

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, increased valve face wear and valve lock damage.

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 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

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.

Valve Clearance Adjustment (Cold Engine)

1. Remove the loose dirt from the valve rocker cover and remove the cover.
2. Place the governor speed control lever in the *idle* speed position. If a stop lever is provided, secure it in the *stop* position.
3. Rotate the crankshaft, manually or with the starting motor, until the injector follower is fully depressed on the particular cylinder to be adjusted.

NOTE: If a wrench is used on the crankshaft bolt at the front of the engine, do not turn the crankshaft in a left-hand direction of rotation because the bolt could be loosen.

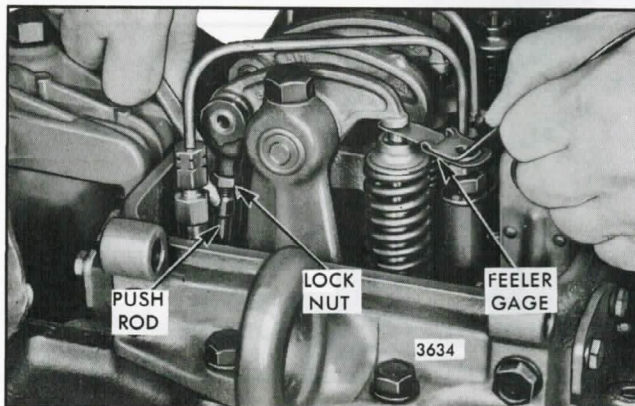


Fig. 1 - Adjusting Valve Clearance (Two Valve Head)

4. Loosen the exhaust valve rocker arm push rod locknut.
5. Place a .012" feeler gage (J 9708-01) between the exhaust 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 locknut 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. Readjust the push rod, if necessary.
8. Check and adjust the remaining exhaust valves in the same manner as outlined above.

Valve Clearance Adjustment (Hot Engine)

NOTE: It is *not* necessary to make a final hot engine exhaust valve clearance adjustment after a cold engine adjustment has been performed. However, if a hot engine adjustment is desired, use the following procedure.

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

NOTE: Since these adjustments are normally made while the engine is stopped, it may be necessary to run the engine between adjustments to maintain normal operating temperature.

1. With the engine at normal operating temperature (refer to Section 13.2), set the exhaust valve clearance with feeler gage J 9708-01. At this time, if the valve clearance is correct, the .008" feeler gage will pass

freely between the end of the valve stem and the rocker arm and the .010" feeler 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 (Section 14.2).

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. The necessary adjustment procedure is outlined in Section 1.2.2.

The exhaust valve bridge balance should be checked when a general valve adjustment is performed. After the bridges are balanced, adjust the valve clearance at the *push rod only*. Do not disturb the exhaust valve bridge adjusting screw.

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.

Valve Clearance Adjustment (Cold Engine)

1. Remove the loose dirt from the valve rocker cover and remove the cover.
2. Place the governor speed control lever in the *idle* speed position. If a stop lever is provided, secure it in the *stop* position.

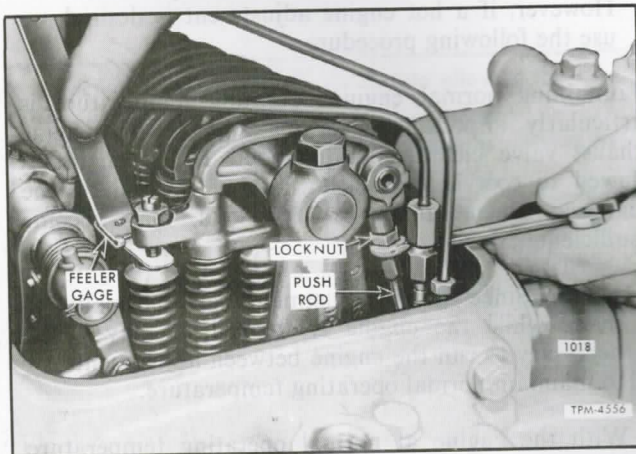


Fig. 2 - Adjusting Valve Clearance (Spring-Loaded Valve Bridge)

Check Exhaust Valve Clearance Adjustment

1. With the engine at 100° F (38° C) or less, check the valve clearance.
2. If a .012" feeler gage ($\pm .004$ ") will pass between the valve stem and the rocker arm bridge, the valve clearance is satisfactory. If necessary, adjust the push rod.

3. Rotate the crankshaft, manually or with the starting motor, until the injector follower is fully depressed on the particular cylinder to be adjusted.

NOTE: If a wrench is used on the crankshaft bolt at the front of the engine, do not turn the crankshaft in a left-hand direction of rotation because the bolt could be loosen.

4. Loosen the exhaust valve rocker arm push rod locknut.
5. Place a .016" feeler gage (J 9708-01) between the end of the exhaust valve stem and the valve bridge adjustment screw (spring-loaded bridge only) or between the valve bridge and the valve rocker arm pallet (unloaded bridge only) -- refer to Figs. 2 and 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 locknut 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 stem and the adjustment screw (spring-loaded bridge) or between the valve bridge and

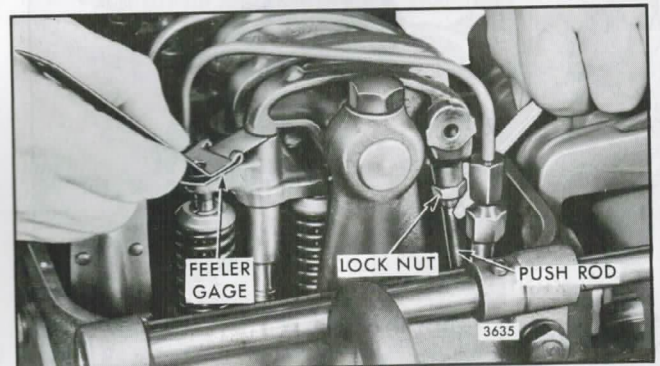


Fig. 3 - Adjusting Valve Clearance (Unloaded Valve Bridge)

the rocker arm pallet (unloaded bridge), but the .017" feeler gage will not pass through. Readjust the push rod, if necessary.

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

Valve Clearance Adjustment (Hot Engine)

NOTE: It is *not* necessary to make a final hot engine exhaust valve clearance adjustment after a cold engine adjustment has been performed. However, if a hot engine adjustment is desired, use the following procedure.

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

NOTE: Since these adjustments are normally made while the engine is stopped, it may be

necessary to run the engine between adjustments to maintain normal operating temperature.

1. With the engine at normal operating temperature (refer to Section 13.2), set the exhaust valve clearance with feeler gage J 9708-01. At this time, if the valve clearance is correct, the .013" gage will pass freely between the valve stem and the valve bridge adjusting screw (spring-loaded bridge) or between the valve bridge and the rocker arm pallet (unloaded bridge), but the .015" feeler 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 (Section 14.2).

Check Exhaust Valve Clearance Adjustment

1. With the engine at 100° F (38° C) or less, check the valve clearance.

2. If a .016" feeler gage ($\pm .004"$) will pass between the valve stem and the rocker arm bridge, the valve clearance is satisfactory. If necessary, adjust the push rod.



Fig. 4. Timing Fuel Injector

LIMITING **FUEL INJECTOR TIMING** NOR AND

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.

Time Fuel Injector

After the exhaust valve clearance has been adjusted (Section 14.1), time the fuel injectors as follows:

1. Place the governor speed control lever in the *idle* speed position. If a stop lever is provided, secure it in the *stop* position.
2. Rotate the crankshaft, manually or with the starting motor, until the exhaust valves are fully depressed on the particular cylinder to be timed.

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

3. Place the small end of the injector timing gage (refer to Section 14 for the correct timing gage) in the hole provided in the top of the injector body with the flat of the gage toward the injector follower (Fig. 1).
4. Loosen the injector rocker arm push rod locknut.
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.

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

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

8. If no further engine tune-up is required, install the valve rocker cover, using a new gasket.

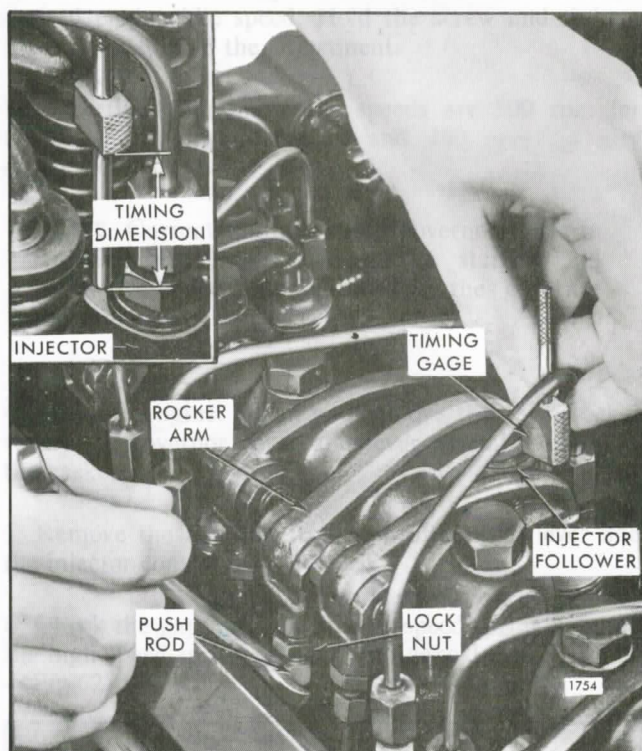


Fig. 1 - Timing Fuel Injector



Fig. 1 - Bellevue Washer Locknut



Fig. 2 - Adjusting Gap (Single Weight Governor) using Tap J 5407

LIMITING SPEED MECHANICAL GOVERNOR AND INJECTOR RACK CONTROL ADJUSTMENT

After adjusting the exhaust valves and timing the fuel injectors, adjust the limiting speed mechanical governor and 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 (refer to Section 14.14).

Back out the external starting aid screw.

NOTE: On "TT" engines, back out the Belleville spring retainer nut until there is approximately .060" clearance between the washers and the retainer nut (Fig. 1).

Adjust Governor Gap (Fig. 2) (Single-Weight Governor)

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

CAUTION: If the gap adjustment is to be made with the engine in the vehicle, it is suggested that the fan assembly be removed due to the closeness of the fan blades to the engine governor.

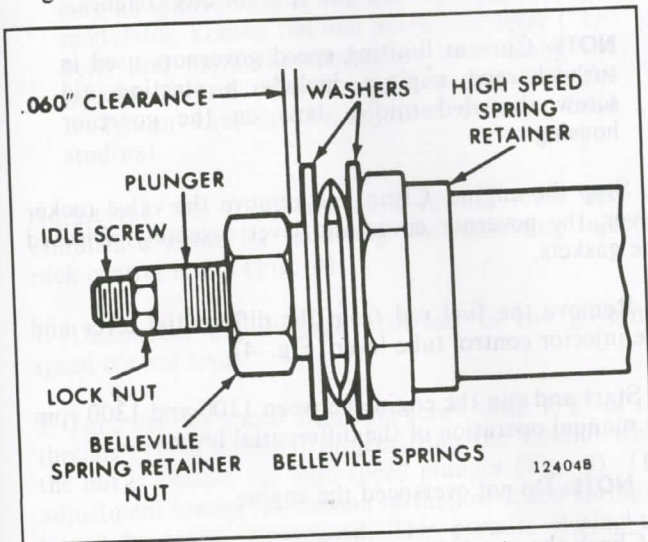


Fig. 1 - Belleville Washer Location

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

2. Back out the buffer screw or fast idle cylinder until it extends approximately 5/8" from the locknut (Fig. 9).

3. Start the engine and loosen the idle speed adjusting screw locknut. Then adjust the idle screw to obtain the desired engine idle speed. Hold the screw and tighten the locknut to hold the adjustment.

EPA certified minimum idle speeds are 500 rpm for trucks and highway coaches and 400 rpm for city coaches.

NOTE: Current limiting speed governors used in turbocharged engines include a starting aid screw threaded into a boss on the governor housing.

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

5. Remove the fuel rod from the differential lever and the injector control tube lever.

6. Check the gap between the low-speed spring cap and the high-speed spring plunger with gage J 5407 (.170") - (Fig. 2).

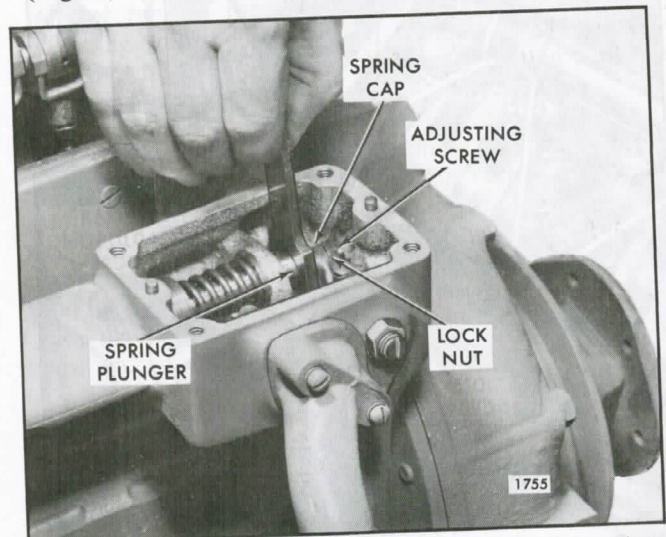


Fig. 2 - Adjusting Gap (Single-Weight Governor) using Tool J 5407

NOTE: Be sure the external starting aid screw (if used) is backed out far enough to make it ineffective when making this adjustment.

7. If required, loosen the locknut and turn the gap adjusting screw until a slight drag is felt on the gage.
8. Hold the adjusting screw and tighten the locknut.
9. Recheck the gap and readjust, if necessary.
10. Install the fuel rod between the governor and injector control tube lever.
11. Use a new gasket and install the governor cover and lever assembly.

Adjust Governor Gap (Fig. 3) (Double-Weight Governor)

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

NOTE: If the governor gap adjustment is to be made with the engine in the vehicle, it is suggested that the fan assembly be removed due to the closeness of the fan blades to the engine governor.

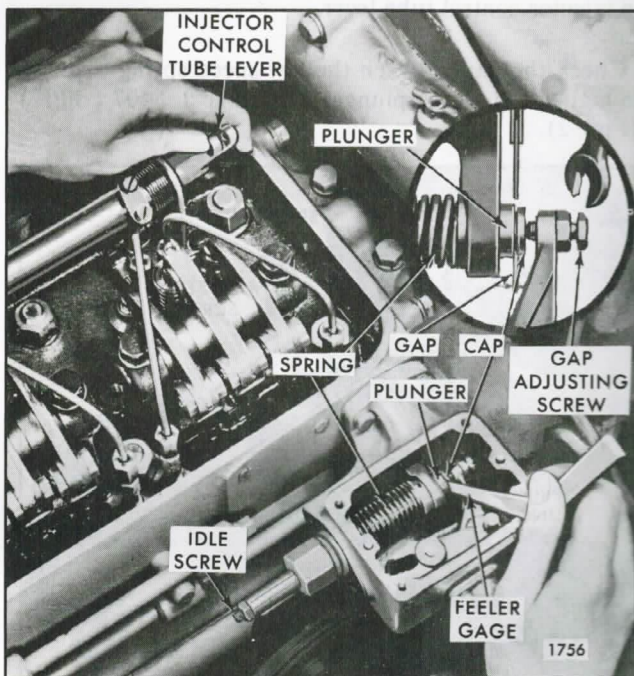


Fig. 3 - Adjusting Gap (Double-Weight Governor) using Tool J 3172

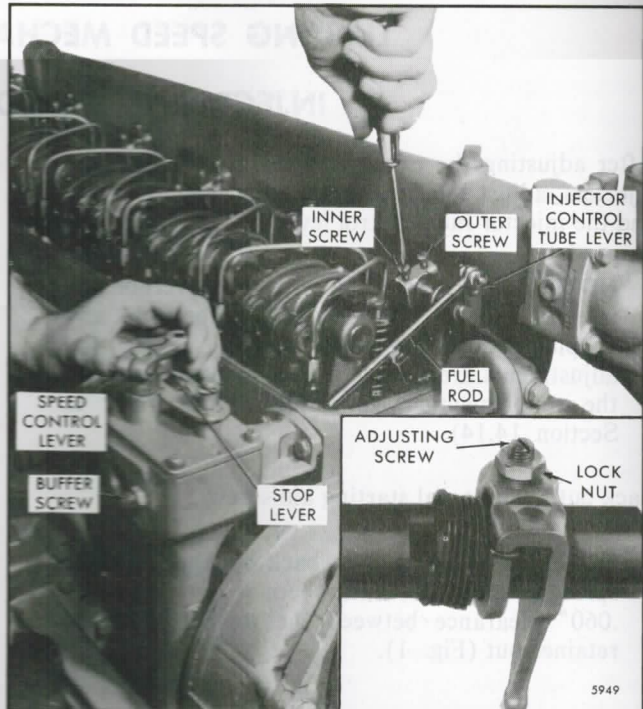


Fig. 4 - Positioning No. 1 Injector Rack Control Lever

1. Remove the governor high-speed spring retainer cover.
2. Back out the buffer screw until it extends approximately 5/8" from the locknut (Fig. 9).
3. Start the engine and loosen the idle speed adjusting screw locknut and adjust the idle screw to obtain the desired engine idle speed (Fig. 9). Hold the screw and tighten the locknut to hold the adjustment. EPA certified minimum idle speeds are 500 rpm for trucks and highway coaches and 400 rpm for city coaches.

NOTE: Current limiting speed governors used in turbocharged engines include a starting aid screw threaded into a boss on the governor housing.

4. Stop the engine. Clean and remove the valve rocker cover, the governor cover and lever assembly. Discard the gaskets.
5. Remove the fuel rod from the differential lever and the injector control tube lever (Fig. 4).
6. Start and run the engine between 1100 and 1300 rpm by manual operation of the differential lever.

NOTE: Do not overspeed the engine.

7. Check the gap between the low-speed spring cap and the high-speed spring plunger with a feeler gage

(Fig. 3). The gap should be .002"-.004". If the gap setting is incorrect, reset the gap adjusting screw.

8. On governors without the starting aid screw, hold the gap adjusting screw and tighten the locknut.

9. Recheck the gap with the engine operating between 1100 and 1300 rpm. Readjust, if necessary.

10. Stop the engine and install the fuel rod between the differential lever and the control tube lever.

11. Use a new gasket and 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 racks in the full-fuel position.

NOTE: When positioning the injector racks on an early engine equipped with a fuel modulator, be sure no interference is encountered from the fuel modulator. Loosen the fuel modulator lever ("U" bolt) and move the modulator lever along the injector control tube to avoid contact with the modulator cam or the adjacent cylinder head stud nut.

Adjust the No. 1 injector rack control lever first to establish a guide for adjusting the remaining injector rack control levers (Fig. 4).

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

2. Turn the idle speed adjusting screw until 1/2" of the threads (12-14 threads) project from the locknut when the nut is against the high-speed plunger (Fig. 3). This adjustment lowers the tension of 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*.

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

Injector racks must be adjusted so that the effort to move the throttle from the *idle speed* position to the *maximum speed* position is uniform. A sudden increase in effort can result from:

- a. Injector racks adjusted too tight, not allowing the speed control lever to reach the end of its travel.
- b. Binding of the fuel rod.
- c. Failure to back out the idle screw.

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

4. Loosen all of the inner and outer injector rack control lever adjusting screws or adjusting screws and locknuts. Be sure all the injector rack control levers are free on the injector control tube.

NOTE: On engines equipped with a yield link type fuel rod, attach a small "C" clamp at the shoulder of the rod to prevent the yield spring from compressing while adjusting the injector rack control levers.

5. Move the speed control lever to the maximum speed position (Fig. 4). Hold the lever in that position with light finger pressure and proceed as follows:

Two Screw Assembly -- Turn the inner adjusting screw on the No. 1 injector rack control lever down until a slight movement of the control tube is observed or a step-up in effort is noted. This will place the No. 1 injector rack in 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 screw.

One Screw and Locknut Assembly -- Tighten the adjusting screw of the No. 1 injector rack control lever until the injector rack clevis is observed to roll up or an increase in effort to turn the screwdriver is noted. Tighten the screw approximately 1/8 of a turn more and lock securely with the adjusting screw locknut. This will place the No. 1 injector rack in the full-fuel position.

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 **lb-in** (3-4 Nm).

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.

6. 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 screwdriver or finger tip and note the "rotating" movement of the injector control rack when the speed control lever is in the maximum speed position (Fig. 5). Hold the speed control lever in the maximum speed position and, using a screwdriver, press downward on the injector control rack. The rack should tilt downward and when the pressure of the screwdriver is released, the control rack should "spring" back upward (Fig. 6).

If the rack does not return to its original position, it is too loose. To correct this condition with the *Two Screw Assembly*, back off the outer adjusting screw slightly and tighten the inner adjusting screw slightly. To correct this condition with the *One Screw and Locknut Assembly*, loosen the locknut and turn the adjusting screw clockwise a slight amount and retighten the locknut.

The setting is too tight if, when moving the speed control lever from the idle speed position 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 with the *Two Screw Assembly*, back off the inner adjusting screw slightly and tighten the outer adjusting screw slightly. To correct this condition with the *One Screw and Locknut Assembly*, loosen the locknut and turn the adjusting screw counterclockwise a slight amount and retighten the locknut.

7. To adjust the remaining injector rack control levers, remove the clevis pin from the fuel rod and the injector

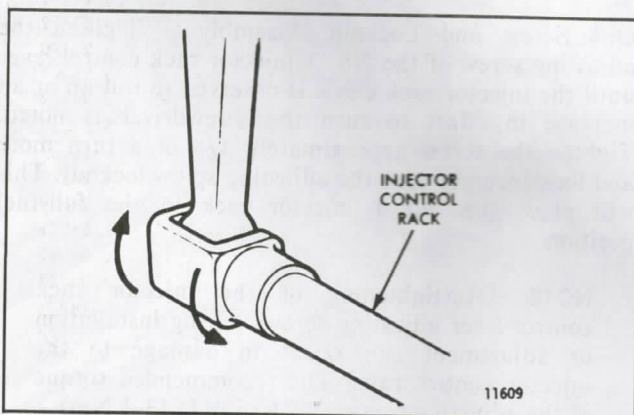


Fig. 5 - Checking Rotating Movement of Injector Control Rack

control tube lever. 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:

Two Screw Assembly:

- a. Turn down the inner adjusting screw of the No. 2 injector until the injector rack has moved into the full-fuel position and the inner adjusting screw is bottomed on the injector control tube. 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 **lb-in** (3-4 Nm).

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

One Screw and Locknut Assembly:

- a. Tighten the adjusting screw of the No. 2 injector rack control lever until the injector rack clevis is observed to roll up or an increase in effort to turn the screwdriver is noted. Securely lock the adjusting screw locknut.

NOTE: Overtightening of the injector rack control tube lever adjusting screws during installation or adjustment can result in damage

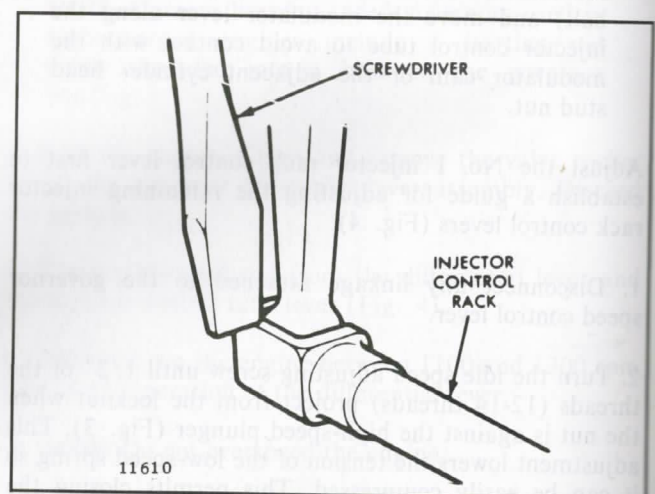


Fig. 6 - Checking Injector Control Rack "Spring"

to the injector control tube. The recommended torque of the adjusting screws is 24-36 lb-in (3-4 Nm).

- b. Verify the injector rack adjustment of No. 1 as outlined in Step 6. If No. 1 does not "spring" back upward, turn the No. 2 adjusting screw counterclockwise slightly until the No. 1 injector rack returns to its full-fuel position and secure the adjusting screw locknut. Verify proper injector rack adjustment for both No. 1 and No. 2 injectors. Turn clockwise or counterclockwise the No. 2 injector rack adjusting screw until both No. 1 and No. 2 injector racks are in the full-fuel position when the locknut is securely tightened.

When the settings are correct, the racks of both injectors must be snug on the ball end of their respective rack control levers.

- 8. Position the remaining injector rack control levers as outlined in Step 7.

- 9. Connect the fuel rod to the injector control tube lever.

- 10. Turn the idle speed adjusting screw until it projects 3/16" from the locknut to permit starting the engine.

NOTE: Remove the "C" clamp from the fuel rod on units equipped with a yield link.

- 11. On current turbocharged engines, adjust the external starting aid screw as follows:

- a. With the engine *stopped*, place the governor stop lever in the *run* position and the speed control lever in the *idle speed* position.
- b. Adjust the starting aid screw to obtain the required setting between the shoulder on the injector rack clevis and the injector body (Fig. 7). Select the proper gage and measure the setting at any convenient cylinder. When the starting aid screw is properly adjusted, the gage should have a small clearance of 1/64" in the space along the injector rack shaft between the rack clevis and the injector body.
- c. After completing the adjustment, hold the starting aid screw and tighten the locknut.
- d. Check the injector rack clevis-to-body clearance after performing the following:
 - 1. Position the stop lever in the *run* position.
 - 2. Move the speed control lever from the *idle speed position to the maximum speed* position.
 - 3. Return the speed control lever to the *idle speed* position.

Movement of the speed control lever is to take-up the clearance in the governor linkage. The injector rack clevis-to-body clearance can be increased by turning the starting aid screw farther in against the operating shaft lever or reduced by backing it out.

The diagram shows a cross-section of the starting aid screw assembly with labels: ADJUSTING SCREW, PLUNGER, SEAT, HIGH SPEED SPRING, CAP, LOCK NUT, STARTING AID SCREW, LOCK RETAINER NUT, LOCK NUT, LOW SPEED SPRING, BUFFER SCREW, and INJECTOR RACK CLEVIS. A second diagram shows the required setting between the injector rack clevis and the injector body, with a dimension line indicating the gap.

INJECTOR	GAGE SETTING*	TOOL NUMBER
N60	.345"	J 24889
N65	.385"	J 24882
N70	.385"	J 24882
N75	.385"	J 24882
N80	.385"	J 24882
N90	.454"	J 23190
C65	.385"	J 24882
C70	.385"	J 24882
7C70	.385"	J 24882
7C75	.385"	J 24882
7E50	.345"	J 24889
7E55	.345"	J 24889
7E60	.345"	J 24889
7E65	.385"	J 24882
7E75	.385"	J 24882
71B5	.345"	J 24889
B55	.345"	J 24889
B60	.345"	J 24889
7G65	.385"	J 24882
7G70	.385"	J 24882
7G75	.385"	J 24882

Fig. 7 - Adjusting Starting Aid Screw (Current Turbocharged Engines)

NOTE: The starting aid screw will be ineffective if the speed control lever is advanced toward wide open throttle during start-up.

12. Use a new gasket and replace the valve rocker cover.

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:

1. Loosen the locknut and back off the high-speed spring retainer approximately five turns (Fig. 8).
2. With the engine at operating temperature and no load on the engine, place the speed control lever in the full-fuel position. Turn the high-speed spring retainer IN until the engine is operating at the recommended no-load speed. The best method of determining the engine speed is with an accurate tachometer.
3. Hold the high-speed spring retainer and tighten the locknut.

Adjust Idle Speed

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

1. Remove the spring housing to uncover the idle speed adjusting screw.
 2. With the engine at normal operating temperature and with the buffer screw (Fig. 9) backed out to 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.
- NOTE:** EPA certified minimum idle speeds are 500 rpm for trucks and highway coaches and 400 rpm for city coaches.
3. Hold the idle screw and tighten the locknut.
 4. Install the high-speed spring retainer and tighten the two bolts.
 5. For "TT" engines, refer to Section 14.3.5 for the adjustment of the Belleville spring.

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 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 locknut.

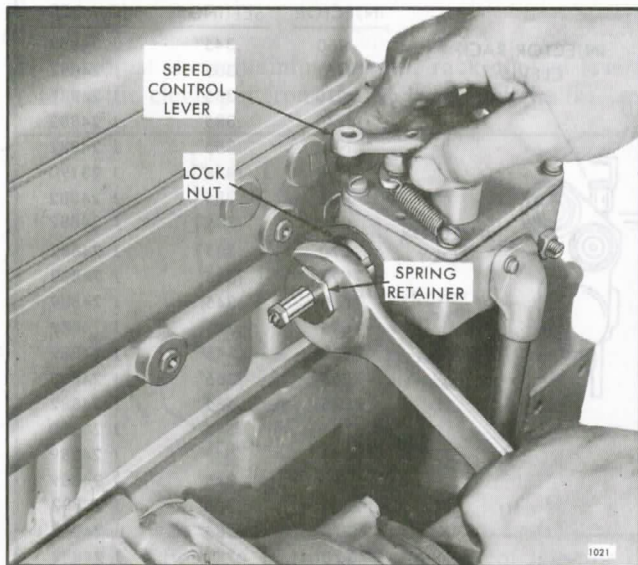


Fig. 8 - Adjusting Maximum No-Load Speed

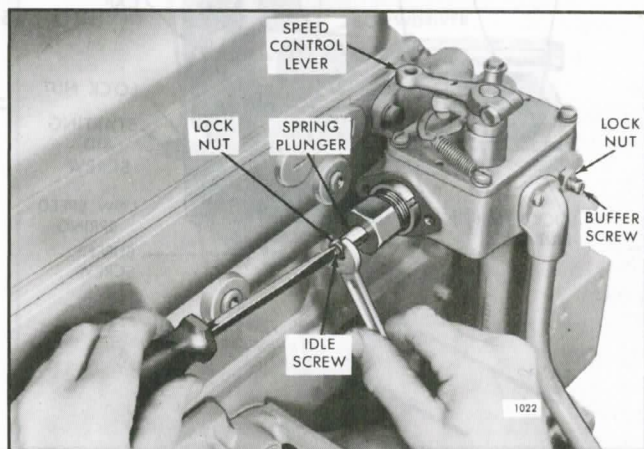


Fig. 9 - Adjusting Engine Idle Speed