

Figure 4-50. Major sections of the G.E./Snecma CFM56-7 high-bypass turbofan

NUMBER 1 AND 2 BEARING SUPPORT SUB-MODULE

The number 1 and number 2 bearing support module belongs to the fan module. [Figure 4-53] The sub-module has a number of functions:

- Supports the fan booster rotor
- Encloses the front section of the forward oil sump
- Supports one of the vibration sensors
- Vents the forward sump
- Provides the fan speed indication
- Directs bearing lubrication

The number 1 bearing support is a titanium casting. The front flange of the support holds the number 1 ball bearing, and its rear outer flange is bolted to the fan frame center hub. The support front flange provides an attachment to the number 1 bearing stationary air/oil seal and the number 1 bearing vibration sensor. The number 1 bearing is a ball bearing that takes up the axial and radial loads generated by the low-pressure rotor system.

The number 2 bearing support is a titanium casting. Its front inner flange holds the number 2 bearing outer race and also allows for the installation of the number 2 bearing oil nozzle. The support also accommodates a guide sleeve for installation of the N_1 speed sensor probe. The number 2 bearing is a roller type and takes up some of the radial loads from the fan and booster rotor.

FAN FRAME SUB-MODULE

The fan frame sub-module is the structure at the front of the engine. [Figure 4-54] It consists of four major assemblies: the containment case, the outlet guide vane assembly, the fan frame assembly, and the radial drive shaft housing. The main purposes of the fan frame sub-module are to:

- Provide ducting for both the primary and secondary airflows.
- Transmit the engine's thrust to the aircraft.
- Support the low-pressure compressor rotor, through the number 1 and 2 bearing support.

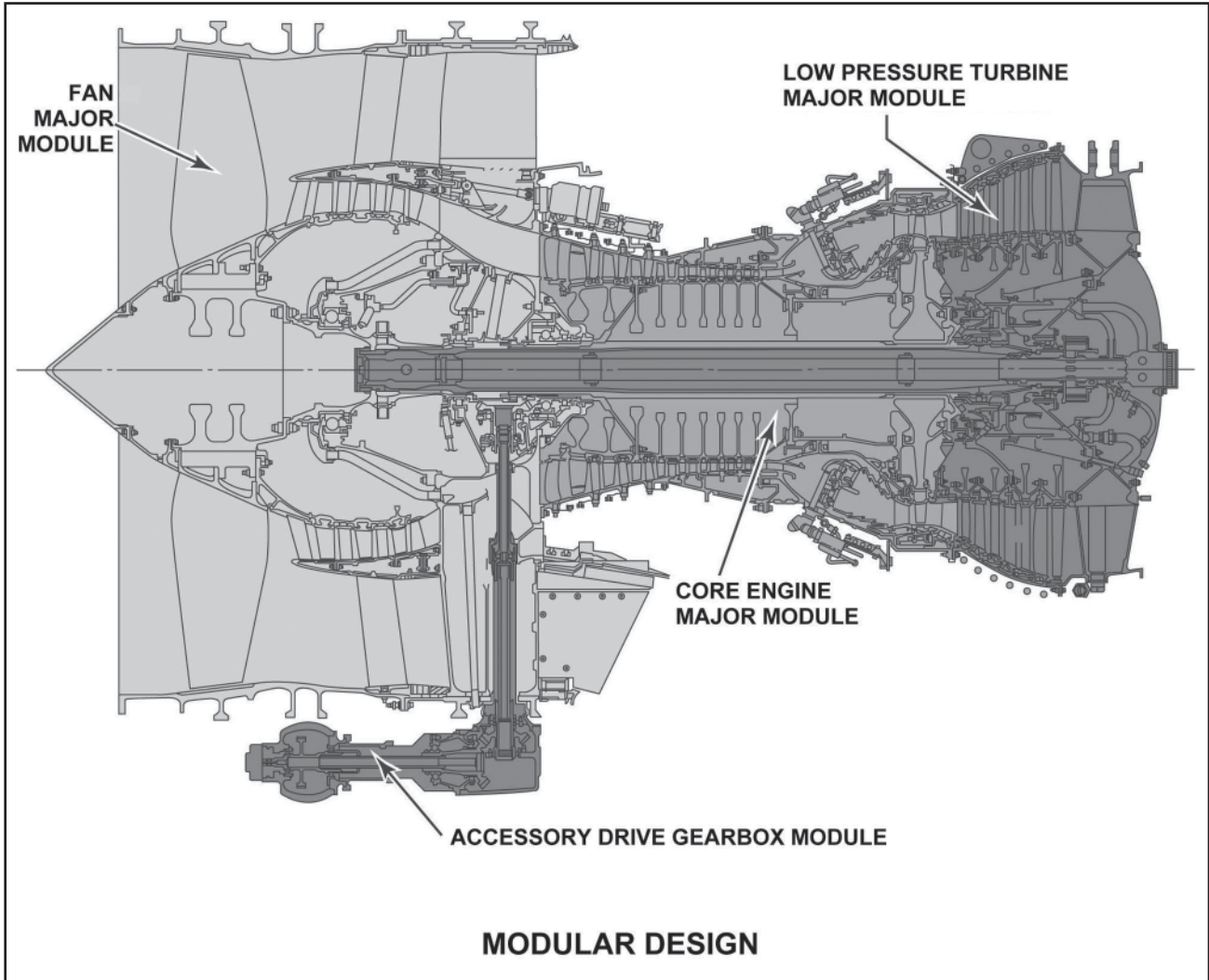


Fig. 4-51 — CFM56-7 Modular design

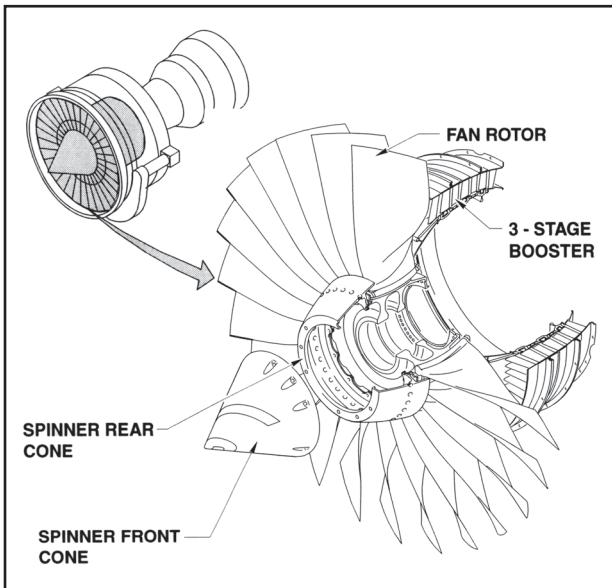


Figure 4-52. CFM56-7 fan and booster module

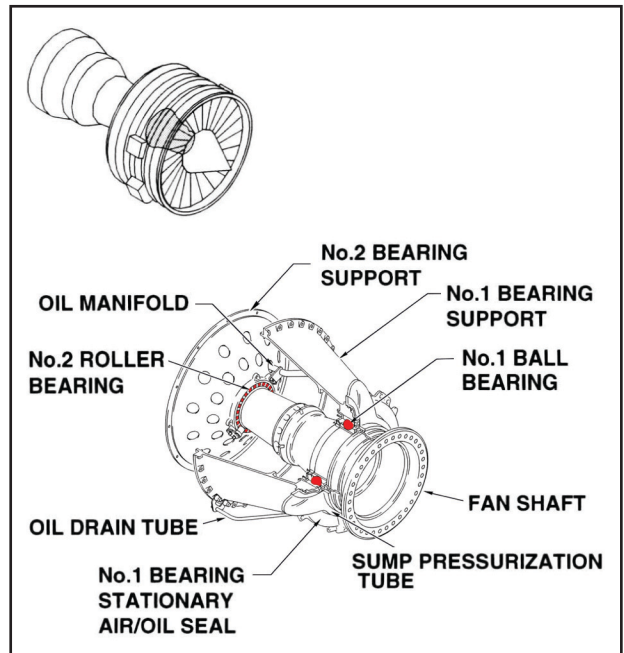


Figure 4-53. CFM56-7 number 1 and 2 bearing support module

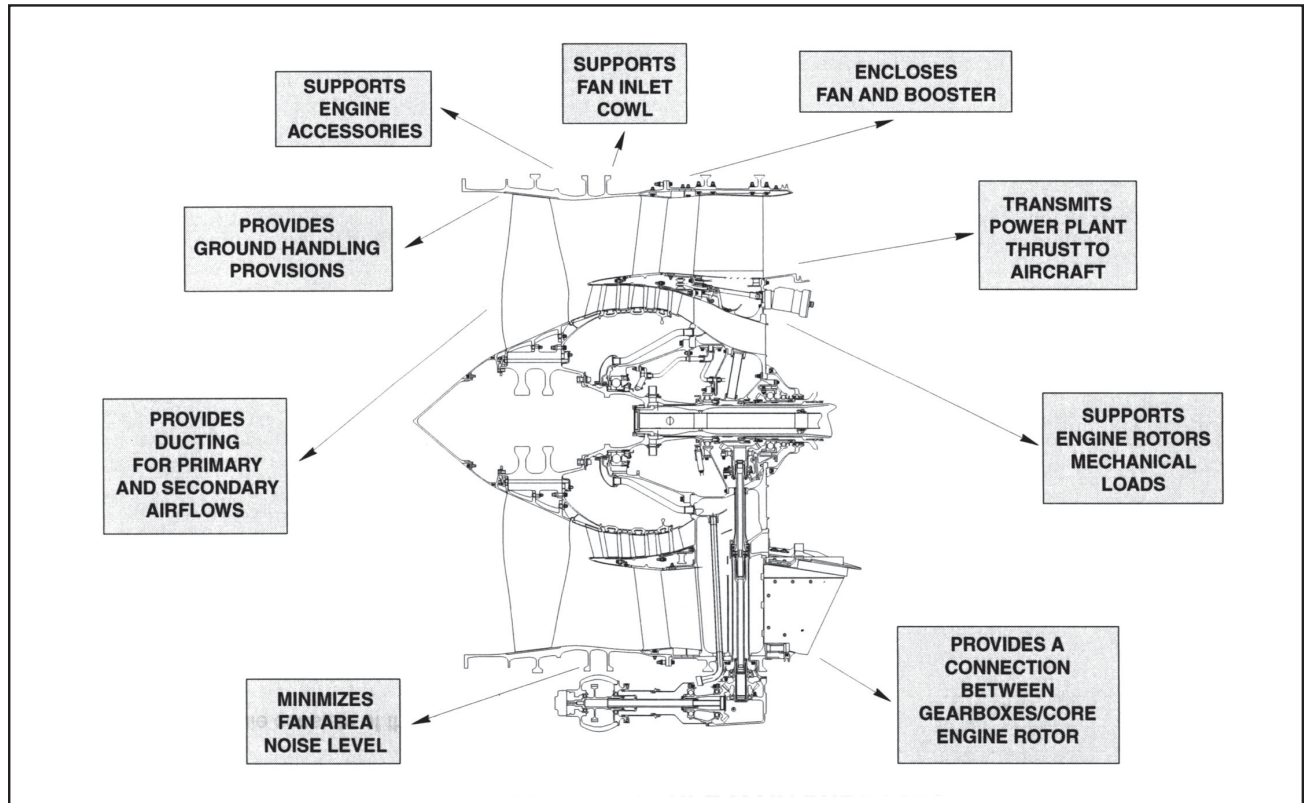


Figure 4-54. CFM56-7 fan frame module main purposes

- Support the front of the high-pressure compressor rotor through the number 3 bearing support.
- Enclose the fan and the booster.
- Support various engine accessories.
- Minimize fan area noise levels.
- Provide attachment for the forward engine mounts, front handling trunnions, and lifting points.
- Support the fan inlet cowl.
- Provide a connection between gearboxes and core engine rotor.

The containment case is a single part made of aluminum alloy. Its outer rear flange is bolted to the outer front flange of the frame shroud. The flanges and ribs on the outer surface provide more strength to the case during engine operation and also provide attachment for equipment brackets. Its inner surface houses an abrasion-resistant shroud, located radially in line with the fan rotor blades.

The outlet guide vane assembly is at the rear of the containment case. Its purpose is to direct and smooth the secondary airflow to increase thrust efficiency. The assembly consists of the fan outlet guide vane inner shroud and 76 aluminum-alloy vanes.

The fan frame assembly is the major structure at the forward section of the engine. It consists of the fan frame shroud, a 12-strut hub, and a radial drive shaft housing. The fan frame shroud is made from aluminum alloy, and the strut hub is made from titanium alloy.

The strut at the 9 o'clock position contains both the forward sump oil supply tube and the radial drive shaft

housing. The radial drive shaft is the mechanical rotating link between the inlet gearbox and the transfer gearbox.

CORE ENGINE MODULE

Figure 4-55 shows the core engine major module, which is made up of the high-pressure compressor rotor, the combustion case and combustion chamber, and the high-pressure turbine.

HIGH-PRESSURE COMPRESSOR

The high-pressure compressor consists of nine stages. It is housed in the compressor case, and the rotor front end is supported by the number 3 bearing (combination ball and roller).

Stages 1 and 2 are cantilever mounted on the front face of the rotor shaft flange and welded together as one unit. The disks are titanium alloy, with 38 blades fitted to stage 1 and 53 blades fitted to stage 2 by dovetail attachments. All blades are titanium alloy.

The stage 3 disk mates with the rotor shaft flange and supports the stage-four through stage-nine disks. It is made of titanium alloy and has individual axial dovetail slots for its 60 titanium alloy blades. Retainer hooks are machined on either side of the disk to provide a slot for the installation of split-ring blade retainers.

The nickel-based alloy spool, made up of stages 4 through 9, is bolted onto the stage-three disk rear face. The outer surface of each disk has a circumferential dovetail groove for the installation of the blades. Each

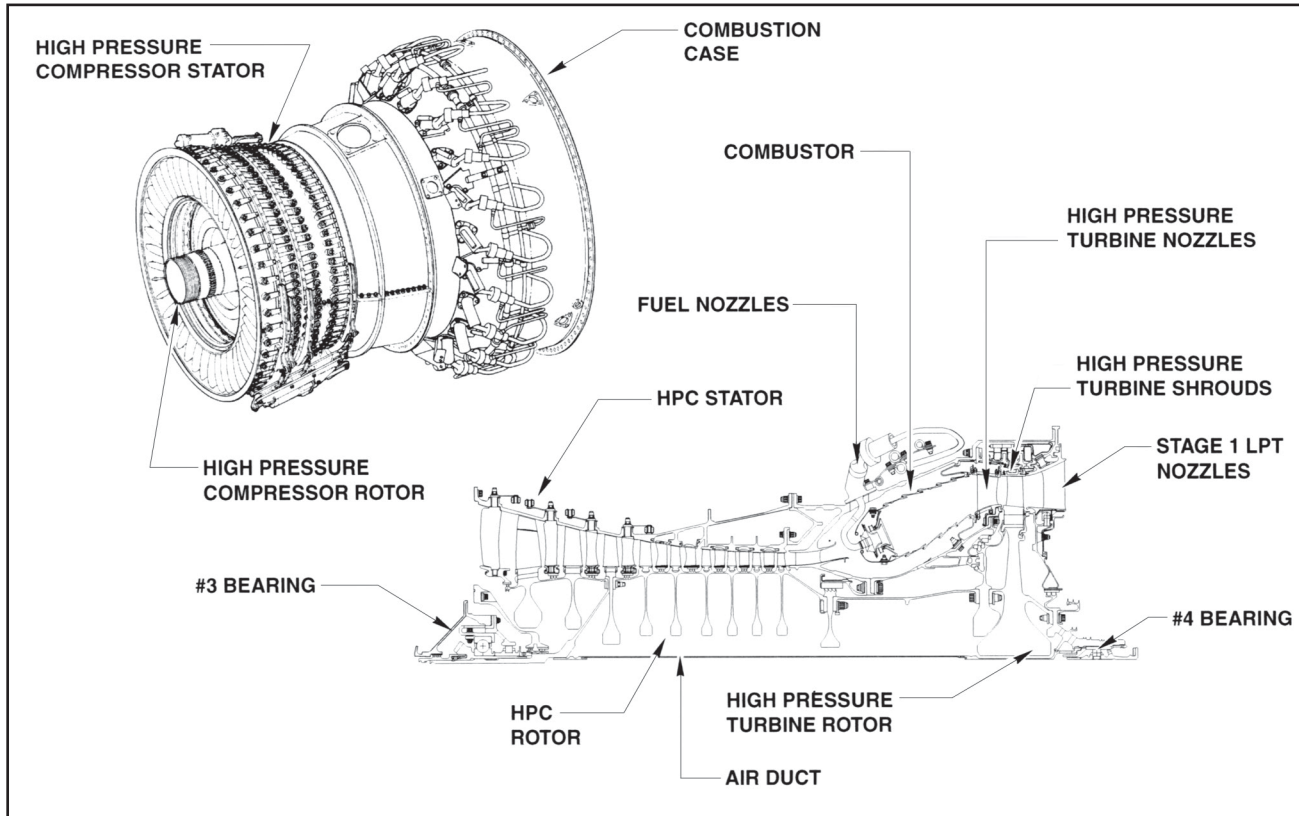


Figure 4-55. CFM56-7 core engine major module

blade tip has a reduced thickness, known as a profile tip or squealer tip. The blades are all made of nickel alloy. The blade count is as follows:

Stage	Blades
1	38
2	53
3	60
4	68
5	75
6	82
7	82
8	80
9	76

The high-pressure compressor case forms the load carrying structure between the fan frame and the combustion case. The case is made up of a front and a rear section, each with a top and a bottom half.

The front case [Figure 4-56] contains the first five stages of the high-pressure compressor, with the two halves being machined as a matched set from a steel forging. Housed within the front case are the inlet guide vanes, the variable stator vanes for stages 1, 2, and 3, and the fixed stator vanes for stages 4 and 5. The inner surface of the case is machined to provide a smooth air flow path through all five stages.

There are ports at stages 4 and 5 to accommodate pipes that supply bleed air for both engine and aircraft use. Bleed air from the stage 4 is extracted for high-pressure turbine cooling and clearance control and for low-pressure turbine cooling. Bleed air from stage 5 is for customer service air.

The rear case shown in Figure 4-57 is for stages 6 through 9 of the high-pressure compressor, with the two halves being machined as a matched set from a zinc-nickel-cobalt alloy forging. The fixed stator vanes for stages 6, 7, and 8 are in the rear case. The fixed stator vane for stage 9 is part of the combustion case.

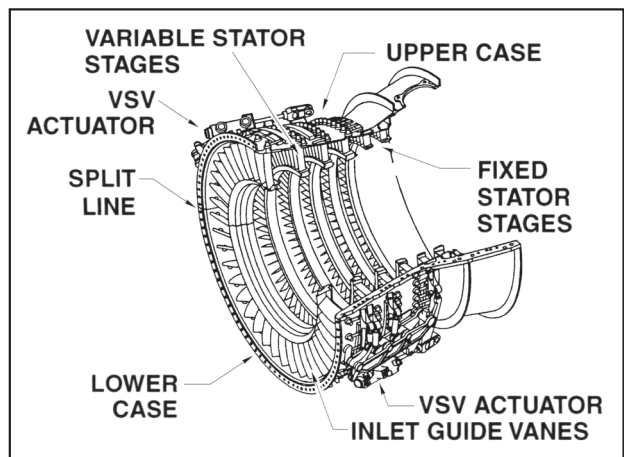


Figure 4-56. CFM56-7 high-pressure compressor front stator design

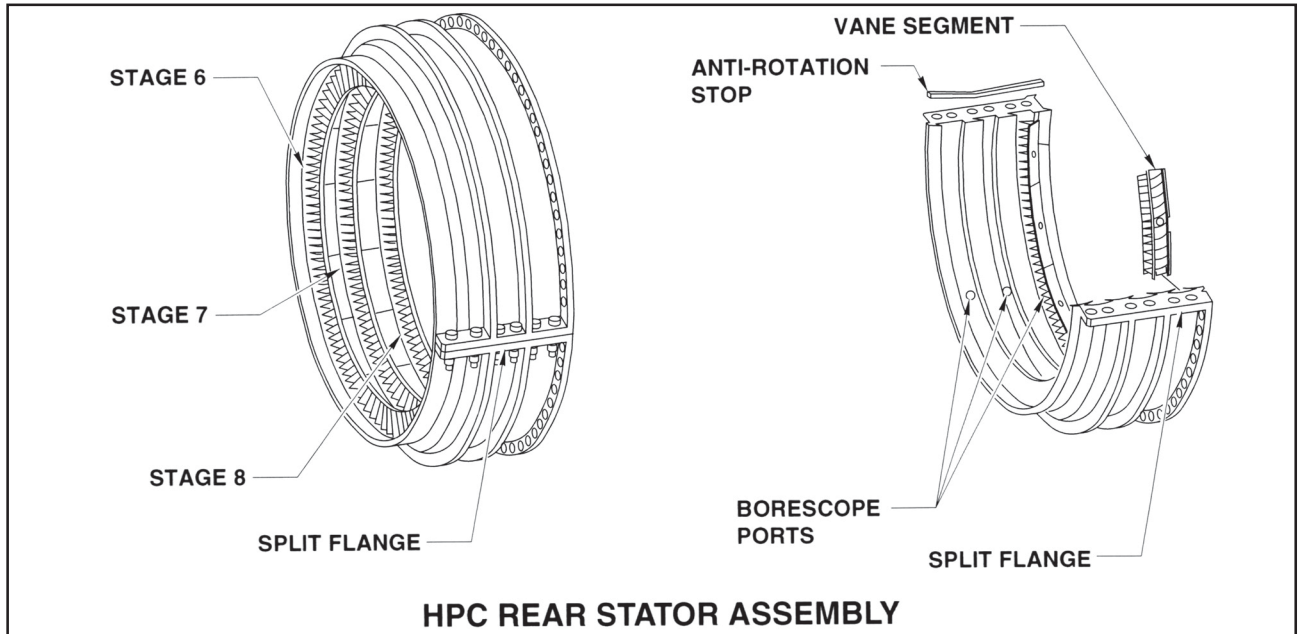


Figure 4-57. CFM56-7 high-pressure compressor rear stator assembly

COMBUSTION SECTION

The combustion section is located between the high-pressure compressor and the low-pressure turbine, and is

made up of a combustion case and a combustion chamber. [Figure 4-58] There are two versions of combustion chamber, a single annular combustor (SAC) and a dual

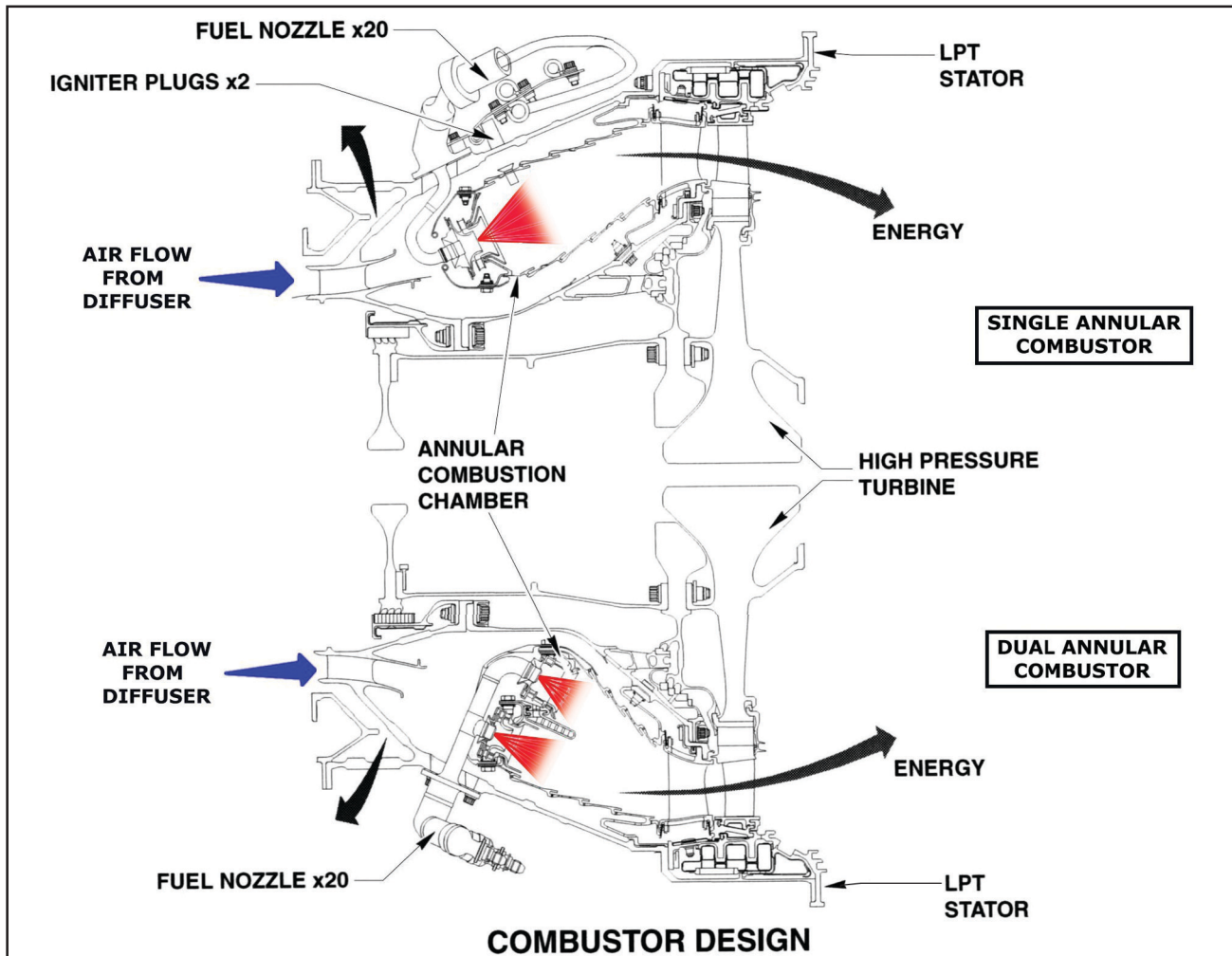


Figure 4-58. CFM56-7 combustor design (single annular, top; dual annular, bottom)

annular combustor (DAC). The SAC has 20 individual locations around its circumference for 20 single-line duplex fuel nozzles; the DAC has 10 circumferential locations for 10 pairs of fuel nozzles. In the SAC and DAC, air from the compressor, called primary airflow for combustion, mixes with fuel supplied by 20 fuel nozzles. (SAC and DAC combustors were discussed in chapter 3.) The combustion case also provides the ports for high-pressure compressor stage-nine bleed air.

The combustion case is a weldment structure that provides the structural interface between the high-pressure compressor, the combustor, and the low-pressure turbine. It also transmits the engine axial loads. It incorporates the compressor outlet guide vanes and a diffuser, which slows the air flow prior to delivering it to the combustion area. The mounting pads around the outer surface accommodate 20 fuel nozzles and 2 igniter plugs.

The combustion chamber is a short annular structure housed in the combustion case. It is installed between the high-pressure compressor stage-nine stator and the high-pressure turbine nozzle. The chamber is made from a nickel-chrome alloy and coated with a thermal barrier material

HIGH-PRESSURE TURBINE

The high-pressure turbine (HPT) is a single-stage, air cooled assembly that converts the kinetic energy in the gasses leaving the combustion chamber into torque to drive the high-pressure compressor. [Figure 4-59] It is housed in the aft portion of the combustion case. The assembly consists of the high-pressure turbine nozzle and rotor, the high-pressure turbine shroud, and the stage-one low-pressure turbine nozzle.

The high-pressure turbine nozzle consists of 21 nozzle segments, each with two vanes that are brazed to inner and outer platforms. Each vane is a cast shell divided into forward and aft cooling compartments by an inner rib.

The vanes and platforms are cooled by compressor discharge air that enters the vane compartments through inserts in the inner and outer ends of the vanes. The air exits through leading edge holes and trailing edge slots. The vanes are made of a nickel base alloy and covered with a thermal protective coating.

The high-pressure turbine rotor front shaft forms the structural connection between the high-pressure compressor and the high-pressure turbine. It is made from a nickel-chrome alloy. The front flange on the shaft is

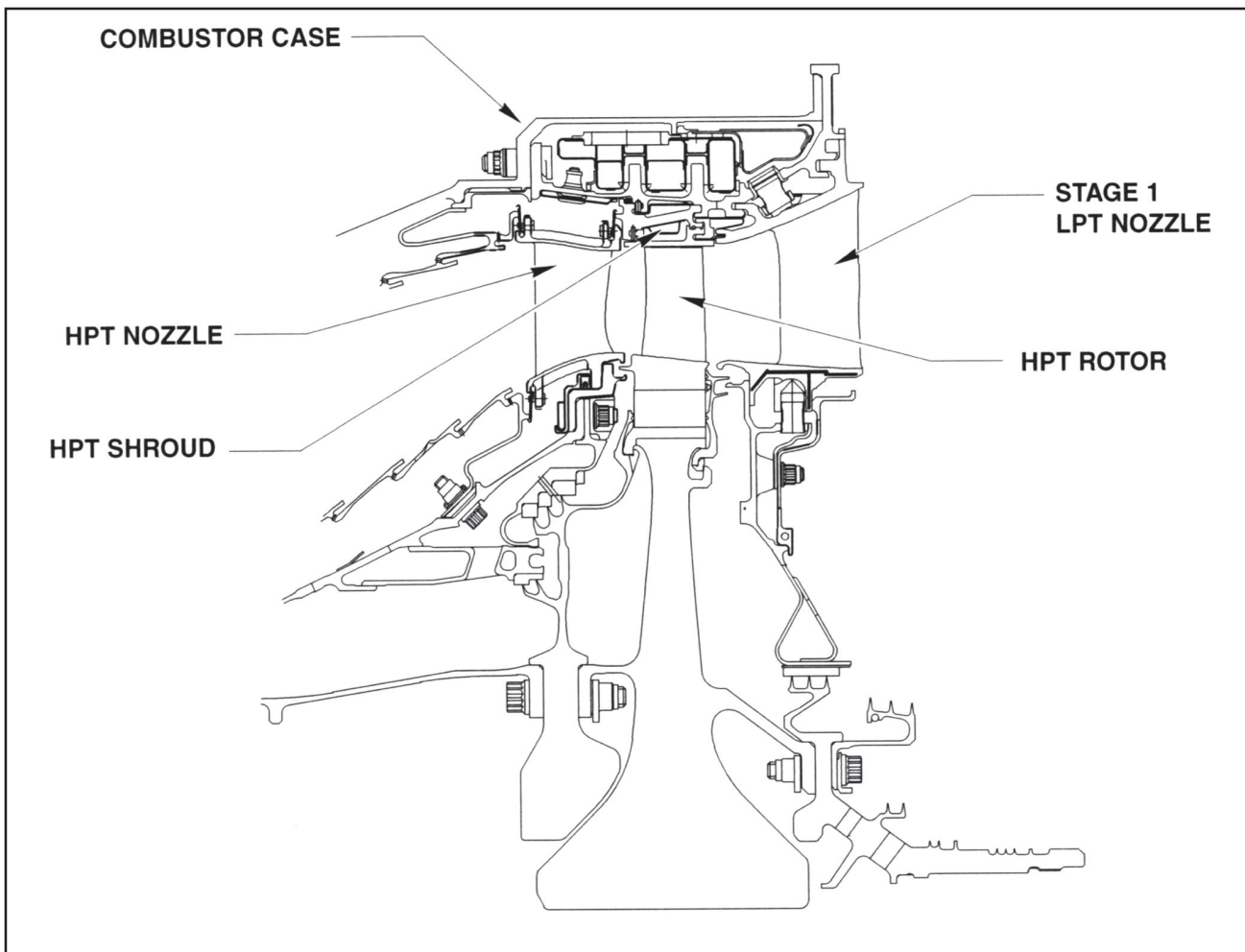


Figure 4-59. CFM56-7 high-pressure turbine