THE HAMILCAR GLIDER

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PRACTICAL MECHANICS

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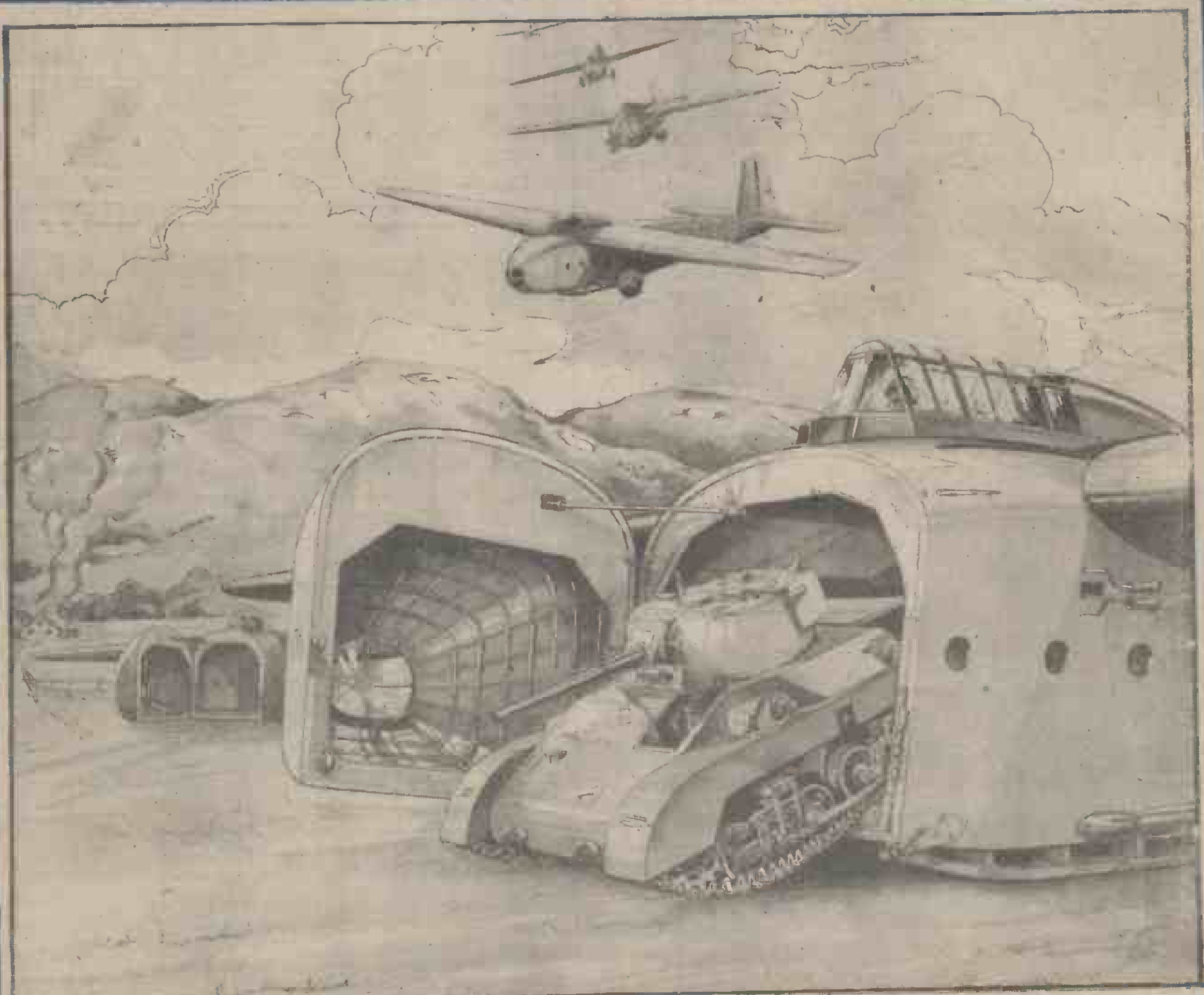
FEBRUARY 1945



Rocket Propulsion

Mails by Rocket: Rocket Propelled Aircraft

By K. W. GATLAND

(Continued from page 101, December issue.)

MANY new research groups and individuals featured prominently in the development of rocket science during the middle 1930's. Apart from the rocket organisations previously mentioned, three more such groups were formed; in the U.S.A., the Cleveland Rocket Society, established in 1933, and the Peoria Rocket Association (Illinois), and in Holland, the Stichting Nederlandes Rakettenbouw (Dutch Rocket Society), both founded during 1934. The Cleveland Society was originated by Ernst Loebell and E. L. Hanna. The former was a prominent engineer of the German Raketflugplatz, before becoming nationalised as a U.S. citizen.

In 1935, another valuable contribution was made to the available rocket literature, by the publication of *L'Astronautique Complement*, R. Esnault-Pelterie, A. Lahure, Paris, a supplement to Pelterie's monumental treatise of 1930.

Zucker experimenting before the German military in 1933.

Gerhard Zucker

Another advocate of the rocket as a mail carrier was German born Gerhard Zucker. This experimenter conducted his initial postal rocket trials in 1933, when he established a successful delivery over the Hartz Mountains, N. Germany. Subsequently he demonstrated large powder rockets before the German military authorities.

A year later, in May, 1934, Zucker travelled to England, and during his stay carried out several mail rocket experiments. None of these further tests, however, can be said to have been crowned with great success.

At the 1934 International Air Post Exhibition in London, a considerable amount of interest was aroused by one of the Zucker postal rockets which had been specially entered. It was reported at the time of the exhibition that Zucker's plans for long-range rocket mail delivery were looked upon favourably by both the Air Minister and the Postmaster-General, and it would appear that a measure of official support was sanctioned, at least for the initial tests of rocket mail carriers in this country.

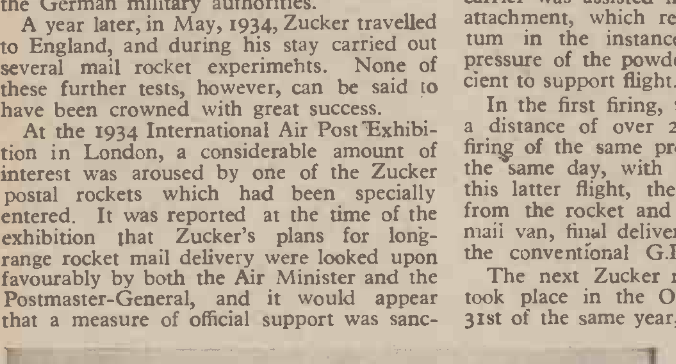
First Trial

The first trial of a mail rocket in England took place near Rottingdean, Sussex, on June 6th, 1934. The rocket projectile used in this particular experiment contained over 1,000 letters, and was fired from an inclined wooden launching rack. The rocket carrier was assisted into flight by a catapult attachment, which rendered initial momentum in the instance before the reactive pressure of the powder charge became sufficient to support flight.

In the first firing, the rocket travelled for a distance of over 2,600 feet. A second firing of the same projectile took place later the same day, with similar success. After this latter flight, the mail was transferred from the rocket and taken to Brighton by mail van, final delivery being made through the conventional G.P.O. service.

The next Zucker rocket mail experiment took place in the Outer Hebrides on July 31st of the same year, the intention being to link the islands Scarp and Harris, in the Western Isles.

The rocket used in this trial was of a larger type than its predecessors, and within a hinged nose compartment were contained 1,200 letters. Again, powder was employed as a propellant. Unfortunately, however, the rocket exploded before it could lift from the launching rack, and was completely destroyed, and tattered and charred remnants were all that remained of its postal cargo. A further and similar test was later carried out in the Western Isles, but this, too, was culminated by an explosion.



Raketenflug-

V 1

Dieser Raketenflug-Erinnerungs-Brief ist im Juli 1928 mit der Schmiedl'schen Versuchsrakete "V1" geflogen. Mit der Rakete "V1" sind insgesamt 19 Stück solcher Erinnerungsbriefe geflogen, welche alle fortlaufend numeriert sind; dieser Erinnerungsbrief trägt die Nummer: 14.

Schmiedl

World's first flown rocket message, by Schmiedl's postal carrier "V.1." A translation of the message is as follows: "ROCKET-FLIGHT-COMMEMORATION LETTER. This rocket-flight-commemoration letter was flown with the Schmiedl experimental rocket 'V.1' in July, 1928. With the rocket 'V.1' were sent 19 such letters, which were all numbered consecutively; this commemoration letter bears the number 14. Schmiedl."

Mainly because of these failures, official support of the Zucker postal rocket experiments was withdrawn. Indeed, while carrying out a later rocket trial in the Isle of Wight on December 25th, 1934, the police intervened and stopped the launching of a rocket intended to reach the mainland, on the grounds that official permission had not been sanctioned. It was made clear that the test could not take place unless the projectile was made to fall into the sea, off-shore of its destination.

In order to meet the requirements of the authorities, Zucker was forced to reduce the propellant charge. When fired, the rocket rose successfully from the launching rack, but lacked sufficient power, and wind blew it from its course. The mail, which landed in Pennington Marshes, was recovered and taken to Leamington for normal G.P.O. delivery. Had the Isle of Wight trials been allowed to take place as originally planned, it was considered that success might finally have been achieved. As it was, the difficulties imposed by the British authorities made it obviously clear that no further gain would result from remaining in the country, and early in 1935 Zucker returned to Germany. Since that time, news on any further activities has been entirely lacking. This year, however, the *Sunday Express*, quoting the German *Hamburger Nachrichten*, published a report concerning an announcement that Herr Gerhard Zucker had been shot by the Gestapo for trying to communicate to a foreign Power secrets of German rocket developments.

Mail-carrying Rocket Aircraft

Small, power-driven rocket 'planes were employed by the German J. K. Roberti in mail experiments carried out in 1935-36.

One of these aircraft, flown just prior to the German postal-rocket ban, was launched from Duinbergan, on June 4th, 1936. The 'plane, which represented the most ambitious mail carriage experiment conducted by Roberti, had an overall length of five feet, and a wing-span of nearly six feet. The weight of the aircraft, fully laden with 2¼lb. of mail, was just over 6½lb. Particular care was taken in design to ensure that structural weight would be the very minimum.

A small catapult-assisting device was employed for the take-off, and when fired the 'plane rose perfectly, flying in the direction of Knocke. Unfortunately, due to a

Reproductions of Rocket Flown Envelopes and Cards

Card carried by Schmiedl's 'N.3' in 1935, showing parachute descent. Signed by Schmiedl.

Card flown by the first U.S. rocket 'plane at Greenwood Lake, N.Y. (1936). Signed by Willy Ley.

(Below) Envelope carried by a Zucker rocket in a night firing experiment at Hasselfelde (1933). Signed by Zucker.

World's first trial under postal authority, Cuba, 1939.

(Right) Letter flown in Zucker's first postal rocket experiment in Gt. Britain —Sussex Downs, 1934.

The first U.S. rocket 'plane in flight at Greenwood Lake (1936).

Rocket 'plane leaving the launching installation at Greenwood Lake, N.Y.

structural weakness, both the wing installed rocket units tore loose from their mountings after a few seconds' flight, continuing as projectiles, and fell several miles distant. The fuselage of the 'plane crashed into a boulevard near Knocke-Zoute.

Tail-less Rocket 'Planes

Other experiments, conducted at Wesermünde, concerned the propulsion of small, unmanned tail-less rocket aircraft, designed by Herr Espenlaub and Herr Sander. The latter will be remembered as the manufacturer responsible for the propellant charges of the Valier-Opel rocket car and 'plane experiments.

A rocket aircraft of this type, towed into the air by a conventional light aeroplane, and released at a height of approximately 60 feet, travelled for a distance of one and a quarter miles. This tail-less machine was fitted with a single powder propellant charge installed on the centre-line, at the c.g. The wings, which were swept back to the tips, incorporated large controllable dual purpose aileron/elevators at the trailing edge, close to the wing tips, and also, vertical stabilisers, one at the extremity of each wing.

Liquid-fuelled Rocket Aircraft

Perhaps the most interesting and technically progressive rocket 'plane mail trials, made to date, took place at Greenwood Lake, New York, U.S.A., during the winter of 1936. The motors of these rocket 'planes, of which there were two, were designed and built by Nathan Carver, of the Reaction Research Laboratories, New York, and prominent member of the American Rocket Society. The propulsion unit, which Carver termed the "concentric feed reaction motor" (Fig. 15), employed liquid oxygen, with denatured alcohol as fuel, and incorporated a unique pre-mixing system, by which the oxygen was introduced directly from the motor "head," the fuel entering through an annular manifold. By this system the oxygen is surrounded by a layer of fuel which acts as insulation, and functions to prevent oxidation of the chamber walls, which are protected until the propellant is adequately mixed, and combustion is virtually complete. the principle of the "concentric feed" motor is shown in Fig. 16.

Concentric-feed Reaction Motor—Initial Tests

Theoretical consideration prior to construction set the desired minimum reaction of the rocket motor at 35lb., with a firing period of 30 seconds.

A number of the Carver concentric-feed motors were subsequently built, with interchangeable nozzles and chamber sections, and numerous proving stand trials conducted, the various motor sections being interchanged until the desired specifications were met. During a final test run, which took place on January 2nd, 1936, the motor recorded a thrust reaction of 41lb., operating for a period of 37 seconds, thus amply fulfilling the requirements. Further details of the test are as follows:

Motor—General Particulars

Propellant, denatured alcohol, 3.35lb.; liquid oxygen, 7.23lb. Tank pressure throughout, 150lb. Motor (material, brass and monel), overall length, 15.5ins.; weight 2.5lb. Nozzle (material, monel), length 4ins., throat diameter, .50in., orifice diameter .75in.

Proving Stand Data

Reaction (first test run), 34.50 seconds, 40lb. Second test run, 2.50 seconds, 50lb. (Due to the burning out of a plug, the nozzle was blown off at the beginning of the second firing run.) Impulse, 1,517lb./sec. Average jet flow, 28lb./sec. Average jet velocity, 4,700 ft./sec. Average fuel input, 850,000 ft. lb./sec. Average jet output, 96,000 ft. lb./sec. Thermal efficiency, 11 per cent.

Rocket Aircraft—Design and Trials

The 'planes themselves, designed by Willy Ley and F. W. Kessler, were of the high wing cantilever type, 11ft. in length, with a wing span of 14ft. 6ins. The mails were housed within a hinged nose compartment, and the liquid oxygen and fuel tanks positioned about the machine's centre of gravity. The reaction motor was fitted within the extreme end of the fuselage, the nozzle protruding from the rear.

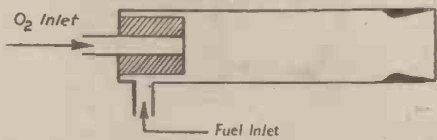


Fig. 16.—Principle of the concentric-feed rocket motor.

For the actual flight trials entirely new motors—duplicates of the most successful motor form previously tested—were specially constructed.

The initial free-flight was scheduled to take place on February 9th, 1936, between Greenwood Lake, New York, and Hewitt, New Jersey, and a special catapult installation was previously assembled for the launching. This took the form of a large inclined track along which the rocket 'planes were intended to take off from a trolley cradle, drawn to the top by a hawser. Unfortunately, due to unforeseen technical difficulties, the test did not take place on the date planned, causing a postponement of two weeks.

On February 23rd, after necessary alterations had been carried out, the aircraft were finally launched. The first 'plane rose successfully from the launching apparatus and climbed away steeply, unfortunately so much so that it ultimately stalled and dived to the lake surface, slithering along the ice before taking to the air a second time for a brief flight, although the motor was severely damaged.

The second aircraft was launched directly from the ice and took off evenly, but, unfortunately, the wings lacked rigidity and one broke off completely. The motor continued to function, however, and drove the 'plane a considerable distance across the lake. The machine was actually airborne for 17.8 seconds.

Although these rocket 'plane trials could hardly be said to have been successful, failure was entirely due to weaknesses in the aircraft themselves, and was no reflection on the Carver concentric-feed motor, which functioned perfectly at all times.

Rocket Terrestrial Transport

A prominent member of the Austrian rocket group, Ing. Dr. Eugen Sänger (University of Vienna), has contributed a number of important theoretical works on the subject of rocket-propelled aircraft. Sänger featured largely in the development of certain high-speed (supersonic) wing sections and body forms, and was among the first to propose practical aircraft forms for operation at forward speeds in excess of sound.

The propulsion of *aircraft* by rocket power presents many problems. To obtain optimum efficiency, the rocket reaction means must operate at high speeds, and in vacuum—clearly, the atmosphere is the prime limiting factor.

On the other hand, it has been argued by the advocates of the *projectile* transport 'craft that this form of conveyance would provide a far greater economy than the machine employing lifting surfaces for terrestrial purposes. Among those who have suggested the rocket projectile are Max Valier and Prof. Oberth.

Oberth's theoretical conception made provision for commencing the flight vertically so as to impose the minimum air resistance. At an altitude of between fifteen to twenty miles, the projectile, having attained a certain desired acceleration factor, would be turned towards its destination. The balance of the journey would then be made under momentum, the 'craft, upon entering the more dense atmosphere, descending in a similar manner to the orthodox aeroplane, or gyro-plane.

As has been mentioned earlier, Dr. Eugen Sänger is another theorist of rocket aviation, and his writings comprise the most complete mathematical investigations yet published on the subject.

Unlike Oberth, Sänger suggests ascent of the rocket 'craft at thirty degrees, and although the time taken to reach a given altitude is greater, distance is covered at the same time. Other details of performance closely resemble the methods suggested by Oberth; both advocated the employment of supporting 'planes for the descent and landing.

The results of these initial investigations are given in *Racketen-Flugtechnik*, Eugen Sänger (220 pp. R. Oldenbourg), Munchen and Berlin, 1933.

The illustrations which accompany this article are reproductions from collections of the well-known air mail specialist, F. J. Field, and are included by the courtesy of Francis J. Field, Ltd. (philatelic dealers), Sutton Coldfield, Birmingham. Some are of actual specimens of flown mail, and these comprise a valuable historic record of the memorable experiments made by the pioneers of the postal rocket.

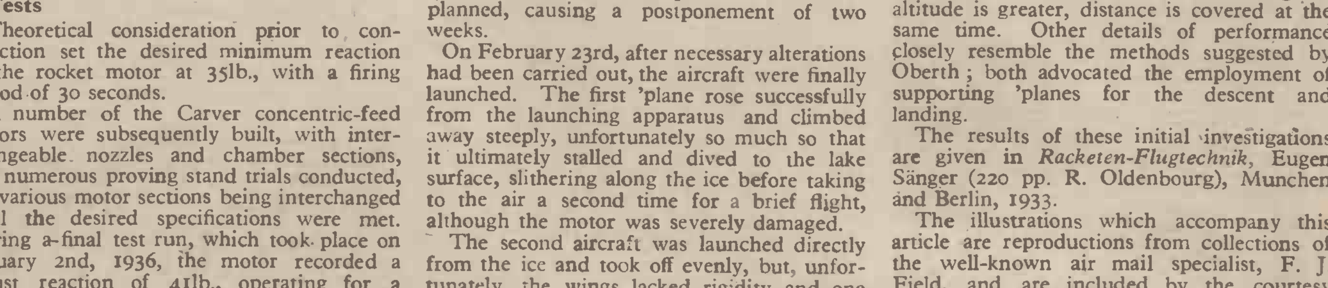


Fig. 15.—Sectional diagram of the Carver concentric-feed motor as used in the rocket mail-'plane trials, Greenwood Lake, N.Y. (1936).

More About the V-2

Further Notes on its Scientific Possibilities

JUDGING from recent correspondence it would seem that quite an amount of interest has been aroused by the statement made in the article, "All About the V-2" (PRACTICAL MECHANICS, January, 1945, p. 114) to the effect that a "step" development of the V-2 could be projected beyond the earth's gravitational influence.

In order to make the matter quite clear, the following summary of the original calculations may be of interest; but first, for the benefit of any who missed the article, let us reiterate briefly the basis of the statement.

Performance Calculations

For the purposes of calculation, the initial mass of the projectile was taken to be 15 tons, and the propellent, liquid oxygen with ethyl alcohol. In place of the 1 ton explosive head, (actual 1,900 lbs.) a rocket of similar fuel/mass ratio was assumed to be fitted. This would be so designed as to discharge from the carrier projectile at the latter's greatest acceleration. The large carrier rocket, having served its purpose, would then drop back to earth under gravity, and in order to minimise risk to life and property—and indeed, to make the project an economic proposition—it would be necessary to employ a parachute, or similar alighting gear.

The final velocity V of a rocket is given by the relation:

$$V = v \log_e R$$

where v is the exhaust velocity and R is the ratio of original mass to final mass. v is of the order of 3 km./sec. for liquid propellent, and an R of 7 was assumed (14 tons at take-off; dead mass, plus load 2 tons). We thus derive a final velocity of 3 log 7, or 6 km./sec. Air resistance and the gravitational loss due to finite acceleration might reduce this to 5 km./sec. (3 m.p.s.), but the former force would only be operative for a short time.

Payload

We now have our payload—a 1 ton rocket; prior to its release from the carrier projectile—travelling with a velocity of 5 km./sec. For it to escape from the earth it must reach the parabolic velocity which is 11.2 km./sec. (7 m.p.s.). It must therefore be capable of increasing its speed by 6.2 km./sec.; and this implies an R of 8. In practice, this figure might have to be increased to 10 in order to overcome gravitational losses. These, however, could be quite small as the small carrier-borne rocket could use a much higher acceleration than the earlier component. There would, of course, be no air resistance.

Assuming, therefore, that it is possible to construct a smaller component of mass 2,000 lb., and R of 10 (i.e., final mass of 200 lb.), it would be possible to project a payload of something a little less than 100 lb., beyond the gravitational influence of the earth. Projected thus far, the 1 ton rocket could be so directed as to crash on the moon.

These figures are, of course, approximate and it might be necessary to increase the overall mass to 20-30 tons; but the order of magnitude is correct.

It is of interest to point out that if the 1 ton rocket were designed to reach the orbital velocity of 5 m.p.s. in horizontal flight outside the atmosphere, it would circle the earth for all time. Indeed, this is a far simpler proposition than the actual escape from the earth, and for many scientific purposes it would be a good deal more beneficial.

Acceleration

Finally, there is the question of acceleration. This is a point which has resulted in more controversy than any other; chiefly through the belief that a rocket must necessarily travel at accelerations prohibitive to the carriage of living beings.

A rocket would not exceed 3 g in the atmosphere, and V-2 does only 1 g. Unfortunately, this rather important point was not brought out in my previous article because of the omission of about five lines, due to an error in re-typing from the original manuscript. As this may have caused confusion, let it be stated that the thrust reaction of the V-2 in practice is 26 tons. Its acceleration is therefore 1 g, but this factor would be almost doubled toward the end of the powered flight because of the progressively improved fuel/mass ratio, due primarily to the consumption of propellent, and the lessening atmospheric resistance with altitude.

A well-protected man in good physical condition can withstand an acceleration of 6 g for prolonged periods, as centrifuge tests have shown. With special suits and drugs it should be possible to better even this figure, but it is unlikely that rockets would ever be operated at more than about 5 g.

Modelling in Pyruma

A New Medium for the Home Craftsman

THERE is a peculiar fascination in making models of various kinds with Pyruma Plastic Cement. The material is ready for use straight from the tin, and it is easily moulded into any shape, producing solid, sectional, or hollow models.

When moulded the plastic cement sets stone-hard on exposure to the air: in an ordinary room interior atmosphere this takes from 24 to 48 hours. Thorough drying is completed by the application of slow heat by baking the model in an oven or placing it in front of a fire, or over a radiator or domestic boiler. Afterwards the model is given a coating of size, and then painted with poster colours, oil-paints, lacquers, etc.

Example of a building modelled by the "hollow" method in Pyruma and Tiluma—"The Bell Inn," Molesey, famed for its crazy windows and centuries-old oddities in architecture. This picture gives a good idea of the modeller's skill.

Only a few simple home-made tools are needed to work Pyruma, and these tools are easily shaped from odd pieces of wood, wire, and strips of tin.

Easily Moulded

As sold, Pyruma can be readily moulded with the fingers to any shape. It can be cut with a penknife or modelling tool; rolled into sheets and then scored to represent brickwork, tiles, slates, weatherboarding or thatch. When dry and stone hard, Pyruma can still be worked upon with a polishing tool, drill, file, or hacksaw.

Hardened sections of Pyruma can be efficiently jointed with Sankey's Tiluma, a semi-liquid, non-inflammable jointing cement.

As examples of the wide scope of Pyruma for modelling purposes it is interesting to note that such widely differing subjects as battle areas, cottages and bungalows, ships, railway accessories, towns, and animals, etc., have been successfully reproduced in miniature in this handy material.

Instructions Leaflet

A new leaflet "Instructions for Modelling in Pyruma Plastic Cement," containing useful hints and many examples of Pyruma modelling, will be forwarded to any reader enclosing a penny stamp to J. H. Sankey and Son, Ltd., Refractories Dept., Ilford, Essex.

Seeing Blast: A Correction

IN the article on Seeing "Blast," by Professor A. M. Low, which appeared in our January issue, it is stated on page 123, that the speed of light is "186,000ft. per second." This, of course, should read "186,000 miles per second.