REACTION MOTORS—*Power of the Future*

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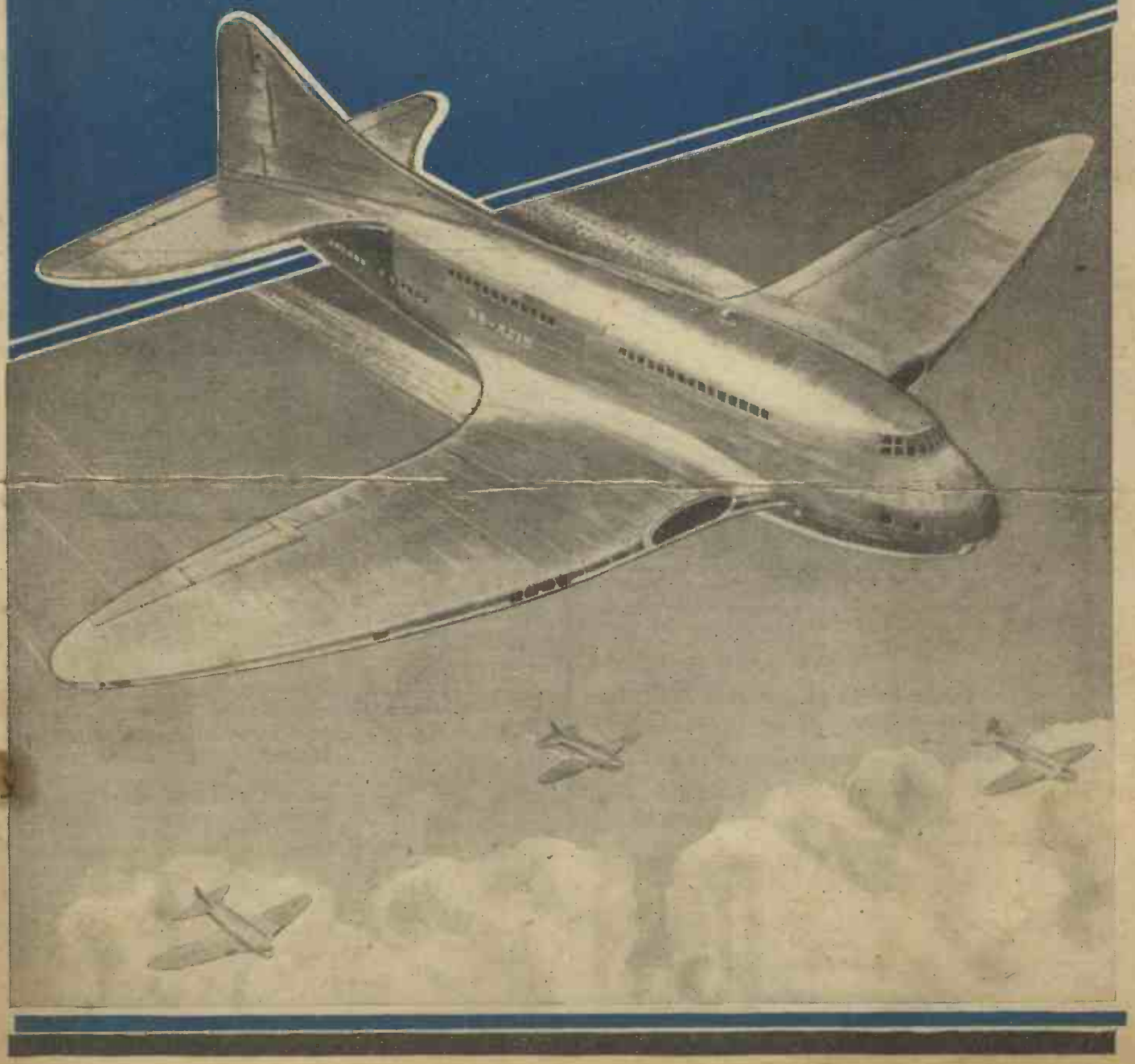
NEWNES

PRACTICAL MECHANICS

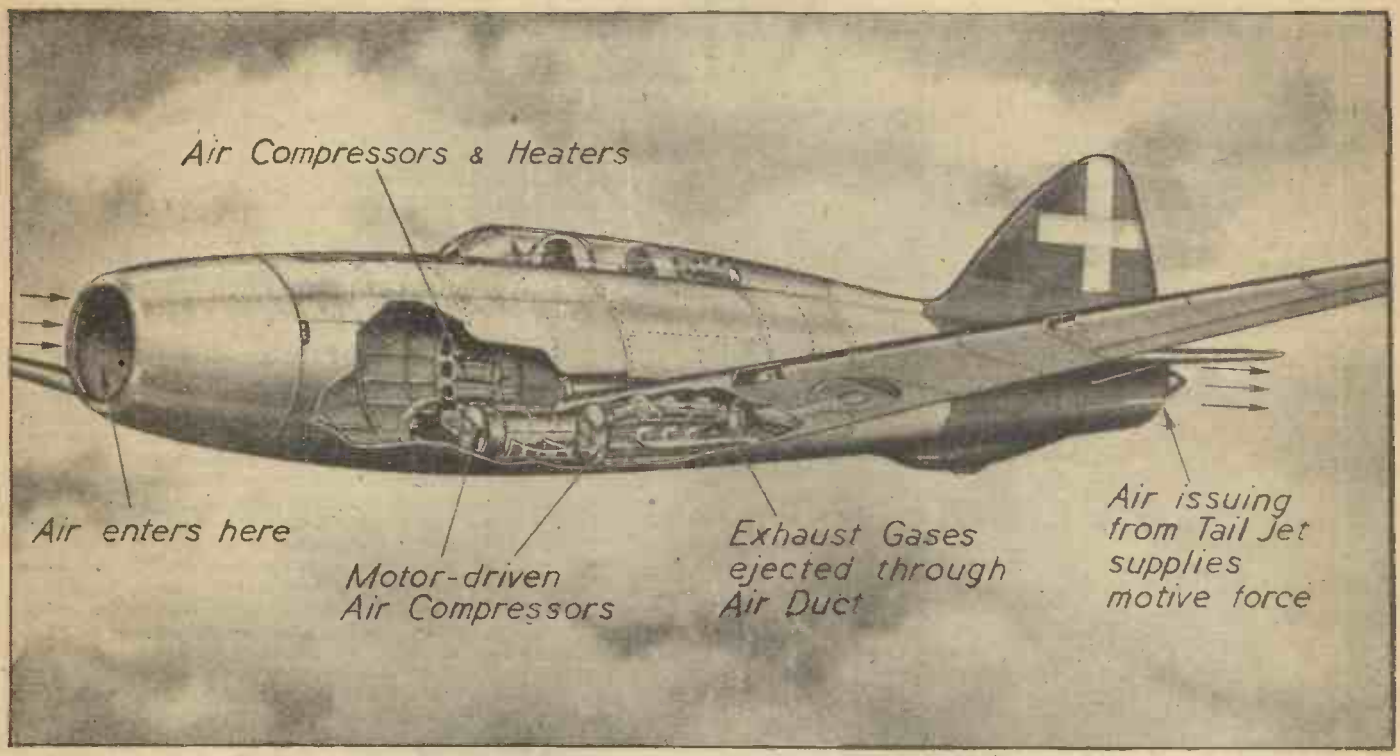
MAY 1943



The Reaction Motor

Notes on the Possibilities of This Form of Propulsion for Aircraft of the Future

By K. W. GATLAND



The Italians in August, 1940, at the Taliedo Aerodrome, flew the Caproni-Campini C.C.1 jet-propelled aeroplane, and it was flown by Colonel Mario de Bernardi. Experiments have continued since that time, and in 1941 Signor Secondo Campini designed and constructed a jet-propelled aircraft on somewhat larger lines. The new machine is known as C.C.2, an illustration of which is given above. It is a two-seater aircraft with pilot and observer seated in tandem, and it is of low wing design with outward retracting undercarriage, and enclosed cockpit, and single fin and rudder. It has no airscrew, and weighs about 11,000lb.

FREIGHT transport in the post-war world will undoubtedly have vigorous competition between sea and airborne methods. Although it is true that under present-day conditions a small fleet of aircraft would be required to transport a cargo equivalent to the amount taken by a single merchant vessel, speed of transit is a factor high in consideration. Upon the cessation of hostilities it must be to a great measure the air freighter (which at first would probably be suitable converted heavy bombers and troop transports) that will bring relief to the subjected peoples of Europe and Asia. The advantages of air transport over the merchant vessel are truly considerable. High speed, coupled with the ability to bring supplies far inland without the trouble and time taken in unloading, reloading and conventional slow transport methods, are factors of great importance. For the aircraft to adequately serve humanity as the tool of progress, however, much further technical development is required to enable such machines to carry the heavier loads required for really practical freight transport operation, without sacrificing speed. Aircraft efficiencies much in excess of those realised to-day by the best machines in the class cannot be appreciably increased, due to the serious limitations of the engine-propeller combination. Various devices, such as the multi-blade and contra-rotating propeller and the supercharger, bring certain, but limited, gains in efficiency, mainly by enabling the aeroplane to operate at altitudes where the rarefied nature of the atmosphere presents less resistance to its passage.

Thermal-jet Propulsion

This deficiency in the orthodox power plant has brought an increasing amount of interest recently to the subject of thermal-jet propulsion. Already the principle has realised practical application as the motive drive for the Italian-built "Caproni Campini" monoplane which flew successfully, after initial tests at the Forlanini Airport, from Milan to Rome, a distance of 168 miles, in November, 1941. With the advent of the jet-propelled machine, communication is likely to be made more rapid, the aircraft gaining, with development, more and more advantage from high altitude operation in those regions of the stratosphere, economy in fuel expenditure, where air supplied to the jet unit under compression is still of sufficient density to support combustion, and where air resistance is so greatly diminished. The jet machine will, in all probability, initially evolve as the somewhat conventional type of aircraft—with wing installed motors. The layout of the jet plant lends admirably to snug installation, the compressors and operating motors (which may be exhaust driven turbines) being sunk deep within the wings, with the addition of an air scoop, possibly arranged in elliptical form, for a short length along the leading edge. The illustration on the front cover gives a conception of the possible form such transport aircraft will take—being not altogether dissimilar to the present-day machine, although streamlining is likely to be taken much farther on the considerably larger aircraft which can be confidently expected with the development of the more efficient jet motor.

While the thermal motor is confidently expected to produce greater efficiencies than the conventional internal-combustion engine, the limitations with regard to altitude are more or less parallel, due to the need for inducting sufficient air to support combustion. Consequently, the development of the thermal jet propulsion is not likely to produce great speed increases due to operation within relatively dense atmosphere, which is the main barrier to further progress. Speeds in the region of 750 m.p.h. appear to be the limit for atmosphere flight expectations, for it is at and around this velocity that "shock waves" (compressed air particles) are built up which set up prohibitive structural stresses, possibly even resulting in the complete fracture of the more vulnerable surfaces—tail plane, etc.

Jet-rocket Reaction Unit

A recent preliminary investigation into the problems of high altitude flight by the Astronautical Development Society, has ultimately produced a basic specification for a power unit, intended not merely for operation within the atmospheric region, but also capable of functioning at high efficiency in vacuum. This is proposed by means of an inter-combined thermal jet-rocket reaction unit—the thermal section operating to an altitude of approximately 45,000ft., at which height the rocket component commences to function to propel the craft still higher. The advantages of such a combination are considerable. High efficiency, with relatively low fuel expenditure, are formidable prophetic features of the design. By employing thermal-jet reaction within the bounds of the more dense regions, and true rocket propulsion above the thermal restricted regions, a high efficiency-economic ratio is maintained under all conditions of flight. The fuel for thermal power units need not be petrol, or in fact any of the highly refined spirits, for paraffin, tar oils and any similar product of the hydro-

carbon range would probably do equally as well. Even solid fuels, such as coal dust, cannot be ruled out as impossible alternative fuel forms. Rocket plant fuels can be either of the "liquid" or "solid" category—petrol, or similar fuel, being combusted with oxygen, stored in highly concentrated liquid form in the case of the former, and in the case of the latter, a combustible mixture (either powder, plastic or paste) with oxygen-bearing content. Due to the relatively high cost and the difficulties of storing oxygen in liquid form, greater attention has been paid in recent years to the development of the plastic "cartridge." These fuel cartridges can be injected into the reaction chamber by means of a specially designed feed. Groups of injector feeds working with alternate pulsating action would be able to maintain a constant propelling thrust. Thus by the further development of reaction power plants, the era of really cheap world-wide travel may soon be realised.

Rocket Bombs and Shells

Amongst other things, the rocket, useful in times of peace (as indeed in war) as the seaman's life-line has, for instance, been used extensively against aerial attack to enable high-explosive shells to be "shot" to ever increasing heights. This is an important factor when the increasingly higher operational altitudes of both fighter and bomber aircraft are considered. It is not altogether impossible, moreover, that the German 88-millimetre gun, used extensively in the early Middle East campaigns, was in reality a "projector" firing rocket shells. These guns were reported to be widely responsible for the destruction of many of the heavily armoured Allied tanks by the high penetrating force of the shells.

Rocket bombs also have been employed by both the Russians and Germans. The rocket principle applied to aerial bombs enables the missiles to strike hard on the target, gaining greater penetration and destructive power than the conventional type of similar weight. Another advantage of the rocket bomb is its ability to travel on a level parallel with the ground. It is possible, for instance, to pitch it ahead from an attacking aircraft without the need for getting within range of the anti-aircraft defences ringing the target.

Assisted Aircraft Take-off

The rocket principle, again, has been applied to the aeroplane for assisted and catapult take-off purposes, which enables defence machines to take off, and climb to the altitude of interception, within a much shorter space of time. Here again high-altitude bombing has to some great measure been made less effective.

Rocket Mails

Rocket mails, a practical solution to speedy delivery over difficult country, are yet another example of the versatility of the reaction principle. Although rocket mail services have not been used extensively in the past, it is no mere conjecture that with the further development of the reaction motor services will be established to enable mails to be projected with accuracy from country to country, the projectile and containers being landed gently by parachute when the "target" is reached. Perhaps the most successful example to date was the mail service instituted over mountainous country between the towns of Berne and Basle, Switzerland, which was in regular operation before the war. Hitherto rocket mail attempts have been made with relatively small projectiles, guided by fins, but experiments have shown that if the rocket is rotated about its axis, by either offsetting the exhaust tubes or by the addition of exhaust deflector vanes, a gyroscopic stabilisation force is set up, which enables the rocket to maintain its predetermined course, and is far less affected by atmospheric variation.

The Lunar Space-vessel

The moon rocket has been the subject of much fantastic speculation during the past decade or so, perhaps the most notable examples being given in novels by Jules Verne and H. G. Wells. Although such works make exceedingly interesting and exciting reading, however, for the most part the conceptions of such authors are completely devoid of technical reasoning, and consequently a completely false interpretation of the possibilities of inter-planetary communication has been built up which has resulted in the subject being regarded with ridicule by the general public. By the publication of the "Preliminary Investigation into the Problems of Space Flight," by the British Interplanetary Society, the subject has been considerably lifted out of the realm of the "fantastic."

The layout of the space vessel, which is the main feature of the investigation, gives a really convincing engineering conception of the project, which has been the subject of serious planning over a period of several years. Cellular construction is the chief feature of the design, which is in reality a series of closely packed tubes (honeycomb fashion) filled with plastic fuel compound. These tubes are fired in clusters, at the control of the operator in the pressure cabin at the nose of the "ship," and are automatically jettisoned with the completion of each firing phase. It can be readily appreciated that as the vessel continues out into space against the earth's diminishing gravitation, by the jettisoning of irrelevant material the "ship" is made constantly lighter and substantial economy in fuel expenditure is effected. The complete "ship" is designed to rotate about its axis, which, as well as providing stability, establishes an artificial gravitation within the vessel to enable the crew to function in a relatively normal manner under constantly changing natural gravitational conditions during the flight.

Landing

Landing is effected by a complete reversal of the vessel—end on to the lunar surface, which is commenced some way off from the satellite for the jets to sufficiently retard the "ship" against the not inconsiderable velocity which has been built up during the journey out. When the vessel is sufficiently close to the surface it descends, the lunar gravitational attraction and jet reaction striking a balance some few feet from the surface, whereupon retractable hydraulic shock absorbers come into play and the vessel is brought to rest.

After exploration, with the aid of special heated pressure suits, the crew are able to jack the machine into position for re-firing. The vessel is able to leave with far greater ease than from earth, due to the lower gravitational attraction.

Upon approaching the earth's atmosphere the "ship," having only the weight of the pressure cabin, auxiliary equipment, crew and the remaining rocket tubes, is once more reversed, the speed being retarded until contact with atmosphere is made, when the supporting parachute is released and the control cabin and crew float gently to earth.

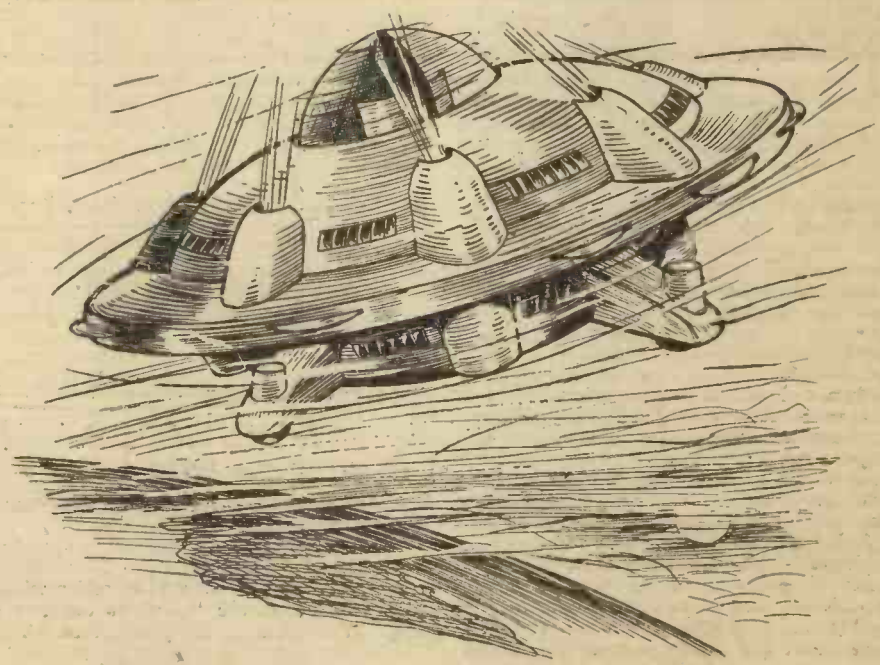
During the initial "climb" through atmosphere, at the commencement of the flight, a heat-resisting carapace is attached, moulded to the contour of the nose, to prevent excessive heat generation, due to friction.

Rotational braking when landing, manœuvring and course alignment can be effected by means of special steam reaction and rocket reaction units. Visual observation during the rotational condition can be made by means of the special "Coelostat" viewing apparatus, also designed by the B.I.S. This system, which is an adaptation of the stroboscope, has been demonstrated satisfactorily at South Kensington Museum.

Although the above brief summary of the project and the conception of operation leaves much to the imagination, it is apparent that the B.I.S. conception of an inter-planetary space vessel is based on a sober understanding of the subject.

Further research during post-war years by the combined efforts of the British Interplanetary Society, the Astronautical Development Society and the Manchester Astronautical Association should do much towards the realisation of interplanetary communication. A rocket test site is proposed for joint post-war research, where the new plastic fuels and reaction units can be proved.

When the day of the space-vessel finally arrives, the world will reap great benefit from the knowledge the reaction machine will unfold.



Our artist's impression of a "space-ship" of the future.