is then passed through the liver, and in this way the organ can be preserved for up to 6 or 7 hours before being transplanted. At St Mary's Hospital in London a liver-shaped plastic box has been designed to keep the organ cool between removal and transplantation, and it seems that this will play a useful part in prolonging the useful life of the liver.

The simultaneous transplantation of heart and lungs would have several advantages, not the least of which is the reduction in time required for this operation compared with transplantation of the heart alone. The heart surgery team at the National Heart Hospital says that the heart transplant operation is the first of a series of operations leading to a combined heart–lung transplant before the end of the year. Whether the recent achievement—and the resultant publicity—will in any way affect the recommendation in the Royal Commission report for the combination of the hospital with the so-called "Chelsea" group remains to be seen.

Meanwhile, in the United States the hunt for another transplantable organ is on, and attention is being focused on the spleen. In the current issue of *World Medicine*, Dr J. Norman of Harvard University reports success in arresting canine haemophilia in three animals by transplanting healthy spleens from animals of the same species. His suggestion that it may be possible for a non-haemophilic mother to donate her spleen to her haemophiliac son should, however, be treated with reserve, according to Dr E. E. Peacock, professor of surgery at the University of North Carolina.

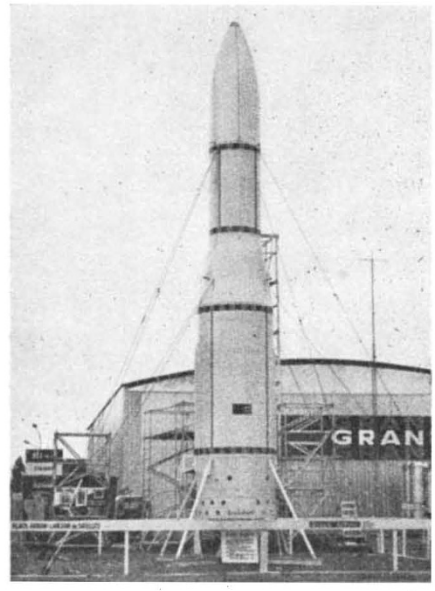
Arrow on the Ground

Now that the demise of ELDO seems to be in sight, probably marking the end of European co-operation on ambitious space projects for some time at least, it is worth asking what the prospects are for a purely national British space programme. This, of course, depends on the availability of a launching rocket, the linchpin of space activities. As a basis for any programme Britain may undertake in the future, three satellite launch vehicles are on order from the Saunders-Roe division of Westland Aircraft. They are Black Arrow launchers, based on the Black Knight ballistic test rocket, and roughly equivalent in capability to the American Scout rocket which last year launched Ariel 3.

Briefly, Black Arrow is a three stage rocket designed to launch satellites of about 240 lb into a 300 mile polar orbit. The first and second stage engines are similar to the Black Knight design and use hydrogen peroxide and kerosene propellants; the third stage has a solid fuel. The first firing is expected to take place from Woomera in March next year, and will be to test the first and second stages, and the separation of the third stage motor together with its payload. The second and third firings, in the autumn next year and early in 1970, will be attempts at satellite launches.

Because the firings are primarily to test the rocket itself, the main function of the satellites carried during the two orbital attempts is to monitor the performance of the third stage. Radio beacons will be carried so that the orbit achieved can be precisely determined. Once the performance of the rocket itself has been proved, the emphasis will be on testing various components of satellite design. A satellite is planned which will test in orbit new telemetry, power supplies and various surface materials to control the temperature of satellites. No Black Arrows have so far been ordered for this stage of the project.

One of the roles envisaged for ELDO rockets in the future was the launching of communication satellites into geo-stationary orbits. Conjecture about Back Arrow fulfilling this objective has been based on the notion that a satellite in a near-Earth orbit could be gradually propelled out to more distant orbits by a so far unproved electric propulsion system. This contrasts with the technique hitherto used to achieve geo-stationary orbits, which is to convert a near-Earth



Black Arrow satellite launcher.

orbit into an elliptical orbit, with apogee at the 37,000 km altitude of geo-stationary orbits. The elliptical orbit is changed into a circular geo-stationary orbit by firing a motor at apogee.

An electric propulsion system involves the acceleration of ions by an electric field, using energy collected from solar radiation by arrays of solar cells. The advantage is that no fuel need be carried to change from a near-Earth orbit into a geo-stationary orbit; on the other hand, an array of solar cells large enough to gather sufficient energy from the Sun have to be incorporated into the satellite, although once a geo-stationary orbit has been achieved these are still available to power electronic systems on board the satellite. Bearing in mind the size of satellite which can be launched into a near-Earth orbit, however, it seems that the launching of a geo-stationary communication satellite large enough to be practicable is beyond the capabilities of the Black Arrow project in its present form.

ESRO-2 Launch

A SECOND attempt to launch the satellite ESRO-2 is expected to be made on May 15 from the Western Test Range in California. The seven experiments on board the satellite are from universities and laboratories in Great Britain, France and the Netherlands,