MODERN METHODS OF LIFE-SAVING AT SEA

NEWNES

PRACTICAL MECHANICS

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The Pilotless Aircraft

Technical Details of Germany's Latest Offensive Weapon

By F. J. CAMM

SEVERAL inaccurate and fanciful articles have appeared in the daily press purporting to give technical details of Germany's new pilotless aircraft, with which they are indiscriminately bombing certain parts of Southern England. In order that our readers, and particularly Northern readers, who have not seen one of these machines in the air, may have accurate knowledge of all of the details of this form of aircraft known to date, I have prepared the following notes and illustrations.

I can say at once these aircraft are not radio-controlled, nor do they make use of turbines. These flying bombs first fell in this country on Tuesday, June 13, 1944, and we have been enabled from the undamaged pieces which have come into our possession to piece together a complete machine, so that we know precisely how it works, its range, its weight, its concussive effect, the capacity of its tanks, its propulsive principles, its wing-loading, its speed, its physical characteristics, method of construction, and not the least important, its limitations.

It is not generally known that this type of machine was first developed by Melot, a French engineer of note, during the last war. It was subjected to tests under the surveillance of the French military authorities, but the experiments were not entirely successful, and the idea was shelved. It was impossible to arouse further enthusiasm for the idea when peace was signed, and there the matter rested so far as France was concerned.

The Germans, however, realising that the Luftwaffe was declining in quantity as well as in quality, about a year ago commenced experiments at the point where Melot left off. In passing, it may be stated that Hitler really expected this to be a blitzkrieg war. He expected it to be over before any other nation was ready, and so he had made no provision for a long war, nor for the elasticity or flexibility of design, particularly of aircraft, necessary to meet changing conditions imposed by a long war.

The entry of America into the war provided us with a vast arsenal from which we could replenish our stocks of war materials and build up an air force which has blown the German air force out of the skies.

The German engineers, crying "Ichabod," perceived in the flying bomb a means of carrying out so-called "reprisals" on England, and of reviving the flagging German morale at a time when the Berliners were pressing the German High Command to "bomb London."

It is not a German invention, but a Teutonic adaptation. The Germans are adept at adapting the ideas of others. Within the space of a year they have perfected the device and demonstrated the practicability of reaction propulsion.

Types and Specification

There are several types of these pilotless aircraft in use by the Germans, and the cardinal difference is in the wing platform. One type, however, seems to be more favoured by the Germans than the others, if we are to judge by the quantities of them which they are using. This type has a square wing form with an aspect ratio of 5-1. The main details of the specification are given on the next page.

It will be seen from the very high petrol consumption that the machine is of low thermal efficiency, and evidence of this is provided by the fiery jet, about 14ft. long, which it emits in flight.

The Power Unit

The power unit is of amazing simplicity, and it has practically no moving parts. Mainly it consists of a Venturi tube, about 11ft. in length, with a maximum diameter of 2ft. A grille of lattice formation is fitted in the forward end, and this grille may be closed by a system of flap-valves, as shown in the diagram, permitting and excluding a flow of air into the unit.

No one has yet inspected or disclosed the method of launching, but presumably the machine is catapulted into the air, the catapult imparting a sufficient velocity to operate the power unit and to cause the shutter-valve to operate. When in motion air pressure lifts the spring steel shutter valve in the grid, thus permitting a flow of air into the unit. Fuel is injected at the same moment into this air stream, causing approximately 40 explosions a minute.

It is obvious that at each explosion the internal pressure, being greater than the external, will close the shutters and so seal the grid inlets, preventing forward emission of the exploded air-and-petrol-mixture.

As soon as the pressure in the combustion chamber diminishes by the escape of gas through the Venturi the pressure on the outer face of the grille exceeds that inside it, and so the spring shutters open, permitting further entry of air. This cycle, of course, is repeated until the fuel runs out.

The heater bars, which are used to provide continuous ignition and preheated to incandescence are streamlined to improve gas flow. Thus the unit is of the compressorless type, similar to those devised by Lorin in 1913, and Luduc in 1933.

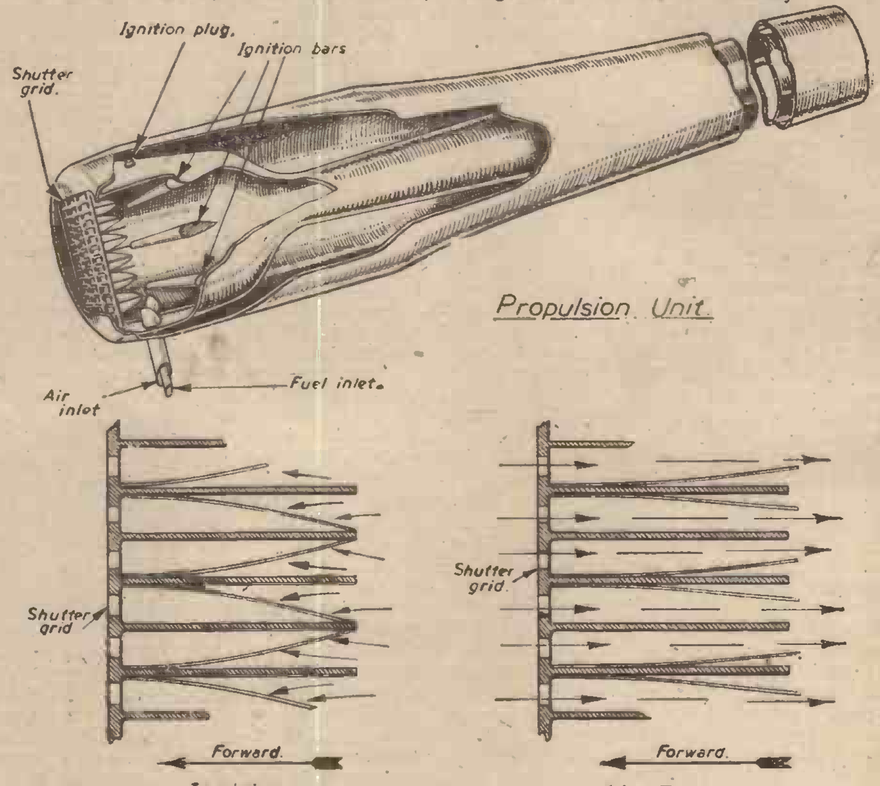
Steel Construction

The explosive is carried in the warhead, mounted in a thin casing in the front of the fuselage. The machine is built practically throughout of sheet steel of about 24 s.w.g. for the fuselage and wings, and 10 s.w.g. for the propulsion unit.

The bulkheads and ribs are of pressed steel, formed to shape and welded together. It is coloured with the usual type of German camouflage—dark green on top, and light blue underneath. It is operated by an automatic pilot set before the take-off, and once it has been launched the enemy has no control over its further movements.

It must not be presumed that the use of this new weapon came as a surprise to us. We knew they were planned for use on this country many months ago, in order to divert the Allied air forces from their attacks on German industry, communications, and transport. It was the main object of the attack by the R.A.F. on the experimental station at Peenemunde on August 17th, 1943, to destroy the plant.

I have no doubt that, as with all new weapons, we shall find the answer, as we have done with the magnetic mine and other "secret weapons." It must be remembered, too, that methods already in use are taking heavy toll of these missiles, only a few of which are getting through to their indiscriminate objectives. A large proportion of them are shot down into the sea or in open country. Our fastest fighter, the Tempest, has a speed in excess of the pilotless aircraft, and has chased and accounted for many hundreds of them already. Many minds are at work, and it is hardly necessary to remind readers that intelligence, inventiveness, and ability to circumvent are not indigenous to the soil of Germany.



Ignition
Shutters closed by force of explosion.

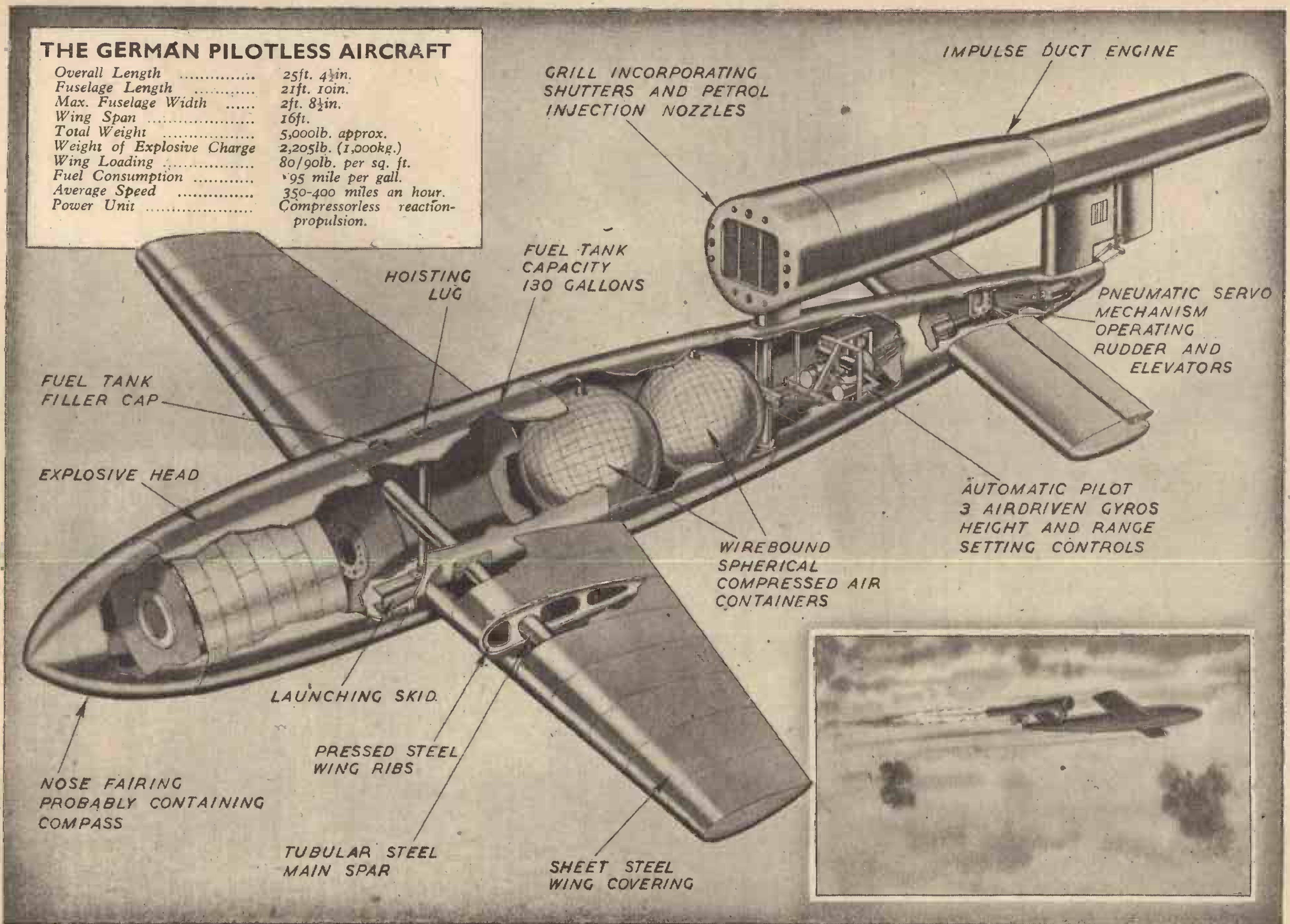
Air Entry
Shutters lifted by air pressure.

(Original drawing copyright of "Practical Mechanics.")

Sectional view and details of the propulsion unit.

THE GERMAN PILOTLESS AIRCRAFT

Overall Length	25ft. 4½in.
Fuselage Length	21ft. 10in.
Max. Fuselage Width	2ft. 8½in.
Wing Span	16ft.
Total Weight	5,000lb. approx.
Weight of Explosive Charge	2,205lb. (1,000kg.)
Wing Loading	80/90lb. per sq. ft.
Fuel Consumption	·95 mile per gall.
Average Speed	350-400 miles an hour.
Power Unit	Compressorless reaction-propulsion.



load, and the ratio of transformation is reduced to a greater degree; this is due to the fact that the transformer windings have more reactance than resistance. It is, therefore, important to design the transformer to keep the reactance to a minimum for an inductive load. In most cases the primary voltage will be fixed so the primary volt drop will reduce the secondary terminal voltage below the value indicated by OV_s.

On the other hand if the secondary load circuit had a high capacity, such as a condenser, the conditions would be somewhat as indicated in Fig. 8. In this case the secondary current will actually be in advance of the secondary voltage. The same notation is adopted and it will be seen that this type of load causes the secondary terminal voltage to increase, and at the same time the ratio of transformation is increased.

The simplest way of dealing with a transformer which has a transformation ratio of more than one is to employ different scales for the primary and secondary values. For instance, if the secondary voltage is half the primary voltage, one inch on the primary voltage vector could represent 50 volts, and 25 volts for the secondary. One amp. primary current could be represented by the same length as two amps. secondary current. By this means all currents can be considered equally effective as regards magnetic effects, since the secondary currents are increased in practically the same ratio as the turns are reduced. If one inch represents 5 amps. primary current in a 1 to 2 step-down transformer, it could also represent 10 amps. secondary current. This will be quite in order since 10 amps. increase of secondary current will necessitate 5 amps. increase of primary current to restore the magnetising ampere turns, if the losses are neglected.

Rocket Propulsion

Further Notes on Its History and Development

By K. W. GATLAND

(*Continued from page 332, July issue*)

IN 1812 an English Army Rocket Brigade was formed, which subsequently gained marked success at the siege of Leipsig in 1813, and also during the Battle of Waterloo, two years later.

After witnessing trials of Congreve rockets at London, in 1813, Austrian army officials succeeded in influencing the Austrian Government, who, a year or so later, established a sizable factory for the purpose of war-rocket manufacture at Weinerisch-Neustadt.

It is desirable to emphasise, before proceeding further, that the rockets developed up to this period were of very low thermal efficiency, decidedly unstable in flight, and, in consequence, inaccurate in trajectory. It was not until Congreve introduced fins, superseding the balancing "stick," that the rocket began to show any marked gain in technical advancement. However, the invention of this stabilising means cannot be actually credited to Congreve, as the idea was first given by Frezier, a French artillery engineer, in his technical book on armaments, published some years previous to the practical development, who also anticipated in the same work, a later refinement of Congreves, the "two charge rocket," to which reference will be made later.

Perhaps the most notable contribution to the science of rocketry, prior to the twentieth century, was the invention of the axially rotated rocket projectile. This rocket system, first developed in America in 1815, displaced both the balancing "stick" and the "fin," the exhaust apertures being spaced in a circle, and drilled offset to the line of thrust, instead of normal to it, as in the "stick" and "finned" principle. Needless to say, this refinement aroused much interest amongst rocket authorities throughout the world, and attention was focused towards its further development. In England Congreve developed many rockets of similar character to the American design, rotation being similarly imparted by virtue of offset thrust.

It was in the year 1826 that Congreve patented a method whereby a series of rocket cases were laid in line within a single containing tube, so that the charges became ignited successively, to thus obtain an increased duration of firing. This method, however, was first conceived by Frezier, as previously mentioned, and has since become known as the "step-rocket" principle.

Congreve was later knighted for his work in connection with English rocket artillery, and subsequently assumed the position of Controller of the Royal Laboratory, Woolwich.

At about the same period rockets of greater efficiency than those previously used in war were employed against the Turks by the Russians, who developed a battery launching system which fired several explosive rocket projectiles at one loading into the enemy lines in much the same way as the Russian rocket batteries operate to-day.

The Rocket Life-line

Although being employed for lighting and signalling purposes at sea, the rocket had found its greatest use in war, and the first evidence of its application actually being instrumental in saving life, instead of destroying it, was in 1826, when four rocket life-line stations were set up at various points on the Isle of Wight coast known to be most perilous to shipping. The rockets employed were designed by Dennett, of Newport. The rocket-line, however, had been first advocated by Trengouse in 1807, but, owing to the employment of the Manby life-line mortar system, which had then just come into extensive use at coastguard stations all round the British Isles, the true merits of the rocket for the purpose of life-saving were overlooked, and it was not until 1855 that the rocket finally came into its own, displacing the Manby mortar, the rockets used ranging in weight from ¼lb. to 2lb. The advantages of the rocket over its contemporary are obvious. The rocket projector, for instance, is considerably more compact than the mortar apparatus and, in consequence, more portable. Still more important, the path of the line is traced out by the rocket exhaust—a great advantage, especially at night. Although it was not until 1870 that universal adoption was finally achieved, the rescue rocket since that time has been instrumental in saving over 14,000 lives. The 6lb. rockets of that period were capable of carrying a ½in. hemp line for distances of approximately 1,050ft.

In 1841, S. Golightly proposed a reaction propelled projectile intended to employ steam as the propellant. However, although his idea was correct in principle, the design was not technically sound, but, allowance being made for the period of invention, his scheme was, nevertheless, a remarkable one.

In the year 1844, William Hale designed and patented a rocket projectile stabilised by axial rotation, the exhaust apertures being practically tangential at the side of the case. The rotary stabilisation principle was further developed during the following years. Macintosh, in 1853, for instance, evolved a firing method in which the launching tube was initially rotated to impart rotation to the rocket prior to flight. A year later Court patented a design in which the exhaust impinged on small vanes inclined to the rocket axis. Fitzmarice, in the same year, developed the method of causing rotation by the action of air pressure on a "spiral" shaped head.

It was about the middle of the century that the rifled cannon came into use, due mainly to the endeavours of General Rodman and W. E. Woolbridge in America, and with its subsequent universal adoption, the war rocket quickly fell from favour.

Step-rocket Line Carrier

However, a great deal of rocket research continued, although mainly in connection with the rocket lifeline. In 1855, Col. Boxer, of the Royal Laboratory, Woolwich, further developed the "step-rocket" as a line-carrier (Fig. 5). This he evinced by placing two rocket charges in line within a single case. When ignited the first charge carried the projectile until its fuel was exhausted, at which stage it fired the second, and was blown off, the rocket thereby gaining additional impetus in flight, substantially improving the range.

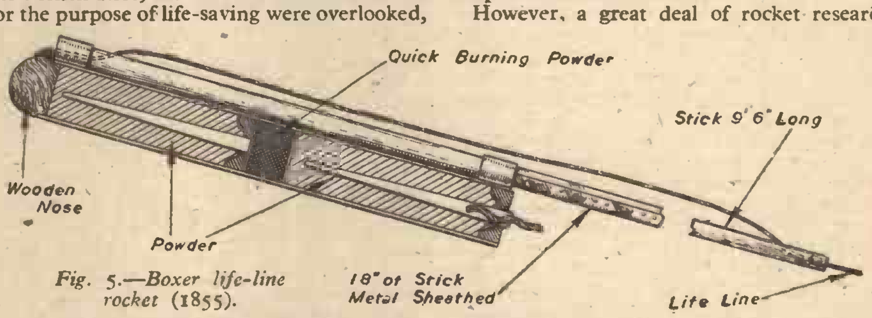


Fig. 5.—Boxer life-line rocket (1855).

A rocket-propelled airship was proposed in 1860 by Betty, an American engineer, but was not, however, proceeded with beyond the design stage.

In the year 1863 William Hale published a technical paper, "A Treatise on the Comparative Merits of a Rifled Gun and a Rotary Rocket," and a few years later further developed the axial rotation principle. Instead of offsetting the exhaust apertures as the Americans, Congreve, and he himself had done previously, Hale provided metal shields (Fig. 6) inclined over three escape holes drilled normal to the axis of the rocket, on to which the exhaust gases impinged, creating a rotary motion. With reference to the diagram, the screwed safety cap was fitted only for purposes of storage, in order that the rocket would explode should spontaneous combustion take place. These type projectiles were of two sizes, and named after their inventor—"Hales 9 and 24-pounders."

Misconceptions of Space-flight in Literature

Although Jules Verne, in his great work of fiction "From the Earth to the Moon," published in 1866, suggested rockets to retard the space-vessel depicted by providing reaction tubes at the nose of the craft, neither he, nor H. G. Wells in "The Shape of Things to Come" (published some years later) suggested the rocket means for propulsion—instead the impossible "space-gun" being employed for projecting the craft beyond the Earth's gravitational influence—in much the same way as a bullet fired from a gun.

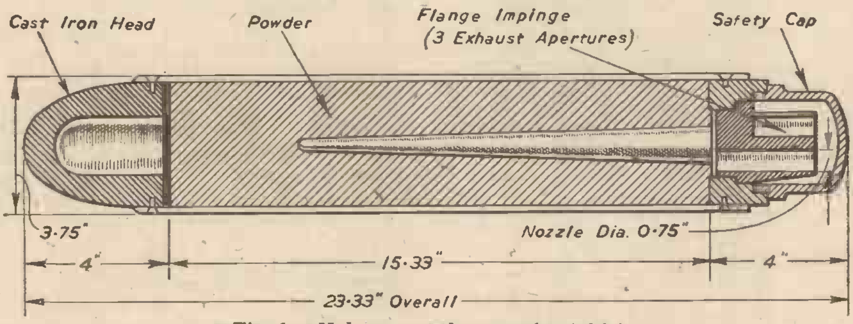


Fig. 6.—Hale 24 pound war rocket (1863).

The obvious fallacy of the "space-gun" principle is in the severe shock acceleration at take-off in order to attain an initial speed of 6.95 miles per second (release velocity), which beyond all measure of doubt would be instrumental in instantly crushing the occupants to death. Another obvious point is that friction caused by the rapid passage of the vessel through the atmosphere would be prohibitive. The rocket, on the other hand, would not need to develop such severe acceleration, due to the fact that a rocket vessel would carry its own propulsive means, the application of energy being spread over a considerable period, and acceleration built up gradually within bearable physical limits. The greatest velocity would be achieved far beyond the Earth's atmosphere belt, and, in consequence, the frictional effect would be by no means as severe. It is curious that having readily available the knowledge of elementary mechanics, these great writers of science-fiction did not realise the impracticability of their fictitious creations, for had they given the subject serious practical consideration prior to writing, the rocket means would have shown itself the only truly feasible method of achieving the conquest of space and, in consequence, further enhanced the value of their work.

The above comments of scientific literature have been included not so much for historical significance, but rather as a convenient point to clarify some of the early fallacies connected with the subject of space-flight, and interplanetary communication.

The First Rocket Aeroplane

A Russian, Niballchitch Kibaldchitch, in 1881, designed what might be termed the first reaction propelled aircraft. In actual fact, he recorded the basic design while imprisoned for being concerned with five others in the assassination of Czar Alexandra II, while awaiting the result of the trial, and the inevitable "Death Sentence." However, his drawings and manuscripts were not discovered until long after his death, actually in 1918, and although the ideas contained were certainly revolutionary for their day of origin, they were naturally enough of little practical consequence at the time of their finding.

It is indeed surprising to find in a book, "Half Hours in Air and Sky," published by James Nisbet and Co., in 1899, the true principle of rocket motion defined, as follows:

"In the infancy of physical science it was hoped that some discovery should be made that would enable us . . . to pay a visit to our neighbour, the Moon. The only machine independent of the atmosphere, we can conceive of, would be one on the principle of the rocket. The rocket rises in the air, not from the resistance offered by the atmosphere on its fiery stream, but from internal reaction. The velocity would, indeed, be greater in a vacuum than in the atmosphere, and could we dispense with the comfort of breathing air, we might with such a machine transcend the boundaries of our globe and visit other orbs."

When it is considered that even to-day the principle of rocket motion is constantly being misinterpreted, often by reputable engineers, the significance of this short paragraph written by an unknown author, is truly remarkable.

Experimental Work

Reverting to the rocket as a line carrier once more, a great deal of experimental work was conducted by various individuals in Britain towards the close of the nineteenth century, resulting in considerable improvement of this type of sea-rescue apparatus. Many of these developments were represented in trials of line-throwing appliances conducted by a sub-committee of the Advisory Committee of the Board of Trade, in which numerous forms of life-saving equipment were demonstrated. It is of interest to note that not only were various types of rocket-line apparatus tested, but in addition, line-throwing guns, drift buoys, kites and balloons. The most promising equipment proved to be a portable rocket apparatus designed by William Schermuly. This apparatus, consisting of a launching trough (into which the rocket carrier was placed), supported by a stand and fixed direct to a line-containing box, was initially tested under the auspices of the sub-committee in 1908 at Greenhithe, on board the "Warspite." The apparatus was set up on the rail of the ship, and fired, in the surprisingly short time of 2¼ minutes, contact being made with the shore some 200 yards distant, using a 2lb. rocket. Further Schermuly rocket line-carriers were tested in this and subsequent trials, later tests being conducted in October of the same year on the Tyne, when even better results were obtained in respect to setting up and firing, in one particular case, preparation taking only one minute, the 1lb. rocket employed bearing a line for 177 yards, a notable achievement for a light rocket. Another rocket of 6lb. set up and fired in 1½ minutes, successfully projected a line for 321 yards. The proved efficiency and extreme portability of the apparatus, which weighed complete only 40lb., were all the more notable in the fact that the tests were carried out single-handed. As the result of the 1908 trials, the Schermuly line-carrying apparatus was approved by the Board of Trade, and to-day, developments of this pioneer portable sea-rescue equipment constitute an important emergency item on all British and a very large number of foreign ships.

The Beginnings of Modern Research

The first to seriously suggest the rocket as a means for interplanetary communication would appear to be a Russian scientist, Konstantin E. Ziolkowsky. His first technical paper on the subject of rocket motion was published in the scientific journal, "Nautschnoje Obosrenije," in 1903, in which he pointed out the functioning principle of reaction, illustrating theoretically that a rocket could operate in vacuum.

In 1907, a French engineer, Esnault-Pelterie, commenced a mathematical investigation into the possibilities of space flight. The work was expanded in 1912, and later submitted to the Société Française de Physique.

Also in 1912 an American engineer, Dr. Robert Goddard, of Princeton University, after a considerable theoretical investigation of rocket motion commenced in 1909, successfully demonstrated that a rocket could function in space. This was arranged by firing a rocket charge within an evacuated glass tank, and the impulse measured, due care being taken at the same time that gaseous rebound did not affect the recording. The result indicated a slight increase in the thrust factor, in comparison with that obtained under normal atmospheric conditions. Thus it was finally proved that instead of being the medium which effects propulsion, the atmosphere actually has a "damping" effect, acting to lower the velocity of the exhaust efflux, thereby reducing efficiency. Much of

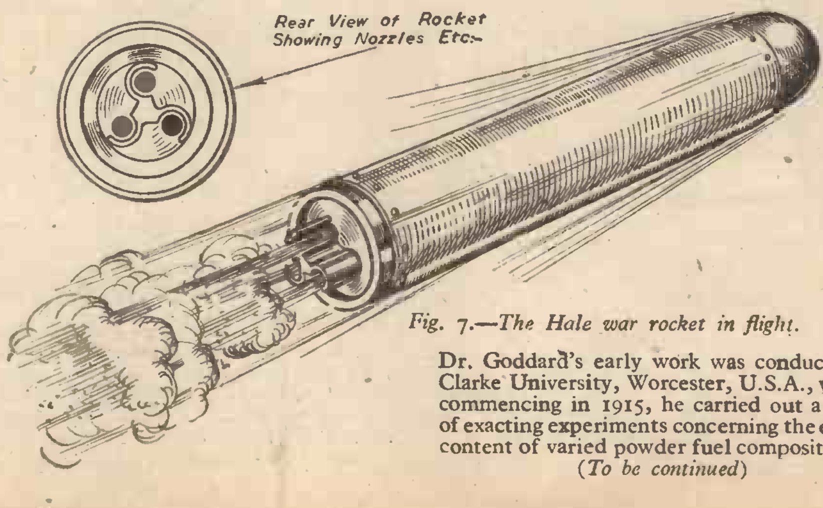


Fig. 7.—The Hale war rocket in flight.

Dr. Goddard's early work was conducted at Clarke University, Worcester, U.S.A., where, commencing in 1915, he carried out a series of exacting experiments concerning the energy content of varied powder fuel compositions.

(To be continued)