SECTION 3

AIR INTAKE SYSTEM

CONTENTS

AIR INTAKE SYSTEM

In the scavenging process employed in the V–92 engines, a charge of air is forced into the cylinders by the blower and thoroughly sweeps out all of the burned gases through the exhaust valve ports. This air also helps to cool the internal engine parts, particularly the exhaust valves. At the beginning of the compression stroke, therefore, each cylinder is filled with fresh, clean air which provides for efficient combustion.

The air, entering the blower from the air cleaner, is picked up by the blower rotor lobes and carried to the discharge side of the blower as indicated by the arrows in Fig. 1. The continuous discharge of fresh air from the blower enters the air chamber of the cylinder block and sweeps through the intake ports of the cylinder liners.

The angle of the ports in the cylinder liners creates a uniform swirling motion to the intake air as it enters the cylinders. This motion persists throughout the compression stroke and facilitates scavenging and combustion.

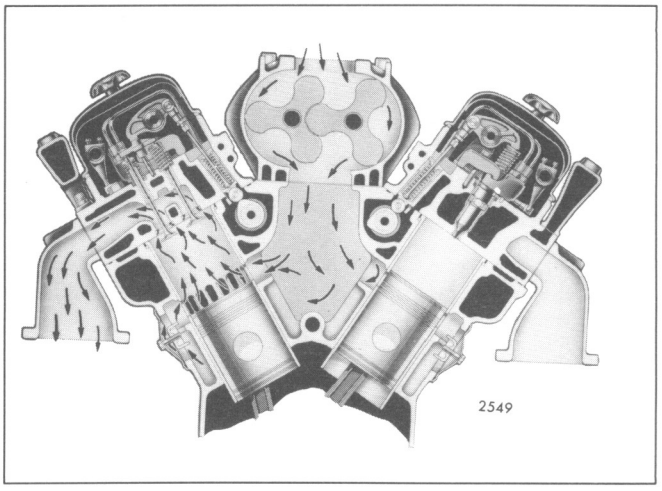


Fig. 1 – Air Flow Through Blower and Engine

OIL BATH TYPE AIR CLEANER

The oil bath type air cleaners used on the V–92 engines are designed to remove foreign matter from the air, pass the required volume of air for proper combustion and scavenging, and maintain their efficiency for a reasonable period of time before requiring service.

The importance of keeping dust and grit–laden air out of an engine cannot be over–emphasized since clean air is so essential to satisfactory engine operation and long engine life. The air cleaner must be able to remove fine materials such as dust and blown sand as well as coarse materials such as chaff, sawdust or lint from the air. It must also have a reservoir capacity large enough to retain the material separated from the air to permit operation for a reasonable period before cleaning and servicing are required.

Dust and dirt entering an engine will cause rapid wear of piston rings, cylinder liners, pistons and the exhaust valve mechanism with a resultant loss of power and high lubricating oil consumption. Also, dust and dirt which is allowed to build–up in the air cleaner passages will eventually restrict the air supply to the engine and result in heavy carbon deposits on pistons and valves due to incomplete combustion.

Air Cleaner Mounting

Air cleaner mountings vary in accordance with the air cleaner installation and the engine units on which they are employed. The air cleaners are mounted on brackets attached to the flywheel housing and the cleaner outlet is connected to the air inlet housing by means of a hose and clamp. A "Y" shaped air inlet housing is used on installations with two air cleaners which are mounted side by side at the rear of the unit (Fig. 1).

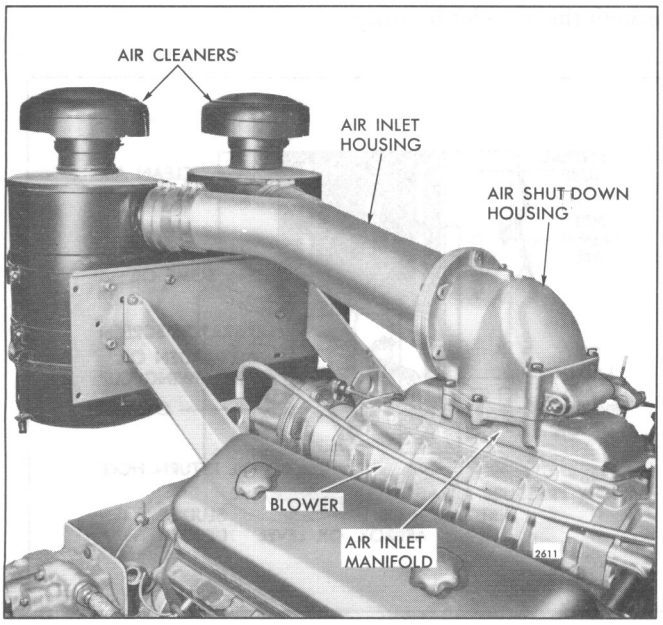


Fig. 1 – Typical Oil Bath Air Cleaner Mounting

Air Cleaner Maintenance

Although air cleaners are highly efficient, this efficiency depends upon proper maintenance and periodic servicing. If the cleaners are not properly maintained, the oil sump will become filled with sludge and the screens or elements will not remove dust properly. This will result in dust and dirty oil entering the engine and also increase the restriction to air flow through the cleaner.

Should dust in the air supply enter the engine, it would be carried directly into the cylinders and, due to its abrasive properties, cause premature wear of moving parts, which would materially shorten engine life. Should the air flow through the cleaner be restricted, it would eventually be impossible for the engine to burn all of the fuel injected into its cylinders and carbon formation would progress at a greatly increased rate.

The efficiency of the air cleaner may be offset by leaks in the duct work, loose hose connections or damaged gaskets which permit dust–laden air to completely bypass the cleaner and enter the engine directly.

The following maintenance procedure will assure efficient air cleaner operation:

1. Keep air cleaner tight on air intake to engine.

2. Keep air cleaner properly assembled so joints are strictly oil and air tight.

3. In case of damage to the air cleaner, intake or connections, repair at once.

4. In dusty areas, inspect the air cleaner frequently for dirt deposits in the oil bath or thickened oil.

   Thoroughly clean the oil bath cleaner often enough to prevent oil from becoming excessively thick with sludge, and be sure to use the proper kind and quantity of oil. Keep the oil at the level mark in the cup. When replacing the cup, be sure it fits snugly to form a tight joint.

5. Where rubber hose from cleaner to blower is employed, remove hose connections and cement them in place. Use new hose and clamps, if necessary, to obtain an air–tight connection.

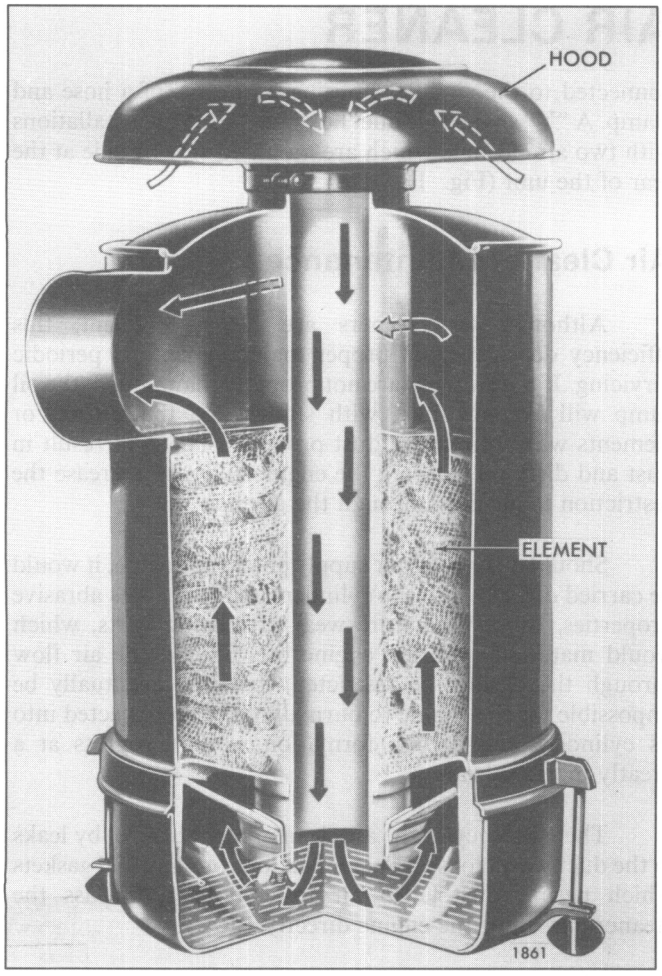


Fig. 2 – Typical Oil Bath Air Cleaner (Industrial Engines)

6. After servicing the air cleaner, remove air inlet housing and clean accumulated dirt deposits from blower screen and air inlet housing. Make sure all air intake passages and air box are kept clean.

7. Make careful periodic inspection of entire air system. Enough dust–laden air will pass through an almost invisible crack to eventually cause serious damage to an engine.

No hard fast rule for servicing any air cleaner can be given since it depends upon the type of cleaner, air conditions and type of application. A cleaner operating in severe dust conditions will require more frequent service than a cleaner operating in clean air. The most satisfactory service period should be determined by frequently inspecting the cleaners, under normal operation, then setting the service period to best suit the requirements of the application.

In air cleaners having an oil bath, use the same viscosity oil as that being used in the engine crankcase. The oil level should not be above that indicated on the air cleaner sump. If too much oil is used, it may be pulled through the element and into the engine, thus carrying dirt into the cylinders and also resulting in excessive speed.

Oil Bath Type Air Cleaner(Industrial Engines)

In the oil bath air cleaners used on industrial units (Fig. 2), the air is drawn through the air inlet hood and down through the center tube. At the bottom of the tube, the direction of air flow is reversed and oil is picked up from the oil reservoir cup. The oil laden air is carried up into the separator screen where the oil which contains the dirt particles is separated from the air by collecting on the separator screen.

A low pressure area is created toward the center of the air cleaner as the air passes a cylindrical opening formed by the outer perimeter of the central tube and the inner diameter of the separator screen (Fig. 3). This low pressure is caused by the difference in air current velocity across the opening. The low pressure area, plus the effect of gravity and the inverted cone shape of the separator screen, causes the oil and dirt mixture to drain to the center of the cleaner cup. This oil is again picked up by the incoming air causing a looping cycle of the oil; however, as the oil is carried toward another cycle, some of the oil will overflow the edge of the cup carrying the dirt with it. The dirt will be deposited in the outer area surrounding the cup. Oil will then flow back into the cup through a small hole located in the side of the cup. Above the separator screen, the cleaner is filled with a wire screen element which will remove any oil which passes through the separator screen. This oil will also drain to the center and back into the oil cup. The clean air then leaves the cleaner through a tube at the side and enters the blower through the air inlet housing.

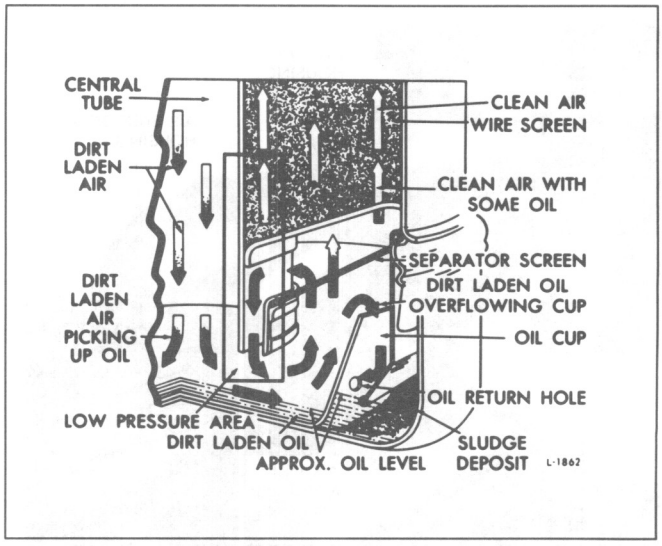


Fig. 3 – Air Flow Through Oil Bath Air Cleaner

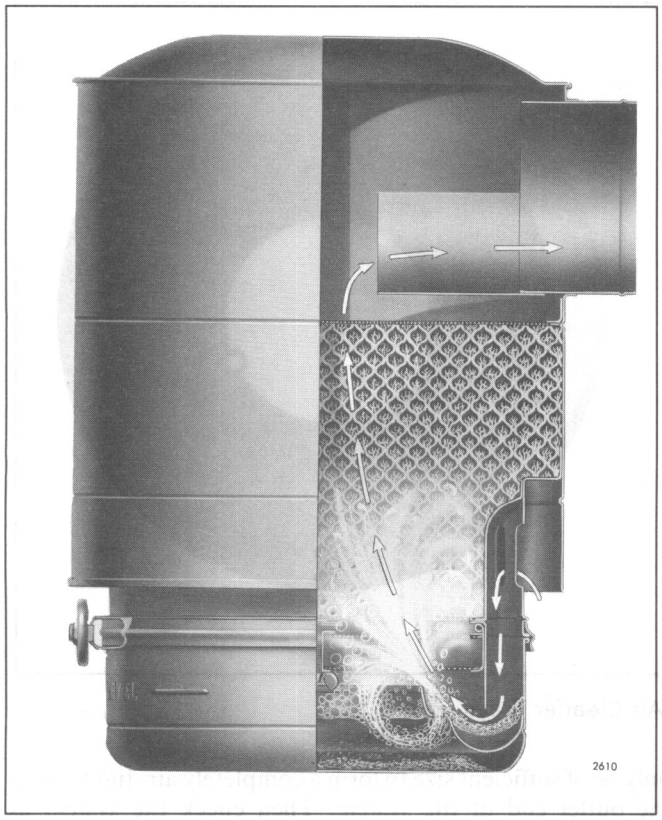


Fig. 4 – Typical Oil Bath Air Cleaner (Marine Engines)

An air inlet hood must be used with the air cleaner. The inlet hood normally requires cleaning more frequently than the main air cleaner. The air inlet hood serves only to prevent rain, rags, paper, leaves, etc., from entering the air cleaner. Air enters the hood through a heavy screen which forms the lower portion of the hood, and the air flow is reversed in the hood and pulled downward into the air cleaner. The hood is mounted on the air cleaner inlet tube and is held in place by a clamp. The openings in the hood should be kept clear to prevent excessive restriction to air flow.

Oil Bath Type Air Cleaner(Marine Engines)

In the oil bath air cleaners used on marine units (Fig. 4), the air is drawn into the cleaner through a series of slots around the perimeter of the cleaner body just above the oil cup assembly. The air passes over the oil and is than directed upwards by baffles and then passes through a removable screen assembly. During this change in the direction of flow, the larger particles of foreign matter such as lint, chaff, leaves, etc., are removed from the air by the oil and the screen assembly and settles in the oil cup sump. The air continues upward through metal–wool elements where finer particles such as dust and the entrained oil are removed. The clean air is then discharged through a side outlet near the top of the cleaner body and flows through the air inlet housing to the intake side of the blower assembly.

Air Cleaner Service

The air inlet hoods used on industrial engine air cleaners are not intended to do any cleaning. However, some dirt will collect on the heavy screens and in the hood itself. Therefore, it will be necessary to remove the hood occasionally for cleaning.

The oil sump should be checked for dirt accumulation. Loosen the wing nuts and pull the side rod assemblies away from their forked retaining brackets to remove the oil cup(s). Empty the oil from the cup(s) and clean with fuel oil to remove all sediment.

A tray type screen is used on the industrial engine air cleaners. A lip on the tray fits over the edge of the oil cup of the cleaner. One rubber seal ring fits over the lower edge of the cleaner body to form an air tight seal between the cleaner body and tray. Another seal ring fits around the tray and forms an air and oil seal between the tray and the oil cup.

The efficiency of the tray type oil bath air cleaner will be greatly reduced unless the fibrous material caught in the tray is removed. It is extremely important that the tray be cleaned regularly and properly.

If a tray is plugged with lint or dirt wash the tray in a solvent and blow out with compressed air (Fig. 5). An even pattern of light should be visible through the screens when a clean tray is held up to the light (Fig. 5). It may be necessary, as a last resort, to burn off the lint. Extreme care must be taken not to melt the galvanized coating in the tray screens. Some trays have equally spaced holes in the retaining baffle. Check to make sure that they are clean and open.

Check for dirt accumulation in the air cleaner center tube. Remove dirt by passing a lintless cloth through the center tube. Some tubes have a restricted portion at the lower end and care must be exercised not to damage this end.

At some regular period of engine service, remove the entire air cleaner from the engine and clean the fixed element. This can be done by passing a large quantity of clean solvent through the air outlet and down into the fixed element. When clean, allow the element to dry thoroughly before installing the cleaner on the engine. If the fixed elements require too frequent cleaning, it is advisable to relocate the air intake to provide a cleaner air supply.

The air cleaner used on marine engines is serviced in a similar manner. However, a replaceable screen element is used in place of the tray type screen. The element is attached to the cleaner body by means of a wing nut. The cleaner does not have a center air passage.

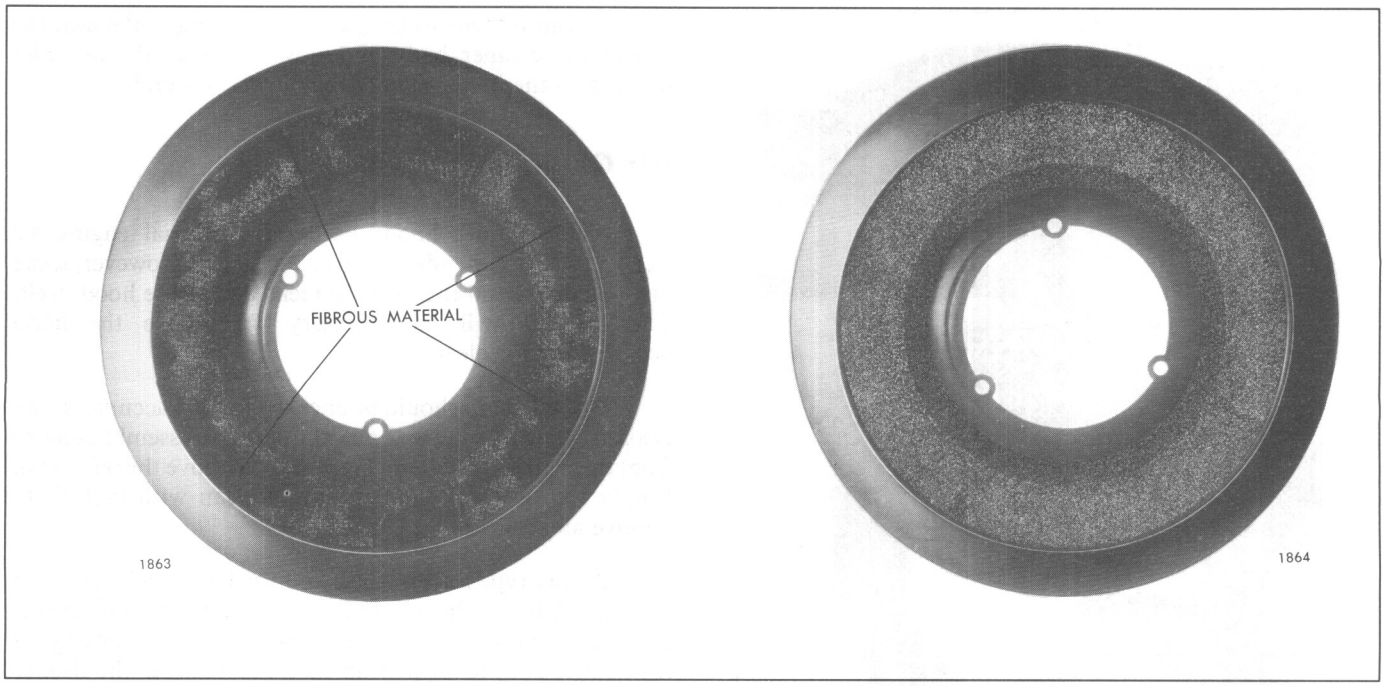


Fig. 5 – Comparison of Air Cleaner Trays

When all of the components have been cleaned, the cleaner is ready for assembly. The removable screen or tray should be installed. Replace the rubber seal rings if necessary. The oil cup(s) should be filled with clean engine oil of the same viscosity and grade as used in the engine crankcase. Fill the cup(s) to the indicated oil level and install on the cleaner. Care should be exercised that all gaskets and joints are tight. All connections from the cleaner to the engine should be checked for air leaks to prevent any air bypassing the air cleaners.

If it is found that unfiltered air is being admitted into the engine through the duct work of an air cleaner installation, the following procedure may be used for finding air leaks in an air duct system. The air cleaning system does not have to be dismantled, thus effecting a saving in time.

To make this check, it is necessary that suitable plugs be provided to block the air cleaner system inlet and outlet. The air cleaner inlet plug should contain a suitable air connection and shutoff valve to maintain two pounds pressure (14 kPa) in the air duct system. The outlet plug need only be of sufficient size to form a completely air–tight seal at the outlet end of the system. Then check the system as follows:

1. Remove the air inlet hood.
2. Insert the plug (with the fitting for the air hose) in the air cleaner inlet to form an air–tight seal.
3. Insert the other plug in the outlet end of the system to form an air–tight seal.
4. Attach an air hose to the plug in the air cleaner inlet and regulate pressure not to exceed 2 psi (14 kPa).
5. Brush a soap–suds solution on all air duct connections. Any opening which would allow dust to enter the engine can then be detected by the escaping air causing bubbles in the soap–suds solution. All leaks thus discovered should be remedied to ensure an air–tight system.
6. Remove the plugs and install the air inlet hood.

DRY TYPE AIR CLEANER

TWO–STAGE AIR CLEANER

The dry type air cleaner is designed to provide highly efficient air filtration under all operating conditions and is not affected by engine speed (Fig. 6). The cleaner assembly consists of a centrifugal air cleaner in series with a replaceable impregnated paper filter element. The dust collected in the centrifugal cleaner is exhausted by connecting the dust bin to an exhaust gas aspirator. The centrifugal cleaner and replaceable filter element are held together in a steel housing. Positive sealing between the two elements and the housing is provided by rubber gaskets. The steel housing incorporates filter fasteners, mounting flanges and an outlet for the filtered air.

Operation

The deflector vanes impart a swirling motion to the air entering the air cleaner and centrifuge the dust particles against the walls of the tubes. The dust particles are then carried to the dust bin at the bottom of the cleaner by approximately 10% bleed–off air and are finally discharged into the atmosphere through an exhaust gas aspirator (Fig. 7).

The exhaust gas aspirator is connected into the exhaust system of the engine (Fig. 8). A flexible hose carries the dust particles from the cleaner dust bin to the aspirator where the waste energy of the exhaust gases draws the dust–laden bleed–off air out and discharges it into the atmosphere along with the engine exhaust gases. Approximately 90% of the total dust load is disposed of in this manner. The centrifugal air cleaner is fully effective at either high or low velocities.

The remainder of the air in the cleaner reverses direction and spirals back along the discharge tubes again centrifuging the air. The filtered air then reverses direction again and enters the replaceable filter element through the center portion of the discharge tubes. The air is filtered once more as it passes through the pleats of the impregnated paper element before leaving the outlet port of the cleaner housing.

An air cleaner restriction indicator may be attached near the outlet side of the cleaner (Fig. 8). As the restriction in the cleaner increases, suction created will pull the indicator plunger upward. A brightly colored card, attached to the plunger and visible through a small window in the indicator, will indicate the relative amount of air restriction in the cleaner. When the card is fully visible, the air cleaner should be cleaned and the indicator reset by pushing the plunger all the way up and then releasing it.

The air cleaner restriction indicator is equipped with a safety fitting. The fitting incorporates an internal filter in one end and does not require any service. When replacing the safety fitting thread the open end of the fitting in the indicator and the screen end in the air cleaner.

Service

The first stage centrifugal air cleaner tends to be self–cleaning due to the action of the exhaust gas aspirator. However, it should be inspected and any accumulated foreign material removed during the periodic replacement of the impregnated paper filter element. Overloading of the paper element will not cause dirt particles to bypass the filter and enter the engine, but will result in starving the engine for air.

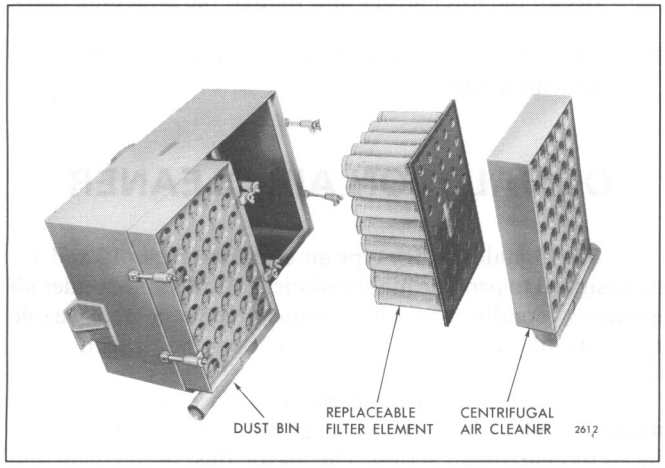


Fig. 6 – Dry Type Air Cleaner

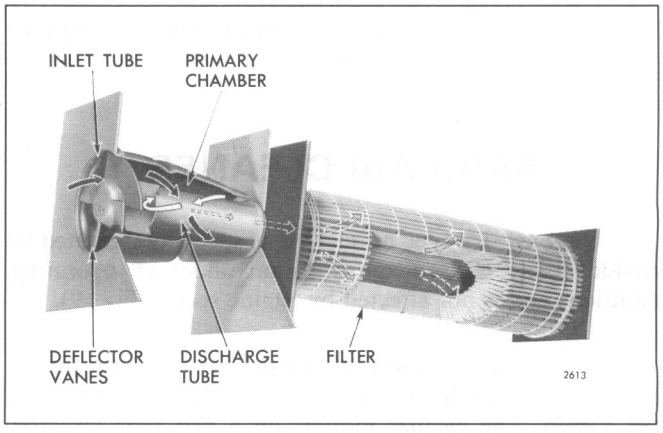


Fig. 7 – Flow of Air Through Dry Type Air Cleaner

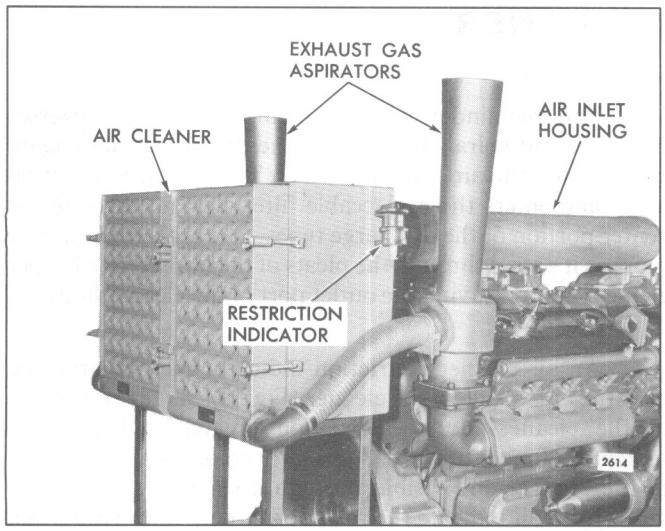


Fig. 8 – Typical Dry Type Air Cleaner Mounting

The filter element may be replaced as follows:

1. Disconnect the flexible aspirator hose at the dust bin of the air cleaner.
2. Loosen the wing nuts on the filter fasteners and swing the retaining bolts away from the cleaner.
3. Lift the cleaner away from the housing and inspect it. Clean out any accumulated foreign material.
4. Withdraw the paper filter element and discard it.
5. Install a new filter element. New sealing gaskets are provided with the element to insure positive air seal at all times.
6. Install the cleaner and secure it in place with the fasteners.
7. Connect the aspirator hose to the dust bin making sure the connection is air tight.

FARR AIR CLEANER

The Farr dry type air cleaner is specially designed to provide highly efficient air filtration under all operating conditions and is not affected by engine speed (Fig. 9).

The air cleaner assembly consists of a plenum pan, a replaceable Dynacell air filter element, holding straps and a inlet screen. The cleaner mounts on a pan type air inlet manifold shutdown assembly.

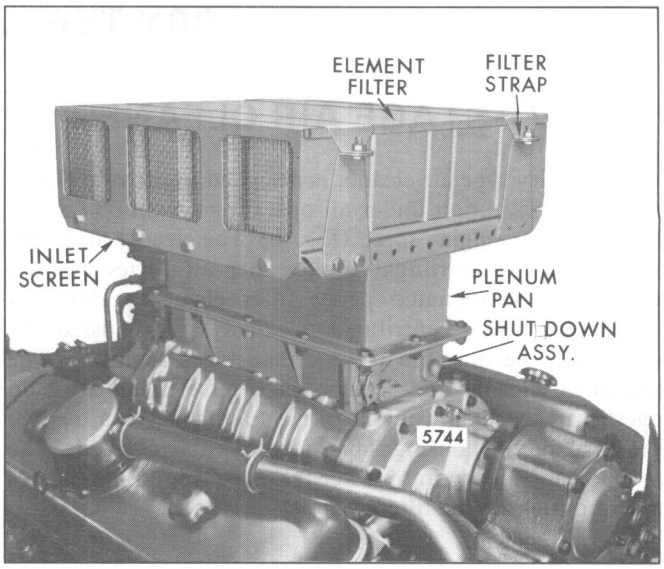


Fig. 9 – Farr Dry Type Air Cleaner

Service

The air cleaner should be inspected and any accumulated foreign material removed during the periodic replacement of the impregnated paper filter element. Overloading of the paper element will not cause dirt particles to bypass the filter and enter the engine, but will result in starving the engine for air.

Replace the filter element as follows:

1. Loosen the attaching bolts and remove the inlet screen.
2. Loosen the attaching bolts and remove the filter straps.
3. Remove and discard the paper filter element.
4. Install a new Dynacell air filter element.
5. Install the filter straps and tighten the attaching bolts.
6. Clean and/or replace the inlet screen and tighten the attaching bolts.

DONALDSON AIR CLEANER

The Donaldson dry type air cleaners (Figs. 10 and 11) are designed to provide highly efficient air filtration under all operating conditions. The cleaners have a replaceable impregnated paper filter element that can be cleaned.

The fins on the element give high speed rotation to the intake air, which separates a large portion of the dust from the air by centrifugal action. The plastic fins, the element and the gasket make up a single replaceable element assembly.

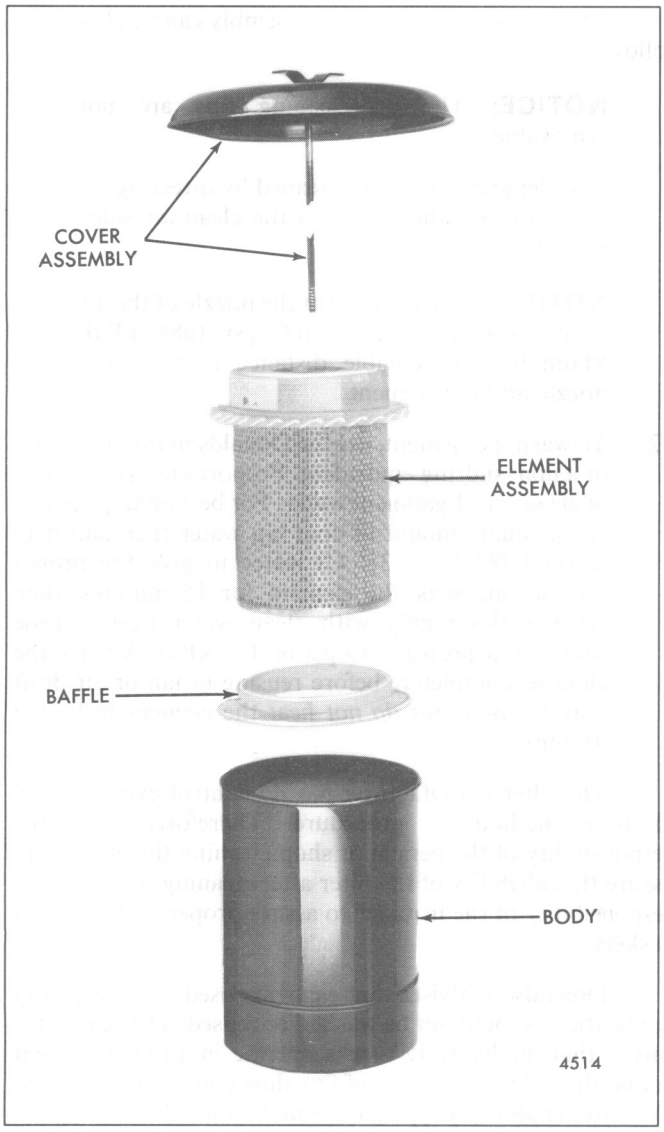


Fig. 10 – Dry Type Air Cleaner

The dust is swept through a space in the side of the baffle and collects in the lower portion of the body or dust cup. The dust remaining in the precleaned air is removed by the element.

The dry type cleaner *cannot be used* where the atmosphere contains oil vapors, or fumes from the breather can be picked up by the air cleaner.

Service (Dry Type)

The air cleaner should be serviced as operating conditions warrant. See Section 15.1 for element change intervals.

Under no engine operating conditions should the maximum allowable air intake restriction shown in Section 13.2 of the service manual be exceeded. Check restriction with a water manometer using the procedure outlined under "final RUN–IN" in Section 13.2.1. In addition, inlet restriction should be adjusted for high altitude conditions (see Table 1). A clogged air cleaner element will

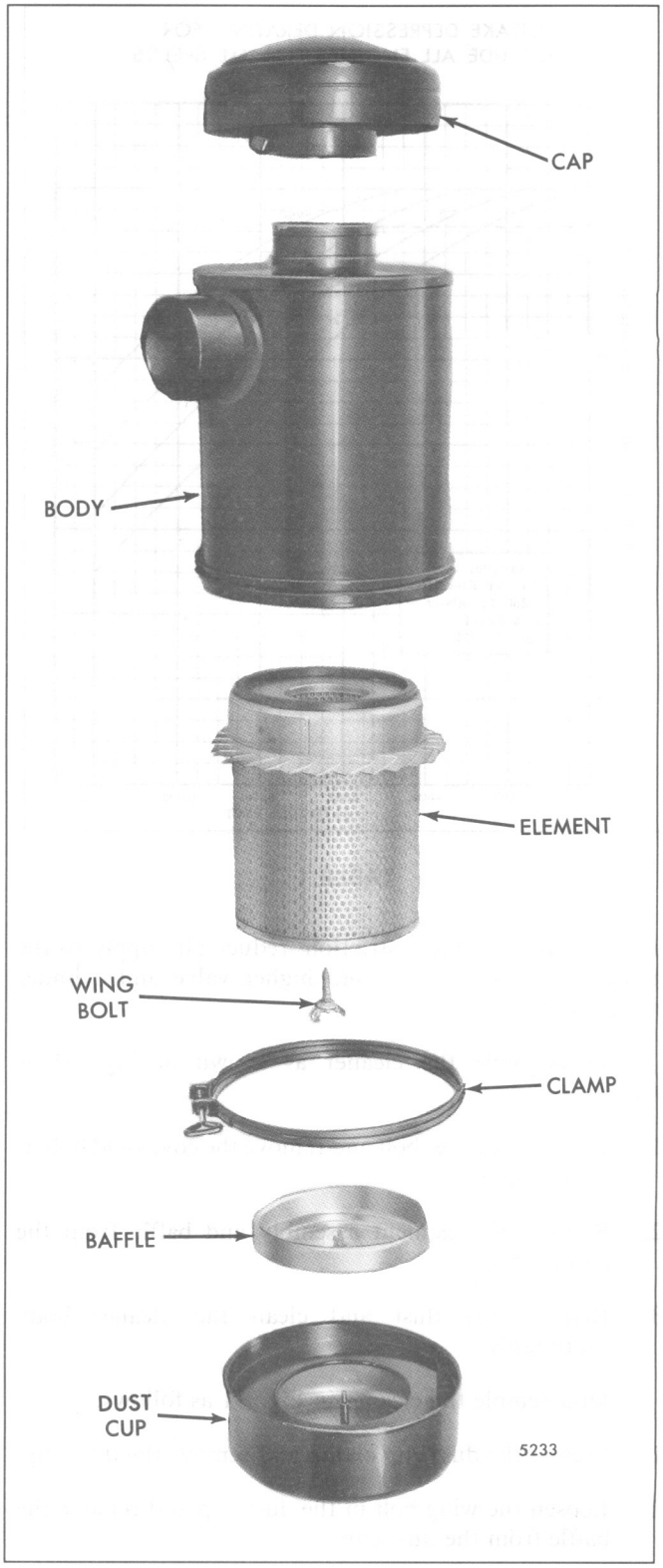


Fig. 11 – Dry Type Air Cleaner (Heavy Duty)

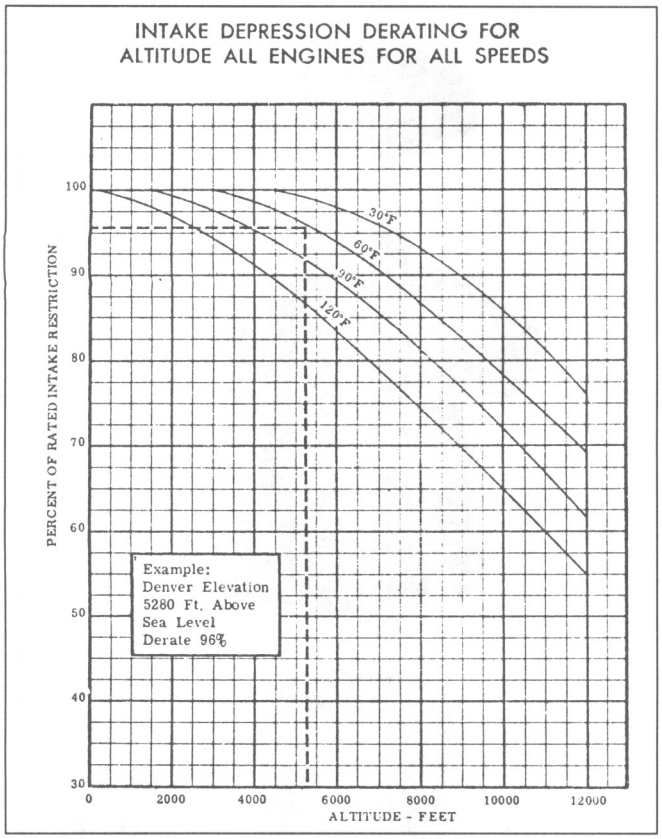


TABLE 1

cause excessive intake restriction, reduce air supply to the engine, poor performance and higher valve and cylinder temperatures.

Disassemble the cleaner as shown in Fig. 10 as follows:

1. Loosen the cover bolt and remove the cover and bolt as an assembly.
2. Remove the element assembly and baffle from the cleaner body.
3. Remove the dust and clean the cleaner body thoroughly.

Disassemble the cleaner in Fig. 11 as follows:

1. Loosen the dust cup clamp and remove the dust cup.
2. Loosen the wing bolt in the dust cup and remove the baffle from the dust cup.
3. Remove the wing bolt from the cleaner body and remove the element assembly.
4. Remove the dust and thoroughly clean the cleaner body, dust cup and baffle.

The paper pleated element assembly can be cleaned as follows:

NOTICE: The pre–cleaning fins are not removable.

1. The element can be dry cleaned by directing clean air up and down the pleats on the clean air side of the element.

NOTICE: Air pressure at the nozzle of the air hose must not exceed 100 psi (689 kPa). Maintain a reasonable distance between the nozzle and the element.

2. To wash the element, use the Donaldson Filter Cleaner or a non–sudsing equivalent. Proportions are 2 ounces of cleaner to 1 gallon of water. For best mixing results, use a small amount of cool tap water then add it to warm (100° F or 38° C) water to give the proper proportion. Soak the element for 15 minutes, then rinse it thoroughly with clean water from a hose (maximum pressure 40 psi or 135 kPa). Air dry the element completely before reusing (a fan or air draft may be used, but *do not heat* the element to hasten drying).

The filter manufacturer has no control over the field cleaning method or procedure. Therefore, it is the responsibility of the person or shop cleaning the element to assure the reliability of the filter after cleaning. It is also the responsibility of the installer to assure proper sealing of the gaskets.

Donaldson advises that elements used in on–highway applications should not be washed or reused. The reason for this is that on–highway trucks operate in an environment contaminated by a mixture of fine dust and exhaust carbon. To better enable dry type air cleaners to handle this type of contaminant, most on–highway truck air cleaners contain special chemically treated elements. Washing can remove the chemical treatment and shorten element life. Consequently, on–highway air cleaner elements should not be washed and reused.

Most Donaldson primary elements used in off–highway applications do not receive the same chemical treatment. These can be cleaned and reused according to the manufacturer's recommendations. Secondary (safety) elements should not be cleaned or reused.

3. Inspect the cleaned element with a light bulb after each cleaning. Thin spots, pin holes, or the slightest rupture will admit sufficient air borne dirt to render the element unfit for further use and cause rapid failure of the piston rings. Replace the element assembly if necessary.
4. Inspect the gasket on the end of the element. If the gasket is damaged or missing, replace the element.

Reassemble the air cleaner in reverse order of disassembly. Replace the air cleaner body gasket, if necessary.

NOTICE: Do not use oil in the bottom of the cleaner body.

The element assembly should be replaced after six (6) cleanings, or annually.

Element Life

The recommended product life (shelf life plus service life) of Donaldson dry type air cleaner elements is three years. Consequently, Donaldson elements should be put into service no later than two years from the date of manufacture. Farr air cleaner elements should be put into service within one year from the date of manufacture.

AIR SILENCER (Turbocharger)

The air silencer is attached at the air outlet end to the turbocharger with a hose and clamps and is supported by a bracket attached to the flywheel housing. An air filter element of polyurethane foam is used on the air silencer inlet screen.

Remove Air Silencer

While no servicing is required on the air silencer, it will be necessary to remove it to perform other service operations.

1. Remove the air filter element.
2. Loosen the clamps and slide the hose back on the turbocharger.
3. Loosen the nut and bolt securing the silencer mounting band to the support bracket. Remove the silencer.
4. If necessary, remove the mounting band from the support bracket and the bracket from the flywheel housing.

Install Air Silencer

1. If removed, attach the support bracket to the flywheel housing with two 7/16"–14 x 1–1/4" bolts and washers. Tighten the bolts.
2. If removed, attach the silencer band to the support bracket with a 5/16"–18 x 1" bolt, plain washer, lock washer and nut. Do not tighten the nut at this time.
3. Align the silencer with the turbocharger and slide the hose in place and tighten the clamps. Then tighten the band bolt.
4. Slide the air filter element over the silencer air inlet screen.

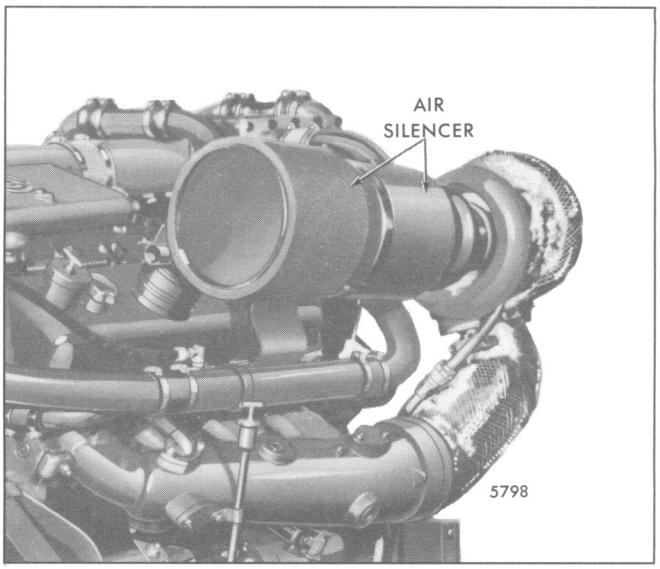


Fig. 1 – Air Silencer Mounted on 6V–92TA Engine

AIR SHUTDOWN HOUSING

The air shutdown housing is mounted on the blower (Fig. 1). A valve mounted inside of the housing may be closed to shut off the air supply and stop the engine when abnormal operating conditions require an emergency shut down.

Remove Air Shutdown Housing

1. On naturally aspirated engines, disconnect and remove the air inlet housing between the air cleaner(s) and the air shutdown housing. On turbocharged engines (Fig. 1), loosen the hose clamp and slide the hose between the air shutdown housing and the turbocharger back on the turbocharger.
2. Disconnect the control wire from the air shutoff cam pin handle.
3. Remove the bolts and lock washers which attach the air shutdown housing to the adaptor. Then, remove the housing and gasket.
4. Remove the bolts and washers which attach the housing adaptor to the blower. Then, remove the adaptor and the blower screen.

Disassemble Air Shutdown Housing

1. Remove the pin from the end of the shutdown shaft. Then, remove the spacer from the shaft and the seal ring from the housing.
2. Remove the two pins that secure the shutdown valve to the shaft.
3. Remove the bolt, lock washer and plain washer which attach the latch to the housing. Then, remove the latch, latch spring and spacer.

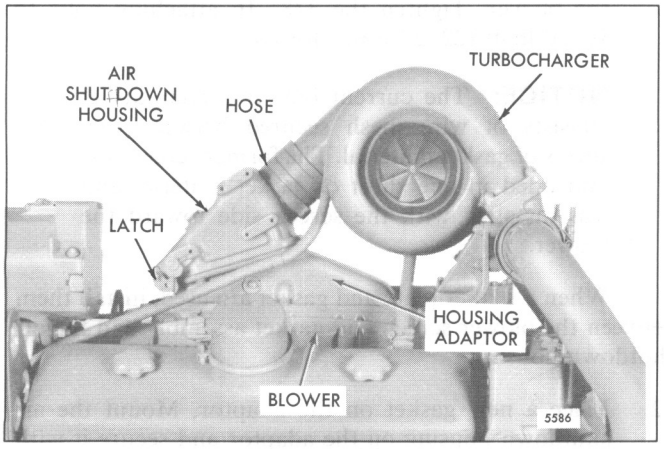


Fig. 1 – Typical Air Shutdown Housing Mounting (Turbocharged Engine)

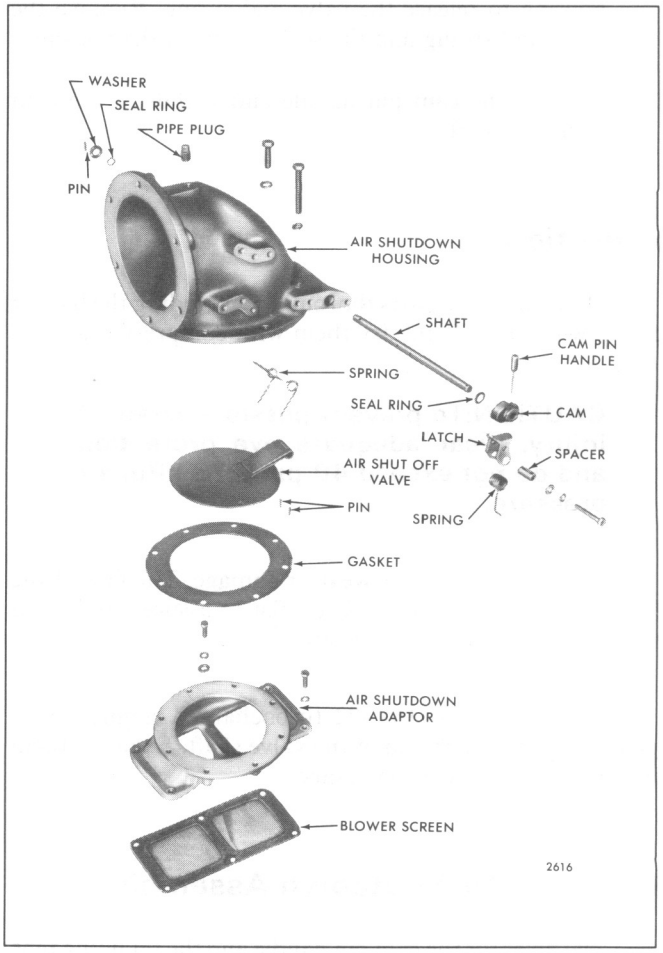


Fig. 2 – Air Shutdown Housing Details and Relative Location of Parts (Non–turbocharged Engines)

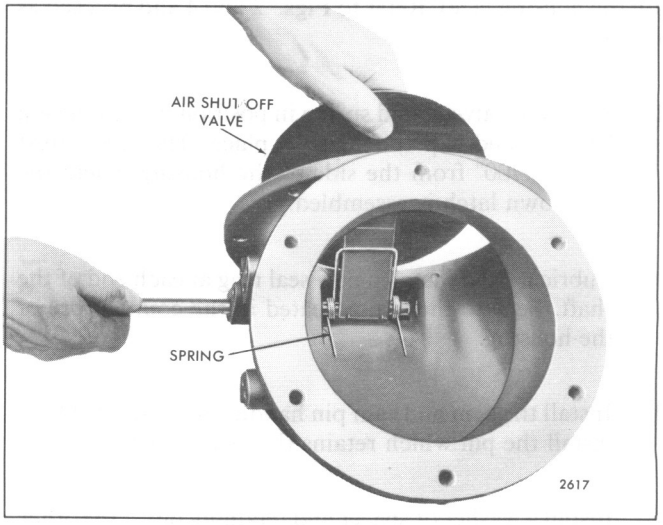


Fig. 3 – Installing Air Shutdown Valve Spring and Valve

4. Note the position of the air shutdown valve spring and valve (Fig. 3), then withdraw the shaft from the housing to release the valve and spring. Remove the valve and spring and the seal ring from the housing.

5. Remove the cam pin handle and withdraw the cam *from* the shaft.

Inspection

Clean all of the parts thoroughly, including the blower screen, with fuel oil and dry them with compressed air.

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

Inspect the parts for wear or damage. The face of the shutdown valve must be perfectly flat to assure a tight seal when it is in the shutdown position.

The 8V–92 and 16V–92 turbocharged engines use a nylon bushing at each end of the valve shaft. Examine them for wear and replace, if necessary.

Assemble Air Shutdown Assembly

The holes for the cam pin handle and the retaining pins must be drilled, using a 1/8" diameter drill, at the time a new service shaft or shutdown valve(s) are assembled (see *Shop Notes* in Section 3.0 for procedure). The valve(s) must be in the same plane within .030" when in the stop position (flush with the housing face). Refer to Figs. 2 and 4 and proceed as follows:

1. Place the valve(s) and spring in position in the housing (Fig. 3) and slip the shaft in place. The shaft must extend .700" from the side of the housing where the shutdown latch is assembled.

2. Lubricate and install a new seal ring at each end of the shaft. Be sure the seal is seated in the counterbore of the housing.

3. Install the cam and cam pin handle on the shaft. Then, install the pin which retains the cam to the shaft.

4. Install a washer or spacer and retaining pin at the other end of the shaft.

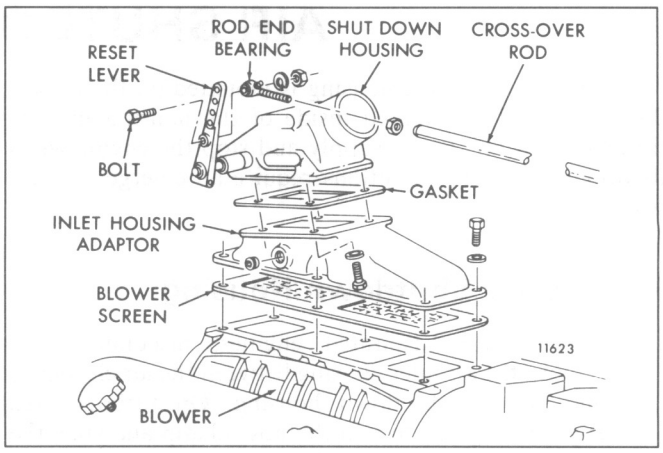


Fig. 4 – Air Shutdown Housing Details and Relative Location of Parts (Rear of Dual Mounting – Turbocharged Engines)

5. Assemble the spacer, spring and latch to the shutdown housing with the 1/4"–20 bolt, lock washer and plain washer.

   a. Align the notch on the cam with the notch on the latch and lock the cam in this position.

   b. Install the pins in the valve(s) to retain it to the shaft with the cam release latch set and the valve(s) in the *run* position.

   c. Level the valve(s) in the shutdown position.

   d. Adjust the cam so the valve(s) contact the housing when the cam release latch is set.

Install Air Shutdown Housing

1. Place the blower screen and gasket assembly, if used, in position and install the shutdown housing adaptor on the blower. Tighten the 3/8"–16 attaching bolts to 16–20 lb–ft (22–27 N•m) torque.

   NOTICE: The current blower screen gasket consists of wire mesh secured between two sheets of gasket material. The former screen was imbedded in one sheet of gasket material and was installed with the screen side toward the blower.

When a striker plate and gasket are used, install them between the blower screen and gasket assembly and the air shutdown housing.

2. Place a new gasket on the adaptor. Mount the air shutdown housing on the adaptor and secure it with 3/8"–16 bolts and lock washers. Tighten the bolts to 16–20 lb–ft (22–27 N•m) torque.

3. On naturally aspirated engines, install the air ducts from the air cleaner to the air shutdown housing. Use a new gasket at the housing. Be sure all connections are air tight. On turbocharged engines, slide the hose in place between the shutdown housing and the turbocharger and tighten the clamps.

4. When dual air shutdown housings (Fig. 4) have been installed, position the crossover rod between the shutdown housings at the reset lever and the shutdown lever.

   NOTICE: Before securing the couplings (non–turbocharged engines), close the valves in both of the shutdown housings and center the couplings on the housing shafts with the aid of new roll pins. On turbocharged engines, secure the rod end bearings at the levers with 5/16"–24 x 1 1/8" bolts. Tighten the bolts to 15–19 lb–ft (20–26 N•m) torque.

5. Reset the air shutdown latch in the *run* position.

6. Start and run the engine at idle speed and no load. Trip the air shutdown latch. If the engine does not stop, check it for air leakage between the valves and the air inlet housing adaptor. If necessary, reposition the valves.

7. After this test has been satisfactorily performed, drill and pin the couplings (non–turbocharged engines) to the shafts with a roll pin for each coupling, using a 1/8" diameter drill.

BLOWER

The *large bearing* blower, designed especially for efficient diesel operation, supplies the fresh air needed for combustion and scavenging. Its operation is similar to that of a gear–type oil pump. Two hollow three–lobe rotors revolve with very close clearances in a housing bolted to the top deck of the cylinder block, between the two banks of cylinders. To provide continuous and uniform displacement of air, the rotor lobes are made with a helical (spiral) form (Fig. 1).

Currently two basic types of large bearing blowers are now being used. The regular type blower is shown in Fig. 1. This blower has six mounting holes in the top of the blower housing and also has regular end plates. The OTM (optional turbocharger mounting) type blower has additional outboard holes for mounting the turbocharger adaptor (6 and 8V blowers). One of the end plates includes two oil drain holes with seal rings for the turbocharger return oil drain back (refer to *Lubrication*, Section 3.5).

The blower used on naturally aspirated engines has a 2.60:1 ratio blower–to–engine speed. The blower used on turbocharged engines has a 2.05:1 ratio blower–to–engine speed. Certain 6V turbocharged aftercooled, 12V turbocharged and 16V turbocharged aftercooled engines have a 1.95:1 ratio blower–to–engine speed.

Two timing gears, located on the drive end of the rotor shafts, space the rotor lobes with a close tolerance. Therefore, as the lobes of the two rotors do not touch at any time, no lubrication is required.

Lip type oil seals are installed in the end plates of blowers on the naturally aspirated engines. Metal ring–type oil seals were formerly used in the blowers on turbocharged engines (inset in Fig. 1). Each ring–type oil seal consisted of a carrier pressed on the rotor shaft, a collar pressed into the end plate and a seal ring contained in a groove of the carrier. The outside diameter of the seal ring rode against the collar to prevent leakage of air or oil.

These 3–piece seals were replaced by double lip Teflon oil seals in 1986.

Each rotor is supported in the doweled end plates of the blower housing by a roller bearing at the front end and a double–row radial and thrust ball bearing at the gear end.

The right–hand helix rotor of the blower is driven by the blower drive shaft. The blower drive shaft is splined at one end to a drive hub attached to the blower drive gear and at the other end to a drive hub attached to the right–hand helix blower timing gear. The mating left–hand helix timing gear drives the left–hand helix rotor.

The basic blower parts for the 6 and 8 cylinder engines are identical and interchangeable with the exception of the housing and rotors which differ in length. Two 6V blowers are mounted on the top deck of the 12–cylinder engines while two 8V blowers are mounted on the top deck of the 16–cylinder engines. Both 12V and 16V blowers are driven by the gear trains at each end of the engine.

The blower rotors are timed by the two rotor gears at the rear end of the rotor shafts. This timing must be correct, otherwise the required clearance between the rotor lobes will not be maintained. A change in rotor timing is obtained by the use of shims between the gears and the bearings.

Normal gear wear causes a decrease of rotor–to–rotor clearance between the leading edge of the right–hand helix (drive) rotor and the trailing edge of the left–hand helix (driven) rotor. Clearance between the opposite sides of the rotor lobes is increased correspondingly.

While the rotor lobe clearance may be corrected by adjustment, gear backlash cannot be corrected. When gears have worn to the point where the backlash exceeds .004", replace the gears.

A coarse spline, 29–tooth blower drive system has replaced the 48–tooth system. The shafts are carbon–nitride hardened and the spline length of the front hub and turbo rear hub has been increased. The new 29 and 29/48 drive shafts are drilled to accept a .24" diameter spring. This spring is pressed into the front of the blower drive shaft nad helps reduce spline wear by limiting the axial (back and forth) movement of the drive shaft. New blower drive supports with a 1/32" oil passage for additional lubrication are being used on turbocharged engines only. The former 48–tooth and the new 29–tooth blower drive shafts, hubs, couplings and supports and the former and new snap rings are not interchangeable.

Two special 29/48–tooth blower drive shaft assemblies have been released to service large bearing blower engines having the former 48–tooth blower drive systems. The new shafts have 29 coarse splines on the blower drive support (rear) end and 48 splines on the blower timing gear (front) end. The new shaft assemblies are to be used only when the 48–tooth shaft and rear hub require replacement. If the blower assembly or front hub requires replacement or at time of major engine overhaul, a complete 29–tooth blower drive system should be installed.

A blower drive coupling spring pack is used in 6V–92 TA coach engines to prevent the transfer of torque fluctuations to the blower and reduce blower drive shaft spline wear. The spring pack is installed with the retainer groove in the cam facing the gear.

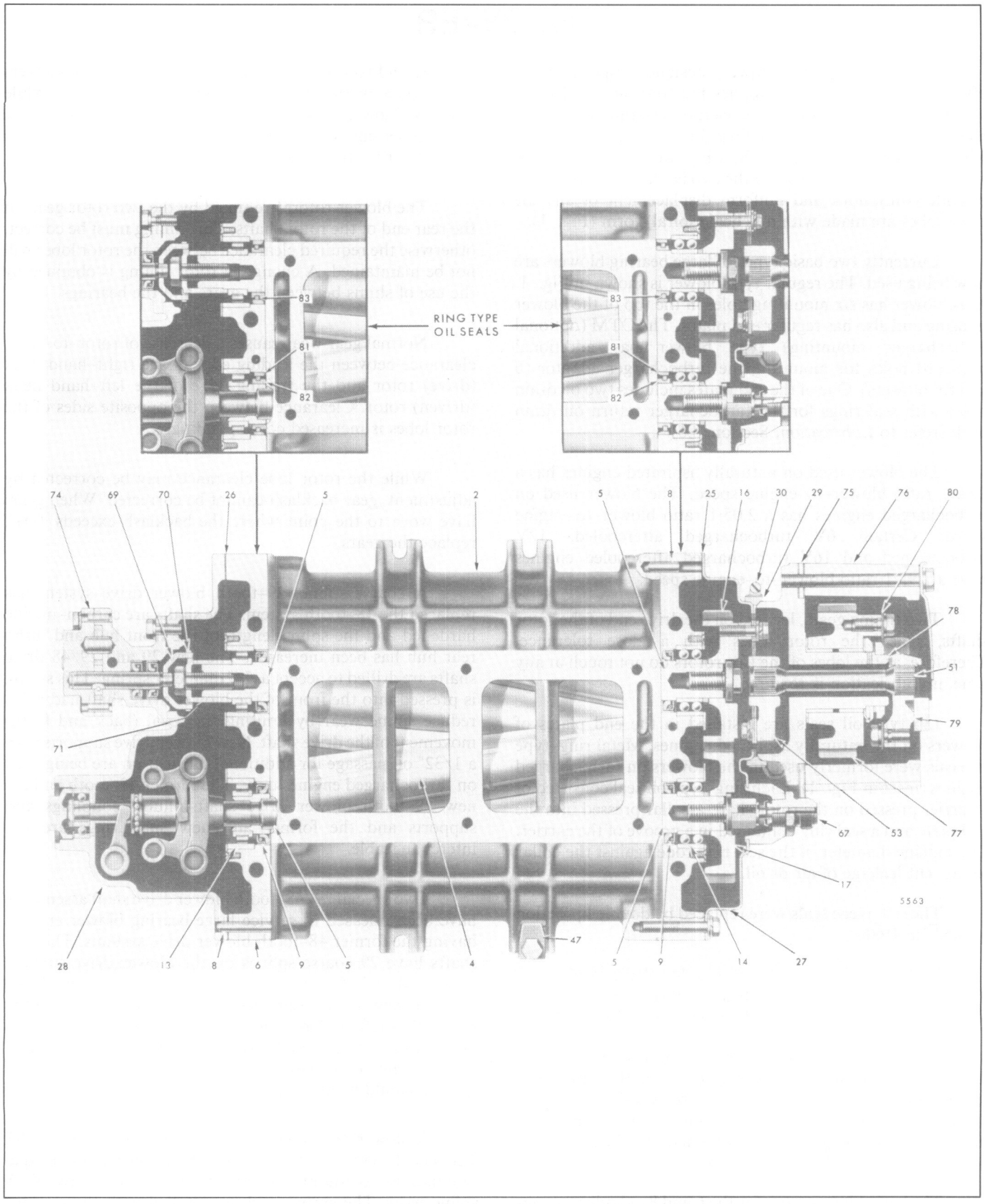


Fig. 1 – Blower and Drive Assembly and Accessories Attached to Blower

2.	Housing—Blower	25.	Gasket—Rear End Plate Cover	51.	Shaft—Blower Drive	76.	Housing—Flywheel
4.	Rotor Assy.—Blower	26.	Gasket—Front End Plate Cover	53.	Hub—Drive	77.	Gear—Blower Drive
5.	Shaft—Rotor	27.	Cover—Rear End Plate	67.	Fitting—Tachometer Drive Adaptor	78.	Support—Blower Drive
6.	Plate—Blower End	28.	Housing—Governor (Front End Plate Cover)	69.	Fork—Fuel Pump Drive	79.	Coupling—Blower Drive Flexible
8.	Pin—Dowel	29.	Seal—Rear End Plate Cover	70.	Disc—Fuel Pump Drive	80.	Plate—Blower Drive Flexible Coupling
9.	Seal—Oil	30.	Clamp—Rear End Plate Cover Seal	71.	Spacer—Fuel Pump Drive Disc	81.	Collar—Blower End Plate
13.	Bearing—Front (Roller)	47.	Lug—Mounting Bolt	74.	Pump Assy.—Fuel	82.	Carrier—Seal Ring
14.	Bearing—Rear (Ball)			75.	Plate—Cylinder Block Rear End	83.	Ring—Seal (Piston Type)
16.	Gear—Rotor Drive						
17.	Gear—Rotor Driven						

Fig. 1 – Blower and Drive Assembly and Accessories Attached to Blower

NOTICE: The shaft bore of the former blower drive supports installed in pre–1979 production engines cannot be rebored to the increased diameter of the current blower drive supports. Therefore, on engines built before 1979, new blower drive supports must be used when converting from a 48–tooth to a complete 29–tooth blower drive system.

Mini–Bypass Blower (6V And 8V Automotive Engines)

Effective with engine serial numbers 6VF–096295 and 8VF–079550, mini–bypass blowers have been released for 6V and 8V–92 Federal–certified and 8V–92 California–certified automotive engines equipped with front blower–mounted and real bracket–mounted turbochargers. Coach engines are not included in this change.

The mini–bypass blower was developed to increase fuel efficiency by reducing the amount of engine power required to operate the blower.

A spring–loaded bypass relief valve (Fig. 2) is positioned in a passage in the rear blower end plate of the turbocharged 6V and 8V–92 automotive engines indicated. This valve is closed at start–up and during low rpm/light load operation. However, as engine speed and load increase, turbocharger speed also increases until the turbocharger provides sufficient boost pressure for scavenging and charging the engine cylinders. At 12" Hg (41 kPa) airbox pressure the valve in the passage opens (Fig. 3). With the valve in the open position, incoming air is allowed to flow through the lobes of the blower and through the rear end plate to the airbox. The blower continues to operate with the valve open, but requires less engine power because the pressure rise across the blower is greatly reduced. This results in decreased brake specific fuel consumption and increased fuel economy.

The mini–bypass valve is externally vented back into the crankcase by means of a small vent hose and tube through the rear blower end plate. A very small amount of air bleeds past the valve and passes through the hose to help keep the valve clean and functioning properly. This has no effect on crankcase pressure.

With the advent of the mini–bypass blower end plate and valve, one of the blower end plate cover bolts is eliminated and a new end plate cover reinforcing plate has been released. A new composition gasket is also being used to ensure proper sealing of the blower–to–end plate cover joint. An end plate cover reinforcing plate is used on 6V and 12V–92 midi–bypass blowers, effective with units manufactured March, 1986.

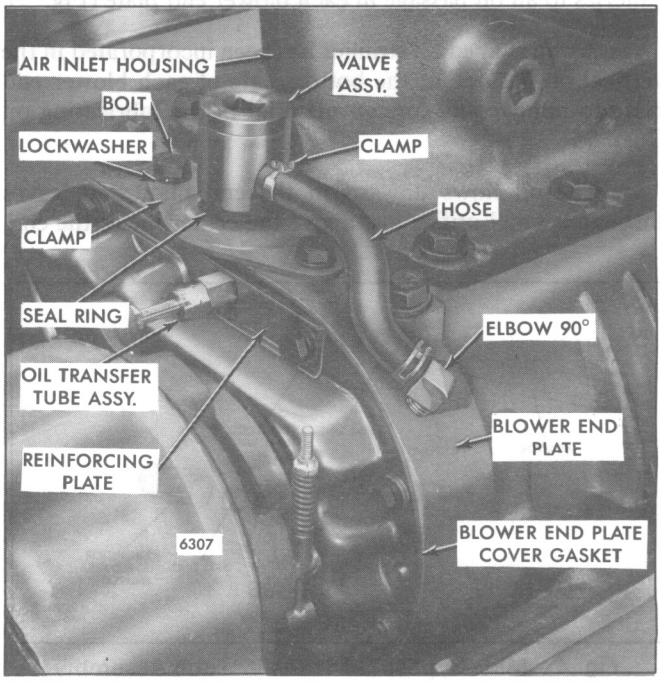


Fig. 2 – Typical Mini–Bypass Blower (6V–92)

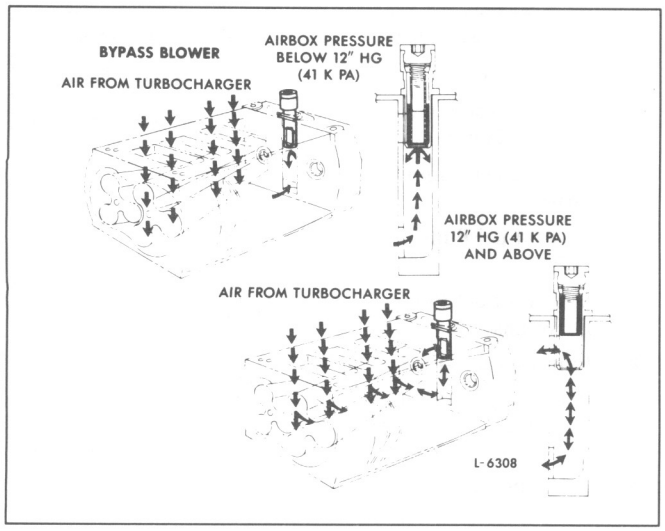


Fig. 3 – Mini–Bypass Blower Air Flow

Due to the size and location of the mini–bypass valve, new oil supply fittings (Fig. 4) are being used between the blower and the blower drive support, and new air inlet housings have been released. The blower assemblies formerly used on 6V and 8V–92 automotive engines equipped with front blower–mounted turbochargers or rear bracket–mounted turbochargers will continue to be serviced.

Lubrication

The blower bearings, timing gears, governor drive and fuel pump drive are pressure lubricated by oil passages in the top deck of the cylinder block which lead from the main oil galleries to an oil passage in each blower end plate (Fig. 5).

A cup shaped oil strainer has been incorporated in the vertical oil passage at the bottom side of each blower end plate to remove any foreign material in the lubricating oil (Fig. 5).

The oil flows upward in the end plate and leaves through a small orifice just above the centerline of the end plate. The oil is ejected from this orifice against the timing gears at the rear and the governor weights at the front of the blower and is then carried by splash to the bearings. Oil which collects at the bottom of each end plate overflows into two drain passages which lead back to the crankcase via oil passages in the cylinder block.

NOTICE: The OTM (optional turbocharger mounting) type blower does not include an oil orifice in the end plate since the blower bearings are lubricated by the drain oil from the turbocharger.

The blower drive support bearings receive oil under pressure from a tube which connects the oil passage in the rear end plate to passages in the blower drive support. Excess oil drains back to the crankcase by way of the gear train.

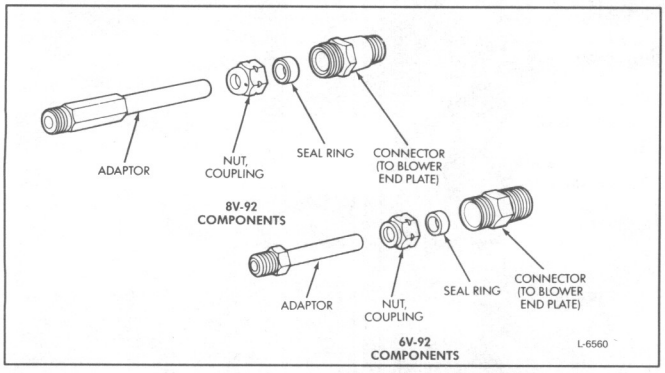


Fig. 4 – Mini–Bypass Oil Transfer Tube Assembly Components

Inspection

The blower may be inspected for any of the following conditions without being removed from the engine. However, the air silencer and adaptor, or the air inlet housing, air shutdown housing and adaptor must first be removed. The turbocharger and adaptor must also be removed on engines equipped with the OTM blower.

CAUTION: When inspecting a blower on an engine with the engine running, keep fingers and clothing away from moving parts of the blower and run the engine at low speeds only.

1. Dirt or chips, drawn through the blower, will make deep scratches in the rotors and housing and throw up burrs around such abrasions. If burrs cause interference between the rotors or between the rotors and the housing, remove the blower from the engine and "dress" the parts to eliminate interference, or replace the rotors if they are badly scored.

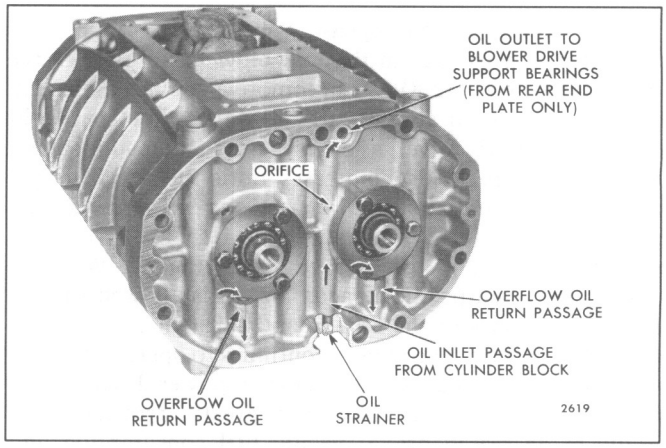


Fig. 5 – Blower Lubrication (Except OTM Blower)

2. Leaky oil seals are usually manifest by the presence of oil on the blower rotors or inside surfaces of the housing. This condition may be checked by running the engine at low speed and directing a light into the rotor compartment at the end plates and the oil seals. A thin film of oil radiating away from the seals toward the inlet of the blower is indicative of leaking seals.

3. Loose rotor shafts or damaged bearings will cause rubbing and scoring between the crowns of the rotor lobes and the mating rotor roots, between the rotors and the end plates, or between the rotors and the housing. Generally, a combination of these conditions exists. Worn or damaged bearings will cause rubbing between mating rotor lobes at some point or perhaps allow the rotor assemblies to rub the blower housing or the end plates. This condition will usually show up at the end where the bearings have failed.

4. Excessive backlash between the blower timing gears usually results in the rotor lobes rubbing throughout their entire length. This usually is on the trailing (close clearance) side.

5. Inspect the blower inlet screen, periodically, if used, as noted in Section 15.1, for an accumulation of dirt which, after prolonged operation, may affect the air flow. Servicing of the screen consists of thoroughly washing it in fuel oil and cleaning with a stiff brush until the screen is free of all dirt deposits. If broken wires are found in the blower screen, replace the screen.

6. Check the lubricating oil connection between the blower and the blower drive support for excessive oil leakage. If oil leakage exists, retighten or replace the fittings or seal rings.

7. Check the rubber seal ring used between the blower end plate cover and the blower drive support for oil leakage. If oil leakage exists, retighten the seal clamp or replace the seal ring. Some engines use a seal ring (.740" wide) that incorporates two raised edges which provide a groove to retain the clamp. To replace a seal ring without removing the blower, refer to Section 3.0.

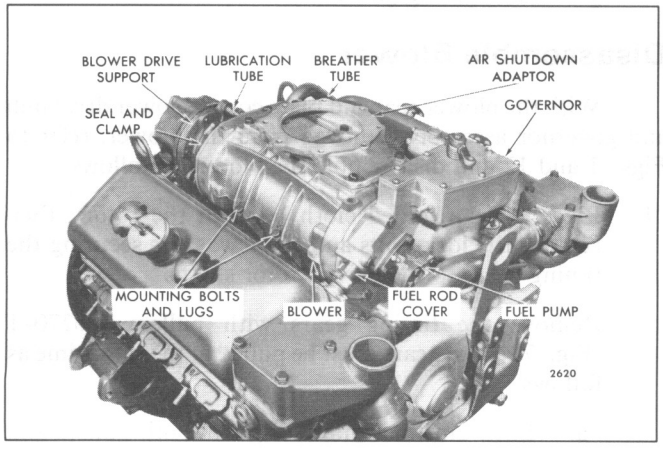


Fig. 6 – Typical Blower Mounting (Single Blower)

To correct any of the conditions cited in Items 1 through 6, the blower must be removed from the engine and either repaired or replaced.

Remove Blower From Engine

The engine governor components are assembled in a combination governor housing and blower front end plate cover. The fuel pump is also attached to the front end of the blower. Therefore, when removing the blower assembly from the engine, the governor and fuel pump will also be removed at the same time. Refer to Fig. 6 and proceed as follows:

1. Disconnect the air cleaner to air shutdown housing, or turbocharger, tubing as required (Section 3.1 or 3.5).

2. Remove the turbocharger, if used, and attaching parts (Section 3.5).

3. Disconnect the shutdown wire assembly from the air shutoff cam pin handle.

4. Remove the air shutdown housing assembly and gasket (Section 3.3).

5. Remove the bolts and washers securing the air shutdown housing to the blower. Remove the adaptor and the blower screen (if used).

6. Loosen the oil pressure line fitting from the rear of the blower to the blower drive support and slide the fitting back on the tube.

7. Loosen the hose clamp on the blower drive support–to–blower seal.

8. Disconnect the tachometer drive cable from the adaptor at the rear of the blower.

9. Remove the flywheel housing cover at the blower drive support.

10. Remove the snap ring and withdraw the blower drive shaft from the blower.

11. Open the drain cocks and drain the engine cooling system.

12. Loosen the hose clamps and slide the hoses back on the bypass tube between the thermostat housings. Remove the bypass tube.

13. Remove the fuel inlet and outlet lines to the fuel pump. Also, remove the fuel return crossover tube between the cylinder heads.

14. Remove or disconnect the breather pipe at the top of the cylinder block.

15. Remove the front engine lifter bracket, if necessary.

16. Disconnect the throttle control rods from the governor.

17. Clean and remove the rocker cover from each cylinder head.

18. Remove the eight governor cover screws and lock washers and remove the governor cover.

19. Disconnect the fuel rods from both the injector control tube levers and the governor and remove the fuel rods.

20. Loosen the hose clamps on the fuel rod cover tube hoses next to each cylinder head and slide each hose and clamp up on the tube in the governor housing.

21 Remove the two bolts and washers through the top of each end plate which secures blower to the cylinder block.

22. Remove the blower–to–block bolts and retaining washers on each side of the blower.

23. Disconnect and remove any tubing or accessories which may interfere with removal of the blower.

24 On 12V and 16V engines, disconnect the governor linkage as outlined in Section 2.7.1. Remove the governor from the engine. Either blower may be removed without disturbing the other blower. Remove the governor to blower gasket.

25. Thread eyebolts in the diagonally opposite tapped holes in the top of the blower housing. Then, attach a rope sling and chain hoist to the eyebolts.

26. Lift the blower up slightly and move it forward to detach the blower from the seal at the drive end. Then, lift the blower up and away from the engine. Remove the blower gasket.

With the blower, fuel pump and governor assembly removed from the engine, cover the air inlet and outlet openings of the blower housing and install the governor cover. Wash the exterior of the blower and governor housing with clean fuel oil and dry them with compressed air.

Remove Blower Rear End Plate Cover

Remove the blower rear end plate cover, governor and fuel pump assembly from the blower as follows:

1. Remove the remaining bolts, lock washers and special washers securing the rear end plate cover to the end plate. Remove the cover and gasket from the end plate.

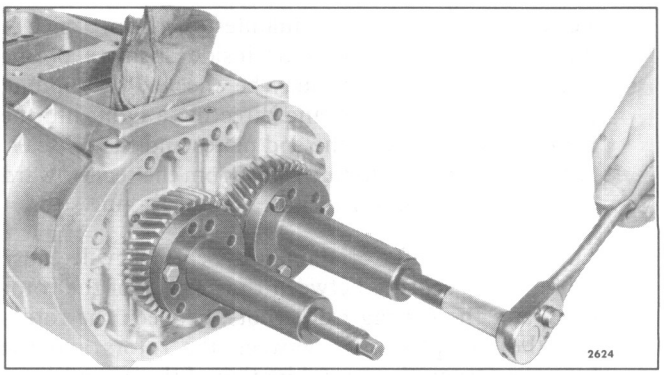


Fig. 7 – Removing Blower Gears with Tool J 6270–31

2. Remove the three bolts and washers or lock bolts securing the flex plates to the right–hand blower rotor gear. Remove the drive coupling from the gear.

   Some former engines are equipped with thin hub spacers. They are not readily accessible, and some mechanics may not be aware that they are behind the flex plate. Consequently, when working on the blower hub assemblies, remove the flex plate attaching bolts carefully to avoid dropping the thin hub spacers into the gear train. If spacers are inadvertently dropped into the gear train, removal of the engine flywheel housing and/or oil pan may be required to retrieve them.

3. Note the location of the two copper washers, one plain washer and eight lock washers on the governor–to–blower bolts before removing them. Then, remove the ten bolts and washers (two inside and eight outside) securing the governor and fuel pump assembly to the blower.

4. Tap the sides of the governor housing slightly with a plastic hammer to loosen the governor from the blower. Then, pull the governor and fuel pump assembly from the dowels in the blower end plate. Remove the fuel pump drive coupling fork and the governor housing gasket.

Disassemble Blower

With the blower rear end plate cover, blower drive hub and governor assembly removed from the blower, refer to Figs. 1 and 12 and disassemble the blower as follows:

1. Place a clean folded cloth between the rotors, then remove the lock bolts and thick washers securing the timing gears to the blower rotor shafts.

2. Remove the timing gears with pullers J 6270–1 (Fig. 7). Both gears must be pulled at the same time as follows:

   a. Back out the center screws of both pullers and place the flanges against the gear faces, aligning

the flange holes with the tapped holes in the gears. Secure the pullers to the gears with 5/16"–24 x 1–1/2" bolts (two bolts on the L.H. helix gear and three bolts on the R.H. helix gear).

b. Turn the two puller screws uniformly clockwise and withdraw the gears from the rotor shafts (Fig. 7).

3. Remove the shims from the rotor shafts, after the gears have been removed, and note the number and thickness of shims on each rotor shaft to ensure identical replacement when reassembling the blower.

4. Remove the self locking screws securing the rotor shaft bearing retainers to the front and rear end plates. Remove the retainers.

5. Remove the blower rear end plate and ball bearing assembly from the blower housing and rotors with the two pullers J 6270–31 as follows:

a. Remove the two fillister head screws securing the rear end plate to the blower housing and loosen the two fillister head screws securing the front end plate to the housing approximately three turns.

b. Back out the center screws of the pullers far enough to permit the flange of each puller to lay flat on the face of the end plate.

c. Align the holes in each puller flange with the tapped holes in the end plate and secure the pullers to the end plate with six 1/4"–20 x 1–1/4" or longer bolts.

NOTICE: Be sure that the 1/4"–20 bolts are threaded all the way into the tapped holes in the end plate to provide maximum anchorage for the pullers and to eliminate possible damage to the end plate.

d. Turn the two puller screws uniformly clockwise and withdraw the end plate and bearings from the blower housing and rotors (Fig. 8).

6. Remove the blower front end plate and roller bearing assembly from the blower housing and rotors as follows:

a. Remove the fuel pump drive bolt, washer and spacer.

b. Remove the two fillister head screws securing the front end plate to the blower housing.

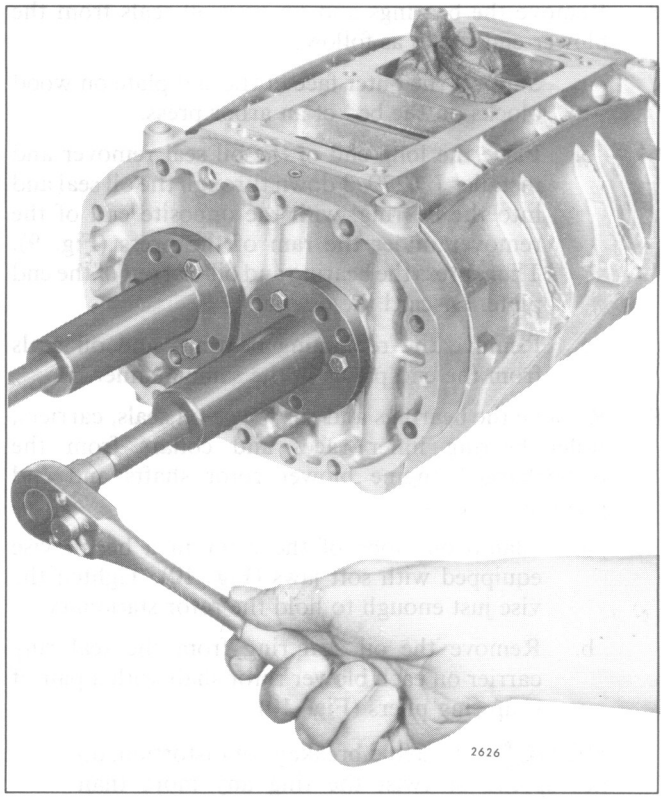


Fig. 8 – Removing Blower End Plate and Bearings from Housing and Rotors with Tool J 6270–31

c. Remove the front end plate and roller bearings from the housing and rotors.

NOTICE: The roller bearing inner races will remain on the shaft of the rotor and the lip type oil seals could be damaged.

7. Withdraw the blower rotors from the housing.

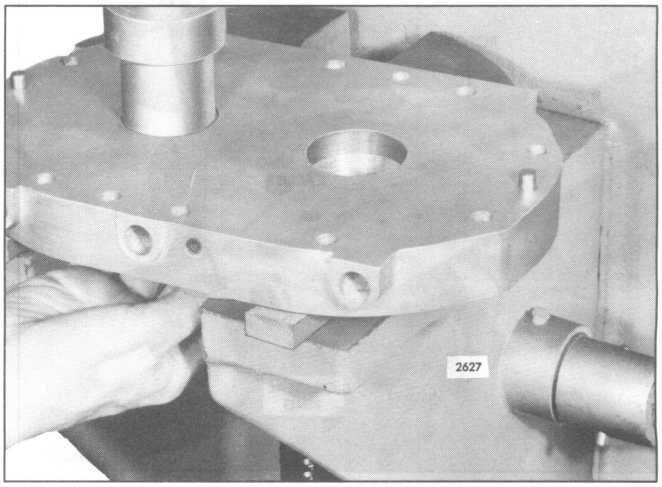


Fig. 9 – Removing Oil Seal (or Oil Seal Ring Collar) and Bearing from End Plate with Tool J 6270–3

8. Remove the bearings and *lip type* oil seals from the blower end plates as follows:
   a. Support the outer face of the end plate on wood blocks on the bed of an arbor press.
   b. Place the long end of the oil seal remover and installer J 6270–3 down through the oil seal and into the bearing, with the opposite end of the remover under the ram of the press (Fig. 9). Then, press the bearing and oil seal out of the end plate. Discard the oil seal.
   c. Remove the remaining bearings and oil seals from the end plates in the same manner.
9. Remove the bearings and *ring–type* oil seals, carriers, roller bearing inner races and collars from the turbocharged engine blower rotor shafts and end plates as follows:
   a. Clamp one lobe of the rotor in a bench vise equipped with soft jaws (Fig. 10). Tighten the vise just enough to hold the rotor stationary.
   b. Remove the oil seal ring from the seal ring carrier on each blower rotor shaft with a pair of snap ring pliers (Fig. 10).

NOTICE: To avoid breakage or distortion, do not spread or twist the ring any more than necessary to remove it.

   c. Refer to Fig. 11 and place the seal ring carrier remover adaptor J 6270–2 over the carrier. Make sure the adaptor is seated in the groove of the carrier.
   d. Back out the center screw of puller J 6270–31 far enough to permit the puller flange to lay flat against the adaptor J 6270–2.

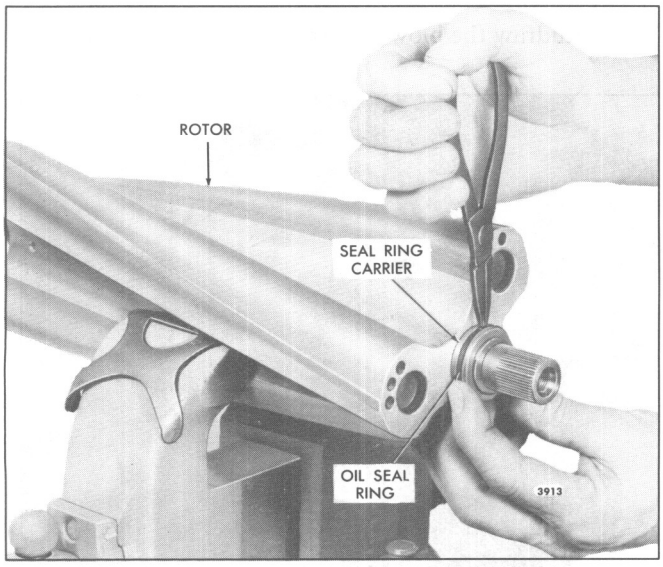


Fig. 10 – Removing Oil Seal Ring from Carrier (Turbocharged Engine Blowers)

   e. Place the puller over the end of the rotor shaft and against the adaptor on the oil seal ring carrier. Align the holes in the puller flange with the tapped holes in the adaptor, then secure the puller to the adaptor with two bolts.
   f. Turn the puller screw clockwise and pull the oil seal ring carrier and roller bearing inner race (front end of blower rotors only) from the rotor shaft (Fig. 11).
   g. Remove the remaining oil seal ring carriers from the rotor shafts in the same manner.
   h. Refer to Fig. 9 and support the outer face of the blower end plate on wood blocks on the bed of an arbor press.
   i. Place the long end of the oil seal remover and installer J 6270–3 down through the oil seal ring collar and into the bearing, with the opposite end of the remover under the ram of the press (Fig. 9). Then, press the bearing and oil seal ring collar out of the end plate.
   j. Remove the remaining bearings and oil seal ring collars from the end plates in the same manner.

The oil seal ring collar can be removed from the blower end plate with the bearing in place as follows:

   a. Insert J 6270–15 bushing ram (with the "O" ring) in the collar with the lip of the remover on the inside edge of the collar.
   b. Support the inner face of the blower end plate on wood blocks.
   c. Insert the small end of the driver handle J 6270–17 through the bearing and into the collar remover, spreading it tight in the collar.
   d. Press or tap on the driver handle to remove the collar.

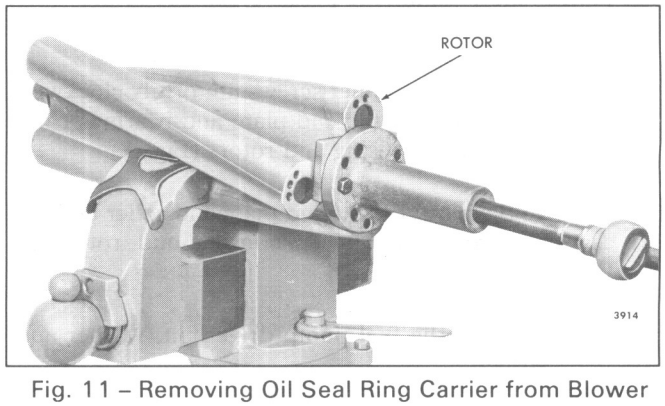


Fig. 11 – Removing Oil Seal Ring Carrier from Blower Rotor Shaft (Turbocharged Engine Blowers) using Tools J 6270–2 and J 6270–31

Inspection

Wash all of the blower parts in clean fuel oil and dry them with compressed air.

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

Examine the bearings for any indications of corrosion or pitting. Lubricate each ball bearing with light engine oil. Then, while holding the bearing inner race from turning, revolve the outer race slowly by hand and check for rough spots.

The double–row ball bearings are pre–loaded and have no end play. A new bearing will seem to have considerable resistance to motion when revolved by hand.

Check the oil seal rings, carriers and collars for wear or scoring. If worn excessively, they must be replaced. The current oil seal rings are chrome flashed and the carriers are liquid nitrided. When replacement of an oil seal ring or carrier is necessary, both parts must be replaced together.

Inspect the blower rotor lobes, especially the sealing ribs, for burrs or scoring. Rotors must be smooth for satisfactory operation of the blower. If the rotors are slightly scored or burred, they may be cleaned up with emery cloth.

Examine the rotor shaft serrations for wear, burrs or peening. Also inspect the bearing and oil seal contact surfaces of the shafts for wear or scoring.

Inspect the inside surface of the blower housing for burrs or scoring. The inside surface must be smooth for efficient operation of the blower. If the inside surface of the housing is slightly scored or burred, it may be cleaned up with emery cloth.

Check the finished ends of the blower housing for flatness or burrs. The end plates must set flat against the blower housing.

The finished inside face of each end plate must be smooth and flat. If the finished face is slightly scored or burred, it may be cleaned up with emery cloth.

NOTICE: Be careful not to remove metal at the joint face between the end plates and the housing. Air or oil leaks could develop after assembly.

Examine the serrations in the blower timing gears for wear or peening. Also, check the gear teeth for wear, chipping or other damage. If the gears are worn to the point where the backlash between the gears exceeds .004", or damaged sufficiently to require replacement, both gears must be replaced as a set.

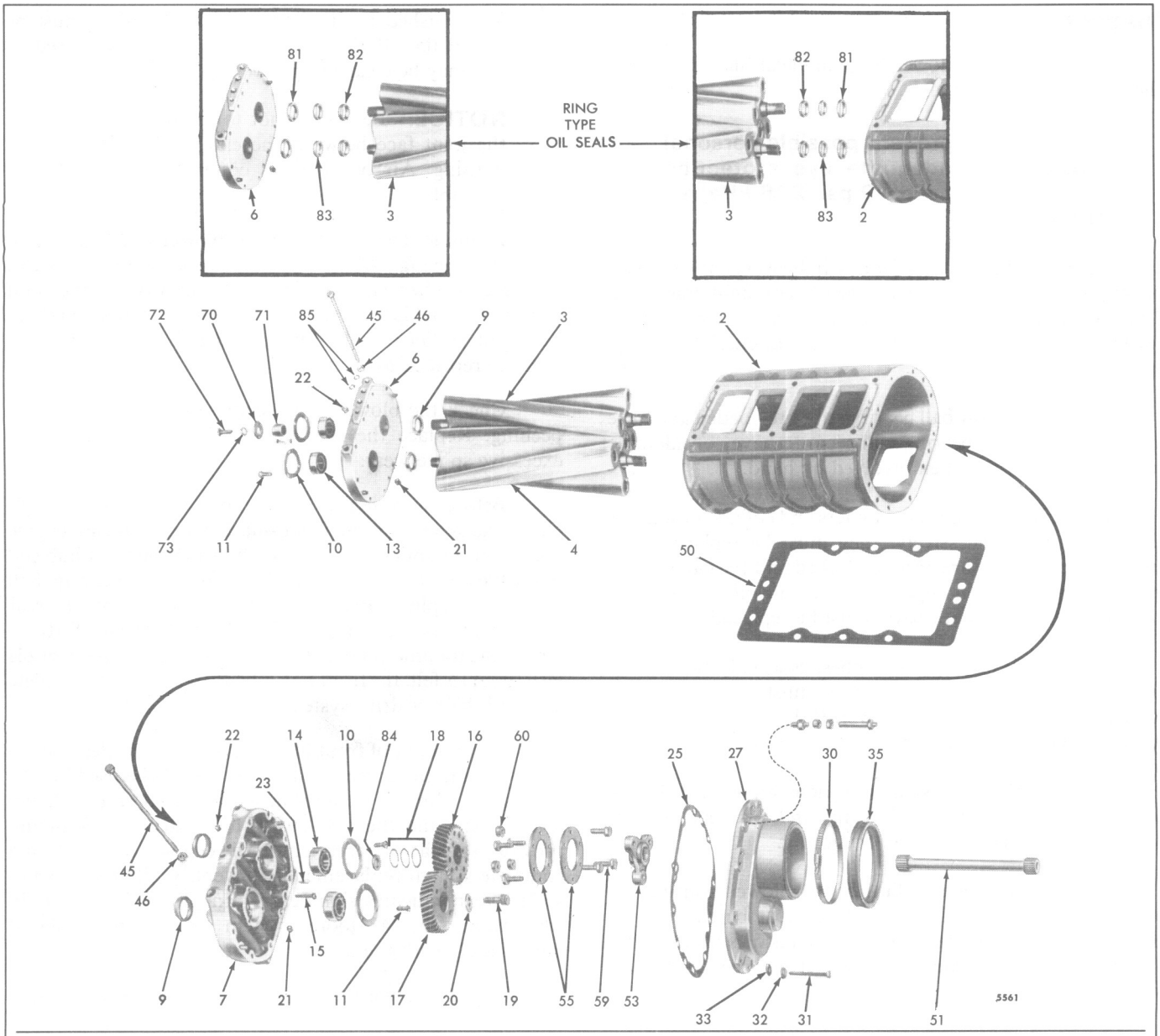
Check the blower drive shaft serrations for wear or peening. Replace the shaft if it is bent, cracked or has excessive spline wear.

Before installing a 29/48–tooth blower drive shaft, check the splines on the front hub for wear. During engine operation the splines on the front hub and the front hub end of the blower drive shaft normally wear at a slower rate than the rear hub splines. Before replacing the drive shaft and rear hub, install the new shaft and rotate it back and forth to determine the amount of front hub spline wear. If perceptible lash (wear) is felt, the front hub is badly worn, and a complete 29–tooth blower drive system should be installed.

The amount of front hub wear can also be determined by inspecting the corresponding splines on the used blower drive shaft. Minimal shaft spline wear indicates minimal hub spline wear, and the new 29–48–tooth drive shaft should provide satisfactory service until engine overhaul and complete system replacement. Conversely, significant shaft spline wear indicates significant front hub spline wear. In this event, the 48–tooth system should be replaced immediately with the 29–tooth system.

Replace all worn or excessively damaged blower parts.

Clean the oil strainer in the vertical oil passage at the bottom side of each blower end plate and blow out all oil passages with compressed air.



2. Housing—Blower
3. Rotor Assy.—R. H. Helix
4. Rotor Assy.—L. H. Helix
6. Plate—Blower Front End
7. Plate—Blower Rear End
9. Seal—Oil
10. Retainer—Blower Bearing
11. Retainer—Lock Screw
13. Bearing—Blower Rotor Front (Roller)
14. Bearing—Blower Rotor Rear (Ball)
15. Screw—Fillister Head
16. Gear—R. H. Helix Rotor
17. Gear—L. H. Helix Rotor
18. Shim—Blower Gear
19. Bolt—Blower Gear
20. Washer
21. Strainer—End Plate Oil Passage
22. Plug—Oil Passage
23. Orifice—Oil Passage
25. Gasket—Cover
27. Cover—Rear End Plate
30. Clamp—Hose
31. Bolt—Cover
32. Lock Washer
33. Washer—Special Flat
35. Hose—Blower Drive Cover
45. Bolt—Blower Mounting
46. Lock Washer
50. Gasket
51. Shaft—Blower Drive
53. Hub—Drive
55. Plate—Flexible
59. Bolt
60. Spacer
70. Disc—Fuel Pump Drive
71. Spacer—Fuel Pump Drive Disc
72. Bolt—Drive Disc
73. Lock Washer
81. Collar—Blower End Plate
82. Carrier—Seal Ring
83. Ring—Seal (Piston Type)
84. Spacer
85. Seal Ring

Fig. 12 – Blower Details and Relative Location of Parts

Assemble Blower

Several precautions are given below to assure proper assembly of the rotors and gears for correct blower timing.

1. The lobes on the *driving* blower rotor and the teeth on its gear form a right–hand helix while the lobes and teeth of the *driven* rotor and gear form a left–hand helix. Hence, a rotor with right–hand helix lobes must be used with a gear having right–hand helix teeth and vice versa.
2. One serration is omitted on the drive end of each blower rotor shaft and a corresponding serration is omitted in each gear. Assemble the gears on the rotor shafts with the serrations in alignment.
3. The rotors must be assembled in the blower housing with the omitted serrations in the rotor shafts aligned as shown in Fig. 24.

With these precautions in mind, proceed with the blower assembly, referring to Figs. 12 through 24 as directed in the text:

1. Install new *lip type* oil seals as follows:

   a. Support the blower end plate, finished surface facing up, on wood blocks on the bed of an arbor press.

NOTICE: If oversize oil seals are being used in the blower end plates, use installer J 6270–28 to install the oversize oil seal spacers on the rotor shafts.

   b. Start the oil seal straight into the bore in the end plate with the sealing edge facing down (toward the bearing bore).

   c. Place the short end of oil seal remover and installer J 6270–3 in the oil seal and press the oil seal into the end plate until the shoulder on the installer contacts the end plate (Fig. 13).

NOTICE: A step under the shoulder of the installer will position the oil seal approximately .005" below the finished face of the end plate. This is within the .002" to .008" specified.

   d. Install the remaining oil seals in the end plates in the same manner.

•2. Install *double–lip Teflon* oil seals as follows:

   a. Press the oversize oil seal spacer onto the rotor shaft with installer J 35787–1 until either the shoulder of the tool or the spacer contacts the rotor.

   b. Support the blower end plate, finished surface up, on wood blocks on the bed of an arbor press.

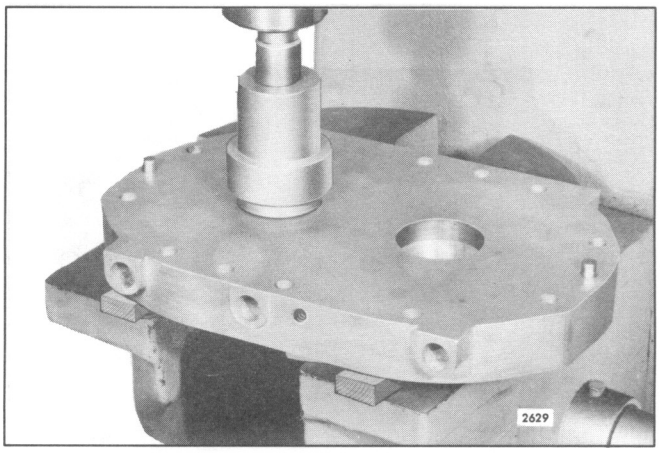


Fig. 13 – Installing Oil Seal (or Oil Seal Ring Collar) in End Plate using Tool J 6270–3

NOTICE: Do not lubricate the seals, spacers, or blower rotor shafts prior to seal installation. Teflon lip seals *must* be installed dry. This allows transfer of the Teflon to the spacer surface for proper sealing.

Double–lip Teflon seals are packaged around a special plastic sleeve which should not be removed prior to seal installation. The sleeve protects the lips of the seals during shipment and acts as a seal lip expander during blower assembly.

   c. With the part number on the seal facing the rotor, start the oil seal straight into the bore in the end plate.

   d. Using installer J 35787–2, press the double–lip oil seal below the surface of the end plate until the shoulder of the installer contacts the end plate.

   e. Install the remaining oil seals in the end plates in the same manner.

3. Install the *ring–type* oil seal carriers, collars, seal rings and roller bearing inner races (front end of blower rotors only) on the rotor shafts and in the end plates as follows:

   a. Support one of the rotor assemblies on wood blocks on the bed of an arbor press (Fig. 15).

   b. Lubricate the inside diameter of the oil seal ring carrier with engine oil. Then start the carrier straight over the end of the rotor shaft with the chamfered inside diameter end facing the rotor.

   c. Place the oil seal ring carrier installer J 6270–13 over the end of the rotor shaft and against the carrier with the end of the installer under the ram of the press. Then press the carrier down tight against the rotor.

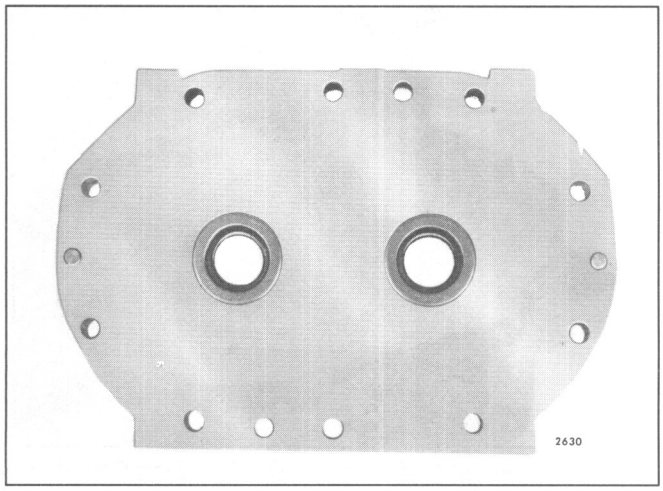


Fig. 14 – Location of Oil Seals in End Plate

d. Install the remaining oil seal ring carriers on the rotor shafts in the same manner.

e. Install an oil seal ring in the ring groove of each carrier with a pair of snap ring pliers in the same manner as shown in Fig. 10.

NOTICE: To avoid breaking the oil seal rings, do not spread them any more than necessary to place them over the end of the carrier. Do not twist the rings or possible distortion may result in loss of side contact area.

f. Support one of the blower end plates, inner face up, on wood blocks on the bed of an arbor press (Fig. 13).

g. Lubricate the outside diameter of a seal ring collar with engine oil. Then start the chamfered outside diameter end of the collar straight into the bore in the end plate.

h. Place the oil seal ring collar installer J 6270–3 on top of the seal ring collar and under the ram of the press (Fig. 13). Then, press the collar into the end plate until the shoulder on the installer contacts the end plate.

NOTICE: A step under the shoulder of the installer will position the collar approximately .005" below the finished face of the end plate. This is within the .002" to .008" specified.

i. Install the remaining oil seal ring collars in the end plates in the same manner.

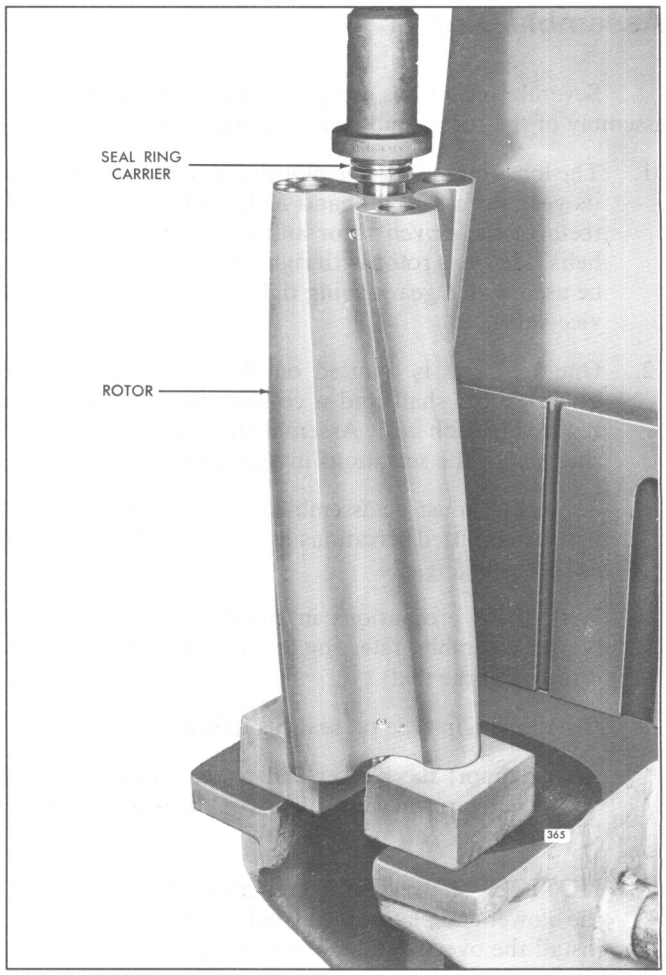


Fig. 15 – Installing Oil Seal Ring Carrier on Blower Rotor Shaft (V–92T Blowers) with Tool J 6270–4

Assemble Rotors And End Plates (Blower With Lip Type Oil Seals)

1. Install the blower front end plate.

The top of the end plate is readily identified by the two bolt holes and one oil hole, whereas the bottom side of the end plate has two bolt holes and three oil holes. Also, the front end plate is thinner than the rear end plate.

NOTICE: The horizontal oil passage in the top front face of the front end plate that intersects the vertical oil passage is plugged. Do not install this end plate on the rear end of the blower housing.

The front end plate should be attached to the front end of the blower housing first. The rear end plate is attached to the blower housing after the rotors are in place. Attach the front end plate to the blower housing as follows:

a. If removed, press a new oil strainer into the vertical oil passage at the bottom side of the end

plate .150" below the bottom surface (Fig. 5). Then, install the pipe plug in the vertical oil passage at the top of the end plate.

b. Check the dowel pins. The dowel pins must project .320" from the flat inner face of the front end plate to assure proper alignment of the end plate with the housing.

c. If removed, press a new bolt guide sleeve (bushing) into one bolt hole in the bottom side of the end plate. Install the sleeve, with the three notches on the sleeve to the bottom side of the end plate and the center notch to the outside of the end plate, flush to .005" below the surface of the end plate.

NOTICE: When installed, the inside flats of the sleeve will be parallel to the center line of the housing.

d. Place the blower housing on a bench with the top side of the housing up and the front end of the housing facing the outside of the bench.

e. Apply a light coating of Permatex FORM–A–GASKET NO. 2 or an equivalent sealant to the mating surfaces of both the end plate and blower housing. Then, position the end plate in front of the blower housing with the top side of the end plate facing up. Start the dowel pins straight into the dowel pin holes in the housing. Push or tap the end plate against the housing. Note that no gaskets are used between the end plates and the housing. Therefore, the mating surfaces should be perfectly flat and smooth, however, caution must be used so that no sealant protrudes into the housing. Also, the sealant must not prevent the end plate from laying flat against the housing.

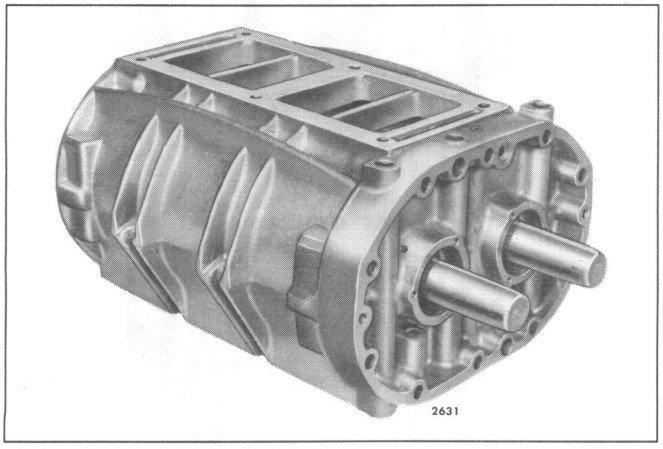


Fig. 16 – Assembling Blower Rotors in Housing and Front End Plate with Oil Seal Pilots (J 6270–5)

f. Insert the two fillister head screws through the end plate and thread them into the housing. Tighten the screws to 5–10 lb–ft (7–14 N•m) torque. Do not use lock washers on these screws.

2. Refer to Fig. 16 and install the blower rotors in the blower housing and end plate as follows:

a. Reverse the blower housing on the bench (open end of housing facing the outside of the bench).

b. Place the rotors in mesh with the omitted serrations in the rotor shafts in a horizontal position and facing to the left as viewed from the gear end. Note that the right–hand helix rotor is marked "GEAR END " on one end. The gear end of the left–hand rotor is that end which has the serrated shaft.

c. Install an oil seal pilot J 6270–5 over the opposite end of each rotor shaft.

NOTICE: When oversize oil seals are used in the blower end plate, use oil seal spacer installer J 6270–28 for the oil seal pilots in place of J 6270–5.

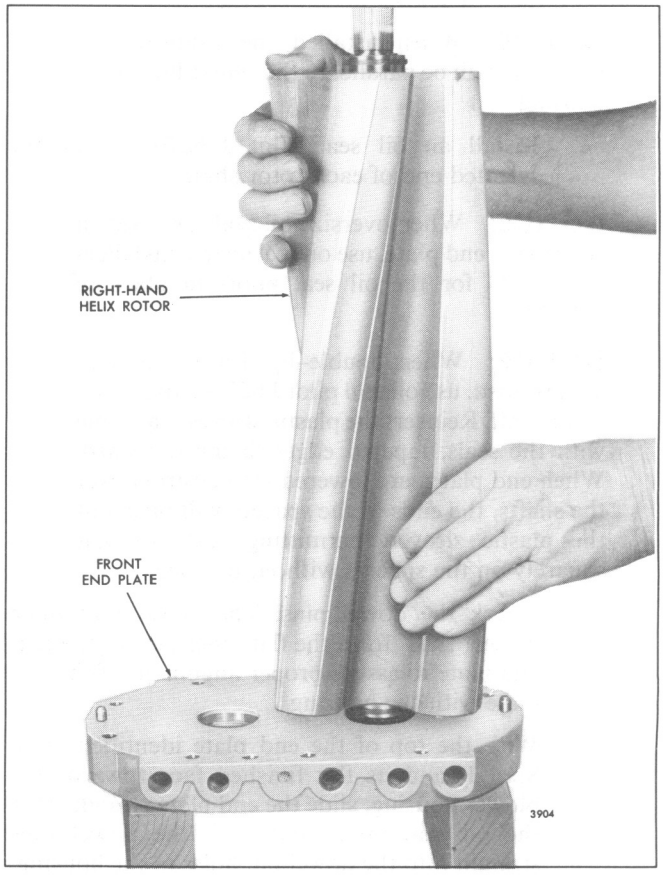


Fig. 17 – Installing Blower Rotor in Front End Plate (V–92T Blowers)

NOTICE: When double–lip Teflon oil seals are installed, use oil seal pilot J 6270–5 over each rotor shaft. Reinsert the plastic sleeves that came with the seals, tapered edges facing outboard. When end plates are lowered into position over the shafts, the ends of the spacers will push out the plastic sleeves, permitting seals to seat squarely on the spacers without damage.

d. Insert the rotors straight into the housing and through the front blower end plate.

e. Remove the oil seal pilots from the rotor shafts.

3. Install the blower rear end plate as follows:

a. If removed, press a new oil strainer into the vertical oil passage at the bottom side of the end plate .150" below the bottom surface (Fig. 5). Then, install the pipe plug in the vertical oil passage at the top of the end plate.

b. If removed, press a new bolt guide sleeve (bushing) into one bolt hole in the bottom side of the end plate. Install the sleeve, with the three notches on the sleeve to the bottom side of the end plate and the center notch to the outside of the end plate, flush to .005" below the surface of the end plate.

NOTICE: When installed, the inside flats of the sleeve will be parallel to the center line of the housing.

c. Install an oil seal pilot J 6270–5 over the serrated end of each rotor shaft.

NOTICE: When oversize oil seals are used in the blower end plate, use oil seal spacer installers J 6270–28 for the oil seal pilots in place of J 6270–5.

NOTICE: When double–lip Teflon oil seals are installed, use oil seal pilot J 6270–5 over each rotor shaft. Reinsert the plastic sleeves that came with the seals, tapered edges facing outboard. When end plates are lowered into position over the shafts, the ends of the spacers will push out the plastic sleeves, permitting seals to seat squarely on the spacers without damage.

d. Check the dowel pins. The dowel pins must project .320" from the flat inner face of the rear end plate to assure proper alignment of the end plate with the housing.

e. With the top of the end plate identified as in Step 1, and its flat finished face towards the blower housing, slide the end plate straight over the oil seal pilots and start the dowel pins straight into the dowel pin holes in the housing. Then, push or tap the end plate against the housing.

f. Insert the two fillister head screws through the end plate and thread them into the housing. Tighten the screws to 5–10 lb–ft (7–14 N•m) torque. Do not use lock washers on these screws.

g. Remove the oil seal pilots from the rotor shafts.

4. Check the relationship of the blower end plates to the housing at the cylinder block side of the blower assembly. The protrusion of the housing with respect to the end plates should not be more than .0005" above to .0065" below the end plate. Excessive protrusion could distort the housing when the end plate to cylinder block bolts are tightened and cause rotor to housing interference.

Assemble Rotors And End Plates (Blower With Ring–Type Oil Seals — Regular And OTM Blowers)

1. Install the blower rotors in the blower front end plate as outlined below.

a. Check the dowel pins. The dowel pins must project .320" from the flat inner face of the front end plate to assure proper alignment of the end plate with the housing.

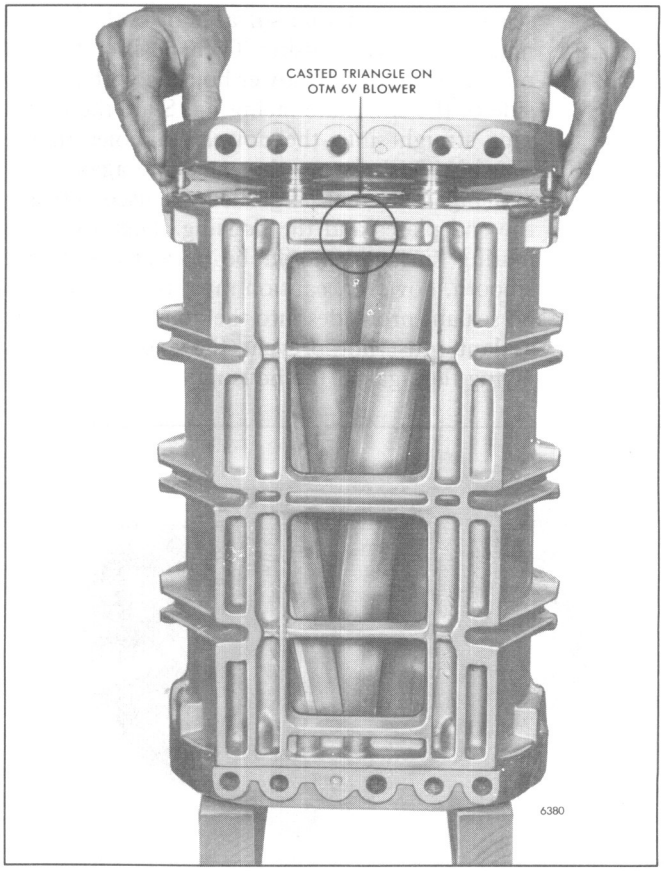


Fig. 18 – Installing Rear End Plate on Blower Rotors and Housing

b. If removed, press a new bolt guide sleeve (bushing) into one bolt hole in the bottom side of the end plate. Install the sleeve, with the three notches on the sleeve to the bottom side of the end plate and the center notch to the outside of the end plate, flush to .005" below the surface of the end plate.

NOTICE: When installed, the inside flats of the sleeve will be parallel to the center line of the housing.

c. Support the front end plate on two wood blocks approximately 4" high, with the inner face of the end plate facing up and the TOP side of the plate facing the serviceman's right (Fig. 17).

d. Lubricate the oil seal ring in the carrier on the front end of the right–hand helix rotor shaft with engine oil.

e. Hold the right–hand helix rotor in a vertical position (gear end up) and position the seal ring in the carrier so the ring protrudes from its groove the same amount on each side and the gap is facing away from the serviceman.

f. With the omitted serration in the splines of the shaft facing toward the top side of the end plate, start the end of the rotor shaft into the right–hand shaft opening in the end plate so that the gap portion of the seal ring is started into the ring collar (Fig. 17). Continue to lower the rotor and very carefully apply pressure to the seal ring approximately 180° from the gap while gently working the seal ring into the collar until the rotor contacts the end plate.

g. Perform Steps "d" and "e" above on the left–hand helix rotor.

h. Position the rotors so the lobes are in mesh and the omitted serrations in the splines of both rotor shafts are facing toward the top side of the end plate. Then install the left–hand helix rotor as in Step "f".

2. Install the blower housing over the rotors and attach it to the front end plate as follows:

NOTICE: When assembling an OTM *6V blower*, it must be determined which is the front end of the housing. For front mounted OTM vehicle engines, the housing must be installed with the stamped triangle end toward the front of the engine. With the rear mounted OTM vehicle engines, the housing is installed with the stamped triangle end toward the rear. On the 8V OTM vehicle engines, either end of the housing can face toward the front of the engine.

a. Position the blower housing over the top of the rotors so the bottom face of the housing faces the bottom side of the front end plate. Then lower the housing over the rotors until it contacts the dowel pins in the end plate.

b. Align the dowel pin holes in the housing with the dowel pins in the end plate. Then push the housing tight against the end plate. If necessary, tap the housing lightly with a plastic hammer.

c. Insert the two fillister head screws through the front end plate and thread them into the housing. Tighten the screws to 5–10 lb–ft (7–14 N•m) torque. Do not use lock washers on these screws.

3. Install the blower rear end plate on the rotor shafts and housing as follows:

a. Check the dowel pins. The dowel pins must project .320" from the flat inner face of the rear end plate to assure proper alignment of the end plate with the housing.

b. If removed, press a new bolt guide sleeve (bushing) into one bolt hole in the bottom side of the end plate. Install the sleeve, with the three notches on the sleeve to the bottom side of the end plate and the center notch to the outside of the end plate, flush to .005" below the surface of the end plate.

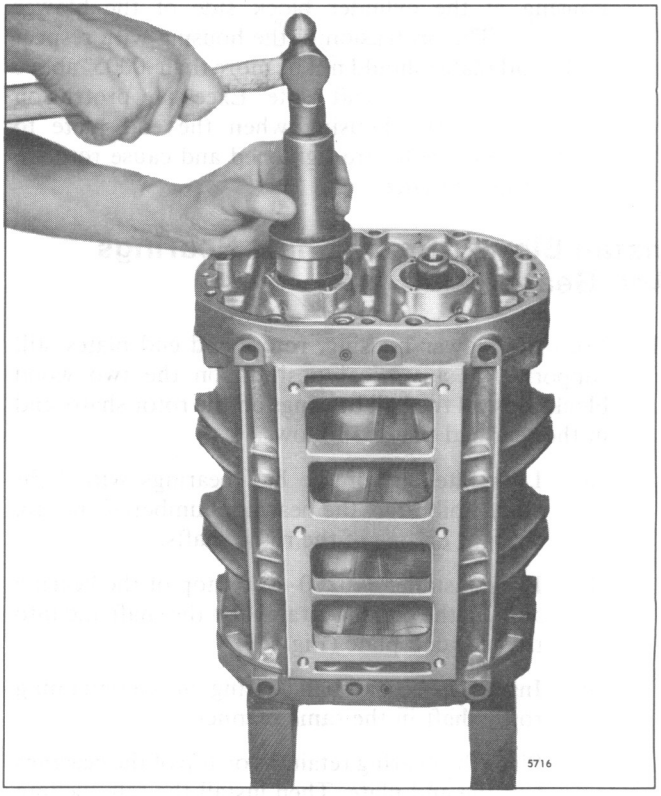


Fig. 19 – Installing Ball Bearings on Rotor Shaft and in Rear End Plate with Tool J 6270–13

NOTICE: When installed, the inside flats of the sleeve will be parallel to the center line of the housing.

c. Lubricate the oil seal rings in the carriers on the rotor shaft with engine oil.

d. Position the oil seal rings in the carriers so the ring protrudes from its groove the same amount on each side.

e. Position the rear end plate over the top of the rotor shafts with the inner face of the end plate facing the rotors and the TOP side of the end plate facing the top side of the blower housing.

f. Lower the end plate straight over the rotor shafts until the dowel pins in the end plate contact the blower housing (Fig. 18). Then, carefully work the dowel pins into the dowel pin holes in the housing and the oil seal rings into the collars. Push the end plate tight against the housing. If necessary, tap the end plate lightly with a plastic hammer.

g. Insert the two fillister head screws through the rear end plate and thread them into the housing. Tighten the screws to 5–10 lb–ft (7–14 N•m) torque. Do not use lock washers on these screws.

4. Check the relationship of the blower end plates to the housing at the cylinder block side of the blower assembly. The protrusion of the housing with respect to the end plates should not be more than .0005" above to .0065" below the end plate. Excessive protrusion could distort the housing when the end plate to cylinder block bolts are tightened and cause rotor to housing interference.

Install Blower Rotor Shaft Bearings And Gears

1. With the blower housing, rotors and end plates still supported in a vertical position on the two wood blocks, install the ball bearings on the rotor shafts and in the rear end plate as follows:

   a. Lubricate one of the ball bearings with light engine oil. Start the bearing, numbered end up, straight on one of the rotor shafts.

   b. Place installer J 6270–13 on top of the bearing and tap the bearing straight on the shaft and into the rear end plate (Fig. 19).

   c. Install the second ball bearing on the remaining rotor shaft in the same manner.

   d. Place the bearing retainers on top of the bearings and the end plate. Then install the self–locking screws. Tighten the screws to 7–9 lb–ft (9–12 N•m) torque.

2. Install the roller bearing inner races on the rotor shafts at the front end plate as follows:

   a. Reverse the position of the blower housing on the two wood blocks (Fig. 20).

   b. Position the roller bearing inner race over the front end of the rotor shaft and press the race on the shaft with tool J 6270–13 until the bearing contacts the shoulder on the shaft.

   c. Install the bearing inner race on the front end of the other rotor in the same manner.

3. Install the roller bearing outer race assemblies in the front end plate as follows:

   a. Lubricate one of the roller bearings with light engine oil. Start the bearing (shoulder side up) over the rotor shaft and bearing inner race and into the end plate.

   b. Place installer J 6270–13 on top of the bearing and tap the bearing straight on the inner race and into the front end plate (Fig. 20).

   c. Install the second roller bearing on the remaining rotor shaft in the same manner.

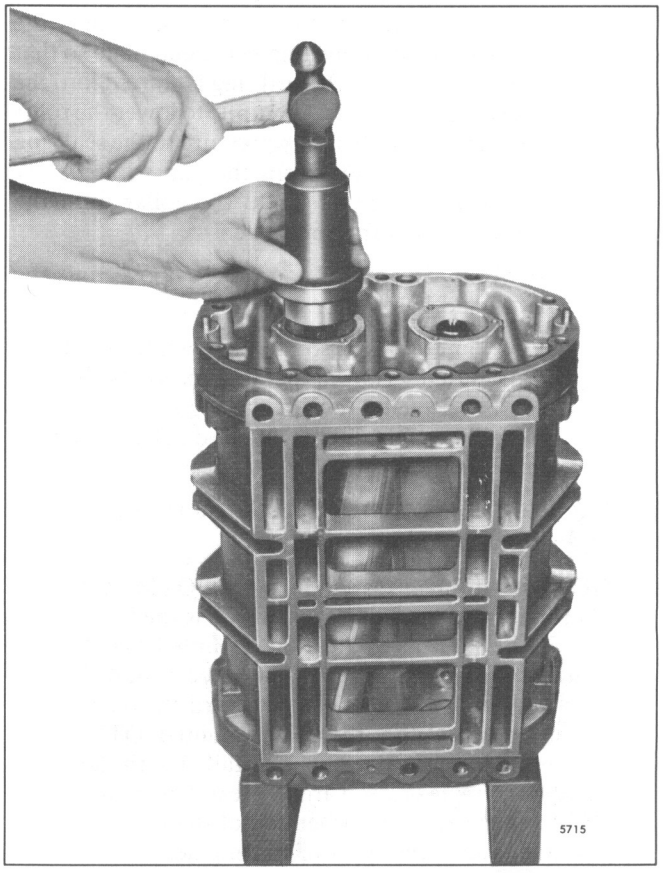


Fig. 20 – Installing Roller Bearings on Rotor Shafts and in Front End Plate with Tool J 6270–13

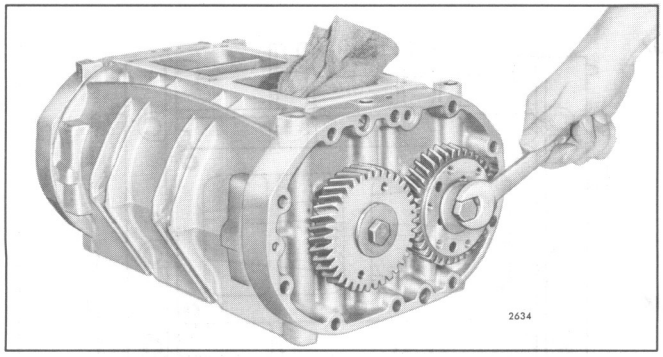


Fig. 21 – Installing Blower Rotor Timing Gears

d. Place the bearing retainers on top of the bearings and the end plate. Then install three self–locking retainer screws in each retainer. Tighten the screws to 7–9 lb–ft (9–12 N•m) torque.

4. Make a preliminary check of the rotor–to–end plate and rotor–to–housing clearances at this time with a feeler gage (Fig. 25). Refer to Fig. 23 for minimum blower clearances.

5. Before installing the blower rotor timing gears on the rotor shafts, observe precautions "2" and "3" relative to the rotor shaft and timing gear alignment under *Assemble Blower.*

The center punch mark in the end of each rotor shaft at the omitted serration will assist in aligning the gears on the shafts.

If shims were removed from the back side of the gears (between the inner race of the bearing and the gear), they should be replaced in their original positions before installing the gears on their respective shafts.

Install the blower timing gears as follows:

a. Place the blower assembly on the bench, with the top of the housing up and the rear end (serrated end of rotor shafts) of the blower facing the outside of the bench.

b. Rotate the rotors to bring the omitted serrations on the shafts in alignment and facing to the left.

c. Install a .140" thick gear spacer and the same number and thickness of shims on each rotor shaft that were removed at the time of disassembly.

d. Lubricate the serrations of the rotor shafts with light engine oil.

e. Place the teeth of the rotor gears in mesh so that the omitted serrations inside the gears are in alignment and facing the same direction as the serrations on the shafts.

f. Start both rotor gears straight on the rotor shafts with the right–hand helix gear on the right–hand helix rotor and the left–hand helix gear on the left–hand helix rotor, with the omitted serrations in the gears in line with the omitted serrations on the rotor shafts.

g. Thread a 1/2"–20 x 1–1/4" bolt with a thick washer into the end of each rotor shaft. Place a clean folded cloth between the lobes of the rotors to prevent the gears from turning (Fig. 21). Draw the gears into position tight against the spacers and shims and the bearing inner races (Fig. 21).

h. Remove the two bolts and washers that were used to draw the gears into position on the rotor shafts.

i. Lubricate the threads of the 1/2"–20 x 1–1/2" gear retaining bolts with engine oil. Place a spacer (.340" thick) on each of the bolts and thread the bolts into the rotor shafts. Tighten the bolts to 100–110 lb–ft (136–150 N•m) torque. Remove the cloth from the blower rotors.

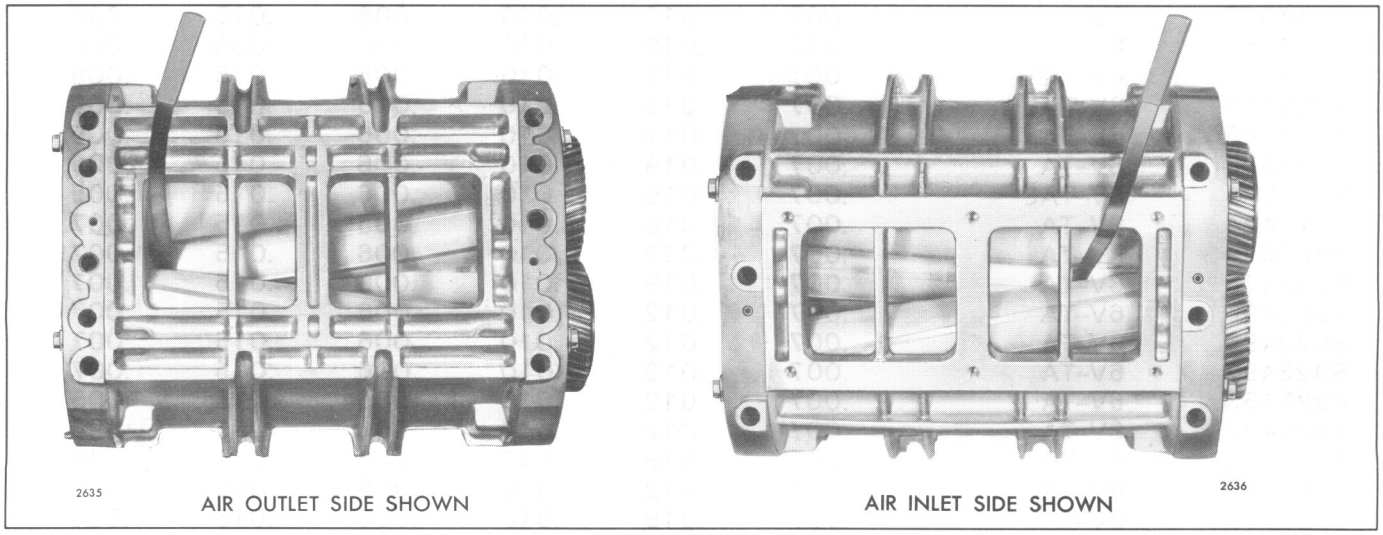


Fig. 22 – Measuring "CC" and "C" Clearance Between Blower Rotor Lobes

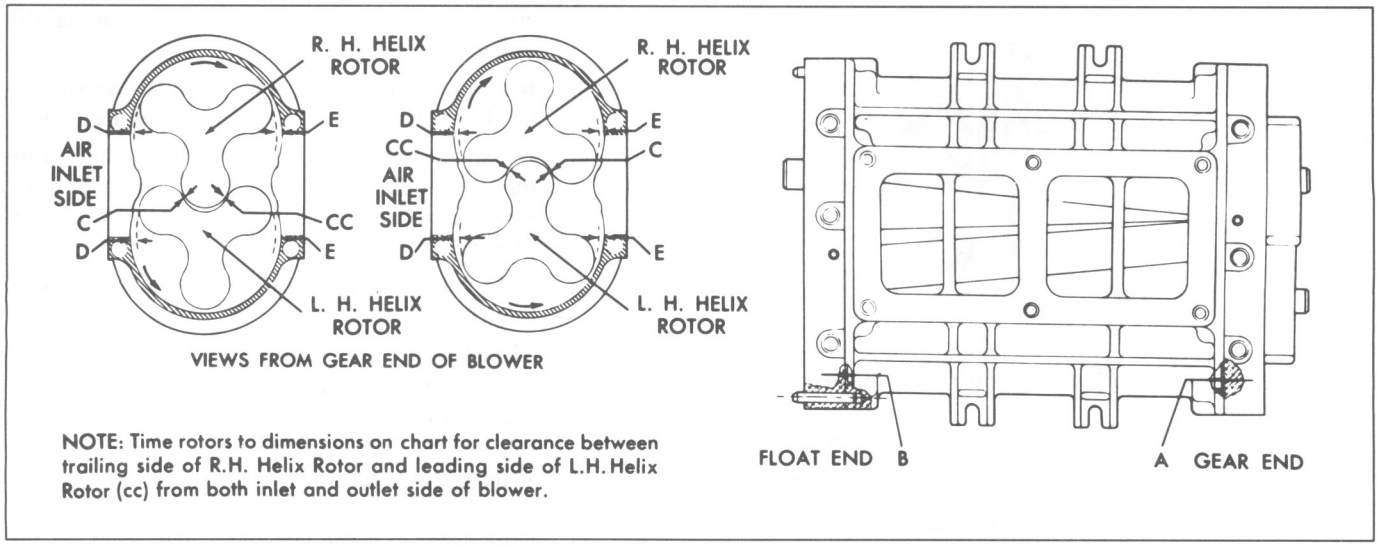


Fig. 23 – End View of Blower Rotor Clearances

CHART OF MINIMUM BLOWER CLEARANCES

Blower Part No.	Engine	CLEARANCES A	B	C	CC	D	E
5101483	8V–TA	.007	.019	.010	.006	.015	.005
5101484	8V–TAE	.007	.019	.010	.006	.015	.005
5101528	6V–TA	.007	.012	.010	.006	.015	.005
5103854	6V–TA	.007	.012	.010	.006	.015	.005
5104936	6V–T	.007	.012	.010	.006	.015	.005
5104937	8V	.007	.019	.010	.006	.015	.005
5144787	8V	.007	.014	.010	.006	.015	.005
5144893	8V	.007	.014	.010	.006	.015	.005
5146912	8V	.007	.012	.010	.006	.015	.005
5147152	8V	.012	.019	.010	.006	.030	.005
5147252	6V, 12V	.007	.012	.010	.006	.015	.005
8920613	8V–TAE	.007	.019	.010	.006	.015	.005
8920748	6V–TA	.007	.012	.010	.006	.015	.005
8921938	8V–TA	.007	.019	.010	.006	.015	.009
8923371	8V–TAE	.007	.019	.010	.006	.015	.005
8923474	8V–TA	.007	.019	.010	.006	.015	.007
8923475	8V–TA	.007	.019	.010	.006	.015	.007
8923476	8V–TA	.007	.019	.010	.006	.015	.007
8923495	6V–TA	.007	.012	.010	.006	.015	.007
8923496	6V–TA	.007	.012	.010	.006	.015	.007
8923497	6V–TA	.007	.012	.010	.006	.015	.007
8925153	6V–TA	.007	.012	.010	.006	.015	.005
8926407	8V–TA	.007	.012	.010	.006	.015	.005
8926408	8V–TA	.007	.019	.010	.006	.015	.005
8926615	6V–TA	.007	.012	.010	.006	.015	.005
8926616	8V–TA	.007	.019	.010	.006	.015	.005
8927037	8V–TA	.007	.019	.010	.006	.015	.007

CHART OF MINIMUM BLOWER CLEARANCES (Cont'd.)

Blower Part No.	Engine	CLEARANCES A	B	C	CC	D	E
8927039	6V–TA	.007	.012	.010	.006	.015	.005
8927041	8V–TA	.007	.019	.013	.013	.015	.009
8927043	8V–TA	.007	.019	.010	.006	.015	.007
8927156	6V–TA	.007	.012	.010	.006	.015	.005
8927468	8V–TA	.007	.019	.010	.006	.015	.009
8928984	12V	.007	.012	.010	.010	.015	.008
23501076	8V–TA	.007	.012	.010	.010	.015	.007
23501261	8V–TA	.007	.019	.010	.006	.015	.009
23501842	8V–TA	.007	.019	.010	.010	.015	.009
23502057	12V–TA	.010	.012	.020	.013	.015	.009
23502485	6V–TA	.007	.012	.010	.007	.015	.007
23502734	6V–TA	.007	.012	.010	.006	.015	.004
23503027	8V, 16V–TA	.010	.019	.025	.013	.015	.009
23503651	8V–TA	.007	.019	.013	.013	.015	.009

Timing Blower Rotors

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

NOTICE: Before timing the blower, install four 5/16"–18 x 1–7/8" bolts with flat washers through four bolt holes in each end plate (top and bottom) and thread them into the blower housing (Fig. 14). Tighten the bolts to 13–17 lb–ft (18–23 N•m) torque. This will hold the end plates against the blower housing so the proper clearance between the rotors and the end plate can be obtained.

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 right–hand helix gear is moved out, the right–hand helix rotor will turn counterclockwise when viewed from the gear end. If the left–hand helix gear is moved out, the left–hand helix rotor will turn clockwise when viewed from the gear end. This positioning of the gears, 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. 22. 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. A specially designed feeler gage set J 1698–02 for the blower clearance operation is available. Clearances should be measured from both the inlet and outlet sides of the blower.

5. Refer to Figs. 22 and 23 and time the rotors to the specified clearance 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. 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. 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 to produce the desired result (Fig. 24). 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 .140" thick gear spacer which is against 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" (Fig. 23). Insert the feeler gages between the end plates and the ends of the rotors (Fig. 25). This operation must be performed at the ends of each lobe, making 12 measurements in all. Refer to Fig. 23 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. 23 for the minimum clearances.

After the blower rotors are timed, complete assembly of the blower, as outlined below:

1. Place the fuel pump drive disc spacer over the forward end of the right–hand helix rotor shaft. Then place the special lock washer and the drive disc on the retaining bolt and thread the bolt into the rotor shaft against the spacer. Tighten the bolt to 55–65 lb–ft (75–88 N•m) torque. Bend one tang of the lock washer over into the slot in the drive disc and two tangs over against the flat sides of the bolt head.

2. Attach the two flex plates and spacers to the drive hub with three new type B hex lock bolts (Fig. 26). *Do Not attempt to reuse patch bolts.* Tighten the 5/16"–24 x .750" bolts to 25–30 lb–ft (34–41 N•m) torque.

   NOTICE: Only the *new* flex plates and type B hex lock bolts should be used to service engines with large bearing blowers.

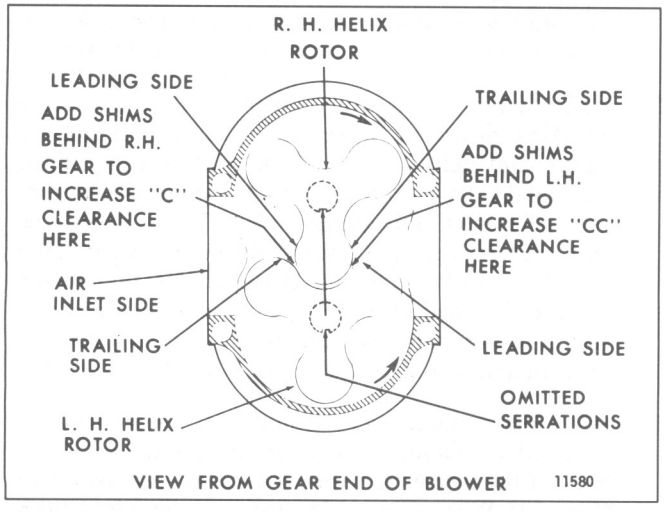


Fig. 24 – Diagram Showing Proper Location of Shims for Correct Rotor Lobe Clearances

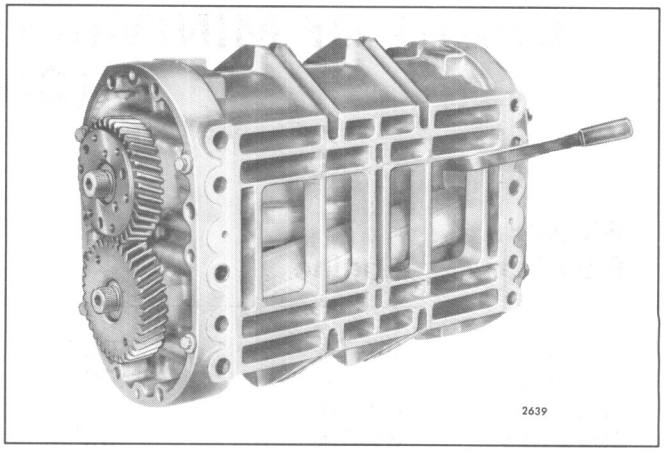


Fig. 25 – Measuring End Clearance Between Blower Rotors and End Plate

3. Attach the drive hub and spring plate assembly to the right–hand helix blower rotor timing gear with three spacers and three type B hex lock bolts (Fig. 26). Tighten the 5/16"–24 x 1" bolts to 25–30 lb–ft (34–41 N•m) torque.

   NOTICE: When replacement of a blower drive hub becomes necessary, the new drive hub *plus* the new blower drive shaft flex plates, type B hex lock bolts and hub spacers *must* be used.

4. Affix a new gasket to the blower rear end plate cover. Place the cover over the gears and against the end plate, with the opening in the cover over the blower drive hub attached to the right–hand helix gear. Install the rear cover using ten 5/16"–18 x 2–1/4" bolts and lock washers. Tighten the bolts to 13–17 lb–ft (18–23 N•m) torque.

   NOTICE: The tab on the gasket is to assure the gasket is in place.

5. On 6V and 12V engines, attach the adaptor and dry seal connector to the rear blower end plate when installing the blower on an engine.

6. On all 8V and 16V engines, attach the lubricating oil tube and dry seal connector to the rear blower end plate when installing the blower on the engine.

7. Attach the governor and fuel pump assembly to the blower as follows:

   a. Affix a new gasket to the forward face of the blower end plate.

   b. Place the fuel pump drive fork on the fuel pump shaft. Position the governor and fuel pump assembly in front of the blower. Rotate the fuel pump fork until the prongs of the fork align with the slots in the drive disc. Rotate the weight shaft and align the splines on the shaft with the splines in the blower rotor.

c. Push the governor straight on the dowel pins in the blower end plate and against the gasket.

d. Refer to Section 2.7.1 for the location and install the bolts, lock washers, copper washers and plain washer which secure the governor to the blower. Tighten the bolts to 13–17 lb–ft (18–23 N•m) torque.

Install Blower On Engine

On 12V and 16V engines, install the rear blower first if both blowers were removed.

Refer to Fig. 6 and install the blower assembly on the engine as follows:

1. Affix a new blower housing gasket to the cylinder block with Scotch Grip rubber adhesive No. 1300, or equivalent, to prevent the gasket from shifting when the blower is lowered into position.

2. If removed, place a fuel rod cover tube hose and clamp on each fuel rod cover tube at each side of the governor housing and tighten the clamps.

3. Place the blower end plate cover seal ring and clamp on the end of the blower drive support.

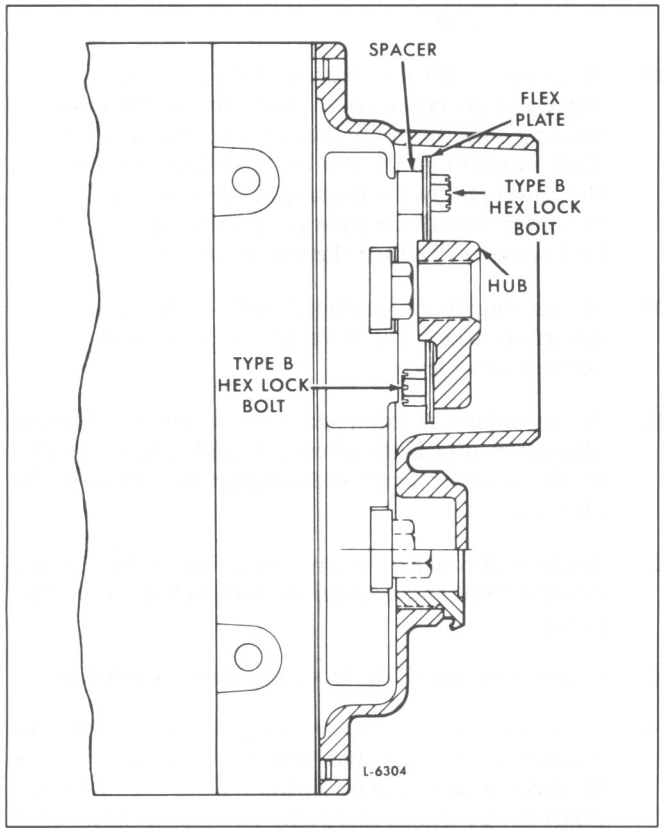


Fig. 26 – Front Hub Assembly – Large Bearing Blowers

4. Thread eyebolts in diagonally opposite tapped holes in the top of the blower housing. Then attach a rope sling and chain hoist to the eyebolts.

5. Lift the blower assembly at a slight angle and position it on top of the cylinder block, with the flange of the rear end plate cover inside the seal ring or hose.

6. Install loose the 7/16"–14 x 8–1/4" blower end plate bolts and special washers. Install loose the 3/8"–16 x 5–1/2" side angle bolts and retaining washers at each side of the blower housing.

NOTICE: The lip at the bevelled end of the bolt retaining washer goes in the small recess in the blower housing just above the bolt slot.

7. Slip the snap ring over the notched end of the alignment tool (J 33001) and thread the blower drive shaft onto the end. Install the alignment tool and position the blower so that the shaft can be removed and reinstalled easily without drag (Fig. 27).

8. Remove the shaft with the tool and rotate the lobes of the blower in 90° increments, reinserting the alignment tool and repositioning the blower, as necessary. Check the alignment at 90° increments through the full 360° of blower rotation.

9. If it is not possible to position the blower so that the tool can be removed and reinstalled without drag in all positions, repeat Step 8. However, this time try to achieve a condition in which the shaft can be removed with minimum drag in the two worst positions.

10. With the shaft in place and the blower properly aligned, tighten the bolts, as follows:

    a. Tighten the blower–to–block end plate bolts to 40–45 lb–ft (54–61 N•m) torque.

    b. Tighten the blower housing–to–block side angle bolts uniformly to 30–35 lb–ft (41–47 N•m) torque in 5 lb–ft (7 N•m) increments.

    c. Recheck the blower–to–block end plate bolts.

11. Install the snap ring. The notch in the tool provides sufficient clearance for the installation of the snap ring with a needle–nose pliers. Installing the snap ring with the alignment tool in place will prevent it from being inadvertently dropped into the engine gear train.

12. Remove the alignment tool from the blower drive shaft.

13. Place the blower rear end plate cover seal ring and hose clamp in position and tighten it. The former rubber seal ring (.740" wide) incorporates two raised edges which provide a groove to retain the clamp.

NOTICE: To retain seal load on the molded blower drive seal rings, a new 4.87" diameter spring loaded T–bolt style clamp is now being used.

After installing the new T–bolt style clamp on the blower drive seal, tighten the clamp nut on the bolt until the spring in the clamp is completely compressed.

14. Connect the lubricating oil tube to the fitting in the blower drive support.

15. Then, attach the flywheel housing cover to the flywheel housing.

NOTICE: If the spring has been removed in error, compress the spring and force it into the drilled hole opposite the tach drive square hole. This operation *must* be done on a press. To check for proper assembly, hold the spring and shaft assembly vertically by the spring. Weight of the shaft cannot allow the spring to come out of the drilled hole. A simple installation tool can be made from a .500" diameter piece of steel stock.

16. Attach the tachometer drive adaptor, if used, to the blower. Then, connect the tachometer drive cable to the drive adaptor.

17. Slide each fuel rod cover tube hose down on the cover tubes attached to the cylinder heads and tighten the hose clamps.

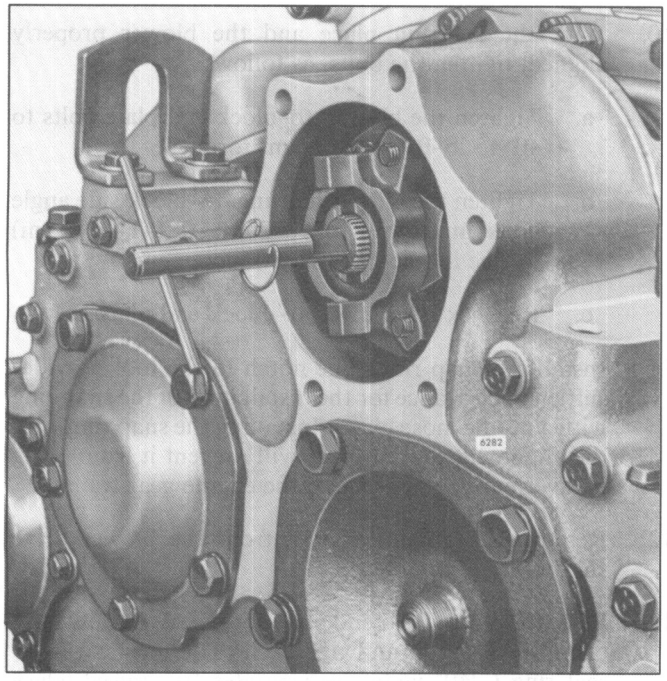


Fig. 27 – Aligning Blower with Tool J 33001

18. Install the fuel rods between the cylinder heads and governor, as follows:

    a. Insert the end of the left–bank fuel rod through the hole in the cylinder head and up through the fuel rod cover tube to the control link operating lever.

    b. Raise the connecting pin up in the connecting link lever. Insert the end of the fuel rod between the two bosses on the lever and insert the connecting pin through the fuel rod and into the lower boss.

    c. Connect the opposite end of the fuel rod to the injector control tube lever with a clevis pin and cotter pin.

    d. Insert the end of the right–bank fuel rod through the hole in the cylinder head and up through the fuel rod cover tube to the control link operating lever.

    e. Remove the short screw pin from the control link operating lever. Insert the end of the fuel rod between the two bosses on the lever and install the screw pin. Tighten the pin securely.

    f. Connect the opposite end of the fuel rod to the injector control tube lever with a clevis pin and cotter pin.

19. Affix a new gasket to the top of the governor housing. Place the governor cover assembly on the governor housing with the pin in the speed control or stop lever shaft assembly in the slot in the differential lever and the dowel pins in the housing in the dowel pin holes in the cover. Install the eight cover attaching screws and lock washers. Tighten the screws securely.

20. If the engine is equipped with a variable speed governor, attach the governor booster spring to the speed control lever.

21. If the engine is equipped with a battery–charging alternator, attach the alternator and support bracket to the cylinder head and connect the wires to the alternator.

22. Install and connect the crossover fuel oil line to each cylinder head and connect the fuel oil lines to the fuel pump.

23. If removed, install the front engine lifter bracket.

24. Place the water bypass tube between the two thermostat housings and slide the hoses part way on the thermostat housings. Position the bypass tube so it clears the governor, fuel pump and fuel oil lines. Then tighten the hose clamps.

25. Attach the air shutdown adaptor to the blower and the air shutdown housing assembly to the adaptor as outlined in Section 3.3.

26. Connect the shutdown wire assembly to the air shutoff cam pin handle at the side of the air shutdown housing.

27. Install the turbocharger and attaching parts, if used (Section 3.5).

28. Connect the air cleaner to shutdown housing, or turbocharger, tubing as required (Section 3.1 or 3.5).

29. Connect the throttle control rods to the speed control and stop levers on the governor.

30. Attach any other accessories to the engine that were removed.

31. Close the drain cocks and fill the engine cooling system.

32. Perform the governor and injector rack control adjustment, as outlined in Section 14. Check for and correct any coolant or oil leaks detected.

TURBOCHARGER (Airesearch)

The T18A40, T18A90, TV71, TV81 and T04B model turbochargers (Figs. 1 and 2) are designed to increase the over–all efficiency of the engine. 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 oil 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 a turbine wheel and shaft assembly, piston ring(s), thrust spacer or thrust collar, compressor wheel and wheel retaining nut. The rotating assembly is supported on two pressure lubricated bearings which are retained in the center housing by snap rings. Internal oil passages are drilled in the center housing to provide lubrication to the turbine wheel shaft bearings and the thrust bearing.

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 T18A40, T18A90 and T04B turbine housing is bolted to the turbine end of the center housing while the TV71 and TV81 turbine housing is secured to the turbine end of the center housing with a "V" band coupling, thus providing a compact and vibration free assembly.

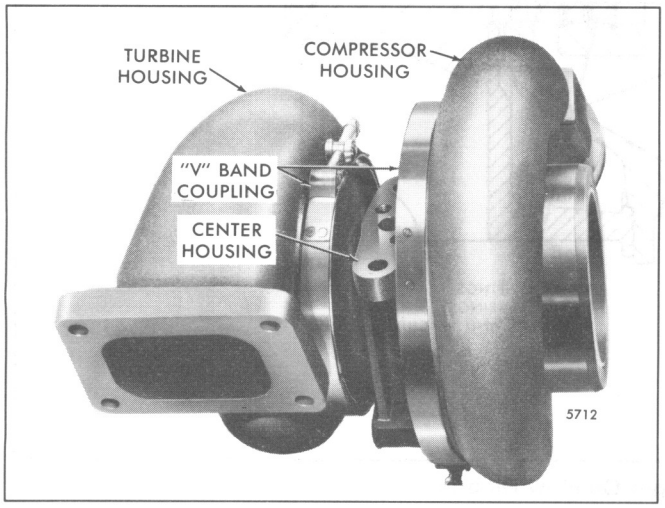


Fig. 1 – Typical Turbocharger Assembly

The compressor housing which encloses the compressor wheel provides an ambient air inlet and a compressed air discharge outlet. The T18A40, T18A90, TV71 and TV81 compressor housing is secured to the backplate assembly with a "V" band coupling. The T04B compressor housing is bolted to the backplate assembly. The backplate assembly is bolted to the compressor end of the center housing.

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 in fresh air, compresses it and delivers high pressure air through the engine 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 engine power output increases or decreases, the turbocharger responds to the engine's demand to deliver the required amount of air under all conditions.

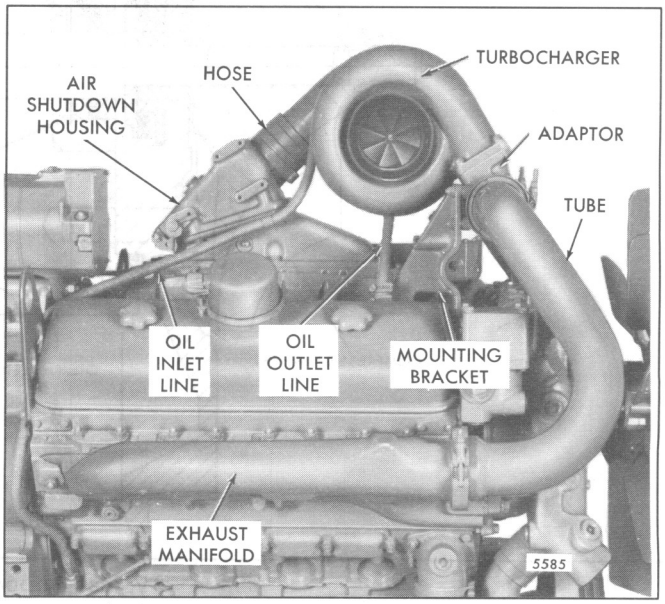


Fig. 2 – Typical Turbocharger Mounting

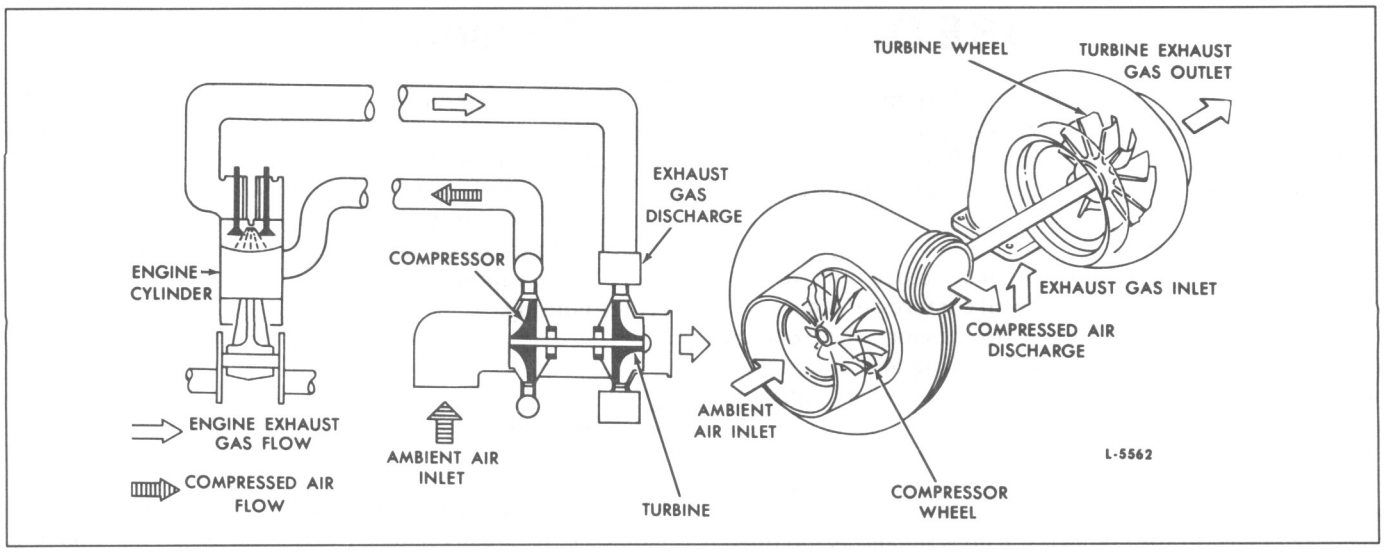


Fig. 3 – Schematic Air Flow Diagram

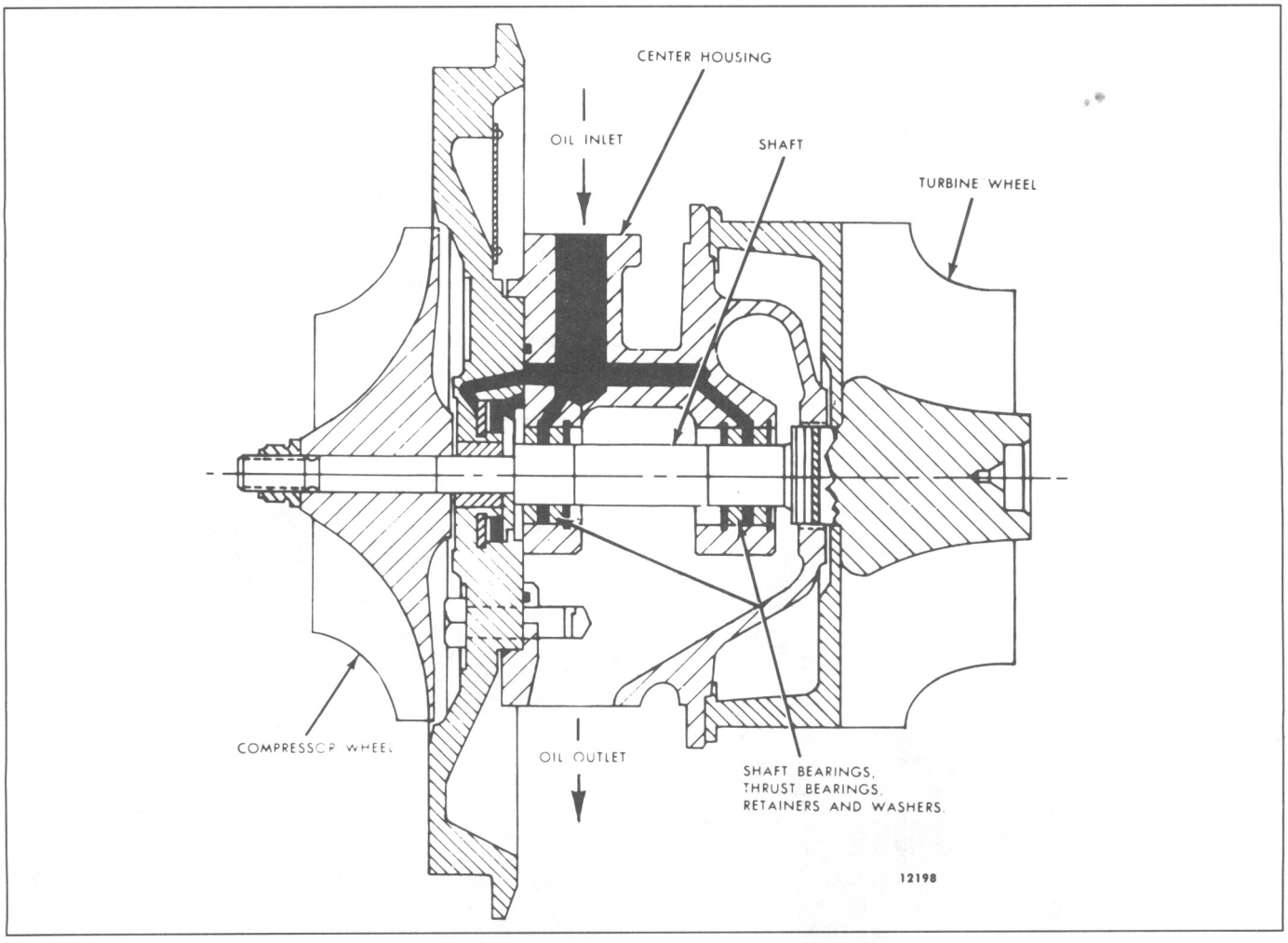


Fig. 4 – Typical Turbocharger Oil Flow Diagram

Certain engines are equipped with an aftercooler to cool the air going into the engine, after it passes through both the turbocharger and the engine blower (refer to Section 3.5.3). Certain marine engines are equipped with an intercooler to cool the air going into the engine, after it passes through both the turbocharger and engine blower (refer to 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 and thrust bearings (Fig. 4). 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.

On OTM (optional turbocharger mounting) vehicle engines, the oil returns by gravity directly from the turbocharger through two drain holes in the blower end plate (front end plate for front mounted turbocharger or rear plate for rear mounted turbocharger) to lubricate the blower bearings and either the timing gears or the governor drive and fuel pump drive (refer to *Lubrication* in Section 3.4).

NOTICE: New service kits have been released to provide more durable rear lube oil supply lines for blower mounted turbochargers used on 6V and 8V–92 engines (Figs. 18 and 19). Each line must be positioned to prevent rubbing or chafing of the braided stainless steel hose cover against other hoses and/or engine components. The hose bracket (to air inlet housing) *must* be used to support the hose and tube assembly at the air inlet housing.

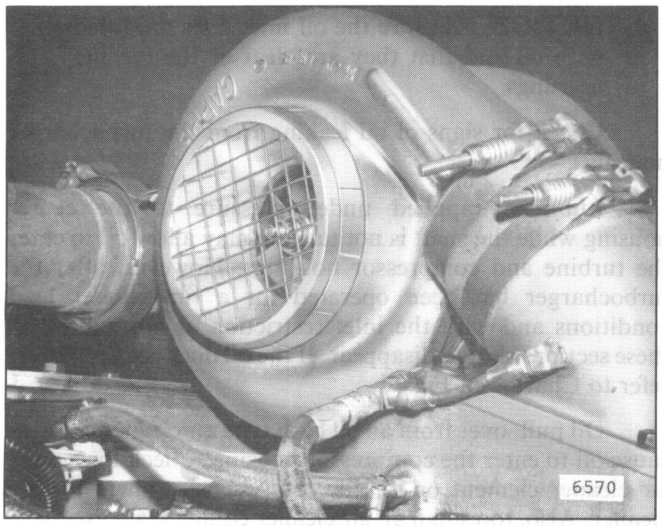


Fig. 5 – Turbo Compressor Inlet Guard Assembly

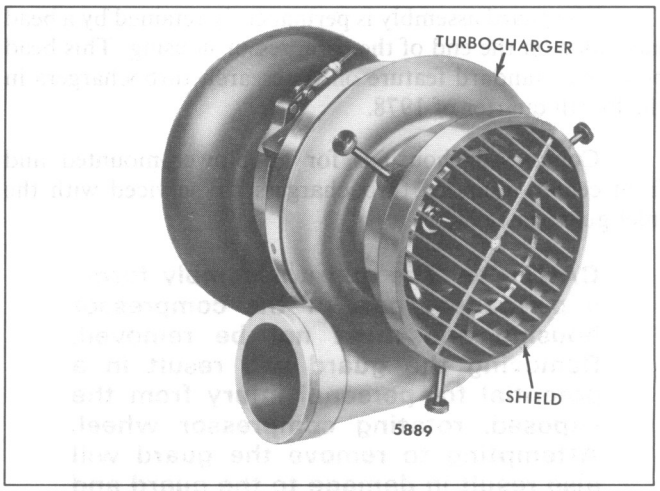


Fig. 5A – Inlet Shield (J 26554–A)

Front–mounted turbocharger lube oil supply line kits are now available to service 6V and 8V–71 engines equipped with blower mounted turbochargers. Marine engines are not included in this change. The new front–mounted turbocharger lines provide a shorter, more direct path for the turbocharger lube oil supply. To conform with the change to the front–mounted lube oil line, two tapped holes have been added to the front of current 6V and 8V–71 cylinder blocks. Refer to Section 3.0 for *Block Modifications* of former cylinder blocks. The right–bank hole is used for the turbocharger oil supply line. The left–bank hole may be used for an additional oil feed location, if desired.

NOTICE: On engines using a governor high idle cylinder, sufficient clearance *must* be provided between the turbo oil supply line and the high idle cylinder to avoid damage to the supply line.

Before the initial 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.

Turbocharger Safety

Effective February of 1988, a new guard assembly is installed over the compressor inlets of all blower–mounted and front center–mounted Airesearch turbochargers. The new two–piece assembly (Fig. 5) 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 compressor housing. This bead became a standard feature on Airesearch turbochargers in the fourth quarter of 1978.

Compressor housings for all blower–mounted and front center–mounted 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 blower–mounted and front center–mounted turbochargers when the air inlet piping is removed for any reason.

CAUTION: The guard assembly cannot be installed on certain turbochargers because they have smaller (5.58") compressor inlet diameters. To avoid the potential for personal injury, shield J 26554–A (Fig. 5A) should be installed whenever the air inlet piping is removed from these turbochargers.

Periodic Inspection

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.

CAUTION: To eliminate the possibility of personal injury when air inlet piping is removed, do not operate an engine with a blower–mounted or front center–mounted turbocharger unless the compressor inlet guard assembly (Fig. 5) or turbo inlet shield (Fig. 5A) is installed.

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 *Trouble Shooting Charts* (Fig. 6). 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. 6. 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.

NOTICE: 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. 6.

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.

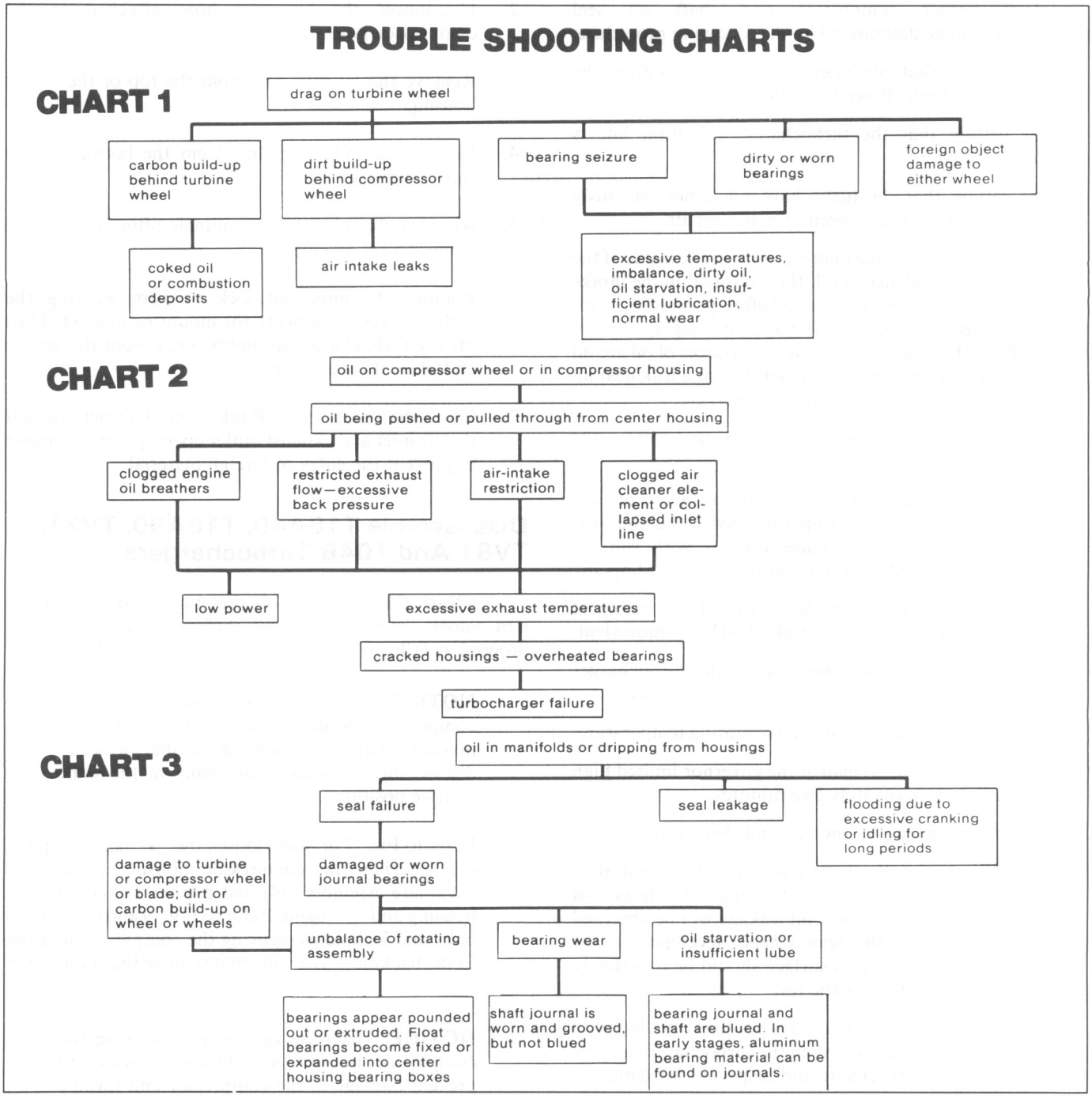


Fig. 6 – Inspection Checks for Turbocharger

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. 6.

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.

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

1. Determine that air inlet restriction is within the 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 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 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. Disconnect the exhaust manifold flange or adaptor attached to the turbine housing.

   NOTICE: When removing the left bank exhaust manifold to turbocharger tube on the blower mounted turbochargers, matchmark one end of the tube for ease of identification when reinstalling the tube.

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 T18A40, T18A90, TV71, TV81 And T04B Turbochargers

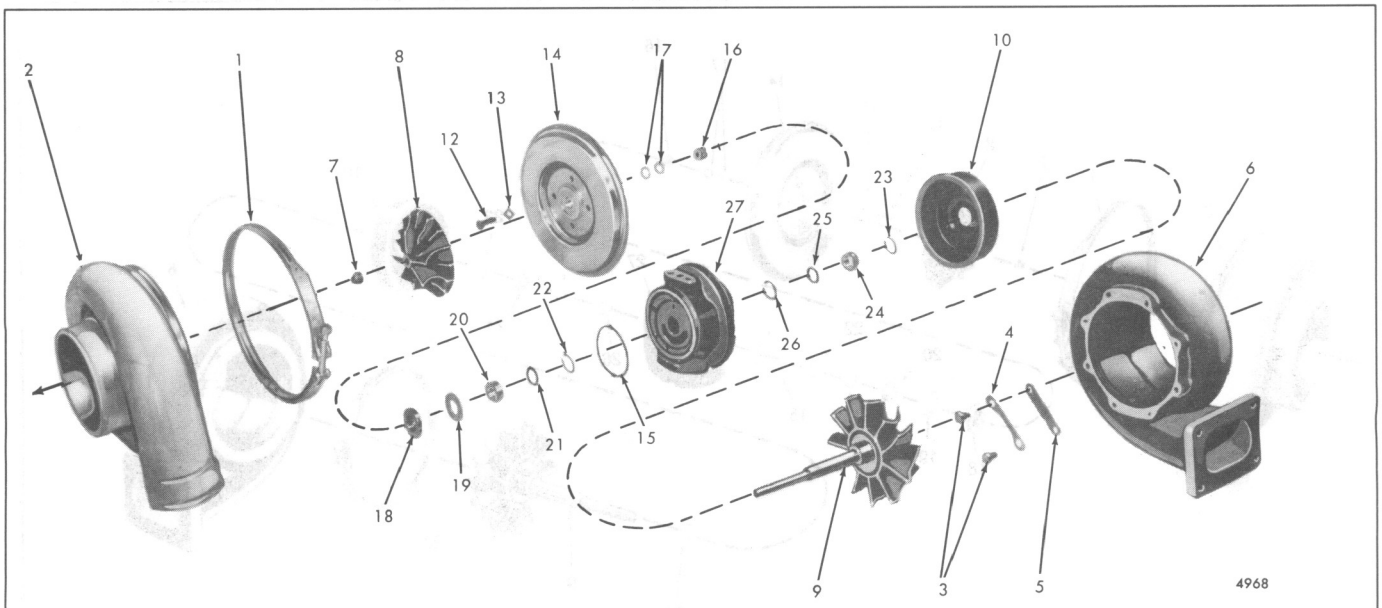
Clean the exterior of the turbocharger with a non–caustic cleaning solvent before disassembly and proceed as follows:

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. Refer to Fig. 7 or 8 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. Refer to Fig. 9 and remove the bolts and lockplates securing the compressor housing to the backplate assembly and remove the compressor housing.

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

2. With the T18A40, T18A90 and T04B turbochargers, bend down the ends of the lockplates (4) and remove the eight bolts (3) securing the four lockplates and turbine housing clamps (5) to the center housing (27) and turbine housing (6). With the TV71 and TV81 turbocharger, loosen the "V" band coupling (28) securing the turbine housing (6) to the center housing (27). Remove the turbine housing from the center housing.



1.	Coupling—"V" Band	8.	Wheel—Compressor	15.	Ring—Seal	21.	Washer—Bearing
2.	Housing—Compressor	9.	Shaft—Turbine Wheel Assembly	16.	Spacer—Thrust	22.	Ring—Snap
3.	Bolt	10.	Shroud—Turbine Wheel	17.	Ring—Piston (Two for 18A90)	23.	Ring—Snap
4.	Lockplate	12.	Bolt	18.	Collar—Thrust	24.	Bearing
5.	Clamp—Turbine Housing	13.	Lockplate	19.	Bearing—Inboard Thrust	25.	Washer—Bearing
6.	Housing—Turbine	14.	Backplate Assembly	20.	Bearing	26.	Ring—Snap
7.	Nut—Self-Locking					27.	Housing—Center

Fig. 7 – T18A40 and T18A90 Turbocharger Details and Relative Location of Parts

NOTICE: 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. 10). Remove the wheel nut (7) from the shaft.

NOTICE: 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.

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. Lift or 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 TV71, TV81 and T04B turbochargers, 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. Do not disassemble the backplate assembly. Also, do not remove the pins from the center housing, unless it is necessary to replace the pins.

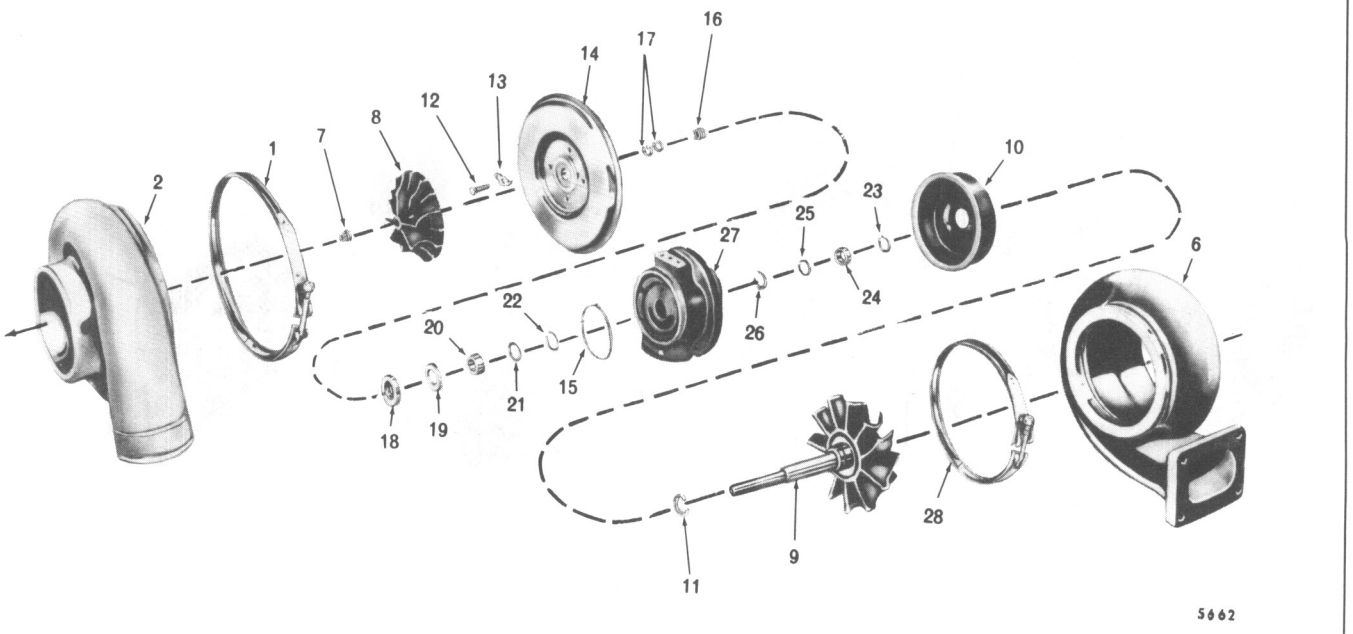
NOTICE: Tap the backplate lightly to remove it from the center housing recess.

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

9. Remove the thrust spacer (16) — thrust bearing for T04B turbocharger — and piston ring(s) (17) from the backplate assembly. Discard the piston ring(s).

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

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



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" Band
		16.	Spacer—Thrust				

Fig. 8 – TV71 and TV81 Turbocharger Details and Relative Location of Parts

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 to avoid the possible toxic effect of the cleaning solvent. Keep away from open flames to avoid the possibility of a fire. 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. Clean the oil passage in the backplate assembly and the housing thrust plate with dry compressed air.

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

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 shroud and 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 backplate assembly 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.

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

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, thrust bearings, bearing washers, snap rings, lockplates and bolts be replaced at time of disassembly. The backplate must be replaced if the thrust bearing is excessively worn.

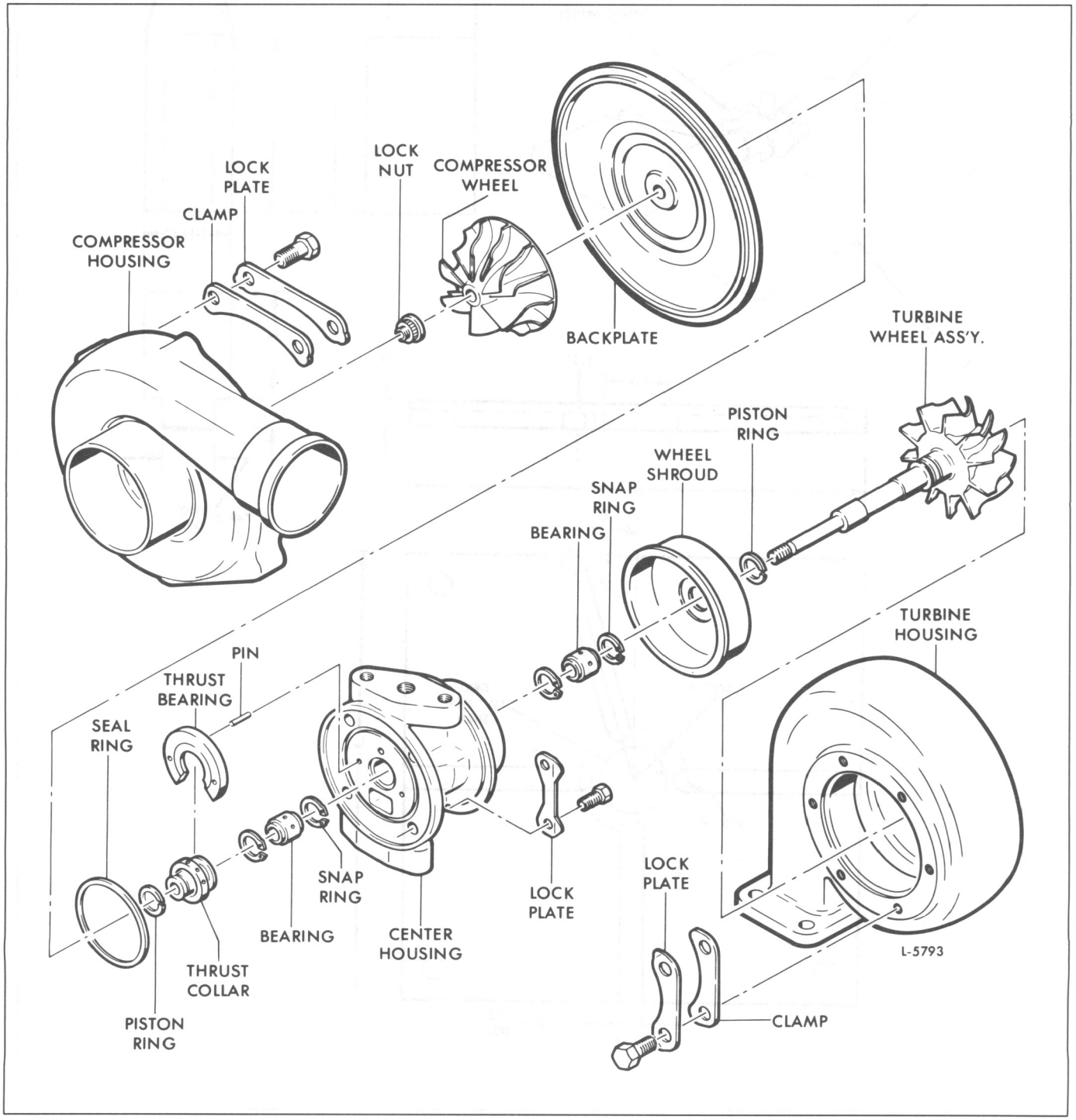


Fig. 9 – T04B Turbocharger Details and Relative Location of Parts

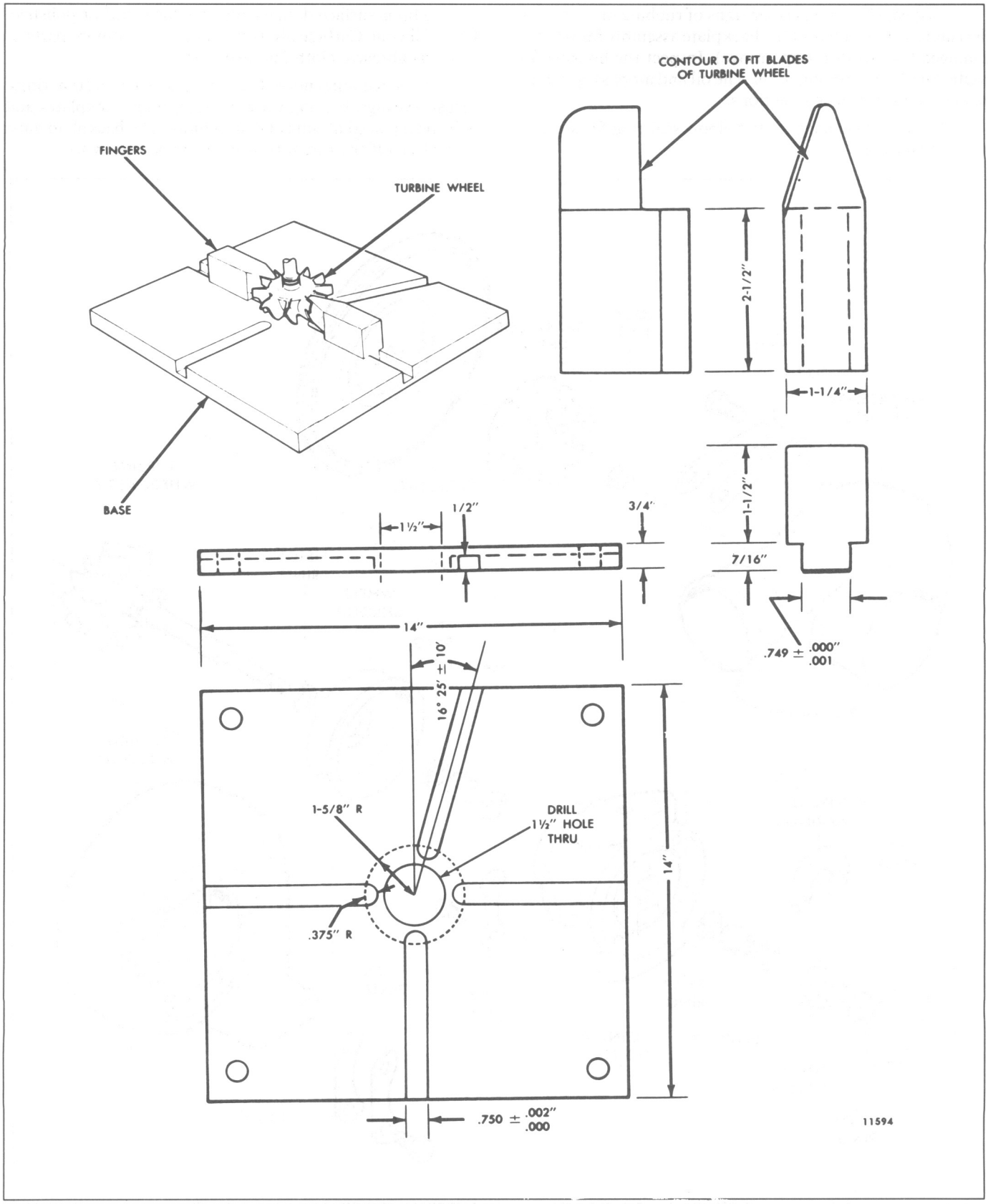


Fig. 10 – Turbocharger Holding Fixture

ASSEMBLE TURBOCHARGER

T18A40, T18A90, TV71 And TV81 Turbochargers

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 Figs. 7 and 8 for parts orientation and proceed as follows:

1. Lubricate the new bearings (20 and 24) with clean engine oil.
2. Install a new snap ring (26), bearing washer (25), bearing (24) and 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.
4. Install a new piston ring(s) (17) on the thrust spacer (16) and gently insert the spacer into the backplate assembly (14). The current thrust spacer (16) 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 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 the T18A bolts to 90–110 **lb–in** (10–12 N•m) torque or the TV71 and TV81 bolts to 80–100 **lb–in** or (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.*

A new steel lockplate and high strength bolts are now being used in the T18A Series turbocharger. The new high strength bolts and lockplates must be used together and the bolts must be tightened to 160 –180 **lb–in** (18–20 N•m) torque. Be sure and bend the lockplate tangs up against the side of the bolt heads, after tightening the bolts. Only the current steel lockplate and high strength bolt are serviced.

9. On TV71 and TV81 turbochargers, install a new turbine piston ring (11) on the wheel shaft assembly.

   NOTICE: 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. Lubricate the wheel shaft assembly journal prior to assembly.

    NOTICE: 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 as shown in Fig. 10.

    NOTICE: 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.

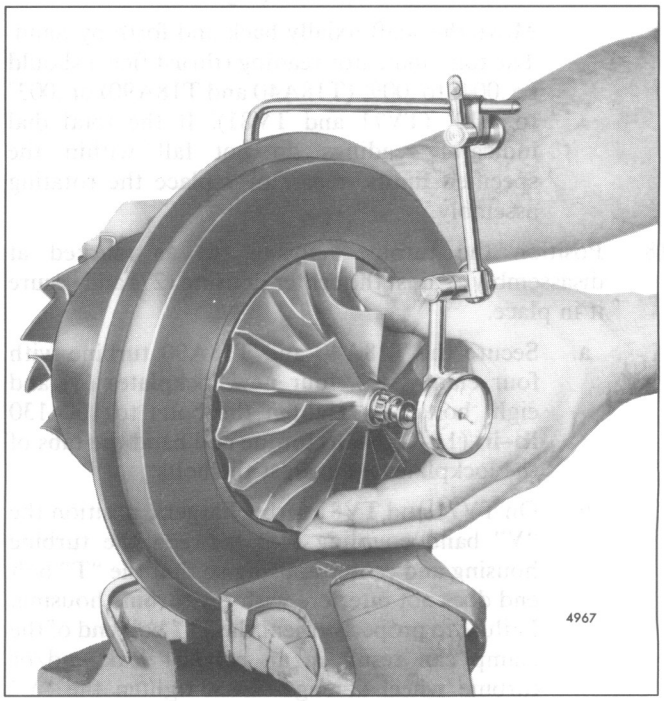


Fig. 11 – Checking Bearing Axial End Play

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 the 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 .007"–.008" in length (T18A40) or .009"–.010" in length (T18A90, TV71 and TV81). Tighten the retaining nut in such a manner as not to impose bending load on the shaft.

    NOTICE: 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 100–110° turn for the T18A40 or 120–130° turn for the T18A90, 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 as shown in Fig. 11.
    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. 11).
    c. Move the shaft axially back and forth by hand. The total indicator reading (thrust float) should be .004" to .009" (T18A40 and T18A90) or .003" to .010" (TV71 and TV81). 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.
    a. Secure the T18A40 and T18A90 turbine with four clamps (5), four new lockplates (4) and eight bolts (3). Tighten the bolts to 100–130 **lb–in** (11–15 N•m) torque and bend the tabs of the lockplates up against the bolts.
    b. On TV71 and TV81 turbochargers, 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. 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:
        1. Lubricate the toggle bolt threads with a high temperature anti–seize compound such as Jet Lube (Mil Spec A–907D), or equivalent.
        2. Tighten the nut on the "V" band toggle bolt to approximately 160 **lb–in** (18 N•m) torque.

        NOTICE: Do not pull a misaligned turbine housing into alignment with the "V" band coupling. The parts must be aligned and seated first.

        3. Loosen the "V" band coupling nut to approximately 50 **lb–in** (6 N•m) torque, then re–torque 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 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 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. 11.
    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.

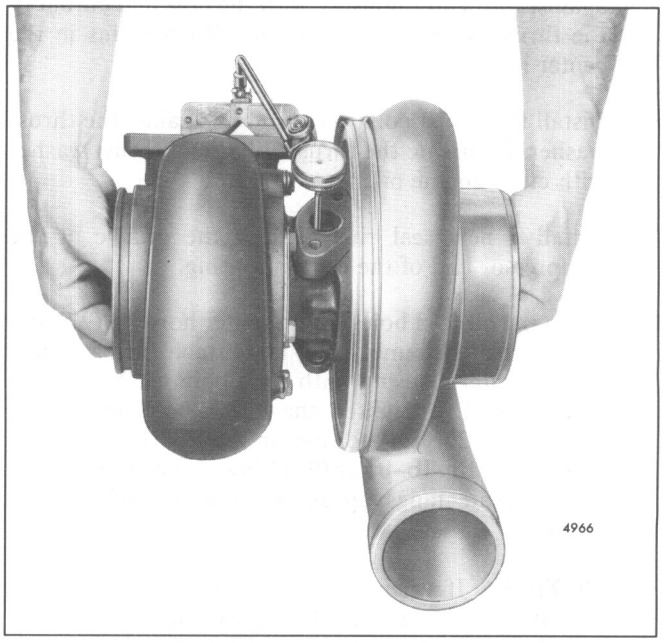


Fig. 12 – Checking Shaft Radial Movement

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. 11) 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. Refer to Section 3.0 for dial indicator displacement. 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.

T04B 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. 9 for parts orientation and proceed as follows:

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.

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

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. 10.

NOTICE: 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.

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

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.

NOTICE: 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 quipped with soft jaws as shown in Fig. 11.

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. 11).

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. 12.

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 adpator.

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. 12) 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.

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.

NOTICE: On TV71 and TV81 turbochargers, 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.

NOTICE: 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. The turbine opening in the T18A40 turbocharger is 3.850", the T18A90 turbocharger is 4.250", the TV71 turbocharger is 3.480", the TV81 turbocharger is 3.892" and in the T04B turbocharger the diameter is 2.581".

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.

NOTICE: 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 (Fig. 17).

6. When installing the left bank exhaust manifold to turbocharger tube on a blower mounted turbocharger, it is very important that the tube is installed correctly. If the tube is installed incorrectly, it can crack in the flange area and adversely affect performance.

The solid left bank tube is almost symmetrical, thus it is difficult to identify which end goes where. Therefore, position the tube between the exhaust manifold and the turbocharger and check to determine that the conical seat at each end of the tube is a flush fit with the openings. If not, reverse the position of the tube and recheck to be sure each end of the tube is a flush fit with the openings.

To help in the installation of the tube, loosen the exhaust manifold mounting bolts and then tighten them alternately while tightening the tube clamps.

NOTICE: Be sure the exhaust manifold remains seated on the locating pads on the cylinder head.

7. Tighten the turbocharger to exhaust manifold adaptor bolts securely. Then remove the chain hoist and lifting sling from the turbocharger.
8. Install the oil drain line between the opening in the bottom side of the center housing and the cylinder block.
9. Attach the oil inlet line to the cylinder block.
10. 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 (Fig. 4).
    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.

NOTICE: The lube oil supply connector formerly installed in the plate is now assembled directly to the turbocharger center housing. The oil inlet of current TV turbochargers is being threaded by the manufacturer (Fig.13).

    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 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.

11. Check all connections, ducts and gaskets for leaks after starting the engine.
12. 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.

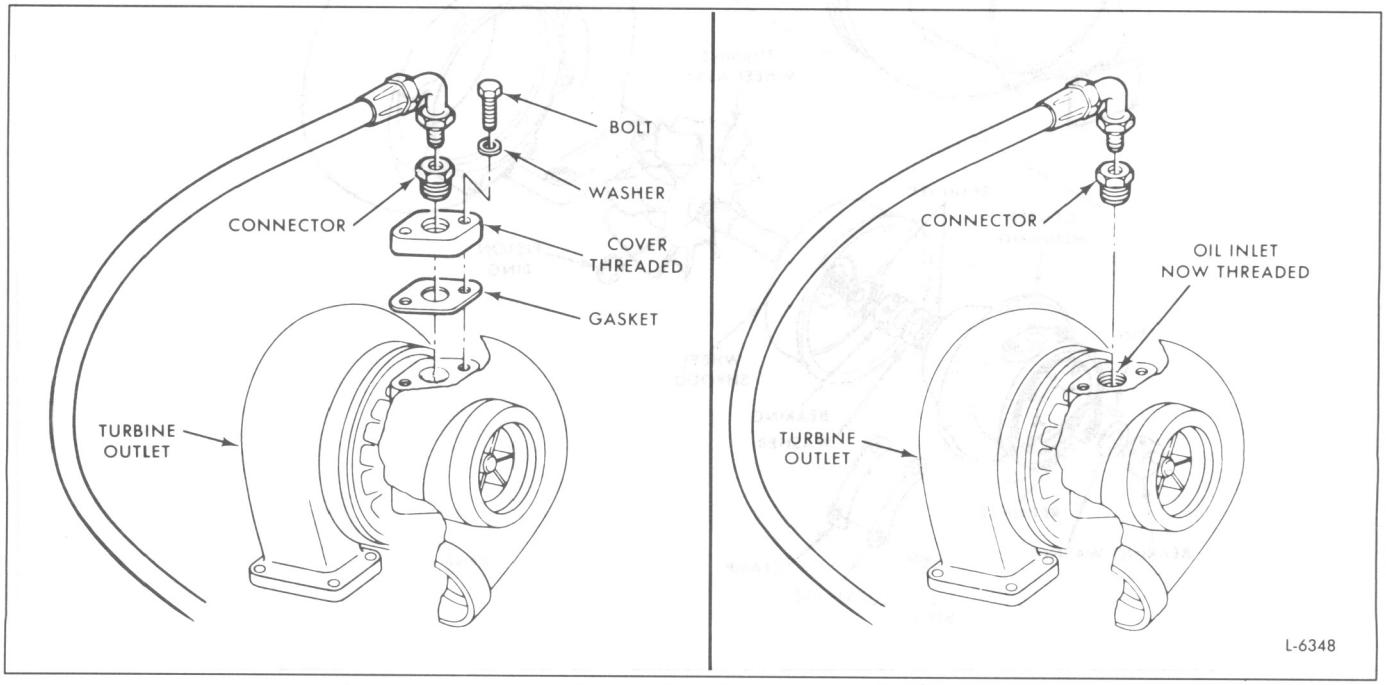


Fig. 13 – Former and Current Lube Oil Supply Connections

TH08A TURBOCHARGER

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.

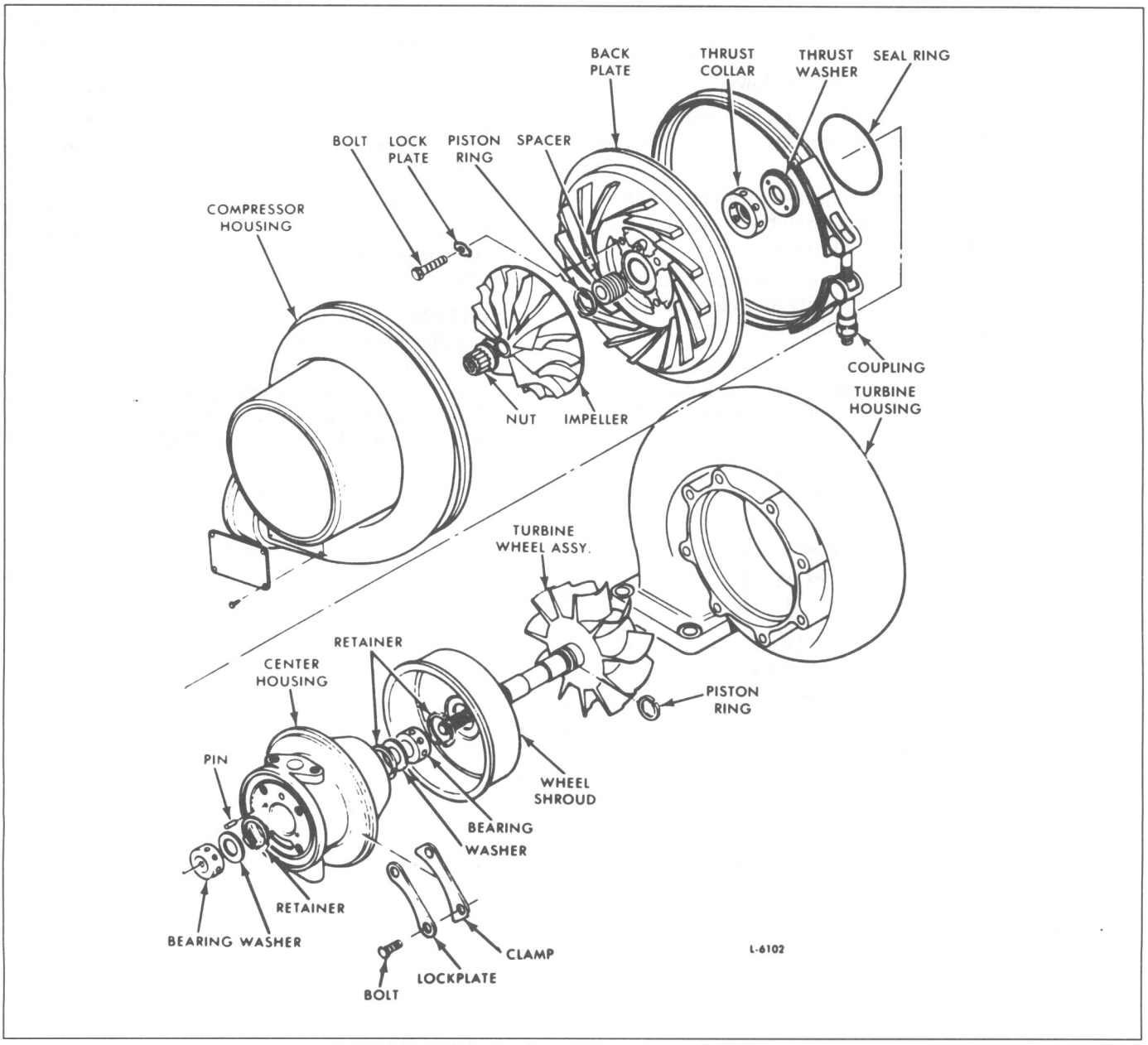


Fig. 13A – TH08A Turbocharger Details and Relative Location of Parts

Disassemble Turbocharger

Refer to Fig. 13A for the location of the various parts and disassemble the turbocharger assembly as follows:

1. Thoroughly clean the exterior of the turbocharger with a non–caustic cleaning solvent.
2. Matchmark the compressor housing, center housing and the turbine housing with a punch or chisel (Fig. 14) so they may be installed in the same relative position.
3. Loosen the "V" band coupling securing the compressor housing to the backplate assembly and remove the compressor housing and "V" band. If necessary, tap the compressor housing with a plastic hammer to loosen it.
4. Bend the ends of the turbine housing attaching bolt lockplates down. Then remove the eight bolts securing the turbine housing to the center housing. If necessary, tap the turbine housing with a plastic hammer to loosen it.
5. Remove the compressor wheel from the shaft as follows:

   NOTICE: The hexagon countersunk hole in the end of the turbine wheel must be scraped clean before installing it in the holding fixture.

   a. Clamp the turbine wheel holding fixture J 21225 in a bench vise. Then place the center housing and rotating assembly in the holding fixture, turbine wheel down (Fig. 10), with the hexagon countersunk hole in the turbine wheel over the protruding hexagon head in the holding fixture. If required, use a suitable holding fixture.

   b. To prevent the possibility of bending the shaft, remove the lock nut from the shaft with a double universal socket and a tee handle.

   c. Place a clean shop towel on the bed of the press and under the turbine wheel to protect the blades. Then place the tapered end of the removing tool J 9496 in the center of the shaft and the opposite end under the ram of the press. Press the shaft out of the compressor wheel.

   d. Remove the compressor wheel from the top of the center housing, then remove the center housing and shaft from the arbor press and place them on a bench. Pull the shaft assembly straight out of the center housing to prevent the threads on the end of the shaft from damaging the shaft bearings.

6. Remove and discard the turbine piston ring from the wheel shaft.
7. Place the center housing, compressor housing end up, on the bench, bend the end of the center housing thrust collar attaching bolt lockplates down. Then remove the four bolts and lockplates securing the thrust collar to the center housing.
8. Support the center housing on edge on the work bench. Then insert a 1/2" wood dowel approximately 8" long through the shaft bearings and against the thrust collar. Tap the thrust collar out of the center housing with a hammer.
9. Remove the thrust spacer and seal ring from the thrust collar, then remove the seal ring from the outside diameter of the thrust collar.
10. Remove the thrust ring and the thrust collar bearing from the center housing.
11. Remove the shaft bearing from the compressor wheel end of the center housing by lifting it straight up out of the housing with one finger inserted in the bearing.
12. Remove the shaft bearing from the turbine end of the center housing as follows:

    a. Place the center housing, turbine housing end up, on the bench.

    b. Remove the shaft bearing retainer from the center housing with a pair of snap ring pliers.

    c. Lift the bearing straight up out of the housing.

    d. If necessary, remove the two spacers and the two remaining retainers inside the center housing.

13. The turbine wheel shroud which is attached to the turbine end of the center housing does not need to be removed. The plate is not readily removable after it has been subjected to prolonged exhaust heat.

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. 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.

Make sure all of the metal chips, from the tapping operation, are removed from the oil reservoir and oil passages in the center housing.

Clean the oil passage in the center housing backplate or 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 the turbocharger parts for signs of damage, corrosion or deterioration. If necessary, replace with new parts.

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

Examine the compressor wheel for signs of rubbing and bent blades. The wheel must be free of dirt and foreign material.

Check the compressor and turbine housings for signs of wheel contact.

Examine the thrust ring, shaft bearings and wear spacers, thrust spacer, seal ring and thrust plate bearing for signs of rubbing, scoring or wear. For shaft bearing dimensions and wear limits, refer to Section 3.0.

Assemble Turbocharger

NOTICE: If foreign particles fall into the turbocharger during the assembly procedure, remove the particles immediately, even though extensive disassembly is required.

Refer to Fig. 13A for the location of the various parts and assemble the turbocharger, as follows:

1. Lubricate the bearings with clean engine oil and install the retainers, bearings and washers from the forward end of the center housing.

   NOTICE: Install the rounded face of the retainer toward the bearing.

2. Install a new piston ring on the turbine wheel shaft.

3. Place the turbine wheel upright and guide the shaft through the shroud and bearings. Be careful not to scuff or scratch the bearings.

   NOTICE: Do not use force to compress the piston ring into place. A gentle rocking and pushing action will allow the ring to seat and the shaft to bottom. A thin tool may be used as an aid in compressing the ring, if necessary.

4. Check to see that the compressor bearing is in place, then install the thrust washer. Be sure that the hole and cut–out engage the pins in the center housing and that the washer is seated flat against the housing.

5. Install the thrust ring snugly against the thrust washer. Lubricate with clean engine oil.

6. Install a new seal ring in the groove of the center housing.

7. Align the oil feed holes of the center housing and thrust collar and install the thrust collar.

8. Install lock plates and bolts. Tighten the bolts to 80–100 **lb–in** (9–11 N•m) torque. Bend both sides of the lock plate up against the flat of the bolt head.

9. Install the piston ring on the thrust spacer. Gently insert the spacer into the thrust collar bore. Do not force the piston ring into place.

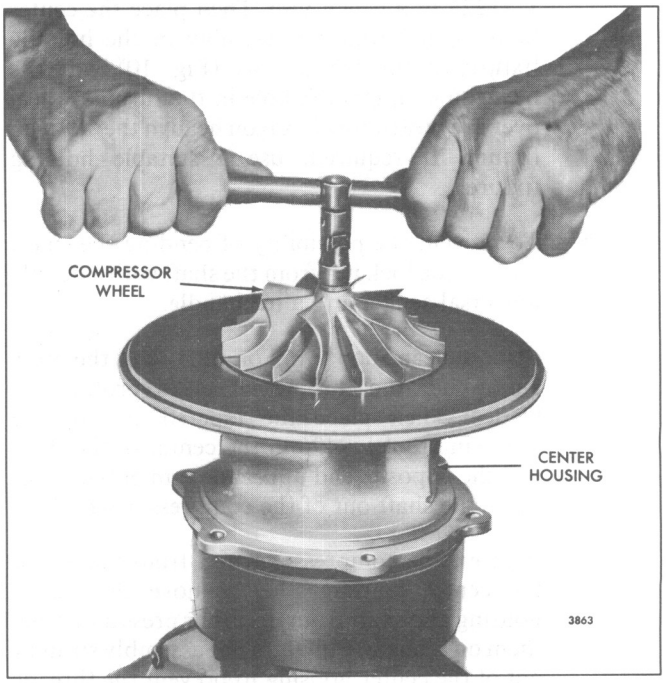


Fig. 14 – Tightening Compressor Wheel Lock Nut using Holding Fixture J 21225

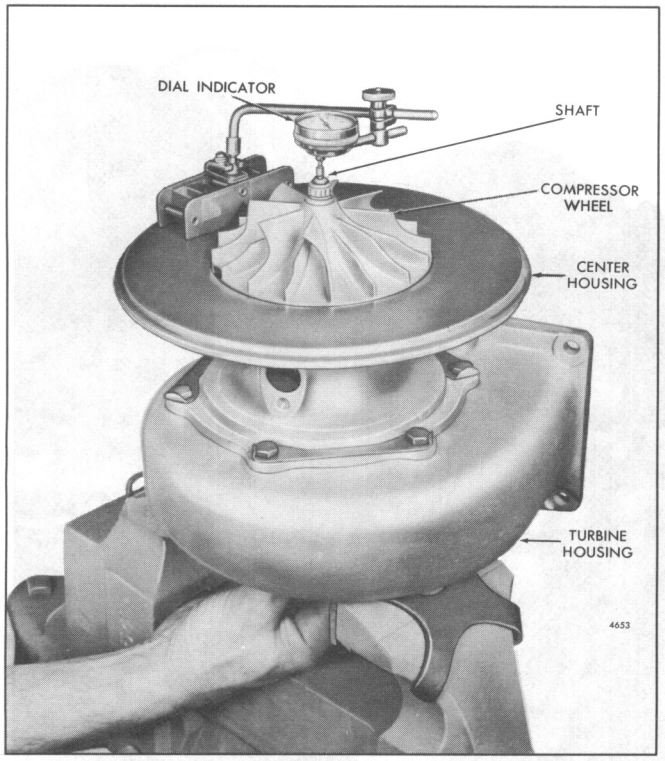


Fig. 15 – Checking Shaft End Play using Adaptor J 21224

10. Install the impeller onto the shaft and pull down with the lock nut until it is bottomed. Tighten the locknut to 18–20 **lb–in** (2 N•m) torque. Continue to tighten the locknut through an angle of 120° (Fig. 14). This will stretch the shaft the required .005"–.006".

    NOTICE: Do not use a box wrench or any other type wrench to tighten the lock nut as the excessive side strain may bend the shaft. Use a sliding tee handle with wrench J 21223–01 and apply an even pressure on each end of the tee handle. This will eliminate the possibility of bending the shaft while tightening the locknut.

11. Check the shaft end play, as follows:

    a. Clamp the turbine housing and center housing and rotating assembly in a bench vise equipped with soft jaws, as shown in Fig. 15.

    b. Attach a clamp or a magnetic base indicator on the center housing and position the stem of the dial indicator on the end of the shaft.

    c. Push up on the rotating assembly by hand and note the indicator reading.

    d. Push down on the rotating assembly by hand and note the indicator reading.

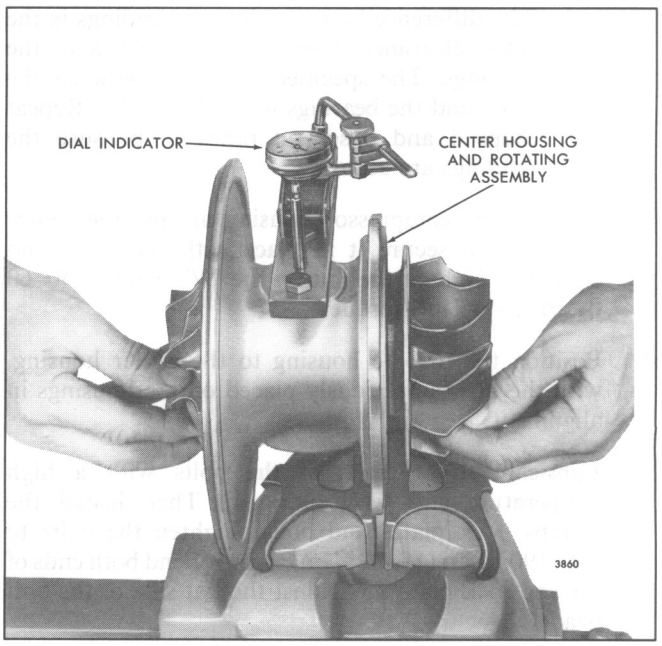


Fig. 16 – Checking Shaft Radial Movement with Tool J 21224

    e. The end play is the difference between the two readings. The specified shaft end play is .003" to .008".

12. Check the shaft radial movement (bearing clearance), as follows:

    a. Clamp the flange of the center housing in a bench vise equipped with soft jaws (Fig. 16), with the oil outlet opening in the center housing facing up.

    b. Place the dial indicator adaptor J 21224 over the oil outlet opening in the center housing with the large flat end of the plunger against the center of the shaft and secure the tool in place with two 3/8"–16 bolts of suitable length.

    c. Attach a clamp or a magnetic base type indicator to the dial indicator adaptor and position the stem of the dial indicator on the end of the plunger.

    NOTICE: For a true reading, the dial indicator stem must be on the same center line as the plunger of the dial indicator adaptor.

    d. Raise the rotating assembly up by hand, as shown in Fig. 16, and note the indicator reading. Then push the rotating assembly down by hand and note the indicator reading.

    NOTICE: Raise and lower both ends of the rotating assembly evenly when checking the radial movement.

e. The difference between the two readings is the total clearance between the shaft and the bearings. The specified clearance between the shaft and the bearings is .003" to .007". Repeat Steps d and e several times to be sure the readings are accurate.

13. Position the compressor housing against the center housing and secure it in place with the "V" band coupling. Tighten the nut on the "V" band to 40–60 **lb–in** (5–7 N•m) torque.

14. Position the turbine housing to the center housing, with the marks previously placed on the housings in alignment.

15. Lubricate the threads of the bolts with a high temperature anti–seize lubricant. Then install the clamps, lock plates and bolts. Tighten the bolts to 160–190 **lb–in** (18–22 N•m) torque. Bend both ends of the end lock plate up against the flat side of the bolt head.

16. With the turbocharger assembled, spin the rotating assembly by hand. The rotating assembly must turn freely without indications of dragging or binding.

17. Cover all openings in the turbocharger to prevent any foreign material from entering.

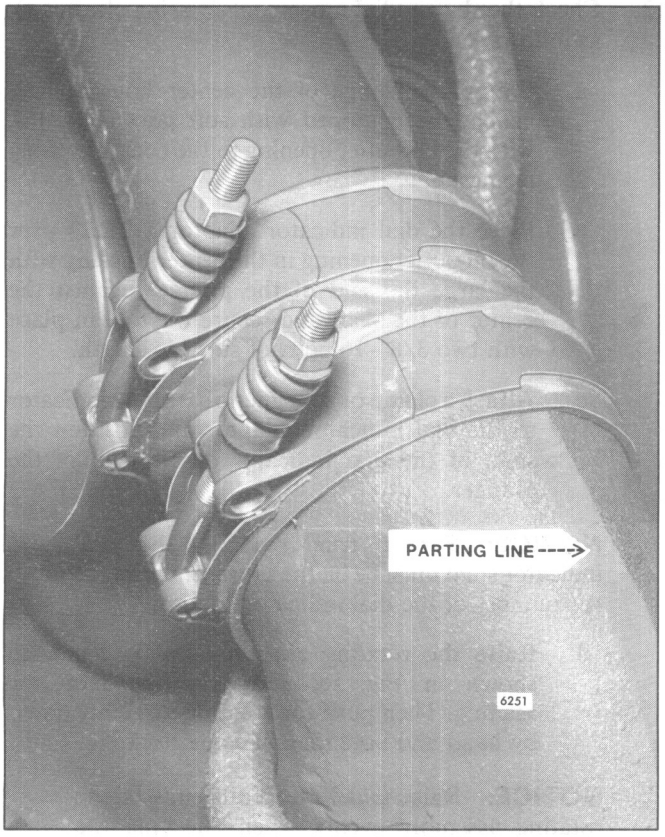


Fig. 17 – Properly Positioned Clamps

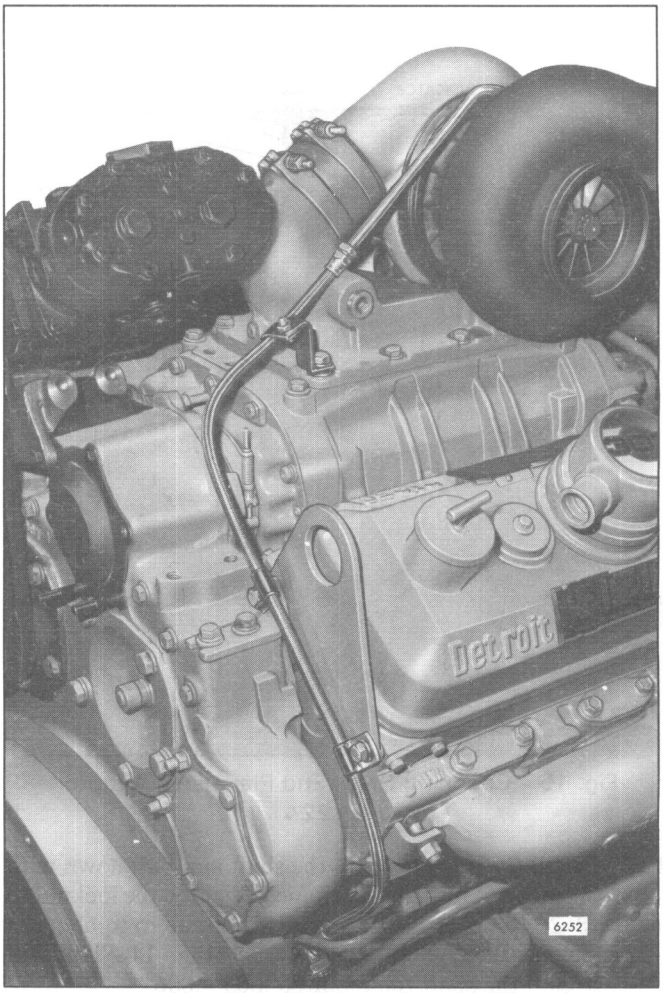


Fig. 18 – Typical 6V–92 Right–Bank Turbo Oil Supply Hose Routing

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 that were placed over the openings when the turbocharger was removed.

   NOTICE: Turbocharged engines use a lockplate for positive locking of the bolts holding the turbocharger mounting support to the cylinder head. It is recommended that whenever a turbocharger is installed on an engine new lockplates and attaching parts be used to ensure positive locking of the attaching bolts. After the attaching bolts have been tightened to 30–35 lb–ft (41–47 N•m) torque, bend the lockplate against the flat of each of the bolt heads.

3. Place the turbocharger assembly into position on the mounting bracket.

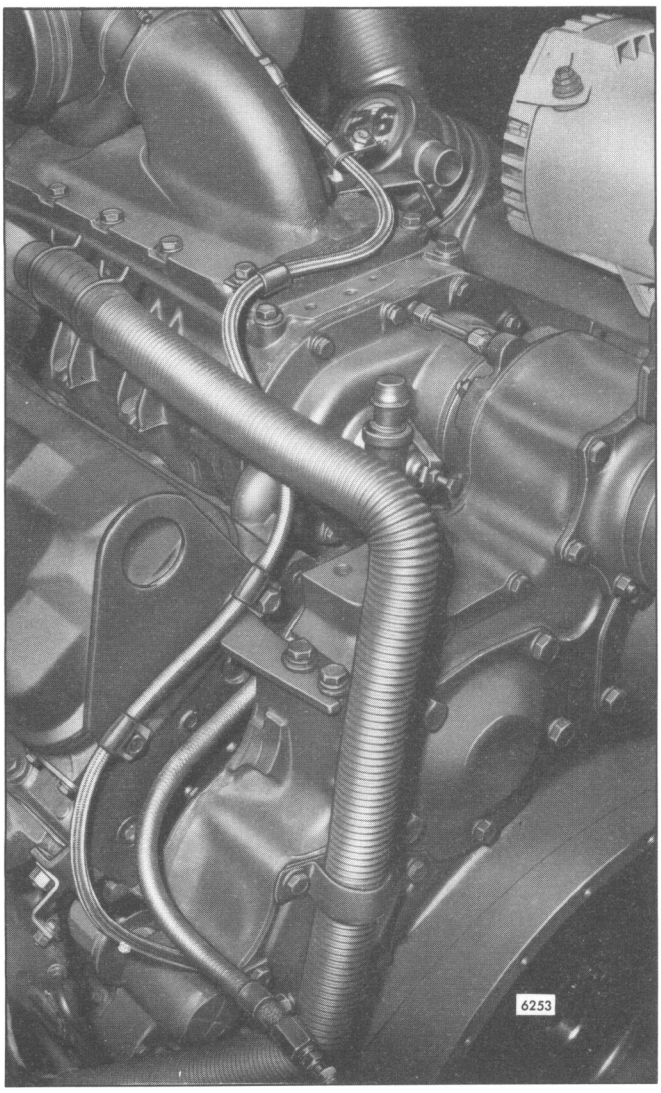


Fig. 19 – Typical 8V–92 Left–Bank Turbo Oil Supply Hose Routing

4. Place a new gasket between the exhaust manifold adaptor and the exhaust flange of the turbine housing, then secure the turbocharger to the adaptor with four bolts, lock washers and nuts. Tighten the nuts just enough to hold the turbocharger tight against the adaptor at this time.

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 (Fig. 17).

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 (Fig. 4).

   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 parts. A good indicator that all 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.

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 INTERCOOLER

An intercooler is placed between the air discharge side of each turbocharger and the air inlet side of the engine blower (Fig. 1). The intercooler is used to reduce the temperature of the compressed air leaving the turbocharger before it reaches the blower. This permits a more dense charge of air to be delivered to the engine.

Cooling is accomplished by a raw water pump driven off the rear end of the engine supplying water to the intercooler. The water makes six passes through the core and is discharged from the connection diagonally opposite the inlet. The air from the turbocharger enters the finned side of the intercooler at the face opposite the water inlet, and flows counterflow to the direction of water flow through the core.

The coolant circulated through the intercoolers of a turbocharged intercooled engine is protected by a cone–shaped 20 mesh water filter (screen). The filter is located at the water connection in the water pump to engine oil cooler tube. Refer to Section 15.1 for service and preventive maintenance.

Remove Intercooler

1. Drain the raw water system.

2. Disconnect the air and water inlet hose connections at the air shutdown housing, the turbocharger

3. Remove the intercooler air inlet housing and then remove the intercooler from the air outlet housing. Discard the gaskets.

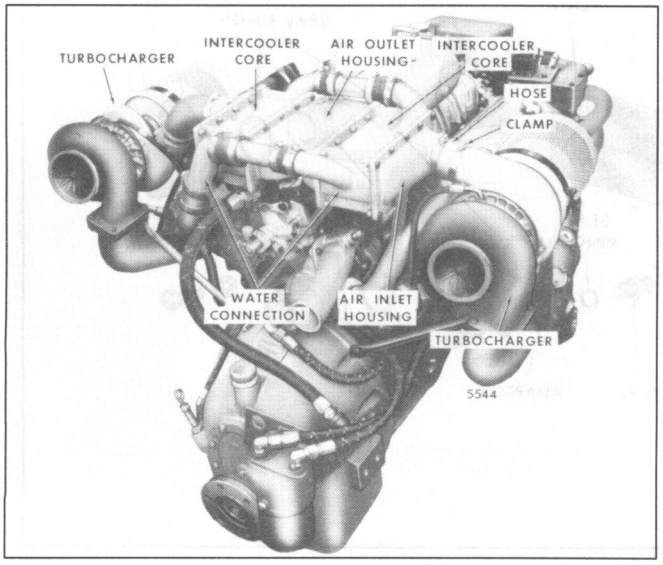


Fig. 1 – Turbocharger Intercooler Mounting

Disassemble Intercooler

1. Remove the two bolts and lock washers and withdraw the drain adaptor with the drain cock from the drain hole below the intercooler outlet connector (Fig. 2).

2. Remove three bolts and lock washers from each connector and withdraw the inlet and outlet connectors straight out from the intercooler. Remove and discard the gaskets.

3. Remove the drain, inlet and outlet tubes and seal rings from the water openings in the intercooler. Remove and discard the two seal rings on each tube.

4. Remove the four cross–head screws from the intercooler adaptor plate, then remove the plate and discard the seal ring.

5. Remove the top one–piece felt pad.

6. Lift the intercooler core straight up and out of the housing.

7. If necessary, remove the eight upright felt pads for cleaning.

Inspection

If inspection or trouble shooting (Section 3.0) reveals marine growth or debris has plugged the tubes of the intercooler, or the air side of the cooler has become plugged with foreign material and greasy soot accumulations, they must be cleaned.

Clean Intercooler

CAUTION: Protect your eyes and avoid breathing the fumes or direct contact of the acid with your skin.

Remove only the covers of the intercoolers.

NOTICE: Prior to removing the covers, matchmark each cover in its original position.

Clean the intercooler core by immersing it in a scale solvent consisting of 1/2 pound of oxalic acid to each 2–1/2 gallons of a solution composed of 1/3 muriatic acid and 2/3 water. The cleaning action is evident by the bubbling and foaming. Carefully observe the process and remove the intercooler core from the solution when the bubbling stops (this generally takes from 30 to 60 seconds). Then thoroughly flush the intercooler core with clean hot water under pressure.

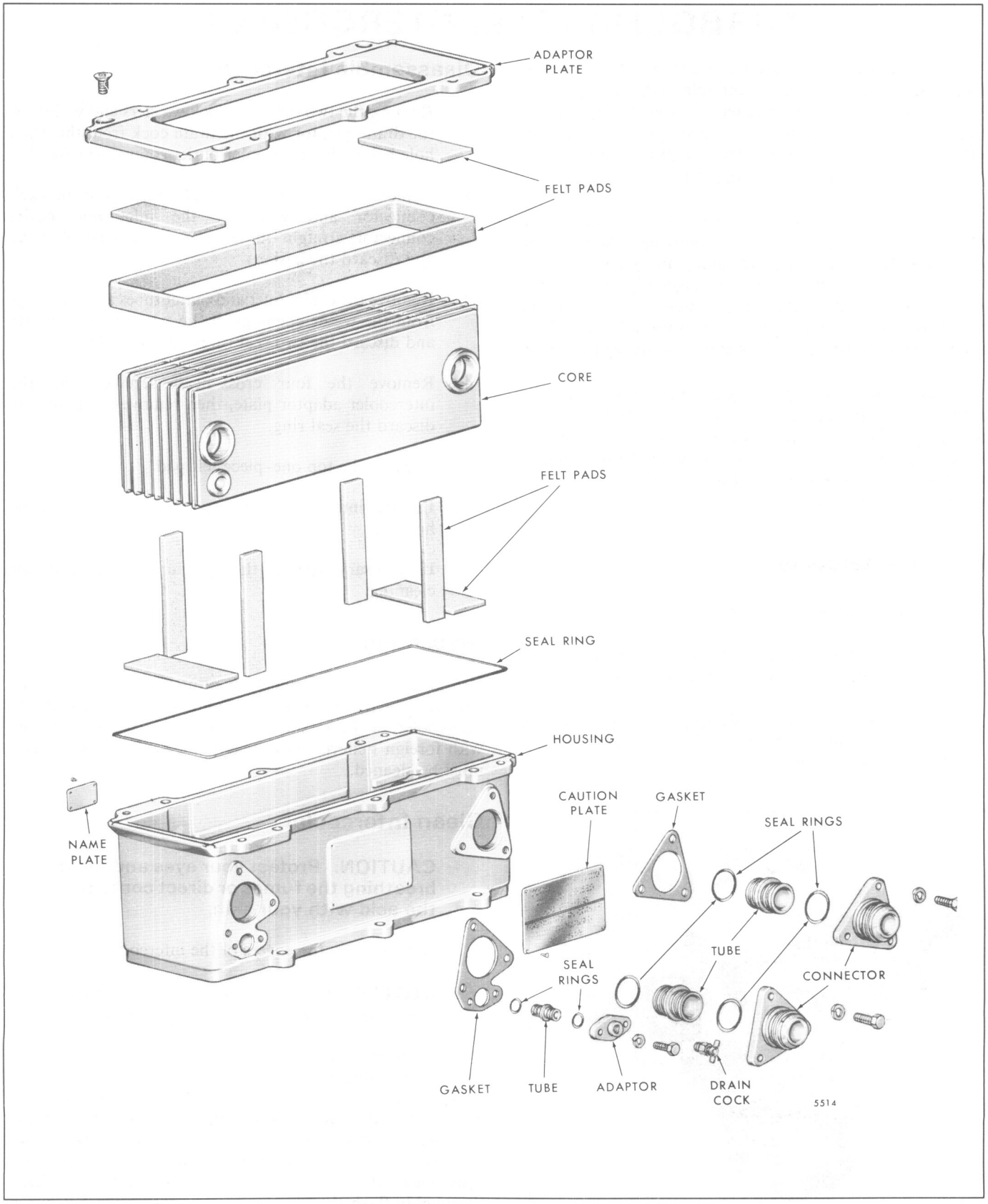


Fig. 2 – Intercooler Details and Relative Location of Parts

The coolant side of the cooler should be cleaned first. If the coolant side of the cooler does not require cleaning proceed with cleaning the air side of the cooler.

Glass bead both sides of the cooler and covers in a suitable glass beading machine.

Rod out each tube in the core with a suitable brass rod and wire brush.

Remove any blasting material with compressed air.

Reassemble the covers using new gaskets, at this time only hand tighten the cover bolts.

Place the complete assembly on a flat drill press table with slots, in order to allow the excess cover gasket material to set in and allow the covers to be square with the top and bottom of the core.

Tighten the cover bolts to the standard bolt torque, and trim excess gasket material from the top and bottom of the cooler.

Pressure Check Intercooler

1. Make a suitable adaptor to which an air hose can be attached and fasten it to the inlet pipe of the cooler core. Use a suitable piece of hose, a plug and clamp to seal the outlet pipe.
2. Attach an air hose and supply approximately 20 psi (138 kPa) air pressure. Then submerge the cooler core in a tank of water. Any leaks will be indicated by air bubbles in the water.

   CAUTION: When making this pressure test, be sure that personnel are adequately protected against any stream of pressurized water from a leak or rupture of a fitting, hose or the intercooler core.
3. After the pressure test is completed, remove the air hose, clamp, plug, hose and adaptor and dry the cooler core with compressed air. Replace the cooler core if leaks were indicated.

Assemble Intercooler

1. If removed, fix the eight upright felt pads in place in the intercooler housing using Silastic 732 RTV, or equivalent.
2. Place the intercooler core straight down into the housing.
3. Fix the one–piece felt pad around the top side of the housing. It should butt together at the center of the housing and must not overlap.
4. Lubricate a *new* seal ring and the groove in the adaptor plate with vegetable shortening and install the seal ring in the plate. Place the adaptor plate on the intercooler housing and thread the four 3/8"–16 x .75" screws into the housing. Tighten the screws to 50 **lb–in** (5.65 N•m) torque.
5. Lubricate *new* seal rings and the two grooves on each drain, inlet and outlet tube with vegetable shortening and place the seal rings on the tubes. Then place the drain, inlet and outlet tubes in the water openings in the housing.
6. Use *new* gaskets and install the water inlet and outlet connectors on the housing with three 3/8"–16 x 1" bolts and lock washers. Tighten the bolts to 240 **lb–in** (27.12 N•m) torque.

   NOTICE: The gasket with the drain hole is used at the outlet opening.
7. Install the drain adaptor and drain cock with two 5/16"–18 x .88" bolts and lock washers. Tighten the bolts to 120 **lb–in** (13.56 N•m) torque.

Install Intercooler

1. Use *new* gaskets and install the intercooler on the air outlet housing with twenty 3/8"–16 x 1" bolts with lock washers and nuts. Tighten the nuts.
2. Use new gaskets and attach the inlet housing to the intercooler with twenty 3/8"–16 x 1–1/8" bolts with lock washers and nuts. Tighten the nuts.
3. Connect the air and water inlet and outlet hoses at the air shutdown housing, turbocharger and intercooler. Tighten the hose clamps.
4. Fill the raw water system. Start the engine and check for any air or water leaks.

TURBOCHARGER AFTERCOOLER

The aftercooler mounts in the cylinder block opening between the cylinders, beneath the blower assembly (Fig. 1). The aftercooler (Fig. 2) cools the air going into the engine after it passes through both the turbocharger and the blower. The air flows downward through the aftercooler and the coolant flows from rear to front through the aftercooler and returns through the left bank thermostat housing (6 and 8V engines) and to the water manifold (12 and 16V engines).

The top deck of the cylinder block has been revised to accept the aftercooler. A water inlet adaptor plug or cup plug replaces the rear 2 1/2" core plug in the bottom of the cylinder block opening (Fig. 3 or 4) to supply water to the aftercooler. Tool J 25275 should be used to install or remove this adaptor plug. Use tool J 28711 to install the cup plug.

A limited number of 6, 8 and 16V blocks used the stainless steel cup plugs and aftercooler inlet adaptor to seal the water holes in the air box floor of the cylinder blocks (Fig. 4). The 2 1/2" cup plug and the solid aftercooler inlet adaptor will remain available to service the blocks.

Remove Aftercooler

Drain the block before removing the aftercooler as some coolant may remain in the cooler if only the radiator is drained.

1. Loosen the two 7/16"–14 x 5 1/4" attaching bolts and lift the turbocharger from the air inlet adaptor (refer to Section 3.5).

2. Remove the air inlet adaptor from the blower.

3. Remove the blower and any accessories attached to the blower from the cylinder block (refer to Section 3.4).

4. Loosen the hose clamps and slide the cylinder block water outlet tube hose back against the thermostat housing (6 and 8V engines) or water manifold (12 and 16V engines).

5. Remove the water outlet tube from the front of the cylinder block. Discard the gasket.

6. Remove and discard the 5/16"–18 x 9/16" attaching bolts with nylon locking patch and lift the aftercooler from the cylinder block opening between the cylinders. *Do not remove the four bolts in the top face of the aftercooler (Fig. 1). They are part of the aftercooler assembly and need not be removed for any reason.*

   NOTICE: Be careful not to damage the cooler fins when lifting the aftercooler from the cylinder block.

7. Remove and discard the seal rings from the grooves in the water inlet and outlet tube ends of the aftercooler.

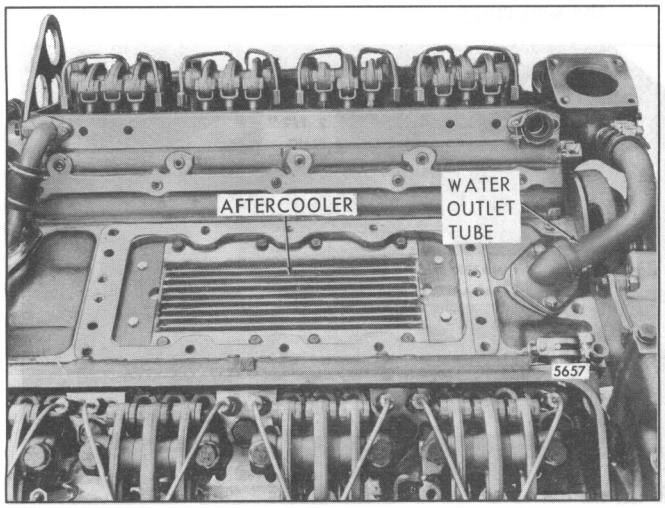


Fig. 1 – Aftercooler Mounted in Cylinder Block

Clean Aftercooler

The length of time an aftercooler will function satisfactorily before cleaning will be governed largely by the kind of coolant and coolant additive used in the engine.

Check all of the cooler fins and air and water passages for plugging at major overhaul. Clean the fins of dirt or any other foreign obstructions with a small brush. Do not apply more than 40 psi (276 kPa) air pressure.

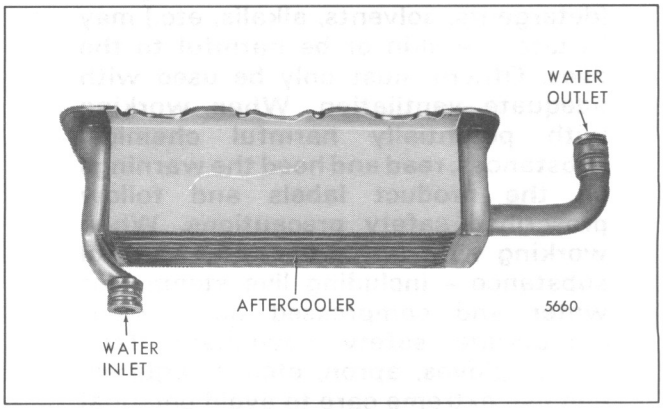


Fig. 2 – Aftercooler

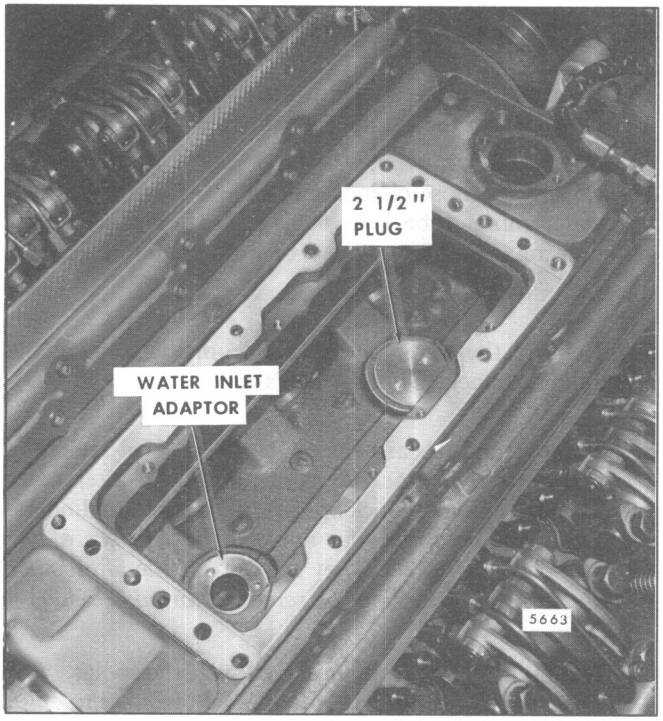


Fig. 3 – Location of Water Inlet Adaptor Plug in Cylinder Block

If an aftercooler core becomes clogged with oil, dirt or carbon during its service life on an engine, the procedure below may be used to clean it:

NOTICE: This procedure is not effective on scale (mineral salts) plugging. If scale plugging has occurred, the air system should be thoroughly inspected and the cause of the scaling determined and eliminated.

1. Stem clean the outside of the core to remove any loose deposits or debris.

CAUTION: Some chemical agents (detergents, solvents, alkalis, etc.) may irritate the skin or be harmful to the eyes. Others must only be used with adequate ventilation. When working with potentially harmful chemical substances, read and heed the warnings on the product labels and follow prescribed safety precautions. When working with any potentially harmful substance – including live steam, hot water and compressed air – wear appropriate safety equipment (face shield, gloves, apron, etc.) if required, and use extreme care to avoid personal injury.

2. Immerse the core in a tank filled with a solution of clean parts dip such as "Soak–NS", or equivalent. Allow it to soak for approximately 12 hours. Leave the water connections open so that the cleaning solution can penetrate both water and air sides of the core.
3. Remove the core from the tank and rinse it thoroughly with a steam cleaner or high–pressure hot water.
4. Blow out the air and water sides of the core using compressed air. To ensure that debris is not forced farther into the fins, direct the stream of air opposite to the direction of normal coolant and air flow.

CAUTION: To avoid personal injury, wear appropriate safety equipment (face shield, rubber gloves and apron).

5. Rinse the core with clean solvent (mineral spirits) to remove any residual oil or grease.
6. Remove the solvent from the core using a steam cleaner or high–pressure hot water rinse.

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

7. Using compressed air, blow dry the air and water sides of the core. Wear eye protection and do not exceed 40 psi (276 kPa) air pressue.
8. Visually inspect the cooler core tubes and fins to ensure that the cleaning process has completely removed all contamination. If necessary, repeat the cleaning procedure and reinspect.

Install Aftercooler

1. Install new seal rings in the two grooves on the water inlet and outlet tube ends of the aftercooler. Coat the seal rings lightly with engine oil or vegetable shortening. Do not scratch or nick the sealing edge of the seal rings.

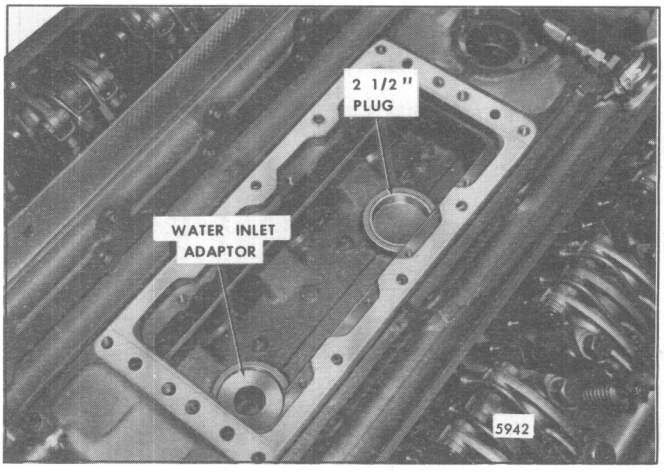


Fig. 4 – Installing Aftercooler Water Plug

2. Place the aftercooler, water outlet end first, into the cylinder block opening between the cylinders. The water inlet end of the cooler seats in the water inlet adaptor plug (Fig. 3 or 4). Install new 5/16"–18 x 9/16" attaching bolts with nylon locking patch (six bolts – 6 and 12V or eight bolts – 8 and 16V).

   Do not tighten the bolts until the water outlet tube to thermostat housing (6 or 8V engines) or water manifold (12 and 16V engine) hose and clamps are aligned and tightened.

3. Use a new gasket and attach the water outlet tube with two 5/16" bolts and lock washers to the cylinder block. Do not tighten the attaching bolts.

4. Align the water outlet tube to the thermostat housing (6 or 8V engines) or water manifold (12 and 16V engine) with the hose and clamps in position. Tighten the clamps.

   NOTICE: The aftercooler water outlet hose used on 16V–92 turbocharged–aftercooled engines has been replaced by a longer hose (2.26" to 2.75"). This change has been made to eliminate the possibility of coolant leakage caused by misalignment of the aftercooler water outlet tube and water outlet elbow during aftercooler installation. The extra hose length further ensures that properly installed hoses do not leak during engine operation.

5. Tighten the two 5/16" water outlet tube bolts, then tighten the aftercooler attaching bolts.

6. Use a new blower to cylinder block gasket and install the blower and any accessories attached to the blower (refer to Section 3.4).

7. Attach the air inlet adaptor to the blower with the 7/16"–14 x 1 1/2" attaching bolts and lock washers (eight bolts – 6 and 12V, ten bolts – 8 and 16V). Tighten the bolts to 46–50 lb–ft (62–68 N•m) torque.

8. Install the turbocharger (refer to Section 3.5). Tighten the two 7/16"–14 x 5 1/4" bolts to 46–50 lb–ft (62–68 N•m) torque.

SHOP NOTES – TROUBLESHOOTING SPECIFICATIONS – SERVICE TOOLS

SHOP NOTES

BLOWER DRIVE SEAL RING

The rubber seal ring used between the blower end plate and the blower drive support can be replaced without removing the blower, as follows:

1. Remove the clamp and cut and remove the old seal ring.

2. After thoroughly cleaning the blower drive groove area, make a square cut on a new seal ring and install the seal ring around the groove, with the cut at the top. Attach the two ends of the seal ring together with Loctite No. 06, or equivalent, as follows:

   a. The cutting blade to be used must be clean and free of contaminants. If a razor edge is to be used, remove the protective oil film by wiping with solvent.

   b. Make a square cut in the replacement seal. The cut ends must remain clean to achieve a satisfactory bond.

   c. Apply a thin film of Loctite Super Bonder Adhesive to one of the cut ends. Shake off excess adhesive. Use adhesive sparingly and avoid contact with skin.

   d. Position the seal in the blower drive groove, locating the adhesive treated end first. Place the other end of the seal in the groove and slide it into the adhesive end to make the joint. Apply light pressure to the joint and hold firmly for 30 seconds.

   e. To remove excess adhesive around the joint, apply a chlorinated solvent (Acetone, MEK or Methylene Chloride) to a cloth and wipe the joint.

   CAUTION: This adhesive contains cyanoacrylate. Keep away from children. Irritating liquid and vapor. Hazardous if swallowed. Use with adequate ventilation. In case of skin contact, flush with plenty of water. For eye or mouth contact, get medical attention.

3. Install the plain clamp between the raised edges of the seal ring and tighten.

   NOTICE: If a former seal ring (without groove) is used, it should be replaced with the current molded (two raised edges) type seal ring.

BLOCK MODIFICATION FOR FRONT-MOUNTED TURBOCHARGER LUBE OIL SUPPLY LINE

At the time of an out–of–frame overhaul, 6V–92 and 8V–92 cylinder blocks may be modified to accept a front–mounted turbo lube oil supply line (Fig. 1). Use the following procedure.

1. Fabricate the locating template shown in Fig. 2.

2. With the cylinder block completely stripped, mount the locating template on the block dowel pins (see Fig. 2 for establishing hole location).

3. Drill a 7/16" hole 1–1/2" deep into the oil gallery at the "B" location. Thread the hole with a 1/4" NPTF tap. If an additional oil feed location is required on the opposite bank, flip the template and repeat the modification procedure.

4. Remove the oil gallery plug (location "C" in Fig. 2) and blow out all metal chips using an air hose and suitable nozzle.

   CAUTION: Do not exceed 20 psi (138 kPa) air pressure. Wear adequate eye protection to avoid personal injury.

If the oil cooler side of the block is drilled for the turbo oil supply, pay special attention to the area around the 1" cup plug that divides the vertical oil gallery between the oil cooler inlet and outlet passages (Fig. 3). Remove the cup plug and flush the oil gallery with the air hose and a cleaning solvent in combination to ensure the removal of all metal chips.

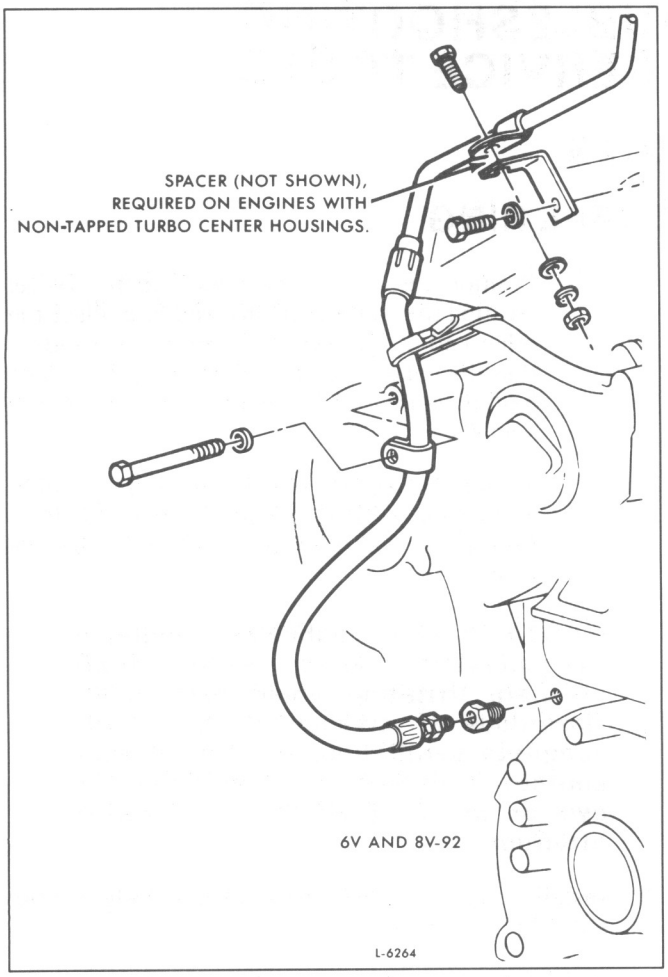


Fig. 1 – Turbo Lube Oil Supply Line Routing

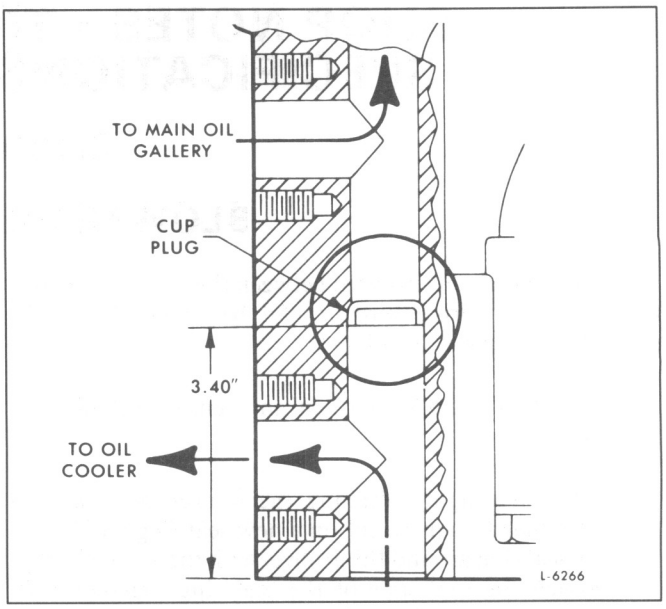


Fig. 3 – Location of Cup Plug in Oil Gallery

5. After cleaning the block thoroughly, apply Loctite J 26558–92 pipe sealant with Teflon (or equivalent) to the oil gallery plug and the cup plug and reinstall. Torque the oil gallery plug to 78–85 lb–ft (105–115 N•m). Install the cup plug to a depth of 3.40" with tool J 33420 (Fig. 3).

NOTICE: Neglecting to install the cup plug allows lube oil to completely bypass both the filter and the oil cooler. The resulting unfiltered and improperly cooled oil can seriously damage the engine.

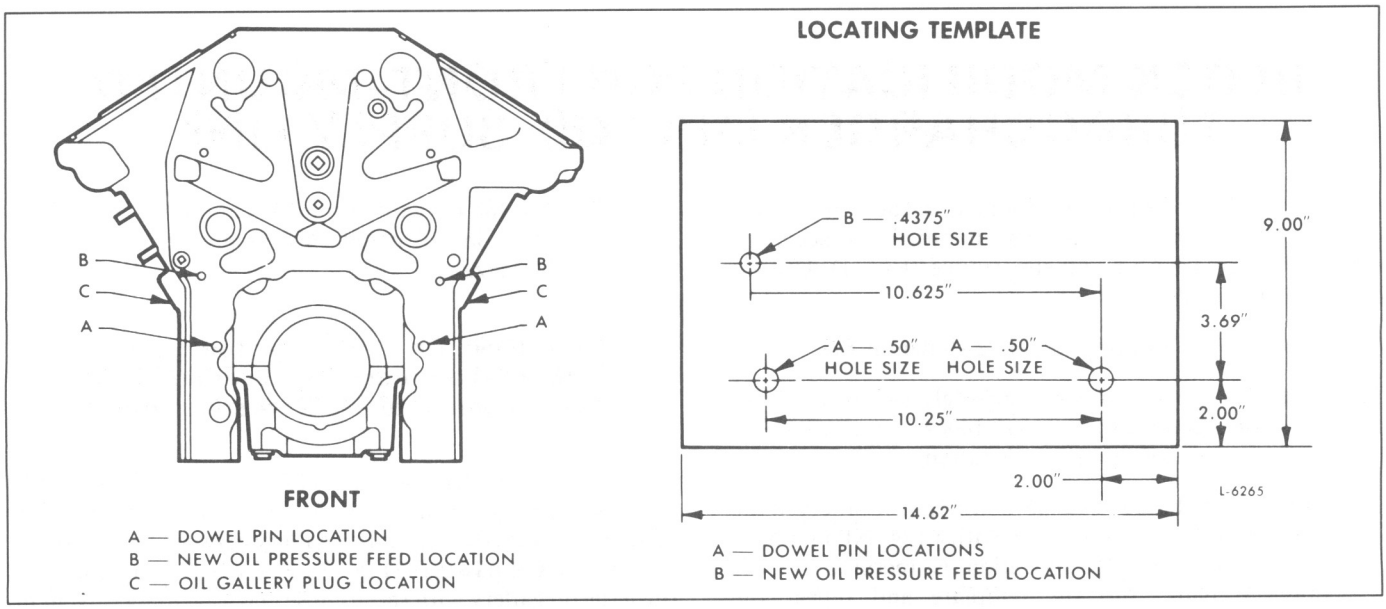


Fig. 2 – Locating Template

DRILLING PROCEDURE FOR AIR SHUTDOWN REPLACEMENT SHAFT

Whenever a replacement air shutdown valve shaft is installed on a Series 149 engine, the shaft must be match–drilled to the cam and the flapper valve in order to ensure positive air shutdown operation. Failure to properly index the shaft can result in improper flapper valve operation and engine run–on at shutdown. Use the following procedure to drill the air shutdown valve shaft:

1. Install a 1/8" drill bit in the chuck of a drill press, then locate and align the bit through the existing hole in the shutdown cam (Fig. 4). Lock the cam in the holding fixture on the drill press, and withdraw the bit.

2. Insert the replacement shaft into the cam until the end of the shaft is recessed 1/8" from the end of the cam. Start the drill and bore a hole through the shaft (Fig. 4). Withdraw the drill bit, install the pin handle through the hole and remove the shaft from the drill press.

3. Insert the shaft into the shutdown housing bore and install the spacer on the end of the shaft. Place a .015" feeler gage between the housing and spacer and mark the shaft with a center punch inserted into the existing hole in the spacer (Fig. 5).

4. Remove the shaft from the housing. Locate and align the 1/8" drill bit through the hole in the spacer and lock the spacer in the holding fixture on the drill press. Withdraw the drill bit.

5. Insert the shaft through the spacer, locate the center punched mark and drill a hole through the shaft. Remove the shaft and spacer from the drill press.

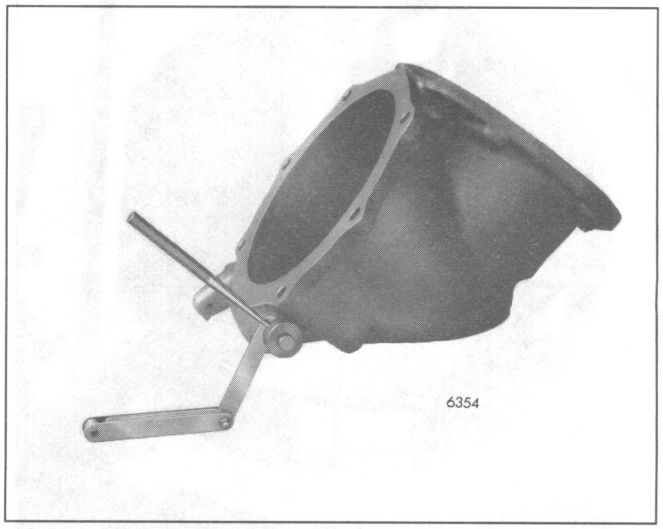


Fig. 5 – Center Punch Shaft thru Spacer Hole

6. Assemble the shaft, seal rings spring, flapper valve and spacer in the housing (see Section 3.3). If using a new valve, center punch for holes in approximately the same position as on the old valve. If reusing the old valve, center punch for holes just inside the existing holes.

7. Align the notch on the cam with the latch and hold in this position with a piece of stiff wire (Fig. 6).

8. Place the housing on the drill press. With the valve held in the wide open *run* position, align the 1/8" drill bit with the marks center punched on the valve in Step 6. Then, drill through the valve and shaft (Fig. 7). Install the retaining pins to hold the valve to the shaft.

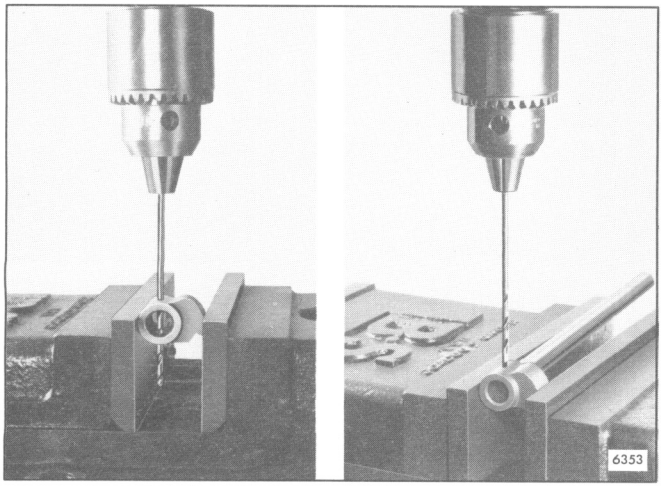


Fig. 4 – Aligning Drill Bit and Drilling Shaft

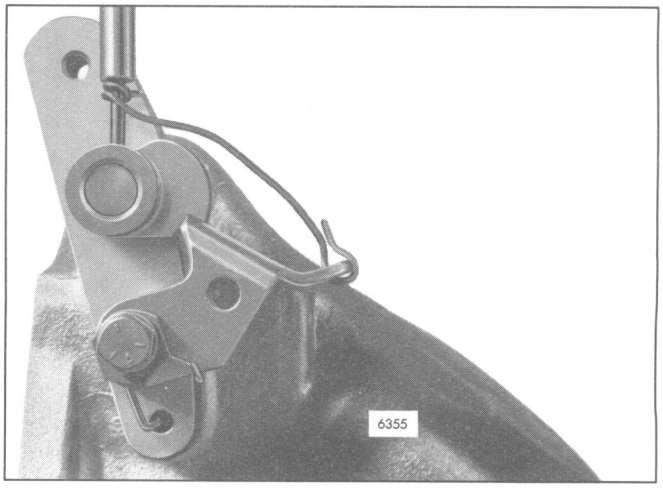


Fig. 6 – Cam and Latch Wired to Prevent Movement

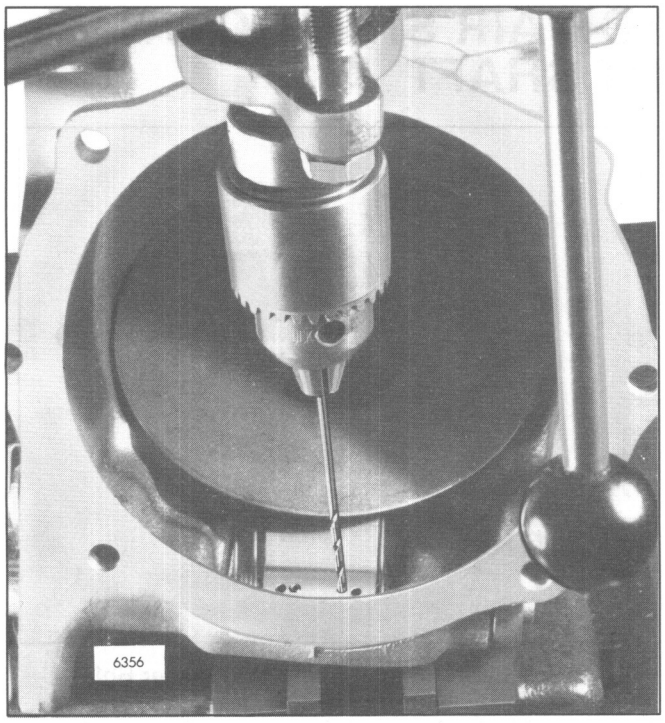


Fig. 7 – Drilling Valve–to–Shaft Holes

9. Clean the air shutdown assembly thoroughly and check for proper operation before installing it on the 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.

INTERCOOLER

CONDITION	PROBABLE CAUSE	SUGGESTED REMEDY
BLACK SMOKE (AIR SIDE)	AIR INLET RESTRICTION	CLEAN SILENCER (SEE SECT. 3.2)
	INJECTORS — HIGH OUTPUT	SEE SECT. 2.0
	DIRTY FINS INTERCOOLER	CLEAN INTERCOOLER FINS
OVERHEATING (WATER SIDE)	THERMOSTATS	CHECK THERMOSTAT (SEE SECT. 5.2.1)
	RAW WATER PUMP	CHECK IMPELLER (SEE SECT. 5.6)
	HEAT EXCHANGER	CLEAN ELEMENT (SEE SECT. 5.5)
	INTERCOOLER (WATER SIDE)	CLEAN INTERCOOLER (SEE SECT. 3.5.2)
	SEA STRAINERS	CLEAN SEA STRAINER
	INDUSTRIAL FILTER	CLEAN FILTER

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 (timing gears)	.0005"	.0025"	.0040"
Oil seal (below end plate surface)	.0020"	.0080"	
Oil strainer (below end plate surface)	.0000"	.0150"	
Dowel pin (projection beyond inside face of front end plate)	.3200"		
Dowel pin (projection beyond inside face of rear end plate)	.3200"		
Clearances:			
Rotor to end plate (gear end)	.0070"		
Rotor to end plate (front end – 6V–92)	.0120"		
Rotor to end plate (front end – 8V–92 and 16V–92)	.0140"		
Rotor to housing (inlet side)	.0150"		
Rotor to housing (outlet side)	.0040"		
Trailing edge of R.H. helix rotor to leading edge of L.H. helix rotor	.0040"	.0080"	.0080"
Leading edge of R.H. helix rotor to leading edge of L.H. helix rotor	.0100"		
T18A40 and T18A90 Turbochargers (Airesearch)			
End play — rotating shaft	.0040"	.0090"	
Radial movement — rotating shaft	.0030"	.0070"	
Turbine wheel shaft journal bearing:			
Inside diameter		.6272"	
Outside diameter	.9780"		
Journal diameter — turbine wheel shaft	.6247"		
Bearing bore — (center housing) inside diameter	—	.9835"	
Back plate seal bore inside diameter	—	.6885"	
Thrust collar:			
Thickness	.2990"		
Bore – inside diameter (18A40)		.3758"	
Bore – inside diameter (18A90)		.4390"	

ENGINE PARTS (Standard Size, New)	MINIMUM	MAXIMUM	LIMITS
Thrust spacer:			
Outside diameter (18A40)	.6715"		
Outside diameter (18A90)	.8600"		
Ring groove width		.0695"	
Thrust washer, inboard thickness	.0900"		
Compressor wheel bore:			
Inside diameter (18A40)		.3739"	
Inside diameter (18A90)		.4378"	
TV81 Turbocharger (Airesearch)			
End play — rotating shaft	.0030"	.0100"	
Radial movement — rotating shaft	.0030"	.0070"	
Turbine wheel shaft journal bearing:			
Inside diameter	.6268"	.6272"	
Outside diameter	.9782"	.9787"	
Journal diameter — turbine wheel shaft	.6250"	.6254"	
Bearing bore – (center housing) inside diameter	.9827"	.9832"	.9842"
Back plate seal bore inside diameter	.6875"	.6885"	.6895"
Thrust collar:			
Thickness	.2990"	.3000"	.2970"
Bore – inside diameter	.3754"	.3758"	.3778"
Thrust spacer:			
Outside diameter	.6715"	.6725"	.6705"
Ring groove width	.0685"	.0695"	.0715"
Thrust washer, inboard thickness	.0900"	.0920"	
Compressor wheel bore inside diameter	.3736"	.3739"	.3749"

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

12252

BOLT IDENTIFICATION CHART

EXCEPTIONS TO STANDARD BOLT AND NUT TORQUE SPECIFICATIONS

APPLICATION	THREAD SIZE	TORQUE lb-ft	TORQUE N•m
Air inlet housing adaptor–to–blower housing bolt	3/8–16	16–20	22–27
Air inlet housing–to–adaptor bolt	3/8–16	16–20	22–27
Blower side angle bolt	3/8–16	30–35	41–47
Blower end plate–to–cylinder block bot	7/16–14	40–45	54–61
Blower rotor gear retainer bolt (large bearing blower)	1/2–20	100–110	136–150
Fuel pump drive disc bolt	1/2–20	55–65	75–88

TURBOCHARGER

APPLICATION	THREAD SIZE	TORQUE lb–in	TORQUE N•m
"V" band coupling locknut (comp.)	1/4–28	110–130	12–15
"V" band coupling locknut (turb. TV71–TV81)	1/4–28	152–168	17–19
Backplate to center housing bolts	5/16–18	90–110	10–12
Turbine housing to center housing bolts	5/16–18	100–130	11–15
Turbine housing to center housing bolts (TH08A)	5/16–18	160–190	18–21
Compressor wheel locknut (18A40)	3/8–24	*125–150	14–17
Compressor wheel locknut (18A90)	7/16–20	*125–150	14–17

*Refer to Section 3.5 for additional instructions.

SERVICE TOOLS

TOOL NAME	TOOL NO.
Blower	
Blower alignment tool	J 33001
Blower clearance feeler set	J 1698–02
Blower service tool set	J 6270–G
Installer, lip type oil seal/wear sleeve (part of J6270–G)	J 35787–A
Turbocharger (Airesearch)	
Dial indicator set (magnetic base)	J 7872
Turbocharger inlet shield	J 26554–A
Turbocharger Aftercooler	
Adaptor cup plug installer	J 28711
Adaptor plug remover and installer	J 25275