CATERPILLAR®

SENR3028-02
August 1997

Service Manual

Caterpillar 3161 Governor

Important Safety Information

Most accidents involving product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards. This person should also have the necessary training, skills and tools to perform these functions properly.

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you have read and understood the operation, lubrication, maintenance and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or other persons.

The hazards are identified by the "Safety Alert Symbol" and followed by a "Signal Word" such as "WARNING" as shown below.

⚠ WARNING

The meaning of this safety alert symbol is as follows:

Attention! Become Alert! Your Safety is Involved.

The message that appears under the warning, explaining the hazard, can be either written or pictorially presented.

Operations that may cause product damage are identified by NOTICE labels on the product and in this publication.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are therefore not all inclusive. If a tool, procedure, work method or operating technique not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and others. You should also ensure that the product will not be damaged or made unsafe by the operation, lubrication, maintenance or repair procedures you choose.

The information, specifications, and illustrations in this publication are on the basis of information available at the time it was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service given to the product. Obtain the complete and most current information before starting any job. Caterpillar dealers have the most current information available. For a list of the most current publication form numbers available, see the Service Manual Contents Microfiche, REG1139F.

Index

Systems Operation

Troubleshooting

Governor Installation

Testing & Adjusting

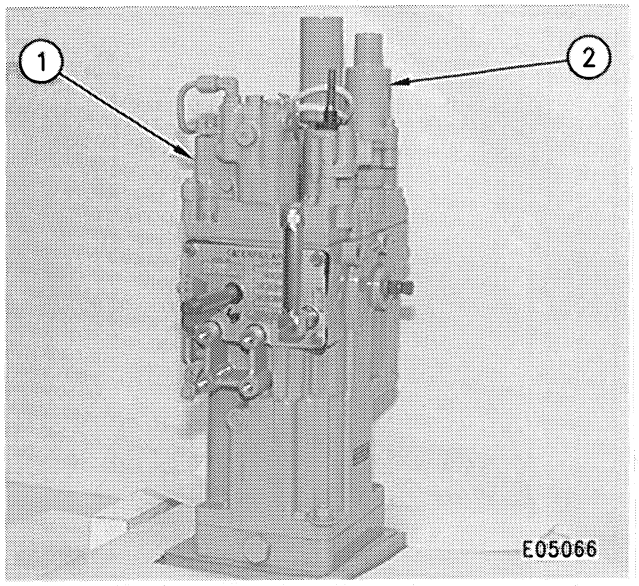
Systems Operation

Governor Types

The 3161 Standard Governor, 3161 Governor with Torque Rise Control and the 3161 Generator Set Governor are the three arrangements of this governor that are available.

A mechanical head cover, a pneumatic head cover and speed adjusting motor head cover are the three top covers available for use with any of the 3161 governors. These top covers make each governor adaptable for use with optional controls. The optional controls can be factory installed or added to a governor already in service without any modification to the governor.

3161 Standard Governor Or Governor With Torque Rise Control



3161 Governor
(1) Pneumatic speed setting control. (2) Fuel air ratio control.

The 3161 Standard Governor is the base governor.

Both the 3161 Standard Governor and 3161 Governor with Torque Rise Control are equipped with:

A pneumatic speed setting control (1) or manual mechanical speed control.
Fuel/air ratio control (2).
A low idle offset control (internal).

The optional controls for this governor are:

1. Manual shutdown.
2. Pressure (pneumatic or hydraulic) shutdown.
3. Electric "energize to shutdown" solenoid.
4. Electric "energize to run" solenoid.
5. Pneumatic mid-speed control.

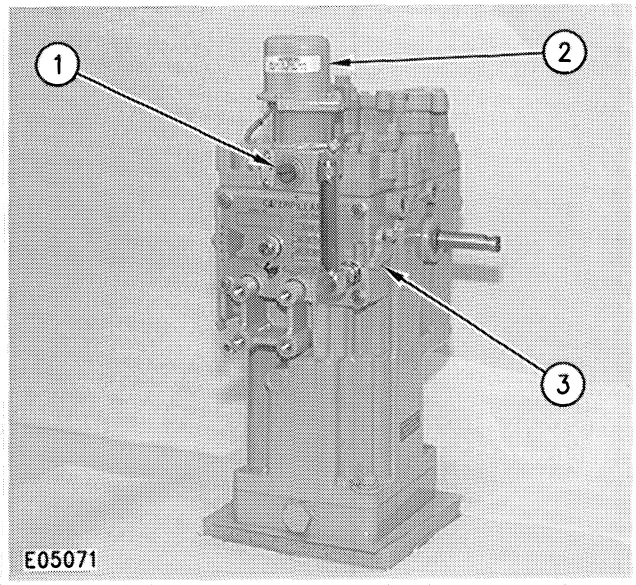
The shutdown controls (manual, pneumatic and electric) can be used separately or together as needed.

The 3161 Governor with Torque Rise Control is a standard base governor with the torque rise control components installed.

This governor is used with engine arrangements that require a specific torque rise control application. The torque rise control can be adjusted and gives similar engine output to that given by the torque spring and spacer arrangement used in other Caterpillar governors.

The 3161 Governor with Torque Rise Control for D11N applications is equipped with an ident detent shutoff feature that is factory installed.

3161 Generator Set Governor



3161 Generator Set Governor
(1) Manual speed setting control. (2) Speed adjusting motor head. (3) External droop adjustment.

The 3161 Generator Set Governor is a special arrangement of the base governor and is primarily for use on electric set engine arrangements.

An electric set engine equipped with a 3161 Generator Set Governor can be paralleled with other generator set engines governed by a 3161, 2301A, a hydra mechanical governor, or with an infinite bus.

The 3161 Generator Set Governor comes with:

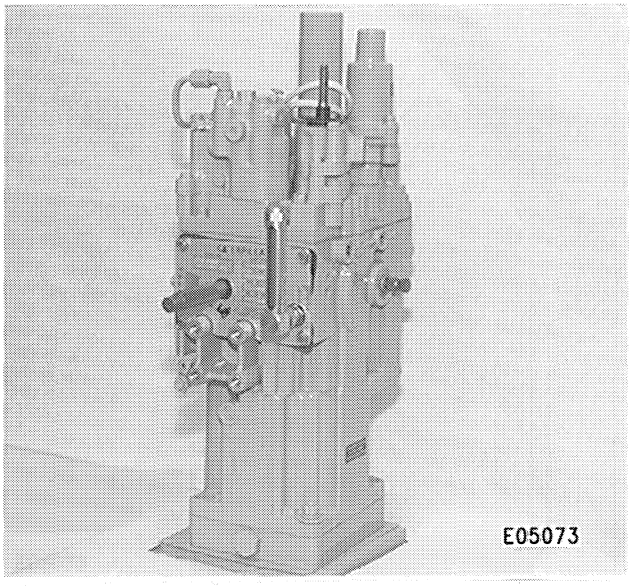
A manual speed setting control (1).
A speed adjusting motor head [24-32 volts DC] (2).
An external droop adjustment (3).

The optional controls for this governor are:

1. Manual shutdown.
2. Pressure (pneumatic or hydraulic) shutdown.
3. Electric "energize to shutdown" solenoid.
4. Electric "energize to run" solenoid.
5. Utility power converter (115-230 volts AC) for speed adjusting motor (24-32 volts DC).

The shutdown controls (manual, pneumatic and electric) can be used separately or together as needed.

Basic Governor



3161 Standard Governor

The 3161 Governor is a mechanical-hydraulic governor that senses (feels) engine speed and is connected to the engine fuel system by mechanical linkage. The governor controls the rate of fuel injected into each of the engine cylinders as needed to adjust for engine loads.

Droop and compensation can be adjusted on the governor as needed for stability of engines with different rates of engine speed changes.

The 3161 Governor has an average torque output of 11 N•m (8 lb ft) work over the full 42 degrees of terminal (output) shaft rotation in both the fuel ON and OFF directions. Because the governor terminal shafts are moved in both directions by hydraulic pressure, no return spring is used on the outside of the governor. A 1.4 N•m (12 lb in) spring inside the governor moves the terminal shafts to the full shutoff position when the governor is not in operation.

The recommended travel (rotation) of the terminal shafts is approximately 30 degrees from low idle to full load. This gives extra travel at each end for the governor to make a complete shutdown and gives maximum fuel when needed.

The self contained 3161 Governor uses a self contained lubrication system. Governors on new engines are factory filled with a high quality synthetic that will perform through the life of the governor. The oil has an operating range to –40°C (–40°F) and will not oxidize over time.

A sight gage shows the oil level in the governor. Proper level is within 25.4 mm (1.00 in) of top cover gasket with engine running. If filling is necessary, it is recommended that 136-9642 Caterpillar Governor Oil is used to maintain peak governor performance.

After removal or overhaul, the governor must be filled with approximately 1.8 liters (2 U.S. qt) of oil before engine startup. Self contained governors should be filled with 136-9642 Caterpillar Governor Oil and non-self contained governors should be filled with clean engine oil. The oil fill plug on all 3161 Governors is located on the top cover.

Non-self contained 3161 Governors are connected to the engine lubrication oil system, the oil supply (under pressure) is sent to the governor through an orifice and internal passages. The governor keeps the correct oil level and drains excess oil back into the engine.

Governor Components

Gerotor Oil Pump

The gerotor oil pump is located in the base of the governor. The inner rotor of the pump is driven by a pin in the drive shaft, and carries the outer rotor around in mesh, this pushes oil to the accumulator piston.

Accumulator

A single accumulator, that consists of a piston and spring, acts as a relief valve for the oil pump and supplies a reservoir of high pressure oil for rapid power piston movement. Oil is sent to the accumulator by the governor pump, with an increase in pressure as the accumulator spring is put under compression. When the pressure gets to a set point, oil is returned to sump through relief ports in the piston wall.

Power Piston

The power piston is fastened to the output shaft by a link and lever assembly. The power piston has a large area on the bottom and a small area on top (differential piston). A small pressure increase on the large area of the piston will move the piston up, this causes the output shaft to turn in the "increase" direction. The direction can move down only when oil under the piston is released to sump. Oil to or from the bottom of the power piston is controlled by the ballhead pilot valve and ballhead pilot valve bushing.

Pilot Valve System

The pilot system is made of two components, the ballhead pilot valve (rotating) bushing, and the ballhead pilot valve plunger. The bushing turns around the pilot valve plunger to reduce friction between the two parts. The control land of the pilot valve plunger controls the flow of oil through the control ports of the ballhead bushing.

When the pilot valve plunger is lowered, oil under high pressure moves through the control port of the bushing, to the bottom side of the power piston, and the piston moves up. When the pilot valve plunger is raised, the oil from the bottom of the power piston is released to sump, and the higher oil pressure on top of the piston moves the piston down. When the engine is running at a steady state, the control land of the pilot valve plunger covers the ports in the ballhead bushing and the power piston does not move. The movement of the pilot valve plunger is controlled by the ballhead assembly.

Ballhead Assembly

The ballhead system has a ballhead, flyweights, speeder spring, thrust bearing, and speeder plug. The ballhead, as part of the pilot valve bushing, is turned by the drive coupling and drive shaft.

As the ballhead turns, the centrifugal force causes the flyweights to pivot outward. At the same time, the force of the speeder spring pushes the thrust bearing down on the flyweight toes against the centrifugal force of the flyweights. When the speeder plug is pushed down this increases the downward pressure on the speeder spring, and the governor speed setting is increased. The engine then runs at a higher speed and puts a higher centrifugal force on the flyweights to equal the speeder spring force and put the system back in balance.

Speeder spring force or speed setting is controlled through the speed setting shaft.

Compensation System

The compensation system has a needle valve and a buffer piston with two springs. This system can be adjusted to give the desired rate of governor control and engine speed stability. Since the governor makes an adjustment rapidly to a change in engine load or speed setting, the engine can go into a "hunt" condition (temporary increase and decrease in engine speed) if too much adjustment is made. The purpose of the compensation system is to prevent over-correction to the engine load or speed setting change. The system uses a pressure differential that is applied across the compensation land of the pilot valve plunger to give a stable governor control.

Speed Droop

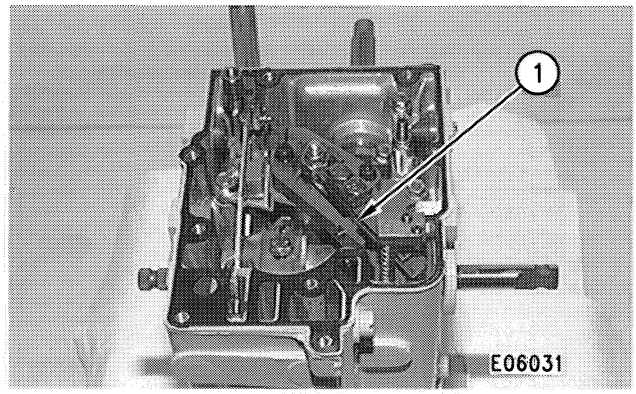
The 3161 Governor is an isochronous governor with the ability to operate with droop by the adjustment of an internal droop pivot pin. The governor may be used with droop to allow for load division between two or more engines connected to a single shaft, or for operating in parallel.

The speed droop of a governor is the percent that the engine speed drops between high idle and full load.

The 3161 Standard and Torque Rise Control Governors are designed to operate with a 1.3 to 5.7 percent droop and have an internal droop pivot pin adjustment.

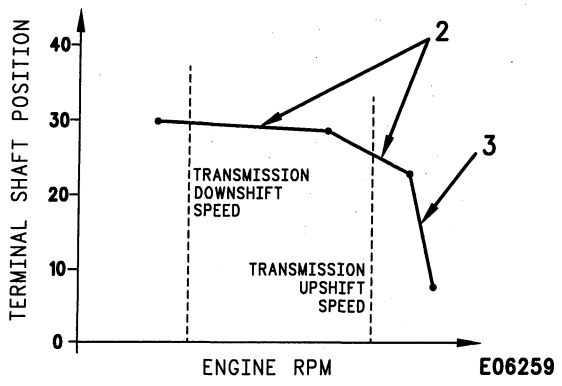
The 3161 Generator Set Governor is designed to operate with a 0 to 5 percent droop. It has an external adjustment lever connected to the internal droop pivot pin. This permits droop adjustments to be on the outside of the governor housing.

Torque Rise Control



Torque Rise Components
(1) Torque control leaf spring.

The torque rise control consists of one or two leaf springs that makes the governor give more fuel to the engine under lug conditions.



Torque Rise Schedule
Torque Rise Slopes For Truck Governors (Shown)
(2) Torque rise curve. (3) Overrun curve.

The torque rise control mechanism can be configured to accept either one or two leaf springs. This translates directly into either one or two slopes of control provided by the mechanism. It should be noted that the total torque rise schedule for vehicular engines is provided by two different mechanisms within the governor. The first slope (overrun curve (3)), which occurs at the highest rpm, is a result of the droop linkage. The next two slopes are provided by the torque rise mechanism. Governors designed for truck applications have two leaf springs which yield a three slope torque rise schedule. Tractor governors have one leaf spring which yields a two slope torque rise schedule.

The reason this feature is called torque rise can be explained by looking at the relationship between horsepower, torque and rpm.

As a vehicle begins to load, the engine slows slightly and the governor acts to provide additional fuel to maintain speed. Additional load increases cause a greater loss in speed. The governor increases fuel position rapidly during the droop portion (overrun) of its schedule, until rated power is reached. Continued load increases cause more speed loss and greater fuel position at speeds less than rated. The engine now operates in a lug condition. Engine torque is related to fuel position. More fuel position allows greater torque output as the engine lugs harder. This commonly is referred to as "Torque Rise".

The torque rise feature is factory installed on the governor and cannot be added to governors in the field.

Calibration of the torque rise feature may be accomplished on a governor test stand or by static calibration. Setting break points on the torque rise schedules require that the pilot valve has previously been set on a governor test stand.

Low Idle Offset

The Low Idle Offset provides two functions. It minimizes speed undershoot when the governor speed setting is suddenly changed from high to low (vehicle throttle goes from maximum to minimum). It also provides a large amount of droop in the idle condition which greatly enhances stability. It should be noted that the additional droop at idle makes the speed setting more sensitive to load.

The load change will cause somewhat slower cold low idle speeds than when an engine is hot. Clutching in a transmission at low idle will cause a drop in speed as the load on the engine increases.

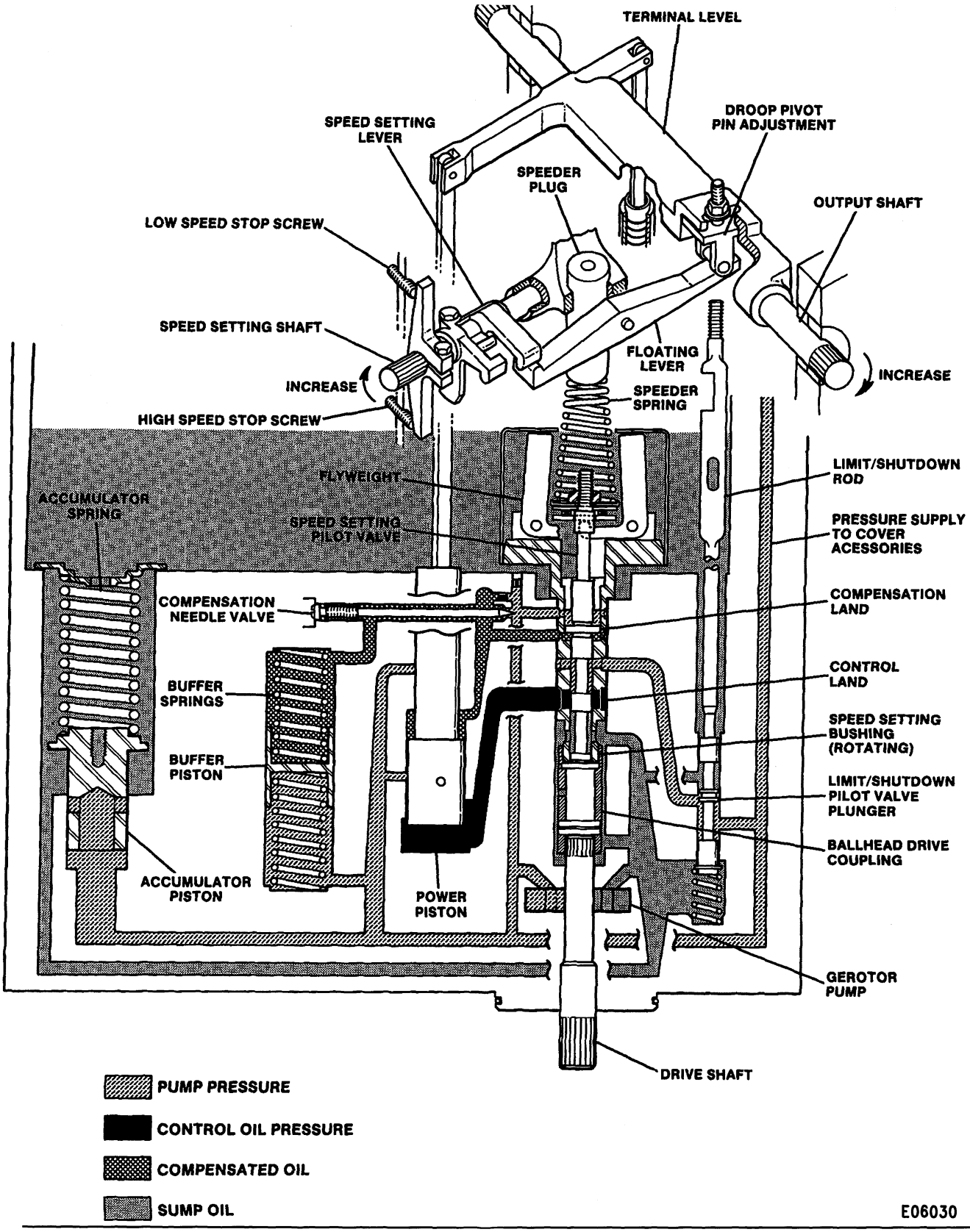
Idle Detent (D11N Applications Only)

The idle detent feature is a shutoff mechanism that works off the speed setting shaft. With this feature, the governor cannot be set to a lower speed than low idle without causing shutdown of the engine. At low idle, the speed setting shaft rests against a detent lever (as opposed to the low idle stop on other 3161 Governors). At this position, additional torque (approximately 7 N•m (5 lb ft)) will move the speed setting shaft past the detent position and into contact with the shutdown lever setting screw, resulting in engine shutdown.

NOTE: With the idle detent feature, the detent speed setting screw is used to adjust low idle, not the low idle stop screw.

Limit/Shutdown Pilot Valve

Shutdown of the engine is done with the limit/shutdown pilot valve. With the engine running on speed, the ballhead pilot valve is in the centered position. When the limit/shutdown pilot valve is lowered, pressure oil above the control land of the ballhead pilot valve is drained back to the pump area. As engine speed begins to slow, ballhead flyweights move in. lowering the ballhead pilot valve plunger. Oil under the power piston is then drained to the pump area. As the power piston moves down, the output shaft is turned in the decrease direction, and the engine is shut down.



Schematic Of The 3161 Governor
(Increased Fuel Position)

Make reference to the 3161 Governor Schematic for use with the systems operations that follow. The schematic shows the governor pilot valve in the increase fuel position.

The 3161 Governor uses its own oil for its hydraulic system. The oil goes through internal passages to the suction side and then to the pressure side of the gerotor pump as the drive shaft is turned by the engine. An accumulator spring and piston keeps the pump pressure at approximately 690 kPa (100 psi). The accumulator piston moves up in its cylinder until the pump pressure is 690 kPa (100 psi). At this time, ports in the piston are opened to control the pump pressure.

The pump pressure, as set by the accumulator, controls the work output of the governor. Pump pressure is also used for the auxiliary controls installed on the governor top cover.

Increase In Speed Setting

When the speed setting shaft is turned clockwise, the speed setting of the governor is increased. The high idle screw limits the high speed setting of the governor. As the speed setting shaft turns, the speed setting lever pushes down on the floating lever which is fastened to the speeder plug. The downward pressure on the speeder plug puts the speeder spring under compression. The speeder spring force then becomes greater than the centrifugal force of the ballhead flyweights, and the ballhead pilot valve plunger is moved down. This increases the governor speed setting.

As the pilot valve plunger is moved down, pressure oil moves under the power piston and pushes the piston up. This moves the terminal lever up and the output shafts are turned in the "increase" fuel direction to increase the engine speed.

Before the engine gets to the new set speed, the compensation system starts to move the pilot valve plunger back to its center position and put the governor under stable control as follows.

The oil above the power piston is connected to the upper side of the buffer piston and lower side of the pilot valve compensation land. As the power piston moves up the oil pressure moves the buffer piston down and increases the compression of the lower buffer piston spring. The force of the spring works against the buffer piston movement and this results in a small increase in oil pressure on the upper side of the buffer piston. This higher pressure is directed to the lower side of the pilot valve compensation land and makes a force to push the pilot valve plunger up toward its center position. This stops the flow of pressure oil to the lower side of the power piston and movement of the piston is stopped.

As the pilot valve plunger is returned to its center position and the power piston movement is stopped, there is oil leakage through the needle valve orifice. This lets the oil pressure above and below the pilot valve compensation land become equal and the pilot valve plunger movement is stopped and the engine speed is returned to a stable condition. As the pressure above and below the compensation land become equal, the buffer springs return the buffer piston to its center position.

Decrease In Speed Setting

When the speed setting shaft is turned counterclockwise, the speed setting of the governor is decreased. The low idle screw limits the low speed setting of the governor (except for the D11N). As the speed setting shaft is turned counterclockwise, the force of the speed setting lever on the floating lever is removed. This lowers the compression of the speeder spring. Centrifugal force from the ballhead flyweights lifts the pilot valve plunger to open the control port in the rotating bushing. Control oil under the power piston now drains to the sump and lets the power piston move down. The output shafts are turned in the "decrease" fuel direction and the engine speed is decreased.

Before the engine gets to the new set speed, the compensation system starts to move the pilot valve plunger back to its center position and put the governor under stable control as follows.

When the pilot valve plunger is lifted the oil under the power piston is released to drain back to the governor sump. Pump pressure oil on the bottom of the buffer piston now forces the buffer piston up. The oil above the buffer piston then puts a force on the top of the power piston to move the power piston down.

The movement of the buffer piston up increases the compression of the upper buffer piston spring. The force of the upper spring works against the buffer piston movement and this results in a small increase to the pump oil pressure on the lower side of the buffer piston and on the top surface of the pilot valve plunger compensation land. This small increase is greater than the pressure sent to the bottom surface of the compensation land. This pressure difference on the two sides of the compensation land makes a force (greater at the top) to push the pilot valve back down to the center position.

When the output shaft has turned far enough to satisfy the new fuel setting, the force of the pressure difference on the compensation land puts the pilot valve plunger in its center position (even though the engine speed is not yet completely back to normal). The movement of the power piston, and the output shaft, is now stopped.

The continued decrease of engine speed to its steady-state setting, results in a continued increase in downward force of the speeder spring on the pilot valve plunger as the ballhead flyweights move in. At the same time, the pressure difference on each side of the buffer piston (and at top and bottom of the compensation land) is being released by the flow of oil through the needle valve orifice. This controlled discharge allows the buffer piston to return slowly to its normal, "centered" position. The speeder spring continues to push down on the pilot valve plunger until the spring force and ballhead flyweight force become equal. At the same time the controlled reduction of the pressure difference on the two sides of the compensation land occur exactly at the same rate (while the pilot valve plunger remains centered) until the engine is again at the on-engine speed condition at the new speed setting.

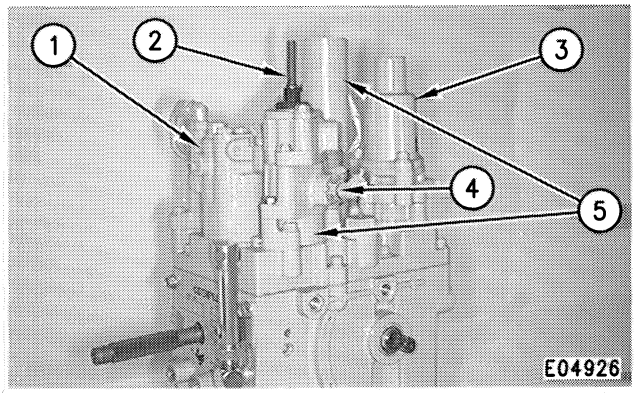
NOTE: An increase or decrease in engine load will give the similar governor movement as an increase or decrease in governor speed setting.

Shutdown

The limit/shutdown pilot valve is located in the pump oil pressure supply line to the ballhead pilot valve. When the engine shutdown system is activated, the limit/shutdown rod pushes the limit/shutdown pilot valve plunger below the supply passage. This drains oil from the supply to the ballhead pilot valve plunger. Control oil from under the power piston now drains past the control land of the pilot valve plunger. The power piston then moves down and the output shaft is turned in the "decrease fuel" direction. As the engine speed decreases, the ballhead flyweights move in and this lowers the ballhead pilot valve. Oil from under the power piston is now drained to the governor sump at a faster rate. As the power piston continues to move down, the output shaft is turned to the shutdown position until the engine is stopped.

Auxiliary Controls

This section describes the auxiliary controls and attachments that are available for the 3161 Governor. These controls are installed and calibrated at the factory before shipment to the user. The shutdown controls can be added to a governor already in service without any further modification to the governor.



Auxiliary Governor Controls
(1) Pneumatic speed setting control. (2) Manual shutdown. (3) Fuel air ratio control. (4) Pressure shutdown. (5) Electric shutdown.

The controls that can be fastened to the governor top cover are:

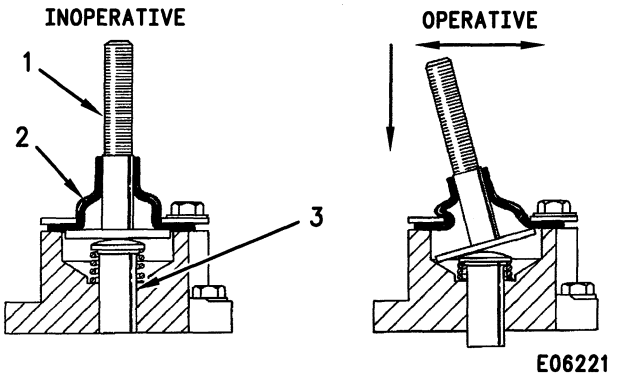
1. Manual Shutdown
2. Pressure Shutdown
3. Electric Shutdown
4. Pneumatic Speed Setting Control

Other controls added to the governor include:

1. Speed Adjusting Motor Head
2. Manual Speed Setting Control
3. Manual Mechanical Speed Control
4. Pneumatic Mid Speed Control

The top cover is made for installation of any of the three shutdown devices. The shutdown devices can be used separately or together as needed.

Manual Shutdown



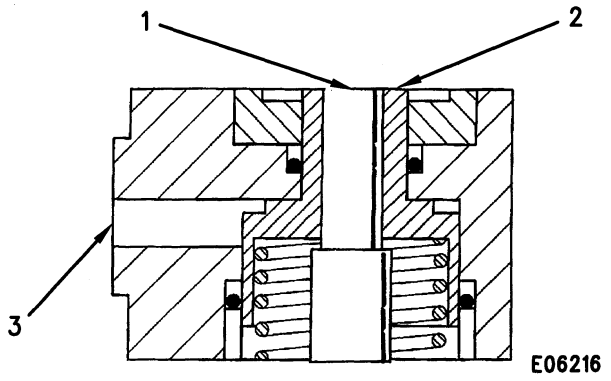
Manual Shutdown
(1) Threaded shutdown handle. (2) Boot. (3) Shutdown plunger.

The manual shutdown assembly is installed on the right front corner of the governor top cover.

To shutdown the engine, the threaded shutdown handle can be either pushed down or tilted in any one of the 360 degrees to make contact with the shutdown rod. As the shutdown handle is tilted, the flat disc of the shutdown handle lowers the shutdown/limit pilot valve, to let control oil drain and cause engine shutdown.

The manual shutdown can be used in addition to the pressure or electric shutdown controls.

Pressure Shutdown



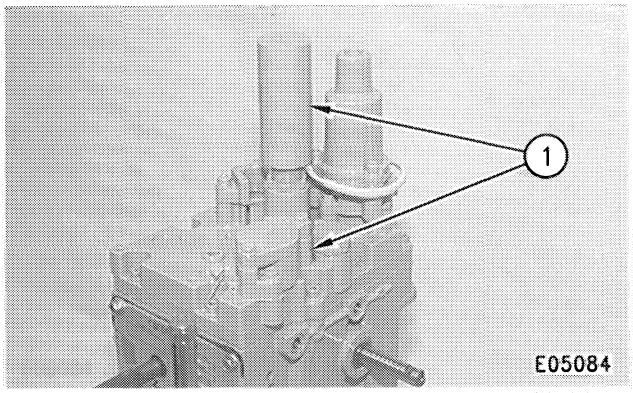
Pressure Shutdown
(1) Shutdown plunger. (2) Shutdown piston. (3) Shutdown control pressure passage.

The pressure shutdown assembly is installed on the right front corner of the governor top cover.

This shutdown uses either pneumatic or hydraulic pressure at a minimum of 276 kPa (40 psi) to shutdown the engine. When the pressure (air or oil) is applied to the shutdown piston, the piston is moved down and makes contact with the shutdown plunger. The plunger then pushes down on the shutdown rod and the shutdown/limit pilot valve. The pilot valve then lets control oil drain from under the power piston and causes engine shutdown. The shutdown will reset when pressure goes below 138 kPa (20 psi) and lower.

The pressure shutdown can be used in addition to the manual or electric shutdown controls. If this shutdown is added after the governor has been shipped from the factory, and is not used with any other shutdown, a small cover and gasket must be installed on top of the shutdown assembly.

Electric Shutdown



Electric Shutdown
(1) Electric shutdown assembly.

The electric shutdown assembly (1) is installed on the right front corner of the governor top cover.

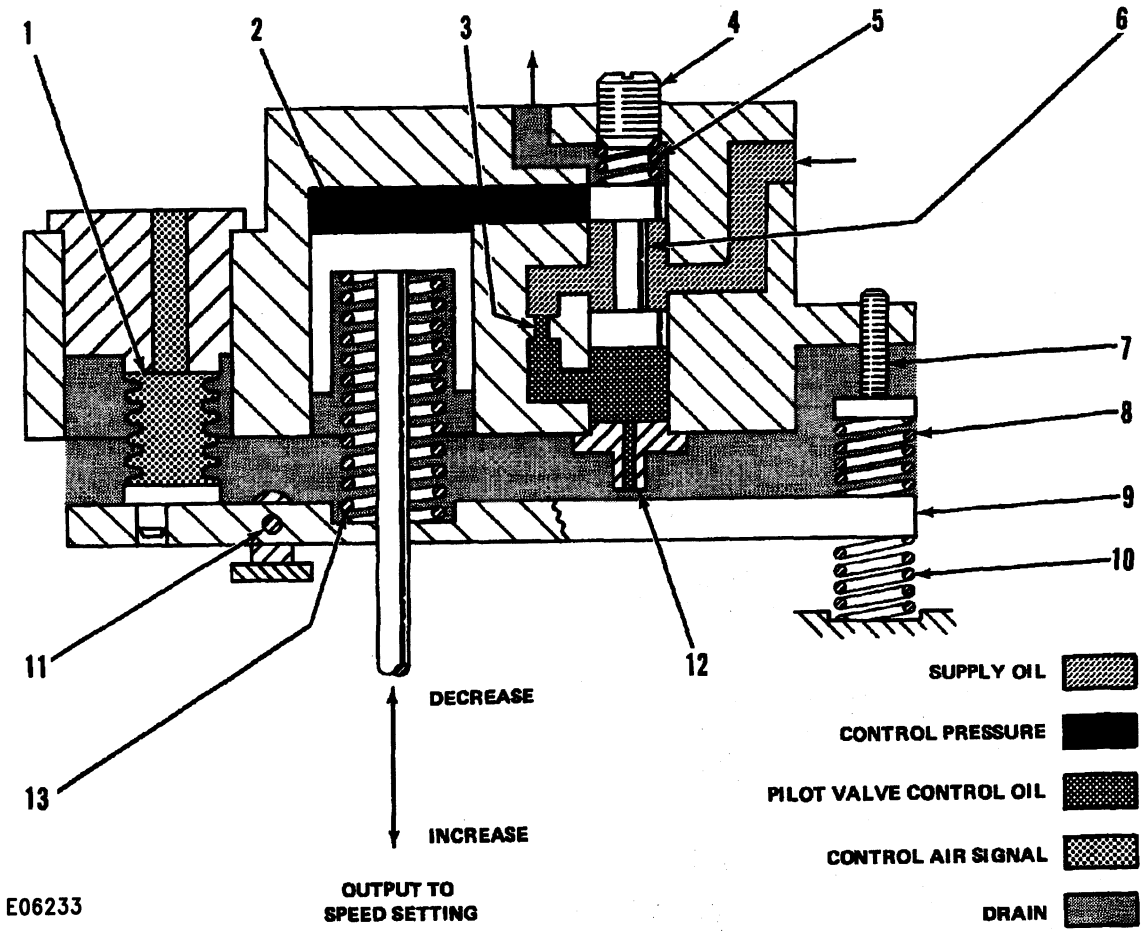
This shutdown uses a 24 volt DC (energized-to-shutdown) solenoid that positions the shutdown lever and shutdown/limit pilot valve. When the solenoid is energized the plunger moves down. It lowers the shutdown rod and shutdown/limit pilot valve to let control oil drain from under the power piston and cause engine shutdown.

There is a diode used in the circuit for the electric solenoid because it is polarity sensitive. If the wires are connected the wrong way the solenoid will not operate.

The electric shutdown can be used by itself, or in addition to the manual and pressure shutdown controls. If this shutdown is added after the governor has been shipped from the factory, an adjustment must be made. Refer to Testing & Adjusting section for the correct adjustment.

When the electric shutoff is used by itself, a small cover and gasket must be installed on top of the shutdown assembly.

Pneumatic Speed Setting Control



Pneumatic Speed Setting Control Schematic
(1) Speed setting bellows. (2) Speed setting piston. (3) Orifice. (4) Spring seat. (5) Pilot valve loading spring. (6) Speed setting pilot valve plunger. (7) Base speed adjusting screw. (8) Upper speed setting bias spring. (9) Speed setting lever. (10) Lower speed setting bias spring. (11) Pivot. (12) Nozzle. (13) Feedback spring.

The pneumatic speed setting control is installed on the left front corner of the governor top cover. Because of its design, it is not practical to add the pneumatic speed control on the 3161 Governor in the field.

System air pressure from a remote throttle and internal pressure oil from the governor operate the control to increase or decrease the speed at which the engine runs. This control has the ability to repeat constant speed settings over a large range of conditions.

The pneumatic speed setting control has a standard air pressure range of 70 to 415 kPa (10 to 60 psi). Special applications of this control can use a pressure range of 35 to 380 kPa (5 to 55 psi) or 35 to 620 kPa (5 to 90 psi).

Increase Engine Speed

As control air pressure enters the speed setting bellows through the inlet port, expansion of the bellows takes place. The bellows pushes down on the speed setting lever to the left of the pivot. This lifts the right end of the speed setting lever against the feedback spring to close the nozzle to drain.

Supply oil flows through an orifice to the lower side of the speed setting pilot valve plunger and then to drain through the nozzle. When oil flow from the nozzle is stopped by the speed setting lever, oil pressure increases and the speed setting pilot valve plunger moves up. This lets control oil go to the top of the speed setting piston. As the control oil pressure increases, the speed setting piston moves down to increase the governor speed setting through a rod and lever connected to the governor speed setting shaft.

As the speed setting piston moves down, the feedback spring is put under compression and pushes the speed setting lever away from the nozzle. Control oil can now go to drain and the pilot valve loading spring pushes the pilot valve plunger down to stop oil flow to the top of the speed setting piston. This results in the speed setting piston stopped in a new position that is proportional to the air pressure supplied to the speed setting bellows.

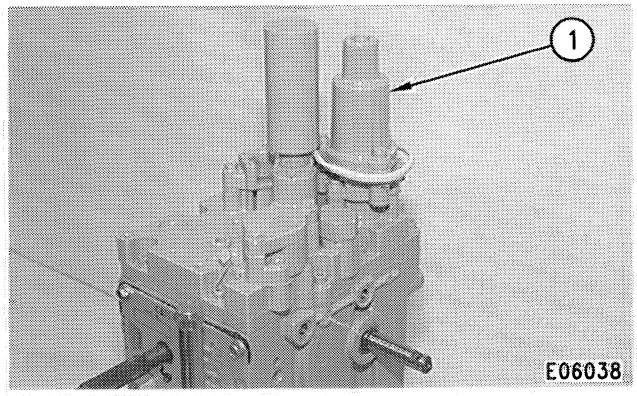
Decrease Engine Speed

When the control air pressure is lowered, the speed setting bellows moves back toward its original position. The feedback spring now pushes the speed setting lever away from the nozzle and control oil goes to drain through the nozzle.

As control oil pressure goes to drain, the oil pressure below the speed setting pilot valve plunger is decreased and the pilot valve loading spring moves the plunger down. This lets control oil above the speed setting piston go to drain and the feedback spring pushes the piston up. When the piston moves up, the force on the governor speed setting lever is lowered and the governor speed setting is reduced.

The speed setting piston moves up until the force of the feedback spring and the speed setting bellows moves the speed setting lever to close control oil to drain at the nozzle. At this time, the speed setting pilot valve plunger moves up to stop control oil movement above the speed setting piston. This results in the speed setting piston stopped in a new position that is proportional to the air pressure applied to the speed setting bellows.

Fuel Air Ratio Control



3161 Governor With A Fuel Air Ratio Control
(1) Fuel air ratio control.

The fuel air ratio control (1) is installed on the right rear corner of the top cover. The control is factory calibrated and installed. This control is not for field installation.

The fuel ratio control is similar to hydraulic fuel ratio controls used on current Caterpillar engines. This control automatically controls the governor output shaft movement in the "fuel increase" direction, until air pressure in the engine inlet manifold is high enough to give complete fuel combustion.

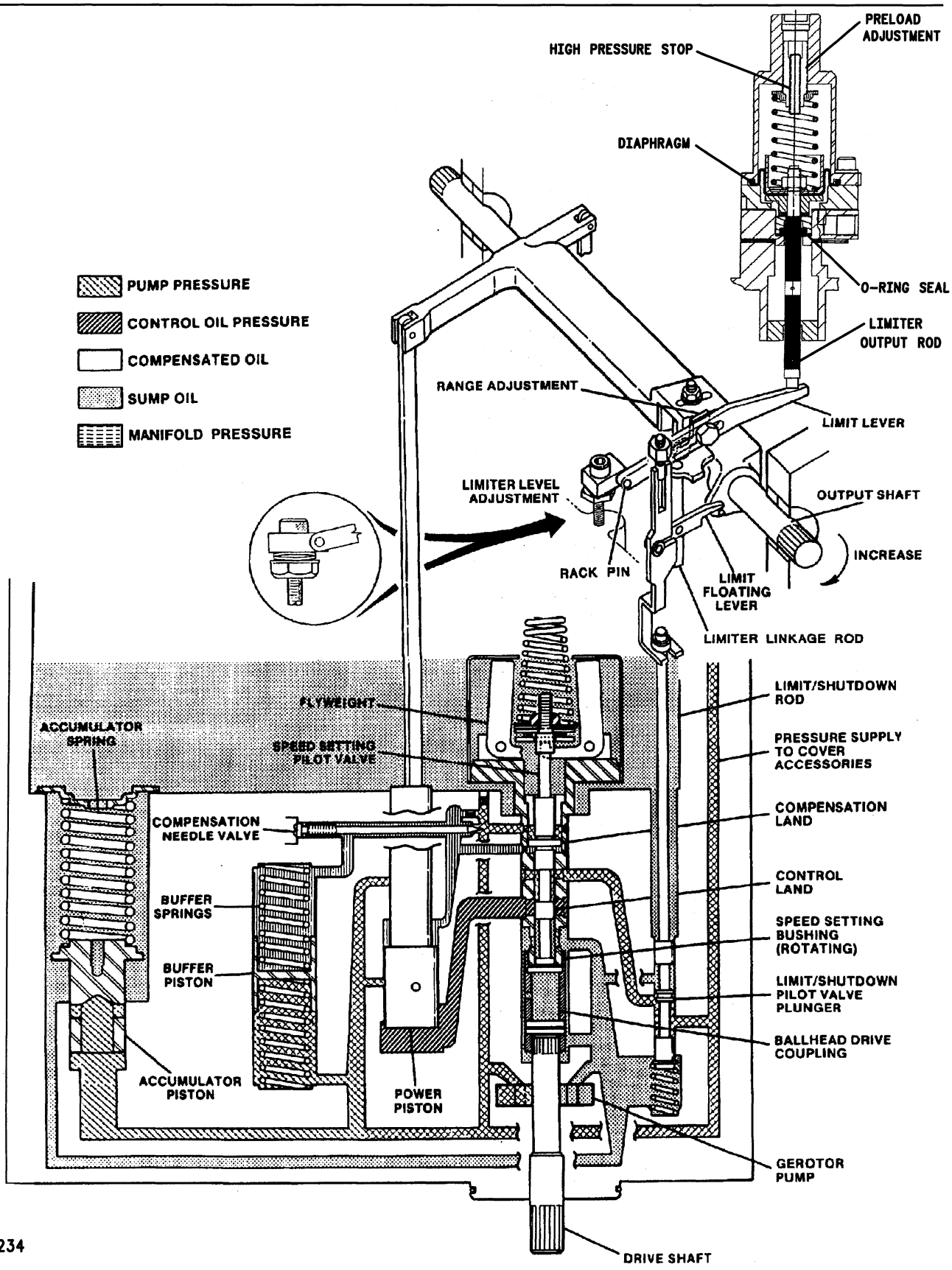
The fuel ratio control limits the fuel to the engine in proportion to the amount of turbocharger boost pressure (pressure above atmospheric) in the inlet manifold.

Engine Load Increases

As load is put on the engine, the air pressure in the inlet manifold is increased. The increased air pressure pushes the rolling diaphragm assembly up and lifts the fuel limiter output rod. At this time the limiter output rod has stopped in a new position that is proportional to the air pressure in the inlet manifold.

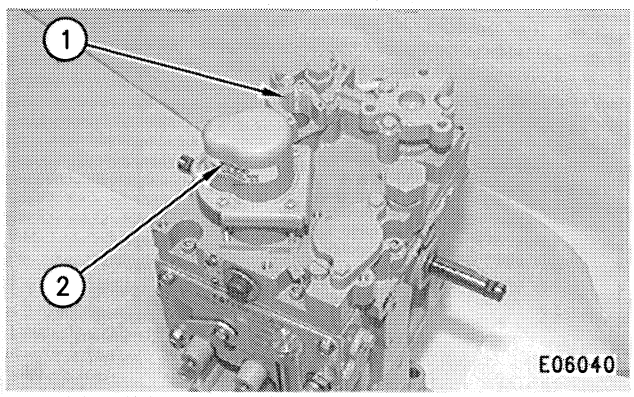
Now, with the engine in operation at a steady speed, load added decreases engine speed. The governor moves to increase fuel as the power piston moves up to turn the output shafts in the "increase" direction. As the output shafts turn, the right end of the limit floating lever is lifted. Because the limit floating lever is fastened to a pivot (pivot position is set by the fuel ratio control), the left end of the lever pushes the limit/shutdown rod down. The limit/shutdown pilot valve plunger closes off governor control oil to the power piston and limits the power piston movement.

As the engine picks up load, air pressure to the fuel ratio control increases. The rolling diaphragm assembly moves up and lifts the fuel limiter output rod. This lets the limit/shutdown pilot valve move up. Fuel limit level is then increased.



Schematic Of Solid Piston Fuel Limiter Operation

Speed Adjusting Motor Governor Head



3161 Generator Set Governor
(1) Conduit connection. (2) Speed adjusting motor.

The speed adjusting motor governor head includes a 24/32 volt DC remote control speed adjusting motor (2) for changing engine speeds from remote locations. The speed adjusting motor is installed on the governor top cover and is connected to the governor speed setting mechanism through a friction clutch. The motor drives through the friction clutch and rotates the speed adjusting screw to position the governor's speed adjusting lever. The governor set speed may be increased or decreased at the rate of 13 rpm per second. One revolution of the manual adjusting screw will increase engine speed 63 rpm (approximately).

To increase the speed setting, the motor shaft rotates clockwise. As the motor shaft rotates, it turns the speed adjusting screw to make contact with the speed adjusting lever and lowers it to increase the governor's speed setting. The motor shaft turns the speed adjusting screw until the speed adjusting lever contacts the high speed stop. If the motor continues to run, the clutch will slip to prevent damage to the motor.

NOTICE

The motor should not be left running with the clutch slipping, or clutch wear will occur. To decrease speed setting, the motor shaft turns counterclockwise and the speed adjusting screw backs out, allowing the speed adjusting lever to move to the "decrease speed" setting.

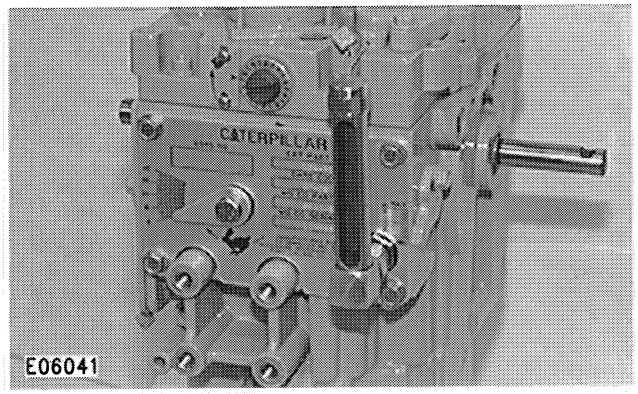
If the motor shaft is permitted to rotate counterclockwise after the speed adjusting lever has reached the low speed stop screw, the speed adjusting screw will turn out to the maximum position. The clutch will then slip until the motor is stopped.

NOTE: If the speed adjusting motor has been allowed to run after the low speed setting has been reached, it may take a period of time for the speed adjusting screw to turn in and make contact with the speed adjusting lever (when an increase in speed setting is required).

All wiring and power to the remote speed setting motor on the governor must be low voltage DC.

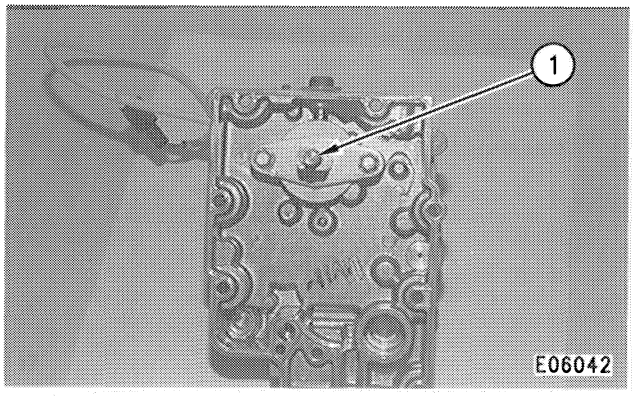
An internal ½ inch thread conduit connection (1) is on top of the governor cover. It is used for installations which require conduit protection for the wiring.

Manual Speed Setting Control



3161 Generator Set Governor

The manual speed setting control is located on the front of the speed adjusting motor governor head. Engine speed is set manually as the speed setting screw is turned. The high and low idle stops limit the speed range.



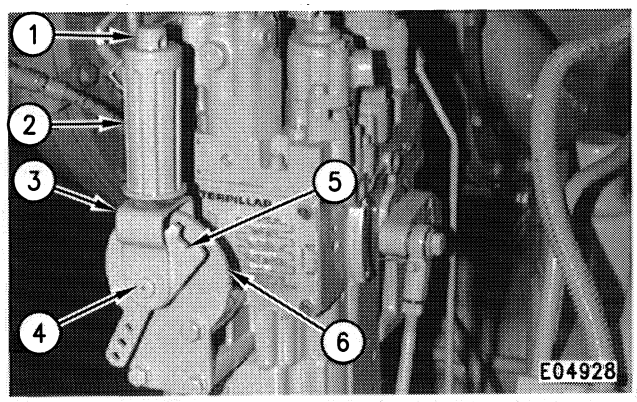
Top Cover Of The 3161 Generator Set Governor
(1) Speed adjusting screw.

An indicator lever is attached to the governor speed setting shaft with a bolt. The bolt can be loosened and the indicator lever can be set to the reference points on the identification and information plate to correspond with the number on the dial. The indicator lever will show the speed setting before the engine is started.

The manual speed setting control and the speed adjusting motor use a common speed adjusting screw (1) which contacts the governor speed adjusting lever.

The speed adjusting motor clutch is above the gear and connects the motor to the speed adjusting screw (1). This clutch keeps force off of the speed adjusting motor as the speed setting is adjusted manually.

Manual Mechanical Speed Control



3161 Governor
(1) Shaft. (2) Handle assembly. (3) Guide. (4) Hub. (5) Quadrant. (6) Ratchet mounting plate.

The manual mechanical speed control with remote and positive lock is available for torque rise and non-torque rise equipped governors. The control is used for manually setting different engine speeds, or it can be used as a remote speed control.

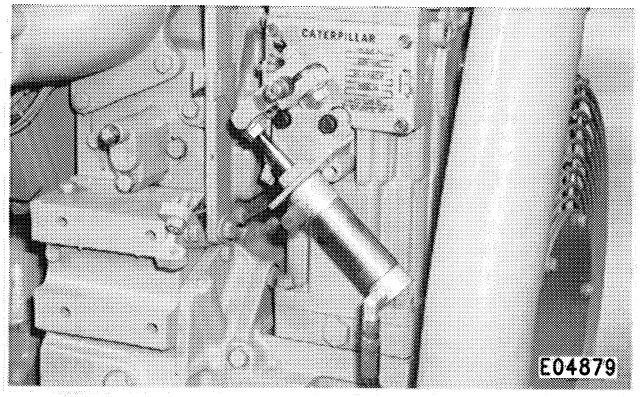
Shaft (1) goes through handle assembly (2) and is threaded into hub (4) on the spline of the speed setting shaft. Guide (3) rotates on the speed setting shaft and supports the handle assembly. Ratchet mounting plate (6) is bolted to the front of the governor and has notches to hold the handle for different engine speeds. Quadrant (5) can be engaged with the handle assembly and used as a mechanical linkage to the speed setting shaft. A cable or rod can be connected to the quadrant and used for remote speed control.

To increase or decrease engine speed, push on the shaft and lift on the handle assembly. This disengages the handle assembly from the ratchet mounting plate. The control can then move the speed setting shaft. Movement of the handle in the clockwise direction increases the engine speed.

To disengage the handle assembly from the ratchet and connect the quadrant, push on the shaft and lift on the handle assembly. With the handle assembly raised, turn it 180 degrees and connect it to the quadrant. The control can now be used for remote operation.

NOTE: The manual mechanical speed control with remote and positive lock should not be used with a pneumatic speed control. Vibration can cause the manual mechanical speed control to engage and stop pneumatic speed control operation.

Pneumatic Mid Speed Control



Pneumatic Mid Speed Control

A pneumatic speed control is normally used on 3161 Governors on vehicular engine arrangements to control the engine speed. A pneumatic mid speed control is also used to make the engine go from low idle to mid speed for dynamic braking with the direct current generator and drive motors.

This control is installed on the front of the governor. With a lever fastened to the speed setting control shaft, the control cylinder sets the engine speed from low idle to mid speed. The mid speed setting of the governor is set by the position the control lever is fastened to the speed setting control shaft.

The control cylinder rod is spring activated (extended) and air retracted. When the cylinder rod is extended, the lever moves the speed setting shaft in the "fuel increase" direction. As air pressure is supplied to the control cylinder, the cylinder rod moves away from the speed setting shaft lever. The governor turns the output shafts in the "fuel decrease" direction to lower the engine speed. When there is a loss or reduction of air pressure, the control moves the speed setting shaft and the engine runs at a speed set by the governor proportional to speed setting shaft position.

Troubleshooting

This troubleshooting guide can be an aid for the service personnel to find the cause of existing problems. Several common problems are covered in the guide, but these problems are not arranged in any particular sequence.

Identify your particular type of problem from the Troubleshooting Problem List, then go directly to that problem in the guide. However, when you begin the procedure for that problem, start at Step 1 and follow through the step by step procedure. The steps in a particular problem provide a definite sequence to be followed for a logical, one by one elimination of many variables. These steps are arranged in order from the more probable/easiest to check, to the less probable/more complex to check.

Troubleshooting Problem List

1. Engine Cranks But Governor Output Shaft Does Not Move From Minimum Fuel Position
2. Governor Response Is Sluggish And/Or Overshoots (Overspeeds)
3. Engine Accelerates Slowly
4. Engine Will Not Produce Rated Power
5. Engine Produces Excessive Smoke When Loaded Or When Accelerating
6. Governor Will Not Shutdown Engine
7. Speed Is Unstable (Surges Or Hunts)
8. Low Idle Speed Does Not Change When Low Idle Screw Is Adjusted
9. Speed Drift
10. Speed Does Not Reach High Idle When Pressure Is Applied To The Pneumatic Speed Control

Troubleshooting Problems

Problem 1: Engine Cranks But Governor Output Shaft Does Not Move From Minimum Fuel Position

⚠ WARNING

The engine may overspeed due to improper reassembly or adjustment, which could result in personal injury, loss of life, and/or property damage. Be prepared to stop the engine by activating the emergency air shut off or closing the air inlets. On natural gas engines, the fuel must also be shut off.

Try to move the governor output shaft toward "FULL FUEL" while cranking the engine. If the output shaft moves easily, go to Probable Cause number 1. If the output shaft does not move easily, go to Probable Cause number 6.

Probable Cause:

1. Check governor oil level. For self contained governors, the oil level must be within 25.4 mm (1.00 in) of top cover gasket when viewed through sight gage with engine running. For non-self contained governors with engine stopped, the oil level must be 60 to 76 mm (2.4 to 3 in) below the surface of the hole where the fill plug is located. On governors with sight glass, check oil level at sight glass.

   Low oil level can be an indication that a governor has not been filled after governor replacement. For self contained governors fill with 136-9642 Caterpillar Governor Oil.

   Also, for non-self contained governors a plugged orifice can cause a low reservoir oil level. Remove and clean the spiral orifice or replace screened orifice. Fill the governor with oil of the correct viscosity for expected ambient operating temperature.

2. Check cranking speed.

   If engine cranking speed is below 75 rpm the starting system is at fault. Make repairs as necessary.

3. Check to see if the engine starts after the oil has had time to cool.

   Engine starts with cold oil is an indication of a worn governor oil pump. Make repairs as necessary.

«TX1» 4. If the governor has been repaired, replaced, or moved to the opposite side of the engine, remove the governor. Check to make sure governor oil pump has been installed for correct rotation. Refer to Governor Oil Pump in the Testing & Adjusting section. Also, check the governor drive rotation by holding or making sure the fuel control linkage is in the "OFF" position and cranking the engine.

If the oil pump is installed wrong, it must be rotated until correct rotation is indicated.
If the governor drive rotation is incorrect, see the engine service manual to disassemble and assemble the accessory drive.

5. Check governor drive shaft rotation. With the governor off engine, turn the governor drive shaft by hand.
   If the drive shaft spins freely with little effort, the shear pin in the oil pump could be broken. Remove the oil pump from the governor and make repairs as necessary. If the drive shaft will not turn, replace the governor and repair any damage done to the governor drive.

6. Check fuel control linkage for binding.
   Linkage does not let governor move to give fuel to the engine. Make repairs as necessary.

7. Check shutoff devices to make sure they are not activated or binding.
   If the shutoff is activated or stuck, the governor shutdown rod is pushed down and does not allow governor oil pressure to move the output shaft.

8. Check adjustment of the electric shutoff. Refer to Electric Shutdown in the Testing & Adjusting section.
   A wrong adjustment can cause the shutdown rod to be pushed down.

9. Check adjustment of the fuel ratio control. See Fuel Ratio Control Adjustments in the Testing & Adjusting section.
   If range adjustment is set too low the fuel ratio control causes the shutdown rod to be pushed.

10. Increase the low idle speed setting. Refer to Low And High Idle Adjustments in the Testing & Adjusting section.
    Adjustment can be set below cranking speed and engine will not start.

11. Clean the top of the governor and surrounding area. Remove all shutoff devices and press down on shutdown rod and release.
    If the shutdown rod remains in the shutoff position, the governor must be repaired. If the shutdown rod returns to its original position, try to start the engine without any shutoff devices. If start is successful, stop engine by pressing down on shutdown rod. The shutoff device must be repaired.

Problem 2: Governor Response Is Sluggish And/Or Overshoots (Overspeeds)

Probable Cause:

Governor Overspeed On Start-Up Or Load Rejection

1. If the engine shuts down, check the overspeed setting of the engine Protective Systems.
   If the overspeed shutoff settings are not correct, the governor shutoff devices can be activated and cause the governor to shutdown the engine or limit fuel. Make the necessary adjustments to get the correct overspeed shutdown settings.

2. Check fuel control linkage movement.
   If the fuel control linkage is binding, fuel to the engine can be held in the maximum fuel position and cause an overspeed condition. Make repairs as necessary.

3. Check high idle setting. Refer to Low And High Idle Adjustment in the Testing & Adjusting section.
   If the governor high idle adjustment screw setting allows too much governor output shaft movement in the "FULL FUEL" position, an overspeed condition can be the result. Make the correct high idle setting.

Speed Overshoot And Sluggish Response

4. Check compensation needle valve adjustment. Refer to Compensation Needle Valve Adjustment in the Testing & Adjusting section.
   The needle valve is out of adjustment. The needle valve adjustment should be approximately ¾ of one turn open from the seated position.

5. For non-self contained governors, make sure the governor and engine oil is of the correct viscosity for ambient temperature conditions.
   Governor operation can be unstable or give slow response when operated in temperatures beyond the viscosity of the oil being used.

Problem 3: Engine Accelerates Slowly

Probable Cause:

1. Check the fuel air ratio control fuel limit setting. Refer to Fuel Air Ratio Control Adjustments in the Testing & Adjusting section.

   The Fuel Air Ratio Control setting is not correct. Make the necessary adjustment.

2. Check the boost pressure to the fuel air ratio control and check lines for air leaks.

   The fuel air ratio control is not getting the correct boost pressure applied and limits the governor output shaft movement. Make sure all air lines are not plugged, broken or disconnected. Also, inspect turbochargers for the ability to generate rated boost pressure. Make repairs as necessary.

3. With the engine stopped, disconnect boost line from the fuel air ratio control. Apply 70 kPa (10 psi) air pressure to fuel air ratio control and close air supply valve to hold pressure on the control diaphragm.

   Rapid pressure decreases to zero indicates a ruptured diaphragm. Replacement of the fuel air ratio control diaphragm is needed.

4. Check fuel control linkage movement.

   If the fuel control linkage is binding, fuel system response to load changes can be slow.

5. Check adjustment of electric shutoff, if so equipped. Refer to Electric Shutdown in the Testing & Adjusting section.

   Electric shutdown devices that are out of adjustment can cause the shutdown rod to be pushed down and limit fuel to the engine.

Problem 4: Engine Will Not Produce Rated Power

Probable Cause:

1. Move the speed control shaft against the high idle stop and load the engine. Refer to Droop Setting Procedure in the Testing & Adjusting section to measure the speed at rated full load fuel setting.

Refer to Measurement Of Full Throttle Speed At A Given Load Or Fuel Linkage Position in the Droop Setting Procedure of the Testing & Adjusting section.

If the engine reaches specified full load speed at full load fuel setting, the governor is not the problem. Look for an engine problem.
If full load speed is below minimum acceptable speed, the governor or engine fuel settings can be incorrect. Proceed to number 2.

2. If the governor is equipped with a pneumatic speed control, check for low control air pressure from the remote throttle. Apply maximum throttle control air pressure to the pneumatic speed control. Apply a clockwise torque on the manual speed control shaft, there should be no further movement of the control shaft.

   Further movement of the manual speed control shaft when full throttle control air pressure is supplied indicates a low air pressure fault or an air leak.

NOTE: Because of speed control shaft bearing clearance, the engine speed can increase 15 to 20 rpm when torque is applied on the control shaft. This condition is normal.

3. Make sure high idle speed is correct, as stamped on the Engine Information Plate. Increase high idle speed by 100 rpm. Repeat number 1.

   If full load speed increases, the high idle speed was low. If full load speed does not increase, reset high idle to the correct specification and go to number 4.

4. With the engine stopped, disconnect boost line from the fuel air ratio control. Wait 5 minutes to let the fuel ratio control return to the start position and repeat number 1.

   If full load speed is now acceptable, an adjustment or repair of the fuel ratio control is needed

5. On governors without a torque rise control, check the fuel setting and droop setting.

On governors with torque rise control, check the fuel setting, droop setting and torque rise control setting.

If the results are not within specifications, make adjustments as necessary.

Problem 5: Engine Produces Excessive Smoke When Loaded Or When Accelerating

Probable Cause:

1. With the engine stopped, disconnect boost line from the fuel ratio control. Apply 70 kPa (10 psi) air pressure to the fuel ratio control and close air supply valve to hold pressure on the control diaphragm.

   Rapid pressure decreases to zero indicates a ruptured diaphragm. If there is no rapid pressure decrease, check for a plugged or leaking boost line. Make repairs or replacement as necessary.

2. Check the fuel ratio control fuel limit. See Fuel Ratio Control Adjustments in the Testing & Adjusting section.

   The Dynamic Fuel Ratio Control is not correct. Make the necessary adjustments.

   -or-

   If the fuel ratio control is adjusted correctly and limiting fuel as specified, but smoke continues, look for engine problems.

Problem 6: Governor Will Not Shutdown Engine

With the engine running at low idle, activate the shutdown system and check fuel control linkage movement toward the "minimum fuel" position. If the linkage does not move, go to Probable Cause numbers 1 and 2. If the linkage moves, go to Probable Cause numbers 2 and 3.

Probable Cause:

1. Check to make sure the shutdown devices are getting a shutdown signal.

   Loose wires, broken wires, disconnected air lines, damaged air lines, disconnected hydraulic lines and damaged hydraulic lines can keep the shutdown devices from working. If an electric shutdown is used, check coil resistance (32 to 50 ohms is correct for 24-32 V solenoids). Also, make sure that the electric shutdown is adjusted correctly before it is installed on the governor.

2. Shut the engine down using the engine mounted manual shutdown lever or by moving the governor output shaft to minimum fuel. Clean top of governor and surrounding area. Remove the shutdown devices from the governor. Start the engine and push down on the governor shutdown rod.

   If the engine does not shutdown when the shutdown rod is pushed down, a replacement of the governor is necessary.

   If the engine shuts down, adjust the shutdown rod nut as follows:

   a. With the engine running, put a straight edge across the opening in the cover so that it is above the shutdown rod nut. There should be no gasket under the straight edge.
   b. Turn the nut counterclockwise until the governor just starts to cause shutdown.
   c. Turn the nut one full turn clockwise and shut the engine down. Install the shutdown devices.

3. Governor moves the fuel control linkage toward "minimum fuel" but does not shut engine down all the way.

   The fuel control linkage is not correct. Be sure that the notch in the fuel control lever engages the governor lever. (Refer to Governor Preparation in the Testing & Adjusting section). The fuel control linkage must move to the "minimum fuel" position before the governor output shaft reaches the "minimum fuel" position.

Problem 7: Speed Is Unstable (Surges Or Hunts)

Probable Cause:

1. Check compensation needle valve adjustment. Refer to Compensation Needle Valve Adjustment in the Testing & Adjusting section.

   The needle valve is out of adjustment. The needle valve adjustment should be approximately ¾ of one turn open from the seated position.

2. Check the fuel control linkage for correct installation and wear.

   Wear, binding, excessive clearance (backlash) and linkage that has been installed with the wrong geometry can cause unstable engine speeds.

3. Check governor oil level. For self contained governors, the oil level must be within 25.4 mm (1.00 in) of the top cover gasket when viewed through sight gage with engine running. For non-self contained governors with engine stopped, the oil level must be 60 to 76 mm (2.4 to 3.0 in) below the surface of the hole where the fill plug is located.

   Low oil level can be an indication that a governor has not been filled after long idle periods or in new installations. For self contained governors fill with 136-9642 Caterpillar Governor Oil. Also, for non-self contained governors a plugged orifice can cause a low reservoir oil level. Remove and clean the spiral orifice or replace screened orifice. Fill the governor with oil of the correct viscosity for expected ambient operating temperatures.

   On governors with a self contained oil supply, check the pump seal for leaks if the oil level is low.

4. Increase droop to observe effect on stability.

   Small engine inertia and light parasitic loads can cause speed instability at isochronous or low droop settings.

Instability continues - Erratic, or smooth, periodic and slow (under 5 cycles per minute).

5. Check for speed setting shaft movement with speed oscillation.

   If the speed setting shaft moves, the problem is in speed setting control system. Make repairs as necessary.

   If there is no speed setting shaft movement, check and correct the following:

   a. Fluctuation in engine load.
   b. Fuel pressure and fuel supply lines.
   c. Is the correct part number governor used.

   If instability continues after the above items have been checked, replace the governor.

Instability continues - Smooth, periodic and fast (above 5 cycles per minute).

6. Check governor drive.

   Misalignment of the governor and drive or excessive gear clearance (backlash) in the gears can affect governor operation. Make repairs as necessary.

Problem 8: Low Idle Speed Does Not Change When Low Idle Screw Is Adjusted

Probable Cause:

1. For D11N applications, use detent speed setting screw to adjust low idle speed.

   Low idle stop screw is inactive with idle detent feature. Make sure low idle stop screw is backed out enough to allow the idle detent to function properly.

2. Remove governor name plate and external linkage connected to the speed control shaft. Rotate manual speed control shaft clockwise to high idle position. Release shaft and look for return of stop lever to contact with the low idle adjustment (stop) screw.

   Failure of the speed control shaft to rotate counterclockwise through the complete travel range indicates an incorrectly adjusted pneumatic speed control, a manual speed control shaft bearing binding or not enough droop linkage spring force. Make repairs as necessary. Inspect external linkage for failure to return to low idle position when released from maximum speed position.

3. With governor name plate removed, inspect stop lever on speed control shaft.

   If the stop lever is loose it must be tightened on the speed control shaft.

4. With the engine running, push manual speed control shaft sideways and up and down. Observe engine speed for speed variation in excess of 100 rpm.

   Speed variations above 100 rpm are caused by speed control shaft movement in the governor housing. A replacement of the shaft bearings is needed to reduce clearance.

Problem 9: Speed Drift

A small amount of speed drift is normal for lever type governors. Speed measurements and settings should be made when the governor oil is warm. Generator set governors have no measurable speed drift, but should be adjusted when warm.

Probable Cause:

1. With the engine running, try to increase speed by moving the speed setting shaft.

   If speed increases by more than 20 rpm, the air supply to the pneumatic speed setting control may not be constant or of high enough pressure to reach the high idle stop. Correct air supply or pneumatic control adjustment problems.

2. With the engine running, push manual speed control shaft sideways and up and down. Observe engine speed for speed variation in excess of 100 rpm.

   Speed variations above 100 rpm are caused by speed control shaft movement in the governor housing. A replacement of the shaft and bearings is needed to reduce clearance.

Problem 10: Speed Does Not Reach High Idle When Pressure Is Applied To The Pneumatic Speed Control

With the engine running, as air pressure to the pneumatic speed control increases, the manual speed setting shaft should move clockwise. If the speed setting shaft moves but does not reach the high idle stop, go to Probable Cause numbers 1 and 2. If the speed setting shaft does not move, go to Probable Cause numbers 3 and 4.

Probable Cause:

1. Check to make sure the correct air pressure is applied to the pneumatic speed control.

   Incorrect air pressure and/or leaks in the air lines or speed setting bellows can keep the pneumatic speed setting control from moving the governor to high idle. Make repairs or replacement of parts as necessary.

2. Check the adjustment of the pneumatic speed control. See Pneumatic Speed Setting Control Adjustments in the Testing & Adjusting section.

   If the pneumatic speed control settings are incorrect, make the necessary adjustments.

3. Check to see if the speed setting shaft is binding by moving it from low idle to high idle.

   If the speed setting shaft is binding, make the necessary repairs.

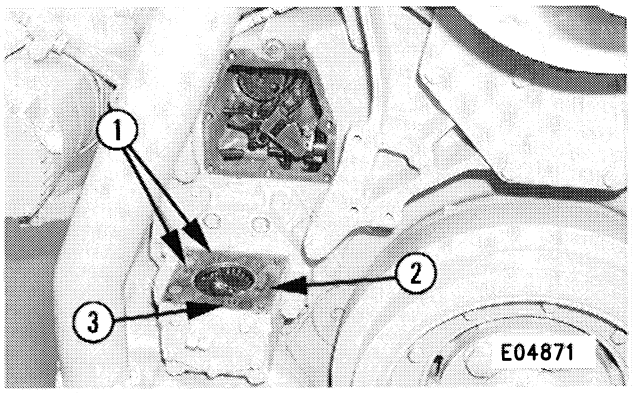
4. Check to be sure that pressure is being applied to the pneumatic speed control.

   Low air pressure and/or leaks in the air lines or speed setting bellows can keep the pneumatic speed setting control from moving entirely. Make repairs or replacement of parts as necessary.

Governor Installation

For 3500 Series Engines

Governor Oil Pump

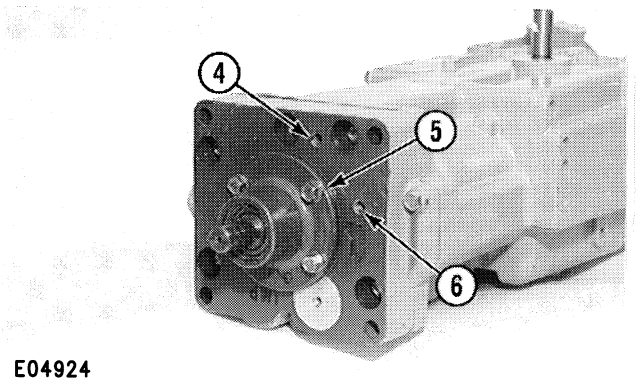


Governor Oil Supply
(Non-Self Contained Governors)
(1) Oil passages. (2) Passage (for oil supply). (3) Passage (for oil drain).

The governor drive adapter has four passages with seals. Passages (2 and 3) on the right side are used when the governor is installed on the right side of the engine. Passage (2) is the oil supply to the governor. Passage (3) is the oil drain port for the governor.

Passages (1) with the seals are used when the governor is installed on the left side of the engine.

NOTE: For self contained governors the passages are not used by the governor.

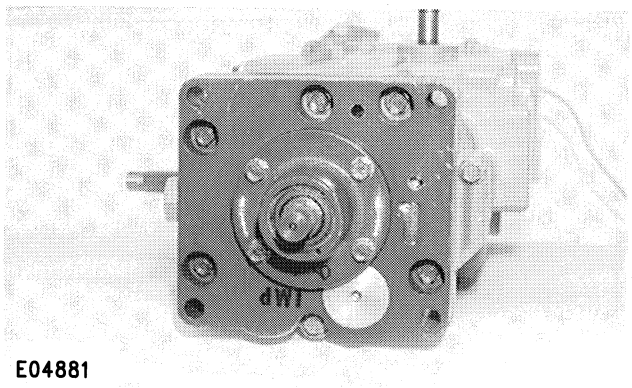


E04924

Oil Passages In Governor Housing
(Non-Self Contained Governor Only)
(4) Passage (oil drain). (5) Groove (in governor pump housing for O-ring seal). (6) Passage (oil supply).

Passage (4) is for oil drain and passage (6) is for the oil supply in the non-self contained 3161 Governors only. These passages are plugged on isolated governors.

No gasket is used between the governor and the drive adapter housing. A seal in groove (5) on the outside of the oil pump housing seals between the governor and the large bore in the adapter housing. Replace the large seal and the four counterbore seals each time the governor is removed and installed for all governor types.



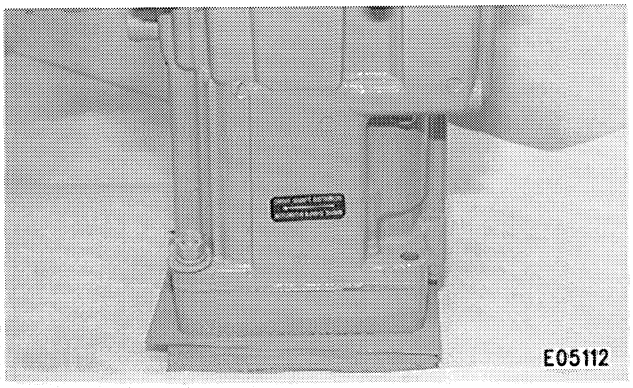
E04881

Governor Oil Pump Rotation
(Earlier Governor Shown)

Check the direction of the oil pump rotation before the governor is installed on the engine.

Two arrows are cast into the oil pump housing. One arrow indicates counterclockwise, and the other clockwise. A reference Rotation V is cast in the bottom of the governor housing.

In the above illustration, the counterclockwise arrow is in alignment with the Rotation V. This is the correct direction of rotation for the 3161 Governor when it is installed on the right hand side of standard rotation 3500 Series Engines.

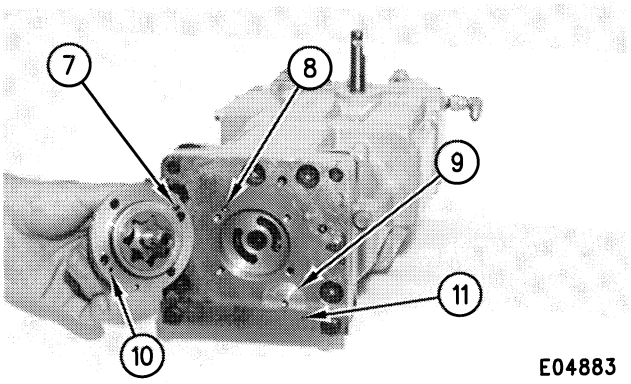


Pump Rotation Decal

A decal on the outside of the governor housing indicates the direction of governor rotation. This oil pump is set for counterclockwise direction as shown by the decal.

If the direction of rotation of the governor and oil pump is changed, a new decal must be installed with the decal arrow in the correct direction.

Oil Pump Rotation (Earlier Governors)



Oil Pump Installation
(7) Roll pin. (8) Reference hole (for roll pin). (9) Plug. (10) Location hole (for roll pin to change pump rotation). (11) Strap (to hold plug in position when pump housing is removed).

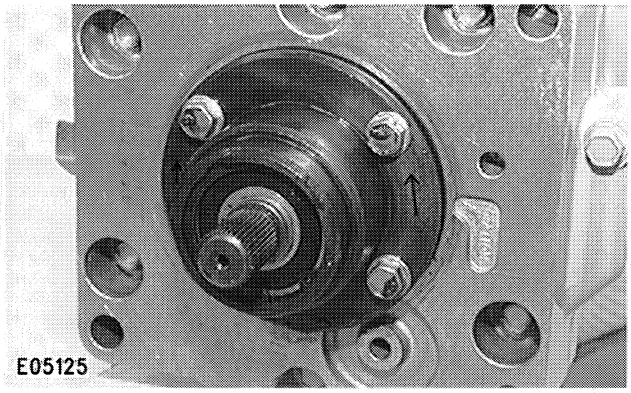
To change the direction of pump rotation do the following steps:

⚠ WARNING

The pump housing holds plug (9) in position. There is a spring force on the plug. To prevent injury, mechanically hold plug (9) in the governor housing when the pump housing is removed.

1. Remove the four bolts that hold the pump in place.
2. Use two screwdrivers to lift the pump housing and O-ring seal from the governor.
3. Pull roll pin (7) from the pump housing flange, and install it in location hole (10) in the opposite side of the flange.
4. Turn the pump housing, and make an alignment of roll pin (7) and reference hole (8) in the governor base.
5. Put a new seal on the oil pump housing. Put clean engine oil on the seal, and install the assembly part way into the bore in the base of the governor.
6. Make sure the external pump drive spline is in correct alignment with the internal coupling spline. If the splines are not in alignment, damage to the governor will be the result when the pump housing bolts are installed and tightened.
7. Use a soft faced hammer and hit the outer pump drive shaft so the pump snaps (moves suddenly) in place.
8. Install the four bolts, and tighten them to a torque of 10 N•m (90 lb in).
9. Make sure the drive shaft turns freely after the bolts have been tightened.

Oil Pump Rotation (Earlier Governors)



Governor Oil Pump Rotation

1. Remove the four bolts that hold the pump in place.
2. If the O-ring seal needs replacement, use two screwdrivers to lift the pump housing and O-ring seal from the governor.

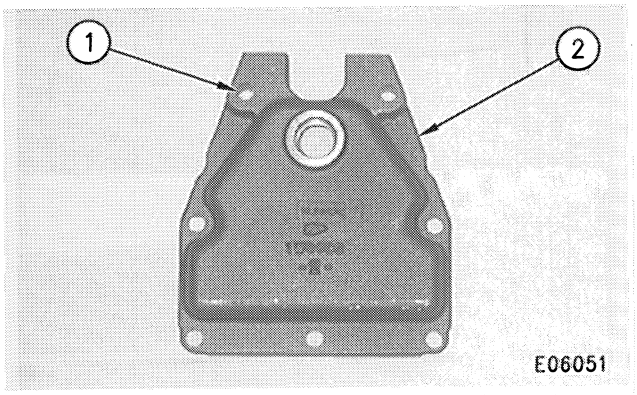
3. Put a new seal on the oil pump housing. Put clean engine oil on the seal and push oil pump in place by hand. The oil pump shaft should turn freely without the pump jumping out of O-ring seal engagement with the governor housing.

4. Turn the oil pump to make an alignment of the rotation arrow and the reference Rotation V.

5. Install the four bolts, and tighten them to a torque of 10 N•m (90 lb in)

6. Make sure the drive shaft turns freely after the bolts are tightened.

Governor Preparation

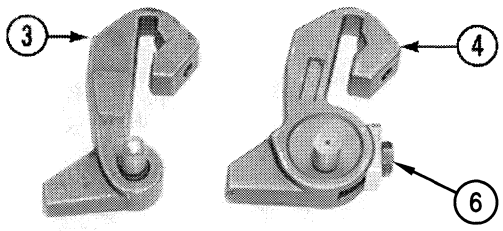


Install Cover On Governor
(1) Location (for bolt). (2) Cover.

Because of the clearance between the fuel control linkage cover and governor, the upper left side bolt at location (1) must be installed before cover (2) is put on the terminal shaft, and before the governor is fastened to the drive adapter housing. The other bolts can be installed after the governor is positioned on the engine.

Install a new 2W9063 Washer and a new 4H1722 Seal (lip type) in the Fuel Control Linkage Cover.

Put clean engine oil on the lip of the seal, and install cover over the governor terminal shaft.



E04865

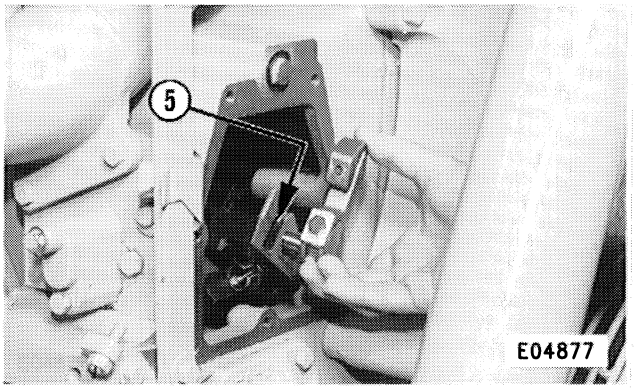
Control Levers
(3) Lever. (4) Lever. (6) Adjustable pin lock bolt.

There are two control levers for the 3161 Governor used on 3500 Engines. Lever (3) has a fixed pin and lever (4) has an adjustable pin. Lever (3), with the fixed pin, is used on 3161 Generator Set Governors and earlier Standard Governors.

Lever (4), with the adjustable pin, is used on 3161 Governors with fuel air ratio control adjustment and torque rise features. Lever (4) is used to synchronize governor fuel air ratio control adjustment and torque rise schedules to engine fuel zero reference position.

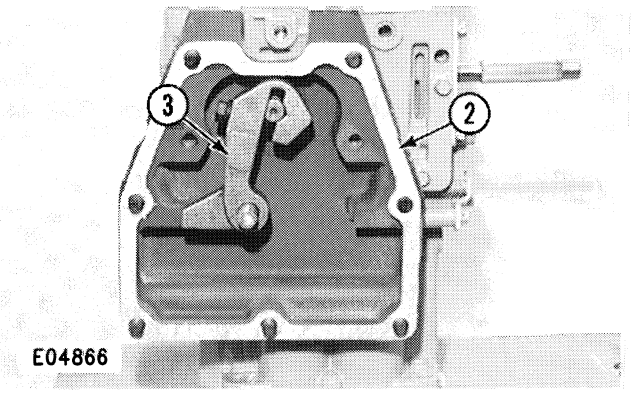
Lever (4), with the adjustable pin, can be used on a right side or left side mounted commercial governor. To convert the lever from right side use to left side use, remove the adjustable pin lock bolt (6) and lock from the adjustable pin.

Remove the adjustable pin from the lever, turn it around, and install it into the lever the opposite way. Install the lock and bolt into the adjustable pin, and tighten just enough to hold in position. The lever can now be used on the other end of the terminal shaft for left side mounted governors.



Alignment Of Control Lever
(5) Notch (in fuel control linkage stop lever).

The lever and pin (fixed or adjustable) connect the governor terminal shaft to the fuel control linkage stop lever. The lever pin moves in notch (5) of the stop lever. This causes the two to move together.



Install Lever
(2) Cover. (3) Lever.

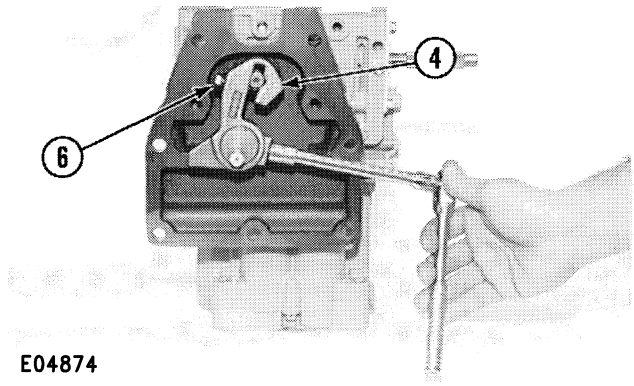
The 3161 Generator Set Governors and earlier Standard Governors with fixed pin control levers do not require special adjustments when installed on the engine.

NOTICE

Some earlier industrial units were sold with fuel air ratio control adjustment without the adjustable lever. These units require setting the fuel air ratio control adjustment after governor installation.

After fuel control linkage cover (2) is in position, install lever (3) on the governor terminal shaft. Tighten the lock bolt to a torque of 25 ± 7 N•m (18 ± 5 lb ft). Because of the flat and groove of the terminal shaft and the lever pin, control levers can only be installed the correct way.

This control lever is for right side mounted governors. On control levers for left side mounted governors, the pin is reversed.



Install Lever
(4) Lever. (6) Adjustable pin lock bolt.

For 3161 Governors with fuel air ratio control adjustment and torque rise features, the adjustable pin control lever is installed on the terminal shaft. Adjustable pin lock bolt (6) is then tightened to a torque of 25 ± 7 N•m (18 ± 5 lb ft).

Before the governor is installed on the engine, tighten the adjustable pin lock bolt (6) so it will hold the pin in position when the governor is installed on the engine.

After the governor is installed on the engine, the adjustable pin is turned to synchronize the governor travel to the fuel control linkage. For the correct adjustment and setting of these governors, refer to 3161 Governor With Fuel Air Ratio Control And Torque Rise – Governor To Engine Synchronization.

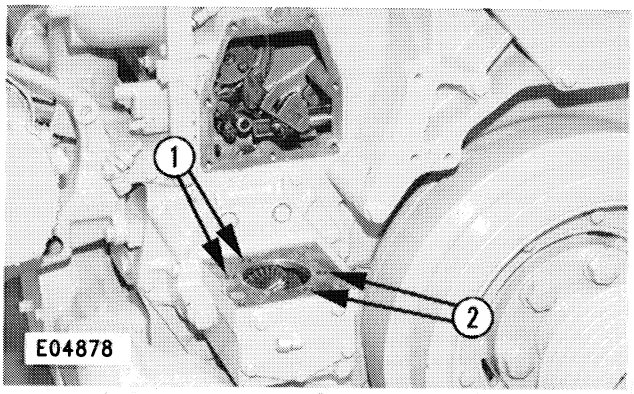
NOTICE

Before the governor is installed on the engine, make sure the pin of adjustable control lever (4) is at the bottom of the lever as shown. If the pin is not in this position, the control lever can bind or become disconnected from the engine fuel control linkage. Engine overspeed can be the result.

Governor Installation

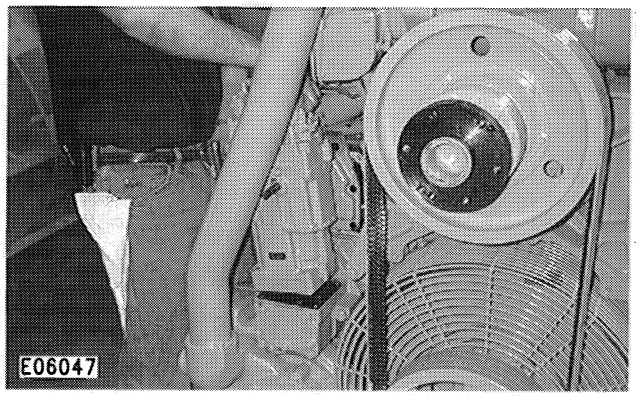
NOTICE
To prevent damage to the governor, do not drop the governor or set the governor on the drive shaft, terminal shaft or speed adjusting shaft.

3161 Generator Set Governors and Earlier Standard Governors (No Fuel Air Ratio Control/Torque Rise)



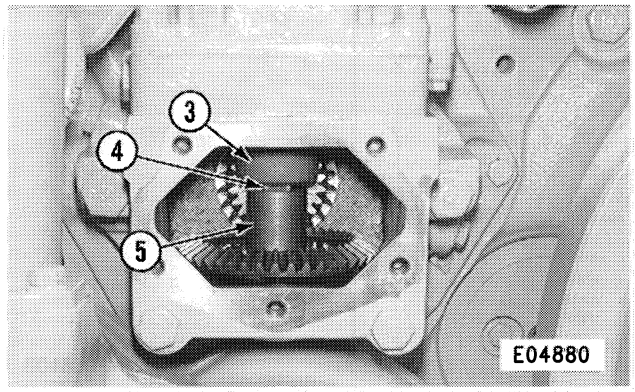
Install Seals
(1) O-ring seals. (2) O-ring seals.

1. Make sure the four O-ring seals (1) and (2) are in position on the governor drive housing. Install the seal on the governor oil pump housing. Put clean engine oil on all seals.



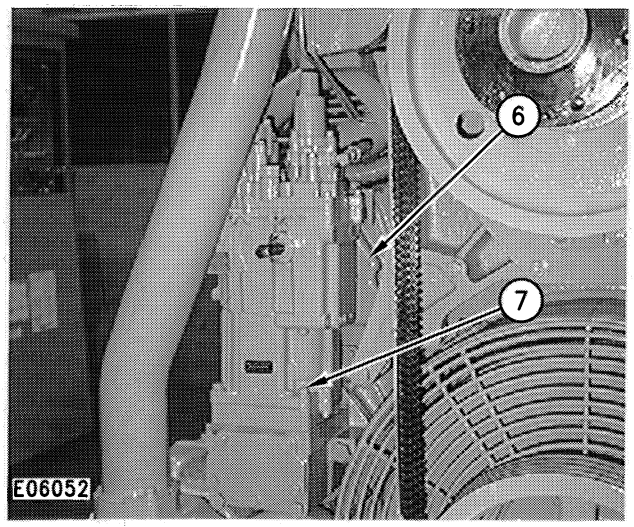
Install Governor

2. Put the governor and cover gasket in position. Make sure the governor drive shaft and the spline drive are in correct alignment. The pin on the governor lever must engage in the slot in the fuel control linkage stop lever.



Alignment Of Governor And Drive
(Cover removed for illustrative purposes only.)
(3) Governor oil pump housing. (4) Governor drive shaft.
(5) Internal spline coupling.

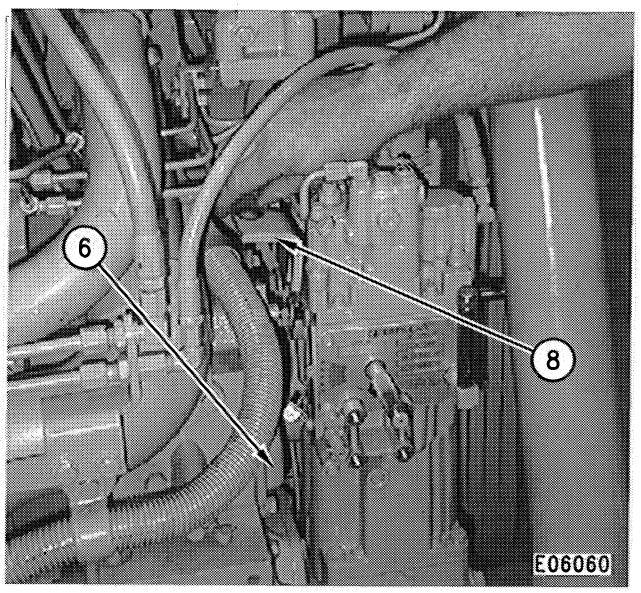
NOTE: Be sure there is no binding, side load on the drive shaft, or looseness in the drive coupling. The maximum runout of the governor drive shaft and coupling must be less than 0.15 mm (.006 in). Parts that do not fit correctly or are not in alignment can cause early wear, shaft seizure or governor drive shaft failure.



Fasten Governor To Drive Housing
(6) Cover. (7) Bolts.

3. Move the governor to put cover (6) in correct alignment (square) with the front housing of the engine. With the governor in alignment, install and tighten bolts (7) to hold the governor to the drive housing.

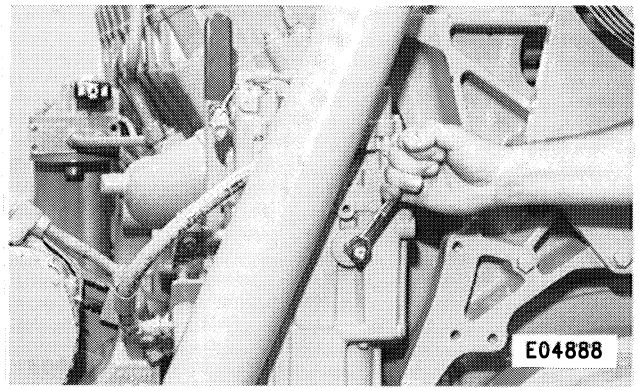
NOTICE
Tighten governor to base by initially tightening each bolt lightly to seat governor. Finish by tightening each bolt to standard torque. This procedure will preserve the base gasket integrity and vertical governor alignment.



Install Cover And Bracket
(6) Cover. (8) Bracket.

4. Put cover (6) against the front drive housing and make sure the gasket is in alignment. Install and tighten the bolts. Check the governor terminal shaft for free movement. Refer to Step 6.

5. Install bracket (8) as follows:
   a. Install two bolts in the side of the governor.
   b. Slide bracket (8) in place on the bolts. Tighten the bolts enough to hold bracket (8) in position. The bracket must be free enough to move.
   c. Install and tighten the two bolts that hold bracket (8) to the top of cover (6). This puts the bracket in correct alignment.
   d. Tighten the two bolts that hold bracket (8) to the governor.
   e. Check the governor terminal shaft for free movement. Refer to Step 6.

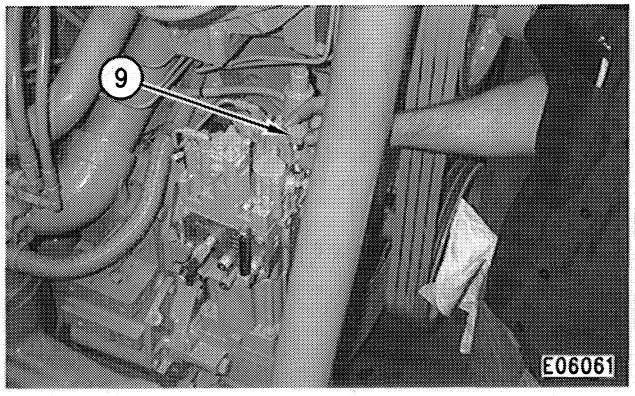


Check Terminal Shaft Movement

6. Move the governor terminal shaft several times in the "FUEL ON" direction, then release it. The terminal shaft must return completely to the "FUEL OFF" position each time. If the terminal shaft does not return, binding can be the result of parts not in correct alignment.

If the terminal shaft is binding, loosen the cover bolts, align the cover, then tighten the bolts. Again check for binding using the above procedure. If this does not correct the binding problem, loosen the bolts that fasten the governor base to the drive housing. Move the governor as necessary and again tighten the bolts. Check for binding again using the above procedure.

NOTE: If the governor terminal shaft is binding after the above procedure, first loosen the bolts for the fuel control linkage cover. Then loosen the bolts that hold the governor drive housing in position. Move the housing to get alignment of the cover bolt holes. Tighten all of the bolts. Again check for terminal shaft binding.



Correct Governor Oil Level
(9) Oil fill plug.

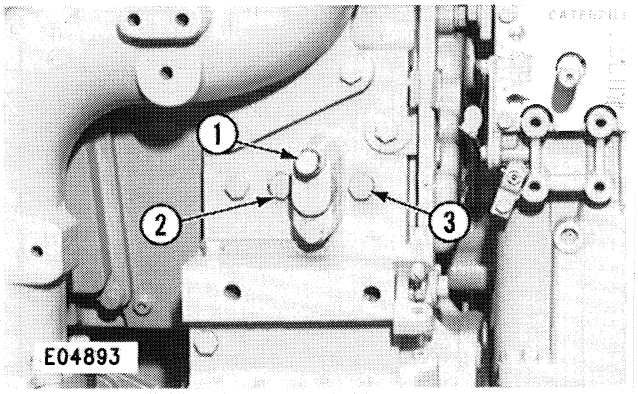
7. It is necessary to fill the governor with oil. Remove the oil fill plug (9) from the governor top cover. Add 1.8 liter (2 U.S. qt) of clean engine oil (for non-self contained governors) to the governor before the first engine start up. Install the plug in the top cover and tighten. For self contained governors, verify that oil level is within 25.4 mm (1.00 in) of top cover gasket with engine running. Add 136-9642 Caterpillar Governor Oil if necessary.

3161 Governor With Fuel Air Ratio Control And Torque Rise - Governor To Engine Synchronization

Tools Needed		
8T1000	Electronic Position Indicator Group [1]	1
5P4814	Collet	1
5P7263	Contact Point, 76.2 mm (3.00 in) long	1
4C6100	Governor Control Group	1
4C6099	Terminal Shaft Torque Arm [2,3]	1
4C6101	Terminal Shaft Torque Arm [2,4]	1
4C6103	Weight, 4.0 kg (9.0 lb) [2]	1
FT1819	Governor Torque Arm [5]	1

[1] If this indicator group is not available, use the 6V3075 Dial Indicator.
[2] Part of 4C6100 Governor Control Group.
[3] Use for 776B, 777B, 785 and 789.
[4] Use for D11N.
[5] Use for Commercial.

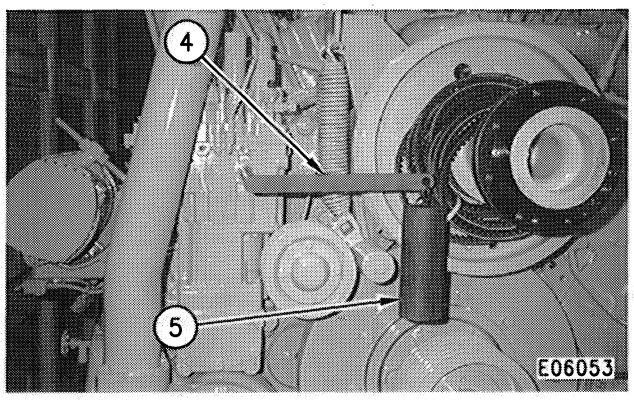
1. Put the governor in position on the engine as in Steps 1 through 3 for 3161 Generator Set And Earlier Standard Governors.



Typical Illustration
(1) Synchronizing pin. (2) Test port. (3) Test port.

2. Remove the plug from test ports (2) and (3).

3. Remove synchronizing pin (1) from the fuel setting cover. **Remove the washer** from the synchronizing pin. Install the synchronizing pin (1) in test port (2). Tighten synchronizing pin (1) to a torque of 10 ± 2 N•m (90 ± 18 lb in).

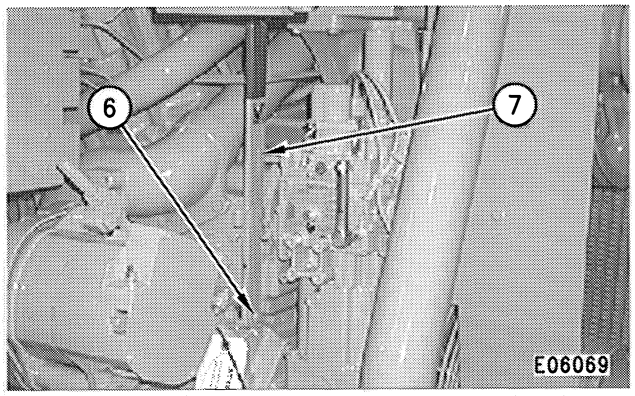


Caterpillar Vehicular Engines.
(4) 4C6101/4C6099 Terminal Shaft Torque Arm. (5) 4C6103 Weight.

4. Install the 4C6101/4C6099 Terminal Shaft Torque Arm (4) on the terminal shaft and turn the shaft to a fully clockwise (CW) position.

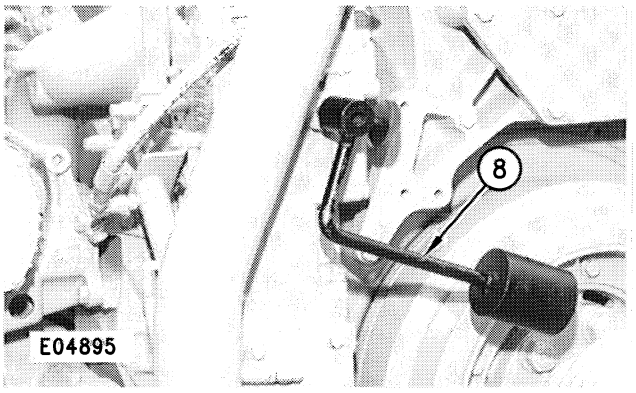
The torque arm handle must point toward the center of the engine and be within ± 30 degrees of horizontal when it is installed and turned clockwise (CW). Hold the shaft in position and hang 4C6103 Weight (5), [40 kg (9.0 lb)] on the hole in the handle of the arm.

The arm and weight are used to hold the terminal shaft of the governor in the full clockwise (CW) position. this puts the fuel control linkage stop lever against the end of the synchronizing pin. The 4C6101/4C6099 Terminal Shaft Torque Arm (4) is to be attached only with the engine "shut down".



Commercial Engines
(6) Bolt. (7) Manual fuel shutoff lever.

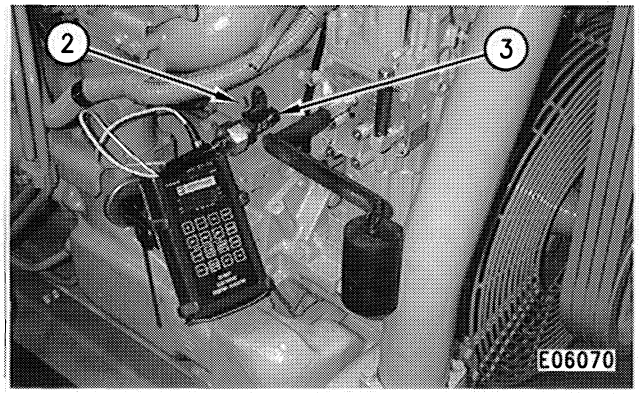
5. Remove bolt (6) and manual fuel shutoff lever (7) (commercial engines only).



Commercial Engines
(8) FT1819 governor Torque Arm.

6. Install FT1819 Governor Torque Arm (8) on the terminal shaft. The FT1819 Governor Torque Arm (8) is used to hold the terminal shaft of the governor in the full clockwise (CW) position. This puts the fuel control linkage stop lever against the end of the synchronizing pin. The FT1819 Governor Torque Arm (8) is to be attached only with the engine "shut down".

NOTE: On some applications, FT1819 Governor Torque Arm (8) can not be used. Move the governor output shaft in the "FUEL ON" direction by hand. Hold the governor output shaft and fuel control linkage against the synchronizing pin with a force of 10 N•m (90 lb in) to give an accurate dial indicator reading.



(2) Test port. (3) Test port.

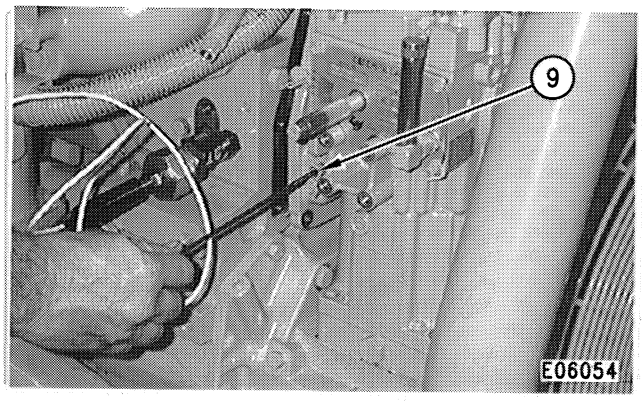
7. Install and zero the indicator. Either an 8T1000 Electronic Position Indicator Group, or, the 6V3075 Dial Indicator are acceptable for use. Installation instructions for both indicators are as follows:

a. 8T1000 Electronic Position Indicator Group
Install the 5P4814 Collet in test port (3). Slide the 8T1002 Probe with the 5P7263 Contact Point into the 5P4814 Collet until 8T1002 Probe sleeve bottoms in the 5P4814 Collet. Tighten the collet enough to hold the probe in this position. Attach the probe to the 8T1001 Indicator. Turn the indicator ON and set it to measure millimeters. With the indicator ON, touch the zero button. The indicator is now ready to be used for the adjustment.

b. 6V3075 Dial Indicator
Install the 5P4814 Collet in test port (3). Slide the 6V3075 Dial Indicator with the 5P7263 Contact Point into the 5P4814 Collet. When the contact point seats against the fuel stop lever, slide the indicator IN or OUT, until the indicator dial reads "ZERO". Tighten the collet enough to hold the indicator in this position. The indicator is now ready to be used for the adjustment.

8. Remove 4C6101/4C6099 Terminal Shaft Torque Arm (4) and 4C6103 Weight (5), or, FT1819 Governor Torque Arm (8) from the governor terminal shaft. Make sure the terminal shaft returns to the "FUEL OFF" position.

9. Loosen synchronizing pin (1) a minimum of 25.4 mm (1.00 in).



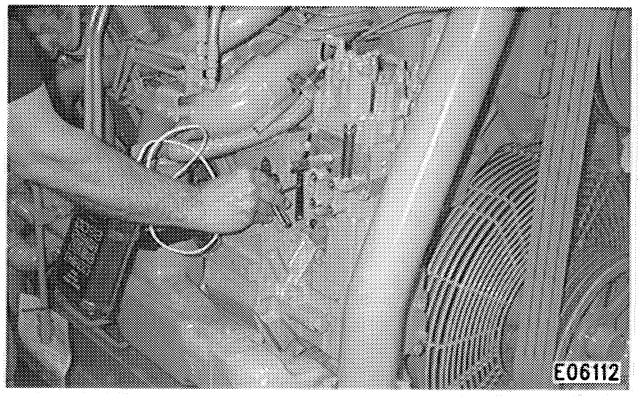
(9) Rig pin.

10. The rig pin (9) is used to stop the governor terminal shaft at a fixed position while setting the adjustable pin control lever, to synchronize governor travel with engine fuel control linkage travel.

NOTE: The rig pin (9) is to be used only with the engine "shut down".

Put a 5/32 hex wrench in the governor rig pin, push IN, then turn it counterclockwise until the roll pin locks squarely behind the bracket.

11. Install the 4C6101/4C6099 Terminal Shaft Torque Arm (4) and 4C6103 Weight (5), or, install FT1819 Governor Torque Arm (8) to turn and hold the governor terminal shaft and linkage against the governor rig pin.



12. With ¼ hex bit x ⅜ drive socket on a 305 mm (12.0 in) extension and ratchet, position the socket and extension between the cover and housing. Put the hex bit in the governor control lever pin lock bolt and loosen the bolt.

NOTICE

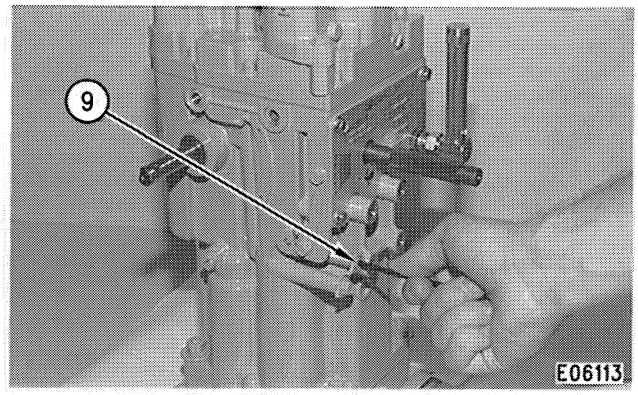
The socket must be secure to the ⅜ drive extension to prevent it from falling into the drive gears of the engine.

NOTE: Earlier pin lock bolts were a ½ standard bolt.

Move the ratchet and extension UP or DOWN until the dial indicator reads 0.00 ± 0.13 mm (0.000 ± 0.005 in) while the terminal shaft is held in the "FUEL ON" direction against the governor rig pin.

Tighten the pin lock bolt on the governor control to 25 ± 7 N•m (18 ± 5 lb ft) of torque.

Move the terminal shaft torque arm tool to the "FUEL OFF" position and return it so it is against the governor rig pin. The dial indicator must return to 0.00 ± 0.13 mm (0.000 ± 0.005 in) each time. If it does not, do the above procedure again.

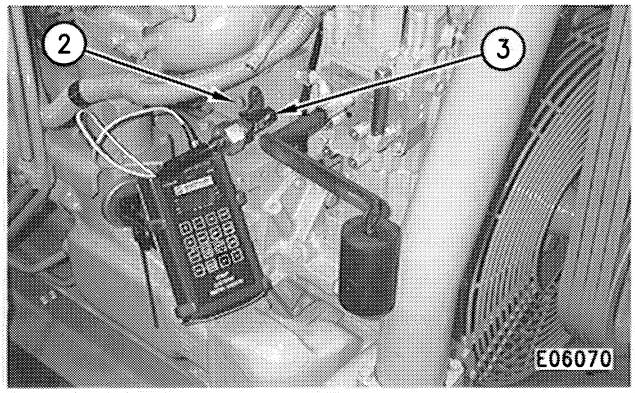


(9) Rig pin.

13. Remove the terminal shaft torque arm tool from the governor terminal shaft.

14. Release the governor rig pin (9). Push on the hex wrench and turn it clockwise (CW) until the roll pin unlocks from the bracket. Release the hex wrench and the spring will return the pin to the disengaged position. Remove the hex wrench.

15. Turn the synchronizing pin (1) IN all the way, and tighten it to 10 ± 2 N•m (90 ± 18 lb in) of torque. Install the terminal shaft torque arm to hold the fuel control linkage stop lever against the synchronizing pin. Refer to Step 6. Without a change to the dial indicator position, make sure the reading is zero to indicate the correct fuel control linkage dimension.



(2) Test port. (3) Test port.

16. Remove 8T1002 Probe or 6V3075 Dial Indicator and 5P4814 Collet from test port (2).

17. Remove synchronizing pin (1) from test port (2). Install the washer on synchronizing pin (1) and install the synchronizing pin in the fuel setting cover.

18. Install the test port plugs in test ports (2) and (3).

19. Follow Steps 4 through 7 For 3161 Generator Set And Earlier Standard Governors to install the cover, bracket, and check for free movement of the fuel control linkage and governor.

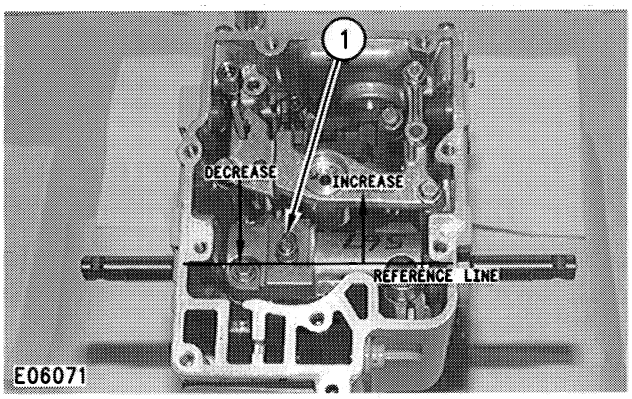
Testing & Adjusting

Governor Adjustments

Droop Setting Procedure

Tools Needed		
6V7880	Timing And Fuel Setting Tool Group	1
5P4814	Collet	1
5P7263	Contact Point, 76.2 mm (3.00 in) long	1
6V3075	Dial Indicator	2
9S0228	Rack Position Tool Group	1
9S0225	Bracket Assembly	1
FT1819	Governor Torque Arm	1
3S3269	Contact Point, 25.4 mm (1.00 in) long	1
8T2819	Linkage Position Indicator	1
6V4060	Set Point Indicator	1
6V2100	Multitach	1

Internal Adjustment



Internal Droop Adjustment
(1) Locknut.

When the position of the droop pivot pin (internal or external) is changed on the terminal lever, the percent of governor droop changes.

To change the droop pivot pin setting on governors not equipped with an external adjustment lever, the governor top cover must be removed.

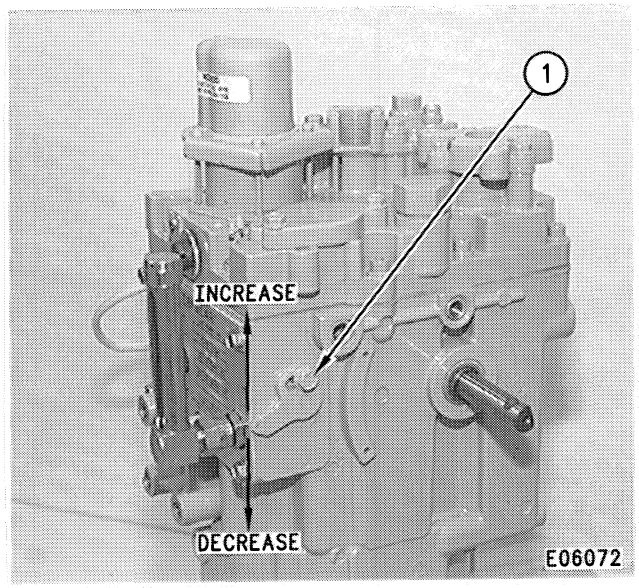
The droop pivot pin is fastened to the terminal lever with locknut (1). With the nut loosened, the pivot pin can be moved from minimum droop to maximum droop. It is shown here in the minimum droop position.

The terminal shafts are clamped in the ends of the terminal lever by two bolts. A line can be drawn through the center of the two bolt heads and used for reference in adjusting the droop pivot pin position.

When the pivot pin and nut is moved near the reference line as shown, the governor is set for minimum droop. As the pivot pin and nut are moved farther away from the reference line, the droop is increased. When the pivot pin and nut are moved to the farthest point away from the reference line the governor is set for maximum droop.

External Adjustment

On the 3161 Generator Set Governor, the internal droop pivot pin locknut must be kept loose enough to be moved by the external droop adjustment lever. The external droop adjustment lever is held in place with a bolt which retains the droop setting.



External Droop Adjustment
(1) Adjustment lever bolt.

To change the droop setting, loosen the adjustment lever bolt (1), and move the lever down to decrease droop, and up to increase droop.

Engine Speed Droop

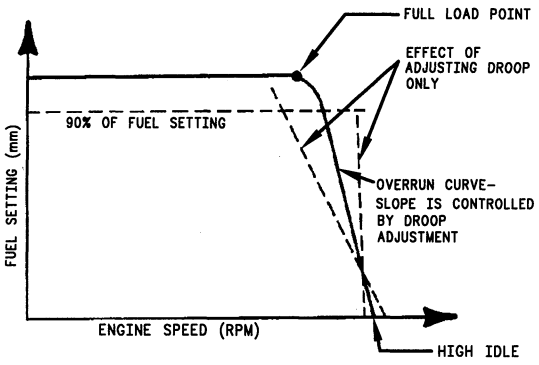


Illustration 1

The internal and external adjustments change the slope of the overrun curve and also change high idle speed (see Illustrations 1) so that high idle has to be adjusted after droop settings are changed.

Measurement of droop is difficult and requires the ability to measure engine speed under near full load conditions.

NOTE: Overrun is governed engine speed, above rated speed, between no load rpm and a point just before full load rpm. The governor controls fuel to the engine and has the ability to change engine speed. The fuel or governor control linkage is not in contact with the fuel stop or torque spring.

The curves shown in Illustration 1 show that the full load point is not on the overrun curve and the formula:

$$\% \text{ droop or regulation} = \frac{HI\text{-}FL}{FL} \times 100$$

Where HI = High Idle Speed
FL = Full Load Speed

will not give an accurate droop measurement.

To be accurate, droop measurement must be done on the overrun curve. The following formula gives an accurate measurement of droop, as long as x is between 50 percent and 90 percent.

$$\% \text{ Droop or Regulation} = \frac{HI - [\text{Speed at X \% Load}]}{HI\left(\frac{X}{100} - 1\right) + [\text{Speed at X \% Load}]} \times 100$$

Definitions:
HI = Hgh Idle Speed
(Speed at X % Load) = full throttle speed at some load or fuel linkage position. See the procedure in the next section under "Measurement of Full Throttle Speed at a Given Load or Fuel Linkage Position."

$$X = \frac{P-I}{F-I} \times 100$$

Where P = The fuel linkage position.
I = High idle fuel linkage position. This is a negative linkage position.
F = Full load fuel linkage position from engine nameplate.

Example of X % of load:

$$X\% = \frac{8 \text{ mm} - (-4 \text{ mm})}{10 \text{ mm} - (-4 \text{ mm})} \times 100 = \frac{12}{14} \times 100 = 85.7\%$$

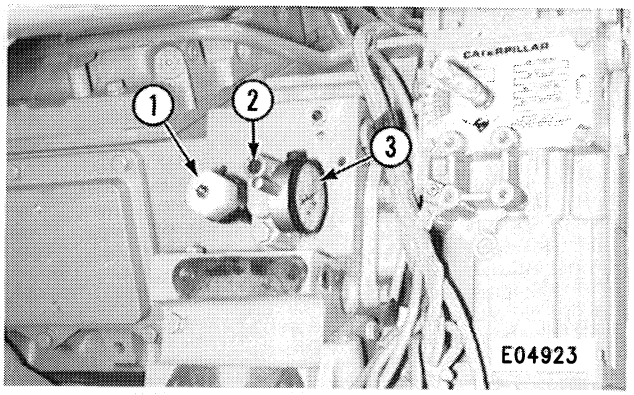
Where P = 8 mm
F = 10 mm
I = –4 mm

Measurement Of Full Throttle Speed At A Given Load Or Fuel Linkage Position

⚠ WARNING

Droop measurement should be performed on stationary engines only. Droop calculations require measurements of rack position at various load and speed conditions, which can result in personal injury or loss of life if attempted on captive applications. If adjustments are necessary, they must be performed on a test stand by an authorized Caterpillar or Woodward dealer.

1. With engine stopped, install and zero dial indicator, see Steps 2 through 7 in the installation procedure for 3161 Governor With Fuel Air ratio Control And Torque Rise Governor To Engine Synchronization. This dial indicator is used to read fuel control linkage position.



Install Linkage Position Indicator
(1) 8T2819 Linkage Position Indicator. (2) Cover over fuel setting screw. (3) 8T1000 Dial Indicator.

NOTE: Clean the contact, inside plastic nut, with a pencil eraser before using the linkage position indicator.

2. Remove synchronizing pin, and install the 8T2819 Linkage Position Indicator in its place.

3. Connect the 6V4060 Set Point Indicator with 6V2100 Multitach. Follow Steps 1 through 3 on page 14 of Special Instruction SEHS7931-02. Instead of connecting to rack contact screw, connect 1P7446 Cable to the 8T2819 Linkage Position Indicator.

4. Decide on the fuel linkage position where you want to measure engine speed. Loosen the setscrews and turn plastic nut of the linkage position indicator until it indicates contact closure at the desired linkage position. Listen for the contact closure indication and observe the dial indicator as the governor is moved in the "FUEL ON" direction. Tighten the setscrews to lock plastic nut in position. Again, check to make sure that contact closure is indicated at the desired point.

5. Start the engine and measure the speed at which the contacts in the 8T2819 Linkage Position Indicator close when engine is loaded at **full throttle.** Follow Steps 4 and 5 on page 14 of SEHS7931-02. This Special Instruction refers to contact closure as "set point". Use the hold source switch (see Step 7 on Page 15 of SEHS7931-02). Load the engine until the lug light and overrun lights are both off. Try to hold this load for ¾ second while the set point indicator averages speed.

Record this speed and repeat this process. Take at least five readings of contact closure speed and average the readings as in Step 8 on Page 15 of SEHS7931-02. The highest and lowest reading used should not be more than 25 rpm apart. This average is the full throttle engine speed at the fuel linkage position set in Step 4.

6. To determine the percent of full load of the fuel linkage position, we also need to measure fuel linkage position. With the engine running at high idle, turn the plastic nut of the linkage position indicator clockwise until the lug light and overrun lights are both off.

7. Shut the engine down and manually move the governor in the "FUEL ON" direction while listening for an indication of contact closure and observing the dial indicator. Record the dial indicator reading of high idle fuel linkage position "I". This reading will be negative (approximately −4 mm).

Matching Droop Settings On Multiple Engine Installations

In some applications it is necessary to set 2 or more engines so that they have the same droop. For such applications use the following procedure.

On Engine No. 1 do the following:

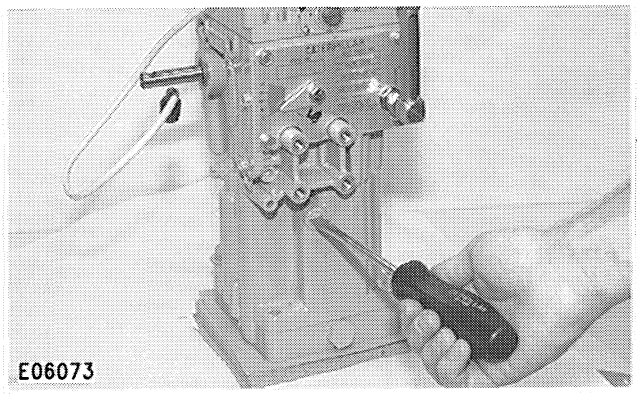
1. Measure high idle speed.
2. Load the engine to a fuel linkage position above 50 percent load and measure speed. (For the procedure, see Measurement Of Full Throttle Speed At A Given Load Or Fuel Linkage Position.)
3. Calculate speed differential:
   speed differential = HI –X percent load

On Engine No. 2 do the following:

4. Do Steps 1 through 3 on engine No. 2.
5. If speed differential is greater than that of engine No. 1, reduce droop setting. If speed differential is less than that of engine No. 1, increase droop setting.
6. Repeat Steps 4 and 5 until the speed differential is the same as engine No. 1 for the same loads or the same fuel linkage positions.
7. Adjust the high idle speed to match the high idle of engine No. 1. Both engines now have identical overrun curves.

Compensation Needle Valve Adjustment

After the engine has started and is under governor control, open the needle valve (turn it counterclockwise) until governor operation just becomes unstable (starts to hunt), then turn the needle valve in until engine speed has stability. Let the governor and engine get to operating temperature by operating a minimum of one-half hour. After the engine and governor are at the operating temperature, again check for stable operation. Adjust as necessary. DO NOT fully close the needle valve. This can cause excessive overshoot on startup, or load rejection.



Needle Valve Adjustment

With the engine at normal operating temperature and no load, operate the engine at low idle speed. Open the governor compensation needle valve and let the governor increase and decrease engine speed (hunt) for a minimum of 30 seconds to remove air from the system. If the governor does not hunt, rapidly move the speed control shaft to change governor stability.

After 30 seconds and the air is removed from the system, turn the needle valve in (clockwise) until the engine runs smoothly.

With the engine running at medium (mid) speed, load the engine (at least one-quarter load) to find the stability of the setting. Quickly remove the load. A slight overshoot of speed is ideal, as it reduces response time. The engine speed should return to smooth steady operation. If it does not have a slight overshoot and return to a smooth steady operation, adjust the needle valve and repeat the above procedure.

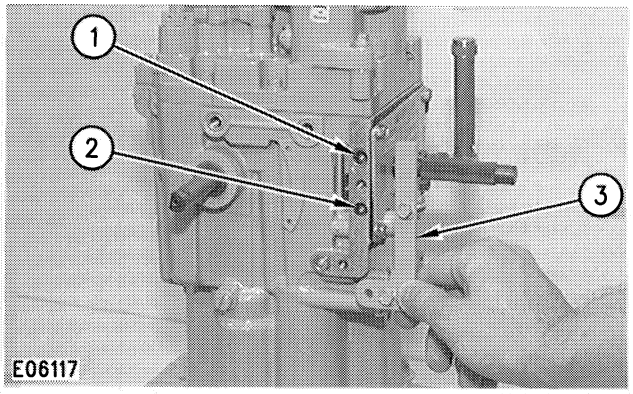
Governor terminal shaft "jiggle" or surge is an indication of:

1. Too little compensation (needle valve out too far);
2. Torsional vibration (pulsing);
3. Improperly aligned governor drive spline;
4. A binding or loose fuel control mechanism.

Low And High Idle Adjustments

Make sure the engine fuel setting is correct before low and high idle adjustments are made. See the Testing & Adjusting section of the Engine Service Manual for the fuel setting procedure.

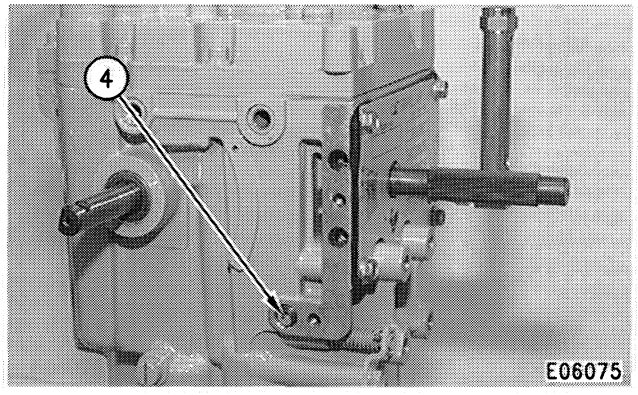
NOTE: The pneumatic speed control can prevent the engine from reaching high or low idle. See Pneumatic Speed Setting Control Adjustments in the Auxiliary Controls section for more information.



Idle Adjustment
(1) Low idle speed stop screw. (2) High idle speed stop screw. (3) Plate.

The adjustments made to high idle change the torque rise settings (where applicable). If adjustments are made to high idle, see the Torque Rise Setting Procedure section for torque rise calibration.

Low and high idle speed stop screws (1 & 2) are on the left side of the governor case, and are adjusted from the outside of the governor.



D11N
(4) Detent speed setting screw.

NOTE: For D11N applications, the detent speed setting screw (4) is used to adjust low idle speed. To ensure proper operation of the detent shutdown feature, the low idle speed stop screw must not be set to a higher speed than the detent speed setting screw.

The low and high idle speed stop screw is covered by plate (3). The plate is held to the governor case with two wire lock bolts. Install a wire and seal on the high idle speed adjustment cover bolts after any governor work to prevent tampering.

A ⅛ inch hex wrench is used for turning both low and high idle speed stop screws.

⚠ WARNING

The engine may overspeed due to improper reassembly or adjustment, which could result in personal injury, loss of life, and/or property damage.

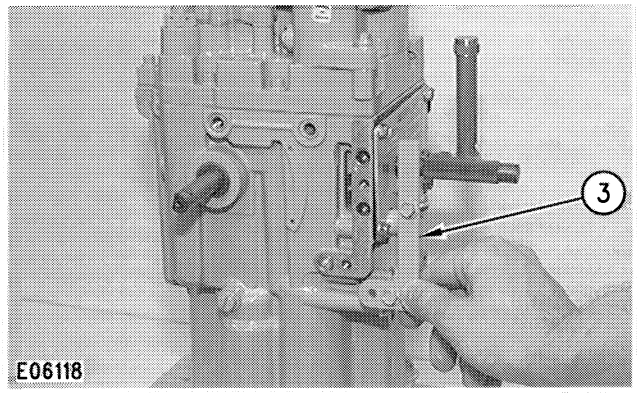
Be prepared to stop the engine by activating the emergency air shut off or closing the air inlets. On natural gas engines, the fuel must also be shut off.

For non D11N applications, to increase low idle speed, turn the low idle speed setting screw (1) clockwise.

For D11N applications, to increase low idle speed, turn the detent speed setting screw (4) clockwise. Back the low idle speed setting screw (1) out (counterclockwise) at least two turns to ensure that it will not affect proper operation of the detent shutdown. Verify detent shutdown operation after adjustment.

NOTE: If the governor is equipped with an electric speed adjusting motor or a pneumatic speed control, reduce engine speed before the high idle setting is reduced to prevent binding of the internal linkage.

Turn high idle speed stop screw (2) clockwise to decrease high idle speed.



Install Cover
(3) Plate.

When the high and low idle speeds are adjusted to the specifications given in the TMI (Technical Marketing Information) or Fuel Setting and Related Information fiche, install the plate and the two bolts. Put a seal wire through the holes in the bolt heads and install the seal as required on other Caterpillar fuel systems.

Torque Rise Setting Procedure

Governors With Single Or Dual Slope Torque Rise Springs

Tools Needed		
8T1000	Electronic Position Indicator Group [1]	2
5P4814	Collet	1
5P7263	Contact Point, 76.2 mm (3.00 in) long	1
4C6100	Governor Control Group	1
4C6098	Speeder Shaft Torque Arm [2]	1
4C6099	Terminal Shaft Torque Arm [2,3]	1
4C6101	Terminal Shaft Torque Arm [2,4]	1
4C6102	Weight, 2.3 kg (5.0 lb) [2]	1
4C6103	Weight, 4.0 kg (9.0 lb) [2]	1
8T0500	Circuit Tester	1

[1] If this indicator group is not available, use the 6V3075 Dial Indicator.
[2] Part of 4C6100 Governor Control Group.
[3] Use for 776B, 777B, 785 and 789.
[4] Use for D11N.

The D11N and 994, have a single slope rise governor. The 776B, 777B, 785, 789 and 793 all have dual slope torque rise governors.

1. Refer to the "Static Fuel Settings" in the TMI (Technical Marketing Information) or Fuel Setting and Related Information fiche to find the correct settings for the FULL LOAD breakpoint and FULL TORQUE setting.

In the past "Static Fuel Settings" in the TMI (Technical Marketing Information) or Fuel Setting and Related Information fiche for the 3500 Engines. This fuel setting was "MAXIMUM RACK TRAVEL" and was listed as "STATIC FUEL SETTING".

For those 3500 Engines equipped with a 3161 Generator Set Governor, or an earlier Standard Governor, the fuel setting procedure has not changed. The fuel setting screw is used to set the "MAXIMUM RACK TRAVEL", but, the specification in the TMI (Technical Marketing Information) or Fuel Setting and Related Information fiche is shown as "FULL LOAD". "FULL LOAD" and "FULL TORQUE" dimensions will be the same number.

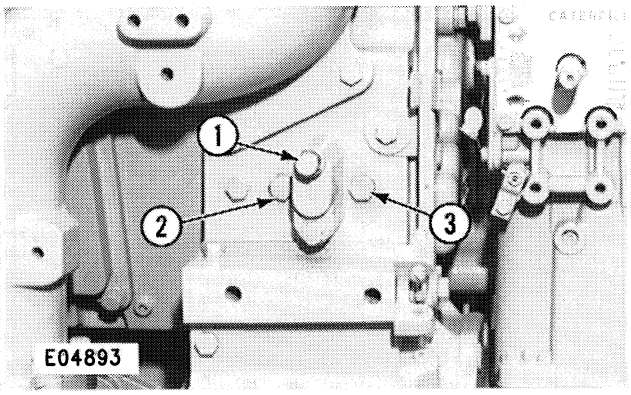
For those 3500 Engines equipped with 3161 Governors that have a single or dual slope torque rise, there are tow static fuel dimensions. The first dimension is "FULL TORQUE", which is maximum rack travel, and is set with the fuel setting screw. The second dimension is "FULL LOAD", which is a "reference position" where the fuel control linkage is held, while the torque rise spring is adjusted. This is a temporary dimension, set with the synchronizing pin. This dimension is shown in the TMI (Technical Marketing Information) or Fuel Setting and Related Information fiche as "FULL LOAD".

The dual slope torque rise governor has an additional dimension "first breakpoint". This "first breakpoint" dimension is 5.43 mm (0.214 in) less than the "FULL LOAD" dimension. This is also a temporary dimension that is set with the synchronizing pin. This dimension is NOT shown in the TMI (Technical Marketing Information) or Fuel Setting and Related Information fiche.

Altitude Deration

Refer to ALTITUDE DERATING DATA under the STATIC FUEL SETTINGS in the TMI (Technical Marketing Information) or Fuel Setting and Related Information fiche to find the correct dimension for the "FULL LOAD" breakpoint and "FULL TORQUE", for operation at a specific altitude. On dual slope torque rise governors the "first breakpoint" will be 5.43 mm (0.214 in) less than the "FULL LOAD" dimension in all altitude ranges.

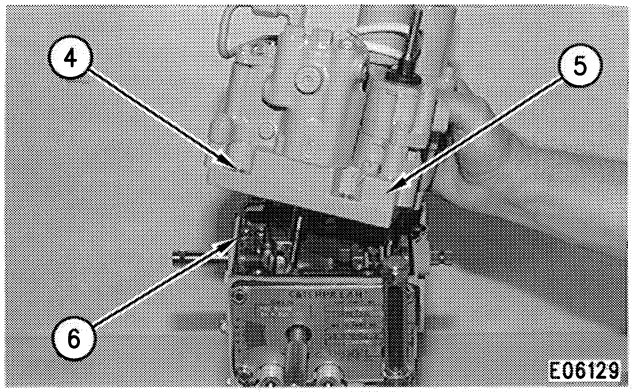
NOTE: Before removing the top cover of the governor, make sure that the entire area surrounding the governor is free from dirt and debris. A high pressure wash is recommended to clean the governor and governor area before adjustment.



(1) Synchronizing pin. (2) Test port. (3) Test port.

2. Remove plugs from test ports (2) and (3).

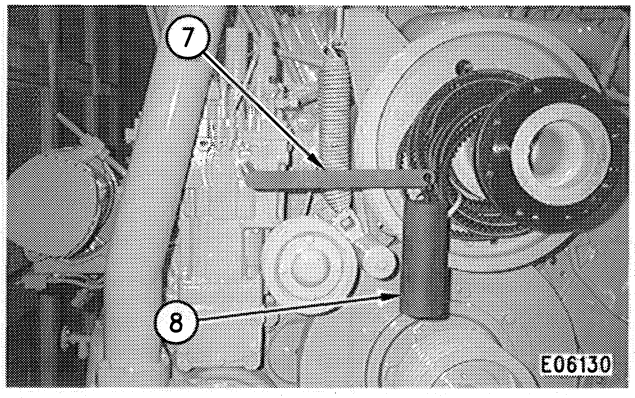
3. Remove synchronizing pin (1) from the fuel setting cover. **Remove the washer** from the synchronizing pin. Install the synchronizing pin in test port (2). Tighten synchronizing pin (1) to a torque of 10 ± 2 N•m (90 ± 18 lb in).



(4) Bolts. (5) Cover. (6) Gasket.

4. Remove bolts (4) that hold the top cover in position on the governor. Make sure that the oil level of the governor is below the joint face of the top cover and the governor housing. This will eliminate the loss of oil due to spillage.

Remove top cover (5) and gasket (6).

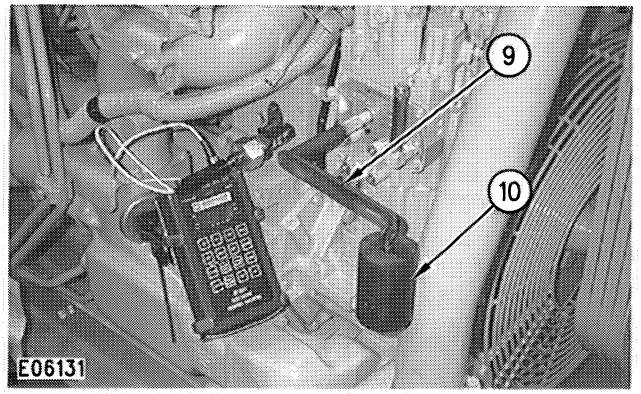


(7) 4C6101/4C6099 Terminal Shaft Torque Arm. (8) 4C6103 Weight.

5. Install the 4C6101/4C6099 Terminal Shaft Torque Arm (7) on the terminal shaft and turn the shaft to a fully clockwise (CW) position.

The Terminal Shaft Torque Arm handle must point toward the center of the engine and be within ± 30 degrees horizontal when it is installed and turned clockwise (CW). Hold the shaft in position and hang the 4C6103 Weight [4 kg (9.0 lb)] (8) on the hole in the handle of the arm.

The arm and weight are used to hold the terminal shaft of the governor in the full clockwise (CW) position. This puts the fuel control linkage stop lever against the end of the synchronizing pin.



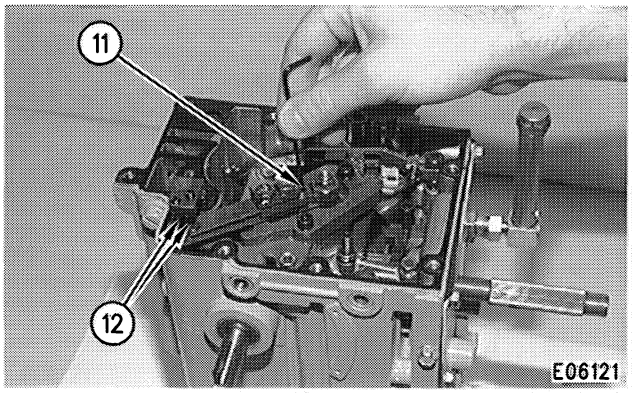
(9) 4C6098 Speeder Shaft Torque Arm. (10) 4C6102 Weight.

6. Install the 4C6098 Speeder Shaft Torque Arm (9) on the speeder shaft and turn the shaft clockwise (CW) to a full throttle position.

The Speeder Shaft Torque Arm handle must point toward the radiator and be within ± 30 degrees horizontal when it is installed and turned clockwise (CW). Hold the shaft in position and hang the 4C6102 Weight [2.3 kg (5.0 lb)] (8) on the hole in the handle of the arm. The arm and weight are used to hold the throttle (speeder shaft) in the "FULL ON" position.

NOTE: The use of the Torque Arms and Weights, puts the fuel control linkage in position for adjustment. Do Not Operate The Engine With These Tools On The Governor. The Tools Are Designed For Adjustment Purposes Only.

7. Install and zero the indicator. Either an 8T1000 Electronic Position Indicator Group, or, the 6V3075 Dial Indicator are acceptable to use. Installation instructions for both indicators are as follows:
   a. 8T1000 Electronic Position Indicator Group
      Install the 5P4814 Collet in test port (3). Slice the 8T1002 Probe with the 5P7263 Contact Point into the 5P4814 Collet until 8T1002 Probe sleeve bottoms in the 5P4814 Collet. Tighten the collet enough to hold the probe in this position. Attach the probe to the 8T1001 Indicator. Turn the indicator ON and set it to measure millimeters. With the indicator ON, touch the zero button. The indicator is now ready to be used for the adjustment.
   b. 6V3075 Dial Indicator
      Install the 5P4814 Collet in test port (3). Slide the 6V3075 Dial Indicator with the 5P7263 Contact Point into the 5P4814 Collet. When the contact point seats against the fuel stop lever, slide the indicator IN or OUT, until the indicator dial reads "ZERO". Tighten the collet enough to hold the indicator in this position. The indicator is now ready to be used for the adjustment.



(11) Null screw. (12) Screw balls, pads and control spring sides.

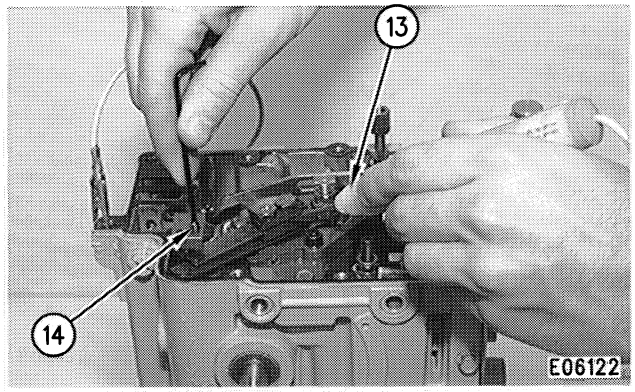
8. Use a 3/32 hex wrench to turn null screw (11), on the governor torque control group, in a clockwise (CW) direction until it stops. This positions the pilot valve to the static adjust/test position for torque control setting screws.

NOTE: Clean screw balls, pads and control spring sides (12) with solvent to insure electrical contact while testing.

NOTE: Steps 9 and 10 do not apply to single slope torque rise governors. Proceed to Step 11 when adjusting a single slope torque rise governor.

9. Loosen the synchronizing pin until the dimension for the "first breakpoint" setting is read on the indicator.

Apply a slight amount of pressure (tapping) on the 4C6099 Terminal Shaft Torque Arm (7) and 4C6103 Weight (8), to make sure the fuel stop lever is solidly against the synchronizing pin.



(13) 8T0500 Circuit Tester. (14) Top leaf spring adjustment screw.

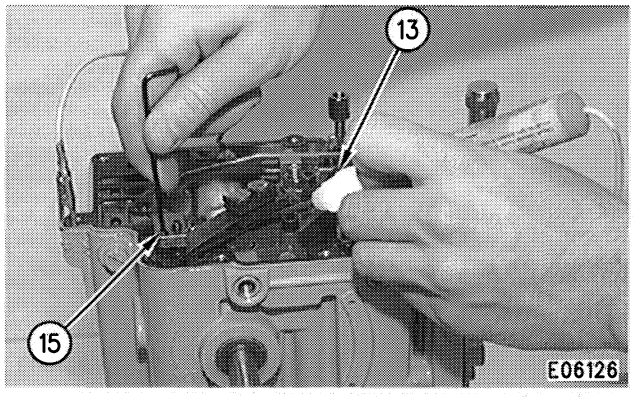
10. Connect the clip end of the 8T0500 Circuit Tester (13) to the governor case-to-cover bolt hole. Touch the probe end of the circuit tester to the edge of the first spring (top leaf spring) in sandwich portion of the control group.

NOTE: Do not touch the probe end to the top surface of the leaf spring because the oxide film will cause faulty continuity readings.

Use a 3/32 hex wrench to turn top leaf spring adjustment screw (14). Turn top leaf spring adjustment screw (14) in a clockwise (CW) direction until the circuit tester light just comes on (a dim light). If the circuit tester light is already lit, turn the top leaf spring adjustment screw (14) counterclockwise (CCW) until light goes off and then turn the adjustment screw clockwise (CW) until light is dimly lit.

11.Loosen the synchronizing pin (1) until the "FULL LOAD" dimension is read on the indicator.

Apply a slight downward "tapping" pressure on the 4C6099 Terminal Shaft Torque Arm (7) and 4C6103 Weight (8), to insure that the fuel stop lever is solidly against the synchronization pin (1).



(13) 8T0500 Circuit Tester. (15) Bottom leaf spring adjustment screw.

12. Connect the clip end of the 8T0500 Circuit Tester (12) to the governor case-to-cover bolt hole. Touch the probe end of the circuit tester to the edge of the bottom leaf spring in sandwich portion of the control.

NOTE: Do not touch the probe end to the top surface of the leaf spring because the oxide film will cause faulty continuity readings.

On single slope torque rise governors there is only one spring.

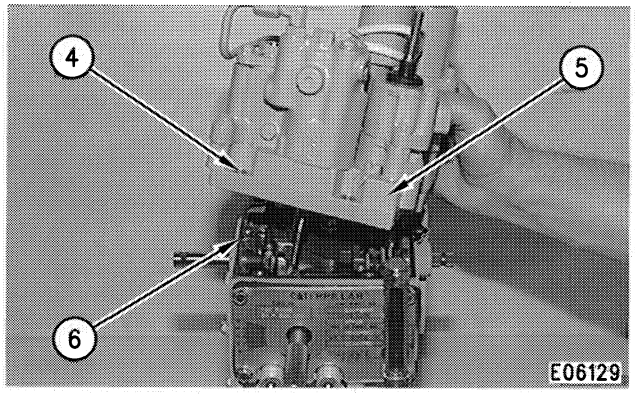
Use a 3/32 hex wrench to turn bottom leaf spring adjustment screw (15). Turn bottom leaf spring adjustment screw (15) in a clockwise (CW) direction until the circuit tester light just comes on (a dim light). If the circuit tester light is already lit, turn the bottom leaf spring adjustment screw (15) counterclockwise (CCW) until light goes off and then turn the adjustment screw clockwise (CW) until light is dimly lit. Single slope torque rise governors have only one adjustment screw.

13. Use a 3/32 hex wrench to turn null screw (11), on the governor torque control group, in a counterclockwise (CCW) direction until it stops. This releases the torque control pivot (pilot valve) to the run position.

NOTE: Null screw (11) must be in the run position before installation of the top cover and running the engine. Failure to return the screw to the run position will result in failure to start, erratic operation of the engine and failure to accept a load.

14. Loosen the synchronizing pin (1) and back it out a minimum of 15.4 mm (1.00 in). Apply a slight downward pressure on the 4C6101/4C6099 Terminal Shaft Torque Arm (7) and 4C6103 Weight (8). The dimension of the indicator should be equal to the "FULL TORQUE" setting.

If adjustment is necessary, refer to the topic entitled Fuel Setting Adjustment in the Testing & Adjusting section of the Service Manual for the adjustment procedure.



(4) Bolts. (5) Cover. (6) Gasket.

15. Install the top cover (5) with a new gasket (6) on the governor. Install bolts (4) and tighten them to a torque of 10 ± 2 N•m (90 ± 18 lb in). After the top cover is installed, put a seal wire through the holes in both the plug and bolt head. Install the governor seal.

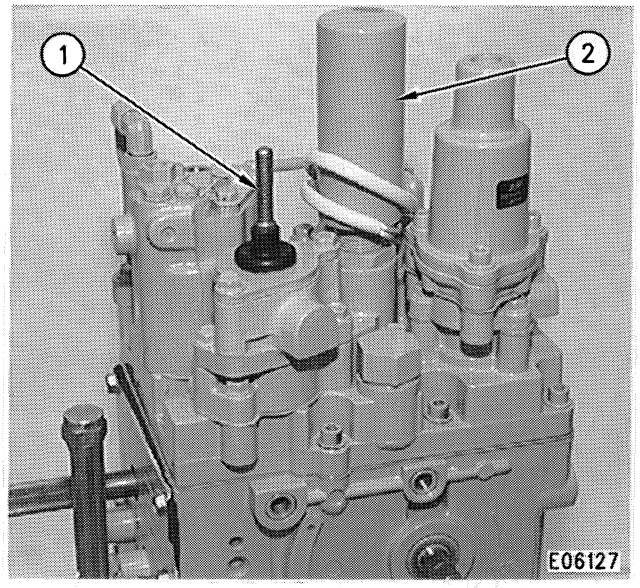
16. Remove the 8T1002 Probe or the 6V3075 Dial Indicator and 5P4814 Collet from test port (3).

17. Remove synchronizing pin (1) from test port (2). Install the washer on the synchronizing pin, then install the synchronizing pin in the fuel setting cover.

18. Install the test port plugs in test ports (2) and (3).

Auxiliary Controls

Shutdown Rod Adjustment

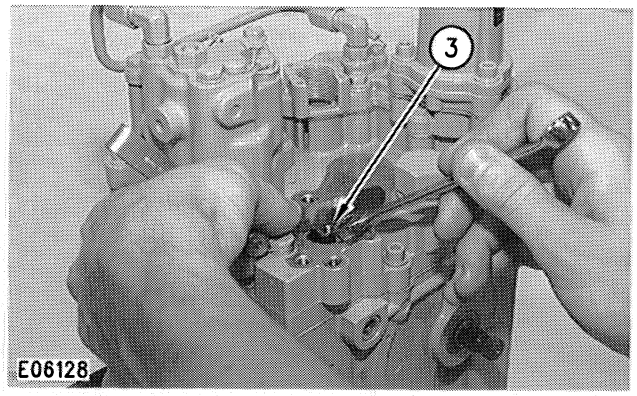


(1) Manual shutdown device. (2) Electric shutdown device.

1. Remove the two bolts that hold Manual shutdown device (1) to the Pressure shutdown device (not shown) or Electric shutdown device (2). Remove the Manual shutdown device and gasket from the governor.

2. Remove the two bolts that hold the Pressure shutdown device (not shown) to Electric shutdown device (2) or governor cover and remove the Pressure shutdown device and gasket.

3. If the Electric shutdown device is used in conjunction with a diode, (64 volt Shutdown) remove the bolt that holds the diode to the governor and the remaining bolts from Electric shutdown device (2) and remove the Electric shutdown device and gasket.



(3) Shutdown rod nut.

4. With engine running, place a straight edge across the shutdown rod opening and shutdown rod nut (3) as shown. Use a 7/16 open-end wrench and start turning shutdown rod nut (3) counterclockwise until the governor just starts to shutdown. Once shutdown starts, turn the nut back clockwise one full turn.

Shutdown Device Adjustment

NOTE: The Electric shutdown device and Pressure shutdown device should be checked prior to installation and tested after installation, plus, tested at 1000 hour intervals thereafter.

NOTICE

Failure to test, inspect and maintain these items could result in faulty operation and possible severe engine damage if an emergency shutdown situation occurs.

The Electric shutdown group is either an ETS (Energized To Shutdown) or ETR (Energized To Run) shutdown. Identify which type you have and make a note of it.

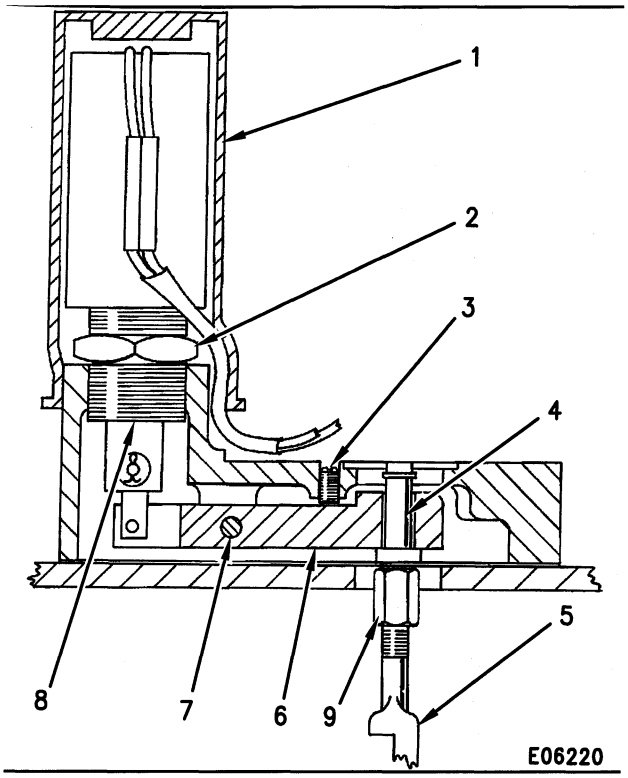
1. Visually inspect the Pressure shutdown components for signs of burrs, nicks, scoring and/or wear. If there is evidence of problems, repair or replace as necessary. Inspect the Pressure shutdown mounting gasket and determine if it is reusable. Replace if necessary.

2. Visually inspect the Electric shutdown device and determine if there is any component wear. If the shutdown is an ETS version, pay particular attention to the connection of the shutdown solenoid plunger and the shutdown lever link pin.

If there is evidence of wear (the plunger pin hole is oval in shape), replace the Solenoid. Inspect the shutdown group mounting gasket and determine if it is reusable. If necessary replace it.

Check size of spacer on the electric shutdown solenoid plunger. Refer to Service Magazine article "Field Replacement of Spacer to Correct Possible Sticking in Woodward 3161 Governor Electric Shutoff Group", November 19, 1990.

Electric Shutdown Solenoid Adjustment



(1) Solenoid coil. (2) Jam nut. (3) Set screw. (4) Shutdown plunger. (5) Limit shutdown rod. (6) Shutdown lever. (7) Pivot pin. (8) Solenoid plunger. (9) Shutdown rod nut.

Energized To Shutdown

1. Place the electric shutdown housing in a vise using copper jaws or shop towels to protect the sides of the aluminum die-cast shutdown housing. Do NOT over tighten the vise.

Loosen the jam nut (2) that holds the solenoid in the electric shutdown housing. Remove solenoid coil (1) exposing the shutdown solenoid plunger (8).

NOTE: Loctite 222 is used on the solenoid coil threads at the time of manufacturing. In addition the jam nut is torqued to 75 N•m (55 lb ft).

2. Carefully clean any dirt, metal filings or metal chips from the solenoid plunger and from the cavity in the solenoid coil. Turn the jam nut on the solenoid coil counterclockwise a couple of turns so it will not interfere with the adjustment of the solenoid coil. Reinstall solenoid coil in the electric shutdown housing only three or four turns.

3. Holding the shutdown housing and gasket on a clean flat surface, adjust the set screw (3) until the shutdown plunger (4) contacts the flat surface, then turn the set screw counterclockwise ¼ turn.

4. Holding the shutdown housing and gasket on a clean flat surface turn the solenoid coil clockwise into the electric shutoff housing until it stops. Turn the solenoid coil counterclockwise two full turns.

Apply a new coat of 9S3263 Thread Lock to the solenoid coil threads and turn the solenoid coil clockwise one full turn.

5. Do not allow the solenoid coil to turn inside the housing. Place the electric shutdown housing in a vise using copper jaws or shop towels to protect the sides of the aluminum die-cast shutdown housing. Do NOT over tighten the vise.

Torque the jam nut to 68 ± 7 N•m (50 ± 5 lb ft) without allowing the solenoid coil to move.

Energized To Run

1. Place the electric shutdown housing in a vise using copper jaws or shop towels to protect the sides of the aluminum die-cast shutdown housing. Do NOT over tighten the vise.

Loosen the jam nut (2) that holds the solenoid in the electric shutdown housing. Remove solenoid coil (1) exposing the shutdown solenoid plunger (8).

NOTE: Loctite 222 is used on the solenoid coil threads at the time of manufacturing. In addition the jam nut is torqued to 75 N•m (55 lb ft).

2. Carefully clean any dirt, metal filings or metal chips from the solenoid plunger and from the cavity in the solenoid coil. Turn the jam nut on the solenoid coil counterclockwise a couple of turns so it will not interfere with the adjustment of the solenoid coil. Reinstall solenoid coil in the electric shutdown housing only three or four turns.

3. Holding the shutdown housing and gasket on a clean flat surface, adjust the set screw (3) until the set screw (3) contacts the shutdown plunger (4), then turn the set screw counterclockwise ¼ turn.

4. Holding the shutdown housing and gasket on a clean flat surface apply the appropriate voltage to the solenoid leads to energize the solenoid. With the shutdown in the energized position turn the solenoid coil clockwise until the shutdown plunger contacts the set screw.

Turn the solenoid coil counterclockwise one turn and apply a new coat of 9S3263 Thread Lock to the solenoid coil threads. Turn the solenoid coil clockwise 1 and ¼ turns. Disconnect voltage from solenoid leads.

5. Do not allow the solenoid coil to turn inside the housing. Place the electric shutdown housing in a vise using copper jaws or shop towels to protect the sides of the aluminum die-cast shutdown housing. Do NOT over tighten the vise.

Torque the jam nut to 68 ± 7 N•m (50 ± 5 lb ft) without allowing the solenoid coil to move.

Shutdown Device Installation

1. Install the Electric shutdown device with gasket on the governor top cover. Torque the three hold down bolts to 10 ± 2 N•m (90 ± 18 lb in).

If the Electric shutdown is equipped with a diode, attach the diode to the cover. Thread the electric leads through the conduit fitting on the governor cover.

2. Install the Pressure shutdown device with gasket on the Electric shutdown group. Torque the hold down bolts to 10 ± 2 N•m (90 ± 18 lb in).

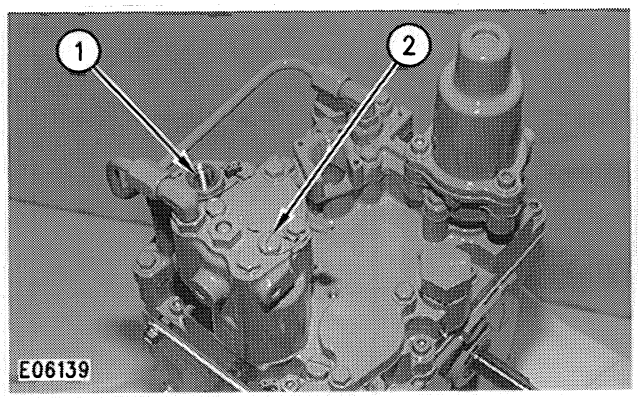
3. Install the Manual shutdown device with gasket on the Pressure shutdown device. If Pressure shutdown device is not used, install Manual shutdown device with gasket on Electric shutdown group. Torque the hold down bolts to 10 ± 2 N•m (90 ± 18 lb in).

4. Check that the terminal shaft goes to fuel off when each shutdown device is activated. Refer to "Shutdown Device Checks" for procedures.

The PSC and FARC MUST be checked and recalibrated (if necessary), whenever the top cover has been removed. Refer to Pneumatic Speed Setting Control Adjustments and Fuel Air Ratio Control Adjustment procedures.

Pneumatic Speed Setting Control Adjustments

Tools Needed		
8T0846	Pressure Indicator	1
2D7325	Tee	1

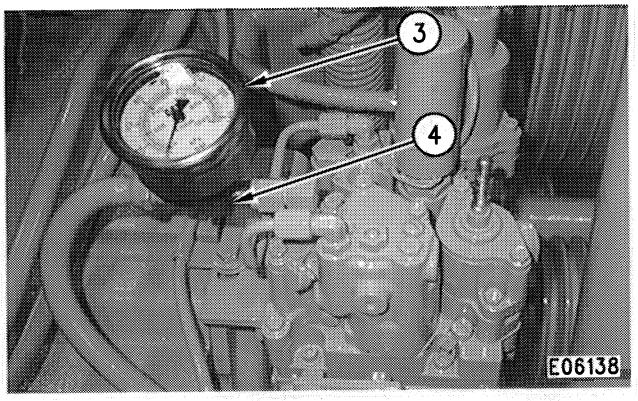


Pneumatic Speed Setting Control
(1) Bellows. (2) Plug (over low idle adjustment screw).

The pneumatic speed setting control has two adjustments. One is the speed range adjustment made by turning the bellows (1) inside the housing to increase or decrease the speed range.

The other is the pneumatic speed level (bias spring) adjustment, made by removing plug (2) and turning the adjustment screw with a ⅛ inch hex wrench.

An incorrectly adjusted pneumatic speed control, or incorrectly adjusted control air pressure can cause unexplained speed changes or an inability to reach high or low idle. Before any adjustment of the pneumatic speed setting control is made, the control air pressure from the remote throttle must be correct. To check control air pressure connect a pressure indicator between the pneumatic speed control and the air supply.



Connect Pressure Indicator
(3) 8T0846 Pressure Indicator. (4) 2D7325 Tee.

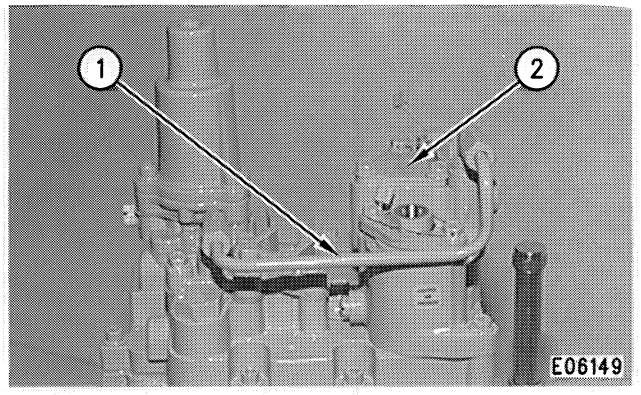
The control air pressure range should be 35 kPa (5 psi) below the pressure at which the governor reaches low idle and 35 kPa (5 psi) above the pressure at which the governor reaches high idle. For example, if the governor's pneumatic control is factory set to reach low idle at 35 kPa (5 psi), the signal pressure at the minimum throttle setting should not exceed 0 kPa (0 psi). If the governor's pneumatic control is factory set to reach high idle at 365 kPa (53 psi), the signal pressure at the maximum throttle setting should be 400 kPa (58 psi) or 35 kPa (5 psi) more.

Make sure that the control air pressure is moving the governor to high and low idle. Remove the governor name plate and see if the speed setting shaft lever makes contact with both the low idle and high idle adjustment screws when air pressure is applied and removed.

If the speed setting shaft lever does not contact the low idle adjustment screw (no control air pressure to the pneumatic control), the engine speed will not drop when the low idle screw is backed out. The speed level adjustment screw (for the pneumatic speed control) must be turned until the governor speed setting shaft lever contacts the low idle adjustment screw.

Feedback Spring

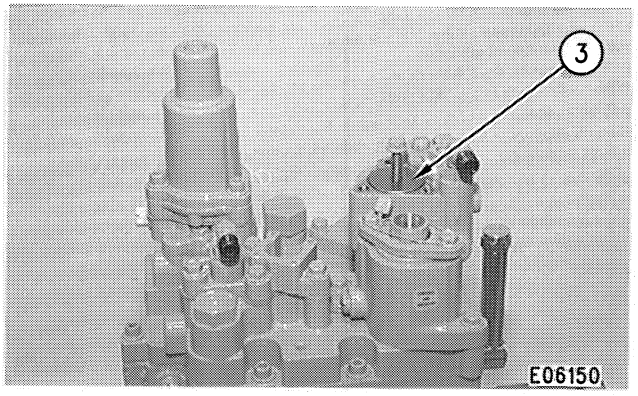
To use the pneumatic speed setting control with different air pressure ranges and engine speed settings the feedback spring must be changed.



Remove Oil Line
(1) Tube assembly. (2) Plate.

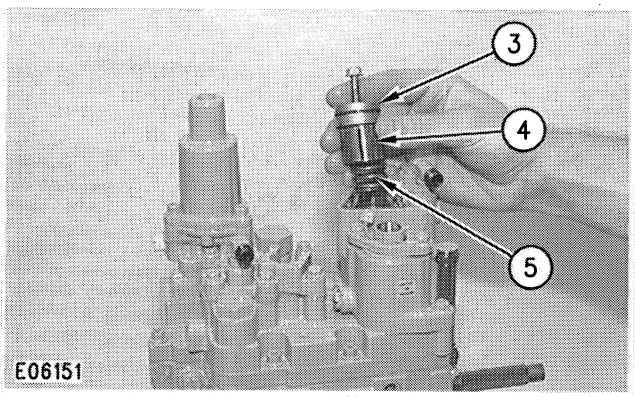
NOTE: Step 1 is not necessary on later governors.

1. Remove tube assembly (1) and plate (2) from the governor.



Remove Plug
(3) Plug.

2. Install one of the bolts for plate (2) into plug (3) as shown and pull plug (3) out of its bore.



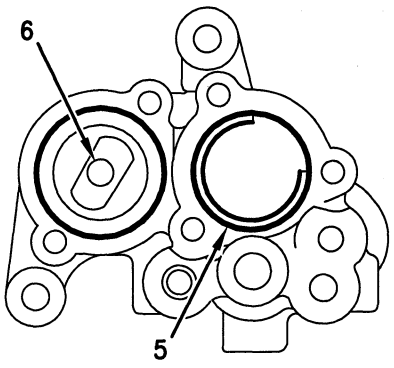
Feedback Spring And Speed Setting Piston Position
(3) Plug. (4) Piston. (5) Feedback spring.

3. With plug (3) out of the bore, speed setting piston (4) and feedback spring (5) can be lifted out of the bore with a magnet.

4. Find the correct feedback spring to use for the air pressure range and engine speed rating from the pneumatic speed control spring chart.

3500 Engine Pneumatic Speed Control Spring Chart				
Rated Speed RPM	**Low Idle RPM ***	**High Idle RPM ***	**Feedback Spring Part No.**	**Spring Identification ****
900	450	897 to 1016	4W6628	79
1000		967 to 1165	4W6632	64
1100 1200 1300		1108 to 1397	4W6627	50 (std.)
1400 1500	600	1375 to 1670	4W6632	64
1600 1700 1800		1585 to 2018	4W6627	50 (std.)

* The speed settings shown are for the standard governor setting air pressure of:
Low idle – 35 kPa (5 psi) or 70 kPa (10 psi)
High idle – 380 kPa (55 psi) or 415 kPa (60 psi)
** The spring identification number is on the flat ground surface on one end of each spring.



(5) Feedback spring. (6) PSC air inlet port.

5. Install feedback spring (5) in the bore over the speed setting rod. The feedback spring should be rotated so the spring coil end on the bottom is located on the bore centerline as shown.

NOTE: Feedback spring (5) may be either left or tight hand wound.

6. Place piston (4) over feedback spring (5) and push it down into the counterbore.

7. Install a new seal on plug (3), if the original seal is not in good condition.

8. Push plug (3) down in the bore and remove the bolt.

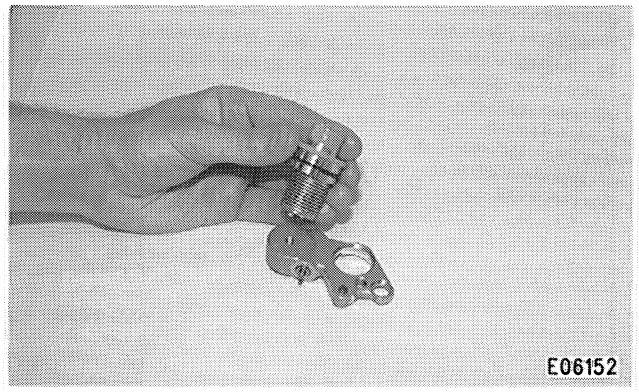
9. Put plate (2) in position, and install the three bolts and tighten them to 10 N•m (90 lb in).

10. Install tube assembly (1) on the governor.

NOTICE
Be careful not to get paint or other foreign material down in the bore, as this will affect the control operation.

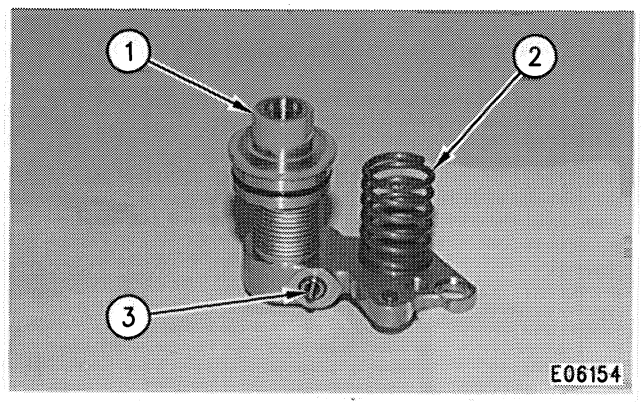
Speed Range Adjustment

The bellows is made off-center (eccentric) to the top flange area. The bottom of the bellows has a swivel pin that engages the hole in the end of the speed setting lever. The swivel pin is set off-center (eccentric) to the bottom of the bellows but is in line with the center of the air inlet port in the top of the flange.



Speed Setting Bellows And Lever

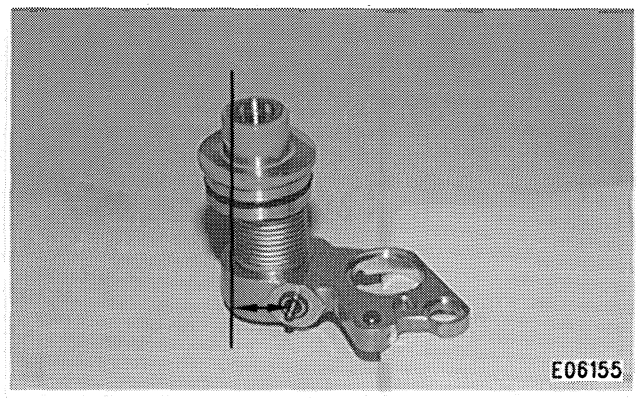
There is an index mark (notch) 0.76 mm (.030 in) deep on the outer face of the bellows flange. The index mark is approximately mid range position when it is turned to the front of the governor (when facing the governor name plate).



Speed Setting Control
(1) Air inlet port. (2) Feedback spring. (3) Pivot.

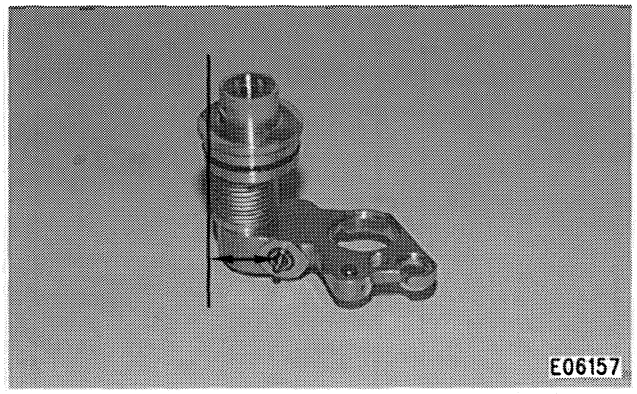
Control air pressure enters the bellows through air inlet port (1) at the top of the flange. Control air pressure expands the speed setting bellows, which pushes down on the lever at the left of pivot (3), raising the right end of the lever against feedback spring (2). The force of the feedback spring is marked on the end of the spring.

When the bellows is turned, the eccentric changes the position of the bellows on the speed setting lever. This changes the length of the lever arm. The lever arm is the distance from pivot (3) to the outer edge of the bellows.



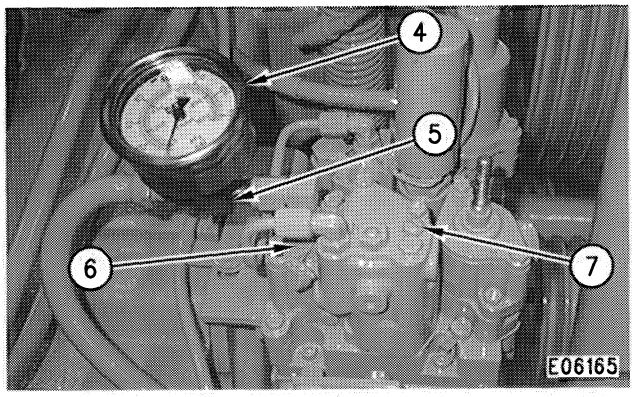
Lower Speed Setting

When the bellows is turned with the index mark to the right side of the governor (counterclockwise as seen from governor nameplate), the bellows moves closer to the pivot pin. This makes the lever arm shorter and lowers engine speed for a given amount of air pressure.



Higher Speed Setting

With the index mark to the left side of the governor (as seen from governor nameplate), the bellows is farther away from the pivot pin. The lever arm is now longer and engine speed is increased for a given amount of air pressure.



Connect Pressure Indicator
(4) 8T0846 Pressure Indicator. (5) 2D7325 Tee. (6) Clamp (over speed setting bellows). (7) Plug (over speed level adjustment screw).

Before the control adjustment can be made, install a pressure indicator as shown in the control air supply line. Also, connect a tachometer with good accuracy to the engine.

1. Disconnect the air supply to pneumatic speed control.
2. Remove the governor nameplate to observe the speed setting control shaft lever movement.

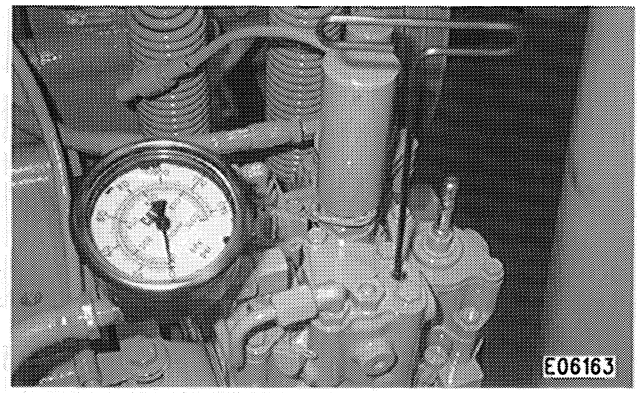
⚠ WARNING

Work carefully around an engine that is running. Engine parts that are hot, or parts that are moving, can cause personal injury.

3. Start the engine and check low and high idle engine speeds by turning the speed setting control shaft by hand. See the Engine Information Plate and the TMI (Technical Marketing Information) or Fuel Setting and Related Information fiche for the correct specifications.

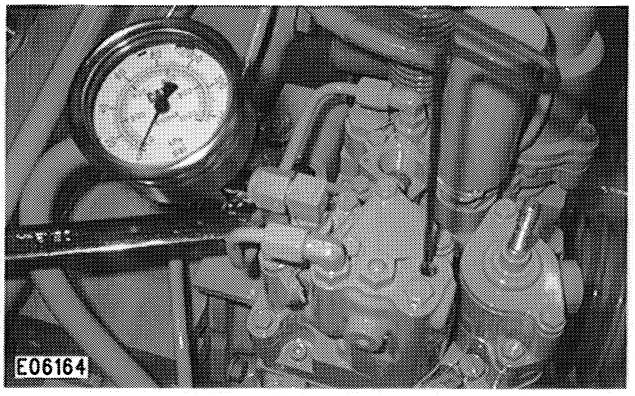
NOTE: Because of speed control shaft bearing clearance, engine speeds can increase by 15 to 20 rpm above normal operating conditions when torque is applied on the control shaft.

4. Turn the low idle adjustment screw and reduce engine low idle speed by 50 rpm (for example 800 – 50 = 750 rpm).
5. Apply the recommended low idle control air pressure to the pneumatic speed setting control with the engine at low idle [for example 35 kPa (5 psi)].



Adjust Low Idle Speed

6. Clean the top of the governor and remove plug (7) from the pneumatic speed control. Use a ⅛ inch hex wrench and turn the speed level adjustment screw to adjust engine low idle speed to its original setting (800 rpm).
7. Increase control air pressure slowly and watch engine speed increase to the high idle setting (for example 1800 rpm). The object is to reach high idle (control shaft lever in contact with high idle adjustment screw) at 35 kPa (5 psi) lower than maximum system control air pressure. For example: Maximum system control air pressure is 480 kPa (70 psi) – 35 kPa (5 psi) = 445 kPa (65 psi).
8. If high idle speed **is** reached before the desired control air pressure [example above 445 kPa (65 psi)], lower the control air to the low idle air pressure 35 kPa (5 psi).



Adjust Bellows

Loosen the two bolts that hold the bellows clamp down. With a ¾ inch wrench, turn the bellows in a counterclockwise direction (as seen from above the governor) and tighten the clamp bolts. Use the ⅛ inch hex wrench to turn the speed level adjustment screw and adjust the low idle speed setting (back to 800 rpm) at low air pressure [35 kPa (5 psi)].

9. If the high idle speed **is not** reached at the desired control air pressure [example 445 kPa (65 psi)], lower the control air to the low idle air pressure 35 kPa (5 psi).

Loosen the two bolts that hold the bellows clamp down. With the ¾ inch wrench, turn the bellows in a clockwise direction (as seen from above the governor) and tighten the clamp bolts. Use the ⅛ inch hex wrench to turn the speed level adjustment screw and adjust the low idle speed setting (back to the 800 rpm) at low air pressure [35 kPa (5 psi)].

10. Again, increase the control air to the pressure required for the high idle speed. If the speed range is still incorrect, repeat the above steps until the correct low idle speed and high idle speed setting is reached for each required air pressure. Make sure to tighten the bellows clamp bolts after the speed setting is correctly adjusted.

11. Turn the low idle adjustment screw back to its original setting (example 800 rpm).

12. Check the pneumatic speed setting control for external leaks. Remove the pressure indicator from the control air supply line.

Fuel Air Ratio Control Adjustments

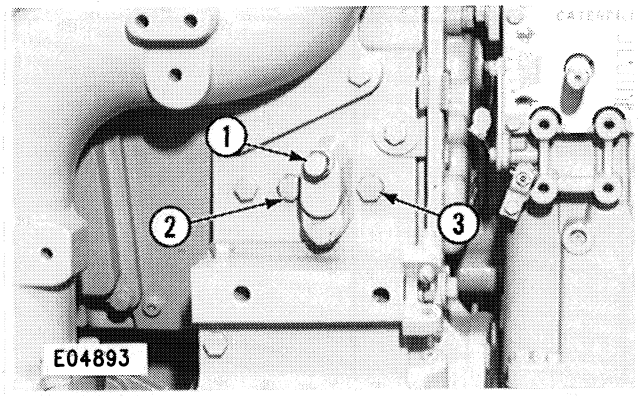
Tools Needed		
8T1000	Electronic Position Indicator Group [1]	2
5P4814	Collet	1
5P7263	Contact Point, 76.2 mm (3.00 in) long	1
4C6100	Governor Control Group	1
4C6098	Speeder Shaft Torque Arm [2]	1
4C6099	Terminal Shaft Torque Arm [2,3]	1
4C6101	Terminal Shaft Torque Arm [2,4]	1
4C6102	Weight, 2.3 kg (5.0 lb) [2]	1
4C6103	Weight, 4.0 kg (9.0 lb) [2]	1
FT1819	Governor Torque Arm [5]	1

[1] If this indicator group is not available, use the 6V3075 Dial Indicator.
[2] Part of 4C6100 Governor Control Group.
[3] Use for 776B, 777B, 785 and 789.
[4] Use for D11N.
[5] Use for Commercial.

There are two adjustments for the fuel air ratio control. One adjustment is the fuel limit adjustment. The other adjustment is a gain rate which is factory set and must not be changed.

Check And Adjustment Of Fuel Limiter

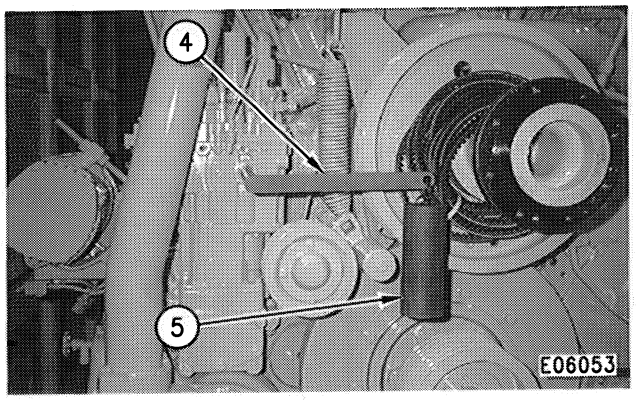
1. For the correct fuel ratio control setting dimension refer to TMI (Technical Marketing Information) or the Fuel Setting and Related Information fiche.



(1) Synchronizing pin. (2) Test port. (3) Test port.

2. Remove the plug from test ports (2) and (3).

3. Remove synchronizing pin (1) from the fuel setting cover. **Remove the washer** from the synchronizing pin. Install the synchronizing pin (1) in test port (2). Tighten synchronizing pin (1) to a torque of 10 ± 2 N•m (90 ± 18 lb in).

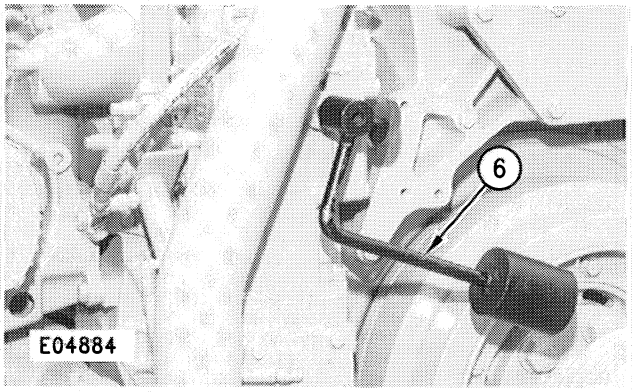


Caterpillar Vehicular Engines.
(4) 4C6101/4C6099 Terminal Shaft Torque Arm. (5) 4C6103 Weight.

4. Install the 4C6101/4C6099 Terminal Shaft Torque Arm (4) on the terminal shaft and turn the shaft to a fully clockwise (CW) position.

The torque arm handle must point toward the center of the engine and be within ± 30 degrees of horizontal when it is installed and turned clockwise (CW). Hold the shaft in position and hang 4C6103 Weight (5), [40 kg (9.0 lb)] on the hole in the handle of the arm.

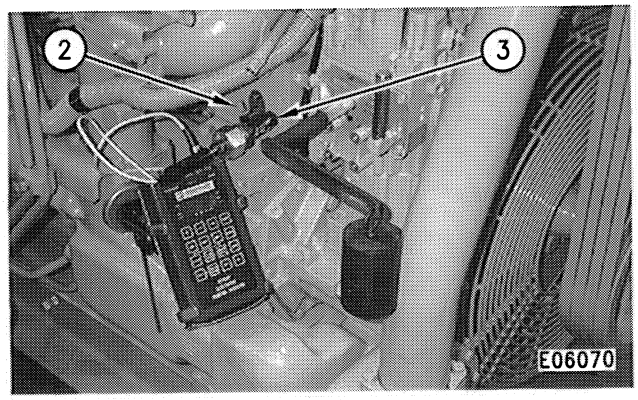
The arm and weight are used to hold the terminal shaft of the governor in the full clockwise (CW) position. This puts the fuel control linkage stop lever against the end of the synchronizing pin. The 4C6101/4C6099 Terminal Shaft Torque Arm (4) is to be attached only with the engine "shut down".



Commercial Engines
(6) FT1819 governor Torque Arm.

5. Install FT1819 Governor Torque Arm (6) on the terminal shaft. The FT1819 Governor Torque Arm (6) is used to hold the terminal shaft of the governor in the full clockwise (CW) position. This puts the fuel control linkage stop lever against the end of the synchronizing pin. The FT1819 Governor Torque Arm (6) is to be attached only with the engine "shut down".

NOTE: On some applications, FT1819 Governor Torque Arm (6) can not be used. Move the governor output shaft in the "FUEL ON" direction by hand. Hold the governor output shaft and fuel control linkage against the synchronizing pin with a force of 10 N•m (90 lb in) to give an accurate dial indicator reading.



(2) Test port. (3) Test port.

6. Install and zero the indicator. Either an 8T1000 Electronic Position Indicator Group, or, the 6V3075 Dial Indicator are acceptable for use. Installation instructions for both indicators are as follows:

   a. 8T1000 Electronic Position Indicator Group
   Install the 5P4814 Collet in test port (3). Slide the 8T1002 Probe with the 5P7263 Contact Point into the 5P4814 Collet until 8T1002 Probe sleeve bottoms in the 5P4814 Collet. Tighten the collet enough to hold the probe in this position. Attach the probe to the 8T1001 Indicator. Turn the indicator ON and set it to measure millimeters. With the indicator ON, touch the zero button. The indicator is now ready to be used for the adjustment.

   b. 6V3075 Dial Indicator
   Install the 5P4814 Collet in test port (3). Slide the 6V3075 Dial Indicator with the 5P7263 Contact Point into the 5P4814 Collet. When the contact point seats against the fuel stop lever, slide the indicator IN or OUT, until the indicator dial reads "ZERO". Tighten the collet enough to hold the indicator in this position. The indicator is now ready to be used for the adjustment.

7. Remove 4C6101/4C6099 Terminal Shaft Torque Arm (4) and 4C6103 Weight (5), or, FT1819 Governor Torque Arm (6) from the governor terminal shaft. Make sure the terminal shaft returns to the "FUEL OFF" position.

8. Disconnect the boost line from the fuel ratio control. Plug the boost line to keep dirt and foreign material out of the engine.

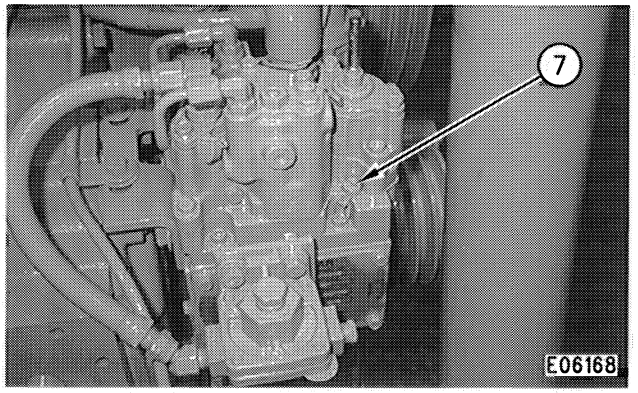
⚠ WARNING

Work carefully around an engine that is running. Engine parts that are hot, or parts that are moving, can cause personal injury.

9. Start the engine.

10. Rapidly move the speed control shaft in the speed increase direction. The rack position indicator will go up to the fuel limit position, pausing momentarily at this position as the engine accelerates to Hi idle and then drops back to the idle rack position as the engine speed reaches Hi idle. Repeat this procedure several times and read the rack position indicator during each pause.

At the point where the rack position indicator pauses is the limit for fuel control linkage movement set by the fuel ratio control. If the fuel limit setting is in need of adjustment, proceed to Step 11. If the fuel limit setting is correct, stop the engine and proceed to Step 13.



(7) Plug.

11. Remove plug (7) from the right front corner of the top cover. Put a 3/16 hex wrench through the hole in the top cover until it engages the adjustment screw. Rapidly move the speed control shaft in the speed increase direction. The rack position indicator will go up to the fuel limit position, pausing momentarily at this position as the engine accelerates to Hi idle and then drops back to the idle rack position as the engine speed reaches Hi idle.

During the momentary pause, turn the limit adjustment screw until the dimension on the rack position indicator is the same as the specifications given the TMI (Technical Marketing Information) or Fuel Setting And Related Information fiche.

Turning the limit adjustment screw clockwise (CW) will decrease the limiter setting, while turning the limit adjustment screw counterclockwise (CCW) will increase the limiter setting.

12. When the adjustment is correct, stop the engine. Remove the hex wrench and install the plug in the top cover. Put a seal wire through the holes in both the plug and the bolt head. Install the governor seal. Remove the plug from the boost line. Connect the boost line from the inlet manifold to the fuel ratio control.

13. Remove 8T1002 Probe or 6V3075 Dial Indicator and 5P4814 Collet from test port (3).

14. Remove synchronizing pin (1) from test port (2). Install the washer on synchronizing pin (1) and install the synchronizing pin in the fuel setting cover.

15. Install the test port plugs in test ports (2) and (3).

Printed in U.S.A.