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THE FIRST ARTIFICIAL SATELLITE

There is no question about it ! The Russians have sprung a very exciting surprise on the West. It had long been known that they were preparing to establish at least one earth satellite as part of their contribution to the Geophysical Year ; and it had been reported that this satellite would be established on a polar orbit. But because the Americans, believed to be at least as well advanced in rocket technology, did not plan to establish a satellite before next year, the announcement late last Friday from Moscow that a Russian satellite was already circling the earth took everyone by surprise. Even more surprising are certain facts about the satellite. It is reported to weigh about 184 lb, as compared with a mere 20 lb for the projected American satellite (though some commentators seem suspicious that a decimal point has been misplaced !) ; and it has been established in an orbit stated to be more than 500 miles above the surface of the earth as compared with the American aim to reach a mean height of about 300 miles. Congratulations are unquestionably due to Russian scientists and engineers. A major scientific and engineering feat has been performed. Its magnitude can be well appreciated when it is realised that the American project is marginal ; that is, the three-stage rocket which will lift and accelerate a " payload " of only 20 lb into an orbit 300 miles above the earth's surface will have only just sufficient power to establish an orbit from which under the drag of residual atmospheric pressure the satellite would not very rapidly descend. Even so, in order to reach the required velocity the three-stage rocket will project the satellite in an easterly direction so that the rotational surface speed of the earth will contribute to the final speed attained.

By contrast the much heavier Russian satellite (supposing it to be confirmed that it does weigh 184 lb) has been established in a more or less polar orbit (65 deg. to the equatorial plane), lacking much of that assistance. If reports about it are true, there is, in fact, much less that is marginal about the Russian achievement. There was more power to spare than the Americans are planning to provide.

To engineers, capable of appreciating the complexity of the technical problems that have been solved, all else pales into insignificance against the achievement of setting up the satellite at all. Further information about the satellite itself, reported to be 23in in diameter, and about the rocket, presumably three-stage, which established it in its orbit will be eagerly awaited. There are already reports that the burnt-out last stage rocket has been detected orbiting around the earth. The discarded nose cone of the rocket should also be orbiting about the earth. But for scientists there are elements of disappointment. The scientific equipment carried by the satellite is rudimentary. It consists apparently solely of two radio transmitters whose frequencies are 20 and 40 megacycles, as compared with the 108 megacycles which had been agreed upon by both Americans and Russians in connection with the International Geophysical Year. There are contradictory reports as to whether the satellite is capable of transmitting information about its own or the surrounding temperature or, indeed, any scientific information at all. Furthermore, the satellite has been established in its orbit so many months earlier than anyone in the West had expected that much equipment on the ground (for example, the Jodrell Bank station—to Professor Lovell's deep disappointment) is not ready to go into action. It is even suggested that the satellite has been established at too high a level in that resistance to its movement from a residual atmosphere at its height will be so slight that it may be many years before it descends to lower altitudes and provides in that way information about the distribution of atmospheric pressure around the earth. Alternative estimates that the useful life will not exceed a few weeks or days illustrate the lack of precise knowledge about atmospheric density at great heights and some present uncertainty about the mean height and eccentricity of the orbit. The present perihelion is stated to be in the Northern hemisphere. But this sense of disappointment is surely unjustified. If the Russians can establish a satellite weighing 184 lb in a polar orbit some 500 miles above the earth it is obviously practicable for them to establish a more fully instrumented satellite in any preferred orbit up to (and possibly beyond) that height. There is no doubt that the Russians plan to do so. It is to be hoped, however, that the world will be informed, next time, well beforehand so that scientific stations the world over will be prepared. This will be all the more necessary should the useful life of satellites established in orbits at 300 to 500 miles above the earth's surface prove to be short. As we go to press, there are already unconfirmed reports that the satellite is losing height. It is understandable that Russian scientists and engineers should have wished to be sure of the success of the first experiment before making an announcement about it. The rulers of the U.S.S.R. relish a spectacular failure even less than Western Governments ! But secrecy about a second firing would seriously diminish the scientific value of the experiment.

It has now been made obvious that Russian engineers are ahead of their American counterparts in the design of rockets. There is, indeed, menacing evidence in the setting up of the satellite

that the Russian claim to have developed a successful inter-continental ballistic missile is true. It may well be, indeed, that elements of international politics have entered into the timing of the firing of this first satellite rocket. The paucity of equipment within the satellite lends support to that idea. For surely if suitably designed instruments for making a variety of scientific measurements had been available the opportunity would have been taken to install them. There is then at least a suggestion that suitable instruments have not yet been fully developed in Russia. Alternatively, of course, the Russians may be planning to establish a number of satellites each instrumentally equipped to serve only one or no more than very few scientific purposes. It may be, however, that in the field of instrumentation the Americans are as well ahead of the Russians as the Russians seem to be ahead of the Americans in rocket technology. If so, how unfortunate it is that it is almost impossible to conceive of American instruments being installed in a Russian-fired satellite! For surely in advancing into outer space the nations should act in unity rather than in a spirit of hostile competition.

AGRICULTURAL (AND OTHER) MACHINERY EXHIBITIONS

The spectacular progress of mechanised farming in the post-war years has created a number of problems for that large section of the engineering industry represented by tractor and agricultural machinery manufacturers. One of these problems relates to exhibitions of farming machinery. It is a matter which causes considerable concern, for manufacturers are understandably anxious to have the best possible facilities for displaying and demonstrating their products to potential home and overseas purchasers. There are at present in this country two exhibitions annually, the greater portion of which is regularly taken up by tractors and agricultural machinery and equipment of all kinds. They are the Royal Show, in July, which is an itinerant event, and the Smithfield Show, in December, which is held at Earls Court, in London. Both these shows are now in their second century, both continue to fulfil a useful function, but both retain much of the atmosphere of those times when horses, cattle and other livestock had a far more prominent place in British farming than they do now relative to machinery.

Stock raising is still an important constituent of this country's agriculture. But it is not irrational to claim that, nowadays, next to the land itself, the farmer's machinery and implements are of the higher importance. Furthermore, agricultural machinery produced by British manufacturers in all its great diversity is one of this country's increasingly valuable exports. Prior to the war, not more than about £1,000,000 worth of agricultural machinery made in this country was sold overseas; now, the export value exceeds £66,000,000 a year. It is not surprising, therefore, that at the Royal Show and at the Smithfield Show the machinery stands normally occupy about two-thirds of the exhibition space. The manufacturers are concerned because they feel by no means confident that the various sites for the Royal Show and the customarily crowded conditions of the Smithfield Show really afford the best facilities for an effective and commercially useful display of such a large quantity of engineering products. Agricultural machinery makers have been talking about this matter for many months. Recently, the subject was given fresh impetus, for it was the principal theme of the discussions at the annual conference of the Agricultural Engineers Association. At that conference the need was stressed for the establishment of a permanent show ground in the vicinity of London, a ground which could be used also for exhibitions other than those of agricultural machinery. Among the reasons advanced in support of the proposal was the necessity to provide adequate accommodation and means of entertainment for overseas visitors.

The idea of a permanent exhibition site in this country is not a new one. Other sections of the engineering industry have also often thought about it. But the proposals for a European Common Market and for an eventual European Free Trade Area surely make it more important than ever that some new consideration should now be given to the matter. Engineers who visit exhibitions abroad are among those who realise that much might be gained if this country had a site and buildings which could conveniently accommodate displays of the heaviest machinery and plant. Perhaps the Agricultural Engineers Association has touched off again a suggestion that will readily command the support of other parts of the engineering industry. The question that inevitably arises first, of course, is "Where could a permanent exhibition site be established?" That question has been asked time and again for more than a century! We would not presume to postulate a final answer, confident though we are that this country could provide within its borders an eminently suitable "shop window" for its excellent engineering manufactures. Whatever faults it may have, London is still the greatest city in the world and it is the heart of the British Commonwealth. A well-planned and æsthetically pleasing exhibition site within it is not an impossibility. Would it *really* be disadvantageous if, say, the east side of Hyde Park was transformed to provide such a site?

The Engineer
100 Years Ago
(OCTOBER 9, 1857)

"HIGH OR LOW PRESSURE STEAM"

"A discussion recently took place at Peel's Arms Inn, Manchester, between Mr. Robert Davies, of Blackburn, and Mr. Edward Ingham, of Oldham, members of the Operative Engineers' Association of Lancashire, Yorkshire, and Cheshire, under whose auspices the meeting was called by printed circular. The room was crowded. The subject of discussion was 'Whether will 35 lb pressure per square inch or 1,000 lb pressure work the cheaper?' . . .

"Mr. Edward Ingham made a few preliminary observations as to how this discussion had originated, and what were its objects; and also as to what were the character and tendencies of the Engineers' Association generally. He then said that even his short experience with high pressure steam convinced him that there was no comparison, in point of economy, between high and low pressure steam. He then read a tabulated statement of the coals consumed at the firm he superintended for the last three or four years, from which it appears that, by raising their pressure only from 26 lb to 50 lb, whilst, in 1854, with 132 indicated horses' power, they consumed 1500 tons of coal; in 1856, with 200 indicated horses' power, they only consumed 1200 tons. . . .

"Mr. Davies said he was only a plain working man, searching after truth on this important subject, and if it could be satisfactorily shown to him that he was in error in the views he entertained, he should go back to Blackburn with feelings of pleasure. He was not alone in his views. In Mr. Longridge's reports he found that the most economical engines were not the compound, using high steam, but the single cylinder engines, using from 20 lb to 2 lb; and Mr. Fairbairn himself, the other day, stated that about 30 lb per square inch was the most economical pressure. Mr. Davies then traced the history of steam from the time of Hero of Alexandria, 130 years before the Christian Era, down to 1781 and 1804, when Hornblower and Woolf introduced the first compound or double cylinder engines; thence to 1811, when a number of the proprietors of Cornish engines established a system of inspection to report the duty of their engines. . . . A miscellaneous discussion then ensued."

TRAINING ENGINEERS FOR THE STEEL INDUSTRY

As initially conceived, courses at colleges of advanced technology for the new Diploma in Technology were to be of the same standard as those for a degree, but of differing content. Since then, however, there has been a tendency in some quarters to suggest that in practical fact the difference in content will turn out to be small. In our view it will be unfortunate if there is no significant difference, as in those circumstances either the Dip. Tech. will never acquire a prestige as high as that attached to a degree, or, if it does, there will be introduced an undesirable sense of competition between universities awarding the degree and advanced technological colleges awarding the Dip. Tech. A university degree should be distinctive. No other award should compete with it. Our fears upon this point have recently been somewhat relieved by the setting up at Loughborough College of a course which does turn out to be significantly different in content from those leading to degrees and for which, very fittingly in our view, recognition for the award of the Dip. Tech. is being sought. It is a sand-

Earth's First Artificial Satellite

The first artificial satellite to be launched from the Earth rose to its orbit on October 4, 1957. A sphere nearly 2ft in diameter and weighing just over 180 lb with its equipment on board, the satellite was carried by a rocket that is reported to have "flattened out" into the chosen orbit at a speed of almost 5 miles per second. The launching represents the most spectacular contribution yet made to the International Geophysical Year.

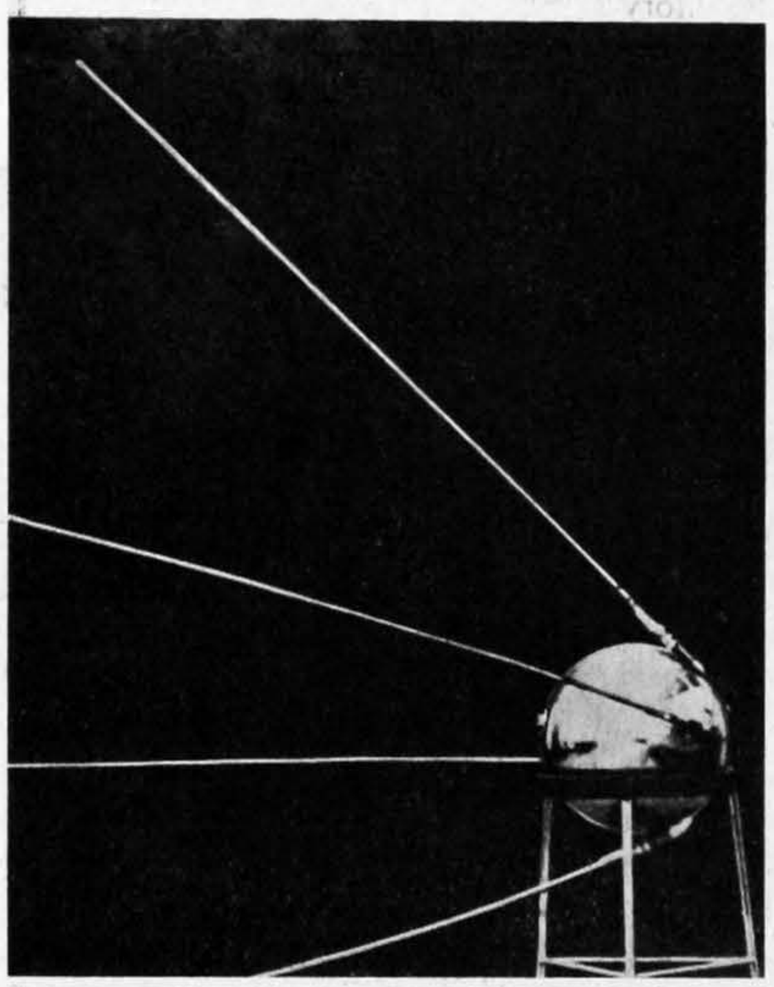
VERY little information on the Russian artificial satellite has so far been released and hardly anything is yet known of the rocket that lifted the device into its orbit on October 4. The satellite itself, dubbed "Sputnik," is reported to be a sphere 58cm in diameter. Made of aluminium alloy, the casing houses two radio transmitters and other equipment in an atmosphere of nitrogen gas, the whole assembly weighing 83·6 kg. Four metal antennæ are attached to the casing: 2·4m to 2·9m long, these rods folded back (as shown in our illustration) when the sphere was on its outward journey. Once established on its orbit, the satellite opened out these antennæ on their swivel joints. While their power supply lasts, the transmitters send continuously (at frequencies of 20·005 Mc/s and 40·002 Mc/s) signals lasting an average of 0·3 seconds; the signal on one frequency is emitted during the pause on the other frequency. The power is believed to be supplied by batteries, not from solar energy. Temperature within the casing is said to be controlled to some extent by forced circulation of the nitrogen, so regulating the thermal "resistance" between the casing and the equipment carried. Sharp variations in temperature tend to arise, of course, because of successive passages through sunlight and the Earth's shadow.

The satellite is visible from the earth's surface only when it is illuminated by the sun, while the earth's surface is in darkness. This is because, relative to the Earth's radius of 4000 miles, the satellite is not high up and visibility only persists for a short period just after sunset and before dawn. The situation is comparable with the observation of a high mountain, whose snows for a short while will be illuminated by the setting sun, when the low ground from which it is observed is already in darkness.

It has been stated in *Pravda* that the signals from the satellite were varied in frequency and timing by the instruments on board according to a predetermined code,* so that readings could be recorded at base for subsequent analysis. One type of instrument that may be carried—going by accounts of Russian exploratory work with high-altitude rockets—is a sensor using piezo-electric plates to detect the number and energy of incident particles. Data on damping may be obtained from measurement of signal level and angles of refraction, and information on the ionised layers in the upper atmosphere may also emerge.

On the actual launching process the same source has little to say. According to the account, the sphere was placed in the nose of a carrier rocket and shielded by a protective cone. Soon after firing, a programming device gradually shifted the course of ascent from the vertical. "At the end of the flight decided on," says the *Pravda* article, "the rocket had reached an altitude of several hundred kilometres and moved parallel to the Earth's surface with a speed of some 8000m per second. After the engines stopped the protective cone was jettisoned and the satellite detached itself from the rocket and began to move independently." Probably a three-stage rocket was used in much the same manner as the Americans plan to use one. The process of launching a satellite with such a rocket was fully described in our issue of August 17, 1956. Another *Pravda* report indicates that launch, guidance and control of the rocket were accurate within a few dozen metres per second of the calculated velocity, and within 1 deg. of the calculated direction of travel.

The orbit is an ellipse with one focus at the centre of the Earth. Dr. D. H. Sadler, of H.M. Nautical Almanac Office, is reported to have calculated the orbit last week from the rather sparse data that was at that time available to him, and the results were sufficiently accurate for optical study to be based on them by the Royal Observatory. Certain of the published Russian figures have been substantially confirmed by this work. According to the account in *Pravda*, on October 9, the plane of the orbit is inclined at an angle of 65 deg. to the equatorial plane, and the trajectory† passes over areas approximately between the north and south polar circles. The plane of the orbit remains unchanged in orientation relative to the fixed stars, and as the Earth rotates on its own axis, the satellite's crossing-over point shifts about 24 deg. along each line of longitude at each appearance over it.‡ The angle of the trajectory to the Equator is not the same as the angle of the orbital plane, since the former is affected by the Earth's rotation. When crossing the Equator to the Northern Hemisphere, the trajectory cuts at an angle of 71·5 deg. in a north-easterly direction, gradually turning east thereafter until it turns south at latitude 65 deg. N. and recrosses the Equator at an angle of 59 deg. in a south-easterly direction. The trajectory reaches latitude 65 deg. S. before veering north again.



This, the first official picture of the Russian artificial satellite, shows the device supported in a stand before attachment to the carrier rocket

The shape of the orbit is expected to change with time, and the satellite is already reported to be slowly descending. The apogee, initially at about 1000km in the Southern Hemisphere, is expected to fall more quickly than the perigee, and the orbit will thus approach more nearly to the form of a circle. More kinetic energy is gained in falling than is lost to atmospheric drag, so that the velocity gradually increases. The horizontal speed of about 29,000km per hour with which the satellite first settled into its orbit will therefore rise, the average radius of the orbit will decrease, and the time per circuit will decline from the initial value of ninety-six minutes. The way in which these changes will occur is one of the important results to emerge from observation of the satellite, as it will provide information about atmospheric densities at its level—it is because the properties of the extremely thin atmosphere at these high levels are unknown that the life of the device cannot be predicted accurately. In announcing the launch, the Russian news agency, *Tass* stated that calculations indicated that the vehicle would burn out when it reached the denser layers of the atmosphere at an altitude of "some dozens of kilometres."

Later (and larger) satellites, a number of which is promised for the International Geophysical Year, are to have a variety of instrumentation covering a wider field of physical measurements. Great attention will be paid (according to one Russian authority§) to recording solar and stellar spectra, &c., and measuring the Earth's magnetic field. Satellites at the present stage of development will not return to the Earth but engineers and scientists are said now to be hard at work on the problem of organising a safe journey home.

* Some authorities have disputed the existence of a code, however.

† That is, the path relative to the Earth's surface which, of course, is not stationary.

‡ This explains the apparent change in the height of the satellite at particular points of observation, since, as already mentioned, the orbit is an ellipse with the Earth's centre at one focus. Depending on the position of perigee, the height observed at stations in this country will be different according as to whether the satellite is northbound or southbound. If there is any precession of the orbit the observed height will be subject to another variation.

§ E. Fyodorov, corresponding member of the U.S.S.R. Academy f Sciences.

Festiniog Railway

A REPORT received from the Festiniog Railway Company states that at the close of the summer season the number of passenger journeys originating on the railway exceeded 54,000, an increase of more than 15,000 on the previous year, whilst traffic receipts at £3000 showed an increase of some 70 per cent. Further progress was made in clearing the line as far as Tan-y-Bwlch, and, although a test train has reached this point, much track renewal will be needed before a regular passenger service is introduced. It is hoped, however, with the approval of the inspecting officer of the Ministry of Transport, to run regular trains to Tan-y-Bwlch next year. For the first time since 1939 it is proposed to run a winter train service on Saturdays only between Penrhyndeudraeth and Portmadoc.

On the motive power side it is reported that the double engine "Taliesin" entered service and ran over 1000 miles during 1937, and the 0-4-0 saddle-tank engine "Prince" steamed over 4000 miles. The performance of "Prince," which is capable of hauling five bogie carriages, has been improved by the fitting of straight links to the valve gear. It is proposed to rebuild further locomotives as and when funds permit, and the company has acquired an 0-6-0 saddle-tank locomotive from the Harrogate gasworks, which is being modified to suit it to the 1ft $11\frac{5}{8}$in gauge of the Festiniog Railway. This locomotive will probably prove a valuable stopgap in view of the likely extension of the line to Tan-y-Bwlch, and until the second Fairlie "Merddin Emrys" is overhauled.

In connection with the signalling, two miniature electric staff instruments have been reconditioned and will be used next year on the Portmadoc–Boston Lodge–Minfford section. Permanent wiring circuits have been reconstructed as far as Penrhyndeudraeth and a temporary circuit will be installed from this station to Tan-y-Bwlch in 1958.

The society now has a membership of nearly 1000 and its annual general meeting will take place at Portmadoc on April 26, 1958. For this meeting a special train will be run from Paddington, calling at Birmingham, Wolverhampton and Shrewsbury, and it is hoped that members and their friends will have the opportunity of travelling on the Festiniog line as far as Tan-y-Bwlch by a train hauled by the double engine "Taliesin."

RADIOACTIVE COMPOUNDS FROM STOCK.—We learn that the following radioactive compounds are now available from stock at Tracerlab, Inc., Technical Division, 1601, Trapelo Road, Waltham 54, Massachusetts, U.S.A.: 2·4 dichlorophenoxy acetic acid, ring labelled, of specific activity 0·20 millicuries per millimole; 1-naphthalene acetic acid $\beta-C^{14}$, 1·25 mc/mM; 1-naphthalene acetamide $\beta-C^{14}$, 1·25 mc/mM: neopentyl glycol $-C^{14}$, 0·20 mc/mM.