

Detroit Diesel Mechanical Unit Injection Systems

These engines have not been EPA certifiable for use on North American highways since 1991. However, they have been the bus and coach power plant of choice for nearly 50 years and due to the tendency of transit corporations to recondition components many times over, these engines will survive well into the next century. Detroit Diesel 2 stroke cycle engines enjoyed some popularity as a truck engine, this popularity peaked in the 1970's (16-71, 8V-71 and 12V-71) and declined through the 1980's (8V-92). Detroit Diesel was owned by General Motors until 1987 when the division was purchased by Penske Corporation: G.M. retains a token slice of the ownership.

In a unit injector fuelled engine, each engine cylinder has its own unit injector, essentially a rocker actuated, pumping and metering element and hydraulic injector nozzle in one unit. Each unit injector has fuel delivered to it at charging pressure, variable between 30-70 psi. (200 KPa - 470 KPa) dependant on engine speed. Charging pressure is generated by a positive displacement, gear pump, driven by the Roots blower drive shaft, and responsible for all movement of fuel through the fuel subsystem. Engine output is controlled by a mechanical governor (in most truck and bus applications) that regulates fuel quantity by controlling the unit injector fuel racks.

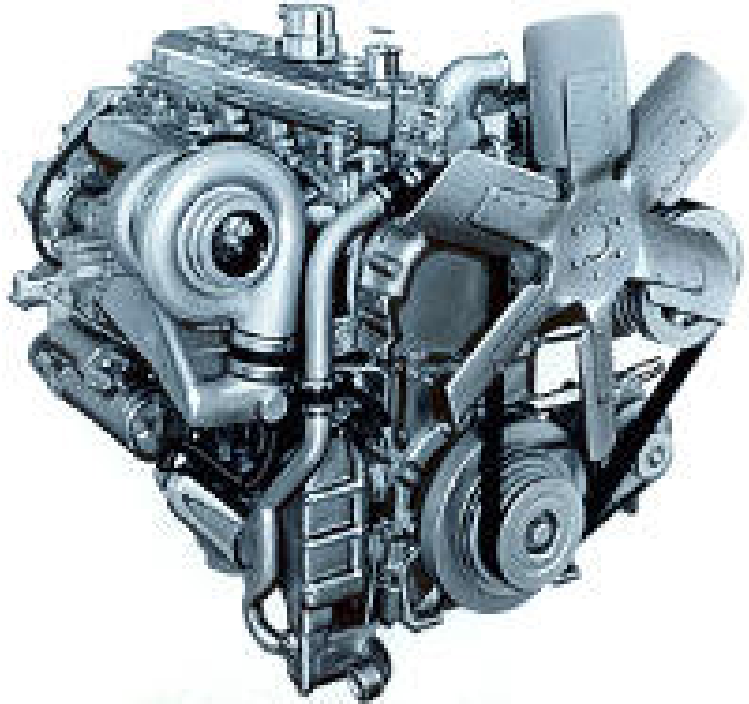
DDC mechanical unit injection system engines were engineered using the Imperial system.

Engine Identification

6V-53
↑
cylinder
↑
configuration
↑
number of cylinders
swept volume in cu. in. per

16-71
↑
cylinder
↑
number of cylinders
↑
configuration
swept volume in cu. in. per

8V-92
↑
cylinder
↑
configuration
↑
number of cylinders
swept volume in cu. in. per



Governor acronyms used in truck and bus applications.

L.S. Limiting speed
V.S. Variable speed
D.W. Double weight
S.W. Single weight
T.T. Torque tailored

Main fuel system components - the layout and primary components are identical for 53, 71 and 92 Series engines.

Fuel filters

Primary - located in series between the fuel tank and the engine mounted gear pump, this filter is under suction. Older applications used non-disposable canisters within which was a disposable element. Fitted with an inlet check valve on the mounting pad.

Secondary - located in series between the gear pump and the inlet port in the cylinder head fuel manifold. Current secondary filters are disposable, spin-on filter cartridges, which entrap particles down to 1 micron in size and may plug on water.

Gear pump

An engine driven, positive displacement pump responsible for charging the unit injectors with pressures between 30-70 psi (200-470 KPa). Also called a transfer pump.

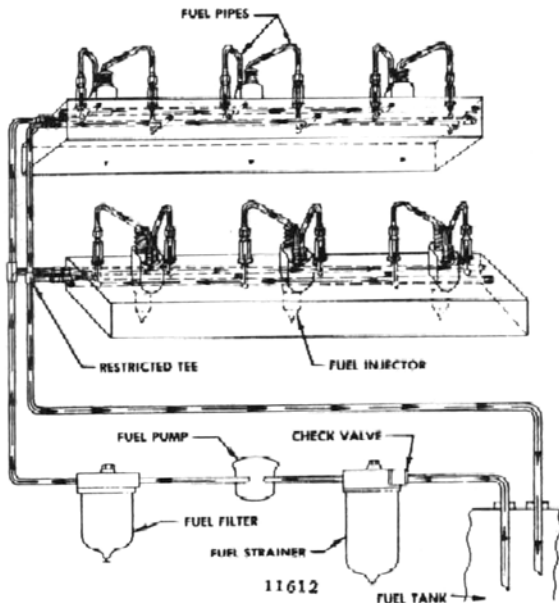


Fig. 1 – Schematic Diagram of Typical Fuel System

Fuel lines and fuel manifold

Hydraulic hose is used to connect the fuel tank with the filters, pump, and deliver fuel to the fuel manifolds. In 53, 71 and 92 Series, the fuel manifolds are drillings within the cylinder head(s) that deliver fuel to the unit injectors at charging pressure and return fuel back to the tank(s). A restriction fitting is located at the exit port of each return fuel manifold. This defines the flow area that establishes the charging pressure window. A relief valve in the transfer pump prevents the charging pressure from exceeding 70 psi.

Jumper pipes

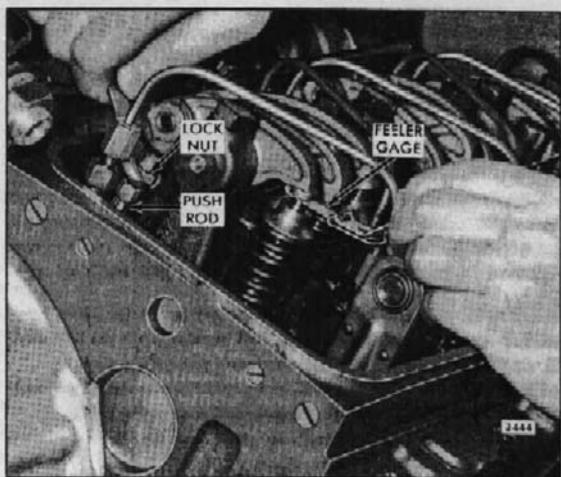


Fig. 1 – Adjusting Valve Clearance (Two Valve Head)

Jumper pipes connect the fuel manifolds in the head with the unit injectors; one charges the unit injector, the other returns fuel to the return manifold.

Unit injectors

A unit injector combines a complete pumping, metering element and a hydraulic injector nozzle in a single cam actuated unit. There are two types. However, the Crown valve type with NOP values of 800 psi can be considered obsolete and will not be discussed here. The Needle valve type was introduced in the early 1970's and is universal in DDC mechanical engines still in use.

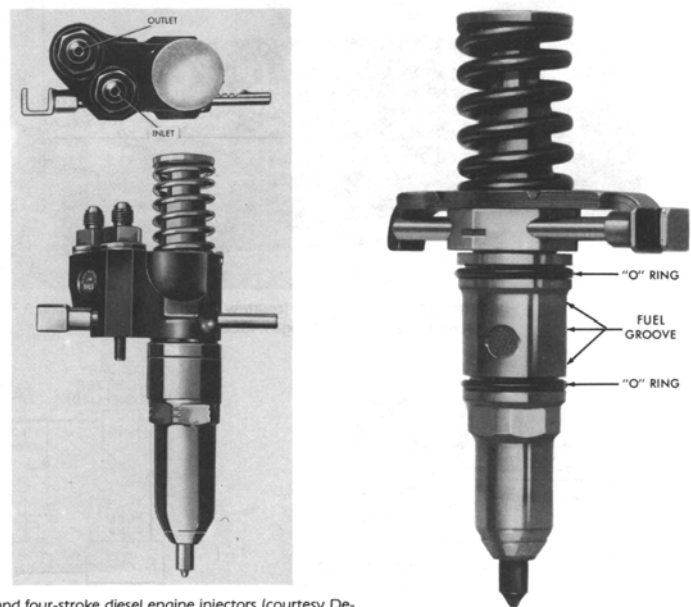


FIGURE 24.4 Two- and four-stroke diesel engine injectors (courtesy Detroit Diesel Corporation, 13400 W. Outer Drive, Detroit, Michigan 48228).

Design

The plunger and bushing within the unit injector can be likened to the pumping element in an in-line, port-helix metering pump. The bushing is stationary and machined with upper and lower ports, 180° offset. The plunger reciprocates within the bushing. It is actuated by the engine camshaft by a cam profile that is mostly inner base circle and an injector train consisting of a follower, rocker and push-rod. The plunger is milled with two helical metering recesses and is centre and cross drilled. The unit injector follower is lug connected to the plunger and the injector follower spring serves to load the plunger to ride its actuating cam profile. A gear positioned over the upper portion of the plunger is tooth meshed with the control rack, permitting the plunger to be rotated within the bushing when the rack is moved linearly. Surrounding the bushing is a spill deflector: this is a stellite alloy sleeve whose function is to prevent high velocity spilled fuel from eroding the injector body. Below the pumping element formed by the plunger and bushing is a needle valve assembly; ducts connect the two sub-components. The needle valve is a simple multi orifici, hydraulic injector nozzle. Spring pressure will determine NOP values which will be within the range 2200 - 3400 psi.

Operation

The fuel injector performs four functions, (Times, Atomizes, Meters and pressurizes):

1. Accurately times the moment of fuel injection.
2. Atomizes the fuel for vaporization and mixing with the air in the combustion chamber.
3. Meters and injects the correct amount of fuel required to maintain engine speed and to handle the load.
4. Creates the high pressure required for proper fuel injection.

For most of the cycle when the injector train is riding on the inner base circle of its actuating cam, the plunger will be in its upward position. Fuel will flow into the unit injector from the supply jumper pipe, flow through the lower bushing port charging the pump chamber, pass up through the plunger centre and cross drillings, charging the recessed metering helices and exit the upper bushing port from which it is ducted to the return jumper pipe. Actual plunger stroke is determined by cam profile and therefore will not vary. Effective stroke is the amount of plunger stroke where fuel is actually being pumped and this is used to control engine fuelling. Effective stroke depends on the rotational position of the plunger which, is controlled by the rack; specifically, it depends on where the helices register with the upper and lower ports machined into the bushing. For effective stroke to occur, both bushing ports must be closed.

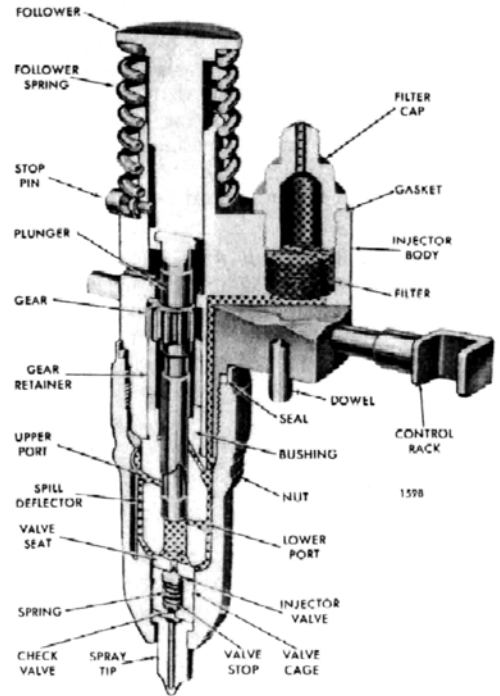


Fig. 1 – Fuel Injector Assembly

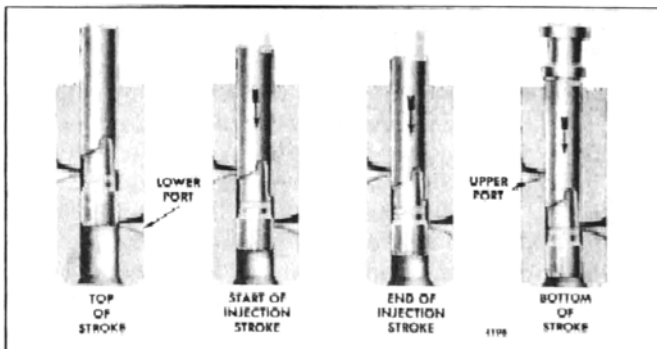


Fig. 3 – Phases of Injector Operation Through Vertical Travel of Plunger

When the injector cam rotates off inner base circle, the plunger begins its descent in the bushing.

Minimal downward travel of the plunger closes the lower bushing port and as the plunger descends, fuel in the pump chamber is displaced passing through the centre and cross drillings and exiting the upper bushing port. This continues until the helical edge of the plunger metering recess closes off the upper bushing port, beginning effective stroke. Effective stroke will continue until the lower portion of the metering recess is exposed to the lower bushing port, spilling fuel from the pumping element.

The duration of effective stroke depends on the rotational position of the plunger. To obtain no fuel, the plunger must be rotated to a position where the lower bushing port is exposed before the upper bushing is closed off.

The shaping of the metering recesses will determine the injection timing characteristics in the unit injector. Depending on application, these may be;

Variable beginning, variable ending of injection pulse. Constant beginning, variable ending of injection pulse. Variable beginning, constant ending of injection pulse.

Unit injector identification

A circular identification tag pressed into the unit injector body identifies the class number. Unit injectors with no line under the manufacturer name are those with the obsolete Crown valve nozzles. A Needle valve nozzle would have this line under the manufacturer's name:

GM N60 and DDC N70-C70 have needle valves, GM B60 has a crown valve nozzle

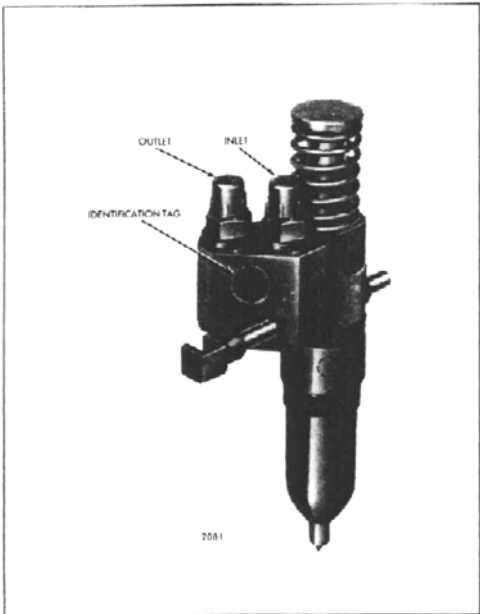


Fig. 4 - Injector Identification

In the first example above, the line under the manufacture name identifies the injector as having a Needle valve nozzle. The N indicates the plunger is of the constant beginning, variable ending design. A (C), would identify the plunger as having variable beginning, variable ending timing characteristics. The number following the letter designation is the comparator bench specification for fuel output per 1000 strokes measured in cubic centimeters.

The digits engraved on the nozzle valve identify the number of orifii, orifii sizing and orifii spray angle.
Unit injector components - Needle valve type.

Follower - actuating mechanism for the plunger to which it is connected by a lug. A stop pin limits the upward travel of the plunger. A follower spring serves to hold the follower (and therefore the plunger) in the raised position and to load the injector train.

Plunger - the moving component of the pumping element, it reciprocates within a stationary bushing. The plunger is milled with metering recesses and centre and cross-drilled. Lapped to the bushing in manufacture. Lapped components are not interchangeable.

Bushing - cylindrical housing within which the plunger reciprocates and with which it forms the pump element. Drilled with upper and lower ports.

Gear - lugged to the plunger and tooth meshed to the control rack. Allows plunger to be rotated while it reciprocates.

Control rack – tooth meshed with the plunger gear, when moved linearly the control rack rotates the plunger. The control rack linear position is controlled by levers that extend from the control tube.

Spill deflector - A stellite alloy sleeve that surrounds the bushing and prevents high velocity fuel from eroding the unit injector body.

Check valve - in the event of the needle valve being unable to seat due to carboning or any other reason, this prevents cylinder gases from entering the unit injector past the nozzle assembly.

Needle valve nozzle assembly - held closed and seated by the valve spring. Fuel pressures developed in the plunger and bushing pump element are ducted to act on a percentage of the total needle valve) sectional area and when that pressure is sufficient to overcome their valve spring tension, the needle valve retracts allowing high pressure fuel to pass around its seat to a sac and exit through nozzle orifii. This begins the injection pulse. When the pump element effective stroke ends, fuel starts to spill from the pump chamber, exiting the lower bushing port; when fuel pressure acting on the sectional area of the needle valve is insufficient to hold the valve spring retracted, it closes ending the injection pulse.

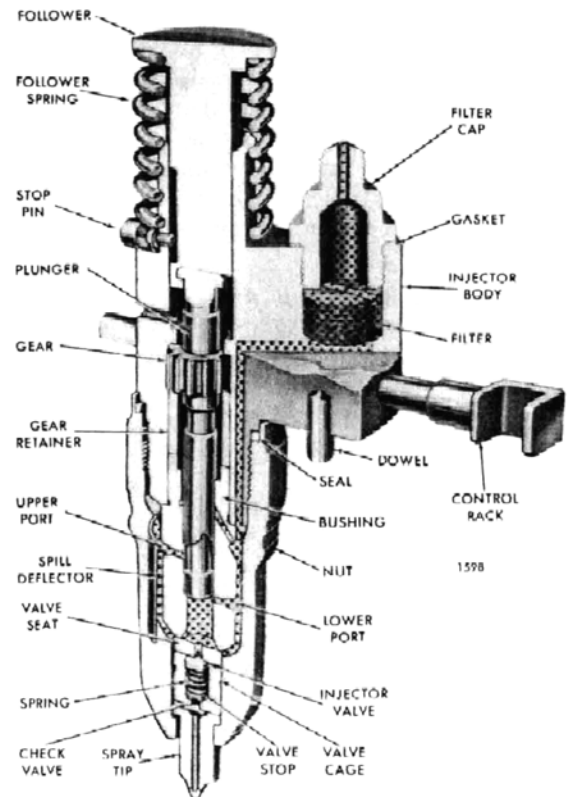


Fig. 1 - Fuel Injector Assembly

Injector to Governor Linkages

The output of the unit injectors is governor controlled by means of a set of linkage. Governor control rods extend from the governor housing and connect to a control tube lever by means of a clevis and pin: linear movement of the governor control rods will by this means be converted into rotary movement of the control tube which runs lengthwise through the upper cylinder head. Extending from the control tube are the rack levers.

The rack levers link the individual unit injectors with the control tube; when the control tube is rotated by the governor control rods, the rack levers extending from the control tube will linearly move the unit injector racks. A critical procedure in DDC engine tune-up is ensuring that the unit injectors are balanced, that is, that the point of register of the helices with the bushing ports in each unit injector in the engine is identical. This is achieved by correctly setting the control tube adjusting screw; this adjusting screw locates the radial position of the rack lever.

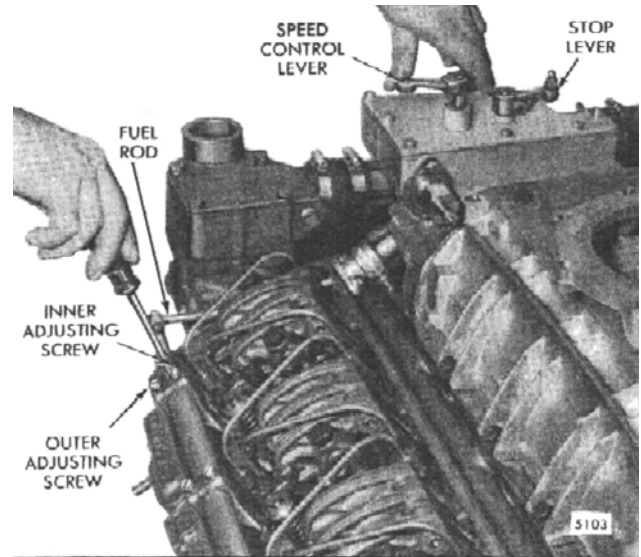


Fig. 8 – Positioning No. 1L Injector Rack Control Lever (Two Screw Assembly)

Governor

A simple mechanical governor is used in most truck and bus applications. Governor components consist of a set of engine driven flyweights, a thrust collar and spring set. As in most mechanical governors, centrifuge exacted by the flyweights attempts to diminish engine fuelling while spring force moderated by speed control lever position attempts to increase engine fuelling. The thrust collar acts as an intermediary. Both limiting speed and variable speed governors are used: the governor type should be identified prior to engine tune-up as the procedure varies with governor type.

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 mechanism, governor, etc should only be required periodically to compensate for normal wear on parts.

To comply with emissions regulations, injector timing, exhaust valve clearance, redline idle and no-load speeds, and throttle delay or fuel modulator settings must be checked and adjusted if necessary, at 50,000 miles intervals.

The type of governor used depends upon the engine application. Since each governor has different characteristics, the tune-up procedure varies accordingly. The following types of governors are used.

1. Limiting speed mechanical.

2. Variable speed mechanical

3. Hydraulic

The mechanical 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.

The engine we will be working on is a D.W.-L.S. so we will concentrate on the procedure for this type of governor but note that the procedures will change slightly for each type so always consult the appropriate service manual. 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 a cylinder head, governor or injectors have been replaced or overhauled, then certain tune-up adjustments are required. Accurate tune-up adjustments are very important if maximum performance and economy are to be obtained.

NOTICE: if a Supplementary governing device, such as the throttle delay mechanism is used, it must be disconnected prior to the tune-up. After the governor and injector rack adjustments are completed the supplementary governing device must be reconnected and adjusted.

Tune-Up Sequence for Mechanical Governor

Before starting an engine after an engine speed control adjustment or after removal of the engine governor cover, the service technician must determine that the injector racks move to the no-fuel position when the governor stop lever is placed in the stop position. Engine over speed will result if the injector racks cannot be positioned at no-fuel with the governor stop lever. An over-speeding engine can result in engine damage which could cause personal injury. The technician should also ensure that the racks are capable of full fueling the engine

1. Adjust the exhaust valve clearance cold.
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 Belleville spring for horsepower, (TT or torque tailored engines only).
8. Adjust the buffer screw
9. Adjust the throttle booster spring (variable speed governor only)
10. Adjust the supplementary governing devices if used.

On-highway vehicle and coach engines built by Detroit Diesel Corporation are certified to be in compliance with Federal and California Emission Regulations established for each model year beginning with 1970. These engines no longer meet the emission standards of today but as long as they meet the standards prevailing in the year they were manufactured they are legal on the road. Due to the propensity of coach fleets such as the TTC and others to overhaul instead of replace we will see these engines in service for some time to come.

Emission certification is dependent on five physical

Characteristics:

1. Fuel Injector type
2. Maximum full load engine speed
3. Camshaft timing
4. Fuel injector timing.
5. Throttle delay (orifice size).

EXHAUST VALVE CLEARANCE ADJUSTMENT

The correct dimension for the exhaust valve clearance and injector timing dimension can be found on the information plate on the rocker cover or in the engine service manual.

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.

All of the exhaust valves can be adjusted in Firing order sequence during one full revolution of the crankshaft. Refer to the manual for the correct engine firing order.

This is the Detroit procedure for adjustment however looking at the adjustment sequence above we see that the next adjustment is the Injector Timing so it makes sense to perform both of these adjustments at the same time as the injector timing adjustment will require the engine to be cranked over as well. We can start at any point and simply by observing the valves and injectors we can determine what is happening in a particular cylinder. If an injector plunger is being depressed by the rocker we know that that cylinder's piston is at the top of its stroke and because it is a two stroke we know that the valves will not be actuated until the piston is moving towards the bottom of the stroke, therefore we can adjust the valves on that cylinder. At the same time on a separate cylinder we will observe the exhaust valves being depressed by the rockers. This tells us that this cylinder is close to the bottom of its power stroke which means we can adjust injector height, (timing). By following this procedure carefully we can adjust all of the valves and injectors in one rotation of the engine.

The actual valve adjustment procedure follows;

Four exhaust valve cylinder heads

On engines with 4 exhaust valves the exhaust valve bridge balance should be checked if the bridges are not balanced they must be removed to loosen and tighten their lock nuts or the bridge pins may be damaged. To check the balance back off the rocker adjusting screw and install two feeler gauges of equal thickness under both ends of the bridge, push down on the bridge and try to remove the feeler gauges simultaneously there should be equal resistance from both gauges. If one is harder to pull the bridge must be removed and adjusted.

Two exhaust valve cylinder heads

On these engine the valves are adjusted by undoing the lock nut on the threaded push rod and turning the push rod counterclockwise to reduce the gap and clockwise to increase the gap.

Timing the injectors

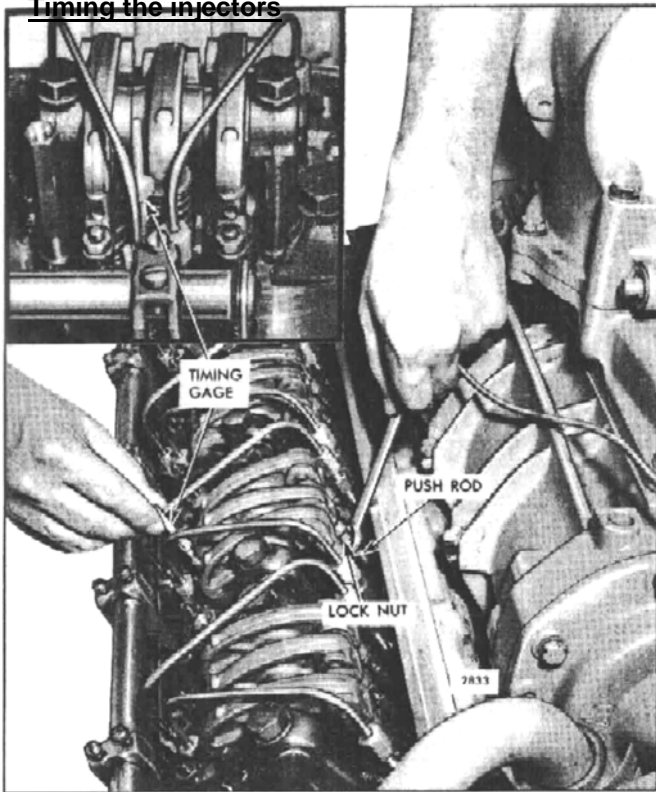


Fig. 1 – Timing Fuel Injector

time an injector properly, the injector follower must be adjusted to a definite height in relation to the injector body. This is accomplished by inserting a precise gauge into a hole in the injector body and matching the position of the flag on the gauge to the height of the injector follower. All of the injectors can be timed during one full revolution of the crankshaft following the procedure above. The injector number will determine the dimension of the gauge to be used. Refer to the information plate on the rocker cover or match the injector number to the chart in the manual.

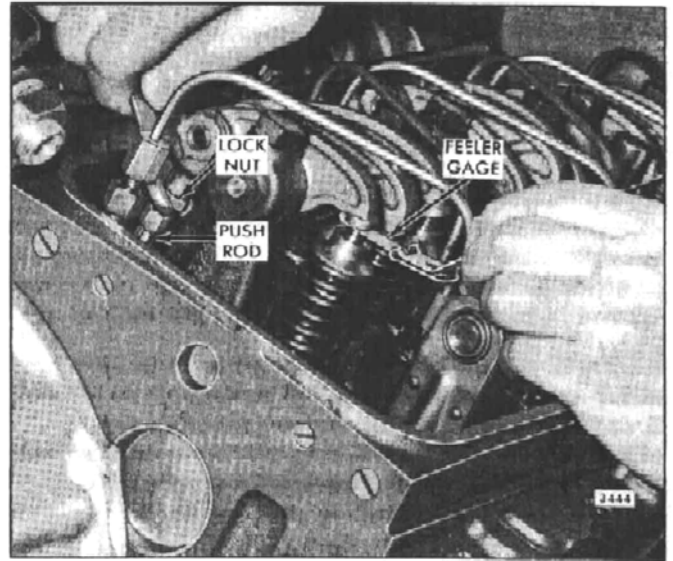


Fig. 1 – Adjusting Valve Clearance (Two Valve Head)

To

#Injector	Timing Dimension	Timing Gage	Camshaft Timing
Generator Sets			
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
N60 Turbo	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	Advanced
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
N90	1.460*	J 1853	Standard
7A50	1.466*	J 26888	Retarded
7A55	1.466*	J 26888	Retarded
7A60	1.460*	J 1853	Retarded
7A65	1.460*	J 1853	Retarded
7A70	1.460*	J 1853	Retarded
7A75	1.460*	J 1853	Retarded
7C70	1.460*	J 1853	Retarded
7C75	1.460*	J 1853	Retarded
7A15	1.460*	J 1853	@
7N65	1.484*	J 1242	@
7N95	1.520*	J 25502	@
6850	1.484*	J 1242	@
7015	1.508*	J 8909	@

† Use 1.470" timing gage (J 24236) for city coach engines.
 * 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-GT-ADV-CAM" stamped on lower right-hand side of option plate.

For automotive applications, refer to Section 14.

@ Refer to Engine Option Label.

TABLE 2 – INJECTOR TIMING GAGE CHART (Needle Valve)

GOVERNOR GAP

A properly adjusted governor gap will accomplish the following:

Provide sufficient weight travel in the idle range to prevent stalling during deceleration. A tight gap reduces weight travel in the idle range

Provide enough weight travel in the high speed Control range to prevent engine over-speed with light loads at full throttle. A loose gap reduces weight travel in the high speed range.

Prevent the force generated by the low speed weights (double weight governors) from depressing the high speed Springs. If the gap is too tight, the force of the heavy idle weights operating on the high speed spring will cause the high speed spring to depress at too low a speed, resulting in low power

DOUBLE WEIGHT GOVERNOR

The gap on double weight limiting speed governors may be set using the "static" or the "engine stopped" method. The static or weight pry method allows the technician to set the gap accurately in the most efficient, cost effective manner, For this reason DDC recommends using this method whenever possible.

ADJUST GOVERNOR GAP

Before proceeding with the governor and injector rack adjustments, disconnect any supplementary governing device such as the throttle delay cylinder. After the adjustments are completed, reconnect and adjust the supplementary governing device.

Static Method

The following procedure is accomplished with the engine stopped using governor weight wedge tool J 35516.

CAUTION: To avoid personal injury and prevent possible engine damage, the following precautions should be observed:

Make sure the turbocharger compressor inlet guard or compressor air inlet shield J-2655FA is installed any time the engine is running and the turbocharger air intake piping is removed. The use of these guards does not preclude any other safety practices contained in the service manual.

After replacing the governor cover and before starting the engine make sure the injector racks move to the "no fuel" position when the governor stop lever is in the "stop position".

Back out the external starting aid screw, (Turbo Charged engines only).

1. With the engine in a vehicle, set the engine idle speed at 600 RPM and stop the engine

NOTICE. This static governor gap setting is established at the factory based upon a 600 RPM engine idle. Therefore, when verifying a factory tune-up the governor idle Speed should be set at 600 RPM.

CAUTION: Disconnect the grounded battery cable(s) to prevent accidental engine cranking and possible personal injury while the gap is being checked or set.

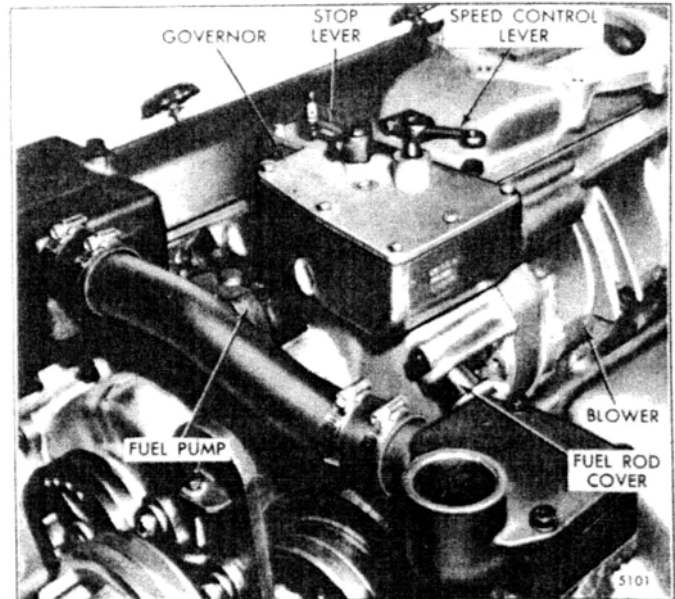


Fig. 5 - Limiting Speed Mechanical Governor Mounting (6V, 8V and 12V Engines)

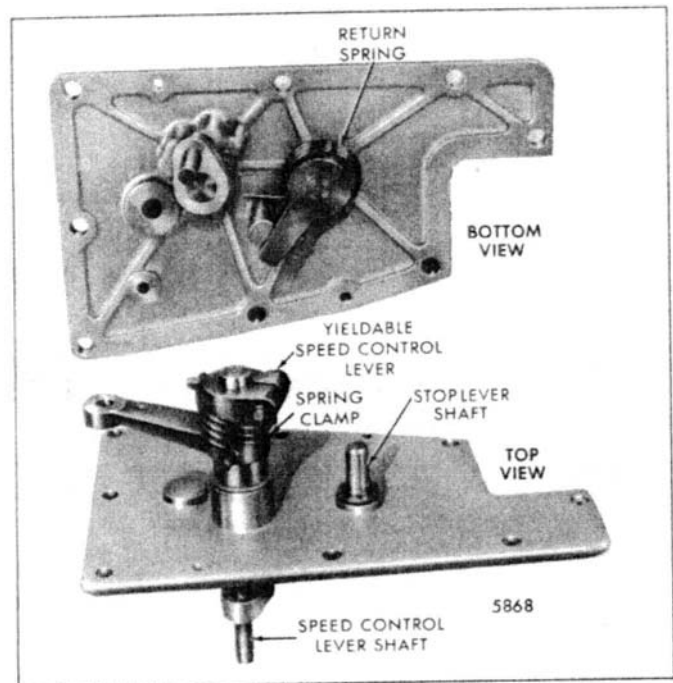


Fig. 4 - Die Cast Governor Covers

2. Clean and remove the governor cover. Discard the gasket.

3. With the engine stopped manually bar the engine over until the governor weights are in a horizontal position

NOTICE; The hex head of the crankshaft bolt may be used to bar, or turn, the crankshaft. However, the barring operation should always be performed in a clockwise direction it is very important to make certain that the bolt has not been loosened during the barring operation Otherwise, serious engine damage may result if the vibration damper or pulley is not securely fastened to the crankshaft.

On TT governors, the Belleville spring retainer nut must be hacked out until there is approximately .060" clearance between the washers and the retainer nest before checking or resetting the governor gap.

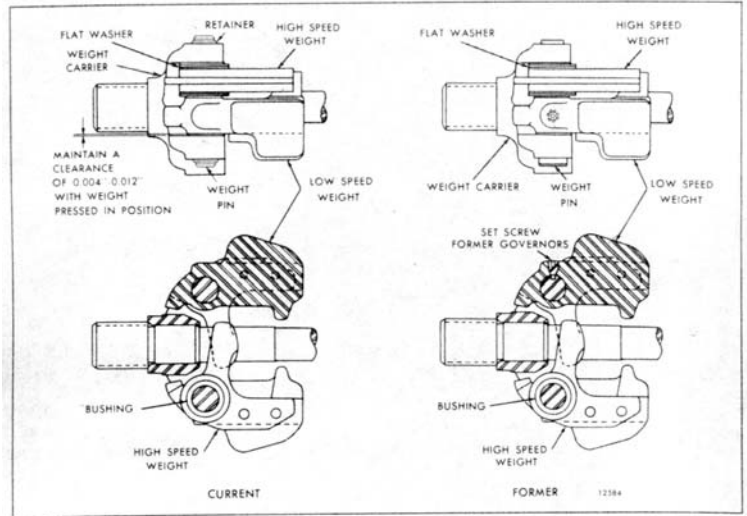


Fig. 13 - Cross Section of Governor Double Weight Assemblies (Former and Current)

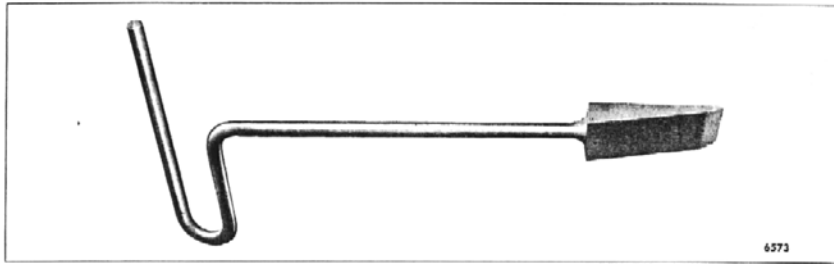


Fig. 2 - Governor Weight Wedge Tool J35516

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SEC. 14.3 Page 3

4. Insert governor weight wedge J35516 between the Low-speed weight and the governor riser the tapered face of the wedge should be against the riser and positioned between the flanges on the ends of the riser, (the riser is the spool shaped component on the governor shaft).

5. Push the wedge as far to the bottom as it will go forcing the weights against the maximum travel stop.

NOTE although not recommended a screwdriver is often used to pry the weights, but care must be taken not to damage to the weights, riser or housing.

6. While holding the low speed weights in their fully extended position, use a feeler gauge to measure the gap between the low speed spring cap and the high speed spring plunger. The gap should measure between .003" - .019"

Reset the gap to .008" if the measured gap is out of limits and tighten the gap adjusting screw locknut.

7. Remove the wedge and replace the governor cover using a new gasket.

8. Reset "Torque Tailored" Bellville Springs if equipped.

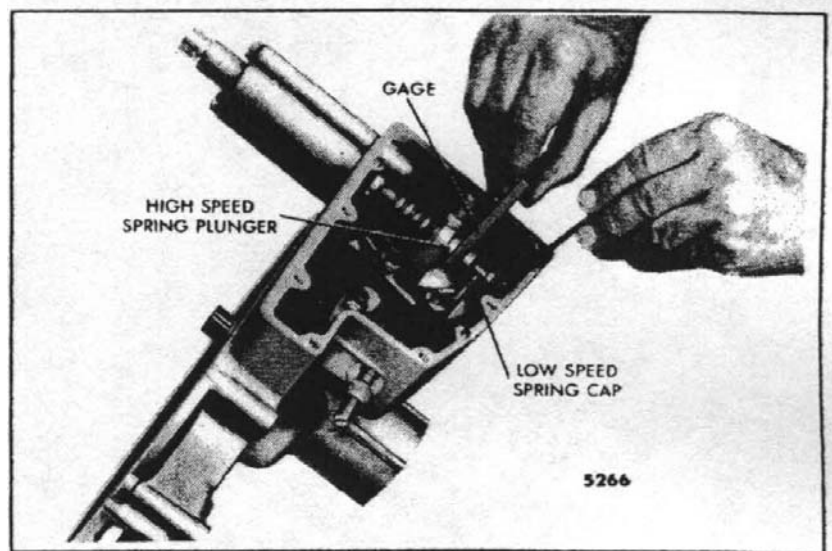


Fig. 7 - Adjusting Governor Gap (Single Weight Governor)

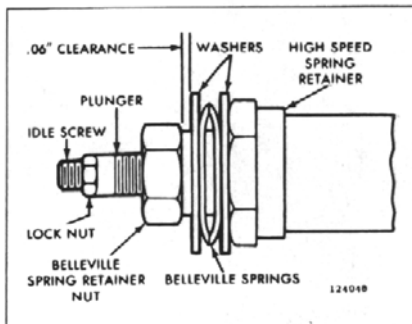


Fig. 1 - Belleville Washer Location

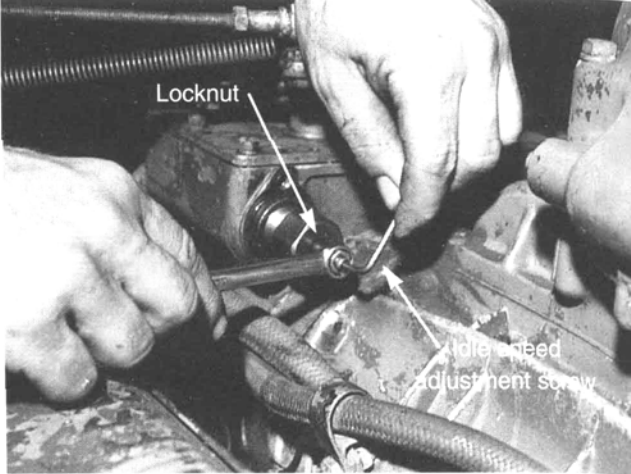
Position Injector Rack Control Levers.

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

NOTICE: To ensure proper injector control rack adjustment, the injector racks must be adjusted with the yield link and governor cover that are to be used with the governor.

The letters "R" and "L" indicates 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. 1 L 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.



B

2. Turn the idle speed adjusting screw until $\frac{1}{2}$ inch of the thread projects from the locknut when the nut is against the high-speed plunger. 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.

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

Injector racks must be adjusted so 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 causing the yield link to separate.
- b. Binding of the fuel rods
- c. Failure to back out idle screw.

3. Back out the buffer screw approximately $\frac{5}{8}$ " if it has not already been done.

4. Remove the clevis pin from the fuel rod at the right cylinder bank injector control tube lever.

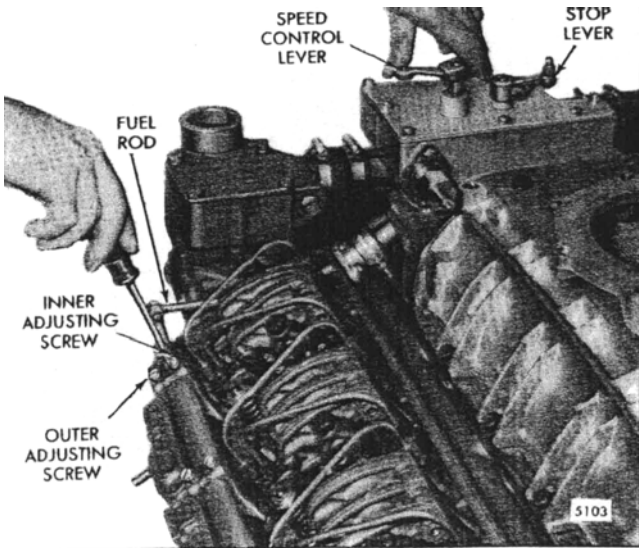


Fig. 8 - Positioning No. 1L Injector Rack Control Lever (Two Screw Assembly)

5. Loosen all of the inner and outer injector rack control lever adjusting screws, (2 screw levers) or adjusting screws and locknuts, (single screw levers). Be sure all of the injector rack control levers are free on the injector control tubes.

6. Move the speed control lever to the maximum speed position and hold it in that position with light finger pressure. Turn the inner adjusting screw of the Left number one rack lever until a slight resistance is felt, then turn down the outer screw until it bottoms lightly then alternately tighten the inner and outer screws until both screws are tight. Check the rack lever for "spring back" to ensure it is in the full fuel position with the fuel lever at maximum.

Remove the clevis pin from the left bank control tube.

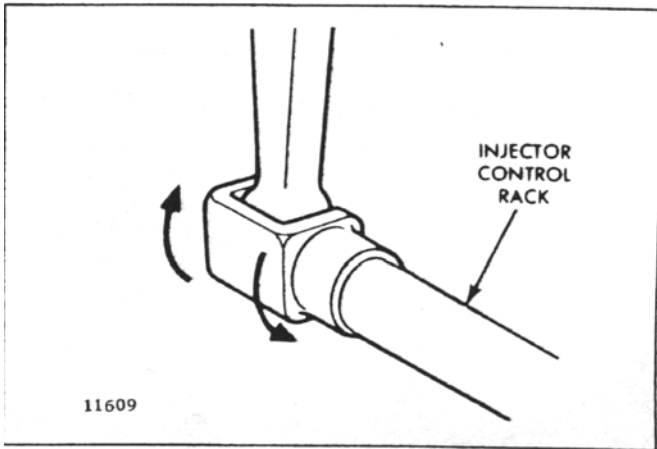


Fig. 10 – Checking Rotating Movement of Injector Control Rack

that the stop lever can move the racks to no fuel.

10. Readjust the idle screw until approximately 3/16" protrudes from the lock nut, this should allow the engine to idle on restart.

11. Reinstall the governor cover using a new gasket and tighten the screws. And again check from proper operation of the fuel control lever and the stop lever. **This check is extremely important and failure to perform it can result in an engine runaway causing engine damage and personal injury!**

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 follows:

Adjust High Idle (Max No-Load Speed)

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

1. Loosen the spring retainer locknut 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 locknut.

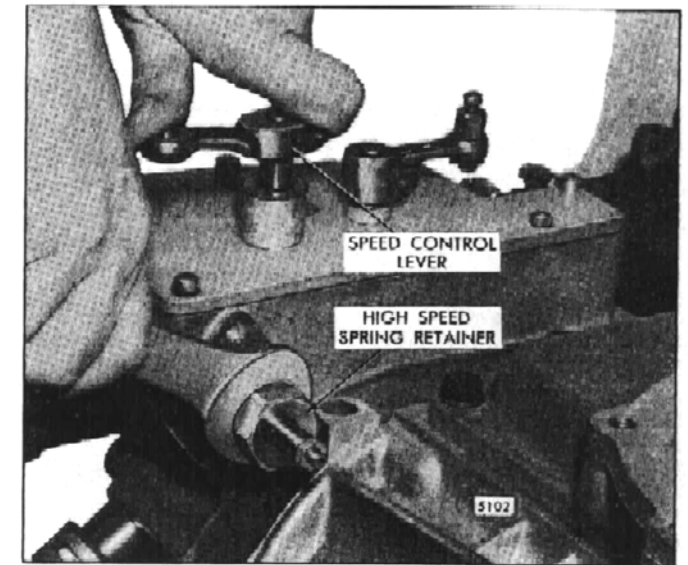
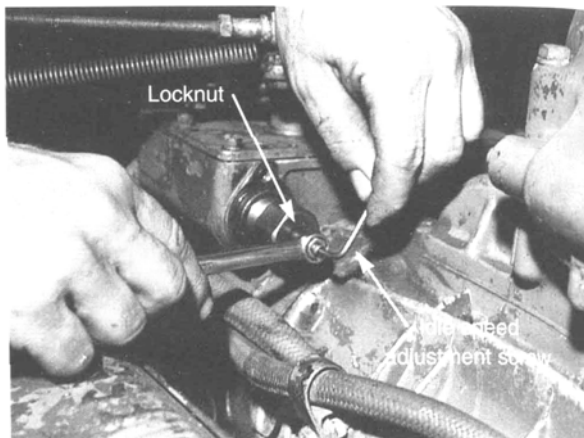


Fig. 14 – Adjusting Maximum No-Load Speed



B

Adjust Idle Speed

1. With the engine operating at normal temperature and with the buffer screw backed out to avoid contact with the differential lever turn the idle speed adjusting screw until the engine operates at approximately 15 rpm below the recommended idle speed. The recommended idle specification for non-EPA certified engines is within the speed range shown on the governor name plate. Speeds are 500 RPM for trucks and highway coaches and 400 rpm for city coaches.
2. Hold the idle screw and tighten the locknut
3. Install the high-speed spring retainer cover and tighten the two bolts.

7. Install the clevis pin in the right bank control tube and repeat the above procedure for the right bank number 1 lever.
Reinstall the left bank control tube clevis and holding the fuel lever at maximum check both bank number one racks for "spring back" and remove both clevis pins.

8. Now holding the number 1 rack on the left bank at full fuel with the control tube, adjust the other injector racks until they have equal "spring back" to number one. Important; under no circumstances readjust number one, if you lose the "spring back" on number one you have over adjusted one of the other racks

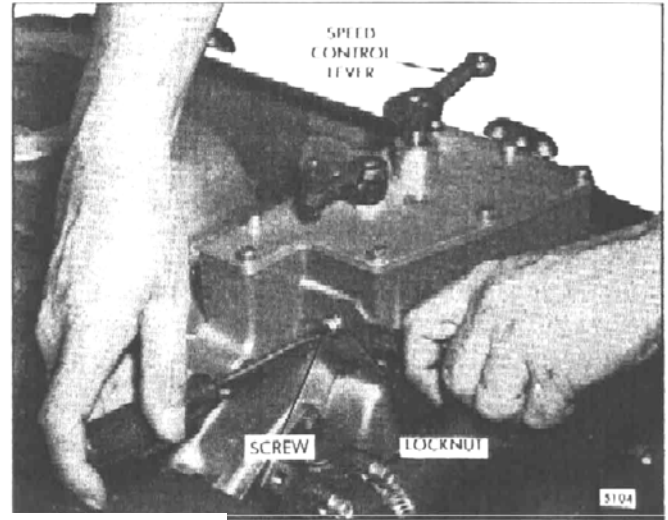
9. Repeat the above procedure for the right bank racks and then reinstall both clevis pins and holding the fuel lever to maximum recheck "spring back" on the left and right banks. Be sure to check that the fuel lever can move the racks smoothly from idle to full fuel and back. Check

Adjust Buffer Screw

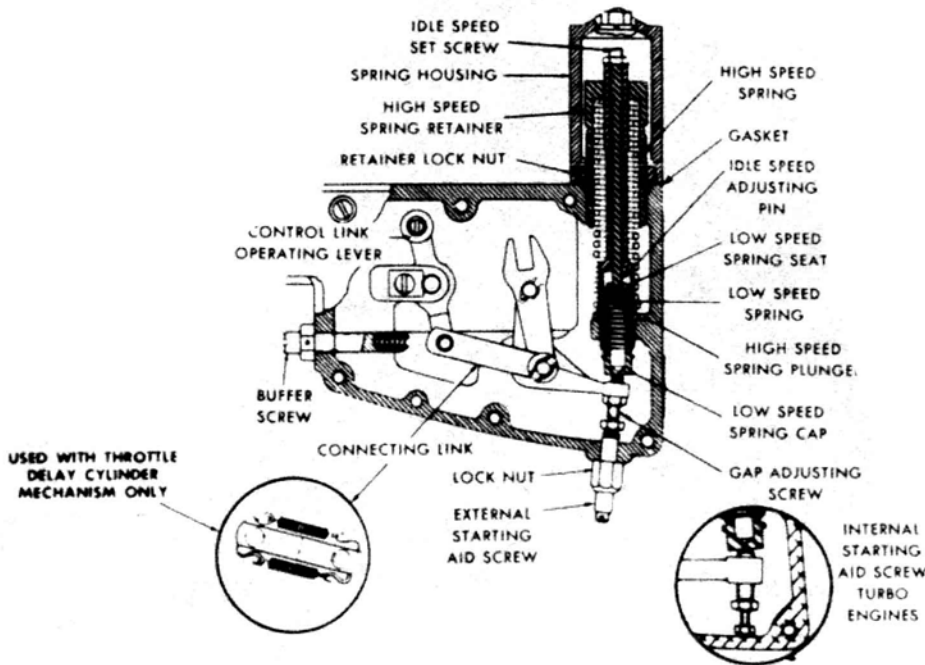
With the idle speed properly set, adjust the buffer screw as follows;

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

THROTTLE DELAY MECHANISM



3 – Adjusting Buffer Screw



The throttle delay mechanism is used to slow the racks movement towards full fuel as the engine is accelerated. Blower and or turbo speed is very low, (nonexistent for turbos), at Idle speed. Delaying the racks movement towards full fuel allows the air induction system to catch up and limits black smoke. So the throttle delay is basically a primitive but effective smoke control device, (puff limiter), that also improves fuel economy. The throttle delay mechanism 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 to avoid stress on the governor while delay is taking place.

Operation

Oil is supplied to a reservoir above the throttle delay cylinder through an oil supply fitting in the drilled oil passage in the rocker arm shaft bracket. As the injector racks are moved toward the no-fuel positions free movement of the throttle delay piston is assured by air drawn into the cylinder through the one way check valve. Further movement of the piston uncovers an opening which permits engine lube 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 or delayed 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.

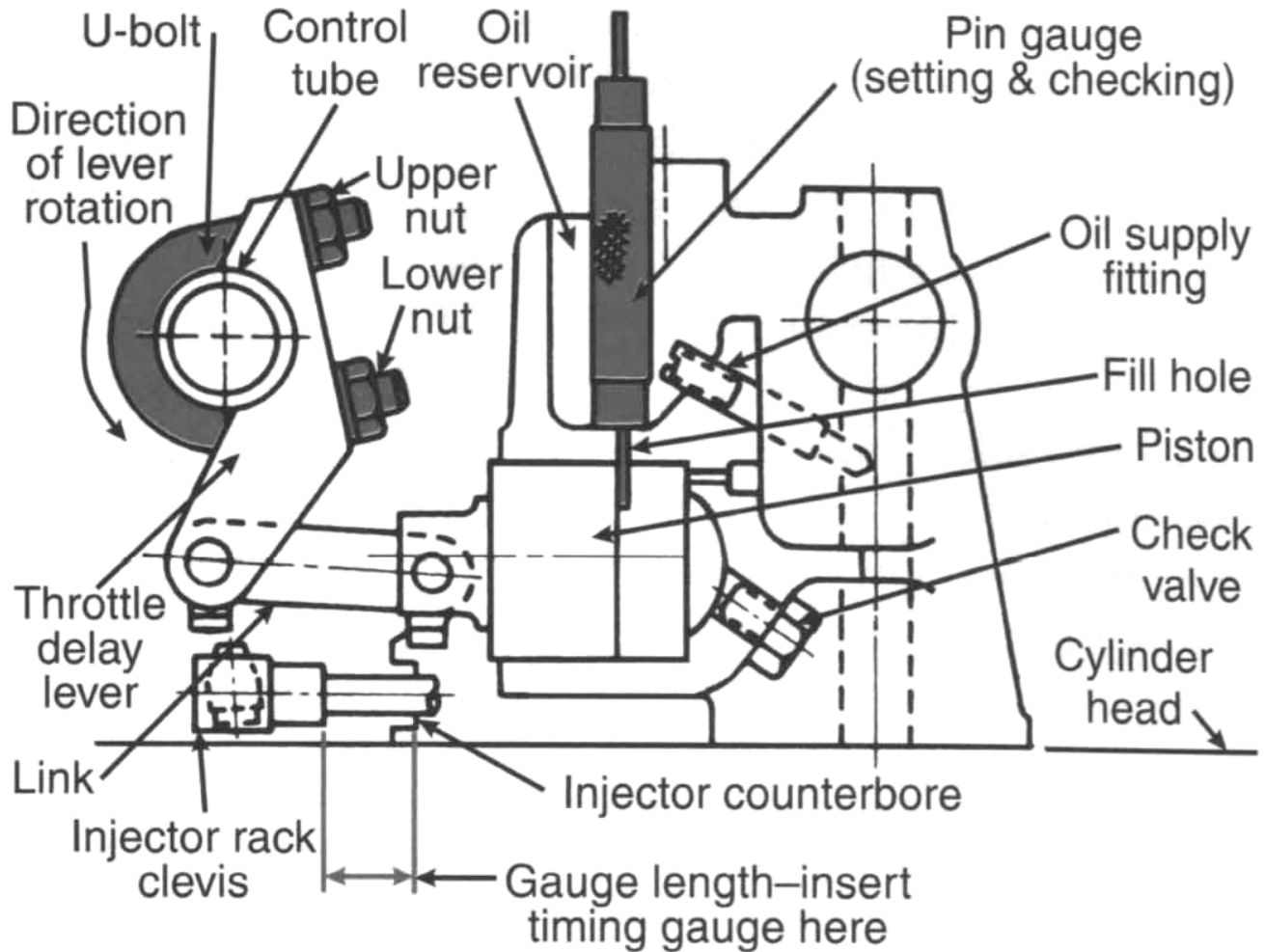


Figure 22-28. Position of go/no-go pin gauge while adjusting the throttle delay cylinder. (Detroit Diesel Corporation)

Inspection of throttle delay cylinder

The current throttle delay bracket has a closer tolerance on the piston and cylinder bore. The current check valve has a nylon check ball in place of the former brass ball. When inspecting the throttle delay hydraulic cylinders it is important that the check valve be inspected for wear.

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 speed position to the fuel-fuel position. If more than a drop of leakage occurs replace the check valve.

Note there are different models of throttle delay cylinders consult the service manual for correct procedures the following is a general procedure only.

Adjustment (Current Throttle Delay)

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 readjusted with the engine stopped, proceed as follows:

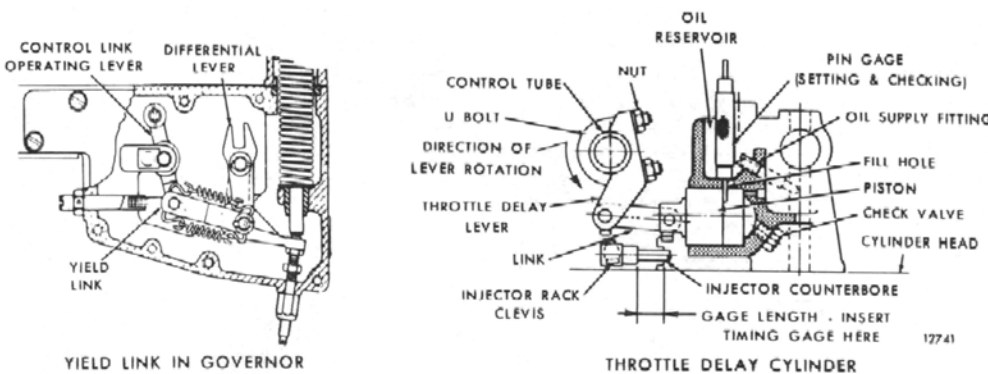
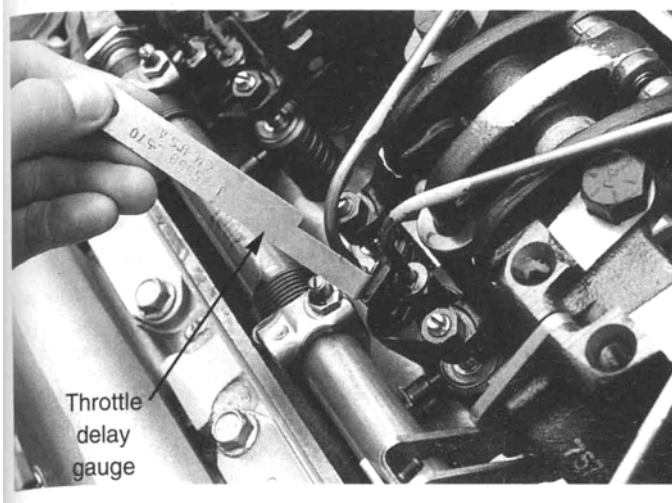


Fig. 3 – Throttle Delay Cylinder and Yield Link

1. Disconnect the throttle delay mechanism by loosening the U bolt which clamps the lever to the injector control tube.
2. To provide adequate lubrication of mechanical components, fill the throttle delay reservoir with clean engine oil. The reservoir does not have to remain full during the entire adjustment procedure



3. Insert the appropriate throttle delay timing gauge, (consult manual), on the rack between the injector body rack hole counter bore and the shoulder on the injector rack clevis. This is the No. 2 injector on 6V and 8V engines, the No. 5 injector on 12V engines and the No 6 injector on 16V engines.
4. Hold the governor throttle lever in the maximum speed position. This should cause the injector rack to move toward the full-fuel position
5. Insert pin gage J 25558 with the "go" (small .069") end in the delay cylinder fill hole.
6. Rotate the throttle delay lever in the "full fuel" direction until further movement is limited by the piston contacting the pin gauge.
7. Tighten the U-bolt while exerting a slight pressure on the lever in the direction of rotation.

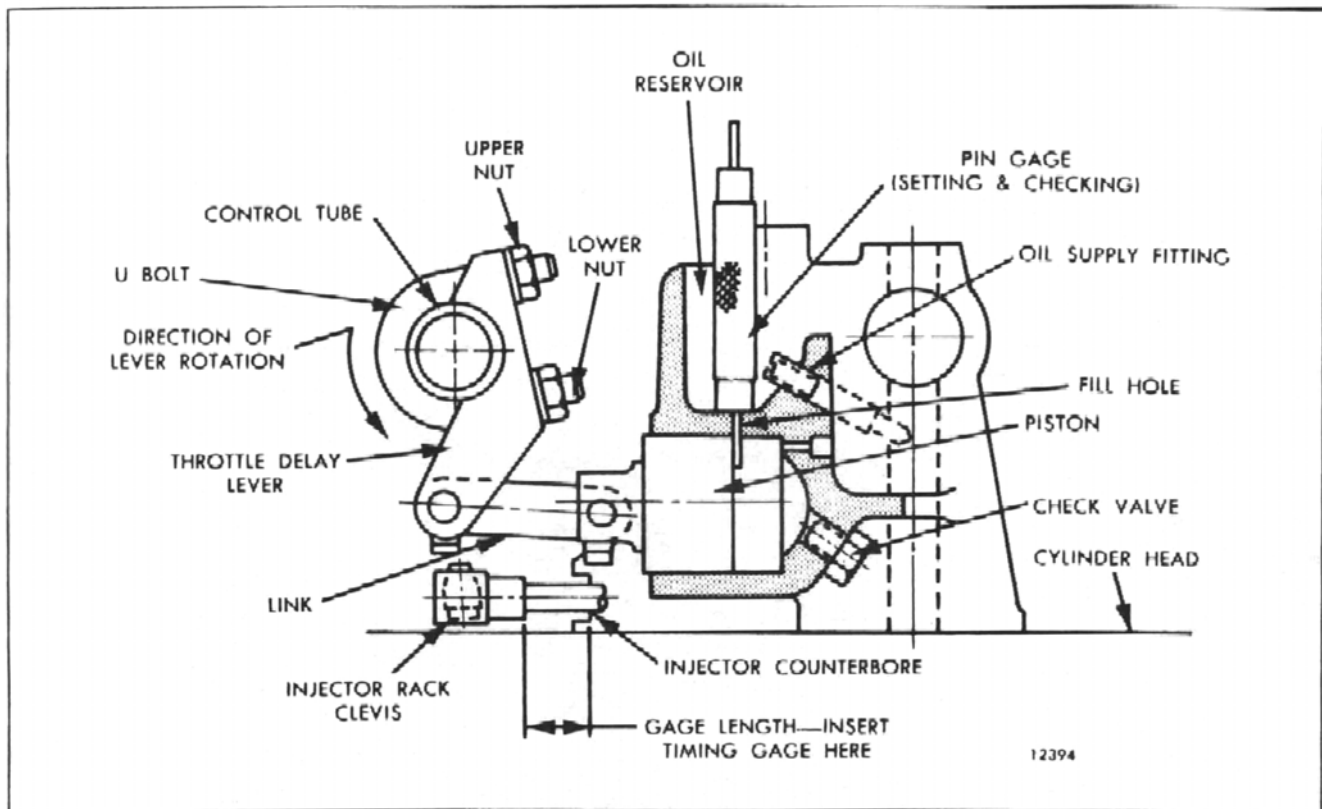


Fig. 4 – Adjusting Throttle Delay Cylinder (Current)

Check the setting as follows:

1. Remove the pin gauge. Hold the throttle towards full fuel. Reinsert the go, (small .069") end of the gauge in the fill hole. If the gauge will not go past the piston without resistance, increase the torque on the lower U- bolt nut and retry the gauge continue until the gauge just fits.
2. Reverse the pin gauge and attempt to insert the no go, (big .072") end in the fill hole. If the "no go" end of the gauge enters the fill hole past the piston without resistance, increase torque on the upper U-bolt nut. It should not be possible to insert the gauge past the piston without moving the injector racks toward the no-fuel position
3. Release the governor throttle lever and remove the timing gauge and pin gauge. If either U-bolt nut is tightened without the pin gauge being inserted, recheck the setting.
4. Move the injector control tube assembly between the no-fuel and the full-fuel position to make sure there is no bind.