SECTION 3

AIR SYSTEM

Contents

3.0000
AIR SYSTEM SPECIFICATIONS

AIR CLEANER

Type	Manufacturer
Standard - Oil Bath	A.C.
Heavy Duty - Centrifugal/Oil Bath	A.C.
Marine - Wire Mesh	A.C.

TURBOCHARGERS

Type	Manufacturer
FO1	CAV
3LD	HOLSET

Bearing End Float (CAV)	0.1 mm - 0.3 mm (0.004" - 0.012")
Piston Groove Thrust Wear (CAV)	0.1778 mm (0.007") maximum clearance
Shaft Concentricity Test (CAV)	0.005 mm (0.0002") maximum eccentricity
Clearance Between Turbine Blades and Exhaust Outlet (CAV)	0.2794 - 0.6096 mm (0.011" - 0.024")

TORQUE WRENCH DATA

Manifold retaining bolts	18-20 Nm (13-15 lb ft)
Turbocharger Impeller (CAV)	14 Nm (10 lb ft)
Shaft Nose Nut (CAV)	11 Nm (8 lb ft)
Turbine Casing Bolts (CAV)	8.5 Nm (75 lb in)
Compressor Casing Bolts (CAV)	8.5 Nm (75 lb in)
Locknut (Holset)	17.6 Nm (13 lb ft)
Compressor Casing Bolts (Holset)	6.8 Nm (5 lb ft)
V Clamps Locknut (Holset)	13.6 Nm (10 lb ft)

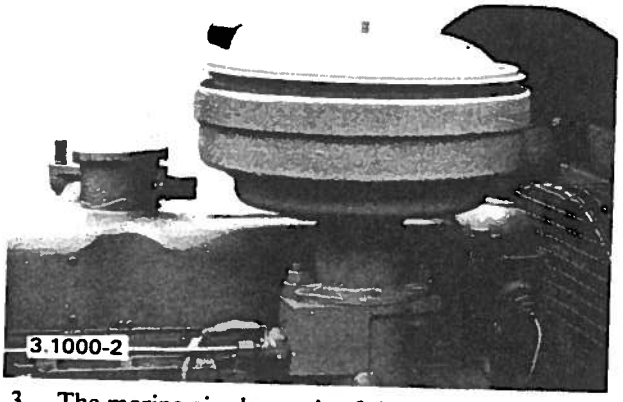
3.1000

AIR CLEANER

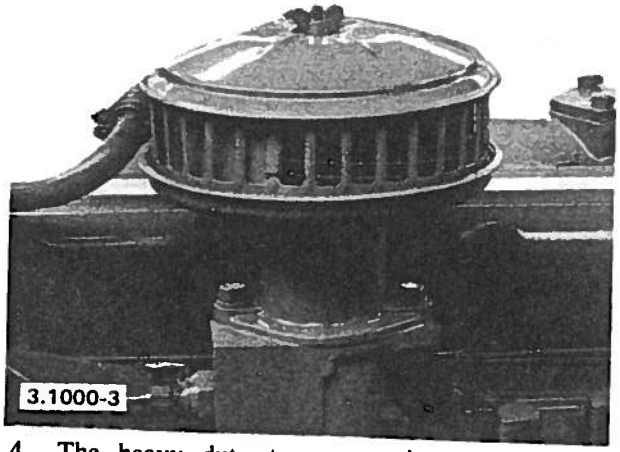
AIR CLEANER (Description)

1. There are three types of air cleaners fitted to the 220/330 cu. in. engines – standard, marine and heavy duty. The cleaner is mounted onto the inlet manifold or venturi assembly and secured with a clip.

2. The standard air cleaner is of the oil bath type comprising an oil bath, filter element, seal ring, cover and retaining nut.

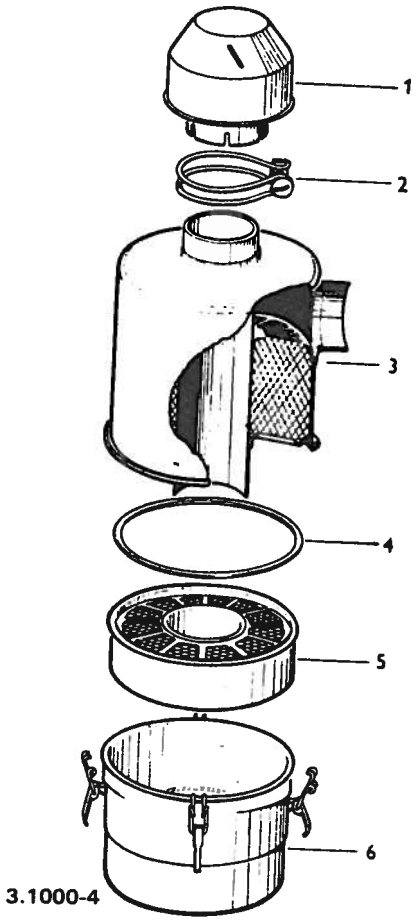


3. The marine air cleaner is of the wire mesh type and is fitted the same as the standard duty air cleaner.



4. The heavy duty type comprises a main body containing a fixed filter element, a detachable oil bath, filter element and centrifugal pre-cleaner. These are arranged so that air entering the intake manifold first passes through three separate stages of filtration.

5. Entering the centrifugal pre-cleaner at the top of the air cleaner assembly, a whirling motion is imparted to the ingoing air. A high proportion of the dust particles in the air are thrown outwards, by centrifugal force to the periphery of the casing where it is ejected through the two outlet slots. After leaving the centrifugal casing, the whirling motion of the air stream is converted to a straight directional flow by vanes and it passes down the central tube in the main body of the air cleaner.



1. Centrifugal pre-cleaner
2. Clip
3. Main body & Fixed filter element
4. Gasket
5. Detachable filter element
6. Oil Bath

6. On reaching the lower end of the central tube, the air impinges on the surface of the oil contained in the oil bath at the base of the air cleaner and the air flow is then deflected upwards to the lower (detachable) wire mesh filter element. Heavy particles of dust are deposited directly into the oil while lighter particles are trapped by the filter element and subsequently washed back into the oil bath by oil which is carried upward into the filter with the air stream. To ensure that the later stages of cleaning are effective, it is essential that the correct grade of oil, see paragraph 19, is contained in the oil bath and that it is maintained at the level marked on the inside of the oil bath casing.

7. After passing through the lower filter element the air is finally filtered by the fixed element in the main body of the air cleaner.

AIR CLEANER (Removal)

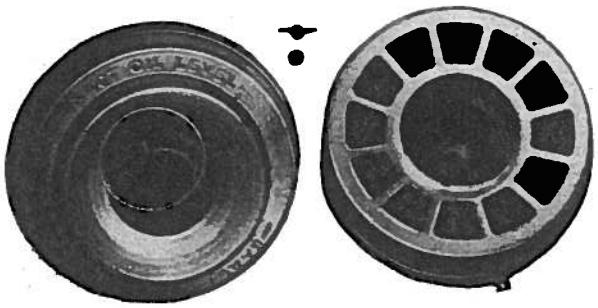
8. Detach the crankcase ventilator pipe, where fitted, and the support bracket from the air cleaner.
9. Slacken the securing clip and lift away the air cleaner from the inlet manifold or venturi assembly. Ensure the cleaner is kept vertical to avoid spilling the oil.

AIR CLEANER (Inspection and Overhaul)

10. Air cleaners should be cleaned at least every one hundred hours or at more frequent intervals, depending on the operating conditions.

Standard Duty Air Cleaners

11. Remove the nut and lift off the cover and gasket. Lift out the filter element and rinse in clean paraffin. Blow out the element to remove all traces of cleaning fluid. Drain the oil from the oil bath and clean out any sediment. Check the condition of the gasket and renew if necessary. Refill the oil bath, with one of the recommended lubricants on page 3, to the level indicated and install the filter element, gasket and cover.



3.1000-11

NOTE: It is not necessary to re-oil the filter element as this is done automatically when the engine is running.

Marine Air Cleaner

12. Unscrew the wing nut at the top of the cleaner and remove the cover and filter element. Rinse the element in clean paraffin (Kerosene) and shake it to remove all traces of paraffin (Kerosene).
13. Replace the element and refit the top cover.

Heavy Duty Air Cleaner

14. Slacken the clip securing the centrifugal pre-cleaner to the main cleaner, and remove any dust or foreign matter from the side of the cowl, and the vanes in the inlet tube.
15. Remove the detachable bottom element and oil container by releasing the four toggle clips fitted around the rim of the oil container. Lift out the element and rinse in clean paraffin (Kerosene). When clean, allow the element to drain thoroughly. Drain the oil from the oil bath and, if necessary, remove any sludge which may have accumulated in the base. Refill the oil container with fresh oil to the level indicated on the case. For recommended oil see paragraph 19.

Note: It is important to ensure that the paraffin (Kerosene) used in cleaning the filter has completely dried off before re-assembling. Failure to observe these precautions may lead to uncontrolled racing of the engine caused by the paraffin or oil being drawn into the air supply.

16. It is not necessary to re-oil the element as this is done automatically when the engine is running. When installing the element ensure that the gasket fitted on top of the flange is in good condition and correctly located.
17. Depending on the operating conditions it will be necessary to periodically clean out the upper element, which is attached inside the main body. To do this remove the main body from the engine and after dismantling the oil container and element, wash the main body in a container of clean paraffin (Kerosene), draining thoroughly before reassembly.

AIR CLEANER (Refitting)

18. Place the air cleaner back onto the inlet manifold or venturi assembly. Refit the crankcase ventilation pipe and then retighten the air cleaner securing clip.

Recommended Lubricants

UNITED KINGDOM

19. The order in which the following recommended brands are listed does not imply any preference. All lubricants shown are equally recommended.

BP	CASTROL	DUCKHAMS	ESSO	GULF	MOBIL	REGENT	SHELL
Energol SAE 50	Castrol Grand Prix	NOL 50	Essolube 40/50	Gulflube 50	Mobiloil B.B.	Havoline 50	Shell X-100 50

OVERSEAS

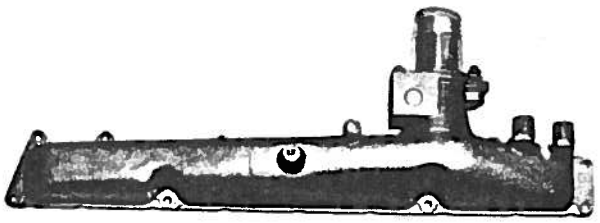
TEMPERATURE RANGE	SAE VISCOSITY No.	GM SPECIFICATION No.
Above 0°C (32°F)	50	4602-M or 4506-M
Below 0°C (32°F)	20	4603-M or 4501-M

3.3000

AIR INLET MANIFOLD

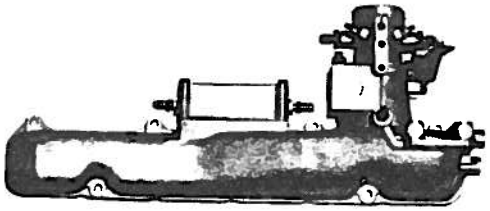
AIR INLET MANIFOLD (Description)

1. The air inlet manifold is an aluminium casting with an inlet onto which the air cleaner adaptor is fitted.



3.1000-1

2. The air cleaner can be directly mounted to the air cleaner adaptor, or remotely mounted with hoses of suitable diameters.
3. A tapped hole in the boss, situated on the inlet is provided to take the cold starting aid igniter. When a cold start aid is not required the orifice is fitted with a plug.
4. On some 220 cu. in. engines a pneumatically governed fuel injection pump is used, where this occurs a venturi is fitted between the air cleaner and the manifold inlet port in place of the air cleaner adaptor, and a damping chamber is located on top of the manifold.



3.3000-4

AIR INLET MANIFOLD (Removal)

5. Remove the air cleaner as described in section 3.1000 and the breather pipe as described in 4.8000.
6. Disconnect the throttle and idling controls from the linkage on the venturi.
7. Disconnect the pipes from the pneumatic governor, venturi and damping chamber.
8. Plug the ends of the pipes and fuel pump governor to prevent ingress of foreign matter.

NOTE: On no account must the engine be rotated or started when the governor pipes are disconnected as no control on the engine speed can be exercised. Should the engine be inadvertently started under these conditions, pull the stop control knob on the instrument panel or the stop lever at the side of the governor, and hold in the stop position until the engine ceases to run.

9. Remove the securing nuts and washers and lift away the manifold.

AIR INLET MANIFOLD (Inspection and Overhaul)

10. Examine the manifold for cracks especially around the attaching flanges. Check the manifold joint face for distortion. Slight bowing of the face can be corrected by placing the manifold on a flat block of hard wood and applying light blows with a hide hammer. Correct local distortion with a fine cut file.

3.3000-10

AIR INLET MANIFOLD (Refitting)

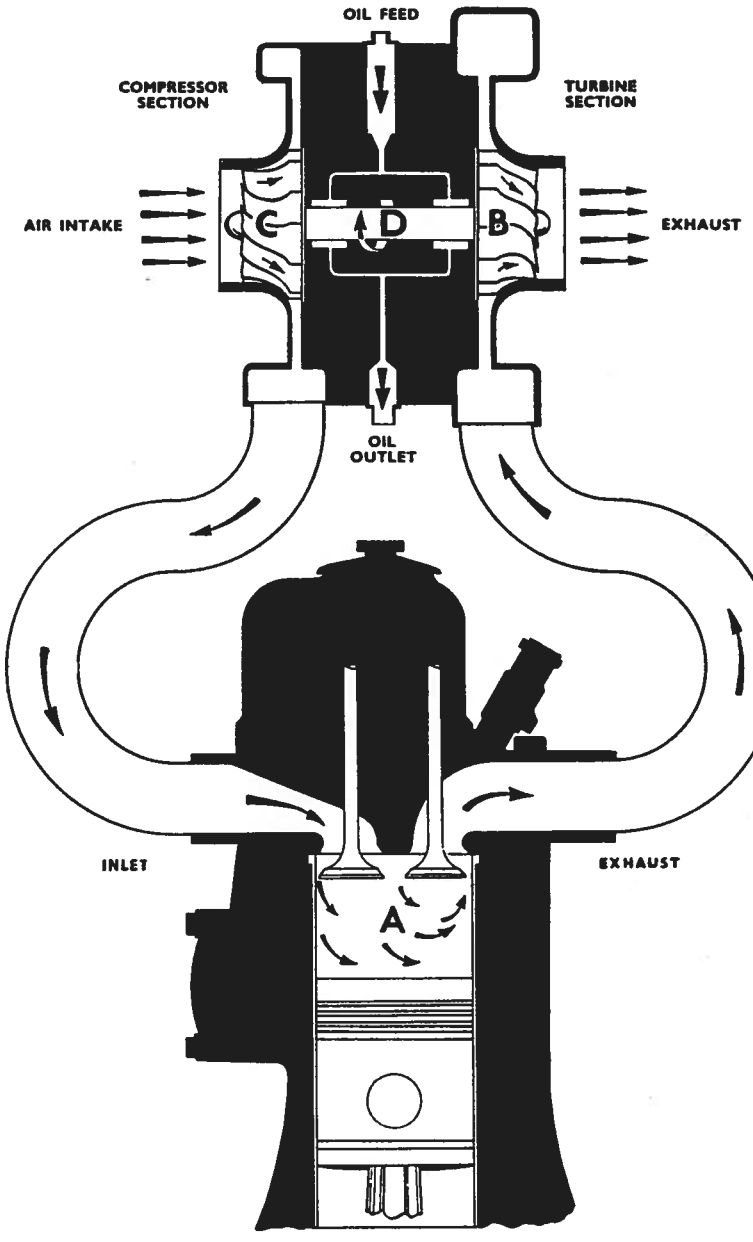
11. Replace the manifold onto the cylinder head ensuring that the faces are clean and tighten the nuts to a torque of 13-15 lbs. ft.
12. Remove the plugs from the fuel pipes and reconnect the pipes to the filter, venturi and damping chamber where fitted.
13. Reconnect the throttle linkage and replace the air cleaner and breather pipes as described in 3.1000 and 4.8000 respectively.

3.5000

TURBOCHARGER

TURBOCHARGER (Description)

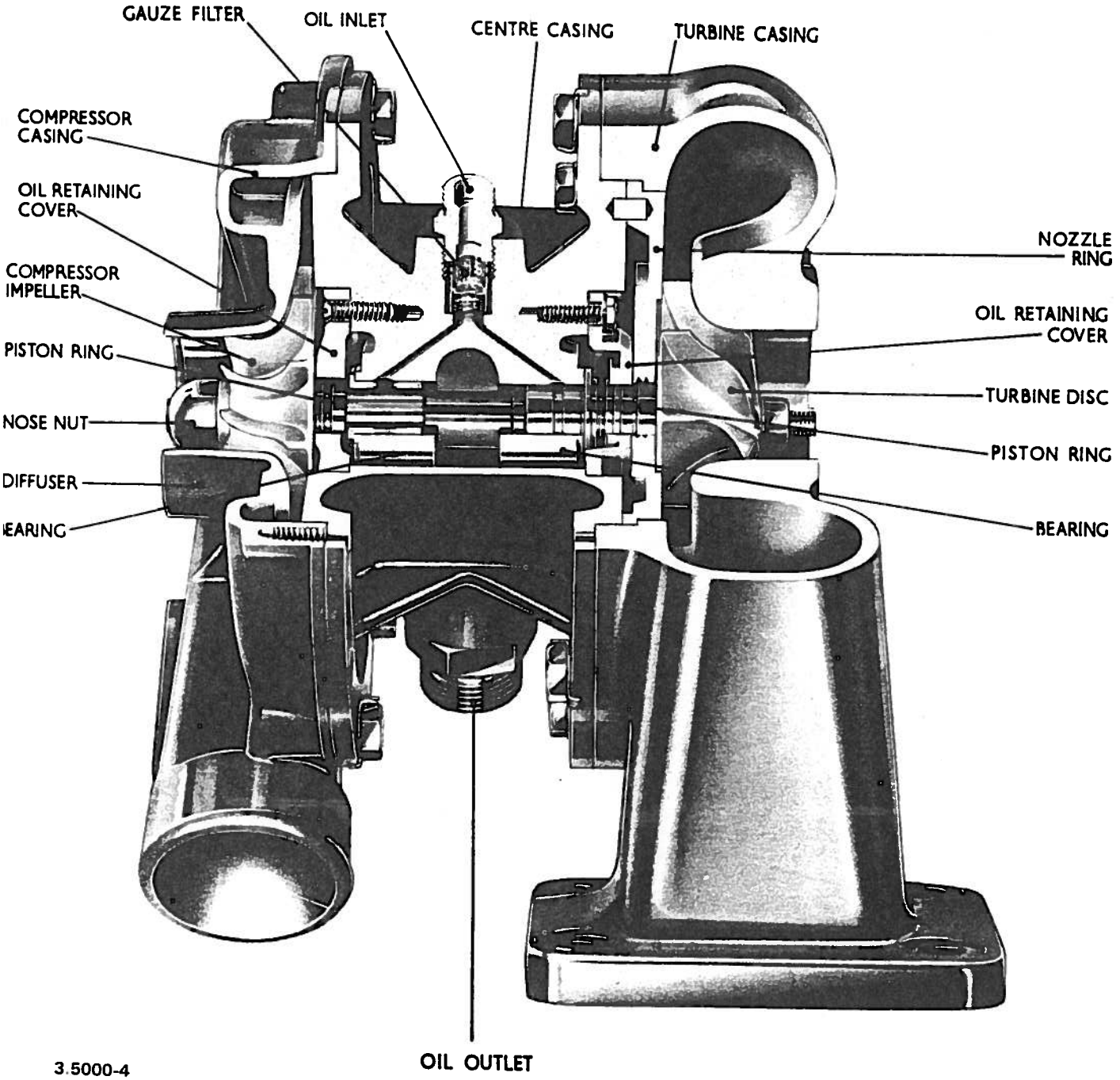
1. Two types of turbocharger are fitted to 330 cu. in. engines. Up to serial number P & I 4665 a CAV turbocharger was used and at P & I 4666 a turbocharger manufactured by Holset Engineering Co. was introduced.
2. Turbochargers are mounted on the exhaust manifold of the engine and obtain their motive power from the exhaust gases expelled by the engine cylinders.
3. The turbine rotor (B) and the compressor rotor (C) are mounted on a common shaft (D). As the turbine is driven by the exhaust gases it drives the compressor rotor which delivers air under pressure to the engine. More air is fed to each cylinder (A), and therefore more fuel can be burnt in a given time than would be possible in a normally aspirated engine. This results in a proportionate increase in engine power.



3.5000-3 DIESEL ENGINE CYLINDER

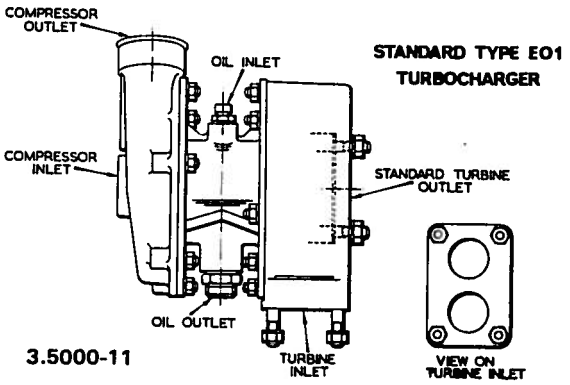
CAV TURBOCHARGER

4. The turbocharger casing comprises an aluminium or iron centre casing, a compressor housing of aluminium, a backplate and a turbine housing of chrome iron. The centre casing carries the rotating assembly and is interposed between the compressor and the turbine housing.



3.5000-4

5. The rotating assembly consists of a compressor turbine, drive shaft and exhaust turbine. The drive shaft and exhaust turbine being permanently fixed together.
6. High precision plain, fully floating bearings are used to mount the rotating assembly in the centre casing.
7. The bearings are lubricated and cooled by the engine oil system. Oil under pressure enters the turbocharger at the inlet union and is directed via a chip tray to each bearing via a gauze filter and an orifice washer. The oil is then drained back into the engine sump.
8. Between the centre casing and turbine casing is the nozzle ring, which is a flat plate fitted with vanes for deflection of exhaust gases. The angle at which the vanes are inclined is of a critical value varying according to the type of turbocharger and is included in the type symbol.
9. The nozzle ring also functions as a gas baffle to prevent gas entering the centre casing. The bore of the nozzle ring through which the drive shaft passes is grooved to form a gas seal.
10. Oil retaining covers at each side of the centre casing prevent the ingress of oil from the centre casing to the turbine and compressor casings. The piston rings fitted to the drive shaft, located in the bores of the oil retaining covers.
11. The inlet and outlet connections for the exhaust gases and charging air, and lubricating oil are shown in the next column.



12. An air cleaner is fitted to the air intake of the turbochargers, which has a capacity 50% greater than that used on the normal aspirated engines.

CAV Type Symbol Explanation

Example E 01 A 77 A 5 51

Design Change Letter

Basic Size

Rotor Assy & Turbine Casing (See Flow Table)

Nozzle Vane Angle in Degrees (Also stamped on nozzle ring)

Radial Position of Turbine Casing (See Figure 3.5000-78)

Radial Position of Compressor Casing (See Figure 3.5000-104)

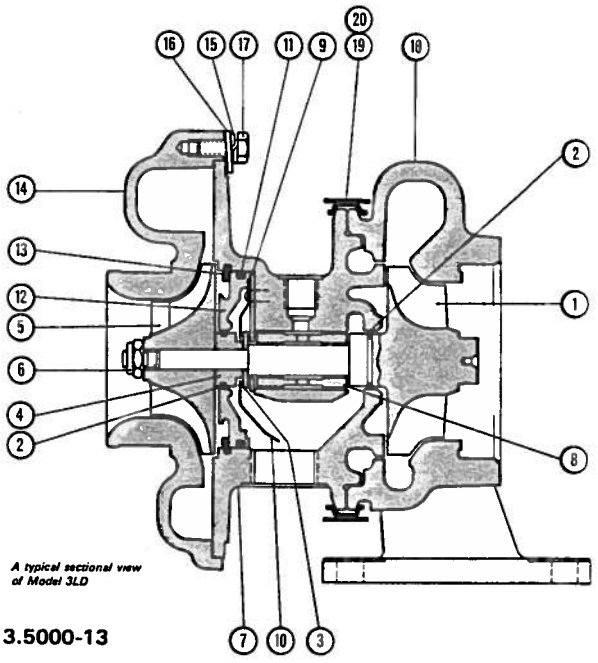
Symbol Number—Special Features

Flow Table

Compressor Casing Flow	Number of Turbine Entries and Flow Sizes								
	0000			000			00		0
	Large	Standard	Small	Large	Standard	Small	Large	Standard	Small
Large		Q		V	P		U	N	
Standard		C	J	E	B	H	O	A	G
Small		M	T		L	S		K	R

HOLSET TURBOCHARGER

13. The Holset turbocharger is a robust and durable unit capable of giving high performance for many thousands of hours if the manufacturers simple recommendations are observed.



A typical sectional view of Model 3LD

3.5000-13

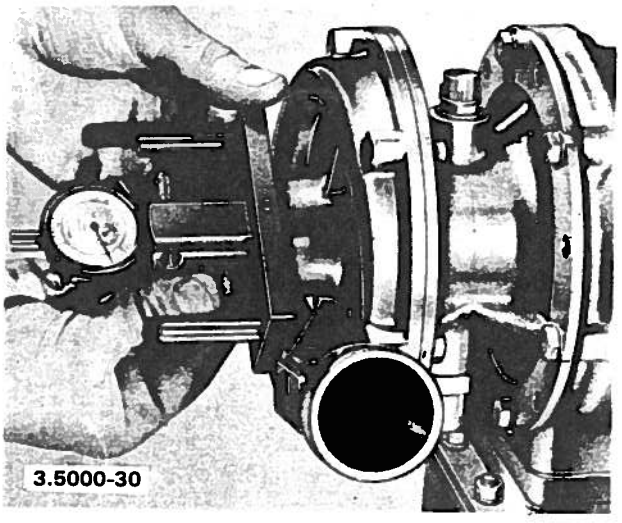
1. Shaft & Turbine Wheel Assembly
2. Piston Ring
3. Thrust Ring
4. Spacer Sleeve
5. Compressor Wheel
6. Locknut
7. Bearing Housing and Pin Assembly
8. Bearing
9. Thrust Plate
10. Oil Deflector
11. 'O' Ring
12. Insert
13. Retaining Ring
14. Compressor Cover
15. Lockwasher
16. Washer
17. Bolt
18. Turbine Housing
19. 'V' Clamp
20. Locknut–'V' Clamp

14. The compressor wheel and turbine wheel are fixed at opposite ends of a common shaft which rotates in a central bearing. The complete rotating assembly including thrust and sealing arrangements is known as the rotor assembly and is designed to rotate at speeds up to 120,000 revolutions per minute under normal conditions.
15. Welded together to form a single part, the shaft and turbine wheel is dynamically balanced as a combined unit. The compressor wheel is made as a separate component and is also dynamically balanced. A new compressor wheel can, therefore, be fitted to any new turbine wheel and shaft assembly without special balancing equipment, although it is advisable to check balance rotors after long service or possible damage.
16. Also mounted on the shaft is a thrust ring and grooved sleeve which accommodates a sealing ring at the compressor end. A piston ring type oil seal is provided at the turbine end.
17. Oil is supplied to the bearing from the engine lubricating system and enters the bearing housing at 'A' (Fig. 3.5000-13) draining back to the engine sump at 'B'.
18. The bearings are fully floating and the stability of the rotor assembly is maintained throughout its speed range by the oil films formed between the bearing, the shaft and the housing. Stabilising forces are generated upon the establishment of oil pressure and commencement of rotation; while the unit is stationery, however, a certain amount of play can be felt in the rotor which is normal.
19. Each turbocharger manufactured by Holset is individually tested on specially designed equipment. In view of the high rotational speeds the turbocharger housing is designed to retain a burst rotor, although the design of the bearing system would normally prevent the rotor reaching burst speed in service. There is, therefore, an adequate safety margin.

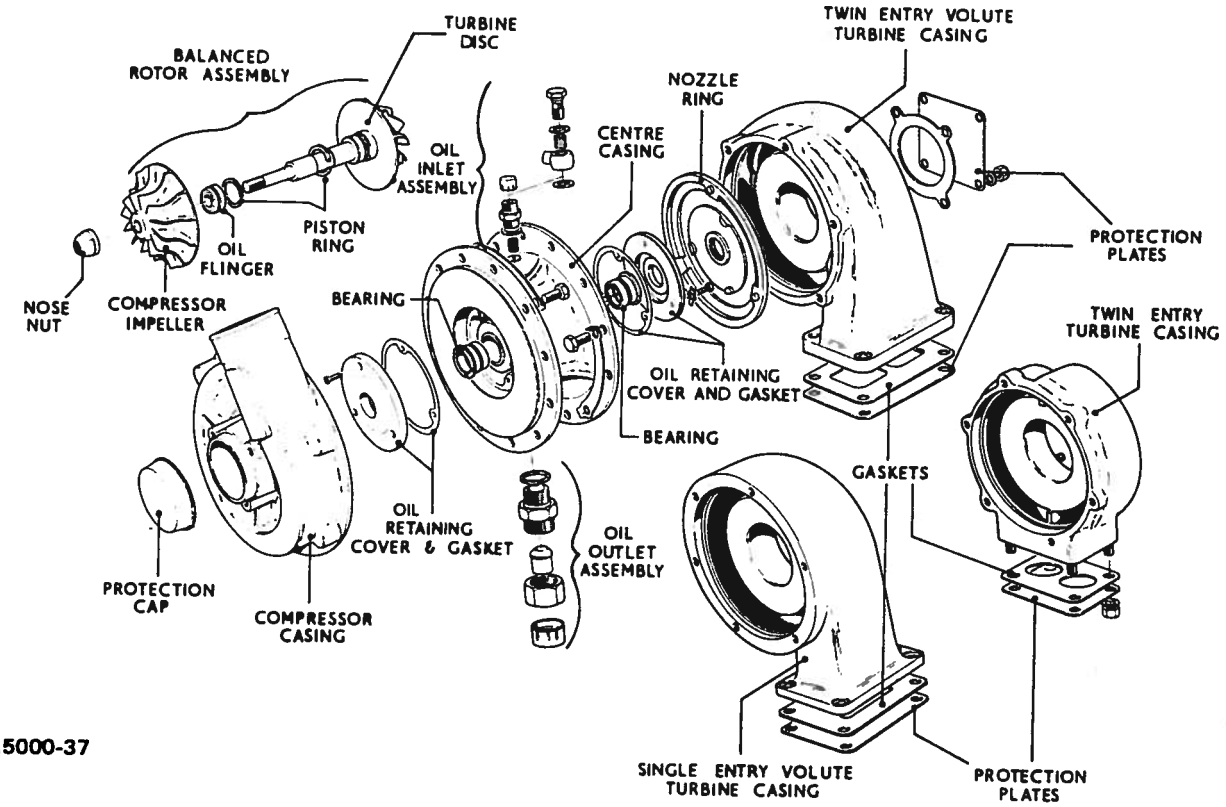
Turbocharger (Removal)
20. On marine engines, disconnect the breather pipe between the air cleaner and crankcase, by releasing the clips around the connecting hose, and then remove the air cleaner by releasing the clip attaching the air cleaner to the turbocharger.
21. Unscrew the banjo bolts to release the oil inlet pipe from the top of the turbocharger and also the two nuts securing the oil drain pipe.
22. The pipe connecting the turbocharger to the inlet manifold should next be removed. This is accomplished by releasing the two clips on the hose at the turbocharger end and securing nuts at the inlet manifold end.
23. On a marine engine, remove the two bolts which secure the turbocharger to its mounting bracket.
24. Finally, the four bolts securing the turbocharger to the exhaust manifold should be removed.

Turbocharger (Inspection and Overhaul)
25. Due to the simplicity of a turbocharger, very little maintenance is required between overhaul periods, which should be carried out every 3,000 hours under normal running conditions.
26. At this stage, the turbocharger should be completely dismantled and inspected as described below, however, the following routine checks should be carried out when the engine is undergoing its normal servicing.
27. Ensure that the air filter is thoroughly cleaned out. Dirty air filters cause restricted air flow and subsequent loss of performance. In severe cases the depression caused in the turbocharger casing due to the restricted air cleaner can be high enough to pull oil from the bearings, resulting in poor lubrication and excessive engine oil consumption.
28. Check all turbocharger hoses and pipe connections for air and exhaust leaks as these can result in reduced performance.
29. Ensure engine oil filter elements are changed regularly and that the oil supply lines to the turbocharger are in good condition and not leaking at unions. In conjunction with the oil filter element change, remove, clean and refit the gauze from the turbocharger oil inlet.
WARNING A turbocharger runs at very high speed and the bearings require a constant supply of clean oil for lubrication and cooling. Therefore, before starting an engine, after an oil change, or whenever the oil supply has been disconnected, it is essential that the turbocharger oil lines and filters are primed. Unless this action is taken, oil starvation and subsequent bearing failure will result. At normal working conditions of the engine, the lubricating oil feed pressure should never be allowed to fall below 30 psi.

CAV Turbochargers
30. Every 1500 hours a bearing check should be carried out in situ. This can be carried out on CAV turbochargers with an end float gauge, part number 7244-7, in the following manner.

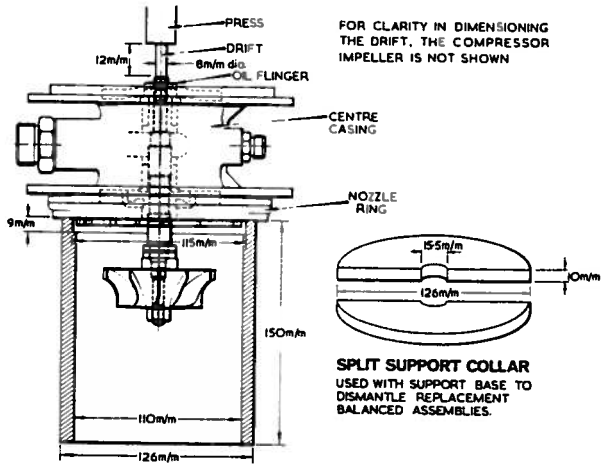

3.5000-30

31. Screw the plunger to the end of the drive shaft. Press on end of plunger, to take up end float of shaft, towards turbine end.
32. Fit the body and plate, (legs away from turbocharger) over the plunger so that the aperture in the body locates over the tapping provided for the plunger lifting screw.
33. Fit the lifting screw.
34. Ensure that the dial gauge arm is touching the end of the plunger and that the clamp screw is tight.
35. Zero dial gauge.
36. Move the plunger axially by means of the lifting screw and note the gauge reading which must be between 0.004″–0.012″ (0.1mm–0.30mm). If end float exceeds maximum limits, the bearings are worn and must be replaced.
37. The following illustration will be of assistance in overhauling the CAV Turbocharger.



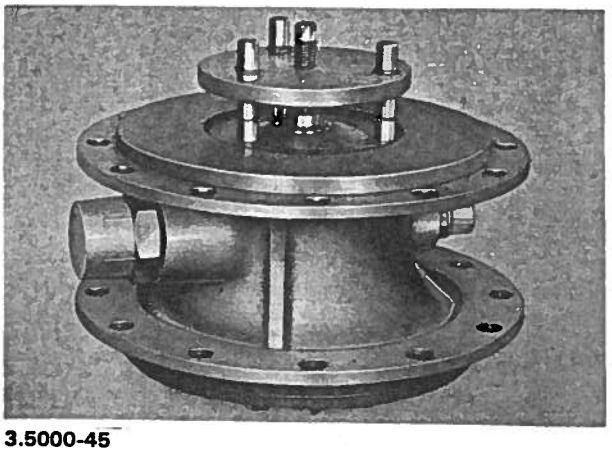
3.5000-37

38. Place the turbocharger on a bench and remove the six bolts and locking tabs from the compressor casing.
39. Remove the compressor casing. To avoid damage to the machined surfaces, sharp instruments must not be used to lever the flange faces apart. If necessary gently knock the casing with a hide mallet.
40. Remove the six bolts and locking tabs from the turbine casing. The turbine casing can be withdrawn by securing three 1'' UNF bolts into the three tappings on the periphery of the centre casing. Gradual and even tightening of the bolts will lift the turbine casing away from the centre casing. On some earlier models the three tappings are not provided and the turbine casing should be gently knocked adrift with a hide mallet.
41. Hold the flats provided on the turbine disc or the end of the drive shaft in a vice and unscrew the compressor nose nut, using a special spanner CAV part number 7144-907.
42. Place the centre casing into a suitable support base and using a suitable drift, press out the drive shaft from the compressor impeller. Place a soft rag under the turbine disc to prevent damage.



3.5000-42

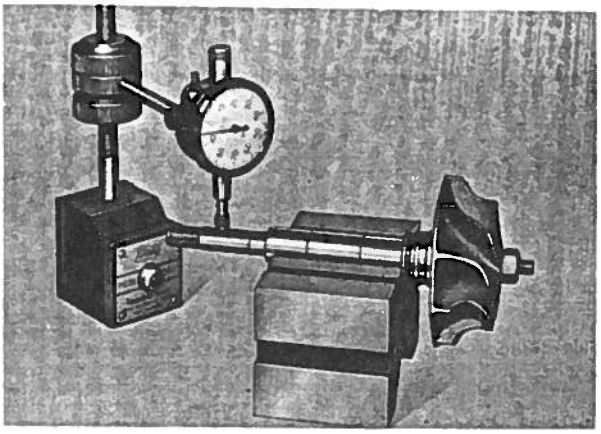
43. Remove the piston ring from the turbine end of the shaft. Carefully lever off the nozzle ring, which is held by dowels, from the turbine side of the centre casing. Place the centre casing into a vice and remove the oil outlet and inlet unions together with the inlet orifice, washer and filter.
NOTE: The centre casing must be held in the vice by the centre section not by the outer flanges.
44. With the centre casing in the vice, release the locking tabs and remove the three bolts securing the turbine oil retaining cover. Reverse the casing in the vice, and remove the three screws securing the compressor retaining cover.
45. Remove the centre casing from the vice and place face down on the bench. Screw the three legs of special tool CAV Part Number 7144-922 into the three holes of the oil retaining cover at the compressor end and place the adaptor (part of the special tool) into the centre bore of the oil flinger. Screw the centre bolt against the plug and slowly withdraw the retaining cover.



3.5000-45

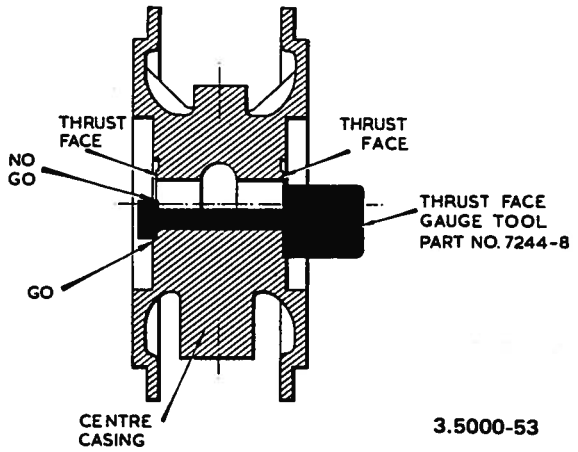
46. Remove the compressor end bearing and then hold the centre casing in the vice and remove turbine and oil retaining cover by using a suitable drift against the remaining bearing face. Discard both of the cover gaskets.
47. Having completely dismantled the turbocharger, all parts should be thoroughly washed, perferably in a proprietary brand of cleaning fluid. Highly carbonised parts may require soaking for 24 hours. All traces of grease must be removed before reassembly.
48. Visibly examine all parts for wear or fractures and renew where necessary.
49. The piston ring grooves of the drive shaft and oil flinger must be examined for thrust wear to the side faces. Thrust wear should only occur on the drive shaft groove furthermost from the turbine disc, and can be checked by the following method.
50. Using special tool (CAV part number 7244-11) insert a new, clean standard piston ring into the shaft drive groove. With the ring in a compressed position, insert a feeler gauge between the piston ring and the groove face. Check the reading at several positions. If the clearance exceeds 0.007'' in any position the complete balanced rotor assembly must be returned to CAV Limited for a modification to enable an oversize piston ring to be fitted. Assemblies with this modification have an 'X' stamped on the centre of the drive shaft for identification purposes. Such an assembly must be fitted with an oversize piston ring when an overhaul becomes necessary.
51. Check the compressor impeller and turbine disc for evidence of rubbing on the edges of the blades. Ensure that the impeller is a tight fit, on the drive shaft and that the shaft is free from corrosion. Check the shaft journals for score marks and surface wear. Carry out a

concentricity test as shown below. Maximum eccentricity must not exceed 0.0002" (0.005 mm). Renew the complete assembly if the figure exceeds this value.



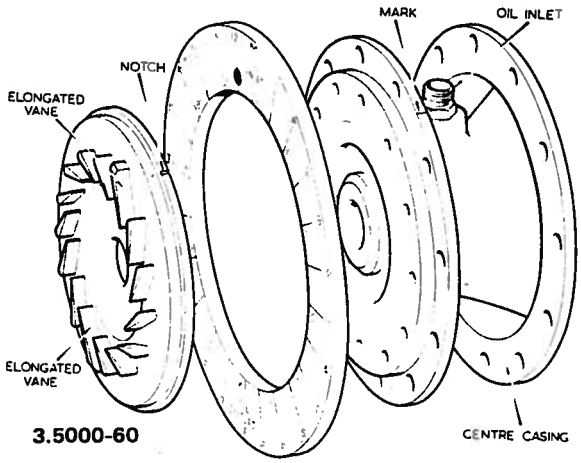
3.5000-51

52. Check for damage to the nose nut, shaft collar and oil flinger, also examine piston ring grooves for damage, as distinct from thrust face wear. If any part other than the piston ring is damaged or defective, the complete rotating assembly must be renewed. Rotating assemblies are supplied in the assembled form and must be dismantled before fitting to the turbacharger, using the split collar shown in Fig. 3.5000-45.
53. Check the centre casing for thrust face wear with the special tool, CAV part number 7244-8. Examine for evidence of rubbing of compressor impeller.



3.5000-53

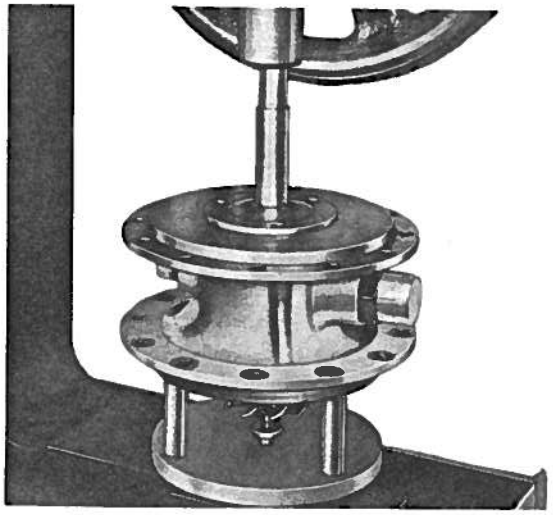
54. Check the compressor casing for signs of rubbing on intake radius and casing for signs of cracks.
55. Inspect the nozzle ring for cracks or distortion and replace if defective. The nozzle vane angle is stamped on the front face of the ring. When ordering a new ring ensure that the part number corresponding to the correct vane is given. Check gas seal bore with go/no-go gauge (part number 7144-906). The tolerance on the gas seal 0.957" Go, 0.964" No-Go. Clean the seal grooves with cleaning tool 7144-905.
56. Examine the turbine casing for heat cracks, particularly in the vicinity of the inlet dividing boss. Check the outlet radius for signs of rotor rubbing. If contact has taken place between the casing and rotor, both the casing and the balanced rotating assembly must be renewed.
57. Finally check the oil retaining covers and renew where necessary.
58. Place centre casing on a flat surface with the nozzle ring dowel holes uppermost. Using clean engine oil, lubricate each bearing surface and insert a new bearing into the turbine head of the centre casing bore. Ensure that the bearing is free to revolve.
59. Using a new oil retaining cover gasket, refit the spigotted oil retaining cover to the turbine side of the centre casing and secure in position with the three bolts and locking tabs.
60. Fit the casing positioning tool, part number 7244-4, to the turbine side of the centre casing, ensuring that the oil inlet and outlet marked on the tool, coincide with the inlet outlet on the centre casing.
NOTE: The large connection hole in the centre casing is the outlet.



3.5000-60

61. Ascertain from the type symbol stamped on the compressor cover outlet, the position code letter (e.g. E10A55B5SI). Fit the nozzle ring so that the notch on the circumference locates against the code letter marked on the tool. For two entry Volute type turbochargers, use letter marked on tool for Volute type. Remove tool after nozzle ring location.
62. Using tool 7244-11 fit a new piston ring on the drive shaft and where applicable to the oil flinger in the following manner.
63. Slide a new ring on the tapered end of the shaft.
64. Place the tool on the drive shaft or oil flinger so that the new ring is parallel to the piston ring groove on the shaft.
65. Gently push the piston ring into the groove, using a knurled ring to achieve a steady pressure. Ascertain the correct size of the piston ring beforehand. When the shaft is marked in the centre with an 'X', an oversize piston ring must be fitted (to turbine end only).
66. When fitting or handling piston rings, care must be taken not to distort them.

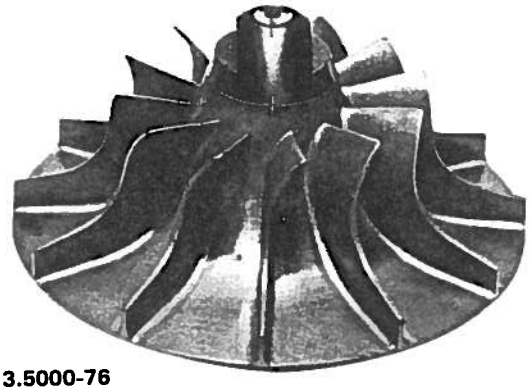
67. Fit the turbine and shaft into the turbine side of the centre casing.
NOTE: The piston ring must be centralised in its groove on the drive shaft before the shaft can be pushed fully home.
68. Place the centre casing on support base, part number 7144-937 and ensure that the adjustable stop on the support base is set so as to position the turbine and drive shaft **fully** into the centre casing.
69. Fit a retaining cover gasket to the centre casing.
70. With the bevelled edge uppermost, fit the oil flinger into the bore of the compressor end oil retaining cover. Place this assembly on the shaft and align the screw holes in the cover with those of the centre casing. Use tool 7144-936 to press the oil flinger and retaining cover into position.



3.5000-70

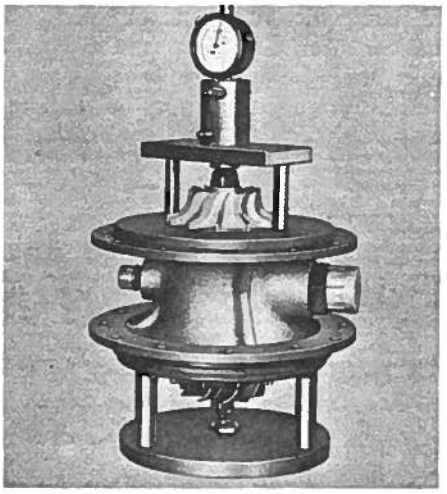
71. Screw the retaining cover down, using new screws which must be lightly coated with 'Loctite' grade 'D' or a compound of similar specifications.
72. The compressor impeller is an interference fit on the drive shaft and must be heated before fitting, if the impeller will fit without heating, it will be unfit for service.
73. Heat the impeller to 180·C (356·F) maximum and place it onto the drive shaft. Ensure that the scribed line on the end of the drive shaft is aligned with the scribed line on the impeller and ease the impeller fully home.
74. Screw tool, part number 7144-933 on to the drive shaft.
75. Remove the centre casing assembly from the support base and place into a vice holding the flats at the end of the drive shaft or turbine disc. If the drive shaft is provided with flats the assembly must be held in a vice by these flats and not by the securing nut. On models fitted with a nut, welded into position, it is permissible to hold the assembly by the flats on the nut. Insert a torque wrench and tighten the impeller to a torque of 10 lbs. ft. Remove the torque wrench and tool, part number 7144-933.

76. Apply a small amount of sealer to shaft and fit nose nut. Using tool number 7144-907, tighten nut to a torque of 8 lbs. ft. After tightening, the scribed line on the nose nut and the scribed line on the impeller must be within $\frac{1}{4}$" of each other.



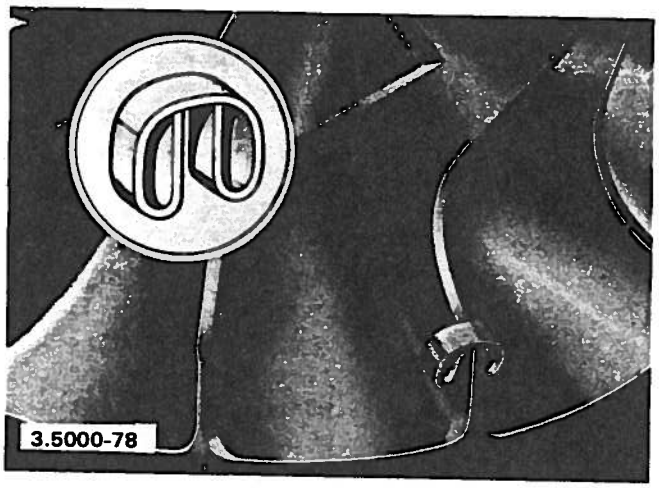
3.5000-76

77. Remove the assembly from the vice and fit it to the support base, part number 7144-937, with nozzle ring towards the base and check the end float by using gauge, part number 7244-7, illustrated below. End float must be between 0.004" (0.1 mm) and 0.008" (0.2 mm).

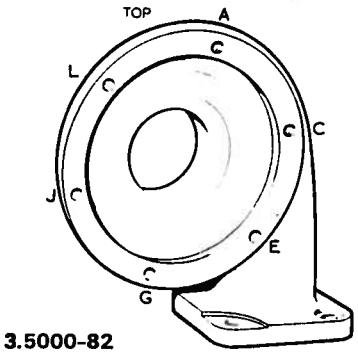


3.5000-77

78. Before final assembly of the turbine casing it must be established that a clearance of 0.011 to 0.024" exists between the turbine blades and the exhaust outlet radius on the casing. To do this, fit a 0.020" clip, part number 7144-727B to one of the turbine blades, see below, and refit turbine casing to centre casing. Tighten down on two opposite studs and check that the rotor assembly is free to turn. If it is prevented from doing so, remove the turbine casing and reduce the size of the clip. If there is no contact between 0.020" clip and the outlet radius when the casing is tightened down, a larger clip size must be fitted. When a clip between 00.11" and 0.024" just makes a brush contact (evident by a slight scraping noise) with the outlet radius, the clearance is correct.

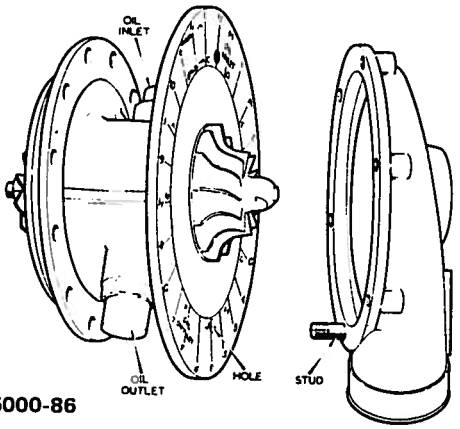


79. When clearance is satisfactory, unbolt the turbine casing **and remove the clip.** Refit turbine casing ensuring that the dividing webs cast in the casing locate against the elongated vanes on the nozzle ring. Bolt the casing in position using six bolts and locking tabs and tighten to a torque of 75 lbs. inch.
80. For positioning turbine casings where a plain nozzle ring without vanes is fitted the following procedure applies.
81. Ascertain from the type symbol, the turbine casing position (e.g. EO1A-A5V1).
82. Bring the centre and turbine casings together so that the oil inlet lies between the two uppermost fixing holes, L & A in Fig. 3.5000-82



3.5000-82

83. Move the centre casing until the fixing hole slightly to the right of the oil inlet on the centre casing matches with the fixing bolt marked with the appropriate letters as denoted in Fig. 3.5000-82.
84. Bolt the casing into position.
85. Fit a 0.020″ clip, part number 7144-727B, to a compressor blade, see Fig. 3.5000-78 and carry out the procedure described above, until a clip between 0.011″ and 0.030″ just makes a brush contact with the inlet radius on the compressor casing.
86. When the clearance is satisfactory, unbolt the compressor casing **and remove the clip.** Fit casing positioning tool, part number 7244-4, to compressor side of centre casing so that the oil inlet and outlet positions on casing and tool coincide. Ascertain from the positioning code stamped on the compressor outlet, the casing positioning code number (e.g. E01A55B5S1)
Note the stud hole in the centre casing corresponding to the code number marked on the periphery of the positioning tool. Remove tool and refit compressor casing so that the stud nearest to the compressor outlet is located in the stud hole corresponding to the code number.



3.5000-86

87. Bolt down compressor casing using six bolts and locking washer, to a final torque of 75 lbs. in.
88. Refit orifice washer and gauze filter (domed insert uppermost) to oil inlet bore. Refit oil inlet union using a new washer and a small amount of 'Loctite' grade AVV on union threads. (The union can be fitted either way).
89. Fit oil outlet union, using a new washer and Loctite grade AVV on union threads.
90. If the turbocharger is not to be fitted to the engine immediately, blanking covers must be fitted to both the compressor inlet and turbine outlet and also to the oil inlet and outlet. This is most important if foreign matter is to be prevented from entering the turbocharger during storage and transit. Similar care must also be taken when fitting a turbocharger or when working on the engine, to ensure that loose articles are not left where they could find their way into the turbocharger.

Overhaul Holset Turbocharger
91. Refer to the sectional view (Fig. 3.5000-13) for itemised parts in the following text.
92. Clamp the unit upright in a vice on the turbine inlet flange.
93. Mark the relative positions of the turbine housing (18), bearing housing (8), compressor cover (14) and V clamp (19).
94. Remove the eight bolts (17) and associated lockwashers (15) fastening the compressor cover (14) to the bearing housing (7) and lift off cover.
95. Remove the 'V' clamp locknut and spring the 'V' clamp (19) back on to the bearing housing (7). Lift the core assembly clear of the turbine housing (18).

96. Holding the turbine wheel at the hub with a 5/8" A/F ring spanner, remove the compressor locknut (7) with a ½" A/F spanner.
97. Slide the compressor wheel (5) off the shaft.
98. Using circlip pliers Seeger A/1 remove the large retaining ring (13) which retains the compressor insert (12). Two screwdrivers should be used to lift the insert from the bearing housing (7). Remove the 'O' ring (11) from the insert.
99. The individual parts of the thrust assembly can now be lifted out.
(a) Spacer sleeve (4) which can be gently pushed out of the insert (12).
(b) Oil deflector (10) positioned by two groove pins.
(c) Thrust ring (3)
(d) Thrust plate (9)
100. The groove pins are a press fit in the bearing housing (7) and should not be removed.
101. Remove the shaft and turbine wheel assembly (1) together with its piston rings (2).
102. Insert fingertip into bore of the bearing (8) and remove.
103. Carefully expand and remove the piston rings (2) from both the spacer sleeve and turbine wheel and shaft assembly. Over expansion of the piston rings will cause a permanent set or breakage.
104. Soak all parts in a commercially approved cleaner until all deposits have been loosened. Caustic solutions **must not** be used as damage would be caused to certain parts.
105. Use a plastic scraper or bristle type brush on all aluminium parts. Vapour blast may also be used providing the shaft and other bearing surfaces are protected.
106. Clean all drilled passages with a compressed air jet.
107. Ensure surfaces adjacent to wheels on stationary housings are free of deposits and are clean and smooth.
108. After cleaning, all parts should be inspected as follows:
109. Shaft and Turbine wheel assembly (18)
(a) Inspect bearing journals for excessive scratches and wear. Minor scratches may be tolerated.
(b) Inspect the piston groove walls for scoring. Minor scratches are acceptable.
(c) Check carefully for cracked, bent or damaged blades, but do not attempt to straighten blades.
110. Bearings (8) must be replaced for excessive scratches and wear.
111. Replace spacer sleeve (4) if piston ring groove or spacer are damaged.
112. Replace the bearing housing (7) if the bearing or piston ring bores are excessively scratched or worn.
113. Thrust ring (3); Thrust plate (9)
(a) Replace if thrust faces are mutilated. Minor scratches are acceptable.
(b) Replace thrust plate if the faces are worn excessively, unevenly or are severely scratched and otherwise mutilated.
(c) The small feed grooves in the thrust plate must be clean and free from obstructions.
114. Compressor wheel (5). Check carefully for cracked, bent or damaged blades, but do not attempt to straighten blades.
115. Replace 'O' ring (11) if section through ring has taken a permanent set, indicated by flats on the sides of the ring.
116. When the turbocharger has been thoroughly cleaned, inspected and any damaged parts replaced, assembly can commence.
117. Assembly of the unit is the reverse of dismantling, but it is advised that the following points be noted, if a satisfactory re-build is to be obtained.
118. Lubricate bearings, thrust assembly, piston rings and rotor shaft, with clean engine oil.
119. When replacing the turbine wheel and shaft (1) into the bearing housing (7), and spacer sleeve (4) into the insert (12) do not force the piston rings into the bore as an off-centred ring will fracture, causing the shaft to bind.
120. The large retaining ring (13) should have the levelled side facing outwards.
121. Torque the locknut (6) to 13 ft/lbs (17.6 newton/metres), bolt (17) to 5 ft/lbs (6.8 newton/metres) and 'V' clamp locknut (20) to 10 ft/lbs (13.6 newton/metres).
122. On completion of assembly spin the shaft to ensure that it rotates freely.

Turbocharger (Refitting)

123. Before refitting the turbocharger to the engine, carry out the following installation checks.
124. Inspect the bore of the air intake tube and renew the tube if the rubber lining is loose or has deteriorated.
125. Check the air intake system for loose nuts and bolts.
126. Check the air intake system for cleanliness and foreign matter.
127. Inspect the exhaust manifold for foreign matter.
128. Inspect the oil drain line, ensure the line is not clogged.
129. Inspect the oil supply line for clogging, deterioration or possibility of leaks under pressure. Renew if serviceability is doubtful.
130. Check the turbocharger mounting pad on the manifold to make certain that all of the old gasket has been removed.
131. Place new gaskets between the turbocharger and exhaust manifold, ensure gasket does not protrude into the opening of the manifold.
132. Mount the turbocharger on the engine and secure with the mounting bolts.
133. Fill the bearing housing of the turbocharger with clean engine oil, through the oil inlet port, then connect the oil supply pipe. Leave the oil drain pipe disconnected.

134. Connect the air inlet pipe and outlet pipes, taking care to check all joints for possible leaks, also ensure that the piping is not producing strain on the compressor cover.
135. Connect the exhaust outlet flange, using a new gasket. It is recommended that an anti-seize compound be applied to the bolt threads.
136. If the engine lubricating oil change period is due, it is advisable to change the oil and renew the filter element before operating the turbocharger.
137. Crank the engine without firing until a steady flow of oil runs from the turbocharger.
138. Connect the oil drain pipe to the engine connections.