THE RUSSIAN SPACE ROCKETS

This photograph is taken from "With Gagarin to the Stars," due to be released on September 3. Until we see the film it is difficult to interpret this illustration, but it appears to show the flames from a close group of engines, with small side flames due to turbopump exhausts or verniers

WHAT picture can we form of Russia's big space rockets? There are a number of leads to follow up, but none takes us to either detailed or definite conclusions. Not, at least, on the basis of publicly available knowledge. But in view of the immense hopes which have been aroused—the drastically foreshortened perspective of travel to the Moon and planets—there can be no question of the crucial interest of the subject.

The course which the Russian space programme has taken is clear. It forms a meaningful pattern, with strong indications of distinct stages of rocketry achievement. The Russians have given precise data about the weights of their payloads and the orbits achieved. This provides a basis for comparison with the capabilities of US rockets, and for analysis according to the theory of rocket propulsion.

Again, the aims of Russia's programme in the next few years are not in much doubt. To realize them will require major developments in rocket technology. If the Russians seem confident of success it should imply that they have these developments well in hand.

The best way to pick up the trail is by a review of the Russian programme already accomplished. At the time of writing, this comprises seventeen major events. These events fall into two main phases. Phase I began with the launching of Sputnik 1 on October 4, 1957, and ended with the success of the automatic interplanetary station Lunik 3 in October 1959. Phase II began with tests of a powerful new rocket for space purposes in January 1960, and led to the manned orbital flights of April 12 and August 6, 1961.

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These phases are primarily characterized by the nature of the mission. The missions are in turn related to the capabilities of the available rockets. There is much evidence that the two phases correspond to two basic launching vehicles.

Phase I. Sputnik 1 was launched about six weeks after the Soviet Union announced successful tests of an ICBM in August 1957. Few would doubt that the ICBM was the launcher. The importance of Sputnik 1 was that it provided initial data on satellite behaviour, and experience with telemetry and tracking. That it did not extend the capabilities of the rocket was evident a month later from Sputnik 2.

Sputnik 2, including in its 1,120lb payload the dog Laika, was a significant early pointer to the motives of the Russians. It proved the feasibility of spaceflight for a higher vertebrate—and so, by reasonable inference, for man. Clearly, the Russians planned for manned space travel before even the first Sputnik was launched, and with the information gained from Sputnik 2 they had no more, for the moment, to ask.

Sputnik 3, a satellite dedicated entirely to physical experiments, came 29 weeks later. At 2,900lb it was a surprising witness to the power of the Russian launching vehicle. Had a new launcher already become available? This was not easy to believe, but the question became acute with Lunik 1, 32 weeks later.

Lunik 1 forms a well-defined group with the two subsequent Luniks in 1959. Payloads accelerated to approximately escape velocity were successively 797lb, 858lb and 957lb; weights of the final stage of the carrier rocket with payload, but without propellants, were 3,245lb, 3,324lb and 3,416lb. Taking a closer look at the figures for Lunik 1, we have by deduction about 2,448lb for the rocket structure, which might contain anything up to nine or ten times its own weight of propellants. The total weight of this final stage with payload might therefore range up to 25,000lb. Dimensions of the exhibited replica of Lunik 2's undoubtedly similar final stage are consistent with this figure.

It is a reasonable inference from these figures that the launching vehicle could have placed into close orbit a payload of perhaps 9,000lb. Thus the Luniks testify to a more powerful launching vehicle even than Sputnik 3; yet it was available only 15 months after Sputnik 1 was launched. Was it essentially a new launching vehicle, or were we seeing simply the progressive exploitation of the original ICBM? On this problem fell a new light with the opening of Phase II a few months after Lunik 3.

Phase II. In January 1960 the Russians made two long-range firings into the Pacific. These were stated to be tests of "a powerful new multi-stage rocket for space activities." The following May this rocket was used to orbit the first Soviet spaceship-satellite, of some 10,000lb weight.

At first sight it may seem that this demonstrates only a relatively small advance on the implicit orbital-payload capabilities of the Lunik rocket. But the subsequent course of events, including the orbiting of Sputnik 7 at 14,295lb, provides good reason for accepting that this is a new and bigger rocket, constructed deliberately for space exploration, making its début with a payload which by no means represents its ultimate potential.

Five more launchings of the spaceship-satellite bring us in the short period of eleven months to the orbital flight of Major Yuri Gagarin. It is appropriate at this point to go back and consider the position that existed after the launching of Sputnik 2. The feasibility of manned spaceflight was broadly established. Plans and projects then already under way could be pressed forward. It was necessary not only to create a spaceship, but to have a suitable vehicle ready for it.

In fact, the launching vehicle and its spaceship payload were available at virtually the same time: early 1960, little more than two years after Sputnik 2 gave the green light. Following the first orbiting of the spaceship-satellite, two more experimental firings of the rocket were made (July 1960); then four further spaceship-satellite launches proved the system sufficiently for the manned orbital flight. Two characteristics stand out about this progress: it is very swift, and very economical in means. Both imply well-integrated design of rocket and spaceship on a basis of research and development initiated long in advance.

The least requirement of a launching vehicle specifically created for space exploration in conjunction with a spaceship-satellite would be to place the spaceship into close orbit. More ambitious experiments might well involve accelerating it to near-escape velocity. It seems, for example, that with little adaptation the spaceship might be suitable for a circumlunar mission. This implies a close-orbital payload capability exceeding the actual weight of the spaceship by a factor of perhaps about 4. In orbiting the 14,295lb-payload Sputnik 7 the rocket confirms part of this conjectured reserve of power. The balance of evidence is therefore strong that the rocket annnonced at the beginning of 1960 was a major advance.

In turn, it becomes unlikely that a basically new rocket was previously introduced. The point at which a new rocket might have been introduced is for Lunik 1, on January 2, 1959. But this is little more than a year before, and it is difficult to imagine that a new, bigger rocket would be introduced to be employed only three times and then superseded in a year. Equally, it is difficult to believe that a basically new rocket was introduced only 15 months after the original ICBM had launched Sputnik 1.

We are driven to conclude that the progressive increase in power revealed during Phase I was the development of the original launching vehicle based on an ICBM. It may have been that Russia had two ICBMs under parallel development, one more powerful than the other, comparable with the US Air Force Atlas and Titan. If this was the case, the projects matured much closer in time than the US projects, suggesting a closer technological relationship. This could mean much the same thing as extensive development of the original ICBM.

How big a rocket was this Phase I launching vehicle in its earlier applications?

The length of the carrier rockets which orbited with Sputniks 1 and 3, and the length of Sputnik 2 where the payload was united with the carrier rocket, were the subject of several optical estimates. These seem to range from about 60ft for Sputnik 1's rocket to 80ft for the Sputnik 2 combination. Some reports give Sputnik 3's rocket as about 70ft in length. On the whole this is a consistent picture for the final stage. We also know that Sputnik 3 was about 6ft across the base, and the Lunik final stage about 10ft in diameter.

First conclusions

The provisional conclusion is that, while the Russians may have varied the tankage of the final stages of Sputniks 1, 2 and 3 by varying the length and diameter within certain limits, it is in all cases big enough to suggest the second stage of a two-stage rocket. By appeal to US information, a two-stage rocket built to a scale rather larger than Titan 2 should account for payloads of the order of these three Sputniks. Conventional propellants are assumed, with specific impulse in the Lox/RP-1 class. At launch the rocket might weigh 250,000 to 300,000lb, and develop a thrust of 400,000 to 500,000lb. These figures may be criticized as larger than necessary, at least in respect of the upper limit. But we can be concerned only with orders of magnitude; and we must allow for the certainty that the Sputnik launchings were not marginal achievements, but were comfortably within the capabilities of the rocket.

We cannot rule out other possibilities. But if we accept a two-stage rocket for Sputniks 1, 2 and 3, we are left with the reasonable assumption that it was adapted for the Luniks chiefly by the addition of one more stage. By itself this third stage would not provide all the extra performance; it would be necessary to increase the first-stage thrust. What size and power would the Phase I launching vehicle represent in its final, most developed form?

This problem can be again approached with US information. The performance of the Phase I launching vehicle in its final form compares closely with the performance predicted for the Atlas-Centaur. Figures which have been given for Centaur are: close-orbit payload, 8,500lb; escape payload, 2,500lb (recently revised from 1,500lb). These are presumably theoretical limits, as against the practical figures established by the Luniks; but they suggest that the vehicles have similar capabilities. Maj-Gen Don R. Ostrander, addressing the American Rocket Society on May 10, 1960 (i.e., before Sputnik 4, the first spaceship-satellite), said: "In Centaur, the US has a launch vehicle able to duplicate the payload capability of the Sputnik vehicles" ["has" or "will have"?—Ed].