ASTRONAUTICS

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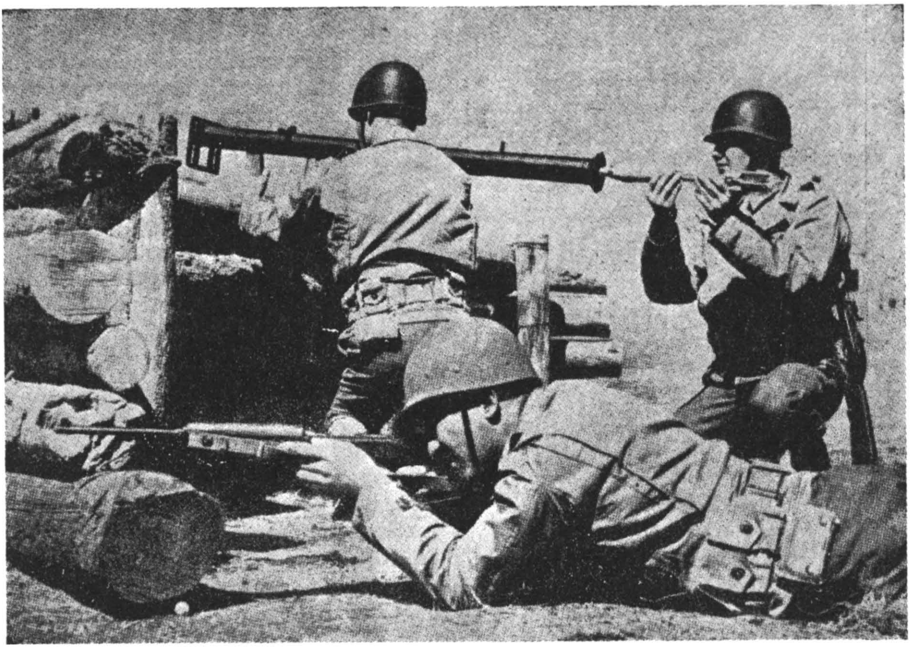


BAZOOKA—Army's lightweight rocket tank blaster. Weighing but a dozen pounds this simple shoulder piece launches a low velocity two and a half pound rocket shell containing a new super explosive. Can knock out a 30 ton tank.

NOTES AND NEWS

During the past few months, as never before, the man-on-the-street has been made aware of rocket propulsion and its many practical military uses. Rocket bombs, anti-tank "Bazookas", aerial rocket cannon, anti-aircraft rockets, jet boost take-off, thermal-air-jet planes — all are receiving daily write-ups in the nations magazines and newspapers. The general descriptions and not-too clear photos released have only whetted the appetites of members of the American Rocket Society.

At the present time many members of this Society are actively engaged in engineering research on jet propulsion — being associated with government research groups or private corporations. No longer is it a secret that the United States armed forces are fully cognizant of the vast potentialities of jet propulsion and are hard at work endeavoring to make up for the earlier start of such countries as England, Russia, Germany and Italy.

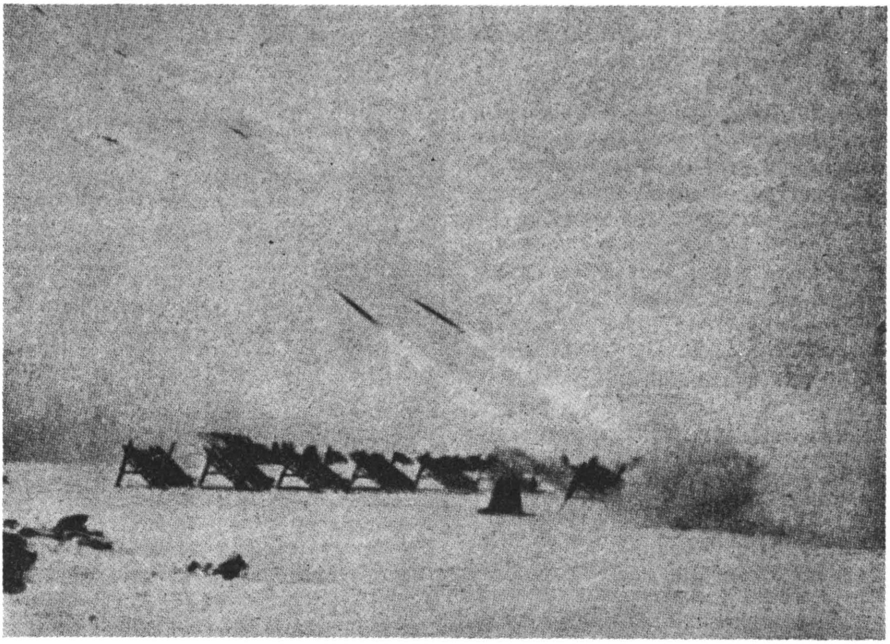
A great quantity of technical data is being accumulated by the various research groups. Much is being learned about rocket ballistics, jet motor design, high-explosive powder fuels, liquid fuels and injection methods, ignition, aircraft installations, rocket cannon design, thermal-air-jet propulsion arrangements and many other ramifications of the rocket propulsion method. As soon as this information is no longer of military value to the enemy ASTRONAUTICS will present authoritative articles on these subjects from the pens of members now participating in the development of these devices. Until that time we ask the reader's indulgence and patience.

Two New Rocket Weapons

BAZOOKA AND KATUSHA BLAST NAZIS

With word from Tunisia that a new anti-tank rocket gun was used most successfully by the U. S. Army in their recent campaign, another rocket-propelled instrument of warfare is added to the evergrowing list. This deadly AT gun, nicknamed by the troops the "Bazooka", is reported to be able to quickly knock medium size tanks and fortifications out of action. Several variations of the weapon are now being placed in production or are undergoing tests at the nation's proving grounds.

The gun is a simplified, light weight, revolutionary in design weapon, designed for use at short ranges. Usually served by two men — one holds the gun on his shoulder while the other inserts the rocket projectile into the rear end of the tube. Once loaded, the loading man steps aside while the first man aims the gun like a rifle and fires by pulling the trigger. Operation of the trigger closes an electric circuit which ignites the propelling charge in the rocket. Under the impetus of the exploding powder



RED ARMY'S ROCKET BARRAGE — VOLLEYS OF HIGH EXPLOSIVE ROCKETS HELPED SAVE LENINGRAD.

the rocket is shot from the tube with accelerating velocity. Tail fins steady the rocket in its course, until it strikes its objective with devastating force. In a pinch one man can operate the Bazooka by himself, by first inserting the rocket then picking up the gun and firing it.

A second rocket weapon has been in use by the Russian Army on the Eastern Front for over a year. Known as the "Katusha", the device was used with great success against the Germany infantry by the defenders of Moscow. The weapon aided at Stalingrad in the destruction of the German 6th Army, and later saw service at Kharkov. Although the Nazis have captured a number of Katushas, the Russians still consider the Katusha a secret war implement and are withholding details.

From the documentary films of the war fronts it appears that the device consists of a platform mounted on the back of a small speedy truck, especially designed for mobility. On top of the platform are fastened a number of firing barrels or chutes, which may be elevated to the correct angle of fire. The firing and loading mechanism is hidden underneath the platform and operated by the crew members. The flaming rocket-shells are discharged from the Katusha in groups of six fired in rapid rounds. The military maneuver usually consists of a number of Katusha trucks driving up to the front line, firing a series of rounds of rockets under the guidance of the specially trained crews, then dashing away.

The designers of the Katusha are believed to be Andrei Kostikov, a military engineer who was awarded the title Hero of Socialist Labor, Vasili Aborenko, a major general of artillery, Ivan Gvai, a military engineer, and Vladimir Golkovski, a designer.

Public interest in rockets was capitalized upon by this advertisement of the R. J. Reynolds Tobacco Company which confuses the Italian Campini plane with a 1932 German Rocket Society motor.

Jet Propelled Helicopters

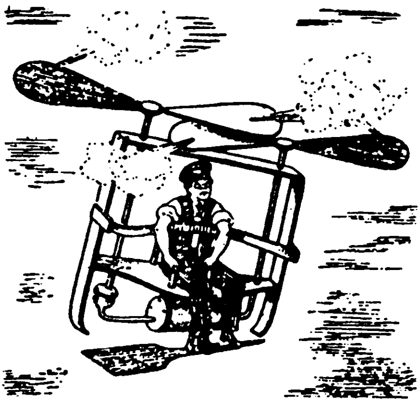
by Cedric Giles

From the end of the fifteenth century, when the famous artist Leonardo de Vince designed the first helicopter, to the present Vought-Sikorsky VS-300 helicopter and its Army counterpart the XR-4, a direct lift flying machine has been dreamed of as the "plane of tomorrow." With the VS-300 successfully solving the problem of vertical ascent and descent the possibility of a practical helicopter for everyday use is vastly increased and may in time supplement if not supersede the present form of airplane. As applied to a type of aircraft sustained by rotors turning on vertical axis, the word "helicopter" is composed of the two Greek words "helix" meaning screw or spiral and "pteron" meaning a wing. The helicopter (as well as airplanes, boats, or other craft with propellers encased in their own supply) is propelled by the reaction of the fluid moved through the propeller rather than the erroneous expression usually given of the propeller screwing its way through the surrounding element similar to a screw in wood.

Application of the rocket principle wherein free jets of air or gas are employed for giving active support to the machine by a direct thrust not only appear to have valuable qualities but also a number of variations of the direct jet method present themselves as worthy of consideration. The use of direct jets for the usual accepted design of helicopters as an auxiliary motivating force would be most essential in providing an additional boost to the helicopter for leaving the ground, for raising the craft above its usual ceiling, and for emergency use in case of failure of the regular engines.

Air Jet Arrangements.

In reviewing the various ways of applying jet propulsion to helicopters, a few appear more novel than practical, while others have enough worth-while qualities to recommend them for further research. A number of interesting ideas are present in the type of design which employs a vertical shaft centrifugal blower system for drawing air from above the helicopter and discharging it



Jet Rotors on Aerial Machine in Old French Print.

with appreciable force. The simplest form is where the air is driven downward and ejected through one or more suitable nozzles giving an upward reaction to the aircraft.

In a second possible arrangement the air instead of being expelled directly downward by the blower fan, is deflected radially by the rotating blades into an outer annular ring surrounding the impeller. Air entering this ring is turned through a second 90° angle downward and is exhausted through deflecting surfaces which give an additional lift to the helicopter and prevents the air from spreading.

Another idea is analogous to the application of Bernoulli's principle in the simple experiment of blowing air through a spool which has a small piece of cardboard covering the spool hole held from sliding sidewise by a common pin. The harder the air is blown through the spool hole the closer the cardboard clings to the spool. A helicopter using this principle would have the air drawn in from above by a blower system in the center of the fuselage. The air after passing through the fan, would make a 180° turn and be forcibly ejected across the top surface of the fuselage in all directions. Due to the difference in air velocities an unbalancing of the air pressures on top and bottom of the fuselage takes place, and the helicopter tends to move towards the lower pressure area or upward.

Combustion Gas Ejection.

The usual proffered prediction that rotor-lifted helicopters will be in time almost as common in urban air traffic as the present automotive ground traffic is questionable. The great mass of air driven downwards by the rotors of a number of machines would create a cyclonic turbulence directly below. The "prop-wash" of helicopters would make the crossing of traffic lanes a dangerous undertaking with stability and control of lower level machines a difficult problem. A partial solution of this may be found through the use of gas combustion ejection. As a helicopter approached a congested center the pilot would disengage the rotors and proceed by jet reaction alone. With the exhaust gases confined within the scope of the craft or at most restricted to a narrow jet any interference with nearby machines would be almost negligible.

When using the so-called "rocket fuels" combinations, gasoline, hydrocarbons, alcohol, or liquefied marsh gas, with liquid oxygen jet exhaust velocities above a mile a second can be attained. Based on the design of present rocket motors, a number of jets could be located at essential points on the craft, each jet having its own individual combustion chamber. The propellants could be fed from a common source controlled by the pilot.

Another method might be where a large single combustion chamber placed in a centralized position on the helicopter supplied a single exhaust jet or fed through piping a number of jets situated at distant points. Besides the usuage of efflux gas jets for ascension, they could be employed for stabilizating and controlling the machine, by intermittent firing or by tilting the jet. A somewhat similar example of this method is used to a large extent on present-day fixed-winged aircraft. In addition to the propelling force of the airscrew, an extra thrust is obtained by ejecting the exhaust gases through nozzled exhaust stacks pointing backward.

Resembling the hot air or thermal jet propulsion system is the arrangement of combining the hot engine combustion gases with an additional quantity of air, and exhausting the entire mass of gases through controlled nozzle outlets. A further development of this system is in the use of thrust augmenters for increasing the jet thrust.

The utilization of the high velocity gases is proposed by Dr. R. H. Goddard, Patent No. 1,809,271, for driving one or more turbine elements which in turn operate aircraft propellers. The invention contemplates the placing of turbine wheels on opposite sides of a gas blast being ejected from a combustion chamber through a nozzle at the rear of the aircraft. The turbine rotors are so located that the propelling vanes project into the gas blast. By shifting the turbine wheels with respect to the gas jet the amount of energy absorbed by the turbine wheels can be varied, until at very high altitudes the turbine elements are dispensed with entirely and the aircraft is propelled by reaction of the gas blast alone.

Similar to the above method is the application of the combustion chamber gases driving a turbine which transmits mechanical energy to the vertical shafts of the helicopter rotors. By directing the impinging jets upon vane surfaces with variable ram the machine could be governed at will. In all cases the various control mechanisms should be so situated as to be accessible to the pilot.

Propeller Jet-Propulsors.

Hero of Alexandria, in 130 B.C., described his "Aeolipile" as a reaction steam motor consisting of a hollow sphere held by trunnions. Steam under pressure entered the globe through a hollow axle and escaped through radial pipes with ends at right angles, causing by reaction a rotation of the sphere "as if it were animated from within by a living spirit."

Based on the same reaction principle is the proposal of Nerst to build a turbine wheel as a single stage compressor and let it operate by pure reaction. As described in Dr. Aurel Stodola's book on "Steam and Gas Turbines", the charge is drawn through the axis into the hollow hub of a two-bladed rotor, compressed by centrifugal force in the hollow propeller blades, ignited either electrically or by other means, and then ejected through nozzles at the arm tips. Dr. Stodola through calculations found that with peripheral speeds as high as 3300 ft. per sec. the overall efficiency would be 24.5%. Emphasis was placed on possible construction difficulties, and the need of the wheel to run in a vacuum to avoid serious rotation loss.

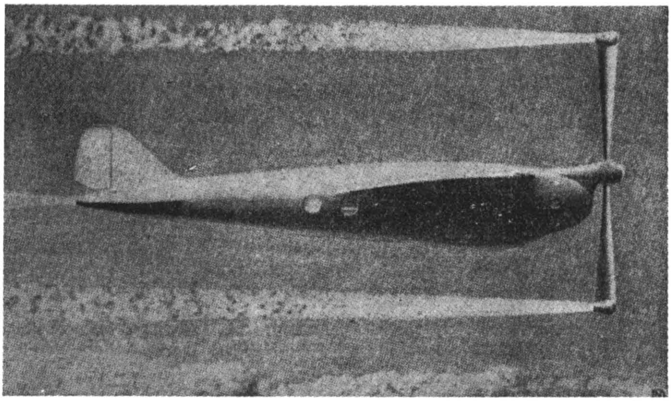
The utilization of jet-propulsors at the tip of propeller blades for the propulsion of airplanes has been proposed as a means for flights in thin air and above the atmosphere. By exhaustion of the burned gases of the ordinary aircraft engine through the propeller tips an added impulse could be imparted to the present propeller thrust. For the reaction to add materially to the plane performance the increased atmospheric resistance to the propeller blade would need be kept to a minimum. Not only may the propeller be driven by peripheral reaction of the exhaust gases issuing from blade tip nozzles, but the jet device may also give a reaction to a stationary propeller at extreme altitudes. In the latter case the craft would operate as a rocket-driven airplane.

Papin-Rouilly Gyropter.

The French Patent Specification No. 440593, applied for by MM. A. Papin and D. Rouilly on May 6, 1911, entitled "Procedure for assuring the suspension and propulsion of a surmerged body in a fluid", suggested a number of ways that jet propulsion could be utilized in aeroplanes, helicopters, dirigibles, aerial-torpedoes, and projectiles.

The proposed helicopter design called for drawing air into a large opening in the rotor hub. The air is then impelled through two diametrically opposite rotor arms and exhausted through multiple openings at the arm tips. Rotation of the rotor arms was intended to lift the aircraft.

A second French patent No. 440,-594 ,applied for at the same time, deals specifically with a revolving airfoil type of helicopter, later commonly known as the Papin-Rouilly Gyropter. Construction on this rotary winged aircraft was started in 1914 at the beginning of World War I, but it was years later in 1921 before a full scale model was completed. Its inventors claimed the machine offered the possible solution to vertical ascent and descent, the ability to hover or progress forward at the will of the pilot, and in the event of engine failure, very slowly fall with the Gyropter "turning like a sycamore leaf."



Several designers have proposed jet driven propellers. Rotating normally at low altitudes, the blades would full-feather at extreme altitudes and propulsion would be by jet action directly.

The original apparatus consisted of a wing balanced on a circular float or base for alighting and taking off from water or the ground. A blower-turbine driven by an 80 h.p. Le Rhone engine was encased in the heavier end of the wing. Air drawn in by the blower was forced through the wing and out a nozzle on the trailing edge of the wing tip. The propulsive reaction developed from this ejected air stream caused the airfoil to rotate around a nacelle mounted directly over the base, thereby through atmospheric traction of the airfoil lifting the machine.

A small jet of air discharged from a tube on the pilot's turret served to provide torque compensation in the nacelle unit and facilitated steering. Although the full size model failed in lifting itself, a number of similar designed smaller models powered by ejected chemical combustion gases were able to ascend from the ground without too much difficulty.

Reaction-Driven Rotors.

As long ago as 1842, a French engineer named Phillips demonstrated before the Royal Society a model of a "helicopere a reaction" which was driven by a steam engine. Although constructed entirely of metal the heavy model is claimed to have performed most successfully. Since the experiments of Papin and Rouilly in adapting high velocity air streams to the propulsion of helicopters, jet-propelled helicopters have been considered as a possible type of aircraft and merited experimental investigation.

The latest acquisition to this mode of propulsion is the patent No. 2,301,-417 granted to A. E. Larsen in 1942. The invention relates to a system of rotating the lifting rotor of wingless aircraft by a relatively small jet-driven outboard airscrew mounted on the rotor blade adjacent to the tip. A fluid pressure is transmitted from its source in the body of the craft through passages in the shaft, hub, and blades of the lifting rotor, and is discharged through the nozzled tip of each blade of the driving air-screw.

Even though the jet reaction is transmitted indirectly to the rotor blade the efficiency of the drive system is contemplated to be higher than a direct drive reaction system as employed in the utilization of jet-propulsors on rotor blade tips. The patent also considers the use of a pair of tandem rotating airscrews for actuating each blade of single or multi-bladed rotors.

Recommended References.

N.A.C.A. T. M. No. 571, Propulsion by Reaction, Maurice Roy, June 1930.

The Problem of Vertical Flight, Parlee C. Rose, 1931.

Helicopter Flying Machine, J. Robertson Porter, 1911.

Latest Rocket Planes for the Stratosphere, Noel Deisch, Astronautics, No. 21, July 1932.

Fairey Jet Propulsion System

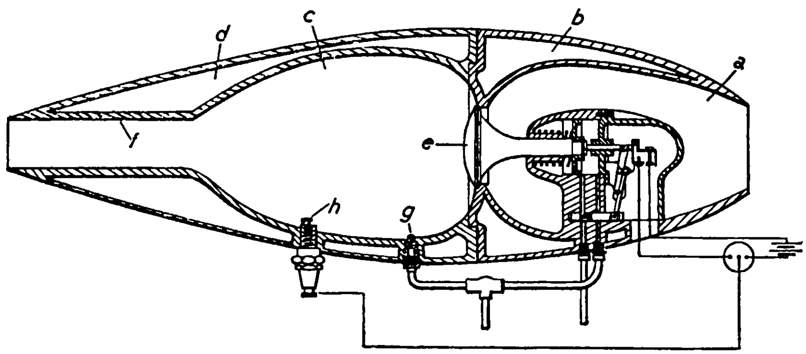
Intermittent Firing System Patented

A British patent on thermal jet propulsion for aircraft has recently been granted to Captain A. G. Forsyth, assignor to the Fairey Aviation Company. The patent proposes the installing of a number of jet propulsive units in the tail or arranged in line in the wing section of ordinary aircraft with inlets starting from the leading edge.

The invention (Patent Specification No. 518,898) consists of two chambers connected by a fairly large poppet type valve which is held closed by spring action. The passage of compressed air from the air intake chamber into the combustion chamber is controlled by a piston valve linked to the poppet valve extended stem. The air pressure that forces the fuel into the explosive chamber is also controlled by the piston valve. As a means of cooling, the poppet valve is sodium-filled and the chambers water-jacketed.

The working cycles of the jet propulsion system are diagramatically shown in the accompanying drawing. Air entering the forward-facing intake chamber **A** is allowed to build up pressure. When the air reaches a predetermined pressure the piston valve operates which in turn opens the poppet valve **E** allowing a quantity of compressed air to enter the combustion chamber **C**. At the same time the piston valve also permits the ejection of fuel through the fuel nozzle **G** into the combustion chamber. When the poppet valve returns to normal contacts of the ignition circuit are closed and spark plug **H** ignites the fuel mixture which is exhausted through nozzle **F** giving a

(Continued on Page 12)



Patent Drawing of the Forsyth-Fairey Jet Propulsion Device

BOOK REVIEWS

Analytical Theory of the Campini Propulsion System. S. Campini. Translation of the article, "Sulla Teoria Analitica del Moto-Propulore Campini," from L'Aerotecnica, January 1938.

A description of the new propulsion system and the definition of the propulsive efficiency is calculated under various conditions of flights with allowance for all internal losses.

The efficiency and consumption curves are plotted, their practical values are discussed, and behavior of the system is analyzed at various altitudes and speeds. Superiority of this over the conventional engine-propeller system, starting from 248 m.p.h. with respect to range and weight per horsepower output is affirmed.

The immediate possibilities of the new system at high altitude flight is discussed in relation to the theoretical and experimental results. This report is a continuation of the study made by the author in 1929. Experiments made in collaboration with the Caproni Airplane Company of Milan have confirmed and afforded a marked improvement in the practical value of this type of propulsion. N.A.C.A. T.M. No. 1010, March 1942.

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Probably the first book entirely devoted to the subject of gas and steam turbine units, and the use of thermal jet propulsion for propelling aircraft has been published in England. Much of the material in the book is taken from articles which originally appeared in Flight magazine. A brief history of aircraft jet propulsion is given with special detailed information on the development of the Caproni-Campini plane and other similar jet-propelled craft.

The author discusses the various schemes relating to this type of propulsion, explains the fundamentals, and gives much practical information on the subject. The concluding chapters describe the utilization of gas and steam turbines for jet propulsion and the driving of ordinary airscrews.

Gas Turbines and Jet Propulsion for Aircraft, by G. Geoffrey Smith, Flight Publishing Co., Ltd., London, 1942; 56 pages, 3s. 6d.

:—o—:

The spirit of Jules Verne lives again in the pages of a new romantic account, as the story of his life is unfolded. The book, so aptly called in sub-title "The Biography of an Imagination," is a fascinating work on his prophecies and writings as he journeyed in his own imagination from one pole to the other, and from the center of the earth through the deepest waters of the seven seas to the thinnest boundaries of outer space.

Of special interest to members are probably the few pages recording the events as the father of scientific fiction began on May 5th, 1865 the slow process of assembling notes on the Baltimore Gun Club as he prepared for his trip "From the Earth to the Moon". For the benefit of the reader a list of Jules Verne's "Extraordinary Voyages," a bibliography, and an index are included in the book.

"Jules Verne," George H. Waltz, Jr., Henry Holt and Company, Inc., New York, 1943; 223 pages, $2.50.

The No. 6 issue of **Rocket Flight,** comprising eight pages, shows a marked improvement over preceding issues. A continued article by Oliver E. Saari gives a brief history of the rocket, and supplemented by two motor drawings describes the rocket combustion chamber.

A large photograph of the interior of the rocket designed for the film "Die Frau in Mond" by Prof. Oberth in 1928 is shown with a detailed description, together with various comments on escape-velocity by the editor. Copies priced at 10c each may be secured by writing to Mr. Keith Buchanan, Box 148, Amsterdam, Ohio.

BOOKS FOR SALE

Journal of the British Interplanetary Society, February, June 1936; December 1937. Each issue Price 25c.

Das Neue Fahrzeug, May 1937—Price 25c.

Journal of the Aeronautical Sciences, June 1936. Contains the article The Design of a Stratosphere Rocket, by A. Africano. Price 50c.

Set of 6 Miscellaneous Drawings—Price 50c.

Index to ASTRONAUTICS, contains a complete and segregated list of important articles on rocketry published in past issues. Free on request.

FAIREY JET SYSTEM

(Continued from Page 10)

propulsive thrust to the aircraft. The water jackets **B** and **D** are also shown.

A number of other arrangements are described in the patent; one in which the propulsive units drive a turbine for operating a supercharger system. In another suggestion a steam turbine is driven by steam pressure formed in the cooling systems.

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