GENERAL MOTORS TURBOCHARGING SYSTEM

VEHICLE APPLICATION

GENERAL MOTORS

Application	VIN Code
3.8L (231") 4-Bbl. Turbo	3

DESCRIPTION

The turbocharging system is mounted on top of the engine. It includes a turbine/compressor assembly, plenum chamber, wastegate, and carburetor. The turbine is spun by exhaust gas, and causes the compressor to draw air. Air is drawn through the carburetor and plenum chamber, into the compressor, then forced into the intake manifold.

A slightly modified 4 barrel carburetor provides air and fuel to the compressor assembly. Maximum manifold pressure (boost) is controlled by an exhaust bypass valve called a wastegate. This valve, sensing pressure differences through a diaphragm type actuator, determines how much exhaust should be routed to the turbine. Any excess exhaust gas is bypassed into the exhaust system.

OPERATION

Air is drawn in through the air cleaner and carburetor assembly. The carburetor mixes an appropriate amount of fuel with the incoming air and passes it into the compressor assembly. As load on the engine is increased and the throttle is opened, more air/fuel mixture flows into the combustion chambers. As this mixture is burned, a greater volume of hot exhaust gas enters the exhaust system. This gas is directed into the turbocharger turbine housing. Some of the energy contained in the exhaust gas is used to increase the speed of the turbine wheel. The turbine wheel is connected by a shaft to the compressor wheel. As the compressor wheel spins faster, it compresses the incoming carburetor air/fuel mixture and forces a denser charge into the combustion chambers. Higher power output is the result.

CARBURETOR & PLENUM

Carburetor is a standard 4 barrel unit with some minor modifications to throttle linkage, enrichment system and choke system. The carburetor is mounted on a plenum that leads directly to the compressor intake.

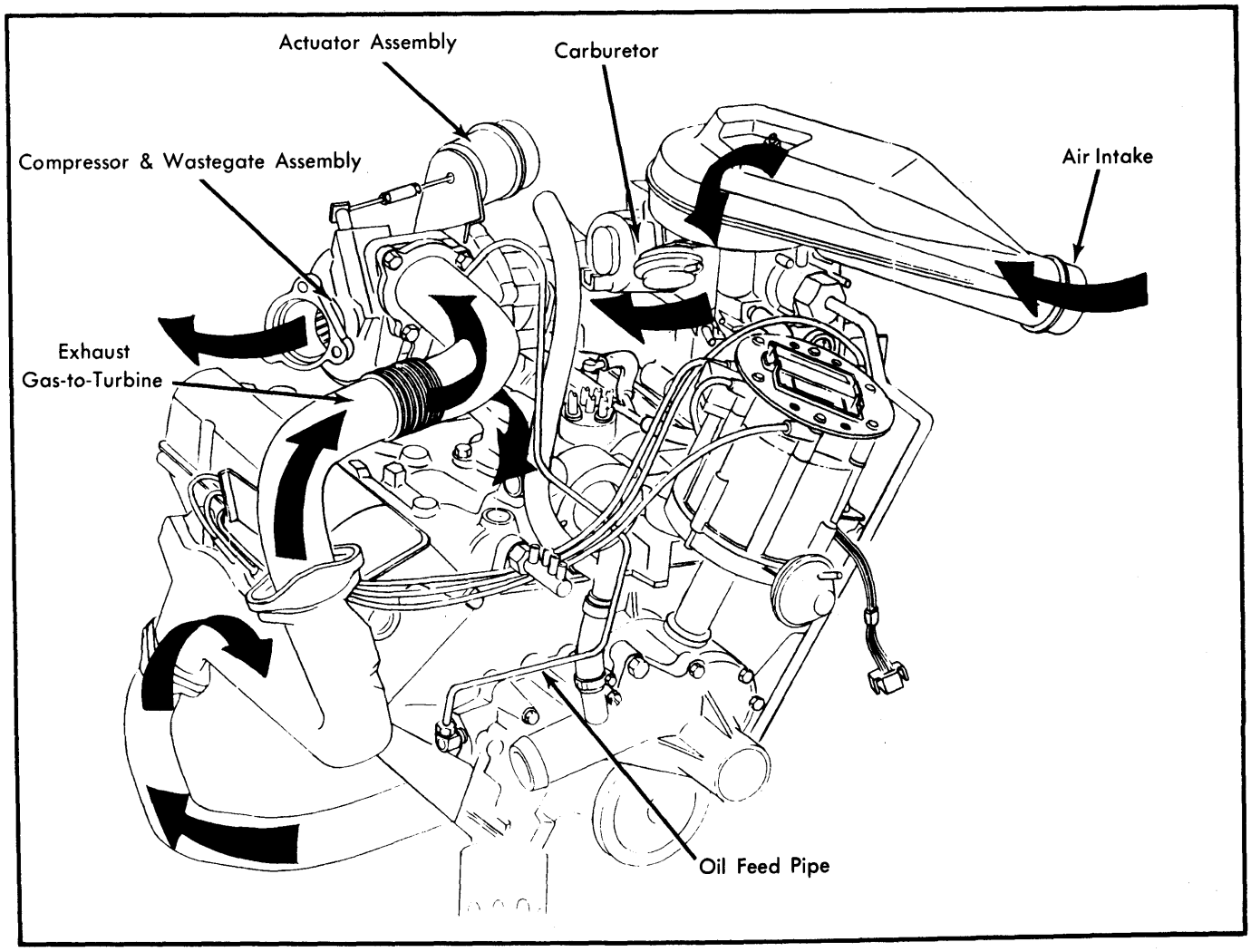

Fig. 1 Diagram Showing Air Flow Pattern For Turbocharged V6 Engine

GENERAL MOTORS TURBOCHARGING SYSTEM (Cont.)

An electric Early Fuel Evaporation (EFE) heater is used on 3.8L (231") Turbo engines. A ceramic heating grid is built into the carburetor spacer and minimizes fuel puddling during cold operation.

TURBINE ASSEMBLY

The turbine is mounted on top of the intake manifold with the compressor. It is connected to the compressor by a shaft. When the turbine wheel turns, the compressor wheel must turn. Hot exhaust gas is fed into the turbine through a pipe. The gas hitting the turbine blades, causes the blades to spin. The more exhaust gas piped to the turbine, the faster it will spin, in turn spinning the compressor faster. In this way, the turbocharger assembly can produce more power as the demand increases.

WASTEGATE & ACTUATOR

When manifold pressure (boost) reaches a certain predetermined level, there must be some method of controlling or limiting boost past that point. The wastegate performs this function. Exhaust gas is piped into the turbine continuously. Once engine demand is satisfied and the proper boost level is attained, the wastegate, acting on command from the actuator assembly, bypasses enough exhaust gas into the exhaust system to maintain required turbine speed.

The actuator is a pressure sensitive diaphragm type unit. It is installed in such a way that it can sense the pressure differential across the compressor. Once this differential reaches a certain level, the diaphragm reacts in conjunction with an internal spring, to partially open the wastegate. The wastegate is mounted to the turbine assembly.

COMPRESSOR

The compressor is connected to the turbine by a shaft. As the turbine wheel turns, so does the compressor wheel. No exhaust gas is actually passed into the compressor. The carburetor directs the air/fuel mixture into the compressor. The spinning compressor forces more air/fuel mixture into the intake manifold than would normally be drawn in under atmospheric pressure. With a higher intake manifold pressure and denser charge available, more mixture is drawn into the combustion chamber on the intake stroke of the piston. A denser mixture results in more power output from the engine. The faster the compressor spins, the more air/fuel mixture is compressed into the manifold. In this way, engine demand can be satisfied. See *Fig. 2*.

POWER ENRICHMENT VACUUM REGULATOR (PEVR)

Due to the change in engine vacuum caused by turbocharger operation, a vacuum regulator is used to control vacuum signals. The Power Enrichment Vacuum Regulator is used to direct a controlled vacuum flow to the power piston enrichment port on the carburetor. The vacuum input port is located in the center of the PEVR; the output on the perimeter of the valve. The manifold signal port extends into the intake manifold.

OIL SUPPLY

The rotating assembly, consisting of the turbine wheel, connecting shaft and compressor wheel, can reach speeds of 140,000 RPM. A sufficient supply of clean engine oil is absolutely necessary to the proper operation of the assembly. Engine oil is

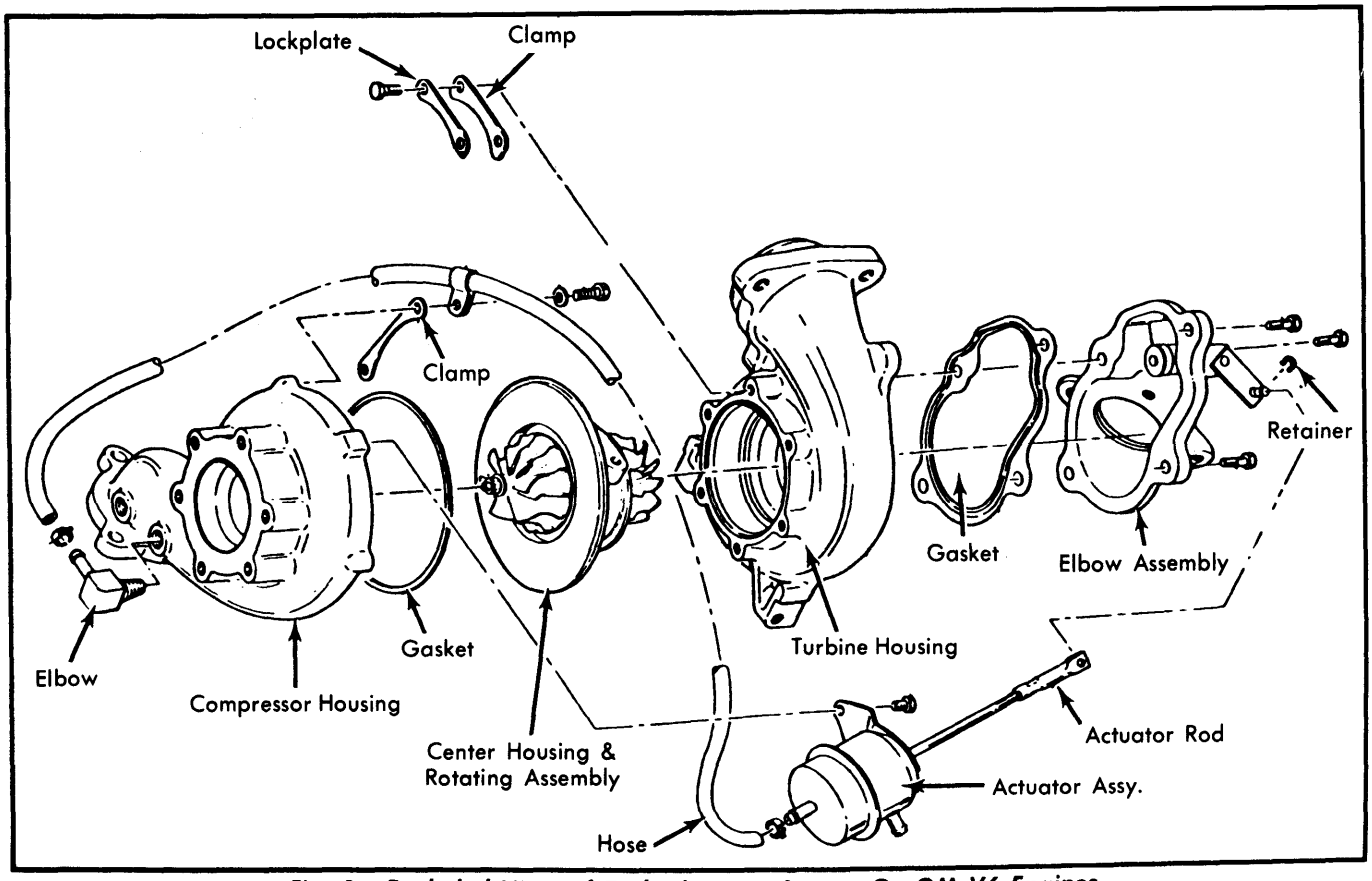

Fig. 2 Exploded View of Turbocharging System On GM V6 Engines

GENERAL MOTORS TURBOCHARGING SYSTEM (Cont.)

fed directly to the center housing rotating assembly. Any interruption or contamination of the oil will result in major turbocharger damage. An oil feed pipe runs from a fitting on the engine block to the turbocharger.

Whenever oil and filter are changed on a turbocharged engine, the oil system must be primed with oil prior to starting. This can be done (after oil and filter are correctly installed) by disconnecting pink wire (ignition switch) at H.E.I. distributor; cranking engine several times (not longer than 30 seconds at a time); and observing when oil light goes out. Reconnect the pink wire and start the engine.

Whenever the oiling system has been contaminated in any way, change oil and filter and flush turbocharger assembly with clean oil. Any time the center housing rotating assembly is replaced, in part or in whole oil and filter should be changed.

IGNITION SYSTEM

Turbocharged engines use a modified H.E.I. system called Electronic Spark Control (ESC). This system is used to control engine detonation by automatically retarding timing during periods when detonation occurs. The four major components of the system are intake manifold, detonation sensor, controller and H.E.I. distributor.

The sensor is mounted at the rear of the intake manifold. It can be recognized by the large diameter (1.12") hex shape and the single electrical connection on top. The sensor detects detonation and reports it to the ESC controller, mounted in the passenger compartment.

The controller processes the information from the detonation sensor and sends a signal to the special 5-pin HEI module. The signal delays spark timing and can retard ignition up to 22° during heavy detonation. Retarding the spark reduces detonation and possibility of engine damage.

NOTE – *For diagnosis and testing of detonation sensor and ESC system, see General Motors Electronic Spark Control in ELECTRICAL Section.*

TESTING

NOTE – *Either road test or shop test may be used to check wastegate operation. It is not necessary to perform both tests.*

WASTEGATE/BOOST PRESSURE TEST

1) Inspect wastegate and actuator assembly for linkage damage. Check condition of hose from compressor housing to actuator, then remove hose.

2) Connect a hand operated vacuum/pressure pump (J-23738) in series with compound vacuum/pressure gauge, and install in place of plenum-to-actuator hose.

3) With 3 in. Hg vacuum applied to actuator, rod should move .015". Replace actuator if not operating properly. Check new unit and crimp threads on rod to maintain proper calibration.

4) Remove test equipment. Reconnect plenum-to-actuator hose.

BOOST PRESSURE ROAD TEST

1) Install compound vacuum/pressure gauge between compressor and boost gauge or vacuum switches. Use tubing to place gauge in passenger compartment.

CAUTION – *Be sure that gauge and tubing are in good condition to prevent leakage of air/fuel mixture into vehicle while testing.*

2) Perform a wide-open throttle acceleration test from 0-50 MPH. Boost pressure should reach 8-9 psi. If not, replace actuator and retest.

POWER ENRICHMENT VACUUM REGULATOR (PEVR) TEST

1) Inspect valve and hoses for wear or damage. Replace as needed.

2) Tee one hose from manometer (J-23951) between yellow striped hose and input port. Connect other manometer hose to output port of PEVR.

3) Start engine and idle. There should be no more than 14" H_2O difference. If there is, replace PEVR.

4) If PEVR passes this test but is still suspected to be faulty, remove PEVR from manifold and plug manifold opening.

5) Connect input and output hoses back to the PEVR. Tee compound gauge (J-28474) into the output hose from PEVR.

6) Start engine and run at idle. Compound gauge reading should be 7-9 in. Hg.

7) Apply 3 psi to manifold signal port of the PEVR. Output vacuum reading should be 1.4-2.6 in. Hg.

8) Apply a minimum of 5 psi to the manifold signal port. There should be no vacuum output.

9) If PEVR does not pass both of these tests, replace with new unit.

REMOVAL & INSTALLATION

Before beginning any unit repair procedures on a turbocharging system, several general cautions should be considered.

- Clean area around turbocharger with non-caustic solution before disassembly.
- Use extreme care during removal to avoid damaging turbine blades. Any damage may result in turbocharger failure when engine is started.
- Scribe reference marks on turbine and compressor housing before disassembly to ensure correct reassembly.

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- If any joints are found to be coated with sealer, clean thoroughly and recoat with sealant during assembly.

WASTEGATE/ACTUATOR ASSEMBLY

Removal – Disconnect hoses from actuator. Remove wastegate-to-actuator rod clip. Remove 2 bolts and actuator.

Installation – To install, reverse removal procedure.

ELBOW ASSEMBLY & CENTER ASSEMBLY

Removal – 1) Disconnect turbocharger exhaust outlet pipe from elbow assembly. Raise vehicle, disconnect outlet pipe from catalytic converter, and lower vehicle. Disconnect inlet pipe from right exhaust manifold and turbine housing.

2) Remove 2 bolts securing turbine housing to intake manifold bracket. Disconnect turbocharger oil feed pipe from center housing. Remove oil drain hose from pipe.

3) Remove clip securing wastegate linkage to actuator rod. Remove 6 bolts holding backplate to compressor housing and 6 bolts holding turbine housing to center assembly.

Installation – To install, reverse removal procedure.

TURBOCHARGER & ACTUATOR ASSEMBLY

Removal – 1) Disconnect exhaust inlet and outlet pipes at turbocharger. Disconnect oil feed line from center housing, then remove linkage from carburetor.

2) Disconnect linkage bracket from plenum and remove 2 bolts securing plenum to side bracket. Disconnect fuel line and all necessary hoses. Drain cooling system and disconnect hoses from front and rear of plenum.

3) Remove power brake vacuum line, then disconnect plenum front bracket from intake manifold. Remove 2 bolts securing housing to manifold. Disconnect EGR manifold from intake manifold and plenum, then remove AIR by-pass hose from pipe.

4) Remove 3 bolts attaching compressor housing to intake manifold. Remove turbocharger and actuator, still attached to carburetor and plenum. Remove 6 bolts and turbocharger assembly. Remove oil drain from center housing.

Installation – Reverse removal procedure.

INTERNAL INSPECTION

TURBOCHARGER

1) Remove exhaust outlet pipe from elbow assembly on turbocharger.

2) Using a mirror, observe movement of wastegate while operating actuator linkage manually.

3) If wastegate fails to open or close, replace elbow assembly.

4) Remove turbocharger assembly from engine. Do not separate center housing rotating assembly from turbine housing.

5) Inspect for loose backplate-to-center housing rotating assembly bolts. Tighten if needed.

6) Gently spin compressor wheel. Replace if binding.

7) Remove oil drain from center housing. Check housing for sludging in oil drain area. If slightly dirty, clean. If heavily sludged or coked, replace center housing rotating assembly.

8) Inspect compressor wheel for signs of oil leakage. If present, replace center housing rotating assembly (CHRA).

9) Inspect compressor wheel for damage or coking. Replace as necessary.

NOTE – *If CHRA is being replaced, lubricate with clean engine oil.*

10) Inspect compressor housing (on engine) and turbine housing for gouges, nicks or distortion. Replace either housing if damaged.

11) If CHRA is not being replaced, remove turbine housing from CHRA and check bearing clearances as described in the following procedures. If clearances are correct, install oil drain and turbocharger assembly.

NOTE – *Before connecting exhaust pipe to turbocharger assembly, gently spin turbine wheel to be sure it is not binding or scraping housing.*

BEARING CLEARANCES

Journal Bearing Radial Clearance — 1) Attach dial indicator with 2" long, 1" offset extension rod contacting shaft of turbine. Insert shaft through oil outlet port. *See Fig. 3.*

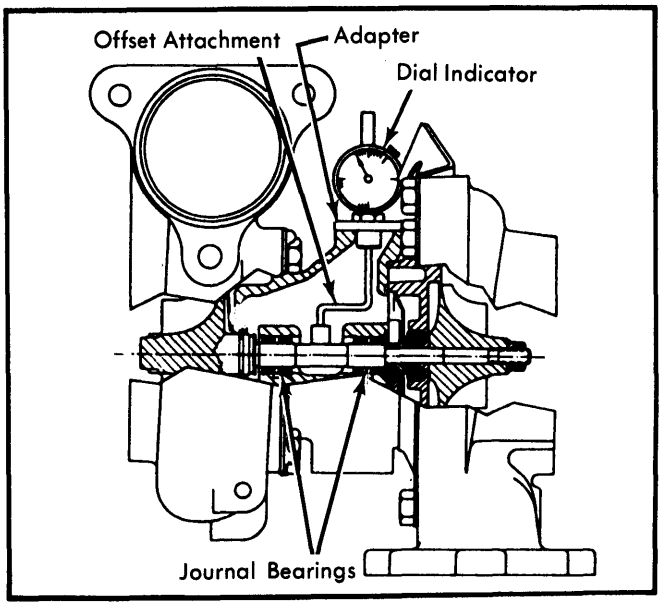

Fig. 3 Dial Indicator Installation for Measuring Journal Bearing Radial Clearance

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2) Apply finger pressure to both turbine and compressor wheels to move shaft AWAY from dial indicator plunger. Set indicator to ZERO.

3) Move shaft TOWARD dial indicator, rotating slightly to ensure it moves as far as possible. Record maximum reading. Move shaft away from indicator and check to be sure indicator moves to ZERO.

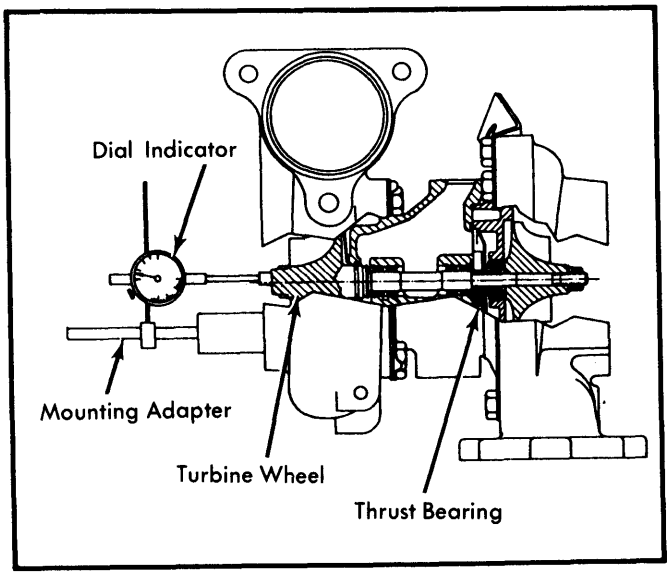

Fig. 4 Dial Indicator Installation for Measuring Thrust Bearing Axial Clearance

4) Repeat procedure to ensure clearance has been measured accurately. If not within .003-.006", replace center housing rotating assembly (CHRA) and inspect turbine and compressor housings.

CAUTION — *If turbocharger is operated with improper radial bearing clearance, severe damage may occur to housing.*

Thrust Bearing Axial Clearance — 1) Mount dial indicator on turbine end of housing so tip rests on end of turbine wheel. *See Fig. 4.*

2) Manually apply pressure to turbine shaft and move it toward and away from indicator plunger. Record maximum travel indicated.

3) Repeat procedure after rotating turbine several times. If clearance is not within .001-.003", replace CHRA and inspect housings.

TIGHTENING SPECIFICATIONS

Application	Ft. Lbs. (N·m)
Exhaust Pipe Fittings	15 (20)
CHRA-to-Housings	15 (20)
EGR Manifold-to-Intake Manifold	15 (20)
Carburetor-to-Plenum	21 (28)
Compressor-to-Plenum	21 (28)
Compressor-to-Intake Manifold	35 (48)
Detonation Sensor	14 (19)