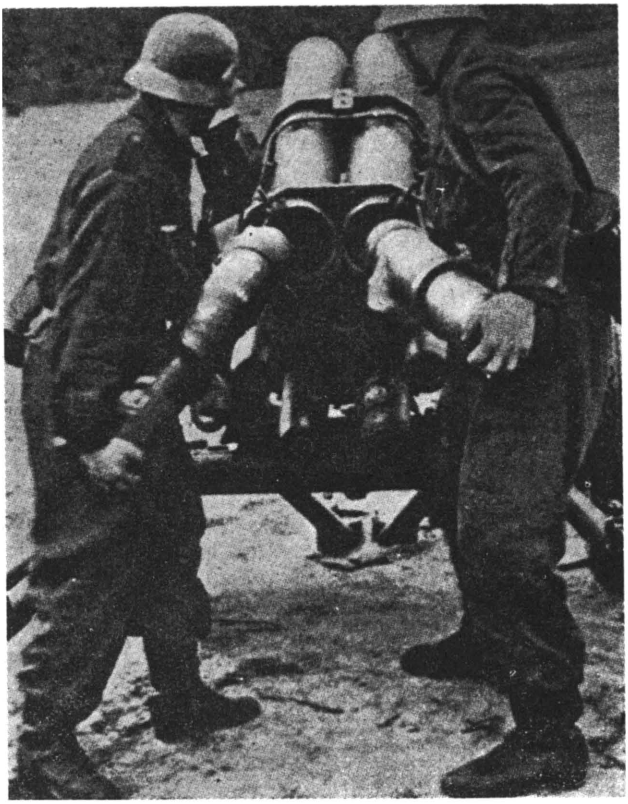
ASTRONAUTICS

Journal of the American Rocket Society

Number 56 December, 1943



NAZI ROCKET SHELLS—These high-explosive projectiles, being loaded into six-barreled projector, are spin-stabilized, have range of 6000 yards, have been used against our troops in Tunisia, Sicily, Italy. Germans are developing numerous jet propulsion devices in effort to stave off their inevitable defeat.

NOTES AND NEWS

Prime Minister Churchill in a recent war review before the House of Commons reported that the Nazis were using a new type of aerial bomb at close quarters against shipping close to the coast. "This bomb may be described as a sort of rocket-assisted glider which releases its bombs from a height and is directed towards its target by a parent aircraft."

Walt Disney's new Technicolor film "Victory Through Air Power," based on the book by Major Alexander P. de Seversky, is an epic of screen production dealing with the history of aviation and the theory of victory through air power. The lone reference to rockets portrays a jet-driven bomb penetrating the roof of submarine pens and is most startling in its live-action reality.

The De Havilland Mosquito twin-engined bomber, which is rated as one of the fastest and outstanding bombers in the world, may obtain some of its power from the ejection of its exhaust gases. Although of extremely light weight, being an all-wood plane powered by two Rolls-Royce engines, it is believed that additional unknown factors aid its performance. Some of the extra power is attributed to unique tubular devices which shield the exhaust manifold on the sides of the engines. These tubular devices have been explained away as "flash-dampeners," although the Mosquito is not a night-flyer.

Nazi Rocket Weapons

Jet Power Widely Used by Germany

by **Roy Healy**

Against the ever growing tide of Allied might the Nazis are pitting their research laboratories and the ingenuity of their best scientific brains in a desperate attempt to find a new world-beating combination of technical weapons A tremendous amount of this research is being concentrated on the development of rocket weapons and jet propulsion devices. From the war fronts come reports of Nazi fighter planes equipped with rocket shells, of jet propelled "flak", of rocket accelerated armor-piercing bombs, of rocket glider bombs, of jet assisted takeoff, of rocket planes and thermal air jet planes, of large fragmentation and chemical rockets used by their ground forces and, of late, the threat of retaliatory bombing of England with gigantic, long-range super rockets.

Rocket Launcher. Nazi device is light, easy to manufacture, requires little maintenance.

Aircraft Rocket Shells.

Beyond escort fighter range classes U. S. Air Force bomber defense has been a close-knit formation moving within a roughly spherical zone of concentrated calibre 50 machine gun fire. The outer limits of this zone has been about 1000 yards beyond each corner of the formation. Until recent months this defense was formidable enough to keep our losses from fighter attack down to a modest figure. The Luftwaffe has now evolved two new tactics to enable its fighters to attack from beyond the 1000 yard danger zone. One of these is air to air bombing, the other is the introduction of rocket shells from ranges of about 2000 yards at our formations. Either measure, if not discouraged, may force a spreading out of our formations, allowing enemy fighters to more safely deliver close-in attacks with machine gun and cannon fire.

Apparently the initial use of aerial rocket shells by the Nazis was made during May and June of 1943, during these months returning pilots told of meeting a few fighters equipped with what were suspected to be rocket launchers. Deep daylight penetration by the 8th Air Force into Germany met with more bitter fighter resistance during the summer months, an increasing number of the German fighters carrying rocket shells, culminating in the Schweinfurt raid of October 14, when 60 of our heavy bombers were lost to the Nazi defensive measures. Since that time, use of long range escorts, and decreased activity due to winter conditions, have served to minimize our losses during daylight raids.

Descriptions of the rocket launching equipment vary—some fighters carry but a single tubular launcher under each wing, others have 2 and 3 tubes under each wing, reports have been received of rocket projectors mounted under the fuselages of twin-engined fighters. Both the Nazi single-engined fighters, the FW 190 and the ME 109 have been encountered with wing launchers, the twin-engined ME 110 and JU 88 are mentioned as also being equipped with rocket projectiles. In some cases obsolete airplanes are equipped with rockets and stay well out of normal combat range, lobbing rocket shells at our formations from distances of a mile or more.

Shells of this type are being used against our Fortresses on daylight raids over German targets.

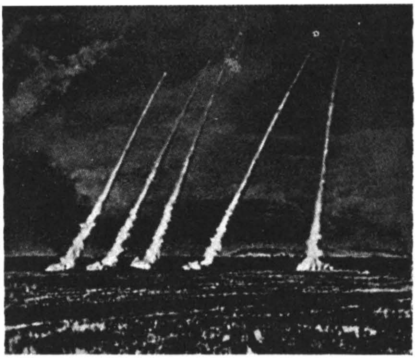
Up to the present time only pieces of the Nazi shells have been recovered from aircraft. but it is believed that they are the same, or slightly modified versions of, explosive rocket shells used by the Wehrmacht, a number of which have been captured and examined. These are of two sizes, the 15 cm (6 inch) and the 21 cm (8 inch) the latter weighing approximately 200 lbs, the former about 75 lbs. with explosive charge and somewhat less when used as a smoke laying shell. The 15 cm projectile is shown in illustrations accompanying this article, its propellant charge is carried in the main chamber in the center, the explosive charge in the tail section. A sheet-metal ballistic cap completes the assembly. The propelling gases exhaust through a score or more of tangential nozzles located in the conical collar at the rear of the rocket chamber. Flight stability is thus obtained through autoratation caused by the oblique streams of exhausting gas. Maximum range of this projectile is 6600 yards, the average velocity is probably on the order of 1000 ft/sec or less.

The rocket shell is about 42 inches in length and its average diameter is about 6 inches, the nominal designation being the diameter of the nozzle cone. Propellant is a double base powder, somewhat similar to Cordite, with a deterrant added to slow combustion. It comes in the form of round sticks and is ignited by an electric squib.

The larger 21 cm rocket is an adaption of the German 21 cm cannon shell, with a rocket attachment at its rear. The exhaust gases vent through a base plate bored with a score of oblique nozzles, rather than emerging at the center of the projectile as in the smaller shell. From the photos so far released, and from reports of returning flyers, it appears that both the 15 and the 21 cm rockets are being fired from aircraft, and possibly a smaller rocket projectile is also being used. The advantages of rocket propelled aerial shells have been pointed out in articles published in ASTRONAUTICS during the past few years.

Nebelwerfer.

The 15 cm shells were initially used for smoke screen purposes and received some publicity in this connection. The standard ground launcher consists of a bolted together assembly of 6 steel tubes, each approximately 5½ feet long, mounted on a modified 37 mm gun carriage and capable of adjustment through a limited traverse and a large elevation. The projectile is pushed into the rear of the tube, a simple latch rests against the nozzle ring to prevent its sliding out when the apparatus is elevated. The shell rests on 3 equally spaced ½ inch angles running the length of the tube, its explosive tail protruding as seen in the cover photo. An insulated copper prong is spring loaded against a squib in one nozzle, a ground is effected by the contact of the shell with the tube.



Nebelwerfer — Smoke shells being fired in Russia to screen troop movements — now usually to the rear.

Rate of fire of the cluster is limited only by the necessity of allowing each rocket to be well away before firing the following round, to prevent the jet blast throwing the following rocket off its course. While the weapon is light and easy to manufacture in large quantities the smoke and flame from these rockets are said to have allowed Allied artillerymen to quickly locate and knock out the Nazi rocket batteries. However, because of their mobility, the Nazis may be expected to use large numbers of rocket projectors to repel Allied invasion thrusts when the Second Front is opened.

The Germans are also using 32 cm chemical and incendiary rockets against our forces in Italy. These projectiles resemble a bomb with an extended cylindrical tail, the latter containing the propelling powder. They are usually carried in a special container, which, when opened, acts as the rocket launcher.

Bazooka Details

War Department Tells of Tank-buster

Two Man Tornado—says this Philco advertisement, outlining the advantages, fire-power of the Bazooka.

Officially called "Launcher, Rocket, AT, M-1" the light weight weapon discharges a projectile which travels under its own power on the rocket principle. The limiting range of the shell is about 300 yards, the striking velocity is quite low but because of a special principle involved in its construction the Bazooka rocket has terrific penetrative ability. The projectile itself does not enter the tank it strikes, rather it blows a hole through the armor plate and the gas blast, along with a slug of molten metal, completes the destruction.

The projector tube weighs about 12 lbs. — it is a simple metal tube about 50 inches long and less than 3 inches in diameter, open at both ends. Attached to the tube is a rifle-like shoulder stock and, in the older model, two hand grips for steadying the projector while aiming. The improved model has only one hand grip, eliminating the need for the firer to bring his hand near the muzzle of the tube. The original framework sights shown in the line drawing have been replaced by a simpler and much more accurate arrangement designed by a soldier after using the Bazooka in battle.

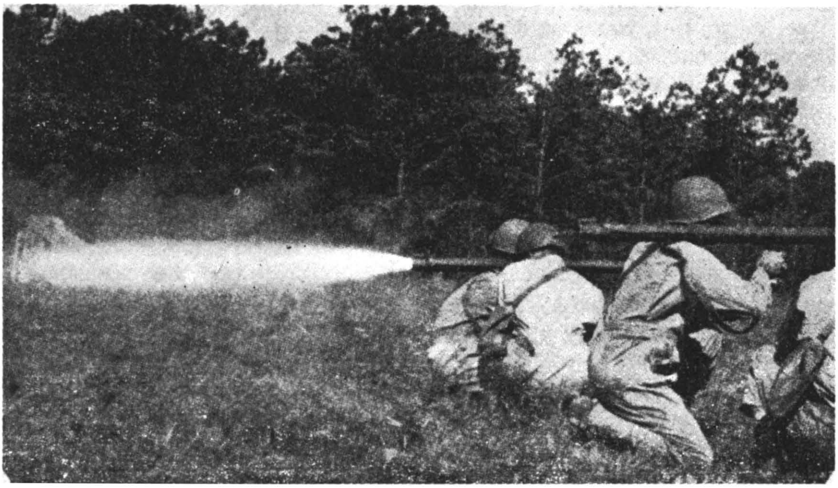
The projector is operated by a two man team—the firer, who carries the rocket launcher, and the loader, who carries the projectiles in a special pocketed canvas bag. The shells are enclosed in cylindrical cardboard

Pyrotechnic Piledriver — This slender handful of destruction has become a great favorite with American troops in action against the enemy.

cases until the moment of use. The loader inserts a rocket into the open end of the tube at the rear, catches it with the wire holding device which prevents its slipping out of position, switches the small contact lever on the small box atop the tube to "Fire" position and taps the firer on the shoulder to signify readiness of the apparatus.

Within the rear hand grip are two small dry-cell batteries, of flashlight size. A wire runs from these, through a trigger switch, to the contact box atop the tube. Through the movable contact arm the current is conducted to the sheet copper band on the head of the projectile. This in turn is connected to an electric squib, within the rocket chamber, the other end of which is grounded to the projector.

When the firer pulls the trigger switch the squib sets off the quick



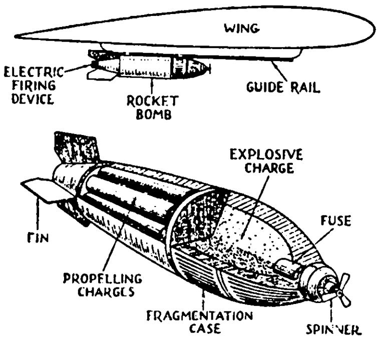
Driving Power—All burning of the projectile's rocket charge takes place within the launcher tube, thus preventing injury to the Bazookaman.

burning propelling charge and the resultant exhaust gas rushing from the nozzle in the end of the rocket propels the shell. Normally all combustion of the rocket charge is supposed to be completed within the launcher, but evidently a small amount of residual burning is sometimes experienced as newsreel depictions of Bazooka firings show firers wearing goggles and gloves and in some cases a metal blast shield is affixed to the launcher muzzle. Later models, now being developed, will undoubtedly eliminate the necessity of these measures.

The rocket projectile weighs about 3½ lbs, is approximately 20 inches long, has a maximum diameter of 2½ inches and is stabilized in flight by fixed, stamped sheet-metal fins. Reports indicate it capable of cutting through 2 to 3 inches of armor plate or 3 feet of cement.

RUSSIAN ROCKET BOMB

One of the earliest applications of jet power in this war was the use of rocket bombs launched from Russian aircraft against Nazi tank columns. Reproduced above is a sketch, recently published in England, illustrating the general arrangement of this bomb, which resembles in outline, the design of most rocket ammunition used by the powers engaged in this conflict. Biggest advance in rocket shells attributable to this war is the use of a toned-down high explosive for propellant, replacing the time honored black gunpowder and giving rocket ammunition much higher velocities and longer ranges. This propellant is usually made in the form of sticks, which are inserted lengthwise in the propellant chamber as shown. In some cases



"Aeroplane" drawing

THE RUSSIAN ROCKET BOMB— A velocity of 800 ft. per sec. gives the projectiles a penetration of seven inches of armour plate.

but a single large stick is used, in others many sticks of smaller diameter are employed. A fairly constant area exposed to combustion is thus maintained in contrast to the pyrotechnic rocket with its sharply rising burning areas. Almost all rockets used in this war are of the short duration type, burning being completed in from a fraction of a second to a maximum of two seconds, depending on the design.

Russia's military rockets, like most of her war weapons, are a closely guarded secret. Current newsreels, and the popular "Battle of Russia" revealed short glimpses of her Katushas, projectors for launching a long, slender, finned rocket projectile. In some cases a multiple rail arrangement seems to be used, in other views perforated tubes are shown through which the projectiles fire. Burning time visible is about 1 second, launching angles of from 20° to 45° are used for various ranges. The weapon is evidently used in large quantities.

Motor Actuated Fuel Feeds

Novel Injection Methods Suggested

by Cedric Giles

Of the two favored methods of feeding the propellants into the rocket motor the more successful procedure employs a gas pressure in the fuel tanks for force-feeding the liquids. The alternate method is to use some form of pressure pump to inject the fuels. In both of these systems the fuel feed apparatus, consisting of a separate container of nitrogen or similar gas or a separate motor driven pump, is auxiliary to the jet motor and fuel tanks.

A third, less well-known arrangement is based on the motivating energy of the rocket motor elements to force the propellants into the firing chamber. The majority of feed systems depending on motor influence for the most efficient operation involve the use of the addition of a small gas pressure on the fuels. Although such an extra gas pressure is not an absolute necessity, if employed it will eliminate any need for initial priming and will aid the injection cycle once the fuels are ignited.

For clearer analysis the motor actuated fuel feeds can be divided into a number of classifications:

1. Recoil — reciprocations of the motor are used to pump the fuels.
2. Exhaust — auxiliary exhaust jet acts as a pressure source.
3. Aspirating—lower pressure areas suck in the fuels.
4. Chamber pressure — based on pressure gradient in combustion chamber.
5. Centrifugal—rotation of fuel containers feeds fuels.

In describing the various motor driven feed systems this paper is only concerned with a general description of such systems and makes no attempt to go into minute detail.

Recoil Feed Systems.

Employing the technique of the test stand, where the motor is held firmly but allowed to recoil against registering mechanisms, the thrust inertia in this stead would be partly translated into a pumping force. In the simplest form, the motor acts as a plunger and recoiling from the combustion pushes directly against the fuels forcing them into the chamber. **(Fig. 1).** The propellants are contained in a cylindrical tank and are separated by a free moving piston which equalizes pressure between them. The fuel discharges directly from its container to the motor, and the oxidizer passes through a long pipeline to the rear of the motor where it reverses its direction of flow and is delivered to the combustion chamber. The oxygen may also be fed through various piping arrangements, such as through an external flexible pipeline connecting oxygen tank and motor with enough slack to compensate for the motor's forward motion, or a flexible feed line which coils together in the fuel tank as the motor moves forward. The feed lines should be of the correct size so as to distribute the fuels to the motor in the proper proportion.

In a more complicated arrangement the motor is suitably mounted on small wheels or bearings so as to enable it to travel a short distance before the complete reaction received from the burning fuels is transmitted into forward action of the vehicle. A coil spring between the front end of the motor and a connecting member between two small vacuum tanks holds the motor in its non-firing position. (**Fig. 2**).

and an even flow of comburants would enter the combustion chamber giving a uniform thrust. Means of pumping the fuels are many and varied ranging from a type of vacuum pump as already described to pistons pushing on the fuels or on collapsable fuel containers. The forward reaction of the motor may also be utilized to compress a gas which in

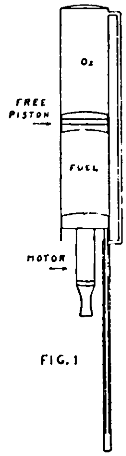


FIG. 1

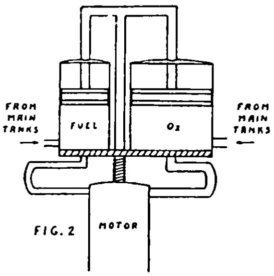


FIG. 2

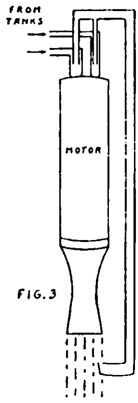


FIG. 3

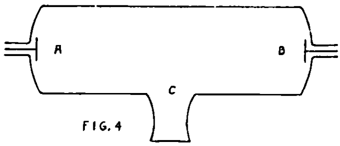


FIG. 4

The injected propellants exploding in the combustion chamber push the motor and connecting pistons forward, overcoming the spring pressure. The forward movement of the pistons lessens the propellant injection and creates a vacuum in the vacuum tanks which draws additional fuel through one way valves from the main fuel tanks. As the motor thrust becomes less, due to insufficient fuel, the spring action forces the motor rearward and the piston push on the fuels becomes greater, forcing an added injection of the liquids into the combustion chamber. Although tending to fire intermittently, when properly regulated the shuttling of the motor will be reduced to a minimum

turn forces the fluids into the combustion chamber.

As fuel injection of motor actuated feed systems is dependent on the firing of the motor some means of initially priming the motor must be provided. This may be accomplished by a small amount of powder exploded in the combustion chamber, a quantity of fuel separately fed into the chamber, use of the ever-present building-up pressure of liquid oxygen, or starting the motor functioning either mechanically or manually.

Exhaust Fuel Feeds.

The idea of using the jet exhaust as the motivating force for operating a gas turbine or gear pump has been mentioned at various times. The usual suggested method is to place an impact tube (similar to a Pitot tube) in the jet stream for tapping off a small quantity of the exhaust gases. **(Fig. 3)**. The reused exhaust gases drives a pumping device which supplies a well regulated amount of propellants to the motor firing chamber. Another possibility derives fuel pumping energy from impellers or vanes placed in the efflux. The main difficulties appear to be the high temperatures of the exhaust on the device placed therein and the flow disturbance caused by inserting the mechanism.

Rather than using the exhaust jet to drive pump devices another method utilizes the exhaust for feed augmentation. In one arrangement the exhaust gases are injected through the center of the fuel feed lines in the inlet direction. **(Fig. 3)**. By reason of the suction effect created by the injected gases the fuels are drawn from their respective tanks into the combustion chamber. A variation of this method is in injecting the burnt gases along the inner walls of the feed lines with the same final result. In both of these cases the efflux pipe outlet should be proximate to the combustion chamber. To prevent pre-ignition of the fuels the exhaust gases should be completely burnt or greatly cooled.

With one propellant being pumped to the combustion chamber through motor action, the other can be introduced by augmentation. In one instance, as the liquid oxygen rushes past the fuel it sucks a small amount of fuel which vaporizes and mixes with the rapidly moving oxygen in the correct proportion. The proper proportion of oxygen and fuel mixed can be controlled by a needle valve which opens or closes the spray jet.

Aspirating Fuel Feed.

In normal fuel fed motors the chamber pressure has been considered 100% efficient when the chamber pressure equals the feed pressure. At this point all fuel flow into the chamber ceases. If the fuel pressure is the greater the flow entering the chamber will be continuous. Although the average motor was found to have a chamber-feed pressure of about 75%, it has been noted in a number of tests that fuel was sucked in against a higher chamber pressure.

Such an aspirating effect has been attributed to the creating of lower pressure areas at the feed inlets due to adjacent rapidly moving streams of gases. This has led to the belief that through proper designing a motor may produce this aspirating effect. The drawing in of the fuels to a successful degree would eliminate to a great extent the need for the usual feed pressure system.

A strictly theoretical proposal for aspiration and compression of the fuels by means of the kinetic energy of the combustion was offered by Esnault-Pelterie some years ago. **(Fig. 4)**. A charge **A** at one end of the elongated combustion chamber is ignited, and while exhausting through a centralized nozzle **C** compresses a similar charge **B** at the opposite end of the chamber. As the pressure waves from the exploded charge **A** retard, a check valve opens allowing a new charge to be aspirated into the chamber. The cycle continues with the compressed charge **B** now being ignited. Although based on supposition the idea is well worth contemplating.

Chamber Pressure Feed.

The high pressure created in the combustion chamber is caused by the expansion of the rapidly burning fuel-oxygen mixture which may develop temperatures as high as 3,000° Fahrenheit. Quick-acting heat instruments actuated by the motor temperature for controlling the feed flow appear as worthy of consideration.

The chamber pressure totaling a few hundred pounds depending upon the size of the motor can be utilized for operating a fuel pumping device. The force for working the device can be obtained in a manner somewhat similar to methods used in utilizing chamber pressures for operating various types of contrivances. The derived energy may be transmitted to pistons or reciprocating rams to provide the fuel pumping force.

Centrifugal Feeds.

The possibility of supplying fuel to the combustion by centrifugal action has also been suggested. In one consideration the fuel tanks are mounted so they can be rotated. As the tanks revolve through applied motive power the elastic fluids due to centrifugal force are discharged outwardly to the combustion chamber.

The fuel tanks in another conception are an integral part of the motor unit. In this case the entire assembly is rotated through motor action and the curvilinear motion produced throws the fuels into the chamber. Whirling containers or spinning hollow wheels—which may be rotors in turbine systems—offer innumerable innovations of fuel feed injection.

Stoppage of Feed Cycle.

The greatest difficulty in rocket motor driven feeds is the problem of preventing the running down of the motor feed cycle. The possibility of the combustion chamber receiving diminishing quantities of comburants until the motor ceases to fire is always present. Care must be taken that the fuel supply does not lag to an appreciable degree with the danger of the flow stopping altogether. To prevent such an occurrence the feed system should be so regulated that only a small amount of combusted fuel will operate the feed apparatus to its full extent.

Interrupted fuel flow requires positive ignition at the moment of flow resumption. In continuous combustion the fresh fuels are ignited by the burning combustibles, whereas in the case of intermittent combustion the fuels will need to be ignited by a spark, or through contact with the hot chamber walls.

Fuel Tank Pressure.

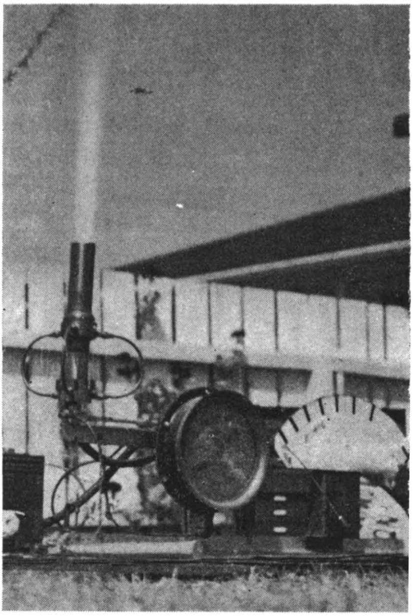
The generally accepted fuel tank pressures for testing motors at the present time is 300 lbs. per sq. in. By having a standard feed pressure, pre-test calculations are easily computed, design of test stand equipment is aided and the comparison of motors is greatly simplified. Under ordinary testing circumstances the greater the pressure on the fuels the better the calculated motor efficiency. This result is due to the lack of most formulas to take into account the tank pressures.

Although as already mentioned, the established practice is to use a set feed pressure, in the case of motor actuated fuel feeds the feed pressures will probably be optional.

California Rocket Society

Amateur Group Builds, Tests Motors

Although the American Rocket Society has not recently conducted any experiments with jet motors—most of the active members being engaged in commercial or governmental research—it is encouraging to hear that our affiliate branch in California has continued to undertake development work despite wartime restrictions, shortage of leisure time, and material scarcity. Regardless of the amount of time and money spent in development work in commercial laboratories amateur research workers have time and again made outstanding contributions to scientific and technical advancement in many lines.



End of Test Run — photo snapped as fuel charge was exhausted.

Writes Robert Gordon, President of the California Rocket Society:

"The CRS has been conducting a series of experiments with the object of developing a practical solid-fluid rocket motor. On April 11, 1943 the Society performed a series of tests on Motor No. 4. During the last of these tests the motor was run to destruction."

"Motor No. 4 embodied refinements in design which were developed from the results of tests performed on preceding motors of this type. Combustion chamber dimensions, the addition of a manifold, and design simplification of the solid fuel constituted the major changes in this motor."

"Although the results of these tests were not spectacular, sufficient evidence was gathered to indicate that certain improvements in design should increase the performance expected. The CRS is working on Motor No. 5, which will be of similar design, but will incorporate modifications based on the findings of our last tests."

BOOK REVIEW

Rockets, New Trail to Empire, by R. H. Farnsworth. United States Rocket Society, Inc., Glen Ellyn, Ill., 1943; 27 pages, $2.00.

The first half of the review and bibliography is devoted to the why, how and where of rockets, with numerous comparisons made with the discoveries and inventions of other sciences.

The bibliography section contains a catalog of rocket books, a list of rocket articles, and an index to articles in ASTRONAUTICS.

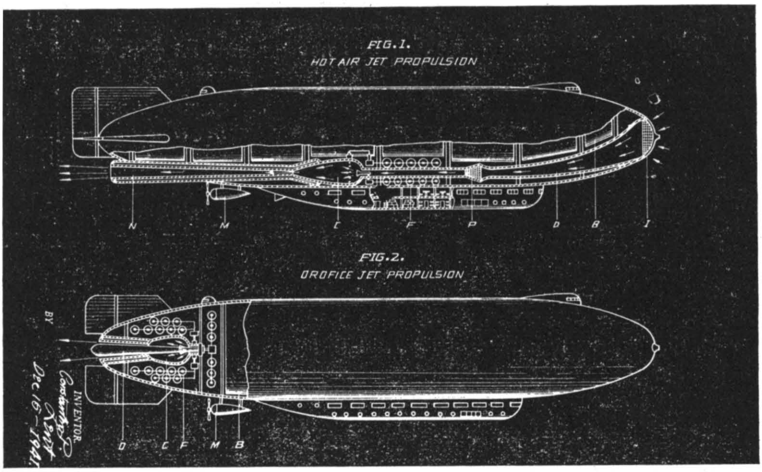
Jet Propelled Dirigible

Imaginative Picture of Future Air Travel

by Constantin Paul Lent

No warning signal to the passengers has been given to fasten their safety belts and there is no mad rush down the long runway accompanied by the deafening roar of the whirling propellers, but instead a slow silent rise so intense as to be awesome, with the remarks and farewells of the spectators from the ground clearly audible within the ascending ship. Soon it has left the ground and is several hundred feet above the airport—then a sharp bark is heard from the rocket motors in the stern and a shower of crimson flame and dark smoke is seen from the exhaust tubes followed by the monotonous diminuendo of a steady purr. With her prow pointed gently skywards the great ship quickly but steadily is gaining speed and rising to her flying level. This is how a transoceanic flight for a large rocket dirigible of the future will begin.

At present, there are those who believe that the future of long range travel belongs wholly to the mammoth flying boats. But the lighter-than-air ship possesses, in addition



TWO FORMS OF POSSIBLE FUTURE TRANSPORTATION.

Key:
N—Hot Air Expansion Nozzle
M—Auxiliary Motor
C—Combustion or Air Heating Chamber
F—Fuel Tanks
P—Air Compressor Motor or Pump
D—Air Duct
B—Helium Filled Lifting Bags
I—Air Intake
O—Orifice Nozzle

to many other advantages such as safety, comfort, roominess and the buoyancy derived from its lifting gas, also an extra aerodynamic lifting force which in the case of larger airships amounts to 100% over and above its payload carrying capacity. Furthermore, the streamlined construction of the dirigible is wonderfully adapted to rocket propulsion and speeds in excess of 200 m. p. h. can be predicted although higher speeds will eventually necessitate changes in the structural design of the present day lighter - than - air craft.

While it is thrilling to travel in an airplane at terrific speeds, the total time required for transoceanic flights is less for the airship than for the commercial Clippers. This is partly due to the fact that the airplane, while possessing a higher initial speed than the airship, requires refueling ever so often, while the airship with its larger lifting capacity can carry enough fuel to last for the entire trip. In addition, the airship can travel uninterruptedly for days, while the clippers are often grounded overnight. In the rocket dirigible of the future, with its higher speeds, this difference will be so much more marked. Furthermore, the taking-off and landing of all the heavier-than-air craft, except possibly the helicopter and autogiro, require not only the best of human skill but are nerve racking to the passengers.

How marked is the contrast offered by the airship with its simple take-off which takes it gently aloft and its landing which allows it to be eased down to earth. Airship travel, even as it is at present, not only compares favorably over long transoceanic distances in time required for crossing but also in speed and greater safety and comfort to the passengers, larger payload capacity, economy of operation and ability to operate on schedule. One of the most important factors, economy of operation, is estimated to be wholly in favor of the airship as for the same payload capacity of, say, 15 tons, it would require the use of 15 large Clippers with a combined output of 50,000 h. p., and operating crews totaling 120 men to equal the transoceanic performance of one airship of only 5000 h. p. and a crew of 40 men.

While the construction cost of 15 Clippers is over $15,000,000 the cost of one medium airship will be only $5,000,000. Even with its lower cruising speed the airship would require only two thirds the time taken by the Clipper to cross either the Atlantic or Pacific. This advantage is partially due to the fact that heavy clippers have to be refueled several times each trip and have to land at several airports some distance from the most direct course, while the airship flying a non-stop course can take the most direct route.

The points here presented in favor of the airship aim to prove that the future of transoceanic passenger service belongs really to the dirigible and not only to large flying boats. The one thing previously lacking was an efficient motor to propel the lighter-than-air ships at higher speeds. The rocket motor should readily fill this need.

To the future rocket dirigible designers two propelling arrangements are suggested, the Hot Air Jet Propulsion principle and the direct rocket jet propulsion method.

MEMBERS PLEASE NOTE

To expedite the delivery of ASTRONAUTICS please send us your correct Post Office Department zone number if you reside in a city affected by the new Zoning Regulation.

What are your ideas about rocket design, the most efficient way to cool a rocket motor, potential fuels, methods of feed and control, and the numerable problems which beset experimenters in this field of science? ASTRONAUTICS is eager to receive contributions from members, sketches, plans, photos or written ideas.

In order to keep the Library up to date the librarian would like to receive information referring to recent published articles on rockets, new rocket patents, and information on similar phases of rocketry.

ERRATA

Due to a typographical error the name of Leonardo da Vinci was misspelled in Mr. Giles article on helicopters in the last issue of ASTRONAUTICS. Da Vinci (1452-1519), an Italian painter, architect, and sculptor, understood propeller, helicopter and parachute principles, and many of the early successful airplanes resembled sketches found in pages of his note book.

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Statements and opinions expressed by contributors in ASTRONAUTICS do not necessarily reflect the views of the American Rocket Society.

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