



NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Western Pacific Region

ENGINE EXAMINATION

WPR17LA172

Accident Date: July 31, 2017
Exam Date: November 13, 2018

This document contains 23 embedded images
(NTSB & CMG)

A. ACCIDENT

Location: Llano, California
Date: July 31, 2017
Aircraft: Cessna T-210F, N6109R, Serial # T210-0009
NTSB IIC: Michael Huhn

B. EXAMINATION PARTICIPANTS:

Michael Huhn
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C. SUMMARY

1.0 Accident

While on a cross-country flight, the pilot was unable to achieve the target/normal manifold pressure (MP) values. He made a precautionary landing, and had an aircraft mechanic examine the engine; no anomalies were noted. The pilot then departed on the continuation of his trip. While in cruise, the pilot noticed that the oil pressure had dropped to 0 psi. The pilot retarded the throttle, and diverted towards an airport. The airplane touched down in the desert terrain about 1 mile short of the diversion airport. The airplane was substantially damaged during the forced landing near Llano, California. Subsequent to the accident, the pilot reported that a "top overhaul" of the engine had been completed about 11 flight hours prior to the accident.

2.0 Initial Examinations

On-scene FAA examination of the airplane revealed that there was no measurable oil in the engine; there were no obvious indications of an oil leak or overboard venting, or any catastrophic internal mechanical failures of the engine. The airplane was recovered to Air Transport in Phoenix where it was examined in more detail. That examination by representatives of Continental Motors Group (CMG) and the NTSB was conducted on August 9-10, 2017. When the engine was manually rotated, the No. 1 piston was immobile in its cylinder, the No. 1 exhaust valve was stuck open, and the No. 1 intake valve remained closed. All other cylinders appeared to be normal. That examination is documented separately. The engine was removed and shipped to CMG in Mobile AL for disassembly and examination.

3.0 CMG Examination

The engine was disassembled at the Continental Motors facility in Mobile, AL. Those results are documented in this report.

When the engine was disassembled, multiple indications of oil starvation/depletion became evident. These included near-absence of oil in the sump, thermally-distressed internal components, failed/disintegrated components, and numerous metallic chips in the oil sump and filter element. The primary failed component was the connecting rod bearing/cap for the No. 1 cylinder. The apparent source of the oil depletion was traced to the turbocharger bearing assembly/housing.

D. EXAMINATION INFORMATION

1.0 General

- The engine remained crated in a secure storage area until this exam
- The engine was uncrated for examination
- The engine dataplate indicated that the engine was a TSIO 520-C, over stamped as a field conversion (non-CMG) to an 'M' version
 - The airplane was a Cessna T210F
 - The FAA TCDS indicated that a 'C' model engine was appropriate.
 - The TCDS did not list the 'M' version as appropriate
- The airplane had "RAM T210" decals on the cowling. Ram Aircraft is a known converter of CMI engines and T210 airplanes.
- An 11/22/04 maintenance record entry by "Corona Cylinder and Engine Overhaul, Inc" for an engine overhaul cited "Ram STC #SA2689SW" at the top.
 - The entry did not explicitly cite that the overhaul or any modifications were accomplished in compliance with that STC
 - According to a representative of RAM Aircraft, "RAM did sell STC SA2689SW to N6109R in November 2004. The STC was sent to a company in Henderson, Nevada. SA2689SW is an airframe STC which allows the installation of the later 310hp TSIO-520-M or R engine."
- CMG technicians removed accessories & components, including:
 - Both magnetos and harness assemblies
 - Propeller governor
 - Fuel pump
 - Fuel manifold valve, lines, & injectors
 - Tachometer drive
 - Starter adapter & starter
 - Vacuum pump
 - External oil filter
 - Oil pump and oil pressure relief valve
 - Oil cooler
 - Spark plugs
 - Intake & exhaust tubing & components (including throttle & metering assy)

- o Turbocharger assembly
 - o Oil sump
 - o Engine mounts
- No evidence of any internal catastrophic failures, including case penetrations, was observed
- No evidence of any significant oil leakage was observed

2.0 Oil Gage Rod (Quantity 'dipstick')

- The oil gage rod was determined to have no part number
- The rod was of appropriate length, but two of the three quantity lines were improperly located

Parameter	CMG Design Value	As-Found Value
Overall Length	22.35"	22 5/16"
6 Qt line	2.80" (from bottom end)	2.8"
8 Qt Line	4.65"	Not present
10 Qt Line	4.80"	3 3/4"
12 Qt Line (full)	5.60"	4 5/8"

- The external housing for the rod was observed to have 3 segments of flexible tubing/sheathing
 - o The factory version is a single piece aluminum tube with a single flexible fitting/sheath at its base (where it installs into the crankcase)
 - o The two additional flex pieces were used to insert a non-aviation, 'homemade' 'T'-fitting into the mid region of the original tube, which had been cut and somewhat shortened
 - o The T fitting appeared to be fabricated from soldered copper tubing sections and a nipple
 - o The T fitting accommodated the oil drain/return line from an oil-air separator (from the crankcase breather)
 - o The overall length of the as-found housing assembly was about 15.5 inches
- The design length of the CMG housing was about 13.1 inches
- The as-found housing excess length would result in an erroneously low oil quantity reading
- CMG representatives reported that there were no known adverse effects of slightly overfilling the oil sump



Figure 1 - Oil Rod Housing as Removed



Figure 2 - Oil Rod Disassembled

3.0 External Components

- The oil filter was cut open
 - The filter element had trapped numerous metallic particles and fragments. These were generally smaller than the fragments observed in the oil sump
- The oil pump assembly was removed and partially disassembled.
 - The assembly included two pumps; the scavenge pump and the main pump
 - Both pumps were gear-type pumps
 - Both pumps were intact and rotated freely
 - No gears displayed any damage
 - The chamber walls of the main pump displayed significant rotational scoring, consistent with the passage of small metallic particles harder than the aluminum chamber walls
 - The pump did not exhibit any signs of leakage or damage other than that described
- All fuel system components were free of pre-impact damage or evidence of any malfunctions
- The vacuum pump did not exhibit any damage, and was not opened

4.0 Case Split & Internal Components

- None of the accessory gears exhibited any damage, and all were properly safetied
- The lower cap for the No. 1 connecting rod was found separated in the oil sump
 - The cap was blackened and severely damaged
 - The blackening was attributed by the CMG personnel to thermal distress
- One of the two cap bolt/nut assemblies was found in the oil sump
 - The bolt was fractured in two, and retained its cotter-pin safetied nut
 - The bolt exhibited severe elongation and necking
 - The bolt was also blackened
- The No. 1 connecting rod remained attached to its wrist pin and piston
 - The rod moved freely on the wrist pin
- The crankcase bores/housings for the two hydraulic lifters for the No. 1 cylinder were partially fractured, with their liberated sections found in the oil sump
 - The pushrods remained in place
- The crankcase interior in the vicinity of the No. 1 connecting rod exhibited gouges and scrapes
- These crankcase fractures, gouges and scrapes were attributed to the failed connecting rod end
- The crankshaft journal for the No. 1 connecting rod was blackened and scored, gouged and peened

- Its bearing was not located/identified
- The oil sump contained a significant amount of metal flakes/chips of at least three colors: black, brownish-copper, and silver-gray
 - These were likely the remnants of the No. 1 bearing cited above
- Two of the 10 total main bearing halves had different part numbers (653547) than the other 8 (AEC 642720). The part number of those two parts was a direct supercedure of the part number of the other 8.
- The other 5 connecting rods showed varying indications of minor thermal distress
- The connecting rod bearings displayed varying indications of wear and distress of undetermined origin
- The two aft cylinder skirts (No. 1 & No. 2) exhibited some damage (presumed to be from the liberated No. 1 connecting rod components)
- All pistons were intact, with no signs of distress



Figure 3 - Oil Sump with Debris

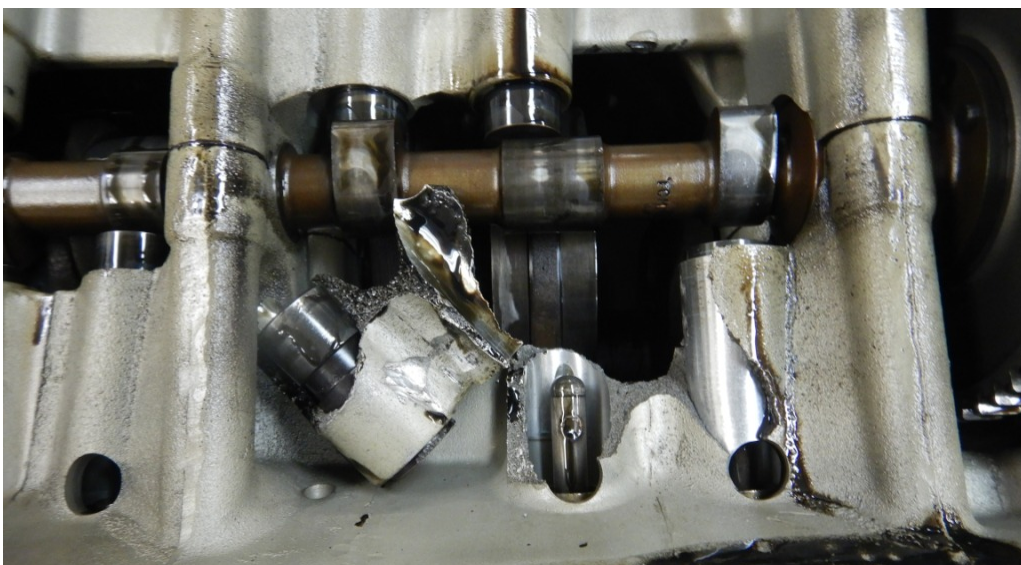


Figure 4 - Crankcase Lifter Housing Fractures

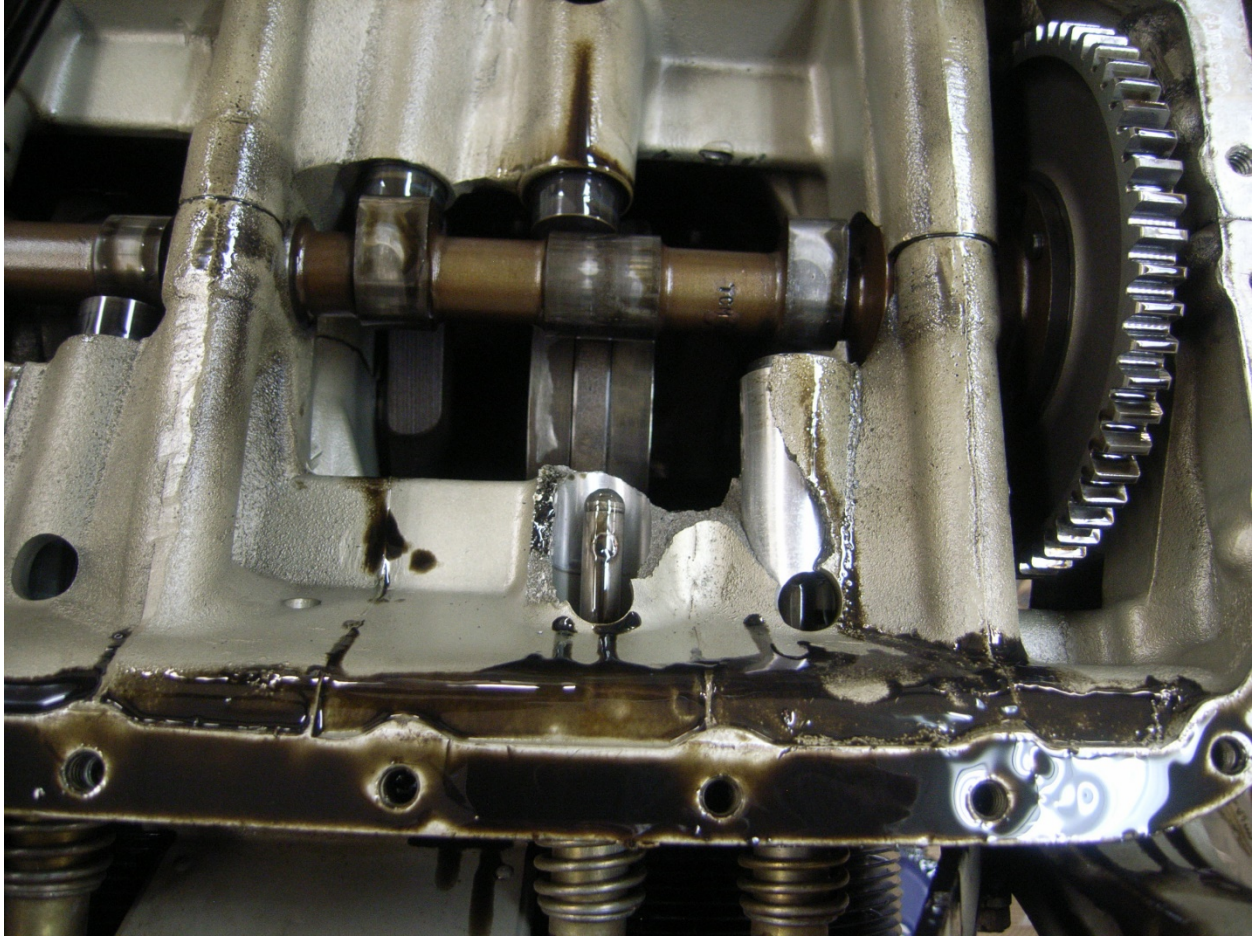


Figure 5 - Fractured Crankcase



Figure 6 - Crankshaft

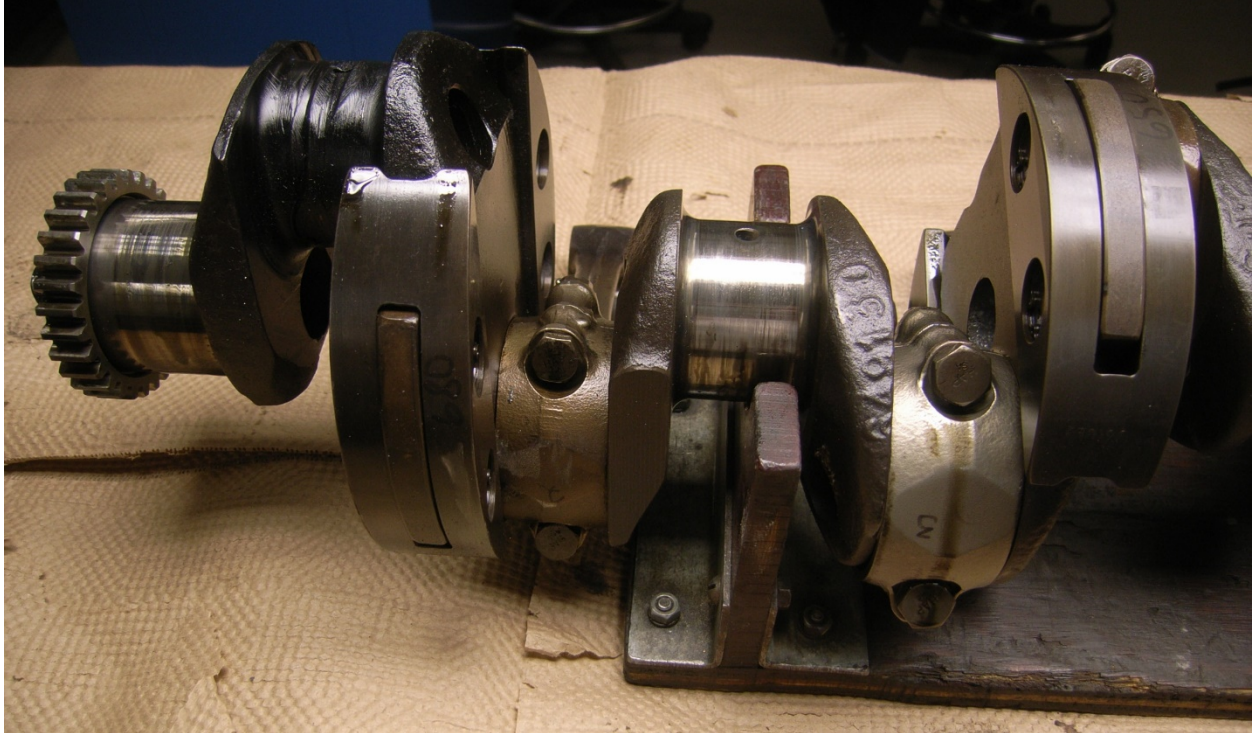


Figure 7 - Aft Crankshaft with Damaged Rod Journal



Figure 8 - No. 1 Connecting Rod Journal on Crankshaft



Figure 9 - Connecting Rods



Figure 10 - No. 1 Connecting Rod End Cap



Figure 11 - No. 1 Connecting Rod End Cap



Figure 12 - Necked Connecting Rod Bolt

5.0 Turbocharger

- The turbocharger was mounted near the lower aft right side of the engine. This was near the external oil filter, and also above the area where most oil was observed in the cowl (see PHX exam report)
- The turbocharger was observed to have several of its compressor inlet blades damaged. The compressor rotor rotated freely, and had about 1/8" axial and radial freeplay.
 - The timing & source of the blade damage and rotor freeplay was not able to be determined.
- Once the turbocharger was removed from the engine, the turbine blades were observed to have damage similar to the compressor blades, and the turbine rotor had axial and radial freeplay of about 1/4 inch.
 - Again the damage and freeplay sources were not identified
- The turbine rotor turned freely, but rotated independent of the compressor rotor. Because the two rotors shared a common shaft, this indicated that the shaft had failed.

- The turbocharger housing in the vicinity of the location of the shaft bearing (between the two rotors), as well as the turbine blades and outlet case, displayed residue of an undetermined nature, some of which appeared to be dirt affixed by oil, or only oil
- The oil lines for the turbocharger were properly attached and were intact, and did not show evidence of leakage
- The turbocharger was partially disassembled in an effort to access the bearings, but this was unsuccessful.
- The two rotor discs were separated, and the shaft was observed to be fractured
 - The shaft fracture end of the turbine was coated with a black substance.
 - Attempts to clean/remove this in a wash tank were unsuccessful
- Some shiny, silvery metal fragments were observed near the area where the shaft was mounted in the bearing assembly
- The end plate of the turbine side of the unit was cracked. This part was also washed to remove some contamination
- It was decided to package these parts (two rotors, bearing housing, and compressor and turbine end plates) for further evaluation by the turbocharger manufacturer or other suitable facility.
- The dataplate indicated that the unit was a Garrett-manufactured & "Factory Rebuilt" item
 - Garrett PN: 406610-9005
 - Cust PN: C295001-0101
 - SN: CCN00658
- An off-CMG-premises review of the maintenance records indicated that an "overhauled" turbocharger was installed on the engine in October 2004, by Corona Cylinder and Engine Overhaul Inc, in conjunction with the overhaul of the engine by the same facility
 - No details of the turbocharger overhaul facility, or the specific maintenance actions accomplished
- The maintenance records did not contain any additional/subsequent turbocharger (excluding wastegate) maintenance or inspection actions
- The maintenance records indicate that the "overhauled" turbocharger accumulated about 1,674 hrs over a period of about 13 years, with no inspections or maintenance noted
- The turbocharger manufacturer's recommended inspection or maintenance schedules and programs have not yet been determined
 - This process is complicated by the fact that the turbocharger design and manufacture company was Garrett AiResearch, which subsequently was purchased by Honeywell, and which subsequently sold off some components (including turbochargers) to Kelly Aerospace.
 - Hartzell Engine Technologies then purchased Kelly Aerospace in 2010, but did not take on the liability responsibilities for all previously manufactured or overhauled units; those responsibilities remained with Kelly Aerospace. Kelly Aerospace has since declared bankruptcy.



Figure 13 - Turbocharger (turbine outlet)



Figure 14 - Turbocharger with Oil System Components



Figure 15 - Turbine Rotor

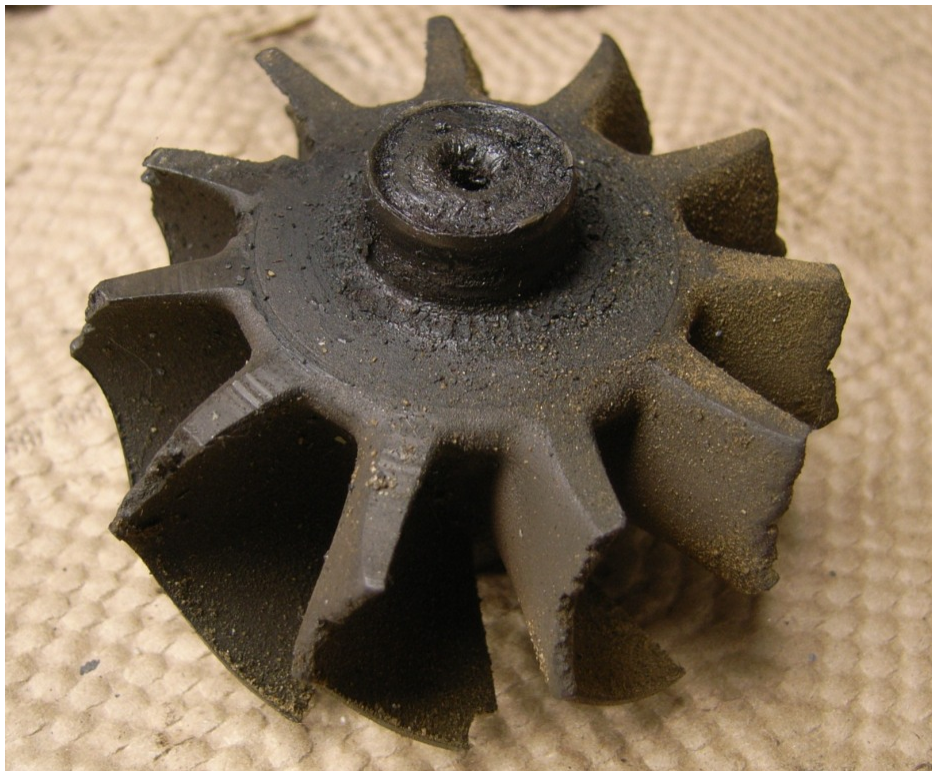


Figure 16 - Turbine Rotor

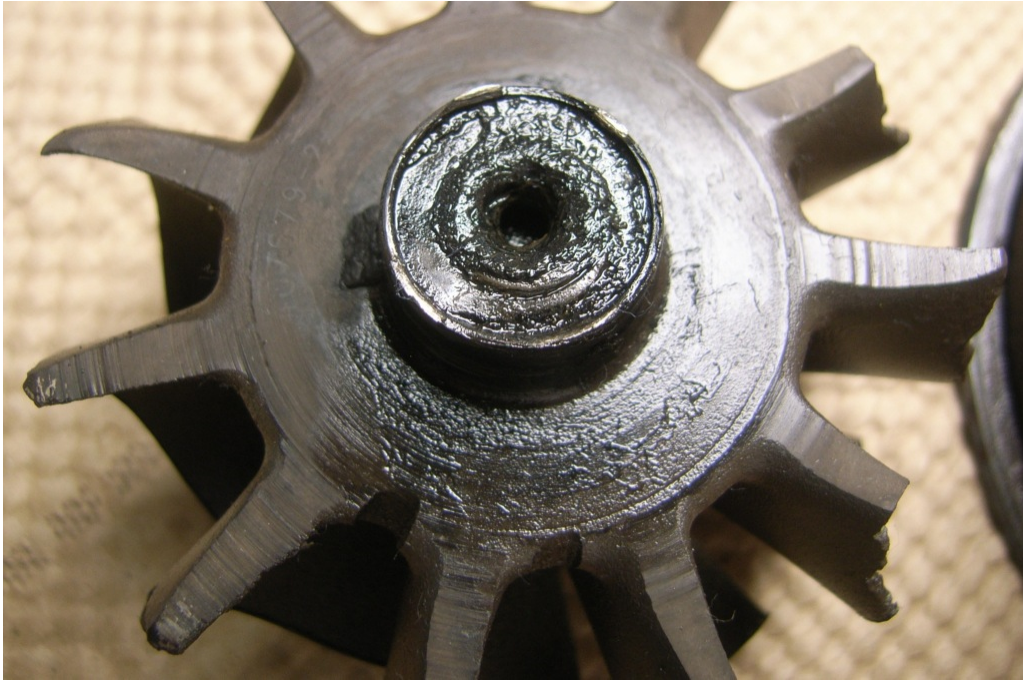


Figure 17 - Turbine Rotor & Shaft Fracture Face



Figure 18 - Turbine End Plate (after cleaning)



Figure 19 - Bearing Housing (compressor side)



Figure 20 - Compressor Shaft



Figure 21 - Compressor End Plate



Figure 22 - Compressor End Plate



Figure 23 - Turbocharger Components for Detailed Examination