GENERAL MOTORS TURBOCHARGING SYSTEM

VEHICLE APPLICATION

GENERAL MOTORS

Application	VIN Code
231" V6 4-Bbl.	3
301" V8 4-Bbl	T

DESCRIPTION

The General Motors turbocharging system is mounted on top of the engine near the carburetor. It is a basically simple system which routes hot exhaust gases through a turbine assembly. This assembly is connected to a compressor. As the compressor spins, it compresses the incoming air/fuel mixture fed to it by the carburetor, and thus increases intake manifold pressure. With this higher manifold pressure available, a denser mixture can be drawn into each cylinder during the intake stroke of the piston.

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.

This system provides increased power on a demand basis. It can therefore, be used on smaller engines to enable them to do the job of larger, normally aspirated engines.

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.

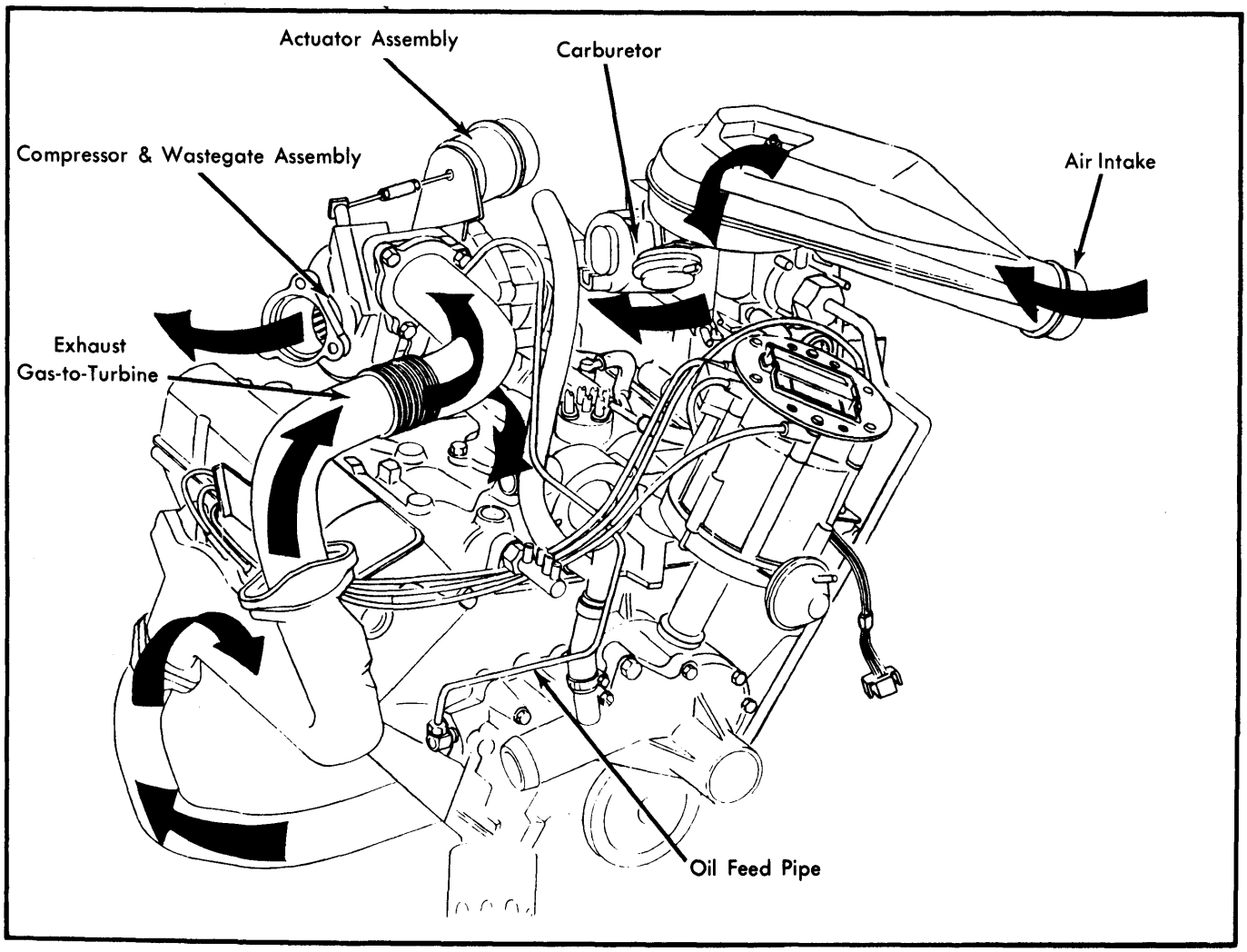

Fig. 1 Diagram Showing Air Flow Pattern For Turbocharged V6 Engine

GENERAL MOTORS TURBOCHARGING SYSTEM (Cont.)

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.

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.

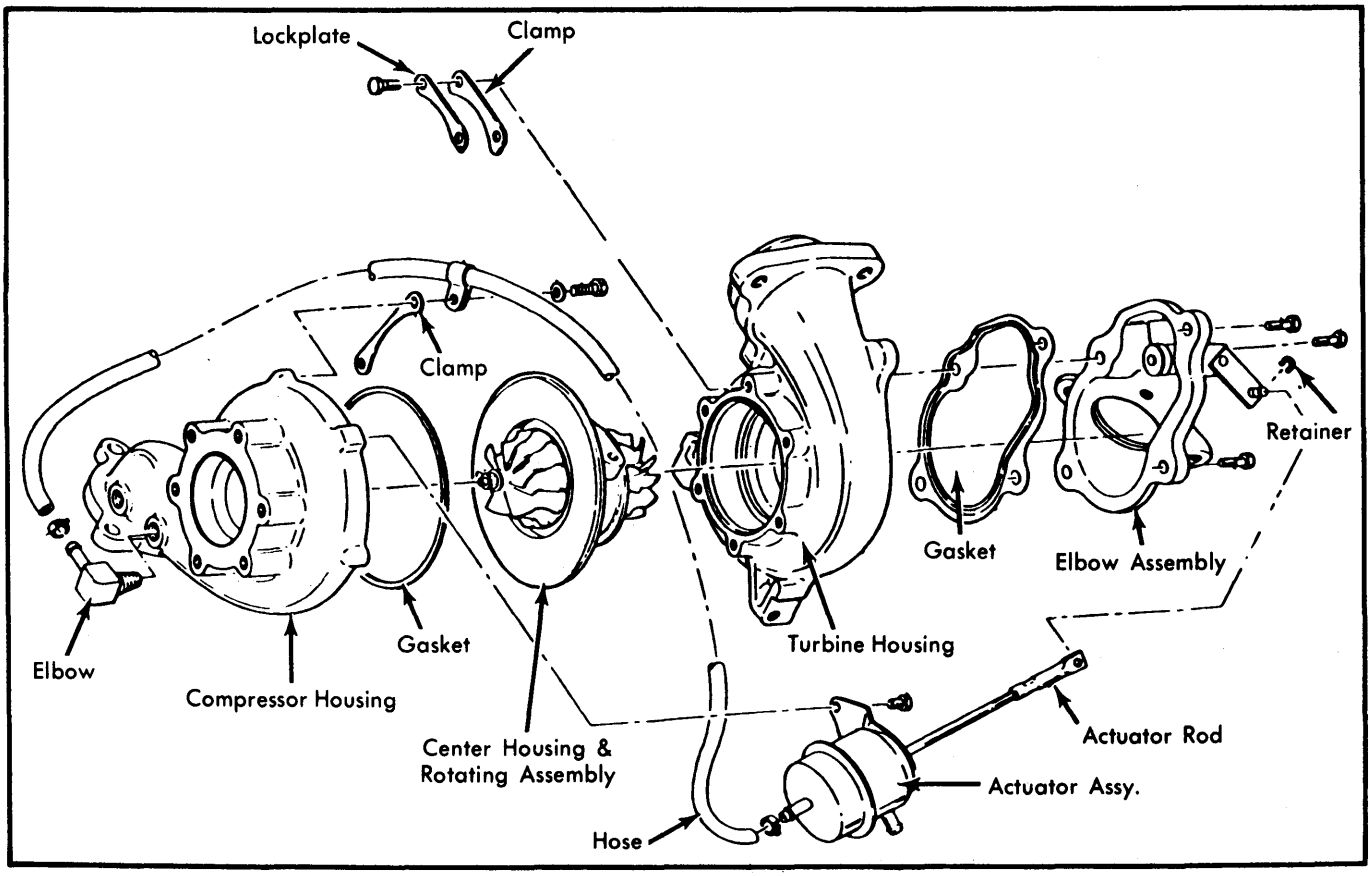

Fig. 2 Exploded View of Turbocharging System On GM V6 Engines

GENERAL MOTORS TURBOCHARGING SYSTEM (Cont.)

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 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, mounted above the thermostat housing, receives vibrations caused by detonation through the intake manifold. Presence and intensity of detonation is detected by the sensor, which feeds this information to the controller mounted on the fan shroud. The controller processes the input and sends the appropriate signal to the distributor to adjust timing. A modified electronic module on the distributor, responds to signals from the controller.

The ESC system operates continuously during engine operation. It can retard ignition timing up to 18-22° to minimize detonation levels as needed.

TESTING

WASTEGATE/BOOST PRESSURE TEST

1) Inspect wastegate-actuator assembly for any damage to mechanical linkage.

2) Inspect hose from compressor housing to actuator. Check return tubing from actuator to PCV "tee".

3) Connect hand operated vacuum/pressure pump (J-23738 or equivalent) in series with compound gauge (J-28474) to actuator assembly. This assembly will replace compressor-to-actuator hose. See *Fig. 2*.

4) With pressure being applied to actuator, actuator rod should move .015" at 8.5 to 9.5 psi. This actuates the wastegate linkage.

5) Replace actuator assembly if not within specifications. Recheck opening pressure. Crimp threads on rod to maintain proper calibration.

6) Remove test equipment. Reinstall hose from compressor to actuator.

BOOST PRESSURE ROAD TEST

1) Install compound gauge (J-28474 or equivalent) into tubing between compressor and boost gauge switches. Use a "tee" fitting and suitable length of hose to place gauge in passenger compartment. See *Fig. 3 and 4*.

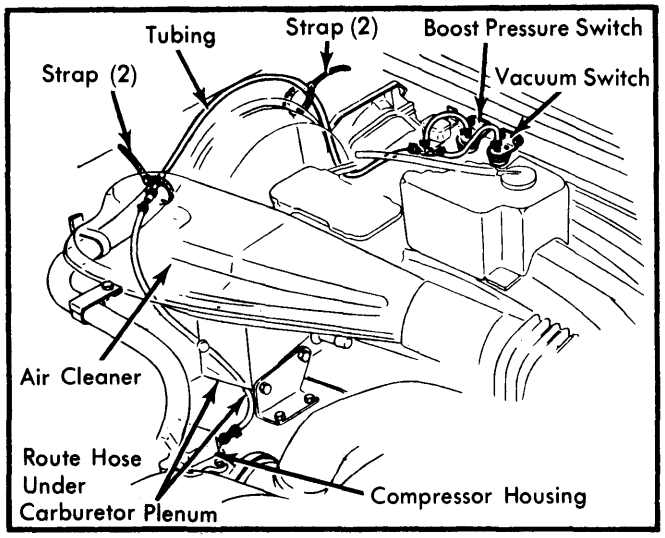

Fig. 3 Boost Gauge Switch Location On Buick Century & Regal Models

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

2) Perform a 0-to-40 or 50 mph wide open acceleration and maintain top speed reached for 2 or 3 seconds.

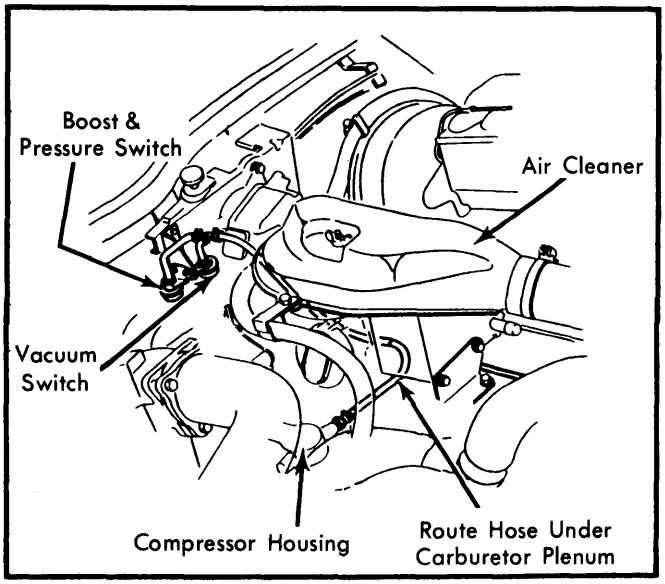

Fig. 4 Boost Gauge Switch Location on Buick LeSabre and Estate Wagon

GENERAL MOTORS TURBOCHARGING SYSTEM (Cont.)

3) Boost pressure should reach 9 to 10 psi.

4) If not within specifications, replace actuator assembly and recheck. Refer to Wastegate/Boost Pressure Test in this article.

POWER ENRICHMENT VACUUM REGULATOR TEST (PEVR)

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 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.

- **a.** Be sure area around turbocharger is cleaned with a non-caustic solution before assembly removal.
- **b.** Use extreme care when removing turbocharger assembly not to damage compressor or turbine wheel blades. Any damage to blades causing an imbalance may result in severe part failure.
- **c.** Scribe marks on compressor or turbine housing when removing center housing rotating assembly. This will aid reassembly in the same relative positions.
- **d.** If silastic sealer, or equivalent, is found at any point in turbocharger disassembly, area should be cleaned and sealed with an equivalent sealer during assembly.

WASTEGATE/ACTUATOR ASSEMBLY

Removal – **1)** Disconnect 2 hoses from actuator.

2) Remove wastegate linkage-to-actuator rod clip.

3) Remove 2 attaching bolts and remove actuator from housing.

Installation – Reverse removal procedure.

TURBINE HOUSING, COMPRESSOR & ELBOW ASSEMBLY

Removal – **1)** Disconnect turbocharger exhaust outlet pipe from elbow assembly.

2) Raise vehicle.

3) Disconnect turbocharger exhaust outlet pipe from catalytic converter and lower vehicle.

4) Disconnect exhaust inlet pipe from turbine housing.

5) Disconnect exhaust inlet pipe from right exhaust manifold.

6) Remove 2 bolts securing turbine housing to intake manifold bracket.

7) Disconnect oil feed pipe from center housing rotating assembly. Remove oil drain hose from oil drain pipe.

8) Remove wastegate linkage-to-actuator rod clip.

9) Remove 6 bolts and 3 clamps securing center housing rotating assembly backplate to compressor housing.

NOTE – *Be sure to scribe locating marks for reassembly.*

10) Remove 6 bolts attaching compressor housing to plenum.

11) Remove boost gauge hose and clamp from compressor housing.

12) Remove 3 bolts securing compressor housing to intake manifold.

Installation – **1)** Install 3 bolts to secure compressor housing to intake manifold.

2) Install boost gauge hose to compressor housing and secure with clamp.

3) Install 6 bolts securing compressor housing to plenum.

4) Align center housing rotating assembly backplate to compressor housing. Install 3 clamps and 6 bolts.

5) Install wastegate linkage-to-actuator rod clip.

6) Connect oil feed pipe to center housing rotating assembly. Install oil drain hose to oil drain pipe.

7) Install 2 bolts securing turbine housing to bracket on manifold.

8) Connect exhaust inlet pipe to right exhaust manifold.

9) Connect exhaust inlet pipe to turbine housing.

10) Raise vehicle and connect exhaust outlet pipe to catalytic converter.

11) Lower vehicle and connect exhaust outlet pipe to elbow assembly.

GENERAL MOTORS TURBOCHARGING SYSTEM (Cont.)

TURBOCHARGER & ACTUATOR ASSEMBLY

Removal – 1) Disconnect exhaust inlet and outlet pipes at turbocharger.

2) Disconnect oil feed pipe at center housing.

3) Remove air intake elbow and flex tube from carburetor.

4) Disconnect accelerator, cruise control and detent linkages at carburetor. Disconnect bracket from plenum.

5) Remove 2 bolts securing plenum to side bracket.

6) Disconnect fuel line and all necessary hoses.

7) Drain cooling system and disconnect coolant hoses at front and rear of plenum.

8) Unhook power brake vacuum line at plenum.

9) Disconnect plenum front bracket from intake manifold and leave attached to plenum.

10) Remove 2 bolts securing turbine housing to manifold.

11) Disconnect EGR valve manifold from intake manifold and plenum (4 bolts).

12) Remove AIR bypass hose at pipe.

13) Remove 3 compressor-to-manifold bolts.

14) Remove turbocharger and actuator, still attached to carburetor and plenum assembly. Disconnect hoses as necessary.

15) Remove 6 bolts securing turbocharger and actuator to plenum and carburetor.

16) Remove oil drain from center housing rotating assembly.

Installation – 1) Install oil drain to center housing.

2) Install 6 bolts securing turbocharger and actuator to plenum and carburetor.

3) Position assembly in place on engine. Connect vacuum hoses as removed.

4) Install 3 bolts securing compressor housing to manifold.

5) Install AIR bypass hose to pipe and tighten clamp.

6) Install 2 bolts attaching EGR valve manifold to plenum loosely. Install and tighten 2 bolts securing EGR manifold to intake manifold. Now tighten the 2 plenum bolts.

7) Install 2 bolts securing turbine housing to intake bracket.

8) Install 1 bolt securing plenum front bracket to intake manifold.

9) Connect power brake vacuum line and coolant hoses to plenum. Refill cooling system.

10) Connect fuel line and vacuum hoses as removed.

11) Secure plenum to side bracket (2 bolts).

12) Attach linkage bracket to plenum. Install detent, cruise and accelerator linkages at carburetor.

13) Install air intake elbow to carburetor (1 nut).

14) Connect exhaust inlet and outlet pipes.

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. Check journal bearing radial clearance and thrust bearing axial clearance as follows:

Journal Bearing Radial Clearance

a. Attach dial indicator with 2" long, ¾ to 1" offset extension rod to center housing. Install so that plunger extends through oil outlet port and touches shaft of rotating assembly.
b. If required, a dial indicator mounting adapter can be utilized. See *Fig. 5*.
c. Manually apply equal pressure to both compressor and turbine wheels to move shaft AWAY from dial indicator plunger as far as possible. Set indicator to ZERO.

GENERAL MOTORS TURBOCHARGING SYSTEM (Cont.)

d. Manually apply equal pressure to both compressor and turbine wheels to move shaft TOWARD dial indicator plunger as far as possible. Record maximum reading on indicator gauge.

NOTE – *Be sure that indicator reading is maximum possible. This can be verified by rolling the wheels slightly in both directions while applying pressure.*

e. Manually apply equal pressure to both wheels to move shaft AWAY from dial indicator plunger. Note that gauge should return to ZERO.

f. Repeat procedure until positive that maximum reading has been obtained. If maximum bearing radial clearance is not within .003-.006", replace center housing rotating assembly (CHRA) and reinspect housings.

CAUTION – *If turbocharger is operated with improper bearing radial clearance, severe damage will result to compressor wheel and housing and turbine wheel and housing.*

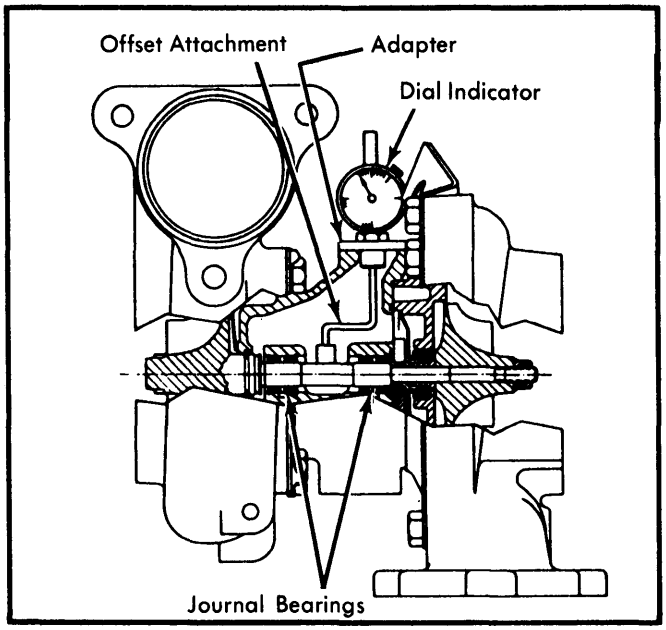

Fig. 5 Checking Journal Bearing Clearance With Dial Indicator

Thrust Bearing Axial Clearance

a. Mount dial indicator at turbine end of turbocharger so that indicator tip rests on end of turbine wheel. *See Fig. 6.*

b. Manually apply pressure to move compressor and turbine wheel assembly toward and away from plunger. Record travel of shaft as shown on indicator.

c. Repeat procedure as required to be sure that maximum clearance is obtained between thrust components.

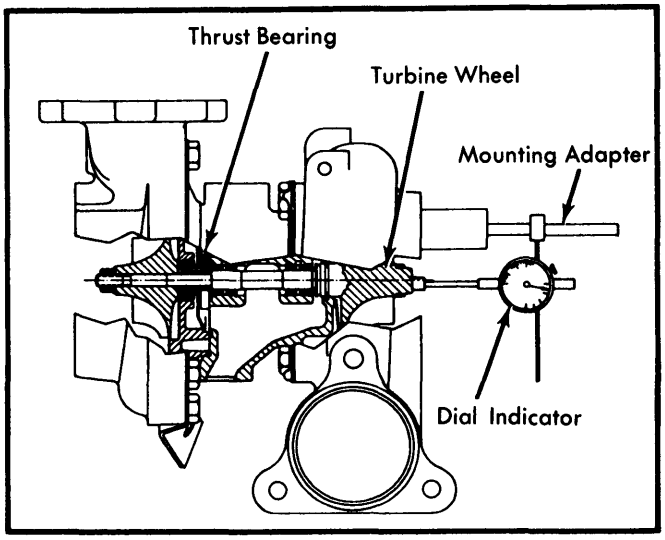

Fig. 6 Checking Thrust Bearing Axial Clearance With Dial Indicator

d. Maximum clearance must be .001-.003". If not within specifications, replace CHRA and inspect housings.

12) Install oil drain on CHRA.

13) Install turbocharger assembly on engine.

NOTE – *Prior to connecting exhaust outlet pipe to elbow assembly, gently spin turbine wheel to be sure that rotating assembly does not bind.*

TIGHTENING SPECIFICATIONS

Application	Ft. Lbs.
Ex. Outlet Pipe-to-Elbow	14
Elbow-to-Compressor Assy.	15
Ex. Inlet Pipe-to-Turbine	14
Ex. Inlet Pipe-to-Rt. Manifold	14
Oil Feed Pipe-to-Fitting	13
Oil Feed Pipe Fitting-to-CHRA	7
CHRA-to-Turbine Hsg.	15
CHRA Backplate-to-Compressor	13
Compressor-to-Plenum	20
Compressor-to-Intake Manifold	35
Oil Drain-to-CHRA	15
EGR Valve-to-EGR Manifold	15
EGR Manifold-to-Intake Manifold	15
EGR Manifold-to-Plenum	15
ESC Detonation Sensor	14
Carburetor-to-Plenum	21
PEVR-to-Intake Manifold	25
Fuel Line-to-Carburetor	20