ENGINEERING

Jets Power Future Flying

Jet research holds promise for peacetime air travel. Four types of jets are making obsolete the best conventional planes with internal combustion engines.

By WATSON DAVIS

➤ THERE'S POWER in roaring flames—whether in a windswept forest fire, your oil burner, or a jet plane of the future.

There's simplicity in a stream of speedy gas pushing an airplane forward.

Jets with their simple power are revolutionizing travel through the air—for peaceful transport or for atomic war if we fail in our attempt to get along with the other peoples of the world.

Applying jet propulsion to our airplanes is the high priority task for our research laboratories today. Already the P-80s, with turbine-jet engines, have made obsolete the best conventional fighter planes with the best internal combustion engines. Jet bombers are being flown experimentally. Jet transport planes are on the drawing boards.

The reciprocating, spark-fired internal combustion engine feeding on gasoline (look under the hood of your automobile to see one) has a rival that may drive it out of the air.

Four Types of Jets

There are four different types of jet-propulsion units:

The turbo-jet and turbo-propeller-jet engines, which operate through the principle of the gas turbine.

The pulse-jet, used by the Germans as the propulsion unit of the V-1 "buzz" bomb.

The ram-jet, currently undergoing rapid development for use on guided missiles or other highspeed transportation.

The rocket, most highly developed in the German V-2 weapon.

Only the turbo-jet and turbo-prop-jet engines rely upon gas-turbine-driven compressors to compress the intake air. The pulse-jet and the ram-jet use oxygen of the air for burning their fuel, but compress the air by their speed. The rocket supplies its own oxygen and thus can go outside the atmosphere.

The principle of the combustion gas turbine is not new, but it makes possible the development of turbo-jet and turbo-prop-jet engines for aircraft. The future of marine and railroad locomotive propulsion will feel its impact. History is full of attempts to develop a satisfactory gas turbine. Early experimenters were unsuccessful. They were handicapped both by lack of knowledge which would permit design of efficient compressors and turbines, and by lack of the proper materials of construction.

War Spurred Research

The wartime need for greater and greater speed in aircraft prompted intensive research that before and during the war increased our knowledge of aerodynamics. Metals were devised that would stand up for extremely high temperatures. This made possible the development of the gas turbine, in the form of the turbo-jet engine, for aircraft. This new type of engine is one of the outstanding developments since the Wrights flew the first heavier-than-air machines.

The design of the combustion gas turbine is simple. There is only one major moving part, a rotating shaft on which is mounted an air compressor and a turbine rotor. The compressor supplies air to the combustion chambers where fuel is burned continuously to increase the energy content of the compressed air by heating it. The resulting hot gases are then expanded through a turbine. The turbine rotor and shaft revolve. In the case of the turbo-jet engine, only sufficient energy is recovered by the turbine to drive the compressor, and the hot gases leaving the turbine are exhausted through nozzles to form the jet. The reaction to the jet propels the aircraft as a result of the increase in momentum of the air stream due to its rise in temperature and volume as it passes through the unit.

In the prop-jet engine, the greater part of the energy available in the hot gases from the combustion chamber is recovered by the turbine. The power thus available, over and above that required to drive the compressor is utilized to drive an air screw propeller, in the case of high-speed aircraft.

Great amounts of fuel and air consumed by the gas-turbine engine in developing its great power are astounding. Philetus H. Holt, a research director of the Standard Oil Development Co., has figured that a turbo-jet engine developing 4,000 pounds thrust, equivalent to 4,000 horsepower at 375 miles per hour, will require more than 4,000,000 cubic feet of air in an hour. At this rate, all the air in a typical six-room house would be exhausted in about nine seconds. Approximately 20 barrels of fuel are burned each hour—enough fuel, if it were gasoline, to drive an automobile 12,000 miles at a speed of 60 miles per hour, or, if heating oil, enough to heat a typical six-room house for two-thirds of a heating season.

Heat is released in the combustion chambers of the turbo-jet engine at the rate of about 20,000,000 Btu. per hour per cubic foot of combustion zone, which may be compared with a rate of one to two million Btu. per hour per cubic foot in the case of industrial furnaces. This great development of power is accomplished with a freedom from vibration unknown in reciprocating engines.

High-Speed Engine

Where fuel economy is of secondary importance, the turbo-jet engine far surpasses the conventional reciprocating engine when high speed at present altitudes is necessary, as is the case in fighters, interceptors and fast attack bombers. When pressurized cabins are used combined with turbo-jet power at very high altitude, fast, long-range commercial transports will be attractive to airlines. At altitudes of 40,000 feet or higher the turbo-jet unit is much more economical of fuel than at low altitudes.

Long flights of 3,000 miles, which presently take 12 to 14 hours, will be made in six to seven hours. Equipment and pilots will do double jobs; passengers will get there faster.

The turbo-propeller-jet power plant has the possibility of competing directly with the conventional reciprocating engine at present-day speeds, since improvements in design should soon give fuel economy and operating life equivalent to those of the reciprocating engine.

How soon will your airlines ticket give you such flight? Some estimate they will come in three years, others in five years and others still 10 years or longer. The rapidity of their introduction, say the engineers, will be in direct proportion to the amount and calibre of the effort expended in research and development.

Turbo-jets will do their job at double the speeds of present airlines, but aviation will turn to the ram-jet to surpass the speed of sound.

Speeds twice the speed of sound, some 1400 miles per hour, have been achieved for short flights by the "flying stove-pipe."

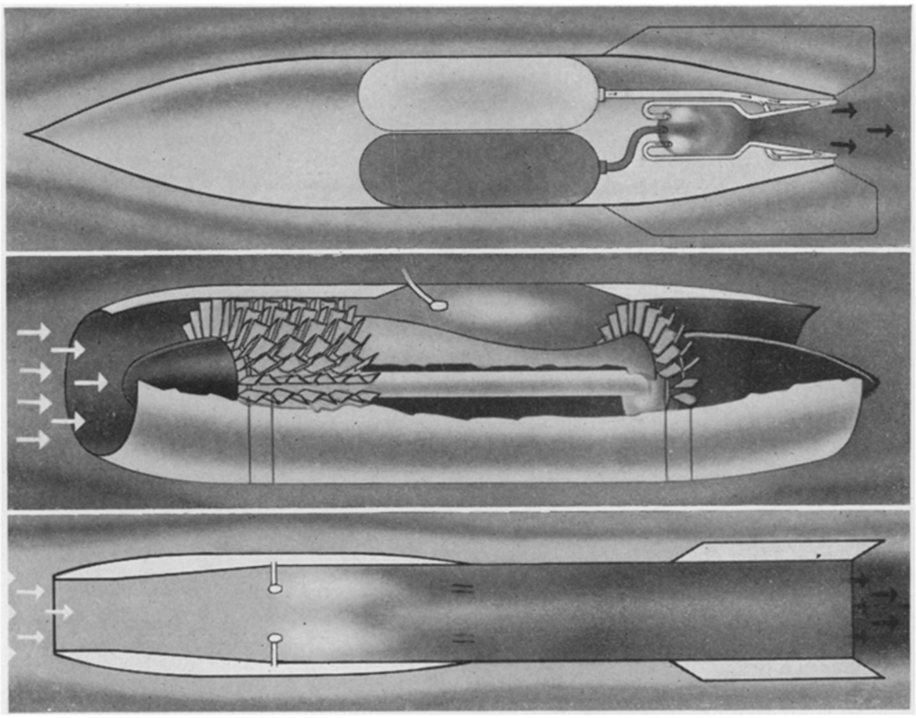
Jap Kamikaze "suicide" planes sparked the post-haste development of the ram-jet to power the Navy's "Bumblebee" anti-aircraft weapon that would have been shooting them down if the war had lasted.

The ram-jet idea is not new, although, like other modern jet engines, it is 20th century in its conception. Rene Lorin, a Frenchman, proposed in 1908 the use of the internal combustion engine exhaust for jet propulsion, and in his scheme the engine did not produce power in any other way. Five years later he described a jet engine where the air was compressed solely by the velocity, or ram, effect of the entering air. This is the ram-jet.

The nickname of the ram-jet, "flying stove-pipe," describes what it looks like. It is a cylindrical duct, with a varying diameter. The air enters through a tapered nosepiece and it comes in at a speed above that of sound. The ram-jet is only efficient when it goes through the air at speeds higher than the speed of sound, which is about 700 miles per hour. In the military version of the ram-jet, it is launched and brought up to speed by rockets which soon burn themselves out and give way to the ram-jet itself.

Air entering the tube when the ram-jet is in flight is slowed down to below the speed of sound. The air mixes with the fuel. The very simple device for doing this is at present one of the secrets in the ram-jet, as applied as an anti-aircraft weapon. The diffuser in the air duct stabilizes the flame and the combustion of the gases increases very rapidly through the duct. Just to the rear of the ram-jet the gases attain a speed of up to 2,000 miles per hour.

When supersonic transportation of mail, express and ultimately passengers is contemplated, the ram-jet offers a



JET POWER—Carrying both fuel and oxygen (shown in the white and dark compartments respectively, top), rockets do not depend upon the earth's atmosphere for combustion of the fuel. The turbo-jet exhaust (center) supplies reaction power for the jet-propulsion. With both rotating and stationary blades at the back of the engine, the exhaust turbine operates the air compressor with similar blades but at the front of the engine. Air is rammed through the nose of the ram-jet (bottom), heated by flaming fuel and discharged through the tail.

motor of great promise. The present military development of this device is by commercial and industrial agencies, under sponsorship of the Bureau of Ordnance of the Navy, with the coordination of the Applied Physics Laboratory of the John Hopkins University. This development may influence peacetime transportation of the future world.

In the future, liquid fuels that are produced from petroleum will be made to fit the requirements of jet engines. Particular fuel requirements for the turbo-jet engine may even bring kerosene and other distillates heavier than gasoline back into prominence.

During the war some of the jet planes were designed to burn kerosene while other jet devices operated on hundred octane gasoline. Such high octane gasoline was not actually necessary but due to the fact that much of the aviation fuel in the war areas was high octane, it was used to simplify the problem of supply.

If jet planes were used in another war emergency, a fifth of the U. S. petroleum refining capacity would be used for making jet fuels, Robert P. Russell, president of the Standard Oil Development Co., estimated recently. Designing of fuel that can be used in a variety of jet motors is as important as designing jet motors themselves. Military specifications are now being considered that will cause more of the fractions of petroleum to be used in making jet fuel. This may prove to be one of the most important decisions affecting flying power for the future.

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• Books of the Week •

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American Aviation Directory:—Spring and Summer 1947— Wayne W. Parrish, ed.,—*Am. Aviation Assoc.,* 620 p., paper, $5. Aviation officials and companies of the United States, Canada, Latin America, Africa, Europe, and Australasia.

Brassey's Naval Annual 1946—H. G. Thursfield—*Macmillan,* 282 p., illus., $6. A record of the peak strength of wartime navies of U. S. and Great Britain as well as an analysis of their present state and losses sustained.

The Doctor Recommends—C. O. Young —*Wetzel,* 319 p., $2.50. This story of the history of some phases of medicine reads like a novel; with some history for background it deals with medical advances in one doctor's lifetime.

Estimation of the Vitamins; Biological Symposia Vol. XII—W. J. Dann and G. Howard Satterfield, eds.—*Ronald Press,* 531 p., $6.50. A careful presentation of the several methods of vitamin assay with specific reference to all vitamins in a series of essays by specialists in each field.

Inventions and Their Management— A. K. Berle and L. S. de Camp—*Int. Textbook,* 2nd ed., 742 p., illus., $6. The principles and practices governing the technical, legal and business procedures of invention.

Life Through the Ages; A Visual Introduction to the Story of Change in Living Things—R. Will Burnett—*Stanford Univ. Press,* 47 p., illus., paper, $1. This story of the development of the world traces the ages of prehistoric time with their accompanying flora and fauna illustrated, the changes in the earth through the tremendous forces of gravity and temperature, and man's advent upon this scene.

Making the Peace Treaties 1941-1947 —Dept. of State—*Govt. Printing Office,* State Publ. 2774, 150 p., paper, 50 cents. Beginning with the Atlantic Charter, this history of attempts at agreement on peacemaking is of present day significance.

Milk and Food Sanitation Practise— H. S. Adams—*Commonwealth Fund,* 303 p., illus., $3.25. A practical text presenting the essential fundamental principles of sanitary supervision of milk and food supplies and how to accomplish them.

Natural Perfume Materials—Y. R. Naves and G. Mazuyer—*Reinhold,* 338 p., illus., $6.75. Translated by E. Sagarin, this book presents fundamental knowledge concerning material extraction by digestion, enfleurage and volatile solvents.

One Hundred Dermatologic Formulas —Herman Goodman—*Froben,* 62 p., paper, $2. Prescriptions for the treatment of common skin diseases.

The Personality of Animals—H. Munro Fox—*Penguin,* 116 p., illus., paper, 25 cents. A discussion of the development of the senses of animals and their various degrees of intelligence.

Rabies and Its Control—Committee on Animal Health—*Natl. Res. Council,* Circular 126, 12 p., paper, 25 cents. The sixth report of this committee.

Relativity: the Special and General Theory — Albert Einstein — *Hartsdale House,* 168 p., $2.50. Published in 1920, this simplified explanation of the theory of relativity somehow passed unnoticed.

Science in Farming: The Yearbook of Agriculture 1943-1947—U. S. Dept. of Agriculture,—*Govt. Printing,* 944 p., illus., $2. Prepared for farmers, this account of new developments in farm science is both practical and specific and offers a background for the understanding of future research.

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