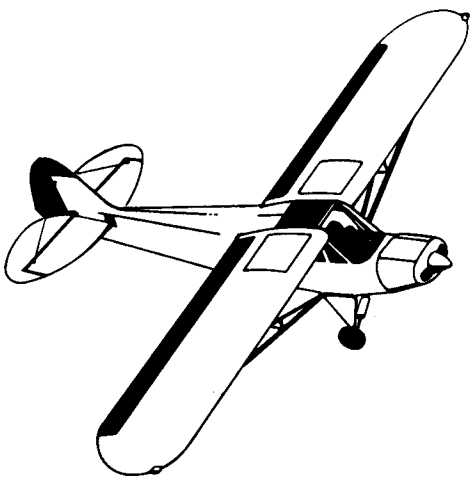
POWER FOR FLIGHT

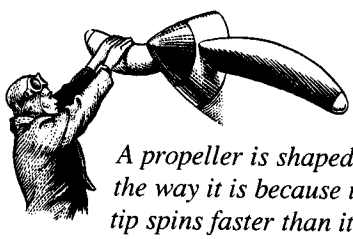
Man's failure in his early attempts at flight were due primarily to two obstacles: First there was a lack of understanding of the basic principles of flight and equally the lack of a suitable power source. It became apparent that man could not develop enough muscle power to lift and propel himself to achieve flight.

The light weight 4-cycle reciprocating engine powering a propeller became, and still is, the most common source of power for the smaller aircraft.

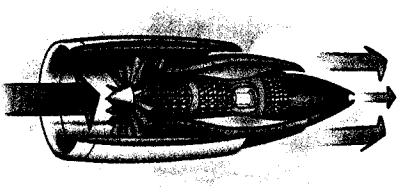
Larger transport aircraft are using the more powerful gas turbine or "jet" engines. These engines have made possible the transport of heavy payloads at very high speeds.

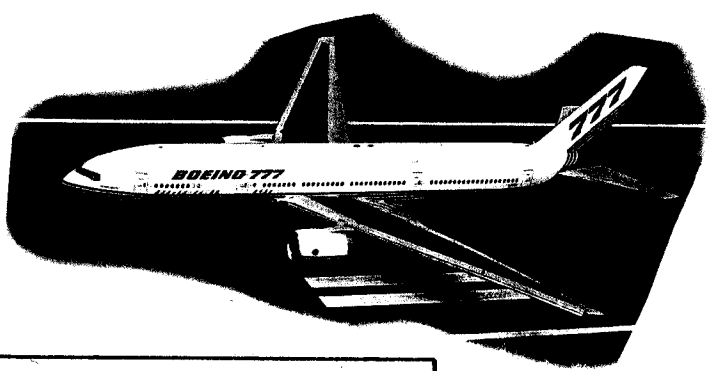
Supersonic flight exists today, but new engine designs are in process which will make hypersonic flight a reality in a few years.

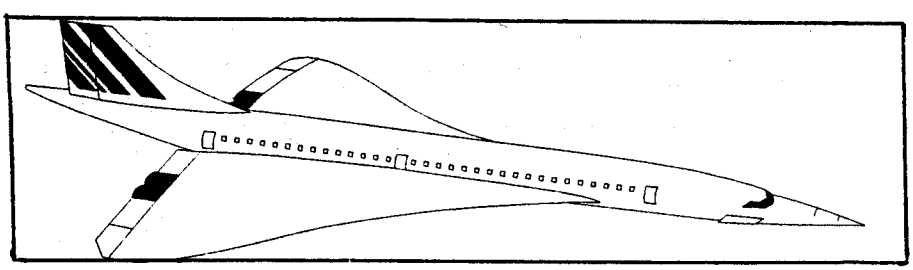




A propeller is shaped the way it is because its tip spins faster than its hub. A twisted blade makes the pitch shallow at the tip and steep at the hub. This gives a propeller even thrust from one end of the blade to the other.





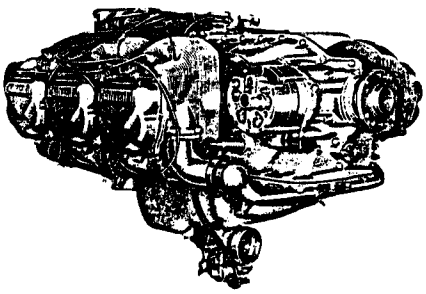


THE RECIPROCATING ENGINE

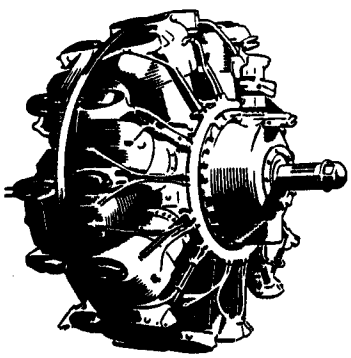
THE MOST COMMON TYPE OF ENGINE TO POWER SMALLER AIRCRAFT IS THE RECIPROCATING ENGINE. THEY OPERATE WITH PISTONS IN A CYLINDER AND ARE A FOUR STROKE INTERNAL COMBUSTION TYPE.

THE NUMBER OF CYLINDERS MAY VARY FROM 4 TO 28 AND BE RATED FROM 65 TO 3500 HORSEPOWER. THE LARGER ENGINES HOWEVER, ARE MOSTLY REPLACED TODAY BY THE JET ENGINES.

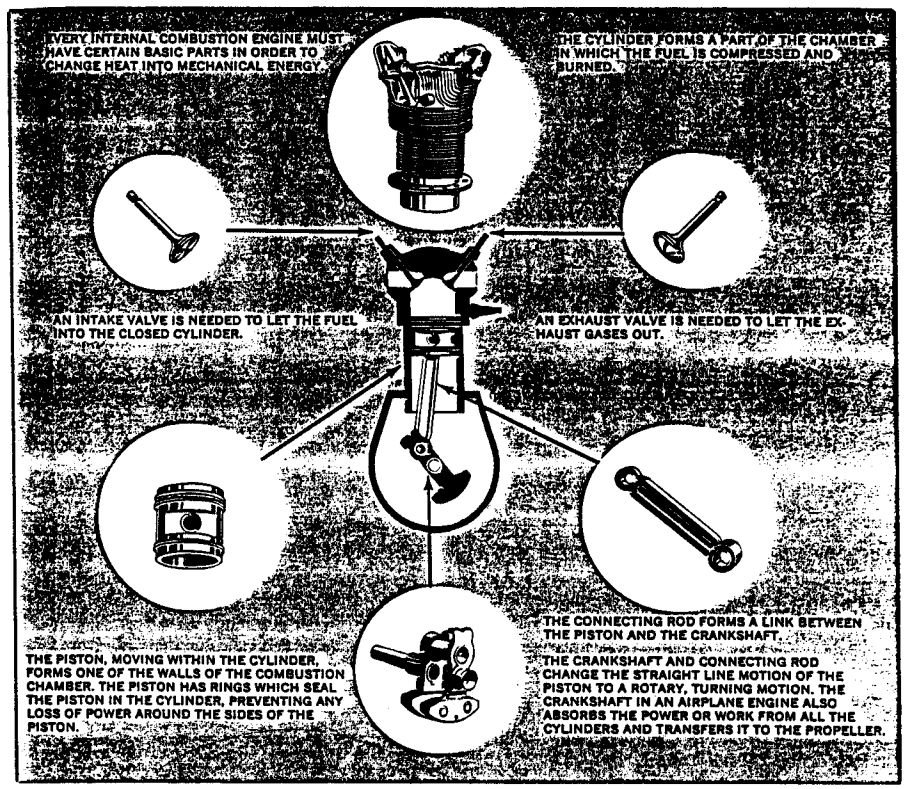
RECIPROCATING ENGINES GENERALLY AS USED BELOW 15,000 FEET DUE TO THE THINNING OF THE ATMOSPHERE. SOME OF THESE ENGINES ARE EQUIPPED WITH TURBO-SUPERCHARGERS WHICH COMPRESSES THE AIR INTAKE FOR THE ENGINE.



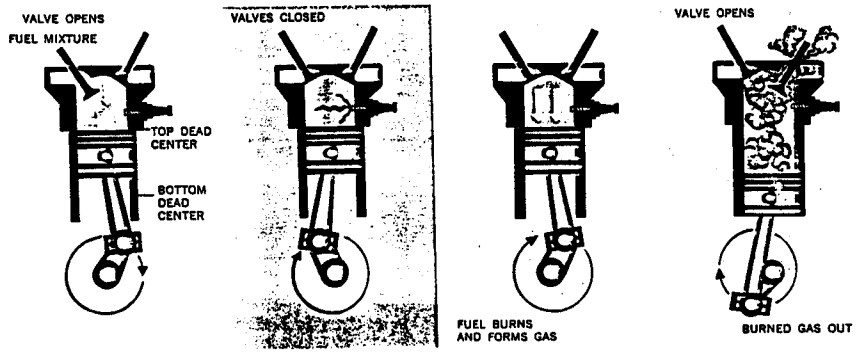
A modern 285-hp horizontally opposed engine.



A typical radial engine.



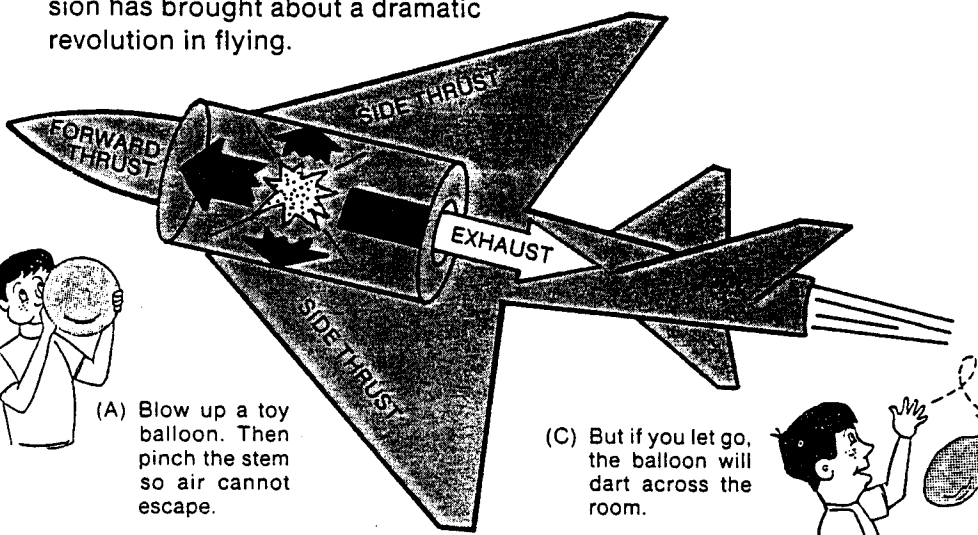
Several cylinder assemblies *(above)* are attached to a common crankcase to make up the reciprocating engine. The four-stroke engine cycle *(below)* generates mechanical energy.



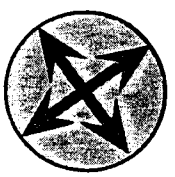
INTAKE (Down) **COMPRESSION** (Up) **POWER** (Down) **EXHAUST** (Up)

JET PROPULSION

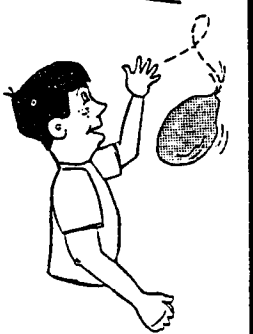
Jet propulsion is created by the rearward expulsion of matter in a jet stream. Jet propulsion is used to drive aircraft and missiles. Jet propulsion has brought about a dramatic revolution in flying.



(A) Blow up a toy balloon. Then pinch the stem so air cannot escape.

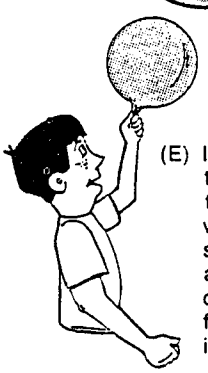


(B) The air pressure inside the closed balloon is equal in all directions.

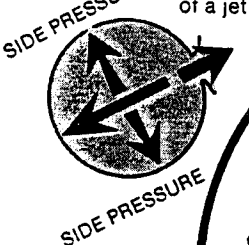


(C) But if you let go, the balloon will dart across the room.

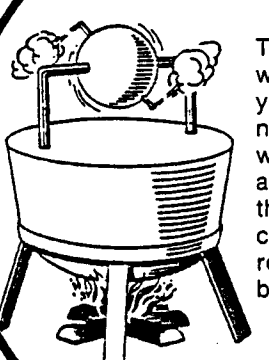
(D) Escaping air releases inside pressure on this side. This is the same as the exhaust action of a jet engine.



(E) Inside pressure on this side pushes the balloon forward. This is the same reaction of air pressure that drives a jet engine forward from within.



JET ENGINE EVOLUTION

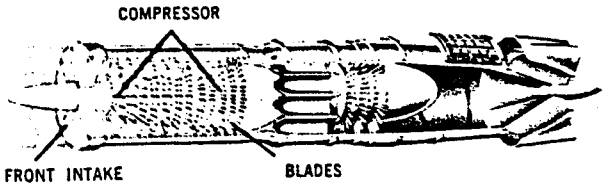


The first jet engine was invented over 2,000 years ago by an Egyptian named Hero. The engine was called an aeolipile and ran by steam. When the water boiled inside the closed kettle, the steam rose through pipes into a ball. Jet steam was expelled from bent tubes attached to the ball. The expelled steam caused the ball to spin around rapidly.

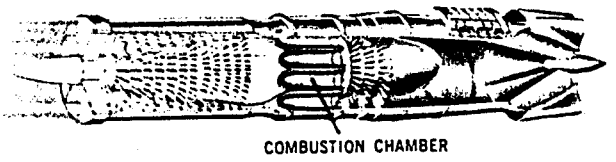
PRINCIPLE OF JET PROPULSION

When gases are compressed in a jet engine, forces are exerted in all directions. The sideward forces, or thrust, equalize each other because they cannot escape from the engine. However, the gases escaping out the rear allow the forward force to act and the plane to move forward. This principle can be demonstrated by blowing up a toy balloon. When the air is released from the balloon, the propulsion of the balloon is much the same as jet exhaust from a jet engine.

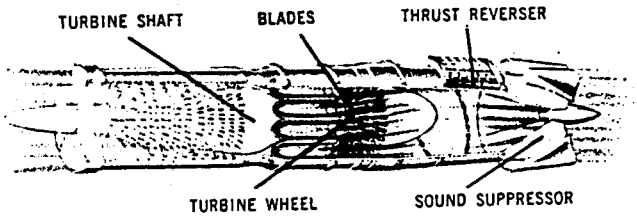
HOW THE JET ENGINE WORKS



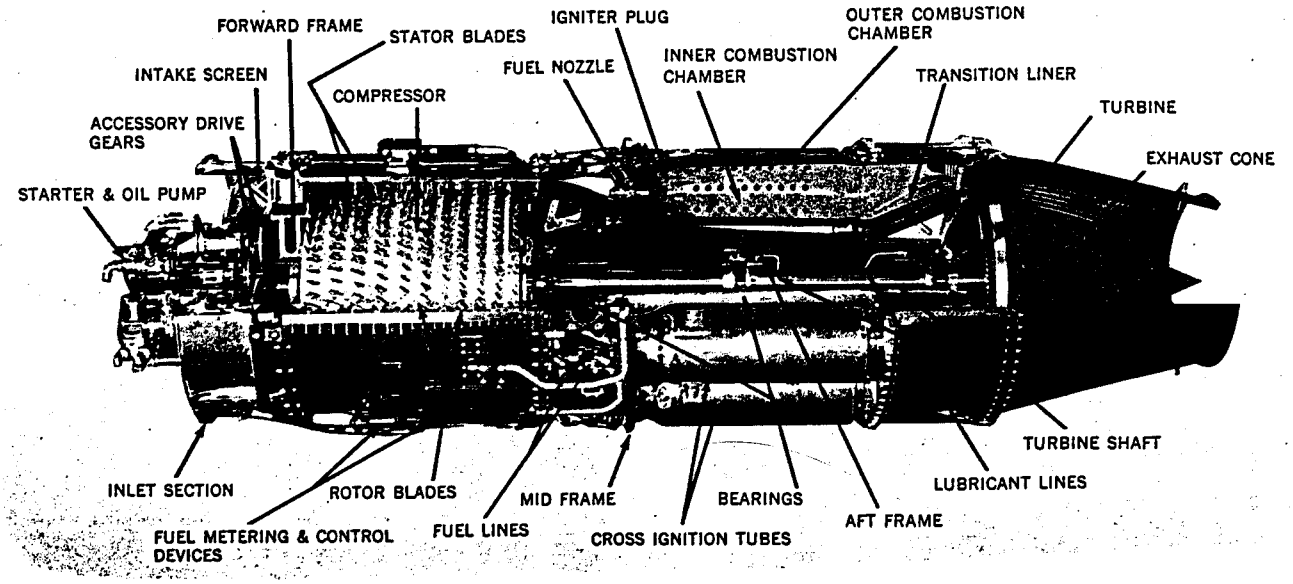
Air is sucked into the engine through the front intake. The compressor, acting like a large fan, compresses the air to more than 12 times atmospheric pressure and forces it through ducts to the combustion chambers.



In the combustion chambers, fuel is sprayed into the compressed air and ignited. The burning gases expand rapidly and blast their way toward the rear of the engine. The speed of these expanding gases causes a reaction equal in force to the change in the speed of the air rushing through the engine. This reaction becomes the engine's forward thrust.

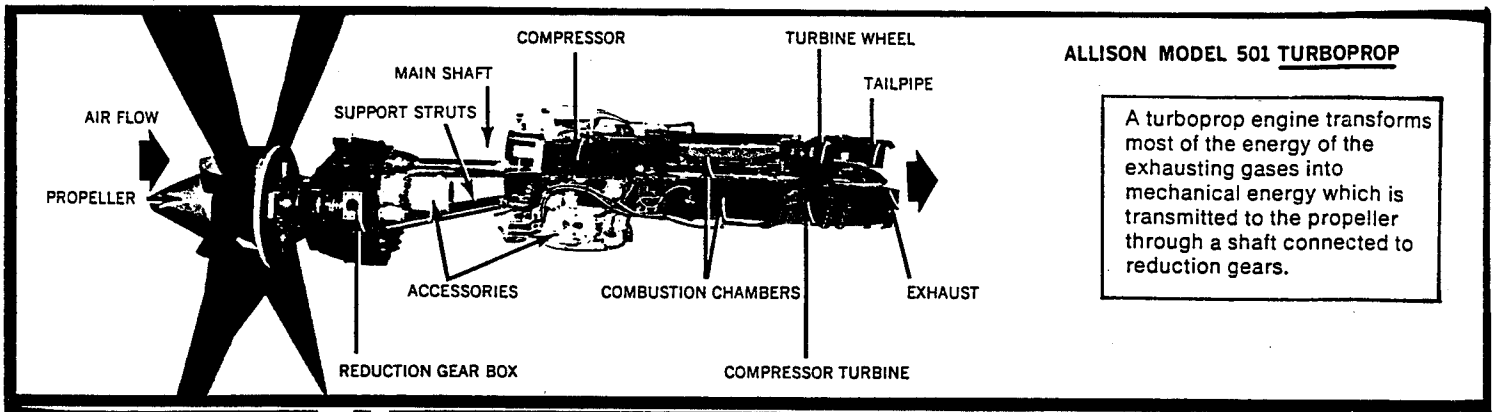


As the hot gases rush out of the engine, they pass through a fan-like set of blades which make up the turbine wheel. These blades react like a windmill and turn the turbine shaft. This turning power is transmitted to the compressor which packs in more fresh air. At the rear of some engines, such as the GE CJ-805-3, are a sound suppressor and a thrust reverser. The sound suppressor acts like a car muffler. The thrust reverser consists of a pair of clam-shell doors which, when closed, reverse engine thrust and provide powerful braking action.



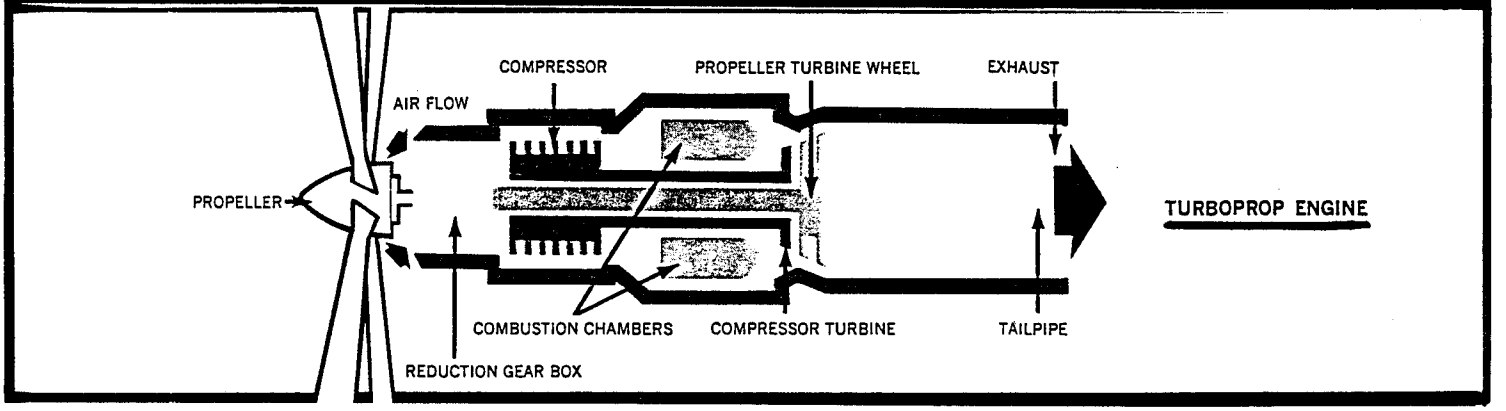
NOTE: What is thrust? One pound of it equals one horsepower when traveling at 375 miles per hour. Horses don't travel this fast, but that is the easiest way to describe jet power.

New jet engines can produce 90,000 pounds of thrust. Can you find a way to explain how much power this would be in terms of most automobiles?



ALLISON MODEL 501 TURBOPROP

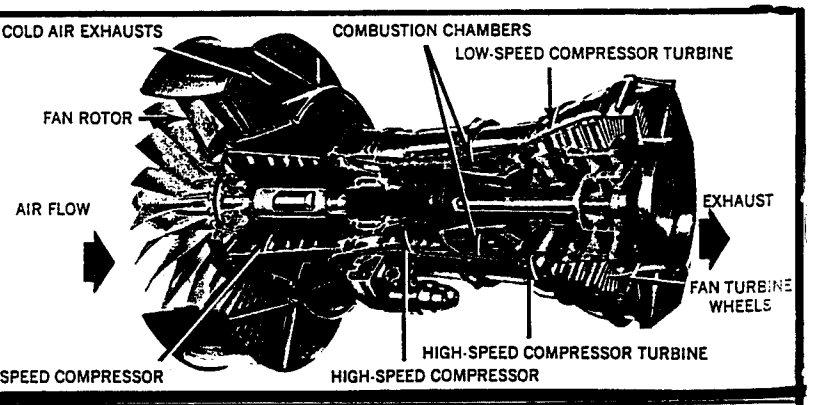
A turboprop engine transforms most of the energy of the exhausting gases into mechanical energy which is transmitted to the propeller through a shaft connected to reduction gears.

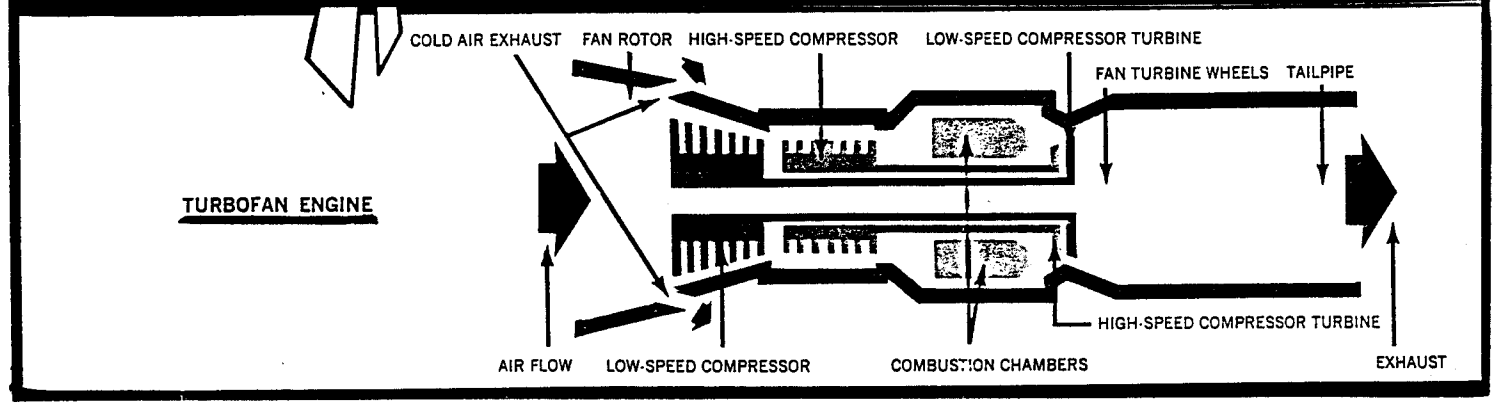


TURBOPROP ENGINE

ROLLS-ROYCE RB. 207 TURBOFAN

A turbofan engine produces increased thrust by a large cold-air fan accelerating and expelling a large volume of cool air in a process separate from regular engine operation.





TURBOFAN ENGINE