ENGINEERING

Engines of the Future

Turbine, rocket motors developed during the war for fighting planes will power transports of tomorrow and give America the speed it craves.

By A. C. MONAHAN

➤ NEW ENGINES developed for fighting planes during the war will power transports of tomorrow and give air-minded America the speed it craves. They include the gas-turbine, father of the jets — turbojet, motorjet, ramjet, pulsejet, turboprop and turbofan—and several types of rocket motors.

Speed means high-altitude flying, even at heights way above the atmosphere surrounding the earth. Ordinary jet planes operate only in the oxygen-bearing air. Rocket motors can operate above the air because they carry their own oxygen for fuel needs.

Low-altitude aircraft in the future may use gas-turbines operating propellers, or they may continue to use the conventional reciprocating engine with its pistons pumping forward and back inside explosion chambers called cylinders. Some planes may be equipped with propellers for low flying and jet propulsion for high altitudes. In fact one installation, the propjet, has already been built and tested that operates propellers when desired and gives jet propulsion at will.

The gas-turbine is not a jet-propulsion engine but from it the jet engine of today was developed. It rotates a shaft which turns ordinary giant fan-like propellers just as does the reciprocating engine. But all moving parts in it move constantly in the same direction, thus eliminating vibration. Also it is a light and powerful unit.

Similar to Steam Turbine

Gas-turbines are somewhat similar to the well-known and long-used steam turbines in which high-pressure steam escapes through many fan-like blades or vanes mounted on a drum causing them and the drum to rotate at high speed.

In the steam turbine, fuel is burned to generate the steam. In the gas-turbine, fuel oil is burned at nozzles, making a rapidly expanded gas that passes directly through the hundreds of vanes on the turbine, imparting to the drive shaft a rapid and powerful rotation.

The principle of the gas-turbine has been known for years, but the development of a successful engine of this type had to await the development of alloy metals that would stand up while operating red hot. Gas-turbines reach their greatest efficiency only at extreme heat. Alloy metals to stand this heat were found in developing turbo-superchargers to supply conventional engines with sufficient atmospheric oxygen at high altitudes.

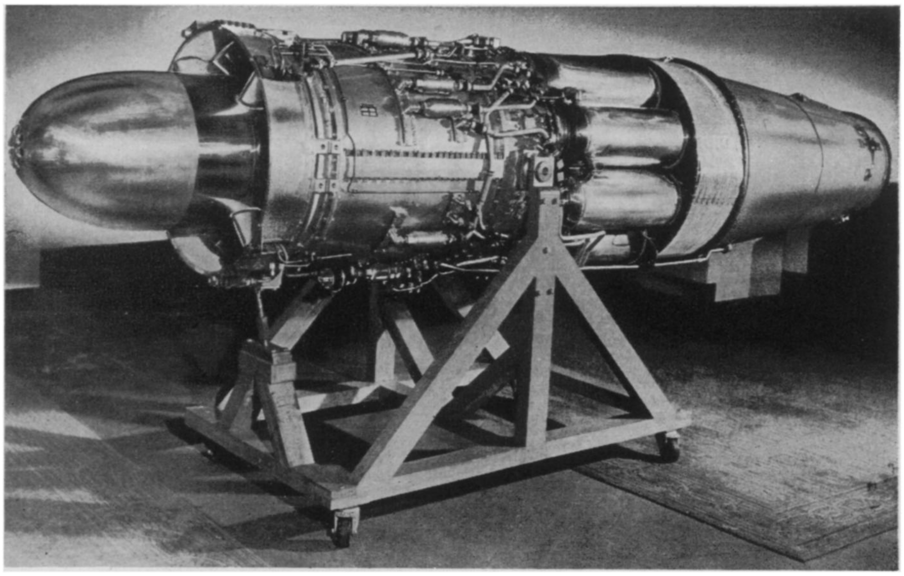
The principle behind jet propulsion is easily understood. First, it is *not* the result of a blast of hot gas pushing against a cushion of air behind the plane, as is commonly supposed. It is the result of a rapidly created gas, seeking room to expand, pushing against the forward end of the combustion chamber in which it is created. If it depended upon pushing against air behind it, jet propulsion would be inefficient in thin air and rockets could not travel above the atmosphere.

Imagine a cyclinder with very strong walls through which a spark plug is inserted, as in an automobile, and within which atomized gasoline and air are confined. By means of the spark plug. and an electric spark, the gasoline is exploded. That means that it is almost instantaneously burned, uniting chemically with the oxygen in the enclosed air and forming a gas that normally requires much more space than there is within the cylinder. The newly-formed gas remains under a heavy compression and would burst the cyclinder if it was not very strong. It exerts a heavy but equal pressure on every square inch of its confining walls.

Now suppose the cylinder has a small opening at one end, and the sudden pressure is created. At the hole there is no wall for the gas to press against, so instead of equal pressures on the two ends, one has a pressure approaching zero. The pressure on the other end tends to force the cyclinder to move in its direction.

"Jet propulsion is in its infancy despite the fact that this war has evolved six distinct methods of utilizing atmospheric oxygen for propulsion," says Gen. H. H. Arnold in his recent report as commander of the Army Air Force. The names of the six are included in the list given above.

The motorjet is a reciprocating engine plus a ducted fan. The turboprop is a



FOR SPEED—Streamlined like a torpedo, this new engine for jet propulsion, developed by General Electric, will speed planes well in excess of 500 miles an hour.

gas-turbine plus propellers. The turbofan is a gas-turbine plus a ducted fan. The turbojet is a gas-turbine plus jet. The ramjet gives a continuous jet with compression by an aerodynamic ram, and the pulsejet is an intermittent jet.

The pure jet-propusion engine utilizes no whirling propellers. It is the engine of the new Army plane, the P-80 Shooting Star, built by Lockheed. The engine is a product of General Electric, and is said to be the simplest, most easily maintained, and one of the most powerful aircraft engines ever built.

The Shooting Star can operate only within the atmosphere as air is required for its engine. The air enters near the front and is compressed by a high-velocity blower which forces it into the combustion chamber. There it mixes with the kerosene fuel, which is injected at high pressure, and combustion takes place. The mixture is burned in a continuous explosion heating the gases and expanding them violently.

These gases rush to the rear and escape through jet nozzles, passing en route through the vanes of a gas-turbine wheel imparting high velocity to it. The turbine operates the compressor blower for the compression of the incoming air.

Simple Ignition System

There is no complicated ignition system in the engine. A spark plug sets off the initial explosion, but once the engine is started a small glow plug becomes white hot and continuously ignites the fuel and air mixture.

Streamlined like torpedoes, the newest of turbojet engines, designed for speedy long-range flights, will fit more snugly into the wings of a plane than any powerful reciprocating engine. They are the axial flow type, with their principal units in a direct line.

In operation, air rams into the relatively small diameter axial flow compressor, and, after compression, is forced almost in a direct line back into combustion chambers. The gases resulting from combustion are expanded through the buckets of a turbine, then pass out through the jet exhaust to furnish the reaction to drive the plane.

Rocket motors can operate above the atmosphere because they carry their own oxygen and are independent of a supply from the air. They carry it, not as compressed oxygen in tanks, but in oxygen-yielding chemical compounds, known technically as oxidizers, mixed with the fuel. The mixture burns with sufficient rapidity to give high velocity to the escaping gas. In some cases the fuel and oxidizer are mixed before use and are made in the form of "grains." A grain is an extruded stick, made from a paste-like mixture and may be several feet in length. Grains must be free of flaws or air pockets to insure an even rate of combustion. In plants where they are made they are examined by X-ray equipment to make certain that they are flawless.

Powered Robot Bombs

The jet-reaction engine known as the liquid-propellant rocket motor is the type that powered German V-2 robot bombs in the last days of the European war. It utilizes a liquid fuel injected as used into a combustion chamber, and for this reason, its operation cannot be compared with the powder- or solid-propellant rocket motor whose entire charge of fuel is lodged in the combustion chamber.

The liquid-propellant rocket motor can be repeatedly operated for long periods of time by merely replenishing the fuel and oxygen-carrying compound. Basically it consists of an injector somewhat similar to the carburetor in an automobile reciprocating engine, a combustion chamber, nozzle and a cooling jacket. The injector is made up of two chambers, one to feed the oxygen-carrying compound, the other to feed the fuel which may be any hydrocarbon.

A new experimental engine, claimed to be the smallest engine in the world today, was demonstrated recently in America by its inventor, a Polish scientist and rocket expert. It is a ramjet motor of a new and unusual design. It was designed to help launch gliders into the air.

This new engine consists of a cylindrical tube, which appears to be just a pipe, mounted on a restraining structure which has a free moving arm to permit the engine to swing in a circle around it when in operation.

The tube has a lining, a topless cone in shape, which opens from a smaller diameter in the front end to a larger diameter at the other. The space between the lining and the outer wall contains the gas which runs into a nozzle at the forward end of the cylinder. Air mixes with the gas coming through the small holes of the nozzle and combustion then takes place, thus providing the force of propulsion.

Gas-turbine engines driving propellers will replace conventional reciprocating airplane engines in all planes designed to travel at speeds under 500 miles an hour and at altitudes less than some 30,000 feet, predicted Hall H. Hibbard of the Lockheed Aircraft Company recently.

For higher speeds, he said, speeds of from 500 to 1500 miles an hour, pure jet engines without propellers will be used. With rocket engines, fighters and bombers of future years will be able to fly above the earth's atmosphere at practically any speed desired.

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