original EMD manufacture, are set to run at 300 RPM idle speed. Also, these engines operate at different speeds for corresponding throttle positions compared to other engines. For identification the wiring diagrams of these locomotives list their specific speeds.

To set speeds on these engines the same general procedure is followed as outlined under a, Items (1) through (8). However, the speeds for each throttle adjustment position should be: #6-660 RPM, #8-835 RPM, #7-775 RPM, #4-520 RPM and #1 or idle speed 300 RPM. These settings should give the following speeds in revolutions per minute at corresponding throttle positions: #1-300, #2-360, #3-460, #4-520, #5-600, #6-660, #7-775 and #8-835 RPM.

c. Pneumatic-Hydraulic Governor

On engines equipped with pneumatic-hydraulic governors, the engine is adjusted for idle speed and full speed as follows:

(1) Release the throttle from "Stop" position to "Idle" position.

(2) Connect air pressure gauge in air line from transmitter in the control stand to receiver of the governor. (The gauge may be fitted so as to be connected between the air line and the governor, at the governor.)

At Control Stand

(3) With throttle in idle, adjust eccentric on transmitter, Fig. 11-4, to give 14 p.s.i. on air gauge.

(4) With throttle in full speed position check air pressure on gauge. The air pressure should be greater than 28 p.s.i.

At The Governor

(5) Start the engine, controlling speed with the layshaft lever. No air pressure is necessary. Set engine speed at 275-283 RPM by adjusting fulcrum nut, Item 6, Fig. 11-10. (Be sure shutdown solenoid is not bottomed, see adjusting solenoids for shutdown.)

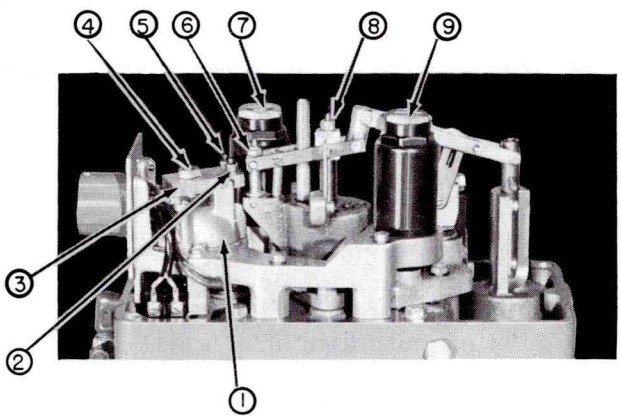
The end of the walking beam should rest against its stop on the top of the receiver, Fig. 11-11, under the walking beam, directly behind the control cable plug. (The walking beam is the 1-3/16" × 2" rectangular plate on the receiver with two 10-32 Allen screws and one 3/8" slot head screw and lock-nut.)

(6) Establish 15 p.s.i. on air gauge by opening throttle. Loosen 3/8" locknut on top of the walking beam and adjust 3/8"-24 screw so as to give a .001" - .002" clearance between bottom of walking beam and its stop on the receiver. Tighten locknut.

(7) Back off the high speed stop screw in the walking beam so as not to limit travel of the beam. Open the throttle to establish air pressure on the air gauge for the required full speed of engine as follows:

Air Pressure	Engine Speed
28 - 29 p.s.i.	800 - 808 RPM
29.5 - 30.5 p.s.i.	835 - 843 RPM

If engine speed is not correct at these pressures, adjust the movable block in the walking



1. GOVERNOR RECEIVER
2. HIGH SPEED STOP SCREW
3. WALKING BEAM
4. 3/8" SLOT HEAD SCREW
5. LOW OIL TIME DELAY BY-PASS ADJUSTING SCREW
6. FULCRUM NUT
7. SHUTDOWN SOLENOID
8. SHUTDOWN NUTS
9. OVERRIDING SOLENOID

Speed Control - Pneumatic-Hydraulic Governor
Fig. 11-10

beam. Loosen the set screw and 3/8" screw and locknut and move sliding block "in" to increase speed, or move block "out" to decrease speed.

NOTE: Each time the sliding block is moved, return to Item 6 and re-adjust the 3/8" screw.

(8) With throttle at full open position, adjust the high speed stop screw on the walking beam to obtain correct full engine speed according to the governor and engine.

2. Adjusting Speeder Spring Piston Stop

The speeder spring piston stop is the Allen head set screw shown as Item 4, Fig. 11-9. The location of the stop is the same on the pneumatic-hydraulic governor and is set as follows: With the engine at 275-283 RPM, run the set screw down until it contacts the top of the speeder spring piston, then back off on the screw 1-1/2 turns and lock. This prevents the piston from hitting top of the cylinder.

3. Adjusting Shutdown Nuts, Electro-Hydraulic and Pneumatic-Hydraulic Governor

Fig. 11-9, Item 3 shows the shutdown nuts on the electro-hydraulic governor and Fig. 11-10, Item 8 on the pneumatic-hydraulic governor. The shutdown nuts on the PG governor should be adjusted at idle engine speed, so there is 1/32" slack or clearance between the bottom of the lower shutdown nut and the top of the speed setting piston extension. (When the rod is released this clearance will not be apparent, since the shutdown rod will drop down.) A special wrench #8208398 is available to facilitate this adjustment. Tool #8208398 has 1/32" gauge wrench for PG governors and 3/32" gauge portion for SI Model governors.

4. Adjusting Solenoids for Shutdown

a. Electro-Hydraulic Governors

The "D" shutdown solenoid is adjusted at the time of engine speed adjustment.

b. Pneumatic-Hydraulic Governors

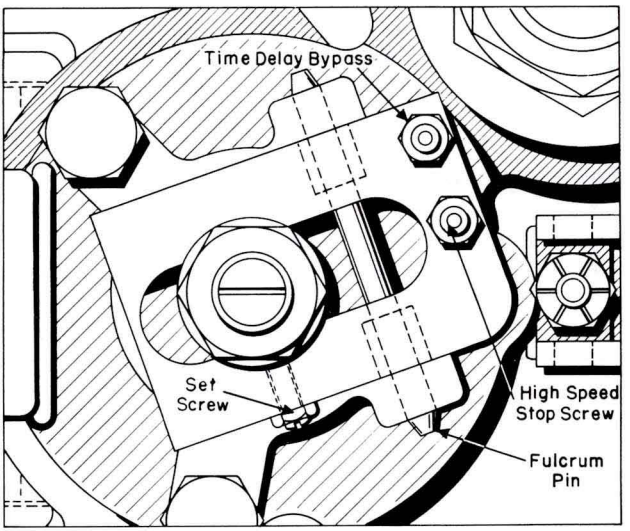
The shutdown solenoid of the pneumatic-hydraulic governor is shown in Fig. 11-6. The solenoid plunger is drilled and partially tapped for application of the adjusting screw. A single screw having two "O" rings at the top is used in present plungers, while earlier plungers have a lower adjusting screw and an upper lock screw.

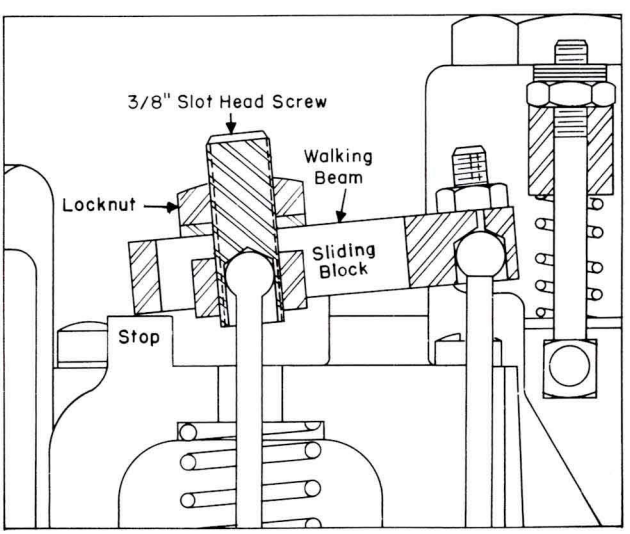
The adjustment is made with the engine shut down, solenoid de-energized, as follows:

(1) Remove the solenoid plunger stop screw and lock nut, making solenoid accessible.

(2) Insert small width rule in solenoid case so as to just rest on top of the solenoid plunger. Observe dimension from top of plunger to top of case. Using the rule, push the solenoid plunger down as far as it will go and observe reading on the rule at the top of the case. The plunger travel should be .060" or approximately 1/16". If plunger travel is over .060", back off on the adjusting screw, or if under .060" travel, run adjusting screw down to obtain .060" travel. (On earlier plungers having two screws, the plunger can be removed using a 1/4"-28 bolt as a lifter. Present plungers need not be removed, since they are prevented from turning by a pin and slot in the plunger.)

(3) After making plunger travel adjustment, replace the plunger stop screw. Using the stop screw, run the plunger down until it bottoms, then back off 2-1/2 turns on the stop screw and lock it using the lock nut.





Slotted Walking Beam Details
Fig. 11-11

(4) Observe shutdown valve during operation of governor. There should be no leakage at the valve.

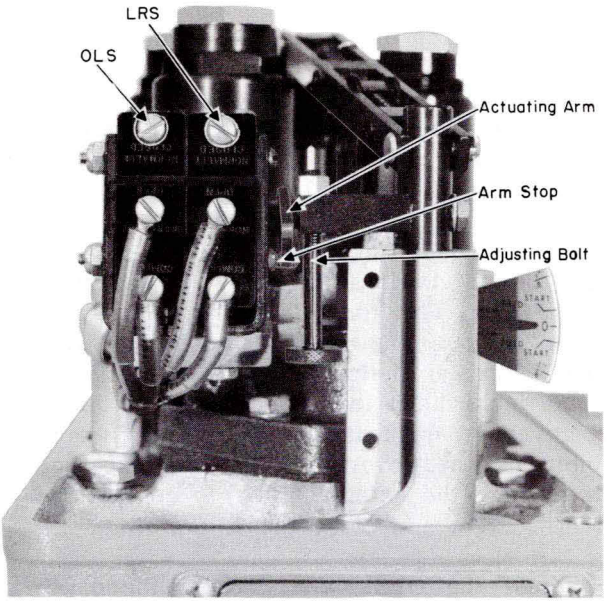
5. Adjusting Compensation

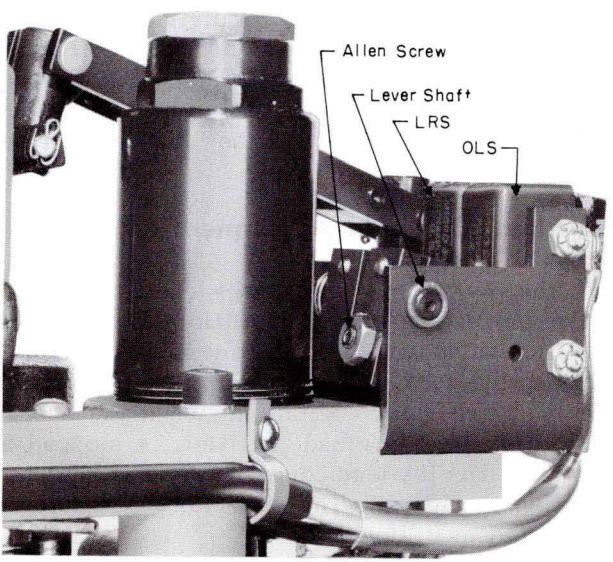
When the engine is started for the first time after installation of a new or reconditioned governor, it is important to adjust compensation. Open the compensating needle valve, located near the power cylinder, Fig. 11-1, six turns. Also, the vent plug (on rear of governor, identified by a triangular plate) should be loosened (not removed) and the engine allowed to surge by hand operating the layshaft lever for about 30 seconds, to work air out of the governor. After the engine has surged sufficiently to remove air from the system, tighten vent plug. Then close compensating needle valve gradually until surging is just eliminated. The proper setting depends on the characteristics of the engine. Keep the needle valve as far open as possible to prevent sluggishness.

After compensating has been adjusted correctly for the engine, it should not be necessary to change it, except for a large permanent temperature change affecting the viscosity of the governor oil. The needle valve setting will vary from 1/8 to 2 turns open.

6. Adjustment of OLS and LRS

The governor is equipped with an OLS switch and a LRS switch which are mounted adjacent to the power piston tailrod under the governor cover, Fig. 11-12. The OLS switch acts to prevent engine overload by completing a circuit to ORS. The LRS serves to cut out fast starting, returning full load control to the load regulator. These switches are set as follows:





OLS And LRS Switch Application
Fig. 11-12

The LRS switch is set to close one terminal shaft scale division, Fig. 11-5, plus or minus one half division (1 ± 1/2 division) lower than the full load injector rack length of the particular engine on which the governor is used. For example, if the full load injector rack length of the engine is .96", the LRS switch would be set to close at .92 ± 1/2 division, or if the full load rack length is .83" the LRS switch would be set to close at .79" ± 1/2 division. (See Table B, page 1119 for full load injector rack length of the various engines.) To set the LRS switch, raise the power piston tail rod, using the governor tailrod jack, until the correct setting dimension on the governor quadrant scale is opposite the scale pointer on the governor. Then adjust the knurled bolt through the extension bar to contact the switch actuating arm and close the LRS switch.

To adjust the OLS switch, raise the power piston tailrod, using governor jack, so pointer on the governor is opposite the .67" (± 1/2 division) mark on the terminal shaft scale. Loosen locknut on Allen screw on OLS lever, Fig. 11-12, and adjust Allen screw to cause ORS (overriding solenoid) to be energized. The OLS switch lever is behind the LRS lever about 5°.

7. Overriding Solenoid Adjustment

When the overriding solenoid is energized, it opens a valve permitting governor oil flow to the load control pilot valve and lift the overriding piston. This positions the load control pilot valve plunger to reduce main generator excitation. When the overriding solenoid is de-energized, oil flow is stopped and a spring returns the load control pilot valve to normal operating condition. The overriding solenoid travel is adjusted as follows:

a. Loosen the locknut on the "0" solenoid and run the screw down until the load control pilot valve raises.

b. Carefully back off the screw until the pilot valve starts down. Then back off the 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 by-passed 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 checked among other checks. The operation of the pilot valve is covered in Section XII of this manual.

8. Flushing Governor

It is not recommended to flush the governor 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.

Although 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:

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. By using layshaft manual 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 the governor. Repeat this operation several

times until the kerosene drained from the governor appears clean. Add two pints of recommended oil to the governor (as given in Item 9 following) and repeat the above procedure and drain. This will remove any kerosene trapped in the governor. Fill governor with recommended oil to proper level and start the engine. Vary speed of engine for several minutes to work air out of the system. The oil level should then be checked and oil added, if necessary.

9. Governor Oil Supply

The oil capacity of the governor is 3 pints. Use new oil of the type used in the engine or SAE #20 turbine type oil having rust and oxidation protection. The oil level should be maintained between the marks on the sight glass. The vent at the top of the sight glass must be open to assure correct readings. It is recommended that the governor oil be changed twice a year, using care that the oil and its containers are clean.

10. Governor Storage

In the event the governor is to be stored for a considerable length of time, it should be protected against rust. Governors using SAE #20 turbine type oil having rust and oxidation protection require no further protection. However, if other oil is used lacking these properties, the oil should be drained and the governor flushed with kerosene and drained. The governor should then be filled with oil providing protection against rust. After filling with this oil, the governor should be run several minutes if possible. When the governor is again put in service the recommended governor oil should be used.

11. Adjusting Low Oil Pressure and High Oil Pump Suction Shutdown

a. Low Oil Pressure Shut-Down — Electro-Hydraulic and Pneumatic-Hydraulic Governors

The low oil pressure time delay shutdown period with the engine at idle may be checked by shutting off the oil supply to the lube oil diaphragm by pressing in on the #10 Allen stop screw, Fig. 11-7, of the high pump suction diaphragm. Regulate the time delay period by adjusting the time delay pointer, Fig. 11-7.

As explained previously, the delay should be regulated at 40 plus or minus 10 seconds, by rotation of the manual time delay pointer, Fig. 11-9, Item 7, located under the "A" and "C" solenoids on electro-hydraulic and under shutdown solenoid on pneumatic-hydraulic governors. Rotation of the pointer counterclockwise increases the time delay period. A very slight change in pointer position is very effective.

(1) Time delay by-pass adjustment — electro-hydraulic governor

The time delay by-pass adjustment on the electro-hydraulic governor is made by regulating the clearance between the 3/32" Allen set screw located centrally, down between the "A," "C" and "D" solenoids and screwed into the triangular fulcrum plate, and the time delay by-pass extension, Fig. 11-7. The clearance at idle should be .010" to .015". It may be set by backing off on the screw several turns, placing the throttle in #3 position with the engine running, screw down carefully until, pressing on the #10 Allen stop screw of the high suction diaphragm will give a shut down

in about two seconds. Then turn the screw 1/4 turn further down and lock.

(2) Time delay by-pass adjustment — pneumatic-hydraulic governor

The time delay by-pass is checked in the pneumatic-hydraulic governor the same as with the electro-hydraulic governor, by pressing in on the #10 Allen set screw on the high suction diaphragm. The adjustment is made as follows: With the throttle at idle, put a 1/32" shim between the idle stop (control plug end of the receiver) and the walking beam of the receiver. Set the by-pass valve screw, Fig. 11-10, Item 5, which is next to the high speed stop screw and bears on the spring loaded by-pass extension, to just push the valve off its seat. Check the setting by pressing in on the #10 Allen set screw of the high suction diaphragm with the engine operating at the third (3) throttle position. The shutdown tripping time when the engine is operating in the third throttle position or higher should be no greater than two (2) seconds.

b. High Suction Shutdown — Electro-Hydraulic And Pneumatic-Hydraulic Governors

The high suction shutdown should operate at 16 to 20 inches of vacuum to initiate the shutdown feature.

The adjustment is made with the #10 Allen stop screw shown in Fig. 11-7. Screwing the set screw in decreases the suction tripping pressure. The setting adjustment may be made by disconnecting the suction line connection at the governor and attaching a device capable of creating a vacuum in the diaphragm chamber of 16" to 20" vacuum, and adjusting the set screw to operate under this

suction. Vacuum should be increased slowly, as rapid increase will give inaccurate setting.

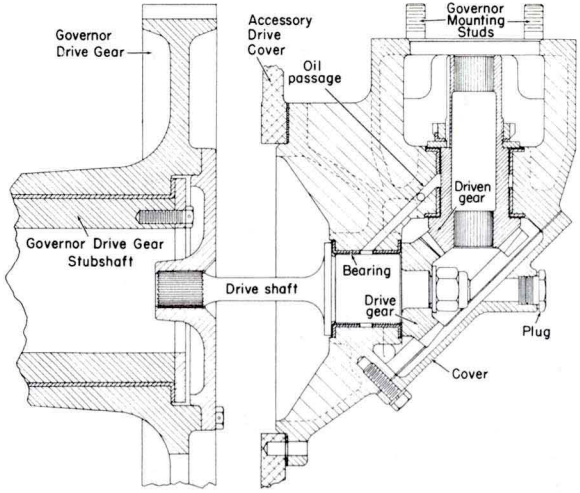
One suitable instrument for this purpose can be made from information in Maintenance Instruction 5522 which gives details of construction from ordinary available parts.

The operation of the suction alarm may be checked manually by pressing in on the #10 set screw. The engine should shut down in about 2 seconds when this screw is held in as far as it will go, when the engine is operating in the third throttle position or higher. In the event a suction diaphragm is broken a small amount of air will be drawn into the lube oil system. The diaphragm may be checked under external oil pressure not greater than 10 p.s.i. to check for leaks.

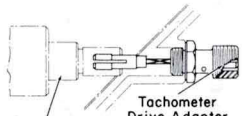
12. Governor Drive Assembly

The governor drive assembly, Fig. 11-13 (a), is mounted at the front of the engine on the accessory drive cover adjacent 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 of the governor drive gear in the accessory gear train. Lubrication of the governor drive bearings and gears is provided through drilled passages in its housing.

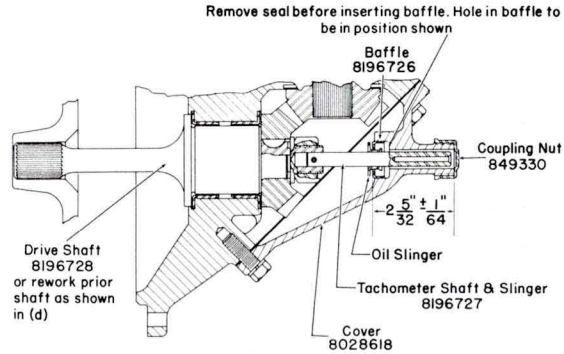
A cover is provided on the housing having a removable plug, so that the tachometer adapter 8210556, Fig. 11-13 (b), can be inserted in the drive shaft end. The adapter end is inserted into a reamed hole in the end of the governor drive shaft and has a friction fit. A permanent electric tachometer drive application may be applied to the governor drive shaft as shown in Fig. 11-13 (c). The permanent



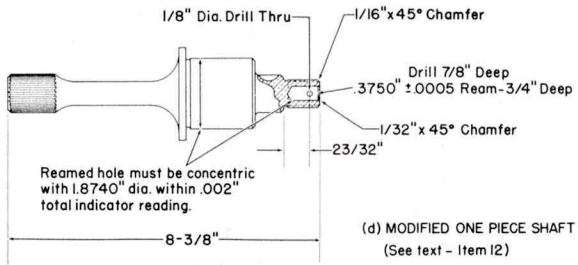
(a) GOVERNOR DRIVE ASSEMBLY



(b) TACHOMETER ADAPTER 8210556



(c) PERMANENT TACHOMETER DRIVE



(d) MODIFIED ONE PIECE SHAFT (See text - Item 12)

Governor Drive Application
Fig. 11-13

tachometer drive is inserted into the hole in the end of the drive shaft and is pinned to the shaft. (One piece governor drive shafts 8028492 or 8024772 used in early 567 series engines can be modified as shown in Fig. 11-13 (d), to fit the 567C engine governor drive.)

The governor drive assembly normally does not require servicing except at the time of general engine overhaul or reconditioning. At this time or when conditions warrant, the governor drive assembly should be removed and the 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. Chipped, flaked or bushings having 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 within limits as given under Specifications at end of this section.

D. GOVERNOR TROUBLES

1. If Engine Fails to Start

a. Check overspeed trip lever.
b. Check fuel supply and return in sight glass.

c. Check governor speed indicator pointer to see that it comes to the idle position (while engine is cranking, or running at idle speed - by manual layshaft control).
d. Check shutdown plunger, must be "in" (no red showing).
e. Start engine and hold 1.79" mark on terminal shaft scale opposite pointer on governor until engine lube oil pressure gauge reaches minimum of 3 to 5 pounds per square inch, then release. If engine will not continue to run and above items are O.K., the power piston probably is not getting oil due to internal governor defect.

2. If Engine Stops Under Load

a. Check shutdown plunger (kicks out and stops engine for low oil pressure or high suction).
b. Check overspeed trip lever.
c. Check fuel supply and return.
d. Restart and check lube oil pressure - minimum 3 - 5 p.s.i. at idle and 14 - 16 p.s.i. at 800 RPM or 14 - 17 p.s.i. at 835 RPM. If below these figures, shutdown plunger will pop out.
e. If pressure is satisfactory and plunger pops out, check suction head on lube oil pumps. This must be less than 16 inches vacuum. If it is greater than 16 inches vacuum, clean suction screens. Shutdown plunger should not pop out below 16 inches Mercury vacuum.

3. Improper Speed Settings

a. Check idle and full speed setting at transmitter and receiver or speed setting solenoids.

4. Engine Not Loading Properly

a. Check pilot valve linkage adjustment.
b. See that engine is operative; i.e., has fuel, air.

c. Check vane motor to see that it moves from minimum field position. If not, check operation of overriding solenoid to see if its hydraulic valve is operative (will move pilot valve up or down). Also, check overriding solenoid plunger operation to see that it moves downward when energized.

5. Engine Running Consistantly Over Or Unloaded

a. Check engine speed and speed indicating scale (inside governor), pilot valve scale, and rack length pointer scale, for accuracy under running, loaded conditions. If speed or pilot valve scales are off location for full load operation, reset and pin in place. Then reset pilot valve linkage. (In the "no fuel" position with the engine shut down the governor pointer should be opposite the 1.96 position on the terminal shaft scale of rotary shaft governors.)

6. Engine "Hunting"

NOTE: This can be caused by three systems. They are (1) Governor; (2) Pilot Valve and Injector Linkage; and (3) Load Regulation.

a. Check oil level in governor, must be between 2 lines on sight glass when running and under normal running temperature.
b. Check injector linkage for binding.
c. Check load regulator vane motor travel timing. If hunting under load, remove load and check at same speed. If regulator timing is off and causing hunting, unloading the engine should stop the hunting. (The hunting can be greatly helped by steadying the engine speed with the layshaft lever.)
d. If all other checks above are O.K. then reset compensating needle of speed governor as necessary.
e. Flush the governor to remove dirt in the system.

7. Governor Overflows with Oil

a. Defective pilot valve oil seal (not to be confused with foaming due to overfilling).
b. Broken "lube oil pressure" diaphragm.

E. SPECIFICATIONS

Governor

Ratio governor speed to engine speed	1.09:1
Governor oil	New oil as used in the engine or SAE #20 turbine type oil having rust and oxidation protection.
Governor oil capacity	3 Pints

Governor Drive Assembly

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

F. EQUIPMENT LIST

Name	Part No.
Rotary shaft bearing - removing and installing tools (punch and knock out pins .685" and .810" dia.)	8225658
Rotary shaft seal removing tools (hook tool and driving punch)	8225659 8225660
Tachometer drive adapter	8210556
Portable speed controller	8227463
Adapter plug used with 8182320 12 point "C" governor	8210256
Solenoid adjustment wrench	8174868
Tachometer - engine speed (Hand)	8107967
Power piston jack - Extra (1 furnished with the governor)	8113650
Speed jack - nut - Extra (1 furnished with governor)	8113925
Shutdown nut adjustment wrench (SI - 3/32", PG - 1/32")	8208398