AIR CONDITIONING

NEWNES

# PRACTICAL MECHANICS

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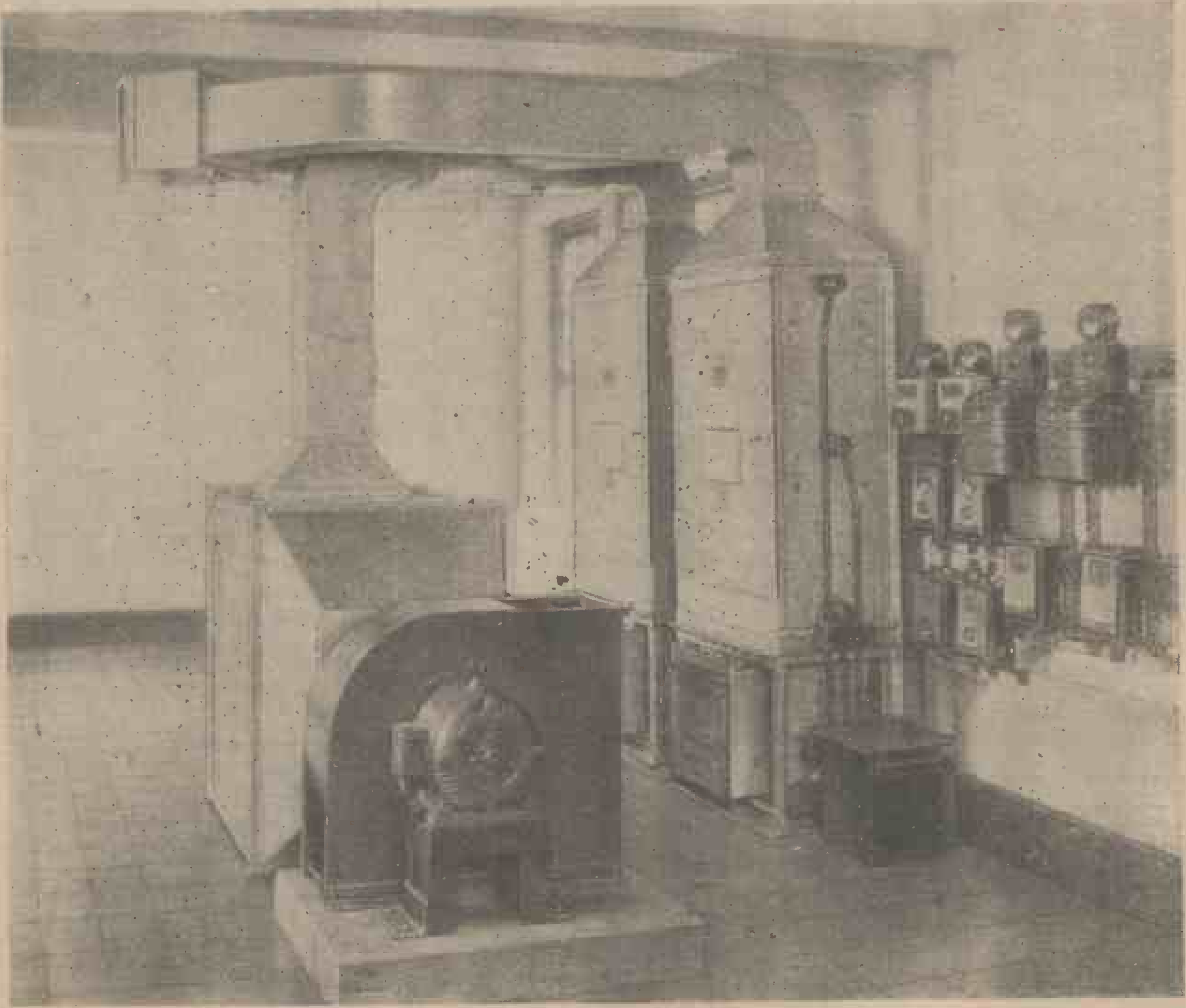


# Rocket Propulsion

## A National Rocket Society: The British Interplanetary Society: The "Lunar Space-vessel"

By K. W. GATLAND

(*Continued from page 417, September issue*)

As may be gathered from the foregoing, particularly with respect to the development of powder rockets, a great deal of the research carried out by one group has invariably been nothing more than a duplication of another's prior efforts.

The early rocket groups worked very largely in ignorance of any other similar bodies, and comparisons of their records make it obvious that the continuous repetition of experiment which ensued among the various rocket societies caused much waste of effort, time and money, and hence the rate of pre-war development was a slow process. Only under war conditions, when ideas and resources have been pooled and fostered by unlimited research grants, has anything approaching the ideal been attained in rocket engineering; but the lessons learned from wartime methods are not likely to be forgotten.

### A National Rocket Society

It is clear that there is a definite need in rocket engineering for the establishment of a central body, possibly a coalition of the existing rocket societies, whose principal function would be the collection of experimental reports and technical data under a suitable reference system. This would provide intending experimenters of a particular problem with a complete history of any previous work conducted and possibly form the basis for more advanced research.

An organisation such as this would not, in view of the great technical advances of recent years and the limited finances available within the society, hope to sponsor active research, but would give every aid to manufacturers of commercial rockets—particularly those who will be concerned with the development of meteorological rockets, who would in their own interests become Associates of the Society.

Apart from the manufacturers, the group would be open for membership to any person interested in rocket development, and offer various grades of admittance rated on age and technical ability. It would also publish a regular journal keeping its members informed of latest advances in the many fields of rocket research, and, in fact, foster the development of the rocket engine and astronautics in similar vein to the Royal Aeronautical Society, whose pioneer work for aviation has had great bearing on the evolution of heavier-than-air flight.

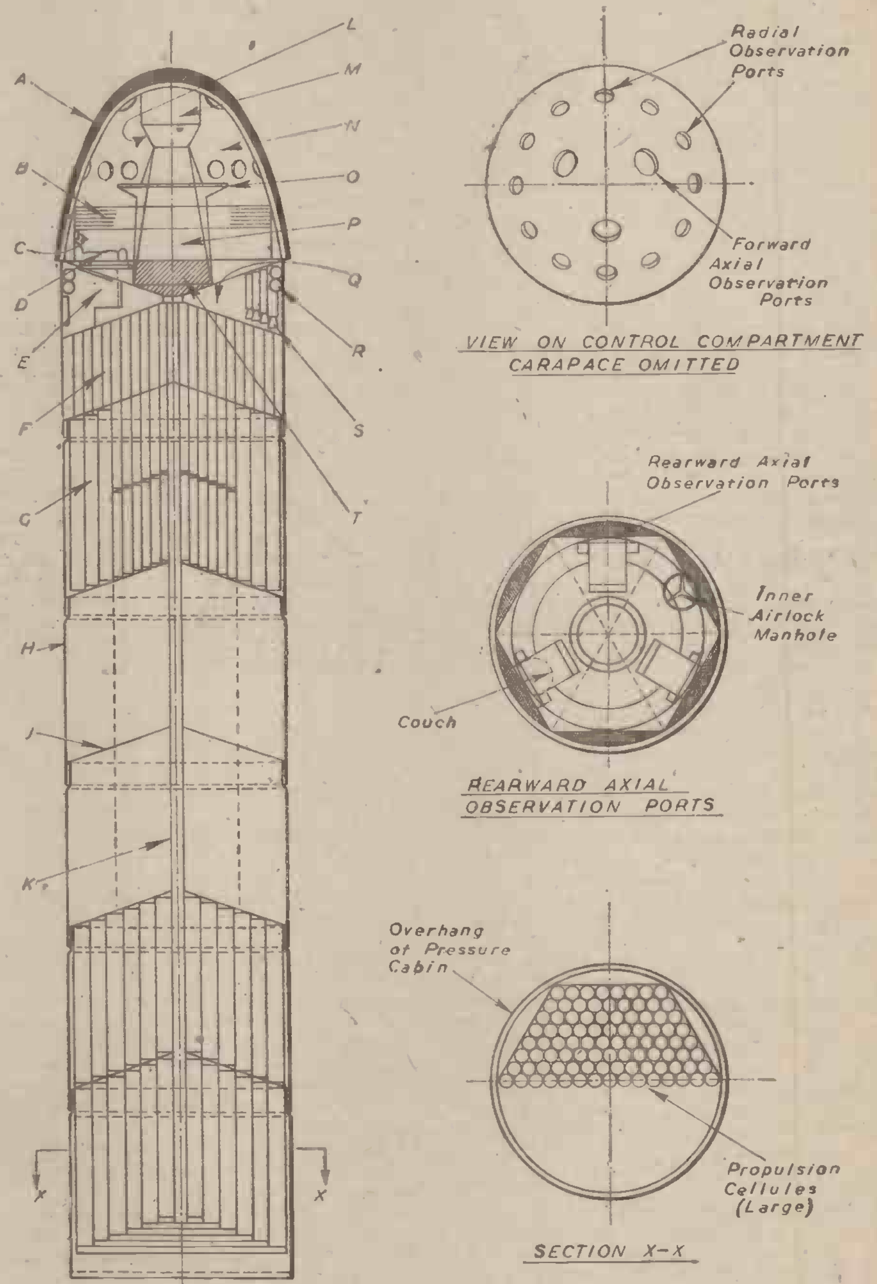
Already a beginning has been made in this direction by the amalgamation, early in 1944, of the two existing British rocket groups, the Manchester Astronautical Association and the Astronautical Development Society, under the title Combined British Astronautical Societies. This is the first positive step toward complete unification, and it is planned that the large national organisation which it is hoped will be the ultimate result of this merger will be recognised by all and sundry, engineer and layman alike, as *the* authority on *astronautics*. In this way it will be possible to direct the development of the science with a minimum financial outlay, and at the same time obtain the fullest advantage from the societies' knowledge and labour.

### Other Pre-war Groups

Beside the rocket groups already mentioned, there was also, prior to the war, a Leeds Rocket Society, organised by H. Gottliffe in 1936, and a Hastings Interplanetary Society, inaugurated at about the same time by J. A. Clarke. Unfortunately, both were in existence only a few months.

The Junior Astronomical Association, too, whose headquarters was at Glasgow, added an astronautical section in 1938. The J.A.A., however, ended its activities with the war.

Some mention has already been made of the British Interplanetary Society, and a great deal more remains to be said of this pioneer body whose theoretical studies, prior to the groups' dissolution with the outbreak of hostilities in 1939, have undoubtedly con-



*A.—Heat resistant carapace (jettisoned after leaving atmosphere). B.—Walkway. C.—Firing control. D.—Navigator's couch. E.—Airlock.—F.—Propulsion cellules (small). G.—Propulsion cellules (large). H.—Cage. J.—Thrust web. K.—Cable duct. L.—Instrument panel. M.—Parachute compartment (for earth alightment). N.—Shell of pressure cabin. O.—Handrail and supports. P.—Food and tool lockers. Q.—Air, water and liquid fuel tanks. R.—Torque jets. S.—Axial liquid fuel control rockets. T.—Ignition power pack.*

*Fig. 38.—Sectional diagram of the British Interplanetary Society's "Lunar Space-vessel" conception* (1938).

tributed much toward the evolution of the extra-terrestrial rocket. Before going on to review this work, however, a word about the Society's function and of those responsible for its success.

### The British Interplanetary Society

Through the enterprise of P. E. Cleator, founder and first President of the B.I.S., Liverpool became the birthplace of astronautics in Great Britain, and from there the first journal of the then new-born science was published in January, 1934. That issue, a six-page official Society booklet, not outstanding in appearance and simply illustrated by hand-carved blocks, will long be remembered by those few engineers whose "revolutionary" ideas were first expressed in its pages.

For a year or two the development of the journal was the Society's prime activity, and with time the "booklet" became increasingly more dignified in appearance, having articles by specialist technicians of almost every branch of science. Its size, too, was much improved, and interest was further stimulated by the inclusion of photographs and line drawings—an achievement not easily maintained by a small amateur group.

In 1936, a branch of the B.I.S. was established in London and the inaugural meeting took place on October 27th.

At about the same time, P. E. Cleator, through pressure of other business, was forced to relinquish the Presidency.

Almost a year later, in the autumn of 1937, the headquarters of the B.I.S. was transferred to London, and at its first City General Meeting, Professor A. M. Low was voted the Society's second President. This post he held throughout the remainder of the group's activity.

In August, 1938, the Society set up a Midlands branch, and early in 1939, as already mentioned, the Manchester Astronautical Association and the Paisley Rocketeers' Society were granted affiliation. This latter agreement brought about increased benefits to members of each group, principally through an exchange of publications. It also involved a better balance of research due to the improved liaison.

In the summer of 1939, meetings of the B.I.S. were held at both the Royal Aeronautical Society and the Science Museum, Kensington. At these places, the Society showed particularly high attendance, which continued on the same level until September when the outbreak of hostilities brought the work of the B.I.S. to an untimely close.

### The B.I.S. Space-vessel

The research for which the British Interplanetary Society is best known concerns their theoretical study which culminated in the provisional design of what has been termed the first practical engineering conception of an interplanetary "Space-vessel"—a work which occupied the Society for a year and a half.

Had the war brought no great advances in the field of rocket development, the very mention of "interplanetary communication" would have invariably been met with scepticism, but to-day, in the light of the outstanding strides made in recent years, particularly in the development of the V-2 rocket weapon, there must be few who remain unconvinced of these vast possibilities inherent in the rocket projectile. The V-rocket has given striking evidence in support of the pre-war B.I.S. declaration that, given the necessary backing, an exploratory journey to our satellite, with provision for landing on its surface and returning to earth, could be undertaken with present knowledge, engineering facilities and materials. Such an expedition, it has been calculated, would occupy three weeks, and the Space-vessel design has been based on accommodating a crew of three for that period. The implications of the V-2 rocket have already been mentioned in my previous writings ("All About The V-2," and "More About The V-2," PRACTICAL MECHANICS, January and February, 1945), in which stress was laid on the plausibility of adapting a V-rocket of slightly improved fuel-load as a two-step rocket, the smaller component replacing the explosive head. The calculations, based on an initial overall mass of 20-30 tons, show that the second step having discharged at the "carrier" rocket's greatest velocity would be capable of increasing its speed (approximately 5 km./sec.—3 m.p.s.—at release) to 11.2 km./sec.—7 m.p.s.—the velocity of gravitational escape. By careful timing of the experiment, the small rocket could be made to crash on the Moon.

It must be emphasised that the B.I.S. design is intended to be no more than an intelligent engineering conception of what the B.I.S. Research Committee considered in pre-war days as practicable using then known methods. As has already been pointed out, much advance has been made under stress of war, and doubtless many improvements due to this work will be incorporated when the British group can allow more time to such development.

As yet, nothing of a detailed nature has been attempted, apart from the design and construction of certain radical instruments affecting navigation, which were considered necessary to prove the basis of the design. Much of this work, unfortunately, will need to be duplicated owing to the destruction of the finished apparatus during an air-raid early on in the war.

### The Propulsion System

From the diagram (Fig. 38) it can be seen that the layout is somewhat of a departure from any previously conceived "space-rocket." The vessel is designed to use solid propellant, which it embodies in myriads of separate "motors" set in cellular formations, permitting fully 90 per cent. of its mass to comprise fuel. Of this method of construction something has already been said. A principal advantage, it will be remembered, is the elimination of heavy forming members in the rocket structure through the arrangement of the cellular charges in lateral contact. Apart from the life compartment at the rocket "head," the entire strength lies solely in the propulsion charges, which are stacked in conical layers for optimum structural stability. There are six primary layers, or banks of cellules, each hexagonal in section (see Fig. 38), and this arrangement provides the closest possible packing of the charges.

The propulsion cellules, each a precision made "fuel-store" rocket motor, are assembled in groups of varying sizes and powers within the banks, and their ignition is set by an automatic relay causing the tubes to fire in rings according to a pre-calculated sequence.

As can be determined from the diagrams, the largest charges, those employed for take-off and the building up of initial acceleration, are contained in the first firing bank.

When ignited, the thrust of the cellules causes them to lift fractionally from the release pins (which lock each tube in place until firing takes place) until they are expended, when, due to the vessel's acceleration, they disengage and drop away. As each bank is reduced, the light webbing structure and release gear are similarly jettisoned, which all adds to bring about a steady improvement of the fuel-weight ratio—a further important advantage of cellular construction.

The B.I.S. design provides for the greatest possible strength obtainable in a cellular formation, and clearly the maximum fuel density in this arrangement largely dictates the external form—as will be observed, streamlining is conspicuous by its absence.

The nose form is designed not so much to reduce resistance at low speeds but to "part" the air at supersonic velocities and produce a partial vacuum along the sides so as to overcome the effect of frictional heating which might otherwise prove disastrous through detonation of the fuel. The nose attachment, which is provided to fit over the nosing portion of the life-container, is envisaged as a detachable carapace of reinforced ceramic compound. This is intended to withstand the main effect of friction and to release immediately the "Vessel" has risen beyond the atmosphere layer.

The cross-sectional diameter of the body shell is determined by the smallest practical size for the life-container; having in mind provision for the crew of three and the essential requirements, pressure conditioning, controls and instruments, etc., etc., and also the minimum firing area required. The latter consideration is highly important, as if the area were too small, the greater power necessitated would cause excessive pressures in the cellules and entail a heavier construction. Obviously, a balance must be found between the most ideal condition in each instance and the final dimension developed accordingly.

### Stability

Since only 0.1 per cent. of the Lunar flight would lie within the bounds of atmosphere, the "Vessel" is provided with no fins or wings as adorn the hyperthetical "space-ships" of popular conception. Working on an acceleration of 2g., the limits of the earth's atmosphere would be passed within three minutes. At this same rate of acceleration, a further period of four minutes would realise gravitational release, and having attained release velocity at approximately 2,410 kms., the ignition would be cut and the "Vessel" allowed to travel under momentum until such time as its forward speed were checked prior to the landing manœuvres. From the time of liberation, the "Vessel" would reach the Lunar orbit within 45 hours.

Stability in the B.I.S. conception takes effect in axial rotation; the "Vessel" rotating once in every three seconds. As the experiments with model rockets have shown, the instance of greatest directional instability is that immediately following launching, and accordingly, a system of launching has been developed which will provide pre-rotation at the required angular momentum.

### Artificial Gravitation

The "Vessel's" rotation will also assist by stimulating a gravitation condition during the period of momentum, which is necessary to avoid nervous and digestive disorders that might otherwise render the crew insensible.

As has already been mentioned, the "Vessel's" acceleration would at no time exceed 2g.; a figure easily borne for prolonged periods. This question of acceleration and its effect on the human system is one which has caused much controversy, and there are many who still hold the view that a rocket must necessarily travel at accelerations prohibitive to the carriage of living beings. The truth is simply that, as centrifuge tests have shown, a well protected man in good physical condition is able to withstand accelerations up to 6g. for quite long periods.

Provided with special suits and drugs it should be possible to better even this figure; but it is unlikely that rockets will ever be required to operate at more than about 5g.

*(To be continued)*