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CONSTRUCTIONAL FEATURES

The combustion section houses:

- the combustion process
- which raises the temperature of the air passing through the engine

This process releases energy contained in:

- the air/fuel mixture.

The major part of this energy is required at the turbine or turbine stages to:

- drive the compressor.

70%

About 2/3 (two thirds) of the energy is:

- used to drive the gas generator compressor

The remaining energy passes through the remaining turbine stages that absorb more of the energy to drive the:

- fan, output shaft, or propeller.

Only the pure turbojet allows the air to create all the thrust or propulsion by exiting the rear of the engine in the form of a high velocity jet

These other engine types have some jet velocity out the rear of the engine but most of the thrust or power is generated by the additional turbine stages driving a large fan, propeller, or helicopter rotor blades.

The primary function of the combustion section is:

- to burn the fuel/air mixture, thereby adding heat energy to the air.
- Convert chemical energy to heat energy

To do this efficiently, the combustion chamber must:

1, Provide the means for proper mixing of the fuel and air to assure good combustion;
2, Burn this mixture efficiently;
3, Cool the hot combustion products to a temperature that the turbine inlet guide vanes/blades can withstand under operating conditions;
4, Deliver the hot gases to the turbine section.

The location of the combustion section is directly between the:

- compressor and the turbine sections
- And this will never change regardless of any type

All combustion chambers contain the same basic elements:

1, Casing;

2, Perforated inner liner

3, Fuel injection system

4, Some means for initial ignition

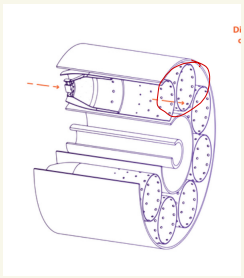
5, Fuel drainage system to drain off unburned fuel after engine shutdown.

There are currently three basic types of combustion chambers These types are:

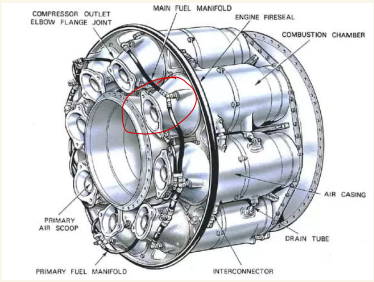
1, Can type

2, Can annular type;

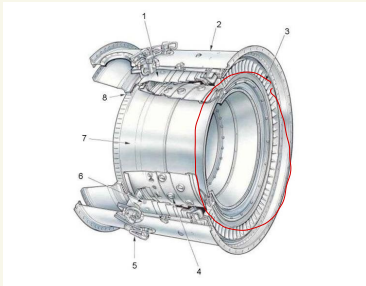
3, Annular type



Can type



Can annular type;



Annular type

1, CAN TYPE COMBUSTION CHAMBERS:

Figure 5-1. Can type combustion chamber.

Figure 5-2. Inside view of a combustion chamber liner.

The can type combustion chamber is typical of the type used on :

- turboshaft
- APUs

Each of the can type combustion chambers consists of an:

- outer case or housing,

within which there is a :

- perforated stainless steel (highly heat resistant) combustion chamber liner or inner liner

The outer case is removed to facilitate liner replacement.

Older engines with several combustion cans had:

- each can connected with an inter connector (flame propagation) tube,
- which was a necessary part of the can type combustion chambers.

Since each can is a separate burner operating independently of the other cans:

- there must be some way to spread combustion during the initial starting operation

This is accomplished by :

- interconnecting all the chambers

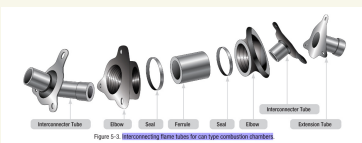


Figure 5-3. Interconnecting flame tubes for can type combustion chambers

As the flame is started by the spark igniter plugs in two of the lower chambers:

- it passes through the tubes
- and ignites the combustible mixture in the adjacent chamber,
- and continues until all the chambers are burning

The flame tubes vary in construction details from one engine to another, although the basic components are almost identical

The spark igniter's previously mentioned are normally :

- two in number
- and are located in two of the can type combustion chambers

An important requirement in the construction of combustion chambers is providing the means for

- draining unburned fuel.

This drainage prevents gum deposits in the

- fuel manifold
- nozzles
- combustion chambers.

These deposits are caused by the

- residue left when the fuel evaporates

most important is the danger of
- after fire
- if the fuel is allowed to accumulate after shutdown.

If the fuel is not drained
- a great possibility exists that, at the next starting attempt,
- the excess fuel in the combustion chamber will ignite and exhaust gas temperature will exceed safe operating limits.

liners of the can type combustors have perforations of
- various sizes and shapes,
- each hole having a specific purpose and effect on flame propagation within the liner.

The air entering the combustion chamber is divided by the:
- proper holes,
- louvers,
- slots into two main streams–primary and secondary air

The primary or combustion air is directed inside the:
- liner at the front end, where it mixes with the fuel and is burned

Secondary or cooling air passes between the:
- outer casing and the liner and joins the combustion gases through larger holes toward the rear of the liner, cooling the combustion gases from about 1 900°C to near 800°C.

Louvers are also provided along the axial length of the liners to :
- direct a cooling layer of air along the inside wall of the liner

To aid in atomization of the fuel, holes are provided :
- around the fuel nozzle in the dome or inlet end of the can type combustor liner

Some provision is always made in the combustion chamber case for
- installation of a fuel nozzle.

The fuel nozzle delivers the fuel into the liner in a
- finely atomized spray.

The more the spray is atomized,
- the more rapid and efficient the burning process is.

Two types of fuel nozzle currently being used in the various types of combustion chambers are the
- simplex nozzle
- duplex nozzle.

2, CAN ANNULAR COMBUSTION CHAMBERS

The spark igniter plugs of the can annular combustion chamber are the same basic type used in the can type combustion chambers, although construction details may vary

There are usually two igniter's mounted on the boss provided on :

- each of the chamber housings

The igniter's must be long enough to :

- protrude from the housing into the combustion chamber.

The burners are interconnected by :

- projecting flame tubes

This type of combustion chamber is: first deference

- not used in modern engines.

The forward face of each chamber presents six apertures which align with the :

- six fuel nozzles of the corresponding fuel nozzle cluster

These nozzles are the :

- dual orifice (duplex) type

requiring the use of a :

- flow divider (pressurizing valve), as mentioned in the can type combustion chamber discussion

Around each nozzle are : second deference

- pre-swirl vanes
- for imparting a swirling motion to the fuel spray,
- which results in better atomization of the fuel, better burning, and efficiency.

The swirl vanes function to provide two effects imperative to proper flame propagation:

1, High flame speed better mixing of air and fuel, ensuring spontaneous burning.
2, Low air velocity axially swirling eliminates overly rapid flame movement axially.

The swirl vanes greatly aid flame propagation:

- since a high degree of turbulence in the early combustion and cooling stages is desirable.

The can annular combustion chambers also must have the required :

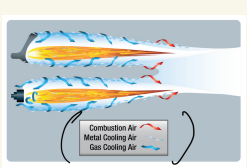
- fuel drain valves located in two or more of the bottom chambers

The flow of air through the holes and louvers of the can annular chambers:

- is almost identical with the flow through other types of burners.

Special baffling is used to :

- swirl the combustion airflow and to give it turbulence.



3, ANNULAR TYPE COMBUSTION CHAMBERS

The basic components of an annular combustion chamber are a :

- housing and a liner, as in the can type

The liner consists of an: first deference

- undivided circular shroud extending all the way around the outside of the turbine shaft housing

The chamber may be constructed of heat resistant materials, which are sometimes:

- coated with thermal barrier materials, such as ceramic materials

Modern turbine engines usually have an:second deference

- annular combustion chamber

the annular combustion chamber also uses:

- louvers and holes
- to prevent the flame from contacting the side of the combustion chamber

Figure 5-6. Annular combustion with chamber ceramic coating.

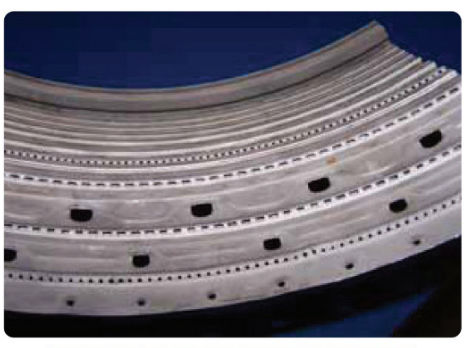


Figure 5-7. Combustion chamber louvers and holes.

OPERATION OF COMBUSTION CHAMBERS

COMBUSTION CHAMBER PERFORMANCE

A combustion chamber must be capable of :

- allowing fuel to burn efficiently over a wide range of conditions without incurring a large pressure loss

In addition, if the flame is extinguished, it must be possible to:

- relight

In performing these functions, the flame tube and spray nozzle atomizers must be:

- mechanically reliable

Because the gas turbine engine operates on a constant pressure cycle, any loss of pressure during combustion must be:

- kept to a minimum

In providing adequate turbulence and mixing, a total pressure loss of:

- from 3-8% of the pressure at entry to the chamber is incurred