ALL ABOUT THE V.2

NEWNES

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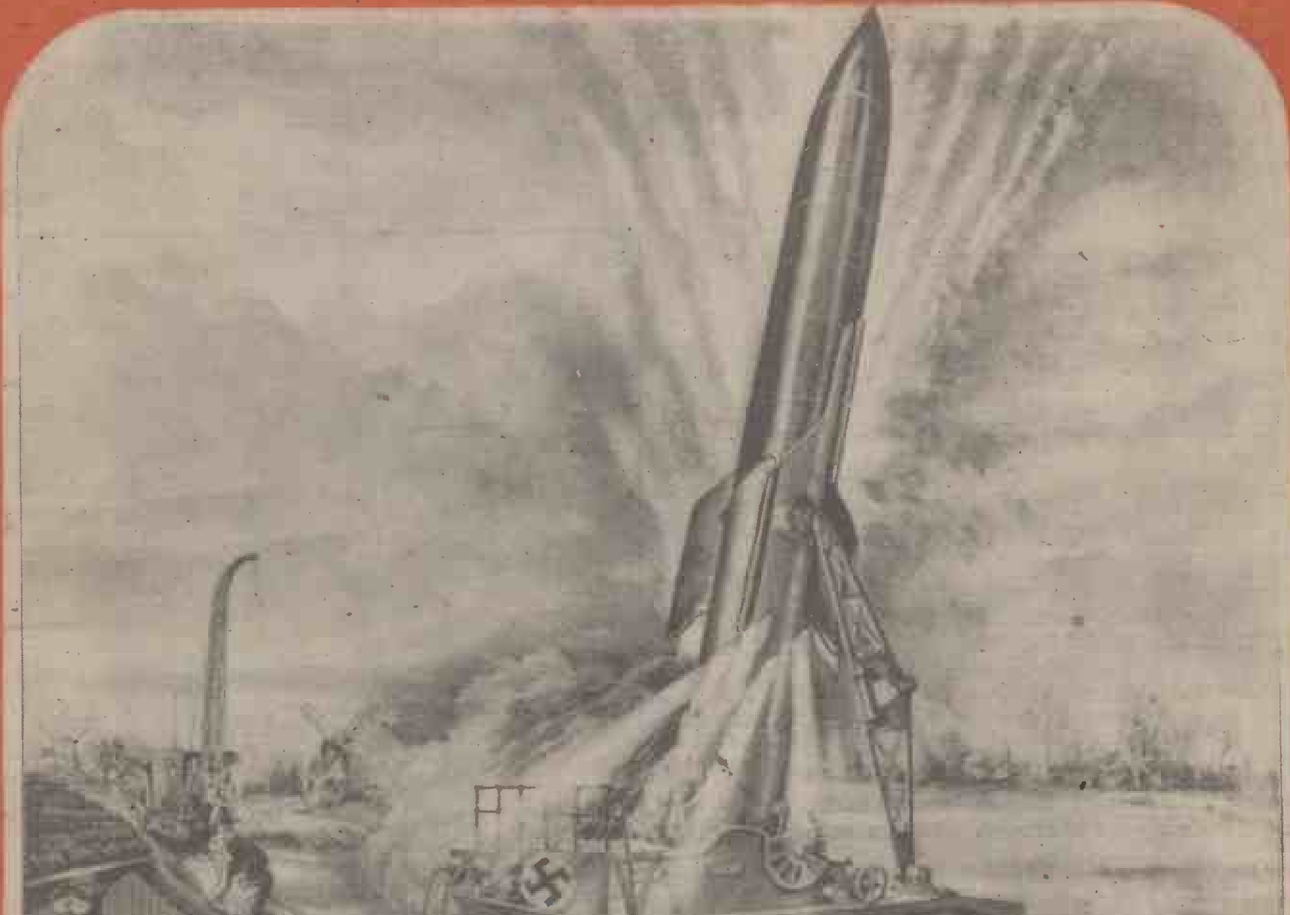


All About the "V-2"

Provisional Details of the Rocket Weapon Vergeltungswaffe No. 2. New Realms of Scientific Endeavour Opened Up

By K. W. GATLAND

NOW that the official "veil" has been lifted on the use of the second Nazi "V" weapon—the long-range rocket shell—we are to some extent free to comment on the technicalities involved.

At the outset, forgetting for a moment its sinister purpose, let us admit directly that "V-2" is an engineering achievement of indisputable brilliance. It is an achievement, too, that will have great bearing on scientific progress in the years of peace to come, by penetration to great altitudes to return with data of conditions existent in the so far uncharted reaches of the atmosphere, and later, by excursions into space itself. But let us trace this further trend of development in logical steps.

"V-2"—Adaptation for Altitude Sounding

The long-range rocket weapon "V-2" is not an instrument designed for the purpose of attaining great heights; the altitude reached is one merely sufficient to carry it, presumably from launching sites located within Reich territory, to districts of Southern England radiating from the Greater London area. The missile is required to "fly high" to achieve *distance* at the minimum expenditure of power.

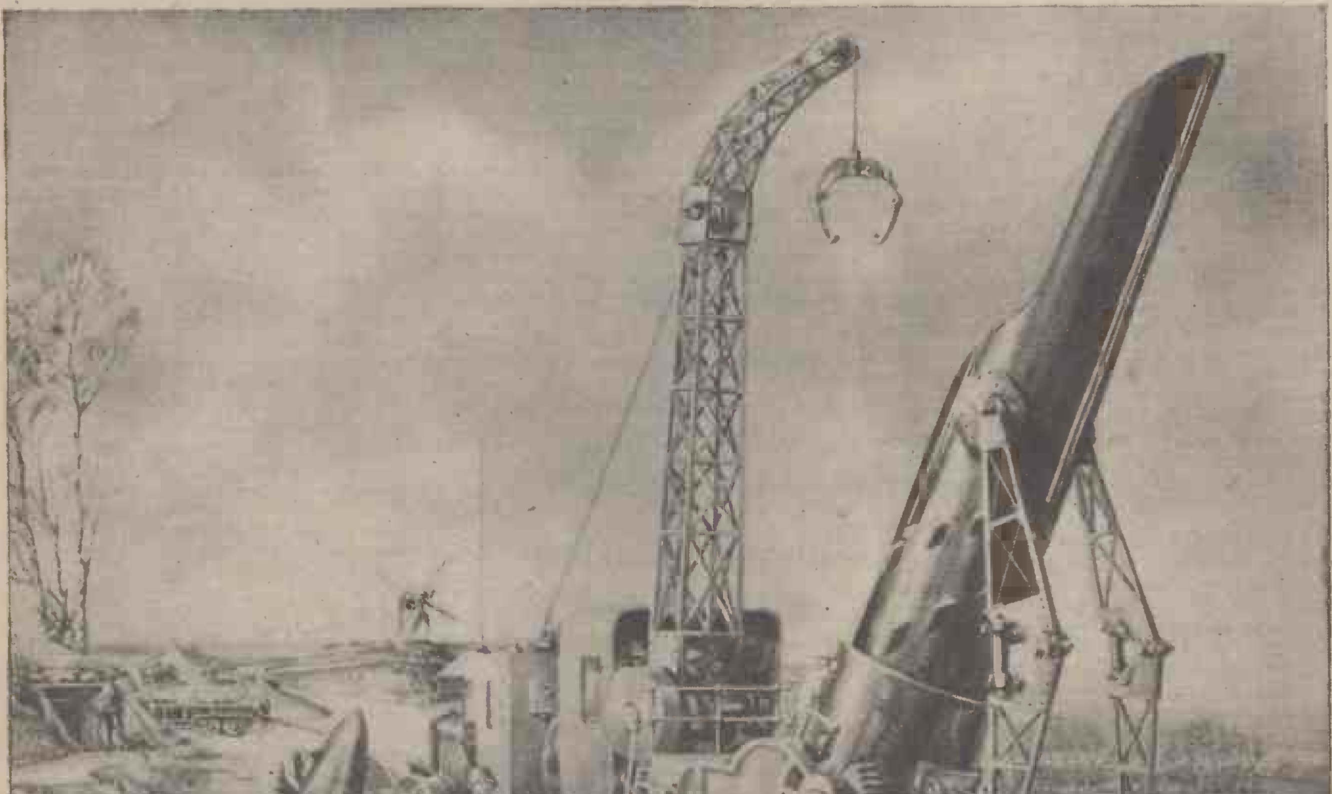
As a weapon of war, the rocket projectile is called upon to carry an explosive load; in this particular instance a war-head of something a little under one ton. It is obvious that if the projectile were used essentially for altitude sounding, this weight of explosive could be replaced by mere *pounds* of delicate meteorological and physical science recording apparatus, the reduction in carrying load adding considerably to the rocket's performance.

We can pursue this question of peacetime adaptability still further. Let us assume the initial mass of the projectile "V-2" to be 15 tons, and the propellent liquid oxygen, with alcohol as fuel. Working from these bases, it is possible to calculate with a fair degree of accuracy details of performance if the missile were projected *vertically*. The figures thus derived give a velocity during ascent of something in excess of three miles per second; the height attainable between 750 and 800 miles.

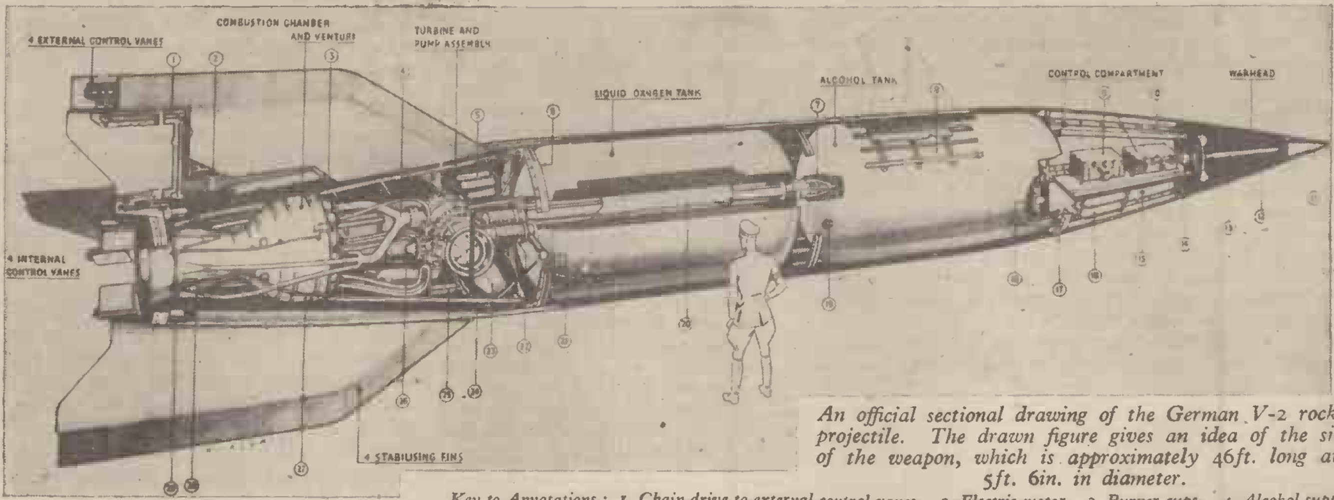
Taking the case still a stage farther: if the war-head were replaced by a self-contained rocket of similar fuel/mass ratio, designed to discharge from the carrier projectile at its maximum velocity, the small rocket would be well able to overcome the earth's gravitational influence and escape from this planet altogether, never to return.

"V-2" In Practice

Working from the most elementary basis, the force required to lift a mass of 15



Our artist's impression of a mobile launching unit for the "V-2."



An official sectional drawing of the German V-2 rocket projectile. The drawn figure gives an idea of the size of the weapon, which is approximately 46ft. long and 5ft. 6in. in diameter.

Key to Annotations: 1. Chain drive to external control vanes. 2. Electric motor. 3. Burner cups. 4. Alcohol supply from pump. 5. Air bottles. 6. Rear joint ring and strong point for transport. 7. Servo-operated alcohol outlet valve. 8. Rocket shell construction. 9. Radio equipment. 10. Pipe leading from alcohol tank to warhead. 11. Nose probably fitted with nose switch, or other device for operating warhead fuse. 12. Conduit carrying wires to nose of warhead. 13. Central exploder tube. 14. Electric fuse for warhead. 15. Plywood frame. 16. Nitrogen bottles. 17. Front joint ring and strong point for transport. 18. Pitch and azimuth gyros. 19. Alcohol filling point. 20. Double walled alcohol delivery pipe to pump. 21. Oxygen filling point. 22. Concertina connections. 23. Hydrogen peroxide tank. 24. Tubular frame holding turbine and pump assembly. 25. Permanganate tank (gas generator unit behind this tank). 26. Oxygen distributor from pump. 27. Alcohol pipes for subsidiary cooling. 28. Alcohol inlet to double wall. 29. Electro-hydraulic servo motors.

tons, with an acceleration factor of 1 g., must be something in the region of 30 tons. Under such conditions, the jet flow of the rocket motors would be only 12lbs./sec., assuming a jet velocity of 6,000 feet/sec., and if the initial weight of fuel were ten tons, this would supply the motors for 30 minutes.

The previous deduction is, of course, purely hypothetical. In practice, the jet flow would probably be in the region of 140lbs./sec; the weight of propellent five or six tons, and the period of firing, at the very maximum, about two minutes. Working to these figures, the thrust reaction calculates to 1,680 tons, and therefore an acceleration of 100 g. This acceleration factor would be almost doubled toward the end of the flight, and, making the necessary corrections for air resistance, the velocity would lie between three and four thousand miles per hour.

Launching

As regards the question of launching the rocket weapon, until such time as more complete details are released by the authorities, we must rely upon the accuracy of information derived through neutral sources, principally Sweden, and also from Holland.

Correspondents in Sweden have described the launching installation as a concrete "well," sunk 80 feet within the ground. Into this the projectile is lowered, and, if the report is correct, actually charged with propellent before being subsequently fired from the "well" along guide rails formed into the concrete side structure.

Information from Dutch sources, on the other hand, suggests that the projectile is merely "stood upright" on concrete slabs, and fired direct. It is quite probable, of course, that both launching systems are employed. There has also been a suggestion that special portable launching installations have been in use.

Directional Control and Trajectory

Whatever its method of take-off, there can be little doubt that the rocket is initially fired vertically in order to surmount the more dense regions of the atmosphere as quickly as possible.

To maintain a vertical flight path, gyroscopes, acting on airstream and exhaust vanes, are employed, operating on the same principle as the Goddard gyro/vane stabiliser (see PRACTICAL MECHANICS, December, 1944, p. 101).

It is also likely that a system of radio-control is used to set the projectile on a final parabolic trajectory, again by the employment of gyro/vane controlling mechanism.

The rocket motors continue to fire until a certain predetermined velocity is attained, and at that precise instant an integregating accelerometer is used to "cut-out" the power. The projectile then "coasts" under momentum for the balance of the distance, the airstream vanes automatically correcting any deviation from the pre-set path.

It is possible that beam transmitting apparatus is included in the equipment of some projectiles, as with the "V-1" pilotless aircraft, for determining the position of the missile.

Upon entering the more dense strata, compressibility friction, due to the passage of the missile at supersonic velocity, causes the forward part of the rocket to be heated considerably, and to the observer the rocket plummeting to earth emulates a meteor, or "shooting star." This com-

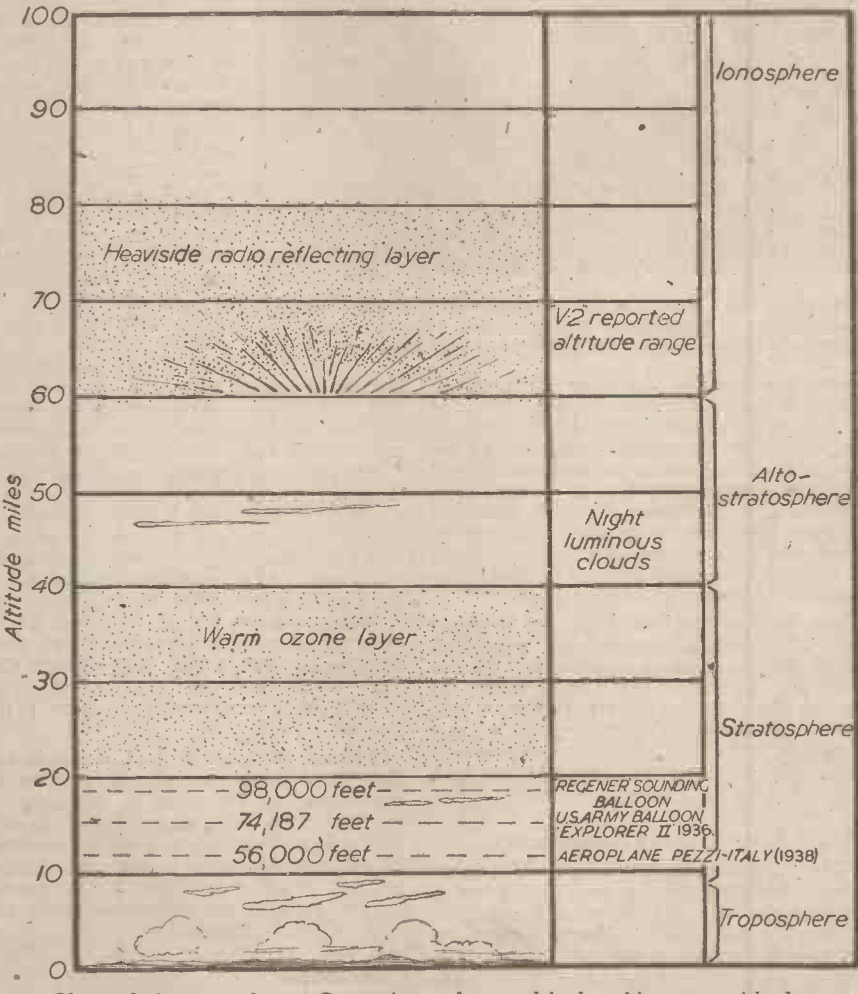


Chart of the atmosphere. Comparisons of past altitude achievement with that of the "V-2" rocket projectile.

pressibility is undoubtedly responsible for the many mid-air explosions which have occurred, although some form of heat resisting carapace is probably provided at the rocket "head."

The Power Installation

The power unit would appear to be a multi-engine arrangement, consisting of between 15 and 20 individual reaction motors of the constant-volume type. This system of propulsion would thus allow for a fine measure of propellent control, and, in addition, would permit the rocket to function even if individual motors were to "burn-out." Each motor is arranged to fire into a single large convergent-divergent chamber,

Part of a "V-2" bomb which fell in Southern England recently. This part has a metal casing between 2 and 3ft. in diameter, and contains a turbine engine, the fuel pump and 18 propelling jets.

where expansion of the gases generated in the combustion chambers takes place, prior to their final ejection. Propulsion is effected, not, as so often erroneously purported, by the "reaction of the exhaust on the atmosphere," but in accordance with Newton's much used "Third Law of Motion," which states, in effect: "For every action there is always an equal and opposite reaction." In the case of a rocket, the gases ejected forcibly rearwards *react on the producing plant.*

For feeding the fuel, hydrogen peroxide and calcium permanganate are employed, which serve to generate superheated steam to drive the turbine. The turbine serves to operate the fuel and oxygen pumps, which extract the propellent components from their respective tanks, and feed them at constant and high pressure, in correctly metered proportion, to the combustion unit.

"V-2" Disposition of Components

The illustration on page 115, which is an official Air Ministry drawing based on a thorough investigation of parts found both in Britain and Belgium, shows clearly the layout of the main components:

The explosive charge—less than one-twelfth the total weight—is contained at the rocket "head." Directly behind is situated a control compartment, in which the radio control and D/F equipment are contained; with the control gyros still farther behind. Aft of these come the fuel and liquid oxygen tanks, in that order; then, the turbine and pump assembly. From the latter emanate feeder lines, which connect to the combustion units and also to supplementary fuel burners in the convergent-divergent venturi.

Four efflux control vanes, which act under gyro control, are fitted to deflect into the efflux stream, regulating the projectile's course by virtue of offset thrust. In addition to these, four large stabilising fins—which extend from the rear for almost a third of the rocket's length—are provided, and at the rear tip of each is incorporated a small vane for atmosphere control, also functioned by the gyros.

Construction

The rocket structure is built up on the monocoque principle; consisting of closely spaced circular forming members, with longitudinal "U" section stringers.

As with the "V-1" pilotless aircraft, sheet and formed steel are used extensively. The propellent tanks are of dural construction.

Development

The reported flight path of the "V-2" projectile bears considerable resemblance to the scheme originally proposed by Professor Hermann Oberth, as outlined elsewhere in this journal; but whether or not Oberth is the technician chiefly responsible for "V-2" is still very much a matter for conjecture. It would appear far more likely that Rudolf Nebel, one time prominent engineer of the Verein für Raumschiffsfahrt, and staunch supporter of the Nazi Party, is the mind behind the development of the long-range rocket weapon. Although Nazi himself, Oberth—Rumanian by birth—had a pacifist outlook, and was a distinct hater of Germans.

Most of the preliminary work on German long-range rocket weapons, during the present conflict, has been carried out at Peenemunde, the German research station on the Baltic, and also, though on more moderate scale, at the more remote experimental sites in Norway, principally at Hardangerplata.

Initial work on "V-2," it is thought, was commenced early in 1942, though, of course, modern German rocket development dates back far beyond the war period, as has already been recounted to readers of this journal.

Toward the close of 1943, it would seem that mass production of the weapon was commenced in fair quantity, but thanks to the continued force of the Allied air offensive, which included, in addition to attacks on the many important manufacturing plants, several assaults on the Baltic research station, development and manufacture must have suffered considerably.

Conclusions

The practical demonstration by the Germans of a rocket projectile of such spectacular performance makes the advent of "V-2" undoubtedly the most memorable achievement in the history of *astronautics.*

The peacetime implications of the development cannot be too strongly emphasised. In its present form, "V-2" must attain an altitude of between 60 and 70 miles. The greatest height previously reached by any man-made contrivance was 98,000 feet, by an unmanned sounding balloon. (See chart on previous page.)

A rocket with the performance of the German long-range missile, fitted with meteorological and specific scientific instruments, would be capable of doubling our present knowledge of the state and nature of the atmosphere at great altitudes. The data thus received would make possible long-range weather forecasts of conditions at lower levels, and would, in effect, raise meteorology to the status of an exact science.

The investigation of electronic phenomena would also be possible. There has never been so many conflicting theories advanced as in the investigation of *cosmic radiation,* for instance. Scientific authorities are generally agreed that these rays have their source in outer space; but by what means has never been directly classified. Moreover, the effects on the human system of cosmic bombardment have, too, never been conclusively defined. A theory has been advanced that the cosmic rays have considerable bearing on the human organism, influencing growth, life-span and general health. It has been said that their effects on earth are "damped" to a certain degree by the density of the atmosphere, and that the intensity of the radiation becomes greater as the atmosphere thins with altitude. Others assert that the effects noticeable at ground level are produced by secondary radiations resulting out of cosmic bombardment on the atmosphere, and that the rays beyond the limits of the atmosphere have no harmful effect.

THE LONG-RANGE ROCKET SHELL

Overall Length	46*ft.*
Max. Shell Diameter	5*ft.* 6*in.*
Total Weight (fully charged with propellent	12-15 *tons*
Weight of Explosive Charge	1,900*lb.*
Weight of Propellent, Liquid oxygen	11,000*lb.*
Ethyl Alcohol	7,500*lb.*
Power unit	*Convergent-divergent combustion unit with* 18 *individual combustion chambers.*
Present range	200 *miles*
Time, under power	2 *mins. approx.*
,, *from launching to impact*	5 *mins. approx.*
Max. Speed	3,000 *m.p.h.*

With further development, it should well be possible, almost certainly within the present century, not only to provide conclusive answers to these "scientific unknowns," but to bring about manned flights into space, and ultimately to achieve man's greatest potential conquest, the power to travel between the worlds of the Solar System. In the time between the present day and the achievement of interplanetary communication, many of the unfathomable mysteries of the universe which have eluded solution for so long will be laid open to us in our constant search for positive knowledge. "V-2" is without doubt a first practical step toward the "conquest of space."