

Figure 3

selection of elements relative to inhibitor compatibility with coolant solutions shown in Figure 2.

Problems have developed from the use of the magnesium lower support plate used by some manufacturers in their coolant filters. The magnesium plate will be attacked by solutions which will not be detrimental to other metals in the cooling system. The dissolved magnesium will be deposited in the hottest zones of the engine where heat transfer is most critical (Figure 3). The use of aluminum or zinc in preference to magnesium is recommended to eliminate this type of deposit.

A high chloride coolant will have a detrimental effect on the water softening capabilities of systems using ion-exchange resins. Accumulations of calcium and magnesium ions removed from the coolant and held captive by the zeolite resin can be released into the coolant by a regenerative process caused by high chloride content solutions.

Bulk Inhibitor Additives

Commercially packaged inhibitor systems are available which can be added directly to the engine coolant or to bulk storage tanks containing coolant solution. Both chromate and non-chromate systems are available and care should be taken regarding inhibitor compatibility with other coolant constituents (Figure 2).

A non-chromate inhibitor system is recommended for use in Detroit Diesel Allison engines. The non-chromate systems can be used with either water or ethylene glycol antifreeze solutions and provide

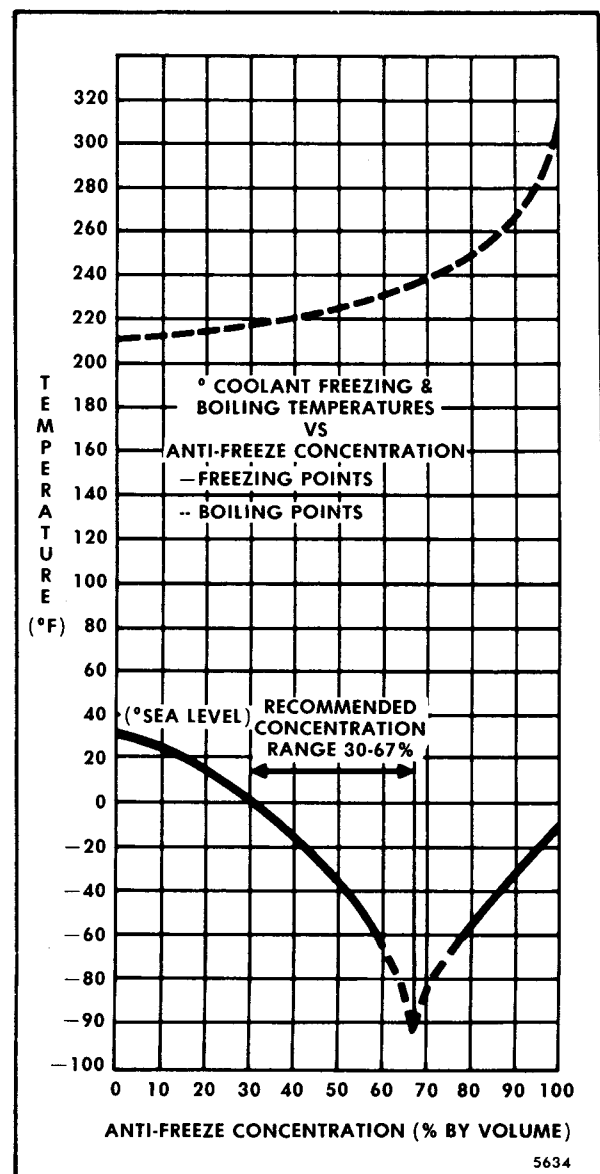


Figure 4

corrosion protection, pH control and water softening. Some of the approved non-chromate inhibitor systems offer the additional advantage of a simple on site test to determine protection level and, since they are added directly to the coolant, require no additional hardware or plumbing.

ANTIFREEZE

When freeze protection is required, an ethylene glycol base permanent antifreeze should be used. An inhibitor system is included in this type of antifreeze and no additional inhibitors are required on initial fill if a minimum antifreeze concentration of 30% by

volume is used. Solutions of less than 30% concentration do not provide sufficient corrosion protection. Concentrations over 67% adversely affect freeze protection and heat transfer rates (Figure 4).

Methoxy propanol base antifreeze may be used for freeze protection in Series 71 engines. Before installing methoxy propanol base antifreeze in an engine, the entire cooling system should be drained, flushed with clean water, and examined for rust, scale, contaminants, etc. If deposits are present, the cooling system must be chemically cleaned with a commercial grade heavy-duty de-scaler.

Inhibitor depletion will occur in ethylene glycol base antifreeze through normal service. The inhibitors should be replenished at approximately 500 hour or 20,000 mile intervals with a non-chromate inhibitor system. Commercially available inhibitor systems (Fig. 2) may be used to re-inhibit antifreeze solutions.

Several brands of permanent antifreeze are available with sealer additives. The specific type of sealers vary with the manufacturer. Antifreeze with sealer additives is *not* recommended for use in Detroit Diesel

Allison engines due to plugging problems throughout various areas of the cooling system.

COOLANT RECOMMENDATIONS

1. Always use a properly inhibited coolant.
2. If freeze protection is required, always use ethylene glycol antifreeze.
3. Re-inhibit antifreeze with a non-chromate inhibitor system.
4. Always follow the manufacturer's recommendations on inhibitor usage and handling.
5. Do not use soluble oil.
6. Chromate inhibitors should *never* be used with permanent antifreeze.
7. Sealer type antifreeze should *not* be used.
8. Maintain prescribed inhibitor strength.
9. Do not mix ethylene glycol base antifreeze with methoxy propanol base antifreeze in the cooling system.

ENGINE TUNE-UP PROCEDURES

There is no scheduled interval for performing an engine tune-up. As long as the engine performance is satisfactory, no tune-up should be needed. Minor adjustments in the valve and injector operating mechanisms, governor, etc. should only be required periodically to compensate for normal wear on parts.

Four types of governors are used. Since each governor has different characteristics, the tune-up procedure varies accordingly. The four types are:

1. Limiting speed mechanical.
2. Variable speed mechanical.
3. Variable speed hydraulic.
4. Limiting speed hydraulic.

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

Normally, when performing a tune-up on an engine in service, it is only necessary to check the various adjustments for a possible change in the settings. However, if the cylinder head, governor or injectors have been replaced or overhauled, then certain preliminary adjustments are required before the engine is started.

The preliminary adjustments consist of the first four items in the tune-up sequence. The procedures are the same except that the valve clearance is greater for a cold engine.

To tune-up an engine completely, all of the adjustments, except the valve bridge adjustment on four valve cylinder heads, are made by following the applicable tune-up sequence given below, after the engine has reached normal operating temperature. Since the adjustments are normally made while the engine is stopped, it may be necessary to run the engine between adjustments to maintain normal operating temperature.

NOTE: The exhaust valve bridges on the four valve cylinder head are adjusted at the time the

cylinder head is installed on the engine and, until wear occurs, no further adjustment is required. When wear is evident, perform a complete valve bridge adjustment as outlined on the following pages.

The tune-up procedures apply to the individual engines of multiple engine units as well as to the single engine units. However, the throttle linkage of multiple engine units must be adjusted after the individual engines have been tuned up.

Tune-Up Sequence for Mechanical Governors

1. Adjust the exhaust valve clearance.
2. Time the fuel injectors.
3. Adjust the governor gap.
4. Position the injector rack control levers.
5. Adjust the maximum no-load speed.
6. Adjust the idle speed.
7. Adjust the buffer screw.
8. Adjust the throttle booster spring (variable speed governor only).
9. Adjust the supplementary governing device (if used).

Tune-Up Sequence for Hydraulic Governor

1. Adjust the exhaust valve clearance.
2. Time the fuel injectors.
3. Adjust the governor linkage.
4. Position the injector rack control levers.
5. Adjust the load limit screw.
6. Compensation adjustment (PSG governors only).
7. Adjust the governor speed droop.
8. Adjust the maximum no-load speed.

EXHAUST VALVE CLEARANCE ADJUSTMENT

The correct exhaust valve clearance at normal engine operating temperature is important for smooth, efficient operation of the engine.

Insufficient valve clearance can result in loss of compression, misfiring cylinders and, eventually, burned valve seats and valve seat inserts. Excessive valve clearance will result in noisy operation, especially in the low speed range.

Whenever the cylinder head is overhauled, the exhaust valves are reconditioned or replaced, or the valve operating mechanism is replaced or disturbed in any way, the valve clearance must first be adjusted to the cold setting to allow for normal expansion of the engine parts during the engine warm-up period. This will ensure a valve setting that is close enough to the specified clearance to prevent damage to the valves when the engine is started.

ENGINES WITH TWO VALVE CYLINDER HEADS

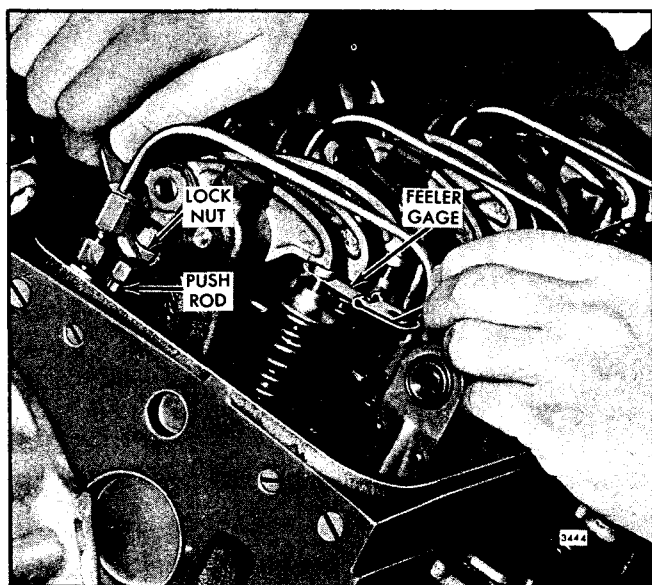


Fig. 1 - Adjusting Valve Clearance

All of the exhaust valves may be adjusted, in firing order sequence, during one full revolution of the crankshaft. Refer to the *General Specifications* at the front of the manual for the engine firing order.

Exhaust Valve Clearance Adjustment (Cold Engine)

1. Place the governor stop lever in the no-fuel position.
2. Clean the loose dirt from the valve rocker covers and remove the covers. Then cover any drain cavities in the cylinder head to prevent foreign material from entering.
3. Rotate the crankshaft, with the starting motor or

engine barring tool J 22582, until the injector follower is fully depressed on the cylinder to be adjusted.

CAUTION: If a wrench is used on the crankshaft or camshaft bolt at the front of the engine, do not turn the engine in a left-hand direction of rotation as the bolt will be loosened.

4. Loosen the exhaust valve rocker arm push rod lock nut.
5. Place a .013" feeler gage, tool J 9708, between the valve stem and the rocker arm (Fig. 1). Adjust the push rod to obtain a smooth "pull" on the feeler gage.
6. Remove the feeler gage. Hold the push rod with a 5/16" wrench and tighten the lock nut with a 1/2" wrench.
7. Recheck the clearance. At this time, if the adjustment is correct, the .011" feeler gage will pass freely between the valve stem and the rocker arm, but the .013" feeler gage will not pass through.
8. Check and adjust the remaining valves in the same manner as outlined above.

Exhaust Valve Clearance Adjustment (Hot Engine)

Maintaining normal engine operating temperature is particularly important when making the final valve clearance adjustment. If the engine is allowed to cool off before setting any of the valves, the clearance when running at full load may become insufficient.

With the engine at normal operating temperature (160° - 185°F.), recheck the exhaust valve clearance with feeler gage J 9708. At this time, if the valve clearance is correct, the .008" feeler gage will pass freely between the valve stem and the rocker arm, but the .010" gage will not pass through.

ENGINES WITH FOUR VALVE CYLINDER HEADS

The exhaust valve bridges must be adjusted and the adjustment screws locked securely at the time the cylinder head is installed on the engine. Until wear occurs, no further adjustment is required on the exhaust valve bridges. When wear is evident, make the necessary adjustments as outlined below.

Exhaust Valve Bridge Adjustment

1. Remove the loose dirt from the valve rocker covers and remove the covers. Remove the injector fuel pipes and the rocker arm bracket bolts. Move the rocker arms away from the exhaust valve bridge.

2. Remove the exhaust valve bridge (Fig. 2).

3. Place the bridge in a vise or holding fixture J 21772 and loosen the lock nut on the bridge adjusting screw.

CAUTION: Loosening or tightening the lock nut with the bridge in place may result in bending the bridge guide or the rear valve stem.

4. Install the bridge on the bridge guide.

5. While firmly pressing straight down on the pallet surface of the bridge, turn the adjusting screw clockwise until it just touches the valve stem. Then turn the screw an additional 1/8 to 1/4 turn clockwise and tighten the lock nut finger tight.

6. Remove the bridge and place it in a vise. Hold the

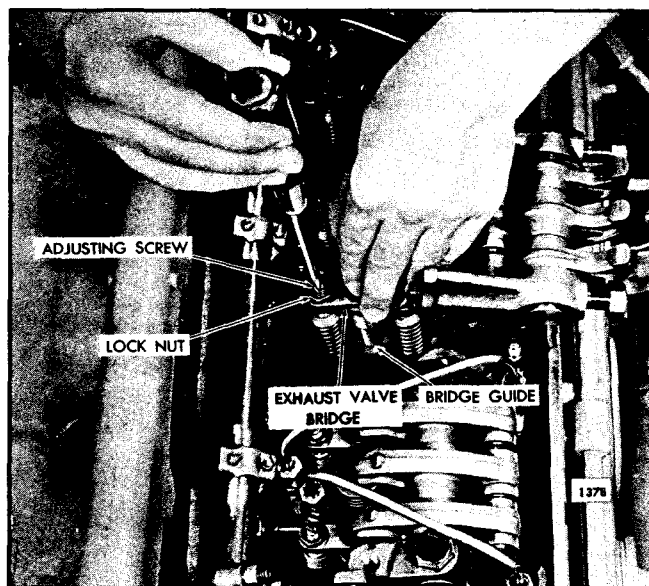


Fig. 2 - Bridge Balancing Adjustment

screw from turning with a screw driver and tighten the lock nut on the adjustment screw. Complete the operation by tightening the lock nut with a torque wrench to 25 lb-ft, being sure that the screw does not turn.

7. Lubricate the bridge guide and the bridge pilot with engine oil.

8. Reinstall the bridge in its original position.

9. Place a .0015" feeler gage under each end of the bridge. When pressing down on the pallet surface of the bridge, both feeler gages must be tight. If both feeler gages are not tight, readjust the screw as outlined in Steps 5 and 6.

10. Adjust the remaining bridges as outlined above.

11. Swing the rocker arm assembly into position being sure the bridges are properly positioned on the rear valve stems. This precaution is necessary to prevent valve damage due to mislocated bridges.

12. Tighten the rocker arm bracket bolts to 90-100 lb-ft torque.

13. Align the fuel pipes and connect them to the injectors and the fuel connectors. Use socket J 8932 to tighten the connectors to 12-15 lb-ft torque.

CAUTION: Do not bend the fuel pipes and do not exceed the specified torque. Excessive tightening will twist or fracture the flared ends of the fuel pipes and result in leaks. Lubricating oil diluted by fuel oil can cause serious damage to the engine bearings.

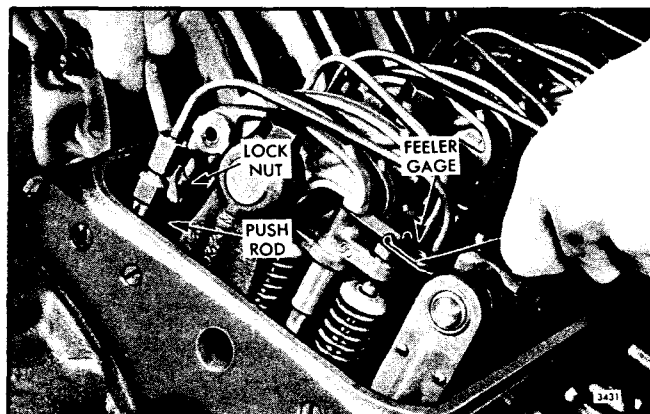


Fig. 3 - Adjusting Valve Clearance

Exhaust Valve Clearance Adjustment (Cold Engine)

All of the exhaust valves may be adjusted, in firing order sequence, during one full revolution of the crankshaft. Refer to the *General Specifications* at the front of the manual for the engine firing order.

1. Place the governor stop lever in the no-fuel position.
2. Clean the loose dirt from the valve rocker covers and remove the covers. Then cover any drain cavities in the cylinder head to prevent foreign material from entering.

NOTE: On certain 12V turbocharged engines, it is necessary to remove the air inlet housing to remove the rocker covers.

3. Rotate the crankshaft, with the starting motor or engine barring tool J 22582, until the injector follower is fully depressed on the cylinder to be adjusted.

CAUTION: If a wrench is used on the crankshaft or camshaft bolt at the front of the engine, do not turn the engine in a left-hand direction of rotation as the bolt will be loosened.

4. Loosen the exhaust valve rocker arm push rod lock nut.
5. Place a .017" feeler gage, J 9708, between the valve bridge and the valve rocker arm pallet (Fig. 3). Adjust

the push rod to obtain a smooth "pull" on the feeler gage.

6. Remove the feeler gage. Hold the push rod with a 5/16" wrench and tighten the lock nut with a 1/2" wrench.

7. Recheck the clearance. At this time, if the adjustment is correct, the .015" feeler gage will pass freely between the valve bridge and the rocker arm pallet, but the .017" feeler gage will not pass through.

8. Check and adjust the remaining valves in the same manner as outlined above.

Exhaust Valve Clearance Adjustment (Hot Engine)

Maintaining normal engine operating temperature is particularly important when making the final valve clearance adjustment. If the engine is allowed to cool off before setting any of the valves, the clearance when running at full load may become insufficient.

1. With the engine at normal operating temperature (160°-185°F.), recheck the exhaust valve clearance with feeler gage J 9708. At this time, if the valve clearance is correct, the .013" feeler gage will pass freely between the valve bridge and the rocker arm pallet, but the .015" gage will not pass through. Readjust the push rod, if necessary.

2. After the exhaust valve clearance has been adjusted, check the fuel injector timing.

TIMING FUEL INJECTOR

To time an injector properly, the injector follower must be adjusted to a definite height in relation to the injector body.

All of the injectors can be timed, in firing order sequence, during one full revolution of the crankshaft. Refer to the *General Specifications* at the front of the manual for the engine firing order.

Use the proper timing gage as indicated in the chart.

Time Fuel Injector

After the exhaust valve clearance has been adjusted, time the fuel injectors as follows:

1. Place the speed control lever in the idle speed position. If a stop lever is provided, secure it in the *no-fuel* position.

2. Rotate the crankshaft, by using the starting motor or engine barring tool J 22582, until the exhaust valves are fully depressed on the particular cylinder to be timed.

CAUTION: If a wrench is used on the crankshaft bolt or camshaft nut at the front of the engine, do not turn the engine in a left-hand direction or the bolt or nut will be loosened.

3. Place the small end of the injector timing gage in the hole provided in the top of the injector body, with the flat of the gage toward the injector follower (Fig. 4).

4. Loosen the exhaust valve rocker arm push rod lock nut.

5. Turn the push rod and adjust the injector rocker arm until the extended part of the gage will just pass over the top of the injector follower.

INJECTOR TIMING GAGE CHART (NEEDLE VALVE)

Injector	Timing Gage Dimension	Timing Gage Tool Number	Camshaft Timing
GENERATOR SET APPLICATIONS			
ALL	1.460"	J 1853	Standard
ALL OTHER APPLICATIONS			
71N5	*1.460"	J 1853	*Standard
N55	*1.460"	J 1853	*Standard
N60	*1.460"	J 1853	*Standard
N65 (White Tag)	1.460"	J 1853	Standard
N65 Turbo (Brown Tag)	1.484"	J 1242	Standard
N65 Non-Turbo (Brown Tag)	**1.484"	J 1242	**Advanced
HN65	1.460"	J 1853	Standard
N70 Turbo	1.460"	J 1853	Standard
N70 Non-Turbo	1.460"	J 1853	Advanced
N75 Turbo	1.460"	J 1853	Standard
N80 Turbo	1.484"	J 1242	Standard
N80 Non-Turbo	**1.484"	J 1242	**Advanced

*Use 1.484" timing gage (J 1242) when engine has advanced camshaft timing. Correct to standard camshaft timing and 1.460" injector timing at first opportunity to be consistent with current production build.

**Use 1.460" timing gage (J 1853) when engine has standard camshaft timing. Correct to advanced camshaft timing and 1.484" injector timing at first opportunity.

NOTE: Advanced camshaft timing is indicated by "Adv-Cam-Timing" stamped on lower right hand side of option plate.

Injector Timing Gage Chart (Needle Valve)

6. Hold the push rod and tighten the lock nut. Check the adjustment and, if necessary, readjust the push rod.

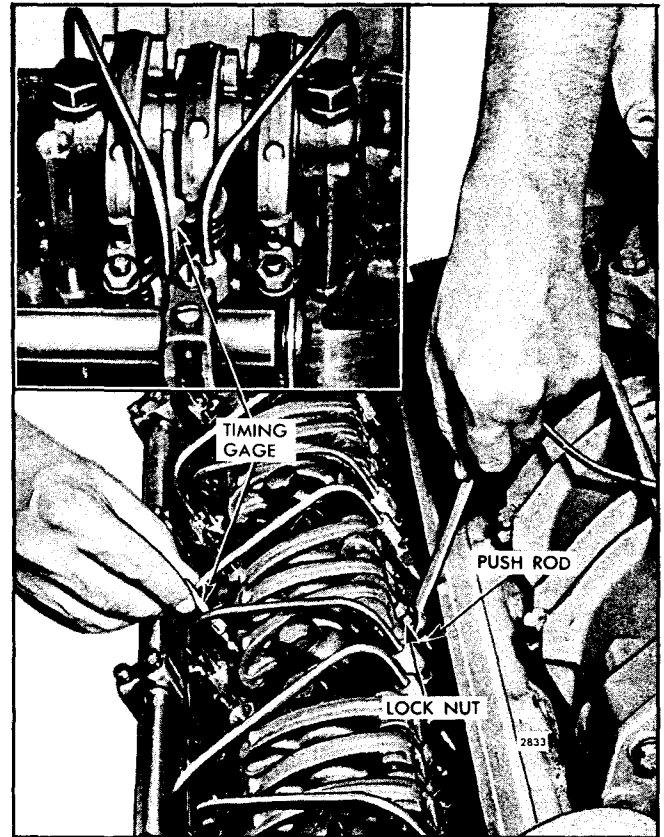


Fig. 4 - Timing Fuel Injector

7. Time the remaining injectors in the same manner as outlined above.

8. If no further engine tune-up is required, use new gaskets and install the valve rocker covers.

LIMITING SPEED MECHANICAL GOVERNOR AND INJECTOR RACK CONTROL ADJUSTMENT

6, 8 and 12V-71 ENGINES

The two types of limiting speed mechanical governors used on the V-71 engines are covered in this procedure. The difference between each type of governor is in the high speed spring retainer and spring housing assembly. Industrial engines use the standard limiting speed governor, while some applications may find it advantageous to use the dual-range limiting speed governor.

The only variation in the tune-up procedure between each type of governor is in the setting of the maximum no-load speed. Therefore, the setting of the maximum no-load engine speed is given for each type of limiting speed governor.

After adjusting the exhaust valves and timing the fuel injectors, adjust the governor and position the injector rack control levers.

NOTE: Before proceeding with the governor and injector rack adjustments, disconnect any supplementary governing device. After the adjustments are completed, reconnect and adjust the supplementary governing device.

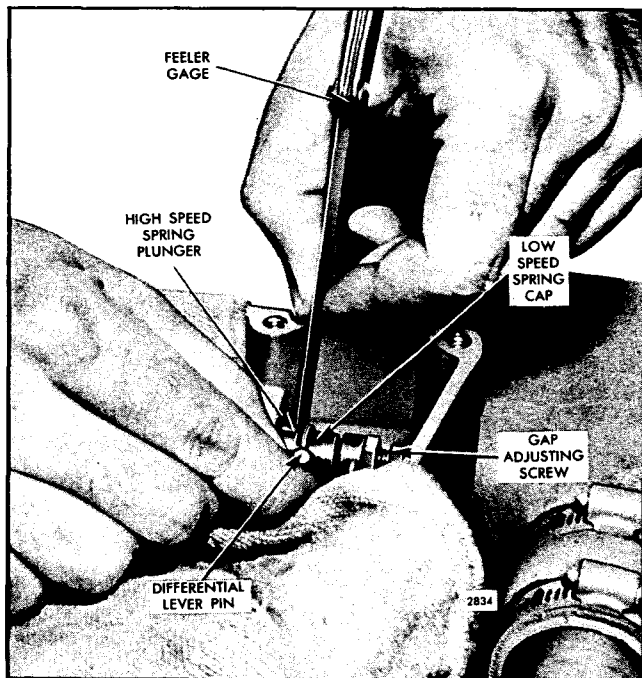


Fig. 1 - Adjusting Governor Gap

Adjust the Governor Gap

With the engine stopped and at normal operating temperature, adjust the governor gap as follows:

1. Remove the two bolts and withdraw the governor high speed spring retainer cover.
2. Back out the buffer screw until it extends approximately 5/8" from the lock nut (Fig. 9).
3. Start the engine and loosen the idle speed adjusting screw lock nut. Then adjust the idle screw (Fig. 8) to obtain the desired engine idle speed. Hold the screw and tighten the lock nut to hold the adjustment.

IMPORTANT: Current turbocharged engines include a starting aid screw threaded into the governor adjusting screw. A lock nut is not required as both screws incorporate a nylon patch in lieu of a lock nut.

NOTE: The recommended idle speed for non-EPA certified engines is 400-450 rpm, but may vary with special engine application.

4. Stop the engine. Clean and remove the governor cover and lever assembly and discard the gasket.
5. Start and run the engine between 800 and 1000 rpm by manual operation of the differential lever.

CAUTION: Do not overspeed the engine.

6. Check the gap between the low speed spring cap and the high speed spring plunger (Fig. 1) with a .0015" feeler gage. If the gap setting is incorrect, reset the gap adjusting screw.

If the setting is correct, the .0015" movement can be seen by placing a few drops of oil into the governor gap and pressing a screw driver against the gap adjusting screw. Movement of the cap toward the plunger will force the oil from the gap in the form of a small bead.

7. Hold the gap adjusting screw and tighten the lock nut.

8. Recheck the governor gap and readjust if necessary.

9. Stop the engine and, using a new gasket, install the governor cover and lever assembly. Tighten the screws.

Position Injector Rack Control Levers

The position of the injector rack must be correctly set in relation to the governor. Their position determines the amount of fuel injected into each cylinder and ensures equal distribution of the load.

Properly positioned injector rack control levers with the engine at full load will result in the following:

1. Speed control lever at the maximum speed position.
2. Governor low speed gap closed.
3. High speed spring plunger on the seat in the governor control housing.
4. Injector fuel control racks in the full-fuel position.

The letters R and L indicate the injector location in the right or left cylinder bank, viewed from the rear of the engine. The cylinders are numbered starting at the front of the engine on each cylinder bank. Adjust the No. 1L injector rack control lever first to establish a guide for adjusting the remaining injector rack control levers.

1. Disconnect any linkage attached to the governor speed control lever.
2. Turn the idle speed adjusting screw until 1/2" of

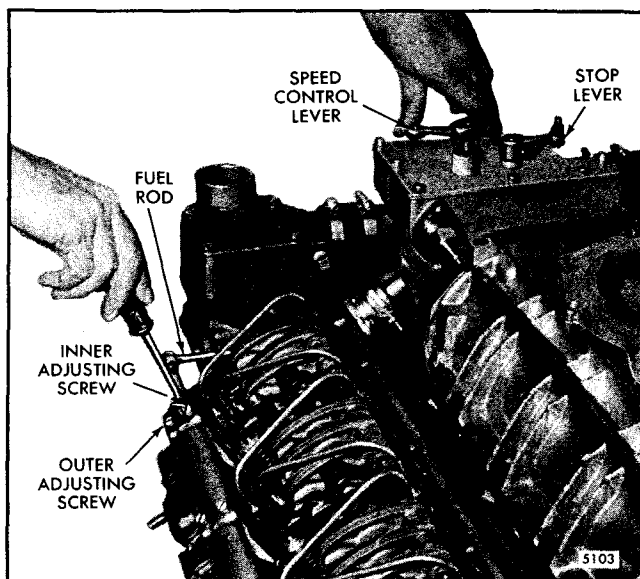


Fig. 2 - Positioning No. 1 Injector Rack Control Lever

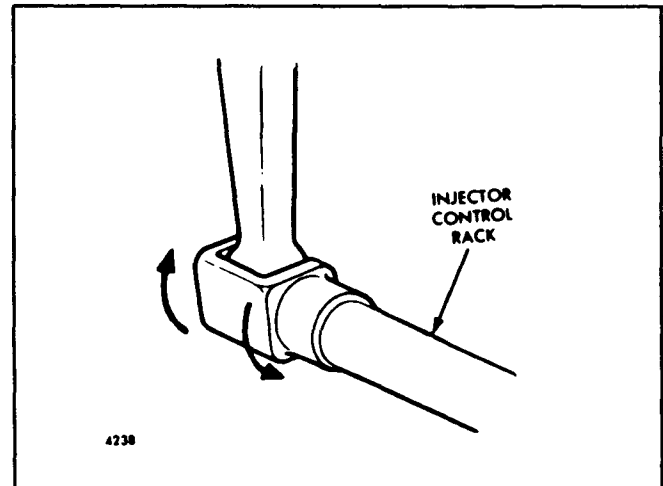


Fig. 3 - Checking Rotating Movement of Injector Control Rack

the threads (12-14 threads) project from the lock nut when the nut is against the high speed plunger.

CAUTION: A false fuel rack setting may result if the idle speed adjusting screw is not backed out as noted above.

NOTE: This adjustment lowers the tension on the low speed spring so it can be easily compressed. This permits closing the low speed gap without bending the fuel rods or causing the *yield mechanism springs to yield or stretch*.

3. Back out the buffer screw approximately 5/8", if it has not already been done.
4. Remove the clevis pin from the fuel rod and the right cylinder bank injector control tube lever.
5. Loosen all of the inner and outer injector rack control lever adjusting screws on both cylinder heads. Be sure all of the injector rack control levers are free on the injector control tubes.
6. Move the governor speed control lever to the maximum speed position; hold it in that position with a light finger pressure. Turn the inner adjusting screw of the No. 1L injector rack control lever down until a slight movement in the control lever is observed or a step-up in effort to turn the screw drive is noted (Fig. 2). This will place the No. 1L injector rack in the full-fuel position. Turn down the outer adjusting screw until it bottoms lightly on the injector control tube. Then alternately tighten both the inner and outer adjusting screws.

NOTE: Overtightening of the injector rack

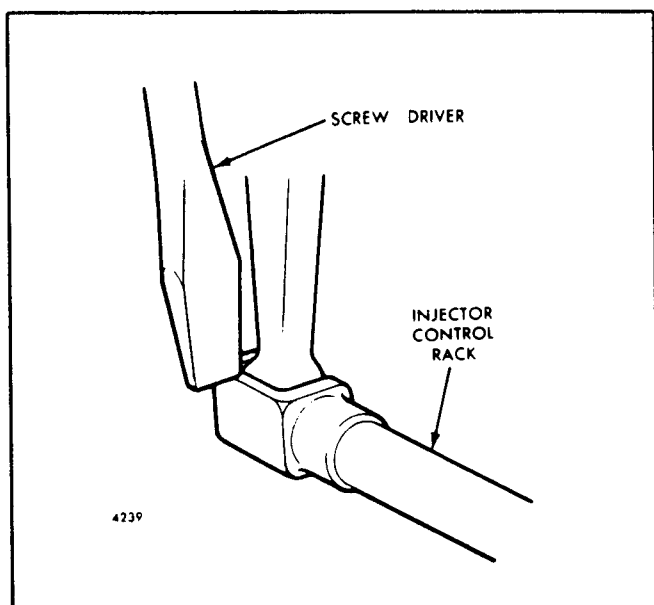


Fig. 4 - Checking Injector Control Rack "Spring"

control lever adjusting screws during installation or adjustment can result in damage to the injector control tube. The recommended torque of the adjusting screws is 24-36 in-lb.

IMPORTANT: The above step should result in placing the governor linkage and control tube assembly in the same position that they will attain while the engine is running at full load.

7. To be sure of the proper rack adjustment, hold the speed control lever in the maximum speed position and press down on the injector rack with a screw driver or finger tip and note "rotating" movement of the injector control rack (Fig. 3). Hold the speed control lever in the maximum speed position and using a screw driver, press downward on the injector control rack. The rack should tilt downward (Fig. 4) and when the pressure of the screw driver is released, the control rack should "spring" back upward.

If the rack does not return to its original position, it is too loose. To correct this condition, back off the outer adjusting screw slightly and tighten the inner adjusting screw slightly.

The setting is too tight if, when moving the speed control lever from the no-speed to the maximum speed position, the injector rack becomes tight before the speed control lever reaches the end of its travel (as determined by the stop under the governor cover). This will result in a step-up in effort required to move the speed control lever to the end of its travel. To correct this condition, back off the inner adjusting

screw slightly and tighten the outer adjusting screw slightly.

8. Remove the clevis pin from the fuel rod and the left-bank injector control tube.

9. Insert the clevis pin in the fuel rod and the right cylinder bank injector control tube lever and position the 1R injector rack control lever as previously outlined in Step 6 for the 1L injector rack control lever.

10. Insert the clevis pin in the fuel rod and the left bank injector control tube lever. Repeat the check on the 1L and 1R injector rack control levers as outlined in Step 7. Check for and eliminate any deflection which occurs at the bend in the fuel rod where it enters the cylinder head.

11. To adjust the remaining injector rack control levers, remove the clevis pin from the fuel rods and the injector control tube levers, hold the injector control racks in the full-fuel position by means of the lever on the end of the control tube and proceed as follows:

- Turn down the inner adjusting screw of the injector rack control lever until the screw bottoms (injector control rack in the full-fuel position).
- Turn down the outer adjusting screw of the injector rack control lever until it bottoms on the injector control tube.
- While still holding the control tube lever in the full-fuel position, adjust the inner and outer adjusting screws to obtain the same condition as outlined in Step 7. Tighten the screws.

CAUTION: Once the No. 1L and No. 1R injector rack control levers are adjusted, do not try to alter their settings. All adjustments are made on the remaining control racks.

NOTE: Overtightening of the injector rack control lever adjusting screws during installation or adjustment can result in damage to the injector control tube. The recommended torque of the adjusting screws is 24-36 in-lb.

12. When all of the injector rack control levers are adjusted, recheck their settings. With the control tube lever in the full-fuel position, check each control rack as in Step 7. All of the control racks must have the same "spring" condition with the control tube lever in the full-fuel position.

13. Insert the clevis pin in the fuel rod and the injector control tube levers.

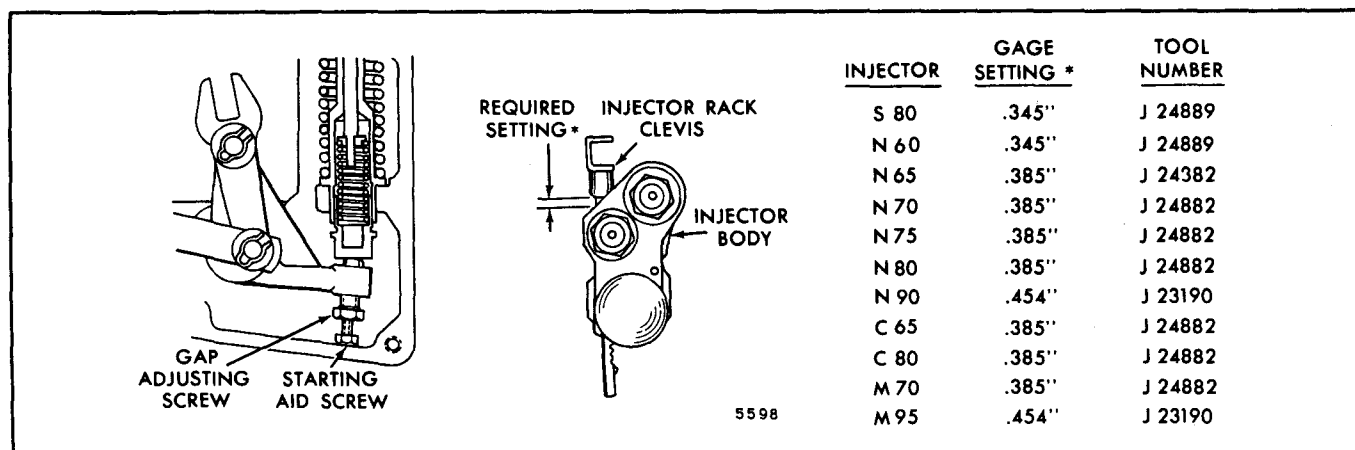


Fig. 5 - Starting Aid Screw Adjustment

14. Turn the idle speed adjusting screw in until it projects 3/16" from the lock nut, to permit starting the engine.

15. Use new gaskets and replace the valve rocker covers.

Adjust Starting Aid Screw (Internal) - Turbocharged Engines

The starting aid screw (Fig. 5) is threaded into the governor gap adjusting screw. This screw is adjusted to position the injector racks at less than full fuel when the governor speed control lever is in the idle position. The reduced fuel makes starting easier and reduces the amount of smoke on start-up.

CAUTION: The effectiveness of the starting aid screw will be eliminated if the speed control lever is advanced to wide open throttle during starting.

After the normal governor *running* gap of .0015" has been set and the injector racks positioned, adjust the starting aid screw as follows:

1. With the *engine stopped*, place the governor stop lever in the *run* position and move the speed control lever to the *idle* position.
2. Hold the gap adjusting screw, to keep it from turning, and adjust the starting aid screw to obtain .330" to .360" clearance between the shoulder on the No. 3R injector rack clevis and the injector body (Fig. 5), with the head of the starting aid screw against the governor wall.

NOTE: With the *engine stopped*, this adjustment will provide a gap of .155" to .160" between

the high speed spring plunger and the low speed spring cap (Fig. 5).

3. Move the stop lever to the *stop* position, with the speed control lever still in the *idle* position, and return it to the *run* position.

4. Re-check the injector rack clevis-to-body clearance. Movement of the governor stop lever is to take-up clearances in the governor linkage. The clevis-to-body clearance can be increased by backing out the starting aid screw or reduced by turning it farther into the gap adjusting screw.

5. Start the engine and re-check the *running* gap (.0015") and, if necessary, reset it. Then stop the engine.

Adjust Maximum No-Load Engine Speed

All governors are properly adjusted before leaving the factory. However, if the governor has been reconditioned or replaced, and to ensure the engine speed will not exceed the recommended no-load speed as given on the option plate, the maximum no-load speed may be set as follows:

ENGINES WITH DUAL-RANGE LIMITING SPEED MECHANICAL GOVERNOR (Fig. 6)

After positioning the injector rack control levers, set the maximum engine speeds.

IMPORTANT: Be sure the buffer screw projects 5/8" from the lock nut to prevent interference while adjusting the maximum no-load speeds.

With the spring housing assembly mounted on the governor, the piston and sleeve assembled with four .100" shims and ten .010" shims and the low

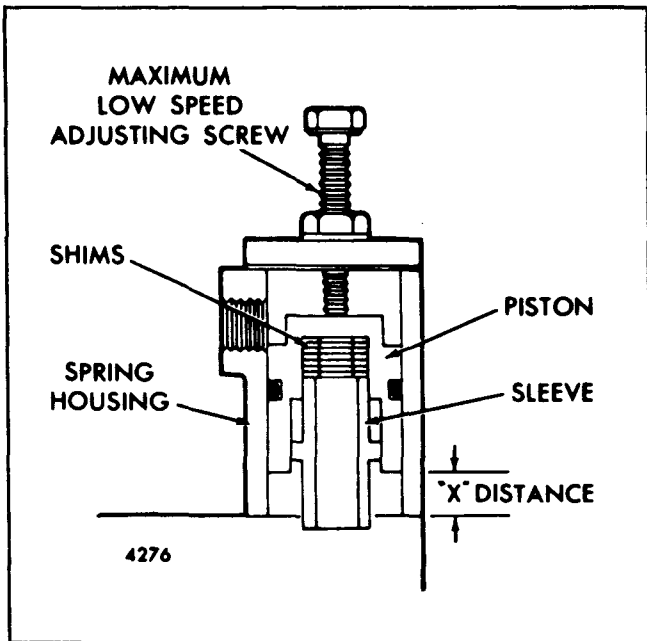


Fig. 6 - Dual-Range Governor (Top View)

maximum speed screw extending from the spring housing approximately 1-1/4", proceed as follows:

CAUTION: Do not apply air or oil pressure to the governor until performing Step 1f.

1. Set the high maximum no-load speed.

a. Start the engine and position the engine speed control lever in the maximum speed position.

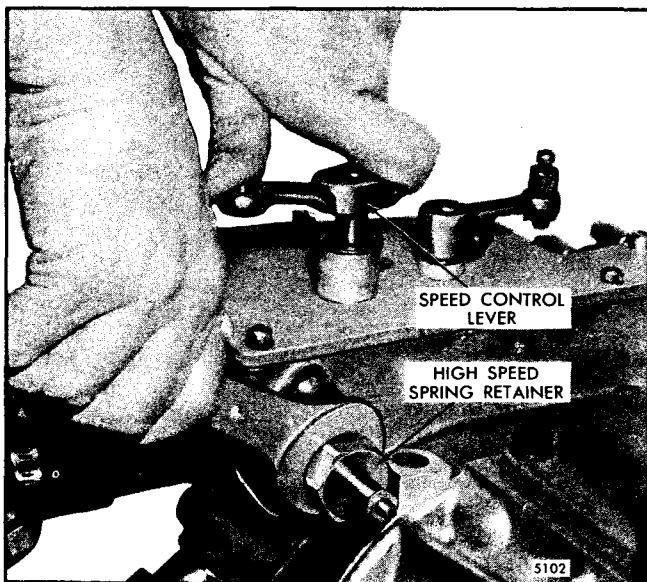


Fig. 7 - Adjusting Maximum No-Load Speed

b. Turn the low maximum speed adjustment screw in until the high maximum speed desired is obtained.

c. Stop the engine and remove the spring housing assembly.

CAUTION: Do not permit the seal ring on the piston to slide past the air inlet port, since the seal ring will be damaged.

d. Note the distance ("X" distance, Fig. 6) the piston is from the bottom of the spring housing when it is against the low maximum speed screw, then remove the sleeve from the piston.

NOTE: When checking this distance, the piston should be held tight against the adjustment screw of the cover that is held in position, with its gasket, against the end of the spring housing.

e. Remove the quantity of shims, from the shims within the piston, equal to the distance noted in Step d.

f. Start the engine and position the engine speed control lever in the maximum speed position and apply air pressure to the governor and note the engine speed.

g. Remove the air pressure from the governor and stop the engine, then install or remove shims as

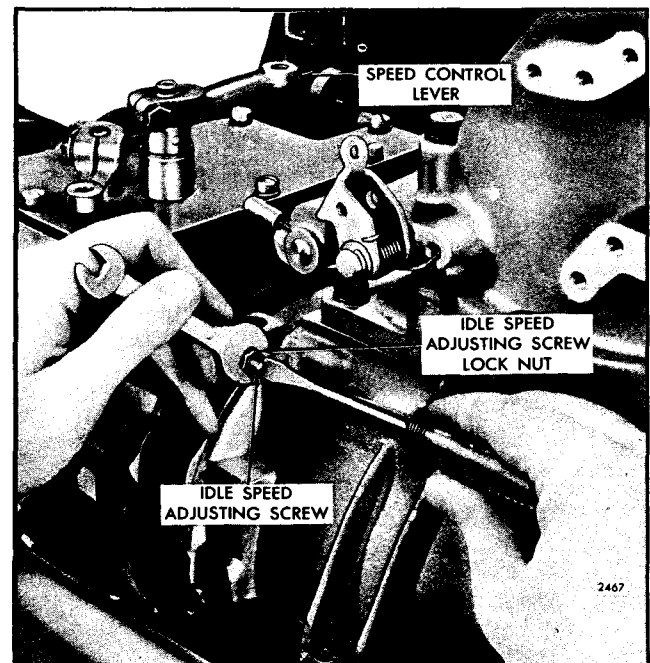


Fig. 8 - Adjusting Engine Idle Speed

required to obtain the correct high maximum no-load speed. Removing shims will decrease the engine speed and adding shims will increase the engine speed.

NOTE: Each .010" shim removed or added will decrease or increase the engine speed approximately 10 rpm.

2. Set the low maximum no-load engine speed.
 - a. Adjust the low maximum speed adjusting screw, with the engine speed control lever held in the maximum speed position, until the desired low maximum speed is obtained. Turn the screw in to increase or out to decrease the engine speed.
 - b. Recheck the engine speed and readjust if necessary.
3. Check both the high maximum and low maximum engine speeds. Make any adjustment that is necessary as outlined in Steps 1 and 2.

ENGINES WITH STANDARD LIMITING SPEED MECHANICAL GOVERNOR (Fig. 7)

After positioning the injector rack control levers, set the maximum no-load engine speed as follows:

NOTE: Be sure the buffer screw projects 5/8" from the lock nut to prevent interference while adjusting the maximum no-load speed.

1. Loosen the spring retainer lock nut (Fig. 7) and back off the high-speed spring retainer approximately five turns.
2. With the engine running at operating temperature and no-load on the engine, place the speed control lever in the maximum speed position. Turn the high-speed spring retainer until the engine is operating at the recommended no-load speed.
3. Hold the high-speed spring retainer and tighten the lock nut.

Adjust Idle Speed

With the maximum no-load speed properly adjusted, adjust the idle speed as follows:

1. With the engine running, at normal operating temperature and with the buffer screw backed out to

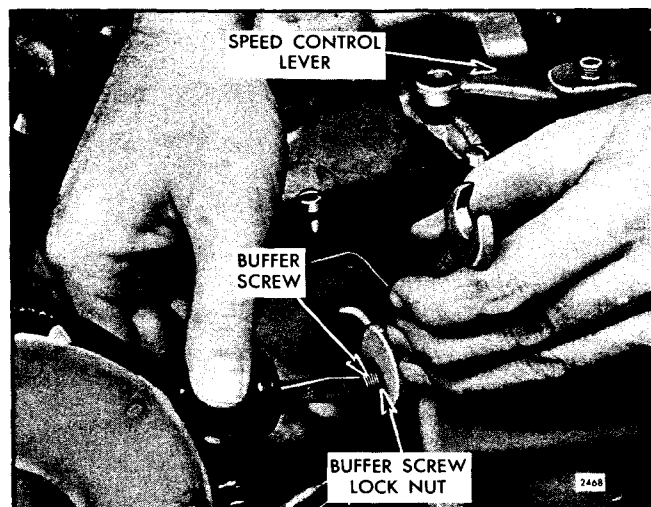


Fig. 9 - Adjusting Buffer Screw

avoid contact with the differential lever, turn the idle speed adjusting screw until the engine is operating at approximately 15 rpm below the recommended idle speed (Fig. 8). The recommended idle speed is 400-450 rpm, but may vary with special engine applications.

IMPORTANT: It may be necessary to use the buffer screw to eliminate engine roll. Back out the buffer screw, after the idle speed is established, to the previous setting (5/8").

2. Hold the idle screw and tighten the lock nut.
3. Install the high-speed spring retainer cover and tighten the two bolts.

Adjust Buffer Screw

With the idle speed properly set, adjust the buffer screw as follows:

1. With the engine running at normal operating temperature, turn the buffer screw (Fig. 9) in so that it contacts the differential lever as lightly as possible and still eliminates engine roll.

NOTE: Do not increase the engine idle speed more than 15 rpm with the buffer screw.

2. Recheck the maximum no-load speed. If it has increased more than 25 rpm, back off the buffer screw until the increase is less than 25 rpm.
3. Hold the buffer screw and tighten the lock nut.

LIMITING SPEED MECHANICAL GOVERNOR AND INJECTOR RACK CONTROL ADJUSTMENT

16V-71 ENGINE

The governor (Fig. 1) on the 16V engine is mounted on and driven from the front end of the rear blower.

After adjusting the exhaust valves and timing the fuel injectors, adjust the governor and injector rack control levers.

NOTE: Before proceeding with the governor and injector rack adjustments, disconnect any supplementary governing device. After the adjustments are completed, reconnect and adjust the supplementary governing device.

If the engine or governor has been overhauled, or the injector control linkage has been disturbed, the control link levers in the governor housing and auxiliary control link housing must be aligned before proceeding with the engine tune-up. Refer to Fig. 2 and position the control link levers as follows:

1. Disconnect the linkage to the governor speed control lever and stop lever.
2. Remove the covers from the governor housing and auxiliary control link housing.
3. Disconnect the adjustable link from the lever in the auxiliary control link housing.
4. Remove the connecting pin from the auxiliary governor control link lever.

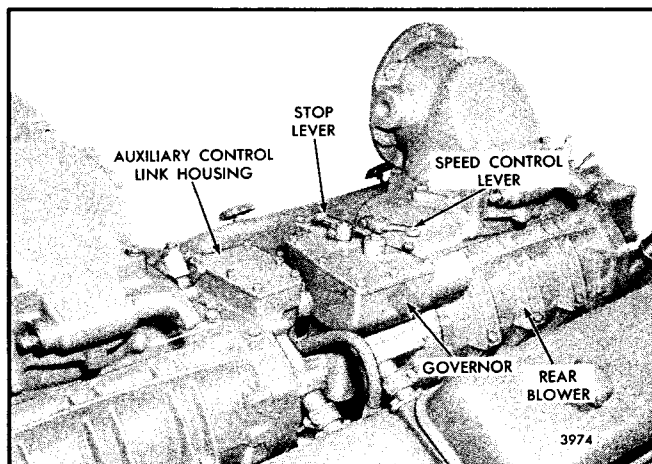


Fig. 1 - Governor Mounting

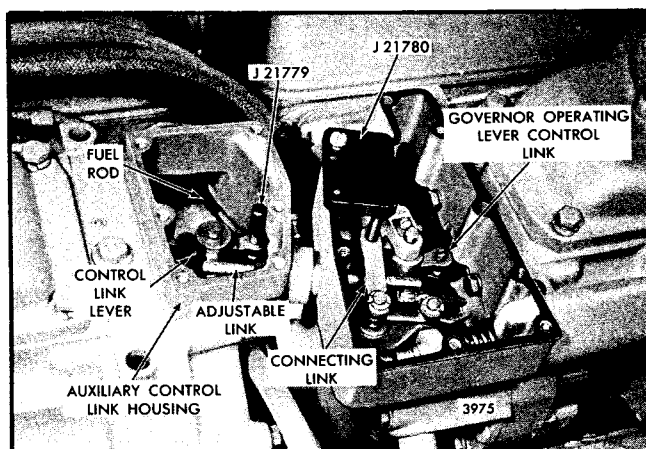


Fig. 2 - Control Link Levers in Position

5. Install gage J 21779 so it extends through the lever and fuel rod and into the gage hole in the bottom of the housing. With the gage in place, the auxiliary control link lever will be in the mid-travel position.
6. Remove the connecting pin from the control link lever in the governor housing and install gage J 21780. Install the gage so the pin extends through the connecting link, control lever and fuel rod and the governor housing dowel pin extends into the small hole in the gage. Then install a governor cover bolt as shown in Fig. 2 to lock the gage in place. With gage

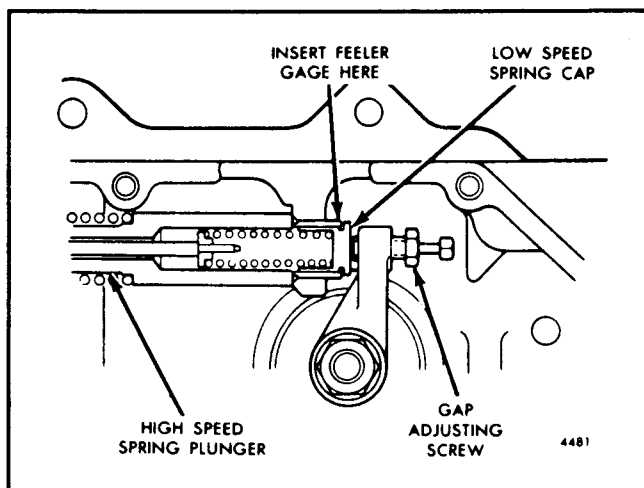


Fig. 3 - Governor Gap Adjustment

J 21780 in place, the governor control link lever will be in the mid-travel position and parallel to the auxiliary control link lever.

7. Adjust the length of the adjustable connecting link to retain the lever positions obtained in Steps 5 and 6 and install the link.

8. Remove gages J 21779 and J 21780 and reinstall the control link lever connecting pins.

9. Install the governor housing and auxiliary control link housing covers.

Proceed with the governor and injector rack control adjustment.

Adjust the Governor Gap

With the engine stopped and at operating temperature, adjust the governor gap as follows:

1. Remove the governor high-speed spring retainer cover.

2. Back out the buffer screw (Fig. 10) until it extends approximately 5/8" from the lock nut.

3. Start the engine and loosen the idle speed adjusting screw lock nut and adjust the idle screw (Fig. 9) to obtain the desired idle speed. Hold the screw and tighten the lock nut to hold the adjustment.

IMPORTANT: Current governors include a starting aid screw threaded into the governor gap adjusting screw. A lock nut is not required as both screws incorporate a nylon patch in lieu of a lock nut.

NOTE: The recommended idle speed is 400-450 rpm, but may vary with special engine applications.

4. Stop the engine. Clean and remove the governor cover and lever assembly and the valve rocker covers. Discard the gaskets.

5. Start and run the engine between 800 and 1000 rpm by manual operation of the differential lever.

CAUTION: Do not overspeed the engine.

6. Check the gap between the low-speed spring cap and the high-speed spring plunger (Fig. 3) with a .0015" feeler gage. If the gap setting is incorrect, reset the gap adjusting screw. If the setting is correct, the .0015" movement can be seen by placing a few drops of oil into the governor gap and pressing a screw driver against the gap adjusting screw. Movement of

the cap toward the plunger will force the oil from the gap in the form of a small bead.

7. Hold the gap adjusting screw and tighten the lock nut.

8. Recheck the gap and readjust, if necessary.

9. Stop the engine and, using a new gasket, install the governor cover and lever assembly.

Position Injector Rack Control Levers

The position of the injector racks must be correctly set in relation to the governor. Their position determines the amount of fuel injected into each cylinder and ensures equal distribution of the load. Properly positioned injector rack control levers with the engine at full load will result in the following:

1. Speed control lever at the maximum speed position.

2. Governor low speed gap closed.

3. High speed spring plunger on the seat in the governor control housing.

4. Injector fuel control racks in the full-fuel position.

The letters R and L indicate the injector location in

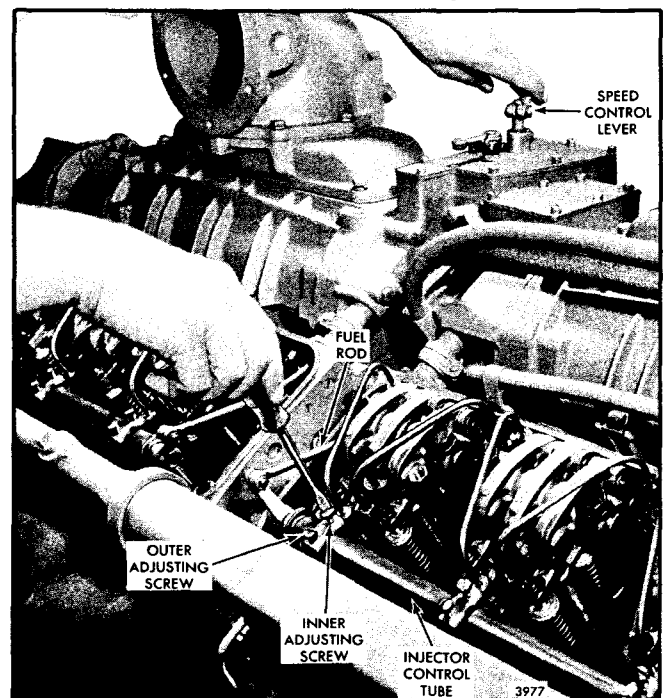


Fig. 4 - Positioning No. 4L Injector Rack Control Lever

the right or left cylinder bank, viewed from the rear of the engine. Cylinders are numbered starting at the front of the engine on each cylinder bank. Adjust the No. 4R injector rack control lever first to establish a guide for adjusting the remaining right bank injector rack control levers.

1. Adjust the idle speed adjusting screw until 1/2" of the threads (12-14 threads) project from the lock nut when the nut is against the high-speed spring plunger.

CAUTION: A false fuel rack setting may result if the idle speed adjusting screw is not backed out as noted above.

NOTE: This adjustment lowers the tension on the low-speed spring so it can be easily compressed. This permits closing the low-speed gap without bending the fuel rods or causing the *yield mechanism springs* to yield or stretch.

2. Back out the buffer screw approximately 5/8", if it has not already been done.

3. Loosen all of the inner and outer injector rack control lever adjusting screws on both cylinder banks. Be sure all of the levers are free on the injector control tubes.

4. Check for any bind in the governor control tube linkage by moving the linkage through its full range of travel.

5. Remove the clevis pins which attach the right rear bank and both left bank fuel rods to the injector control tube levers.

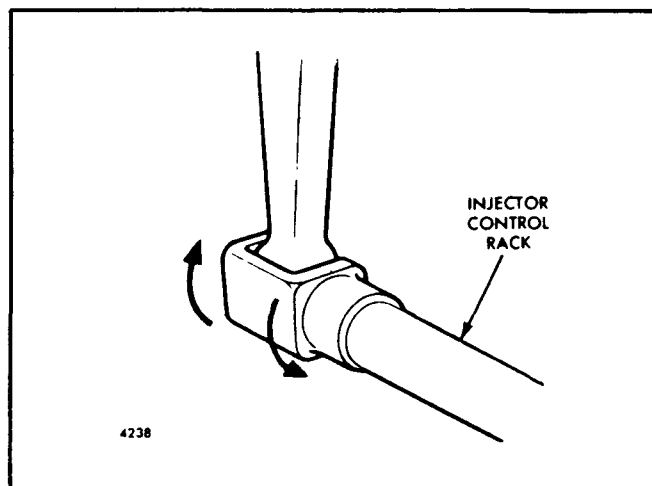


Fig. 5 - Checking Rotating Movement of Injector Control Rack

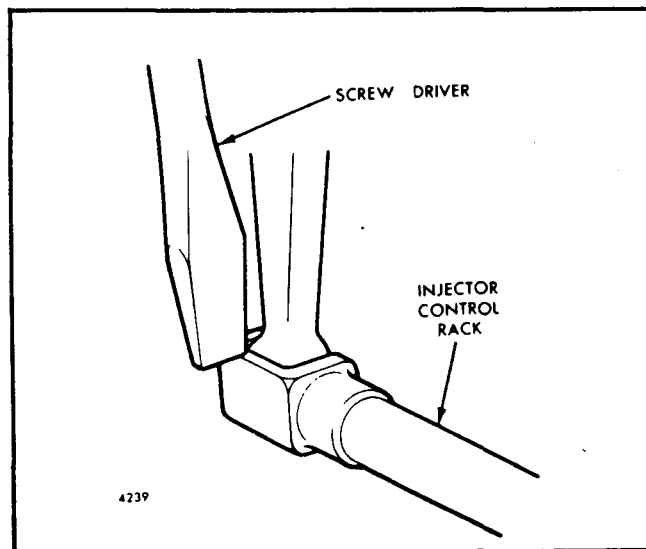


Fig. 6 - Checking Injector Control Rack "Spring"

6. Move the speed control lever to the maximum speed position.

7. Hold it with light finger pressure (Fig. 4) and adjust the No. 4R injector rack by turning the inner adjusting screw down until a slight movement of the control tube is observed or a step-up in effort to turn the screw driver is noted. This will place the rack in the full-fuel position. Turn the outer adjusting screw until it bottoms lightly on the control tube. Then tighten both the inner and outer adjusting screws alternately.

CAUTION: Care should be taken to avoid setting the rack too tight, causing the fuel rod to bend.

NOTE: Overtightening of the injector rack control lever adjusting screws during installation or adjustment can result in damage to the injector control tube. The recommended torque of the adjusting screws is 24-36 in-lbs.

IMPORTANT: The above step should result in placing the governor linkage and control tube assembly in the same position that they will attain while the engine is running at full load.

8. To be sure of the proper rack adjustment, hold the speed control lever in the maximum speed position and press down on the injector rack with a screw driver or finger tip and note "rotating" movement of the injector control rack (Fig. 5). Hold the speed control lever in the maximum speed position and, using a screw driver, press downward on the injector control rack. The rack should tilt downward (Fig. 6)

and when the pressure of the screw driver is released, the control rack should "spring" back upward.

If the rack does not return to its original position, it is too loose. To correct this condition, back off the outer adjusting screw slightly and tighten the inner adjusting screw slightly.

The setting is too tight if, when moving the speed control lever from the no-speed to the maximum speed position, the injector rack becomes tight before the speed control lever reaches the end of its travel (as determined by the stop under the governor cover). This will result in a step-up in effort required to move the speed control lever to the end of its travel. To correct this condition, back off the inner adjusting screw slightly and tighten the outer adjusting screw slightly.

9. Remove the fuel rod-to-control tube lever clevis pin from the right front bank fuel rod and install it on the right rear bank fuel rod and adjust the No. 5R injector rack as outlined in Steps 5, 6 and 7.

10. Repeat Step 9 for adjustment of the No. 4L and 5L injector racks. When the settings are correct, the No. 4R, 5R, 4L and 5L injector racks will be snug on the ball end of the control levers when the injectors are in the full-fuel position.

11. With the fuel rod disconnected from the injector control tube lever, adjust the remaining injector rack control levers on the right front bank. Hold the No. 4R injector rack in the full-fuel position by means of the control tube lever and turn the inner adjusting screw of the No. 3R injector rack control lever until the injector rack has moved into the full-fuel position. Turn the outer adjusting screw down until it bottoms lightly on the injector control tube. Then alternately tighten both the inner and outer adjusting screws.

NOTE: Overtightening of the injector rack control lever adjusting screws during installation or adjustment can result in damage to the injector control tube. The recommended torque of the adjusting screws is 24-36 in-lbs.

12. Recheck the No. 4R injector rack to be sure it has remained snug on the ball end of the injector rack control lever. If the rack of the No. 4R injector has become loose, back off the inner adjusting screw slightly on the No. 3R injector rack control lever and tighten the outer adjusting screw. When the settings are correct, both injector racks must respond in the same manner on the ball ends of the control levers when the injector control tube lever is held in the full-fuel position.

13. Position the remaining injector rack control levers

on the right front cylinder bank as outlined in Steps 11 and 12.

14. Adjust the remaining injector rack control levers on the right rear, left front and left rear cylinder banks in the same manner as outlined in Steps 11, 12 and 13.

15. Install the four fuel rod-to-control tube lever clevis pins and check the adjustment of the injector rack control levers.

16. Turn the idle speed adjusting screw in until it projects 3/16" from the lock nut, to permit starting the engine.

17. Use new gaskets and replace the valve rocker covers.

Adjust Starting Aid Screw

The starting aid screw (Fig. 7) is threaded into the governor gap adjusting screw. This screw is adjusted to position the injector racks at less than full fuel when the governor speed control lever is in the idle position. The reduced fuel makes starting easier and reduces the amount of smoke on start-up.

CAUTION: The effectiveness of the starting aid screw will be eliminated if the speed control lever is advanced to wide open throttle during starting.

After the normal governor *running* gap of .0015" has been set and the injector racks positioned, adjust the starting aid screw as follows:

1. With the *engine stopped*, place the governor stop lever in the *run* position and move the speed control lever to the *idle* position.

2. Hold the gap adjusting screw, to keep it from turning, and adjust the starting aid screw to obtain .330" to .360" clearance between the shoulder on the No. 3R injector rack clevis and the injector body (Fig. 7), with the head of the starting aid screw against the governor wall.

NOTE: With the *engine stopped*, this adjustment will provide a gap of .155" to .160" between the high-speed spring plunger and the low-speed spring cap (Fig. 7).

3. Move the stop lever to the *stop* position, with the speed control lever still in the *idle* position, and return it to the *run* position.

4. Re-check the injector rack clevis-to-body clearance. Movement of the governor stop lever is to take-up

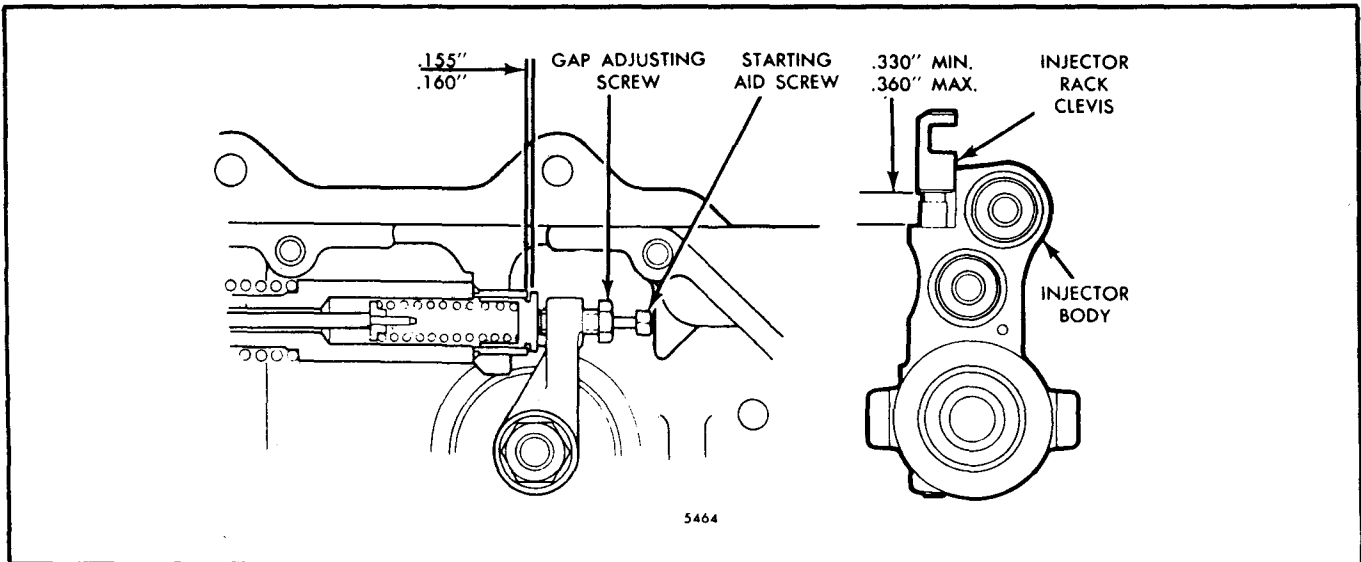


Fig. 7 - Starting Aid Screw Adjustment

clearances in the governor linkage. The clevis-to-body clearance can be increased by backing out the starting aid screw or reduced by turning it farther into the gap adjusting screw.

5. Start the engine and re-check the *running* gap (.0015") and, if necessary, reset it. Then stop the engine.

Adjust Maximum No-Load Engine Speed

All governors are properly adjusted before leaving the factory. However, if the governor has been reconditioned or replaced, and to ensure the engine speed will not exceed the recommended no-load speed as given on the option plate, set the maximum no-load speed as follows:

NOTE: Be sure the buffer screw projects 5/8" from the lock nut to prevent interference while adjusting the maximum no-load speed.

1. Loosen the spring retainer lock nut (Fig. 8) and back off the high-speed spring retainer approximately five turns.
2. With the engine running at operating temperature and no-load on the engine, place the speed control lever in the maximum speed position. Turn the high-speed spring retainer until the engine is operating at the recommended no-load speed.
3. Hold the high-speed spring retainer and tighten the lock nut.

Adjust Idle Speed

With the maximum no-load speed properly adjusted, adjust the idle speed as follows:

1. With the engine running, at normal operating temperature and with the buffer screw backed out to avoid contact with the differential lever, turn the idle speed adjusting screw (Fig. 9) until the engine is

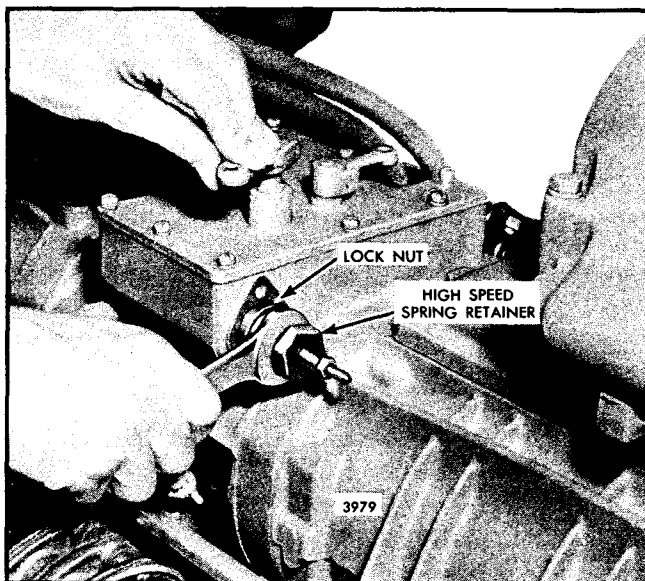


Fig. 8 - Adjusting Maximum No-Load Speed

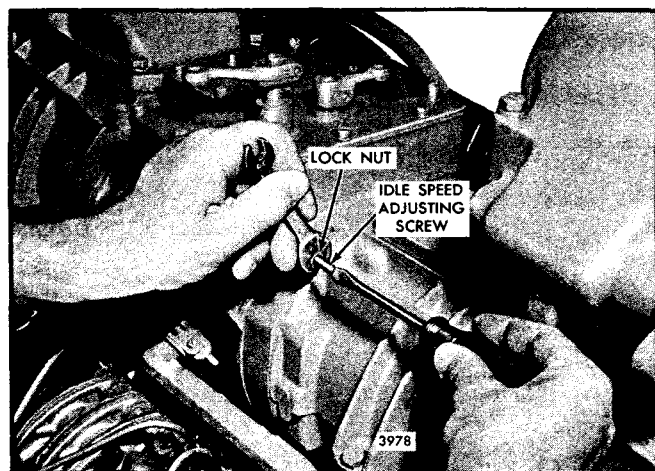


Fig. 9 - Adjusting Engine Idle Speed

operating approximately 15 rpm below the recommended idle speed.

IMPORTANT: It may be necessary to use the buffer screw to eliminate the engine roll. Back out the buffer screw, after the idle speed is established, to the previous setting (5/8").

NOTE: The recommended idle speed is 400-450 rpm, but may vary with certain engine applications.

2. Hold the idle screw and tighten the lock nut.
3. Install the high-speed spring retainer cover and tighten the two bolts.

Adjust Buffer Screw

With the idle speed properly set, adjust the buffer screw as follows:

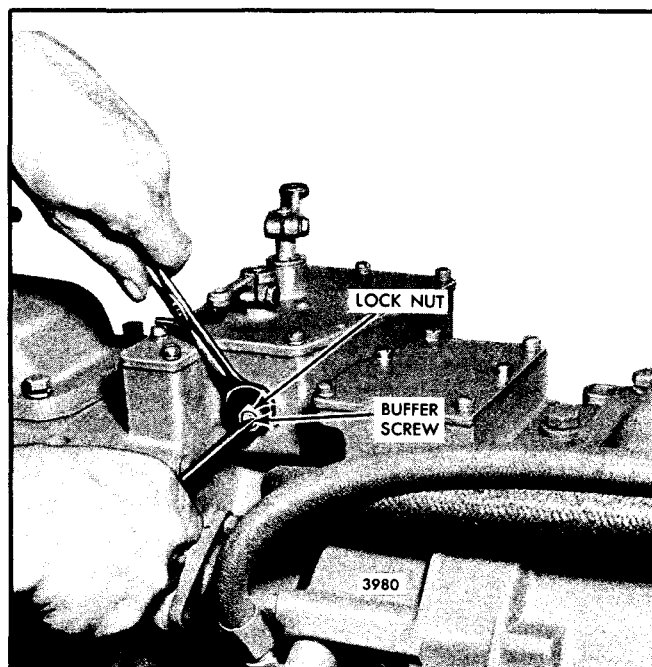


Fig. 10 - Adjusting Buffer Screw

1. With the engine running at normal operating temperature, turn the buffer screw in so it contacts the differential lever as lightly as possible and still eliminates the engine roll (Fig. 10).

NOTE: Do not increase the engine idle speed more than 15 rpm with the buffer screw.

2. Recheck the maximum no-load speed. If it has increased more than 25 rpm, back off the buffer screw until the increase is less than 25 rpm.
3. Hold the buffer screw and tighten the lock nut.

LIMITING SPEED MECHANICAL GOVERNOR (Fast Idle Cylinder)

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

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

The fast idle air cylinder and the throttle locking air cylinder are actuated at the same time by air from a common air line. The engine shutdown air cylinder is connected to a separate air line.

The air supply for the fast idle air cylinder is usually controlled by an air valve actuated by an electric solenoid. The fast idle system should be installed so that it will function only when the parking brake system is in operation to make it tamper-proof.

The accelerator-to-governor throttle linkage is connected to a yield link so the operator cannot overcome the force of the air cylinder holding the speed control

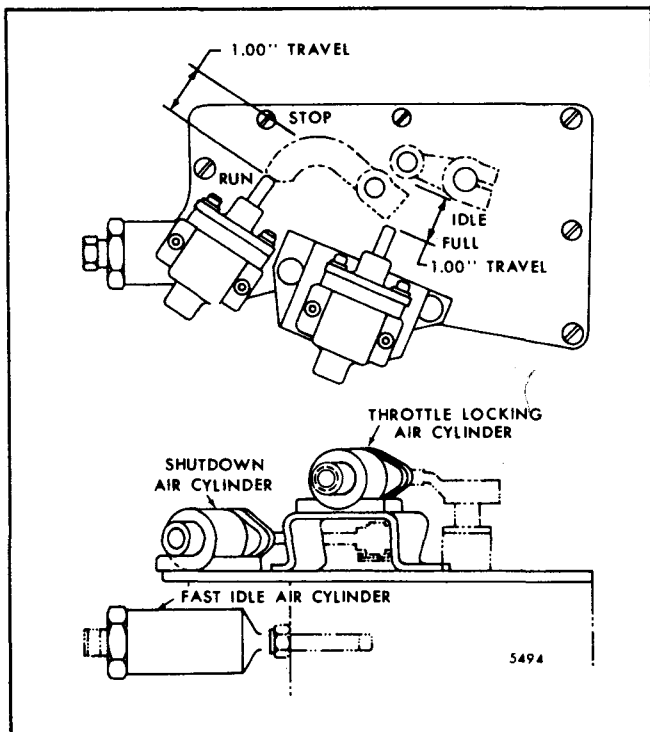


Fig. 1 - Governor with Fast Idle Cylinder

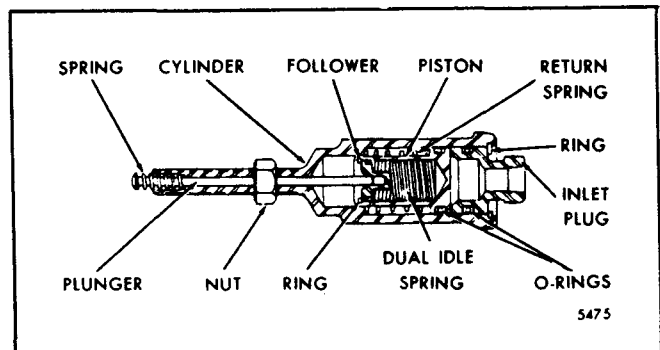


Fig. 2 - Fast Idle Air Cylinder

lever in the idle position while the engine is operating at the single fixed high idle speed.

Operation

During normal operation, the governor functions as a limiting speed governor.

For operation of auxiliary equipment, the vehicle is stopped and the parking brake set. Then, with the engine running, the low-speed switch is placed in the ON position. When the fast idle air cylinder is actuated, the force of the dual idle spring (Fig. 2) is added to the force of the governor low-speed spring, thus increasing the engine idle speed.

The governor now functions as a constant speed governor at the high idle speed setting, maintaining a

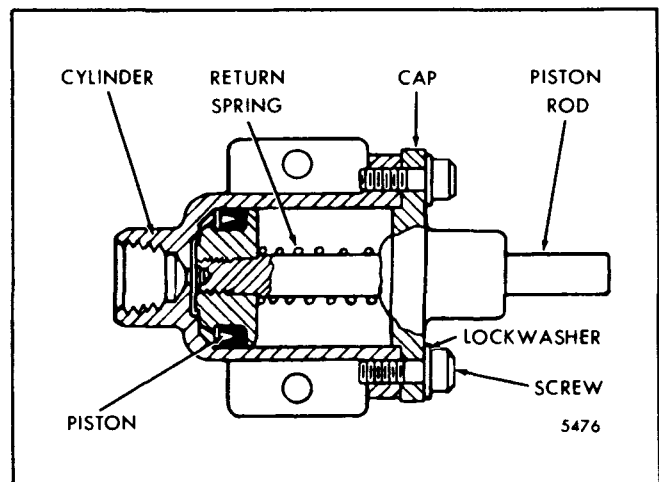


Fig. 3 - Throttle Locking Air Cylinder

near constant engine speed regardless of the load within the capacity of the engine. The fast idle system provides a single fixed high idle speed that is not adjustable, except by disassembling the fast idle air cylinder and changing the dual idle spring. As with all mechanical governors, when load is applied, the engine speed will be determined by the governor droop.

Adjust Governor

Before adjusting the governor gap, back out the de-energized fast idle air cylinder until it will not

interfere with the governor adjustments. After the normal idle speed setting is made, adjust the de-energized fast idle air cylinder in the same manner as outlined for adjustment of the buffer screw.

The throttle locking air cylinder is adjusted on its mounting bracket so it will lock the throttle in the idle position when it is activated, but will not limit the throttle movement when not activated.

VARIABLE SPEED MECHANICAL GOVERNOR AND INJECTOR RACK CONTROL ADJUSTMENT

6, 8 and 12V ENGINES

The single-weight variable speed governor is mounted on the front of the engine and is driven by the blower rotor.

After adjusting the exhaust valves and timing the fuel injectors, adjust the variable speed mechanical governor and injector rack control levers.

NOTE: Before proceeding with the governor and injector rack adjustments, disconnect any supplementary governing device. After the adjustments are completed, reconnect and adjust the supplementary governing device.

Adjust Governor Gap

With the engine stopped and at normal operating temperature, adjust the governor gap as follows:

1. Disconnect any linkage attached to the governor levers.
2. Back out the buffer screw until it extends approximately $5/8$ " from the lock nut.
3. Clean and remove the governor cover and valve rocker covers. Discard the gaskets.
4. Place the speed control lever in the maximum speed position.
5. Insert a .006" feeler gage between the spring plunger and the plunger guide as shown in Fig. 1. If required, loosen the lock nut and turn the adjusting screw until a slight drag is noted on the feeler gage.
6. Hold the adjusting screw and tighten the lock nut. Check the gap again and, if necessary, readjust.
7. Use a new gasket and install the governor cover. Tighten the screws.

Position Injector Rack Control Levers

The position of the injector control rack levers must be correctly set in relation to the governor. Their position determines the amount of fuel injected into each cylinder and ensures equal distribution of the load.

Properly positioned injector rack control levers, with the engine at full load, will result in the following:

1. Speed control lever at the maximum speed position.
2. Stop lever in the Run position.
3. High speed spring plunger is within .005" to .007" of its seat in the governor control housing.
4. Injector fuel control racks in the full fuel position.

The letters R and L indicate the injector location in the right or left cylinder bank, viewed from the rear of the engine. The cylinders are numbered starting at the front of the engine on each cylinder bank. Adjust the No. 1L injector rack control lever first to establish a guide for adjusting the remaining control levers.

1. Remove the clevis pin from the fuel rod and the right cylinder bank injector control tube lever.
2. Loosen all of the inner and outer injector rack control lever adjusting screws on both injector control tubes. Be sure all of the injector rack control levers are free on the injector control tubes.

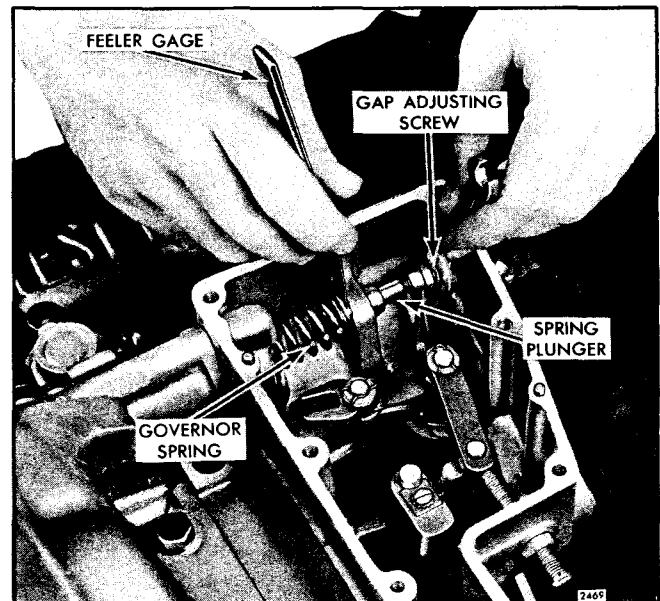


Fig. 1 - Adjusting Governor Gap

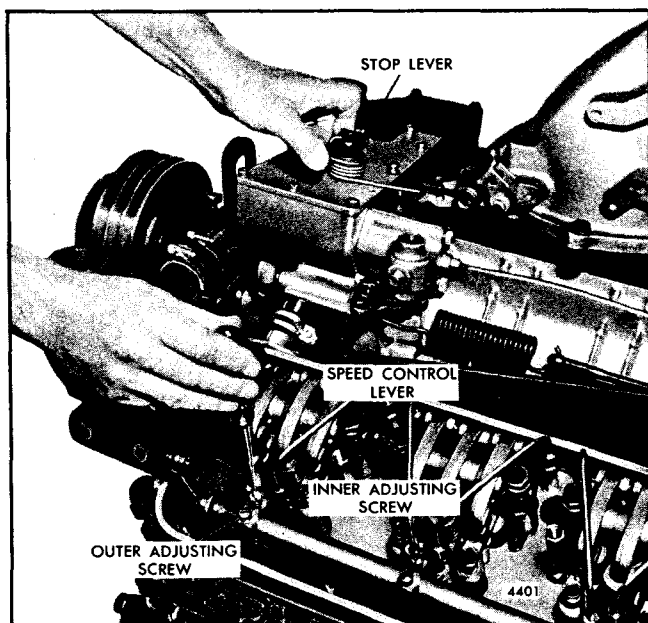


Fig. 2 - Positioning No. 1 Injector Rack Control Lever

3. Move the speed control lever to the maximum speed position.

4. Move the governor stop lever to the "run" position and hold it in that position with light finger pressure. Turn the inner adjusting screw of the No. 1L injector rack control lever down until a slight movement in the governor stop lever is noted. Turn down the outer adjusting screw until it bottoms lightly on the injector control tube. Then alternately tighten both the inner and outer adjusting screws (Fig. 2).

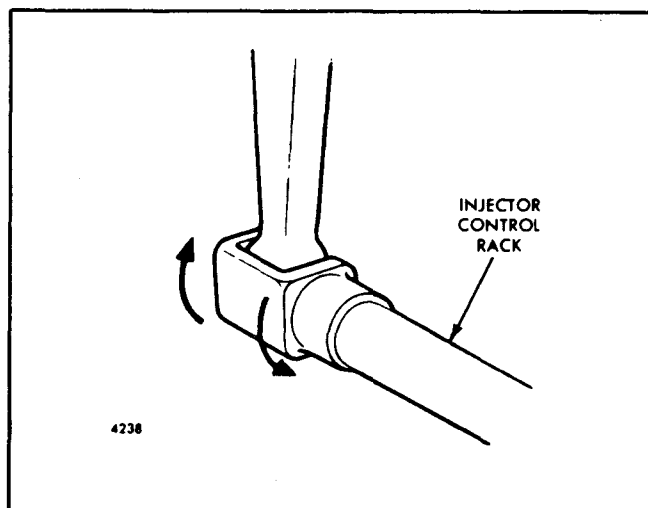


Fig. 3 - Checking Rotating Movement of Injector Control Rack

NOTE: Overtightening of the injector rack control lever adjusting screws during installation or adjustment can result in damage to the injector control tube. The recommended torque of the adjusting screws is 24-36 in.-lbs.

IMPORTANT: The above step should result in placing the governor linkage and control tube assembly in the same position that they will attain while the engine is running at full-load.

5. To be sure of the proper rack adjustment, hold the stop lever in the run position and press down on the injector rack with a screw driver or finger tip and note "rotating" movement of the injector control rack (Fig. 3) when the stop lever is in the run position. Hold the stop lever in the run position and, using a screw driver, press downward on the injector control rack. The rack should tilt downward (Fig. 4) and when the pressure of the screw driver is released, the control rack should "spring" back upward.

If the rack does not return to its original position, it is too loose. To correct this condition, back off the outer adjusting screw slightly and tighten the inner adjusting screw slightly.

The setting is too tight if, when moving the stop lever from the stop to the run position, the injector rack becomes tight before the stop lever reaches the end of its travel. This will result in a step-up in effort required to move the stop lever to the end of its travel. To correct this condition, back off the inner adjusting screw slightly and tighten the outer adjusting screw slightly.

NOTE: Overtightening of the injector rack control lever adjusting screws during installation or adjustment can result in damage to the injector control tube. The recommended torque of the adjusting screws is 24-36 in.-lb.

6. Remove the clevis pin from the fuel rod and the left bank injector control tube lever.

7. Insert the clevis pin in the fuel rod and the right cylinder bank injector control tube lever and position the 1R injector rack control lever as previously outlined in Step 4.

8. Insert the clevis pin in the fuel rod and the left bank injector control tube lever. Repeat the check on the 1L and 1R injector rack control levers as outlined in Step 5. Carefully observe and eliminate any deflection, which occurs at the bend in the fuel rod where it enters the cylinder head.

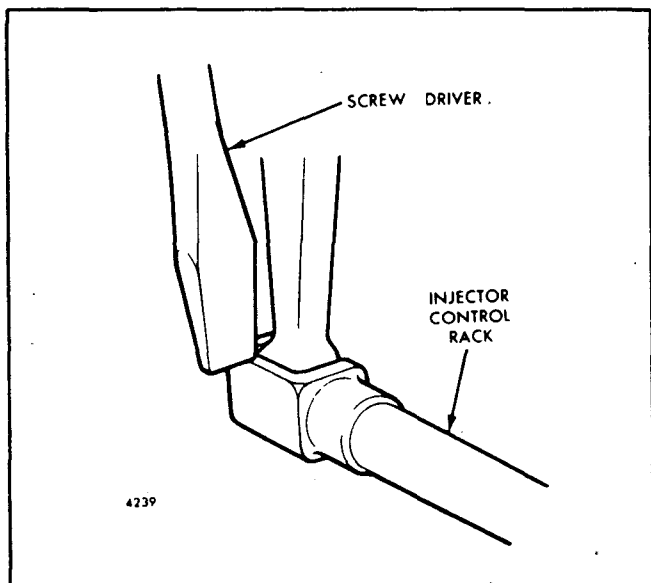


Fig. 4 - Checking Injector Control Rack "Spring"

9. To adjust the remaining injector rack control levers, remove the clevis pin from the fuel rods and the injector control tube levers, hold the injector control racks in the full-fuel position by means of the lever on the end of the control tube, and proceed as follows:

- a. Turn down the inner adjusting screw of the injector rack control lever until the screw bottoms (injector control rack in the full-fuel position).
- b. Turn down the outer adjusting screw of the injector rack control lever until it bottoms on the injector control tube.
- c. While still holding the control tube lever in the full-fuel position, adjust the inner and outer adjusting screws to obtain the same condition as outlined in Step 5. Tighten the screws.

CAUTION: Once the No. 1L and No. 1R injector rack control levers are adjusted, do not try to alter their settings. All adjustments are made on the remaining control racks.

10. When all of the injector rack control levers are adjusted, recheck their settings. With the control tube lever in the full-fuel position, check each control rack as in Step 5. All of the control racks must have the same "spring" condition with the control tube lever in the full-fuel position.

11. Insert the clevis pin in the fuel rods and the injector control tube levers.

12. Use new gaskets and install the valve rocker covers.

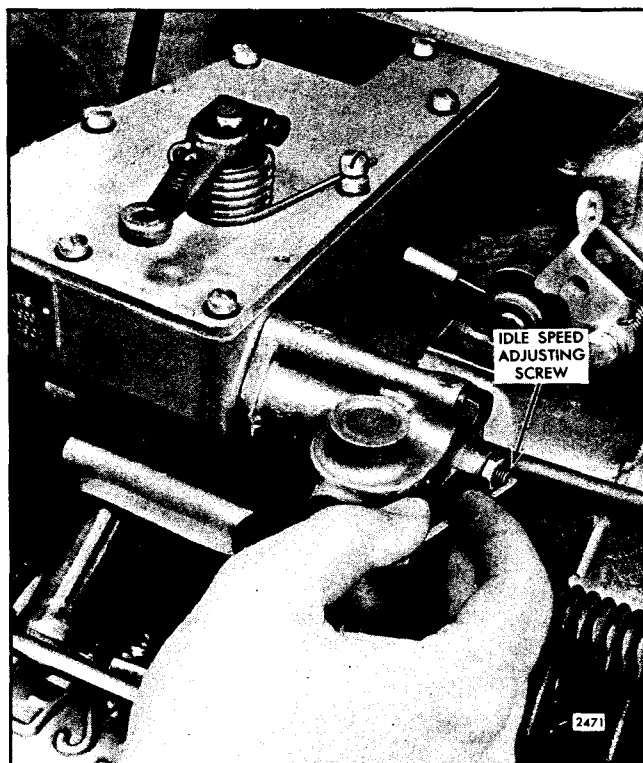


Fig. 5 - Adjusting Idle Speed

Variable Speed Governor Adjustment		
Full Load Speed*	Stops	Shims
1200-1750	2	Up to .325" in Shims Maximum
1750-2100	1	
2100-2300	0	
*No load speed is 125-200 rpm above full load speed depending upon engine application.		

TABLE 1

Adjust Maximum No-Load Engine Speed

All governors are properly adjusted before leaving the factory. However, if the governor has been reconditioned or replaced, and to ensure the engine speed will not exceed the recommended no-load speed as given on the engine option plate, set the maximum no-load speed as outlined below.

Start the engine and, after it reaches normal operating temperature, use an accurate hand tachometer to determine the maximum no-load speed of the engine. Then stop the engine and make the following adjustments, if required:

1. Disconnect the booster spring and the stop lever spring.

2. Remove the variable speed spring housing and the spring retainer from the governor housing.
3. Refer to Table 1 and determine the stops or shims required for the desired no-load speed.
4. Install the variable speed spring retainer and housing and tighten the two bolts.
5. Connect the booster spring and the stop lever spring. Start the engine and recheck the maximum no-load speed.
6. If required, add or remove shims to obtain the necessary operating speed. For each .001" shim added, the operating speed will increase approximately 1 rpm.

IMPORTANT: If the maximum no-load speed is raised or lowered more than 50 rpm by the installation or removal of shims, recheck the governor gap. If readjustment of the governor gap is required, the position of the injector racks must be rechecked.

NOTE: Governor stops are used to limit the compression of the governor spring, which determines the maximum speed of the engine.

Adjust Idle Speed

With the maximum no-load speed properly adjusted, adjust the idle speed as follows:

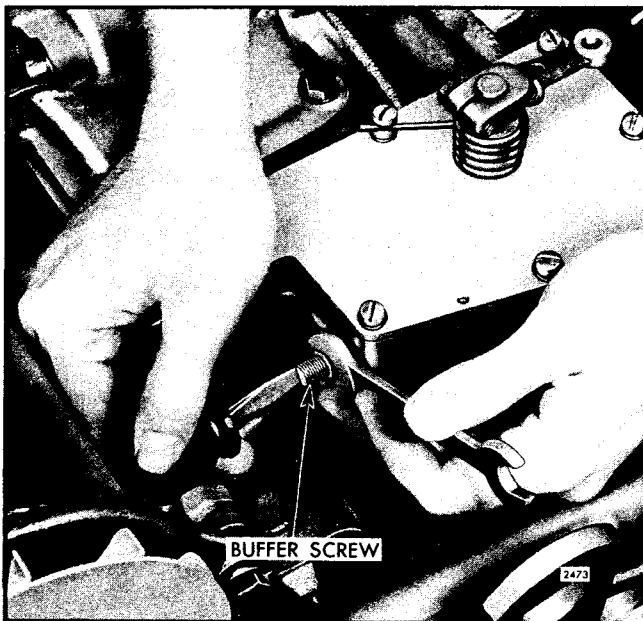


Fig. 6 - Adjusting Buffer Screw

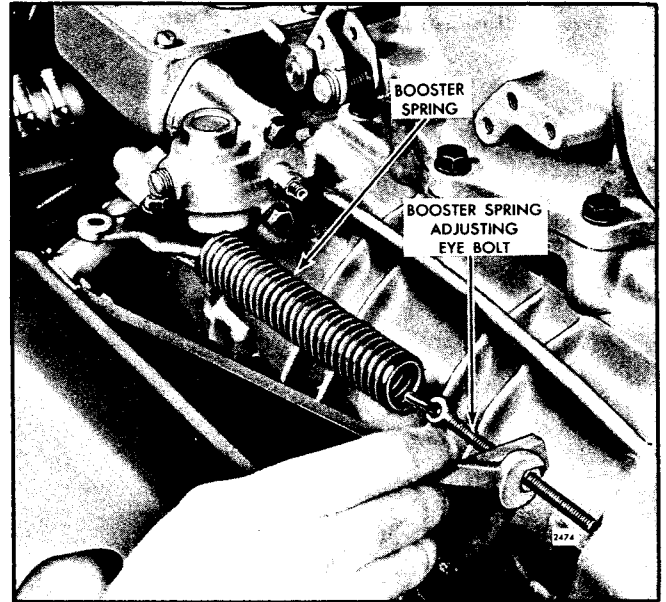


Fig. 7 - Adjusting Booster Spring

1. Place the stop lever in the "run" position and the speed control lever in the "idle" position.
2. With the engine running at normal operating temperature, back out the buffer screw to avoid contact with the differential lever.
3. Loosen the lock nut and turn the idle speed adjusting screw (Fig. 5) until the engine is operating at approximately 15 rpm below the recommended idle speed.

NOTE: The recommended idle speed is 550 rpm, but may vary with special engine applications.

4. Hold the idle speed adjusting screw and tighten the lock nut.

Adjust Buffer Screw

1. With the engine running at normal operating temperatures, turn the buffer screw "in" (Fig. 6) so that it contacts the differential lever as lightly as possible and still eliminates engine roll.

NOTE: Do not raise the engine idle speed more than 15 rpm with the buffer screw.

2. Hold the buffer screw and tighten the lock nut.

Adjust Booster Spring

With the idle speed adjusted, adjust the booster spring as follows:

1. Move the speed control lever to the idle speed position.
2. Refer to Fig. 7 and loosen the booster spring retaining nut on the speed control lever. Loosen the lock nuts on the eye bolt at the opposite end of the booster spring.
3. Move the bolt in the slot of the speed control lever until the center of the bolt is on or slightly over center

(toward the idle speed position) of an imaginary line through the bolt, lever shaft, and eye bolt. Hold the bolt and tighten the lock nut.

4. Start the engine and move the speed control lever to the maximum speed position and release it. The speed control lever should return to the idle position. If it does not, reduce the tension on the booster spring. If it does, continue to increase the spring tension until the point is reached that it will not return to idle. Then reduce the tension until it does return to idle and tighten the lock nut on the eye bolt. This setting will result in the minimum force required to operate the speed control lever.

5. Connect the linkage to the governor levers.

VARIABLE SPEED MECHANICAL GOVERNOR AND INJECTOR RACK CONTROL ADJUSTMENT

16V-71 ENGINE

The governor (Fig. 1) on the 16V engine is mounted on and driven from the front end of the rear blower.

After adjusting the exhaust valves and timing the fuel injectors, adjust the governor and injector rack control levers.

If the engine or governor has been overhauled, or the injector control linkage has been disturbed, the control link levers in the governor housing and auxiliary control link housing must be aligned before proceeding with the engine tune-up. Refer to Fig. 2 and position the control link levers as follows:

1. Disconnect the linkage to the governor speed control and stop levers.
2. Remove the covers from the governor housing and auxiliary control link housing.
3. Disconnect the adjustable link from the lever in the auxiliary control link housing.
4. Remove the connecting pin from the auxiliary governor control link lever.
5. Install gage J 21779 so it extends through the lever and fuel rod and into the gage hole in the bottom of the housing. With the gage in place, the auxiliary control link lever will be in the mid-travel position.
6. Remove the connecting pin from the control link lever in the governor housing and install gage J 21780.

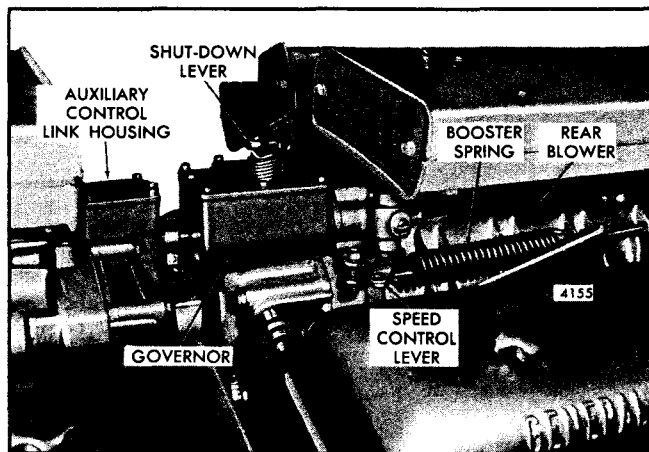


Fig. 1 - Governor Mounting

Install the gage so the pin extends through the connecting link, control lever and fuel rod and the governor housing dowel pin extends into the small hole in the gage. Then install a governor cover bolt as shown in Fig. 2 to lock the gage in place. With gage J 21780 in place, the governor control link lever will be in the mid-travel position and parallel to the auxiliary control link lever.

7. Adjust the length of the adjustable connecting link to retain the lever positions obtained in Steps 5 and 6 and install the link.

8. Remove gages J 21779 and J 21780 and reinstall the control link lever connecting pins.

9. Install the governor housing and auxiliary control link housing covers.

Proceed with the governor and injector rack control adjustment.

Adjust Governor Gap

With the engine stopped and at normal operating temperature, adjust the governor gap as follows:

1. Clean and remove the governor cover and the valve rocker covers. Discard the gaskets.
2. Back out the buffer screw until it extends approximately 5/8" from the lock nut.

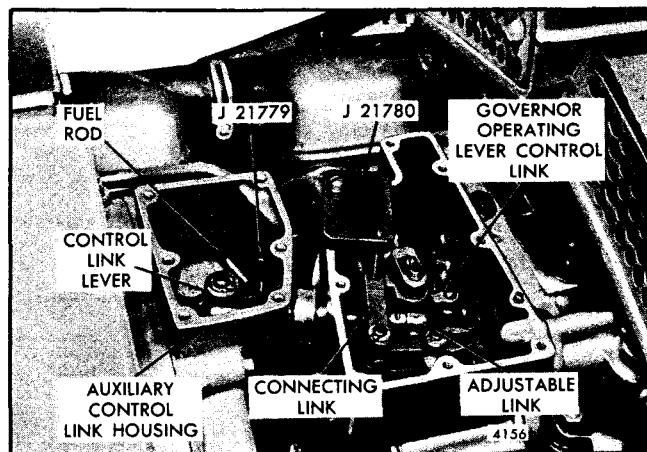


Fig. 2 - Control Link Levers In Position

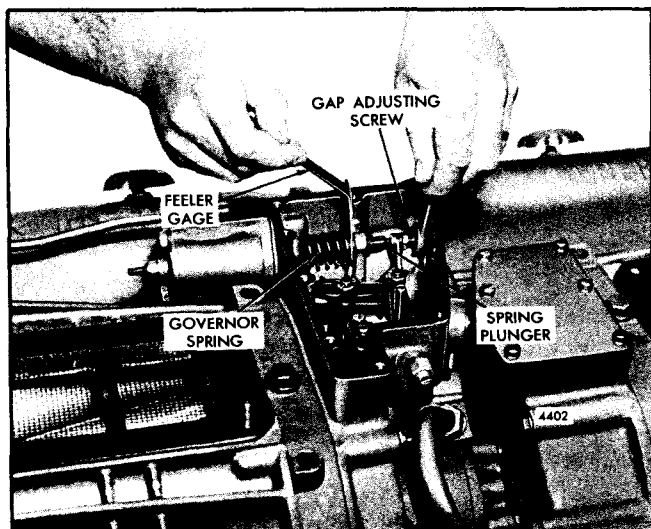


Fig. 3 - Adjusting Governor Gap

3. Place the speed control lever in the maximum speed position.
4. Insert a .006" feeler gage between the spring plunger and the plunger guide as shown in Fig. 3. If required, loosen the lock nut and turn the adjusting screw until a slight drag is noted on the feeler gage.
5. Hold the adjusting screw and tighten the lock nut. Check the gap and readjust if necessary.
6. Use a new gasket and install the governor cover.

Position Injector Rack Control Levers

The position of the injector control rack levers must be correctly set in relation to the governor. Their position determines the amount of fuel injected into each cylinder and ensures equal distribution of the load.

Properly positioned injector rack control levers with the engine at full-load will result in the following:

1. Speed control lever at the maximum speed position.
2. Stop lever in the Run position.
3. High speed spring plunger is within .005" to .007" of its seat in the governor control housing.
4. Injector fuel control racks in the full-fuel position.

The letters R and L indicate the injector location in the right or left cylinder bank, viewed from the rear of the engine. Cylinders are numbered starting at the front of the engine on each cylinder bank. Adjust the No. 4R injector rack control lever first to establish a

guide for adjusting the remaining injector rack control levers.

1. Remove the clevis pins which attach the right rear bank and both left bank fuel rods to the injector control tube levers.
2. Loosen all of the inner and outer injector rack control lever adjusting screws on both cylinder banks. Be sure all of the levers are free on the injector control tubes.
3. Move the speed control lever to the maximum speed position.
4. Move the stop lever in the RUN position and hold it in that position with a light finger pressure. Turn the inner adjusting screw of the No. 4R injector rack control lever down until a slight movement of the stop lever is noted (Fig. 4). Turn down the outer adjusting screw until it bottoms lightly on the control tube. Then alternately tighten both the inner and outer adjusting screws.

NOTE: Overtightening of the injector rack control lever adjusting screws during installation or adjustment can result in damage to the injector control tube. The recommended torque of the adjusting screws is 24-36 in-lbs.

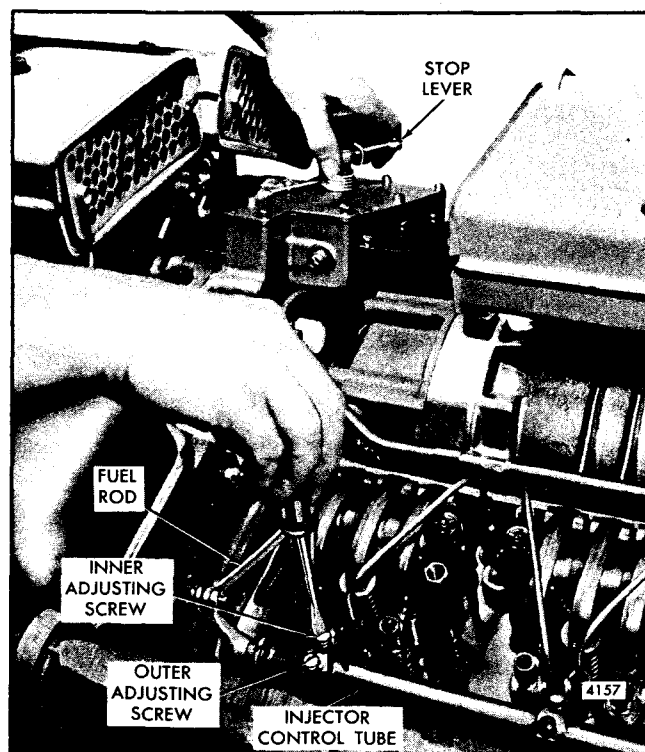


Fig. 4 - Positioning No. 4R Injector Rack Control Lever

IMPORTANT: The above step should result in placing the governor linkage and control tube assembly in the same position that they will attain while the engine is running at full-load.

5. To be sure of the proper rack adjustment, hold the stop lever in the RUN position and press down on the injector rack with a screw driver or finger tip and note the "rotating" movement of the injector control rack (Fig. 5). Hold the stop lever in the run position and, using a screw driver, press downward on the injector control rack. The rack should tilt downward (Fig. 6) and when the pressure of the screw driver is released, the control rack should "spring" back upward.

If the rack does not return to its original position, it is too loose. To correct this condition, back off the outer adjusting screw slightly and tighten the inner adjusting screw slightly.

The setting is too tight if, when moving the stop lever from the stop to the run position, the injector rack becomes tight before the stop lever reaches the end of its travel. This will result in a step-up in effort required to move the stop lever to the end of its travel. To correct this condition, back off the inner adjusting screw slightly and tighten the outer adjusting screw slightly.

6. Remove the fuel rod-to-control tube lever clevis pin from the right front bank fuel rod and install it on the right rear bank fuel rod and adjust the No. 5R injector rack as outlined in Steps 4 and 5.

7. Repeat Step 6 for adjustment of the No. 4L and 5L injector racks. When the settings are correct, the No. 4R 5R, 4L and 5L injector racks will be snug on

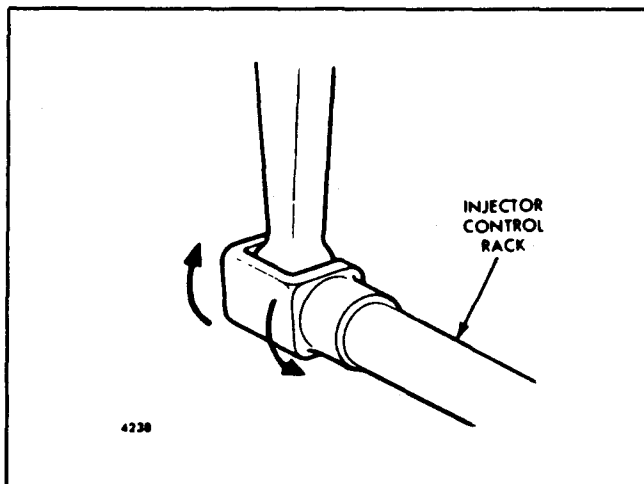


Fig. 5 - Checking Rotating Movement of Injector Control Rack

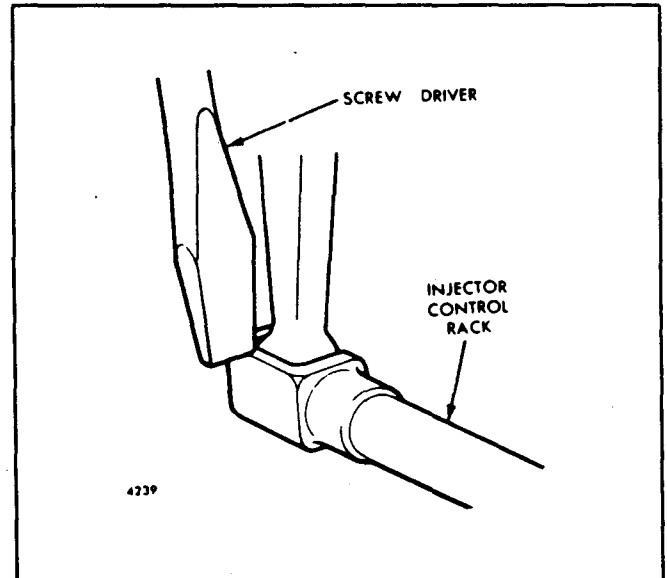


Fig. 6 - Checking Injector Control Rack "Spring"

the ball end of the control levers when the injectors are in the full-fuel position.

8. With the fuel rod disconnected from the injector control tube lever, adjust the remaining injector rack control levers on the right front bank. Hold the No. 4R injector rack in the full-fuel position by means of the control tube lever and turn the inner adjusting screw of the No. 3R injector rack control lever until the injector rack has moved into the full-fuel position. Turn the outer adjusting screw down until it bottoms lightly on the injector control tube. Then alternately tighten both the inner and outer adjusting screws.

NOTE: Overtightening of the injector rack

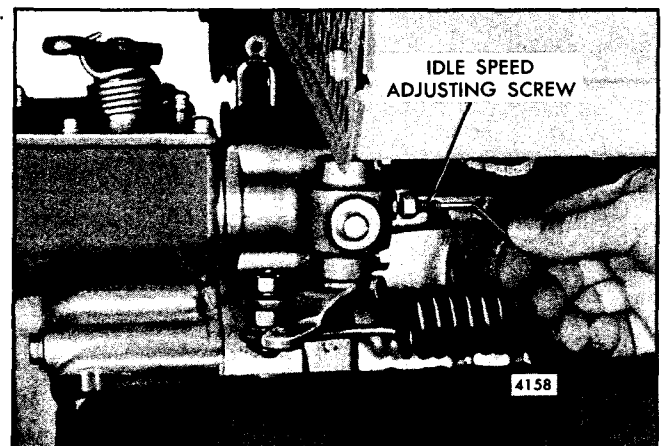


Fig. 7 - Adjusting Idle Speed

control lever adjusting screws during installation or adjustment can result in damage to the injector control tube. The recommended torque of the adjusting screws is 24-36 in-lbs.

9. Recheck the No. 4R injector rack to be sure it has remained snug on the ball end of the injector rack control lever. If the rack of the No. 4R injector has become loose, back off the inner adjusting screw slightly on the No. 3R injector rack control lever and tighten the outer adjusting screw. When the settings are correct, both injector racks must respond in the same manner on the ball ends of the control levers when the injector control tube lever is held in the full-fuel position.

10. Position the remaining injector rack control levers on the right front cylinder bank as outlined in Steps 8 and 9.

11. Adjust the remaining injector rack control levers on the right rear, left front and left rear cylinder banks in the same manner as outlined in Steps 8, 9 and 10.

12. Install the four fuel rod-to-control tube lever clevis pins and check the adjustment of the injector rack control levers.

13. Use new gaskets and install the valve rocker covers.

Adjust Maximum No-Load Speed

All governors are properly adjusted before leaving the factory. However, if the governor has been reconditioned or replaced, and to ensure the engine speed will not exceed the recommended no-load speed as given on the engine option plate, set the maximum no-load speed as outlined below.

Start the engine and, after it reaches normal operating temperature, use an accurate hand tachometer to determine the maximum no-load speed of the engine. Then stop the engine and make the following adjustments, if required:

Variable Speed Governor Adjustment		
Full Load Speed*	Stops	Shims
1200-1750	2	Up to .325"
1750-2100	1	in Shims
2100-2300	0	Maximum
*No load speed is 150-225 rpm above full load speed depending upon engine application.		

TABLE 1

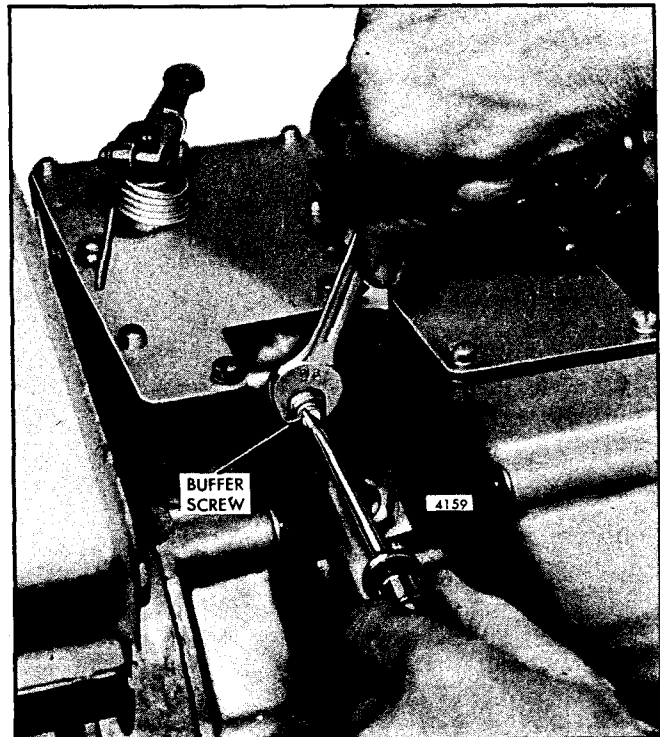


Fig. 8 - Adjusting Buffer Screw

1. Disconnect the booster spring and the stop lever spring.
2. Remove the variable speed spring housing and the spring retainer from the governor housing.
3. Refer to Table 1 and determine the stops or shims required for the desired no-load speed.
4. Install the variable speed spring retainer and housing and tighten the two bolts.
5. Connect the booster spring and the stop lever spring. Start the engine and recheck the maximum no-load speed.
6. If required, add or remove shims to obtain the necessary operating speed. For each .001" shim added, the operating speed will increase approximately 1 rpm.

IMPORTANT: If the maximum no-load speed is raised or lowered more than 50 rpm by the installation or removal of shims, recheck the governor gap. If readjustment of the governor gap is required, the position of the injector racks must be rechecked.

NOTE: Governor stops are used to limit the compression of the governor spring, which determines the maximum speed of the engine.

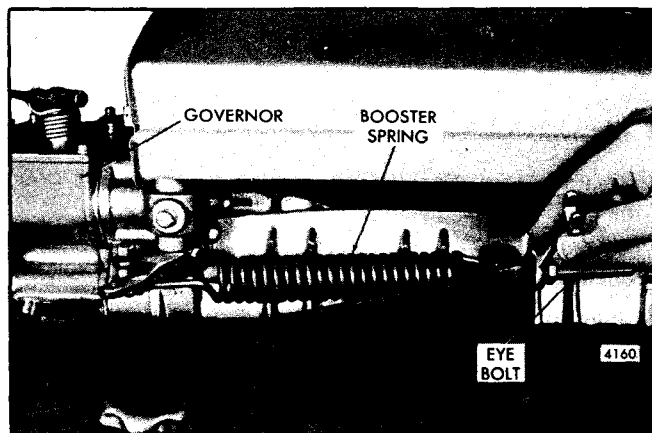


Fig. 9 - Adjusting Booster Spring

Adjust Idle Speed

With the maximum no-load speed properly adjusted, adjust the idle speed as follows:

1. Place the speed control lever in the *idle* position and the stop lever in the *run* position.
2. With the engine running at normal operating temperature, back out the buffer screw to avoid contact with the differential lever.
3. Loosen the lock nut and turn the idle speed adjusting screw (Fig. 7) until the engine is operating at approximately 15 rpm below the recommended idle speed.

NOTE: The recommended idle speed is 550 rpm, but may vary with special engine applications.

4. Hold the idle speed adjusting screw from turning and tighten the lock nut.

Adjust Buffer Screw

1. With the engine running at normal operating temperature, turn the buffer screw "in" (Fig. 8) so that it contacts the differential lever as lightly as possible and still eliminates engine roll.

NOTE: Do not raise the idle speed more than 15 rpm with the buffer screw.

2. Hold the buffer screw from turning and tighten the lock nut.

Adjust Booster Spring

With the idle speed adjusted, adjust the booster spring as follows:

1. Move the speed control lever to the idle speed position.
2. Refer to Fig. 9 and loosen the nut on the booster spring retaining bolt on the governor speed control lever. Loosen the lock nuts on the eye bolt at the opposite end of the booster spring.
3. Move the bolt in the slot of the speed control lever until the center of the bolt is on or slightly over center (toward the idle speed position) of an imaginary line through the bolt, lever shaft and eye bolt. Hold the bolt from turning and tighten the lock nut.
4. Start the engine and move the speed control lever to the maximum speed position and release it. The speed control lever should return to the idle position. If it does not, reduce the spring tension. If the lever does return to the idle position, increase the tension of the spring until the lever will not return to idle. Then reduce the tension until the lever will return to idle and tighten the lock nut on the eye bolt. This setting will result in a minimum force required to operate the speed control lever.

SUPPLEMENTARY GOVERNING DEVICE ADJUSTMENT

ENGINE LOAD LIMIT DEVICE

Engines with mechanical governors may be equipped with a load limit device (Fig. 1) to reduce the maximum horsepower.

This device consists of a load limit screw threaded into a plate mounted between two adjacent rocker arm shaft brackets and a load limit lever clamped to the injector control tube.

The load limit device is located between the No. 1 and No. 2 cylinders on *each* cylinder bank of a 6V engine, between the No. 2 and No. 3 cylinders on *each* cylinder bank of an 8V engine, or between the No. 3 and No. 4 cylinders on *each* cylinder bank of a 12V engine. On the 16V engine, four load limit devices are used (one on each cylinder head): between the No. 2 and No. 3 cylinder and between the No. 6 and No. 7 cylinder on each bank.

When properly adjusted for the maximum horsepower desired, this device limits the travel of the injector control racks and thereby the fuel output of the injectors.

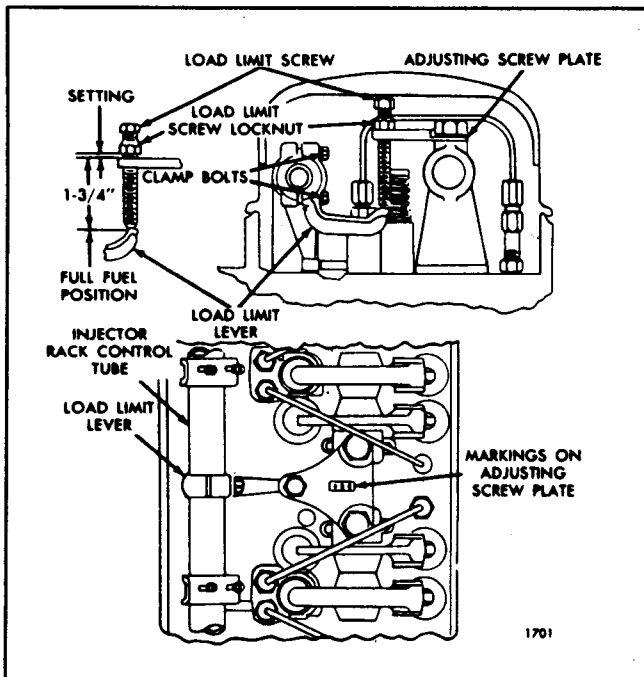


Fig. 1 - Engine Load Limit Device

Adjustment

After the engine tune-up is completed, make sure the load limit devices are properly installed as shown in Fig. 1. Make sure the counterbores in the adjusting screw plates are up. The rocker arm shaft bracket bolts which fasten the adjusting screw plate to the brackets are tightened to 75-85 lb-ft torque (all other rocker arm shaft bracket bolts are tightened to 90-100 lb-ft torque). Then adjust the load limit device, on each cylinder head, as follows:

1. Loosen the load limit screw lock nut and remove the screw.
2. Loosen the load limit lever clamp bolts so the lever is free to turn on the injector rack control tube.
3. With the screw out of the plate, adjust the load screw lock nut so the bottom of the lock nut is 1 3/4" from the bottom of the load limit screw (Fig. 1) for the initial setting.
4. Thread the load limit screw into the adjusting screw plate until the lock nut *bottoms* against the top of the plate.
5. Hold the injector rack control tube in the full-fuel position and place the load limit lever against the bottom of the load limit screw. Then tighten the load limit lever clamp bolts.
6. Check to ensure that the injector racks will just go into the full-fuel position -- readjust the load limit lever if necessary.
7. Hold the load limit screw to keep it from turning, then *set* the lock nut until the distance between the bottom of the lock nut and the top of the adjusting screw plate corresponds to the dimension (or number of turns) stamped on the plate. Each full turn of the screw equals .042, or .007" for each flat on the hexagon head.

NOTE: If the plate is not stamped, adjust the load limit screw while operating the engine on a dynamometer test stand and note the number of turns required to obtain the desired horsepower. Then stamp the plate accordingly.

8. Thread the load limit screw into the plate until the lock nut *bottoms* against the top of the plate.
9. Hold the load limit screw to keep it from turning, then tighten the lock nut to secure the setting.

POWER CONTROL DEVICE

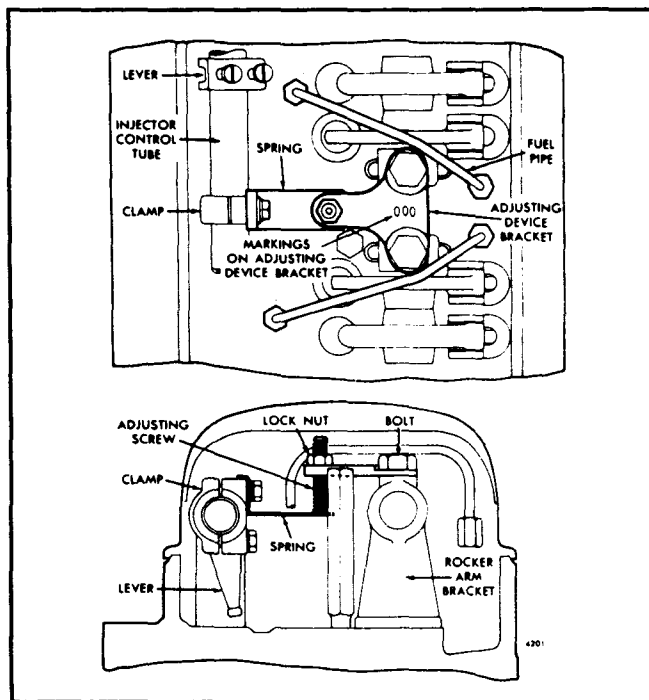


Fig. 2 - Power Control Device

The power control (torque limiting) device (Fig. 2) is used to limit the maximum horsepower output at the wheels without diminishing the performance at lower speeds where full power may be required. It limits the horsepower at, or just below, the normal full-load governed speed. These limiting characteristics are proportionately lessened as the engine speed is reduced and the horsepower required is reduced.

This device, one on each cylinder bank, consists of an adjusting screw threaded into a plate mounted between two adjacent rocker arm shaft brackets and a spring attached to a clamp on the injector control tube.

NOTE: The rocker arm shaft bracket bolts that retain the adjusting screw plates are tightened to 75-85 lb-ft torque; all other rocker arm shaft bracket bolts are tightened to 90-100 lb-ft torque.

The power control device is located between the No. 1 and No. 2 cylinders on *each* cylinder bank of a 6V

engine, between the No. 2 and No. 3 cylinders on *each* cylinder bank of an 8V engine, or between the No. 3 and No. 4 cylinders on *each* cylinder bank of a 12V engine.

Adjustment

After the engine tune-up is completed, adjust the power control device on both cylinder banks as follows:

1. Place the vehicle on a chassis dynamometer and check the maximum wheel horsepower.
2. Loosen the power control spring attaching bolts. Then adjust both springs until they project parallel to the cylinder heads when the injector control racks are held in the full-fuel position. Tighten the spring attaching bolts to 7-9 lb-ft torque to retain the adjustment.
3. Set each power control device, while holding the injector control racks in the full-fuel position, by turning the adjusting screw down (clockwise) until it just touches the spring and the lock nut is tight against the plate. Then release the injector control racks.

NOTE: Wipe the oil from each spring and the bottom of each adjusting screw so the point of contact can be seen readily.

CAUTION: Steps 2 and 3 must be completed on both cylinder banks before proceeding with Step 4.

4. Start the engine. Then, with the engine running at full governed speed, check the horsepower. If necessary, re-adjust the screws to obtain the specified horsepower. Turn the screws down to decrease the horsepower; turn the screws up to increase the horsepower. When the desired wheel horsepower is obtained, hold the screws from turning and tighten the lock nuts.

NOTE: If a dynamometer is not available, back up the lock nuts the distance stamped on the plates. Then turn the screws and lock nuts down together until the lock nuts *bottom* on the plates. Hold the screws from turning and tighten the lock nuts.

THROTTLE DELAY MECHANISM

The throttle delay mechanism is used to retard full-fuel injection when the engine is accelerated. This reduces exhaust smoke and also helps to improve fuel economy.

The throttle delay mechanism (Fig. 3) is installed between the No. 1 and No. 2 cylinders on the right-bank cylinder head. It consists of a special rocker arm shaft bracket (which incorporates the throttle delay cylinder), a piston, throttle delay lever, connecting link, orifice plug, ball check valve and U-bolt.

A yield link replaces the standard operating lever connecting link in the governor.

Operation

Oil is supplied to a reservoir above the throttle delay cylinder through an orifice plug in the drilled oil passage in the rocker arm shaft bracket (Fig. 3). As the injector racks are moved toward the no-fuel position, free movement of the throttle delay piston is assured by air drawn into the cylinder through the ball check valve. Further movement of the piston uncovers an opening which permits oil from the reservoir to enter the cylinder and displace the air. When the engine is accelerated, movement of the injector racks toward the full-fuel position is momentarily retarded while the piston expels the oil from the cylinder through an orifice. To permit full accelerator travel, regardless of the retarded injector rack position, a spring loaded yield link replaces the standard operating lever connecting link in the governor.

Inspection

When inspecting the throttle delay hydraulic cylinder it is important that the check valve be inspected for wear. Replace the check valve if necessary.

To inspect the check valve, fill the throttle delay cylinder with diesel fuel oil and watch for check valve leakage while moving the engine throttle from the idle position to the full fuel position.

Adjustment

Whenever the injector rack control levers are adjusted, disconnect the throttle delay mechanism by loosening the U-bolt which clamps the lever to the injector control tube. After the injector rack control levers have been positioned, the throttle delay mechanism must be re-adjusted. With the engine stopped, proceed as follows:

1. Refer to Fig. 4 and insert gage J 23190 (.454" setting) between the injector body and the shoulder on the injector rack. Then exert a light pressure on the injector control tube in the direction of full fuel.
2. Align the throttle delay piston so it is flush with the edge of the throttle delay cylinder.
3. Tighten the U-bolt on the injector control tube and remove the gage.
4. Move the injector rack from the no-fuel to the full-fuel position to make sure it does not bind.

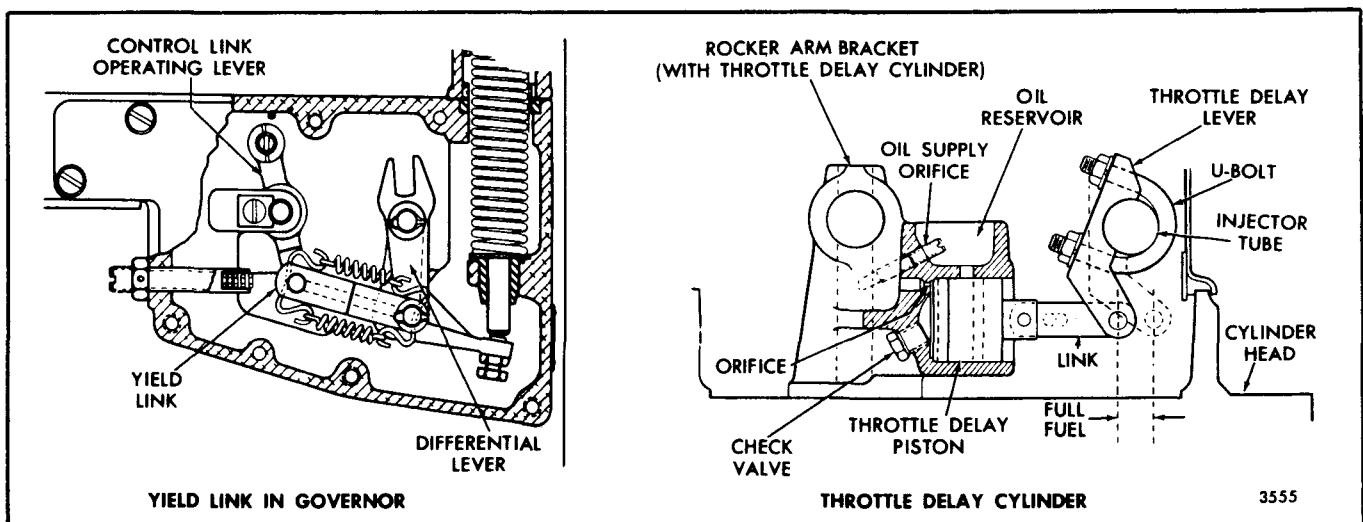


Fig. 3 - Throttle Delay Cylinder and Yield Link

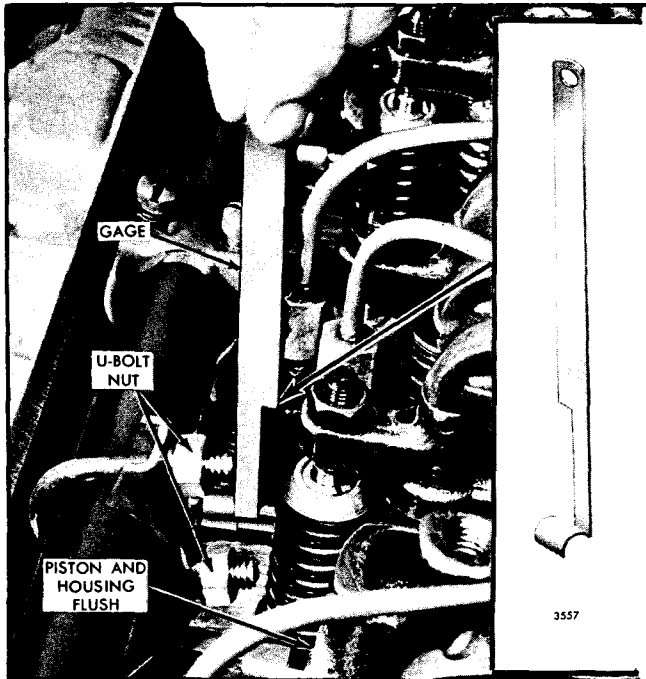


Fig. 4 - Adjusting Throttle Delay Cylinder

ADJUSTMENT OF MECHANICAL GOVERNOR SHUTDOWN SOLENOID

When a governor shutdown solenoid is used on an engine equipped with a mechanical governor, the governor stop lever must be properly adjusted to match the shutdown solenoid plunger travel.

The solenoid plunger can be properly aligned to the governor stop lever as follows:

1. Remove the bolt connecting the rod end eye (variable speed governor) or the right angle clip (limiting speed governor) to the stop lever (Figs. 5 and 6). Align and clamp the lever to the shutdown shaft in such a way that, at its mid-travel position, it is perpendicular to the solenoid plunger. This assures that the linkage will travel as straight as possible. The solenoid plunger has available 1/2" travel which is more than adequate to move the injector control racks

from the full-fuel to the complete no-fuel position and shutdown will occur prior to attaining complete travel.

2. With the stop lever in the *run* position, adjust the rod end eye or right angle clip for minimum engagement on the solenoid plunger when the connecting bolt is installed. The oversize hole in the eye or clip will thereby permit the solenoid to start closing the air gap, with a resultant build-up of pull-in force prior to initiating stop lever movement.

3. The bolt through the rod end eye or the right angle clip should be locked to the stop lever and adjusted to a height that will permit the eye or clip to float vertically. The clearance above and below the eye or clip and the bolt head should be approximately 1/32" minimum.

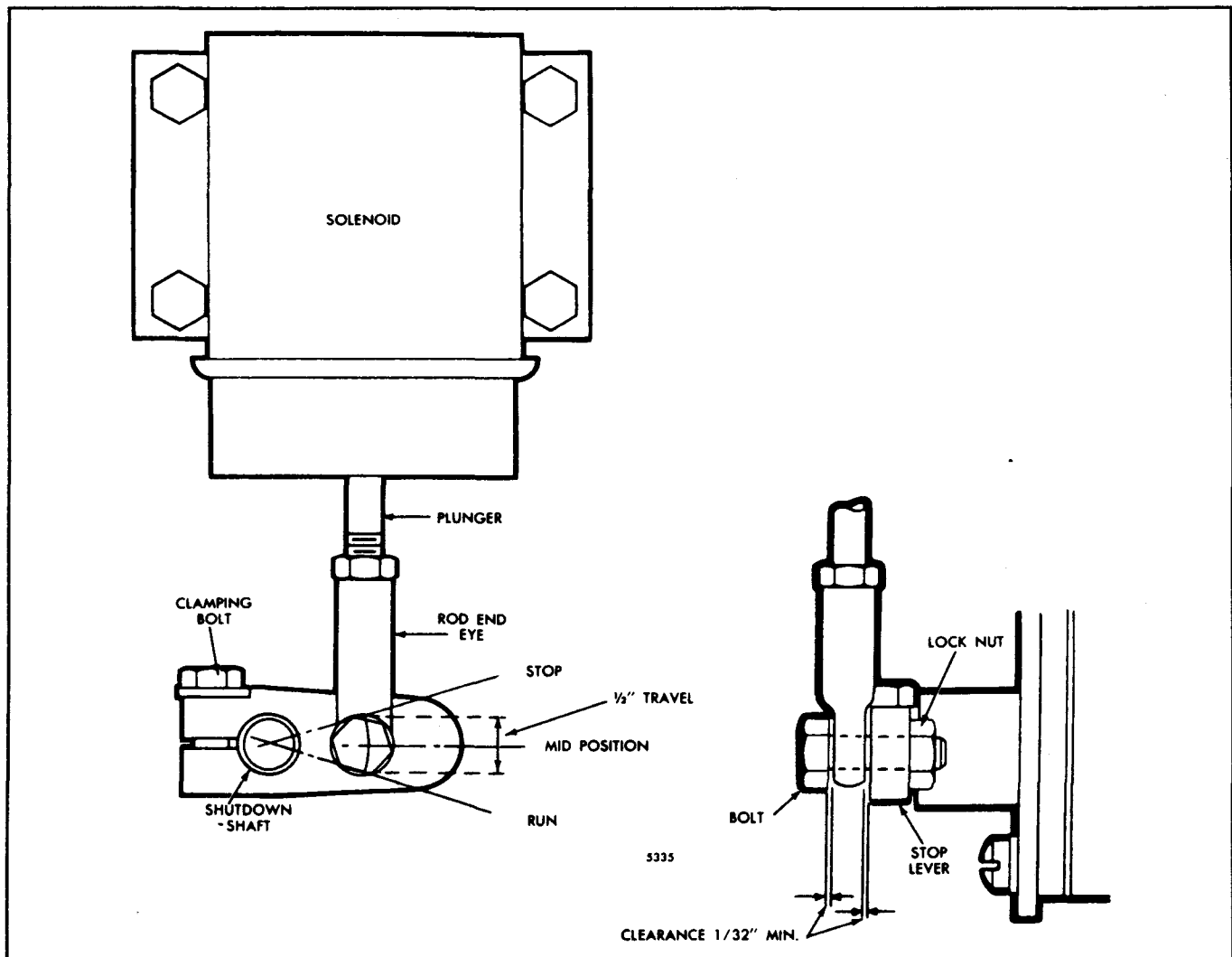


Fig. 5 - Typical Variable Speed Governor Lever Position

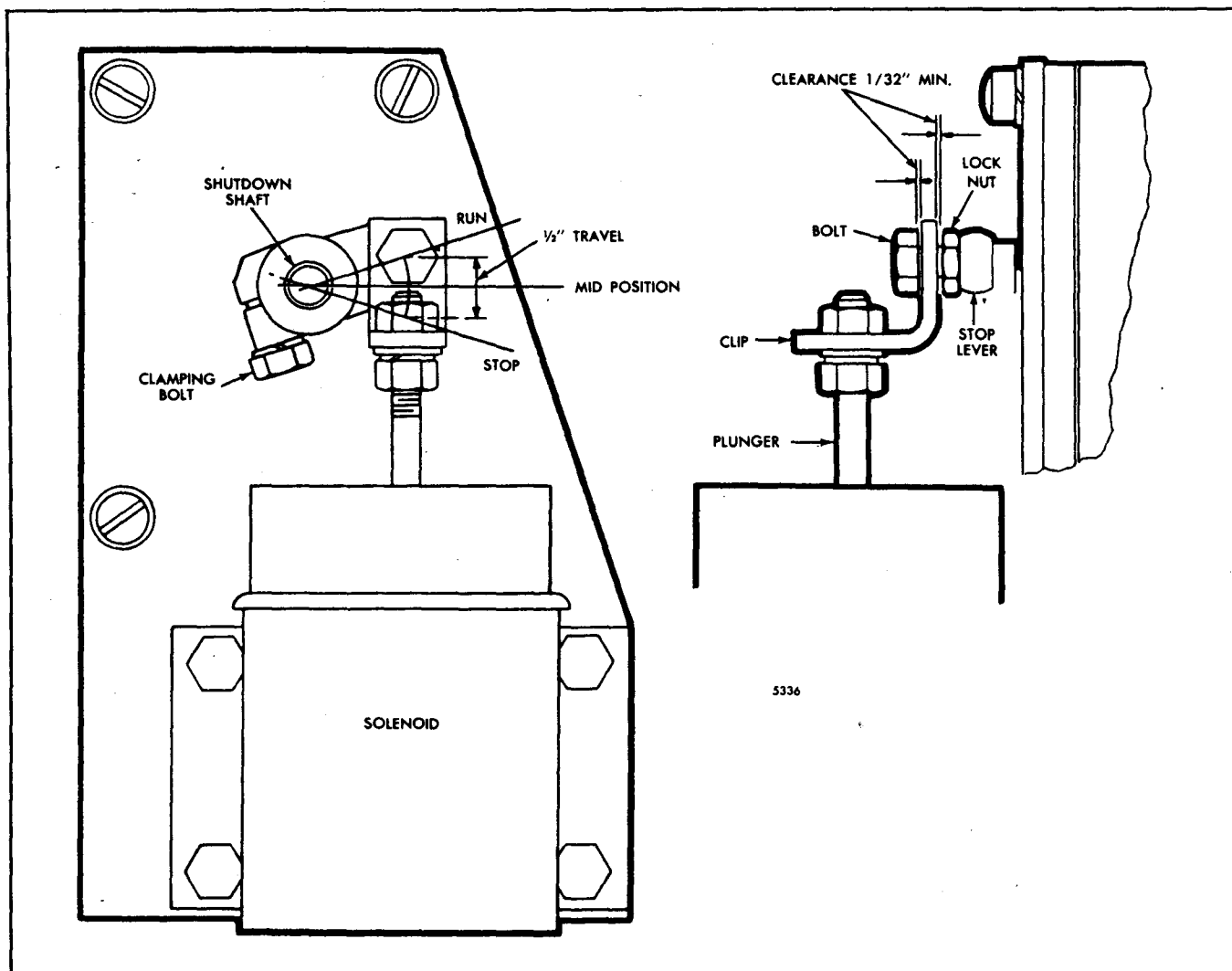


Fig. 6 - Typical Limiting Speed Governor Lever Position

NOTE: The lock nut can be either on top of or below the stop lever.

4. Move the lever to the *stop* position and observe the

plunger for any possible bind. If necessary, loosen the mounting bolts and realign the solenoid to provide free plunger motion.

VARIABLE SPEED HYDRAULIC GOVERNOR AND INJECTOR RACK CONTROL ADJUSTMENT

6, 8 and 12V ENGINES

After adjusting the exhaust valves and timing the fuel injectors, adjust the governor linkage (Fig. 1) and position the injector rack control levers.

Adjust Governor Linkage and Position Injector Rack Control Levers

1. Clean and remove the valve rocker cover from each cylinder head. Discard the gaskets.
2. Loosen all of the inner and outer injector rack control lever adjusting screws. Be sure all of the control levers are free on the control tubes.
3. Disconnect the vertical link assembly from the governor operating lever and the bell crank.
4. Loosen the bolt and slide the governor operating lever from the serrated shaft.
5. Place the bolt (removed from the lower end of the vertical link) through the bell crank and into the recessed hole in the governor drive housing.
6. Adjust the No. 1R injector rack by turning the inner adjusting screw down until it bottoms on the control tube (Fig. 2). Turn down the outer adjusting screw until it also bottoms on the control tube. Then

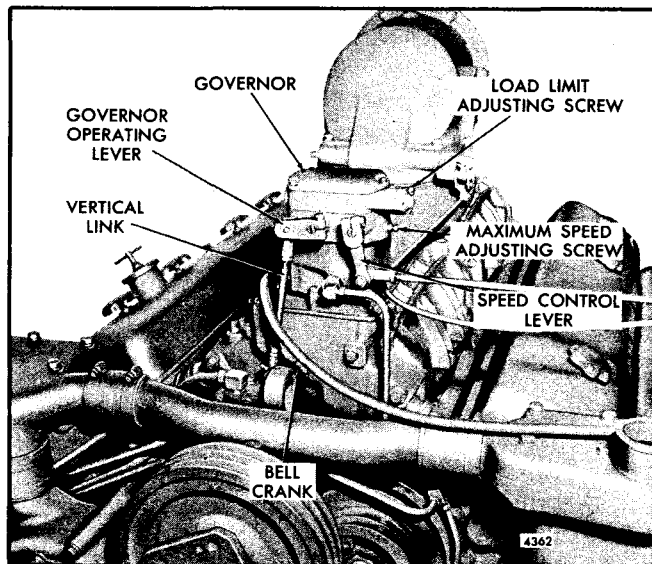


Fig. 1 - Hydraulic Governor Mounted on Engine

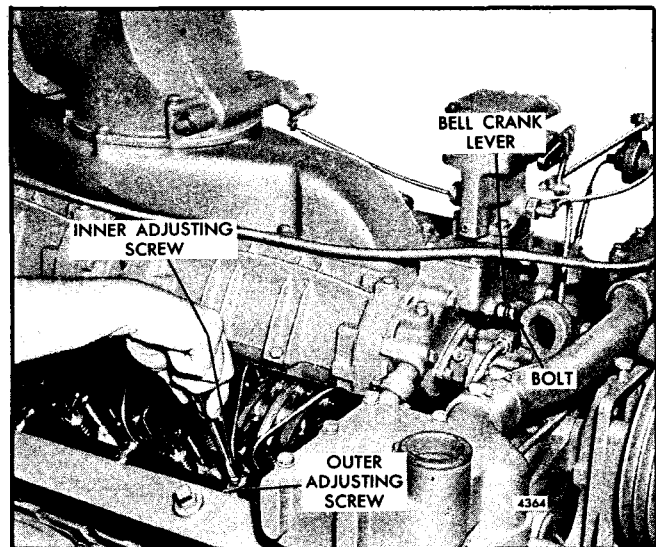


Fig. 2 - Positioning No. 1R Rack Control Lever

alternately tighten both the inner and outer adjusting screws.

CAUTION: Care should be taken to avoid setting the racks too tight and causing the fuel rod to bend.

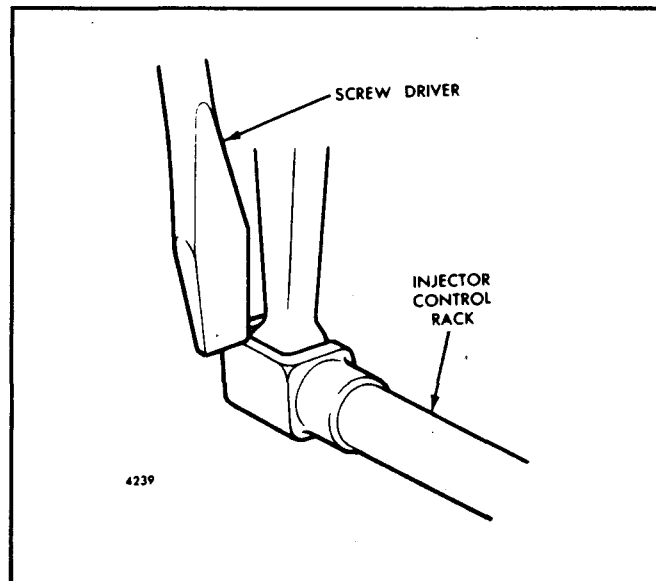


Fig. 3 - Checking Injector Rack "Spring"

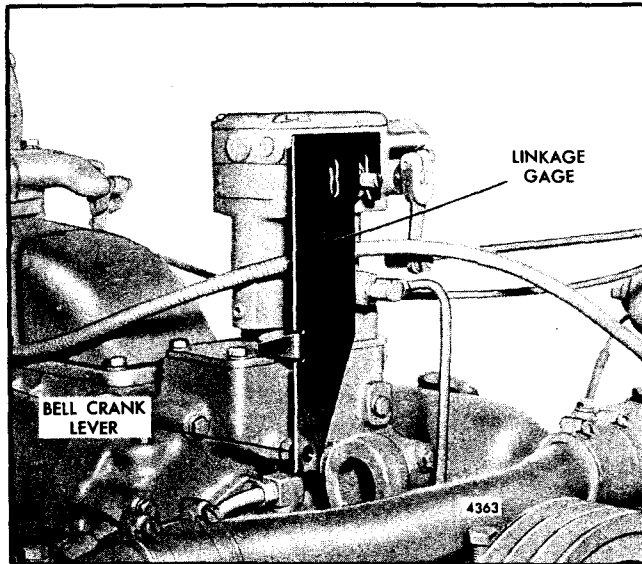


Fig. 4 - Linkage Gage in Position

7. To be sure the rack control lever is properly adjusted, press down on the injector rack with a screw driver or finger tip (Fig. 3). A light pressure should cause the rack to rotate. The rack is sufficiently tight if the rack returns or springs back to its original position when the pressure is removed. The rack is too tight if a heavy pressure is required to rotate the rack.

8. Adjust the No. 1L injector rack control lever as outlined in Steps 6 and 7.

9. Check the adjustment on the 1R and 1L injector rack control levers. If the setting is correct, the injector racks will be in the full-fuel position and snug on the ball end of the control levers.

10. To adjust the remaining injector rack control levers, hold the No. 1L injector rack in the full-fuel position by means of the lever on the end of the control tube assembly. Turn down the inner adjusting screw of the No. 2L injector rack control lever until the injector rack has moved into the full-fuel position. Turn the outer adjusting screw down until it bottoms lightly on the injector control tube. Then alternately tighten both the inner and outer adjusting screws.

NOTE: Overtightening of the injector rack control lever adjusting screws during installation or adjustment can result in damage to the injector control tube. The recommended torque of the adjusting screws is 24-36 in-lbs.

11. Recheck the No. 1L injector rack to be sure that it has remained snug on the ball end of the injector rack control lever while positioning the No. 2L injector rack. If the rack of the No. 1L injector has become loose, back off the inner adjusting screw slightly on the

No. 2L injector rack control lever. Tighten the outer adjusting screw. When the settings are correct, both injector racks must respond in the same manner on the ball end of their respective rack control levers as previously outlined in Step 7.

12. Position the remaining injector rack control levers on the left and right cylinder heads as outlined in Steps 10 and 11. When the settings are correct, all of the injector racks will be snug on the ball end of the control levers when the injector control tube lever is held in the full-fuel position.

13. Remove the bolt from the recessed hole in the drive housing and install linkage gage J 21304 (Fig. 4).

14. Replace the governor operating lever on the serrated shaft so that the bolt hole is lined up within the proper lines on the gage (Fig. 5). The type of governor (SGX or PSG) will determine the proper position of the lever.

15. Remove the gage.

16. Move the bell crank lever to the no-fuel position.

17. Adjust the length of the vertical link so that the bolt holes of the levers and the centers of the rod end bearings are lined up (Fig. 6).

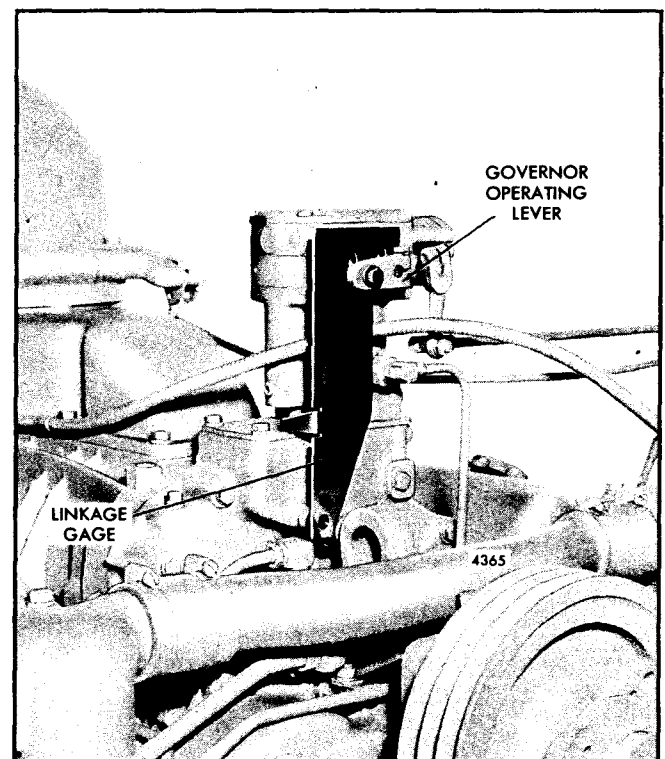


Fig. 5 - Governor Operating Lever in Position

18. Replace the two bolts in the levers and tighten the bolts.

19. Remove the governor cover.

20. With the load limit screw backed all the way out, retain the governor operating lever in the full-fuel position. The governor terminal lever should touch the boss in the governor housing (Fig. 7). Adjust the vertical link so that all of the injector racks are in the full-fuel position, then tighten the rod end lock nuts securely.

21. Use a new gasket and install a valve rocker cover on each cylinder head.

Adjust Load Limit

The load limit is set at the factory and further adjustment should be unnecessary. However, if the governor has had major repairs or the injector rack control levers have been re-positioned, the load limit screw should be re-adjusted.

With the injector rack control levers properly adjusted, set the load limit as follows:

1. With the governor cover off and the load limit screw lock nut loosened, adjust the screw to obtain a distance of approximately 2" from the outside face of the boss on the governor sub-cap to the end of the screw. Then place and retain the governor operating lever in the full-fuel position as shown in Fig. 7.

CAUTION: Do not overstress the linkage.

2. Turn the load limit adjusting screw until a .020" space exists between the fuel rod collar and the terminal lever. If the adjustment cannot be made with a feeler gage, turn the load limit adjusting screw (with the lock nut tight enough to eliminate slack in the threads) inward until the injector racks just loosen on the ball end of the control levers.

3. Release the governor operating lever and hold the adjusting screw while tightening the lock nut. Then install the governor cover and tighten the screws.

Compensation Needle Valve Adjustment (PSG Governor)

Start the engine and, after the engine reaches normal operating temperature, adjust the governor compensation needle valve (without load on the engine) as follows:

1. Open the compensation needle valve (Fig. 11) two or three turns and allow the engine to "hunt" or

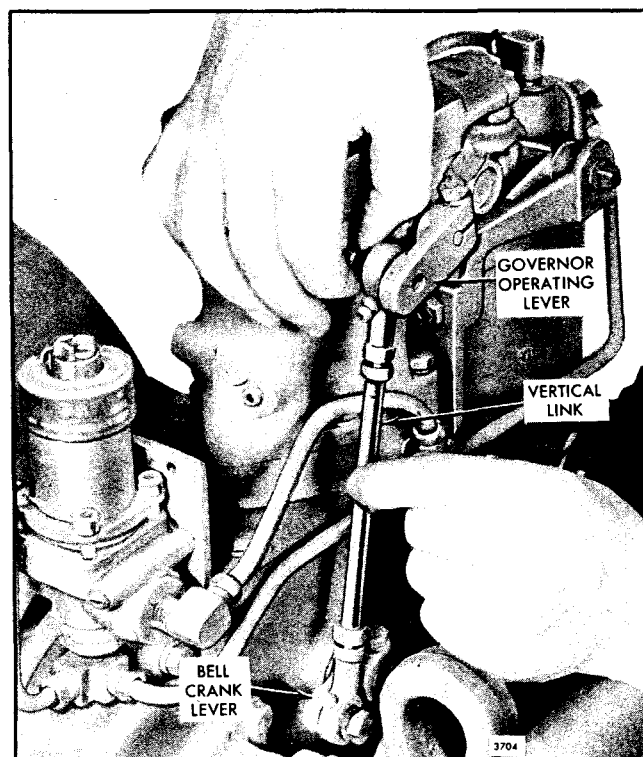


Fig. 6 - Adjusting Vertical Link

"surge" for about one-half minute to bleed any air which may be trapped in the governor oil passages.

2. Gradually close the valve until the "hunting" just stops. Check the amount of valve opening by closing the valve completely and noting the number of turns

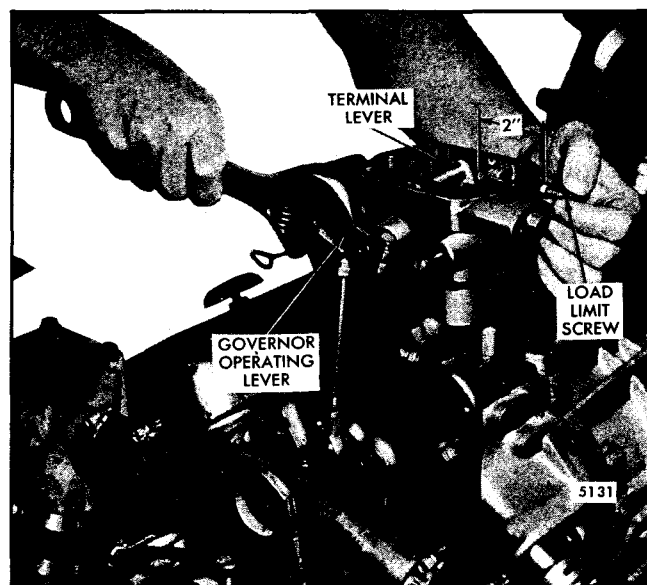


Fig. 7 - Adjusting Load Limit Screw

required to close it. Open the valve to the previously determined position at which the "hunting" stopped. Test the action of the governor by manually disturbing the engine speed. The engine should return promptly to the original steady speed with only a small overshoot. The correct valve setting will be between 1/8 and 1/2 turn open. Closing the valve farther than necessary will make the governor slow in returning the engine to normal speed after a load change.

Adjust Governor Speed Droop

INTERNAL DROOP ADJUSTMENT

The purpose of adjusting the speed droop is to establish a definite engine speed at no-load with a given speed at rated full-load.

The governor speed droop is set at the factory and further adjustment should be unnecessary. However, if the governor has been overhauled, the speed droop must be readjusted.

The best method of determining the engine speed is by using an accurate tachometer.

If a full rated load can be established on the unit, and the fuel rods, injector rack control levers and the load limit have been adjusted, set the speed droop as follows:

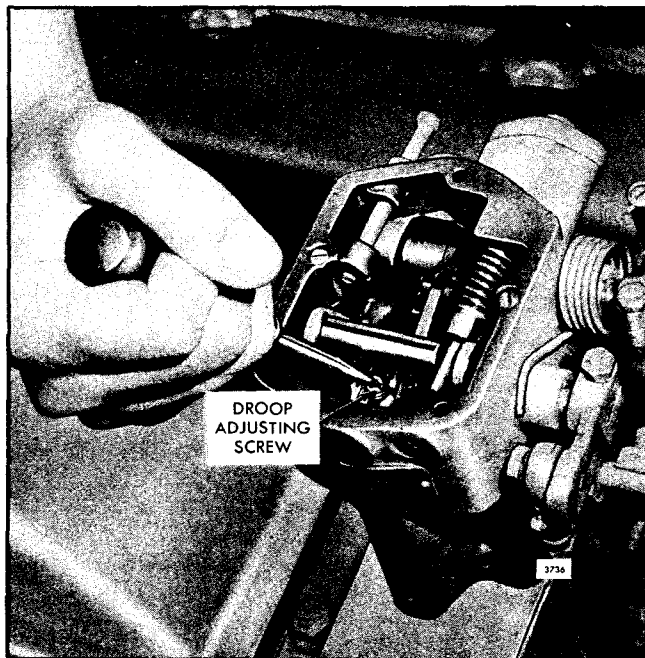


Fig. 8 - Adjusting Speed Droop

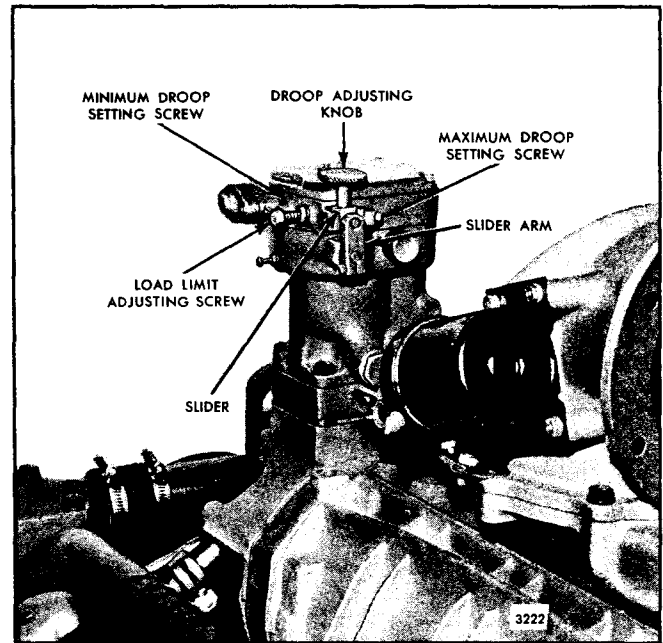


Fig. 9 - External Droop Control on PSG Isochronous Governor

1. Start the engine and run it at approximately one-half the rated no-load speed until the lubricating oil temperature stabilizes.

NOTE: When the engine lubricating oil is cold, the governor regulation may be erratic. Regulation will become increasingly stable as the temperature of the oil increases.

2. Stop the engine and remove the governor cover.
3. Loosen the lock nut and back off the maximum speed adjusting screw approximately 5/8".
4. Loosen the droop adjusting screw. Move the droop bracket so that the screw is midway between the ends of the slot in the bracket. Tighten the screw (Fig. 8).
5. With the throttle in the RUN position, adjust the engine speed until the engine is operating at 3% to 5% above the recommended full-load speed.

FULL-LOAD	NO-LOAD
50 cycles 1000 rpm	52.5 cycles 1050 rpm
60 cycles 1200 rpm	62.5 cycles 1250 rpm
50 cycles 1500 rpm	52.5 cycles 1575 rpm
60 cycles 1800 rpm	62.5 cycles 1875 rpm

TABLE 1

6. Apply the full rated load on the engine and readjust the engine speed to the correct full-load speed.

7. Remove the rated load and note the engine speed after the speed stabilizes under no-load. If the speed droop is correct, the engine speed will be approximately 3% to 5% higher than the full-load speed.

If the speed droop is too high, stop the engine, loosen the droop adjusting screw and move the adjusting bracket IN toward the center of the governor. Tighten the screw. To increase the speed droop, move the bracket OUT, away from the center of the governor.

The speed droop in governors which control engines driving generators in parallel must be identical, otherwise the electrical load will not be equally divided.

Adjust the speed droop bracket in each governor to obtain the desired variation between engine no-load and full-load speeds. The recommended speed droop for generator sets operating in parallel is 50 rpm (2-1/2 cycles) for units operating at 1,000 and 1,200 rpm, and 75 rpm (2-1/2 cycles) for units operating at 1,500 and 1,800 rpm (Table 1). However, this speed droop recommendation may be varied to suit the individual application.

EXTERNAL DROOP CONTROL

Some PSG type governors are equipped with an external adjustable droop control (Fig. 9). This permits the speed droop to be adjusted without removing the governor cover. With this feature, a unit can be paralleled with another unit that is operating at constant frequency (zero droop). The incoming unit must have its droop bracket set in the maximum position while it is being paralleled and while operating in parallel. When it is desired to stop the unit operating at constant frequency, shift the load to the incoming unit and move the governor droop bracket to zero droop. Then adjust the outgoing unit to maximum droop, remove it from the line and stop the engine. The incoming unit will now be carrying the load and operating at constant frequency (zero droop).

Adjust the governor speed droop as follows:

1. Start the engine and run it at approximately one-half of the rated full-load speed until the lubricating oil temperature stabilizes.
2. Remove the load from the engine.
3. Back off the compensation needle valve to release any air that may be trapped in the system. Turn the needle valve in slowly to reduce governor "hunting". The correct needle valve setting will be between 1/8 and 1/2 turn open.

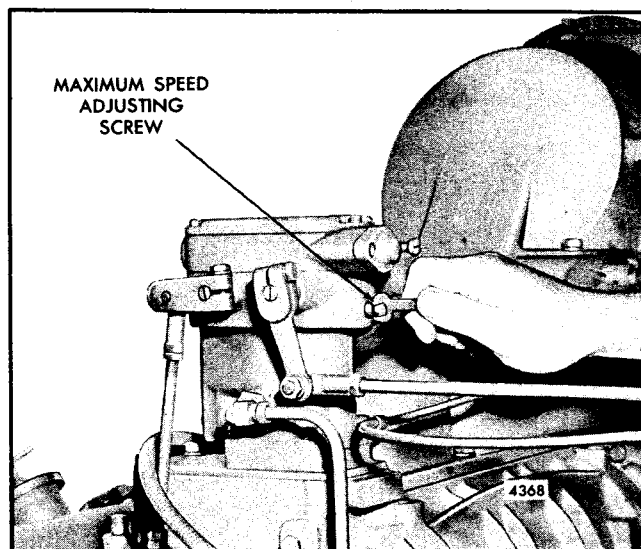


Fig. 10 - Adjusting Maximum No-Load Engine Speed

4. Back out the minimum and maximum droop setting screws.
5. Loosen the droop adjusting knob and move the slider all the way in toward the center of the governor. Then tighten the knob.
6. Loosen the lock nut on the maximum speed adjusting screw (Fig. 10) and turn the screw out until 5/8" of the threads are exposed.
7. With the engine operating at the recommended full-load speed, apply the full rated load and recheck the engine speed. If required, readjust the engine to full-load speed.
8. Remove the load and note the engine speed. If the zero droop setting is correct, the engine speed will remain constant. If the engine speed is higher, loosen the droop adjusting knob and set the slider to a reduced droop position.
9. When the desired minimum droop setting is reached, loosen the lock nut and turn the minimum droop setting screw inward until it contacts the droop linkage within the governor. This will be felt by a step-up of resistance while turning the adjusting screw. Lock the adjusting screw in this position.
10. Loosen the droop adjusting knob and slide the droop bracket in a direction to increase the droop. Perform Steps 7 and 8 to check the droop until the desired maximum speed droop is attained.
11. When the desired maximum droop setting is reached, loosen the lock nut and turn the maximum

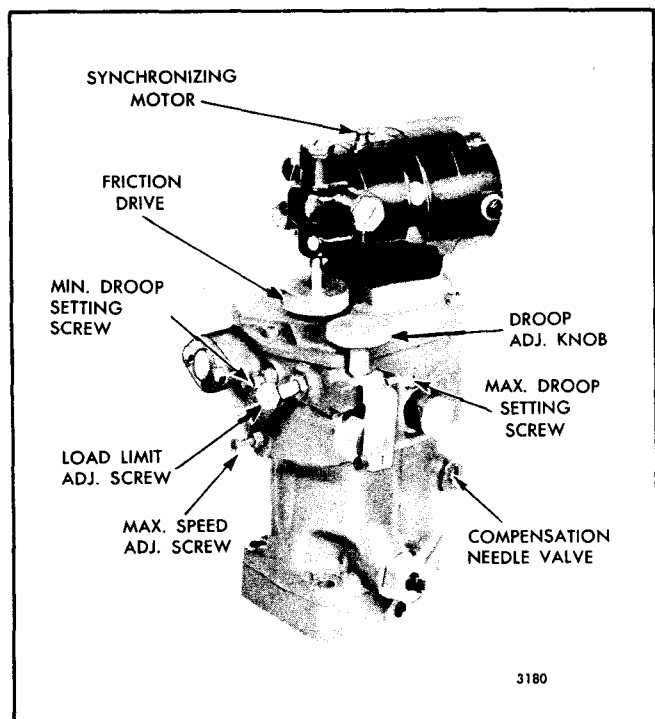


Fig. 11 - Typical Synchronizing Motor Mounting

droop setting screw inward until it contacts the droop slider arm. Lock the adjusting screw in this position.

12. Recheck the minimum and maximum droop setting as outlined in Steps 7 and 8 and adjust the

adjustment screws, if necessary, until the correct settings are obtained.

Adjust Maximum No-Load Speed

With the speed droop properly adjusted, set the maximum no-load speed as follows:

1. With the engine operating at no load, adjust the speed until the engine is operating at approximately 8% higher than the rated full-load speed.
2. Turn the maximum speed adjusting screw (Fig. 10) in until the screw contacts the throttle linkage internally, limiting the maximum speed of the engine at 8% above the rated full-load speed.
3. Hold the screw and tighten the lock nut.

Governors with Synchronizing Motor

Some hydraulic governors are equipped with a reversible electric synchronizing motor (Fig. 11) mounted on the governor cover.

The adjustments on a governor equipped with a synchronizing motor are the same as on a governor without the motor. However, the governor cover and motor assembly must be removed when setting the engine speed droop (except on a governor equipped with an external droop adjustment). The cover and motor must be reinstalled to check the speed droop.

VARIABLE SPEED HYDRAULIC GOVERNOR AND INJECTOR RACK CONTROL ADJUSTMENT

16V-71 ENGINE

The governor on the 16V engine is mounted on and driven from the front end of the rear blower (Fig. 1). The governor-to-injector control tube linkage is shown in Fig. 2.

After adjusting the exhaust valves and timing the fuel injectors, adjust the governor linkage and position the injector rack control levers.

Adjust Governor Linkage and Position Injector Rack Control Levers

1. Clean and remove the valve rocker cover from each cylinder head. Discard the gaskets.
2. Loosen all of the inner and outer injector rack control lever adjusting screws. Be sure all of the control levers are free on the control tubes.
3. Remove the vertical link assembly from the governor operating lever and the bell crank lever.
4. Loosen the bolt and slide the governor operating lever from the serrated shaft.
5. Place the bolt (removed from the lower end of the vertical link) through the bell crank and into the recessed hole in the governor drive housing (Fig. 3).

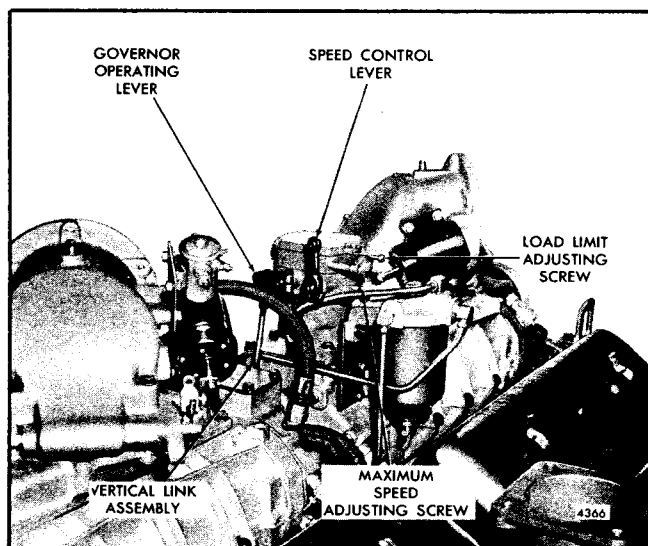


Fig. 1 - Hydraulic Governor Mounting

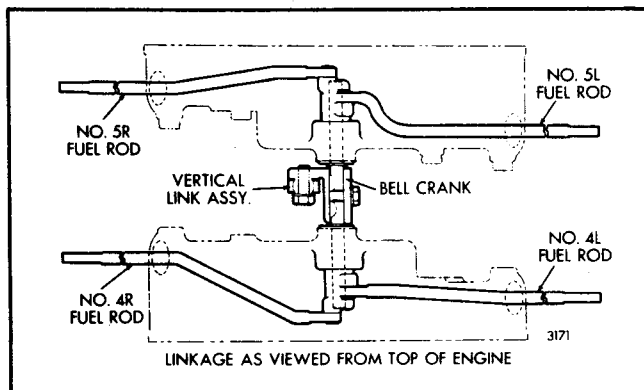


Fig. 2 - Governor to Injector Rack Control Linkage

6. Adjust the No. 4R injector rack by turning the inner adjusting screw down until it bottoms on the control tube (Fig. 4). Turn down the outer adjusting screw until it also bottoms on the control tube. Then tighten both the inner and outer adjusting screws alternately.

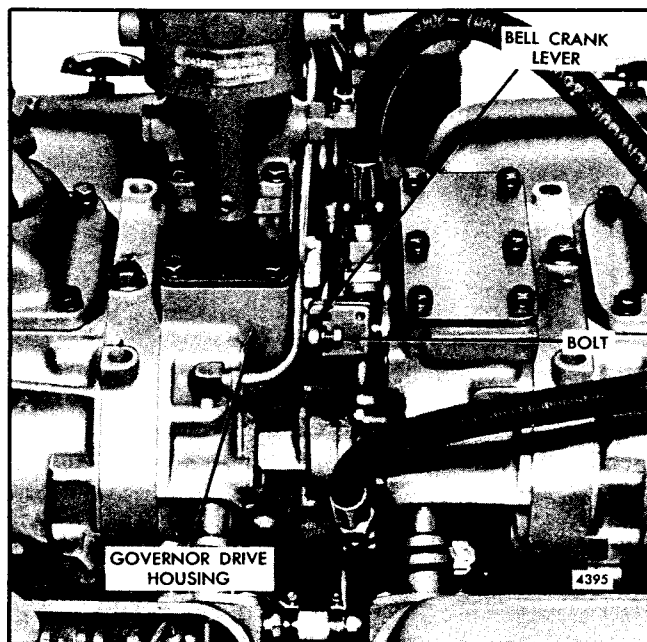


Fig. 3 - Bolt in Position through Bell Crank Lever

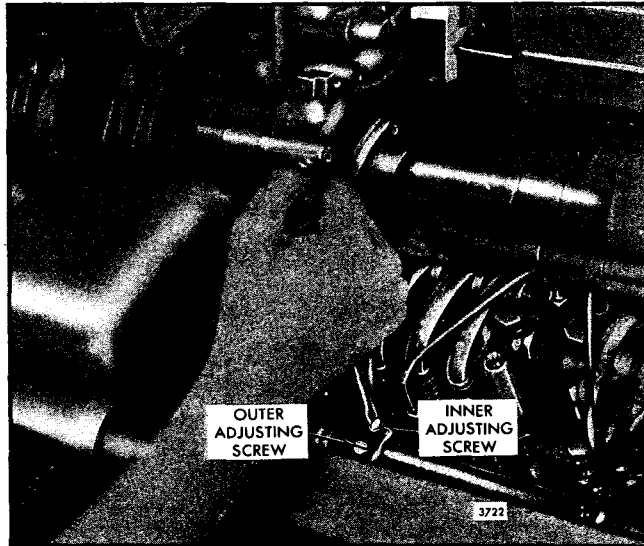


Fig. 4 - Positioning No. 4R Injector Rack Control Lever

CAUTION: Care should be taken to avoid setting the racks too tight, causing the fuel rod to bend.

7. To be sure the rack control lever is properly adjusted, press down on the injector rack with a screw driver or finger tip (Fig. 5). A light pressure should cause the rack to rotate. The rack is sufficiently tight if the rack returns to its original position when the pressure is removed. The rack is too tight if a heavy pressure is required to rotate the rack.

8. Adjust the 5R, 4L and 5L injector rack control

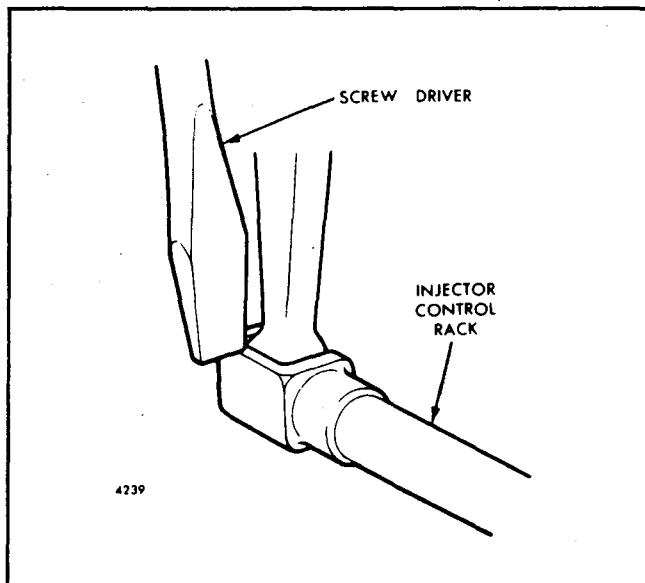


Fig. 5 - Checking Injector Rack "Spring"

levers as outlined in Steps 6 and 7. When the settings are correct, all four of the injector racks will be snug on the ball end of the control levers when the injectors are in the full-fuel position.

9. To adjust the remaining injector rack control levers on the right front bank, hold the 4R injector rack in the full-fuel position by means of the lever on the control tube assembly and turn down the inner adjusting screw of the 3R injector rack control lever until the injector rack has moved into the full-fuel position. Turn the outer adjusting screw down until it bottoms lightly on the injector control tube. Then alternately tighten both the inner and outer adjusting screws.

NOTE: Overtightening of the injector rack control lever adjusting screws during installation or adjustment can result in damage to the injector control tube. The recommended torque of the adjusting screws is 24-36 in-lb.

10. Recheck the No. 4R injector rack to be sure that it has remained snug on the ball end of the injector rack control lever. If the rack of No. 4R injector has become loose, back off the inner adjusting screw slightly on the 3R injector rack control lever. Tighten the outer adjusting screw. When the settings are correct, both injector racks must respond in the same manner on the ball ends of their respective rack control levers as previously outlined in Step 7.

11. Position the remaining injector rack control levers on the right front cylinder head as outlined in Step 9. When the settings are correct, all of the injector racks will be snug on the ball end of the control levers when the injector control tube lever is held in the full-fuel position.

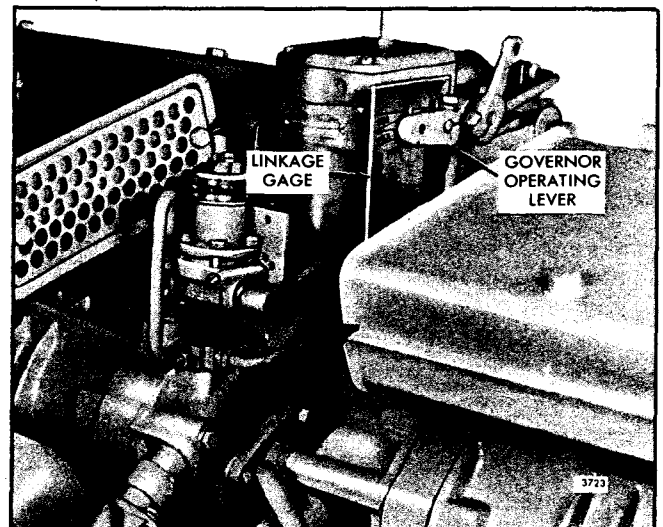


Fig. 6 - Governor Operating Lever in Position

12. Adjust the remaining injector rack control levers on the right rear, left front, and left rear cylinder heads in the same manner as outlined in Steps 9, 10 and 11.
13. Remove the bolt from the recessed hole in the drive housing and install linkage gage J 21304.
14. Replace the governor operating lever on the serrated shaft so that the bolt hole is lined up within the proper lines on the gage. The type of governor (SGX or PSG) will determine the proper position of the lever (Fig. 6).
15. Remove the gage.
16. Move the bell crank lever to the no-fuel position.
17. Adjust the length of the vertical link so that the bolt holes of the levers and the centers of the rod end bearings are lined up (Fig. 7).
18. Replace the two bolts in the levers and tighten the bolts.
19. Remove the governor cover.
20. With the load limit screw backed all the way out, retain the governor operating lever in the full-fuel position. The governor terminal lever should touch the boss on the governor housing. Adjust the vertical link so that all of the injector racks are in the full-fuel position, then tighten the rod end lock nuts securely.
21. Use a new gasket and install the valve rocker cover on each cylinder head.

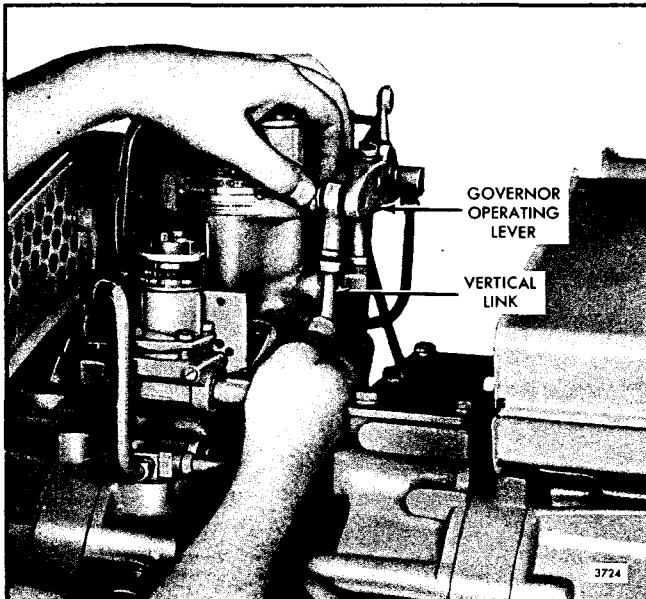


Fig. 7 - Adjusting Vertical Link

Adjust Load Limit

The load limit is set at the factory and any further adjustment should be unnecessary. However, if the governor has had major repairs, or the injector control rack levers have been re-positioned the load limit screw should be re-adjusted.

With the injector rack control levers properly adjusted, set the load limit as follows:

1. With the governor cover off and the load limit screw lock nut loosened, place and retain the governor operating lever in the full-fuel position as shown in Fig. 8.

CAUTION: Do not overstress the linkage.

2. Turn the load limit adjusting screw until a .020" space exists between the fuel rod collar and the terminal lever. If the adjustment cannot be made with a feeler gage, turn the load limit adjusting screw (with the lock nut tight enough to eliminate any slack in the threads) in until the injector racks just loosen on the ball end of the control levers.
3. Release the governor operating lever and hold the adjusting screw while tightening the lock nut. Then install the governor cover and tighten the screws.

Compensation Needle Valve Adjustment (PSG Governor)

Start the engine and, after the engine reaches normal

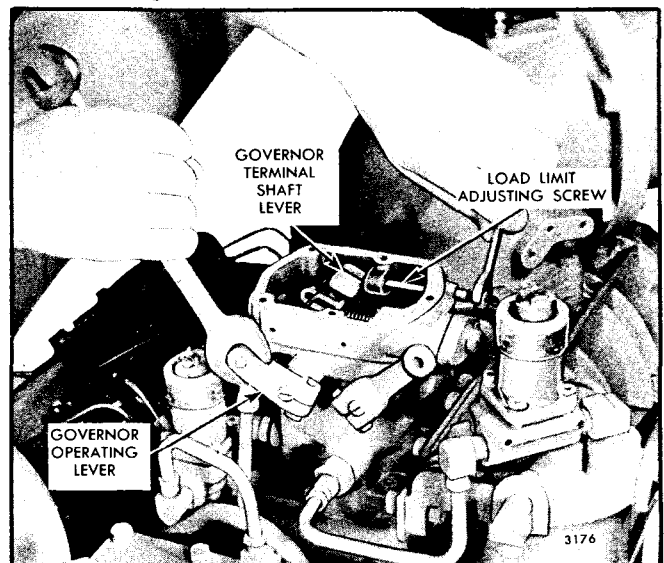


Fig. 8 - Adjusting Load Limit Screw

operating temperature, adjust the governor compensation needle valve, without load on the engine, as follows:

1. Open the valve (Fig. 10) two or three turns and allow the engine to "hunt" or "surge" for about one-half minute to bleed any air which may be trapped in the governor oil passages.
2. Gradually close the valve until the "hunting" just stops. Check the amount of valve opening by closing the valve completely and noting the number of turns required to close it. Open the valve to the previously determined position at which the "hunting" stopped. Test the action of the governor by manually disturbing the engine speed. The engine should return promptly to the original steady speed with only a small overshoot. The correct valve setting will be between 1/8 and 1/2 turn open. Closing the valve farther than necessary will make the governor slow in returning the engine to normal speed after a load change.

Adjust Governor Speed Droop

INTERNAL DROOP ADJUSTMENT

The purpose of adjusting the speed droop is to establish a definite speed at no-load with a given speed at rated full-load.

The governor speed droop is set at the factory and further adjustment should be unnecessary. However, if the governor has been overhauled, the speed droop must be readjusted.

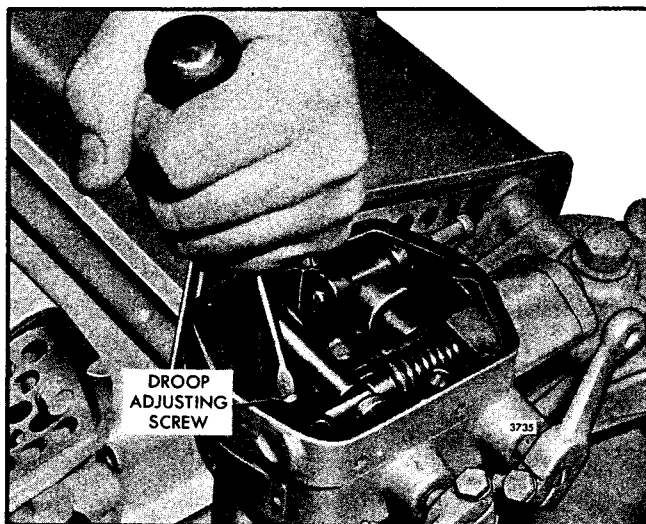


Fig. 9 - Adjusting Speed Droop

The best method of determining the engine speed is by using an accurate hand tachometer.

If a full rated load can be established on the unit, and the fuel rods, injector rack control levers and the load limit have been adjusted, set the speed droop as follows:

1. Start the engine and run it at approximately one-half the rated no-load speed until the lubricating oil temperature stabilizes.

NOTE: When the engine lubricating oil is cold, the governor regulation may be erratic. Regulation will become increasingly stable as the temperature of the oil increases.

2. Stop the engine and remove the governor cover.
3. Loosen the lock nut and back off the maximum speed adjusting screw approximately 5/8".
4. Loosen the droop adjusting bolt on former units or the screw on current units (Fig. 9). Move the droop bracket so that the screw is midway between the ends of the slot in the bracket. Tighten the screw.
5. With the throttle in the RUN position, adjust the engine speed until the engine is operating at 3% to 5% above the recommended full-load speed.
6. Apply the full rated load on the engine and readjust the engine speed to the correct full-load speed.
7. Remove the rated load and note the engine speed after the speed stabilizes under no load. If the speed droop is correct, the engine speed will be approximately 3% to 5% higher than the full-load speed.

If the speed droop is too high, stop the engine, loosen the droop adjusting screw and move the adjusting bracket IN toward the center of the governor. Tighten the screw. To increase the speed droop, move the bracket OUT, away from the center of the governor.

The speed droop in governors which control engines driving generators in parallel must be identical,

FULL-LOAD	NO-LOAD
50 cycles 1000 rpm	52.5 cycles 1050 rpm
60 cycles 1200 rpm	62.5 cycles 1250 rpm
50 cycles 1500 rpm	52.5 cycles 1575 rpm
60 cycles 1800 rpm	62.5 cycles 1875 rpm

TABLE 1

otherwise the electrical load will not be equally divided.

Adjust the speed droop bracket in each governor to obtain the desired variation between engine no-load and full-load speeds. The recommended speed droop for generator sets operating in parallel is 50 rpm (2-1/2 cycles) for units operating at 1,000 and 1,200 rpm, and 75 rpm (2-1/2 cycles) for units operating at 1,500 and 1,800 rpm (Table 1). However, this speed droop recommendation may be varied to suit the individual application.

EXTERNAL DROOP CONTROL

Some PSG type governors are equipped with an external adjustable droop control (Fig. 10). This permits the speed droop to be adjusted without removing the governor cover. With this feature, a unit can be paralleled with another unit that is operating at constant frequency (zero droop). The incoming unit must have its droop bracket set in the maximum position while it is being paralleled and while operating in parallel. When it is desired to stop the unit operating at constant frequency, shift the load to the incoming unit and move the governor droop bracket to zero droop. Then adjust the outgoing unit to maximum droop, remove it from the line and stop the engine. The incoming unit will now be carrying the load and operating at constant frequency (zero droop).

Adjust the governor speed droop as follows:

1. Start the engine and run it at approximately one-half of the rated full-load speed until the lubricating oil temperature stabilizes.
2. Remove the load from the engine.
3. Back off the compensation needle valve to release any air that may be trapped in the system. Turn the needle valve in slowly to reduce governor "hunting". The correct needle valve setting will be between 1/8 and 1/2 turn open.
4. Back out the minimum and maximum droop setting screws.
5. Loosen the droop adjusting knob (Fig. 10) and move the slider all the way in toward the center of the governor. Then tighten the knob.
6. Loosen the lock nut on the maximum speed adjusting screw and turn the screw out until 5/8" of the threads are exposed.
7. With the engine operating at the recommended full-load speed, apply the full rated load and recheck the engine speed. If required, readjust the engine to full-load speed.

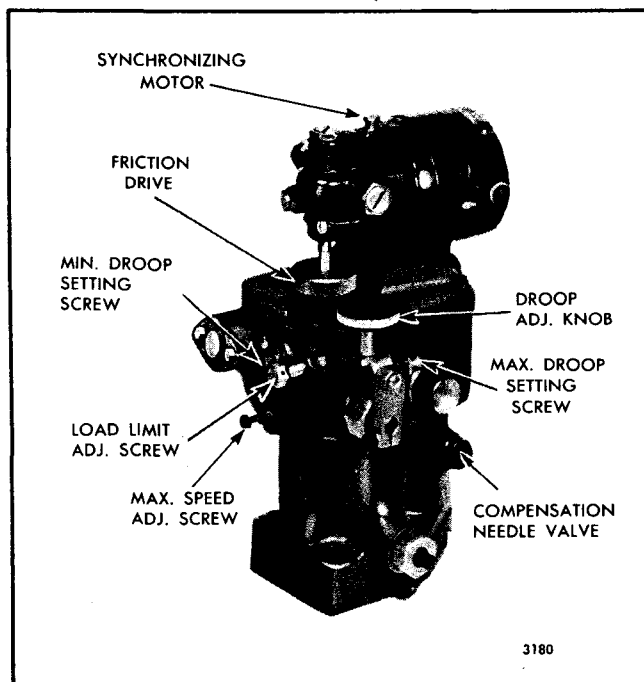


Fig. 10 - Typical Synchronizing Motor Mounting

8. Remove the load and note the engine speed. If the zero droop setting is correct, the engine speed will remain constant. If the engine speed is higher, loosen the droop adjusting knob and set the slider to a reduced droop position.
9. When the desired minimum droop setting is reached, loosen the lock nut and turn the minimum droop setting screw in until it contacts the droop linkage within the governor. This will be felt by a step-up of resistance while turning the adjusting screw. Lock the adjusting screw in this position.
10. Loosen the droop adjusting knob and slide the droop bracket in a direction to increase the droop. Perform Steps 7 and 8 to check the droop until the desired maximum speed droop is attained.
11. When the desired maximum droop setting is reached, loosen the lock nut and turn the maximum droop setting screw in until it contacts the droop slider arm. Lock the adjusting screw in this position.
12. Recheck the minimum and maximum droop setting as outlined in Steps 7 and 8 and adjust the adjustment screws, if necessary, until the correct settings are obtained.

Adjust Maximum No-Load Speed

With the speed droop properly adjusted, set the maximum no-load speed as follows:

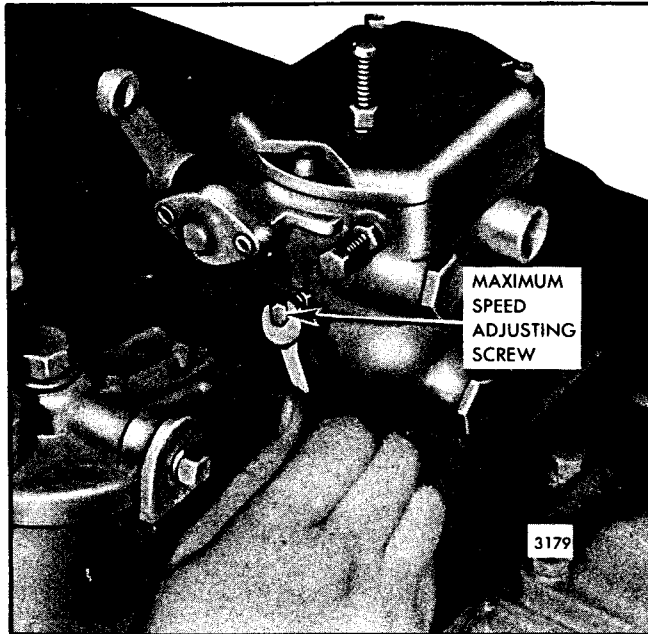


Fig. 11 - Adjusting Maximum No-Load Engine Speed

1. With the engine operating at no-load, adjust the speed until the engine is operating at approximately 8% higher than the rated full-load speed.
2. Turn the maximum speed adjusting screw (Fig. 11) in until the screw contacts the throttle linkage internally, limiting the maximum speed of the engine at 8% above the rated full-load speed.
3. Hold the screw and tighten the lock nut.

Adjust Low-Speed Stop Screw

The low-speed stop screw (Fig. 12) projects from the top of the governor cover. This screw is used to establish an idle speed setting when the throttle is moved to the **idle/neutral** position on marine units, thus preventing false engine shutdowns. To establish the desired engine idle speed, proceed as follows:

1. Loosen the lock nut and back out the low speed stop screw.
2. Start the engine and carefully reduce the speed with the throttle until the desired idle speed is established.

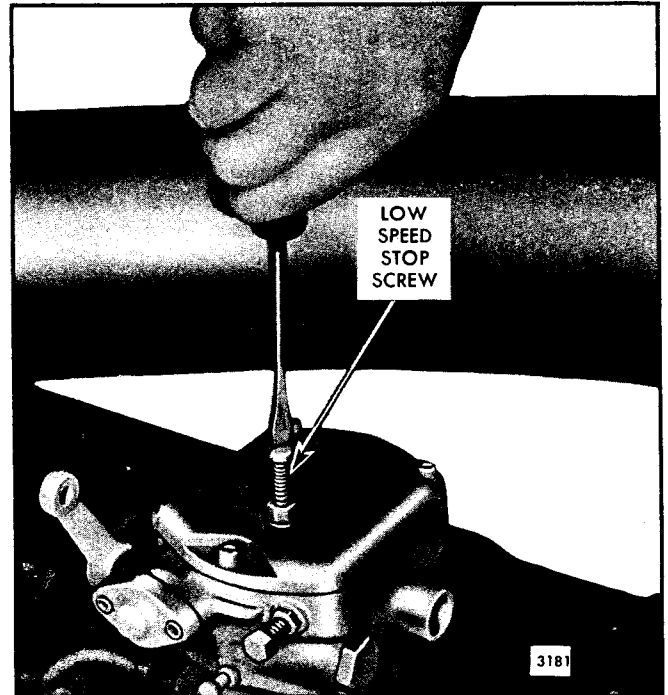


Fig. 12 - Adjusting Low-Speed Stop Screw

3. Turn the low-speed stop screw down until the engine speed just begins to increase.
4. Tighten the lock nut to secure the stop screw in place.

NOTE: The marine engine is stopped when the solenoid in the oil dump line from the governor servo-piston is energized.

Governors with Synchronizing Motor

Some hydraulic governors are equipped with a reversible electric synchronizing motor (Fig. 10) mounted on the governor cover.

The adjustments on a governor equipped with a synchronizing motor are the same as on a governor without the motor. However, the governor cover and motor assembly must be removed when setting the engine speed droop (except on a governor equipped with the external droop adjustment). The cover and motor must be reinstalled to check the speed droop.

LIMITING SPEED HYDRAULIC GOVERNOR AND INJECTOR RACK CONTROL ADJUSTMENT

16V-71 ENGINE

The governor on the 16V engine is mounted on and driven from the front end of the rear blower (Fig. 1). The governor to injector rack control linkage is shown in Fig. 2.

The objectives of the tune-up are (1) to adjust the linkage so the injector racks will be at the full-fuel position when the terminal lever shaft pointer indicates exactly 18° , (2) to set the band-level so the governor will place the pointer at exactly 18° just below full-load speed and, (3) to adjust the speed droop, idle speed and maximum no-load speed.

Prior to starting the tune-up, remove the governor control housing cover and turn the buffer screw out until it clears the differential lever approximately 1/4 inch, when the speed control lever is in the idle position. Then hold the speed control lever in the maximum speed position and move the governor operating lever to check the travel of the terminal shaft lever as indicated by the pointer.

The pointer should move from 0° to 36° (on some governors, the pointer may not quite reach 36°). Next, check to be sure that the pointer is exactly at zero when the linkage is in the no-fuel position. If not, adjust the pointer or the terminal lever shaft position indicator plate (scale).

The pointer is attached to a metal ring which is secured to the terminal shaft by a set screw (Fig. 3). To make the zero adjustment, loosen the set screw and, with the linkage in the no-fuel position, set the pointer at exactly zero. Then tighten the set screw.

After the zero adjustment is completed, to make sure the shaft is assembled correctly, reach in behind the differential lever in the governor control housing and force the governor operating lever upward until the pointer is aligned exactly with the 18° mark (Fig. 6). The pointer should be vertical; if it is approximately 1/16" off vertical, the shaft is probably out one serration. To make the necessary correction, remove the sub-cap (refer to *Adjust Maximum No-Load*

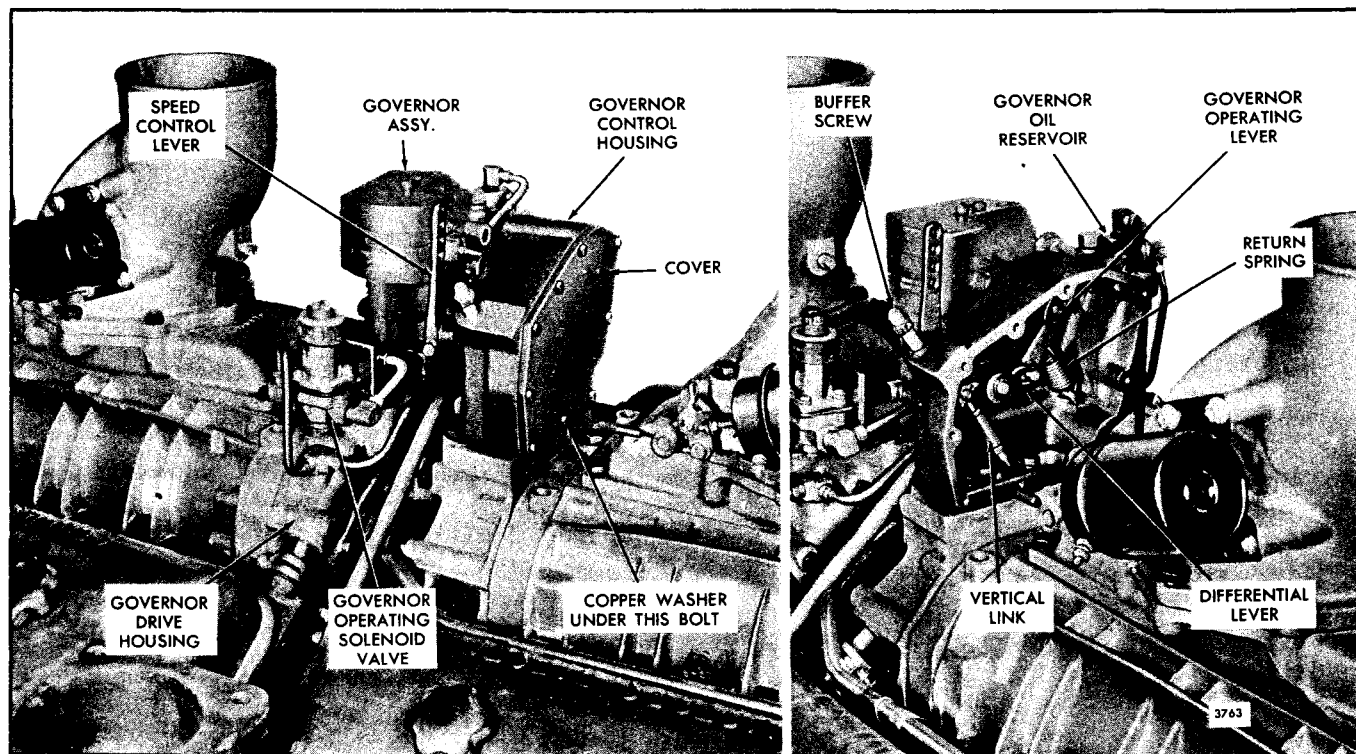


Fig. 1 - Governor Mounting and Linkage in the Control Housing

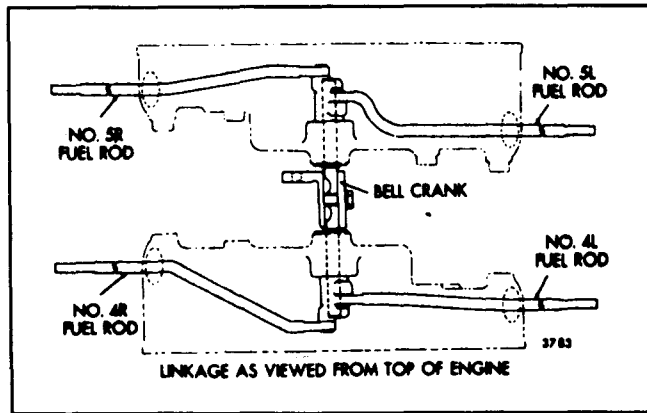


Fig. 2 - Governor-to-Injector Rack Control Linkage

Speed), then remove the cotter pin from the shaft and make a careful visual check of the alignment of the holes in the terminal lever and the shaft. If they are not in alignment, remove the shaft and reinstall it so the holes are in perfect alignment. Then install the cotter pin and sub-cap.

Then, after adjusting the exhaust valves and timing the injectors, position the injector rack control levers, adjust the governor linkage and adjust the governor.

Position Injector Rack Control Levers and Adjust Governor Linkage

1. Clean and remove the valve rocker cover from each cylinder head.

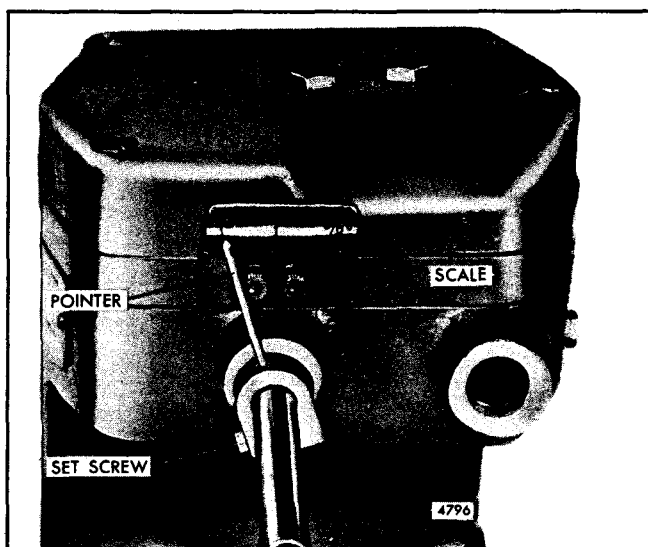


Fig. 3 - Governor Pointer and Scale

2. Loosen all of the inner and outer injector rack control lever adjusting screws. Be sure all of the control levers are free on the control tubes.

3. Disconnect the upper end of the adjustable vertical link (Fig. 1) from the differential lever pin.

CAUTION: Stuff a clean rag in the opening to prevent the clip or washer from dropping into the engine.

4. Place linkage gage J 21351 in position so the pin in the gage enters the hole in the bell crank lever and the tangs on each side of the gage rest on top of the governor drive housing cover (Fig. 4). The gage holds the linkage in the full-fuel position while the injector racks are being adjusted.

5. Adjust the 4R injector rack by turning the inner adjusting screw down until a slight movement of the control tube is observed or a step-up in effort is noted (Fig. 5). This will place the rack in the full-fuel position. Turn the outer adjusting screw down until it bottoms slightly on the control tube. Then alternately tighten both the inner and outer adjusting screws.

CAUTION: If the injector rack is set too tight, it will cause the fuel rod to bend.

6. To be sure the injector rack control lever is properly adjusted, press down on the injector rack with a screw driver or finger tip. A light pressure should cause the rack to rotate. The rack is sufficiently tight if it returns to its original position when the pressure is removed.

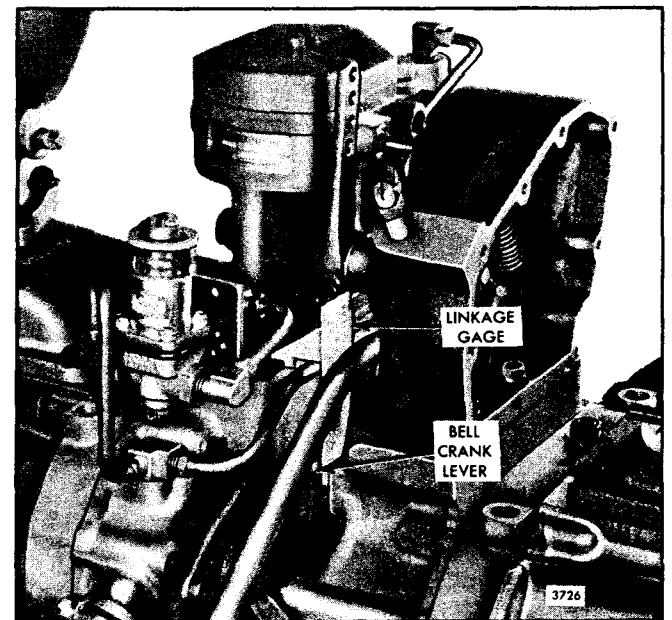


Fig. 4 - Linkage Gage in Position

The rack is too tight if a heavy pressure is required to rotate it.

7. Adjust the 5R, 4L and 5L injector rack control levers as outlined in Steps 5 and 6. When the settings are correct, all four of the injector racks will be snug on the ball end of the control levers when the injectors are in the full-fuel position. The linkage gage may be removed at this time.

8. To adjust the remaining injector rack control levers on the right front bank, hold the 4R injector rack in the full-fuel position, by means of the control tube lever, and turn down the inner adjusting screw of the 3R injector rack control lever until it bottoms lightly on the injector control tube. Then alternately tighten both the inner and outer adjusting screws.

NOTE: Overtightening of the injector rack control lever adjusting screws during installation or adjustment can result in damage to the injector control tube. The recommended torque of the adjusting screws is 24-36 in-lb.

9. Recheck the 4R injector rack to be sure it has remained snug on the ball end of the injector rack control lever. If the 4R injector rack has become loose, back off the inner adjusting screw slightly on the 3R

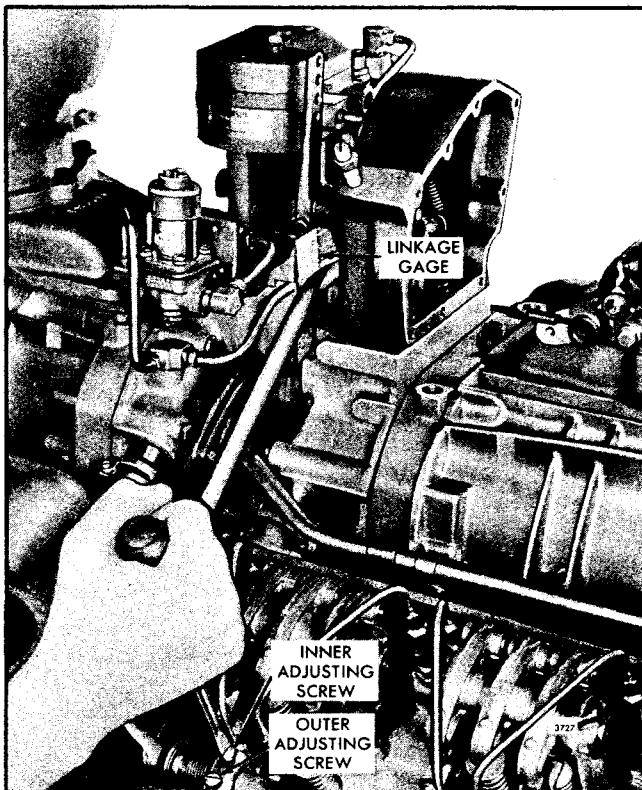


Fig. 5 - Positioning No. 4R Injector Rack Control Lever

injector rack control lever and tighten the outer adjusting screw. When the settings are correct, both injector racks must respond in the same manner on the ball ends of their respective rack control levers as in Step 6.

10. Position the remaining injector rack control levers on the right front cylinder head in the same manner. When the settings are correct, all of the injector racks will be snug on the ball end of the control levers when the injector control tube is in the full-fuel position.

11. Adjust the remaining injector rack control levers on the right rear, left front, and left rear cylinder heads in the same manner as in Steps 8, 9 and 10.

12. Reconnect the upper end of the adjustable vertical link on the differential lever pin and secure it in place with the washer and clip.

13. To be sure that the governor flyweights will be in the vertical position throughout the intermediate speed range (between idle speed and full-load speed), adjust the vertical link as follows.

- Loosen and back off the two turnbuckle lock nuts two or three turns.
- Secure the speed control lever in the maximum speed position.
- Reach in behind the differential lever in the governor control housing and force the governor operating lever upward until the governor pointer is aligned exactly with the 18° mark (Fig. 6). Hold the lever in this position.

NOTE: It is very important that the force to

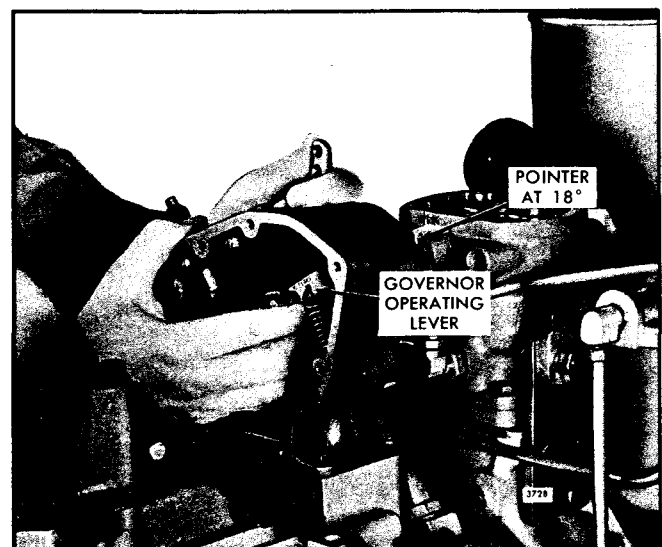


Fig. 6 - Moving Operating Lever

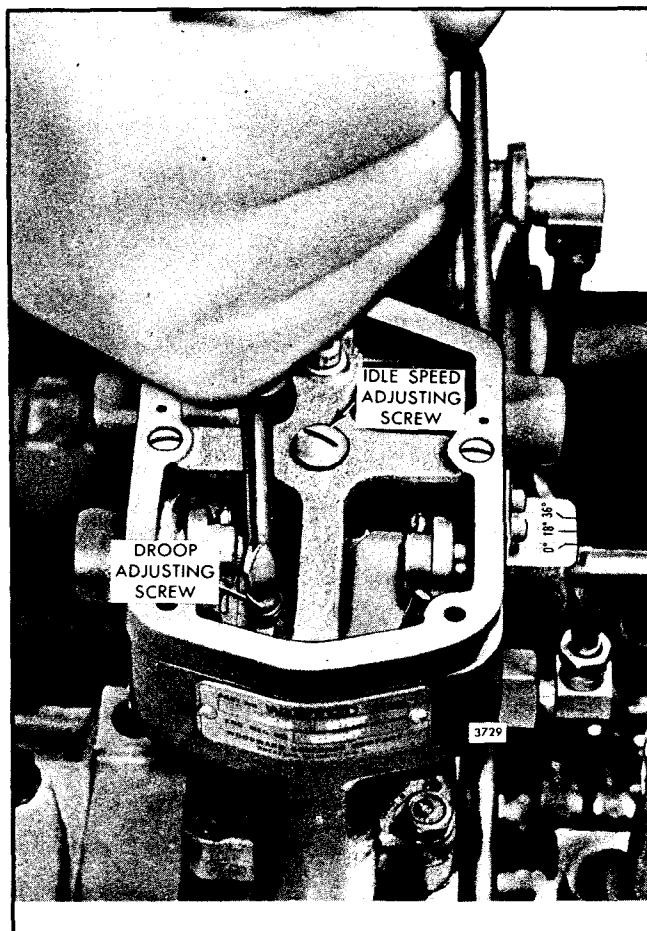


Fig. 7 - Adjusting Speed Droop

move the pointer to 18° be applied to the governor operating lever rather than to the differential lever. This is necessary to ensure that the terminal lever pin is tight against the upper side of the slot in the differential lever just as it is when the engine is running under governor control.

- d. Adjust the length of the vertical link, by means of the turnbuckle, so the injector racks are in the full-fuel position. Then tighten the lock nuts.
 - e. Recheck to determine if the pointer still points to exactly 18° when the injector racks are at the full-fuel position. Readjust the vertical link, if necessary.
 - f. Release the speed control lever. With the lever in the idle speed position, the pointer should be at approximately 18° .
14. Use a new gasket and install the valve rocker cover on each cylinder head.

Adjust Governor Speed Droop

1. Remove the governor cover.
2. Set the governor speed droop bracket at its mid-position (Fig. 7). After the other adjustments are made, the speed droop may be increased if the engine speed is unstable.

Preliminary Band-Level Adjustment

The band-level adjustment corresponds to the gap adjustment on a mechanical limiting speed governor. In the low idle speed range, the governor pointer will be between the 18° and 36° marks. As the speed is increased, by moving the speed control lever, the pointer will gradually approach 18° and should be exactly at 18° just below the full-load speed of the engine. After full load is reached, the pointer will move rather rapidly until at the no-load speed it will indicate a position approximately half way between the 18° and 0° marks.

If the pointer is above 18° just below the full-load speed of the engine, the band-level is too low; if the pointer is below 18° , the band-level is too high. Perform a preliminary band-level adjustment as follows:

1. Hold the linkage so the pointer indicates 18° .
2. With a long thin screw driver, pry one of the flyweights outward with a light force (Figs. 8 and 9). It should reach a vertical position. If not, proceed with Step 3.

NOTE: The position of the flyweights determines the position of the pilot valve plunger, which controls the flow of oil to the servo piston. If the flyweights are too far in, the plunger will not close off the ports and oil will flow to the servo piston. This will cause the terminal lever to move the pointer beyond 18° and result in excessive speed when the engine is started. When the flyweights are too far out, the plunger moves up and dumps the oil from the servo piston. This causes the terminal lever to drop below the 18° position and will result in difficulty in starting the engine or in attaining speed.

3. Loosen the band-level pivot arm lock screw and turn the band-level adjusting nut (Figs. 8 and 10) clockwise to raise the band-level or counter-clockwise to lower the band-level. Tighten the lock screw to draw the pivot arm assembly in place. Then check the adjustment as described in Step 2. Readjust the band-level, if necessary.

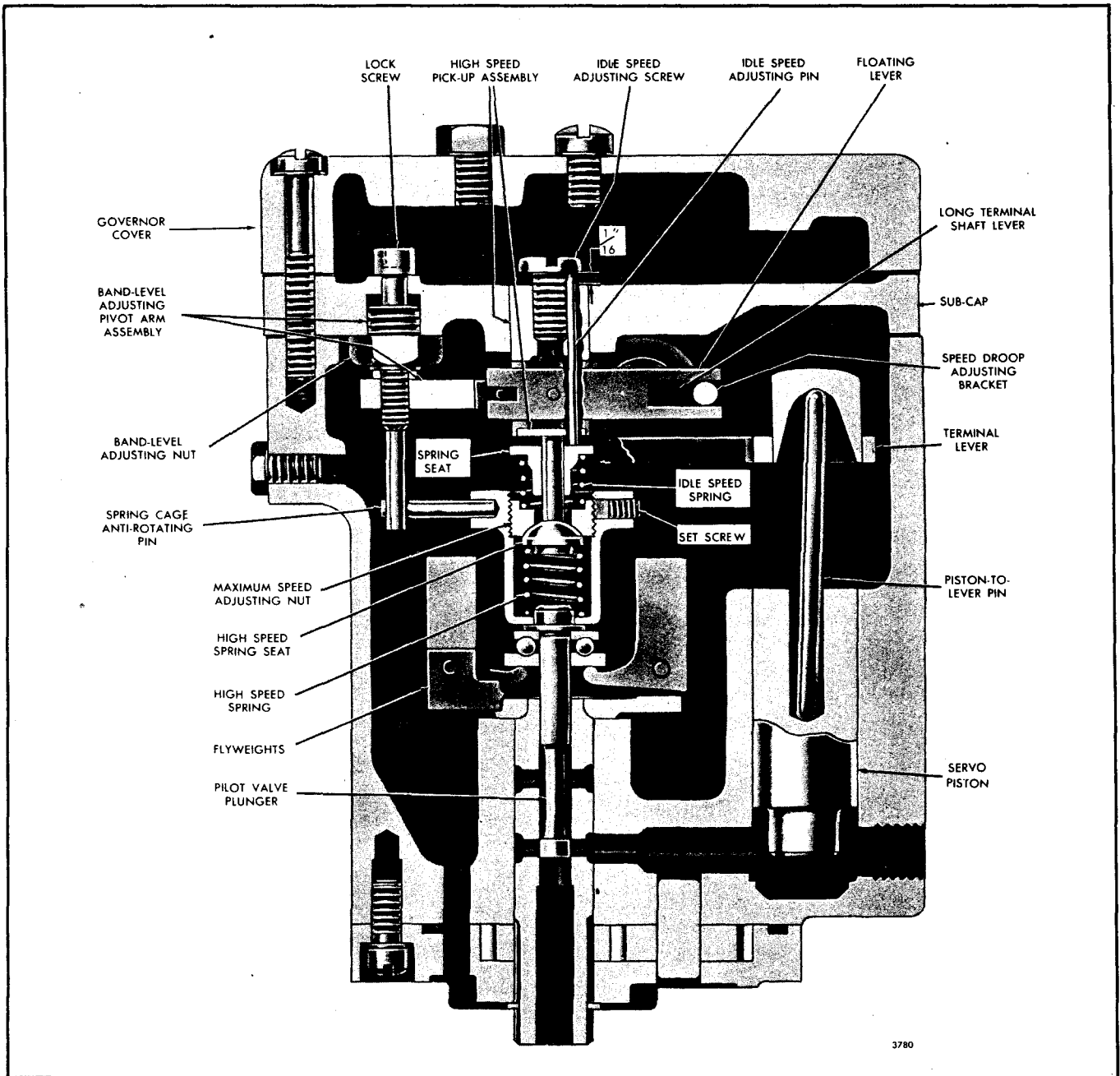


Fig. 8 - Cross-Section of Limiting Speed Hydraulic Governor for 16V Engine

CAUTION: Turning the band-level adjusting nut does not in itself complete the adjustment. The lock screw must be tightened to draw the pivot arm assembly into the new position, especially if the nut was turned down.

Adjust Idle Speed

There should be approximately 1/16" clearance

between the bottom of the idle speed adjusting screw head and the plunger directly under the screw head (Fig. 8).

1. Close the governor operating solenoid valve switch, if a normally open type valve is used.
2. Start the engine.

CAUTION: Stop the engine if the speed starts to increase above idle speed while the speed

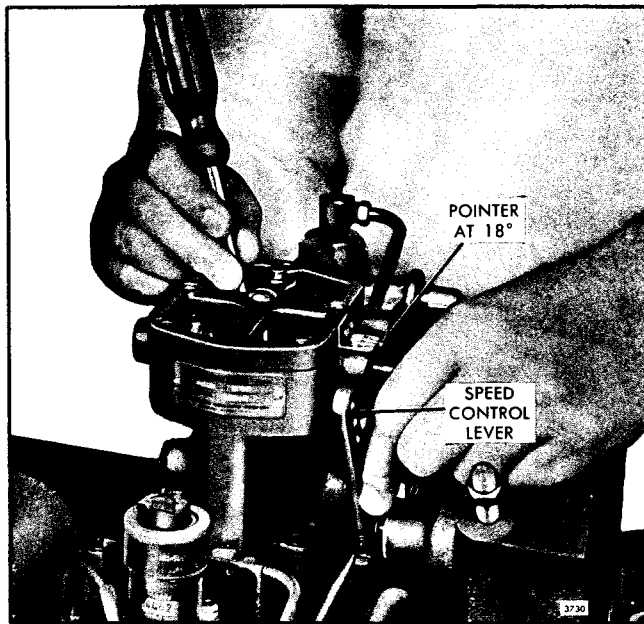


Fig. 9 - Moving Flyweight with Screw Driver

control lever is in the idle position. Raise the band-level again until the speed remains at idle.

3. If the engine stalls with the speed control lever in the idle position, turn the idle screw down (clockwise) 1/4 turn or until the engine will continue running.
4. Hold the speed control lever in the idle position. Then turn the idle speed adjusting screw (Figs. 8 and 10) in or out until the desired idle speed is obtained.

Set Band-Level at 18°

1. Gradually move the speed control lever from the idle to maximum speed position and while doing this, observe the movement of the pointer and also record the top no-load speed. The normal movement of the pointer in response to the speed control lever travel should be as follows:

- a. During the first 100 or 200 rpm increase above idle speed, the pointer should move from approximately midway between 18° and 36° to slightly above 18°. Then, as the speed increases on up to approximately 300 rpm below the top no-load speed, the pointer should move slightly until it is exactly at 18°. From full-load speed up to no-load speed, the pointer should move from 18° to nearly midway between 18° and 0°.
- b. If the pointer indicates more than 18° at approximately 300 rpm below the top no-load speed, the band-level is too low. The adjusting nut should be turned clockwise, in small increments,

until the pointer indicates exactly 18° at the above speed.

- c. If the pointer indicates less than 18° at approximately 300 rpm below the top no-load speed, the band-level is too high. The adjusting nut should be turned counterclockwise, in small increments, until the pointer indicates exactly 18° at the above speed. If the band-level is too high, the engine speed may fall several hundred rpm below the top no-load speed even though the speed control lever is in the maximum speed position.

- d. Reset the idle speed, if the band-level has been changed.

Adjust Maximum No-Load Speed

1. Remove the sub-cap assembly, including the idle speed spring. Since the sub-cap is dowelled to the governor housing, removal will be made easier by moving the linkage so the pointer is near the 36° mark.

CAUTION: Hold the idle speed spring seat or spring with your finger, as shown in Fig. 11, to prevent it from falling into the governor housing.

2. Loosen the small set screw (on the side opposite the

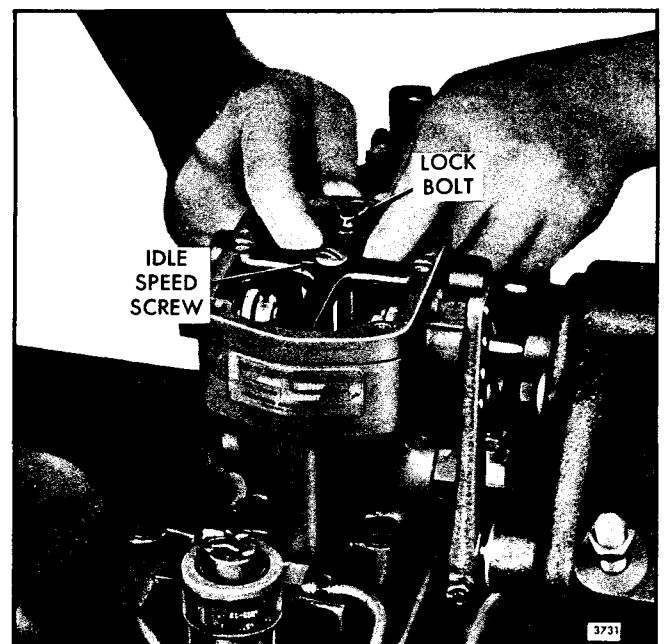


Fig. 10 - Adjusting Band-Level

anti-rotating pin) in the high speed spring cage with a 5/64" Allen wrench (Figs. 8 and 12).

3. Turn the high speed adjusting nut up to decrease or down to increase the speed (Fig. 13).

NOTE: A 1/6th turn of the nut changes the speed 30-40 rpm. Use a 1/4" Allen wrench (the end of the wrench should be ground flat or slightly concave).

4. Tighten the small set screw to lock the adjusting nut in place.

5. Check to make sure the idle speed adjusting pin is in position and place the idle speed spring against the spring seat. Then, holding the spring in place with your finger (Fig. 11) and holding the linkage so the pointer is near the 36° mark, install the sub-cap assembly. Make sure the pin in the speed droop adjusting bracket enters the slot in the floating lever.

6. Reset the band-level adjustment.

7. Reset the idle speed.

8. Check the maximum speed.

9. Check the engine speed by suddenly moving the speed control lever from idle to maximum. If the engine speed does not stabilize after two to four surges, move the droop bracket outward. Recheck the idle and maximum speeds.

10. Install the governor cover and tighten the screws.

Adjust Buffer Screw

The purpose of the buffer screw adjustment is to prevent the injector racks from going all the way to the no-fuel position and causing the engine to stall.

1. With the warm engine at idle, turn the buffer screw in until it just touches the lower left end of the differential lever. Then, back off three complete turns and tighten the lock nut.

2. Install the cover on the governor control housing.

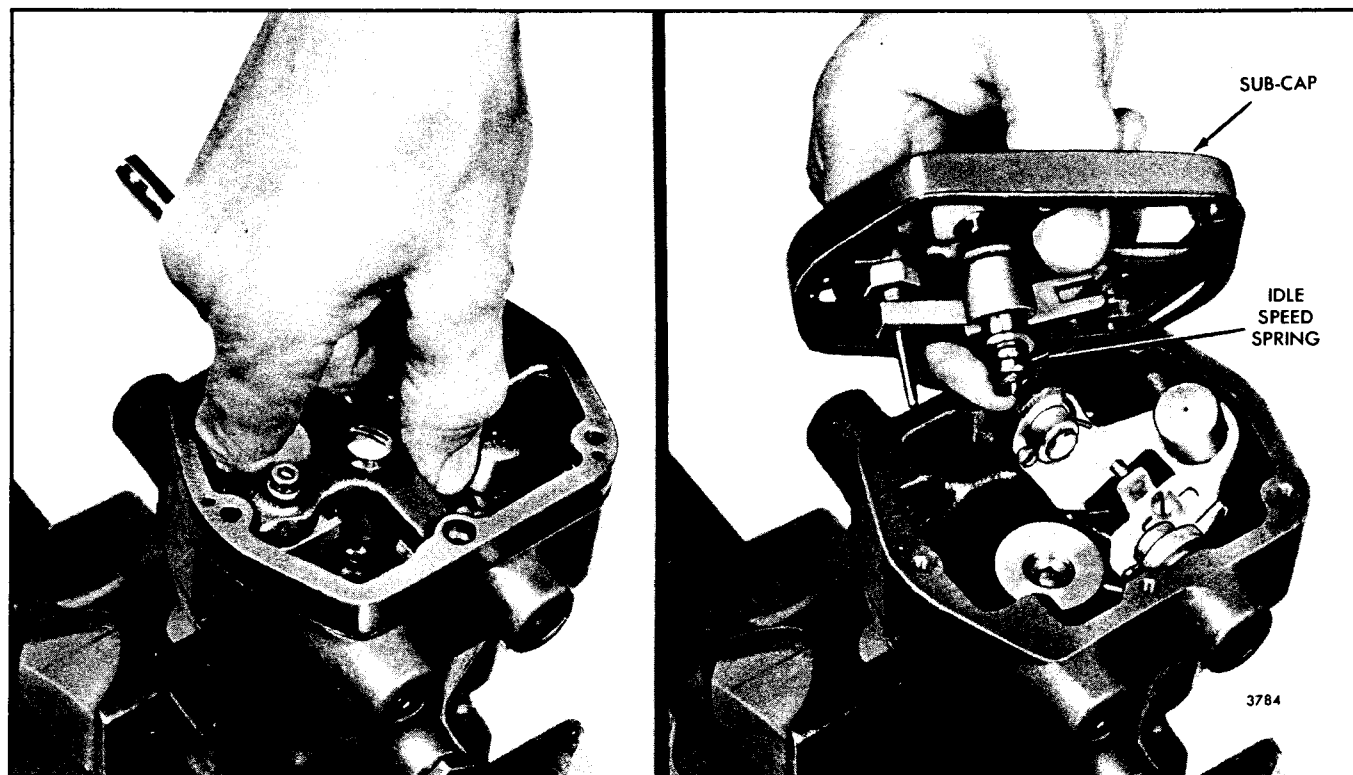


Fig. 11 - Removing or Installing Governor Sub-Cap Assembly

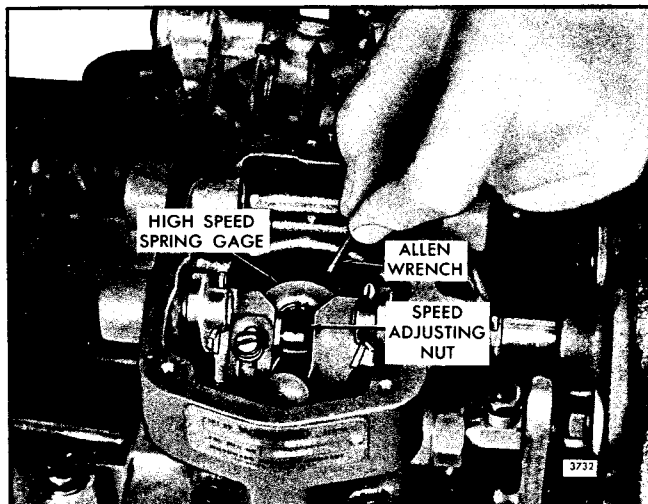


Fig. 12 - Loosening Allen Screw on Spring Cage

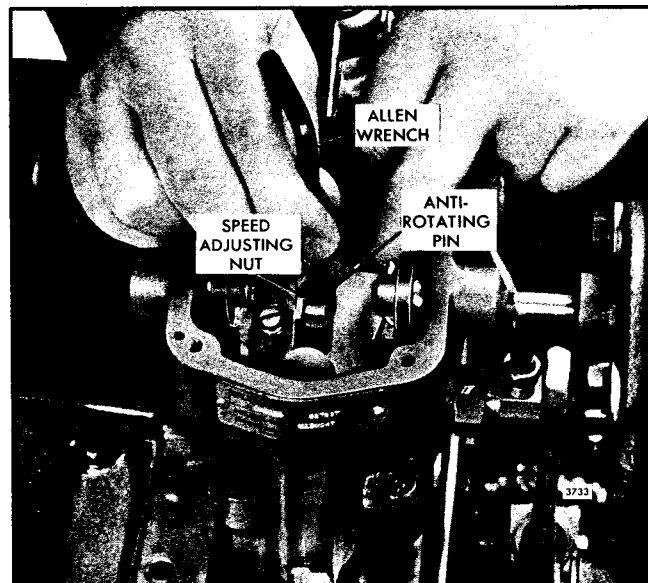


Fig. 13 - Turning High Speed Adjusting Nut

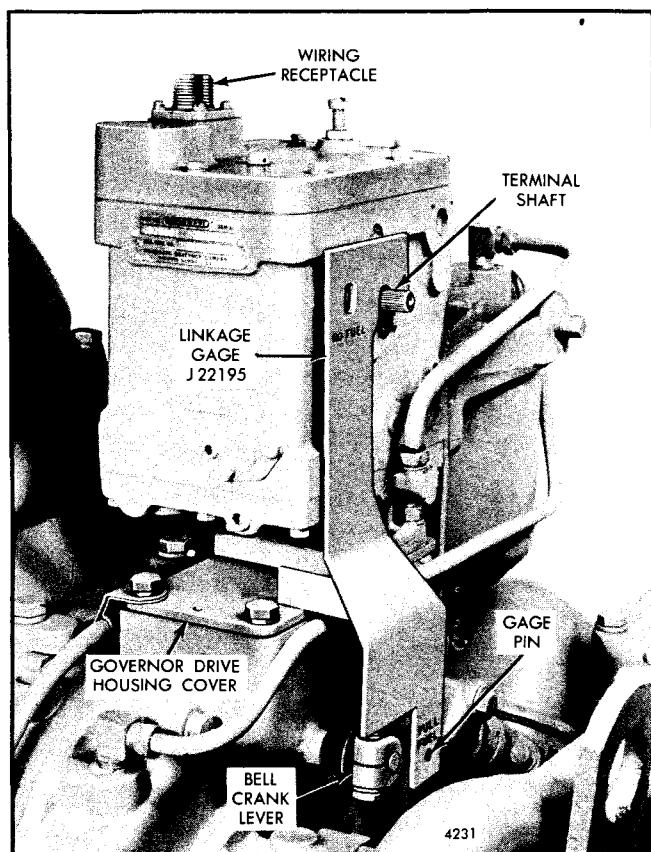


Fig. 2 - Linkage Gage in Position

Position Injector Rack Control Levers and Adjust Governor Linkage

After adjusting the exhaust valves and timing the fuel injectors, position the injector rack control levers and adjust the governor linkage.

The position of the injector control racks must be correctly set in relation to the governor. Their position determines the amount of fuel injected into each cylinder and ensures equal distribution of the load.

The letters R and L indicate the injector location in the right or left cylinder bank, viewed from the rear of the engine. Cylinders are numbered starting at the front of the engine on each cylinder bank. Adjust the No. 1R injector rack control lever first to establish a guide for adjusting the remaining levers.

1. Clean and remove the valve rocker covers.
2. Loosen all of the inner and outer injector rack control lever adjusting screws on both injector control tubes. Be sure all of the injector rack control levers are free on the control tubes.

3. Remove the vertical link assembly (Fig. 1) from the governor operating lever and the bell crank lever.

4. Loosen the clamping bolt and slide the governor operating lever from the governor terminal shaft.

5. Place the linkage gage J 22195 over the governor terminal shaft and insert the gage pin in the bell crank lever bolt hole (Fig. 2). The tang on the side of the gage should just touch the top of the governor drive housing when the gage is properly positioned. The gage will hold the injector control racks in the full-fuel position while the levers are being adjusted.

6. Remove the clevis pin from the fuel rod and the left cylinder bank injector control tube lever.

7. Turn the inner adjusting screw of the No. 1R injector rack control lever down (Fig. 3) until a slight movement of the control tube is observed, or a step-up in effort to turn the screw driver is noted. This will place the No. 1R injector rack in the full-fuel position. Turn the outer adjusting screw down until it bottoms lightly on the injector tube. Then alternately tighten both the inner and outer adjusting screws.

CAUTION: Avoid setting the rack too tight, causing the fuel rod to bend.

8. To be sure the control lever is properly adjusted, press down on the injector rack with a screw driver or finger tip. The setting is sufficiently tight if the rack returns to its original position when the pressure is released.

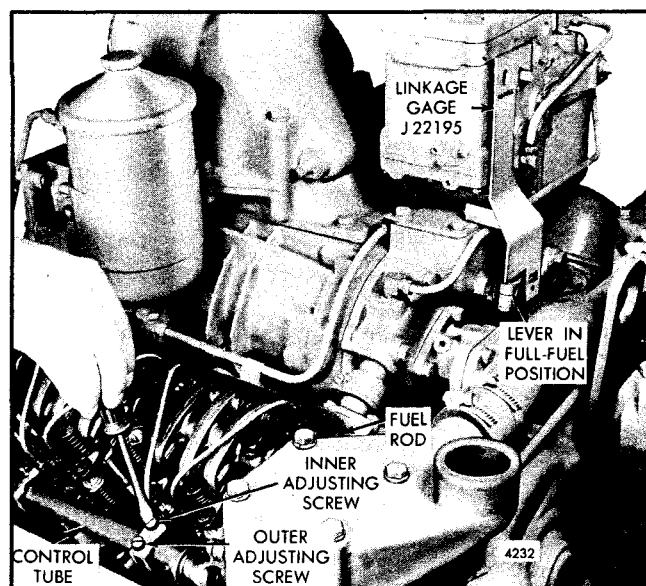


Fig. 3 - Positioning No. 1R Injector Rack Control Lever

9. Remove the clevis pin from the fuel rod and the right cylinder bank injector control tube lever.

10. Install the clevis pin in the fuel rod and the left cylinder bank injector control tube lever. Then position the No. 1L injector rack control lever as outlined in Steps 7 and 8.

11. Install the clevis pin in the fuel rod and the right cylinder bank injector control tube lever. Recheck the No. 1R and 1L injector rack control levers as in Step 8. Check for and eliminate any deflection in the fuel rods. If the settings are correct, both injector racks will be in the full-fuel position and snug on the ball end of the control levers.

12. Manually hold the No. 1R injector rack in the full-fuel position by means of the injector control tube lever. Turn down the inner adjusting screw of the No. 2R injector rack control lever until the injector rack moves into the full-fuel position. Turn the outer adjusting screw down until it bottoms lightly on the injector control tube. Then alternately tighten both the inner and outer adjusting screws.

NOTE: Overtightening of the injector rack control lever adjusting screws during installation or adjustment can result in damage to the injector control tube. The recommended torque of the adjusting screws is 24-36 in-lbs.

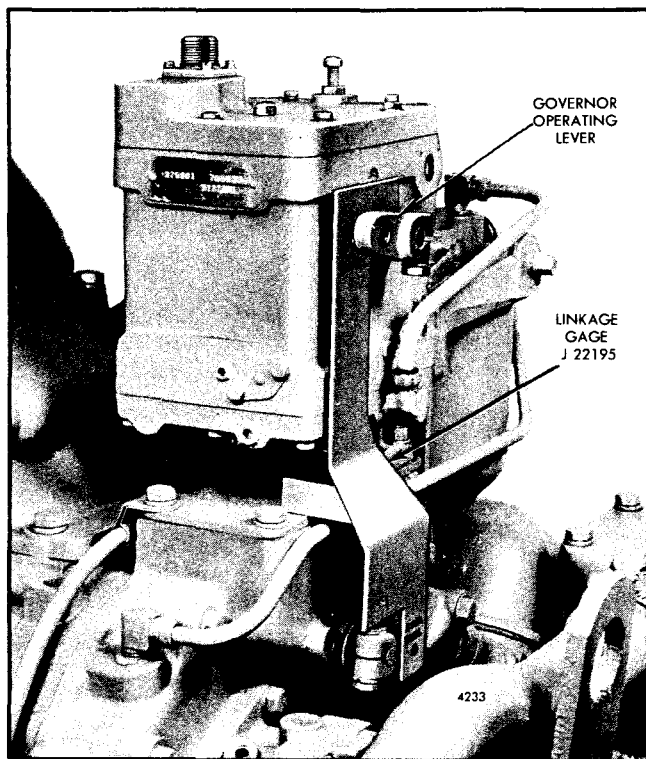


Fig. 4 - Governor Operating Lever in Position

13. Recheck the No. 1R injector rack to be sure it has remained snug on the ball end of the rack control lever while positioning the No. 2R injector rack. If the rack of No. 1R injector has become loose, back off the inner adjusting screw on the No. 2R injector rack control lever slightly and tighten the outer adjusting screw. When the settings are correct, both injector racks will respond in the same manner on the ball end of their respective rack control levers.

14. Position the remaining injector rack control levers on the right and left bank cylinder heads as outlined in Step 12. When the settings are correct, all of the injector racks will be snug on the ball end of the control levers when the injector control tube levers are held in the full-fuel position.

15. Turn the terminal shaft clockwise to the no-fuel position. Then place the governor operating lever on the terminal shaft so that the bolt hole in the lever is aligned with the center of the slot in the linkage gage (Fig. 4). Remove the gage and tighten the clamping bolt on the lever.

16. Move the bell crank lever to the no-fuel position.

17. Adjust the length of the vertical link so the bolt holes in the two levers and the rod end bearings in the vertical link are in alignment.

18. Install and tighten the vertical link attaching bolts.

19. As an additional check, the governor operating lever should be in a position indicating maximum on the dial indicator (Fig. 6), when the injector rack control levers are in the full-fuel position. If not, readjust the vertical link.

20. Use a new gasket and install the valve rocker cover on each cylinder head.

Governor Adjustments

The centrifugal governor section of the actuator has three operating adjustments.

1. *Speed setting:* An external adjustment used to set the speed at which the centrifugal governor will control.

2. *Speed droop:* An internal adjustment used to permit parallel operation of units controlled by the centrifugal governor.

3. *Needle Valve:* An external adjustment used to stabilize the centrifugal governor.

Once set, these adjustments do not usually require further adjustment.