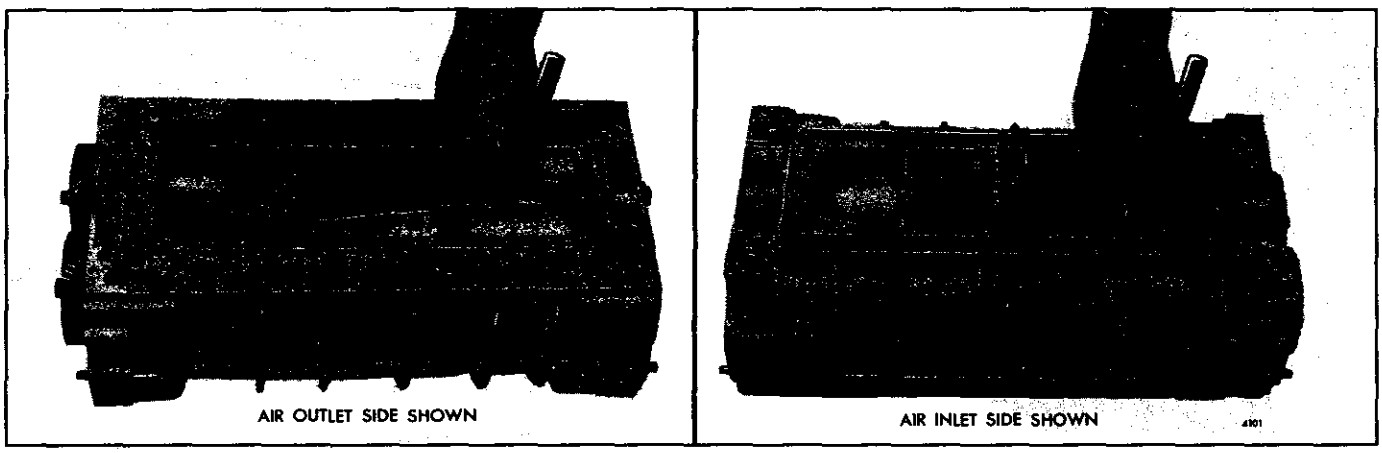
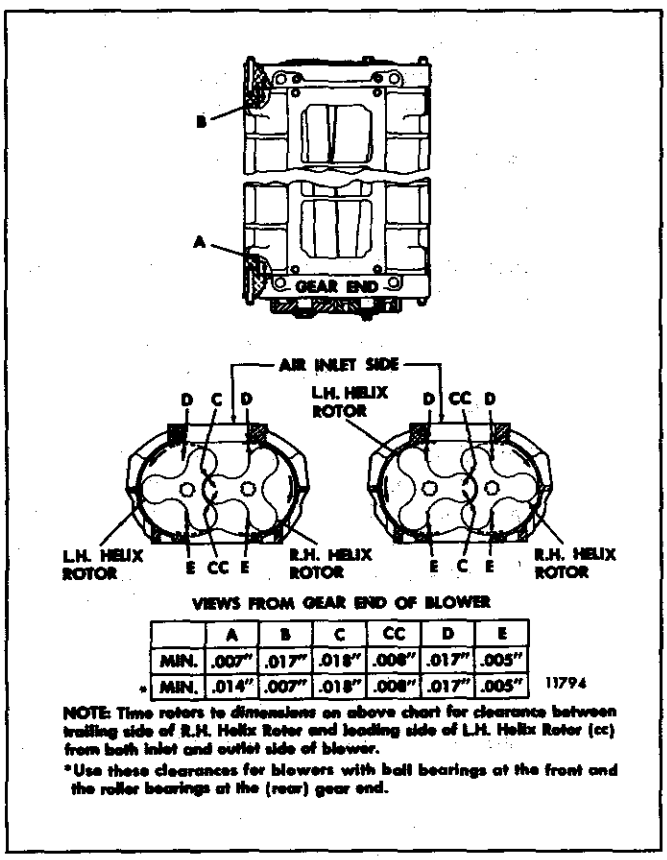


Fig. 18 – Measuring Clearance Between Blower Rotor Lobes



	A	B	C	CC	D	E
MIN.	.007"	.017"	.018"	.008"	.017"	.005"
* MIN.	.014"	.007"	.018"	.008"	.017"	.005"

11794

NOTE: Time rotors to dimensions on above chart for clearance between trailing side of R.H. Helix Rotor and leading side of L.H. Helix Rotor (cc) from both inlet and outlet side of blower.

*Use these clearances for blowers with ball bearings at the front and the roller bearings at the (rear) gear end.

Fig. 19 – Chart of Minimum Blower Clearances

Timing Blower Rotors

After the blower rotors and rotor gears are installed, the blower rotors must be timed.

1. The blower rotors, when properly positioned in the housing, run with a slight clearance between the lobes. This clearance may be varied by moving one of the helical gears in or out on the shaft relative to the other gear.
2. If the left–hand helix gear is moved out, the right–hand helix rotor will turn clockwise when viewed from the gear end. If the right–hand helix gear is moved out, the left–hand helix rotor will turn counterclockwise when viewed from the gear end. This positioning of the gear, to obtain the proper clearance between the rotor lobes, is known as blower timing.
3. Moving the gears *out* or *in* on the rotor shafts is accomplished by adding or removing shims between the gears and the bearings.
4. The clearance between the rotor lobes may be checked with 1/2" wide feeler gages in the manner shown in Fig. 18. When measuring clearances of more than .005", laminated feeler gages that are made up of .002", .003" or .005" feeler stock are more practical and suitable than a single feeler gage. Clearances should be measured from both the inlet and outlet sides of the blower.
5. A specially designed feeler gage set J 1698–02 for the blower clearance operation is available. Time the rotors as follows:
   a. Time the rotors to pass an .008" feeler gage at the closest point between the *trailing* edge of the right–hand helix rotor and the *leading* edge of the left–hand helix rotor ("CC" clearance) measured from both the inlet and outlet sides as shown in Figs. 18 and 21.
   b. Then check the clearance between the *leading* edge of the right–hand helix rotor and the *trailing* edge of the left–hand helix rotor ("C" clearance) for the minimum clearance of .018". Rotor–to–rotor measurements should be taken 1" from each end and at the center of the blower.
6. After determining the amount one rotor must be revolved to obtain the proper clearance, add shims back of the proper gear as shown in Fig. 20 to produce the desired result. When more or less shims are

required, both gears must be removed from the rotors. Placing a .003" shim in back of a rotor gear will revolve the rotor .001".

7. Install the required thickness of shims back of the proper gear and next to the bearing inner race and reinstall both gears. Recheck the clearances between the rotor lobes.

8. Determine the minimum clearances at points "A" and "B" shown in Fig. 19. Insert the feeler gages, as shown in Fig. 21, between the end plates and the ends of the rotors. This operation must be performed at the ends of each lobe, making 12 measurements in all. Refer to Fig. 19 for the minimum clearances.

9. Check the clearance between each rotor lobe and the blower housing at both the inlet and outlet side — 12 measurements in all. Refer to Fig. 19 for the minimum clearances.

Attach Accessories to Blower

On the former blowers, the drive hub is attached to the left–hand helix gear with four bolts. On the current blowers, a new drive hub is used with three bolt holes and utilizing two steel plates. The plates are bolted between the left–hand helix rotor drive gear and the drive hub to provide a flexible drive connection.

On former blowers, the right–hand helix rotor gear is separately interchangeable, but the current drive hub and attaching parts must be included to replace the left–hand helix rotor gear.

1. On the former blower, attach the blower drive hub to the left–hand helix rotor gear with four bolts. On the current blower, bolt two steel plates between the left–hand helix rotor drive gear and the drive hub. Tighten the bolts to 15–19 lb–ft (20–26 N·m) torque.

2. If removed, install a new blower drive hub oil seal (former blower) in the groove in the outside diameter of the drive hub.

3. Attach the blower drive support assembly to the blower assembly as follows:

   a. Affix a new gasket to the blower rear end plate. Then place the blower drive support assembly over the two dowel pins in the rear end plate and against the gasket.

   b. Attach the blower drive support assembly to the rear end plate with six bolts, lock washers, plain washers and one socket head bolt. Tighten the bolts to 20–24 lb–ft (27–33 N·m) torque.

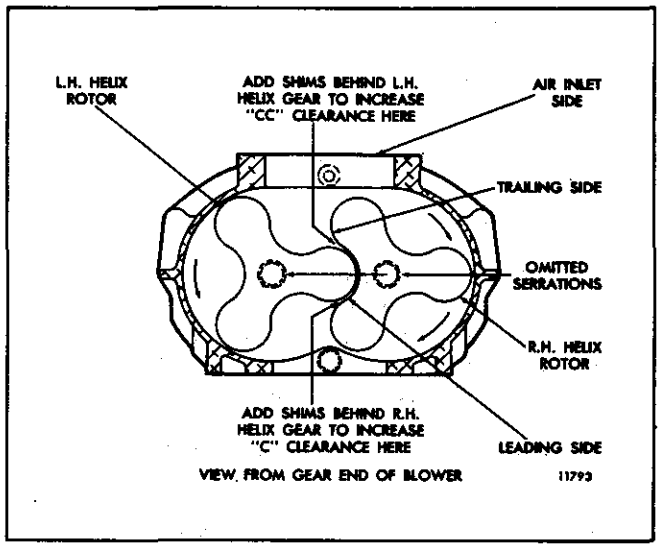


Fig. 20 – Diagram Showing Proper Location of Shims for Correct Rotor Lobe Clearances

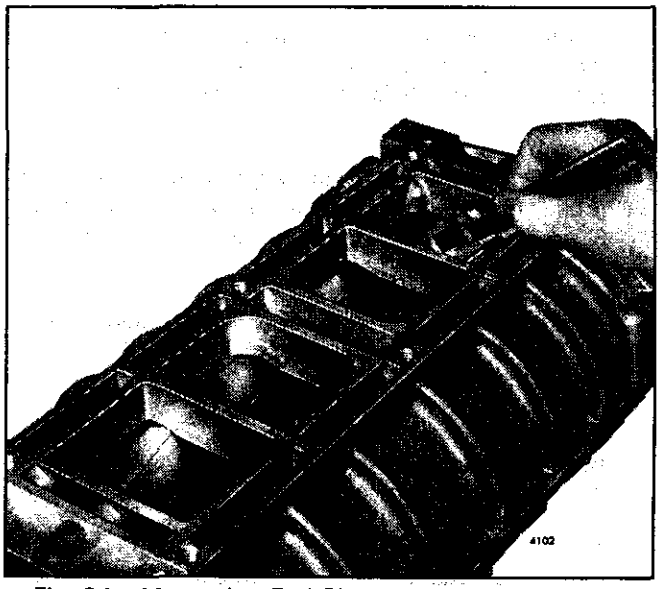


Fig. 21 – Measuring End Clearance Between Blower Rotors and End Plate

4. Attach the governor assembly to the blower assembly as follows:

   a. Affix a new gasket to the blower front end plate.

   b. Position the governor assembly in front of the blower, then start the weight shaft straight into the end of the rotor shaft. If necessary, rotate the weight shaft or rotor shaft to align the splines. Now push the governor assembly on the dowel pins in the end plate and against the gasket.

   c. Attach the governor to the front end plate with seven bolts and copper washers (two bolts inside and five outside). Tighten the bolts to 20–24 lb–ft (27–33 N·m) torque.

Install Blower

1. Affix a new governor housing gasket (83), Fig. 10, to the cylinder block.
2. Affix a new blower drive support housing gasket (84) to the cylinder block. Also affix a new gasket to the cylinder block rear end plate.

   NOTICE: Use Scotch Grip Rubber adhesive No. 1300, or equivalent, on the governor housing and blower drive support housing gaskets to prevent them from slipping when the blower assembly is lowered into position.

3. Place the blower housing–to–cylinder block seal ring in the groove in the top of the cylinder block.
4. If removed, place a fuel rod cover tube hose and clamp on each fuel rod cover tube at the side of each cylinder head.
5. Thread eyebolts in two diagonally opposite tapped holes in the top of the blower housing. Then attach a rope sling and a chain hoist to the eyebolts as shown in Fig. 4.
6. Lift the blower assembly at a slight angle and position it over the top of the cylinder block. Then lower the assembly on the cylinder block and mesh the blower drive gear with the camshaft gear.
7. Install two 7/16"–14 x 7–1/2" bolts and special washers in each blower end plate. Tighten the bolts to 55–60 lb–ft (75–81 N·m) torque.
8. Install the two 7/16"–14 x 7/8" governor housing–to–cylinder block bolts and copper washers. Tighten the bolts to 46–50 lb–ft (62–68 N·m) torque.
9. Install the five blower drive support housing–to–engine end plate bolts, lock washers and one plain washer. Tighten the bolts to 20–24 lb–ft (27–33 N·m) torque.

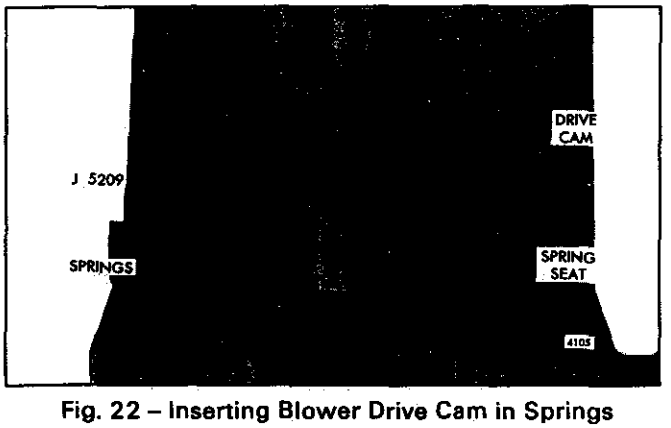


Fig. 22 – Inserting Blower Drive Cam in Springs

10. If disassembled, install the springs and blower drive cam in the two blower drive coupling supports as follows:
    a. Place the drive spring supports on a bench. Then place the drive spring seats inside the support.
    b. Lubricate the springs with engine oil. Then place the spring packs, consisting of 15 leaves per pack, in between the spring seats as shown in Fig. 22.
    c. Place the second drive spring support on top of the first drive spring support, then install the spring seats and spring packs in the second support as outlined in Steps "a" and "b" above.
    d. Place the two drive spring supports, with springs, over a small opening in the bed of an arbor press so the spring seats and the ends of the spring packs will rest on the bed of the arbor press.
    e. Place the blower drive cam, the protruding end of the cam down, over the end of the installer J 5209. Insert the tapered end of the installer in between the spring packs and under the ram of the press, then press the cam into place between the spring packs as shown in Fig. 22. Catch the installer by hand after it passes through the spring packs.
11. Attach the blower drive coupling supports to the blower drive gear as follows:
    a. Insert the blower drive coupling supports through the opening in the rear face of the flywheel housing, with the protruding end of the drive cam facing the drive shaft (Fig. 1).
    b. Align the bolt holes in the supports with the holes in the blower drive gear, then thread two bolts with flat washers in two diametrically opposite holes, finger tight only. Install the two remaining bolts finger tight only.
    c. Insert the blower drive shaft, flat end first, through the blower drive cam and into the blower drive hub. Then tighten the two bolts with the flat washers to 8–10 lb–ft (11–14 N·m) torque.
    d. Check the blower drive shaft for alignment and freeness by sliding the shaft in and out of the splines in the drive hub and cam. If the drive shaft binds, loosen the two bolts with flat washers and move the blower drive support coupling slightly and retighten the bolts.
    e. Remove the two bolts without the flat washers. Place the blower drive shaft retainer against the

end of the blower drive support, then install the two bolts and tighten them to 8–10 lb–ft (11–14 N·m) torque.

12. Affix a new gasket to the blower drive gear hole cover, then place the cover in position against the flywheel housing and install the five bolts and lock washers. Tighten the 5/16"–18 bolts to 13–17 lb–ft (18–23 N·m) torque and the 3/8"–16 bolt to 20–24 lb–ft (27–33 N·m) torque.

13. Slide the fuel rod cover tube hoses up on the cover tubes in the governor housing and tighten the hose clamps.

14. Install the governor fuel rods and connect them to the governor and injector rack control levers.

15. Place the governor cover on the governor housing and secure it in place with eight screws and lock washers.

16. Connect the fuel oil supply line to the fuel oil pump and the fuel oil filter.

17. Connect the fuel oil supply and return lines to the fuel manifold fittings in the cylinder heads.

18. Place the water by–pass tube with seal rings and flanges in between the two thermostat housings and secure it in place with four bolts and lock washers. Tighten the bolts to 7–9 lb–ft (10–12 N·m) torque.

19. Connect the blower housing breather tube and hose to the breather housing with a hose clamp, then attach the tube clamp at the lower end of the tube to one of the water pump attaching bolts.

20. Attach the air compressor (if used) to the engine flywheel housing as follows:

    a. Affix a new gasket to the bolting flange of the air compressor.

    b. Install the air compressor drive coupling in the drive plate attached to the rear face of the camshaft gear.

    c. Place the air compressor in position at the rear of the flywheel housing and guide the teeth on the drive coupling into the teeth in the drive plate on the air compressor, then push the air compressor against the flywheel housing. If necessary, rotate the crankshaft to align the teeth of the drive coupling and the drive plate.

    d. Install the four bolts and lock washers and tighten them to 71–75 lb–ft (96–102 N·m) torque.

    e. Connect the water inlet and outlet tubes to the air compressor. Then connect the oil supply line to the air compressor and the cylinder block.

21. If removed, attach the battery–charging generator mounting bracket to the top of the governor housing with four bolts and lock washers. Tighten the bolts to 30–35 lb–ft (41–47 N·m) torque.

22. Attach the battery–charging generator to the mounting bracket. Install the generator drive belts, then tighten the generator mounting bolts and adjust the drive belt tension.

23. Use new gaskets and install a valve rocker cover on each cylinder head.

24. Attach a valve rocker cover breather tube to each rocker cover with a hose clamp, then secure the breather tube clamp at the lower end of each tube to the flywheel housing.

25. Place the blower screen and gasket assembly in position on top of the blower, with the screen side of the assembly toward the blower. Then place the air inlet adaptor on the blower screen. Install the six bolts and lock washers and tighten them to 16–20 lb–ft (22–27 N·m) torque.

26. Affix a new gasket to the top of the air inlet adaptor, then place the air shutdown housing on top of the gasket. Install the six bolts and lock washers and tighten them to 16–20 lb–ft (22–27 N·m) torque.

27. Connect the throttle control rods to the governor levers.

28. Attach any other accessories that were removed from the engine.

29. Adjust the governor and injector rack control levers as outlined in Section 14. Check for and repair any coolant or oil leaks detected when performing the tune–up.

TURBOCHARGER (AIRESEARCH)

TE0675 TURBOCHARGER

The TE0675 turbocharger (Figs. 1 and 2) is designed to increase engine efficiency and power output. Power to drive the turbocharger is extracted from the waste energy in the engine exhaust gas.

The turbocharger consists of a radial inward flow turbine wheel and shaft, a centrifugal compressor wheel, and a center housing which serves to support the rotating assembly, bearings, seals, turbine housing and compressor housing. The center housing has connections for oil inlet and outlet fittings.

The turbine wheel is located in the turbine housing and is mounted on one end of the turbine shaft. The compressor wheel is located in the compressor housing and is mounted on the opposite end of the turbine wheel shaft to form an integral rotating assembly.

The rotating assembly consists of the turbine wheel and shaft assembly, piston ring(s), thrust spacer, compressor wheel and wheel retaining nut. The rotating assembly is supported on two pressure lubricated bearings which are retained in the center housing by retaining rings. Internal oil passages are drilled in the center housing to provide lubrication to the turbine wheel shaft bearings and thrust collar, thrust bearing, piston ring(s) and thrust spacer.

The oil is sealed off from the compressor and the turbine by seal arrangements at both ends of the center housing. Oil drains from the center housing by gravity.

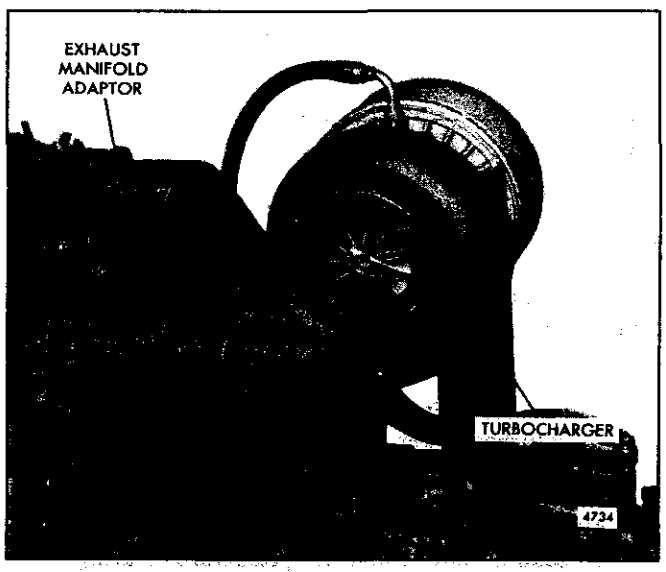


Fig. 1 – Turbocharger Mounting

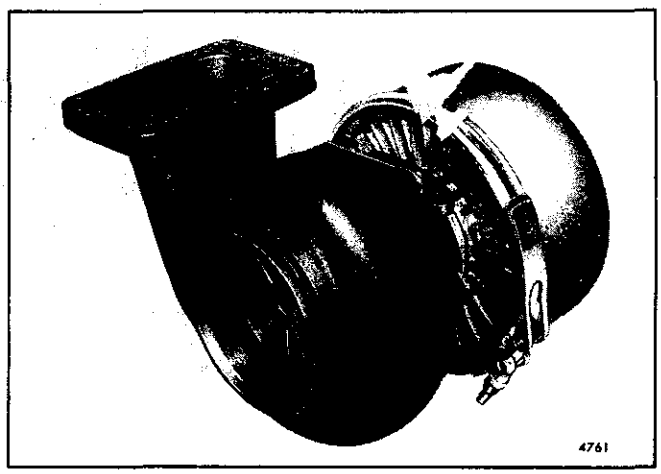


Fig. 2 – Turbocharger Assembly

The turbine housing is a heat resistant alloy casting which encloses the turbine wheel and provides a flanged engine exhaust gas inlet and an axially–located turbocharger exhaust gas outlet. The turbine housing is bolted to the turbine end of the center housing, thus providing a compact and vibration free assembly.

The compressor housing which encloses the compressor wheel provides an ambient air inlet and a compressed air discharge outlet. The compressor housing is bolted to the compressor end of the center housing backplate assembly with a "V" band coupling.

Operation

The turbocharger is mounted on the exhaust outlet flange of the engine exhaust manifold. After the engine is started, the exhaust gases flowing from the engine and through the turbine housing cause the turbine wheel and shaft to rotate (Fig. 3). The gases are discharged into the atmosphere after passing through the turbine housing.

The compressor wheel, which is mounted on the opposite end of the turbine wheel shaft, rotates with the turbine wheel. The compressor wheel draws the ambient air into the compressor housing, compresses it and delivers it to the engine blower.

During operation, the turbocharger responds to the engine load demands by reacting to the flow of the engine exhaust gases. As the engine power output increases or decreases, the turbocharger responds to the engine's demand to deliver the required amount of air under all conditions.

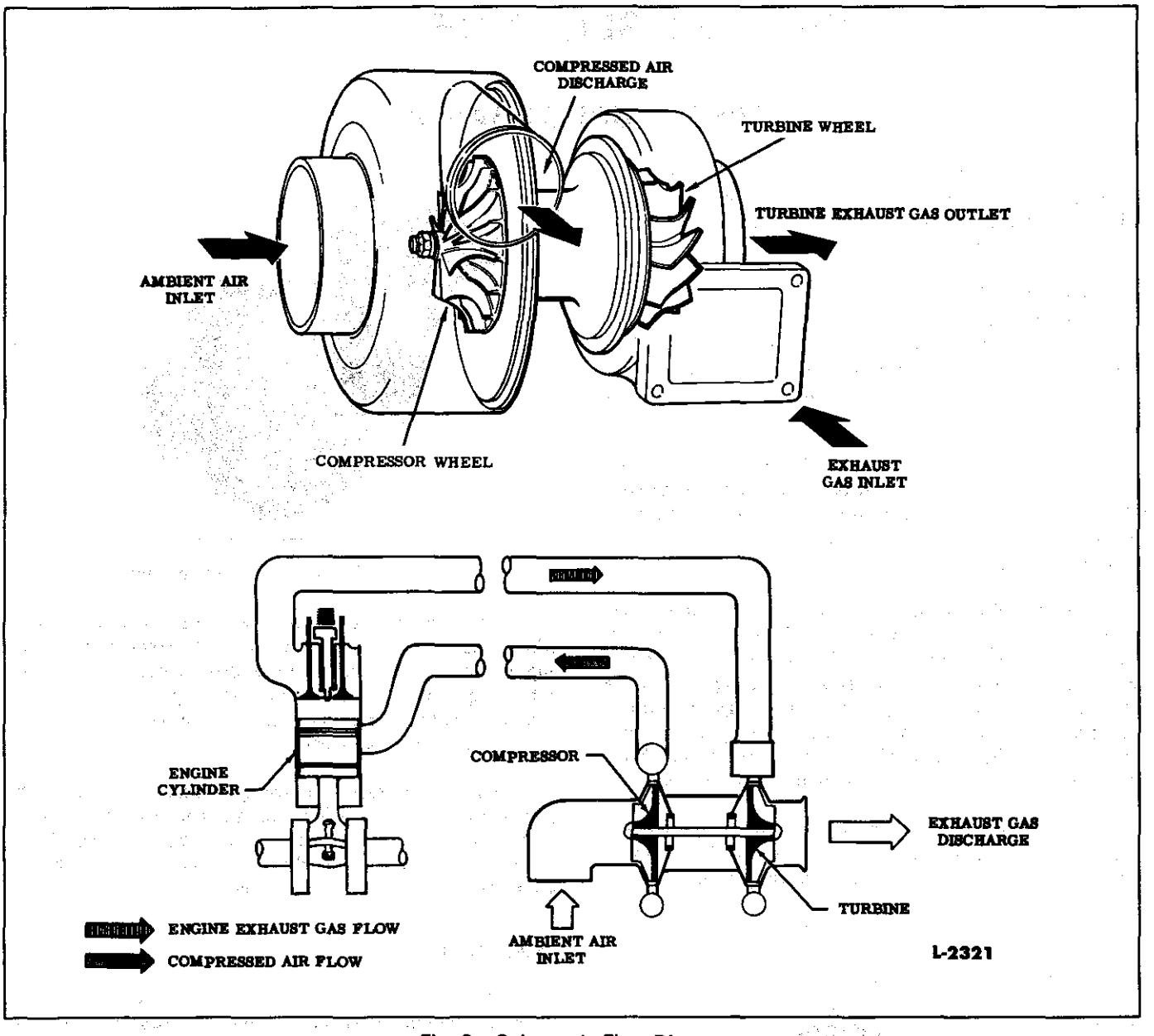


Fig. 3 – Schematic Flow Diagram

Certain engines are equipped with an intercooler to reduce the temperature of the discharge air from the turbocharger before it enters the engine blower (Section 3.5.2).

Lubrication

Lubricating oil for the turbocharger is supplied under pressure through an external oil line extending from the engine cylinder block to the top of the center housing. From the oil inlet in the center housing, the oil flows through the drilled oil passages in the housing to the shaft bearings, thrust ring, thrust bearing and backplate. The oil returns by gravity to the engine oil pan through an external oil line extending from the bottom of the turbocharger center housing to the side of the cylinder block.

Minimum oil flow to the turbocharger with the engine at idle speed is achieved at 10 psi (69 kPa) with an oil temperature of 200°F (93°C).

Before the initial engine start, when a new or overhauled turbocharger is installed, the turbocharger must be pre-lubricated as outlined under *Install Turbocharger*.

NOTICE: Failure to perform the prelubrication procedure may result in premature bearing failure due to "oil lag" or lack of lubrication.

Periodic Inspection

CAUTION: To avoid personal injury, a turbocharger compressor inlet shield, J 26554–A, should be installed anytime the engine is operated with the air inlet piping removed (Fig. 4). The shield helps keep foreign objects from entering the turbocharger and prevents a service technician from touching the moving impeller. The use of this shield *does not* preclude any other saftey practices contained in this manual.

Inadequate air filtering and excessive restrictions to air and exhaust flows will adversely affect turbocharger life and performance. Do not permit restriction levels to exceed the specified limits (refer to Section 13.2).

A periodic inspection of the turbocharger should be made along with an engine inspection.

Inspect the turbocharger mountings and check all of the air ducting and connections for leaks. Make the inspection with the engine running and with it shut down. Check for leaks at the manifold connection, the turbine inlet and exhaust manifold gasket.

NOTICE: Do not operate the engine if leaks are found in the turbocharger ducting or if the air cleaner is not filtering efficiently. Dust leaking into the air ducting can damage the turbocharger and the engine.

Remove the inlet duct to the turbocharger compressor housing and check for carbon or dirt buildup on the impeller or in the housing. Excessive accumulations indicate either a leak in the ducting or a faulty air filtering system. Remove all such accumulations and determine and correct the cause. Refer to *Troubleshooting Charts* (Fig. 5). Uneven deposits left on the compressor wheel can affect the balance and cause premature bearing failure.

NOTICE: Do not attempt to remove carbon or dirt buildup on the compressor or turbine wheels without removing the turbocharger from the engine. The blades on the wheels must be thoroughly cleaned. If chunks of carbon are left on the blades, an unbalanced condition would exist and subsequent failure of the bearings would result if the turbocharger is operated. However, it is not necessary to disassemble the turbocharger to remove dirt and dust buildup.

For proper operation, the turbocharger rotating assembly must turn freely. Whenever the exhaust ducting is removed, spin the turbine wheel by hand. If it does not spin freely, refer to Chart 1 of Fig. 5. Inspect the compressor and turbine wheels for nicks or loss of material. Both wheels are precision balanced. A broken or bent blade can throw the rotating assembly out of balance and shorten the life of the turbocharger.

Inspect the oil inlet and oil return lines to make certain all of the connections are tight and that the lines are not dented or looped so that oil flow to and from the center housing is restricted. Looping the oil return lines disrupts gravity flow of the oil back to the engine. *Be sure the oil inlet lines are filled with oil and that they are clear of the turbine housings.*

Check for signs of oil leaking from the turbocharger housings.

Lubricant applied under pressure to the center housing while the shaft is not turning may allow oil to enter the turbine and compressor housings. However, after the turbocharger has been operated for a time under load conditions and with the inlet restriction at normal, oil in these sections should disappear. If the oil does not disappear, refer to Chart 2 of Fig. 5.

Oil pull–over from an oil bath type air cleaner can also cause oil to enter the compressor housing. Check for a dirty air cleaner element or for too low viscosity oil in the air cleaner. Also, too small an air cleaner could create excessive air flow velocity and result in oil pullover.

Evidence of oil in the inlet or outlet ducts or dripping from either housing indicates a seal problem that will require overhaul of the turbocharger. Refer to Chart 3 of Fig. 5.

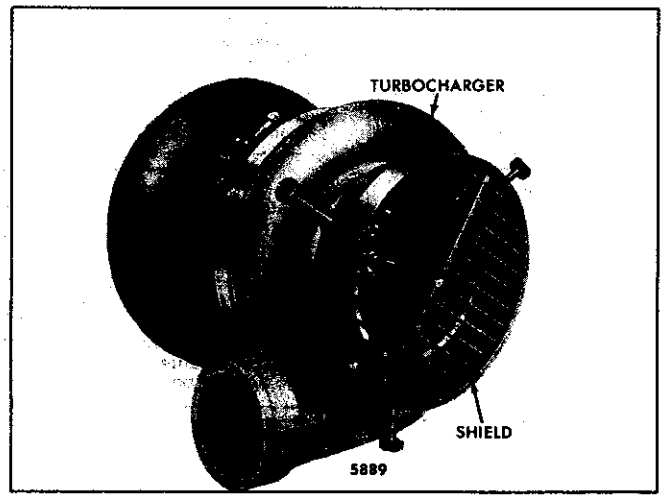


Fig. 4 – Inlet Shield (J 26554–A)

TROUBLE SHOOTING CHARTS

CHART 1

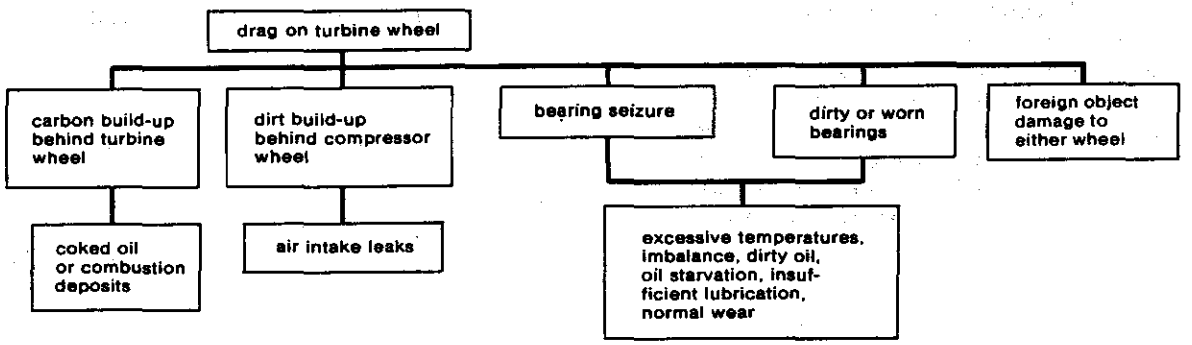


CHART 2

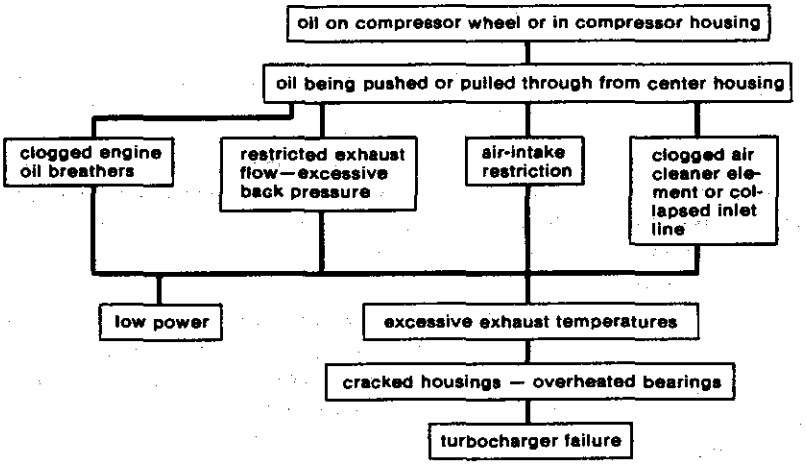


CHART 3

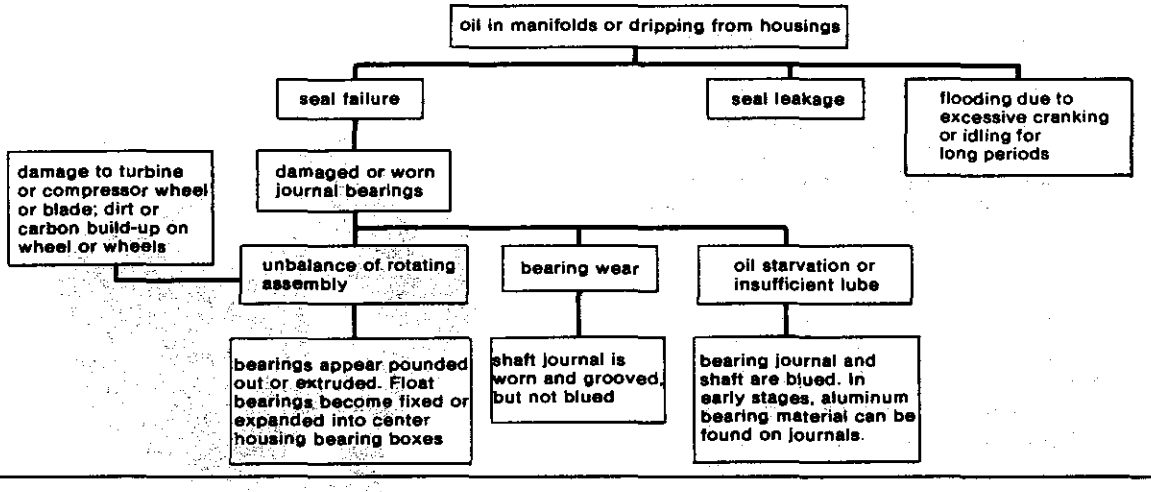


Fig. 5 – Inspection Checks for Turbocharger

Tests show there are three conditions that contribute to oil seal leakage at the internal turbocharger oil seal:

1. A worn or defective oil seal, which must be replaced.
2. High air inlet restriction (above specified limits). This will cause oil to be pulled past the oil seal.
3. Long periods of operation where the engine is being motored (using the engine as a braking device when going down a long hill). This can also cause oil to pass by the oil seal.

To confirm oil leakage from one or more of these conditions, remove the compressor housing and inspect the backplate. If the surface is wet with oil, it indicates leakage.

If this test does not show leakage patterns, the oil seal assembly is good for normal operation. This simple test will allow some positive testing on each engine in all cases.

Turbocharger compressor end shaft oil seal effectiveness can be determined by the following procedure:

1. Determine that air inlet restriction is within the Detroit Diesel maximum limit. Refer to Section 13.2.
2. Be certain that the turbocharger oil drain line is unrestricted.
3. Be certain that the turbocharger has not obviously been damaged and in need of major repair.
4. Remove air intake ducting. Inspect inside of ducting for evidence of oil. If oil is found in the intake system, determine the source before proceeding with compressor seal test and also thoroughly remove oil from the intake. Some external sources of oil are oil bath air cleaners, air compressor line, or a leak near an oil source such as an engine breather, etc.
5. Remove the compressor housing from the turbocharger.
6. Thoroughly clean the internal surfaces of the compressor housing, impeller cavity behind the impeller, and the backplate annulus with suitable solvent spray and then dry completely with shop air.
7. Spray the backplate annulus with a light coating of "Spot–Check" developer type SKD–MF, or equivalent.
8. Install the compressor housing on the turbocharger and reconnect the inlet and outlet connections.
9. Warm up the engine to normal operating temperature.
10. Operate the engine at no load at the governor limited high speed for approximately five minutes.
11. Return the engine to low idle and then stop it.
12. Remove the intake duct and outlet hose and then remove the compressor housing. Evidence of compressor end shaft seal oil leakage will be observed as oil streaks in the "Spot–Check" developer on the backplate annulus. This surface should be completely free of oil streaks after the test.
13. If leakage is detected, and oil is positively not entering through the intake duct, then the turbocharger may be removed from the engine and inspected for damaged components.

Remove Turbocharger

1. Refer to Fig. 6 and remove the turbocharger support bracket.
2. Disconnect the oil supply line and the oil drain line from the turbocharger.
3. Cover the end of each oil inlet and oil outlet line and the air inlet and exhaust outlet openings on the engine to prevent the entrance of foreign material.
4. Loosen the two hose clamps securing the cover hose to the turbocharger and the air inlet tube and slide the cover hose down over the inlet tube.

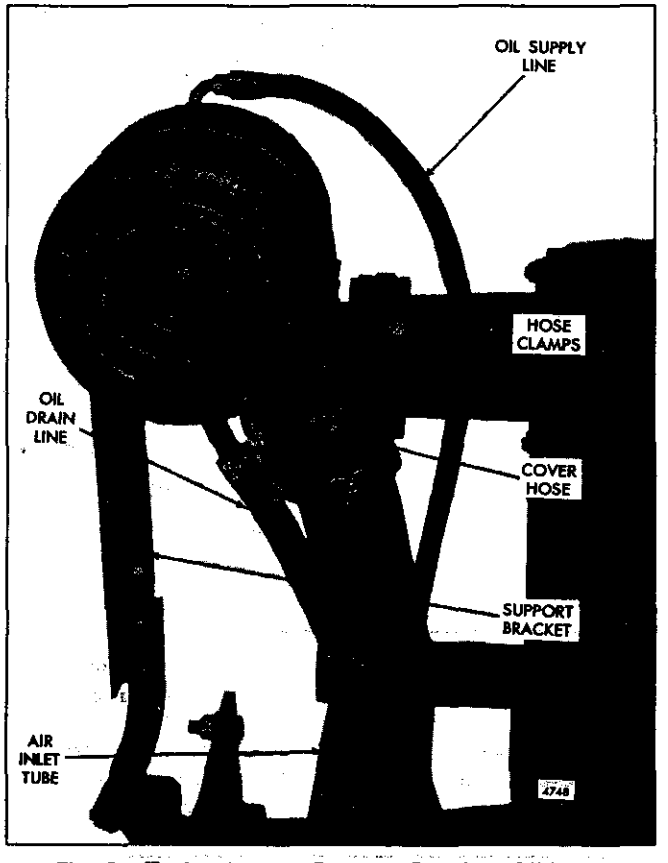


Fig. 6 – Turbocharger Support Bracket, Oil Lines and Air Inlet Tube

5. Remove the four bolts, nuts and lock washers securing the turbocharger to the exhaust manifold adaptor and remove the turbocharger and gasket. Refer to Fig. 1.

Disassemble Turbocharger

Clean the exterior of the turbocharger with a non–caustic cleaning solvent before disassembly and proceed as follows:

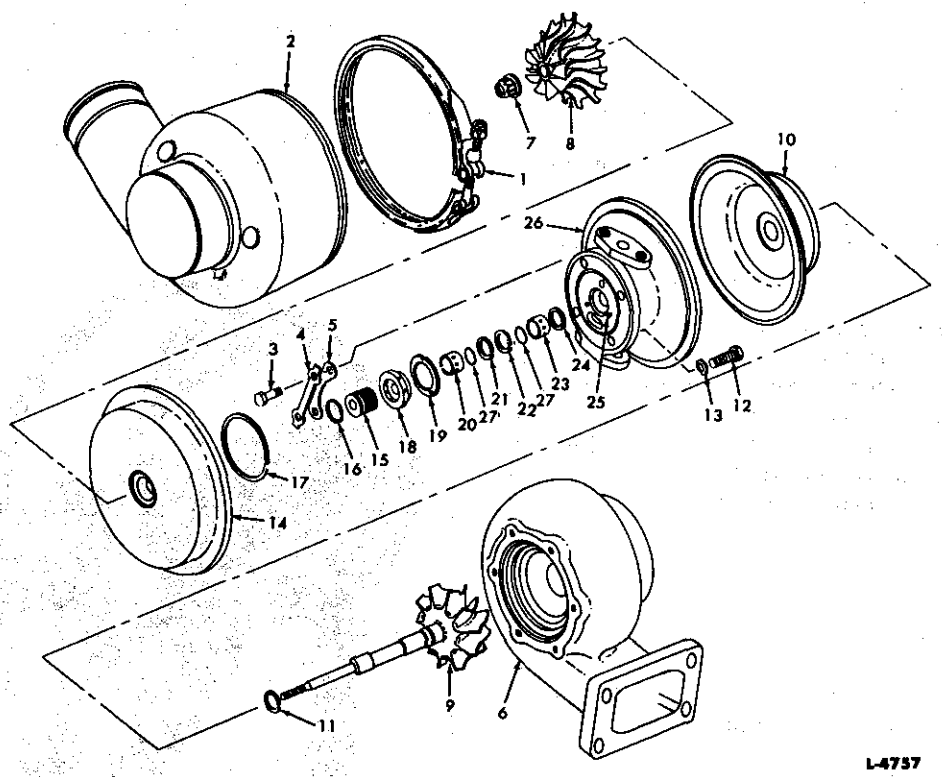
NOTICE: Mark related positions of the compressor housing, center housing and turbine housing with a punch or scribe prior to disassembly to assure reassembly in the same relative position.

1. Loosen the "V" band coupling (1) securing the compressor housing (2) to the backplate assembly (14) and remove the compressor housing and "V" band.

   NOTICE: Exercise care when removing the center and turbine housings to prevent damage to the compressor or turbine wheel.

2. Bend down the ends of the lockplates and remove the eight bolts (3) securing the four lockplates (4) and turbine housing clamps (5) to the center housing (26) and turbine housing (6). Remove the turbine housing from the center housing. Tap the housing with a soft headed hammer if force is needed for removal.

3. Position the turbine wheel (9) of the center housing assembly in a suitable holding fixture (Fig. 8). Remove the wheel nut (7) from the shaft.



1.	Coupling—"V" Band	8.	Wheel—Compressor	14.	Backplate Assembly	21.	Ring—Retaining
2.	Housing—Compressor	9.	Shaft—Turbine Wheel	15.	Spacer—Thrust	22.	Ring—Retaining
3.	Bolt		Assembly	16.	Ring—Piston	23.	Bearing
4.	Lockplate	10.	Shroud—Turbine Wheel	17.	Ring—Seal	24.	Ring—Retaining
5.	Clamp—Turbine Housing	11.	Ring—Piston	18.	Collar—Thrust	25.	Pin—Groove
6.	Housing—Turbine	12.	Screw	19.	Bearing—Inboard Thrust	26.	Housing—Center
7.	Nut—Self-Locking	13.	Lockplate	20.	Bearing	27.	Spacer

Fig. 7 – Model TE0675 Turbocharger Details and Relative Location of Parts

NOTICE: To prevent the possibility of bending the turbine wheel shaft, remove the compressor wheel nut from the shaft with a double universal socket and tee handle.

4. Place the center housing and rotating assembly in a oven, furnace or hot oil bath that has been preheated to 350–375°F (177–190°C) for no longer than ten minutes.

5. Press the compressor wheel (8) from the wheel shaft assembly (9).

6. Withdraw the wheel shaft assembly (9) and wheel shroud (10) from the center housing. The wheel shroud (10), which is not retained, will fall free when the wheel shaft is removed.

7. Remove the piston seal (11) from the wheel shaft assembly (9).

8. Bend down the lock tabs and remove the four bolts (12) and lockplates (13) securing the backplate assembly (14) to the center housing (26) and remove the backplate assembly. Tap the backplate lightly to remove it from the center housing recess.

9. Remove and discard the seal ring (17) from the groove in the center housing.

10. Remove the thrust spacer (15) and piston ring(s) (16) from the backplate assembly. Discard the piston ring(s).

11. Remove the thrust collar (18), inboard thrust bearing (19), bearing (20), spacer (27) if used, and retaining ring (21) from the center housing. Discard the bearing and retaining ring.

12. Remove the retaining ring (22), spacer (27) if used, bearing (23) and retaining ring (24) from the center housing. Discard the retaining ring and bearing.

Cleaning

Before cleaning, inspect all of the parts for signs of burning, rubbing or other damage which might not be evident after cleaning.

Soak all of the parts in a non–caustic cleaning solvent for about 25 minutes. After soaking, use a stiff bristle brush and remove all dirt particles. Dry all of the parts thoroughly.

CAUTION: Never use a caustic cleaning solution for cleaning as this will damage certain parts. Use the cleaning solution in an open or well ventilated area. Avoid breathing the fumes. Keep away from open flames. Do not use a wire brush or a steel blade scraper to clean the parts.

Make sure that both wheel blades are thoroughly clean. Deposits left on the blades will affect the balance of the rotating assembly.

Clean all of the internal cavities and oil passages in the center housing thoroughly with dry compressed air.

- **CAUTION: To prevent possible personal injury, wear adequate eye protection and do not exceed 40 psi (276 kPa) air pressure.**

Clean the oil passage in the center housing thrust plate with dry compressed air.

Remove the oil inlet and outlet lines from the engine and thoroughly clean the oil lines inside and out. An oil line that is dented or crimped enough to restrict the flow of oil must be replaced.

Inspection

Inspect all of the parts for signs of damage, corrosion or deterioration. Check for nicked, crossed or stripped threads.

Visually check the turbine wheel for signs of rubbing. For shaft bearing journal dimensions and wear limits, refer to Section 3.0.

Inspect the shaft for signs of scoring, scratches or bearing seizure.

Check the compressor wheel for signs of rubbing or damage from foreign material. Check to see that the wheel bore is not galled. The wheel must be free of dirt and other foreign material.

Inspect the seal parts for signs of rubbing or scoring of the running faces.

Inspect the housing for contact with the rotating parts. The oil and air passages must be clean and free of obstructions.

Minor surface damage may be burnished or polished. Use a silicone carbide abrasive cloth for aluminum parts or a crocus abrasive cloth for steel parts.

It is recommended that piston ring(s), thrust washers, bearings, bearing washers and retaining rings be replaced at time of disassembly.

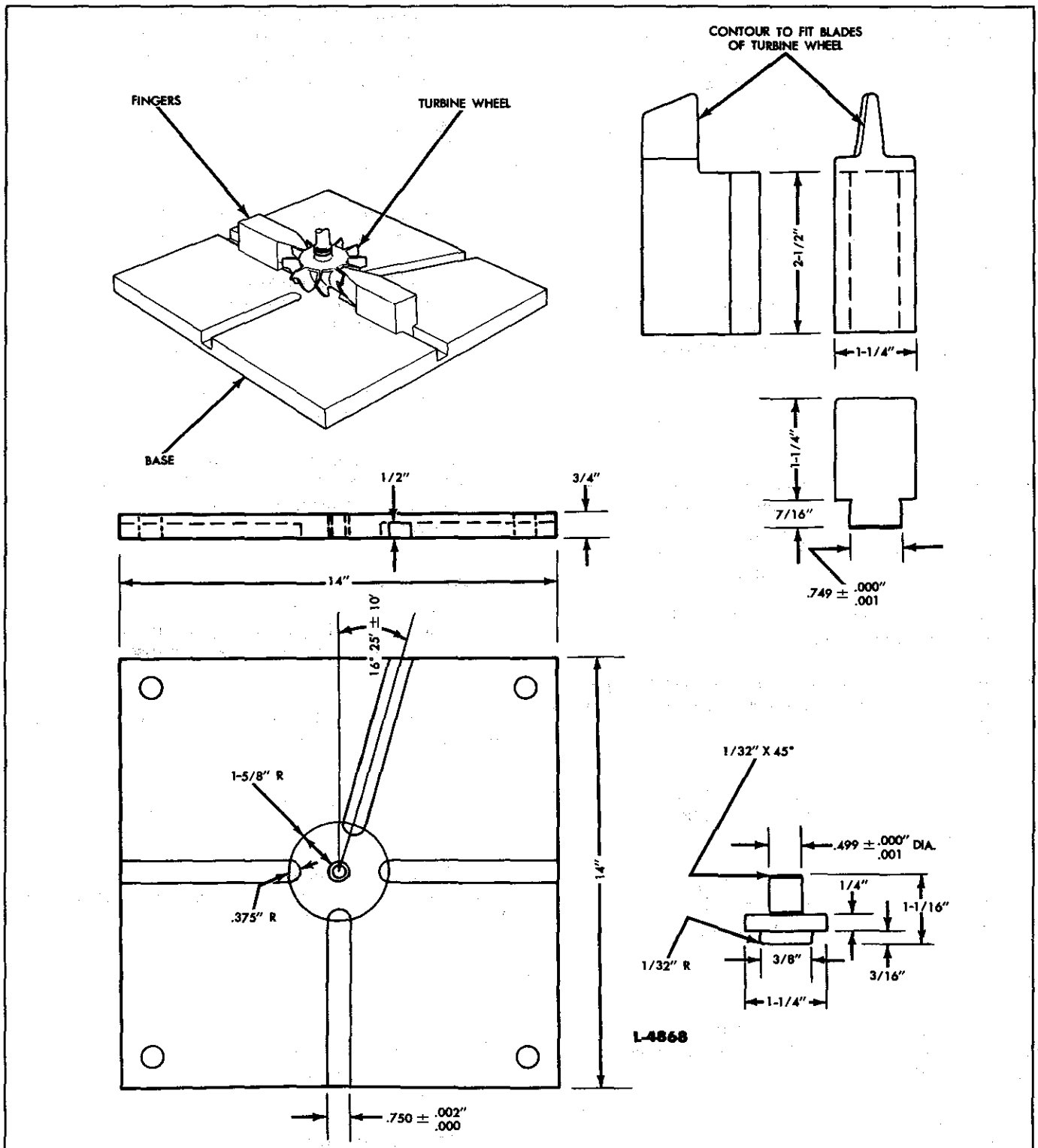


Fig. 8 – Turbocharger Holding Fixture

Assemble Turbocharger

Check each part prior to installation to ensure cleanliness. As the parts are assembled, cover the openings to prevent entry of dirt or other foreign material.

Refer to Fig. 7 for parts orientation and proceed as follows:

1. Lubricate the new bearings (20 and 23) with clean engine oil.
2. Install a new retaining ring (24), bearing (23), spacer (27) and retaining ring (22) in the turbine housing end of the center housing (26).
3. Install a new retaining ring (21), spacer (27) and bearing (20) in the center housing.
4. Install a new piston ring(s) (16) on the thrust spacer (15) and gently insert the spacer into the backplate assembly (14).

   The current thrust spacer has two grooves. When replacing the former one groove spacer with the two groove spacer, be sure and include two piston rings.

   NOTICE: Do not force the piston rings into place.
5. Position the inboard thrust bearing (19) flat against the center housing with the hole and cut–outs in the bearing in alignment with the pins (25) in the center housing.
6. Install the thrust collar (18) snugly against the thrust bearing (19). Lubricate the thrust collar and bearing with clean engine oil.
7. Install a new seal ring (17) in the groove in the backplate assembly (14).
8. Align the oil feed holes in the center housing (26) and the backplate assembly and install the backplate, using four bolts (12) and new lockplates (13). Tighten the bolts to 75–90 **lb–in** (8–10 N·m) torque and bend the lockplate tangs up against the side of the bolt heads.
9. Install a new piston seal (11) on the wheel shaft assembly (9).
10. Position the wheel shroud (10) against the center housing (26) and insert the wheel shaft assembly (9) through the wheel shroud and into the center housing.

    NOTICE: Be careful not to scuff or scratch the bearings when installing the shaft. Do not use force to compress the piston ring into place. A gentle rocking and pushing action will allow the piston ring to seat and the shaft to bottom. A thin tool may be used as an aid in compressing the piston ring is difficulty is encountered.

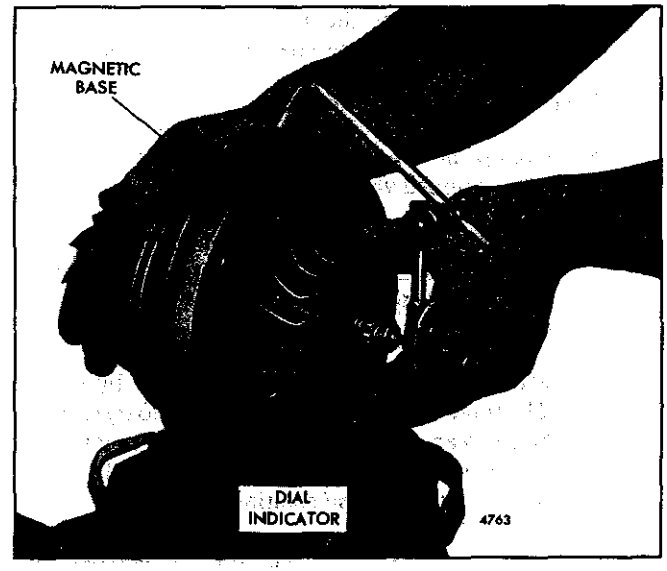


Fig. 9 – Checking Bearing Axial End Play

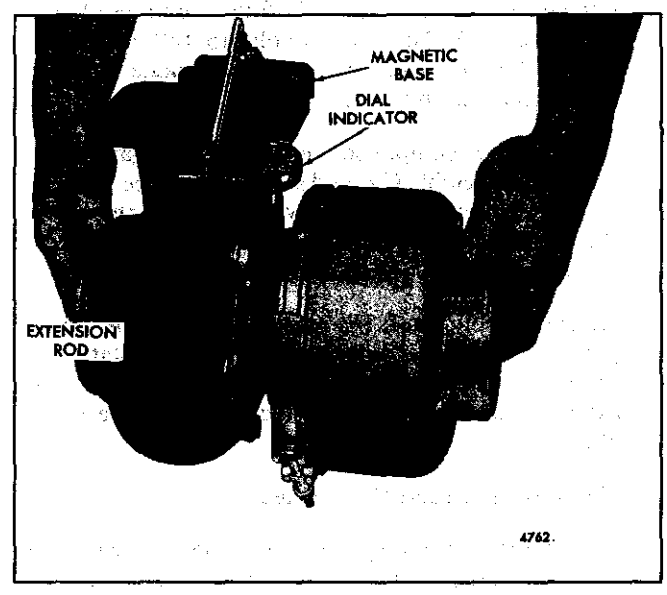


Fig. 10 – Checking Shaft Radial Movement

11. Heat the compressor wheel in an oven or hot oil bath to 325–375°F (163–190°C) for no more than ten minutes.
12. Position the turbine wheel (9) of the center housing assembly in the holding fixture (Fig. 8).
13. Position the compressor wheel over the shaft and install the wheel retaining nut. Tighten the nut to 120 **lb–in** (14 N·m) torque. After the compressor wheel has cooled to room temperature, remove the retaining nut.
14. Check the face of the retaining nut and the wheel face to make sure they are smooth and clean. Lightly oil the shaft threads and washer face and reinstall the nut. Tighten the nut to 18–20 **lb–in** (2 N·m) torque. Continue to tighten until the shaft increases in length

.008"–.009". Tighten the retaining nut in such a manner so as not to impose a bending load on the shaft.

15. Check the bearing axial end play:

    a. Clamp the center housing assembly in a bench vise equipped with soft jaws as shown in Fig. 9.

    b. Fasten the dial indicator and magnetic base (J 7872) to the center housing so that the indicator tip rests on the end of the rotating shaft on the compressor side.

    c. Move the shaft axially back and forth by hand. The total indicator reading (thrust float) should be between .004" and .007". If the dial indicator readings do not fall within the specified limits, repair or replace the rotating assembly.

16. Position the turbine housing (6) as marked at disassembly against the center housing (26) and secure it in place with four clamps (5), four lockplates (4) and eight bolts (3). Tighten the bolts to 160–190 **lb–in** (18–22 N·m) torque. Bend the lockplate tabs up against the flat on the bolt heads.

17. Position the compressor housing (2) against the backplate assembly (14) and secure it in place with the "V" band coupling (1). Lightly lubricate the threads of the toggle bolt with engine oil and tighten the nut on the coupling to 30–45 **lb–in** (3–5 N·m) torque.

18. After assembly, push the rotating assembly as far as possible from the turbine end. Then, rotate the assembly and check for bind. Push the rotating assembly in the opposite direction and repeat the check.

19. Check the shaft radial movement:

    a. Position the magnetic base J 7872–2 with the swivel adaptor J 7872–3 on the flat surface of the turbine housing inlet flange as shown in Fig. 10.

    b. Fasten the dial indicator extension rod J 7057 to the dial indicator J 8001–3 and attach the dial indicator to the swivel adaptor.

    c. Insert the extension rod into the oil drain tube mounting pad opening so that it is against the wheel shaft and is perpendicular to the shaft.

    NOTICE: Make sure the extension rod does not make contact with the sides of the center housing, otherwise it will be impossible to obtain an accurate reading.

    d. Grasp each end of the rotating assembly and, applying equal pressure at each end, move the rotating shaft first toward and then away from the dial indicator, creating a transverse movement in the shaft. The dial indicator displacement should be between .003" and .007". If the displacement does not fall within the specified limits, disassemble and repair or replace the rotating assembly.

20. If it is to be stored, lubricate the turbocharger internally and install protective covers on all openings.

21. Stamp the letter "R" in the lower left–hand corner of the name plate to identify that the turbocharger has been reworked.

Install Turbocharger

If a turbocharger is to be installed on a new or overhauled engine, operate the engine for approximately one hour *before* the turbocharger is installed. This must be done to ensure that no foreign material is carried from the engine into the turbocharger lubrication system.

1. Position the turbocharger, using a new gasket, against the exhaust manifold adaptor and secure it in place with four bolts, lock washers and nuts (Fig. 1).

2. Slide the cover hose (Fig. 5) over the end of the turbocharger air outlet opening and tighten the two hose clamps.

3. Install the turbocharger support bracket.

4. Install the oil drain line from the opening in the bottom side of the center housing (Fig. 5) to the cylinder block.

5. Attach the oil inlet line at the cylinder block.

6. After installing a rebuilt or new turbocharger, it is very important that all of the moving parts of the turbocharger center housing be lubricated as follows:

    a. Clean the area and disconnect the oil inlet (supply) line at the bearing (center) housing (Fig. 3).

    b. Fill the bearing housing cavity with clean engine oil. Turn the rotating assembly by hand to coat all of the internal surfaces with oil.

    c. Add additional clean engine oil to completely fill the bearing housing cavity and reinstall the oil line. Clean off any spilled oil.

    d. Start and run the engine at idle until oil pressure and supply has reached all of the turbocharger moving A good parts. indicator that all of the moving parts are getting lubrication is when the oil pressure gage registers pressure (10 psig or 69 kPa at idle speed).

CAUTION: Do not hold the compressor wheel, for any reason, while the engine is running. This could result in personal injury.

The free floating bearings in the turbocharger center housing require positive lubrication. This is provided by the above procedure *before the turbocharger reaches its maximum operating speed* which is produced by high engine speeds. Starting any turbocharged engine and accelerating to any speed above idle before engine oil supply and pressure has reached the free floating bearings can cause severe damage to the shaft and bearings of the turbocharger.

7. Check all ducts and gaskets for leaks.

8. Operate the engine at rated output and listen for sounds of metallic contact from the turbocharger. If any such noise is apparent, stop the engine immediately and correct the cause.

NOTICE: After the turbocharger has been operating long enough to permit the unit and the oil to warm up, the rotating assembly should coast freely to a stop after the engine is stopped. If the rotating assembly jerks to a sudden stop, the cause should be immediately determined and eliminated.

TO4B AND TV61 TURBOCHARGERS

The turbocharger (Figs. 11 and 12) is designed to increase engine efficiency and power output. Power to drive the turbocharger is extracted from the waste energy in the engine exhaust gas.

The turbocharger consists of a turbine wheel and shaft, a compressor wheel, a center housing which serves to support the rotating assembly, bearings, seals, a turbine housing and a compressor housing. The center housing has connections for oil inlet and outlet fittings.

The turbine wheel is located in the turbine housing and is mounted on one end of the turbine shaft. The compressor wheel is located in the compressor housing and is mounted on the opposite end of the turbine wheel shaft to form an integral rotating assembly.

The rotating assembly consists of the turbine wheel and shaft assembly, piston ring, thrust collar, thrust bearing, compressor wheel and wheel retaining nut. The rotating assembly is supported on two pressure lubricated bearings which are retained in the center housing by retaining rings. Internal oil passages are drilled in the center housing to provide lubrication to the turbine wheel shaft bearings and thrust bearing, piston ring and thrust collar.

The oil is sealed off from the compressor and the turbine by seal arrangements at both ends of the center housing. Oil drains from the center housing by gravity.

The turbine housing is a heat resistant alloy casting which encloses the turbine wheel and provides a flanged engine exhaust gas inlet and an axially–located turbocharger exhaust gas outlet. The TO4B turbine housing is bolted to the turbine end of the center housing and the TV61 turbine housing is secured to the center housing with a "V" band coupling.

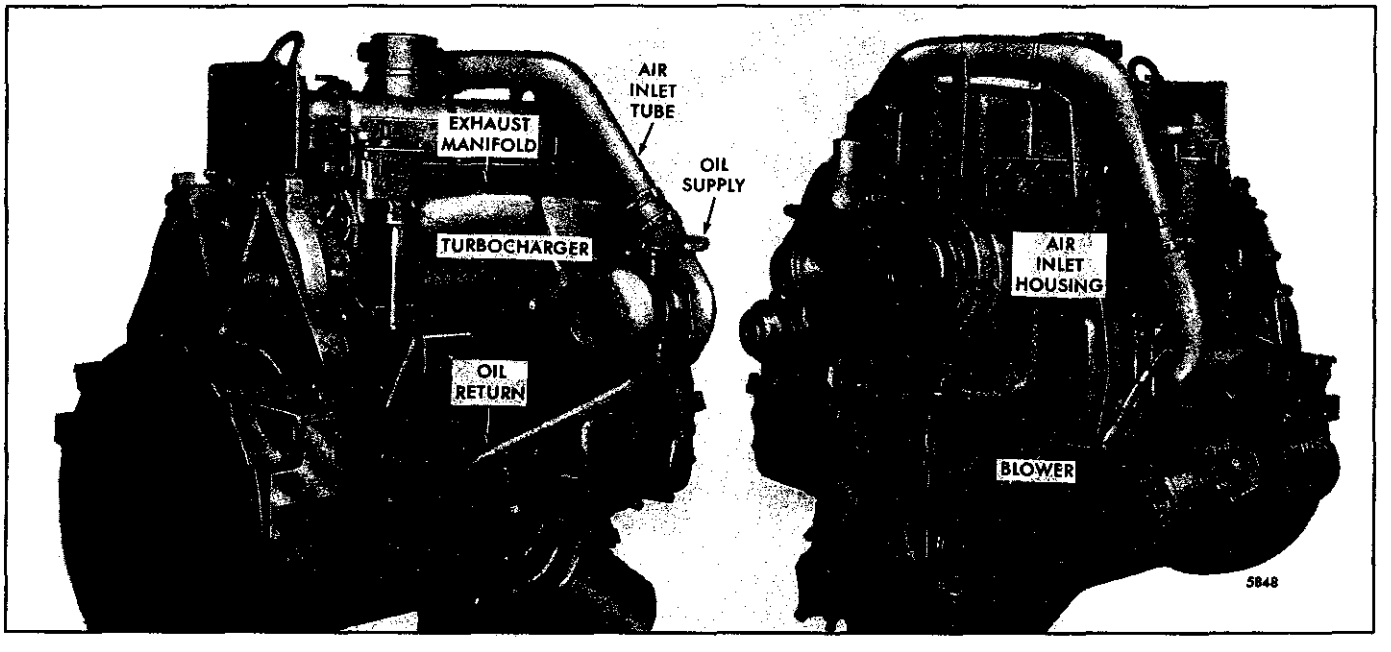


Fig. 11 – TO4B Turbocharger Mounting (In–Line Engine)

The compressor housing, which encloses the compressor wheel, provides an ambient air inlet and a compressor air discharge outlet. The compressor housing is bolted to the backplate assembly. The TO4B backplate assembly is bolted to the compressor end of the center housing. The TV61 backplate assembly is secured to the compressor end of the center housing with a "V" band coupling.

Operation

The TO4B turbocharger is mounted on the exhaust outlet flange of the engine exhaust manifold (Fig. 11). The TV61 turbocharger is mounted between the air inlet housing and the air outlet tube adaptor. The air inlet housing is mounted on the blower. The air outlet tubes are clamped to the exhaust outlet flange of each engine exhaust manifold and the air outlet tube adaptor (Fig. 12).

After the engine is started, the exhaust gases flowing from the engine and through the turbine housing cause the turbine wheel and shaft to rotate (Fig. 13). The gases are discharged into the atmosphere after passing through the turbine housing.

The compressor wheel, which is mounted on the opposite end of the turbine wheel shaft, rotates with the turbine wheel. The compressor wheel draws the ambient air into the compressor housing, compresses the air and delivers it through the blower to the engine cylinders.

During operation, the turbocharger responds to the engine load demands by reacting to the flow of the engine exhaust gases. As the power output of the engine increases, the flow of exhaust gases increases and the speed and output of the rotating assembly increases proportionately, delivering more air to the engine blower.

Lubrication

Lubricating oil for the turbocharger is supplied under pressure through an external oil line extending from the engine cylinder block to the top of the center housing. From the oil inlet in the center housing, the oil flows through the drilled oil passages in the housing to the shaft bearings, thrust collar and thrust bearing (Fig. 14). The oil returns by gravity to the engine oil pan through an external oil line extending from the bottom of the turbocharger center housing to the cylinder block.

Before the initial engine start, when a new or overhauled turbocharger is installed, the turbocharger must be pre-lubricated as outlined under *Install Turbocharger*.

NOTICE: Failure to perform the pre-lubrication procedure may result in premature bearing damage due to "oil lag" or lack of lubrication.

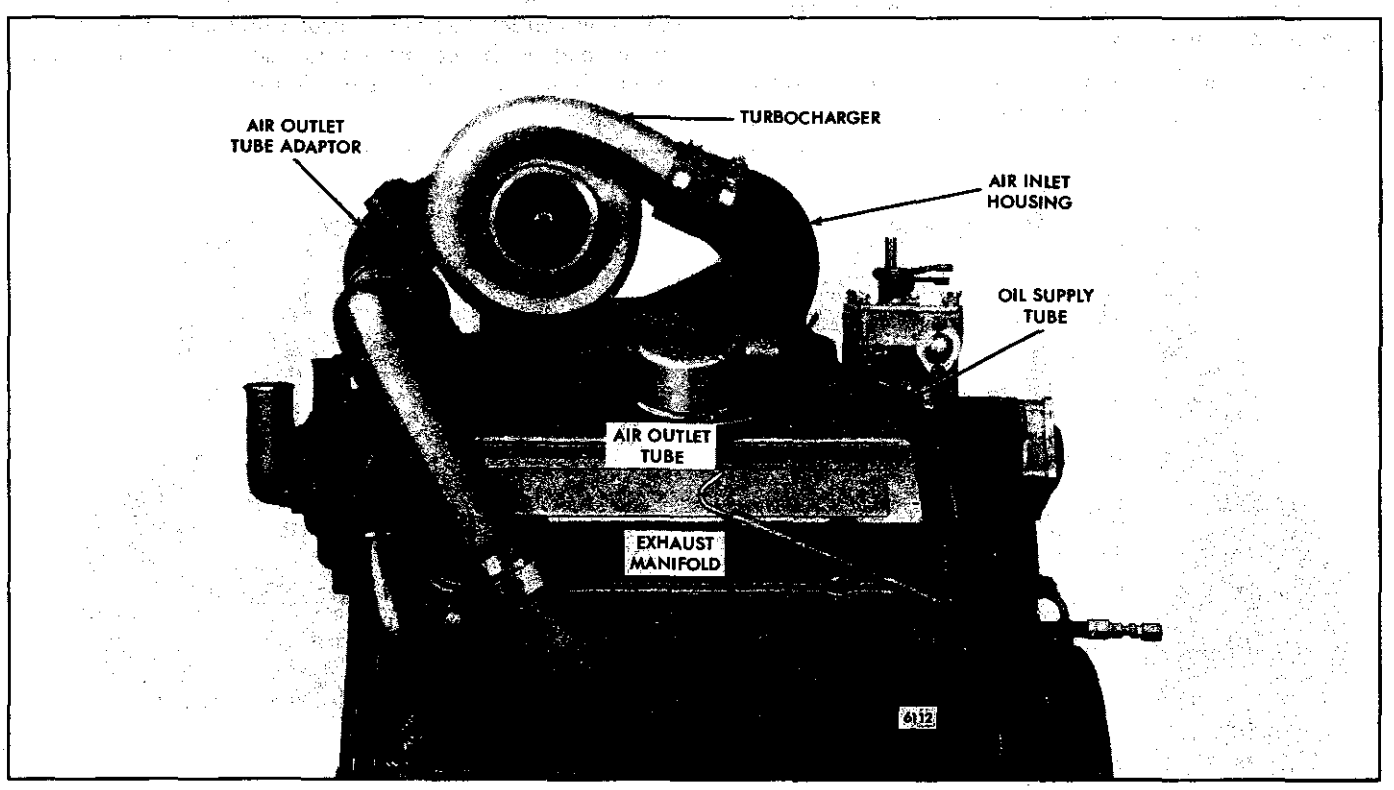


Fig. 12 – TV61 Turbocharger Mounting (6V Engine)

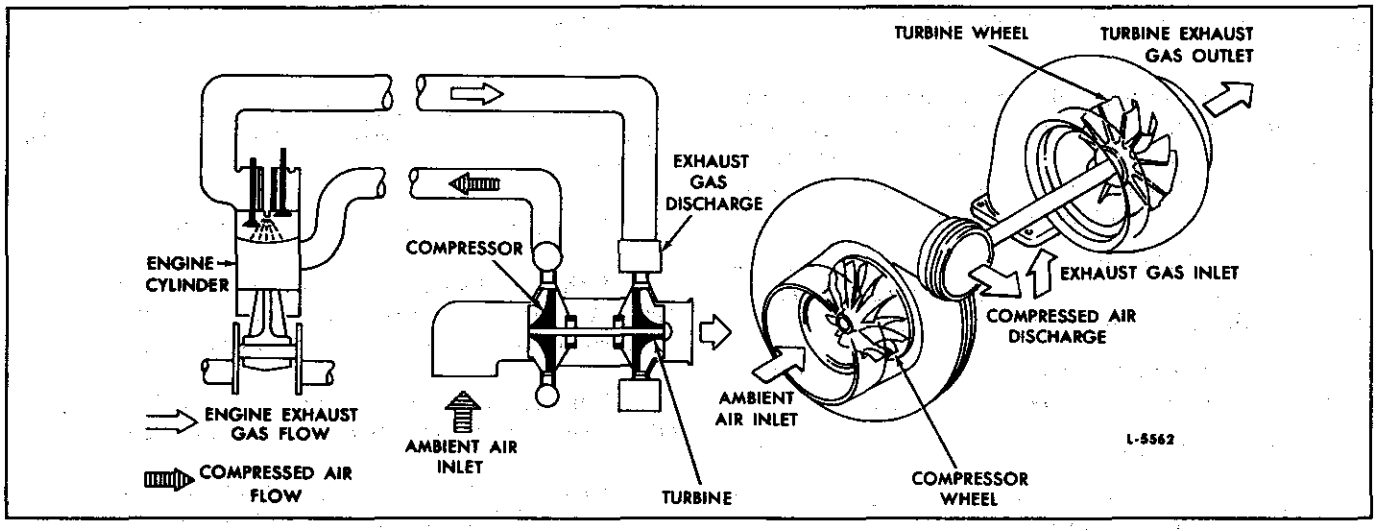


Fig. 13 – Schematic Air Flow Diagram

Periodic Inspection

NOTICE: A turbocharger compressor inlet shield, J 26554–A, is available for use anytime the engine is operated with the air inlet piping removed (Fig. 4). The shield helps to prevent foreign objects entering the turbocharger and prevents a service technician from touching the moving impeller. The use of this shield *does not* preclude any other safety practices contained in this manual.

Inadequate air filtering and excessive restrictions to air and exhaust flows will adversely affect turbocharger life and performance. Do not permit restriction levels to exceed the specified limits (refer to Section 13.2).

A periodic inspection of the turbocharger should be made along with an engine inspection.

Inspect the turbocharger mountings and check all of the air ducting and connections for leaks. Make the inspection with the engine running and with it shut down. Check for leaks at the manifold connection, the turbine inlet and exhaust manifold gasket.

NOTICE: Do not operate the engine if leaks are found in the turbocharger ducting or if the air cleaner is not filtering efficiently. Dust leaking into the air ducting can damage the turbocharger and the engine.

Remove the inlet duct to the turbocharger compressor housing and check for carbon or dirt buildup on the impeller or in the housing. Excessive accumulations indicate either a leak in the ducting or a faulty air filtering system. Remove all such accumulations and determine and correct the cause. Refer to *Troubleshooting Charts* (Fig. 5). Uneven deposits left on the compressor wheel can affect the balance and cause premature bearing failure.

NOTICE: Do not attempt to remove carbon or dirt buildup on the compressor or turbine wheels without removing the turbocharger from the engine. The blades on the wheels must be thoroughly cleaned. If chunks of carbon are left on the blades, an unbalanced condition would exist and subsequent failure of the bearings would result if the turbocharger is operated. However, it is not necessary to disassemble the turbocharger to remove dirt and dust buildup.

For proper operation, the turbocharger rotating assembly must turn freely. Whenever the exhaust ducting is removed, spin the turbine wheel by hand. If it does not spin freely, refer to Chart 1 of Fig. 5. Inspect the compressor and turbine wheels for nicks or loss of material. Both wheels are precision balanced. A broken or bent blade can throw the rotating assembly out of balance and shorten the life of the turbocharger.

Inspect the oil inlet and oil return lines to make certain all of the connections are tight and that the lines are not dented or looped so that oil flow to and from the center housing is restricted. Looping the oil return lines disrupts gravity flow of the oil back to the engine. *Be sure the oil inlet lines are filled with oil and that they are clear of the turbine housings.*

Check for signs of oil leaking from the turbocharger housings.

Lubricant applied under pressure to the center housing while the shaft is not turning may allow oil to enter the turbine and compressor housings. However, after the turbocharger has been operated for a time under load conditions and with the inlet restriction at normal, oil in

these sections should disappear. If the oil does not disappear, refer to Chart 2 of Fig. 5.

Oil pull–over from an oil bath type air cleaner can also cause oil to enter the compressor housing. Check for a dirty air cleaner element or for too low viscosity oil in the air cleaner. Also, too small an air cleaner could create excessive air flow velocity and result in oil pull–over.

Evidence of oil in the inlet or outlet ducts or dripping from either housing indicates a seal problem that will require overhaul of the turbocharger. Refer to Chart 3 of Fig. 5.

Tests show there are three conditions that contribute to oil seal leakage at the internal turbocharger oil seal:

1. A worn or defective oil seal which must be replaced.
2. High air inlet restriction (above specified limits). This will cause oil to be pulled past the oil seal.
3. Long periods of operation where the engine is being motored (using the engine as a braking device when going down a long hill). This can also cause oil to pass by the oil seal.

To confirm oil leakage from one or more of these conditions, remove the compressor housing and inspect the backplate.

If the surface is wet with oil, it indicates leakage.

If this test does not show leakage patterns, the oil seal assembly is good for normal operation. This simple test will allow some positive testing on each engine in all cases.

Turbocharger compressor end shaft oil seal effectiveness can be determined by the following procedure:

1. Determine that air inlet restriction is within the Detroit Diesel maximum limit. Refer to Section 13.2.
2. Be certain that the turbocharger oil drain line is unrestricted.

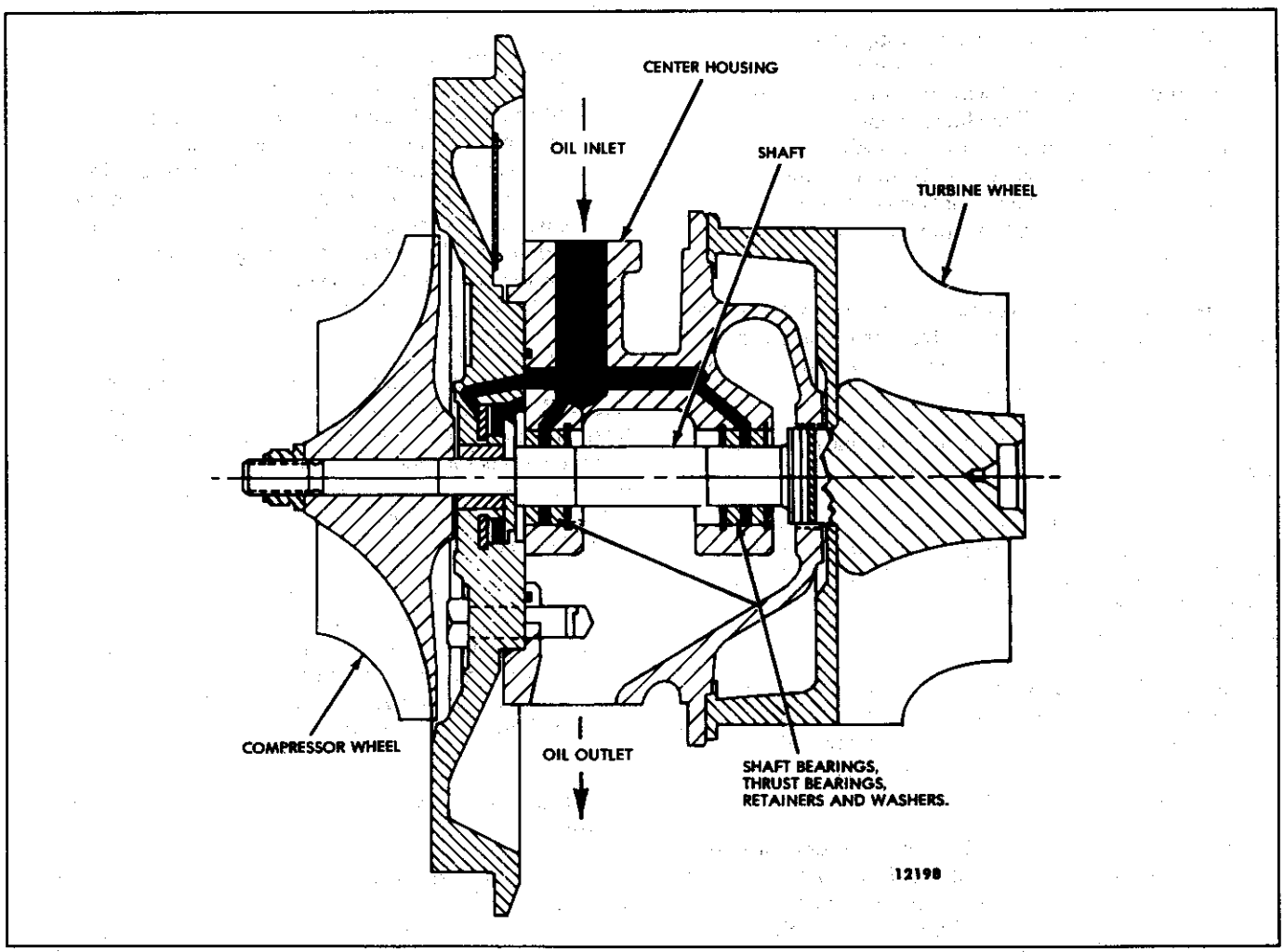


Fig. 14 – Turbocharger Oil Flow Diagram

3. Be certain that the turbocharger has not obviously been damaged and in need of major repair.

4. Remove the air intake ducting. Inspect the inside of the ducting for evidence of oil. If oil is found in the intake system, determine the source before proceeding with the compressor seal test and also thoroughly remove oil from the intake. Some external sources of oil are oil bath air cleaners, air compressor line, or a leak near an oil source such as an engine breather, etc.

5. Remove the compressor housing from the turbocharger.

6. Thoroughly clean the internal surfaces of the compressor housing, impeller cavity behind the impeller, and the backplate annulus with suitable solvent spray and then dry completely with shop air.

7. Spray the backplate annulus with a light coating of *Spot–Check* developer type SKD–MF, or equivalent.

8. Install the compressor housing on the turbocharger and reconnect the inlet and outlet connections.

9. Warm up the engine to normal operating temperature.

10. Operate the engine at no load at the governor limited high speed for approximately five minutes.

11. Return the engine to low idle and then stop it.

12. Remove the intake duct and outlet hose and then remove the compressor housing. Evidence of compressor end shaft seal oil leakage will be observed as oil streaks in the *Spot–Check* developer on the backplate annulus. This surface should be completely free of oil streaks after the test.

13. If leakage is detected, and oil is positively not entering through the intake duct, then the turbocharger may be removed from the engine and inspected for damaged components.

Remove Turbocharger

1. Remove the TO4B turbocharger support bracket.

2. Disconnect the oil supply line and the oil drain line from the turbocharger.

3. Cover the end of each oil inlet and oil outlet line and the air inlet and exhaust outlet openings on the engine to prevent the entrance of foreign material.

4. Loosen the two hose clamps securing the cover hose to the turbocharger and the air inlet tube and slide the cover hose down over the inlet tube.

5. Remove the four bolts, nuts and lock washers securing the turbocharger to the exhaust manifold adaptor or exhaust outlet flange and remove the turbocharger and gasket.

Disassemble Turbocharger

Clean the exterior of the turbocharger with a non–caustic cleaning solvent before disassembling and proceed as follows:

NOTICE: Mark related positions of the compressor housing, center housing and turbine housing with a punch or scribe prior to disassembly o assure reassembly in the same relative position.

TO4B Turbocharger – Fig. 15.

1. Bend the lock tabs of the lock plates down and remove the bolts which hold the lockplates and clamps securing the compressor housing and turbine housing.

NOTICE: Exercise care when removing the compressor housing and turbine housing to prevent damage to the compressor and turbine wheels. Tap the housing with a soft hammer if force is needed for removal.

2. Position the turbine wheel of the center housing assembly in a suitable holding fixture (Fig. 8). Remove the wheel nut from the shaft. If a holding fixture is not available, clamp a suitable socket or box end wrench in a vise and place the extended hub on the shaft in the socket or wrench. Hold the center housing upright and remove the wheel nut from the shaft.

NOTICE: To prevent the possibility of bending the turbine wheel shaft, remove the compressor wheel nut from the shaft with a double universal socket and tee handle.

3. Lift the compressor wheel off of the turbine wheel shaft assembly.

4. Invert the center housing and turbine wheel assembly and remove the turbine wheel assembly (with piston ring) from the center housing. Remove the piston ring from the wheel assembly.

5. Bend the lock tabs down and remove the bolts and lockplates securing the backplate assembly to the center housing. Remove the backplate assembly.

NOTICE: Tap the backplate lightly to remove it from the center housing recess.

6. Do not disassemble the backplate assembly. Also, do not remove the pins from the center housing, unless it is necessary to replace the pins.

7. Remove and discard the seal ring from the groove in the center housing.

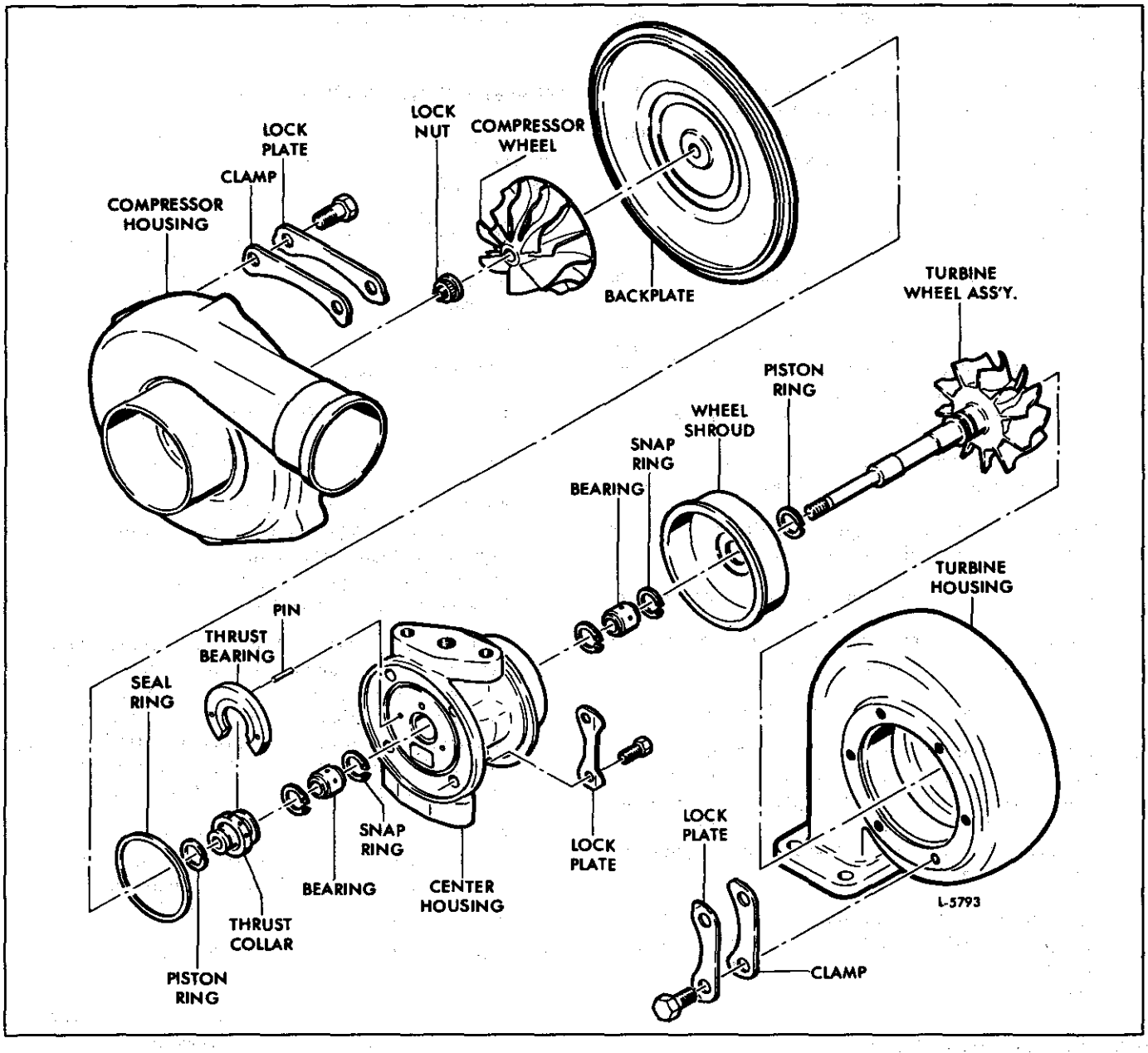


Fig. 15 – TO4B Turbocharger Details and Relative Location of Parts

8. Remove the thrust bearing and piston ring from the backplate assembly. Discard the piston ring.

9. Remove the thrust collar, bearing and snap ring from the center housing. Discard the bearing and snap ring.

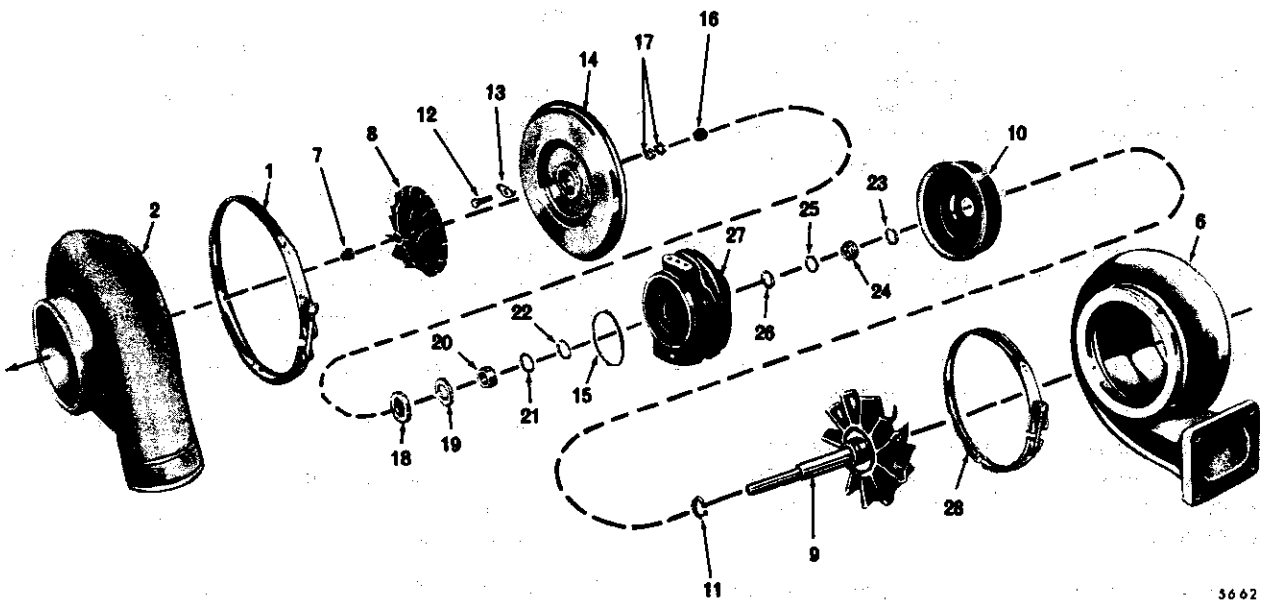
10. Remove the snap ring, bearing and snap ring from the opposite end of the center housing. Discard the snap rings and bearing.

TV61 Turbocharger – Fig. 16.

1. Loosen the "V" band coupling securing the compressor housing to the backplate assembly and remove the compressor housing and "V" band.

   NOTICE: Exercise care when removing the compressor housing and turbine housing to prevent damage to the compressor and turbine wheels.

2. Loosen the "V" band coupling securing the turbine housing to the center housing. Remove the turbine housing from the center housing. Tap the housing with a soft hammer if force is needed for removal.



1.	Coupling—"V" Band	10.	Shroud—Turbine Wheel	17.	Ring—Piston	23.	Ring—Snap
2.	Housing—Compressor	11.	Ring—Turbine Piston	18.	Collar—Thrust	24.	Bearing
6.	Housing—Turbine	12.	Screw	19.	Washer—Inboard Thrust	25.	Washer—Bearing
7.	Nut—Self-Locking	13.	Lockplate	20.	Bearing	26.	Ring—Snap
8.	Wheel—Compressor	14.	Backplate Assy.	21.	Washer—Bearing	27.	Housing—Center
9.	Shaft—Turbine Wheel Assy.	15.	Ring—Seal	22.	Ring—Snap	28.	Coupling—"V" Band
		16.	Spacer—Thrust				

Fig. 16 – TV61 Turbocharger Details and Relative Location of Parts.

3. Position the turbine wheel of the center housing assembly in a suitable holding fixture (Fig. 8). Remove the wheel nut from the shaft. If a holding fixture is not available, clamp a suitable socket or box end wrench in a vise and place the extended hub on the shaft in the socket or wrench. Hold the center housing upright and remove the wheel nut from the shaft.

   NOTICE: To prevent the possibility of bending the turbine wheel shaft, remove the compressor wheel nut from the shaft with a double universal socket and tee handle.

4. Press the compressor wheel from the wheel shaft assembly.

5. Withdraw the wheel shaft assembly from the center housing. The wheel shroud, which is not retained, will fall free when the wheel shaft is removed.

6. Remove and discard the turbine piston ring from the wheel shaft.

7. Bend down the lock tabs and remove the four bolts and lockplates securing the backplate assembly to the center housing and remove the backplate assembly. Tap the backplate lightly to remove it from the center housing recess.

8. Remove and discard the seal ring from the groove in the center housing.

9. Remove the thrust spacer and piston ring(s) from the backplate assembly. Discard the piston ring(s).

10. Remove the thrust collar, inboard thrust washer, bearing, bearing washer and snap ring from the center housing. Discard the thrust washer, bearing, washer and snap ring.

11. Remove the snap ring, bearing, bearing washers and snap ring from the opposite end of the center housing. Discard the snap rings, bearing and washers.

Cleaning

Before cleaning, inspect all of the parts for signs of burning, rubbing or other damage which might not be evident after cleaning.

Soak all parts in a non-caustic cleaning solvent for about 25 minutes. After soaking, use a stiff bristle brush and remove all dirt particles. Dry all of the parts throughly.

CAUTION: Never use a caustic cleaning solution for cleaning as this will damage certain parts. Use the cleaning solution in an open or well ventilated area. Avoid breathing the fumes. Keep away from open flames. Do not use a wire brush or a steel blade scraper to clean the parts.

Make sure that both wheel blades are thoroughly clean. Deposits left on the blades will affect the balance of the rotating assembly.

Clean all of the internal cavities and oil passages in the center housing thoroughly with dry compressed air.

- **CAUTION: To prevent possible personal injury, wear adequate eye protection and do not exceed 40 psi (276 kPa) air pressure.**

Clean the oil passage in the center housing thrust plate with dry compressed air.

Remove the oil inlet and outlet lines from the engine and thoroughly clean the oil lines inside and out. An oil line that is dented or cramped enough to restrict the flow of oil must be replaced.

Inspection

Inspect all of the parts for signs of damage, corrosion or deterioration. Check for nicked, crossed or stripped threads.

Visually check the turbine wheel shroud and turbine wheel for signs of rubbing.

Inspect the shaft for signs of scoring, scratches or bearing seizure.

Check the compressor wheel for signs of rubbing or damage from foreign material. Check to see that the wheel bore is not galled. The wheel must be free of dirt and other foreign material.

Inspect the seal parts for signs of rubbing or scoring of the running faces.

Inspect the backplate for wear or damaged bore (piston ring groove).

Inspect the housing for contact with the rotating parts.

The oil and air passages must be clean and free of obstructions.

Minor surface damage may be burnished or polished. Use a Silicone Carbide abrasive cloth for aluminum parts or a crocus abrasive cloth for steel parts. It is recommended that the seal ring, piston rings, bearings, snap rings, lockplates and bolts be replaced at time of disassembly.

Inspect the exhaust outlet elbow seal ring for signs of wear or breakage.

Assemble Turbocharger

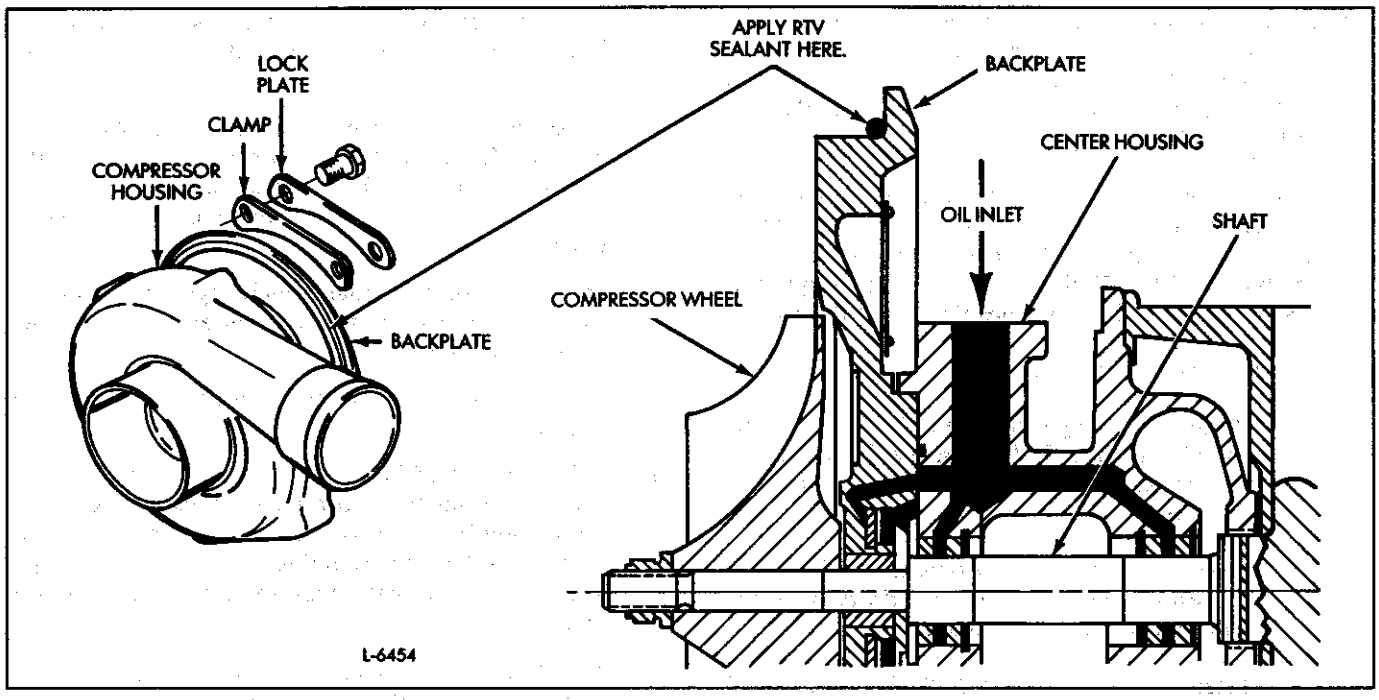
Check each part prior to installation to ensure cleanliness. As the parts are assembled, cover the openings to prevent entry of dirt or other foreign material.

TO4B Turbocharger – Fig. 15.

1. Lubricate the new bearings with clean engine oil.
2. Install a new snap ring, bearing and snap ring in the turbine end of the center housing, using snap ring pliers J 28507.
3. Install a new snap ring, bearing and snap ring in the compressor end of the center housing, using snap ring pliers J 28507.
4. Fill the piston ring groove in the turbine wheel shaft assembly with high vacuum silicone grease. Then install the piston ring on the wheel assembly.
5. Position the wheel shroud on the wheel of the shaft assembly and insert the shaft assembly into the center housing as far as it will go.

   NOTICE: Be careful not to scuff or scratch the bearings when installing the shaft and do not force the piston ring into the center housing bore.
6. Place the turbine wheel shaft assembly, shroud and center housing upright in a suitable holding fixture as shown in Fig. 8. If a holding fixture is not available, clamp a suitable socket or box wrench in a vise and place the extended hub on the shaft in the socket or wrench.
7. Lubricate the thrust collar and thrust bearing with clean engine oil and install the thrust collar on the shaft of the turbine wheel assembly. Then install the thrust bearing in the groove of the collar and slide the assembled parts down against the center housing so that the pins engage the holes in the thrust bearing.
8. Install a new piston ring on the thrust collar.

   NOTICE: To avoid breakage, do not force the piston ring into place.
9. Install a new seal ring in the groove at the compressor end of the center housing.



• Fig. 17 – Application of RTV Sealant

10. Install the backplate assembly over the shaft and carefully guide the piston ring on the shaft into the backplate bore, ring gap first.

- On engine applications where crankcase vapors are routed to the breather system and into the air intake of the T04B turbocharger, oil seepage may be experienced between the turbocharger compressor housing and the backplate area. If seepage is observed in this area, apply a small uniform bead of high temperature RTV sealant on the outside diameter of the backplate (Fig. 17)

- **NOTICE:** Make certain that the sealant does not cause compressor housing misalignment, which can result in compressor wheel–to–housing contact and resultant damage.

- Surfaces must be clean and dry. Application instructions for the sealant are normally available on the RTV tube or package.

11. Align the oil feed holes in the center housing and the backplate assembly and attach the backplate to the center housing with bolts and new lockplates. Tighten the bolts to 75–90 **lb–in** (8–10 N·m) torque and bend the lockplate tabs up against the side of the bolt heads.

NOTICE: If a new backplate with a warning plate is inadvertently installed, *the warning plate must be removed and the three drive screw holes plugged to prevent air leakage.*

12. With the compressor wheel at room temperature, position it over the shaft.

13. Lightly lubricate the shaft threads and wheel face that will be under the nut with engine oil and install the locknut on the shaft. Tighten the nut to 18–20 **lb–in** (2 N·m) torque above the drag torque required to bottom the locknut.

NOTICE: Bottoming of the locknut will be indicated by the sharp increase above the drag torque observed while running the nut down.

14. Retighten the locknut through an angle of 90°. This additional tightening will result in stretching the shaft .0055″ to .0065″ in length. *Tighten the retaining nut in such a manner as not to impose a bending load on the shaft.*

15. Check the bearing axial end play:

    a. Clamp the center housing assembly in a bench vise equipped with soft jaws as shown in Fig. 9.

    b. Fasten the dial indicator and magnetic base (J 7872–2) to the center housing so that the indicator tip rests on the end of the rotating shaft on the compressor side (Fig. 9).

    c. Move the shaft axially back and forth by hand. The total indicator reading should be between .004″ and .009″. If the total dial indicator readings do not fall within the specified limits, repair or replace the rotating assembly.

16. Position the turbine housing as marked at disassembly against the center housing and secure it in place with clamps, new lockplates and bolts. Tighten the bolts to 100–130 **lb–in** (11–15 N·m) torque and bend the tabs of the lockplates up against the bolts.

17. Position the compressor housing as marked at disassembly against the center housing and secure it in place with clamps, new lockplates and bolts. Tighten the bolts to 100–130 **lb–in** (11–15 N·m) torque and bend the tabs of the lockplates up against the bolts.

18. Check the shaft radial movement:

    a. Position the magnetic base J 7872–2 with the swivel adaptor J 7872–3 on the flat surface of the turbine housing inlet flange as shown in Fig. 10.

    b. Fasten the dial indicator extension rod J 7872–1 to the dial indicator J 8001–3 and attach the dial indicator to the swivel adaptor.

    c. Insert the extension rod J 7872–1 into the oil drain tube mounting pad opening so that the rod is against the wheel shaft and is perpendicular to the shaft.

    NOTICE: Make sure the extension rod does not make contact with the sides of the center housing, otherwise it will be impossible to obtain an accurate reading.

    d. Grasp each end of the rotating assembly (Fig. 10) and, applying equal pressure at each end, move the rotating shaft first toward and then away from the dial indicator, creating a transverse movement in the shaft. The dial indicator displacement should be between .003" and .007". If the displacement does not fall within these limits, disassemble and repair or replace the rotating assembly.

19. If it is to be stored, lubricate the unit internally and install protective covers on all openings.

20. Stamp the letter "R" in the lower left–hand corner of the name plate to identify that the turbocharger has been reworked.

TV61 Turbocharger – Fig. 16.

1. Lubricate the new bearings with clean engine oil.

2. Install a new snap ring, bearing washer, bearing and snap ring in the turbine end of the center housing.

3. Install a new snap ring, bearing washer and bearing in the compressor end of the center housing.

4. Install new piston rings on the thrust spacer and gently insert the spacer into the backplate assembly. *Do not force the piston into place.*

5. Make sure the compressor bearing is in place, then position the inboard thrust washer flat against the center housing with the hole and cutout in the thrust washer in alignment with the pins in the center housing.

6. Install the thrust collar snugly against the thrust washer. Lubricate the thrust collar and thrust washer with clean engine oil.

7. Install a new seal ring in the groove at the compressor end of the center housing.

8. Align the oil feed holes in the center housing and the backplate assembly and attach the backplate to the center housing with four bolts and new lockplates. Tighten the bolts to 80–100 **lb–in** (9–11 N·m) torque and bend the lockplate tangs up against the side of the bolt heads.

    NOTICE: If a new backplate with a warning plate is inadvertently installed, *the warning plate must be removed and the three drive screw holes plugged to prevent air leakage.*

9. Install a new piston ring on the turbine wheel shaft assembly. Before installing the piston ring, fill the piston ring groove with Dow Corning High Vacuum Silicone grease, or equivalent.

10. Position the wheel shroud against the center housing and insert the wheel shaft assembly through the wheel shroud and into the center housing. *Be careful not to scuff or scratch the bearings when installing the shaft.*

11. Place the turbine wheel shaft assembly, shroud, center housing and backplate upright in a suitable holding fixture (Fig. 8). If a holding fixture is not available, clamp a suitable socket or box wrench in a vise and place the extended hub on the shaft in the socket or wrench.

12. With the compressor wheel at room temperature, position it over the shaft.

13. Lightly lubricate the shaft threads and wheel face that will be under the nut with engine oil and install the retaining nut. Tighten the nut to 125–150 **lb–in** (14–17 N·m) torque to seat the compressor wheel against the thrust spacer.

14. Loosen the nut and inspect the nut face and front face of the compressor wheel to be sure they are smooth and clean.

15. Retighten the nut to 35–55 **lb–in** (4–6 N·m) torque.

16. Continue to tighten the retaining nut until the shaft increases in length .009"–.010". Tighten the nut in

such a manner as not to impose bending loads on the shafts.

If equipment is not available to measure the shaft stretch, tighten the wheel retaining nut to 35–55 **lb–in** (4–6 N·m) torque. Then continue to tighten the nut through an angle of 120–130° turn (90° is 1/4 turn).

17. Check the bearing axial end play:

    a. Clamp the center housing assembly in a bench vise equipped with soft jaws as shown in Fig. 9.

    b. Fasten the dial indicator and magnetic base (J 7872–2) to the center housing so that the indicator tip rests on the end of the rotating shaft on the compressor side (Fig. 9).

    c. Move the shaft axially back and forth by hand. The total indicator reading (thrust float) should be between .003" and .010". If the total dial indicator readings do not fall within the specified limits, repair or replace the rotating assembly.

18. Position the turbine housing as marked at disassembly against the center housing and secure it in place with the "V" band coupling. Position the "V" band coupling between the turbine housing and center housing so that the bolt end does not interfere with the turbine housing. Failure to properly orient the "T" bolt end of the clamp can result in an exhaust leak and/or turbine wheel damage. Tighten the toggle nut as follows:

    a. Lubricate the toggle bolt threads with a high temperature anti–seize compound, such as Jet Lube (Mil Spec A–907D), or equivalent.

    b. Tighten the nut on the "V" band toggle bolt to approximately 160 **lb–in** (18 N·m) torque.

    NOTICE: To avoid turbocharger damage, do not pull a misaligned turbine housing into alignment with the "V" band coupling. The parts must be aligned and seated first.

    c. Loosen the "V" band coupling nut to approximately 50 **lb–in** (6 N·m) torque, then retorque the nut to 152–168 **lb–in** (17–19 N·m) torque.

19. Position the compressor housing as marked at disassembly against the backplate and secure it in place with the "V" band coupling. Lightly lubricate the threads of the toggle bolt with engine oil and tighten the nut to 110–130 **lb–in** (12–15 N·m) torque.

20. Check the shaft radial movement.

    a. Position the magnetic base J 7872–2 with the swivel adaptor J 7872–3 on the flat surface of the turbine housing inlet flange as shown in Fig. 10.

    b. Fasten the dial indicator extension rod J 7872–1 to the dial indicator J 8001–3 and attach the dial indicator to the swivel adaptor.

    c. Insert the extension rod J 7872–1 into the oil drain tube mounting pad opening so that the rod is against the wheel shaft and is perpendicular to the shaft.

    NOTICE: Make sure the extension rod does not make contact with the sides of the center housing, otherwise it will be impossible to obtain an accurate reading.

    d. Grasp each end of the rotating assembly (Fig. 10) and, applying equal pressure at each end, move the rotating shaft first toward and then away from the dial indicator, creating a transverse movement in the shaft. The dial indicator displacement should be between ,003" and .007". If the displacement does not fall within these limits disassemble and repair or replace the rotating assembly.

21. If it is to be stored, lubricate the unit internally and install protective covers on all openings.

22. Stamp the letter "R" in the lower left–hand corner of the name plate to identify that the turbocharger has been reworked.

Install Turbocharger

1. Attach a chain hoist and a suitable lifting sling to the turbocharger assembly.

2. Remove the covers from the air inlet and exhaust outlet openings on the engine that were placed over the openings when the turbocharger was removed.

3. Place the turbocharger assembly into position. Use a new gasket between the exhaust manifold adaptor or exhaust outlet flange and the turbine housing flange.

   When attaching the exhaust flange or adaptor to the turbine housing, be sure the inner diameter of the adaptor or flange is the same as the turbine inner diameter. The turbine opening in a T04B turbocharger is 2.581" and the TV61 turbocharger is 3.100".

4. Secure the T04B turbocharger to the mounting bracket with bolts, lock washers and nuts. Tighten the nuts just enough to hold the turbocharger tight against the bracket.

   When self–locking nuts are used to secure the turbocharger to the mounting bracket, be sure there is

full thread engagement (at least one full thread above the nut) of the self–locking nuts on the bolts.

5. Slide the blower air inlet tube hose over the compressor housing outlet opening and secure it in place with the hose clamps.

6. Tighten the turbocharger to exhaust manifold adaptor (T04B) or exhaust outlet flange (TV61) bolts securely. Then remove the chain hoist and lifting sling from the turbocharger.

7. Install the oil drain line between the opening in the bottom side of the center housing and the cylinder block.

8. Attach the oil inlet line to the cylinder block.

9. After installing a rebuilt or new turbocharger, it is very important that all of the moving parts of the turbocharger center housing be lubricated as follows:

   a. Clean the area and disconnect the oil inlet (supply) line at the bearing (center) housing (Fig. 14).

   b. Fill the bearing housing cavity with clean engine oil. Turn the rotating assembly by hand to coat all of the internal surfaces with oil.

   c. Add additional engine oil to completely fill the bearing housing cavity and reinstall the oil line. Clean off any spilled oil.

   d. Start and run the engine at idle until oil pressure and supply has reached all of the turbocharger moving parts. A good indicator that all of the moving parts are getting lubrication is when the oil pressure gage registers pressure (10 psig – 69 kPa at idle speed).

   CAUTION: Do not hold the compressor wheel, for any reason, while the engine is running. This could result in personal injury.

   The free floating bearings in the turbocharger center housing require positive lubrication. This is provided by the above procedure *before the turbocharger reaches its maximum operating speed* which is produced by high engine speeds.

   NOTICE: Starting any turbocharged engine and accelerating to any speed above idle before engine oil supply and pressure has reached the free floating bearings can cause severe damage to the shaft and bearings of the turbocharger.

10. Check all connections, ducts and gaskets for leaks.

11. Operate the engine at rated output and listen for sound of metallic contact from the turbocharger. If any such noise is apparent, stop the engine immediately and correct the cause.

    NOTICE: After the turbocharger has been operating long enough to permit the unit and the oil to warm up, the rotating assembly should coast freely to a stop after the engine is stopped. If the rotating assembly jerks to a sudden stop, the cause should be immediately determined and eliminated.

TV7301 AND TV8101 TURBOCHARGERS

•Turbocharger Safety

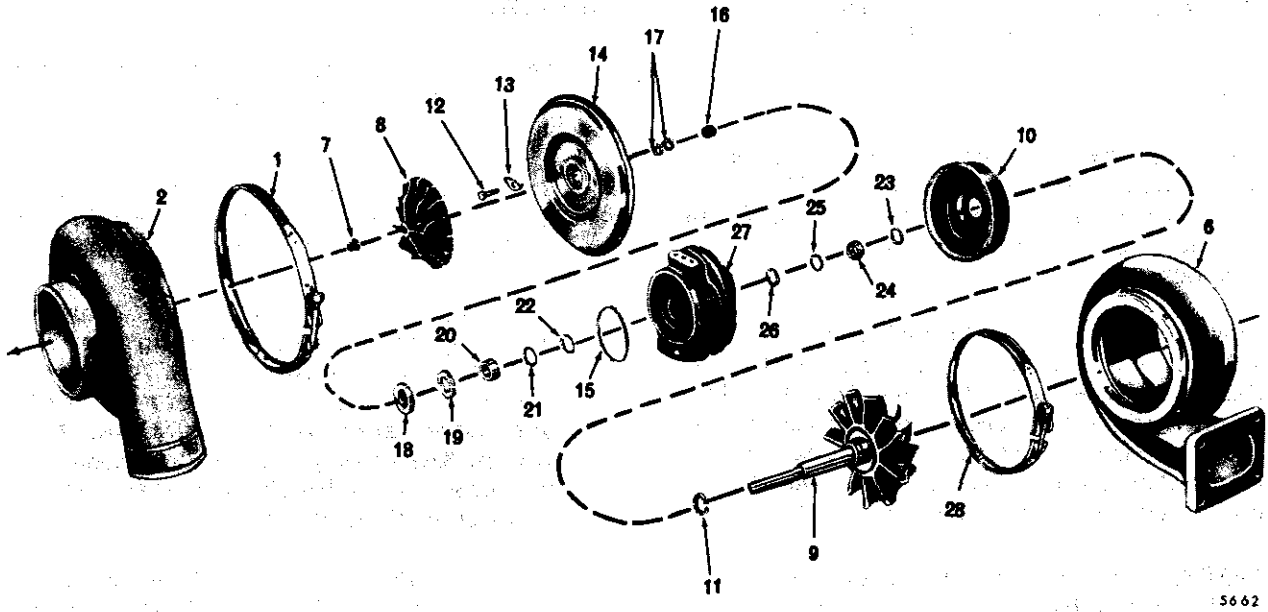
Effective February of 1988, a new guard assembly was installed over the compressor inlets of Airesearch TV 7301 and TV 8101 turbochargers. The new two–piece assembly is intended to protect the service technician from the exposed turbocharger compressor wheel when the engine is operated with the air inlet piping removed from the compressor housing. The guard assembly also prevents foreign objects from being ingested by the turbocharger and causing damage.

The guard assembly is permanently retained by a bead machined on the end of the compresor housing. This bead became a standard feature on Airesearch turbochargers in the fourth quarter of 1978.

Compressor housings for TV 7301 and TV 8101 turbochargers are serviced with the inlet guard installed.

CAUTION: The guard assembly forms a permanent part of the compressor housing and must not be removed. Removing the guard will result in a potential for personal injury from the exposed, rotating compressor wheel. Attempting to remove the guard will also result in damage to the guard and the housing. A damaged guard or housing cannot be reused.

Because of the added margin of safety provided by the inlet guard assembly, DDC recommends having the guard installed on early TV 7301 and TV 8101 turbochargers when the air inlet piping is removed for any reason.



1.	Coupling—"V" Band	10.	Shroud—Turbine Wheel	17.	Ring—Piston	23.	Ring—Snap
2.	Housing—Compressor	11.	Ring—Turbine Piston	18.	Collar—Thrust	24.	Bearing
6.	Housing—Turbine	12.	Screw	19.	Washer—Inboard Thrust	25.	Washer—Bearing
7.	Nut—Self-Locking	13.	Lockplate	20.	Bearing	26.	Ring—Snap
8.	Wheel—Compressor	14.	Backplate Assembly	21.	Washer—Bearing	27.	Housing—Center
9.	Shaft—Turbine Wheel Assembly	15.	Ring—Seal	22.	Ring—Snap	28.	Coupling—"V"
		16.	Spacer—Thrust				

Fig. 18 - TV7301 and TV8101 Turbocharger Details and Relative Location of Parts

CAUTION: The guard assembly cannot be installed on certain turbochargers becuase they have smaller (5.58") compressor inlet diameters. To avoid the potential for personal injury, shield J 26554-A (Fig. 4) should be installed whenever the air inlet piping is removed from these turbochargers.

Remove Turbocharger

1. Disconnect the exhaust manifold adaptor attached to the turbine housing.
2. Disconnect the air inlet hose attached to the compressor housing.
3. Remove the oil inlet line from the top of the center housing.
4. Remove the oil outlet line from the bottom of the center housing.
5. Attach a chain hoist and a suitable lifting sling to the turbocharger assembly.
6. Remove the nuts and lock washers securing the turbocharger assembly to the mounting bracket. Then lift the turbocharger assembly away from the engine and place it on a bench.
7. Cover the end of each oil inlet and oil outlet line and the air inlet and exhaust outlet openings on the engine to prevent the entry of foreign material.

Disassemble Turbocharger

Clean the exterior of the turbocharger with a non-caustic cleaning solvent before disassembly and proceed as follows:

Mark related positions of the compressor housing, center housing and turbine housing with a punch or scribe prior to disassembly to assure reassembly in the same relative position.

1. Refer to (Fig. 18) and loosen the "V" band coupling (1) securing the compressor housing (2) to the backplate assembly (14) and remove the compressor housing and "V" band.

NOTICE: Exercise care when removing the compressor housing and turbine housing to prevent damage to the compressor and turbine wheels.

2. Loosen the "V" band coupling (28) securing the turbine housing (6) to the center housing (27). Remove the turbine housing from the center housing. Tap the housing with a soft hammer if force is needed for removal.

3. Position the turbine wheel (9) of the center housing assembly in a suitable holding fixture (Fig. 19). Remove the wheel nut (7) from the shaft. If a holding fixture is not available, clamp a suitable socket or box end wrench in a vise and place the extended hub on the shaft in the socket or wrench. Hold the center housing upright and remove the wheel nut from the shaft.

   NOTICE: To prevent the possibility of bending the turbine wheel shaft, remove the compressor wheel nut from the shaft with a double universal socket and tee handle.

4. Press the compressor wheel (8) from the wheel shaft assembly (9).

5. Withdraw the wheel shaft assembly (9) from the center housing. The wheel shroud (10), which is not retained, will fall free when the wheel shaft is removed.

6. With the TV7301 and TV8101 turbocharger remove and discard the turbine piston ring (11) from the wheel shaft.

7. Bend down the lock tabs and remove the four bolts (12) and lockplates (13) securing the backplate assembly (14) to the center housing (27) and remove the backplate assembly. Tap the backplate lightly to remove it from the center housing recess.

8. Remove and discard the seal ring (15) from the groove in the center housing.

9. Remove the thrust spacer (16) and piston ring(s) (17) from the backplate assembly. Discard the piston ring(s).

10. Remove the thrust collar (18), inboard thrust washer (19), bearing (20), bearing washer (21) and snap ring (22) from the center housing. Discard the thrust washer, bearing, washer and snap ring.

11. Remove the snap ring (23), bearing (24), bearing washers (25) and snap ring (26) from the opposite end of the center housing. Discard the snap rings, bearing and washers.

Cleaning

Before cleaning, inspect the parts for signs of burning, rubbing or other damage which might not be evident after cleaning.

Soak all parts in a non-caustic cleaning solvent for about 25 minutes. After soaking, use a stiff bristle brush and remove all dirt particles. Dry all of the parts thoroughly.

CAUTION: Never use a caustic cleaning solution for cleaning as this will damage certain parts. Use the cleaning solution in an open or well ventilated area. Avoid breathing the fumes. Keep away from open flames. Do not use a wire brush or a steel blade scraper to clean the parts.

Make sure that both wheel blades are thoroughly clean. Deposits left on the blades will affect the balance of the rotating assembly.

Clean all of the internal cavities and oil passages in the center housing thoroughly with dry compressed air.

CAUTION: To prevent possible personal injury, wear adequate eye protection and do not exceed 40 psi (276 kPa) air pressure.

Clean the oil passage in the center housing thrust plate with dry compressed air.

Remove the oil inlet and outlet lines from the engine and thoroughly clean the oil lines inside and out. An oil line that is dented or crimped enough to restrict the flow of oil must be replaced.

Inspection

Inspect all of the parts for signs of damage, corrosion or deterioration. Check for nicked, crossed or stripped threads.

Visually check the turbine wheel for signs of rubbing or wear. For shaft bearing journal dimensions and wear limits, refer to Section 3.0.

Inspect the shaft for signs of scoring, scratches or bearing seizure.

Check the compressor wheel for signs of rubbing or damage from foreign material. Check to see that the wheel bore is not galled. The wheel must be free of dirt and other foreign material.

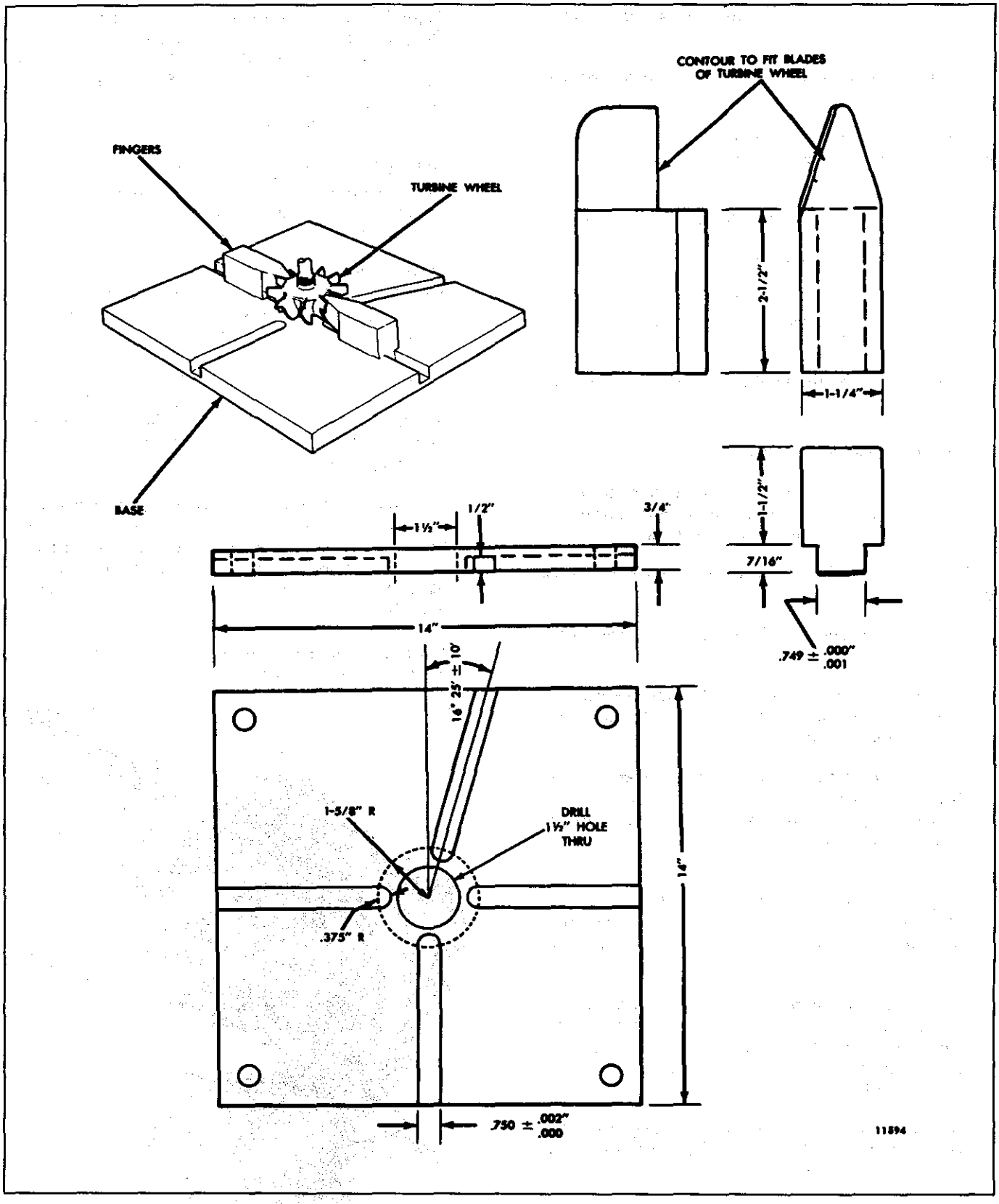


Fig. 19 – Turbocharger Holding Fixture

Inspect the seal parts for signs of rubbing or scoring of the running faces.

Inspect the backplate for wear or damaged bore (piston ring groove).

Inspect the housing for contact with the rotating parts. The oil and air passages must be clean and free of obstructions.

Minor surface damage may be burnished or polished. Use a silicone carbide abrasive cloth for aluminum parts or a crocus abrasive cloth for steel parts.

It is recommended that the piston rings, thrust washers, bearing, bearing washers and snap rings be replaced at time of disassembly.

Inspect the exhaust outlet elbow seal ring for signs of wear or breakage.

Assemble Turbocharger

Check each part prior to installation to ensure cleanliness. As the parts are assembled, cover the openings to prevent entry of dirt or other foreign material.

Refer to (Fig. 18) for parts orientation and proceed as follows:

1. Lubricate the bearings (20 and 24) with clean engine oil.
2. Install a new snap ring (26), bearing washer (25), bearing (24) and new snap ring (23) in the turbine end of the center housing (27).
3. Install a new snap ring (22), bearing washer (21) and bearing in the compressor end of the center housing. Install the current inboard thrust bearing (three oil grooves) with the smooth side against the center housing.
4. Install a new piston ring(s) (17) on the thrust spacer (16) and gently insert the spacer into the backplate assembly (14). *Do not force the piston ring(s) into place.*
5. Make sure the compressor bearing is in place, then position the new inboard thrust washer (19) flat against the center housing with the hole and cutout in the thrust washer in alignment with the pins in the center housing.
6. Install the thrust collar (18) snugly against the thrust washer. Lubricate the thrust collar and thrust washer with clean engine oil.
7. Install a new seal ring (15) in the groove at the compressor end of the center housing.
8. Align the oil feed holes in the center housing (27) and the backplate assembly (14) and attach the backplate to the center housing with four bolts (12) and new lockplates (13). Tighten bolts to 80–100 ***lb–in*** (9–11 N·m) torque and bend the lockplate tangs up against the side of the bolt heads.

   NOTICE: If a new backplate with a warning plate is inadvertently installed, *the warning plate must be removed and the three drive screw holes plugged to prevent air leakage.*
9. Install a new turbine piston ring (11) on the wheel shaft assembly. Before installing the piston ring, fill the piston ring groove with Dow Corning High Vacuum Silicone grease, or equivalent.
10. Position the wheel shroud (10) against the center housing (27) and insert the wheel shaft assembly (9) through the wheel shroud and into the center housing. Be careful not to scuff or scratch the bearings when installing the shaft.
11. Place the turbine wheel shaft assembly, shroud, center housing and backplate upright in a suitable holding fixture (Fig. 41). If a holding fixture is not available, clamp a suitable socket or box wrench in a vise and place the extended hub on the shaft in the socket or wrench.
12. With the compressor wheel at room temperature, position it over the shaft.

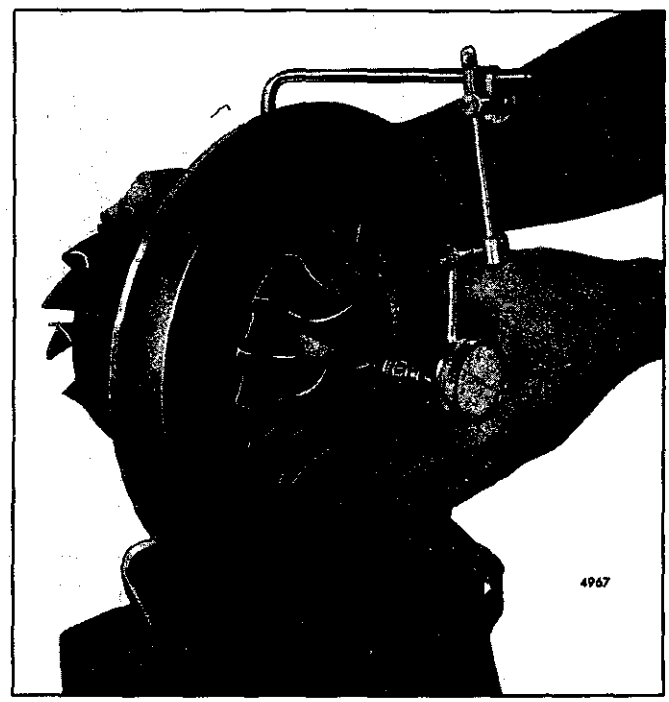


Fig. 20 – Checking Bearing Axial End Play

13. Lightly lubricate the shaft threads and wheel face that will be under the nut with engine oil and install the retaining nut. Tighten the nut to 125–150 ***lb–in*** (14–17 N·m) torque to seat the compressor wheel against the thrust spacer.

14. Loosen the nut and inspect the nut face and front face of the compressor wheel to be sure they are smooth and clean.

15. Retighten the nut to 35–55 ***lb–in*** (4–6 N·m) torque.

16. Continue to tighten the retaining nut until the shaft increases in length .009"–.010". Tighten the nut in such a manner as not to impose bending loads on the shafts.

    If equipment is not available to measure the shaft stretch, tighten the wheel retaining nut to 35–55 ***lb–in*** (4–6 N·m) torque. Then continue to tighten the nut through an angle of 120–130° turn for the TV71 and TV81 (90° = 1/4 turn).

17. Check the bearing axial end play:

    a. Clamp the center housing assembly in a bench vise equipped with soft jaws (Fig. 20).

    b. Fasten the dial indicator and magnetic base (J 7872–2) to the center housing so that the indicator tip rests on the end of the rotating shaft on the compressor side (Fig. 20).

    c. Move the shaft axially back and forth by hand. The total indicator reading (thrust float) should be between .003" and .010". If the total dial indicator readings do not fall within the specified limits, repair or replace the rotating assembly.

18. Position the turbine housing (6) as marked at disassembly against the center housing (27) and secure it in place.

    Position the "V" band coupling (28) between the turbine housing and center housing so that the "T" bolt end does not interfere with the turbine housing.

    NOTICE: Failure to properly orient the "T" bolt end of the clamp can result in an exhaust leak and/or turbine wheel damage.

    Then tighten the "V" band coupling nut as follows:

    a. Lubricate the toggle bolt threads with a high temperature anti–seize compound, such as Jet Lube (Mil Spec A–907D), or equivalent.

    b. Tighten the nut on the "V" band bolt to approximately 160 ***lb–in*** (18 N·m) torque.

    NOTICE: To avoid component damage, do not pull a misaligned turbine housing into alignment with the "V" band coupling. The parts must be aligned and seated first.

    c. Loosen the "V" band coupling nut to approximately 50 ***lb–in*** (6 N·m) torque, then retorque the nut to 152–168 ***lb–in*** (17–19 N·m) torque.

19. Position the compressor housing (2) as marked at disassembly against the backplate (14) and secure it in place with the "V" band coupling (1). Lightly lubricate the threads of the toggle bolt with engine oil and tighten the nut to 110–130 ***lb–in*** (12–15 N·m) torque.

20. Check the shaft radial movement:

    a. Position the magnetic base J 7872–2 with the swivel adaptor J 7872–3 on the flat surface of the turbine housing inlet flange (Fig. 21).

    b. Fasten the dial indicator extension rod J 7872–1 to the dial indicator J 8001–3 and attach the dial indicator to the swivel adaptor.

    c. Insert the extension rod J 7872–1 into the oil drain tube mounting pad opening so that the rod is against the wheel shaft and is perpendicular to the shaft.

    NOTICE: Make sure the extension rod does not make contact with the sides of the center housing, otherwise it will be impossible to obtain an accurate reading.

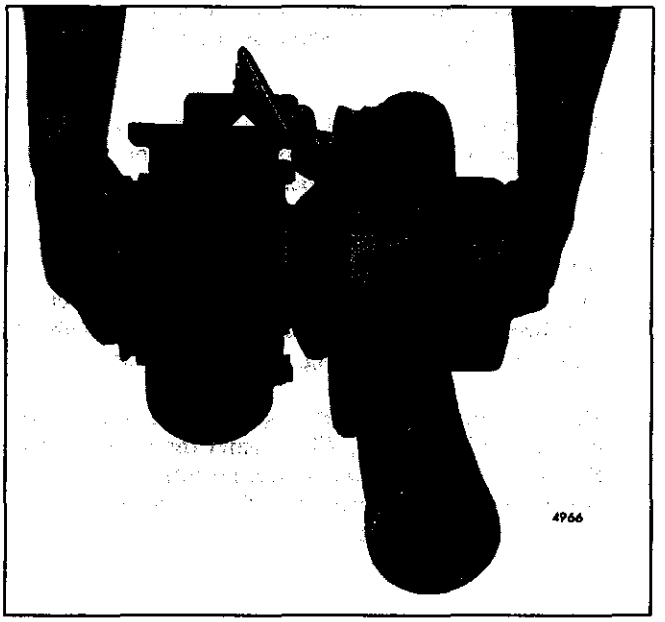


Fig. 21 – Checking Shaft Radial Movement

d. Grasp each end of the rotating assembly (Fig. 21) and, applying equal pressure at each end, move the rotating shaft first toward and then away from the dial indicator, creating a transverse movement in the shaft. The dial indicator displacement should be between .003" and .007". If the displacement does not fall within these limits, disassemble and repair or replace the rotating assembly.

21. If it is to be stored, lubricate the unit internally and install protective covers on all openings.

22. Stamp the letter "R" in the lower left-hand corner of the name plate to indicate that the turbocharger has been reworked.

Install Turbocharger

1. Attach a chain hoist and a suitable lifting sling to the turbocharger assembly.

2. Remove the covers from the air inlet and exhaust outlet openings on the engine that were placed over the openings when the turbocharger was removed.

   Be sure gaskets are installed at the three mounting bracket to flywheel housing attaching bolts.

3. Place the turbocharger assembly into position on the mounting bracket. Use a new gasket between the exhaust manifold adaptor and the turbine housing flange.

   When attaching the exhaust flange or adaptor to the turbine housing, be sure the inner diameter of the flange or adaptor is the same as the turbine housing inner diameter.

4. Secure the turbocharger to the mounting bracket with bolts, lock washers and nuts. Tighten the nuts just enough to hold the turbocharger tight against the bracket.

   When self-locking nuts are used to secure the turbocharger to the mounting bracket, be sure there is full thread engagement (at least one full thread above the nut) of the self-locking nuts on the bolts.

5. Slide the blower air inlet hose over the compressor housing outlet opening. Then center the hose between the turbocharger and the blower air inlet housing and secure the clamps with the "T" section positioned away from the parting line on the air inlet housing.

6. Tighten the turbocharger to exhaust manifold adaptor bolts securely. Then remove the chain hoist and lifting sling from the turbocharger.

7. Install the oil drain line between the opening in the bottom side of the center housing and the cylinder block.

8. Attach the oil inlet line to the cylinder block.

9. After installing a rebuilt or new turbocharger, it is very important that all moving parts of the turbocharger center housing be lubricated as follows:

   a. Clean the area and disconnect the oil inlet (supply) line at the bearing (center) housing.

   b. Fill the bearing housing cavity with clean engine oil.

   c. Reinstall the oil line. Clean off any spilled oil.

   d. Start and run the engine at idle until oil pressure and supply has reached all of the turbocharger moving parts. A good indicator that all of the moving parts are getting lubrication is when the oil pressure gage registers pressure (10 psi or 69 kPa at idle speed).

      CAUTION: Do not hold the compressor wheel, for any reason, while the engine is running. This could result in personal injury.

   The free floating bearings in the turbocharger center housing require positive lubrication. This is provided by the above procedure *before the turbocharger reaches its maximum operating speed* which is produced by high engine speeds. Starting any turbocharged engine and accelerating to any speed above idle before engine oil supply and pressure has reached the free floating bearings can cause severe damage to the shaft and bearings of the turbocharger.

10. Check all ducts and gaskets for leaks.

11. Operate the engine at rated output and listen for sounds of metallic contact from the turbocharger. If any such noise is apparent, stop the engine immediately and correct the cause.

    NOTICE: After the turbocharger has been operating long enough to permit the unit and the oil to warm up, the rotating assembly should coast freely to a stop after the engine is stopped. If the rotating assembly jerks to a sudden stop, the cause should be immediately determined and eliminated.

TURBOCHARGER (SCHWITZER)

The Schwitzer turbocharger, Model 3LM (2.7 square inches), (Figs. 1 and 3) is comprised of a centrifugal compressor which shares a bearing system and rotor shaft with an exhaust gas–driven turbine. The turbocharger boosts the blower intake pressure of an engine above that which would prevail if the engine were naturally aspirated. The rotating assembly is supported radially by a free–floating, pressure lubricated, sleeve type bearing. Axial end play is controlled by a stationary pressure lubricated thrust bearing, with attendant hardware in the compressor end of the bearing housing.

The oil cavity is separated from the air and exhaust chambers by piston type seal rings located in the cylindrical bores at both axial extremities of the bearing housing.

The external configuration of both the Schwitzer and the Airesearch turbochargers are identical and hardware connections will not change. However, the internal components are different.

Lubrication

Lubricating oil for the turbocharger is supplied under pressure through an external oil line extending from the engine cylinder block to the top of the center housing. From the oil inlet in the center housing, the oil flows through the drilled oil passages in the housing to the shaft bearing, thrust bearing and thrust sleeve. The oil returns by gravity to the engine oil pan through an external oil line extending from the bottom of the turbocharger center housing to the cylinder block.

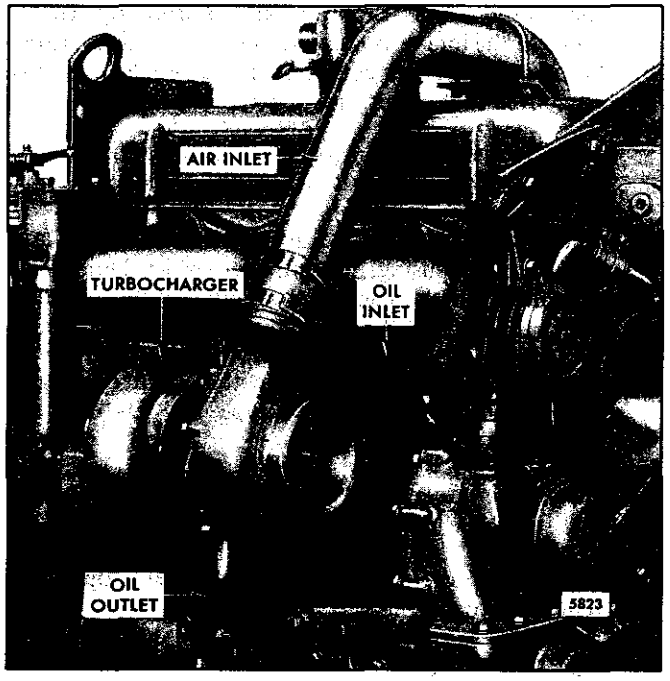


Fig. 1 – Model 3LM Turbocharger Assembly

Before the initial engine start, when a new or overhauled turbocharger is installed, the turbocharger must be pre–lubricated as outlined under *Install Turbocharger.*

> **NOTICE:** Failure to perform the pre–lubrication procedure may result in premature bearing failure due to "oil lag" or lack of lubrication.

Periodic Inspection

> **NOTICE:** A turbocharger compressor inlet shield, J 26554–A (Fig. 2), is available for use anytime the engine is operated with the air inlet piping removed. The shield helps to prevent foreign objects entering the turbocharger and prevents a service technician from touching the moving impeller. The use of this shield *does not* preclude any other saftey practices contained in this manual.

Inadequate air filtering and excessive restrictions to air and exhaust flows will adversely affect turbocharger life and performance. Do not permit restriction levels to exceed the specified limits (refer to Section 13.2).

A periodic inspection of the turbocharger should be made along with an engine inspection.

Inspect the turbocharger mountings and check all of the air ducting and connections for leaks. Make the inspection with the engine running and with it shut down. Check for leaks at the manifold connection, the turbine inlet and exhaust manifold gasket.

> **NOTICE:** Do not operate the engine if leaks are found in the turbocharger ducting or if the air cleaner is not filtering efficiently. Dust leaking into the air ducting can damage the turbocharger and the engine.

Remove the inlet duct to the turbocharger compressor housing and check for carbon or dirt buildup on the impeller or in the housing. Excessive accumulations indicate either a leak in the ducting or a faulty air filtering system. Remove all such accumulations and determine and correct the cause. Refer to *Troubleshooting Turbocharger* in Section 3.0. Uneven deposits left on the compressor wheel can affect the balance and cause premature bearing failure.

> **NOTICE:** Do not attempt to remove carbon or dirt buildup on the compressor or turbine wheels without removing the turbocharger from the engine. The blades on the wheels must be thoroughly cleaned. If chunks of carbon are left on the blades, an unbalanced condition would exist and subsequent failure of the bearings would result if the turbocharger is operated.

For proper operation, the turbocharger rotating assembly must turn freely. Whenever the exhaust ducting is removed, spin the turbine wheel by hand. If it does not spin freely, refer to Chart 1, Fig. 3. Inspect the compressor and turbine wheels for nicks or loss of material. Both wheels are precision balanced. A broken or bent blade can throw the rotating assembly out of balance and shorten the life of the turbocharger.

Inspect the oil inlet and oil return lines to make certain all of the connections are tight and that the lines are not dented or looped so that oil flow to and from the center housing is restricted. Looping the oil return lines disrupts gravity flow of the oil back to the engine. *Be sure the oil inlet lines are filled with oil and that they are clear of the turbine housing.*

Check for signs of oil leaking from the turbocharger housing. Lubricant applied under pressure to the center housing while the shaft is not turning may allow oil to enter the turbine and compressor housings. However, after the turbocharger has been operated for a time under load conditions and with the inlet restriction at normal, oil in these sections should disappear. If the oil does not disappear, refer to Chart 2, Fig. 3.

Oil pull–over from an oil bath type air cleaner can also cause oil to enter the compressor housing. Check for a dirty air cleaner element or for too low viscosity oil in the air cleaner. Also, too small an air cleaner could create excessive air flow velocity and result in oil pull–over.

Evidence of oil in the inlet or outlet ducts or dripping from either housing indicates a seal problem that will require overhaul of the turbocharger. Refer to Chart 3, Fig. 3.

Tests show there are three conditions that contribute to oil seal leakage at the internal turbocharger oil seal:

1. A worn or defective oil seal, which must be replaced.
2. High air inlet restriction (above specified limits). This will cause oil to be pulled past the oil seal.
3. Long periods of operation where the engine is being motored (using the engine as a braking device when going down a long hill). This can also cause oil to pass by the oil seal.

To confirm oil leakage from one or more of these conditions, remove the compressor housing and inspect the backplate. If the surface is wet with oil it indicates leakage.

If this test does not show leakage patterns the oil seal assembly is good for normal operation. This simple test will allow some positive testing on each engine in all cases.

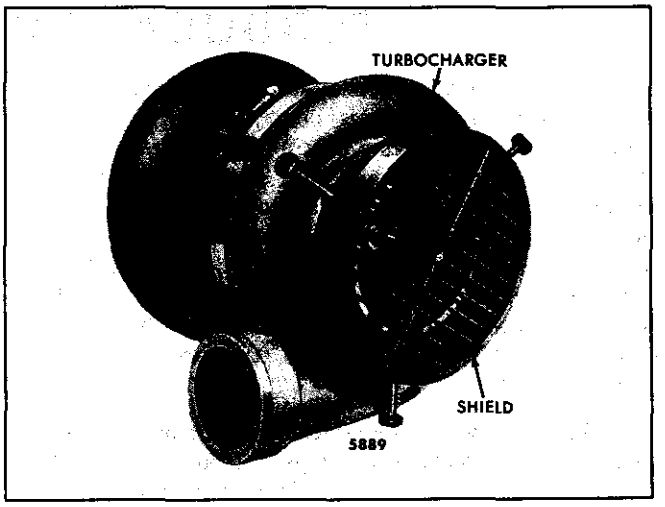


Fig. 2 – Inlet Shield (J 26554–A)

Turbocharger compressor end shaft oil seal effectiveness can be determined by the following procedure:

1. Determine that air inlet restriction is within the Detroit Diesel maximum limit. Refer to Section 13.2.
2. Be certain that turbocharger oil drain line is ununrestricted.
3. Be certain that the turbocharger has not obviously been damaged and in need of major repair.
4. Remove the air intake ducting. Inspect inside of the ducting for evidence of oil. If oil is found in the intake system, determine the source before proceeding with the compressor seal test and also thoroughly remove oil from the intake. Some external sources of oil are oil bath air cleaners, air compressor line, or a leak near an oil source such as an engine breather, etc.
5. Remove the compressor housing from the turbocharger.
6. Thoroughly clean the internal surfaces of the compressor housing, the impeller cavity behind the impeller, and the backplate annulus with a suitable solvent spray and then dry completely with shop air.
7. Spray the backplate annulus with a light coating of "Spot–Check" developer type SKD–MF, or equivalent.
8. Install the compressor housing on the turbocharger and reconnect the inlet and outlet connections.
9. Warm–up the engine to normal operating temperature.
10. Operate the engine at no load at the governor limited high speed for approximately five minutes.

TROUBLE SHOOTING CHARTS

CHART 1

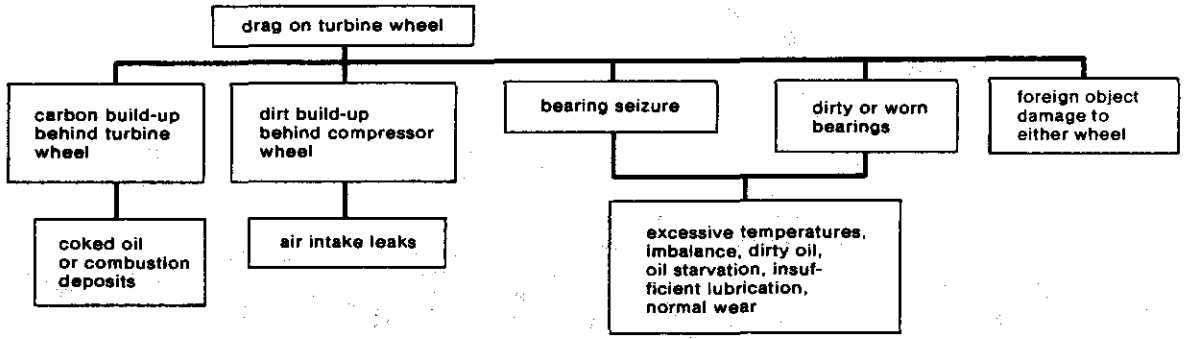


CHART 2

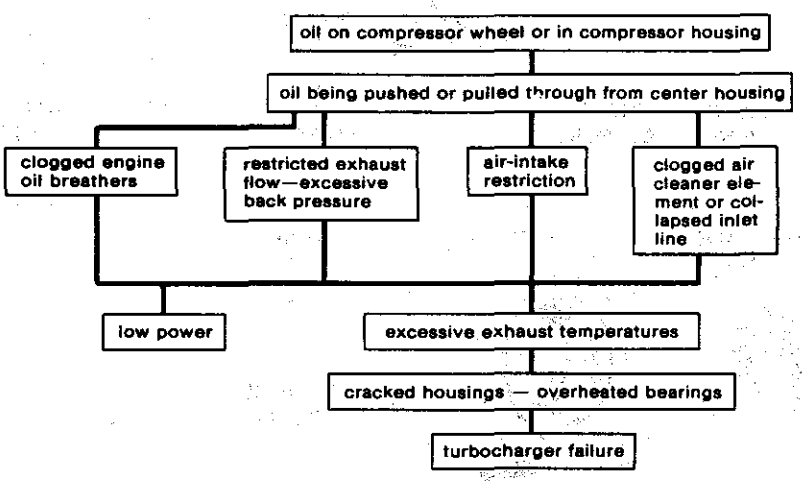


CHART 3

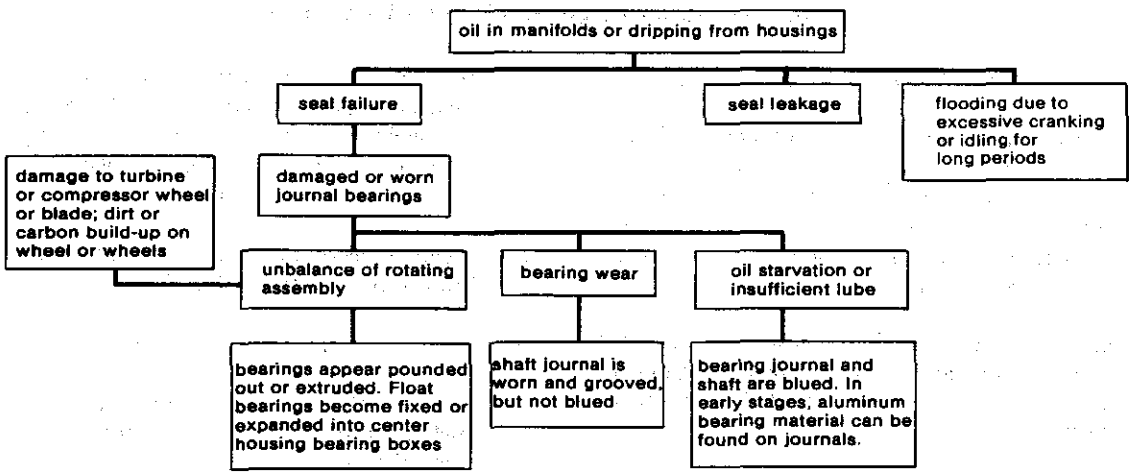


Fig. 3 – Inspection Checks for Turbocharger

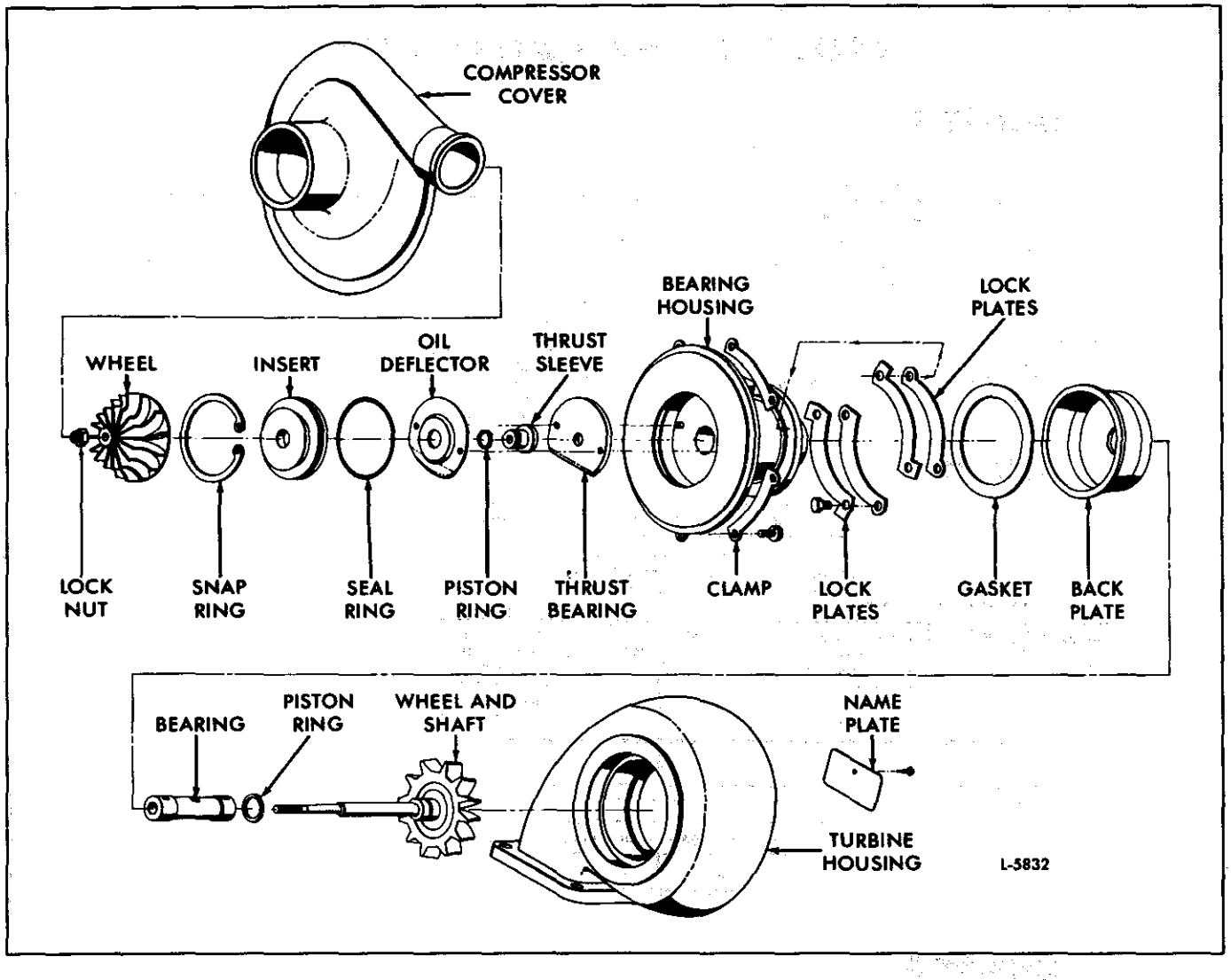


Fig. 4 – Model 3LM Turbocharger and Relative Location of Parts

11. Return the engine to low idle and then stop it.

12. Remove the intake duct and outlet hose and then remove the compressor housing. Evidence of compressor end shaft seal oil leakage will be observed as oil streaks in the "Spot-Check" developer on the backplate annulus. This surface should be completely free of oil streaks after the test.

13. If leakage is detected, and oil is positively not entering through the intake duct, then the turbocharger may be removed from the engine and inspected for damaged components.

Remove Turbocharger

1. Disconnect the air inlet connection and the exhaust outlet connection from the compressor housing and turbine housing respectively. This will permit inspection of the compressor and turbine wheels. Spin and wobble the rotor assembly variously by hand for evidence of wheel to turbine housing and impeller to compressor housing contact.

2. Remove the oil inlet and outlet lines from the top and bottom of the bearing housing.

3. Attach a suitable lifting sling to the turbocharger.

4. Remove the nuts and lock washers securing the turbocharger to the mounting bracket. Lift the turbocharger from the engine.

5. Cover the oil inlet and outlet openings and the air inlet and exhaust openings on the engine to prevent the entry of foreign material.

Disassemble Turbocharger

CAUTION: To avoid personal injury during disassembly it is recommended that safety glasses be used.

1. Clean the exterior of the turbocharger with a non–caustic cleaning solvent before disassembly and proceed as follows:

   NOTICE: Exercise care when removing the compressor housing and turbine housing from the bearing housing to prevent damage to the compressor and turbine wheels.

2. Secure the turbine housing mounting flange in a vise and bend back the lock tabs on the lock plates. Then remove the four screws, two lock plates and two clamps.

3. Remove the rotating assembly and compressor cover as an assembly out of the turbine housing and invert it and place it on a work bench with the turbine wheel facing up.

4. Remove the eight screw and lock washer assemblies and four clamps. Then remove the rotating assembly from the compressor cover.

5. With the turbine wheel lug of the rotating assembly in a 1" wrench (Fig. 5), remove and discard the compressor wheel lock nut.

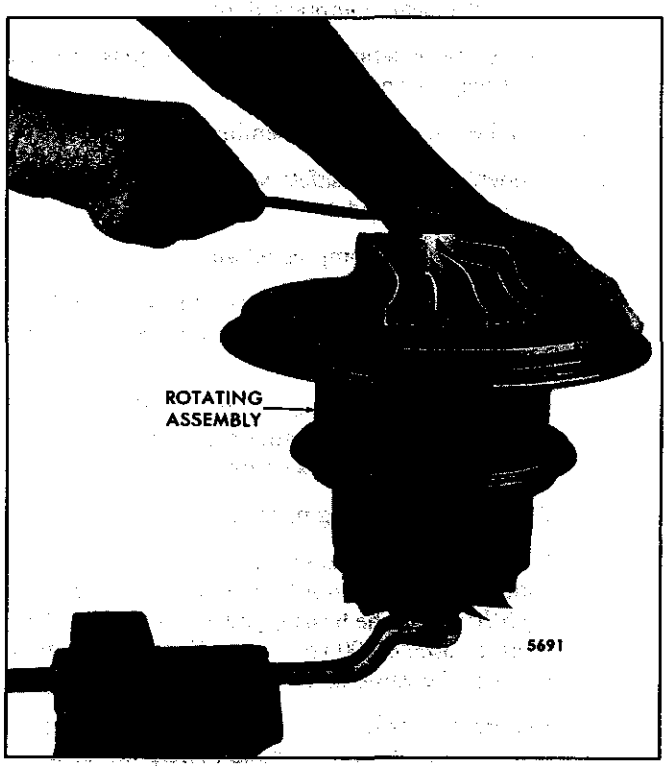


Fig. 5 – Removing Compressor Wheel Lock Nut

Fig. 6 – Removing Compressor Wheel from Turbine Shaft

6. Remove the compressor wheel from the turbine shaft assembly by hand (Fig. 6). The wheel is a slip fit on the shaft.

7. Remove the external snap ring from the compressor end of the bearing housing (Fig. 7). Use medium size internal snap ring pliers and restrain the ring with a shop cloth to prevent injury, in the event the ring goes astray.

8. Remove the compressor insert from the bearing housing by prying evenly and gently with screw drivers placed under the lip of the insert (Fig. 8).

   NOTICE: To avoid turbocharger damage if the insert tilts and binds, tap it back into place and repeat the procedure. *Do not force* the insert from the bearing housing.

9. Remove the oil deflector, outer piston ring, thrust sleeve, thrust bearing (discard) and inner piston ring from the cavity in the bearing housing. *Do not remove the dowels from the bearing housing.*

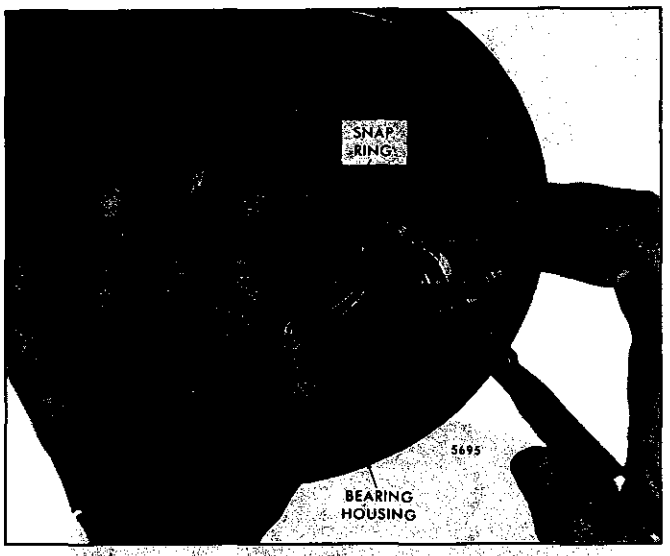


Fig. 7 – Removing External Snap Ring from Bearing Housing

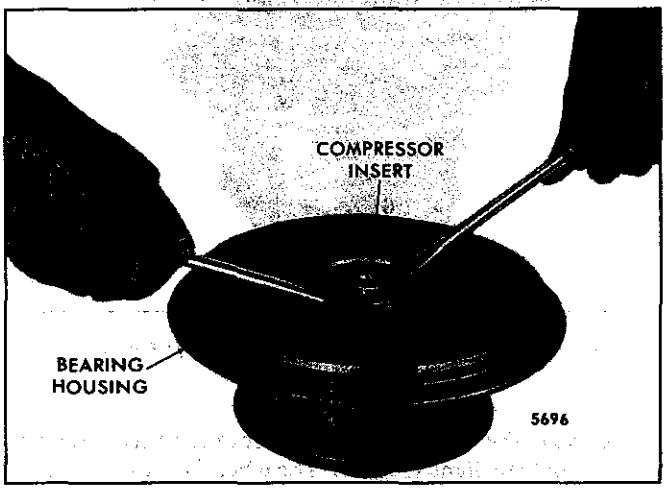


Fig. 8 – Removing Compressor Insert from Bearing Housing

10. Tap the turbine shaft assembly gently with a plastic faced mallet to release it from the bearing housing (Fig. 9).

11. Remove the turbine wheel and shaft assembly. The shaft should slip freely out of the bearing after the initial release by tapping.

12. Remove and discard the turbine shaft bearing from the bearing housing bore (Fig. 10).

13. Separate the backplate and gasket from the bearing housing. Discard the gasket.

NOTICE: If the seal ring bore in the bearing housing is encrusted with carbon, preventing removal of the bearing components, scrape away the carbon with a sharp–edged tool. Be careful not to scratch or gouge the seal ring bore surface.

14. Remove and discard the seal ring from the turbine wheel–and–shaft by prying and breaking with a screw driver. Take care not to mar the hub or groove surfaces of the turbine wheel.

Cleaning Procedures

1. Bearing Housing and Dowel Assembly:
   a. Scrape or wipe appropriately any loose or heavy foreign material accumulations from the exterior surfaces.
   b. Immerse briefly in safety solvent to remove any traces of oily residue.
   c. Dry with clean compressed air, again taking care that all drilled oil passages are thoroughly cleaned.
   - **CAUTION: To prevent possible personal injury, wear adequate eye protection and do not exceed 40 psi (276 kPa) air pressure.**
   d. Oil all interior and exterior surfaces to prevent rust and *immediately* wrap in a clean, dry plastic bag until inspection and reuse.
2. Compressor Wheel:
   a. Immerse briefly in safety solvent to remove any traces of oily residue.
   b. Dry with clean compressed air.
   c. *Immediately* wrap in a clean, dry plastic bag until inspection and reuse.
3. Turbine Wheel–and–Shaft Assembly:
   a. Immerse briefly in safety solvent to remove any traces of oily residue.
   b. Dry with clean compressed air.
   c. Mask the entire shaft section with either appropriately sized rubber hose or adhesive backed cloth tape.
   d. Vapor blast or dry hone the entire turbine wheel and the hub to total cleanliness, taking care not to concentrate on the seal ring groove.
   e. Remove the masking material.
   f. Mount the small diameter shaft section in a lathe chuck, taking care not to mar the shaft surface. *Lightly* polish the bearing journal section of the shaft, at 300 to 600 rpm, with 400 grit abrasive paper and clean engine oil.
   g. Reimmerse briefly in clean safety solvent, agitating moderately by hand to help loosen any remaining particles of foreign material.

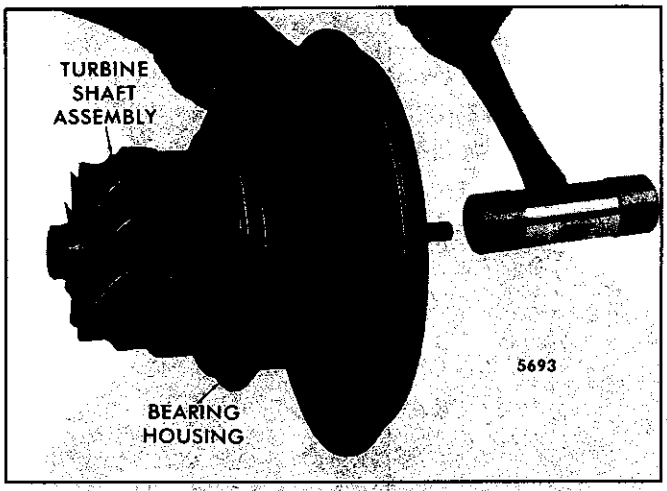


Fig. 9 – Tapping Turbine Shaft Assembly from Bearing Housing

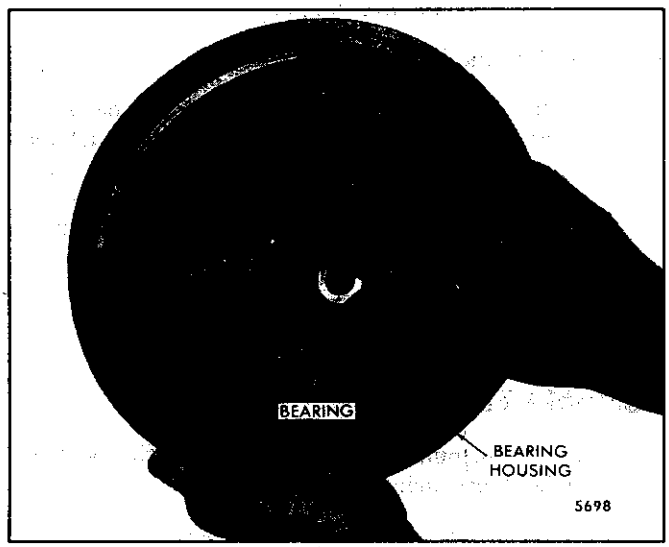


Fig. 10 – Removing Turbine Shaft Bearing from Bearing Housing

h. Dry with clean compressed air.

i. Oil the shaft surfaces liberally to prevent rust and *immediately* wrap in a clean, dry plastic bag until inspection and reuse.

4. Compressor Housing:

a. Scrape or wipe appropriately any loose or heavy foreign material accumulations from the exterior surfaces.

b. Immerse briefly in safety solution to remove any traces of oily residue.

c. Dry with clean compressed air.

d. *Immediately* wrap in a clean, dry plastic bag until inspection and reuse.

5. Turbine Housing and Turbine Backplate:

a. Immerse briefly in safety solvent to remove any traces of oily residue.

b. Dry with clean compressed air.

c. Oil all interior and exterior surfaces to prevent rust and *immediately* wrap in a clean, dry plastic bag until inspection and reuse.

6. Clamp Bands:

a. Immerse in safety solvent until foreign material deposits have been softened or dissolved, agitating moderately and occasionally by hand.

b. Dry with clean compressed air.

c. Wrap *immediately* in a clean, dry plastic bag until inspection and reuse.

7. Small Internal Parts:

a. Immerse briefly in clean safety solvent to remove any traces of oily residue.

b. Wipe dry with a clean shop rag.

c. Oil liberally to prevent rust and wrap *immediately* in a clean, dry plastic bag until inspection and reuse.

Inspection

1. Bearing Housing and Dowel Assembly:

NOTICE: The installation of the two groove pins into the bearing housing of Schwitzer 3LM turbocharger used on 4–53 engines is an extremely critical operation requiring special tools not generally available to the service technician. Since improper assembly of the pins into the housing can result in high turbocharger oil flow, seal leakage and serious turbocharger damage, the service technician should not attempt to replace them when worn or damaged. Instead, the bearing housing assembly incorporating the factory–installed pins should be used. Only the bearing housing assembly with factory–installed pins will be serviced.

a. Inspect visually for evidence of cracks and fractures, pitting (as from corrosion or hot gas erosion) of gasket and other machined surfaces, and warpage of the turbine end flange. Replace if any of the above conditions are excessive.

b. Closely inspect the bearing bore visually for evidence of surface distress. The condition of the bearings that were removed during disassembly will serve as a good indicator of probable bore

condition. Replace if the bore condition is sub–standard. The maximum bore diameter is .7505".

c. Install the turbine seal ring in its bore, inspect visually for full circle contact, and measure the ring gap with a feeler gage (Fig. 11). The gap range is .002" to .007". Replace if the ring fit is faulty. *Do not attempt to restore the bore condition by reaming or honing.*

2. Compressor Wheel:

Inspect visually for evidence of bent, burred or eroded vanes and for evidence of scuffing on the backplate. Replace if this damage is present. Slightly nicked vanes are acceptable. *Do not attempt to straighten bent vanes.*

3. Turbine Wheel and Shaft Assembly:

a. Inspect the wheel visually for evidence of bent, burred or eroded vanes and for evidence of scuffing on the back face. Replace if damaged. *Do not attempt to straighten bent vanes.*

b. Inspect the hub visually for evidence of smearing (as from high speed contact with the bearing housing bore) and for deterioration of the seal ring groove. Replace if damage is excessive.

c. Inspect bearing journals visually for evidence of other than superficial deterioration (as from a bearing failure). Replace if journal condition is sub–standard. The minimum journal diameter is .5611".

d. Measure the concentricity between the large and small turbine shaft diameters with a dial test indicator and vee–block (Fig. 12). Limit of eccentricity is .0006" total indicator reading. Replace if the measurement is excessive. *Do not attempt to straighten a bent shaft.*

4. Compressor Housing:

Inspect visually for evidence of contour damage (as from high speed wheel contact). Replace if damaged.

5. Turbine Housing and Backplate:

Inspect visually for evidence of contour damage (as from high speed wheel contact) and for evidence of excessive heat damage, to internal and flanged surfaces, such as cracking, pitting or warpage. Replace if damaged.

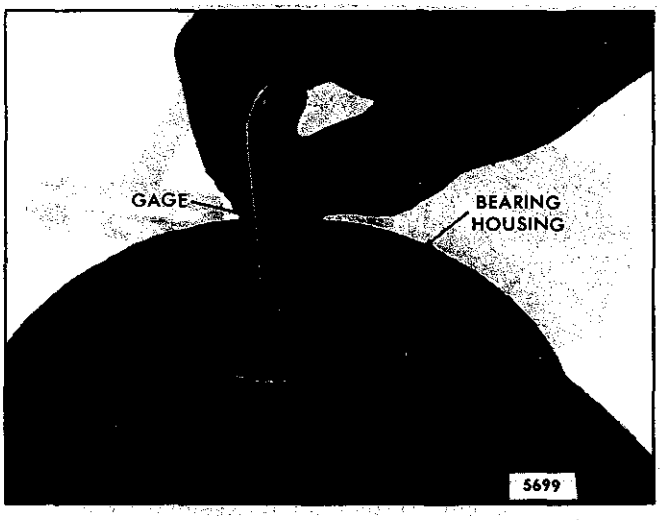


Fig. 11 – Checking Turbine Seal Ring Gap in Bearing Housing

6. Small Internal Parts:

a. Install the compressor seal ring in the insert bore, inspect visually for full circle contact and measure the ring gap with a feeler gage. Gap range is .002" to .007". Replace the insert if the ring fit is faulty. *Do not attempt to restore bore condition by reaming or grinding.*

b. Inspect both thrust rings visually for evidence of wear and scratching. Replace if damaged.

Assemble Turbocharger

1. Place the turbine housing in a vise with the four threaded holes facing up.

2. Lubricate a new piston ring with clean engine oil and install it in the ring grooves of the wheel and shaft assembly (Fig. 13). *Do not over expand the ring.*

3. Position the bearing housing, turbine end up (Fig. 14). Then install a new gasket and the turbine backplate.

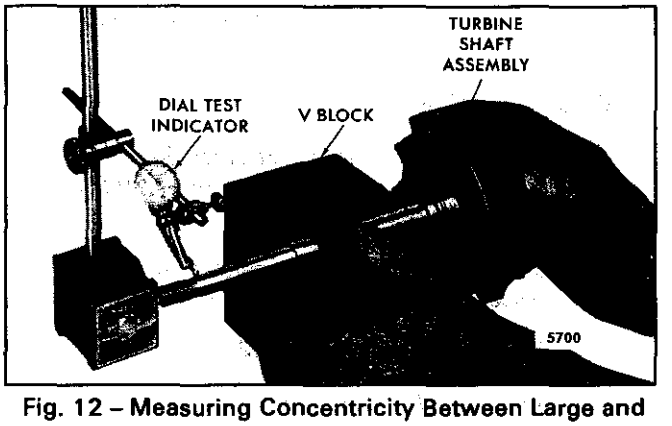


Fig. 12 – Measuring Concentricity Between Large and Small Turbine Shaft Diameters

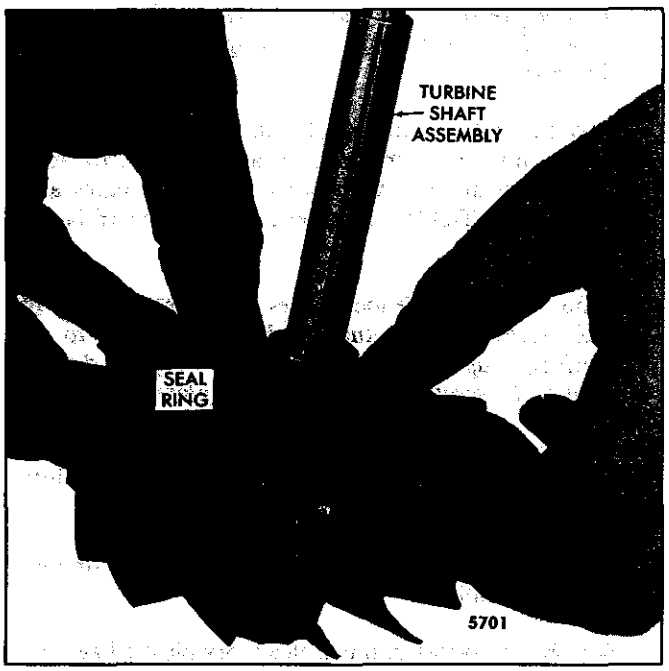


Fig. 13 – Installing Seal Ring on Turbine Shaft

The backplate has no attachment to the bearing housing. Its position is fixed when the bearing housing and turbine housing are clamped together.

4. Lubricate the piston ring area of the shaft and wheel assembly with clean engine oil and install it through the backplate and into the bearing housing (Fig. 15). *Be careful and avoid damage to the piston ring.*

5. Holding the end of the shaft, to prevent the shaft and wheel assembly from falling out of the bearing housing, install the assembly in the turbine housing wheel end down.

6. Lubricate the inner and outer diameter of the bearing. Then install the bearing down over the shaft and into the bearing housing bore.

7. Lubricate the thrust faces on both side of the thrust bearing and install the bronze side of the bearing over the shaft and groove pins, engaging the pins to the holes in the thrust bearing (Fig. 16).

8. Install the oil deflector on the thrust sleeve.

9. Lubricate a new piston ring and install it on the thrust sleeve. *Do not over expand the piston ring.*

10. Lubricate a new seal ring and install it in the groove on the insert.

11. Lubricate the thrust sleeve and install the small end into the hole of the insert from the concave side of the insert. Be careful to avoid damage to the piston ring.

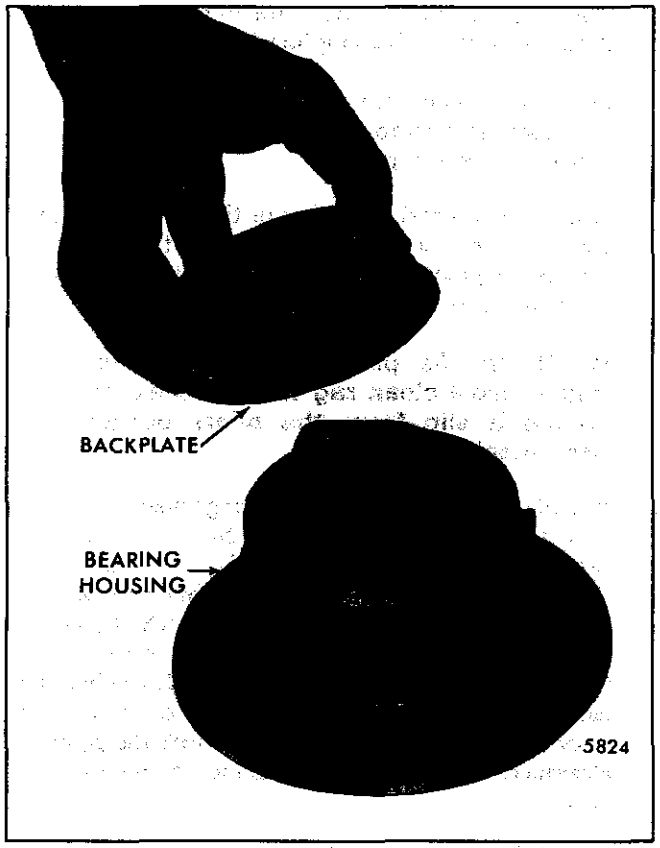


Fig. 14 – Assembling Bearing Housing, Gasket and Backplate

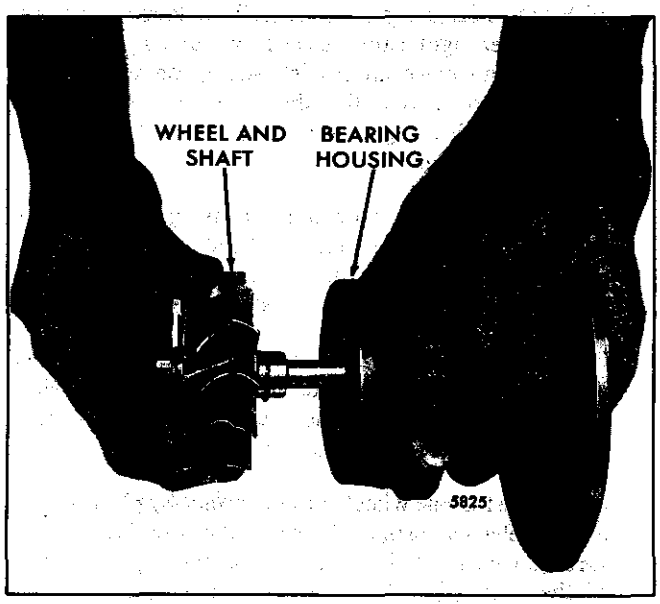


Fig. 15 – Installing Shaft and Wheel Assembly through Back Plate into Bearing Housing

12. Lubricate the thrust cavity in the bearing housing and install the insert, oil deflector and thrust sleeve assembly over the shaft and into the bearing housing

(Fig. 17). Align the oil deflector to mate with the oil drain cavity in the bearing housing.

NOTICE: It may be necessary to tap the insert with a soft hammer to seat it completely. Do not damage the seal ring.

13. Install the external snap ring in the compressor end cavity of the bearing housing. Be sure the ring seats fully in the groove, by twist–prying against the insert rim with a screw driver.

CAUTION: To prevent eye or facial injury, use a clean rag to snub the ring should it slip from the pliers during compression (Fig. 7).

14. Mount a dial indicator on the bearing housing with the stem resting on end of the shaft. Make sure that the turbine end of the bearing housing is properly seated in the turbine housing. Then move the shaft vertically to determine turbine wheel contour clearance. It must be .018" to .049". If the clearance is not within these tolerances, disassemble the unit to determine the cause. Look for burrs, dirt particles or incorrectly assembled parts. Reassemble and check the contour clearance. If it is still out of tolerance, do not attempt to use.

15. Install the compressor wheel on the shaft.

16. Lubricate the back face and threads of the lock nut with anti–seize compound. Install the lock nut on the shaft finger tight (until elastic of nut engages shaft threads) and place an 11/16" socket on the turbine wheel lug to prevent the shaft from turning. Use a torque wrench to tighten the lock nut to 13 lb–ft (18 N·m) torque (Fig. 18).

17. Mount the dial indicator on the bearing housing with the stem resting on the end of the shaft to check end play. Total movement must be .002" to .005". If not within these tolerances, proceed as in Step 14 above.

18. Place the compressor cover on a work bench with the wheel cavity up. Lubricate the pilot diameter with grease or oil and place the rotating assembly in the compressor cover with the turbine wheel up.

19. Check the turbine wheel back clearance by placing two equal feeler gage stacks between the back face of the turbine wheel and the backplate on the opposite sides of the shaft (Fig. 19). Clearance must be .017" to .049". If clearance is not within limits, proceed as in Step 14 above.

20. Install four clamp plates and eight screw and lock washer assemblies. Tighten the screws to 5 lb–ft (7 N·m) torque. Use care not to overtighten the screws. *If the compressor cover needs to be reoriented upon installation on the engine, do not tighten the screws at this point.*

21. Turn the unit over and install it in the turbine housing. Apply anti–seize compound to the threads of the four screws. Install the two clamps, two lock plates and four screws. Tighten the screws to 12 lb–ft (16 N·m) torque.

22. Bend the tabs of the lock plates up against one flat of each screw. *If the turbine housing needs to be reoriented upon installation on the engine, do not tighten the screws or bend the lock plate tabs at this point.*

23. Inject approximately 1/4 ounce of clean engine oil into the oil inlet port of the bearing housing.

24. Spin the rotating assembly by hand to assure smooth and free rotation.

25. Seal the completed unit in a clean, dry plastic bag until installed on the engine.

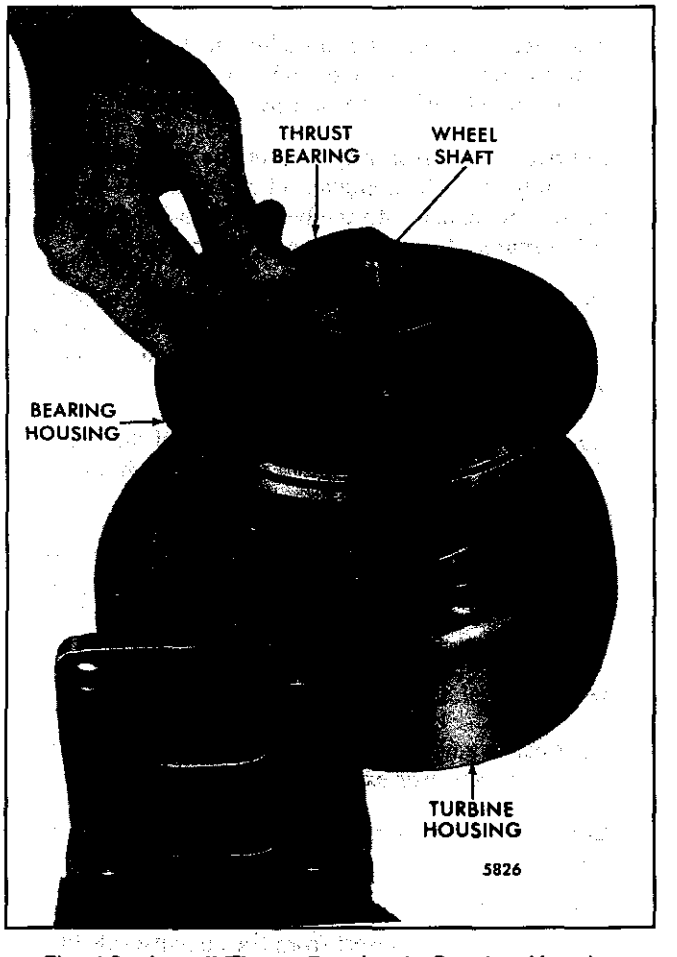


Fig. 16 – Install Thrust Bearing in Bearing Housing

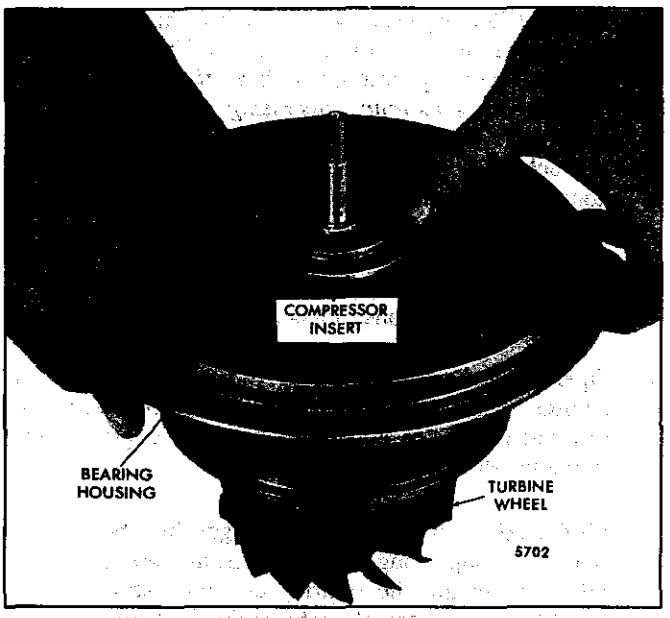


Fig. 17 – Installing Compressor Insert in Bearing Housing

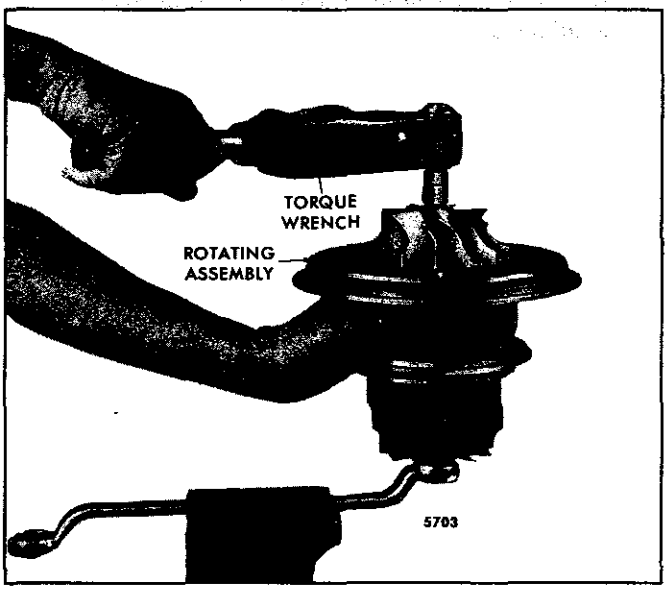


Fig. 18 – Tightening Compressor Locknut

Install Turbocharger

1. Inspect the intake and exhaust systems leading to the turbocharger to ensure absence of foreign material (even small particles can cause severe damage to the rotating assembly when inducted at high speeds).
2. Use *new* gaskets at all of the air, oil and exhaust connections to the turbocharger. *Do not use joint compound at the oil inlet and exhaust connections.*
3. Use anti–seize thread compound on all threaded fasteners used to mount the turbocharger.
4. Attach a chain hoist and a suitable lifting sling to the turbocharger assembly.
5. Position the turbocharger so that it aligns with all corresponding connections on the engine.
6. Tighten the compressor housing and turbine housing clamp band retaining nuts to 10 lb–ft (14 N·m) torque.
7. Secure the turbocharger to the mounting bracket with bolts, lock washers and nuts. Tighten the nuts just enough to hold the turbocharger tight against the brackets.

   When self locking nuts are used to secure the turbocharger to the mounting bracket, be sure there is full thread engagement (at least one full thread above the nut) of the self locking nuts on the bolts.
8. Slide the blower air inlet tube hose over the compressor housing outlet and secure it in place with hose clamps.
9. Tighten the turbocharger to exhaust manifold adaptor bolts securely.
10. Connect the oil inlet line to the cylinder block.

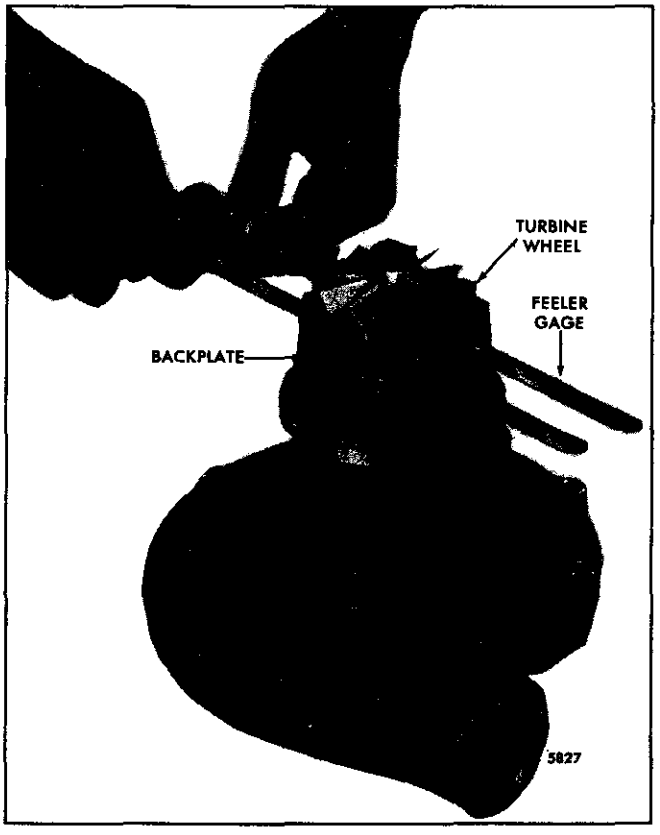


Fig. 19 – Checking Turbine Wheel to Backplate Clearance

11. After installing a rebuilt or new turbocharger, it is very important that all of the moving parts of the turbocharger center housing be lubricated as follows:
    a. Clean the area and disconnect the oil inlet (supply) line at the bearing (center) housing.
    b. Fill the bearing housing cavity with clean engine oil. Turn the rotating assembly by hand to coat all of the internal surfaces with oil.
    c. Add additional engine oil to completely fill the bearing housing cavity and reinstall the oil line. Clean off any spilled oil.
    d. Start and run the engine at idle until oil pressure and supply has reached all of the turbocharger moving parts. A good indicator that all of the moving parts are getting lubrication is when the oil pressure gage registers pressure (10 psig – 69 kPa at idle speed).

    CAUTION: Do not hold the compressor wheel, for any reason, while the engine is running. This could result in personal injury.

    The free floating bearing in the turbocharger bearing housing requires positive lubrication. This is provided by the above procedure *before the turbocharger reaches its maximum operating speed,* which is produced by high engine speeds. Starting any turbocharged engine and accelerating to any speed above idle before engine oil supply and pressure has reached the free floating bearing can cause severe damage to the shaft and bearing of the turbocharger.

12. Check all connections, ducts and gaskets for leaks.

13. Operate the engine at rated output and listen for sounds of metallic contact from the turbocharger. If any such noise is apparent, shut the engine down immediately and correct the cause.

    NOTICE: After the turbocharger has been operating long enough to permit the unit and the oil to warm up, the rotating assembly should coast freely to a stop after the engine is stopped. If the rotating assembly jerks to a sudden stop, the cause should be immediately determined and eliminated.

TURBOCHARGER INTERCOOLER

The turbocharger intercooler is mounted on the air inlet side of the engine blower and is used to reduce the temperature of the compressed air from the turbocharger before the air enters the engine blower. This permits a more dense charge of air to be delivered to the engine. The cooling is accomplished by the raw water from the heat exchanger passing through the cells of the intercooler core. The compressed air enters the intercooler via the air inlet housing and circulates past the cooler core of the intercooler.

Remove Intercooler

1. Drain the raw water system.
2. Loosen the two hose clamps on the hose connecting the raw water inlet tube to the inlet end of the intercooler (Fig. 1).
3. Remove the four 5/16"–18 x 1" bolts and lock washers that retain the air inlet tube flange to the air inlet housing.
4. Disconnect the connection between the outlet end of the intercooler and the raw water discharge line.
5. Disconnect the manual shutdown, if used.
6. Remove the six bolts, nuts, washers and lock washers that retain the air inlet housing to the intercooler and remove the air inlet housing and the screen and gasket assembly.

   NOTICE: The bolts are not all the same length and their location should be noted during removal to facilitate installation.

7. Remove the six bolts and lock washers that retain the intercooler to the blower and remove the intercooler. Note the location of the two shorter bolts.
8. Remove the gasket from the side of the blower.

Clean Intercooler

Check all of the intercooler tubes to be sure they are free of obstructions.

If the tubes contain dirt or any other foreign material, they can be cleaned with a small brush or by use of a suitable solvent cleaning solution. Flush the core thoroughly with water to remove any foreign material and the solvent.

Install Intercooler

1. Affix a new gasket to the side of the blower.
2. Mount the intercooler assembly to the blower with the six bolts and lock washers and tighten the bolts to 16–20 lb–ft (22–27 N·m) torque.
3. Affix a new air inlet screen and gasket assembly on the intercooler.
4. Mount the air inlet housing to the intercooler with the six bolts, nuts, washers and lock washers and tighten the nuts to 35–39 lb–ft (47–53 N·m) torque.
5. Affix a new gasket on the air inlet housing flange and secure the air inlet tube flange to the air inlet housing with the four 5/16"–18 x 1" bolts and lock washers. Tighten the bolts to 13–17 lb–ft (18–23 N·m) torque.
6. Connect the raw water inlet tube to the inlet end of the intercooler with the hose and clamps. Tighten the clamps securely.
7. Connect the raw water discharge line to the outlet end of the cooler.
8. Connect the manual shutdown, if used.
9. Fill the raw water system. Then start the engine and check for air or water leaks.

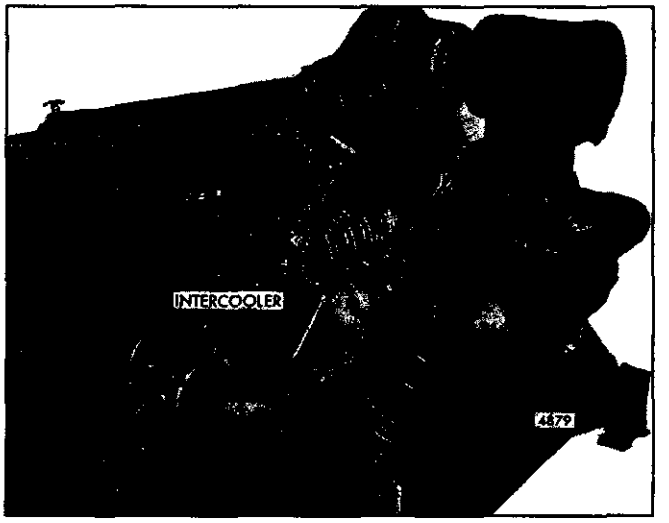
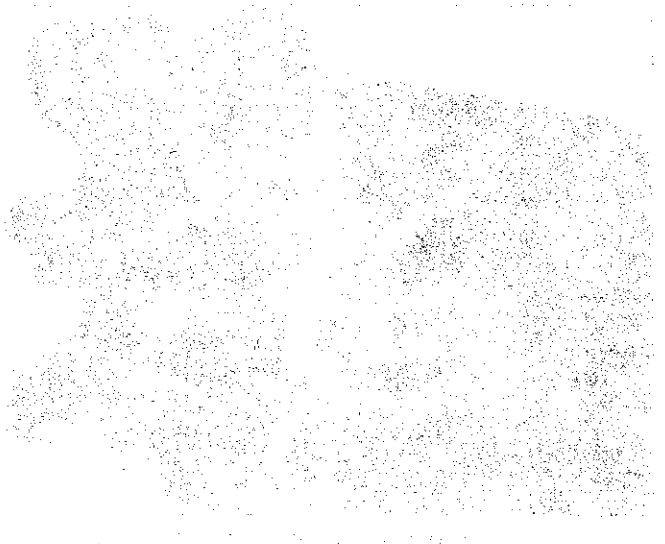


Fig. 1 – Turbocharger Intercooler Mounting



SHOP NOTES - TROUBLESHOOTING SPECIFICATIONS - SERVICE TOOLS

SHOP NOTES

REWORKING BLOWER FRONT END PLATES - 6V-53 ENGINES

When rebuilding a 6V-53 blower assembly in the field, the front end plate can be reworked to provide improved lubrication, when desirable, in the area of the thrust washers. The rework procedure is as follows:

1. Remove the pipe plug from the horizontal oil gallery (B–B) of the end plate. Place a reamer in the chuck of the drill press and ream a .3070" – .3085" diameter hole 2.060" deep from the boss face (Fig. 1). Remove the metal cuttings from the hole.
2. Install the copper–plated dowel pin to the full depth of the reamed portion of the horizontal oil gallery.
3. Locate and mark the center of hole "A" (Fig. 5). The center of hole "A" is where the center line (B–B) of the horizontal oil gallery intersects with the center line (C–C) of the drain hole. Clamp the end plate on the bed of the press and center drill at the location marked. Then drill a 3/8" diameter hole 5/8" deep from the gasket face of the end plate. Lubricate the drill and the area of the end plate that is being reworked with mineral spirits or fuel oil.
4. Place either an end mill or a 3/4" counterbore reamer (remove the pilot from the reamer) in the chuck of the drill press and counterbore a 3/4" diameter hole 5/8" deep from the gasket face of the end plate.
5. Wash the end plate in clean fuel oil to remove the metal cuttings and dry it with compressed air.

   - **CAUTION: To prevent possible personal injury, wear adequate eye protection and do not exceed 40 psi (276 kPa) air pressure.**

6. Cut a piece of 3/8" I.D. Bundy tubing 2.00" long. Coat the tubing with Gasola or an equivalent type sealant. Press the tubing into the oil drain hole in the end plate flush to .010" below the edge of the plate. It is important that the area around the tube be oil tight.
7. Reinstall the pipe plug in hole (B–B).
8. When assembling the blower, apply a liberal amount of Lubriplate, or equivalent, on the surfaces of the thrust washers. This will provide lubrication of the thrust washers during initial start–up of the engine.

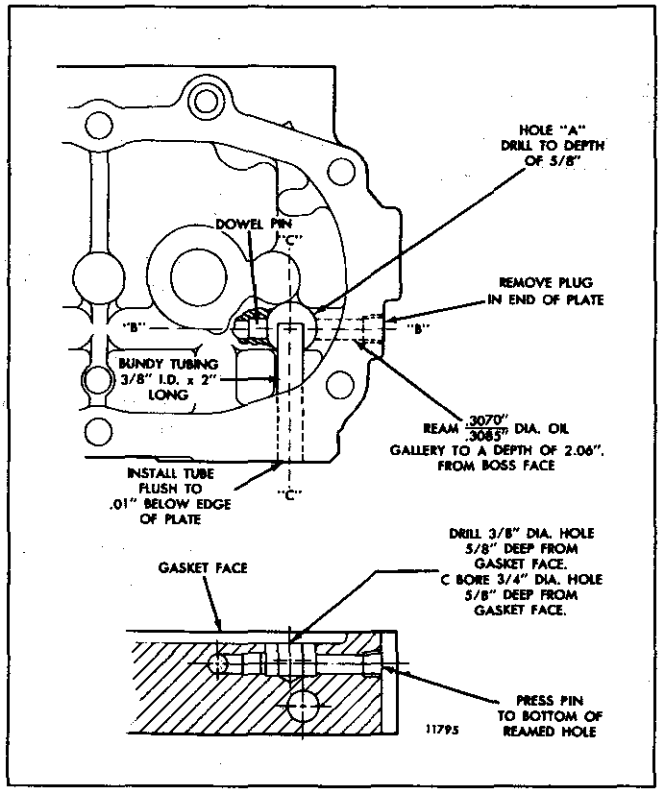


Fig. 1 – Dimensions for Reworking Front End Plate (6V–53 Engine)

TROUBLESHOOTING

TURBOCHARGER

CONDITION	PROBABLE CAUSE	SUGGESTED REMEDY
NOISY OPERATION OR VIBRATION	WHEEL SHAFT BEARINGS ARE NOT BEING LUBRICATED	Locate cause of loss of oil pressure and repair. Remove, dis-assemble and inspect turbocharger for bearing damage.
	IMPROPER CLEARANCE BETWEEN TURBINE WHEEL AND HOUSING	Remove, disassemble, and inspect turbocharger.
	LEAK IN ENGINE AIR INTAKE OR EXHAUST MANIFOLD	Tighten all loose connections or replace exhaust manifold gaskets as necessary.
ENGINE WILL NOT DELIVER RATED POWER	CLOGGED AIR INTAKE SYSTEM	Check air cleaner and clean air intake ducts.
	FOREIGN MATERIAL LODGED IN COMPRESSOR OR TURBINE WHEELS	Remove, disassemble and clean turbocharger.
	EXCESSIVE DIRT BUILD-UP IN COMPRESSOR	Thoroughly clean compressor assembly. Clean air cleaner and check for leaks.
	LEAK IN ENGINE AIR INTAKE OR EXHAUST MANIFOLD	Tighten all loose connections or replace exhaust manifold gaskets as necessary.
	ROTATING ASSEMBLY BEARING SEIZURE	Remove and overhaul turbocharger.

SPECIFICATIONS

Specifications, clearances and wear limits are listed below. It should be specifically noted that the clearances apply only when all new parts are used at the point where the various specifications apply. This also applies to references within the text of the manual. The column entitled "Limits" in this chart lists the amount of wear or increase in clearance which can be tolerated in used engine parts and still ensure satisfactory performance. It should be emphasized that the figures given as "Limits" must be qualified by the judgement of personnel responsible for installing new parts. These wear limits are, in general, listed only for the parts more frequently replaced in engine overhaul work. For additional information, refer to the text.

TABLE OF SPECIFICATIONS, NEW CLEARANCES AND WEAR LIMITS

These limits also apply to oversize and undersize parts.

ENGINE PARTS (Standard Size, New)	MINIMUM	MAXIMUM	LIMITS
Blower			
Backlash — rotor gears (all)	.0005″	.0025″	.0035″
Backlash between upper rotor and camshaft or balance shaft gear (2–53 and 3–53)	.0030″	.0070″	
Backlash between blower drive gear and camshaft gear	.0030″	.0070″	
Oil seal (below end plate surface) (In–line and 6V–53)	.0020″	.0080″	
Oil seal (below end plate surface) (8V–53)	flush	.0100″	
Oil strainer (below end plate surface) (8V–53)	flush	.0150″	
Pin — Dowel (projection beyond inside face of front end plate) (8V–53)	.3800″		
Clearances:			
Thrust plate and thrust washer (In–line)	.0010″	.0030″	
Thrust plate and thrust washer (4–53T and 6V–53)	.0025″	.0050″	
Rotor to air outlet side of housing:			
In–Line and 6V–53	.0040″		
8V–53	.0050″		
3–53T	.0060″		
4–53T	.0070″		
Rotor to air inlet side of housing:			
In–Line	.0075″		
6V–53	.0100″		
3–53T	.0120″		
8V–53	.0170″		
Rotor to front end plate:			
In–Line	.0060″		
3–53T, 4–53T and 6V–53	.0080″		
+8V–53 (former)	.0070″		
6V–53T	.0100″		
†8V–53 (current)	.0170″		

ENGINE PARTS (Standard Size, New)	MINIMUM	MAXIMUM	LIMITS
Rotor to rear (gear) end plate:			
2–53	.0060″		
3–53	.0080″		
4–53 and 3–53T	.0090″		
4–53T and 6V–53	.0100″		
6V–53T	.0120″		
+8V–53 (former)	.0140″		
†8V–53 (current)	.0070″		
Rotor–to–rotor clearance:			
In–line	.0100″		
3–53T	.0120″		
6V–53	.0090″		
6V–53T	.0130″		
Trailing edge of R.H. helix rotor to leading edge of L.H. helix rotor (8V–53)	.0080″		
Leading edge of R.H. helix rotor to trailing edge of L.H. helix rotor (8V–53)	.0180″		
Turbocharger (TE0675)			
Rotating shaft axial end play	.0040″	.0070″	
Rotating shaft radial movement	.0030″	.0070″	
Turbine wheel rotor shaft journal bearing:			
Inside diameter	.6268″	.6272″	
Outside diameter	.9780″	.9785″	
Turbine wheel shaft journal diameter	.6251″	.6254″	
Bearing bore diameter in center housing	.9827″	.9832″	
Turbocharger (T04B and TV61)			
Rotating shaft axial end play	.0040″	.0090″	
Rotating shaft radial movement	.0030″	.0070″	

+This clearance applies to former blowers with the ball bearings in the front end plate and roller bearings in the rear end plate.

†This clearance applies to current blowers with the roller bearings in the front end plate and ball bearings in the rear end plate.

STANDARD BOLT AND NUT TORQUE SPECIFICATIONS

THREAD SIZE	260M BOLTS TORQUE (lb-ft)	260M BOLTS TORQUE N·m	THREAD SIZE	280M OR BETTER TORQUE (lb-ft)	280M OR BETTER TORQUE N·m
1/4–20	5–7	7–9	1/4–20	7–9	10–12
1/4–28	6–8	8–11	1/4–28	8–10	11–14
5/16–18	10–13	14–18	5/16–18	13–17	18–23
5/16–24	11–14	15–19	5/16–24	15–19	20–26
3/8–16	23–26	31–35	3/8–16	30–35	41–47
3/8–24	26–29	35–40	3/8–24	35–39	47–53
7/16–14	35–38	47–51	7/16–14	46–50	62–68
7/16–20	43–46	58–62	7/16–20	57–61	77–83
1/2–13	53–56	72–76	1/2–13	71–75	96–102
1/2–20	62–70	84–95	1/2–20	83–93	113–126
9/16–12	68–75	92–102	9/16–12	90–100	122–136
9/16–18	80–88	109–119	9/16–18	107–117	146–159
5/8–11	103–110	140–149	5/8–11	137–147	186–200
5/8–18	126–134	171–181	5/8–18	168–178	228–242
3/4–10	180–188	244–254	3/4–10	240–250	325–339
3/4–16	218–225	295–305	3/4–16	290–300	393–407
7/8–9	308–315	417–427	7/8–9	410–420	556–569
7/8–14	356–364	483–494	7/8–14	475–485	644–657
1–8	435–443	590–600	1–8	580–590	786–800
1–14	514–521	697–705	1–14	685–695	928–942

Grade identification markings are normally stamped on the heads of the bolts. To aid identification of the various bolts used in Detroit Diesel engines, refer to the following chart.

Grade Identification Marking on Bolt Head		GM Number	SAE Grade Designation	Nominal Size Diameter (inch)	Tensile Strength Min. (psi)
None		GM 255-M	1	No. 6 thru 1 1/2	60,000
None		GM 260-M	2	No. 6 thru 3/4 over 3/4 to 1 1/2	74,000 60,000
	Bolts and Screws	GM 280-M	5	No. 6 thru 1 over 1 to 1 1/2	120,000 105,000
	Hex Head Sems Only	GM 275-M	5.1	No. 6 thru 3/8	120,000
	Bolts and Screws	GM 290-M	7	1/4 thru 1 1/2	133,000
	Bolts and Screws	GM 300-M	8	1/4 thru 1 1/2	150,000
	Bolts and Screws	GM 455-M	None	No. 6 thru 1 1/2	55,000

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BOLT IDENTIFICATION CHART

EXCEPTIONS TO STANDARD BOLT AND NUT TORQUE SPECIFICATIONS

APPLICATION	THREAD SIZE	TORQUE lb-ft	TORQUE N·m
Blower drive coupling-to-rotor gear bolt (In-line and 6V-53)	1/4-28	14-18	19-24
Blower drive gear pilot bolt (In-line and 6V-53)	5/16-24	25-30	34-41
Blower thrust washer retaining bolt (In-line and 6V-53)	5/16-24	25-30	34-41
Blower timing gear-to-rotor shaft bolts (In-line and 6V-53)	5/16-24	25-30	34-41
Air inlet adaptor-to-blower bolts	3/8-16	16-20	22-27
Air inlet housing-to-adaptor or blower housing bolts	3/8-16	16-20	22-27
Blower drive gear cover bolt	3/8-16	20-24	27-33
Blower drive support-to-blower rear end plate bolts	3/8-16	20-24	27-33
Blower-to-engine rear end plate and flywheel housing bolts (2-53 and 3-53)	3/8-16	20-25	27-34
Flywheel housing-to-blower drive support bolts	3/8-16	20-24	27-33
Front end plate cover bolts (4-53 and 6V-53)	3/8-16	20-25	27-34
Governor-to-blower front end plate bolts	3/8-16	20-24	27-33
Blower thrust washer retaining bolt (In-line and 6V-53)	3/8-24	54-59	73-80
Blower timing gear-to-rotor shaft bolts (8V-53)	3/8-24	50-55	68-75
Rotor shaft ball bearing retaining bolt (8V-53)	3/8-24	50-55	68-75
Blower end plate-to-block bolts	7/16-14	55-60	75-81
Rotor shaft ball bearing retaining nut (8V-53)	.781"-32	50-60	68-81

SERVICE TOOLS

TOOL NAME	TOOL NO.
Blower	
Blower clearance feeler gage set	J 1698–02
Blower drive cam installer	J 5209
Blower gear puller (part of J 23679)	J 28483
Blower service tool set (except 8V–53)	J 23679–A
Blower service tool set (8V–53)	J 21672
Handle	J 7079–2
Turbocharger	
Extension rod (2.500")	J 7057
Magnetic base indicator set	J 7872
Turbocharger inlet shield	J 26554–A

NOTES