In the last flight, the engines of all three stages ignited correctly, but the propellant system of the third stage failed almost immediately. This time, the third stage has been slightly modified and extensively tested on the ground while the electronic system of the second stage has been made more reliable, so that now it seems likely that the rocket will successfully launch its 354 kg test satellite into a low circular orbit on Monday. In the next flight, which should take place this November, the test satellite will carry a limited telecommunications experiment.

The Europa III rocket which ELDO hopes to start developing in 1971 will be designed to launch geostationary satellites of up to 700 kg, which would be sufficient for semi-direct TV transmission. To launch this sort of payload, the power of the first stage will have to be increased, and the three possible ways of doing this are to use Blue Streak with solid or liquid boosters, to use an entirely new first stage, possibly based on a French idea known as L 135 or, more tentatively, to design a new first stage based on Rolls-Royce engines. Blue Streak has the advantage that it has been well tested, and the development of the complete rocket should take two years less than the eight years estimated for the development of a rocket with a new first stage. A spokesman from the Ministry of Technology assured the press conference that Blue Streak with boosters was capable of anything a new stage would be. The director-general guessed that Europa III might cost something like $450 m to develop using Blue Streak and possibly $600 m without. The second stage of Europa III will use liquid hydrogen and oxygen as propellants.

ELECTRONICS

Radars Galore

from our Special Correspondent

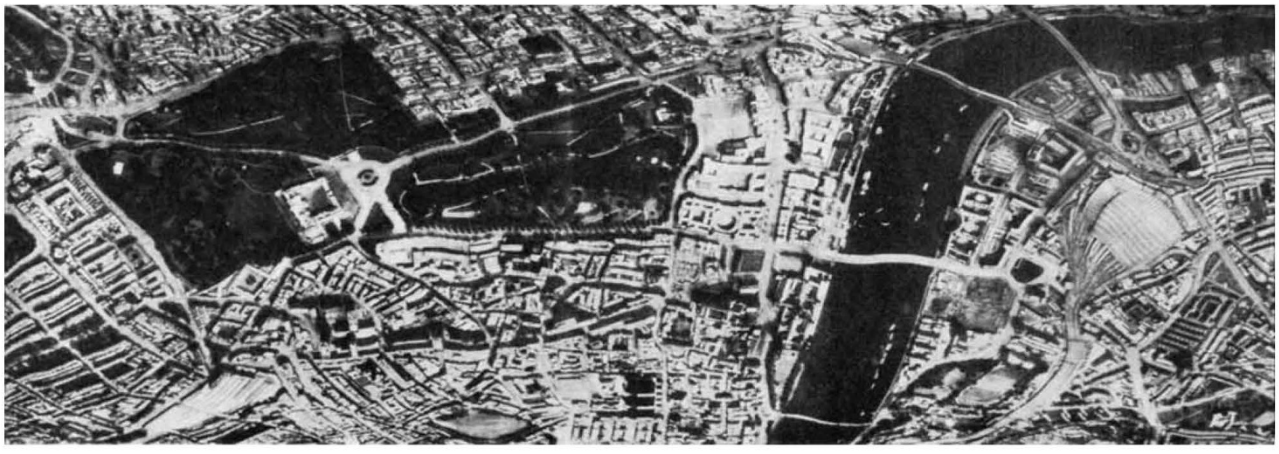
Malvern, June

"DIVERSIFY or die" may be the slogan of many research organizations, but the chief commodity of the Royal Radar Establishment, in the lee of the Malvern Hills, is still radar. And radar in all shapes and sizes, for the establishment's experiments range from the most powerful radar in Britain, coupled to a 43 m dish aerial to probe the ionosphere, to the tiniest hand-held radar torch. In between, there are radars to help 200,000 ton oil tankers to dock, radars which look sideways for airborne reconnaissance and radars to track satellites. Last week, all this equipment was on show at the establishment's first open day since 1963, together with much of the basic research which has made the small radar systems, in particular, possible.

The secret of the small radars is a gallium arsenide solid-state device called the Gunn diode which can be made to oscillate and produce radio waves in the frequency interval from 1 to 88 GHz. Except when high power radar beams are required, the Gunn diode can replace the bulky and less robust klystron as the generator of microwave signals. Development of the Gunn diode at the Royal Radar Establishment has made possible radars which fit neatly into the hand, and which are finding applications as speedometers, burglar alarms, high resolution radars and in SPRAT (Small Portable Radar Torch), a hand-held radar weighing less than 5·5 pounds which can detect movement within 625 m. Wearing headphones, the operator points SPRAT like a torch, and any movement which is picked up is presented as an audible tone. Although developed for the battlefield, SPRAT has obvious applications as an aid for the blind.

So long as solid state devices such as the Gunn diode continue to be developed, the Royal Radar Establishment will have a happy hunting ground devising equipment to measure small distances and speeds. At the other end of the scale, the establishment has developed a new kind of sideways looking radar for the Phantom aircraft which picks out moving targets and displays them on a map of the ground, and has built a high power ionospheric radar which can measure electron densities from 80 to 1,000 km. Unlike an ionosonde, which probes the atmosphere by detecting radar echoes only from the ionospheric layers, the Malvern radar is powerful enough to produce an electron density profile throughout most of the ionosphere.

The establishment is earning its keep by applying the electronic techniques of radar to other situations. A project called Terminal Area Air Traffic Control, devised to see whether computers can safely cut down the intervals between landings (and between takeoffs) at Heathrow, is under consideration. The hope is to increase the airport's capacity by 10 per cent, and thus



A thermal picture of part of London taken with a Royal Radar Establishment infrared sensor. Buckingham Palace is to the left of centre and Waterloo Station is on the right.

give the procrastinators among the airport planners more time to decide how the airport should develop. The establishment is also carving out something of a reputation for itself in the field of infrared mapping.

PHOTOGRAPHY

Silent Talkie

THE visit of a group of Russian scientists to a special conference on high speed photography at the National Physical Laboratory on June 20 seems to have been a moderate farce. Not only had they singularly little to report, but the translation facilities provided by the Association of High Speed Photography seem to have created confusion, not enlightenment, and to have diverted the sizable audience from the few points that were of interest.

The conference was organized by the Association for High Speed Photography in conjunction with the Ministry of Technology. The Russian delegation, consisting of twelve specialists in high speed recording, image tube cameras, lasers, holography and flow visualization techniques, is on a fact-finding visit to Britain, and the one-day conference was inserted to give British specialists in these fields the opportunity to learn about recent developments in the Soviet Union. It seems that the organization of the conference was rather hurriedly contrived.

One point which made some impact at the conference was the sheer number of optical and mechanical devices that have been developed in the Soviet Union for recording high speed phenomena. Although no new techniques emerged from the lectures, the scale of work on high speed photographic techniques in the Soviet Union caused some surprise. The most informative paper was that of Professor U. Nesterikin, director of the Institute of Automation and Electrometry in Novosibirsk, who described experiments that have been carried out in the Soviet Union using electronic image tube cameras. One of these involved measurements on plasma flow to give the temperature in different regions of an electron plasma shock wave. The exposure time for the photographs was of the order of a few nanoseconds. Professor Nesterikin also showed some slides of his image converter tubes.

NUCLEAR REACTORS

Dragon Looks Ahead

ON its tenth anniversary, the Dragon reactor project at Winfrith is beginning to show promise of a commercial benefit, although the electricity boards are doing little more than make encouraging noises. Run by the European Nuclear Energy Agency of the OECD, Dragon is a joint project involving twelve European states. It has a noble history, beginning as a feasibility study by the UKAEA which was suggested to the predecessor of the OECD by Sir John Cockcroft as a possible collaborative project. Now, the chief executive of the project, Dr L. R. Shepherd, says that Dragon is at a stage where industrial application is imminent.

The concept of Dragon is that it eliminates the known limitations of gas-cooled reactors by making extensive use of graphite, in particular to replace the metal sheaths around the fuel. With no metal in the reactor, high temperatures can be achieved in a compact reactor core—that of Dragon, producing 20 MW, is 4 feet across—and with a high conversion efficiency. The structure of the core and moderator is also graphite, the fuel is ceramic (uranium oxides or carbides, for example) and the coolant is an inert gas—helium. The project began in March 1959 with twelve countries signatory to the agreement, and the reactor began operation in August 1964.

But the sponsors of Dragon still do not know whether their pioneering work will be taken up commercially in Europe. The chief British utility, the Central Electricity Generating Board, is, for example, satisfied to say that the third generation of reactors (high temperature gas cooled reactors like Dragon) are likely to come into operation in Britain in 1975–76.

Meanwhile Dragon's sponsors have their competitors. One of the twelve signatories, Germany, has its own national effort in this field. Gutehoffnungshütte is building a 25 MW high temperature gas cooled reactor (HTGCR) at Geesthacht, in which the helium cooling gas drives the generating turbines directly, instead of through an intermediate steam-producing cycle. The same company has designs for 300 MW and 1,000 MW stations. Using a similar principle to the Dragon reactor, Brown Boveri has built a 15 MW reactor at Jülich (the "Pebble Bed" reactor) and is said to be about to receive an order for a 300 MW plant. In the United States, there is a 40 MW experimental HTGCR (the "Peach Bottom" reactor) and a 300 MW reactor is planned for Colorado. This work is being done by General Atomic, sponsored by the Gulf Oil Company of America.

What of the future of Dragon, now that the pioneering work has been done? The reactor management is eager to keep at least the nucleus of the design team in existence. Dr Shepherd says that his team are increasingly giving support to industry and the utilities which are concerned with exploiting the system. The experimental facilities seem to be very much in demand. The current agreement expires in March next year when the total investment in Dragon will be £31 million, but Dr Shepherd hoped this could be extended to March 1973, and to an investment of £38 million. A decision will be made in September this year.

Dr Shepherd considers that the ultimate advantage of the HTGCR will be that it sounds the death knell for the intermediate steam cycle. The CEGB has concluded that the third generation of reactors can be expected to produce savings in generating costs of 10 per cent over the second generation reactors, the AGR. But, using the helium to power the turbines, an extra saving variously estimated at from 5 to 25 per cent is possible. At one time, Dr Shepherd said, some organizations tried to persuade the Dragon management to add a small gas turbine, but the feeling was that the information gained would not be worth the trouble.

ROLLS-ROYCE

Engines by Appointment

IF there are legends left in British industry, Rolls-Royce is one of them. For almost as long as there have been internal combustion engines, the company has been selling distinctive automobiles which make up