

Plaque 17

# TURBOCHARGER OPERATION AND MAINTENANCE

Plaque 18

# **WHITE**

**ENGINES, INC.**

CANTON, OHIO

*Makers of Hercules Engines Since 1915*

## I N T R O D U C T I O N

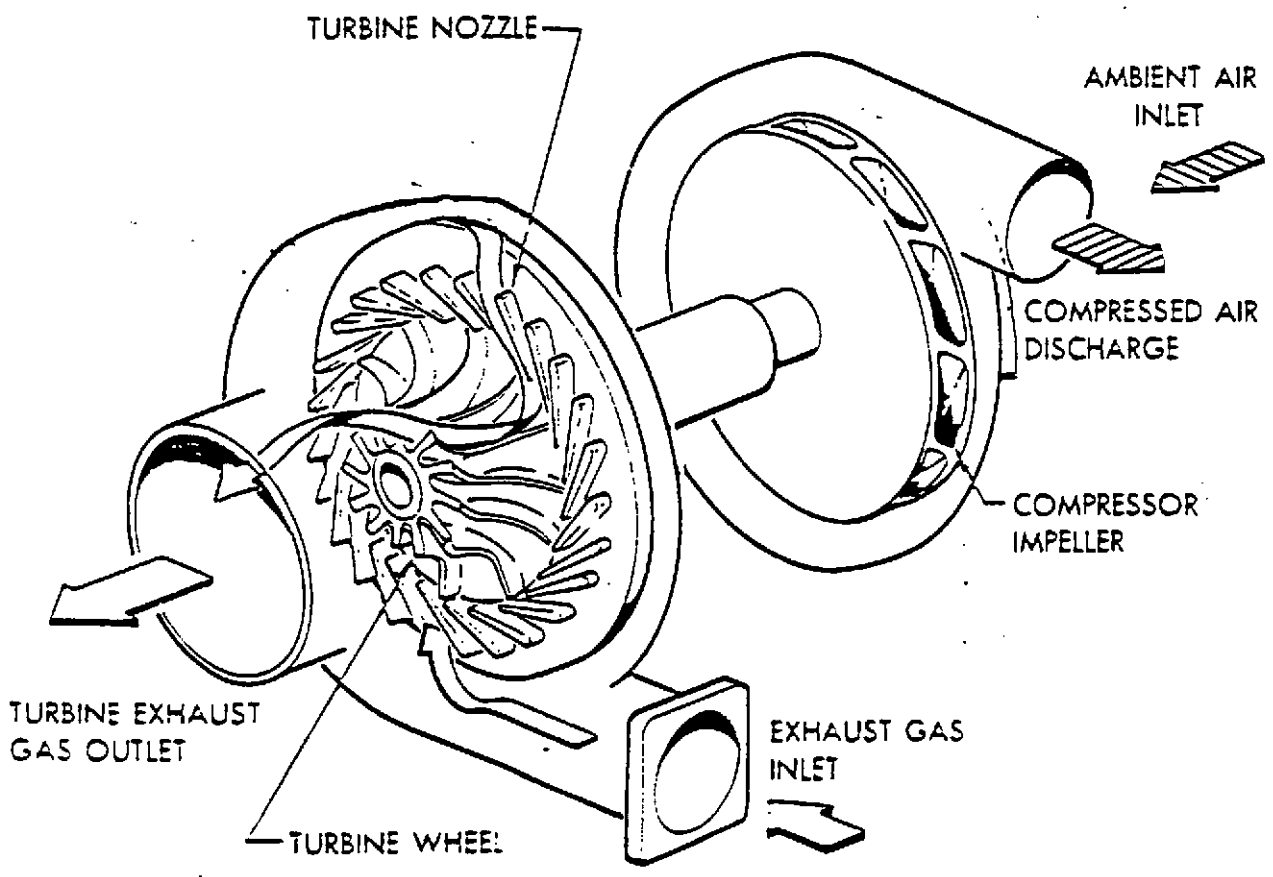
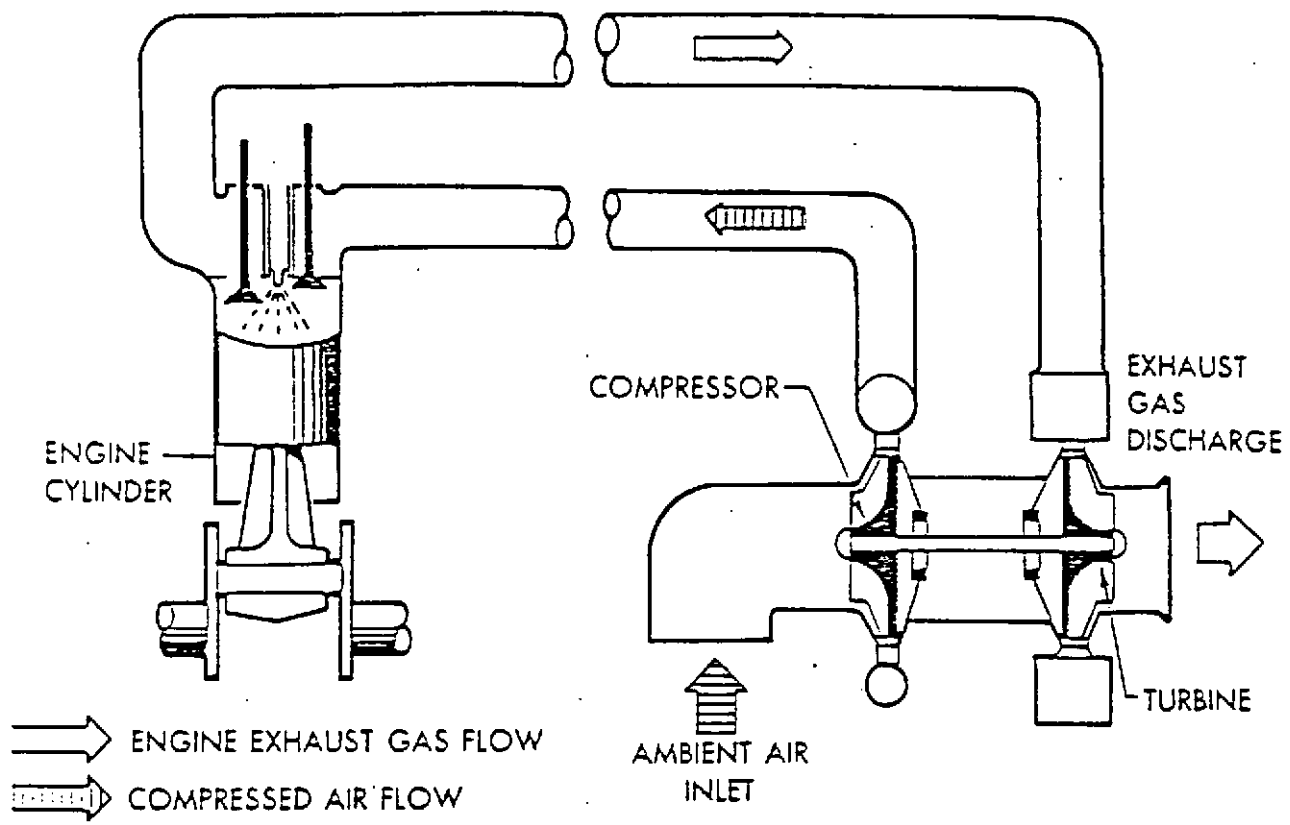
Turbochargers are installed on an engine to put increased air flow and density into the engine combustion chambers. Because of this increased volume of weight and compressed air, more fuel can be scheduled to produce more horse power from a given sized engine. The Turbocharged version of an engine will also maintain a higher level of power output than the Naturally Aspirated version.

Misuse, misapplication or modifications of the turbocharger can result in serious injury and engine damage. Install a turbocharger only on an engine which has been approved for such an application. The turbocharger is a precision built product which has been matched and tested for use of specific engines only.

## O P E R A T I O N

During the operation of the engine, exhaust gases from the engine pass through the turbine housing and cause the turbine wheel to rotate. The compressor wheel which is mounted on the same shaft as the turbine, rotates with the turbine. The compressor draws in ambient air, compresses the air, and delivers it to the engine intake manifold. During operations, the turbocharger responds to engine demands by reacting to the flow of engine exhaust gases. As the power output of the engine increases, the flow of exhaust gases increases and the speed and output of the rotating assembly increases proportionately.

Nearly all of the present day turbochargers operate at shaft speeds in excess of 75,000 RPM and utilize full floating bearings which have correspondingly high rotational speeds. Filtered oil, as supplied by the engine, is required for cooling and lubrication to maintain the turbocharger bearing system.



Schematic Flow Diagram.

Always warm up the engine to allow warm oil to reach the turbocharger before operating under load.

### C A U T I O N

ALWAYS ALLOW THE ENGINE TO IDLE FOR ONE MINUTE BEFORE

SHUT DOWN, THIS PROCEDURE WILL COOL THE TURBOCHARGER BEARINGS.

### LONG TERM STORAGE AND MAINTENANCE

Oil lag conditions will most often occur during the first engine start, after engine oil and filter change, when the lubricating oil system is empty. Similar conditions can also exist if an engine has not been operated for a prolonged period of time because engine lube systems have a tendency to bleed down.

Use the following procedures for initial start up:

1. If equipped, remove the 12 Volt wire from the electric shutdown solenoid on the injection pump. Crank over until oil pressure is observed. Do not exceed the 10 second maximum cranking limit. Reconnect the electric shutdown wire on the injector pump.
2. If equipped with manual shut down, pull lever to stop position, crank over until a steady oil pressure reading is observed.. Do not exceed the 10 second maximum cranking limit. Push lever forward to start engine.

Start the engine and allow to idle for one minute. After one minute, the engine speed may be increased. Do not overfill engine crankcase.

When Outside Temperature is Consistently	Use SAE Viscosity Number
-10° to 30°F (-23° to -1°C)	10W
30° to 60°F (-1° to 16°C)	20W-20
40°F (4°C) and up	30W
-10°F (-23°C) and up	10W-40

NOTE: Only multigrade oils with API "CD" classification are acceptable for White engines.

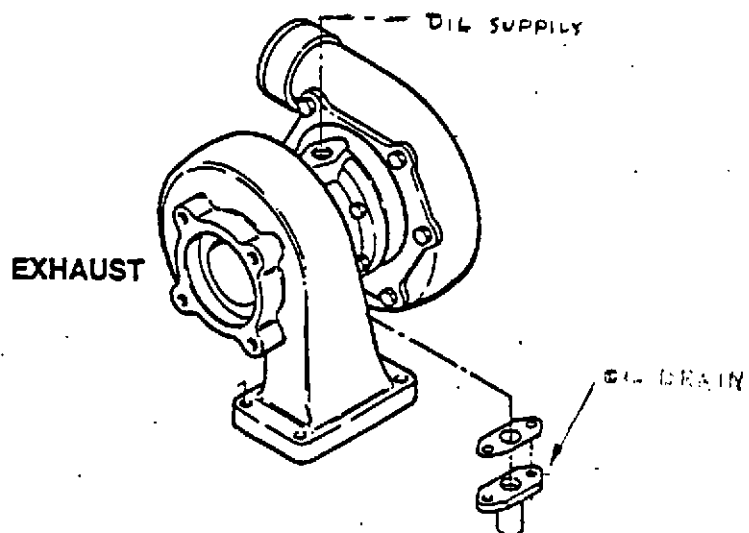
### DAILY MAINTENANCE

Good maintenance practices should be observed. Check all air inlet connections.

Foreign matter entering the turbocharger compressor housing from a leaky air inlet system can seriously erode the compressor wheel blades and will result in the deterioration of the turbocharger and engine performance. The wearing away of the blades, if uneven, can induce a shaft motion which will pound out and eventually fail the turbocharger shaft bearings.

Check and service air cleaner. Plugged or restricted air cleaner systems, resulting from poor maintenance procedures, will cause the turbocharger to lose performance. Restricting the air inlet reduces air flow to the engine and an over fueled condition results, causing excessive engine exhaust temperatures and black smoke. The restricted air cleaner and the resultant air pressure drop between cleaner and turbocharger can, during engine idle periods, cause oil pullover at the compressor end of the turbocharger.

A turbocharger is sensitive to a limited oil supply due to the high rotational speed of the shaft and the relatively small area of the bearing surfaces.



## TROUBLESHOOTING

All too frequently, servicable turbochargers are removed from engines before the cause of the malfunction has been determined. Always inspect and assess turbcharger condition before removal from the engine.

Recommended inspection procedures:

1. Remove inlet and exhaust tubing from the turbocharger.
2. Inspect both wheels for blade damage caused by foreign material. The compressor wheel is easily inspected by looking through the compressor housing inlet opening. A light is necessary when examining the turbine wheel blade tips, as they are positioned inside the turbine housing and you have to look between the turbine wheel blades from the exhaust outlet end of the turbine housing.
3. Examine the outer blade tip edges on both wheels, adjacent to their respective housing bores, and check for wheel rub.
4. Rotate the shaft wheel assembly by hand and feel for drag or binding conditions. Push shaft to side and rotate to feel for rub.
5. Lift both ends of the shaft up and down at the same time and feel for excessive journal bearing clearance. If clearance is normal, very little shaft movement will be detected. If a unit having normal bearing clearance of .003 to .006 is rocked up and down from one end only, the movement at end of shaft when dial indicated should not exceed .015 to .020. Actual shaft play is easily indicated without removing the turbocharger from the engine.

6. If the shaft assembly rotates freely and no wheel damage, binding or rub has been noted, it can be assumed that the turbocharger is serviceable.
7. If turbocharger is defective, do not disassemble, take it to an authorized service dealer.

#### W A R N I N G

OPERATION OF THE TURBOCHARGER WITHOUT ALL NORMALLY  
INSTALLED INLET DUCTS AND FILTERS CONNECTED CAN  
RESULT IN INJURY TO PERSONNEL.

If the turbocharger is found to be functional, proceed with a check of the air system as follows:

Engine not running:

1. Check air cleaner for a restricted condition.
2. Check all hose clamps for tightness.
3. Check intake manifold gaskets.
4. Check all hoses for cracks or deterioration.

Leaks in engine intake or exhaust manifold and inlet to turbocharger will also create a noise level change and reduced turbocharger performance.

Check exhaust system as follows:

1. Check manifold gaskets for leakage.
2. Check manifold retaining bolts for tightness.
3. Check manifold for cracks or porosity.
4. Check turbocharger inlet gasket for leaks.
5. Check turbocharger inlet flange bolts for tightness.

Exhaust leakage is detected by heat discoloration in the area of the leak.

NOTE: Back pressure in the exhaust system, measured near the turbocharger, should not exceed 2.5" Hg or 35" H<sub>2</sub>O. An increase in exhaust back pressure will result in a corresponding decrease in engine power output.

#### PISTON COOLING SQUIRTERS

Turbocharged engines develop higher piston temperature than naturally aspirated engines and the means for cooling is to inject oil onto the inner surface of the piston. Cooling squirters are installed into the main oil header and directs a steady stream of oil to the inner surface of the piston.

Care must be taken when removing and installing the connecting rod and piston assembly to assure the cooling squirters are not bent out of adjustment. If alignment is changed, realignment could be accomplished by slightly bending the squirter to direct the stream of oil between the wrist pin boss of the connecting rod and the inner surface of the piston.

Due to the high volume of oil needed to cool the piston, the oil pressure on most turbocharged engines is considerably lower than on naturally aspirated engines. With bearings in good condition and the proper grade of oil being used, the pressure should be 18 to 35 PSI at 1800 RPM depending on temperature.

#### OIL COOLER

Engine oil temperature will run hotter than naturally aspirated engines because of the heat rejection into the oil from the piston. A cooler for the oil is installed into the lower radiator hose to reduce the oil temperature. Oil sump temperature should not exceed 250 degrees F.

