

DIESEL MECHANIC



MINING QUALIFICATIONS AUTHORITY

CODE: OB

OVERHAUL AND MAINTAIN

THE BLOWER OF AN

ENGINE

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OBJECTIVE

What you must do

1. Dismantle, assess and assemble the blower.
2. Comply with the requirements stated on the hazard identification and control (HIAC) form.

What you will be given

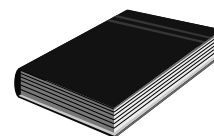
1. The blower of an engine.
2. All the necessary tools.
4. All the necessary equipment.


How well you must do it

1. There must not be any damage to any fasteners.
2. The clearance between the trailing side of the upper rotor and the outlet and inlet sides of the blower must be within the limits of the dimensions given in the Workshop Manual.
3. The clearance between the leading side of the upper rotor and the outlet and inlet sides of the blower must be within the limits of the dimensions given in the Workshop Manual.
4. The end clearance between the blower rotors and the end plates must comply with that in the Workshop Manual.
5. All the fasteners must be torqued to specifications.

ADDITIONAL RESOURCES

1. Your Training Officer
2. Workshop Manual.
3. Audio-visual aids if available.



| <p align="center"><u>HAZARD IDENTIFICATION AND CONTROL (HIAC) FORM</u></p> <div style="display: flex; justify-content: space-around; align-items: center;">  <div style="text-align: center;"> <p><u>OB</u></p> <p><u>OVERHAUL AND MAINTAIN BLOWERS</u></p> </div> </div> | | |
|---|--|--|
| STEPS IN OPERATION / PROCESS | POTENTIAL ACCIDENT / INCIDENT | CONTROLS (BY RESPONSIBLE PERSON) |
| Use hand tools | <ul style="list-style-type: none"> Using damaged tools or wrong tools for the job can cause injury and damage to equipment. | <ul style="list-style-type: none"> Always use the correct tool for the job. Ensure tools are in good condition. Use tools correctly. Wear appropriate PPE where necessary. Always take good care of tools. Maintain, clean and store it properly. |

NOTE: Before doing the practical work contained in this module, the learner must study the content of the above HIAC Form again and then sign the statement below:

The above risks, which will be encountered in this module, are fully understood and will be controlled during the practical work.

Signature of Learner:.....

Signature of Training Officer:.....

Date:.....

OVERHAUL AND MAINTAIN THE BLOWER OF AN ENGINE

ITEM / TASK: Introduction

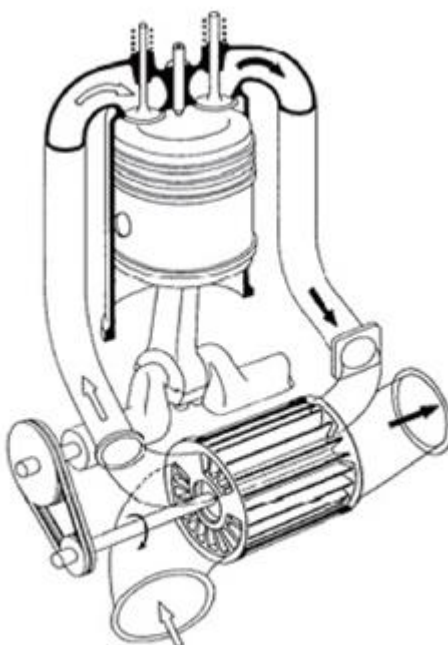
DESCRIPTION:

Superchargers and Turbochargers

- A normally aspirated engine, also called an atmospheric engine, uses atmospheric pressure (14.7 psi or 100 kpa. at sea level) to push air into the engine.
- With outside air pressure as a moving force, only a limited amount of fuel can be burned on each power stroke.
- The term **supercharger** originally meant that some type of air pump was used to increase engine power by pushing more air and fuel into the combustion chambers.
- With a greater amount of air and fuel (a denser air-fuel mixture), combustion can generate more heat energy and pressure to push the pistons down in their cylinders.

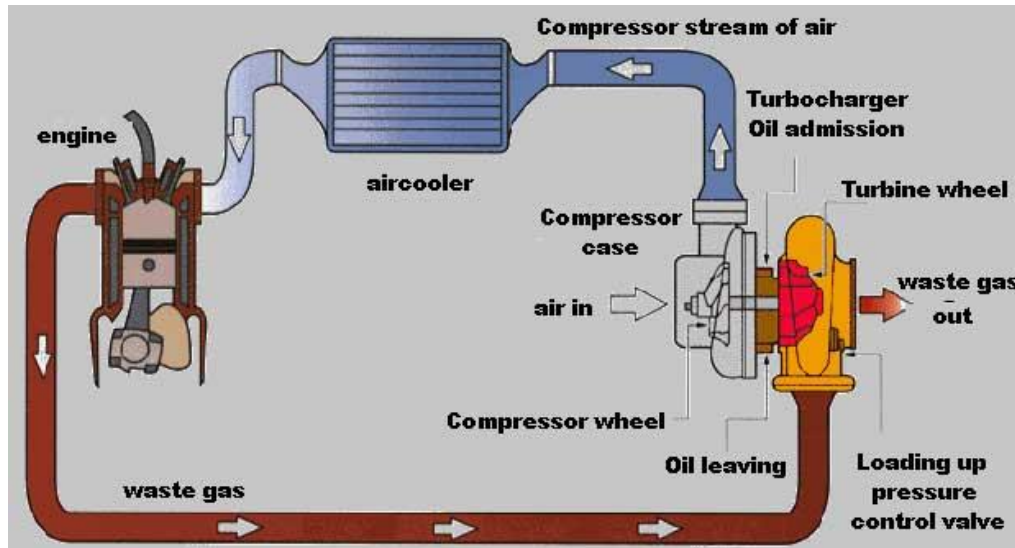
A supercharger is a blower driven by a belt, gears, or a chain. Superchargers are used on large diesel truck engines and racing engines. They are sometimes found on high-performance passenger cars. (Fig 1)

Fig 1



A **turbocharger**, or “turbo,” is a blower driven by engine exhaust gases. Turbochargers are commonly used on passenger cars, trucks, and competition engines. (Fig 2)

Fig 2



Blowers (supercharger)

- Sometimes called a **blower**, the **supercharger** is used for the air supply pump that supplies the air under pressure to two-stroke engines, the primary purpose being to scavenge burnt gas from the engine cylinder.
- Engine horsepower can be doubled in racing applications with engine modifications and a blower.
- As a secondary function, blowers usually ensure that the cylinder is completely filled with fresh air by raising the cylinder pressure to above atmospheric.
- The primary function is achieved by having both the inlet and exhaust ports open together, allowing the fresh air to sweep through the entire cylinder, while the secondary function is performed by closing the exhaust port (or valve) before the inlet port (or valve), thus allowing the pressure to build up in the engine cylinder before the air supply is shut off.
- Almost all engine manufacturers use Roots blowers for this purpose

Fig 3



Superchargers have the advantage of not suffering from turbo lag. A supercharger will instantly produce boost pressure at low engine speeds because it is mechanically linked to the engine crankshaft.

This low-speed power and instant throttle response is desirable in a passenger car when passing other vehicles and when entering interstate highways.

Supercharger Types

There are three basic types of superchargers (Fig 4)

- Centrifugal supercharger.
- Rotor (Rootes) supercharger.
- Vane supercharger.

Note the differences in construction and operation.

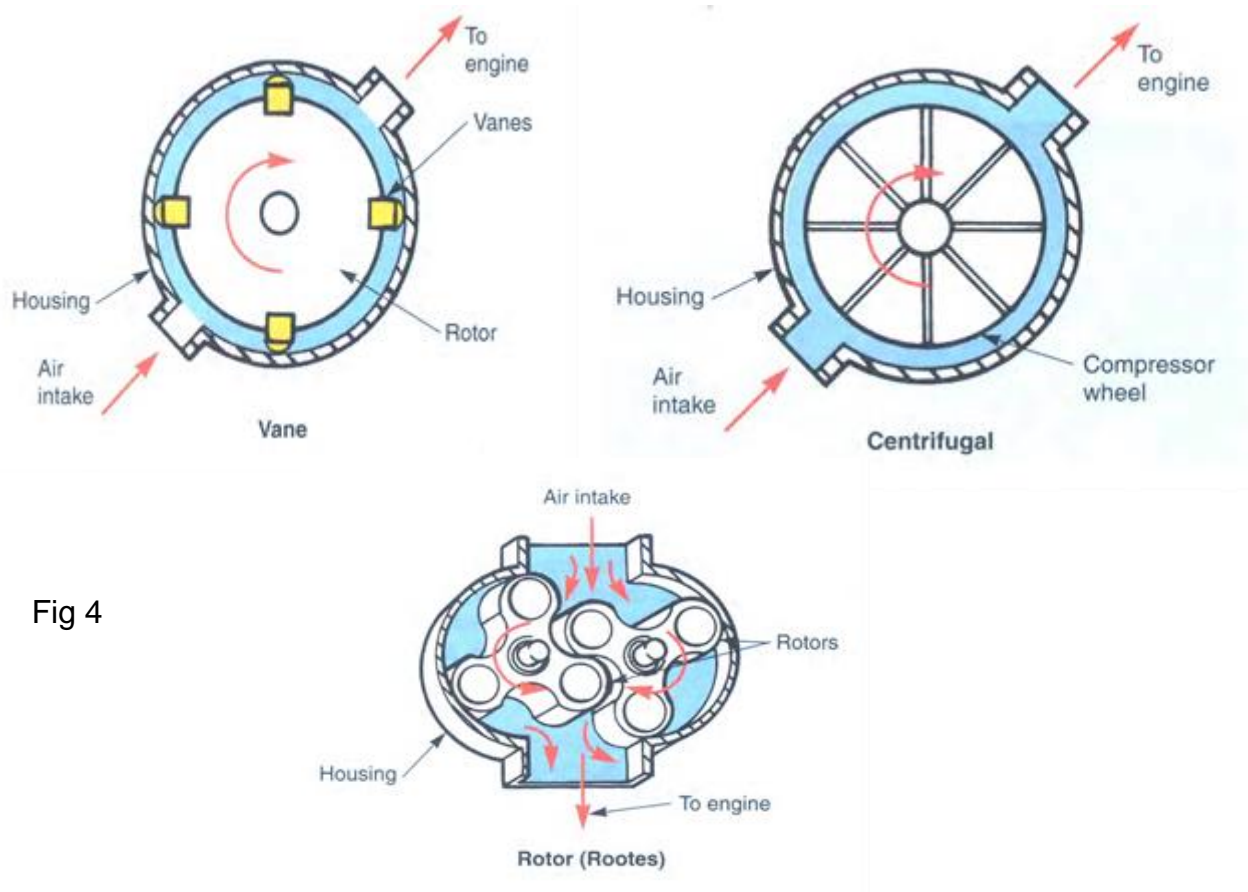
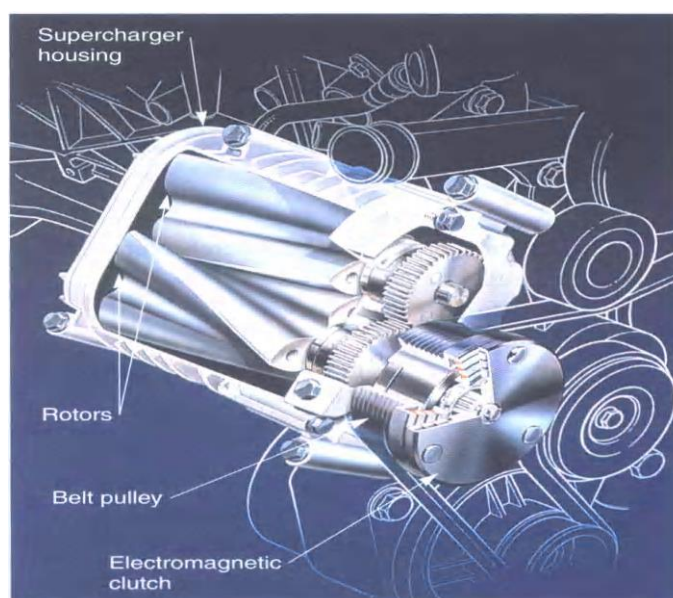


Fig 4

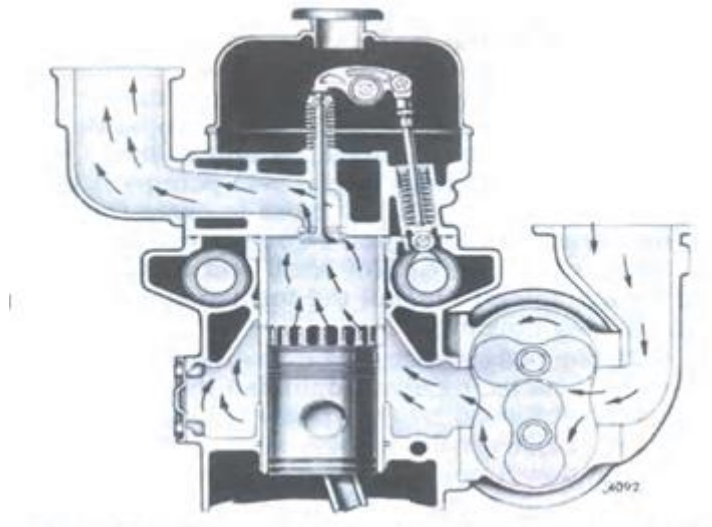
An **electromagnetic clutch** is sometimes used to disengage the drive belt from the blower. It works like an air-conditioning compressor clutch to save energy when additional power is not needed. (Fig. 5). Alternatively, the blower will be driven mechanically by means of the timing gears of the engine.

Fig 5



A positive displacement rotary blower, driven by the engine, compresses the air into an air chamber surrounding the intake ports to scavenge the engine from burnt gasses (Fig. 6).

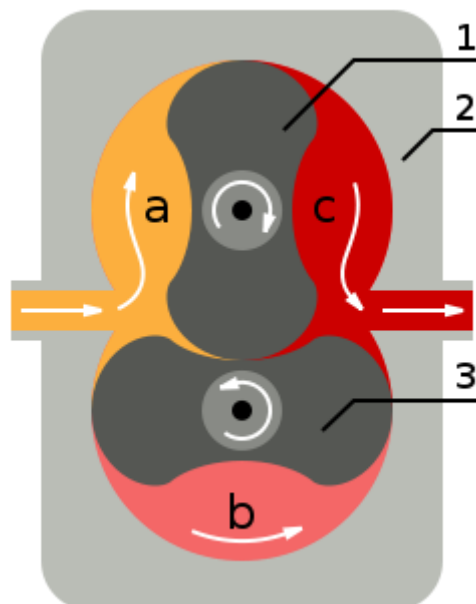
Fig 6



Construction

- The operation of the blower is similar to that of a gear-type oil pump.
- The hollow three-lobe rotors revolve within very close clearances in housing.

Fig 7

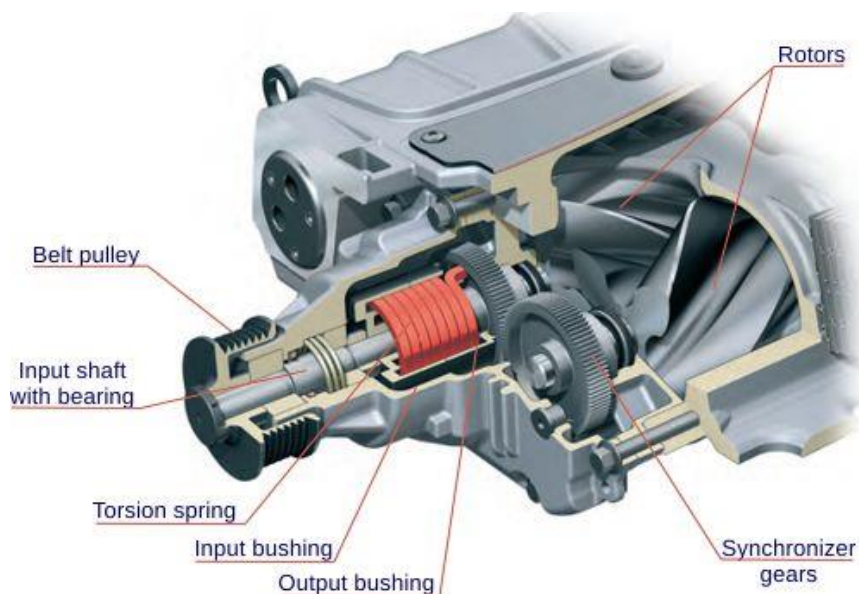


A Roots blower with two-lobed rotors. Most real Roots blowers' rotors have three or four lobes. (Fig 7)

Key:

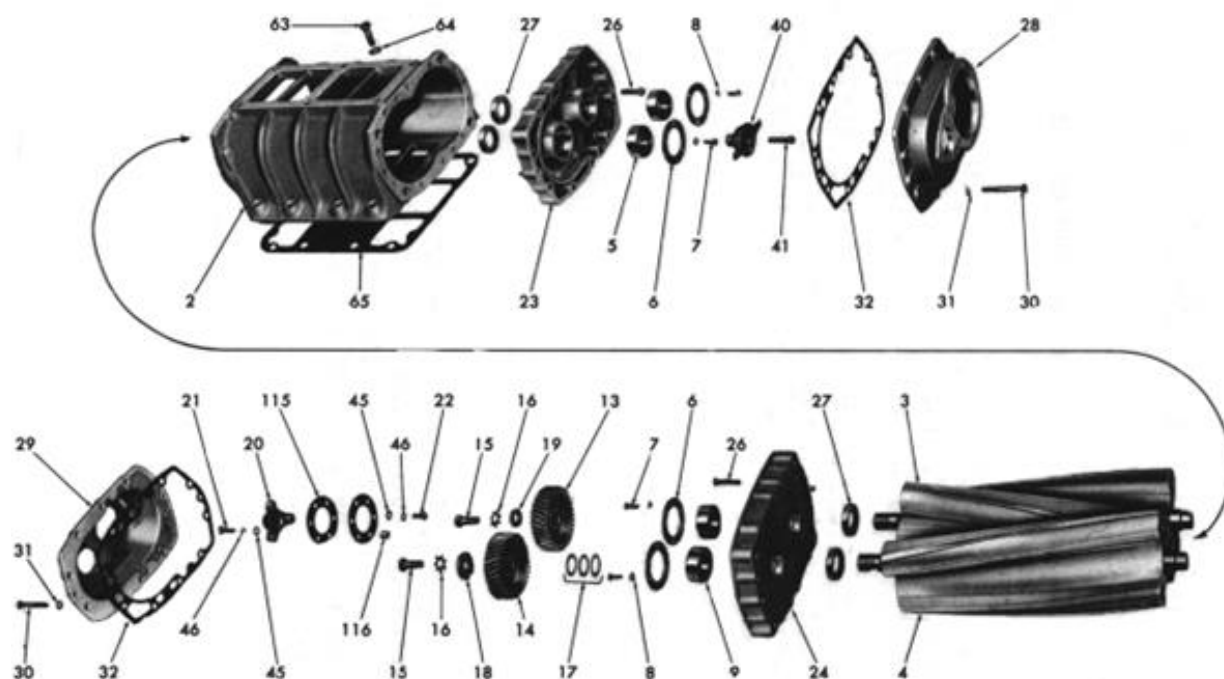
1. Rotary vane
 2. Pump body
 3. Rotary vane
 - a. Intake
 - b. Pumping
 - c. Forced air or air-fuel mixture into intake manifold
- The basic Roots blower consists of three major subassemblies: an oval housing, a pair of rotors and associated bearings, gears and seals, and two end covers.
 - The rotors are geared, one to the other, and turn in opposite directions in the housing, supported in antifriction bearings in the end covers.
 - Each rotor consists of a steel shaft with (usually) three lobes surrounding it. These are generally twisted along their length and are known as helical rotors (see Fig .5). Rotors with two lobes only are also used in some blowers.
 - Although designed to pump air, the blower rotors are not fitted with seals, but rely on the precise and limited clearances between the rotors themselves and between the rotors and the housing.
 - 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 upper and lower rotors do not touch at any time, no lubrication is required. (Fig 8)

Fig 8



Exploded view of blower (Fig 9)

Fig 9



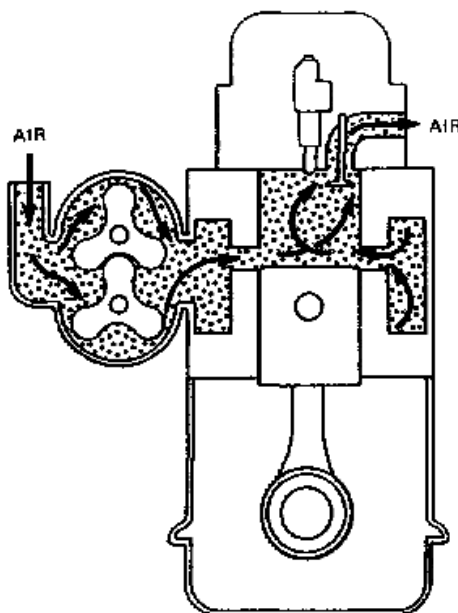
The names of the numbered parts in Fig 9 are:

| | | |
|--------------------------|--------------------------|----------------------------|
| 2. Housing—Blower | 3. Rotor--Blower—Upper | 4. Rotor—Blower Lower |
| 5. Bearing (Roller) | 6. Retainer—Bearing | 7. Bolt—Bearing |
| 8. Lock Washer | 9. Bearing (Ball) | 13. Gear--Rotor |
| 14. Gear--Rotor | 15. Bolt--Rotor Gear | 16. Lock Washer--Belt |
| 17. Shim-Gear to Bearing | 18. Disc--Fuel Pump | 19. Washer—Rotor |
| 20. Hub-Rotor Drive | 21. Bolt—Plate | 22. Bolt—Plate |
| 23. End Plate—Front | 24. End Plate—Rear | 25. Pin (Dowel) |
| 26. Bolt--End Plate | 27. Oil Seal--End Plate | 28. Cover--End Plate |
| 29. Cover--End Plate | 30. Bolt--End Plate | 31. Lock Washer |
| 32. Gasket--End Plate | 40. Coupling Assembly | 41. Bolt--Allen Head |
| 45. Plain Washer | 46. Lock Washer | 64. Plain Washer |
| 65. Gasket—Blower | 115. Plate--Blower Rotor | 116. Spacer--Plate to Gear |

OPERATION

- The air between adjacent lobes is carried to the outlet as the rotors turn, where it is forced from the valley by the re-entry of the meshing lobe. This creates the discharge and pressurisation of the air.
- In order to eliminate the typical pulsating action associated with a gear or lobe pump, the helical rotors are used and provide a continuous and uniform air displacement from the blower. (Fig 10)

Fig 10

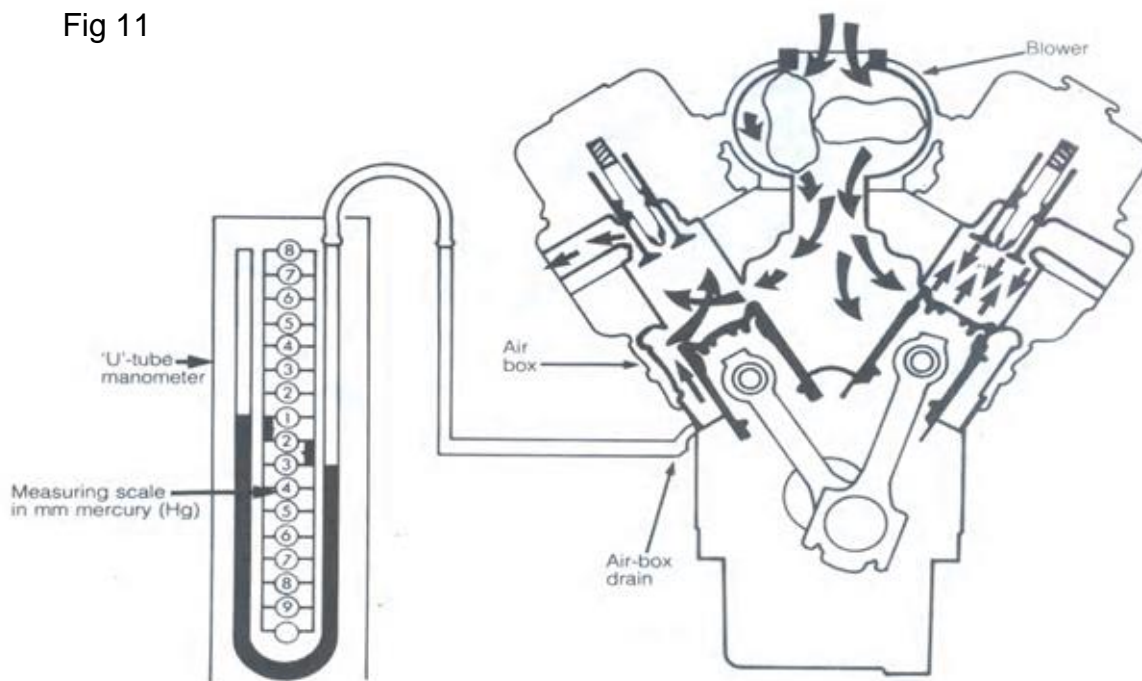


- Blowers fitted to two-stroke diesel engines rotate at approximately twice engine speed.
- The rotor gears have to be timed to each other, otherwise the required clearance between the rotor lobes will not be maintained, and damage to the lobes and engine can occur.
- Due to normal wear, the running clearances will alter and may have to be adjusted during the blower's service life. To alter this clearance, the helical drive gears are shim adjusted.
- Because the rotor lobes turn within close tolerances and never contact one another, no form of lubrication is necessary within the blower housing.
- However, the support bearings and timing gears at the end of the rotors need constant lubrication from the engine lubrication system
- To prevent engine oil from entering the rotor compartment, lip or piston-ring-type oil seals are fitted within the blower end plates to separate the two sections of the blower and prevent the entry of oil into the air chamber (Fig .9)

SERVICING A BLOWER

- A faulty supercharger will exhibit many of the same symptoms described for a faulty turbocharger: lack of power, blue engine smoke, abnormal noises, etc.
- If the engine lacks power, measures boost pressure by connecting a pressure gauge to a fitting on the intake manifold. If boost is low, check the bypass actuator, which controls the supercharger boost pressure, (Fig 11)
- When in service, the efficiency of the blower is checked by measuring the discharge pressure by means of a mercury-filled manometer—a 'U'tube device that indicates pressure by means of the difference between fluid levels in the arms of the tube (Fig 11).
- To check blower output (or air-box pressure), connect the manometer to an air-box drain, usually located on the lower side of the cylinder block, just below inlet-port level. (The air box is the compartment that surrounds the tangential ports area of the cylinder liners.)

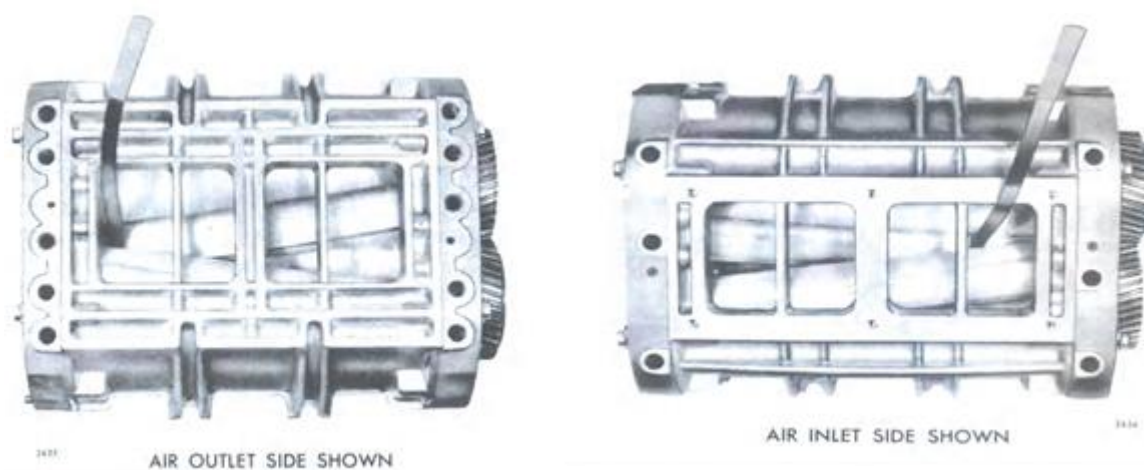
Fig 11



- To carry out a static inspection of the blower, the air inlet housing and safety screen leading into the blower inlet must be removed.
- The safety screen is a wire gauze screen located at the blower inlet to prevent the entry of foreign objects during engine operation.

- The rotors should be examined for evidence of contact by visually checking the edges of the rotor lobe crowns and mating rotor roots for signs of scoring or contact wear marks.
- At the same time, the drive gear backlash should be checked by mounting a dial indicator on the blower housing with the indicator probe perpendicular to, and in contact with, the side of the lobe.
- The backlash is measured by moving the rotor in one direction and then the other within the limits of the gear teeth clearance (the second rotor must not move).
- The allowable backlash is generally 0.1 mm, and if this is exceeded, the blower drive gears will have to be renewed. (Fig 12)

Fig 12

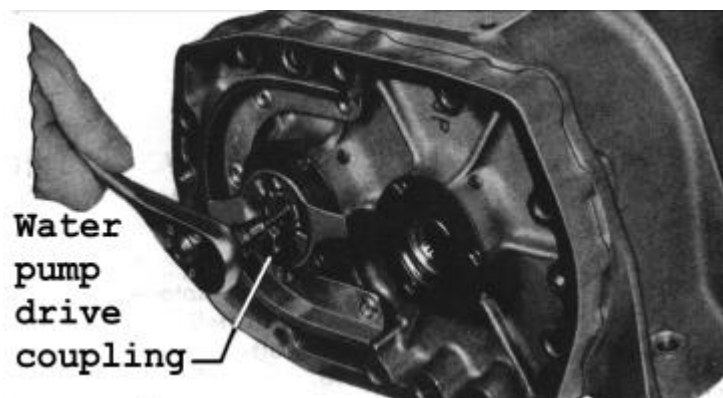


- During an inspection, oil on the blower rotors indicates leaking rotor shaft oil seals, which may be the result of worn rotor bearings, worn seals or lip-type seals that have been turned inside out due to the closure of the emergency shutdown flaps during high-speed engine operation.
- The emergency shutdown flap is a shutter mounted on the inlet to the blower, which, when operated, closes off the air supply to the blower (and engine), thereby stopping the engine. The emergency shutdown flap is to be used only in an emergency when the normal method of engine shutdown is inoperative.
- Finally, the safety screen should be checked for signs of damage and, after the emergency shutdown flap has been refitted, the latch checked to ensure that the flap remains open during engine operation.

DISMANTLING THE BLOWER

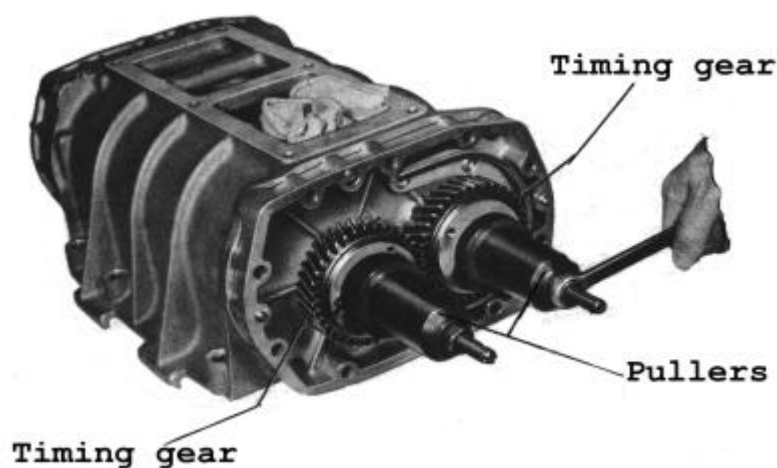
- When disassembling, inspecting and reassembling a blower, the appropriate workshop manual should always be used. However, as a guide to procedures, a general description of overhauling a blower fitted to a Detroit Diesel Allison 'V' series 71 engine is detailed below.
- After the governor assembly and fuel feed pump have been removed from the blower, the drive gears are ready to be pulled off the rotor shafts. (Fig 13)

Fig 13



- By placing rag between the two rotor lobes to prevent the rotors from turning, unscrew and remove the Allen-headed bolts retaining the drive gears.
- Mount a suitable puller and remove both drive gears together— because they are helical gears, pulling one alone will cause partial rotation of one rotor against the other. (Fig 14)

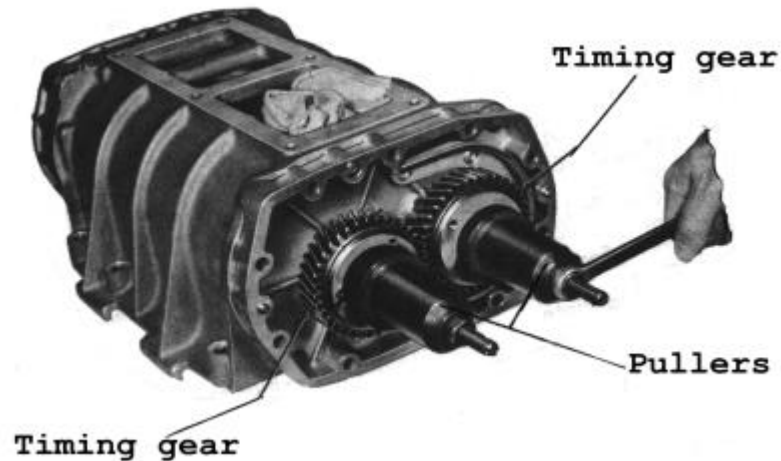
Fig 14



- Also remove the spacer shims from behind the gears and mark the gears and shims to ensure correct positioning of parts on reassembly.

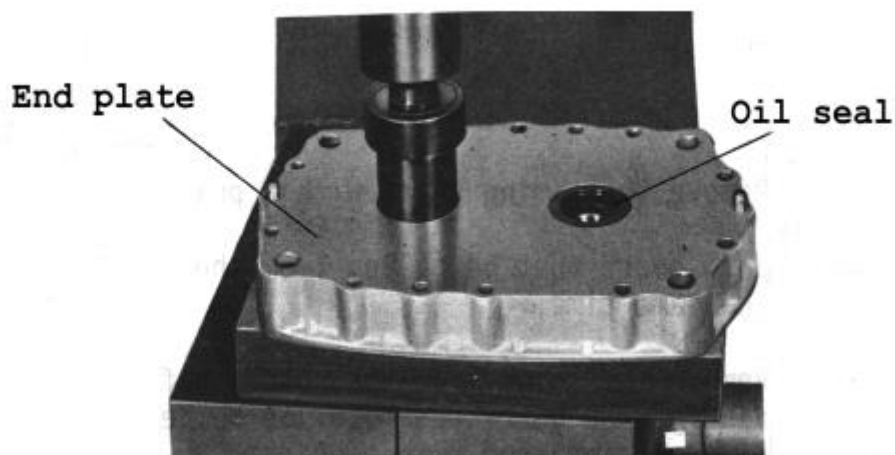
- Remove the bearing retainer bolts and retainers for all four bearings and, with the aid of a puller, remove the rear end plate and bearing assembly. (Fig 15)

Fig 15



- Repeat the procedure for the front end plate.
- Next, remove the two rotors from the blower housing.
- With the aid of a press, remove the bearings and oil seals from both end plates.
- The following main steps must be followed. For more details refer to your Workshop Manual.
- Remove the end plate covers from the front and rear end plates. (Fig 16)

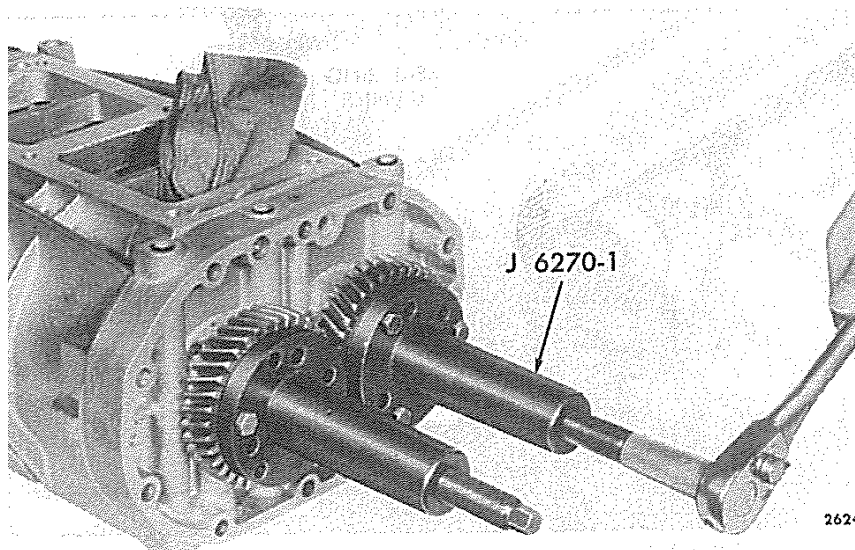
Fig 16



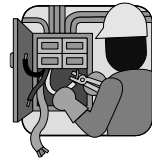
- Remove the drive coupling.
- Remove the drive hub.
- Remove the timing gears with a puller.
- Withdraw the blower rotors from the housing.
- Remove the oil seals and bearings from the end plates.

NB: Both gears must be pulled from the rotor shaft at the same time (Fig 17)

Fig 17



- Remove the shims from the rotor shafts or the inner face of the gears and note the number and thickness of the shims used with each gear.
- Remove the bearing retainers.
- Remove the blower end plates with a puller.



PRACTICE

Take the blower and by referring to your Notes and the Workshop Manual, dismantle it.

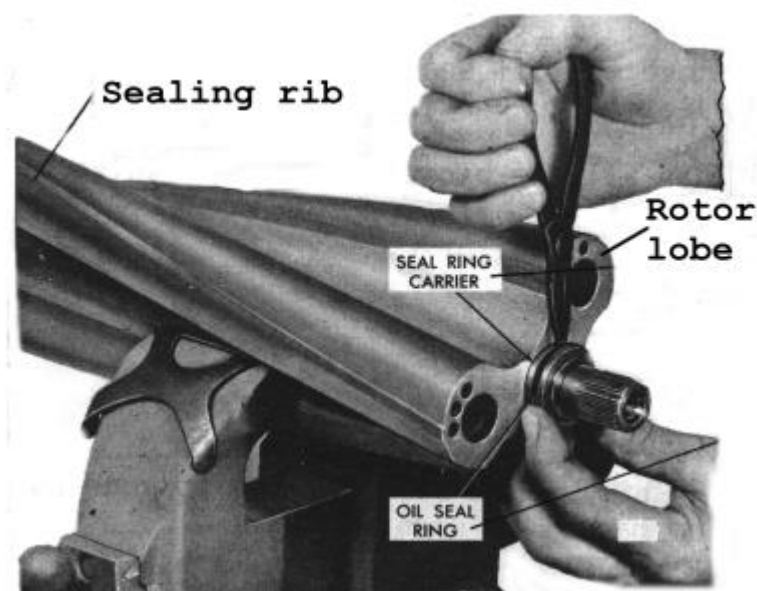
Call your Training Officer to check your work. When you have achieved the required standards, ask him to sign below before you go to the next section.

| LEARNER | TRAINING OFFICER |
|----------------|------------------|
| Date: | Date: |
| Signed: | Signed: |

ASSESSMENT OF COMPONENTS (Fig 18)

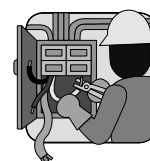
- Prior to inspection, all the blower components should be washed in a suitable cleaning solution and dried off with compressed air.
- All the parts of the blower should be examined and measured to determine whether they should be reused.
- Examine the bearings for any indication of corrosion, pitting or any rough spots.
- Check if the oil seals are scored or hard.
- The rotor lobes should be examined for burrs and scoring, especially on the sealing edges.
- Witness marks along the full length of the lobe usually indicate worn bearings or excessive backlash in the timing gears.
- Small imperfections on the lobe or rotor roots can be removed with fine emery tape.
- The internal surface area of the blower housing and the blower end housings should be checked for scoring. My fine score marks can be removed with fine emery tape.
- Deep score marks will necessitate replacement of the housing. The blower end housings should also be replaced if necessary.

Fig 18



- Examine the rotor shaft serrations for wear, burrs, or peening.
- Inspect the inside surface of the blower housing for burrs and scoring.

- Check and finished ends of the blower housing for flatness and burrs.
- Check the finished inside face of each end plate for flatness and burrs.
- Examine the serrations in the blower timing gears. Also check the teeth for wear, chipping or damage.
- NB: If the gears are worn to the point where the backlash, between the gear teeth exceeds 0,01 mm, they must be replaced.



PRACTICE

Assess all the parts of the dismantled blower, write down the names of all the parts which must be replaced and state the reason..

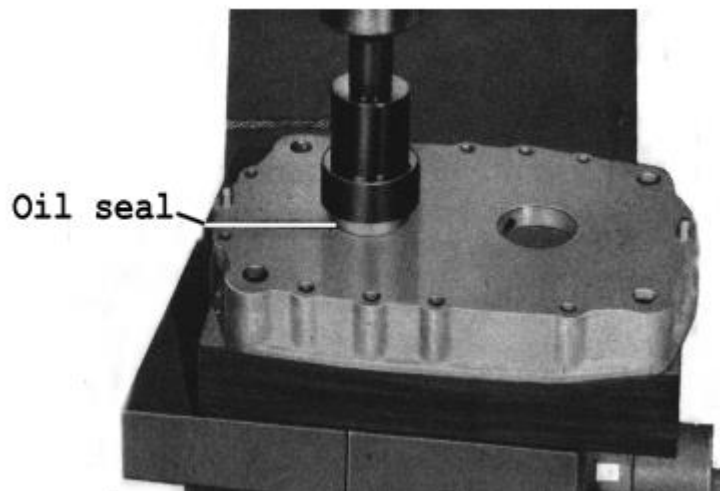
Call your Training Officer to check your work. When you have achieved the required standards, ask him to sign below before you go to the next section.

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| Date: | Date: |
| Signed: | Signed: |

ASSEMBLING THE BLOWER

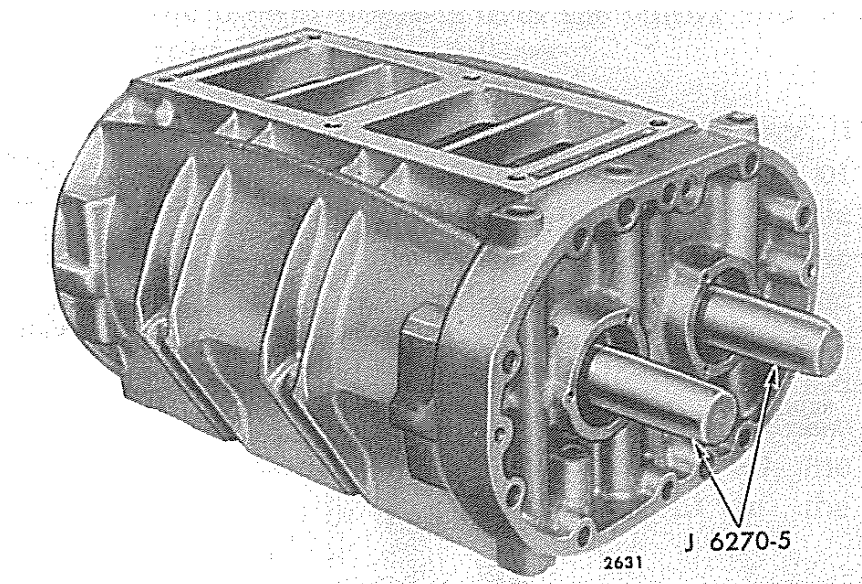
- The assembly procedure as described below is that for a typical blower with lip-type oil seals sealing the rotor shafts (some blowers use other types of seal). (Fig 19)

Fig 19



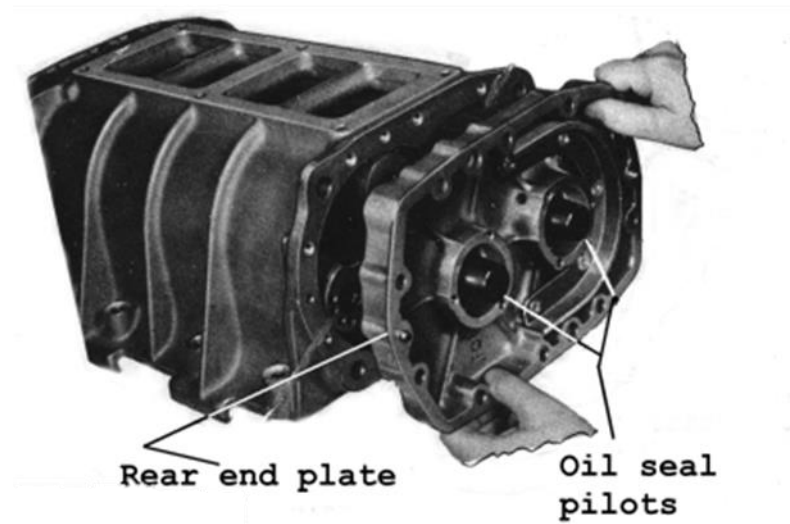
- Before installing the rotors, establish where the driving rotor is to be placed in the blower housing relative to the drive shaft coming from the engine.
- The driving rotor lobe and its associated drive gear are identified by the way they both form a right-hand helix. The driven rotor lobe and drive gear form a left-hand helix.
- Match the rotors together so that the master splines (omitted serrations) lie in a horizontal position and face the left when looking at the rear of the blower (non drive end). (Fig 20)

Fig 20



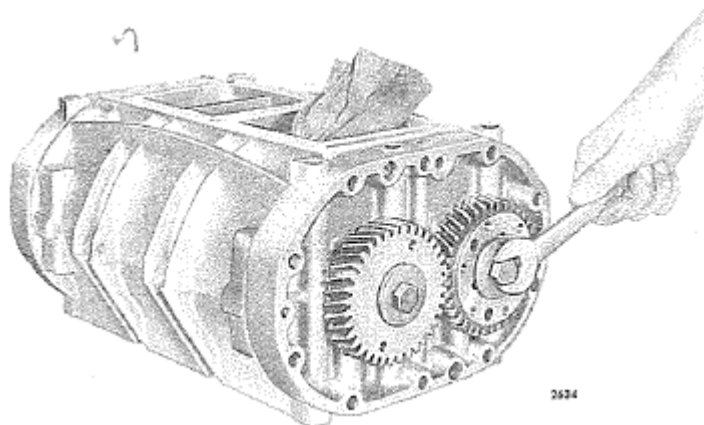
- Install the rotors into the blower housing and fit the rear end plate. (Fig 21)

Fig 21



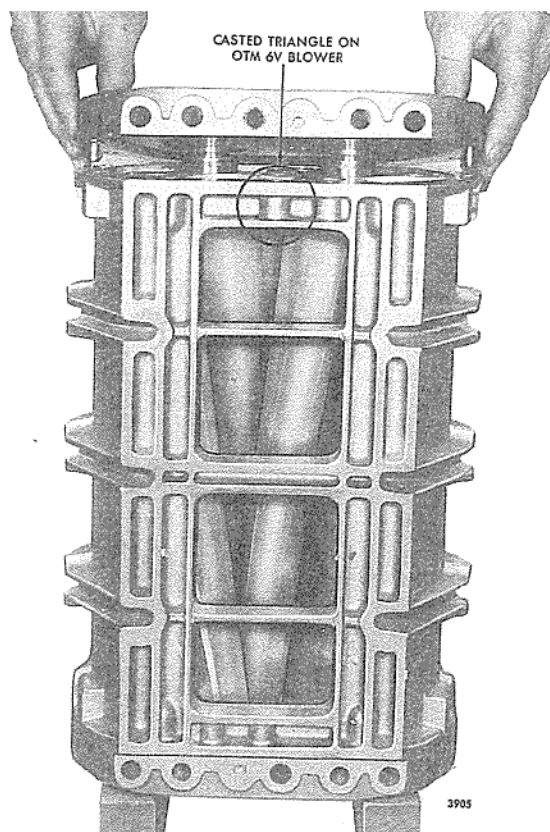
- Reposition the assembled blower into a vertical position and, with its housing and rotor shafts supported, install the rotor shaft bearings.
- After all the bearings have been fitted, reinstall the drive gear spacer shims on their respective shafts.
- The drive gears can now be refitted to the shafts, taking note that the left- and right-hand helical gears are matched to their corresponding rotor lobes, and that the master splines on the rotor shafts and drive gears are in alignment with one another prior to the gears being pressed on.
- With rag placed between the rotor lobes to prevent them from turning, the drive gears can be pressed onto the shafts by means of a puller bolt screwed into the end of the blower shaft. (Fig 22)

Fig 22



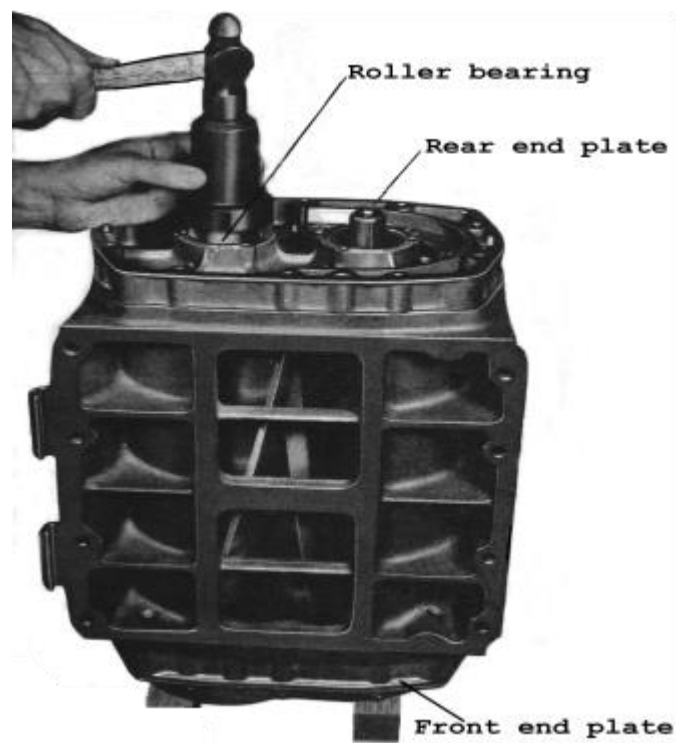
- As with removal, the gears must be installed together, to prevent rotation of one in relation to the other.
- With the end plates bolted up and the drive gears installed, the rotors can be timed to each other.
- During operation, the rotor lobes run with a slight clearance between them. This clearance can be adjusted by moving either one of the helical drive gears on the rotor shaft in or out relative to the other gear. (Fig 23)

Fig 23



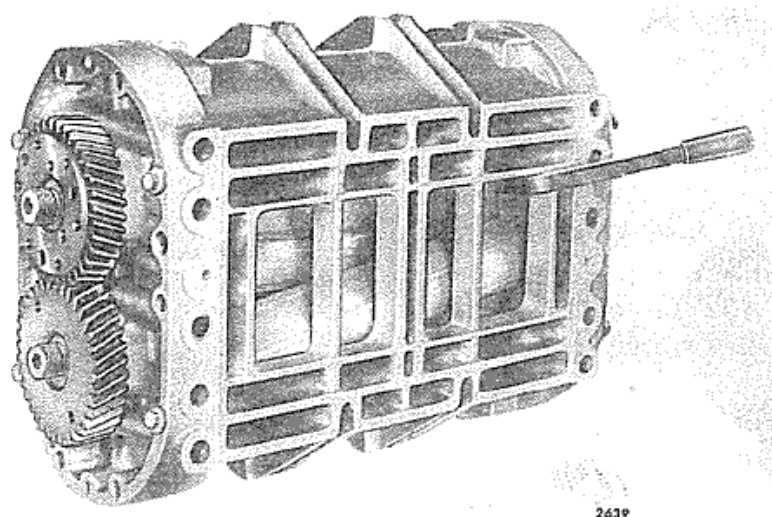
- The positioning of the drive gears is determined by addition or removal of spacer shims from between the gears and bearings.
- During the blower timing procedure, if the left-hand helix gear is moved in, the left-hand rotor lobe will turn counter clockwise (CC) and if the right-hand helix gear is moved in, the right-hand rotor lobe will turn clockwise (C)
- Refit the ball bearings on the rotor shaft and in the rear end plate. (Fig 24)
- Refit the bearing retainers, bolts and lock washers. (Fig 24)

Fig 24



- Make a preliminary check of the rotor-to-end plate and rotor to housing clearances. (Fig 25)

Fig 25

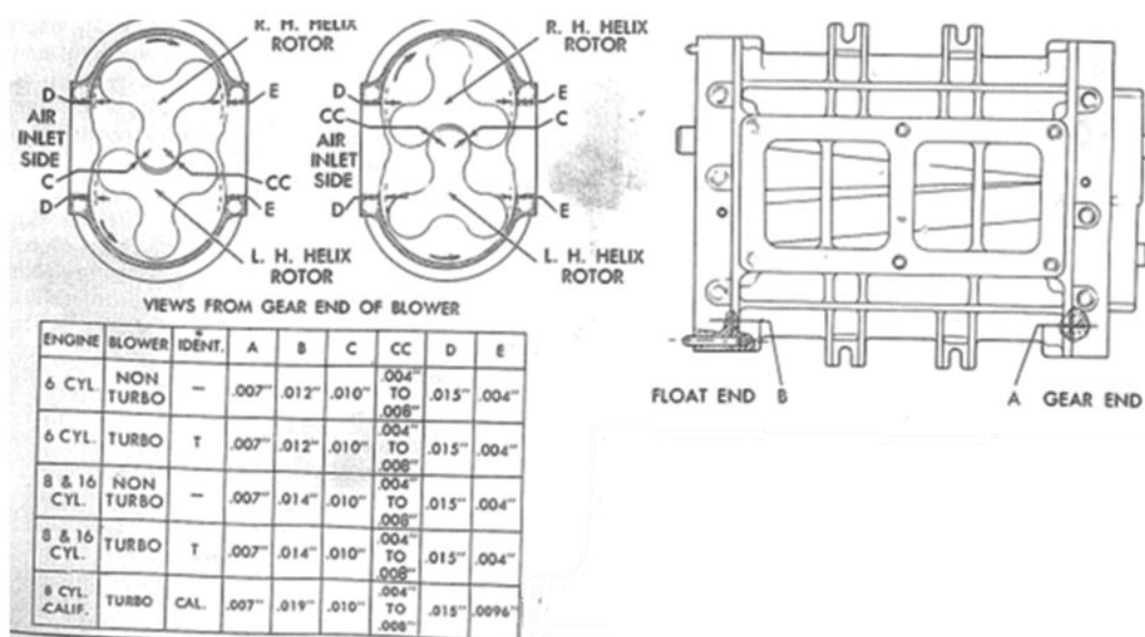


- For more details refer to the Manual.
- Install the timing gears.

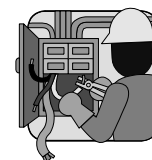
- Time the blower rotors.(Fig 26)
- Replace the drive hub.
- Replace the drive coupling.

NB: Time the rotors to dimension specifications for clearances between trailing side of R/H Helix Rotor and leading side of L/H Helix Rotor (cc) from both inlet and outlet side blower.

Fig 26



PRACTICE



Assemble the blower by referring to your Notes and the Workshop Manual.

Call your Training Officer to check your work. When you have achieved the required standards, ask him to sign you off.

| LEARNER | TRAINING OFFICER |
|---------|------------------|
| Date: | Date: |
| Signed: | Signed: |



REMEMBER ALWAYS WORK SAFE

Once you have passed all practices, you are now at liberty to request a Formative Assessment from your Assessor.