PROGRESS IN X-RAYS

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PRACTICAL MECHANICS

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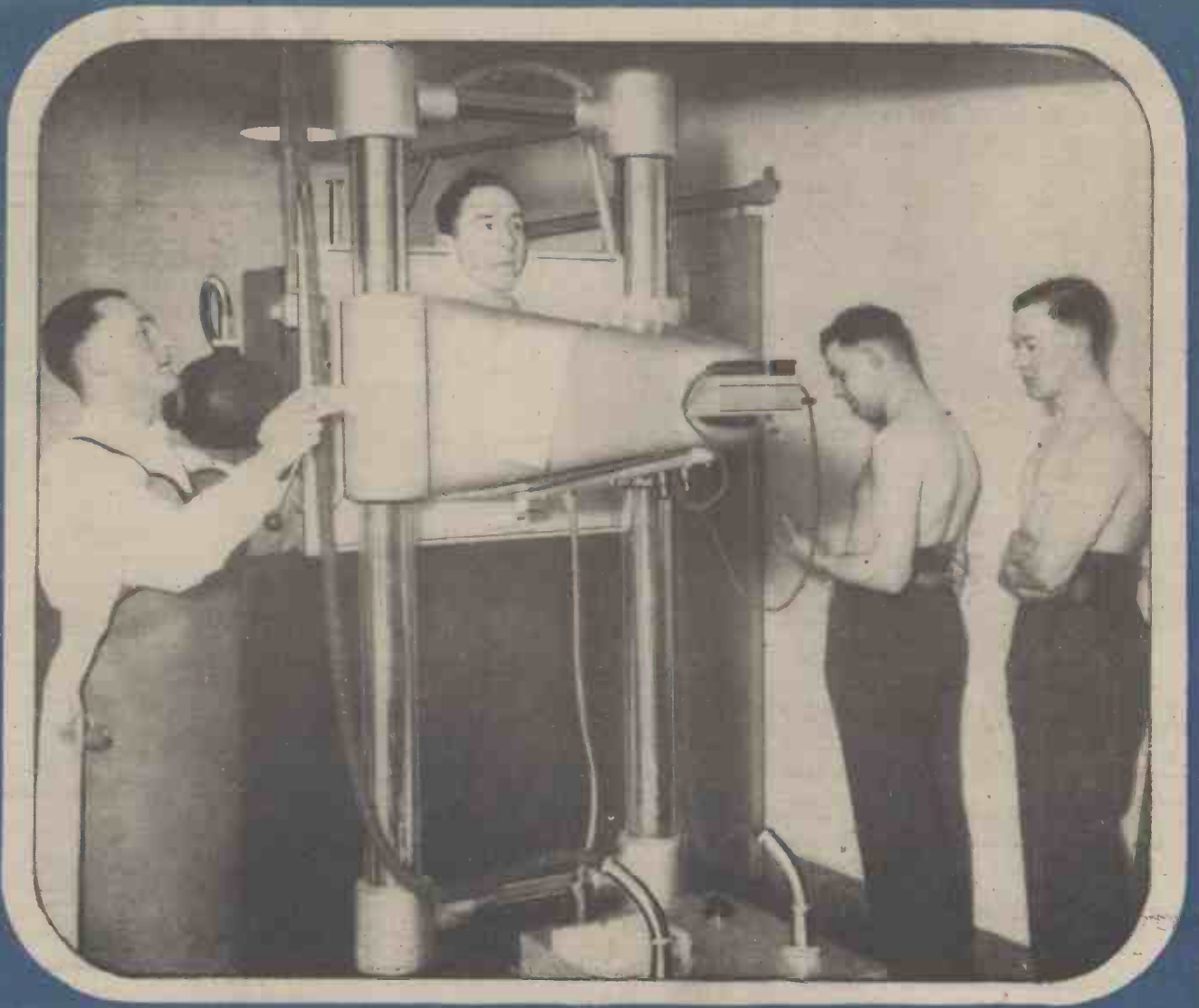
NOVEMBER 1944



Rocket Propulsion

Improved "Mirak" and "Repulsor" Rockets

By K. W. GATLAND

(*Continued from page 22, October issue*)

ON July 2nd, 1930, the Verein für Raumschiffsfahrt E.V. engineers conducted preliminary trials of a new constant volume combustion chamber, designed by Professor Oberth, known as the "Kegelduse" (cone nozzle) type. Tested on a special proving stand, the motor recorded a thrust of approximately 16lb., constant for 90 seconds, operating at an estimated thermal efficiency of 6.3 per cent.; not a highly satisfactory result.

"Mirak" II—Development

Fortified by experience gained from the trials of its predecessor, the second Mirak (Fig. 10) remained essentially the same, improvements being in the provision of a valve within the liquid oxygen tank, designed to relieve excess pressure; and in the shape and make up of the combustion chamber. A ceramic liner was provided inside the combustion chamber as a precautionary measure aimed at the prevention of combustion heat effecting a too vigorous expansion of the liquid oxygen. The combustion chamber in this design was cylindrical and in order to gain a certain desired strength factor, a lining of steel was also provided on a copper alloy base.

An attempt to provide internal cooling of the combustion chamber was also made by the substitution of an alcohol-water mixture, in lieu of petrol, as fuel.

Despite the many improvements made, however, after a number of tests, "Mirak" II suffered the same fate as its former stable companion; the oxygen tank exploding due to the inadequate function of the relief valve.

"Mirak" III

Later in 1931, yet a third "Mirak" (Fig. 11) was produced at the Ratenflugplatz, and as with its immediate predecessor, several design modifications were embodied.

A considerably more efficient combustion chamber of a much improved internal shape was the main feature of the new design, which incorporated, in addition, a special cooling system; the motor being finned externally to provide a greater radiation surface. The complete unit, motor and coolant, was in this design mounted outside the liquid oxygen tank—positioned symmetrically below, about the rocket axis. The increased capacity oxygen tank fitted was provided with a pressure relief valve as before; designed to function at a pressure of 90lb. per square inch.

The feed system, too, was improved; a second tank, containing compressed nitrogen, being fitted in lieu of the carbon-dioxide pressure "charger" previously employed. A reversion to petrol as fuel was also made.

This third model, when subsequently tested, proved highly successful in operation, responding perfectly in every way, without exploding.

The "Repulsor" Rockets

After the tests of "Mirak" III were completed, the Society engineers continued with their development work, building several more rockets rather more ambitious both as regards design and size. These rockets were termed "Repulsors"; the first of the type, constructed in the spring of 1931, being designed by engineer Klaus Riedel, essentially for the purpose of free flight test.

The rocket motor of "Repulsor" I consisted of a combustion chamber, distinctly similar to the one employed in the "Mirak" III; housed with in a water coolant jacket. This assembly formed the nosing shell. Below, and separated from the motor nosing, were fitted two thin tubular tanks, one containing petrol, with pressure charger, the other liquid oxygen.

Connecting the combustion chamber, and nosing, to the tanks were feed lines, the

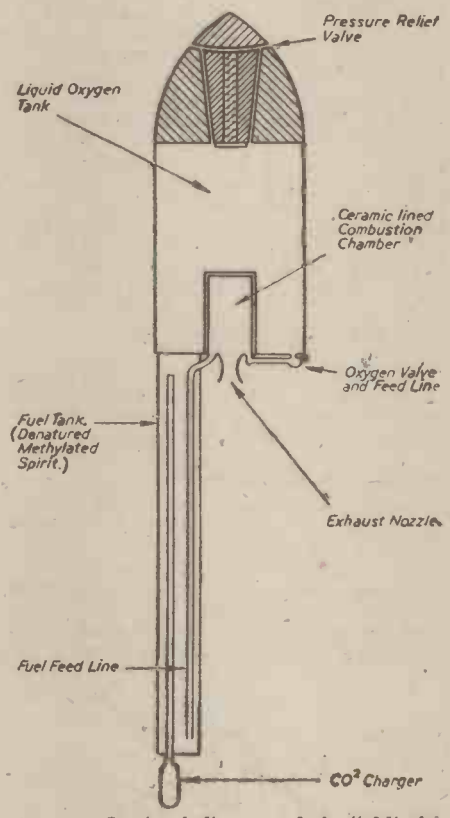


Fig. 10.—Sectional diagram of the "Mirak" II rocket.

tanks being supported beneath by rigid metal struts. The all-up weight of this first rocket of the "Repulsor" series was 250lb.

After initial trials of its motor on the proving stand, "Repulsor" I was fired in free flight on May 14th, 1931. No parachute was provided for descent. Unfortunately, the rocket did not rise vertically, but took off slantwise, striking a small building during its path of flight. Nevertheless, the rocket rose to a height of nearly 200 feet, but was not sufficiently stable, and spun in the air, jettisoning most of the water from the cooling jacket, prior to its return to earth. Examination showed that a hole had been burnt through both the side of the combustion chamber and the outer casing of the water jacket.

A second "Repulsor" (Fig. 12) was built, and was ready for test by May 23rd. This particular model did not differ greatly from its predecessor, the only alteration being the elimination of the heavy support struts. Circular aluminium "hoops" were fitted in their stead, the tanks being supported solely by means of the rigidity of the feed lines. Again, no parachute was fitted.

When fired, "Repulsor" II climbed vertically to about 200 feet, before curving over, slowly losing altitude, and ending in the branches of a tree some 2,000 feet from the point of take-off. A further "Repulsor" was built before the end of the month, and this time a parachute provided to enable a safe return. The design was essentially the same as the former rocket, the only difference being that the tanks were located closer to the rocket axis, in an attempt to improve stability.

The third "Repulsor" was fired in June, and attained a height of over 15,000 feet. Unfortunately, the parachute was released too early in the flight—while the motor was still functioning, and was torn away. The rocket covered a distance of nearly 2,000 feet, in a well-stabilised flight, before hitting the ground as a complete wreck.

In all, more than 30 "Repulsor" type rockets were built, and most of their tests were recorded as highly satisfactory. Some of the later rockets were termed "one-stick Repulsors," and differed considerably from the early types, the main distinguishing feature being that both tanks were placed in line about the vertical axis. The first rocket of this type was free-flight tested in August, 1931, and attained an altitude of practically 33,000 feet; a parachute opening at the peak of trajectory, wafting the rocket gently back to the ground.

Rocket Motor Tests

While work on the "Repulsors" continued, another section of the Society concerned itself essentially with the development of the rocket motor combustion chamber. These investigations resulted in the construction of a number of highly efficient rocket motors of varied internal shapes, which were subjected to stringent test on the Society proving stands. Specially constructed reaction units of highly durable metals were thoroughly tested, and many of the special heat-resisting steels and alloys produced up to that time were quickly disposed of as practical combustion chamber materials. A number of rocket motors, constructed of materials considered to be highly satisfactory for the purpose, literally disintegrated into a mass of white hot sparks, after being on test for merely a few seconds. Others, fired for their respective runs, were so severely scarred internally that they had to be discarded as useless for further experiment. Nevertheless, several successful rocket motors were produced during 1931, most of these being constructed of aluminium. By the end of 1933, over 500 individual ground tests had been satisfactorily concluded at the Ratenflugplatz. Six large Oberth designed rockets were also built during this period, but did not prove so efficient (relatively) as the third "Mirak," and "Repulsor" types, although on occasions thrust values of over 450 lb. were recorded during tests.

End of the Verein für Raumschiffsfahrt E.V.

At one time, during the peak of its career in 1929, the Verein für Raumschiffsfahrt E.V. had a total of nearly 2,000 members on record. However, by 1933, the Society's numerical strength was considerably changed, only 200 members remaining. Due to the consequent depletion of funds, publication of "Die

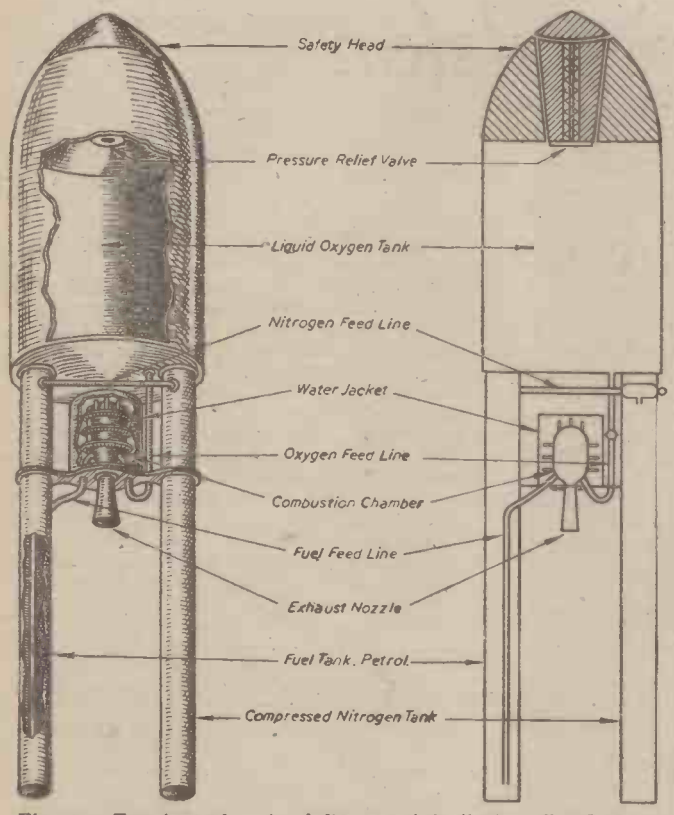


Fig. 11.—Exterior and sectional diagram of the "Mirak" III rocket.

Rakete," the Society journal, was indefinitely suspended early in 1933. Towards the end of the year, the position had grown considerably worse and the Society was facing the prospect of disruption.

Not only were troubles restricted to lack of funds; prominent members were accused of using the Society for personal gain, and there were also questions of extravagance.

While this dispute was at its height, Willy Ley (one time vice-president of the Society), together with a number of his associates whose interests in the development of the rocket were less superficial than the rest, disassociated themselves completely from the Verein für Raumschiffsfahrt E.V. A short time after, the Society was dissolved.

The German Interplanetary Society

Ley's idea was to form another research group around the nucleus of rocket enthusiasts which remained, in order that the work of years should not fade with the name of his former Society, and with the aid of another German organisation, the E.V. Fortschrittliche Verkehrstechnik (Society for the Progress of Traffic Technique), a Society interested in all forms of propulsion, success in this direction was achieved. A proposal was put to Dr. Otto Steinitz, the founder of that Society, to the effect that the Ley group should amalgamate with the E.V. Fortschrittliche Verkehrstechnik, with the view to establish the projected coalition as the German Interplanetary Society. This proposal was readily accepted by the Steinitz organisation, which at that time was also in precarious straits with regard to funds. Thus substantially augmented numerically, the new Society grew slowly but steadily in strength, and by the spring of 1934 the total membership had risen to about 200. Regular publication of the Society journal, "Das Neue Fahrzeug," was also possible by the increased income, which although adequately sufficient to satisfy this problem, was not, however, large enough to finance practical experimentation. Nor was this the worst of their problems; the rise of National Socialism throughout Germany did not make the problem of maintaining the Society an any too easy proposition, and complications with the military authorities soon arose, making the prospect of further progressive research virtually impossible.

In 1935, Willy Ley, together with H. Scharfer, another engineer of the Verein für Raumschiffsfahrt E.V., and other fellow countrymen quick to size up the situation, quitted the German scene, travelling to the U.S.A. There Ley continued his researches; but mention of this more current work will be made in a subsequent article.

On the other side, Hermann Oberth, von Opel, and many others prominent in German rocket development, remained in Germany, getting caught up in the Nazi ideals. (Unofficial reports have indicated that the German long-range rocket weapon, "V-2," is an Oberth creation.)

In this way, free German research came to an end, later rocket development being catered for by special Government departments under a cloak of extreme secrecy.

An Austrian Research Society

Another European rocket society, the Oesterreichische Gesellschaft für Raketentechnik (the Austria Society for Rocket Technique) was formed on August 16th, 1930, in Vienna. Investigations were concerned largely with theoretical research of the problems connected with interplanetary communications; engineer G. von Pirquet, the Society's vice-president, featuring prominently in this work. A similar fate as that which befell the German Society, however, brought about disruption of this group but a few years after its formation.

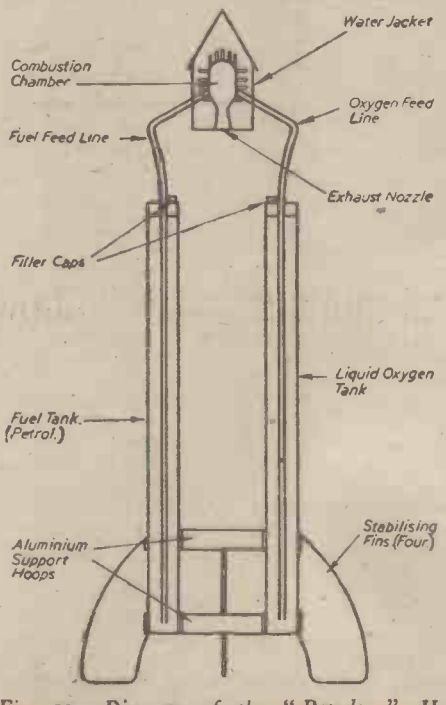


Fig. 12.—Diagram of the "Repulsor" II rocket.

The American Interplanetary Society

In the spring of 1931, a year after the formation of the American Interplanetary Society, the president, G. E. Pendray, travelled to Germany and visited the Ratenflugplatz. There he witnessed a number of tests of the "Repulsor" type rockets, and gained much valuable experience, both concerning the design and construction of liquid fuelled rockets, and also of the organisation of the Society itself.

Upon his return to New York, Pendray set about a policy of reorganisation, combining ideas of his own society with those of the German group, and finally succeeded in the establishment of an experimental programme to cover the development of a series of liquid fuelled rocket units.

As might be expected, the first rockets constructed by the Society engineers were not highly original in design, but incorporated many features proved by the German "Repulsors." A great deal of acutal test experience was required before technical improvement became a practical possibility, but within a relatively short space of time the Society successfully constructed and proved as highly satisfactory, a number of rockets embodying many original design innovations.

A.I.S. Experimental Rockets Nos. 1 and 2

The first rocket, Experimental Rocket No. 1, fuelled by petrol with liquid oxygen, was tested in November, 1931. For the purpose of this, and subsequent tests, the Society engineers constructed a small proving stand.

During the initial firing, however, an accident occurred in which parts of the combustion system were damaged. In view of the mishap, the Society's first rocket was not put to further test. Instead, a number of components, which included the motor and tanks, were used in the construction of Experimental Rocket No. 2, the design and building of which occupied the Society for a year and a half. After a number of proving stand trials, the rocket was finally fired in free flight on May 14th, 1933.

The rocket was fired out over the sea from the Society's proving ground at Staten Island, New York, and exploded upon reaching a height of approximately 250 feet. An examination of the wreckage found that the liquid oxygen tank had burst, despite the fact that a relief valve was fitted—the direct cause being the heat from the combustion chamber had effected an excessive expansion of the contents.