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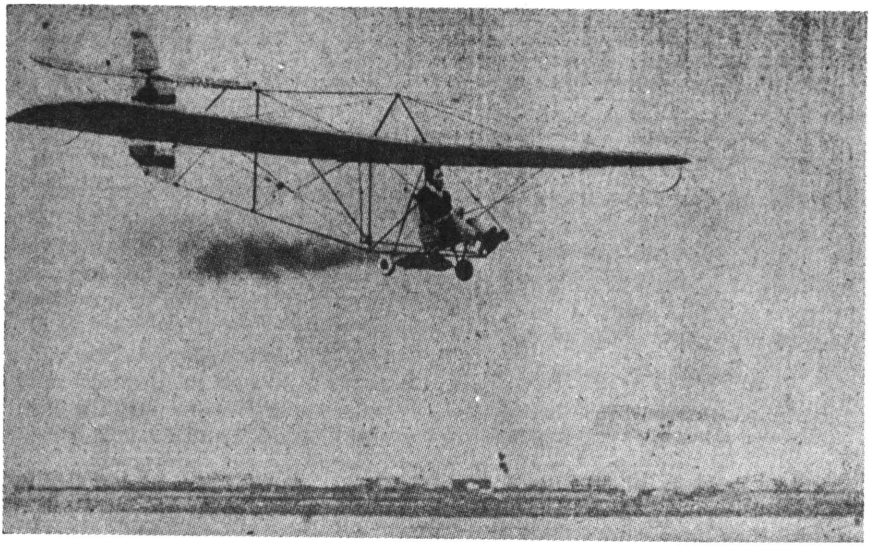

POWDER ROCKETS FOR GLIDER LAUNCHING — An interesting photo indicating the possibility of eliminating the need for tow cars or winch arrangements by the use of several powder rocket charges.

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THE AMERICAN ROCKET SOCIETY

was founded to aid in the scientific and engineering development of jet propulsion and its application to communication and transportation. Three types of membership are offered: **Active,** for experimenters and others with suitable training; **Associate,** for those wishing to aid in research and publication of results, and **Junior,** for High School Students and others under 18. For information regarding membership, write to the Secretary, American Rocket Society, 50 Church Street, New York City.

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NOTES AND NEWS

Major Alexander de Seversky, in his empassioned appeal for, "Victory Through Air Power", mentions the probability of jet propulsion take-off and rocket aerial torpedoes as essential parts of future air war. In a more recent article (Mechanics Illustrated for Sept. 1942) Major de Seversky goes so far as to suggest that the time is not far distant when all aircraft will be propelled on the reactive principle.

It is gratifying to note this belated interest in the potential uses of rocket power, however if our military planners had shown a bit more interest in the work of the American Rocket Society a few years ago this country would not now be trailing behind other nations in this field. Even today there is a tendency, in some uninformed quarters, to discount our group as "moon-flight dreamers". This is due, no doubt, to ignorance of the fact that the American Rocket Society, through "Astronautics" has made available a fund of technical information on the subject of jet propulsion, and has conducted numerous informative ground tests on various types of jet motors.

Willy Ley, writing in the Coast Artillery Journal for May-June, 1941, echoed the belief of many when he claimed, "Rockets as a weapon of war, are about as obsolete as the catapult and cross-bow". However, reports emanating from the various theatres of war tell of extensive use of rocket charges, evidently of the humble and much neglected black powder variety. For this reason we have devoted the larger part of this issue to a study of this once scorned member of the jet propulsion family.

The Black Powder Rocket Charge

Its Military Uses

by Roy Healy

PERSISTENT, although meager, reports indicate that the peculiar conditions of modern warfare have brought about a resurrection of the rocket propelled projectile. According to reliable reports reaction propelled bombs, anti-tank and anti-aircraft shells are being used by Russia, Britain and Germany.

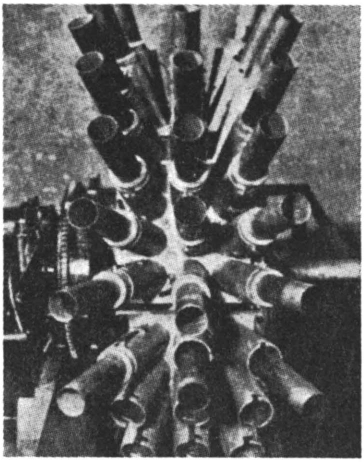
It will be recalled that the early half of the 19th Century saw rather extensive use of war rockets. Cannon artillery, with its improved accuracy and dependability, rendered reaction ammunition obsolete about the time of our Civil War, although explosive rockets were stocked in British arsenals as late as 1905.

During the first World War rockets were used for non-offensive purposes such as signalling and message carrying. Experiments with large metal war rockets were conducted by the German firm of Spandau, but these had not reached successful conclusion at the time of the Armistice.

Modern Rocket Weapons

Bombs, propelled downward at high velocity by rocket charges contained in their rear sections, are being used by the Nazis in the Mediterranian area against Allied shipping and the isle of Malta. Greater penetrative power, due to higher target velocity, would appear to be the outstanding advantage of these bombs. Accuracy may also be improved, as the normal arc described by bombs might be flattened out considerably by the application of power to the descent.

The Red Army is using both rocket bombs and shells against Nazi tank divisions, the former being launched by Stormavic planes as they dive at the tanks, much in the manner the torpedo plane delivers its missile at a warship. The very slight recoil effect of a rocket shell has also enabled the Russians to incorporate large numbers of firing tubes into a single battery unit, easily transported and attended to by two men. Salvos of 20 to 30 shells can be launched simultaneously at an oncoming tank, giving greatly improved fire power to the defenders. Modifications of these multi-tube rocket guns are being used effectively as anti-aircraft weapons.



Russian Multi-tube Gun of the Type Used to Fire Rocket Shells

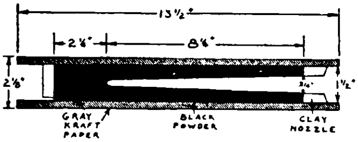
Although it has been known that the British have been experimenting with rocket shells, for some years, it has only recently been disclosed that such weapons are already in active service. Fired aloft by small merchant ships, lacking heavy and expensive anti-aircraft guns, these Grindell-Mathews type rockets discharge a parachute-suspended wire snare which serves to discourage the Nazi habit of swooping low and machine-gunning and bombing these small ships.

Night bombing flyers, returning from sweeps into Europe, report that the Nazi anti-aircraft fire has been augmented by a form of rocket shell. Certain models of the Junkers JU-88 dive bomber are reported taking-off with an overload of 3,000 lbs. with the assistance rendered by some form of jet propulsion, probably in the form of batteries of powder rocket charges. The entire device is dropped after helping the plane into the air.

Detailed technical data relating to these various devices is not available at this time, but analysis of the reports indicate that the propellant in each case is nothing more than a large black powder rocket charge. This being the case it seems timely to look into the characteristics of the rocket charge.

Black Powder

Black gunpowder has changed but little since the time of its discovery, variations in the proportioning of its ingredients appearing to be the main difference in the modern product over its historic counterpart. The constituents of which it is a mechanical mixture (not a chemical compound) are potassium nitrate, sulphur and charcoal; the latter being usually made from willow, although hazel, alder, poplar and lime wood have been used. For normal ordance use these materials are machine mixed, hydraulically compressed into cakes and then broken into pieces of the desired size; the larger the piece the slower the combustion. Black powder for rocket charges, on the other hand, is manually incorporated — close cohesion of the grains not being as necessary. In larger sizes of rocket charges granulated saltpetre is generally used.



"6 lb." Rocket Charge

Upon ignition the nitrogen atoms free themselves of oxygen, which in turn quickly combines itself with the carbon of the charcoal. Some of the potassium atoms combine with oxygen, others with the sulphur atoms. As the potassium salts, constituting over half of the original bulk of the powder, remain as an inert powder, they are made visible in the form of white smoke. Because of this incomplete transformation into gases, black powder is classed as a low explosive, as contrasted to high explosives which are almost smokeless.

The chemical process of combustion may be approximately stated as:

$$KNO_3 + C + S = CO + CO_2 + N_2 + K_2S + K_2O + K_2CO_3$$

There are other complexities of the process which are of interest only to the chemist. The temperature of combustion may reach 2100° C, while the theoretical potential energy content of gunpowder is stated as approximately 500 ft/tons per lb. Its expansion ratio, from solid to gases and smoke, is about 400 times as contrasted to the 1640 times expansion of smokeless powder and 2360 times for T.N.T. The ignition point of black powder is about 300° C.

Composition of Black Powder for Rockets

Authority		Saltpetre	Sulphur	Charcoal
Chinese Rockets		57	14	29
Morel		59	14.8	26.2
Bigot		55	14	31
Geisler		56.25	25	18.75
Congreve		62.44	14.38	23.18
Hale-Hooper		66.7	13.3	20
British Mk VII		65	15	20
Faber	A	54	9	36.5
(Modern	B	56.2	12.2	32.8
practice)	C	72.8	13.6	13.6

Proportions

Most countries have settled on a proportion of: Saltpetre 75, Charcoal 15 and Sulphur 10 ior their black powder used in ordnance. For use in rocket charges, where a slower rate of burning is desired, the proportions differ somewhat and various experimenters do not agree upon the ideal combination, at witnessed by the table below.

Attempts to substitute potassium chlorate for the potassium nitrate, which would produce a more powerful explosive, have invariably ended in disastrous explosions as the chlorate renders the mixture much more susceptible to shock, and the combustion is more violent.

The pyrotechnic rocket's fiery tail consists of small particles of burning charcoal. Frequently small quantities of other chemicals are added to the mixture to produce various colors in the tail. While particularly desirable for signaling purposes a long and brilliant tail is not wanted in war rockets, for a trail of sparks and smoke not only would make the missile more visible to the enemy but would be evidence of inefficient combustion. Charcoal of the lighter woods is thus preferred because of its more rapid and complete combustion.

Test Results

A series of tests with black powder charges, of the type used in signal rockets, conducted by the writer with the cooperation of the American Rocket Society, revealed results of sufficient promise to justify construction of much larger charges for military use. After a series of flight tests were conducted an attempt was made to measure the thrust developed by three different sized charges. These tests were run

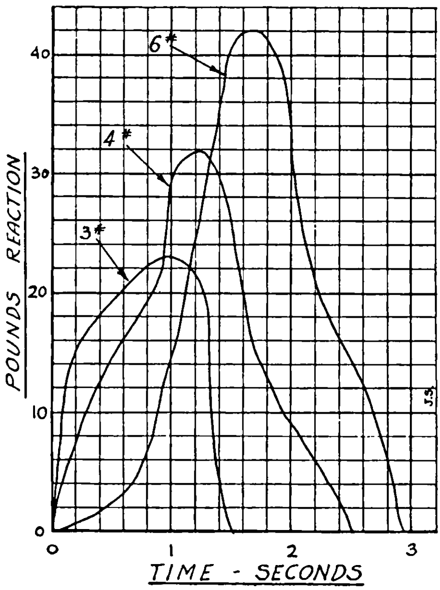
Summarized Data on Small Rocket Charges

Manufacturer's designation	3 lb.	4 lb.	6 lb.
Actual wt. of charge, lbs.	.6875	.9375	1.5
Powder content wt, lbs.	.250	.406	.6875
Maximum reaction, lbs.	23	32	42
Average reaction, lbs.	15.5	15	17.1
Duration of reaction, sec.	1.5	2.5	2.8
Average jet flow, lbs/sec.	.167	.1624	.246
Average jet velocity, ft/sec.	2980	2970	2230
Input: Output ratio, lbs/sec	92	92	69

on a proving stand equipped with a direct reading reaction gauge, of the hydraulic type, and an electric sweep-second clock. Photographic recording of the gauge and clock with a moving picture camera enabled results to be accurately measured.

As the general figure of 1000 B.t.u. given for regular gunpowder of 75:15:10 proportions obviously does not hold true for black powder with proportions varied according to the manufacturer and size of the rocket charge, accurate thermal efficiency calculations can not be made without exact knowledge of the powder's energy content. However, rough calculations made on the above listed charges indicate their efficiency is much higher than the figure of 2% given by Goddard and other experimenters whose tests were conducted with ballistic pendulums, spring deflection and other means not as accurate as the hydraulic device used in these tests.

What is important, however, is the finding that a return of as much as 92 lbs/sec may be obtained from 1 lb/sec consumption of black powder. It will be noted that the input: output ratio is lower for the largest size charge, indicating that the powder mixture used here is weaker than in the smaller sizes. Nonetheless, and granting that the mixture may have to be further weakened with increased size, we may safely assume a figure of 1:65 —meaning that a charge capable of developing an average thrust of 100 lbs for 5 seconds would need only 7.70 lbs. of black powder. For military purposes, large charges of standardized sizes, and not dissimilar in construction from those now produced, would be adaptible to many uses.



Thrust Curves of Powder Charges

Large Experimental Rockets

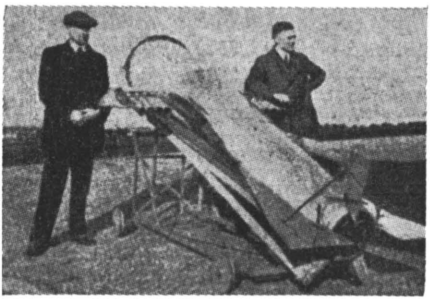
In tests with large powder rockets, for mail-carrying and sounding purposes, conducted in the last decade, there have been numerous violent explosions in which the rocket was blown into pieces. To-date no explanation has been offered, other than Obereth's remark that, "It (black powder) believes it must explode all at once, from the old uses in shells and guns, it is too well trained, always to destroy." Of course this is sheer nonsense, for the behavior of any chemical substance, or combinations of such, can be controlled providing it is thoroughly understood and properly handled.

In the conventionally designed rocket charge the combustion space consists of a conical hollow bored out of the center of a densely packed cylinder of black powder, which is encased within a strong container of grey

Kraft paper. During combustion the walls of this chamber, being composed of fuel, burn away rapidly. Consequently, as combustion continues, more fuel is exposed — resulting in a very rapid rise in temperature and pressure, as witnessed by the sharply rising thrust curves. Should this temperature and pressure reach the detonating point of the fuel before all the fuel is consumed, the remainder will detonate and destroy the rocket.

Old treatises on pyrotechnics suggest weakening of the mixture in larger size rocket charges, and modern commercial practice evidently follows this advice. Unfortunately, amateur experimenters constructing their own charges seem to have been unaware of this practice and disastrous explosions have occurred.

By decreasing the quantity of potassium nitrate and increasing the proportions of sulphur and charcoal the temperature and pressure resulting from combustion may be lowered and the detonating point correspondingly increased. Of course if this is carried to an extreme the charge will become too weak to be of any value.



Zucker Experimental Mail Rocket

Constant Thrust Rocket Charges

Weakening of the mixture is not desirable from the viewpoint of efficiency, hence other methods of preventing detonation should be investigated. Most logical would be elimination of the conical chamber and instead have the powder burn uniformly from one end of the charge back to the other, thus maintaining a constant area exposed to the flame. A charge of this type would have much more constant temperature, pressure and thrust than the conventional type. It might be possible, by the use of specially treated paper, to continue use of the present type container. The wrappings might be made considerably lighter and thinner, in proportion to the charge, if the charge were slipped into tubular metal containers within the shell, bomb or take-off device. This supporting sleeve would strengthen the paper container sufficiently to withstand the firing pressure. A similar supporting sleeve would be used while packing the powder into the container.

Should it be necessary to use metal containers, as in the old war rockets the problem of preventing the heat of combustion from raising the wall temperature to the combustion point of the mixture, would arise. Lining of the tube with asbestos might prevent this tendency of the mixture to burn inwardly from the walls. With a metal case a flared metal nozzle might be used, but this would make for a more complicated and expensive rocket charge.

If possible the conventional clay nozzle would be preferable for these general purpose rocket charges. Breakdown of the clay nozzle material is a problem sometimes encountered with large rockets. Insertion of metal discs in the clay, for added support and cohesion, will strengthen the nozzle.

Rocket Shells

Congreve stated only part of the case for reaction shells when he said, "Rockets are the soul of artillery without the body". Other advantages possessed by rocket shells, besides their elimination of cumbersome and expensive cannon, are the possibility of increasing target velocity while decreasing recoil to a negligible figure. The latter is of particular importance in reference to aircraft armament.

Investigation of war rockets of the past, from the viewpoint of design rather than historical curiosity, reveals that they were quite effective within a range of one mile. An interesting table, reproduced here from old records, reveals some performance characteristics of the much-mentioned Congreve rockets.

Construction

The Congreve rockets were of cylindrical sheet iron construction, with pointed head and flat base plate of iron. The 5 driving jets were arranged in a circle around the long stabilizing stick screwed into the center of the base plate. The stick was plated with tin where in contact with the driving jets. The Hale-Hooper rockets were of similar construction but dispensed with the stick, using autorotation for stability. The Mark VII modifications of the Congreve rocket has cases of steel tubing, a warhead of cast iron, and base plate of mild steel.

Stability

It has been mentioned that flight stability of the rocket is of utmost importance as with the thrust line of the rocket coinciding with its longitudinal axis any deviation of this axis from its course will take the rocket off its line of intended flight. The Congreve rockets used sticks of from 9 to 20 feet in length, depending on the size of the rocket. As stabilizers these did not always function as desired—frequently the rocket would curve in flight and return at its launchers.

Autorotation of the rocket seems to have proven more successful. The early Hale rockets achieved this by surrounding one-half the periphy of each of the 3 drive holes in the case with a curved flange. Impingement of the jet gases on these flanges caused deflection of the gases which in turn

Congreve Rockets

Wt. of Rocket	Load	Estimated Range ft.	Elevation Optimum
42 lbs	12 to 18 lbs. incendiary material	3500	60^0
42 lbs	12 lb explosive shell	3500	60^0
32 lbs	18 lbs incendiary material	2000	60^0
32 lbs	12 lbs incendiary material	2500	$55\text{-}60^0$
32 lbs	8 lbs incendiary material	3000	55^0
32 lbs	12 lb explosive shell	2500	55^0
32 lbs	9 lb explosive shell	3000	50^0
32 lbs	5 lb explosive shell	8000	55^0
32 lbs	200 carbine balls	2500	55^0
32 lbs.	100 carbine balls	3000	50^0
12 lbs	72 carbine balls	2000	45^0
12 lbs	48 carbine balls	2500	45^0
9 lbs.	Hand grenade	2000	45^0

caused rapid rotation of the rocket. Hale later modified this rocket and used but a single drive hole in the base, rotation being imparted by 3 oblique, nearly tangential, vents in the head of the shell. Evidently these vents were in direct communication with the inner chamber of the fuel.

An ingenious method once tried was installation of spiral flanges on the head of the rocket, these literally causing the shell to screw itself through the air. Spinning of the launching tube, before firing the shell, may easily be accomplished in fighter aircraft, by using the hollow propeller shaft as a barrel, the shell would thus be launched at a rotational speed of over 2000 r.p.m.

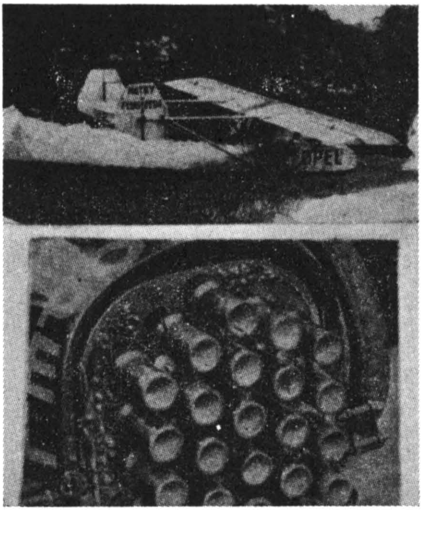
Experiments with metal fins, attached to the exterior of the rocket, were conducted by the American Rocket Society on rocket models in vertical flight. These might be useful on non-rotating rockets to impart a measure of "arrow feather" stability, or might be twisted to cause rotation.

Aside from aircraft adaptations, the writer is inclined to favor a compromise shell given its initial propulsion by a reduced firing charge of high explosive in a rifled thin-walled light weight gun. As the most critical point in rocket flight is the period immediately after launching this method would give us the advantage of a muzzle velocity of say, 700 ft/sec and rotation already imparted. Once clear of the barrel a delayed fuse might ignite the powder rocket charge and the shell would continue on with increasing velocity.

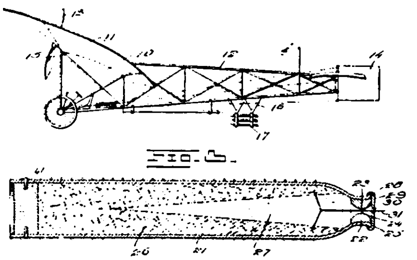
Of course, this would necessitate a heavier launching apparatus than would an unaided rocket shell, but the consequent gain in velocity and accuracy would more than overcome this disadvantage, it would also enable the rocket shell to function at a higher velocity-ratio efficiency.

Rocket Bombs

By use of autorotational stability the present tail finning of aerial bombs might be eliminated. The rocket bombs might be kept in thin walled launching tubes and fired downward, thus minimizing the tendency of modern bombs to follow the aircraft after being released. Improved penetrative power is very much desired, particularly against heavily armoured warships, where hits on the superstructure do not put the vessel out of action. The actual construction of rocket bombs would not present much of a problem, an extension on the orthodox bomb, to hold the powder charge, being the main change. The charge could be ignited electrically simultaneously with the release of the bomb.



Von Opel Plane at Take-off, and Typical Rocket Battery Arrangement



Early Rocket Booster Patent

For Assisted Take-Off

It has been demonstrated that powder rocket charges are capable of supplying enough power to move vehicles at high speeds over short distances. Especially prepared charges for the von Opel flight are said to have developed a thrust of over 50 lbs for some 25 seconds. The launching was made with charges giving a peak thrust of over 600 lbs, according to reports at the time of the flight.

An additional thrust of 2000 lbs for a period of 10 seconds would materially increase the bomb load which our bombers could carry. It would enable fighters to operate from the decks of small merchant ships converted into carriers. The desirability of some form of assisted take-off is generally agreed upon.

Assuming the development of a 20 lb rocket charge, capable of delivering 200 lbs thrust for 5 seconds, a thrust of 2000 lbs for 10 seconds could be developed by two batteries of 10 charges apiece — firing 10 charges the first 5 seconds and the remaining 10 charges immediately afterwards. In all probability the Nazis are using something very much like this.

The charges, which would probably be about 3 feet long by 3 inches in diameter, might be slipped into metal supporting tubes within a streamlined, sheet metal case fastened under each wing of the airplane. Ignition would be electrical and controlled from the cockpit. After using the entire container might be dropped from the airplane, thus gaining the advantage of auxiliary take-off power without the necessity of carrying any additional weight once in the air.

While rocket motors, burning liquid fuel, offer the advantage of much greater power, per unit weight, and also controllability, powder rocket charges might be used with present design warplanes, with the slight modification of installing fittings to hold the charges and transmit the thrust to the structure of the airplane. Other important advantages of the powder rocket battery, over rocket motors, for take-off are:

1. They can be cheaply and quickly produced in quantity.
2. Will keep indefinitely, and are always ready for use.
3. Are easy to ship, handle, store and install.
4. May be handled by personnel with a minimum of training.

While all of the foregoing applies directly to black powder rockets research should also be conducted with high explosive rocket charges. The possibilities of the various solid and gelatinous explosives will be outlined in a later article on this subject.

BOOKS FOR SALE

ROCKETS THROUGH SPACE, by P. E. Cleater (277 pages) a popular treatment of rockets, their history, how they work and what they promise. Price to members $2; to non-members $2.50.

STRATOSPHERE AND ROCKET FLIGHT, by C. G. Philip. Possibilities of jet propulsion for high altitude and space flights. Price $1.25.

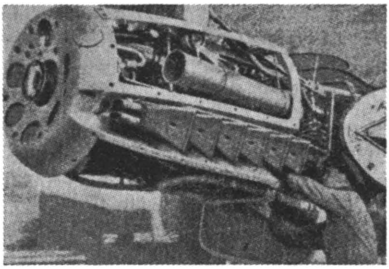
Engine Exhaust Propulsion

Recovery of Previously Lost Energy

by Cedric Giles

WITH the ever growing need for greater speed, range and altitude in aircraft flight the application of exhaust gases as an additional source of power is becoming of increasing importance. Whereas formerly the exhaust gases were directly dissipated into space, the possibility of utilizing some of this surplus energy has been shown in recent years in driving turbo-superchargers. Even more recently steps have been taken to utilize the reaction of the hot exhaust gases by passing them through appropriately shaped nozzles to boost the speed of the aircraft.

Increased speeds become possible at high altitudes, due to less resistance, but engine power will have a tendency to fall off also unless some means of compressing the relatively thin air is used. For this purpose a supercharger is usually employed on aircraft engines. There are two main types of superchargers used today, the direct gear driven blower and the turbo-supercharger driven by the exhaust gases. The mechanically driven blower consists of a high-speed impeller rotating within a special part of the engine's crankcase. It serves to suck air in through the carburetor, compress the fuel-air mixture, distribute it to the cylinders through a diffusor, under greater pressure than would be the case otherwise. Unfortunately, as the blower is directly geared to the engine, while the power is increased on the ground it will still tend to fall off with altitude. To overcome this disadvantage, two-stage gear driven blowers are now used, the higher gear ratio coming into effect at a specified altitude.



Nozzled Exhaust Stacks of the Heinkel 111 Bomber.

The exhaust gases, upon exiting through the manifold, are discharged into the slipstream — recently, through nozzling this exhaust, an added thrust has been added to the aircraft, particularly in the case of liquid-cooled engines.

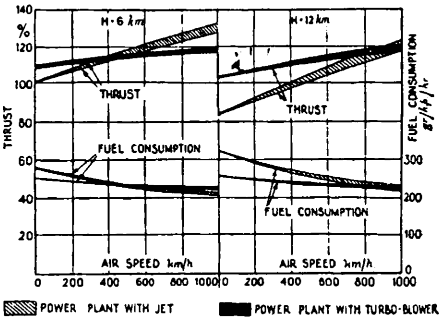
Turbo-superchargers

In the turbo-superchargers the exhaust gases pass through the exhaust manifold then are directed to impinge upon the buckets of a high-speed turbine wheel, which in turn drives the blower in a separate compartment. By proper regulation of control valves in the manifold the desired amount of exhaust gas is fed to the turbine, the balance being by-passed into the atmosphere. The gases leaving the cylinders may have temperatures as high as 1000°C., and enter the turbine at a few hundred degrees less. To prevent excessive heating of the turbine blades they are cooled by a flow of cool air. The gases leaving the turbine may then be passed through nozzles to add to the thrust, but they have been slowed down considerably.

Ducted Radiators

For cooling liquid-cooled engines at high altitudes a ducted radiator system is used. The air in passing through a diffusor in the radiator of the cooling system is slowed down while its pressure is increased. With the addition of heat, from the radiator, and passage through properly formed ducts, the air is ejected from the duct outlet with a higher velocity than that with which it entered the system. This velocity difference can be utilized for additional thrust. Under exceptional circumstances not only is this sufficient to compensate for the drag of the radiator but actually this thrust may be greater than the drag, involving into a "flying radiator" which becomes an asset to the airplane.

In order to attain the maximum power output of the engine, exhaust mufflers are eliminated from aircraft as they lessen the efficiency of the engine by building up back pressure; a condition which is not apparent when the engine exhausts directly into the open air. Upon increasing the back pressure by the utilization of the waste gases the engine output is lowered, but with higher aircraft speeds the combine power of engine and exhaust jets will be of greater value. To prevent an excessive back pressure, from the exhaust outlets throughout the greater part of the exhaust system, suitable automatic regulation is a necessity. The exhaust gas thrust of ejector exhaust engines may increase the speed of fast-flying aircraft as much as 20 to 30 m.p.h.



Exhaust gas utilisation through ejector exhaust and turbo-blower at different altitudes.

Dr. Ing. Gunther Bock in an article in Flight March 26, compares the efficiency of utilizing the exhaust gas energy in a turbine to direct ejector exhaust thrust. Naturally such comparison must also depend upon the type of engine as well as its essential parts.

In the accompanying diagram the shaded areas represent the engine with the mechanically driven blower and ejector exhausts, while the black areas refer to the engine with turbo-blower where the greater amount of exhaust gas energy is utilized in the turbine.

In the left drawing where 6 km. is the full-pressure height of the engines, the turbo-blown engine loses superiority above air speeds of 400 km/hr. The drawing on the right with the engines having a full-pressure height of 12 km. shows the turbo-blown engine the most efficient up to 900 km/hr. air speeds.

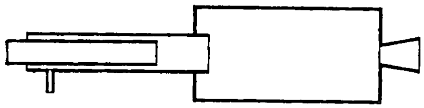
Due to the drop in temperature with increase in altitude turbo-blower type engines when designed for full power at higher altitudes are superior to a power plant with jet. The fuel consumption is also found to be more economical for the turbo-blower engine.

A MODIFIED ROCKET ENGINE

By Charles T. Piecewicz

The Midvale, New Jersey, rocket tests of last summer on the Society proving grounds were significant in at least one respect. They proved that simply mixing the fuel and oxygen at random in an orthodox chamber is a sporadic and an inefficient means of securing power. On the other hand, the nozzle-less motor, in spite of the fact that it was ice cold after the run, was not as efficient as expected. However, both approaches have their merits, and the present discussion deals with a motor design utilizing the best features of each. The significant fact that has arisen as a result of the tests is that the two schools of thought must be combined to produce a better, more efficient motor.

The "nozzle-less" Piecewicz-Carver motor has a concentric feed with a long tubular cylinder. The liquid oxygen is fed in the center, and the alcohol is fed around it. As demonstrated at Midvale, New Jersey, on June 8, 1941, this motor after its run was frosted over on the outside walls after developing violent flames at the outside of the cylinder. This indicates that a concentric feed arrangement is a desirable way of emitting fuel for a rocket motor since its combustion contact range can be controlled. From the nature of the nozzle-less motor construction a considerable amount of energy was wasted since most of the combustion was taking place outside of the tubular cylinder. Even Africano's motor showed a great deal of outside burning in spite of the fact that a great deal of ceramic lining was melted away and exhausted through the nozzle. If the fuel lasted longer it is obvious that the motor would have burned up.



MODIFIED ROCKET MOTOR

Where does this lead us to? The answer is obvious. We can not with present metals expect to have a motor last if we inject at random in a cylinder a stream of alcohol and liquid oxygen and allow combustion to take place. The combustion temperature of alcohol and liquid oxygen is at least high enough to melt any readily available metals. However, if we feed the fuel and liquid oxygen concentrically we can control readily the flow in a form of a long, slender cylinder which upon ignition looks like a cone-shaped Bunsen burner flame. The hotest part of this flame is near the center and the temperature drops off on the outer fringes. A cylindrical chamber with a nozzle can be designed to fit over this expanded cone of flame in the proper portions so that the chamber will not burn up. Thus the best working conditions can be realized. To be sure the efficiency will not be maximum since the gases next to the cylinder wall will be slightly cooler than in the center, but this will give a good practical efficient motor with a long life.

A self-explanatory schematic diagram of the motor built by the author is included.

American Rocket Patents

Past issues of ASTRONAUTICS have at frequent intervals mentioned patents pertaining to the subject of Rocketry, and on numerous occasions have described in detail patents of exceptional interest.

Realizing that many of the readers of this publication have not the opportunity or time to search the columns of ASTRONAUTICS for descriptions of required patents, the following list of the most important ones has been compiled.

No. 59,487, "Improvement in War-rockets"; granted to J. J. B. Walbach, of Baltimore, Maryland.

No. 502,168, "Aerial Machine"; granted to Sumter B. Battey, of New York, N. Y.

No. 508,753, "Airship"; granted to Edwin Pynchon, of Chicago, Illinois.

No. 847,198, "Rocket Apparatus"; granted to Alfred Maul, of Dresden, Germany.

No. 1,102,653, "Rocket Apparatus"; granted to Robert H. Goddard, of Worcester, Mass.

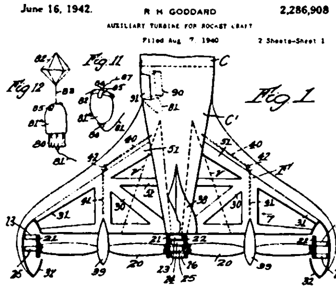
No. 1,003,411, "Pyrotechnical Auxiliary Mechanism for Aerostructures"; granted to Haden H. Bales, of Ashcroft, British Columbia, Canada.

No. 1,103,503, "Rocket Apparatus"; granted to Robert H. Goddard, of Worcester, Mass.

No. 1,809,271, "Propulsion of Aircraft"; granted to Robert H. Goddard, of Worcester, Mass.

No. 1,834,149, "Means for Decelerating Aircraft"; granted to Robert H. Goddard, of Worcester, Mass.

No. 1,838,984, "Rocket Motor Aeroplane"; granted to Louis Berkowitz, of New York, N. Y.



Dr. Goddard's Latest Patent. A Detachable Turbine for Increased Sounding Rocket Efficiency

No. 1,879,187, "Mechanism for Directing Flight"; granted to Robert H. Goddard, of Worcester, Mass.

No. 1,879,579, "Rocket"; granted to Hermann Stolfa and Rudolf Zwerina, of Vienna, Austria.

No. 1,880,579, "Method of Producing Rockets, especially for Aeronautic Purposes"; granted to Reinhold Tiling, of Osnabruck, Germany.

No. 1,880,586, "Flying Rocket"; granted to Reinhold Tiling, of Osnabruck, Germany.

No. 1,979,757, "Liquid Fuel Burner"; granted to Henri F. Melot, of Montrouge, France.

No. 1,980,266, "Propulsion Apparatus"; granted to Robert H. Goddard, of Worcester, Mass.

No. 1,982,665, "Explosion Turbine"; granted to Hans Holzwarth, of Dusseldorf, Germany.

No. 1,982,666, "Apparatus for Charging Explosion Chambers"; granted to Hans Holzwarth, of Dusseldorf, Germany.

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LETTERS TO THE EDITOR

With the continuation of the war in Europe the majority of rocket organizations have found it advisable to disband. Consequently, it is of particular interest to receive a communication from Mr. Sidney Harris of the Manchester Astronautical Association describing the present state of affairs of the Association.

The M.A.A. in 1939 planned to construct a passenger carrying stratoplane, capable of short flights, merely to test the design and motors. When this proved successful, they intended to construct a larger machine. Details of these ships were not published but the following specifications may be taken as authentic. The wing span of the plane was to be approximately 20 feet, its overall length 16 feet, its height 15 feet, and its gross weight 120 lbs. The Association estimated that with their present resources, construction would take about 2 to 3 years.

Mr. Harris in his letter writes as follows:

"Over here however, we have concentrated on popularizing the interplanetary idea, and hence articles and publications have dealt chiefly with the popular aspect of the subject, — space travel, space ship design, etc. However, Mr. Burgess, president of the M.A.A., has informed me that he has designed a rocket motor for testing fuels and that it is partially completed, so this year may see some practical work accomplished. The motor, if successful, will be used for the sounding rocket that the Association is developing. Two or three articles of the series on the sounding rocket appear in the copies of SPACEWARDS, the Journal of the Manchester Astronautical Association. Whatever their present worth, I am convinced that publications like these will have a definite historical value in the future."

"As the M.A.A. is, at present, probably the only organization of its kind still active in Europe, you may be interested to hear something of it. (Though, as Mr. Burgess humorously put it, our progress during the war has been more of a stagger than a march!). The M.A.A. was founded in 1938 by Eric Burgess and Trevor Cusack (since killed at sea through enemy action). Its work consisted in the design of a spaceship, and the design and construction of a stratoplane, several models of which were built. Work is now progressing on the design of a sounding rocket, the motor of which is partially completed. Mr. Burgess has informed me that a Midlands Interplanetary Society is in process of formation with headquarters at Rowley Regis, Staffordshire, and that there is in existence an Astronautical Development Society, but I am waiting further details of both of these. Mr. Burgess has been serving with the Royal Air Force for a year, and I think you will agree that he has done a fine job in keeping the M.A.A. going.

"In conclusion, I should like to take this opportunity of wishing you the best of luck, and your Society every success, during 1942."

Communication from two amateur rocket experimenters outline some interesting points in their respective tests. The first, from Mr. Terry Leazer, of Sioux City, Iowa reports:

"Experiments with a liquid fuel motor ended in failure, due to improper combustion. A flame about a foot long issued from the nozzle, but no reaction was evident. Better results were obtained with a powder fuel rocket -- 3 inches long and ½ inch in diameter — which made some interesting if rather erratic flights. The small rocket had two exhausts, each of which was coated with magnesium oxide, and a zinc alloy body was used. Unfortunately no accurate measurements of these tests were taken."

Mr. Leazer does not indicate the nature of his fuel, nor the object of his experiments. Another brief mention of unsuccessful research is forwarded by Mr. Henry Kordela, whose 36" x 4" rocket exploded when tested.

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American Rocket Patents

(From Page 14)

No. 1,983,405, "Method of Producing Motive Forces on Aircraft, by the Explosion of Inflammable Mixtures of Substances"; granted to Paul Schmidt, of Munich, Germany.

No. 2,024,274, "Reaction-propulsion Method and Plant"; granted to Secondo Campini, of Milan, Italy.

No. 2,090,039, "Igniter"; granted to Robert H. Goddard, of Roswell, New Mexico.

No. 2,122,521, "Cooling Jacket Construction"; granted to Robert H. Goddard, of Roswell, New Mexico.

No. 2,158,180, "Gyroscopic Steering Apparatus"; granted to Robert H. Goddard, of Roswell, New Mexico.

No. 2,183,311, "Means for Steering Aircraft"; granted to Robert H. Goddard, of Roswell, New Mexico.

No. 2,183,312, "Fuel Storage and Discharge Apparatus"; granted to Robert H. Goddard, of Roswell, New Mexico.

No. 2,183,313, "Combustion Chamber for Aircraft"; granted to Robert H. Goddard, of Roswell, New Mexico.

No. 2,183,314, "Gyroscopic Apparatus for Directing Flight"; granted to Robert H. Goddard, of Roswell, New Mexico.

No. 2,217,649, "Combustion Chamber for Rocket Apparatus"; granted to Robert H. Goddard, of Roswell, New Mexico.

No. 2,256,198, "Aircraft Power Plant"; granted to Max Hahn, of Seestadt Rostock, Germany.

No. 2,271,224, "Parachute Attachment for Aircraft"; granted to Robert H. Goddard of Roswell, New Mexico.

Compiled by Cedric Giles.

Letters To The Editor

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Fuel used in this case was a mixture of charcoal, cotton and liquid oxygen, forming, no doubt, an explosive of great potency. In the course of his research Mr. Kordela received a rather painful injury which terminated, for the time being, any further rocket construction of this nature.

A timely suggestion is written in on the back of his application blank by Lt. Hugh Robertson, Jr., of Pensacola, Florida:

"I have been much interested in gliders and sailplanes, and have wondered about the possibilities of launching these for pleasure and training flights with some sort of simple, safe rocket motor, perhaps even using a handy cartridge type of charge."

"I believe soaring will become a very popular sport in time, especially for youngsters and sportsmen of limited means. This valuable (to national defense) evolution can be hastened by making soaring and gliding both cheaper and simpler. At present the pilot and the sailplane are but a part of the outfit, in addition there is a ground crew of 3 or 4, plus a special towcar or expensive winch and cable arrangement. Monotonous also is the waiting of the ground crew during an hour or two of soaring; and the hundred or so miles of driving after a distance try."

"A simple impulse launch would make soaring a one or two man sport; with landings, cross country flights and emergency boosts easily possible."

We heartily echo Lt. Robertson's sentiments — this is a fertile field for the rocket cartridge. We believe he will find the article on powder rocket charges, published in this issue, of interest in this respect.

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