FTD-HC-23-542-70

AD724978

FOREIGN TECHNOLOGY DIVISION

ACADEMICIAN S. P. KOROLEV, BIOGRAPHY

by

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180

UNCLASSIFIED

Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author) Foreign Technology Division Air Force Systems Command U. S. Air Force	2a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED 2b. GROUP

3. REPORT TITLE

ACADEMICIAN S. P. KOROLEV, BIOGRAPHY

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)
Translation

5. AUTHOR(S) (First name, middle initial, last name)

Astashenkov, P. T.

6. REPORT DATE 1969	7a. TOTAL NO. OF PAGES 270	7b. NO. OF REFS 25
8a. CONTRACT OR GRANT NO. F33657-71-D-0057 b. PROJECT NO. 6010507 c. d. DIA Task No. T65-01-21A	9a. ORIGINATOR'S REPORT NUMBER(S) FTD-HC-23-542-70 9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)	

10. DISTRIBUTION STATEMENT

Distribution of this document is unlimited. It may be released to the Clearinghouse, Department of Commerce, for sale to the general public.

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY Foreign Technology Division Wright-Patterson AFB, Ohio

13. ABSTRACT

To tell about the life and activity of Sergey Pavlovich Korolev is not a simple matter. For his entire life is an uninterrupted creativity, a scientific search for ideas and solutions, and labor on projects in new engineering forms, in whose development large numbers took part. A book about Korolev has to show how strong and significant he was as a designer, innovator, organizer of science, an all-around statesman, to show the qualities happily united in Sergey Pavlovich, and their formation and development. Such traits in the character of Sergey Pavlovich as resolute will, bold thinking, faith in his own ideas, and extraordinary energy are especially noteworthy. These qualities of his were particularly indispensible for solving the complex engineering and scientific tasks in space rocket disciplines.

DD FORM 1 NOV 68 1473

UNCLASSIFIED

Security Classification

14 KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Biology Academician S. P. Korolev						

EDITED TRANSLATION

ACADEMICIAN S. P. KOROLEV, BIOGRAPHY

By: P. T. Astashenkov

English pages: 270

Source: Akademik S. P. Korolev 1969, pp. 1-208

Translated under: F33657-71-D-0057

PREPARED BY:

TRANSLATION DIVISION
FOREIGN TECHNOLOGY DIVISION
WP-AFB, OHIO.

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FRONTISPIECE

From the edge of the universe, which the sacred earth of our Motherland has become, over and over the Soviet spacecraft will take off even to unknown distances, lifted by the powerful launching rockets. And each of their flights and returns will be a great occasion for the Soviet people, for all progressive-minded mankind — a victory of reason and progress!

S. Korolev

FOREWORD

To tell about the life and activity of Sergey Pavlovich Korolev is not a simple matter. For his entire life is an uninterrupted creativity, a scientific search for ideas and solutions, and labor on projects in new engineering forms, in whose development large numbers took part. A book about Korolev has to show how strong and significant he was as a designer, innovator, organizer of science, an all-around statesman, to show the qualities happily united in Sergey Pavlovich, and their formation and development.

Such traits in the character of Sergey Pavlovich as resolute will, bold thinking, faith in his own ideas, and extraordinary energy are especially noteworthy. These qualities of his were particularly indispensible for solving the complex engineering and scientific tasks in space rocket disciplines.

It has become a widely accepted opinion that nowadays discoveries, as a rule, are made with large groups of specialists. However, the mutual dependence of creators of a new venture does not at all sink to the mean of their creative individualities, nor fetter their initiatives. On the contrary, it displays fully the talent of each one of them. This applies particularly to persons heading up large scientific groups, and to initiators of new trends in science. They have to combine scientific foresight and sober evaluation of the feasibility of proposed projects, the determination to struggle to the finish with new ideas, and the intellect to organize the

efforts of creative and productive groups, not infrequently on a nation-wide scale. Sergey Pavlovich Korolev brilliantly displayed all these qualities during the years of the assault on space.

Korolev dedicated all his strength to the development of rocket technology and the realization of Tsiolkovskiy's dream of space flights. Splendid engineering training and design experience helped the remarkable talent of Korolev to be displayed quickly in these new areas of science and engineering. The realism of Sergey Pavlovich was especially noteworthy in approaching the problems of creating rockets. On the whole, this greatly assisted in working out correct approaches to these problems of our national science.

He entered the history of mankind in gold lettering, October, 1957. The first artificial satellite of the Earth was carried into orbit then, using the space-rocket system created under the direction of S. P. Korolev. Like a bolt of lightning, he illuminated our progress clearly, and graphically demonstrated the strength of human reason. Even our antagonists abroad could not hide their amazement at the great exploit of the Soviet people, opening up the space age in the history of mankind.

After the impetus of the first satellites came test flights of spacecraft, and, as a consequence, automated interplanetary stations. The first Soviet marker was placed on the Moon, having made a circumnavigation and photography of the back side of the Moon, and having accomplished a soft landing on the Moon. These flights were fulfilled using a system constructed through the direct participation of S. P. Korolev.

Under the guidance of S. P. Korolev, piloted vehicles were created and devices were worked out for flight of a man in space, returning him to Earth, and for leaving the craft in free space. It can be said that he truly sensed the scope of space engineering developments, and that no small recognition should be accorded S. P. Korolev for the fact that Soviet science gained priority in mastering outer space.

Sergey Pavlovich possessed gigantic energy, an extraordinary boldness for solving complex problems, a sharp engineering intuition, and scientific insight. He understood well that the basic role in scientific forecasting belongs to entire bodies of specialists, and in his quests he was always supported by these specialists. Without fail, he strived to have every urgent matter in rocket technology and space travel development discussed with the specialists.

Space travel is a new area of human activity. The Soviet people touched off the dawn of the space age, and persons would like to find out, as much as possible, more about the pioneers of the national rocket program.

How were the traits in Korolev's character which made him an eminent designer hammered out on the forge of life? Cosmonauts who got to know Korolev in his later years were quite interested in this. He frequently talked with them about future space trips and about his plans. But it was almost impossible to get him to talk about himself. As much as he could, he would receive everyone, especially the young. Sergey Pavlovich displayed valuable traits already in his youth — resolve, clearness of purpose, love of work, and independence. From childhood he was attracted to a winged dream — to fly, and he was successful at it. This all greatly helped him achieve prominent results in science and technology.

On becoming acquainted with the biography of S. P. Korolev, you will begin to comprehend where he got such a deep understanding of the "people of the great flight", and his warmth and closeness for cosmonauts. He always knew how to encourage, to give needed advice, and was able to work things out under new circumstances. He was a scientist and designer of the new Soviet order, a fervid and active patriot of our Motherland.

A fatherly concern about youth was indeed characteristic for Sergey Pavlovich. He fostered a whole galaxy of specialists in rocketry and space travel.

IN THE RISING STREAM

> Development and education can't be given or transmitted even to a single person. Each one who wishes to gain them must achieve them by his own activity, his own efforts, his own direction.
>
> A. Disterveg

Years of Childhood and Youth

On the former Dmitriyev Street in Zhitomir, there stands a single-story house with large windows, surrounded with birch trees. Nowadays this house and street are well-known to every inhabitant of the city: on December 30, 1906 (old-style), there was born here in the family of the literature teacher, Pavel Yakovlevich Korolev, of the local gymnasium, a son Sergey — who later became the rocket and spacecraft designer.

Information about the father of the future scientist is extremely scant. It is known that Pavel Yakovlevich graduated from the humanities division of the Nezhin College of Letters and Languages

in 1905. This college was in turn formed from a lyceum founded in 1820. N. V. Gogol studied here from 1821 to 1828.

P. Ya. Korolev attended the college as a government scholarship student. He took a science curriculum, and got lodging, board, and uniforms. On completing college he was obligated to serve in the Ministry of National Education, where they would withhold from him all the expenses of his education. Thus, P. Ya. Korolev became a literature teacher in the Men's Gymnasium in Zhitomir.

The year he finished college, Pavel Yakovlevich married Maria Nikolayevna Moskalenko, who came from a very old family of Nezhin Cossacks. Their life together did not go well, nor did the birth of a son strengthen the family. Little Sergey was two years old when his parents separated. The child remained with the mother. Actually, he did not remember his father, and never saw him later.

The mother took the boy to his grandfather and grandmother in Nezhin. There Sergey spent his childhood years. Maria Nikolayevna herself left for Kiev, where she entered a woman's college, in preparation to teach French.

Maria Nikolayevna often visited her son in Nezhin. Meeting days with his mother were holidays for little Sergey. After one was over, he would miss her, and begged her in the spontaneous letters of his childhood to write more often. "When I don't get a letter for ten days, I become anxious and upset", he remarked in a letter, December 3, 1915.

Afterwards, as Korolev's relative A. N. Lazarenko remembers, Serge Pablovich would say, "I did not have any childhood". Obviously, one must note this: all the years spent in Nezhin — almost till eight years old — he was among adults, and was deprived of play and amusements with those his own age.

His first teacher, L. M. Grinfeld, reminisces: "Little Sergey lived in adult surroundings. He didn't have any child acquaintances

his own age, and never knew child's games with little friends. He was often completely alone at home, and when I arrived from the gymnasium he would cry: 'Is that you, Lidia Mavrikievna? I'm glad that you've come...'."

"They didn't allow him to run in the street. The gate was always bolted. He would sit a long while on the upper celler door and watch what was happening in the street..."

"In his room there was a whole mountain of blocks and little sticks. For hours he would build houses, bridges, and towers."

"While Sergey was seven years old, Maria Nikolayevna asked me to take care of him. He accepted instruction avidly.. He was attentive, industrious, and capable. He especially loved arithmetic, and could already count to a million. He quickly mastered the four rules, and the multiplication tables, first in rows of one hundred, and then in thousands."

"We also studied the Russian language. He soon mastered writing, already read rather skillfully, and wrote short dictations spoken to him. He really loved reading, and would avidly recall what he read. I remember that he liked the fables, 'Cuckoo and the rooster', and 'Fox and the black horse'. He would recite them vigorously. After reading them the first time he wrote me questions: 'What does gossip mean?', 'What is a prophetess?', etc."

A childhood spent among adults, and familiarity with solitude brought about some of his reserve and, to a significant degree, his early self-reliance. He taught himself to write printed letters, and was attracted to reading books.

The adult influence can also explain the broad interests which would be a characteristic of Korolev. He liked music, and knew literature and history well. In the Moskalenko home, there were many educated and talented people. They frequently made music, while the grandmother herself played the violin splendidly.

According to the statements of A. N. Lazarenko, grandmother Maria Amtveyevna was an above-average person. Of course she studied several years at a private boarding school, but was progressive for women of her time, and traveled much about Russia. In contrast to her phlegmatic husband, Nikolay Yakovlevich, she displayed remarkable determination and energy. She kept house herself and worked at educating the children. Thanks to her perseverance, they all received higher education, although at that time it was not easy.

People who knew the Moskalenko family closely affirm that Sergey inherited many qualities from his grandmother. Doubtless, the energetic grandmother, who had seen much and knew how to tell about it clearly, strongly influenced the small Sergey.

Uncle Vasilii Nikolayevich Moskalenko — at that time a student at the Nezhin College of Letters and Languages — was particularly close to little Sergey. According to the recollections of A. N. Moskalenko, Uncle Vasya was genial and cheerful. He spent his free time with Sergey, told him many stories, wheeled him on the bicycle, played croquet with him, and sat him down alongside while he developed and printed photos. On one photo from 1911, the five-year old Sergey printed: "To dear Uncle Vasya from Sergey, 1912". This was an obvious expression of the child's affection.

However, absolutely, the mother with an energetic and richly clever nature had the most influence on little Sergey. His childhood letters, held now in the Archives of the USSR Academy of Science, breathed love for her, the hope of being together always. He wrote Mama about all his latest happenings. On January 6, 1916, Sergey wrote Maria Nikolayevna: "I have been a little ill. But now I'm getting ready for the Gymnasium, and will start studies just the day after tomorrow... I got some New Year's gifts: pictures to glue, an elephant, and 30 foreign marks."

In 1916, Maria Nikolayevna married a second time. Sergey's stepfather was Grigoriy Mikhaylovich Valanin, a mechanical engineer by profession. Maria Nikolayevna remained a short time at home with her son: she was getting ready for the exam for a teaching position. On

April 26, 1916, Sergey begged the stepfather in a letter: "Write more often, because Mama misses you so much. Only, please, if Mama doesn't pass the exams, don't get angry. I will soon be in the first form, and will be a top student for you.: In another letter of the same period he notes that it was very difficult for him to "learn according to the rules of both God and arithmetic."

That same year the family settled in Odessa, where Valanin got an engineering position in the administration of the Southwestern Railroad. Later, he went into the service of the power station chief in the sea port.

Sergey received his primary education in Nezhin. In Odessa, he ventured enrolling in the first form in the gymnasium. He passed the exams and began studies. His father, P. Ya. Korolev, sent a certificate from Kiev, exempting Sergey from payment for education in the gymnasium. It stated in it: "I certify hereby, and also for properness affix the official seal of the gymnasium, that Pavel Yakovlevich Korolev currently holds a state teaching position in the Women's Gymnasium of the First Teaching District in the city of Kiev... This certification is given for presentation in the Pedagogic Union of the Third Odessa Gymnasium for the purpose of exempting the son of P. Ya. Korolev by his first marriage, Sergey Korolev, a first rank student in the aforesaid gymnasium, from payment for the right of study."

However, the studies were not long. The gymnasium closed. He succeeded in continuing work in the senior class of the primary school.

The childhood and youth of Sergey coincided with the revolutionary and civil war years. The revolutionary events were the flames in which the souls of youth were tempered. Sergey got acquainted with the revolution as a lad of ten, and the final liberation of Odessa from the White Guards and interventionists occurred when he was just 13. These two years were quite significant for Sergey. He evaluated and understood much with his young mind. The revolution wiped out everything that prevented an industrious person from developing his

own strengths and capabilities. It opened ample elbow-room for dreams and great things.

It was 1921. Not far from the house where the Valanin family had settled, a hydro-aviation detachment was situated. Sergey would watch with interest how the hydroplanes took off from the water, raising clouds of spray, and how they, even though big and clumsy appearing, gained altitude and went into flight...

Soon Sergey became a good acquaintance with the hydroplane base fliers. Sometimes they took him flying when he went there. After such flights he would say more than once at home: "I will build planes and fly in them."

Little by little Sergey joined in with the aviator's life. They even entrusted him with some small jobs. He assisted the base mechanics. But to prepare the planes for flight, one had to know a lot, and he didn't have the knowledge. So Sergey got and read books that told about why airplanes fly and how they are built. If he didn't find the answer in a book, then he turned to the aviators with his questions. The more he found out about aviation, the more sharply he felt a longing to construct some kind of flying equipment with his own hands. Before long, he undertook a decision — to build a glider — and worked stubbornly on his project. This was the first manifestation of his designing streak.

By June, 1923, this inclination drew him into the district division of the gliding society OAVUK (Aviation and Air-Glider Society of the Ukraine and Crimea).

It is interesting to note that the stepfather of Sergey was also a member of the OAVUK cell. In the group membership rolls No. 85 in the archived documents it is noted: "Valanin, Grigory Mikhailovich, born 1881, nonparty man, engineer, livelihood — port power plant."

His mother didn't guess right away how seriously Sergey was studying gliding. She understood that only after several conversations.

"Today I'll be late. I"m going to give a paper", Sergey warned his mother one day.

"What kind of paper?" wondered Maria Nikolayevna.

"On sail-planing."

His mother had even more cause for amazement. One day she went with Sergey to the city and was looking at the silvery cloud drifting in the sky over the port.

"Isn't that beautiful, really?" she indicated with a glance at her son.

"Up over it is even better!" Sergey answered with rapture.

"And you really know it up there?" Her mother's heart was in anxiety; he was beginning to fly. In vain, everyone repeated to her: "It's good to be a flier!"

The attraction to sail-planing didn't prevent Sergey from thinking about his further education. That same year, 1923, he entered the Odessa Building Trades School No. 1. It was situated in house No. 18 on Staroportofrankovski (now Komsomolskiy) Street. Now the city freezer is in that building.

The school had an architectural-construction and a sanitational-construction division. It turned out masons, plasterers, carpenters, tile setters, and pipe layers. Sergey selected the specialty of tile setting. The school curriculum was rather broad, and its graduates were then successfully taking examinations for institutions of higher learning. We have here a recollection of a fellow student of Sergey — Lidia Aleksandrovna Aleksandrova:

"Sergey Korolev... In my memory there stands out an energetic, brown-eyed youth, a trade-schooler, about twenty... "

"Our youth was like the rest of the youth of the Soviet nation, rising from destruction. It was a difficult time. In the summer of 1920, drought prevailed over the south of the Ukraine, and a cholera epidemic was raging. We were then about 16 to 18, and the world was splendid: we saw a great future ahead! And few of us were concerned that we were poorly dressed and shod — in our parents' old clothes and with wooden shoes on our feet. Not even the constant feeling of cold spoiled our spirits. For the most important thing for the majority of us was that we studied, and we studied hard, avidly, passionately, each with the desire to do his own work the best, the most completely, the most splendidly possible..."

The Odessa Building Trades School No. 1 during that year was a distinctive educational institute. It was situated in the former Second Mariinski Gymnasium.

It was a fine building, with desks, blackboards, and tables. But at first there was no fuel for the stoves, no electric light, nor any student handbooks, notebooks, paper, pencils... There weren't any laboratories, and of course, any workshops.

It is difficult to say how the popularity of the school among the 15 to 17 year-old youths was explained; there were more than enough children wanting to study in it. And it was just here that Sergey Korolev, who lived rather far away from the school in the port, came to study.

"School was wonderful!" you will invariably hear from those of the school graduates you might chance upon now. In the school there was a friendly group of teachers. With the large burden of work in the classical gymnasiums off their shoulders, they were seeking new paths in teaching, new forms of communicating with the students. One of such enthusiasts and innovators was the assistant headmaster, A. G. Aleksandrov, who taught physics, several sections of mathematics, and strength of materials.

Professor V. P. Tverdiy has worked in the Odessa Hydrometeorological Institute up to the present. Even today, at the age of almost 80, he leads the Institute symphonic orchestra, in addition to teaching a physics course. In the school he taught physics and supervised the laboratory work, which was skillfully set up with materials on hand, without any equipment.

Not long ago in 1966, the students of F. A. Temtsunik greeted their former mathematics instructor warmly at a meeting of the old Trade Schoolers. The construction teacher, engineer Todorov, innoculated them with a lively interest in construction work.

The old Odessa artist Stilianudi taught drawing and inking. The youths gave their utmost to make a drawing or design the best possible.

V. I. Sedenko taught natural science and chemistry. And what heated discussions rang out over the Russian Literature lessons with Lecturer B. V. Lupanov! What speeches, full of emotion, resounded through the class!

The school party paper printed verses on the burning issues of the day. Plays of A. N. Ostrovskiy were set on a small stage lit with a 25-wick kerosene lamp. The drama classes were invited to other schools in the city with their stage presentations. The Russian language teacher Pavel Sergeyevich Zlatoustov was the unflagging leader and enthusiast of theatrical extra-curricular activities.

After lessons, everyone took part in various clubs. Sergey Korolev was a member of three groups: mathematics, astronomy, and physical culture.

In February, 1923, an important happening occurred in the school. The opening of the workshops was set aside as a great holiday.

A. N. Aleksandrov had succeeded in getting somewhere a set of wood-cutting benches, a few joiner's benches, a band-saw, and some

kind of carpenter's instruments. One couldn't hold down the pride of the youths as they began to get familiar with the carpenters' and joiners' trades.

"During this period", L. A. Aleksandrova went on recounting, "Sergey Korolev was always alongside our old craftsman Vavizel."

"One other recollection of mine about Sergey in the years 1923-1924: this figure of a stocky guy, charging the length of the school corridor at recess, on his hands, feet up. He practiced this with surprising stubbornness, and before long he could go on his hands the whole corridor, a distance of a few tens of meters. He fashioned some wooden grips for his hands as a convenience. Then, shifting his center of gravity from one hand to the other in order, he could travel along the school corridor to the amazement of all his comrades and teachers."

"More than once I reprimanded him for overdoing such an unnatural method of locomotion, so that when he got on his feet, his face, which was already ruddy, and everything, his neck, and ears, were all blood-red. I reminded him that he might 'drown himself', that is, die from blood congestion in his head. But Sergey smiled and went his own way. Imitators who tried to outdo him in this circus act quickly found out their own incompetence."

"Sergey studied well. But no one ever would have known that this quite reserved, sympathetic youth would, so to say, grab the stars out of the sky. Besides, we had kids with more apparent capabilities. But sometimes, there would occur an extraordinary happening in the class, in the event of some subject of physics or mathematics not covered in the courses. Suddenly it seemed that Korolev alone would know it and could answer correctly on this ill-starred matter."

"One such instance occurred in Aleksandrov's class, which I even put to verse. After a whole string of nonsense paraded out by a good half of the class registered for the course, Korolev went up to the board and made an excellent outline of the working principles of

the telephone, sketching them out elegantly on the blackboard."

"In the school verses of the time, which were composed at graduation, mainly about the lessons on one's favorite subject, Sergey is remembered generally as an athlete and as the ardent admirer of our co-student Ksana Vintsentina — later (after 10 years) his wife. He was surprisingly persistent in this relationship in spite of his modesty."

"Our group finished school in the summer of 1924. We were supposed to go into the building trades. However, there wasn't any building going on anywhere in the city, and the school directorate made a decision to renovate the school building thoroughly with the student force. A few experienced craftsmen were invited as instructors: plasterers, painters, roofers, and metal workers."

"One group of kids from our class were assigned to repair a wing of the Odessa Medical Institute. The group was composed of volunteer beginners, and Sergey Korolev went into it."

Sergey later wrote on a questionnaire, that in 1924 "I completed the No. 1 Building Trade School in Odessa. Obtained experience in building and repair work as an assistant tile-setter"....

On August 8 that year he got his graduation document: "Certificate No. 975. This certifies that Korolev, S., has completed studies in the Trade School during the school year 1923-1924, and is credited in the following subjects: political fundamentals, Russian, mathematics, higher mathematics, physics, hygiene, cultural history, Ukrainian, German, drawing, and craftsman work."

Now he had to decide where to study further.

The attraction of gliding affected the selection of a path ahead. The initiative, energy, and self-reliance won great respect for the youth not only in the gliding group around the port, but also in the regional aviation transportation section. This is what a credential issued to him said then:

"This is to certify that Comrade Korolev, Sergey Pavlovich, has taken active participation in all efforts of the Regional OAVUK Gliding Club since June, 1923."

"Recently Comrade Korolev became a member of the Regional Transportation Section, directing the port gliding club administration."

"The Regional Transportation Section recommends Comrade Korolev as an energetic, capable, and fine worker, with the power to derive great benefit both in the organization and in the leadership of the gliding club."

Young Korolev himself wrote how he became a specialist: "I got all the indispensable knowledge in the areas of higher mathematics and aerial navigation independently, using only instruction from the literature..."

During 1923-1924, Sergey acted in the roles of club leader, also teacher, and even inspector. On May 27, 1924, he made an accounting of the gliding club directorship in the sea port, on instructions from the Regional Transportation Section. A short excerpt of his report is preserved:

"Club organizer Comrade Korolev is informing the Regional Transportation Section on the number and quality of the club membership, and indicates the low level of aviation knowledge and the strong efforts of its members towards working. The club proposes to build a glider of its own design. Lecturers for theoretical details are necessary."

In June, 1924, the Regional Transportation Section entrusted Sergey Korolev with inspection and leadership duties "in the Vadin, Chizhikov, and Odvoyen Sea Base glider club facilities."

Soon after this, the expanded Presidium of the Black Sea Aviation Group noted successes in "theoretical work of the group, part of which has fully completed their aviation course".

S. Korolev was also among those giving lectures. A directorate letter of one of the clubs of the Odessa Regional Air Transport Section OAVUK Chairman is excerpted: "I genuinely beg you to remunerate the lecturing work of Comrade Korolev, who gave lectures twice a week during the period 6/12 to 7/15 this year in the groups under my charge. A total of 8 (eight) lectures."

Thus, studies in the Building Trades School came to an end, but the efforts in the Air Transport Section continued on. In the minutes of the Black Sea Aviation Group taken August, 1924, there is noted: "Korolev, 19 years old, post of service — worker, modelling and glider section, Port Administration, and instructor, Port Administration."

It was natural that the N. Ye. Zhukovskiy Air Force Academy became the first educational institution to pay attention to gliding instruction. He sent an application to Moscow for entrance to the Academy. But it turned out that he wasn't old enough to enroll in a military educational institution. All the same, as an exception, the command decided to admit him as an auditor. However, the notification of this arrived too late: Sergey had already decided to acquire an aviation degree in the Kiev Polytechnic College. He went to Kiev in August, 1924.

Korolev found out, just on arrival there, that the gliders of the Polytechnic College were planning to go to the Crimea for an all-Union assembly. Sergey wanted to go with them very much, but in Kiev, no one knew him as a glider. Korolev hurriedly wrote B. V. Fayershteyn in Odessa:

8/20/24, Kiev

Highly esteemed Boris Vladimirovich!

Reminding you of your words at my departure, I am turning to you with a request: arrange a trip for me to the meeting in Feodosia. A large group from Kiev is going, and as a new person, I can't insist on a trip

from Kiev. Thus, I risk not getting to see a meet this year, which I wish very much to attend, and I could work with great success in the areas of aviation and gliding. I hope that the Odessa Regional Section of the OAVUK will consider the possibility and send me to the meet, remembering my previous efforts in the leadership of the gliding clubs. In addition, this mission would allow me to establish my personal role, and would also increase the influence of the whole Odessa Section in Kiev.

I am adding a stamp with the hope of getting a speedy reply at the address: Kiev, Kostelnaya 6-6 Moskalenko for S. P. Korolev.

In the meanwhile, I am winding up my affairs by August 27/28, and then I could leave to be in Feodosia on the 30th. If the matter is approved, then write me, please, the details of my trip — where and how to arrange this.

Yours truly, S. Korolev

But the trip to the meet which Sergey was asking for did not come about this time. Fayershteyn's decision about this is told in a letter: "We are sorry, Comrade Korolev, that the conditions for the gliders selected for the meet are already set by the OAVUK administration. Part are already gone, and the second part will leave 8/30. The VSS (Air Transportation Section) did not allot more funds, and there are no (more) places for Odessa. Fayershteyn."(1)

The unsuccessful attempt to go to the meet vexed Sergey for a certainty, but he wasn't deterred from gliding.

Footnote (1) appears on page 52

In the meanwhile, he began studies in the Institute. Since he was already acquainted with higher mathematics and mechanics, Sergey Korolev did well without any particular strain. From the beginning of activities, the problem arose for him: how to make a living? He could look for occasional student jobs or ask his uncle for a steady allowance. Young Korolev decided to make a living independently. He was a stevedore, put on roofs, sold newspapers. He wrote his mother in one of the letters of those years:

"I get up early in the morning, at five o'clock. I run to the printers, get the newspapers, and then I rush to Solomenkiy, and peddle them. So that's how I earn eight silver rubles. And I am even thinking of taking a corner."

Where didn't his search for jobs take the student Korolev! He even had to get familiar with cinematography. He was an extra in the filming of a few motion pictures on the Civil War.

Nineteen twenty-five arrived. No matter how studies or working strained him, Sergey did not let up his activities in the aero-clubs, taking part in gliding meetings with enthusiasm.

Unfortunately, Sergey did not succeed in constructing his own glider, which he called K-5. In the club of the Polytechnic College in Kiev, as before in Odessa, his project got approval, but he built instead gliders of other designers — A. B. Yumashev and V. K. Gribovskiy. This effort provided him with much useful information. As a matter of fact, there was a solid scientific background in the Polytechnic College Club. In the aviation technology society, there were several scientific research schools of thought present: flying, construction, gliding, and aviation engines. There was even an office of scientific information, an aero-cabinet, and an aero-library.

"In the summer of 1925," recollects S. Karatsuba, "Comrade S. Korolev from the college — Sergey — worked in the brigade building a student glider. He got this brigade together himself; here was the chance to get flying more quickly. No record-breaking glider of the

flying trials in Kiev came to pass, but a student glider did. However, while he was working on the student glider, he learned the design of all the racing gliders, especially during their final assembling and trimming."

"The tempo of our efforts was pushed. By September 10, all the gliders had to reach the Crimea for the III All-Union Gliding Meet. Frequently, we had to spend the night in the shops, on the sawdust."

"What was Sergey like in my recollections? Very devoted to work. The sleeves of his shirt were rolled up business-like above the elbow. Yes, he really remained in my mind that way — ready to take out after some difficult detail. He was one of those you didn't have to explain or remind of anything all the way. He just had to know what to do and how to do it — and it was already his worry. And he never got angry about anything. I don't remember an instance when anyone had to redo something after him."

"The gliders who prepared for the 1925 meetings in the Kiev Polytechnic College were among the best in the country."

Moscow — Koktebel'

The gliding activities were even more interesting in Moscow, where Sergey transferred in 1926. To be a third-form student, he shifted from the Kiev Polytechnic College into the Moscow Higher Engineering School (MVTU) to specialize in aeromechanics. The training of aviation engineers was cut out in Kiev.

The MVTU fitted Korolev's spirit. Here the great N.Ye.Zhukovskiy was conducting for the first time a course on aviation disciplines. Here the disciples of N.Ye.Zhukovskiy, the noted scientists S.A. Chaplygin, V.P. Vetchikin, V.V. Golubev, and A.N. Tupolev, worked with the students.

The theoretical instruction of the students in the MVTU was still very closely tied in with practical activities during the time of

N.Ye.Zhukovskiy. And when Sergey appeared within the walls of the MVTU, he was attracted right away to work on designing flying equipment and flying in gliders. His activeness, energy, and strong motivation qualities quickly separated Korolev from his comrades. He became the deputy chief of the gliding school, while he himself was studying to fly gliders in this school.

The student flights were carried out in the Lenin Hills region. There a light hangar was built to store gliders at the start of winter, 1926, and the gliders "Pegasus", donated by German sail-planers, "Mastyazhart" (an acronym of the Heavy Artillery Works), a design of S. N. Lyushin and I. P. Tolstiye, and "Zakavkazets" (The Transcaucasian, a design of A. V. Chesalov) were transported there.

Every Sunday morning the Lenin Hills became a noisy place — the gliding school candidates arrived there by train. Sergey Korolev was invariably among them. They quickly opened up the shed, which they called a hangar like good aviators, and put together the dismantled gliders, since they couldn't fit three gliders in it at one time.

Sergey Korolev and a group of his comrades, working with "Pegasus", would go off to a flat place. At first they made runs trying out the aileron controls. Then a trainee would sit down in the glider, which they gave speed necessary for a slight take-off. That way they got familiar with the elevators. Then, they drew it up the slope of a hill, right up to the summit. In a flight from there, enough height was provided for studying various maneuvers.

From 1925 on, they began to use elastic shock-absorbers for launching the gliders from a height. In addition, they also got more space.

What was involved in launching a glider with a shock-absorber? A ring was fastened to a hook on the glider nose. It, in turn, was connected with the two ends of a shock-absorbing rope (or shock-line), 20 millimeters in diameter and 50-70 meters long. The starting crew held the glider on a tether, with part of the people drawing on the

ends of the shock-line. Four or five people pulled on each end of the shock-line, sometimes even more. On the starter's command, they began to draw the shock-line, gradually separating to the sides, just like a child's slingshot, where the glider was the stone, and the crew took the place of the wooden piece. When the shock-line was tight enough to make the people march in place, the command was given — "Run!", and to the one holding the glider on the tether — the command, "Let go!". The glider moved off from the spot, and flew several tens of meters. The shock-line ring, when the tension fell off, dropped off the hook and fell to the ground. The glider, having been given a low velocity, made a free flight.

They carried out flights in the Lenin Hills from the gliding school winter and summer, right up to the start of the IVth All-Union Gliding Meet in Koktebel, Koktebel, located 18 kilometers from Feodosia, represented the most favorable place for glider flights.

Sergey Korolev arrived for the first time in Koktebel in the fall of 1927. There he got acquainted with Sergey Lyushin, with whom he later built his first glider. From that time on they were linked by a long and firm friendship. Beginning with gliding, S. P. Lyushin remained faithful to aviation technology forever. In the post-war period he worked out the first catapault device for rescuing rocket aircraft fliers.

At that memorable meet, Lyushin lived on the second floor of a stone house, situated in the center of Koktebel, and Korolev was in a little single-story house on the outskirts.

As Sergey Lyushin recalls, one night there broke out a terrible uproar, as though someone were breaking down the front door.

"Who's there?", shouted Lyushin.

"Who's there? I'll shoot!", repeated his friend, the pilot Gribovskiy, who had a firearm.

But their neighbor, the pilot Pavlov, guessed the most quickly of all the true reason for the noise:

"Brothers, it's an earthquake! To the terrace!"

In a flash, all three appeared on the terrace. Screams were being shouted all around. The rumble and roar wouldn't die down. It seemed as though the ground kept on shaking under their feet, although the first shock of the earthquake lasted (just) 15 or 20 seconds.

After ten minutes, S. Lyushin and his friends returned to the room and found everything in complete chaos. Everything in the room was shifted out of place, piled up with pieces of plaster, and covered with grey dust. Lyushin turned to Sergey Korolev's room in search of shelter. They became acquainted and continued on together closely.

They had no time to spare. They had to get up at five o'clock; breakfast was over at six. After breakfast, everyone went out to Mt. Klementyev(2) on whose flat summit tent hangars were set up to keep the most valuable gliders. The others just stood there, fastened down to screws driven into the ground, and covered over with tarpaulins. The highest starting altitude was 200 meters, but the trainees, of which Korolev was also a member, took off at about a quarter of the slope.

The whole day was filled with flights. After the takeoffs, the gliders were carried by hand to the start. Only one person rested; the one whose turn it was to fly. And that's the way it was from dawn to dark. The trainees ate what they brought with them on the mountain, or could buy on the spot from the peasants of the nearest settlements. Organized meals consisted of breakfast and dinner.

Footnote (2) appears on page 52

After dinner, Lyushin and Korolev often went off to the seashore, dreaming of new gliders. They didn't want to rush to their housing, since everyone still had fresh recollections of the earthquake. And even more, weak aftershocks persisted during the whole time of the sail-planers' stay in Koktebel'.

Day after day, the trainees increased their learning. They carried out experiments in glider launching. However, they still didn't give examinations in sail-pane flying. Therefore, activities were continued in Moscow, but no longer in the Lenin Hills, or in Kraskov.

In the summer of 1928, Sergey Pavlovich again went to Koktebel. On arrival there, the trainees picked up two gliders set aside for them, "Kik" (named for the Kukhmisterov Club), a design of A. A. Senkov, and "Drakon" (Dragon), a design of B. I. Cheranovskiy. The glider "Kik" quickly disappointed the trainees: its flying qualities were poor. One had to complete a set flying time in this "Kik" in order to go over to the soaring glider "Drakon". But as they say, if you weren't happy about it, it did no good to be unhappy.

Right after that, as the flights were finishing up and the gliders were already in the hangars, a warning notice occurred: a storm was expected with strong winds up to 30 meters per second. The tenthangars were on the mountain and would not likely withstand such a wind. It was decided to take the gliders out of them, dissemble them, and accommodate them in the ravines, covered with tarpaulins and weighted down with stones.

The trainees worked in the hangar where "Drakon" and "Kik" were. The majority of the gliders had been already taken away, when the wind increased sharply. The working tempo got slower, since the whole group had to carry each major piece of the glider, besieging it like an anthill. Sergey Korolev was rescuing the gliders along with everyone else. His voice resounded powerfully and energetically. He was calm, collected, and full of energy.

As the wind was reaching maximum strength, there remained in the hangar only two gliders, "Kik", and the sail-plane G-6 designed by Gribovskiy. The tent was already barely holding, and could collapse any minute. They had to choose which glider to take first. So the trainees took G-6. "Kik" was doomed, since its rescue was not possible. It was demolished by the collapsing tent.

In the morning, they had to put up the hangar again. And then they began to fly. The storm helped the trainees, relieving them of training flights in "Kik", they went directly to the soaring gliding "Drakon".

On returning to Moscow after the meet, Sergey Korolev found out the news: in the aeroplane factory where he worked, they were transferring him into the experimental design office, headed by the French expert, Paul Richar. The intention was to build an open sea torpedo carrier — TOM. Among the Soviet experts in this office were S. A. Lavochkin, M. I. Gurevich, V. B. Shavrov, N. N. Karmov, G M. Beriyev, and others. Here also was S. P. Lyushin, with whom Sergey Pavlovich had become so closely attached after the recent gatherings.

Both to Build and to Fly

Their common dream was getting closer: to design and build a soaring glider. Without getting bogged down in long discussions, they set down a rough sketch of the sail-plane and how it would appear to them. No controversies arose — the scheme pleased both of them.

They decided to work out a preliminary design. The quarters of Sergey Pavlovich were the roomiest. They became a place of feverish calculation. In the end, they settled on an approach unusual at that time: the profile was chosen with much, much higher aerodynamic characteristics than the ordinary. The specific loading on the wing was quite significant, and the wing spread was also large.

The young designers were in agreement in their efforts to achieve good wing stiffness and strength, and balance and stability in the glider. All of these, according to their ideas, were important for getting favorable flying properties and assuring pilot confidence. The problems of landing control and speed were examined for several versions, without selecting the best.

They were living so much with their design that they already saw the glider clearly flying in their imagination. The friends spent all their spare time on calculations. When the preliminary design, the re-arranging, and the calculations were all ready, they delivered them for the examination of the technical committee of the USSR Aviation Ministry transportation section. Many agonizing days went by before they found out the decision on their proposal. Sergey Pavlovich awaited the answer with particular impatience. He wanted so to accomplish this project quickly, second to living.

Finally they found out that their calculations were approved, and the glider was accepted for construction. They were allotted money for preparing working drawings, and a place for construction was set aside.

The details of preparation were distributed as follows. All the wooden parts — the fuselage framers, the wing ribs, spars, and tail empennage — were to be completed in the carpentry shops of the Tschepetilnikovskiy streetcar factory. The shops of the N.Ye.Zhukovskiy Air Force Academy were preparing the metal parts. Korolev and Lyushin were in charge of overseeing the production and the assembly of the finished articles.

The preparation of the working drawings was organized as follows. Sergey Pavlovich took upon himself the fuselage and its framework. Lyushin had the wings and tail. There was an assistant for each of them, and they worked away with sweat running off their brow, using every spare moment of time.

The winter of 1929 was passing. At the very height of the work on the glider, Korolev found out that the War Aviation Ministry was setting up a group of six glider-fliers for accelerated instruction in flying airplanes. The goal being pursued by this experiment was to discover whether preliminary instruction in glider flying aided in aircraft flying. At that time there was a high dropout rate in the flying schools, which was contributing to nonproductive expenditures of funds. If gliding could prove itself, then it would produce a serious economy in time and funds. In this event, one could see the birth of aeroclubs, which would appear later.

The Air Force command set aside the training aircraft U-1 for the experimental group. The Zhukovskiy Academy selected the instructor. When Sergey Pavlovich heard of this change to study airplane flying, he told Lyushin right away:

"Tomorrow morning let's go to the medical commission."

"I won't go", Lyushin objected, "I have had a muscle atrophy in my left hand from childhood."

"They can't notice it."

"No, it's obvious right off."

"But if you don't go, then you'll surely not get to fly, and here is a real chance. Tomorrow morning I'll go in behind you and will petition the commission," Korolev finished the conversation.

"I knew Sergey Pavlovich's character well", Lyushin reminisced afterwards, "I knew that he never wasted a word on any matter, so in the morning I obediently went to the commission with him."

Sergey Pavlovich successfully passed the commission, but not Lyushin. The Aviation Ministry glider section intervened for Lyushin, and indicated that he could and should become a flier. Both were enrolled in the experimental group. The activities and flights began in March, 1929 (once a week, on Sunday, and more often later

on). The instructors were changed frequently, until the fighter-pilot, Dmitriy Koshits, arrived. He gave them a real ticket to the clouds. The group into which S. P. Korolev entered was composed of youths having studied gliding in practice and having standing as glider pilots. The participants underwent a double screening: based on progress in flying gliders, and on activeness in social work.

All the trainees were carrying a tremendous load, since they continued working in production and being active in social work.

The instruction was conducted without any preliminary stages of steering, directly starting out on an aircraft with dual controls, with the student sitting in the pilot's seat from the very first flight. The study proceeded quite successfully, in as much as the trainees had already passed through a"natural selection" in glider flights. The single legacy of gliders which arose in studying aircraft flying was that they were accustomed to rather coarse movements of the rudders. It particularly cropped up in those students who kept on flying gliders along with studying in the school (several trainees were gliding school instructors).

After the middle of September, the trainee group advanced to studying aerobatics, since in the very first flights the students demonstrated full control of the machine and splendid legibility in filling out the figures.

The Air Force command carefully followed the study group. From time to time its representatives tested the trainees in the air. They were frequent guests in the experimental group.

D. A. Koshits knew his students well and paid special attention to the MVTU students — Korolev and Lyushin. When it came time to study spins, the instructor was wondering whether the old machine would hold up in fulfilling this maneuver. And at this point he turned to Korolev and Lyushin:

"You are pretty much the engineers for us. Tell me, can one spin in this machine?"

"It is impossible to say anything from an external examination," the young persons concluded, "one has to take off the paneling and look at all the joints ..."

Koshits remarked to this:

"All my life I've never seen them scatter around "specs" in the air".

At that time the drawings of the future glider of Korolev and Lyushin were filled out and completed. Production was begun. The designers paid special attention to the wooden parts. They made sure that the joints were true, and that the fuselage framers and stringers were constructed exactly according to the detailed contour.

In the spring, Korolev and Lyushin were busy through the day, first with their glider, then with flying. The time of solo takeoffs was approaching. On a summer evening in 1929, Sergey Pavlovich took off into the air alone. After that, as all the trainees of the group made independent flights, they picked out the new airplane at their disposal.

Soaring in "Koktebel'"

The summer was coming to an end. A new sail-planers' meet was approaching. The assembly of Korolev's and Lyushin's glider began under an awning on Begovaya Street. Other gliders were also lined up alongside, in particular the "Gnome" of B. I. Cheranovskiy. Although the assemblers were experienced, the work was going rather sluggishly, and there was a danger of missing the meet in Koktebel with this glider. So here, just like the time of the storm in Koktebel, the organizational talents and energy of Korolev appeared. He didn't want to think that it was possible to miss the meet. The butt joints were being delayed? He went right to the shops and put himself at the bench. The assemblers were dragging on something? Several evenings he worked hand in hand with them. This, evidently, brought the assemblers to life. They began to function efficiently

there, and even called for assistance from their fellow metal workers and painters by setting up shifts so they didn't hinder one another. So Korolev's first-born was ready — on the very eve of the meet. In the Aviation Ministry they couldn't believe this; no one had thought that the glider would take part in the 1929 meet. But it was ready, and was given the name "Koktebel'". News of the Air Fleet" announced that "a new glider designed by Comrades Lyushin and Korolev, with almost 17 meters in span and interesting construction for the wings," would fly at the VIth Gliding Assembly.

On the designated day, the glider was set up on a special truck and transported completely across Moscow to the Rogozhkiy Gate, where the freight station of the Kursk Railway was located. And within the day, a train set out for the Crimea, with cars of gliders and participants for the meet.

On the train the students rested from the strain of the preceding days. It had been especially hard on Sergey Pavlovich: he worked as a designer, studied in the MVTU and the flying school, and was building a glider. After all, really phenomenal energy was required for this. And he had it. But he got good and tired, and was enjoying every minute of rest.

Sergey Pavlovich was on his way to the Crimea with completely understandable trepidation, involuntarily thinking about flying his glider. Here is what he wrote his mother on the trip and beginning of the flights: "This year at the meet there were many new impressions and sensations, especially for me. First there was the arrival in Feodosia, where we met Thursday, September 24. Then the interminable transport of our machines, hauling them from Feodosia to Uzyn-Syrt, the locale of our flights. The first two days were one big fuss from morning up to the full darkness in which our wheezing truck 'AMO' brought us back to Koktebel' from Uzyn-Syrt."

"Finally, the first machine was ready. The flier Sergeyev was seated in it and strapped in. Once again the (starting) command — and Sergeyev was jerked away from the earth in the glider "Gamayun".

Everyone followed his flight with a feeling of joy, and he drew out curves and figure-eights for us along Uzyn-Syrt. 'Gamayun' passed by us, and our commander, Comrade Pavlov, shouted up words he could hear: "Well done, Serveyev. Just like a hawk!" We were all happily excited — the flights had begun."

But the joy was unexpectedly darkened by a wreck. Sergey Pavlovich describes the event thus: "Sergeyev was coming in impetuously, but smoothly, for a landing. He was blown over the tents and put the machine into a steep turn, and suddenly...either a puff of wind, or something else, but 'Gamayun' plunged straight down from ten meters up... It hung a second in front of us, the wings spread out, just like a really huge hawk, and then collapsed onto a wing with a horrible rumble. The fuselage was ripped away from the wings in the air. Just an instant...and there on the green hillock, from which the proud bird had just taken aloft, was only a heap of jagged fragments, plus a little dust whirling up into a faint column."

"Everyone was stunned. Then they rushed there, fast, fast... A staggering figure was rising from the fragments, and a sigh of relief ran among everyone: He's getting up. He's alive! We came running up. Sergeyev was really alive, and by some sort of miracle, not injured. He moved about, staggering a little, and mechanically sifted through fragments with trembling hands..."

"So once again, everything was set, and the takeoff crew was carrying on its normal hard life. In the tents they were raising new machines."

The gliders brought to the Crimea were set up this time in a place protected from the wind. "Koktebel'", situated among them, wasn't giving its creators any rest. The glider was provoking contrary opinions among the designers and technical committee. They examined it in detail, checked out the calculations, and the centroid. An officially designated pilot had to be (chosen) for the first flight. Konstantin Konstantinovich Artseulov was the one selected by them, one of the best-known and most experienced fliers of all time. Sergey

Pavlovich, learning of this, said to Konstantin Konstantinovich:

"Thank you!"

He looked there at Korolev with astonishment:

"For what? There hasn't been any flight yet?"

"Because, you believe in us."

The word of Artseulov was very highly valued. He was one of the pioneers of gliding in the USSR. His glider, the A-5 design, was the winner of the First All-Union Trials in 1923. Leonid Yungmeister flew in it (Konstantin Konstantinovich couldn't pilot his own glider after a crash which happened during the tests of an experimental fighter).

Konstantin Konstantinovich is also credited with the selection of Koktebel' as a locale for carrying on glider meets. He was a native of the Crimea, the grandson of the artist, Ayvazovskiy. He knew well the possibilities of this region in regard to soaring flight conditions.

Finally, the preparation of the glider "Koktebel'" was concluded. Even though the skeptics' words were still being heard: "It won't climb", in the souls of the designers there was confidence: "How could it not go into flight! Everything was all worked out!"

They helped Konstantin Konstantinovich get seated in the cabin, and were convinced that all was set for launch. They retired quickly to the side. The starter was heard: "Attention!" "On the shock-line!" "Pull!", and when the shock-line was about drawn to the breaking point, the starter pealed out: "Run!", "Let go!". The glider was hurled forward. Rising up from the earth, it quickly gained speed and altitude (six-seven meters). It went firmly into a glide, and then sat down. In an instant the designers and the technical committee representatives were already on the landing spot. Konstantin

Konstantinovich reported:

"The glider is balanced successfully. The rudder could be heard, and it might let go in soaring flight."

The designers were warmly congratulated on their success. A turn to go soaring in the glider "Zhar-ptits (Firebird)" was offered to them and their friends. Sergey Pavlovich describes with insight his actual feelings in that memorable start: "We five persons in crash helmets and leather coats were forming a small detached group... Everyone was surrounding us like a ring, us and our red machine, in which we were to take off for the first time. That small blunt-nosed machine rightly merited the reputation of the most difficult of all we had, and now we were to try this out."

"We five persons were a flight group flying together not yet a whole year, but now we were even more closely united. Every year before the first takeoff a terrific uneasiness would grip me, and although I'm not superstitious, this particular flight took on some kind of special significance. Finally, everything was ready. I buckled up my coat and got seated, smiling. The familiar faces around answered with smiles, but inside of me there were a cold void and guardedness. I checked the rudders, and looked around. The starters's words fell short and...suddenly there was only a stream of frigid wind in my face. I set the machine sharply on its side. Far below the starting crew could be made out as black dots, and silly little mounds of mountain went by alternated with square farm fields. Great! Stupendously great!"

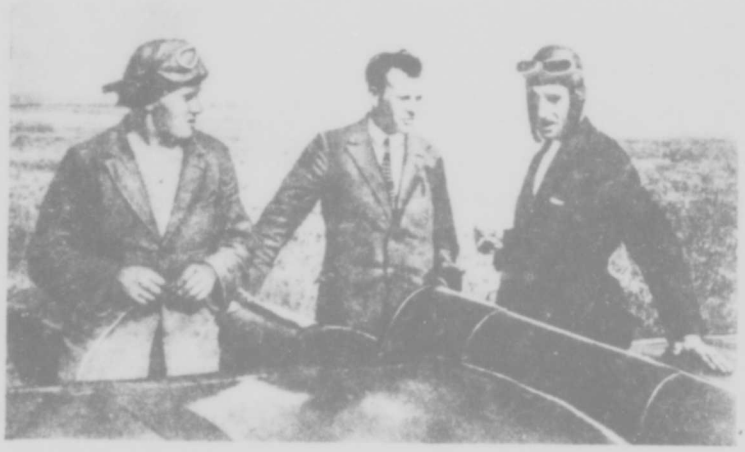
So did the first flight of Sergey Lyushin also proceed successfully. Korolev got an aching throat from joyful excitement. He was clearing his throat and looking at everything around in rapture. A red and blue machine was standing among the tents. People were lingering around it, and it seemed strange even to himself that he was indeed the designer, that everything in it up to the last screw and bolt was thought up by him, taken from no one, except a piece of marked up white paper. Sergey Lyushin was experiencing

Maria Nikolayevna Balanina
(mother of S. P. Korolev)

Pavel Yakovlevich Korolev

Little Sergey Korolev with his favorite rifle.

Sergey Korolev, graduate of the First Odessa Building Trade School.



S. P. Korolev, S. N. Lyushin, and K. K. Artseulov with the glider "Koktebel".

The training group of glidermen with the glider designed by A. S. Yakovlev. Koktebel. S. P. Korolev, third from left.

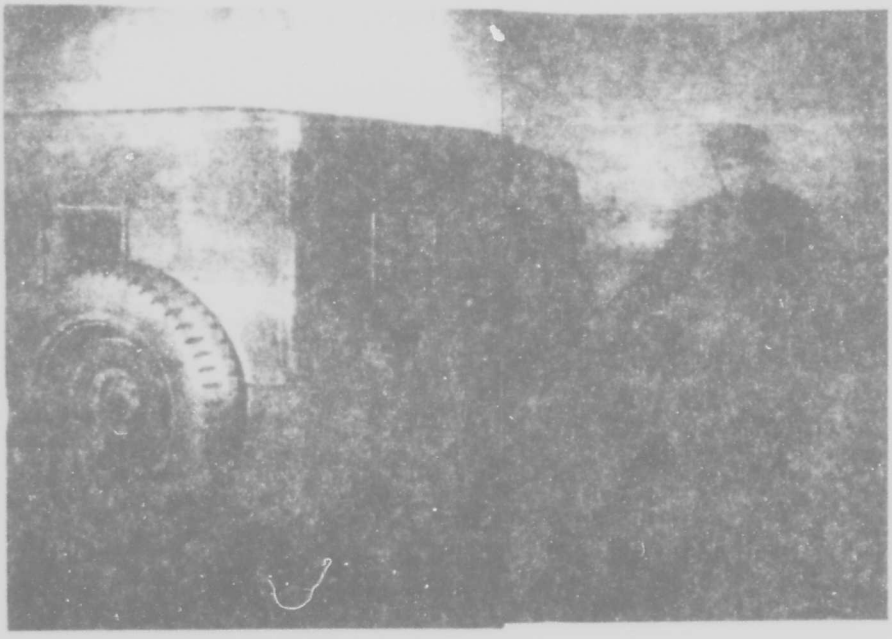
S. P. Korolev and B. I. Cheranovskiy with the BICh-8 glider.

S. P. Korolev, 1928.

S. P. Korolev in pilot's uniform, 1929.

Korolev's SK-9 glider in flight.

Sergey Pavlovich with daughter Natasha (right) and niece Ksana (left), 1938.



S. P. Korolev at rocket tests with a military GAZ (jeep of the Gorkiy Auto Plant).

S. P. Korolev and L. A. Voskresenskiy at the tests, 1947.

the same thing. He went up to Korolev and thoughfully remarked:

"You know, truly, it's easier to fly than to build."

Korolev quietly nodded his head and continued watching what was going on around the glider. The closer a new flight approached, the more his serene mood gave up a place to anxiety. "Was anything forgotten?" was passing through his mind. "Was everything done reliably and lastingly?" But there wasn't any more time for further musing. It was his comrade's turn to be seated in the glider, and he was saying jokingly: "Well, designer, wave good-bye!"

And at these times the two Sergey's had difficulty overcoming the tense waiting for the flight outcome. But there comes an end to every trial. The last comrade had flown, and there rang out a chorus of congratulations aimed at Korolev and Lyushin.

In the evening staff meeting of the assembly administration, the successful union of flier and engineer in Korolev was acknowledged. Sergey agreed with them: he himself fully perceived the usefulness of this combination.

But they also had another thought in mind: "How does this 'Koktebel' do at soaring?"

After the glider launch from the mountain, everyone was convinced it soars fine! Such a result literally inspired the young designers. They were overwhelmed by an even stronger desire to take the exams for sail-plane pilots sooner, so that they could try out for themselves the glider about which they had dreamed, on which they had labored through the long winter evenings.

And now this day had come! They remembered him a long time, because during Sergey Pavlovich's flight, there occurred an event which could have cost him his life.

At that time they fastened a parked glider with a hawser to a

steel pin driven into the earth. The other end of the hawser was strung though a ring on the glider tail and wrapped around the pin again, to hold the glider down.

When it was Sergey Pavlovich's turn to fly, Oleg Konstantinovich Antonov was selected to hold the tail. Nowadays he is a well-known Soviet aviation designer. Sergey Pavlovich instructed him at length when to let loose the tail, because "Koktebel'" had to have a strong pull from the shock-lines.

Oleg Antonov was lying on the ground almost under the glider tail. Two more people were holding on to his feet so that the glider wouldn't drag him along. Oleg had the rope in his hands. Sergey Pavlovich sat in the cabin and commanded: "On the shock-lines!" The reply: "Ready!" Then the command: "On the tail!", and reply — "Ready, pull!"

They began to pull the four shock-lines. The tension grew, the glider strained a little, barely moving, taking up some tail-line slack. They were awaiting the command "Let go!" from Sergey Pavlovich, but it never came. The ground pin pulled out of the earth, not holding up under the tension. Oleg Konstantinovich barely managed to get the rope end out of his hands. The glider broke away easily and went up smoothly. It began a turn, spreading its long, narrow wings and glistening like lacquer in the sun.

Sergey Pavlovich described his soaring in "Koktebel" this way in a letter to his mother, which we cite here: "In the morning, the orders. I will fly myself in my own machine. Everything is going well, even better than I expected myself, and it seems like for the first time in my life I feel a colassal satisfaction. I want to shout out something into the wind which is embracing my face and making my red bird shudder with its gusts."

"And I almost don't believe that such a heavy piece of metal and wood could fly. But just let it get away from the ground, and you feel as though the machine comes to life and flies with a singing

you hear with each movement of the rudder. Isn't it even more satisfying and rewarding to fly oneself in his own machine? One could forget it all with the joy of this: the whole string of sunless nights, days, spent in dogged work without rest, without respite..."

In this letter Korolev didn't tell his mother, to spare her tranquility, that the flight could have ended tragically. Those at the launch got just such an impression of Comrade Korolev. Following the receding glider with their gaze, they observed a strange object dangling under the tail of the machine. On examination it was clear: that ground pin, hanging on the tangled rope.

Everyone followed the flight with concern. Apparently, Sergey Pavlovich wasn't noticing anything strange in the glider behavior — for he was flying in it for the first time.

An hour passed, and Sergey Pavlovich flew all around. But the landing was coming up, when the pin could precipitate a crash by driving into the ground.

Now four hours had passed. The glider came out from behind a hill and began to come down. It was just in the last turn before landing. Everyone ran to the landing point. When they came up, they saw Sergey Pavlovich going around the glider business-like. Two large holes gaped from the elevators, but the vitally important parts of the rudders weren't damaged.

The glider was ready to fly again with barely two hours repair work. This time Sergey Lyushin took off in it.

The journal "News of the Air Fleet" referred thus to the glider "Koktebel'" after the meet: "The glider exhibited excellent aerodynamic properties. Although of significantly larger specific loading than all the other gliders, it flew in no way any more poorly than the models lighter than itself. With a high horizontal speed and natural stability, the glider controls quite manageably because

of the large rudder moment."(3)

In this reference, which was absolutely favorable, the remark on the large specific loading on the wings draws attention. Actually, it amounted to 19.6 kg/m^2. This method of Korolev's for glider design was maintained and even expanded in the future. His glider companions reflected on this circumstance that year, but didn't come upon an explanation. Now Korolev's far-sightedness is obvious, and we will comment further on it below.

Let us discuss other characteristics of "Koktebel'". Wing spread was 17 m, wing area 16.3 m^2, length/width elongation, 17.6, and the lift/drag ratio was 25. Glider body length was 7.62 m, height 1.2 m, and fuselage thickness was 0.61 m. The empty glider weighed 240 kg., and in flight, 320 kg.

These dry figures really came to life in the memories of those who observed the flights of "Koktebel'" in 1929, and in particular, the record flight of K. K. Artseulov. He flew through a course that no one has yet surpassed. This happened October 20. "The purpose of the flight," recalls a witness, "was to penetrate through a region of the Klement'yev Mountains which was rather unfavorable for soaring — Staryy Krym (Old Crimea) —, and on reaching Mt. Agarmish and starting from it along a ridge of mountains which stretched almost to Simferopol, to try to achieve a long distance record. Under these conditions, it might amount to more than 100 kilometers".

Artseulov started at 1 pm in a south wind at 12 meters per second (25-30 miles per hour). After getting through the pass in Mt. Klement'yev, which led to Sudak, the glider achieved an altitude above the takeoff point of 350 meters. Artseulov crossed the Koktebel' Valley and headed towards the foot of Mt. Koklyuk. Here he found a rising current, and after several zig-zags, raised the

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Footnote (3) appears on page 52

glider to the level of the Koklyuk summit, and went around it.

Ahead began the wooded pass between Otuz and Staryy Krym, where the glider came down almost to the tree tops. The wind in the valley had little directivity, and didn't produce any rising currents.

Finally, a strong rising current occurred from one of the mountain saddles, and with its help he succeeded in topping through the neighboring mountains, and even in gaining a significant altitude. Now the possibility of getting to Agarmish by a direct glide appeared. The glider went straight across the Staryy Krym Valley with a bad loss of height, passing at about 200 meters altitude over the city, and reached the slopes of Agarmish. However, here not only rising currents were found, but there also occurred strong downdrafts, which were also the cause of an almost immediate landing. The most complex part of the mission, connected with overcoming this difficult region, was fulfilled with this flight.

Sergey Pavlovich, satisfied with the success of his glider, couldn't relish the final fruits of triumph. He departed from Koktebel' earlierthan the others. He sailed on the steamship "Lenin", headed for Odessa. "From morning on," Sergey Pavlovich wrote to Moscow," not a bit of land was visible any longer, and just water surrounded us, along with the sky, covering our steamship like a blue nightcap."

"But there is just one stop for my journey: I am on the way to Odessa. Why I chose the sea route, now I can't remember, but I am not sorry about it, which means it is splendid. I am alone all the time in my cabin. I am sleeping a great deal, and fully love the sea. It is pleasant to be alone among such an amount of water, even more so since I am taking such a 'big' sea voyage for the first time."

"Still in the evening, when we passed along the Crimean shore, I spent all the time on deck, and couldn't take my eyes off the mountains, wrapped in lilac mist. How wonderfully beautiful are their masses with the trimming of white clouds on the summits!"

But even in this almost ideal situation, Korolev was already thinking over a new matter — to build a glider for aerobatics, which up till then had only been for equipment with motors....

Nesterov Loops in a Glider

At the VII All-Union Glider Meet, S. P. Korolev presented his new SK-3 glider, "Red Star", named thus in honor of the newspaper, "Red Star". This was a single-seater flying machine which could carry out aerobatic maneuvers. Before it was placed the assignment of executing Nesterov loops, the first time for a sail-plane which gained altitude independently.

The glider was manufactured under difficult conditions in ar exceptionally short period (47 days). Limits in time and funds were set, under which the construction couldn't be done, as Korolev himself remarked. Further, the static tests couldn't be carried out according to the project plan. Only the joints for attaching the cantilevers to the main body were tested to the breaking point.

Sergey Pavlovich constructed a freely supported monoplane with the wings located at the pilot's head level. The oval cross section fuselage was made up of 15 box frames. Longerons and stringers were connected to the frames by using plywood gussets whose edges were reinforced with laths. The firm frame obtained this way was sheathed by plywood one millimeter thick. Runners for landing were omitted. Landing was accomplished directly on the fuselage. A wide, roomy pilot's cabin was settled on because of the parachute.(4)

Sergey Pavlovich did everything so that the glider, along with great simplicity, would possess flying properties permitting one to soar in quite strong winds, and so that not aspiring for any "special record" role — something new in design could be tried out.

Footnote (4) appears on page 52

The designer himself conducted the flight tests. The whole thing consisted of four flights, generally 20 minutes in duration. In one of the flights, it became evident that the steering rudder response was too great. After an alteration, the machine was launched for soaring. Here the advantage of a combined designer-flier-test pilot in one person was obvious.

But now the unforeseen came to pass. Sergey Pavlovich fell ill with typhoid fever on arriving at the meet. He was taken right away from Koktebel to the hospital in Feodosia. His mother came from Moscow, and as soon as he was better, she transferred him to a guest home. After recovery from the typhoid fever, Sergey Pavlovich had a middle ear inflammation. His mother took him to Moscow, and he lay in the hospital a second time.

The orphaned glider didn't remain without the attention of the meet participants, and a very successful flight was completed in it, in spite of bad weather. Sergey Pavlovich himself later wrote the following about the flight of his glider in the magazine "Aircraft": "On the record day, October 28 (1930), glider pilot Comrade Stepanchenok, from the southern launch-strip of Mt. Klement'yev in winds from 12 to 15 m/sec, completed a flight which was exceptional in daring and beauty, executing three deadman loops in 'Red Star'".

This is how glider pilot V. A. Stepanchenok recalled the glider "Red Star": "Glider 'SK-3' was able, using the winds of 12-15 m/sec force, to gain altitude quickly and easily, and to soar freely from the slope. The glider control was good.... Maneuverability was completely superb. Turns were easily carried out with small radius. The glider didn't care for sharp, rough movements on the controls. The deadman loops were executed at a speed of 140 km/hour without hesitating on the top stall point. Without a doubt, rolls and spins could also be successfully carried out.... Acrobatic flights would be as expedient for increasing glider-pilot proficiency as aerobatics for powered aviation fliers".

Referring to that same VII All-Union Glider Meet, S. V. Ilyushin wrote: "For a great achievement of this year it is necessary to put down the deadman loops completed by flier V. A. Stepanchenok in the glider 'SK-3". It is extremely important from the viewpoint of implanting aerobatics in glider flight training, and even for outfitting gliders with devices for determining glider properties and taking down glider responses."

What were the data for glider SK-3, "Red Star"? By geometrical measurements, it was significantly smaller than "Koktebel'". Wingspread 12.2 m, wing area 12m^2, elongation 12.4, glider length 6.79 m, height 1.1 m. It weighed 189 kg. empty and 269 kg. in flight. Fuselage width was practically the same as "Koktebel'", — 0.6 m. On the other hand, the specific loading on the wing was sharply increased — up to 22.5 kg/m^2 —, and was the most of all the gliders presented at the VII meet. Apart from solving other problems, there was still one more step for S. P. Korolev in accomplishing aviation assignments. This would yet become a reality on completion of a subsequent glider.

Enthusiasm for a Lifetime

During 1930-1931, a period of tense creative effort, the student and flier Sergey Pavlovich became acquainted with the ideas of K. E. Tsiolkovskiy on the rocket engine and cosmonautics. They caught his imagination, which was absorbed with the novel, the unusual, the astonishingly daring. He wanted to find out about them in detail. So he pursued the study of the works of Konstantin Eduardovich and other scientists, even though there was not a scrap of time to spare: he was working in the aerofactory, was teaching in the flying school, and was building gliders. To save time during the day, he got a motorcycle for transportation, and rushed at terrible speeds from the factory to the MVTU, from the MVTU to the airport, and from the airport to his glider construction.

The study of K.Ye.Tsiolkovskiy's works led Sergey Pavlovich to realize how great were the ideas of the Kaluga dreamer. They seemed fantastic, and made up, to many, and only for the very far

future. They found a warm echo in Korolev's heart, and answered his passionate, active nature which was attracted to everything new. Here one must note an important trait of his character -- a constant striving to pass his every abstract thought through a prism of sound thinking, to find a practical approach to it, or its closest engineering embodiment. Young Korolev quickly perceived such an embodiment of his dream pertaining to space flight in the installation of a liquid rocket engine on a glider.

But he also perceived something else: the road to space lay through an ocean of air, through knowing the flight laws governing it, through possessing the skills of designing various flying devices.

Therefore, Sergey Pavlovich didn't lock himself into the circle of glider ideas alone. At first his attention was drawn by the tailless glider designs of B. I. Cheranovskiy (in one of them, the BICh-8, he made 12 flights, which were discussed in detail in the pages of the magazine "Aircraft", in an article, "Experimental Glider BICh-8"), and afterwards he got busy designing his own plane.

On first glance, the multi-faced enthusiasms of Korolev might seem like the disorientation or disorganization of the young designer-flier. But only at first glance. Fridrikh Arturovich Tsander, an engineer of the Central Institute of Aviation Motor Engineering, perceived in Korolev a purposeful, decisive person, fully desirous of injecting himself wholly into rocketry. Both of them, Tsander and Korolev, were trying in some way to popularize the idea of rocket flight through articles in the magazine "Aircraft", Fridrikh Arturovich just like Professor N. A. Rinin of the Leningrad Engineering College, by way of communications.

In the meanwhile, Sergey Pavlovich was not only turning to the works of K. E. Tsiolkovskiy, he was re-reading them repeatedly with a pencil in hand. And the more deeply he learned rocket engine theory, the more firmly his faith became well-planned reality. It is not difficult to imagine the joy Sergey Pavlovich went through on meeting Konstantin Eduardovich in 193[illegible] in the Hall of the Unions,

where the 75th year of the scientist was being feted.

Konstantin Eduardovich was not well, but he tried to conduct himself cheerfully, and indeed, his face almost spoke: "I am with you, young friends! Forward and upward to the stars!"

The plan of the SK-4 aircraft was born in the period of great successes in glider designs and joining in with the idea of rocket flight. This was a thesis project of Korolev in the MVTU. He carried it out under the guidance of A. N. Tupolev and defended it at the end of 1929. In the beginning of 1930, he finished the MVTU and received a diploma as mechanical engineer.

The SK-4 aircraft was built on assignment of the Central Soviet on Special Aviation, and was designated for long distance flying, as a means of communication, and also for flights to airline stations, propaganda flights, and for flier training.

According to the plan, this was a two-seater strutted monoplane with thick profile wing, located on the fuselage. In terms of strength, the plane was designed for executing complicated flight maneuvers.

A motor of 60 HP output was to be installed on the SK-4, although the design of the entire plane and its centroid were predicated on a more powerful installation, up to 100 HP. There wasn't any suitable engine at that time. Six tanks for gasoline and one for oil were situated within the wing, in its middle part. A small auxiliary gasoline tank was placed in the fuselage. The total fuel provision was calculated for a flight duration up to twenty hours with a full load.

The plywood sheathed wing was divided easily into three parts, and had two box longerons and a composition of plywood ribs. The high rigidity wing with low structural height profile (147 mm maximum) and long, internally supporting cantilevers was achieved by plywood skin and stringers reinforcing it.

According to the description of S. P. Korolev[5], the plywood fuselage of oval cross section had a narrow pyramid in its center section, on which the wing rested. To the rear of the back seat there was a hump running towards the tail directly into the vertical fairing. The seating was set one after the other: pilot to the rear, passenger forward. The rear one was over the wing, on the aircraft center of gravity. Next to the seating, for the convenience of embarking people, the fuselage had deep cut-outs which were covered with easily removable covers, and for the wing there were retractable hatches. The similar seating arrangement furnished a good view both for the pilot and the passenger. In case of nose-over, it protected people from a blow, and provided a chance of getting out of the machine quickly.

The air-foil and motor controls were in duplicate. The stabilizer setting could be regulated in flight (only from the rear seat). All the fittings and joints were easily accessible for inspection and repair. There was free access to the engine. A shock-absorbing tail skid was placed externally. Small baggage compartments were set in the wing and fuselage.

The calculated data were the following: wingspread 12.2 m, lifting surface 15.36 m^2, elongation 8.17, length 7.15m, height 1.88 m, design weight 335 kg. motor and propeller weighed 110 kg, and all the tanks, 55 kg. The fuel and oil supply amounted to 30 kg. Crew weight was assumed at 160 kg. Flight weight for a two hour cruise amounted to 690 kg. Maximum speed was 160 km/hour, and landing speed was 68 km/hour. The ceiling was 4700 m.

The plane completed the first trial flights with flier D. A. Koshits and the designer himself at the controls. For the first flight, in the early fall of 1930, Koshits sat in the second cabin, Sergey Pavlovich in the first. According to the recollections of mechanic P. V. Flerov, the flight went well enough, but on the

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Footnote (5) appears on page 54

landing the flier pulled the plane out early and broke out the left landing gear on touchdown. There came a break in the tests. Sergey Pavlovich left for Koktebel' to the regular glider meet.

During his absence, P. V. Flerov repaired the SK-4. Flier I. A. Sitnikov tried to raise it into the air, but each time the engine gave out. The engine apparently didn't get along with winter, and they decided to put the plane in test again at the end of May.

Unfortunately, no judgement could be made about the great hopes which had been placed in this aircraft. The SK-4 suffered a wreck from engine failure. It was broken up falling on the hangar roof at the aeroport where they were testing it. Flier Kosnits survived, receiving minor injuries.

Korolev felt the failure deeply. With the loss of the plane, all the hopes connected with it fell through. In this regard, only one specimen of the plane was built because of a shortage of funds for the Special Aviation Central Soviet.

However, the failure didn't overwhelm Sergey Pavlovich. New schemes were ripening in his head. Plans for making a long-distance glider and a motor-glider completely took possession of him. A discussion of the glider will be given in further detail. At this point we will postpone the discussion on the motor-glider project.

The magazine "Aircraft" contained an eloquent account of it during 1936. In the No. 5 issue of the magazine, a questionnaire was published: "What are we working on?" S. P. Korolev was the first designer coming out with answers to the questionnaire. His portrait was also placed in the magazine, with a smiling face, military field shirt, strap over the shoulder....

Sergey Pavlovich said, answering the question about what he was working on:

"In a very short while a six-seater passenger motor-glider SK-7 of my own design will take off on its first flight. Quite unfortunately, this machine comes out of construction after significant delays, since it was already designed at the end of 1934. The motor-glider SK-7 has six seats, including the pilot, and a baggage compartment. The flight weight is 1800 kg, with a payload of 500 kg."

Now at about this period in his technical progress, the young aviation designer turned away from light planes. For what new device was he destined now? We refer again to his answer, published in that same issue of "Aircraft". "The flight trials of the Sk-7 will be of great interest in examining data for similar machines in practice, and in particular, for clarifying the matter of the maximum potentials of medium-weight motor-gliders".

Medium weight, but as applied not to an airplane, but to a motor-glider, was imagined by him as something midway between an airplane and a glider. A small-power motor would be installed on it, which would "assist" the aircraft-towplane and motor-glider, according to the designer's thoughts, would be able to supply quick and cheap distribution of payloads to long distances; the towplane could be uncoupled along the way, and the motor-glider could fly on to the destination point independently.

Korolev's scheme was approved in the Special Aviation Central Soviet, and Sergey Pavlovich got busy in his spare hours working out the project. He attracted N. I. Yefremov to this project, who wrote in his memoirs that "efforts on a glider-ship project were begun at the end of summer, 1934. Sergey Pavlovich worked out a general view of the machine personally. He was already foreseeing then the engine placement and accommodation of fuel. The fuselage of the glider-ship, executed for a reason in the shape of a spindle, looked like a rocket. Such a fuselage shape allowed unification of the frames, and we could make the whole set of them from a template of one cross-section. The wing location in the middle was later repeated by Sergey Pavlovich with winged rockets."

"Everyone whom Sergey Pavlovich induced into the work got a solid education from him. I was entrusted with working out the fuselage, another designer the wing, and a third, the undercarriage and controls. Korolev kept the coordination and leadership for himself. We worked at home in the evenings. Sergey Pavlovich called almost daily on all his 'homebodies'."

"When the project was ready, Sergey Pavlovich and his designers turned it over to the draftsmen of the Scientific Research Institute of the Civil Air Fleet. The draftsmen were...thirty young and merry girls. They worked skillfully, and gave the designers no quarter. But to Sergey Pavlovich this was necessary. He would explain the design of the pieces with pleasure, joking with the girls. The work proceeded noisily and quickly."

Giving up the project, Yefremov was going on vacation. Sergey Pavlovich met him:

"The drawings are blueprinted and delivered, ready for production. Engineers are being loaned to them, and this will take a month. I'm getting all the benefit here alone. So after vacation, you come too. Special Aviation has allotted us a little per diem. Take your share. Of course, it's not much, but we really aren't working for the money.."

The motor-glider entered the flight tests in 1935.

What were the data for the SK-7? An M-11 motor of 100 HP output was installed in it. The wingspread achieved 20.7 m, and the motor-glider length was 9 m, 2.5 m height, wing area 39.2 m^2, top speed 150 km/hour, landing speed 54 km/hour, ceiling 4000 m, and lift/drag ratio, 19.

In concluding the answers for the questionnaire, S.P.Korolev wrote: "In the current year (which would be 1936 — P.A.) I will apparently still be working on a pair of machines for the tow flights. One of these is a two-seater racing glider, and the second, a motor-glider with a low-power auxiliary engine."

It would be difficult to tell which glider Sergey Pavlovich was thinking of building. However, his SK-9 glider became his most widely known, after which he no longer built gliders. We will discuss more about this in detail.

The SK-9 glider was designed by S.P.Korolev in 1935, and a long life was ordained to it by fate. It was presented for the first time before the spectators at the XIth All-Union Glider Meet in Koktebel', and flew 7 hours and 55 minutes there. But before this, it was tested in flights around the Moscow region, and completed a trip along the route Moscow — Karkhov — Krivoy Rog — Koktebel'. The trip time amounted to 11 hours and 20 minutes. The towplane flier was Orlov, and mechanic, Bocharov. The glider pilot on the SK-9 was Romanov, and in the passenger cabin was Sergey Pavlovich.

They took off from Moscow September 19, and flew into Koktebel' the following day, covering a distance of 1600 kilometers. The landing in Krivoi Rog was forced, since it was necessary to check the route.

The glider designer Sergey Pavlovich himself characterized the glider designation thusly in the article "SK-9 Glider" ("Aircraft", No. 10, 1935): "a two-seater glider for long towed trips and distance flights ahead of thunderstorm fronts". In that same article he gave the glider data; wingspread 17 m, length 7.33 m, empty weight 300 kg, payload 160 kg, flight weight 460 kg, wing area 22 m^2, loading per square meter 20.8 kg, wing elongation 13, stability index 1.59, lift/drag ratio 23.

Here are some details on the SK-9 glider flights. The glider was demonstrated for foreign guests. Representatives of the Czechoslovakian Aviation League attended the XIth All-Union Glider Meet in Koktebel' on September 26. The meet administrator, Comrade Minov, flew the SK-9 glider with one of the Czech guests. They planned for a flight in thunderstorm cloud conditions, but flew freely in a weak orographic current. After landing, the guest expressed his delight at the flight, the comfort of the glider, and the thoughtfulness in accommodating the equipment in it.

A reference of that time on the SK-9 glider ran:

"A scheme with a midway location of the wing was presented in the unique example of the two-seater SK-9 glider designed by Korolev..."

"According to the pilot's statements, the glider controls well and easily. It conducts itself quite stably in soaring and while being towed. Its dropping speed is large, due to which it goes lower than other two-seater gliders in orographic currents. On landing, it holds quite a long time above the ground, which is evidently explained by the "cushioning" effect of low wing location."

That summer a cartoon was carried in the magazine "Aircraft". The SK-9 was in flight. The inscription under it went: "Packing weight 16 tons, Westinghouse brakes, new design of S. Korolev."

A glider needed a rising air current for good flight. Figuratively speaking, the beneficial atmosphere of creative searching which surrounded him during those years was the rising stream for S. P. Korolev.

FOOTNOTES

Footnote (1) page 14	State Archives of the Odessa Oblast, FR 1189, op. 1, div. 9, No. 220.
Footnote (2) page 19	Mt. Uzun-sirt has been called Mt. Klementyev since 1924 in memory of the glider who perished here in the II All-Union Gliding Meet.
Footnote (3) page 39	"News of the Air Fleet", No. 10-11, 1929, p. 64.
Footnote (4) page 41	S. P. Korolev: The Glider "Red Star", "Aircraft", No. 1, 1931.
Footnote (5) page 46	S. P. Korolev: A new Soviet light plane. "News of the Air Fleet", No. 2, 1931, p. 44.

AMONG FIERY JETS

> It is fair to consider as the genius of a scientific idea he who recognizes not only the philosophical, but also the practical side of the idea, who knows how to throw light on the matter, so that everyone can be convinced of its correctness, and by this fact makes the idea into a universal possession....
>
> D. I. Mendeleyev

One's Impatience is Not Enough

In a 1954 autobiography, Sergey Pavlovich wrote that he worked in an aviation factory as a designer from May, 1927, to September, 1928. From October, 1928, to June, 1930, he was head of a designer brigade in one of the industrial All-Union Aero-institutions, and from June, 1930, to September, 1933, he carried out duties as senior engineer of CAGI (the successor of the Central Aerodynamic Institute founded by N. Ye. Zhukov). The outline of his working activities completely corresponded to the starting career of an aviation engineer.

But in reality, aviation engineer Korolev was becoming even more of a specialist, not in aviation, but in rocket technology, which was almost considered non-existent then. Tsiolkovskiy had awakened his interest in it. The urgent problems in rocketry themselves were being delineated during the very same period in which Korolev was busy applying rocket principles to aviation.

He talked over these matters more than once with F. A. Tsander.

From the moment of their acquaintanceship, Fridrikh Arturovich already had many years experience in his avocation with rockets. He had a slightly old-fashioned appearance about him, with a thinning, intent face and feverishly glistening eyes, giving him the countenance of a person who knew but a single, burning passion, literally consuming him, a passion for space flights.

Tsander was almost two decades older than Sergey Pavlovich. He was well known as the author of original articles on interplanetary travel and designs for interplanetary ships. He spent seven years (from 1922 to 1929) on the design of his first engine, the OR-1 (for "Experimental rocket No. 1"), which he then also built himself. Gasoline served as the fuel in it, with compressed air as an oxidizer. The engine was made from a gasoline pressure-lantern.

Fridrikh Arturovich more than once in conversations with the young energetic designer Korolev expressed regrets to him that he could not get him interested in his suggestion of some kind of serious organization. Apparently, the fact that he was attached to his notion of space flights made everyone to whom he turned a bit wary. Actually, in those years, a person stood a bit off the mainstream with the notion of rocket flight. For this reason many Utopias and unsound inventions could be encountered in the literature.

"A few days ago," he complained in a letter to Comrade S. F. Korolev, "In one journal they said directly in my face: 'We are

refraining from printing material on rocket matters, such as all this lunar phantasy etc.' So I had a hard job convincing them that it wasn't like that, that rockets were really the equipment of science."

There were even scientists who considered it unnecessary to begin the work, although later on they even led the way to developing rocket flight equipment, and aided in opening the path to space flights.

Sergey Pavlovich, while conversing with Tsander, observed attentively how his "gas lantern" engine threw out a flaming jet. As an experienced engineer-designer, he understood that the thrust which was generated in the little throat of OR-1 constituted an insignificant quantity — 145 grams. It couldn't do anything practical. But Sergey Pavlovich believed in the possibility of raising the thrust of such liquid engines, which greatly enthused Tsander. For increasing the thrust would make rocket flights a reality.

S. P. Korolev knew that they were trying out powder rockets on board flying equipment abroad. Turning on the powder rocket gave the device a thrust, and furthermore they even flew on inertia. Such tests began in Germany in 1927 with the installation of a powder rocket on a model plane. It was fastened right under the wing. The takeoff and flight of the model lasted 10 seconds. Within a year, the first takeoff of a plane with a powder rocket aboard was accomplished.

In 1930 and 1931, new tests on applying powder rockets were conducted in Germany and Italy.

That same year in the Soviet Union, an employee of the Gasdynamic Laboratory(1) in Leningrad, V. I. Dudakov, tested powder thrustors on an aircraft, a heavy TB-1 bomber. He was convinced that adding a rocket at the takeoff would cut the roll length threefold, or else augment the flight weight by two tons.

Footnote (1) appears on page 108.

Sergey Pavlovich found out about the GDL tests and arrived in Leningrad in the summer of 1932 to watch the rocket thrustors being lifted into the air on the TB-1 during a rocket takeoff.

After comparing "auxiliary" solid and liquid engines, Sergey Pavlovich gave preference to the latter. He stated his intention of putting a liquid rocket "heart" into a flying device. The chief difficulty lay in where to get a powerful enough engine.

Sergey Pavlovich learned not only of Tsander's schemes and Dudakov's experiments, but also that liquid engines for a rocket were being planned and built in the Gasdynamic Laboratory. Two engines were being tested in 1931. One, working on liquid oxygen and gasoline, put out a thrust of 20 kilograms. While Sergey Pavlovich was in Leningrad, he got acquainted with these engines.

Even more to the point, the matter was as follows: how to speed up getting an engine? How would one make the idea of rocket flight popular to the people, so that the idea itself would become strong? Sergey Pavlovich was in many organizations, but they supported him most of all in the Central Soviet for Special Aviation, since he was one of their people.

"We will assume that the organization most interested in rocket flights," Sergey Pavlovich summed up his research in a meeting with Tsander, "is the Central Soviet for Special Aviation, Aerochem."

In the beginning of 1931, a rocket engine section was actually formed in the CS for Special Aviation. It was concerned with propagandizing Tsiolkovskiy's idea, the concept of jet propulsion. However, even more important, at its meetings the matter was debated lively: how to bring into reality the concept of rocket flight the most quickly and certainly.

The participants of the discussions recalled that Sergey Pavlovich proposed: "Let us give impetus to a liquid engine on a glider. And we will try to fly in a rocket plane. Furthermore, I'll take one myself...

Eyes were gleaming among the attendees: here was a simple proposal, direct and accessible. Just what was needed.

As a matter of fact, a suitable glider was easy to find, and the engine was possible to build. One had in mind Tsander's second engine, OR-2. The leadership of the Central Soviet for Special Aviation took note of the urgent requests. On August 18, 1931, a group to study rocket propulsion was formed in Special Aviation group — GIRD. An agreement to construct a rocket plane was made. This was designated RP-1. The chief for the rocket plane was S. P. Korolev. F. A. Tsander headed up the first group.

Sergey Pavlovich esteemed F. A. Tsander highly, seeing in him, as he wrote later, "a researcher and outstanding scientific official in the areas of rocket engineering and astronautics." However, in practical matters, he frequently had to restrain Fridrikh Arturovich from premature actions. For example, in the GIRD organization, Tsander proposed first of all to acquire....waterproof suits in case the future rocket should go into the water during the experiments. Sergey Pavlovich had to promise, with a straight face, that there would be a waterproof suit when the rocket was ready.

In addition to Tsander, many enthusiasts got into GIRD, in particular, aviation design engineers. Some of them, who were attracted to rocket engineering, hastened over to GIRD to spend the evening at the drawing boards after a day's work at the Central Institute of Aerohydrodynamics (CIA) or in a factory.

Along with all those who tarried late over the drawings was also Sergey Pavlovich, talking things over with his comrades and clearing up points on the rocket plane project. No other work could divert him from this matter. And in the meanwhile, his problems increased — he was recently married. His wife was his childhood girlfriend, Kseniya Maksimilianovna Vintsentini, the same one who studied with him in the Odessa Trade School. After school she graduated from a medical

institute and worked in the Donbas (Donetz Basin) as a doctor. At that time she had gone to Moscow to a meeting, and there the young persons set their marriage.

When they went to the ZAGS (Civil registry office), Ksenia still had the train ticket in her hands. Then from the ZAGS, the newlyweds went home just for a few hours. Here, besides the relatives, were also awaiting some friends of Sergey Pavlovich — the well-known fliers Mikhail Gromov and Dmitriy Koshits. They raised their champagne goblets, wished happiness to the young couple and ... went to get a cab, to get back to Kursk Station.

Before the departure, the newlyweds agreed that Kseniya would move to Moscow, but the hospital administration wouldn't release her. Sergey Pavlovich went to the Donbas and pleaded. The CIA administration pleaded. But only after three months did Kseniya return to Moscow and catch her husband right in the heat of his new pursuits.

Sergey Pavlovich and his comrades were aflame with impatience: to build faster, to fly sooner in the rocket plane. They had even thought up a banner for their future device: "In honor of the XIVth October Anniversary". The anniversary came to pass, but the rocket plane was not yet ready.

Yes, the matter was dragging a bit. From February, 1932, GIRD had settled on a glider designed by B. I. Cheranovskiy. The glider had a triangular shaped wing and lacked a tail, which was thought to be appropriate for installing a rocket engine. Nevertheless, some changes had to be made in the glider: improving the rear part, putting on metal trim, and installing tanks in the wing. In order to build an engine, a decision to set up a production base for GIRD was reached in the middle of that same year, 1932. The Central Soviet for Special Aviation (Aerochem), knowing Sergey Pavlovich well as both a designer of aircraft and gliders, charged him with the leadership of this new undertaking.

B. V. Raushenbakh, associate member of the USSR Academy of Sciences, recollects on this occasion: "I heard about Sergey Pavlovich for the first time in the beginning of the 30's as a glider designer. In those days talented young people were designing them, bold and enthusiastic. From the ranks of the glider builders arose such remarkable aviation officials as S. V. Il'yushin, and O. K. Antonov. S. P. Korolev might also have been a general designer in aviation engineering. But aviation lost him, and rocket engineering gained one of its founders".

In the future it became clear just what rocket engineering did gain in this person. From the very start, this technology intrigued him, as a discipline, if not a surprise.

The impatience with which the youth charged after a rocket plane was an unhoped-for ally. The tailless glider flopped, and it was not all due to the engine. Sergey Pavlovich understood: broad and fully controlled research was needed. He started off by requesting that some kind of sequestered church be donated to him for GIRD. It would have thick walls, he thought, and explosions wouldn't bother it. But instead, a large basement in an inhabited dwelling at the corner of Sadovo-Spasskiy Street and Orlikov Lane was supplied for this new production. They tried to find something better. They didn't. They had to set it up there. They covered the walls with plywood and pasted on wallpaper. They furnished laboratories and shops. The quarters got an inhabitable appearance, and the work went on full swing.

GIRD established an idea center — an engineering council. Specialists in the various sciences pertinent to starting up rocket technology went onto it. F. A. Tsander, M. K. Tikhonravov, Ye. S. Tchetnikov, Yu. A. Pobedonostsev, N. I. Yefremov, and others became members of the council. Heading up the council was — Korolev.

The GIRD members viewed him displaying his capabilities more than once in difficult situations where something wasn't going right. For example, like the time GIRD got in new material for the rib-frames, the

strengthening parts of the future rockets, which were unexpectedly difficult to machine. The braziers spoiled the first components through disagreement with the designer. Right then Sergey Pavlovich appeared in the foundry. He criticized the engineer for carelessness in preparation, and was especially shocked at how large an effort was spent in vain. After having practically repaired it with his own hands, he would not tolerate worthless work.

GIRD gradually increased in size — there were now four groups in it. The first under F. A. Tsander was occupied with designing and building of liquid rocket engines. These were the OR-2 and an engine for a proposed ballistic missile, "GIRD-X". Both engines were continued even after the premature death of F. A. Tsander. He died of typhus in Kislovodsk on February 28, 1933.

Situating GIRD in the basement of an inhabited house raised many new worries for S. P. Korolev. After an especially noisy and smoky experiment, an uproar would break out among the occupants of the house. They would assail the GIRD members with reproaches:

"It's getting dangerous to be alive!"

Sergey Pavlovich would quiet them down, explaining the plans of the tests. Usually his imperturbability and goodwill would render the salutary effects.

Of course, it is also easy to understand the building occupants. One group under Yu. A. Pobedonostsev could spoil the good humor of most of them. In the course of their research, they ignited phosphorus there, and thick smoke poured out of the basement. The wind tunnel which this group built would also shriek with the force of a hundred sirens. And now and then there was an explosion from another of the groups.

The GIRDists, never giving up, looked for a place for further experiments and tests. Sergey Pavlovich, frequently making requests

in this regard, directed a letter to Acting Defense Commissar M. N. Tukhachevskiy. Mikhail Nikolayevich decided to visit GIRD personally.

When the Acting Peoples' Commissar arrived, Sergey Pavlovich greeted him and took him around to each group. Mikhail Nikolayevich listened closely, intensely, attentively, to Tsander and the other group leaders. As usual, Fridrikh Arturovich was attaching the GIRD efforts to Moon and Mars flights. Tukhachevskiy was not amazed, and said sympathetically:

"Yes, indeed, flights to the planets won't come so soon, but it is necessary to think about them..."

On getting acquainted with the engines and rockets which GIRD was building, Mikhail Nikolayevich remarked:

"The work is interesting and success is here. We will try to help out with a place for tests."

He fulfilled his word. GIRD was presented a section in the engineering complex in Nakhabino. Thus Nakhabino became the first experimental rocket-base for GIRD.

All the groups energetically "moved into" their complex. They didn't work isolated from one another. Affairs in GIRD were conducted so that the interests of each group were all in common.

The GIRD party organization secretary, N. I. Yefremov, recalls a typical episode. One time the first group was all excited over the lack of a heat-resistant material for a combustion chamber and nozzle. On Sergey Pavlovich's assignment, one of the GIRDists went to Khar'kov and got the covering material. They decided not to test the chamber right away. Korolev put himself at the control console in the test pit. The GIRD engineers were right along with him. The engine firing tests were begun.

The engine was easily started and headed into the main stage. Judging from the sound and the flames, all was going well, as though there were no cause for concern. Then suddenly... an explosion, a fountain of fire. Alcohol splattered against the walls in a strong jet and burst aflame there. Fire covered the whole test stand area. Its intensity was strengthened by excess oxygen fumes.

The voice of Sergey Pavlovich was heard:

"Shut down the feed!"

"Shut off," answered A. I. Polyarniy.

But this didn't save the situation. Spurts of alcohol and liquid oxygen continued to fly out of the broken-off pipe lead-ins. The flame increased and reached toward the oxygen tank. Here a new explosion would occur. Mechanics V. P. Avdonin and B. V. Florov rushed into the danger zone at the risk of their lives and practically snatched the liquid oxygen tank right out of the fire. With the enormous effort exerted by them, it was successfully dragged aside from the fire.

The engine cooling and ignition was worked out, but not without difficulties.

"We didn't get the necessary instrumentation, or tools. We were especially troubled by the measuring equipment", recall the veteran GIRDists.

And once again, S. P. Korolev, along with the GIRD party organization, sought the support of the Acting Peoples' Commissar for Army-Navy Affairs, M. N. Tukhachevskiy. Mikhail Nikolayevich wrote a letter to the Commission about the work on K. E. Tsiolkovskiy's ideas:

"The 'MOSGIRD' organization is working in Moscow in the Special Aviation system. A special group of engineers in this organization is

working intensively on building rocket motors for liquid fuel, in which regard, they already have motors in working drawings which are approaching immediate realization. These efforts, in connection with the inventions of K. E. Tsiolkovskiy in the areas of rockets and interplanetary travel, have great significance for the military and the USSR as a whole."

"In view of the particular requirements of rocket motors, it is absolutely indispensible to have a small experimental mechanical shop in MOSGIRD for their manufacture."

"I am asking... to take every means in line with the public good to render active aid to MOSGIRD in regard to presenting them with the equipment from the People's Commisariat of Trade and Industry (NKTP). MOSGIRD as such is a little-known organization, so that it has not been able to get the equipment up till now, even though steps have been taken.

Acting Army-Navy Peoples' Commisar,
and Chairman of the Revolutionary
Military Council of the USSR

Tukhachevskiy"

So by obtaining the most authoritative aid, Sergey Pavlovich got tools, stands, and apparatus. Gradually, GIRD was being outfitted with the necessary equipment.

Indeed, the external appearance of the GIRD workers was changing. Sergey Pavlovich obtained aviation leather coats with collars — warm, good-looking, and strong — for all those taking part in tests at the complex. Veterans of that time remember them with delight.

The work on engine OR-2 was approaching an end. In December, 1932, it was delivered for cold trials.

The First Liquid Engine Flies!

Parallel with the first group, engine and rocket design proceeded in a second group. M. K. Tikhonravov headed this group. Capable engineers with outstanding physics and mathematics backgrounds were working in it. This group first built a rocket designed by M. K. Tikhonravov, which was called "09". The engine for it was made by this same group. It ran on a liquid oxygen oxidizer and jellied gasoline, like a paste, as a fuel. It underwent more than 40 firing tests.

The liquid oxygen oxidizer caused the group much trouble. Sergey Pavlovich knew well of the catastrophes which resulted from oil contacting gaseous oxygen in tanks. Explosions were observed on machines which used liquid oxygen. Therefore, Korolev asked for the consultation of the most prominent expert on compressed gases within GIRD. The consultant declared:

"You don't have to be afraid of liquid oxygen. It is only necessary to maintain caution in dealing with it. It is dangerous for it to touch oil."

And so they took liquid oxygen to the complex. They kept Dewar bottles on hand for the dangerous product, but how to fuel the rocket? For the liquid oxygen had to be poured into a tank, right alongside mechanisms all covered with grease and preservative. And any other way was impossible.

Korolev and Tikhonravov decided to determine how menacing the oxidizer really was, and whether it could be loaded in such conditions. They tested everything themselves and determined in their experiments how best to handle liquid oxygen in transportation and takeoff. But every now and then, some stubborn person would tempt its "disposition".

One of the engine runs was stuck because the valves had frozen up. So there was Tikhonravov, suggesting to unstop the valves... with ordinary water.

"Really," agreed Sergey Pavlovich, "it's just like boiling water to liquid oxygen."

And the water warmed up the valves.

Now they had to find out all about jellied gasoline and where to get it in GIRD. In the summer of 1932, N. I. Yefremov was about to travel on vacation to Gagri, and Korolev suggested to him:

"You'll be in the Caucasus. Drop off in Baku and pick up a few papers. Find out the latest information, for they are also making the fuel for our rocket. I know, you'll lose part of your vacation, but you don't get ahead in life without exerting yourself."

The Baku trip turned out to be fortunate — gasoline was found jellied to a paste. Within a short while such gasoline was received at GIRD. It was more dense, but in its properties, it was close to a liquid. The jellied gasoline permitted simplifying the engine design. The paste was put into the combustion chamber ahead of time, and to run the engine, only the oxidizer had to be added there.

The rocket test with jellied gasoline took place at the Nakhabino complex on July 8, 1933. Many GIRD specialists attended. Sergey Pavlovich was also there. Two engine runs took place. On the first run the engine developed a thrust of 28 kilograms; on the second, 38 kilograms. This was explained by the fact that the chamber pressure in the second case was three atmospheres higher. They decided in the future to work at even higher pressures.

Within a month, on August 7, 1933, Sergey Pavlovich attended engine tests at the Nakhabino complex with a chamber pressure of 13 atmospheres. A thrust of 53 kilograms was obtained.

They tried out various methods of igniting the mixtures in the combustion chamber for the future rocket. They tried to use a slow-

burning compound on a powder base. The process would be like this: the compound in the chamber was to set the fuel mix aflame. They acquired the needed powder, and put it in a metal vessel. They began to check out how it would burn. And it blew up right off.

After this experiment, they understood that time was needed to iron out this ignition system, and this was delaying the rocket launch. Then Korolev and Tikhonravov, using their aviation experience, decided to apply the ignition from a sparkplug, as is done in airplane engines. And the sparkplug didn't let them down, although sometimes there were also troubles.

Some kind of explosion occurred when the ignition problem was being solved with Korolev, Tikhonravov, and Efremov in attendance. (.) Billows of steam and dense smoke rolled over the pit. Yefremov was closest of all to the explosion site. It stunned him. And suddenly he sensed some hand clutching his shoulders. This was Sergey Pavlovich. He was looking at his comrade with concern, and when the latter said that he was all right in spite of everything, he answered with relief "You were born in a shirt (i.e. with a silver spoon in his mouth)."

And he himself was forgetting in the excitement who was right there alongside...

The failures in succeeding days over the rocket launch were particularly distressing, because the takeoff had to be put off three times, the 9th, 11th, and 13th of August. It was finally set for August 17, 1933, the eve of Air Force Day, which the GIRDists, as former aviators, considered their own holiday. Only the immediate participants of the launch gathered at the Nakhabino complex. "Devyatka (Number Nine)" was already loaded with fuel and set in launch position. Sergey Pavlovich, like all the rest, was intently following the pressure buildup in the oxygen tank. A small manometer was also installed in the upper part of the rocket body. The tiny markings of its scale

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Footnote (2) appears on page 108.

were poorly distinguishable. To follow the indicator fluctuations, one had to get up on supports.

The pressure reached 13.5 atmospheres. Here the safety vent began to be activated. An ice frosting was forming on its lip, and the valve wouldn't fit evenly onto its seating. Therefore, the pressure couldn't be raised higher than 13.5 atmospheres. What to do?

Sergey Pavlovich thought it over: "Yefremov is proposing a launch with the current pressure. The calculated altitude can hardly be reached, but the flight will take place, and we will get an answer to the most interesting of our questions."

The GIRD chief didn't rush with the reply. He considered the situation, and finally agreed.

From then on everything went normally. The safety fuse in the system was timed to throw a parachute up, and everyone hurried into the bunker to control the launch from there.

Takeoff! The rocket is in the air!

A special issue of the GIRD internal newspaper, "Rocket No. 8", was dedicated to the flight of "Devyatka". A slightly altered phrase from the remarks of S. P. Korolev was headlined the whole width of the newspaper: "Soviet rockets will conquer space!". And below was the comment itself.

"The first Soviet rocket with liquid fuel has been launched. The 17th of August will absolutely be a notable day in the life of GIRD, and beginning from this day on, Soviet rockets will fly over the Union of Republics."

"The GIRD group must exert all their strength so that the rocket data can still be gathered this year, and the rocket can be delivered for use in the Workers-Peasants Red Army."

"In particular, special attention has to be devoted to the quality of work at the complex, where, as a rule, a large number of defects, lack of coordination, and the like are turning up."

"It is also indispensible to master and to launch other types of rockets into the air as soon as possible, in order to study all the phases and to strengthen the technology of rocketry to an adequate degree."

"Soviet rockets have to conquer space!"

The comments of all the group representatives were also printed in the newspaper, although the second group built the rocket. In the name of the first group, its leader declared that the first flight justified the correctness of the technical decisions, and showed the validity of the ideas in the design of our rocket.

Here the words "our rocket" are especially noteworthy. Everyone thought of it that way. This was reflected in the single-purposeness and solidarity of the GIRDists.

The launch moment was described in the newspaper:

"So everything was ready. Nikolay Ivanovich gets up to look at the manometer a few times, and makes signs showing the pressure rise. Now Sergey Pavlovich is setting the safety fuse. We know there remains just a minute, only one minute..."

In this commentary, it shows as something usual and everyday that the GIRD chief, the chairman of the engineering council, should be working, namely, <u>working</u>, at the takeoff side by side with everyone else, sharing all the dangers, failures,... This became the pattern of work of S. P. Korolev.

Almost a pictorial of the first rocket flight is outlined in the commentary of B. Shedko:

"I had the assignment of raising the rocket at flight time... They shouted to us to get ready."

"The rocket came up off the stand with a roar and a cone of flame and rose into the air. It came up slowly, and then suddenly took on a great speed, and rose straight up about 400 meters, no less, and then, going over horizontally, it fell into the woods near the fence."

"At that moment we were all so excited that we were all ready to scream with joy. I was literally out of my head, and took a picture of a tree."

"Our rocket hurtled proudly and absolutely vertically into the blue sky with growing speed," wrote O. Parovina. "The flight lasted 18 seconds, but these seconds seemed like hours."

A photograph caught the joyful faces of Sergey Pavlovich and his comrades standing around the rocket which had just completed its flight. Sergey Pablovich, in a bright shirt with rolled-up sleeves, looked just like he was quickly getting ready to take on any kind of new business.

This moment is also depicted in the internal newspaper:

"Everyone was around the rocket which was lying on the ground. Faces were excited, joyful, all speaking at the same time. It was hard to decide what to say, but it wasn't necessary, it was understandable without words..."

"We headed merrily for home. Songs echoed the whole route to Moscow, interrupted with reminiscences. There was no end of excitement and joy — for that day in our country they mastered a new, unknown branch of technology."

And here is how Akt viewed the experiments:

"We, the undersigned, the GIRD plant commission for launching the experimental model of object 09, composed as follows:

— Chief GIRD design engineer S. P. Korolev.

— Design engineer, Brigade No. 2, N. I.Ye Efremov.

— Chief Brigade No. 1, design engineer L. K. Korneyev.

— Production Shop Brigade, Brigadier Ye. M. Matysika, this August 17, having examined the object and the equipment for launching, got it ready to launch into the air.

The takeoff occurred at stand No. 17 of the Nakhabino engineering complex, August 17 at 19 hours.

Weight of the object -- 18 kg.

Weight of fuel — flammable solid gasoline — 1 kg.

Weight of oxygen -- 3.45 kg.

Pressure in the oxygen tank — 13.5 kg.

Flight duration from moment of launch to moment of touchdown — 18 sec.

Height of vertical rise (visual) — at least 400 m.

Takeoff proceeded slowly. At maximum height the rocket moved horizontally and then returned into neighboring woods along a sloping trajectory. During the entire flight time the engine kept working. On falling, the skin was crumpled.

The transition from vertical flight to horizontal flight occurred as a consequence of puncture (burnout) at the flange, as a result of which a side thrust was developed, which also tilted the rocket...

Compiled in one report and written at the Nakhabino complex.

17 August at 20 hours, 10 min.
1933"

The GIRD engineering council with Sergey Pavlovich at the head judged the flight results. It reached a verdict, which sounded optimistic:

"The rocket was stable...Fundamental damage to the rocket was received from striking a tree. The rocket is recommended for further trials".

On returning home, Sergey Pavlovich, as his mother Maria Nikolayevna remembered, couldn't get to sleep for a long while. To her anxious questions he answered:

"All is well, Mama, our first rocket flew up 400 meters. And it will fly higher!"

Subsequently six 09 rockets were launched. They achieved the calculated altitude — a kilometer and a half.

Sergey Pavlovich called on the first group to speed up building and testing the GIRD-Kh rocket. This plea and his active help produced its effect. On November 25 that same year, GIRD-Kh took off at Nakhabino.

Winged Rocket Devices

Much research was carried on in the third group, headed up by Yu. A. Pobedonostsev. Here problems were worked out on a single-pass jet engine. As is well known, the single-pass engine begins to work at very large speeds, where the air, taken into the burning mixture, exerts a subsequent pressure contrary to the air flow. How to drive an engine up to high speed? In that brigade a very interesting method was found: they mounted a miniature ramjet engine in an artillery shell and fired it out of a cannon. On reaching a high speed, the engine would activate and develop a thrust, whose magnitude

was determined by the "added" range of the shell with the engine, compared with the usual value.

Design-wise, the engine in a shell was as follows. Into a special channel made in the shell body, they stuffed a fuel — phosphorus. Over it they poured a lacquer, so that it didn't ignite itself (for phosphorus is self-igniting in air). In order to clear off the protective film from it, they placed a metal spine in the channel. When the shell flew forward in the shot from the weapon, the spine went back and struck the film. The phosphorus flared up and the engine started to work.

The application of phosphorus in itself occasioned not a few unpleasant incidences at the complex. Once in a while a crumb of phosphorus remaining would set someone's clothes afire.

As a matter of fact, this happened to driver Gudkov. He belonged to the second brigade at the complex, but Pobedonostsev only seldom worked out there. The driver was very interested in jet engines, but the mechanics had too many worries, and no one explained anything to him. The offended Gudkov set down at a workbench, and...began to feel with horror: something was burning down below. He got up and looked — his pants were smoking in places. He started running with fright, swatting at his buttocks with the palms of his hands and trying to stop the smouldering of his clothes. The mechanics doubled up with laughter, and as Gudkov approached them, someone shouted out: "Now you know all about jet engines for yourself; why don't you go fly?"

Damage resulted only to the ruined pancs. Sergey Pavlovich calmed the victim: "We will recompense your industrial loss".

Right to the point, during tests of new technology in GIRD, there were unexpected mishaps with people, but there weren't any victims really worse than this. And the credit for this is Korolev's — a prudent, demanding, and concerned chief.

Sergey Pavlovich tried to take part personally in the most important tests of the third group. In the archives, a report of

April 15, 1933, about research with ramjet engines on gaseous fuel is preserved. Among those attending was S. P. Korolev. The research was carried on as follows. Air and hydrogen were introduced into a jet engine. The mixture was ignited by a lighter, consisting of a nickel-alloy wire wound on an insulated rod and inserted into the engine chamber. At 7 hours, 50 minutes, the air and hydrogen were turned on. Within 10-15 seconds an explosion resounded. A yellowish flame appeared from the exit duct, and a sound characteristic of the beginning of engine operation was heard. By increasing the air consumption, the flame emitted would retreat into the engine, and the noise would become high and sharp.

At 7 hours, 55 minutes, the air feed was shut down. The flame came out of the engine and quickly died out. An attempt to start the engine a second time did not succeed. Sergey Pavlovich along with everyone else was looking for the reason for this. They determined it after an examination: the lighter was burned out. Nonetheless, the research produced its result: the theoretical considerations at GIRD concerning propulsive engines with gaseous fuel were vindicated. Ignition using a nickel-alloy lighter was accepted as quite reliable.

The research led to working out schemes for certain types of engines with experimental data enriching the theory. The creation of an aerodynamic wind tunnel also contributed to the success of the third brigade. It had a flow speed equal to three times the speed of sound, and increased the flow speed 15 times over that of other wind tunnels of that period.

And, finally, the fourth group. It was under the personal guardianship of Sergey Pavlovich. Its concern was the winged rocket flying device. This very brigade prepared the BICh-11 glider for installation of a rocket engine in it. The group members went to the aerodrome at Trikotazhnaya and unanimously pulled the shock-lines when Sergey Pavlovich took off, trying out the glider. During one such flight, Korolev was ejected from the cabin in the takeoff. Only his athletic condition could withstand such a shock....

In spite of the holdup in perfecting the RP-1, the GIRDists didn't abandon hope. The GIRD secretary wrote to K. E. Tsiolkovskiy:

"Our experimental work on the 'GIRD-RP1' rocketplane is approaching an end....We have many highly qualified engineers working for us, but the best of the best is the president of our engineering council, engineer S. P. Korolev....He himself will also fly the first rocketplane".

The rocketplane engine was still not at all ready. And the wooden glider was approaching the end of its service life. While it was impossible to complete the rocketplane project, Sergey Pavlovich set up an investigation in the fourth brigade which at the time seemed completely fantastic: safeguarding human life during stratospheric flights and higher. In those advancing times, the group researches were carried on in cooperation with the flight labor laboratory of the N. Ye. Zhukovskiy Air Force Academy. In particular, flight safety in pressure suits, in hermetic chambers with air regeneration, etc., was being examined.

In the archives(3), there is an account of one of the investigations, which was carried out in the Zhukovskiy Academy and entitled, "Safety of breathing equipment for a stratoplane". It says in the account: "In the interest of reaching a solution, phenomena taking place in a hermetic chamber were studied first of all by GIRD in the laboratory." Therefore, experiments were carried on in a welded steel hermetic chamber 1.37 m^3 in size with two persons spending various periods of time in it."

Thus, everything which a person would encounter at high altitudes was gradually studied. But the construction of the equipment, which, in Korolev's opinion, was necessary to inject a person into the stratosphere, was being held back for lack of a capable engine. What to do? Wait? The constantly inquisitive nature of Sergey Pavlovich

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Footnote (3) appears on page 108.

wouldn't get along with that. For there were already liquid engines, though not powerful enough: the "heart" of the flying "Number Nine", of the ORM-65 of the Leningrad GDL organization. Maybe they wouldn't lift up a person, but instead, for example, a robot which would replace the human, might be carried up all the way. As a matter of fact, why not construct a rocket for robots? Let it have wings, and controls, like a plane, and the robot will pilot: for a flight in the stratosphere, an altitude gain, a descent, a crash.

Of course, this representation of how Sergey Pavlovich created the scheme to make a winged rocket with a robot aboard is simplified. But the important thing is that this plan had a great future. He held back on winged rockets until first he planned flights into the stratosphere. There he intended to use automated flight control, and to organize safe preparation of a flying stock for future space voyages.

This was a completely new matter. Even the approach to the problem had to be worked out in itself. Sergey Pavlovich began with constructing models of future winged rockets.

They began to check out control devices on the models. In the beginning, they were hard to keep under command, and would frequently go off from "obedience". One of the veteran rocketeers recollects that those working on winged rockets in GIRD were jokingly called "stump-knockers" because of the unexpected excursions of their creations, often colliding with a stump. On the other hand, what joy those very same models occasioned when people learned how to fly them!

Gradually the possibility of a rocket control system, which was under the command of the automation of those years, was being developed. The brigade pressed towards working out winged rocket 06/1.

Sergey Pavlovich considered GIRD as not only the center of development, but also the information center of rocket engineering. He personally did very much himself to spread to the masses the significance of the new technology, its perspectives, and the

endowment of our scientists, and particularly K. E. Tsiolkovskiy, in working out the theory of rocket propulsion.

Sergey Pavlovich dreamed of making rocket construction a nation-wide matter. On July 31, 1932, he wrote to Ya.I. Perel'man:

"In spite of the large burden in different experimental efforts, we are all very concerned with the development of our social work. Really, it is out of the question to base it only on the military.... side of the matter, and it would be completely untrue. In this regard, it would serve the development of our civil air fleet in good measure. Indeed, after just 1.5-2 years, how far and widespread the matter has developed, how firmly public opinion has turned! Therefore, we must not be yawning, but must take the initiative and point out how to create definite, positive, public opinion around rocket propulsion problems, stratospheric flights and even interplanetary flights in the future. But first, of course, it has to be in people's minds and in the literature. And it isn't, except for two or three books, and even those no one has around here."

"We think it would be completely timely to publish a whole series (10-15 pieces) of small popular booklets on rocket propulsion, with just one particular topic covered in each booklet. For example, 'Just what is rocket propulsion', 'Fuel for rocket engines,' 'Applications of rocket engines', etc., popular, but at the same time technical books. Later on they could be replaced with a series of more technical material."

"In general we have too many descriptions of all the complicated and noncomplicated things and calculations about how an interplanetary ship will approach the Moon and the like, but here there is absolutely no material on it for the GIRD circles who are thirsting to study it, to work it out."

In a later letter to Ya. Perel'man, Sergey Pavlovich turned to this matter again: "If only you desired, you might in your further efforts, as a knowledgeable specialist in rocket matters and the author of a number of splendid booklets, put greater attention not

on interplanetary topics, but on the rocket engine itself, or on a stratospheric rocket, etc. That is to say, all this is closer, more understandable, and more necessary to us now."

"You might also like very much to see your own splendid booklets in the ranks of those works which agitate for rocketry, which teach and champion its cause. And if this is so, then there will also be a time when the first spacecraft departs from the Earth. Whether or not we live to see this, or are fated to putter around deep below — doesn't matter. Only in this life will successes be possible".

S. P. Korolev attracted the most illustrious specialists to writing books on rockets, and he wrote himself. He even urged publication of a journal, "Soviet Rocket". The proposition of publishing a journal was supported by the Central Soviet for Special Aviation (Aerochem), in a decision of March 8, 1933. But the matter didn't have a chance to reach publication.

At the First Rocket Institute.

GIRD existed for a whole year and a half with little. But its endowment to the development of rocket technology was priceless: making and flight-testing the first rockets, working out winged rockets and a rocketplane. And history will preserve forever the name of the GIRD chief, who was simultaneously both a brigade chief and the leader for the most dangerous experiments and most important takeoffs. For service in the development of rocket engineering, S. P. Korolev was awarded the highest recognition of society, the medal "For outstanding effort", by decree of the Presidium Bureau of the Central Soviet for Special Aviation.

GIRD ended its independent existence in the fall of 1933, being merged into the Propulsion Scientific Research Institute (RNII). Korolev, as well as the GDL leadership, had placed the matter of setting up such an institute before M. N. Tukhachevskiy. On February 25, he, along with GDL representatives, who had come from Leningrad for a meeting with the Administration for Military Inventions, had talked

over the structure of the future institute. On October 31, on the motion of M. N. Tukhachevskiy, the Soviet for Labor and Defense affirmed the 'Establishment of an organization on the GDL and GIRD framework, the first Propulsion Scientific Research Institute in the world.

On November 9, 1933, Korolev was named Deputy Chief of the institute. He received a soldier's rank of a divisional engineer, and got to wear two rhombi in his collar-buttons. Before discussing the work of S. P. Korolev in the RNII, a recollection of M. K. Tikhonravov should be brought up concerning that period of their lives:

"Within the portals of No. 19 on Sadovo-Spasski Street in Moscow, there lived two persons, two engineers from GIRD, who were quartered in the courtyard of this house. They were going to the tramway establishment — at that time the streetcars still went along Sadovo loop — to inquire about travelling to that region of Moscow where they were organizing an institute, which was to unify the efforts of two of the most innovative groups in our country for working out the basic problems of jet propulsion.

"I would like to know", said one of them, "who will design and build a vehicle for flying a person into space?"

"Naturally, this will be a group, certainly a group!" answered the other. "Both you and I know we will be in this collective. And if even not a one of our rockets should fly into space, it wouldn't mean that we won't live to see man in interplanetary flight. Certainly, we'll live to see it, as spectators, and maybe we'll fly into space ourselves. It will come, there will be remarkable days!"

In this conversation of two dreamers, who turned out to be sober realists at the time of reckoning, one heard the assuredness of Sergey Pavlovich (the reader, of course, has guessed by now that one of the speakers was Korolev) that victory in space would be achieved by a collective ("certainly a group!"). And further, the remarkable prediction: "Certainly, we'll see it as spectators, and maybe, we'll fly in space ourselves!"

The GIRD members entered into RNII with their own plans and ideas, and this faith in the future rockets. Thus, Sergey Pavlovich was flight-testing already in May, 1934, the winged rocket 06/1 which had previously been worked out in GIRD by Ye. S. Shchetinkiv under his guidance. It completed a flight May 5, flying up about 200 meters. Externally it was a copy of the tailless glider. The engine from rocket 09 was installed in it, running on liquid oxygen and gasoline in the form of a gel.

Unfortunately, in the literature, the construction and testing of winged rockets in our country has been poorly discussed. Similar research was carried on later abroad. For example, in Germany, a winged war rocket was proposed in July, 1941, and its first flight in battle took place June 13, 1944.

When the author of this book told Sergey Pavlovich of a wish to describe the birth of our winged rockets, he quickly got back a letter in which (Korolev) warmly supported this idea.

He wrote: "Truly, in the USSR we were working with winged rockets many years ago and earlier than abroad." And then he gave some advice on how to prepare such material: "One must set it down... seriously and basically, as one must when writing on the memory of something dear and important in the history of our native technology. S. P., 6-5-65."

How to Conquer the Stratosphere?

In 1934, from March 31 to April 6, the First All-Union Conference on Study of the Stratosphere took place in Leningrad. Eminent scientists, representatives of the Air Force, Civil Air Fleet, and Aerochem, participated in its proceedings (The USSR Academy of Science acted as the convocation initiator for the conference). Academician S. I. Vavilov made the opening address to the conference. He was a future president of the Academy of Sciences. He introduced interesting data on what kind of interest Soviet science was developing already in the beginning of the 1930's among our entire public on research matters of the stratosphere. When the

call for the first conference on studying the stratosphere was put out, a letter arrived from the Northern part of the country from state farm worker T. Golub.

"The animal husbandry workers of the Komi state farms send brotherly greetings to the participants of the Conference on Studying the Stratosphere...The proletariat in studying the sky is making a 'heaven' on earth, bending the force of nature to the interests of mankind...The study of the sky is and has been a matter not only for scientists, but also for every herdsman, nomad, and worker...: We suggest an All-Union society for studying the stratosphere. The first members of this will be the animal husbandry workers of the Northern state farms, and also myself, personally, for which I contribute an enrollment sum of 25 rubles. Please tell me the amount and where to sent it."

S. I. Vavilov thanked the state farm workers and the author of the letter, in the name of the conference participants. It clearly showed all the attendees what kind of sympathy the laborers of their country would present to the acts of the Conference, if they turned far away from immediate, practical results. S. P. Korolev, sitting in the hall, was very pleased with Golub's plea: "to know the sky."

Representatives of the Civil Air Fleet, Aerochem, and the factories were welcomed to the conference in the name of Soviet fliers of the legendary I. U. Pavlov Red Army Air Group of the civil war period. A greeting was received from K. E. Tsiolkovskiy. The conference sent him back a cordial telegram in reply.

The problems of rocket engineering played a large role in the conference work. Even in the opening address, Academician S. I. Vavilov pointed out: "The conference has to consider decisions on the most rational designs of stratospheric balloons, and the prospects of stratospheric navigation with rocket flights." Professor N. A. Rynin spoke the most usefully on technical means of mastering the stratosphere.

Professor N. A. Rynin was a colorful figure in domestic aviation. He alone of the older Russian balloonists and fliers was a scientist who dedicated great efforts to aviation and ballooning matters. During the Soviet period, Nikolay Aleksandrovich became attracted to rocket technology and cosmonautics. He became friendly with K. E. Tsiolkovskiy. After twenty years, Rynin put together the first encyclopedia in the world on cosmonautics — the "Interplanetary Report", which had received the enthusiastic endorsement of Tsiolkovskiy.

Sergey Pavlovich knew well the efforts of Rynin and valued them highly. Korolev and Rynin had worked at the same time on the magazine, "Aircraft". In Rynin's articles there was a useful review of everything being done abroad in rocket engineering.

In his paper at the conference, Rynin devoted a special section to rocket navigation in the stratosphere, which testified to the far-sighted progress of our science in beginning a thirty year affair in achieving high speed and altitude flight. The most interesting thing was the absoluteness with which N. A. Rynin emphasized the need for shifting in the future from piston to jet engines.

Also, especially interesting to the listeners, it might be supposed, were Sergey Pavlovich with an analysis of the work of F. A. Tsander, Crocco (Italy), Senger (Germany), and a review of actual engines. Also, a useful classification of rocketplanes, models, and stratospheric planes was quite penetrating.

A concluding summary made by Professor N. A. Rynin was based on the recent data of the science of that time, and evoked the applause of the audience:

"These prospects appear the most realistic....flight of jet strato-planes are possible to altitudes up to 50 kilometers, and rocket flights are even higher. The fundamental problems requiring solution for mastering the stratosphere are, at the present time, theoretical and experimental study of aerodynamics at high speeds.... a rocket working on liquid fuel..."

After N. A. Rynin the specialists appeared concerned with studying the design and flying of rockets. The first to come out to the podium was M. K. Tikhonravov, representative of the first graduating class of the N. Ye. Zhukovskiy Academy. His paper was titled: "Application of rocket aircraft for investigating the stratosphere". In it, Mikhail Klavdiyevich primarily gave the basic determinations of rocket technology which were concluded in the results of the GIRD work and the first RNII studies.

Tikhonravov opened by giving a schematic of the rocket of that period, so that the rocket concept could be understood. He gave a useful outline of the question of rocket potential. These scientifically based propositions were developed, as we shall see further, also in the paper of S. P. Korolev.

At the conference, all the confusion and illiteracy, which were sometimes published then in print, were subjected to a friendly criticism. For example, Tikhonravov cited one of the current magazines, "In the Struggle for Technology" (No. 1, January, 1933): "To test the force of recoil", the magazine wrote, "a powerful solid rocket was constructed. It was fastened to a telegraph pole. On being lit, it hurtled away with a speed of 1000 km per hour, carrying the pole along with it", and so on.

S. P. Korolev and M. K. Tikhonravov also spoke up at the conference about guarding rocket technology from this type of popularization. They pointed out directly that "the rocket will have the advantage where other devices cannot be used. Consequently, at lower altitudes, up to 30 km, the rocket won't give results equivalent to these other devices. However, for altitudes higher than 30, they then are of significant interest... Here begins the field of rocket activity."

M. K. Tikhonravov outlined the possibilities of using rockets in stratospheric research. He touched on the problem of carrying persons using a rocket. But this matter was covered in its entirety by Sergey Pavlovich in his presentation at the conference.

Korolev began his paper with a well-known aphorism: "To conquer an enemy, one has to study him well". The meaning of these words is clear: the enemy he is considering is the stratosphere, in which he is faced with flying. Further, Korolev emphasized over and over that it is important not to make a simple ascent into the stratosphere, but to complete the flight on a set trajectory. "These matters," he said, "are for rocketeers sick matters, a kind of soft spot in our work..." And he tried to illuminate this complicated topic, which he was placing before science. As we see, he was one of the first to introduce the household word so widespread nowadays: "rocketeer".

Sergey Pavlovich gave a classification of rocket equipment according to the form of fuel on which their engines operated — solid fuel, liquid fuel, and air-breathing. He also distinguished especially the potentials of each group of devices. In regard to solid-propellant engines, he said: "The area of their application would be shortening the takeoff of aircraft, or in a few words, using a rocket to start them."

On the other hand, Sergey Pavlovich attributed a more essential place to rockets with liquid engines for flight missions in the stratosphere. Here are the characteristics of these rockets given by him: "It is indispensable to point out the great significance of feasible designs whose operation doesn't appear to be in short-lived ballistic shots, and which can be extended for an arbitrary period. An intentionally altered operating regime is possible, i.e., a controlled engine."

To these engines he attributed the basic role of rocket equipment to fly people to high altitudes. Sergey Pavlovich fortified this judgement with accounts of all types of equipment specifications for liquid-fueled engines.

The first, which Sergey Pavlovich examined, was the crew weight. "Here," he said, "one can talk of one, two, or even three persons"... The second was the life-support supply. "This," Korolev declared, "includes all the installations, equipments, and supplies to maintain

crew living conditions during their work at high altitude". The third was "the cabin, which will obviously be air-tight." Sergey Pavlovich put the cabin weight at a half-ton.

Sergey Pavlovich went through an analysis of the weight and specifications of the power equipment just as thoroughly. According to his opinion, it had "to allow takeoff and flight (altitude gain) in the lower layers, in the troposphere. Further, there had to be a flight at high speed in the stratosphere. And, finally, a downward glide and landing."

Sergey Pavlovich cautioned all who approached the problem of rocket flight too lightly: "Rocket equipment will hardly be more simple or lighter in weight than aviation designs known well enough to us... Its weight will be measured not in tens, not in hundreds, or perhaps, a thousand or couple of thousand kilograms, and more".

Then he sketched out the takeoff conditions of the future device: "Independent of the way the takeoff is carried out, it can be said that it will be, at least in the very first part, rather slow. This will occur primarily because the human organism will not withstand large accelerations. Accelerations on the order of four (times gravity) are permissible, but then only for limited spans of time. In addition, the lower, more dense layers of the atmosphere are best penetrated at smaller speeds... In this fashion, we see that rocket equipment in the takeoff and altitude gain period is quite far from fabulous speeds (and....accelerations) about which we read and hear so much."

Further, Sergey Pavlovich introduced a table of rocket engine fuel expenditures and added: "I recommend this table to the attention of designers who are inquiring about flying into the stratosphere on devices equipped with liquid-fueled rocket engines."

Then the words of Korolev echoed as an appeal to the metallurgists on the need to find new heat-resistant alloys, and as an education to all the inventors of the USSR:

"On the opening day of our conference, in greeting it in the name of BOIZ (All-Union Society of Inventors, author), comrade Chudnovskiy....undertook the efforts of the inventors to fulfill the socialist decree for the speedy conquest of the stratosphere. In the name of the propulsion people, I can transmit to comrade Chudnovskiy the specifications for fuels, for high-flame resistant alloys, or for pumps or other equipment for supplying large fuel expenditures, and the like. A number of unresolved matters should also be kept in mind, such as: steering rocket devices, their stability, landing problems (which, as might be supposed, will be a difficult matter), the need to make completely new devices for steering, various controls, etc."

Sergey Pavlovich joined the opinion expressed by O. N. Rozanov and V. S. Pyshnov, about the limited potentials of the air-screw group of flying devices, with whose application "flight speed in the stratosphere would hardly exceed 700 kilometers per hour." The correctness of this opinion was justified by the subsequent development of aviation.

But, on the other hand, Sergey Pavlovich saw the prospects for rocket devices quite happily: "The altitude and speed limits which rocket flying machines will have are significantly higher. But I won't undertake to set these numbers down today because of the stream of information which still is coming in, and due to other considerations. And if rocket devices don't have the immediate and low limits, such as those for stratoplanes with propeller-motor types, then these are still quite far from actuality".

And there were noteworthy phrases in his conclusion: "Work on rocket flying equipment is difficult, but unusually interesting and multi-faceted. The difficulties, in the final outcome, are completely surmountable, although perhaps with a little greater effort than might be apparent at first glance".

Associate member of the Academy of Science, B. V. Raushenbakh, reminisces on what kind of impressions S. P. Korolev's appearance at the conference occasioned among the participants: "In 1934, as a

student, I entered the Academy of Science conference hall. I recall only his paper. I was thrilled by his confidence that one could and would fly in machines with rocket engines".

Another also speaks of the interest in the scientist-rocketeer papers. When the greeting to them had been presented, the President of the Academy of Science, A. P. Karpinskiy, left the chairman's post and sat right alongside those presenting papers, and listened attentively to them, with his hand held up to his ear.

After the session at which S. P. Korolev and M. K. Tikhoravov appeared, the young specialists in cosmic rays, the astronomers, surrounded them. They wanted to know when rockets were going to lift investigators, or maybe just the apparatus, higher than the aircraft or strato-balloons, beyond the limits of the atmosphere.

"An Intelligent, Interesting, and Useful Book"

Sergey Pavlovich didn't limit himself to merely appealing to scientists, designers, and engineers to push rocketry ahead. In trying to make rocket construction a nation-wide matter, he wrote a book, "Rocket flight into the stratosphere", which was issued by Voyenizdat (Military Press) in 1934. At that time, this book popularized the concept of rocket technology, making it understandable to soldiers, workers, and students. Now it would acquire a new tone, as evidence of the formulation and development of the ideas to whose incarnation Korolev was devoting his whole life.

In the foreword, attention is drawn to the categorical acceptance of rockets in the role of "the exclusive and irreplaceable means for high and ultra-high flights and attaining enormous speeds".

And further in the foreword, there is expressed the reason why it was necessary to popularize knowledge of rockets widely: "In order to avoid any possible surprise or unexpected occurrence", said Korolev, and he forewarned on the import "of all the efforts being carried on in these areas in imperialist countries....for war aims".

In his book, S. P. Korolev presented a classification of rockets according to their construction.

He placed wingless rockets in first place. We now call them ballistic. They are basically a modern rocket arsenal. In second place were the winged rockets, which nowadays have enormous ranges.

Korolev made a special place (and not without foundation, as science has since shown) to rocket devices made up of a number of successively-functioning rockets. "This is a rocket", as Sergey Pavlovich explained, "which is detached and jettisoned in flight to make things lighter."

Then finally Sergey Pavlovich dealt specially with a group of guided missiles, which in the future would be the really last word in technology. He foresaw such rockets guided either automatically or by people located aboard.

In the chapter, "Characteristics of rocket engines and equipment", a thought was emphasized which organically resulted from the very serious attitude of Sergey Pavlovich to problems of rocket flight: "The unusual simplicity and even the evident straight-forwardness of rocket devices should not serve as a reason for excessive frivolity towards working in this area."

"...The course traversed, set by inertia, without a motor, can constitute a very large quantity, several times over the length produced with the motor", wrote Korolev. With the modern ballistic rocket, which has a range up to 13 thousand kilometers, the powered portion constitutes a tiny part of the course, and the rocket flies on due to inertia.

In one chapter, Sergey Pavlovich examines the potentials of using rocket devices, and notes in ending, not without humor: "The short list presented is rather limited to those rocket devices which have a chance of being used for some purpose or another, leaving out all the rest of the matters in the realm of the fantastic, where

they hardly have to be justified."

Sergey Pavlovich put the main attention in his book on equipment and rocket engines with liquid fuel, which even then were promising to lift persons to high altitudes. And in his remarks on the scientist from Kaluga, there resounded the pride of a patriot: "K. E. Tsiolkovskiy is rightly considered the founder and theoretician of rocket flight, our scientist, well-known for his works in the various areas of science."

Sergey Pavlovich already recognized the efforts of Tsiolkovskiy in their historical development:

"The rocket working on liquid fuel was already proposed by K. E. Tsiolkovskiy in 1903", Korolev wrote in his book, "as a means for flying people into interplanetary space. At that time K. E. Tsiolkovskiy still had not given the outline of his flight to the stars, considering the necessary preliminary, more detailed working out of his idea to be the principal aim..."

"With the development of his designs, K. E. Tsiolkovskiy paid more and more attention to the very source of rocket motion — the rocket engine, problems of fuel supply, engine control, etc."

Then Sergey Pavlovich once more repeated the conclusion again: "Only by having an engine, working on a new principle, as well as being sufficiently reliable and perfected, can a flight at high altitude be completed, and possibly, sometimes even into interplanetary space".

In reviving the notion that the engine had to be the center of attention, Sergey Pavlovich made use of aviation history, which was well-known to him: "During that time, there were no motors, all the projects remained in the realm of fantasy, and practical experiments didn't go any further than leaps completed over short distances, quite frequently ending catastrophically."

Obviously remembering his unsuccessful attempt to make a light plane having a long radius of action, Sergey Pavlovich forewarned: "Even now, notwithstanding the tremendous progress in aviation motor construction technology, many tasks are not resolved because of a lack of equipment."

When he wrote these lines, truly, he was remembering that hazy summer day, the field by the hangar, where the pieces of his SK-4 were piled up in disarray, the flier Koshits sitting on the grass alongside, noteven aware of his dirty hands and face. His chagrin was great, that the only model of the machine was destroyed. The grief of this failure continued over the years, and Sergey Pavlovich even joked with Koshits, remembering the wreck:

All the seven gathered
About the broken body,
Koshits face was smashed,
Only I was smiling...

And in the book, wiser with life, he over and over emphasized the domination of all the remaining sections of rocket engineering by the engine problem:

"All the remaining, even the most complicated, matters in working with flying models and entire objects (and they will fly safely in case there is a reliable engine), will absolutely be cleared up in good time and sufficiently completely."

In Sergey Pavlovich's declarations that the rocket would fly safely (!) if there was a reliable engine, and that all the matters would absolutely be eventually and sufficiently completely cleared up, the confirmations have been accomplished. His already accumulated experience in designing and flying home-grown rockets gave Sergey Pavlovich this faith in his conclusions.

The author reminisced further on his accounts of the Rocket-plane based on a glider with a delta shape. Its wingspread was 12.1 meters, the glider length of 3 m, height 1.25 m, wing area 20 m^2, and weight without the engine was 200 kg. In the glider centerbody, the

rocket engine, the tank, and all connections were installed. There were rocket engines with different thrusts — 50 and 100 kgf.

And what was attained? On the first occasion, the glider run with the rocket engine took one minute, the ground speed reached 139 km/hr over a distance of 810 meters, and the flight continued for six minutes and a distance of 13 km. The second time, the run took three minutes, and the ground speed reached 200 km/hr over 1400 km. The flight was continued four minutes and a range of 20 km.

From this example, Sergey Pavlovich made the conclusion that with a thrust of 50 kgf, the flight would actually be completed with great difficulty and over an insignificant distance. There would be more success with a 100 kgf thrust, but for a longer-lasting flight one would have to take on such an amount of fuel mixture that the device would hardly get into the air. And again the author asserted that in the future, a person could certainly achieve the ascent using a liquid rocket engine device at some altitude above the Earth, and with a flight over a more or less extended interval of time along the assigned route.

In this book Sergey Pavlovich made the first weight calculations of the high-altitude plane with an LRE (liquid rocket engine), about which more information will be given later on. He gave merely the rough data on the weight of the crew (from 100 to 300 kg), the sealed cabin (about 300 kg), and the total weight of the device (2000 kg).

The author analyzed the chances of lowering the weight of the thrust equipment by the choice of a system for supplying the combustion chamber with fuel. The author considered a pressure-fed system which necessitated high pressure in the tanks and consequent tank reinforcement to be less feasible than a pump system, but he emphasized this was true for especially capacious tanks. Actually, pumped fuel supply systems for large-size rockets today are considered more advantageous than pressure-fed ones according to weight data.

Pilotless rockets, in the author's opinion, would outstrip planes in reaching high altitudes. From his lips, the lips of a strict realist, the words about the wingless rockets echoed quite convincingly: "Achieving heights of 20-50-100 km using, for example, wingless rockets will be a completely matter-of-fact occasion". This was being said while the flight distance of planes on the whole amounted to several kilometers.

"Theoretically," Sergey Pavlovich reminded, "the rocket doesn't have a limit." And here he emphasized the quite exclusive place of the rocket in investigating the stratosphere.

In examining the scientific significance of the rocket, Sergey Pavlovich was already forecasting to the readers in 1934:

"It is understandable that in the imperialist countries the rocket will be used least of all for scientific and investigative purposes. Its chief assignment will be for war, for the significant altitude and distance of its flight are the most valued qualities for this use".

Life vindicated the prophetic words of S. P. Korolev. Beginning with the Second World War, the significance of the rocket in military affairs grew more and more, until it emerged in first place among all other forms of weapons.

In the conclusion of his book, Sergey Pavlovich warned against excessive optimism in regard to using rockets for flights into the stratosphere and interplanetary space: "It should be understood," he remarked," that the future conquest of the stratosphere, and the present-day expansion of aviation on the Earth depends exclusively just on how soon we can put a rocket engine on a plane. But in the long run the matter doesn't turn out so simply and clearly. Human flight in a rocket is still impossible. Trips into the stratosphere with pilotless, wingless rockets is a task for the present day."

And once more Sergey Pavlovich enunciates the catchword of this stage of rocket development: "The rocket motor is the center of attention!"

Right after this, he brought out another appeal: "Away from the usual places of drawings and plans, to the serious scientific examination of each separate theme!" Then here he gave some concrete thoughts on investigating and solving problems with respect to the rocket engine.

"We are sure," Sergey Pavlovich closed his book," that in the very near future rocket flying will be widely accepted and will occupy a deserving place in socialist engineering. Aviation can serve as a clear-cut example of this. It has achieved such a scale and has been successful in the USSR. Rocket flying, certainly, can hardly aspire to less in its area of application, and in time has to become something ordinary and determinable."

At the present time, in the epoch of rocket weaponry and cosmonautics, the success of rockets has actually become ordinary and determinable.

The book of Sergey Pavlovich drew response from the aviation press. "News of the Air Fleet" gave it a good review. Basically the newspaper noted the chapter on the engines. "In this chapter," it said in the review, "the understanding of rocket engines and their elements is set out clearly and unusually briefly, and with a short classification of existing rocket systems. This chapter is particularly interesting".(4)

The magazine "Aircraft" included Sergey Pavlovich's book in a list of those books "indispensable for an aeroclub library".(5)

K. E. Tsiolkovskiy warmly recalled the book on February 8, 1935,

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Footnotes (4) and (5) appear on page 108.

in a letter to the Stratospheric Committee (V. A. Sitin): "....S. P. Korolev sent me his book, 'Rocket Flight', but he didn't put on his address. I don't know how to thank him for this kindness. If possible, send him my thanks, and let me know his address. It is an intelligent, interesting, and useful book."

The complimentary evaluation of the founder of rocket engineering echoed as a good exhortation to the author. Now that 34 years have passed from the publication date of the book, it is obvious how important it was at the time to determine the actual needs in the development of rocket technology, and to state that it would be useful in the very near future.

Wings Again

After the merger of the two groups — GIRD and the GDL — into the Rocket Scientific Research Institute (RNII), Korolev made a correct choice which had far-ranging consequences. The scientist and designer preferred the immediate solution of urgent scientific-experimental problems in rocket engineering to administrative work.

In the institute he became even closer to his companions working with him on winged rockets — his first assistant Ye. S. Shchetinkov, the specialist on gyroscopic autopilots S. A. Pivovarov, and the young engineers M. P. Dryazgov, B. V. Raushenbakh, and A. V. Pallo.

In this friendly group there was also born the idea of launching a whole series of winged rockets indexed as 06/1, 06/2, etc. (the serial number of the rocket would be indicated in the denominator). Rocket 06/1, which was conceived as a tailless glider model with the engine from rocket 09, was already tested earlier. Rocket 06/2 looked like a copy of the future large rocket 06/3 (another nomenclature was 216). "The Heart" in it was that very same engine that the first liquid rocket 09 had.

M. K. Tikhonravov reminisces on the flight of the winged rocket 06/2. In addition to him, Korolev, Shchetinkov, and the mechanics were at the takeoff. At takeoff the rocket rushed upward and went

into a loop. In closing the outside loop, it flew by about five meters from the people at an altitude of two meters. The engine kept running and the rocket went into a second outside loop and finally crashed into the Earth.

After the flight dynamics on model 06/2 were worked out, the construction of rocket 06/3 was begun. This had the shape of a miniature plane with a wingspread of three meters. The 02 engine initially designed under Tsander was installed on it. Later they began to design and build the fourth winged rocket (alternate designation was 212). This was a long-distance rocket.

After the successful winged rocket flights, Sergey Pavlovich became a section leader, and later even a division leader.

Why were the experiments with winged rockets so remarkable? In them the peculiarities of designing and building pilotless devices were revealed. An original method of testing the rockets was found, for which special stands and instrumentations were set up. Thus, Korolev and his aides applied a rocket takeoff with a catapult for the first time. A long rail guide, on which a carriage ran, was constructed for this by them. Solid engines were on it. They served as takeoff accelerators, driving the carriage and the liquid rocket being launched, which was installed on it. After separation from the cart, the rocket then flew under the power of its own engine The rail guide with the propelled carriage subsequently was widely used in the USA for testing rockets.

Much interesting and feasible (activity) was carried on in controlling and stabilizing winged rocket flight in the efforts of S. P. Korolev's division. A self-aiming system was even proposed and the accessories necessary for it were ordered, but unfortunately it was never received at RNII. Nevertheless, work on making automatic stabilization and control was continued through their own efforts. Engineer Pivovarov was directly concerned with this in Korolev's division. Several gyroscopic stabilization devices (GSD) were designed. These devices were tried out at first on solid rockets with wings. Then these automatics were transferred to

rockets with LRE. The most complete control using automatics was applied to the 06/4 (212) rocket.

On the surface it reminded one of a small plane with rectangular wings and tail and rudder control. Fuselage length amounted to 3.16 m, wingspread was 3.06 m, and fuselage diameter was 0.3 m. Flight weight was 210 kg. Of this, 30 kg was taken up by fuel and another 30 by the warhead. Internally, the fuselage was divided up: warhead in the nose section, then the gyroscopic stabilization equipment, and automatic control. In the tail section the liquid propulsion engine ORM-65-1 was situated. It was installed in a special frame and covered with a streamlined cowling with metal flaring to shield the rocket rudders from the flame of the propelling jet.

S. P. Korolev and his workers built this rocket in 1936. The calculated range for it was 50 km. The first firing trials were carried out on April 29, 1937. Such ground trials in 1937-1938 amounted to 13.

Two other winged rockets had indices 201 and 217. Rocket 201, according to contemporary representations, might be put into the "air-ground" class. Rocket 217 might be called an anti-aircraft rocket, with aiming along a projected beam. Incidentally, the group which Sergey Pavlovich headed was planning to install self-steering equipment on its winged rockets.

While busy with efforts on pilotless winged rockets, Korolev didn't abandon the prospects of building a rocketplane. The most detailed analysis of the chances existing at that time to make such a device was contained in his presentation at the Ist All-Union Conference on using rocket equipment to study the stratosphere, which took place March 2, 1935, at the M. V. Frunz Central House of the Red Army.(6)

Footnote (6) appears on page 108.

In this presentation, Korolev first outlined the peculiarities and possibilities of piloted rocket schemes precisely, and examined their weight and flying characteristics.

"From various inventors," said Sergey Pavlovich, "there has been proposed at different times a multitude of all kinds of rocket devices, which, according to the notions of the authors, had to bring a revolution into engineering. In the majority of these, the schemes were quite weak, and in particular for the rocket section itself, quite ignorantly devised. Recently there have been many suggestions pertaining to simple installation of a rocket engine (with solid or liquid fuels) on generally well-known types of aircraft. There is not much need to speak on all the worthlessness of such mechanical transfer of rocket technology into aviation".

He showed how, even with all the similarities of rocket and propeller flying devices, there are differences in their flight dynamics, trajectories, and weight data. The rocket plane was presented by Korolev in the form of an internally supported monoplane with a centrally situated fuselage and tail empennage on it. He would assign small wings, little elongation, and small lifting surface to it. The fuselage would have a significant length and would basically be occupied by the engine, tanks, and the engine feed equipment. It was possible that the wing would also be used to accommodate various engine accessories and apparatus.

Sergey Pavlovich in his presentation pointed out exactly those key questions in creating a piloted rocket, on which the success of the matter would depend. The first was to make a powerful engine on liquid fuel. Korolev considered that the "realization of stratospheric flight of humans in rocket equipment" depended namely on the solution of this problem. The second was to make a sealed cabin of large dimensions, which would represent a grand effort in itself. The third was making and developing "very high-altitude apparatus and the unusual difficulty of working with huge amounts of liquified gases".

in a letter to the Stratospheric Committee (V. A. Sitin): "....S. P. Korolev sent me his book, 'Rocket Flight', but he didn't put on his address. I don't know how to thank him for this kindness. If possible, send him my thanks, and let me know his address. It is an intelligent, interesting, and useful book."

The complimentary evaluation of the founder of rocket engineering echoed as a good exhortation to the author. Now that 34 years have passed from the publication date of the book, it is obvious how important it was at the time to determine the actual needs in the development of rocket technology, and to state that it would be useful in the very near future.

Wings Again

After the merger of the two groups — GIRD and the GDL — into the Rocket Scientific Research Institute (RNII), Korolev made a correct choice which had far-ranging consequences. The scientist and designer preferred the immediate solution of urgent scientific-experimental problems in rocket engineering to administrative work.

In the institute he became even closer to his companions working with him on winged rockets — his first assistant Ye. S. Shchetinkov, the specialist on gyroscopic autopilots S. A. Pivovarov, and the young engineers M. P. Dryazgov, B. V. Raushenbakh, and A. V. Pallo.

In this friendly group there was also born the idea of launching a whole series of winged rockets indexed as 06/1, 06/2, etc. (the serial number of the rocket would be indicated in the denominator). Rocket 06/1, which was conceived as a tailless glider model with the engine from rocket 09, was already tested earlier. Rocket 06/2 looked like a copy of the future large rocket 06/3 (another nomenclature was 216). "The Heart" in it was that very same engine that the first liquid rocket 09 had.

M. K. Tikhonravov reminisces on the flight of the winged rocket 06/2. In addition to him, Korolev, Shchetinkov, and the mechanics were at the takeoff. At takeoff the rocket rushed upward and went

Sergey Pavlovich examined the way to overcome these difficulties. And he did this from the basis of exact calculations, illustrating his conclusions with numerous graphs. The concentrated expression of his thoughts was found in the data derived by him for the simplest winged rocket to fly a human into the stratosphere under minimum weight restraints. Sergey Pavlovich named such a weight as 2 (metric) tons. He alloted 5.5% of the total weight to the pilot in a pressure suit, 2.5% to the engine, 10% to the pressure tanks, 10% to the (propellant) tanks, and 22% to the body construction. The remaining half of the weight consisted of fuel. Sergey Pavlovich calculated that with an engine specific impulse of 200 kg/kg/sec and a thrust of 2000 kg, such a rocket would be able to lift a person to an altitude of 20 km.

A rocket flight with the most modern engine was sketched out by Korolev as follows: the rocket would be driven up to a speed of 80 m/sec on the ground by the jettisonable solid accelerators: it would then take off and begin an ascent to high altitudes at an angle of 60° with its own engine. After using up all the fuel the rocket would switch into vertical flight on inertia and would reach an altitude of 32,000 m. From this altitude it would regain a speed of 600-700 m/sec (i.e., double the speed of sound). The flight time was suggested as about 18 minutes and the range as 220 km.

"In all of our calculations", said Sergey Pavlovich, "we reached a very modest altitude, on the order of 20 km. Looking somewhat ahead, weeding out technically disadvantageous designs, perfecting the engine, we see the chance of reaching a height of the order of 30 km. And even this, which is not really so large, a high altitude is not reached so easily".

Sergey Pavlovich explained further that he stayed away from definite values of speeds for takeoff, landing, etc., in his calculations. "A real rocket," he said, "may turn out worse than that designed."

"What can still be done?", he posed the question for himself and answered; "One has to seek new rocket designs". He suggested trying

out combined and staged rockets. "A large rocket," he declared, "would have a smaller one on it up to an altitude of, say, 5000 m. Further, this rocket would lift an even smaller one to an altitude of 12,000 m., and finally this third rocket or maybe a fourth would easily fly at several tens of kilometers up."

He also made another suggestion: "Possibly, one will profitably ascend without wings, and for descent and horizontal flight, let out fins from the rocket body which would develop a lift force."

In addition he repeated again and again: "The most fundamental thing is that one has not only to perfect the engine and its accessories, but also to seek new methods and apply new fuels".

Looking over the material of the conference at which Sergey Pavlovich appeared and reading the collections of rocket articles at that time, one can see that not he alone was busy with the problem of rocket equipment. V. I. Dudakov, for example, analyzed takeoff with rocket accelerators, Ye. S. Shchetinkov was considering rocket-plane flight, V. P. Vetchinkin was exploring the characteristics of a vertical flight device.... But in the presentations of Korolev, there was something distinguishing him from the others. He felt the thrill of news and the latest word in rocket affairs, and could simply and clearly tell about it even to nontechnical people. In his own theoretical efforts he acted not merely as an investigator, but as an agitator of the concept of flying a rocket, and as an organizer in the struggle for its speediest realization.

And in the dossier of the conference, and in an article in the journal, "Air Fleet Engineering", Sergey reached a practical conclusion from his considerations: it was necessary to build a rocket-plane laboratory. Therefore, Sergey Pavlovich left from the GIRD work, and got busy installing a rocket engine on a device for experimental-type flights. The reporter showed a drawing on which there was outlined the glider constructed by the engineer Cheranovskiy for GIRD in 1932. "The glider was planned." declared Korolev, "with the experimental engine system of the engineer Tsander. Engine trouble didn't allow carrying out flight testing".

Sergey Pavlovich explained further: "If one isn't aiming at setting some kind of special record, then, certainly, at the present time the idea of building a laboratory device presents a means with which one might systematically carry out studies on various rocket devices in the air."

"On it one might set up the first tests of jet engines and a whole series of other experiments, after first boosting the device to the altitude necessary. The ceiling on such equipment might reach 9-10 km".

"Setting up the first rocketplane-laboratory to carry on a series of scientific studies, although difficult at the present time, is,however, a possible and indispensable task which confronts Soviet rocketeers right now in the current year."

In concluding, Sergey Pavlovich once more noted the enormous significance of the correct approach to rocket flight problems:

"Winged rockets are of great importance for ultra-high human flight and for stratospheric research."

"A further task lies in stubborn, everyday working, without excessive fanfare and advertisement, such as unfortunately frequently requires even now a great many efforts in order to storm the foundations of rocket engineering and to occupy the upper strato- and ionosphere first. The tasks for the entire public, the job of the Aviation Section and Aerochem are to aid in this area in every way, and also to establish the correct thematics on rocket affairs for the lower echelons of society, the inventors, and the literate popularization of the rocket flight concept."

At that time when Sergey Pavlovich was working on the design of the winged rocket, an appeal was directed to him from the writer Ya.I.Perelman, a popularizer of rocket concepts, with a request to tell about himself and his comrades in RNII. On April 18, 1935, Sergey Pavlovich answered this request thus:

"Highly esteemed Yakov Isidorovich!"

"Your request placed me in a rather trying situation, that is to say, really, how does one tell a ranking engineer about one's personal work? I also would rather not characterize the work of my comrades in the institute (Glushko, Tikhonravov, and the others). I can only say that they are both very knowledgeable people, deeply committed to rocket affairs, and dreaming of the future paths on high of our Soviet rockets. I personally work mainly on human flight, about which on March 2, this year, I gave a paper in Moscow at the Ist All-Union Conference on application of rocket devices for stratospheric research...."

"I suggest that for your efforts it would be of obvious interest in line with your proposals and appeals, even more so, since all the material has been publicized previously. The conference resolved to build during the current year a winged rocket-laboratory for human flight at moderate altitudes (up to 6-8 km). Right now I am working along this vein."

"I assign a very great significance to the jet engine, on which Yuriy Aleksandrovich Pobedonostsev (still with us in RNII) is working...."

"RNII is occupied with a full array of matters on making various flying rocket devices, on several informal applications of rocket engines, plus a number of collateral and attendant studies. We are working on making rocket engines using various fuels; on stratospheric rockets; and on winged rockets for human flight."

In closing the letter to Ya.I.Perelman, one can find proof of how much responsibility Sergey Pavlovich was shouldering himself at that time:

"Forgive me," Korolev wrote to Perelman, "for chattering on with such self-evident themes. I will always be glad to get news of your work from you, and although I am loaded down higher than humanly possible, I respond to you with pleasure."

"Sincerely yours, S. Korolev".

On reading the expressions of Korolev shown above about the merit of the immediate and maximum development of winged rockets, the reader might think that all his interests in this period of life were fundamentally just these rockets. But Sergey Pavlovich had a wider view. As proof of this, one can quote the following fact. That very year, 1935, a proposal was considered in RNII on temporarily cutting off effort on a wingless ballistic rocket. The institute leadership was favorable to the proposal. However, Sergey Pavlovich spoke up categorically against it. He declared, as told in the minutes of the session:

"It is absolutely necessary not to cut off studies on wingless rockets, just as it is impossible to run away from design failures — the whole history of technology says the opposite."

And indeed, the wingless rocket has become today the most powerful tool for storming space.

Sergey Pavlovich was changing during the decade devoted to rockets. The youthful fullness of his face faded. The incessant mental effort made the former lively and merry look of his eyes more severe and concentrated. Marks of compassion were noted all over his appearance, and, at times, also reticence.

The approach of Sergey Pavlovich to rocketry also was changing. He aimed at solving the problems arising before him by thorough research. For example, Sergey Pavlovich approached the problem of rocket reliability anew. It had come up more than once in tests. Now he introduced a system of preliminary test stands to work out each design element.

He saw to it that designers of new technology had to go hand in hand with scientists. Thus, Korolev carried the matter of winged rocket flight stability before the consideration of professors of the Moscow University. The theoreticians could help in pointing out how to assure rocket stability, which increased the performance of

the group on flight stabilization and control.

Joining a glider and rocket engine was no longer seen as an end in itself by Sergey Pavlovich. This project remained only as an experiment, for the moment, included in the broader plan to make rocket flying devices.

With him and his closest aides, with Ye.S. Shchetinkov first in line, there unfolded a clear realization of the advantages which would accrue to the use of rocket engines in aircraft — tremendous acceleration and speed.

"Here might be all kinds of records", Sergey Pavlovich said more than once.

How did Sergey Pavlovich see this approach to building a rocket plane? A design completed in 1936 by him together with Ye. S. Shchetinkov tells clearly of this. They proposed carrying out a whole series of logically connected experiments and designs. They considered making the rocket fighter-plane RP-218 as the first step. It was planned for flight at an altitude of 9 km.

Of course, the authors of the project did not limit themselves to speculative presentations, and they began working out the concrete shape of such a device. They sketched its external appearance and considered the construction. They stayed late at the institute, and then went together to Korolev's quarters. In order not to embarass Kseniya Maksimilianova, Sergey would tenderly suggest to her:

"Maybe, you could go read in another room, and we will eat here like bachelors."

Then he would smile ingenuously. Korolev, Shchetinkov, and Pallo, once alone, would set out reviewing their plans. And on the following day their plans were set down as designs on sheets of paper. More and more clearly there emerged from these drawings the contours of the future fighter, equipped — according to the plans

of the designers — not with one, but a combination of three rocket engines with a total thrust of 900 kilograms.

Further, the designers proposed lifting the RP-218 fighter about eight kilometers using a heavy mother-plane, and there it would start out in independent flight. After a short while, it could gain an altitude of 25 kilometers and then complete a landing on the ground.

The designers considered the next step to be achieving a record distance in the rocket plane. And one step further was reviewed by them — a prospective model of a high-altitude machine. It, according to their calculations, might ascend to an altitude of 53 kilometers.

Yes, a great scheme was born in S. P. Korolev's division in the RNII laboratories. Many features of this project exceeded modern tests on the takeoff of rocket planes from on board aircraft and achieving high altitudes....

In June, 1936, the engineering council of RHII examined the project drafter for rocketplane 218, submitted by S. P. Korolev and Ye. S. Shchetinkov, and approved a work program in this direction at the earliest moment. In the decision of the council it was stated: "The Institute divisions should regard the efforts on the 218 in the 1937 plans as one of the leading efforts of the Institute."

For the beginning, it was resolved to build the rocket-plane-laboratory RP-318. Korolev's glider SK-9 was selected as the first of the Soviet flying devices to get a "rocket heart". In 1937 this glider was delivered to RNII. First off, the rocket engine ORM-65, with a maximum thrust of 175 kilograms and a specific impulse of 210 seconds was installed on the rocketplane. During 1937-1938, 30 ground firing tests were carried out with this engine. However, in 1939, the ORM-65 engine was replaced with a modification of this engine, which was called RDA-1-150, with a specific impulse of 180 seconds and a thrust of 150 kilograms. The RDA-1-150 was built in a year and a half.

By that time, the glider was also quite worn out, and it had to be gone over in detail and renovated. In addition, it was outfitted with winter skis and a shroud-diverter covering the rocket engine, which was installed at the end of the fuselage. In order to test how the glider would act in the air, it was lifted into the air four times by the engine. Five ground tests of the rocket engine were carried out directly on the glider.

When the work on RP-318 was at its climax in RNII, Sergey Pavlovich said to Tschetinokov:

"Let's start the joints of 218 with production orders...."

And quickly they began to order ribs for it, wing joint reinforcers, and other parts. They were getting ready to build a rocket fighter...

The flight tests of the rocket plane, made under Sergey Pavlovich's leadership and receiving the designation RP-1-318, were conducted in February, 1940. But before discussing these tests, let us return to events of 1938.

That year the firing tests of the winged rocket 212 were continued. They were successful. This heartened Sergey Pavlovich. He mentally already saw his rocket in flight. And afterwards he was then to outline the takeoff of a sounding rocket along a projected beam, in the "air-ground" class of aircraft.

In 1939, there were two flights of rocket 212, January 29 and March 8. In accordance with the independent nature of the designer, he didn't attend the flight tests himself for his own winged rocket.

The rocketplane tests were conducted without Korolev from plans over which he had then spent many years.

What was this rocketplane like? Let us make a pre-flight rundown along with the flier. Here is the engine. It fits in a special

frame, fuel pipes passing within the fuselage tail section. The tanks are set behind the flier's seat in place of a second seat. The pressure tanks are set in the centerbody of the plane, and the electric batteries are in the nose section. The rocket engine controls are on the instrument panel. The external lines of the glider were also altered — in particular, those of the turning rudder. It has equipment uniting all the elements of a plane and rocket engine within itself.

They chose one of the best fliers and glider pilots of that time to try out the rocketplane, Vladimir Pavlovich Fedorov. They told him, "Keep away from dangerous flights'". Fedorov replied, "I understand". Then he calmly began to make ready for the trial. Later, he loved flight-testing so much that he completely devoted himself to this profession.

The preliminary outline of the tests, sketched out on yellow, rough scratch paper, says a lot. And most of all, because on February 28, 1940, the first free flight of a glider with a rocket engine took place in the USSR.

And this is how it went. The rocket-plane on a P-5 booster took off at 17 hours 28 minutes, and gained an altitude of 2800 meters in 31 minutes. Then the glider was detached, and Fedorov began independent flight. The moment of switching on the rocket engine was approaching. This is how the flier Fedorov subsequently recalled what went on in the air:

"After separation, flight control was established by gliding at a speed of 80 km. Having awaited the approach of the plane which was going to observe me, I began to turn on the rocket engine."

"I did everything according to the instructions. The launch went normally. All control instruments were working well. Turning on the engine occurred at 2600 meters height. Right away an even, dull noise was heard."

"At about 5-6 seconds after turning on the engine, the flight speed increased from 80 to 140 km/hr. After this I established a flight attitude and held it to the end of engine operation. According to the variometer indication, the ascent took place with a speed of 3 meters per second. Over a span of 110 seconds, an altitude gain of 300 meters was produced. On exhausting the fuel supply, I closed the fuel valves and let off the pressure, which occurred at 2900 m height."

"After turning on the engine, the speed increase occurred very smoothly. Over the course of its operation, no influence was noted from my own control of the apparatus. The rocket plane acted normally, and there was no vibration."

"The speed increase from the engine operation and using it to gain altitude was for me, as a flier, a very pleasant experience. After shut-down, the descent went normally. During the descent a number of deep spirals and war maneuvers were carried out at speeds of 100 to 165 km/hr. Landing was also normal".

From the P-5 aircraft, a crew made up of Fikson, Shcherbakov, and Pallo observed the rocketplane flight. They communicated the following:

"When the flier Fedorov switched on the engine, a small cloud of smoke from the ignition blast was noted. Then the flame looked like a starting burner, leaving behind a trail in the form of a light grey stream. Quickly the starting burner flame faded and a long tongue of flame appeared, about a meter and a half long from the engine operation on the basic fuel makeup. In this case, a light trail was left behind in the form of a light grey stream which quickly dissipated. Fuel combustion was complete".

"After engine turn-on the rocket plane quickly increased speed and left us gaining altitude. Our observations were not crowned with success in following the whole test. Although the motor revolutions were maximum, the P-5 aircraft lagged behind the rocketplane hopelessly."

Thus the first-born of rocket technology presented an object-lesson to the propeller plane in developing a speed not accessible to it. This lesson was significant not only for aviation of our own country, but also for the whole world.

The rocketplane landed smoothly. The engineers surrounded the flier. Each one wanted to ask personally how the flight went, how the equipment, the engine, acted.

Ten years had passed from the time Tsander and Korolev first considered the possibilities of rocket flight. And here their dream had taken life, it was a reality.

The first achievement led to subsequent ones after it. Within two years after the RP flight, a fighter-interceptor with the liquid-rocket engine BI-1 was created in a group headed by V. F. Bolkhovitinov. Flier G. Ya. Bakhchivandzhi put it in the air May 15, 1942. Afterward followed the remarkable achievements of jet aviation, and finally rockets and spacecraft.

FOOTNOTES

Footnote (1) page 55 The Gasdynamic Laboratory (GDL) was the first scientific research and experimental design organization for rocket engineering in the USSR. The first domestic engines for liquid fuel were made in the GDL. Type ORM liquid rocket engines, ORM-1 up to ORM-22, were already tested in 1931 and 1932.

Footnote (2) page 66 Archives of the USSR Academy of Science, sec. 4, v. 14, No. 50, subject 16.

Footnote (3) page 74 Archive of the USSR Academy of Science, Div. 4, No. 14, subject 167.

Footnote (4) page 92 "News of the Air Fleet", 1935, No. 3, p. 51.

Footnote (5) page 92 "Aircraft", 1935, No. 9, p. 49.

Footnote (6) page 95 Excerpts of this were published in the journal "Air Fleet Engineering", No. 7, 1935.

PAVING THE WAY TO THE FIRST ORBITAL FLIGHTS

> One of the greatest conquests of all time in science and technology will always be associated with the name of S. P. Korolev... the opening of the age of mastering outer space by mankind.
>
> M. V. Keldysh

On the Drawing Board — The Ballistic Rocket

On the fields of the past war, as on a gigantic proving ground, the latest types of armaments were tested under complex combat conditions. Rockets underwent a second birth. Soviet solid-fuel guided missiles, called "Katushas", revealed themselves as a formidable method of fighting. Accepted the day before the war as armament in the Soviet Army, they found use on all fronts.

In Fascist Germany, whose rulers aspired to world supremacy, new weapons were being feverishly sought.

In the Spring of 1944 it was reported that the Hitlerites were shelling England with V-2 ballistic rockets. Statistics after the war showed that, from September 1944 through April 1945, 1054 V-2

rockets landed on 12 English towns. The total number of deaths from this new weapon was 2724 men killed and 6467 seriously wounded.

The V-2 rocket was more refined than that used somewhat earlier in the V-1 winged missile. It was equipped with a liquid-fuel rocket engine, operating on 75% ethyl alcohol and liquid oxygen. The launch weight of the rocket was 12.9 tons, the maximum flight range was 250 kilometers, the highest point of the trajectory was 82 kilometers, and the maximal flight velocity was 5700 kilometers per hour. The guidance system held the rocket to a given trajectory. Slightly less than half of the rockets launched reached English territory.

It is now obvious that the V-1's and V-2's exerted no substantial influence on the course of the war, although it was specifically this purpose that the Fascist leaders had in mind. This was simply because the German winged missiles and ballistic rockets were imperfect. It was certainly shown also that the economy of Fascist Germany could not ensure the production of guided weapons on really large scales.

Nevertheless the new rocket weapons claimed their place.

There were no liquid-fuel rockets for use as combat weapons in the Soviet arsenals during the war. But the research of our scientists continued in this direction. And on May 15, 1942, our BI-1, with a liquid-fuel rocket engine, appeared in the Ural skies. An engine of this type was also tested as a flight booster for combat planes.

During the war S. P. Korolev had become designer for the wing brigade in the crew of A. N. Tupolev, and by the end of the war he was involved in research on rocket boosters for aircraft.

From August 1944 Sergey Pavlovich was assigned to the experimental design office. Here he was concerned with testing liquid-fuel rocket engines for increasing the speed of combat planes during decisive moments of air combat.

The engines, which were designed at this time in this experimental design office, operated with nitric acid as the oxidant and kerosene as the fuel. The components of the fuel were pumped by the force of the aircraft's piston engine. The mixture was ignited chemically. The design provided for unlimited possibility of fully automated ignition. The force in these engines was regulated. It reached a maximum of 300 to 900 kilograms on the ground.

The first model of the seven aviation boosters was the RD-1. It can now be seen in the "Kosmos" Pavillion in the Exhibition of Achievements of the National Economy of the USSR. This is a genuine relic of rocket technology. It passed official flight testing in 1943. But on-board testing on aircraft continued until 1946. Simultaneously another liquid-fuel rocket engine of a later model — the RD-1Kh3 — was tested as a booster. Four prototypes were built. They were all made in the Design Office, up to the last propeller. All together about 400 flying tests were made on these engines on aircraft such as the Pye-2 of V. M. Petlyakov design, the La-7R and the La-120R of S. A. Lavochkina, the Yak-3 of A. S. Yakovlev, the Su-6 and the Su-7 of P. O. Sukhoy.

Sergey Pavlovich was concerned with directing the installation of boosters on aircraft and making flight tests of the first liquid-fuel rocket engines. This is a complex and risky business. Here is what is recalled about those days by K. I. Trunov who worked with S. P. Korolev and subsequently remained one of his closest friends:

"Sergey Pavlovich was very skillful in experimental technology, especially in flights. This skill came to him because of his engineering erudition and flight tests, which accustomed him to risk. Where risk existed he always tried to carry out the experiment personally. He was resourceful, was able to see and eliminate errors. The professional design school which he finished in his youth gave him the experience to do everything with his own hands, which was also useful in flight.

During the war when he was concerned with the booster equipment — liquid-fuel rocket engines — on certain aircraft, this was an absolutely new business and, as we have seen, quite risky. The engines had only just been developed and sometimes exploded. This happened for example with the Pye-2 aircraft when the liquid-fuel rocket engine was tested on it.

Sergey Pavlovich asked me to determine how the liquid-fuel engine operated on the airplane on the airfield and then he had to test it in the air. "As a pilot, give me your opinion," he requested. We sent it to the airfield. On the ground the engine operated normally. "We must nevertheless test it in the air and be personally convinced that everything operates properly" said Sergey Pavlovich.

He took his place in the rear cabin of the airplane, the pilot gave it gas and the airplane sprang to a start. He took off, reached a low altitude and passed over the airfield along the course at which the booster had to start. We on Earth awaited this moment. Finally the booster started. But what happened? Why did the airplane make a landing so unnaturally? Now the airplane had taxied to the parking area. We rushed to it and found Sergey Pavlovich in the cabin with a blood-stained head. We helped him out of the airplane, bandaged his head and entrusted him to the care of a physician. As we saw, he was wounded in the face by fragments of the exploded engine, but fortunately not seriously. "It is good that I flew it myself or I would have always been torn apart by conjectures: what went wrong during ignition? Why did the engine explode? This is the major thing which we must establish!" And all this he said in the hospital.

After recovering somewhat, Sergey Pavlovich continued testing the engines, with a bandage on his head. The doctor would not permit him to remove it.

As to the scope with which the flight tests were carried out on the liquid-fuel rocket boosters, we can judge from the fact that the

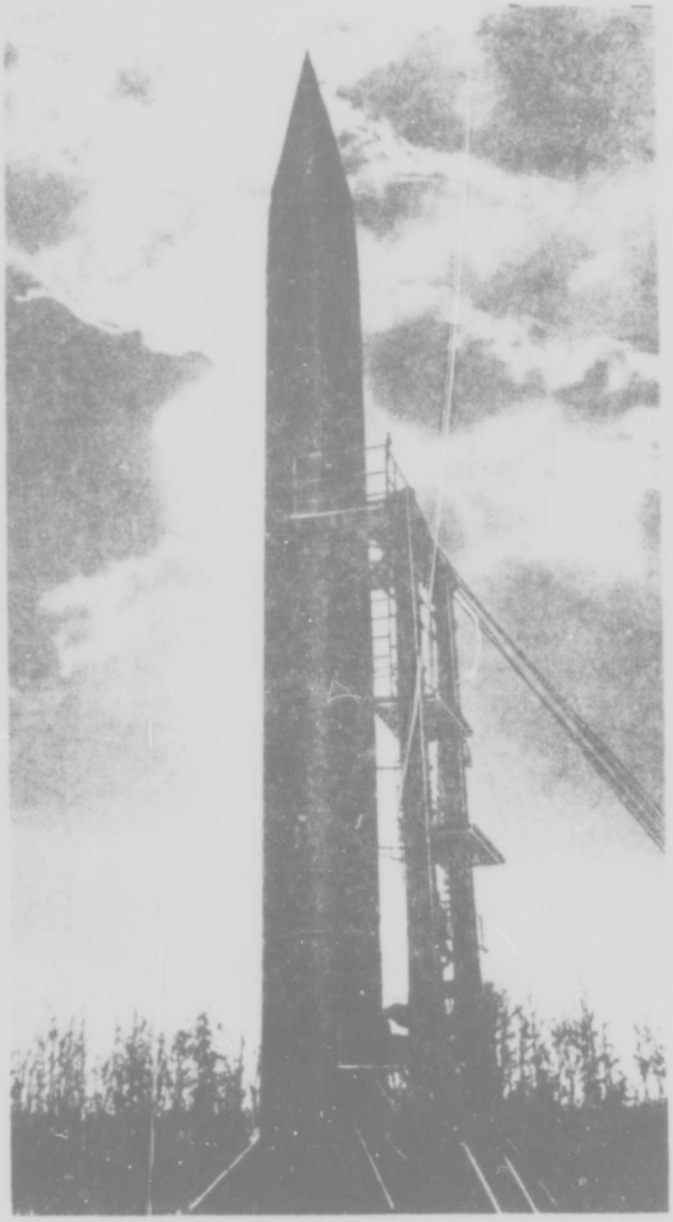
Korolev at the proving ground, September 1948.

At leisure, October 1948.

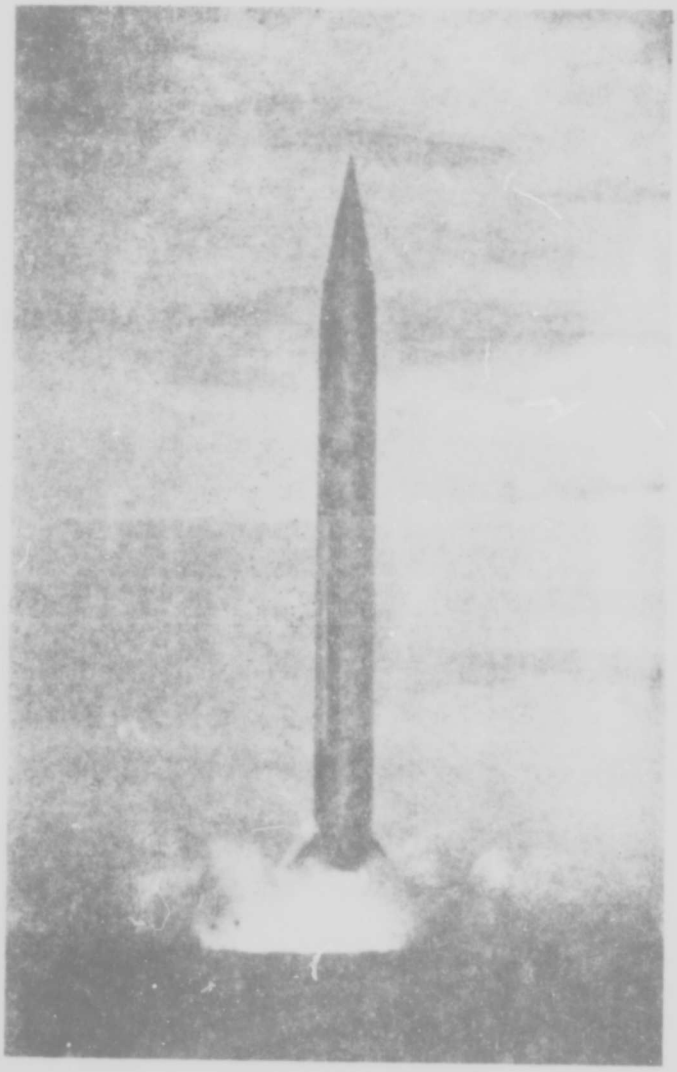
After successful launching
on visit with Mother, 1951.

Stepfather of Korolev,
Grigoriy Mikhaylovich Balanin.

He has achieved fame! 1953.



Rocket being prepared for launching.



Rocket being launched.

One of the first dogs carried on board the rocket, in the hands of Sergey Pavlovich.

S. P. Korolev, I. V. Kurchatov and M. V. Keldysh.

S. P. Korolev and I. V. Kurchatov in the Kremlin.

K. Ye. Voroshilov awards S. P. Korolev the Order of Lenin on his fiftieth birthday.

Pye-2 bomber made 110 flights with the RD-1Kh3 engine. In 1945 the YaK-3 underwent flight testing. With a rocket booster added, the increase in speed on this machine reached 182 kilometers per hour.

In reporting on the factory tests of the La-7R aircraft with an RD-1Kh3 booster it was said that they had the "complete capability of using the RD-1Kh3 as an auxiliary engine-booster".

Distinctive recognition of the success of the designer of the liquid-fuel engines and their flight test personnel was the participation of the 120R aircraft with a booster during the aerial parade in Tushino on August 18, 1946.

The attempt to design and test aviation rocket boosters brought great benefits. The design of the liquid-fuel rocket engines came more of age, ways could be seen to increase the power, the reliability of ignition and controlling the thrust. No less important is the fact also that the rocket engine felt at home on board — so quickly had aviation converted to rocket thrust.

Boosters became now the most important take-off device for aircraft and rockets. For his participation in the development and testing of rocket boosters for military aircraft, in 1945 Sergey Pavlovich was awarded the order of "Medal of Honor".

We Believe in a Lucky Star

1945 — the year of the great victory of the Soviet people in the war against Fascist Germany — was the turning point in the life of Sergey Pavlovich. It was in this year that he again turned to rockets.

The Central Committee of the Communist Party and the Soviet Government opportunely appraised the tremendous significance of powerful rockets which they would acquire for progress in science and defense of our nation. The government turned their attention to scientists to

carry out research in the field of rocket technology on a wide government scale similar to that which specialists had given to the field of nuclear physics.

Our scientists, including Sergey Pavlovich, then received the direct task: design a powerful ballistic rocket.

On December 2, 1944, Korolev wrote: "My research proceeds successfully, although it is very difficult for me: so little time and I must enter into a field that is completely new to me although I have worked for some time in this general area.

But the problems are so huge and the altitudes to which we must soar are so high that our predecessors and teachers could only dream about that on which we have now begun actual work."

At this time Sergey Pavlovich moved to his own room assigned to him by the factory. Here not without humor he wrote of his life to his mother: "I have a room 22 m^2 with a door to a future balcony and 2 windows, so that the entire outside end wall is aglow. Much light and sun, since my window looks out to the south and somewhat to the east. In the morning from sunrise to noon or longer everything is inundated with the blinding bright sun. I had not earlier (before the war) been aware of the charm of everything surrounding us, but now I know also the worth of the sun's ray and a throat of fresh air and a crust of dry bread.

"My room is "stylishly" furnished: a bed with all that is necessary. A kitchen table, covered with a bed sheet, 2 stools, a night table and a writing desk, which I brought from work. My dishes are on the window: 3 glass jars and 2 bottles, a glass and one tea spoon. Here then is all my property and possessions. I feel your derisive smiles, and it is humourous to me also. But I do not become angry... This you know is not important in life and in general this is all trifling."

Korolev made the first estimates of the future rockets. "I am attempting to finish the sketches by the 15th of December," he reported to Moscow where he was urgently invited. "But if I am not successful then I shall not come before I have to." Continuing to work enthusiastically, he answered to various invitations to transfer to other areas: we must "remember the difference between my work and that of the purely bureaucratic engineers or the practical engineer, the exploiters, etc. I do not say this from pride and conceit, but for the benefit of the work. And the name of this work is life! My life."

Korolev had already directed development of the first rockets in the Group for the Study of Jet Propulsion. But in the assigned task much remained that was new. He had to design a powerful automatically guided long-range rocket.

He was officially named chief engineer of one of the departments of the institute involved in rocket design on August 9, 1946, but did not set about fulfilling his duties until the beginning of 1947. Until then he was on a protracted scientific mission.

Sergey Pavlovich, just as our other rocket scientists, was familiar with the German liquid-fuel military rockets from the war. Nothing novel was found in them: they were fundamentally based on the concepts of K. E. Tsiolkovskiy.

Our scientists had to develop a proper method for designing powerful rockets, to found the branch of science and technology on an industrial base, capable of ensuring the development and construction of an engine with great propulsion, rockets, control systems, and all types of complex set of ground and on-board equipment.

Why then was it necessary to seek a new method of designing rockets? Earlier an experimental design was made of the technique in artillery and aviation. And in this and other fields the Soviet designers showed remarkable skill. But long-range ballistic rockets

had many peculiar characteristics of their own. Their construction and manufacturing technique differed considerably from the construction and manufacturing technique in artillery and aviation technology.

Thus in an airplane the weight of the fuel rarely reaches 50% of the starting weight, but in the ballistic rockets of that time it approached 70%, and later reached 90%. The requirements for fuel tanks in the rockets were specific. They had to possess a very large volume, and a weight as small as possible. In a word, completely new problems arose.

Sergey Pavlovich along with his assistants proposed in designing rockets to change to using patterns on which the large-scale components were drawn to full scale. The templates were taken from these patterns and the components themselves were made from them. This method has been used in aviation for some time. It was necessary to turn to one of the aviation factories. In spite of the heavy load, the workers in the factory responded directly to the request of the rocket designers In a short time they quickly and well prepared the patterns, which played their role in the development of powerful rockets.

Thus it became obvious: in design and construction a powerful rocket is not similar to an airplane, but neither is it similar to a cannon.

Sergey Pavlovich spent his nights with the workers in the plant. They discussed what order to give to what undertaking when the engines, the automatic equipment and the ground equipment must be ready. Then together they went to the first tests of the rocket assemblies, the electronic systems, and here gave the orders for their final adjustment. This was the support of the youthful crew directed by S. P. Korolev and shaped into an independent design office.

The crew of the design office strengthened and grew along with the construction of the "first-born" rocket. Alongside the veterans

in rocket technology, the grey-with-age academicians and well-known professors, many youths could be seen. Thus, one of the deputies of Sergey Pavlovich was an experienced veteran of the civil war, and another shoulder-to-shoulder comrade was a designer of only a few years experience.

In the beginning, everything did not go smoothly. It seemed sometimes that the design office was not ready to use the ground equipment. And vans with the apparatus for future launchings kept arriving and each of the devices required its own microclimate.

Anxious that the unique equipment would be damaged, Sergey Pavlovich took one of his deputies, a former red army pilot. With his assistants he flung himself onto the loaded automatic machinery between the parked cars and tossed up coke into the furnaces, thus maintaining the temperature conditions.

Under difficult conditions the style and form of work of the design office was shaped.

The formation of a creative crew required much worry on the part of Sergey Pavlovich. "The creation of a crew of like-minded persons," S. V. Il'yushin noted in one of his speeches, "in science and designing — creators — enthusiasts of the business — the problem is no less complex than, for example, the development of a good project."(1)

In answer to questions from the author of this book as to how the Soviet school for developing large-scale rockets was formed, Sergey Pavlovich replied:

"The big difference is between the designer of previous times and now. Earlier the designer designed and built the machine himself.

Footnote (1) appears on page 180.

Under the direction of A. N. Tupolev, at the end of the 1920's I did my diploma work, designing a light-engine aircraft. I myself made half of the sketches. The writer writes the entire book himself, crossing out something, inserting something. If the present-day designer wished to carry out all the computations himself, when the projected apparatus contains tens of thousands of components, he would have to turn into a handyman. For this no superhuman mind nor superhuman force would suffice.

The designer can never be likened to a singer who screws up his eyes and sings to himself. The designer must properly pose the problem and listen to the opinion of his crew. We must wander around the entire design bureau, seek and check. He who says that the fulfillment of an idea is near, when it is far from reality, leads to a dead end.

From the very beginning, with the first rocket we were guided by collective action. Not one decision, object or graph without discussion! In the council of the design office are ten men. Often contradictory assumptions exist among them. Not once did life frustrate our sketches. The final stage was formed from data obtained in developing parts of the rocket."

Sergey Pavlovich himself, as they say, was confined to his role as a designer of rockets. In the engineering sense this meant that the work of the designer was for him natural and that he succeeded.

A man who knew him for a long time recalled: "I am familiar with the style of designers Tupolev and Polikarpov, who brilliantly were able to "go to the boards". This means that they could, by going from one drawing board to another, be quick to grasp what was created during the designing, and also oversee the operation. I also saw that Sergey Pavlovich used this same approach of "going to the boards". At first I thought: "He imitates." But later I heard his comments made from the drawings and I understood that his grasp was true, he forgave no one's blunders.

The year 1947 became the year for proving the capability of the crew, directed by S. P. Korolev, to solve the greatest problems in the development of contemporary technology. The thirtieth anniversary of Soviet power approached, the tests of the first long-range liquid-fuel rockets developed by the crew approached...

But before proceeding to the tests, Sergey Pavlovich came out with a report devoted to analysis of the creative heritage of K. E. Tsiolkovskiy. This took place on September 17 in the Red Banner Hall of the Central House of the Soviet Army im. M. V. Frunze, where the 90th birthday of the great scientist was being celebrated.

"The most noteworthy, courageous and original creation of the creative mind of Tsiolkovskiy," he said from the platform of the Red Banner Hall of the Central House of the Soviet Army, "is his concepts and research in the field of rocket technology. Here he has so far outstripped the scientists of all other nations in modern times."

In the rough copy of his report one could read: "Tsiolkovskiy could not live until the days when the sacred thought, embodying in itself the greatest dream of mankind about the subjugation of super-atmospheric altitudes, ceased to be considered an unrealizable phantasy and was made the technical problem of our time."

Let us note that these words on the conquest of outer space, as on the problem of our time, were written in 1947.

Then Sergey Pavlovich mentions seven major conditional points of the creative heritage of Konstantin Eduardovich. He begins with the characteristics of how Tsiolovskiy developed the theory of rocket flight:

"He analyzed in detail the question on the motion of a rocket, he formulated equations of motion in an atmosphere without gravity and resistance, and also by allowing for them. He gave a series of brilliant theoretical solutions on the theory of flight, bearing today his

name and widely used everywhere. Included is the dependence of the rate of motion of a rocket on the rate of flow of the combustion products and the logarithm of the ratio of final and initial masses of the rocket (the Tsiolkovskiy formula).

Korolev especially noted the service of Konstantin Eduardovich in the development of liquid-fuel rocket engines.

"He advanced the concept and developed a whole complex of questions associated with the use for flight of high-caloric liquid fuels (liquid fuel and as the oxidant — liquid oxygen)."

The use of high-caloric fuels continuously involves the stability of the materials in the engine and the questions of cooling. These questions grew into a problem of tremendous significance. Tsiolovskiy thoroughly investigated these questions and developed an entire series of practical proposals in this field.

A significant place in Tsiolkovskiy's research is naturally occupied by the questions of the effectiveness of a rocket as a moving system in the power and weight sense. These questions, and particularly the question as to the principle of supplying the fuel into the engine, which is directly related to the question of weight and economy of the conditions selected, he developed in detail and made a series of technical conclusions and assumptions.

The creation of multi-stage rockets is a huge service to our science and technology. Sergey Pavlovich back in 1947 pointed out this idea of Tsiolkovskiy. "He was the first to propose" — noted the reporter — "plans for composite rockets, which permits most fully using the energy and weight possibilities for obtaining the necessary velocities, he advanced the idea of cosmic space trains, where a complete family of mutually-connected rockets start and then as the fuel is expended the superfluous parts are discarded and the moving system in

this way retains the necessary relationship between masses and reaches the required velocity."

As we know Konstantin Eduardovich devoted much attention in his research to the questions of guiding and stabilizing rocket flight. Even in his very earliest works and projects — noted S. P. Korolev — this scientist proposed a special guidance system involving the gas jet from the combustion products emitted in the course of the flight.

In the words of Korolev, the main thought through all Tsiolkovskiy's works is that of human flight. He investigated many questions associated with this problem, particularly the question on behavior of the human organism at high-altitudes, in outer space, in the presence of accelerations, etc. In the most detailed manner he developed questions of the life of future interplanetary travelers.

In his report of 1947, Korolev (by the way this has never been published) emphasizes Tsiolkovskiy's idea concerning the satellite and interplanetary station: "He considered the project of creating an artificial Earth satellite in the form of an intermediate island or station which must be built along the route of the space voyages. This is a fantastic and staggeringly grandiose, even now, miracle in our century, but we must recognize that this is a scientific truth and scientific prediction of the not too distant future."

Korolev's last phrase concerning the nearness of the time of satellites and interplanetary stations is very significant. Significant also is another statement which is found in Korolev's more detailed and factual report of 1957:

At the present time it is still impossible to fully evaluate the gigantic scale of Tsiolkovskiy's ideas, all his suggestions and investigations in the field of rocket technology, all the characteristics and at times incomprehensible details of his projects, suggestions, theoretical research, writings, etc.

In 1957 all these suggestions of Tsiolkovskiy received an exhaustive appraisal in Korolev's report. But let us return to 1947. The words with which Sergey Pavlovich finished his report made a great impression on those attending the Central House of the Soviet Army: "They say that time sometimes subtly erases the aspects of the past. But the ideas and the labors of Konstantin Eduardovich will attract more and more attention as this new field of technology, which is now being recreated on the basis of his labors literally before our eyes, is developed.

Tsiolkovskiy was a man who lived much before his century as a true and great scientist must live."

In this generous appraisal of the scientist Tsiolkovskiy, also resounds the wish of Korolev himself to be similar to him, to do as much as possible for the new technology. The courageous steps of the designer received the first recognition — in 1947 he was elected a member-correspondent of the Academy of Artillery Sciences.

The year 1947 was also a landmark in Sergey Pavlovich's personal life. For a number of reasons by this time his family had come apart. Sergey Pavlovich met Nina Ivanovna Kotenkova, who became his wife and with whom he spent the remainder of his life.

In the Fall of 1947 S. P. Korolev left for the rocket tests. On October 8 he wrote: "We arrived well. I slept a deep sleep for four days (so exhausted from preparation of the forthcoming rocket tests). I must say, my neighbors have very touchingly looked after me on the entire trip and I could rest somewhat."

As to how things went, he notes:

"On Saturday we arrived and everything whirled at a mad pace. But the conditions are relatively good and they look after me here very well to see that I eat every day(!)."

The severe climate in these sites annoyed the test personnel. "The dust is horrible," wrote Sergey Pavlovich, "it is hot by day and cold by night. There is a shortage of water. And this dismal saline steppe all around. Our mobile living quarters are simply an oasis. But little is needed to exist in them."

Even in his first letters he resounded confidence in the success of the difficult and dangerous affair that had begun:

"My debt I will pay to the end and I am convinced that we shall return with good, great accomplishments."

What then would explain such a solid faith in success? The answer to this question is given in a letter from Sergey Pavlovich dated October 12, 1947:

"My day consists approximately of the following: I arise at 0430 hours, Moscow time, quickly breakfast and stroll a bit in the field. We return sometimes by day and sometimes in the evening, but then as a rule comes an infinite succession of all possible questions until 1 or 2 o'clock in the morning; it is rare that we can go to bed earlier."

And here he reveals a second, so-called moral, reason for success — the extraordinarily similar, properly friendly and thoughtful attitudes of a closely-knit crew:

"On the third day I fell into a light slumber and awoke on the divan at 6 o'clock. My friends decided not to arouse me at this time."

And then:

"Our work abounds with difficulties, with which we can as yet not cope. It is comforting that our ground crew turned out to be so friendly and unified. For under these conditions it would have certainly been impossible to work otherwise. The mood of the people is cheerful, as the decisive days approach..."

And, finally, their strength was increased by the knowledge that they are at the sources of the birth of a new technology:

"It is often difficult for me to think and meditate so much without asking anyone. But my mood is also not bad, I believe in our work, knowledge and our lucky star."

The decisive days approached for launching the rockets. Sergey Pavlovich wrote: "... it is very difficult for me now, our most fervent days are approaching..."

And these fervent days began October 17. For several minutes prior to the launch of the rockets he made a brief notation with a simple pencil:

"I write hurriedly on our first night of combat... my days pass with a heavy load and stress, but my mood is good. We hurry so that we are not detained here for long..."

In the exceptionally short period of time during celebration of the thirtieth anniversary of the October Revolution the designers and test personnel launched 11 rockets and completed the cycle of tests. On November 2, Sergey Pavlovich wrote:

"We have worked for the past two days without interruption..."

The first tests were finished on the large ballistic rockets. Of course these tests were considered by the scientists and the designers not as the completion of the work, but as the first stage in the creation of future designs — more powerful, more carrying capacity, longer range. The tests confirmed that the beginning was proper and promising.

Sergey Pavlovich participated in the development of a method for testing the rockets: how to better prepare them for launching? how to be sure of the reliability of all systems?

Sergey Pavlovich gave advance notice to the launch crew: do not overlook details. He always remembered how strict Tsiolkovskiy was in this respect. Once the scientist was invited to Moscow for a balloon flight and a photograph of the flying apparatus was sent to him. He looked at the photograph and said to his guests who were visiting him in Kaluga that the flight could not be worked out. He explained, "The rope is all tangled up. In our business it is always so — think about the major things and then forget the rope, and this is most important when it is tangled up." In fact on the day of the launch, he wrote from Moscow that the balloon did not fly: the ropes became entangled when the balloon was being filled with hydrogen.

"While thinking about the major things, do not forget the details" — this was the first commandment given him by Tsiolkovskiy.

On the launch pad there must be ideal order, each person must know his own place. One of the participants of the first tests recalls: "When the first rocket was readied for launch, then all the lower and higher supervisors considered it to be their duty to be where they could see where they had to go or not go.

Sergey Pavlovich appeared and many did not even see him. But he climbed into the bunker, looked through the periscope and announced over the loudspeaker system:

"Comrade Vasil'yev, leave the machine."

Vasil'yev was astonished but left. The others continued to mark time on the pad.

"Do you think I was speaking only to Vasil'yev", a strict voice resounded in the loudspeaker.

He was exacting and strict. But these characteristics of Sergey Pavlovich were accompanied by kindness and consideration to his working

associates. Somehow he saw at the launch an engineer in a light jacket, in the November wind on the steppes, even in a fur flying suit it was not warm. This engineer recounted afterwards that he was pretty well freezing in his jacket and in the evening in the trailer where we lived he had to warm himself before he could lie down to sleep. In the evening after he had gone to bed and had already gone to sleep an unknown man aroused him with a package in his hands.

"What do you want?" he growled half awake.

"I am bringing warm clothing. I bring it from Sergey Pavlovich. He ordered you to dress in a fur jacket and trousers."

The engineer "warmed up" by Sergey Pavlovich came to him much later in the design office with a business paper. In the office of the chief designer there occurred the discussion: "Perhaps it is useless to wait without a sign?" — asked the engineer of the secretary. "He said wait, that is a sign" — came the answer. In fact, at midnight he was invited to enter the office. Sergey Pavlovich immediately recognized him from the launching and joked:

"He froze then and now he is overheated. Oh, well, the doctor says it is better to be steamed up five times than to freeze once. Give me the paper."

He looked at it quickly and in his characteristic handwriting signed: "Agreed. S. Korolev."

"It is good that I received this. It is exactly this question that was resolved at the conference. Tomorrow morning we shall attend to this matter!"

He loved to tend to matters. And he suffered from lack of success, we can say, physically. He even said that he felt a pain in his body. At those times he became hot tempered and even harsh. His

associates recall: "He makes a lot of noise and drives everyone out. And this is all because failure in all technical questions he takes as a personal one. He could not distinguish the physical from the psychological. If things went badly he could not live peacefully. He said: "I can never forget, going home, that something is wrong with the technique."

There was no complacency nor conceit. "Everything must advance, the only important thing is that the rockets must be better!"

After testing the first rockets he returned home. With the appearance of Nina Ivanovna the former bachelor room began to grow warm. Love and family harmony seemed to increase his strength.

Although the work as before remained very stressing, he still made up his mind to study. He wanted to complete his knowledge in the general sciences. In 1948 he enrolled in the evening university of Marxism-Leninism at the town committee of the Communist Party of the Soviet Union. Such an eminent designer, member-correspondent of the Academy of Artillery Sciences, again sat at a desk and after two years finished the university with excellent marks.

The Rockets Gain Power

After the first successful step our ballistic rockets began to swiftly climb aloft.

One the basis of the new possibilities the crew under the direction of S. P. Korolev in cooperation with other crews constructed a second model of the rocket with twice the radius of operation of the first. Following this, after several years of persistent labor, a third rocket model was created which permitted the thousand-kilometer range barrier to be exceeded.

Sergey Pavlovich said: "Rocket technology is not the affair of twenty or even of fifty individuals, this is the affair of the entire nation." Everything new in rocket technology was created by him in conjunction with the major designers of engines, guidance systems, the complex of surface equipment and other on-board and surface systems. As a result of the friendly efforts expended by them in the experimental design office in close contact with the scientific research institutes of industry and the Academy of Sciences USSR, outstanding models of rocket technology were produced and placed into production.

Sergey Pavlovich and his associates — rocket designers — worked also in creative contact with atomic scientists, especially with Igor Vasil'yevich Kurchatov. By their joint efforts they connected the rocket to an atomic charge. Thus the first nuclear-rocket weapons were obtained.

In one of his speeches I. V. Kurchatov spoke with satisfaction about the successful combined work of the Soviet scientists — the atomic scientists and the rocket engineers. "The Soviet atomic scientists," noted Igor Vasil'yevich, "on assignment by the party and the government labored for many years persistently and selflessly to create and then to perfect atomic and hydrogen weapons... Soviet scientists and atomic engineers have fulfilled their debt to their country.

"They did their work brilliantly" — he noted, "the Soviet designers of rockets and other carriers of nuclear weapons. The people may be at ease. The defense of the homeland is now reliably ensured."(2)

It is worth mentioning that the first rocket with a thermonuclear charge — the most powerful weapon of modern times — was produced in the USSR. Igor Vasil'yevich spoke of this also in one

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Footnote (2) appears on page 180.

of his speeches. He gave a rebuke to those American public figures who attributed to themselves superiority in this respect.

"Let us turn", said Igor Vasil'yevich Kurchatov, "to certain dates. In November 1952 on Eniwetok Atoll in the Pacific Ocean, the United States of America conducted a test explosion of a thermonuclear device with the conventional designation "Mike". The well-known American journalist Stewart Olson gave a picturesque description of "Mike". He wrote: "Mike represents a monstrously large device, exceeding in its dimensions a large house; it is impossible to launch anything as large as a house into space; the problem then is to decrease the size of "Mike" so that a hydrogen charge small enough to be placed into a ballistic rocket could carry a powerful impact on the order of a million tons."

Such a charge was created, not in the United States of America, but in the Soviet Union and tested August 12, 1953."(3)

Sergey Pavlovich, just as other Soviet scientists and designers, saw another application in the powerful rockets. This is the service to science. With the aid of rockets extensive research can be carried out on the high-altitude layers of the atmosphere and outer space. Man had obtained for the first time the means for launching complex research devices and experimental animals beyond the limits of the atmosphere. And not only to launch them, but to bring them with care back to earth. Soviet rockets could complete flights at very high, as yet unattained, altitudes above the surface of our planet.

S. P. Korolev's services received recognition. In 1953 he was chosen associate member of the Academy of Sciences USSR. During this year he joined the ranks of Lenin's party. Now next to his fervent, indefatigable heart he always carried a little red book bearing the number 00329128. He was forty seven years old... for the time

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Footnote (3) appears on page 180.

being maturity, creative forces, the highest success in the field of technology. Up to his neck in work he never forgot his loved ones and faithfully worried about their health.

On April 5, 1953 he sent from the space center a letter to his daughter Natasha from his first marriage with respect to the fact that on April 10 she would be 18 years old:

"Natasha! In a few days you will have become of age and by right you can be considered a grown person.

From all my heart I greet you on this day and hope you will be a worthy citizen of our Great Soviet Motherland. In spite of the difficult tests which we have all undergone during past years, not for one instant has our Motherland not remained anxious about you. However difficult it may have been, you have grown and studied and life has been bright for you.

"Remember this always and always love our people and the Earth, on which you grew up. This I wish you forever and always!

"I also wish you joyous labor, good studies as well as happiness in your life. I have no doubts of your success in studying and working. You have chosen a noble path for yourself. (Natasha studied in an institute of medicine.) And I am sure that you will be worthy in your choice.

"Your personal life is very much in your own hands and you will meet many good people. There will be a great love and friendship — all this will certainly be!

"I sincerely and deeply love you and often think of you...

"...Now I am far away from you, but on the 10th of April — know that I shall think of you here in this wilderness.

"Do not forget your father who very much loves you and will always remember and never forget you.

"I heartily, heartily embrace and kiss you.

Always your friend,
Sergey"

Much of him is contained in this letter. Both the word of a man grown wise with experience and the fervent feeling of a father...

The Intercontinental Rockets are Starting

From 1953 Sergey Pavlovich directed his major efforts to the creation of superpowerful rockets, which would be capable of travelling over intercontinental distances. Such a rocket not only made available any point on the face of the earth, but it also opened the way to outer space. Its creation was an unprecedentedly complex and immense problem.

"Many organizations and institutes were involved in our work," wrote Sergey Pavlovich in one of his letters, "practically throughout the entire country. The numerous different opinions, the numerous experiments, the many most diverse results — all this must finally result in only one correct decision. This is why so much might and nervous energy went into all this."

In this new affair success depended not only on the knowledge and skill to design and compute something, but also on the skill to imagine and dream.

"Dreams, dreams...," wrote Sergey Pavlovich in those days. "But then a man without dreams is like a bird without wings. True?

And now near to accomplishment, is the most forbidden dream of mankind. In all centuries, in all ages people have looked intensely into the dark blue of the sky and dreamed..."

"In the infinite book of Knowledge and Life (loudly said!)," he writes in another place, "we have turned another page for the first time. We must quickly understand, reflect on one or another event, its appearance and then give a solution without error."

In order to find completely correct solutions for the time, Sergey Pavlovich turned to the collective mind of his associates as advised by K. E. Tsiolkovskiy. On the pages of the scientist's labors appear new marks on the fields, the most topical thoughts, computations and assumptions.

In the report, which Sergey Pavlovich made in honor of the 100th birthday of Konstantin Eduardovich he noted: "In his theoretical works Tsiolkovskiy arrives at a large number of fundamental conclusions which even to this day are being used in rocket technology. Moreover, as the practical work and perfection of rocket technology progresses, the many conclusions and assumptions of Konstantin Eduardovich which he expressed quite some time ago are being confirmed more and more precisely."

From these ideas taken as the requisites by our scientists in the course of working on the intercontinental rocket, Sergey Pavlovich mentions the following: "His (K. E. Tsiolkovskiy) investigations showed that the velocity and thus the flight range of the rocket grows with increase in the relative reserve of explosive matter (fuel) on board the rocket. By storing various amounts of them, we can achieve any final velocity of motion and any flight range."

This idea of Tsiolkovskiy was also emphasized by S. P. Korolev: "The rate of motion at the end of combustion (at the end of the powered part of the flight trajectory of the rocket) is found to be greater as

the relative velocity of the ejected particles is higher. The velocity of the rocket at the end of the powered section is increased also with growth in the ratio of the initial weight of the rocket to its weight at the end of combustion.

From Tsiolkovskiy's formula there follows a quite important practical conclusion: accomplishment of possibly higher rates of motion of the rocket is attained more effectively by increasing the relative velocities of the ejected particles, i.e., by increasing the degree of perfection of the engine installation rather than increasing the relative reserve of fuel on board the rocket, i.e., by refining its design."

Sergey Pavlovich emphasized that K. E. Tsiolkovskiy, not only theorized, but with exceptional insight and depth surrounded all his, sometimes quite extraordinary, theorectical conclusions, with such serious and detailed practical observations that the "vast majority of them found application and are widely used to this day in all nations of the world, concerned with rocket technology."

What specifically did Sergey Pavlovich have in mind? First of all the power of the rocket, the choice of fuel for the engines and their equipment. Tsiolkovskiy had proposed liquid fuel with the use of liquid oxygen, liquid hydrogen, oil and its derivatives.

Then Sergey Pavlovich mentions the proposals of Tsiolkovskiy on construction of the combustion chamber, the combustion tube with cooling of the fuel by its components and fuel pumps.

"In Tsiolkovskiy's works," emphasized Sergey Pavlovich, "we can find references to the probable utilization of atomic energy, radiant energy from the sun and the energy from cosmic radiation for operating the rocket."

S. P. Korolev also mentions Tsiolkovskiy's idea on guiding rocket flight by using automatic apparatus and gyroscopic instruments. Orientation in space during rocket flight can be carried out by an

automatic tracking system, using the magnetic properties, either tuned to the sun or to some star. Gas rudders (in air-free space) and air rudders and ailerons (in the dense layers of the atmosphere) were suggested for the control organs.

Many of the above are already being used today, said S. P. Korolev, as something ordinary and natural. Is it really not obvious today in our time to use of the rocket as a flying device, and liquid oxygen as one of the fuel components, and for example, gas rudders for controlling flights. And yet all this was proposed by Tsiolkovskiy 60 years ago, when there were no heavier-than-air craft and a rocket was only a pyrotechnical toy."

It is understandable that on the lips of the man who directed the construction and testing of the Soviet ballistic rockets, the analysis of the creative accomplishments of Tsiolkovskiy would resound quite ponderably. Sergey Pavlovich emphasized the actuality of K. E. Tsiolkovskiy's ideas relative to the construction of the rocket, its shape, and internal arrangement. Tsiolkovskiy proposed using internal pressure in the rocket for increasing its stability, and to maintain and regulate the obtained pressure drops in more suitable limits which in turn was associated with the problem of lowering the passive weight of the rocket at the end of combustion. After investigating the conditions of rocket motion in the dense layers of the atmosphere, Tsiolkovskiy proposed several methods for cooling it and for heat resistance.

But Sergey Pavlovich especially mentioned the idea of K. E. Tsiolkovskiy on the composite multi-stage rocket and rocket trains. "In order to attain cosmic velocity we must have a large supply of fuel in one rocket... The train does not have the possibility... of reaching high cosmic velocities," — Korolev cited the famous words of his great teacher. And he added: "Essentially, this assumption opened the road to outer space for mankind."

Thus, by analyzing the works of K. E. Tsiolkovskiy, Sergey Pavlovich described a huge circle of problems which had to be solved by the successor to the affairs of the great scientist on the way to creating a multi-stage ballistic intercontinental rocket.

How much tension the work on preparing it for launch caused can be judged from the letters of Sergey Pavlovich in May — June of 1957. Even on holidays he knew no rest. He wrote home on May 1:

"I arose late and at 11 o'clock I went to the bath and bathed thoroughly, then I again lay down to sleep and now (1615 hours) I have decided to go for my "holiday dinner", i.e., simply go to dinner in our dining room.

I have worked much during these days, tomorrow, May 2, we have a normal working day (and thank God — to more quickly finish what must be done and not merely sit, with folded hands).

Here it is almost a year since I have worked with my good friends — designers...

I am increasingly convinced how much the relationship of one or another man to his assigned problem means in any affair, his character and how much of himself he puts into his work. And this is especially (important) in our new and unusual work where without ceremony we must leaf through the book of knowledge.

I am in fact in the most festive mood today."

May 3:

"It is already 2330 hours and I must go to work...

...Yesterday and today were very busy; (in) the next few days (anxieties) will be even greater. These ten days will be very busy for me."

And now the time for the decisive testing of the superpowerful rocket approached. On June 6 Sergey Pavlovich wrote:

"Our life and work, as they say, go quickly, and I would add — very quickly. Of course everything involves the events which are happening and those which have happened, to the extent we have knowledge of them; the process of studying the data obtained, gives us ever newer surprises and discoveries..."

Since a large number of representatives from various organizations participated in the work, Sergey Pavlovich expended much energy on the coordination of their work during these responsible times. And disagreements did occur.

The difficulties encountered on the path to launching a fundamentally new rocket increased the divergence of opinions. "I think," wrote Sergey Pavlovich, "that it is not far to the shore and we of course will reach it if only we are friendly and do not fight the waves and the gales...

Until June 12 — 13 I shall be very busy. (...) We must finish here; that is, here and now we must find the solution."

And they finished in spite of all the difficulties. The weather did not favor them. "The last couple of days," noted Sergey Pavlovich "have not been so hot, but the strongest wind and dust bureis everything... The nights are quite cold. In general, as they say here, this is certainly not Rio de Janeiro. It is hard not to agree with this, but it is better than the amber shore."

In August 1957 TASS informed the entire world about the creation and testing in the USSR of an intercontinental multi-stage ballistic rocket. The entire stage had been completed in the development of a Soviet rocket design — in the field of the most powerful liquid-fuel

rocket our nation occupied the leading position in the world. No other country possessed a similar rocket.

At the height of his work on the powerful carriers Sergey Pavlovich received the suggestion to give a number of lectures on designing contemporary rockets in one of the Moscow institutes of higher learning. When he accepted, many were surprised:

"There is no time to spare, how can you?"

"We must refresh ourselves. It is very important to comprehend what is being done, so to say, change to theory."

And, by making every moment count, he prepared himself for the lectures. The day came for his encounter with youth. He understood that his lecture would be the account of our rocket science to the future, this was the rough draft of those boundaries from which they, the youth, would have to take the baton in their own hands.

After the lecture the students remained for a long time under his influence. And how could one remain at peace after hearing Sergey Pavlovich speak of his extraordinary work on rockets! "Our strategic flights", reminded his words, "at a speed of 28,000 kilometers per hour are capable of reaching targets at a distance of tens of thousands of kilometers away. It is 20 times faster than an airplane and 10 times faster than a cannon shell fired from a gun."

The number cited by Korolev to characterize the power of the engines on the strategic rocket captured the students: it was equal to the power of scores of the most powerful electrical power plants! And if we attempt to compare its power with that of an airplane engine? It is clear only that tens of thousands of such motors would be needed to approach the total power of the rocket.

The automatic guidance system of the rocket in flight also won the comprehension of the young people. Its autonomy was especially valuable — its independence from any surface radiotechnical instruments. The invulnerability of the new strategic weapon comes from its high velocity and flight altitude, from the impossibility of interfering with the control of the rocket.

Our most powerful rockets can reach any point on the face of the Earth, not only along the shortest but also along the longest and most roundabout path.

And when we say that Soviet scientists and designers have designed the best nuclear rocket weapon in the world, we are including the large crew of specialists. They have brought fame to the Soviet Union by their distinguished scientific and technical accomplishments. Their successes showed the entire world with its own eyes that the Soviet Union occupies the most advanced position in the field of science and technology.

Sergey Pavlovich was much concerned with research rockets. Under his direction rockets were modified for scientific research. In order to satisfy the requirement: small space — many instruments, he made careful computations, removed mutual encumbrances. He called these academic rockets.

On the academic rockets Sergey Pavlovich decided to attempt the launching of animals to an altitude up to 100 kilometers. Such a problem now seems to us ordinary. This speaks only of the rapid development of rocket and space technology. Then though, in the summer of 1950, many scientists expressed doubt that a dog could be kept alive during such a high-altitude flight. But Sergey Pavlovich had the staunchest supporters, including Academician A. A. Blagonravov. A rocket was quickly prepared with room for two passengers — dogs. In spite of the fears, the dogs endured the G-load and returned to Earth in good health. All subsequent flights of animals on rockets also were successful.

Then Sergey Pavlovich proposed going to the second stage of the experiments. "We must," he said, "develop a system for rescuing the dogs in emergency situations. This will stand us in good stead for future flights of man." And soon after the rocket reached the desired altitude a special explosive cartridge detonated. The force of the detonation ejected the dog from the rocket and then let it descend to Earth safely by parachute.

The research rockets reached altitudes of 100, 200 and 500 km and "disclosed" to the scientists information about the density of the atmosphere at different altitudes, and the composition of cosmic rays, and explored the ionosphere. Since that time rockets have been launched in various regions of the nation including the Far North. Soviet expeditions in Antarctica also launched them.

In 1956 Sergey Pavlovich was awarded the title of Hero of Socialist Labor. In 1957 he was elected Academician, a member of the Presidium of the Academy of Sciences USSR.

To the First Orbit

When correspondents sometimes asked Sergey Pavlovich how the idea of the first satellite was born, they received the answer:

"I came to rocket technology with the hope for flight into space, to the launching of a satellite. But for a long time there was no real possibility of this. I could only dream about orbital velocity. With the creation of powerful ballistic rockets the cherished goal came ever nearer. We carefully watched reports from the United States of America on the preparation of a satellite, designated not without allusion as "Avant Garde". It seemed to someone that it would be the first in space.

I requested information about this future satellite. It was prepared for me. We read it through and were convinced that the American rocket engineers could launch into orbit ... an orange.

Everything was restricted for them to the limit. The main thing they were forging together was the rocket. Its thrust was such that it gave no reserve and imposed tremendous requirements for precision and for separation of the stages.

Rather than making proposals we made calculations. We were convinced: we can launch a good hundred kilograms into orbit. We turned to the Central Committee of the party. They said: "This is tempting. But we must think..."

In the summer of 1957 we called upon the Central Committee. Then we were given the go-ahead.

Thus our first satellite was born on strict calculation. It was launched into orbit without incident. On the first try!"

But before we describe how the first satellite in the world was launched, let us return to the analysis of the works of Tsiolkovskiy which Sergey Pavlovich had made in his report devoted to the hundredth birthday of the great scientist. Above we discussed only, so to say, the rocket part of the report. In the "space" part of his report Sergey Pavlovich, already fully occupied with readying the first satellite for launching, emphasized that the works of Konstantin Eduardovich pertaining to the problem of interplanetary voyages, undoubtedly are the most interesting and fascinating. He investigated the problem of launching rockets beyond the Earth's gravity, variations in trajectories and characteristics of orbits, conditions of life on board spacecraft. Many of the ideas expressed by Konstantin Eduardovich were used in developing our spacecraft. Sergey Pavlovich noted particularly the idea of Tsiolkovskiy about using solar energy at interplanetary stations. It is a straight line of development from this idea to the production of solar batteries.

As far as Tsiolkovskiy's other ideas are concerned, they are eithe becoming fact or will be in the future. Sergey Pavlovich in his report

especially mentioned the problem of building interplanetary stations. In them he saw not only a tremendous relief for flights of space rockets, which in his opinion must be based on these stations, but also the means for accomplishing his dream of conquering the space about the sun by man.

The day before the assault on space the words of Sergey Pavlovich enthusiastically resounded that the great scientist did not doubt the possibility of man living in outer space, that in the interplanetary stations living conditions could be ensured for a long period of time...

It seems the scientific positions of Tsiolkovskiy were only a starting point for the activity of the creative work of Soviet scientists. This is emphasized by Sergey Pavlovich:

"Today (this was said two and a half weeks before launching the first satellite) we can say that the scientific legacy of Tsiolkovskiy, bequeathed to the Bolshevist party and to the Soviet Government, does not stand still and is not perceived dogmatically, but is being creatively developed and successfully continued by Soviet scientists."

On the basis of Tsiolkovskiy's labors Sergey Pavlovich reached exhaustive conclusions on what must be had in order to blast off from the fetters of Earth's gravity. "We must have velocity, — he explained in print. — The work necessary for launching a body beyond the pull of Earth's gravity is very high — more than six million kilogrammeters (6,000,000!) per kilogram of load to be lifted. In order to carry out such a colossal task the space ship must develop a velocity of 11,200 meters per second. This velocity characterizes the reserve of kinetic energy required for overcoming the Earth's gravity.(4)

Sergey Pavlovich again singled out the importance of K. E. Tsiolkovskiy's discovery about the multi-stage rocket. He wrote about it thus:

Footnote (4) appears on page 180.

"Tsiolkovskiy developed rational designs of rockets, their shapes, their plans for internal arrangements and the distribution of masses, automatic control of the flight, etc.

His projects of multi-stage rockets and rocket trains were remarkable and immense. For a single rocket to attain, for example, escape velocity, it would have to have too large a reserve of fuel, thus making solution to this problem practically unrealistic...

A multi-stage rocket consists of several rockets (stages), affixed either one over the other or in various combinations. The lower rocket is operative during launch from the Earth, this is usually called the first stage. When the tanks of this stage are empty, they are separated so as not to interfere with further flight. By this time the multi-stage rocket has reached a preassigned altitude and the velocity increases according to the amount of fuel expended.

The second stage goes into operation. After all the fuel contained in its tanks has been used up, it also will be separated. Then the third stage begins operation, etc. The number of stages depends on the purpose of the carrier and its structural characteristics.

Multi-stage rockets may consist of stages with different fuel, and the escape of the gases may vary from stage to stage. There may be a certain interval between the time when the engine of one stage is turned off and the next one is turned on.

Each composite rocket of the multi-stage complex successively increases the speed of the flight and the last upper stage, which is the spacecraft, reaches the preassigned velocity in the vastness of outer space. The idea of multi-stage rockets has been found to be quite effective."

But is it only the speed which must be taken into account during launch into space? "No," answered Sergey Pavlovich, "we must also

consider the variable density of the air and the variable force of Earth's gravity." Based on this "we select some optimal trajectory and optimal law of momentum for the launch, at which all the factors slowing down the launch, assume minimal value."

Under Sergey Pavlovich's direction a rocket-carrier was readied, and computations were made for the first orbital launch. And in this work, just as in the production of the rocket, many different specialists and large creative crews participated. Sergey Pavlovich suggested that the design of the first satellite not be complicated — to make it maximally simple. It was later called the "SS" (simplest satellite).

"We are concerned with the principle," said Sergey Pavlovich. "If our theoretical calculations and solutions are valid, then the satellite will go into orbit. This will be the main problem. Incidentally we can judge other things: radio transmissions from the satellite — passage of radiowaves, the braking of the satellite — the density of the upper layers of the atmosphere.

After careful consideration we decided that our "first-born" would be a sphere with a diameter of 58 cm and a weight of 83.6 kg. Adjacent to the sphere would have to be four whisker-antennas, two for each radiotransmitter. The supply sources were designed for 3 weeks operation. The temperature conditions inside the satellite had to be ensured by using a system of thermal control in which gaseous nitrogen circulated.

Sergey Pavlovich not only directed the development and preparation of the technology but found and promoted persons capable of carrying out the new scientific and technical ideas.

Aleksey Ivanov — who participated in building the first artificial earth satellite — recalls how Sergey Pavlovich instructed him in this work. Korolev received him late one evening.

"Well, what do you conceive of as a satellite?" Sergey Pavlovich asked point-blank. After seeing that the eyes of his young company, in spite of the late hour, were full of fervor, he smiled...

The engineer, without answering the question directly, said that he did not know, the affair was unfamiliar, there were no tests.

"And you think," immediately parried Sergey Pavlovich, that everything with which we were concerned is not new? Or do you assume that this is all familiar to me and that I have a large number of tests of flights into space. Ah, youth, youth! But youth is still not your main lack! Will you undertake it?"

"I will undertake it, Sergey Pavlovich!"

"Good. And now go, I have plenty to do."

Midnight approached and still the pile of paper on his desk was impressive.

In August they set about assembling the satellite. At first it was proposed that this work be carried out in an ordinary shop of the factory. But when Sergey Pavlovich visited the area prepared for the satellite, everything was suddenly changed.

"Can you really attain special cleanliness in assembling and outfitting the satellite under these conditions?" he severely asked the shop superintendent. "We must equip special premises."

And such premises appeared very quickly. The walls sparkled with fresh paint, blinds showed white at the windows and curtains at the doors. The metal craftsmen and fitters were dressed in white smocks, they were issued white cotton gloves. Special supports, covered with black velvet, were earmarked for components of the satellite having polished surfaces. But the concern was not only in the conditions but

also in the responsibility, the accuracy, the precision with which the workers of the design office and the factory labored on the spacecraft. In another shop the same intense preparation of rocket-carriers was conducted. Sergey Pavlovich often appeared in the shops, thoroughly investigating the details of the work, advising and assisting.

The cameraman, visiting the assembly shop of the plant, recalls the impression which the assembled rocket made on him: its shape was not ordinary, and the dimensions so large that it would hardly fit into the auditorium of the Bolshoi Theater.

Sergey Pavlovich was found near the rocket among the other people. As always he was severely dressed, on his face — interest, animation. Looking at the rocket components — he holds his head to one side. Brown eyes stare penetratingly.

The operator heard how the starters called him "Espy" among themselves: "Espy said..." "Espy assumes..." But sometimes an incident occurred. When the first satellite PS was ready, one of the designers reported this to Sergey Pavlovich. He briskly scribbled:

"We shall soon launch Espy into orbit, for now Espy is already in the hangar. We have the possibility of assembling a second Espy."

Here Sergey Pavlovich could not restrain himself:

"Espy — that is I. The satellite is PS. But in other respects everything is correct."

The young people noticed quickly when he was in a mood. But he was exacting regardless of his mood. If an unexpected discrepancy arose in assembling the rocket, everyone here knew what to do: quickly eliminate it. Never in conversation with him did one load his guilt onto another, one simply had to report what was, without concealment.

An engineer responsible for reading the first [illegible] recalls: "I loved to observe Sergey Pavlovich from the side. He would go another time late in the evening to the shop where the huge body of the satellite lay at berth, no engineers or designers accompanying him.

His face thoughtful, thoughtful, He sits and is silent. He looks around. He is thinking about something. And then seeming to shake off the thoughts that had just possessed him, he gets up. His face is different, completely different from the one a minute ago. And a cascade of categorical, indisputable, clear-cut instructions. You have time only to catch them on the wing. God forbid that you forget. He recalls the case later and if you have forgotten — you have only yourself to blame!"

At the beginning of September 1957 the group of co-workers of the design office, with Sergey Pavlovich at their head, was sent to Baykonur.

Again the spacious office came to life for conferences. Here at a simple blackboard, hanging on the wall opposite the entrance our scientists gathered together to discuss and ultimately clarify all the characteristics of the forthcoming grandiose experiments.

A long, wide table stands in the study for the conferences. To the right of the entry, under a dark cover stands a large globe. Further on, on the blank wall behind a blind, hang plans and charts.

After the conferences Sergey Pavlovich returned to his small work study. On the left of the window on a night table stand telephones. Alongside the work table is a switchboard. Without leaving his office, Korolev can be connected with any part of the vast expanse of the space port.

This does not mean that Sergey Pavlovich remains much in his office. No, he is restless. Today here, tomorrow in another place,

and the day after, he has gone quite far away. His friends recall how after one of his jobs he was tired, he sat in the airplane and immediately began to calculate something. Even in flight. And "at home", in the space port, the light in the windows of his office shone far beyond midnight.

A wide range of questions, the burden of responsibility was great, which he took unto himself when the first space steps were made. His time was scheduled in advance. When you come to him, after his greeting, he usually says: "The crux of the matter is that time is so short, so brief."

The operator, after taking the film on the space launch, recalls his visit to Korolev: "My meeting with him was scheduled for 12 noon. In order to not forget anything, I arranged to be in the well-lit room of Sergey Pavlovich's secretary. Exactly at 12 o'clock the secretary's telephone rang and I could hear over the instrument his resounding voice:

"Send the operator to me."

When I entered he stood behind the desk, without a jacket, both hands resting on the desk. There was a pile of papers on the desk. Apples lay in a low bowl. Sergey Pavlovich reached his hand out to the bowl, took several large apples and offered them to me: "Sit and eat. I shall return in half an hour." — and he smiled.

The half hour passed inconspicuously.

"It seems you are quite short of free time," I said to Sergey Pavlovich.

"Yes, I don't have very much," he answered.

"Why not, if it isn't a secret?"

"Time, health." And he added playfully: — "And my wife scolds."

"All wives scold," I noted cheerfully, recalling how my wife nagged me to take a vacation.

"Yours too?"

"Everyday." I answered, "sometimes for the sake of something to do."

Sergey Pavlovich with a gesture indicated that it was time to settle down to business.

"Well, what do you have there?"

"The movie requires a sacrifice."

"And the sacrifice — that is I?"

"Today — yes."

"O.K., I'll help you."

He explained what was coming to photograph the flight and how this could best be done.

By the way, the future satellite here also at the space port in Baykonur, received a special room (in which the first cosmonaut of the USSR Yu. A. Gagarin later was prepared for his flight). And the rocket-carrier in accordance with its imposing size occupied the huge assembly hall. The moment arrived when the silvery ball was delivered on a light cart to the assembly room. With the help of a crane it was lifted to the nose compartment of the rocket. The satellite seemed to be a toy in comparison with the carrier. And then it was connected to the rocket, the whisker-antennas extended along the nose of the carrier.

Sergey Pavlovich gives the command for final connection of the equipment. For a moment in the hall an anxious silence fell. And then sounds filled the air, like the sound of a strange bird: beep-beep-beep... The designers, the test personnel, the engineers, the technicians listed attentively to it: everything seemed to be normal on earth, but what would it be after the rocket was launched?

The gates of the assembly room and a tractor slowly took the fantastically appearing rocket with the gleaming ball of the satellite at his head.

"A good journey," says Sergey Pavlovich, "Let us go join our 'first-born'."

These words, as eye-witnesses recall, he pronounced with such sadness as if he were saying farewell to a loved one.

People with bare heads walked for a long time behind the tractor pulling the rocket and the satellite.

Finally, the rocket reached the launch pad. On the fourth of October at 5 hours and 45 minutes the fueling began.

One half hour to launch time. There were fewer people near the soaring and droning operating mechanisms of the rocket. Only Sergey Pavlovich and his closest aides were still there. Sergey Pavlovich was silent and attentive. What was he thinking about then — was he recalling to mind the events of the past few days, was he estimating how this launch might end and what might be its results? But then he returned to the bunker.

Fifteen minutes remained. The last assembly had reached the pad. The command rang out: "Let the boom down!"

Footnote (5) appears on page 180.

Soon the loudspeakers announced: "Five minutes to launch!" Everyone present at the observation point kept their eyes glued to the rocket.

Ten loudspeakers conveyed the first command for launching in the silence. A special tower led the cables from the rocket to a safe distance. The apparatus of the rocket became autonomous at that moment.

There were still several commands and finally the decisive one: "Launch!"

When it was certain that the satellite had gone into orbit, Sergey Pavlovich returned to the participants in the launch with the emotional word:

"My dear friends! Today that which the best minds of mankind have dreamed about has come to pass. The prophetic words of Konstantin Eduardovich that mankind would not remain forever on Earth, begin to be realized. Today the first artifical satellite in the world was launched into circumterrestrial orbit. With this we have begun the assault on outer space. And the first nation to pave the way to outer space was our nation — the Nation of the Soviets! Let me congratulate all of you on this historic date. Let me especially thank all the specialists, technicians, engineers, designers who have participated in readying the rocket carrier and satellite, for their titanic labor. Again to you a sincere Russian thanks."

His words were drowned in shouts of "Hurrah!"

The tremendous difficulties which Soviet scientists overcame in building and launching the first satellite, in the words of Sergey Pavlovich, "include not only the attainment of precision of launching, computation of trajectories, development of the automatic and

radiotechnical systems, which possess a high accuracy and precision of operati n, but also construction of the rocket-carriers."(6) Then he wrote with pride: "The works of hundreds of Russian and Soviet scientists have caused the Soviet Union to become the motherland of the majority of the new and most refined types of rockets."

Sergey Pavlovich singled out the basic fact that is characteristic of our rockets. "Modern rocket-carriers may develop a flight velocity measured in tens of thousands of kilometers per hour.

The rocket-carrier has an engine capable of producing thrust, both at low and high flight velocities, operating both in air and in airless space. On board are installed special guidance systems, retro-engines, heat protective systems..."

To believe in an imminent flight into space, one had to be, similar to S. P. Korolev, a very bold person. It was sufficient to refer to the predictions of foreign scientists. Twenty-two years before the flight of the first satellite one English professor called Tsiolkovskiy a charlatan and demanded "that the idea of penetrating outer space be rejected as unattainable." And 16 years prior to the beginning of the space age, a Dutch specialist on rockets stated that it would be at least 100 years before the first space flight would be possible.

Academician Blagonravov at a meeting to honor the memory of S. P. Korolev noted that Sergey Pavlovich boldly and prudently founded the design office and the industrial base for rocket-space technology. As a scientist, looking far ahead, Sergey Pavlovich came to a solid conclusion: modern science and technology permit a sharp increase in the flight range of rockets due to the use of automatic control. He carried out his titanic work in developing ballistic rockets. Under his direction experiments were conducted which produced the new possibilities of rockets, specifications for their guidance and launch

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Footnote (6) appears on page 180.

equipment. In his field of view there were instruments for guiding the rocket and its engines.

"During the time of launching the first satellite," recalls Academician Blagonravov, "I was in the United States of America. The scientists there literally inundated me with questions: How did the USSR leave the USA behind? Does this mean that your intercontinental ballistic rocket is not a bluff? Isn't there a mistake in the weight of your satellite — 83 kilograms — our first one will only weigh a few pounds?"

As much as I could I tried to explain the mistakes of my American colleagues. No, there was no mistake. Moreover, we were already preparing a second satellite weighing half a ton...

At the ceremony for the monument to K. E. Tsiolkovskiy in Kaluga, September 15, 1957.

At a party in honor of M. K. Tikhonravov (at the table in the center. S. P. Korolev is seated second from the left, 1960.)

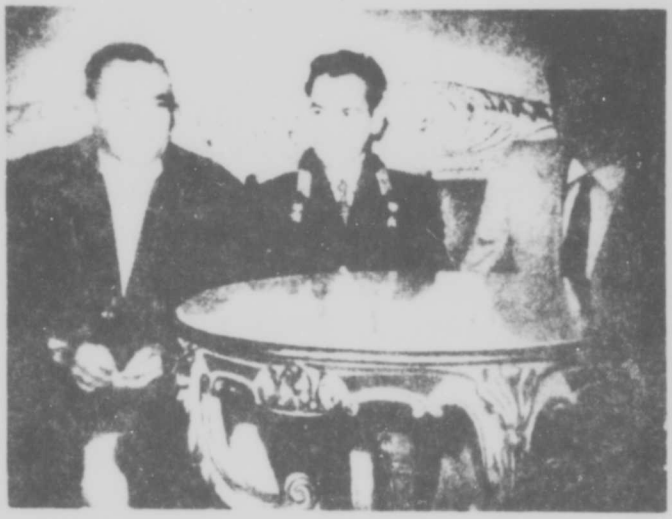
S. P. Korolev congratulates Yu. A. Gagarin on his successful flight, April 1961.

Yu. A. Gagarin, V. I. Gagarina,
N. I. Koroleva and S. P. Korolev
on a holiday, May 1961.

The artist shows S. P. Korolev portraits of the first cosmonaut in the world.

Conversation about future flights. Yu. A. Gagarin and S. P. Korolev, 1961.

The discussion of future fligh s even continues on a Holiday by the sea. S. P. Korolev, N. P. Kamanin and V. I. Yazdovskiy.



G. S. Titov's flight is completed. At the Academy of Sciences of the USSR: S. P. Korolev, G. S. Titov and M. V. Keldysh.

S. P. Korolev with V. V. Nikolayeva-Tereshkova, Yu. A. Gagarin and V. F. Bykovskiy, June 1963.

Memorial Plaque on the building of the Moscow Higher Technical School im. N. E. Bauman, where academician S. P. Korolev studied.

When Sergey Pavlovich returned to the design office he knew what had been written abroad about the first satellite. "It seems it is not only in politics but also in technology that there are die-hards!" He joked appropos of the foreign specialists who continued to say that the Soviet Union remained significantly behind the United States in the design of intercontinental ballistic rockets.

The flight of the artificial earth satellite it would seem completely refuted the possibility of such predictions. But the die-hards were found here too. One American general, after launching of the Soviet satellite, announced: "It is rubbish, simply a piece of iron, we can also accomplish such a launch, we simply do not wish to."

"We simply do not wish to," — Sergey Pavlovich said ironically. He knew that the great majority of persons on Earth thought otherwise. The satellite launching struck their imagination and ignited their hearts with enthusiasm.

The magazine "Paris-Match": "On October 5, 1957 Washington was struck by a cyclone which razed signboards, knocked down poles, tore up the roots of the trees, lifted to the sky hosts of deciduous forests and in final account brought down a flood on the capital. But the hurriedly summoned scientists, specialists and political figures thought about another event, an event which was uppermost in the public mind. The Russians had just succeeded in doing what the Americans had so often prematurely depicted: they had launched the first artificial earth satellite. This was a miracle... The tenet of the technical superiority of the United States had been destroyed."

The newspaper, New York Times: "American tourists in the USSR have caught a peculiar illness — sputnikomania. They had a deep feeling of their inferiority, based on the assumption that since the Soviet rockets are better than the American ones, then everything Soviet must already be, now or in the near future, better than everything of ours."

The statement of another American newspaper appeared to be significant: "The widespread usage in the West of the Russian word "sputnik" instead of the clumsy American term "artificial earth satellite", appears to be, while perhaps not a major but nevertheless significant evidence... of the priority that the Soviets have established in the conquest of outer space."

And American historians wrote: "The satellites, the discussion on the Soviet system of production... a new phase in Communist external politics and external trade, — all of this together forces us to concentrate all our powers to study, as much as possible, Soviet Russia, her past and present."

The English magazine "Tribune": "How could the Soviets go so far ahead in the conquest of outer space: How were they able to ready the required staff of scientists, technicians and engineers for this colossal technical achievement? The answer should be sought not only in the Russian tradition, which goes back to the father of Russian space science and government, but also in the system of education. Soviet Communism employs different methods of education than do we."

The World Held Its Breath

The first practical step in cosmonautics made this branch of science and technology exceptionally popular throughout the world. The most developed nations in the world came to judge their scientific and technical progress by it. And in the center of the research in this most attractive branch of science and technology stood Sergey Pavlovich. You can imagine how all this very quickly changed his life, increased his responsibility even more, as well as the scale of his plans and worries.

Sergey Pavlovich felt with his mind and heart the demands of this historical moment, new ideas were born in his mind and those of the crew which he headed, the outlines of future research, the next steps in the orbits were contemplated.

The successful flight of the first satellite permitted Sergey Pavlovich to think about adjustments in previous plans. Prior to this there existed three projects on the satellites. The first was planned as a very complex space installation. This project was embodied in the third satellite to be launched into orbit. It was planned to launch a living creature only after two launches. After the flight of the simplest satellite Sergey Pavlovich abruptly changed his thoughts. He decided to not delay any further the launch of an animal — "to pull it out", as he expressed it, from the third project and connect its cabin with the simplest satellite. Thus was born the new idea of the second satellite, launched a month after the first.

The new satellite had to answer the ancient question: can we exist beyond the atmosphere? The work was in full swing...

His associates in the design office recall that each morning in the assembly shop Sergey Pavlovich carried out his operations. Thoroughly and carefully he checked the day's assignments, scheduled in hourly graphs. His conversations were always brief, tense and maximally clear. As a rule no one volunteered repeatedly... In everything the iron hand and will of Sergey Pavlovich was felt.

According to his idea the second satellite must represent a joining of the first satellite with its radio system and an air-tight cabin for the dog. The cabin contained a system of air conditioning, a supply of food and oxygen for 7 days, instruments for measuring temperature and pressure in the container. The sensors, attached to the body of the animal, permitted registering the pulse and breathing rate, the blood pressure, the biopotential and movement. The apparatus for transmitting the temperature information on the condition of Layka was installed on the last stage of the rocket-carrier. This means that the cabin with the dog and the container with the apparatus were not separated from this stage after reaching orbit.

On the satellite there was installed an apparatus for investigating cosmic rays and ultraviolet and x-radiation from the Sun. The overall weight of the second satellite reached a half ton.

Medical technicians under the direction of V. I. Yazdovskiy and O. G. Gazenko monitored the "candidates" during the flight. Among the aspirants was Al'bina, who had completed already two launches on rockets to an altitude of 100 kilometers. But they felt sorry for her for her previous services — it was still impossible for people to return animals from outer space. The choice fell on Layka. And Layka did not object. She was transported quite well to the pad and was placed in the air-tight cabin. During the day of November 3, 1957 Sergey Pavlovich and his associates launched her into orbit. For the last time they gave her water, for in the zero gravity of space it could not be done: water could get into the equipment. Layka was fed, during the flight, space food which contained water in the required amount and flavored to stimulate her appetite with a tasty aromatic sausage.

The starting rocket had been prepared and the first living animal had rushed into the unknown. Telemetric information reported: Layka lives, she has survived takeoff, weightlessness did not kill her. We can already plan to send man beyond the limits of the atmosphere although this would still be in the future.

The first information on the interesting geophysical phenomenon was received from the satellite. This concerns the "waveguides", formed by the upper layers of the ionosphere. Incident on them the radiowaves were propagated to significant distances. The waveguide effect led to the appearance of a "signal — precursor", arising approximately 30 seconds before the basic time of reception. In several instances the signals from the satellite were received when the satellite was on the opposite side of the Earth. All this indicated a tremendously greater degree of ionization of the ionosphere than had been assumed prior to launching the satellites.

Sergey Pavlovich hurried these results: laboratories were needed in orbit and the first laboratory was launched half a year following

launching of the PS*. One of Sergey Pavlovich's associates recalls his words, said to him at the space port.

— Let us add another stage. Then the weight in orbit will be tripled.

And the weight of the third satellite was in fact almost three times the weight of its predecessor (1327 kg). In the second and then in the third satellites, as proposed by Sergey Pavlovich, the shape was changed — a cone instead of a sphere. Its height on the third satellite was twice the height of a man (357 cm); it carried almost a ton of equipment (986 kg).

What new equipment was there then that was used on the third satellite? First of all — there were instruments for investigating micrometeorites, atmospheric pressure, cosmic rays, solar radiation, electrostatic and magnetic fields of the Earth... Information from the satellite was transmitted with the aid of a multi-channel telemetric system with memory and programming equipment. This equipment included a system for every passage of the satellite over the territory of our nation and especially at the moment of passing over the surface measuring stations.

In addition to the electrochemical current sources, on board the satellite were installed solar silicon batteries.

The third satellite (let us remember that this was in 1958) used ion traps for determining the concentration of charged particles at high altitudes. In the USA this method was not used until the end of 1960.

The third satellite acquired a negative electrostatic charge and the electric field strength on its surface was found to be much greater than anticipated. The field strength in the upper layers of the atmosphere was found to be scores of times greater.

*Translator's Note: This may designate the first satellite.

The first three satellites contributed much new to science. The amount of the flattening of the Earth was found; this has previously required the most complicated geodesic measurements over a number of years. The density of the atmosphere was determined at high altitudes and its dependence on solar activity. The curtain was pulled back for determination of the Earth's magnetic field, and its radiation belts from space. It was established that the "meteoric hazard" was low, although on May 15, 1958 the sensor on the third satellite recorded from 4 to 11 impacts from micro-meteorites having a mass of about 6.10^{-8} grams per square meter per second. In subsequent days the number of impacts decreased significantly.

Sergey Pavlovich wrote in 1962: "A year and a half after launching the first artificial Earth satellite, the second and third satellites were placed into orbit... These were, in the full sense of the word, flying laboratories..."

To the Moon

As a man who lived with thoughts of flights to outer space, Sergey Pavlovich speculated much and spoke about flights to the Moon. He undoubtedly knew of the precautions that K. E. Tsiolkovskiy had expressed in one of his letters appropos of the project of the American Goddard, that was widely acclaimed abroad in 1924. This is his precaution: "This undertaking of Goddard, probably, under some pretext will be postponed. His rocket will not even reach 500 versts. And in any case it will not reach the Moon without guidance. This problem is difficult even in theory. It is my duty to say this in advance."

But with the apparatus launched beyond the confines of the atmosphere Sergey Pavlovich could begin planning a flight to the Moon with a solid hand: a space rocket does exist, guidance systems do exist that are capable of reaching Selene (second name for the Moon). It is characteristic that the Moon launch became our fourth space launch

overall. No small role in this respect was played by the idea of flights to the Moon advanced by K. E. Tsiolkovskiy.

The proposal for launching the first lunar satellite was first discussed at the technical council of the design office. Then Sergey Pavlovich organized a larger conference and invited well-known Soviet astronomers including A. A. Mikhaylov, V. V. Sharonov, N. P. Barabashov, and A. G. Masevich. In his introductory words Korolev reported:

"We wish to go to the Moon and orbit a stable Earth satellite, in order to photograph its dark side."

Mikhaylov was surprised:

"Is that really possible? Surely we would need an accuracy exceeding that of astronomy!"

Sergey Pavlovich coolly and positively stated:

"Do not worry about it. We shall do it and you will help us. What equipment must be used for the photographs, what exposure must we employ?..."

And the astronomers responded. And not only astronomers, but scientists from various specialities with glee and enthusiasm participated in readying the legendary moon satellites.

With the approach, and especially with the beginning, of the space age Korolev labored with increasing intensity. This can be judged somewhat from his missions. From April and up to the end of 1957 he travelled for 55 days. From September 27 to October 6 at the space port he continuously directed the preparation and launching of the first satellite, and from October 26 to November 4 — the second.

In the next year, 1958, Sergey Pavlovich spent 73 days travelling on missions and even spent the new year, 1959, at the center. Under his direction the first automated station "Luna-1" was readied.

Ten days before his birthday, — he had reached his 52nd birthday, — on January 2, 1959, along with his associates he completed launching the space rocket with the station on board. Just as the first satellite, the "Luna-1" was a "sphere", but weighed almost ten times more than had the first satellite. It was designed to carry out reconnaissance of circumlunar space. It carried instruments which were designed to detect the magnetic field on the Moon, to determine the intensity of the cosmic rays beyond the confines of the Earth's magnetic field and to define the location of the radiation belts.

Early in the morning of January 3, there first appeared in the sky an artificial cloud. Sergey Pavlovich so wanted to leave the building of the control center, and tossing back his head he admired the unusual spectacle. But he knew that, as astronomical observations had shown, it was forbidden to look at this man-made cloud with the naked eye. It ascended to an altitude of 120,000 kilometers and had a brilliance of 7 stellar magnitudes. (7) This effect produced a kilogram of sodium vapors in atomic state, emitted from the station. The power of the cloud as a source of light comprised 7,000 kilowatts.

The first station passed at a distance of 5—6,000 kilometers from the surface of the Moon and became a satellite of the Sun. Sergey Pavlovich said to his circle of friends:

"It was not without purpose that Konstantin Eduardovich said: 'This problem is difficult even in theory.'"

In 8 months and 10 days Sergey Pavlovich was again at the space center and again he was to direct the launching of an unmanned station. This time it was "Luna-2". It was also spherical in shape, but it weighed 30 kilograms more than the first station. This means that the number of instruments had been increased. And from the "Luna-2" would come data that would lead scientists to discoveries of the existence of an outer region of the Earth's ionosphere at altitudes from 2,000 to

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Footnote (7) appears on page 180.

20,000 km, and an outermost zone of charged particles at distances up to 75,000 km. And "Luna-2" emitted a sodium cloud. It was visible to Sergey Pavlovich and his associates on September 12 at 21 hours 48 minutes, Moscow time for a period of 5 — 6 minutes and had a maximum brightness of 4.5 stellar magnitude. After the data were received from the "Luna-2" it became clear that there was no lunar radiation belt, and that the magnetic field of the Moon was at least 400 — 1,000 times less than the magnetic field on the surface of the Earth.

But the most striking result of launching the "Luna-2" was its precise landing on the surface of our ancient satellite. Pennants were delivered there with the imprint of the National Emblem of the Soviet Union.

And the apparatus, created by the Soviet scientists, designers, laborers is on the Moon! The people of our nation were enraptured by it all. The announcements which Sergey Pavlovich had broadcast were greeted with delight. The moment of the landing was recorded by cessation of the radio signals from the rocket and from the data of radio tracking and especially from the Doppler frequency shift as a result of acceleration produced by the gravity of the Moon when the satellite neared it. The fact of the landing on the Moon was confirmed by the observatories of many countries. Thus the observatories in Hungary (Budapest and Baya) and Sweden (Upsala) noted the appearance of a cloud of dust rising on the northern slopes of the lunar Appennines. This corresponded to the information received from radio media. Moreover, the observatory in Upsala succeeded in photographing a dark point observable above the landing site for a period of 1.9 minutes.

The year 1959 was a new stage in the intense activity of Sergey Pavlovich. During this year he spent 79 days on missions. Of these missions, especially significant was the trip to the space center from September 1 to September 13. On September 12 a lunar rocket was launched with the emblem of the Soviet Nation.

Another memorable mission for Korolev in 1959 lasted from September 24 to October 5. October 4 was the day for launching a third space rocket, which placed into orbit around the Moon the unmanned station "Luna-3". Now in its last stage was no longer a sphere but a cylinder with semispherical bottoms. The length of the station was 1.3 meters and a diameter of 1.2 meters. Altogether it comprised 278.5 kilograms.

The scientists with the participation of Sergey Pavlovich developed a "route" for the station to fly that would permit it to land on the dark side of the Moon. By October 6 at 1700 hours 16 minutes (Moscow time) it had reached the shortest distance to the Moon (5 — 6 kilometers). And then began something that had long been considered fantastic. "Luna-3" was oriented to the center of the Moon and for a period of 40 minutes, from 0600 hours 30 minutes to 0700 hours 10 minutes, it continued to photograph the dark side of the Moon, formerly hidden from the eye of man. At this time the distance of the space photographer to the object being photographed slightly exceeded 60,000 kilometers.

You can imagine with what intensity these 40 minutes were observed at the command point. Those who were present there recall how Sergey Pavlovich went from screen to screen, pressing his hand to his forehead. Even though th re was little to interfere with imprinting the invisible body onto the film, even amateurs with the simplest of cameras can make mistakes.

But the anxiety proved to be unnecessary. The transmissions from the station occurred, thus meaning that the process was accomplished successfully in zero gravity.

When all the signals had been received and interpreted, Sergey Pavlovich found happily that the films were successful From the photographs obtained, astronomers as a result of tedious work discovered 107

objects on the Moon. Their calculations proved to be right: they were able to capture on film already known objects observable from the Earth. Of the already known objects which could be rejected in compiling a map of the dark side of the Moon, 51 were found on the film.

Like an exciting poem, Sergey Pavlovich read the lunar map. In his free minutes he approached the chart and thoughtfully gazed at the seas and craters that were for the first revealed to the view of man. There were especially many craters. The bottom in many of them was dark, sometimes very bright. "Could this be luminescence?" — he pondered.

Besides photographing the dark side of the Moon, which in itself was the greatest of accomplishments, the third station contributed much new to our knowledge of outer space. In particular, it confirmed that the gas mantle of the Earth extends to 20,000 kilometers, and the region embraced by the radiation belts even further to 80,000.

Measurements on board the "Luna-3" showed an irregularity in the distribution of micrometeorites. And to the point, a meteorite was certainly to blame for the cessation of communication with Earth in November. But the "cosmic missile" could not detract from the tremendous value of the "Luna-3" flight. Throughout the world this flight was recognized as the most significant achievement since the beginning of the "space age".

Sergey Pavlovich evaluated our first steps to the Moon by saying:

"... The greatest event," he wrote, "was the launch of three Soviet space rockets. Escape velocity was reached and slightly exceeded, which undoubtedly meant a new step in the progress of Soviet science.

Our Soviet space apparatus became the first artificial satellite of the Sun. The radio signals from the interplanetary stations were the first to be received on Earth.

A Soviet rocket carried our emblem to the Moon. The dark side of the Moon was photographed."

The Moon — our natural and ancient satellite — has substantial differences from the Earth. There is no atmosphere on the Moon. There is also no discernible magnetic field or radiation belts. The force of gravity on the lunar surface is approximately one sixth of that on Earth.

Under these unusual conditions, which exist only on the Moon, we have tremendous opportunities for scientific research, which are completely unattainable on Earth."

Then Sergey Pavlovich further explains that observing the processes of the Universe is difficult from the Earth: "The Earth's atmosphere," he wrote, "absorbs radiation from the celestial bodies with ozone, water vapor and carbon dioxide, remaining transparent only in a comparatively narrow "visible" part of the spectrum. In the microwave region there is also only a narrow region where the Earth's ionosphere, which reflects the radiation coming from outer space, is transparent."

And as if weighing the problems for the future, in spite of the great significance of the results attained, Sergey Pavlovich passes sentence on himself:

"The period of the first sensational discoveries and the first photographs, taken from long distances... is found to be... inadequate."(8)

By this time Soviet cosmonautics was rapidly approaching the edge of manned flight. Pondering over the question from which this had all started, Sergey Pavlovich wrote: "Some people, in answering this

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Footnote (8) appears on page 180.

question, recall the ancient dream of man to fly over the Earth, to conquer the ocean of air, and to solve the secrets of remote stars. Others associate these dreams with the works of K. E. Tsiolkovskiy which are amazing in their genius, where phantasy joined scientific bases. Still others proceed from the practical works of our scientists and technicians who produced the first flying apparatus, the first rocket engines, etc. We can argue as to who is closer to the truth. In our view these are all links in one chain, a single concept of conquering outer space, embodied in the life of all the Soviet people.

FOOTNOTES

Footnote (1) page 125 "Aviatsiya i Kosmonavtika", No. 10, p. 32, 1968.

Footnote (2) page 135 Speech at the Session of the Supreme Soviet, March 31, 1958.

Footnote (3) page 136 Same footnote as above.

Footnote (4) page 148 "Aviatsiya i Kosmonavtika", No. 3, p. 4, 1964.

Footnote (5) page 156 The service boom is a device at the launch which ensures access of people, delivery of instruments, etc. to the various stages of the space craft.

Footnote (6) page 158 "Aviatsiya i Kosmonavtika, No. 3, p.3, 1962.

Footnote (7) page 174 Stellar magnitude is a means for measuring the brightness of a star. The weakest stars visible to the naked eye have a stellar magnitude on the order of 6, and the weakest stars obtained on photographs, made with the aid of the most powerful telescopes, have a magnitude on the order of 22.

Footnote (8) page 178 "Pravda", January 1, 1965.

SENDING THE COSMONAUTS ON THEIR WAY...

Sergey Pavlovich, figuratively speaking, guided space orbits of our first cosmonauts with his own hand.

(From an article entitled "Outer Space Assaulted", "Pravda, January 14, 1967.)

Test Craft

The preparation for manned orbital flight spread and grew. The heart of the space rocket system was undoubtedly the satellite ship, obedient to its commander. Much had to be sought and tested by the designers, with Sergey Pavlovich at the head, in order to build the first spacecraft. Gradually there appeared a structure in two parts — that which would descend, i.e., return from orbit into the dense layers of the atmosphere, the apparatus and the instrument compartment.

A few words about the terms. Today we are used to hearing the words "spacecraft", "eject devices", "cosmonaut"... But we know at that time they were merely being born. Some proposed calling the ship either a star flyer or a space flyer, and the crew a star pilot or space pilot. The taste of Korolev and his associates prevailed. And new concepts entered our language that came to be

generally accepted — spacecraft, cosmonaut...

Each new concept, each term was discussed thoroughly by the crew of the design office, and was carefully considered by Sergey Pavlovich. Here it should be mentioned how persistently Korolev sought a precise definition of the concept of space flight. "It seemed to be so clear," he wrote, "but in fact this was not the case — in pursuit of records, and superiority this concept (abroad) has been arbitrarily interpreted and distorted".

Sergey Pavlovich urged the various specialists to try out their own definitions. He received them, read them and made his own comments on each.

Korolev decided that he had to personally determine the space flight. Pondering, he draws the globe; with a wavy line he denotes the dense layers of the atmosphere. He draws the first trajectory: the pencil steeply "ascends into space" and then steeply "descends to Earth". This is the so-called ballistic ascent. Can this be used as the space flight?, — he ponders. And he answers: "For a certain duration". And the plan of the rocket flight? He draws still another curve, more sloping. "Apparently, under these conditions", — decides Sergey Pavlovich.

He takes a pen and on a clean piece of paper appears the headline. "What is space flight?". This article by Sergey Pavlovich, preserved in manuscript and still unpublished, begins as: "Recently more and more projects are appearing for flight into outer space of different types of rocket flying apparatus both manned and unmanned. In connection with this it is completely natural that the question arises as to just what is space flight? What are its peculiar properties? What do we mean by outer space, where does this flight take place? What is the principal difference between space flight and other types of flight known today?"

Sergey Pavlovich posed these questions in 1960. And in 1961 the triumphal flights of our cosmonauts, about which we shall speak later, began. It will be interesting to the reader to know how

Sergey Pavlovich answered his own questions. We shall quote his manuscript.

Thus, the answer of Sergey Pavlovich to the question of outer space:

"By outer space we mean that space which surrounds the Earth, beginning from those altitudes where even at very high momentum the volume of the atmosphere is insufficient to sustain flight. Outer space is infinite, and only near the surface of planets, possessing an atmosphere at altitudes where the influence of this atmosphere is already significant, does a region begin for example, of surface space — for the Earth, the region of the Martian atmosphere or of Venus, etc.".

And at what level of the atmosphere does the Earth lose its "dominion" over a flying object? Sergey Pavlovich answers: "Beginning with altitudes of 150-200 km even for artificial Earth satellites, moving at orbital velocity on the order of 8 km/sec, the influence of the atmosphere is so insignificant, that it cannot be used for flight.

With outer space apparently now perfectly clear, let us see how Sergey Pavlovich approaches the definition of flight in it: "One of the criteria defining space flight is the motion of a flying apparatus in space above the dense layers of the atmosphere, beyond any significant influence from it. On the other hand, any flight in the dense layers of the atmosphere is a flight near the ground. Space flight becomes flight near the ground, for example, when the flying apparatus re-enters".

And what about duration of flight? Is any entry into outer space a flight? "If the flying apparatus, — answers Sergey Pavlovich, — completes a flight around the Earth, even though it is no more than one orbit, without falling to Earth, then the flight is a space flight. Here we must mention that in the general case space flight may take place not necessarily around the Earth, but also when either the extent of the flight or its duration is

comparable to one orbit of the satellite. For example, vertical space flight is theoretically possible".

And what is the conclusion from the above — the formulation: "We call it space flight when the flight of a flying apparatus at a momentum equal to or greater than orbital velocity is above the dense layers of the atmosphere for a sufficiently long period of time. Here the Earth's natural gravity is lost.

The definitions are pretty well finished, but the meditations continue still. Not long before the launching of Yu. Gagarin on March 19, 1961, he again returns to the idea of landing. Sergey Pavlovich writes: "Space flight presumes landing on Earth. Otherwise it is a free fall or a shot, etc.". Then he makes the further statement: "Not necessarily to Earth!".

The terminology was so carefully developed. And it seems the flights were readied a hundred times more carefully.

In the course of readying man for flight into outer space, Sergey Pavlovich paid special attention to the reliability of all systems and the safety of the cosmonaut. Virtually faultless operation had to be ensured for the systems, assemblies, instruments and components under conditions of space flight. The requirement for reliability is easy to understand, if we remember that each satellite consists of hundreds of the most complex systems, thousands and tens of thousands of parts and components. And it is only necessary for some insignificant element to go out of order for the flight to be unsuccessful.

In order to be sure of a high degree of reliability, said Sergey Pavlovich, it is essential that we think about it beginning from the very inception of planning. Therefore, we first designed means for checking the operation of all designs both on the ground and during flight.

And in the course of production he followed most strictly the observance of technique, for the "well-being" of all systems, each

of which before installation on board the craft had to be tested numerous times and under the most diverse conditions. And then the craft and its systems were tested on the ground. Only after this was done did the launching and orbital flights begin.

However, the safety of man in space flight depends not only on the technological reliability, but also on the guarantee of conditions necessary for man to live. Sergey Pavlovich noted for himself in 1960: "What are the difficulties? Prolonged life in outer space and the guarantee of biological conditions. Communication and assistance. Power engineering, etc.".

What does this "communication and assistance" mean? Man, launched into outer space, must at any moment be guaranteed the chance of immediate emergency landing on Earth. Such a landing, depending on the phase of the flight, Sergey Pavlovich intended to accomplish in different ways. Let us assume that the emergency situation has arisen immediately prior to launch or immediately after launch, when the speed of the rocket is still relatively slow. Here it is best to employ a special low-power rocket device which will catapult the cabin with the pilot. And if the ship is already in orbit? Then we must have a device that is capable of returning the craft to Earth or at least to a low altitude where the cabin is separated and then descends to Earth via parachute.

As Korolev had described in his imagination, so was it accomplished and tested, first on Earth and then in flight.

The shape of the ejection device was also touched upon in seeking the best solutions to this problem. Various shapes were proposed: to make it either in the shape of a cone or a sphere. The defenders of each viewpoint had their own arguments. The designers called the head of one of the departments to the office. Sergey Pavlovich listened to the proponents of the various suggestions, but did not rush to any conclusion. His meditative face, pale from the bright light of the ceiling, was impenetrable. As always he did not wish to impose his solution without discussion, he waited and let the debaters present their arguments. Those who

participated in the conference recall that the question as to what kind of ejection device would be used was solved in one hour.

"So what was there to "unravel"? — Sergey Pavlovich repeated the phrase with which the discussion had begun. He briefly examined all the variations and announced that the game had gone on long enough. He finished with the words:

"The suggestion is to use a sphere..."

And he explained why: a spherical shape ensures dynamic stability, it is capable of enduring thermal loads, it is suitable for the component and it has a high resistance in the dense layers of the atmosphere.

It was decided to build the instrument compartment in two truncated half shells.

Everything necessary for ensuring the cosmonaut's life during flight and during landing was placed into the ejection device. A console with instruments to allow control of temperature and humidity of the air in the cabin was installed on the left of the cosmonaut's seat. The control units for the complex of radio engineering devices and to orient the ship were also installed there. The ejection device was covered with a heat-resistant layer on the top, heat-resistant glass was placed into the viewers; with entry into the dense layers of the atmosphere the "sphere" is heated to a high temperature. In the instrument compartment were concentrated the equipment which had to operate during the flight as well as the braking mechanism.

The complexity of the craft's contents are confirmed by figures — 56 electrical engines are required. And the number of crystal instruments is 100 times more — more than 6,000, relays and switches — 800. The wire used to connect all the instruments of the craft would extend to 15 kilometers.

In order to ensure a reliable determination of the position in space and the velocity, orientation of the craft toward the sun during flight and in landing, intricate systems were developed. However, one of these systems which Sergey Pavlovich described, "stumbled" in the first test of the satellite ship.

...This test launch was made on May 15, 1960. As yet the cabin was occupied by mice, drosophilas and algae rather than by man... They as well as Layka who had preceded them in flight served as living indicators and helped in judging how outer space affects life.

The experiment was begun and proceeded normally; information came in by radio. It confirmed that the satellite was in the computed orbit, "life conditions" were being maintained in the cabin. On its 64th loop during the night of May 19 the research program was completed. The command was given to turn on the braking mechanism and separate the ejection apparatus from the instrument compartment. Then the unforeseen started. True, the cabin was separated, but... instead of starting its descent, it soared into an even higher orbit. This was because the orientation system did not ensure a precise direction of the braking impulse. Everyone at the command point automatically recalled the words of Sergey Pavlovich about the special responsibility of this operation.

But there is no bad without good. Thanks to this trouble for the first time, on signal from the Earth, a transfer was automatically made from one orbit to another. Thus, the possibility of maneuvering in orbit had been confirmed.

It is completely natural that before the next launch Sergey Pavlovich paid special attention to the orientation system and landing. The cabin this time contained the dogs Belka and Strelka. In special space suits they took their positions at the automatic feeding troughs. Along with them were forty mice, two rats, insects and plants. In the process of preparing for launch unforeseen complications arose: it was found that the cosmic particle analyzer could not be placed into the cabin beforehand, but some way had to

be contrived to install it some moments before takeoff; then at the very last moment one of the partitions in the cabin came unfastened. All these details were later analyzed carefully so that henceforth they would cause no trouble.

But now all these problems are behind us: the second satellite was ready for launching and to orbit the Earth for 17 times. The decisive moment arrived.

"Give the command for launch," said Sergey Pavlovich with a faint note of tension in his voice.

On the 18th orbit the command was received on board the ship to land. On Earth they awaited to see if the braking would take place. The radio signals from the ship disappeared. Good, this means that it has left orbit. Sergey Pavlovich is connected with the navigation equipment separated from the instrument compartment of the ejection mechanism. Soon a smile touches his lips: "The ejection mechanism is on course".

Later it became known that the cabin traveled 11,000 kilometers from the beginning of the launch and reached an altitude of seven kilometers, and from this altitude descended by parachute. Then the dogs were catapulted and descended in a container with their own parachutes. The cabin and the container, intact and safe, landed in the region of Orsk at a point only 10 kilometers away from the computed one.

"The container landed in a very good site," Sergey Pavlovich said later on to correspondents. "On a level meadow with a field. The farmers laboring the field noticed the unusual device and surrounded it. Someone even knocked on the wall: will there be a voice? But then over the heads of the crowd appeared an airplane and three specialists parachuted down. They opened the hatch — and from there, to the surprise of the farmers, jumped out ordinary canines..."

Thus, for the first time in the world a successful return was made from outer space of a satellite with living creatures. Someone jokingly said: "And so after all there is a God!". Sergey Pavlovich, catching the joke, answered: "If He does exist, then He is for the communists".

Sergey Pavlovich was very interested in the radiation danger in orbit. The amount of radiation dose received by the dogs was not high. With a quiet sun — he concluded, — the flight of man in circumterrestrial space is not dangerous.

On December 1, 1960 the third satellite was launched into orbit around the Earth. On board the ship were the dogs Pchelka and Mushka. The flight was begun and finished successfully, but the animals did not return to Earth: the trajectory of the descent deviated from the computed one, and the satellite ceased to exist during entry into the dense layers of the atmosphere. Nevertheless in spite of the failure, this flight made its own contribution to science.

On December 2 there was a flare on the Sun. The instruments on the ship registered a 12-minute increase in intensity of the cosmic rays. These data were sent to Earth and carefully studied by our scientists along with Korolev.

"In the absence of powerful flares, — it is safe to fly," again repeated Sergey Pavlovich.

Thus, the year 1960 — the year of preparing for assault of space by man — was for Sergey Pavlovich an especially intense one. Six times this year for 10-12 days at a time he was away on missions. For 12 days in August he stayed at the space center when the satellite was launched with Belka and Strelka. He had to remain at the space center for half a month for launching of the satellite with Mushka and Pchelka on board.

And the next year 1961 was even more intense for Sergey Pavlovich. For 139 days — more than 1/3 of the year — he was away from

home. Eight long missions he spent at the space center.

On February 12 Sergey Pavlovich launched the interplanetary station from the space center to Venus. He quickly flew to the observation point from the center. In another half month he was again at the center (from March 3 to March 11): He was preparing the launch of the fifth satellite ship. On March 9, 1961 they sent into space the dog, Chernushka, guinea pigs, mice and frogs. The flight was successful; the landing was made after one orbit around the Earth.

After two weeks the dog, Zvezdochka, completed one orbit — she was in the cabin along with a mannequin "Ivan Ivanovich". This mannequin, simulating man, "sang" songs from the repertoire of the Pyatnitskiy chorus. The landing took place at the designated site.

— The preparation can be assumed finished, — summarized Sergey Pavlovich at the end of the two flights — the fourth and the fifth satellites, — was carried out strictly according to the program of the future manned flight.

Commander of the "Vostok"

Before we discuss the direct preparation for manned flight into outer space, let us return to 1959 when the requirements for future cosmonauts were defined. At the conference devoted to this problem there were representatives from various scientific fields, designers and physicians. Many opinions were expressed concerning the physical development and the knowledge of the future cosmonaut. Finally, Sergey Pavlovich spoke. Participants of this conference recall that Sergey Pavlovich said:

"Everything that has been said here is correct. Much is required of man in his flight to outer space. Undoubtedly the physical data and the overall training are important. But the determining factor in selecting the future pilot of the spacecraft must be the idea as to who can best control this complex space technology in flight. The man who must be readied for outer space

must have flying experience and a clear concept of all flight characteristics; he must have the habit of dealing with unusual circumstances and have the capacity for making instantaneous decisions. The man chosen for the first flights into outer space will find himself isolated. This means that he must be to some degree a jack-of-all-trades — a pilot, a navigator, a communications expert and an engineer. Who is best prepared for this task? There cannot be two opinions — he must be a modern jet fighter pilot. He flies in the stratosphere in a single seater high-speed airplane and in aviation jargon — he sows, he reaps and he plays on the fife ..."

S. P. Korolev's viewpoint was supported by the majority and became the starting point for further practical steps.

...At the beginning of 1960 in a pine forest below Moscow a village arose which is now called Zvezdniy. The future cosmonauts lived in this village after a multilateral and hypercritical choice. Familiar now to everyone, then they were ordinary combat pilots. Senior Lieutenants Yuriy Gagarin, Valeriy Bykovskiy, Lieutenant Aleksey Leonov were all of the same age — 26.

One year younger than the three friends was German Titov, a classic combat pilot. The older generation of the future cosmonauts was "represented", if one can say this, by Captain Pavel Popovich, also a combat pilot. His younger comrades had flown mainly on MiG-15 and MiG-17 fighters but Pavel had experience in flying the MiG-19. They all came into cosmonautics with the position of senior pilot. Only the 33-year old engineer Captain Vladimir Komarov had been an assistant to the foremost engineer-tester before entering the detachment of cosmonauts. He had considerable overall experience. And the 35-year old Pavel Belyayev, former squadron commander, had flown even more before becoming an astronaut.

Sergey Pavlovich seemed to be very pleased at meeting the sturdy, intelligent young lads with the light blue tabs on their jackets. They had all breathed the air of outer space about which

Sergey Pavlovich always dreamed.

In the memory of the cosmonauts, the first encounter with Korolev in the Spring of 1960 left the impression of a brilliant event. For example, A. A. Leonov liked the tender salutation which Sergey Pavlovich gave them:

"So my eaglets do you know on what you shall fly? No, not on airplanes, but on completely new machines."

A. A. Leonov after only a day's acquaintance noted that Sergey Pavlovich spoke for an especially long time with Yuriy Gagarin. The young clear-eyed pilot had somehow caught Korolov's fancy. Perhaps it was his buoyancy, his enthusiasm. In those days, which in his own words were very happy for Yuriy Alekseyevich, he became a communist and experienced a great inward animation.

Gagarin, according to his conversations, also liked Sergey Pavlovich from the first glance — he was strongly built, wide-shouldered, affectionate and understanding a sharp word. "A real hare", thought Gagarin then. And not only he, but all the other young lads in the flying jackets quickly came around to Korolev. This was especially true since he immediately conducted himself with them as equals just as with his closest assistants.

Vladimir Komarov recalls this meeting: "The cosmonauts were very anxious before him. There was the prospect of a conversation with the director of the crew who had built the space rockets and ships. Korolev entered and with the simplest of questions began conversation with us. He knew the last and first names as well as patronymic of each, where he had studied, whence his origin, if he had a family. We forgot that before us stood the designer about whom we had heard so much. The tension melted. When he came in turn to me, Sergey Pavlovich said:

— And you, engineer-captain, are suited to be the commander of a multi-seated craft.

Perhaps he said this because I was somewhat older and had an engineering education. I did not put much faith in these words at that time, but later, as we know, these words were well founded".

Sergey Pavlovich was interested in the well-being of the cosmonauts during training.

— It is hard! But we must go through all this, otherwise you will not endure up there, — he said and pointed with his hand to the sky.

Several complained that it was hot in the heating chamber. He explained that during the flight the temperature would fluctuate in the cabin of the ship from 15 to 22°C, but the cosmonaut had to be ready for any event, since during the time of the ship's re-entry into the dense layers of the atmosphere the outer shell would heat up, possibly, to several thousand degrees.

When the cosmonauts arrived at the design office, Sergey Pavlovich without haste led them to the creation of his crew — the spacecraft.

— Look, — he said, — the outer surface of the ship and pilot's cabin is covered with the necessary heat protection. It will protect them from heat during re-entry.

Sergey Pavlovich explained that the satellite is mounted onto a powerful multi-stage rocket carrier and after launching into orbit is separated from its last stage. He said to the cosmonauts that which they had not known before, — that the program of the first flight had been planned for one loop around the Earth.

— By the way, the satellite can also perform more lengthy flights, — he added.

After the future cosmonauts were acquainted with the ship, Sergey Pavlovich continued:

— The cosmonaut may land and remain in the cabin of the ship, but he may also abandon ship. We have designed a variation for when the cosmonauts land separately from the ejection apparatus. At an altitude of 7,000 meters the roof of the re-entry port opens automatically and two seconds thereafter the seat with the cosmonaut is catapulted out. A parachute system then comes into play. But the cosmonaut lands without the seat; it is separated from him at an altitude of 4,000 meters. The cosmonaut himself continues to descend by parachute, carrying emergency rations and water, which are automatically inflated with air. This is in case he lands in water. As soon as you land on Earth, a direction finder is turned on, and we will find you from its signal.

The eject apparatus, explained Sergey Pavlovich, also lands by parachute, but it falls more rapidly than does the man.

The future cosmonauts expressed interest in the seat of the cabin. The ship designers themselves had also been very interested in the finished seat when it arrived at the design office. One of the senior specialists mentioned it to his associates:

"They gathered around to stare as if at a miracle."

Sergey Pavlovich phoned:

"Have they brought the seat?"

When they told him that the seat was there and that it was time to install it in the ship, he gave notice:

"I am coming to the ship now, and not alone but with its occupants."

And sure enough, wearing a white smock thrown over his shoulder, entered Sergey Pavlovich, and following behind him were Yuriy Gagarin, German Titov, Andriyan Nikolayev, Pavel Popovich and Valeriy Bykovskiy... They were accompanied by an Air Force General — one of the first Heroes of the Soviet Union — Nikolay Petrovich Kamanin.

The conversation between the designers and the cosmonauts was lively and friendly. After examining and installing the seat in the ship, Sergey Pavlovich turned his attention to the problem of how our cosmonauts are to be safeguarded at launch. In the event of an emergency it must quickly eject the cosmonaut to a safe distance. Rocket engines would be used as an assist to him, they are turned on and send the seat with the cosmonaut to an altitude which is sufficient for operation of the parachute system. The seat pleased everyone, although several details had yet to be worked out. The designers recall now: "We grew to be friends with the cosmonauts. These lads' impression us was splendid".

The preparation for manned space flight was in full swing. The designers worked day and night at the plant. Sergey Pavlovich, as A. Ivanov recalls, found time to be everywhere. Once he noticed that a defect in the altitude control system had appeared in the mounting frame, and the chief engineer of the ship was not present. Quickly the stern question was heard:

"Why are you not at the assembly? Do you know what is going on there?"

The chief rushed to the site of the incident. But "Espy" had already hastened to another department.

If he detected omissions, and he detected them with some special perspicacity, then he gave the strictest times for their correction.

Once he noticed that there was no brace that was needed for training on the ship, — he was not exasperated, he did not fly into a rage, he simply showed the chief engineer the number "9" on the dial of the clock.

"By 9 o'clock tomorrow this will be done. Where you get the parts is none of my business."

By morning everything was already in order.

When the cosmonauts flew to the space center, Sergey Pavlovich was already there. He greeted N. P. Kamanin with the question:

"As you see, we have little time at our disposal. What do you intend to do?"

"Training, — was the answer."

"Right. It is helpful if the cosmonauts thoroughly repeat the order of manual landing, if they do not forget the communications and training in the space suits. This is very, very important."

"All this has been planned for. We shall begin our tasks today."

"Why such a rush? After the flight one must rest. Become acclimatized."

On April 6, 1961 at a meeting of the Government Commission Sergey Pavlovich reported on the system of regenerating air in the ship's cabin. The concept is simply to guarantee operation of the system for several days although the flight might be only for a duration of two hours.

At the end of the conference Sergey Pavlovich with his associates defined the task of the cosmonaut for a single-orbit flight.

On April 10 the cosmonauts met the starters — those who prepared their flights. Sergey Pavlovich said emotionally:

"Dear friends! Not quite four years have passed since we launched our first satellite and we are already preparing for the first manned flight. Here we have a group of cosmonauts, each of whom is able to carry out the flight. We have decided that the

first to fly will be Gagarin. The others will follow him in the near future, even this year. The next new flights will be of interest to science, a boon to mankind. We are sincerely convinced that the present flight has been well prepared and will go successfully."

In the evening at the meeting of the Government Commission at the space center Sergey Pavlovich again emphasized that the rocket and the ship were completely ready for flight: "The rocket carrier and the spacecraft have undergone a complete cycle of tests in the factory and at the space center. There are no doubts about the operation of the rocket carrier and the ship...".

This was the last good wish and parting word to the flight of the "Vostok". But Sergey Pavlovich was interested naturally not only in the ship, but also in who would fly in it. Yuriy Gagarin remembered how on the day before the flight Sergey Pavlovich, as always attentive and kind, dropped by the room where he lived with his backup man, German Titov. Asking no questions, he simply said:

"In five years there may be a trade-union pass needed to fly into outer space."

The cosmonauts burst out laughing. Their mood pleased Sergey Pavlovich and he glanced cursorily at his wristwatch and quickly left. "There was no trace of alarm in him, said Yu. Gagarin. He was confident of me, as I was confident of him".

Sergey Pavlovich hastened to the launch pad where the last preparations were being made. As participants in this historic occasion recall, during the night of April 11 and 12 none of the specialists slept. At three o'clock in the morning the final tests were begun. At five o'clock Yuriy and German had to be awakened.

Before Yuriy Gagarin could dress in his space suit and be brought to the launch site in a bus, Sergey Pavlovich visited him again. "At first, — writes Yuriy Gagarin, —"I saw that he was preoccupied and tired, he had apparently had a sleepless night.

But even so a slight smile played around his firm, tightly compressed lips. I wanted to embrace him as a father. He gave me several recommendations and some advice which I had not heard before and which would prove useful in flight. It seemed to me that after seeing the cosmonauts and conversing with them, he became more cheerful."

Yuriy was correct — Sergey Pavlovich in fact was anxious about the cosmonauts. He even asked Kamanin to inform him often as to neir well-being and their mood. With sincere frankness, he explained:

"You know that a man will fly in outer space. He is ours, he is a Soviet. He is Yuriy." And then after a moments' silence, he added: — I have known him for a long time. I am used to him. I love him like a son. I have become very fond of him, he is dear to my heart.

The bus carrying the cosmonauts arrived at the pad. Yuriy extended his hand and announced:

— Comrade representative of the Government Commission, cosmonaut pilot senior lieutenant Gagarin is ready for the world's first flight in the satellite "Vostok"!

And what was Sergey Pavlovich thinking during this time? Perhaps he lamented to himself over his age? It was as though he himself wished such a space suit and he heard how cheerfully the young man had announced his readiness for the first orbital flight. For sure at this minute he envied Yuriy with the sincere envy of an old rolling stone. And when he came to say farewell, he embraced him strongly as though putting all the warmth of his own heart into this last caress.

The moment of farewell, recalled observers, threatened to drag on. Sergey Pavlovich was first to break it off:

"It's time, Yura; it's time!"

He spoke these words simply and quietly. "Each specialist," — later recalled Yuriy Gagarin, "who had participated in equipping the ship, knew that anything could happen on such a long and still poorly studied journey, and only Sergey Pavlovich alone was one hundred percent convinced that everything would finish as a triumph to Soviet science. Being at the pad, he was able with his own inimitable confidence to assure everyone, including even me."

And another time Yuriy recalled his launch in a letter to the S. P. Korolev Museum in Zhitomir: "I never asked Sergey Pavlovich for advice, he was so involved with thoughts about so many different problems. I shall never forget how he cautioned my on the first space flight".

And now the first launch nears. Sergey Pavlovich reminded everyone standing by the console of a man capable of behaving himself without giving in to his nerves. In his hands he held a microphone. His conversation with Yuriy on board the rocket has long since become history:

Korolev: How are you feeling, Yuriy Alekseyevich?

Gagarin: I never felt better. The telephones and loudspeakers check out normally; I will change to the telephone.

Korolev: I understand you. Everything here is proceeding normally; the machine is being readied normally; everything is fine.

Gagarin: Understood. I knew it would be so.

Korolev: I understand you; good, everything is normal.

Gagarin: Communication check finished. How did you understand? The initial position of the tumbler switch on the control panel is set.

Korolev: I understood you perfectly. We have received all your data, I confirm. Readiness for launch assumed. Everything proceeds normally with us...

Korolev: How do you hear me? I must transmit to you.

Gagarin: I hear you fine.

Korolev: Yuriy Alekseyevich, I want to simply remind you... (he gives advice). So that you will not worry.

Gagarin: I understood you. I am perfectly at ease.

Korolev: Excellent, fine. Six minutes, so they say, will reveal everything.

After completing these urgent affairs, Sergey Pavlovich again went to the microphone:

Korolev: Yuriy Alekseyevich, how do you hear me?

Gagarin: I hear you fine; I know with whom I am speaking.

Korolev: Yuriy Alekseyevich, I want to remind you of something.

Gagarin: I understood, and it is so I thought.

Korolev: Good.

Several minutes passed. Korolev's radio dialogue with Gagarin resumed.

Gagarin: Give me a "twenty" for signal.

Korolev: "Twenty" for signal.

Gagarin: For a reliable signal on the powered segment, please give me the time, after or before the second of launch.

Korolev: Understood, understood, your request will be answered, Yuriy Alekseyevich.

To keep Yuriy from getting bored while waiting for the launch, it was decided to turn on music. The dialogue was curious that took place between Sergey Pavlovich and Yuriy on this occasion.

Korolev: Well, you have music, don't you?

Gagarin: Not yet.

Korolev: That's understandable. They are musicians, sometimes there, sometimes here, things are not done quite so quickly as the fairy tales say, Yuriy Alekseyevich.

Gagarin: They're playing love songs.

Korolev: Love songs? I think that makes sense, Yuriy Alekseyevich.

The final tests were coming to an end. Sergey Pavlovich again spoke into the microphone.

Korolev: The vacuum seal has been tested — everything is normal, in complete order. Understood?

Gagarin: Understood: vacuum seal in order. I hear and see: vacuum seal checked.

Korolev: I just observed you on television — everything is normal, your appearance has made us glad: cheerful. How do you hear me?

Gagarin: I hear you fine. I feel fine; I'm in a cheerful mood, and ready for launching.

Korolev: Excellent, fine. Everything is normal at this end.

Just before the launch, Sergey Pavlovich again calls Yuriy.

Korolev: One minute to launch, can you hear me?

Gagarin: Understood: one minute to launch. I have taken liftoff position.

Korolev: Understood.

Gagarin: Understood. My mood is cheerful; I feel fine, ready for launch.

Korolev: Excellent.

After reporting to the ship that the engines had been turned on, Sergey Pavlovich literally shouted: "Lift off!" In reply he heard Gagarin:

— I'm off... Everything is proceeding normally; I feel well; my mood is cheerful; everything is normal.

Korolev: We all wish you a good flight, everything normal.

Gagarin: Goodbye until we meet soon, dear friends!

Korolev: Goodbye, until we meet soon!

Gagarin: The vibration is increasing, the noise is growing slightly...

Korolev: The time is 70 (70 seconds from launch).

Gagarin: Understood. Time 70. I feel great. Am continuing flight. G-load is increasing; everything is fine.

Korolev: 100. How do you feel? (100 seconds from launch).

Gagarin: I feel fine, how are you...

Korolev: Everything is normal in velocity and time. How do you feel?

Gagarin: I feel fine...

Korolev: Everything is in order, the machine is going well.

Gagarin: The nose section is jettisoned... I can see the Earth. The G-load is increasing somewhat; I feel fine, am still cheerful.

Korolev: Excellent, lad! Everything is going fine.

Gagarin: I see clouds over the Earth — small, cumulus clouds and the shadow from them. It is pretty. Such beauty! Do you hear me?

Korolev: We hear you perfectly. Continue flight.

Gagarin: The flight is continuing well. G-load is growing, slow rotation, everything is going fine, the G-loads are small, I feel excellent. I can see the Earth in the viewer: everything is getting more covered with clouds.

Korolev: Everything is proceeding normally. We understand and hear you fine.

The son of Earth looked for the first time at his native planet from a distance. This was delightful, but there were moments of alarm.

"Communication... ceased,"— recalls N. P. Kamanin. —"We know, this was only for several seconds, for the briefest of instants. He had to reach another point to continue communication and we listened, we listened carefully to what was happening on board so that we could question Yuriy... Several seconds passed... it seemed an eternity. They could not pass quickly enough. And then finally!"

Konstantin Petrovich Feoktistov wrote about this event: "As it was explained, some kind of breakdown occurred in the communication line. These seconds of the breakdown shortened the life of the designer".

...The flight continued. In response to one of Yuriy's reports, Sergey Pavlovich transmitted to him: "Lad, excellent!"

And Yuriy, hearing this, remembered how Sergey Pavlovich had talked about the ship. In his memory he heard the rather muffled voice of Korolev speaking to the cosmonauts about the control instruments which ensured a high degree of reliability. Remembering all this, — Gagarin said later, — I started to think how much Sergey Pavlovich and his assistants had to foresee.

But there was no time for contemplation. He had to observe, to remember, to describe what he had seen through the open-eyed stare of a man in space.

Gagarin's flight was announced to the entire world by radio. A demonstration took place on Red Square in Moscow. Telegrams with congratulations from the entire world came to the capital of the USSR.

And from the command point of the space center Sergey Pavlovich and his assistants directed the landing of the "Vostok". From the attenuation of the long wave signals from the ship, they determined that the ship had re-entered the dense layers of the atmosphere. And when the navigation transmitters of the "Vostok" began working, it became clear — he was on Earth. They quickly announced: Yuriy and the ship have landed in the village of Smelovok, not far from Saratov, at 10 hours 55 minutes.

At the space center, excitement reached a peak. Congratulating one another, they shouted loudly and shook each other's hands, kissed each other and rushed to the airplane. In the evening, Sergey Pavlovich, with the other designers, visited Yuriy at his home on the shore of the Volga. On the morning of April 13 at 10 a.m.

hours the scientists and specialists, who had equipped the Vostok's flight, gathered together. Sergey Pavlovich was also here. In Gagarin's words, he smiled and his face looked younger. Now, after man had reached outer space, orbited the planet and returned home, everything was finally in complete order. Sergey Pavlovich embraced him and they kissed each other.

The responses of foreign specialists expressed universal delight. The English scientist, William Hilton, wrote: "The entire solar system is at Russia's feet". On this occasion Sergey Pavlovich said to his friends:

"Perhaps it is exaggerated, but in essence it is true..."

The American newspaper, "New York World Telegram and Sun", was forced to acknowledge: "...The Russians... have sent a man into orbit around the Earth and have successfully returned him before we have. The significance of their accomplishment is immeasurable. This is one of the greatest victories of science and technology".

These days were celebrated in the Soviet land with enthusiasm and rejoicing. A stream of telegrams and letters flowed to the address of the Central Committee of the Party and the Soviet Government. A new concept was born — "cosmonaut mail", which brought congratulations from all ends of the world. The outstanding achievements in space especially inspired our youth. Here is an extract from the cosmonaut's mail received in 1968. A student, A. N. Zagorkov, writes: "I was a student in the 8th grade. It was Spring. We were taking exams in mathematics. Suddenly the loud-speaker solemnly announced: "The world's first man in space is a citizen of the Soviet Union...".

Man in space! My heart thumped. I looked, without stopping, at the pink loudspeaker box and perspiration dropped from my forehead.

For a week I went around joyfully excited; later on, I quieted down. And I decided for myself finally: I will fly. This is not

the sudden impulse of a dreamer. I am preparing for this; I am studying. I simply understood quite well that there would be new steps in outer space — we shall fly still further".

By the Blue Sea.

In May, 1961, the author of this book succeeded in meeting with Sergey Pavlovich and seeing Yuriy Gagarin and the other cosmonauts on vacation in Sochi.

More often than not the young men could be found on the volleyball court. Everything was so simple as if there had been no flight in circumterrestral orbit, no universal delight, no triumphal trips through friendly nations. The bright blue southern sky still shown, and the Black Sea still showed deep blue through the lacquer-bright leaves of the subtropical plants.

A ball is being passed over the volleyball net. Now Yuriy Gagarin has it.

— Up! — With an elastic thrust from his fingers, he sends the ball to his partner. And he advises with characteristic Gagarin intonation to this friend: — Lesha, Lesha, pass it higher!

Alongside Yuriy is the cosmonauts' commander in blue athletic trousers. Both had deeply suntanned backs and streams of perspiration between their shoulder blades. The other players wore sports shirts. These were the future cosmonauts. They play with excitement. Flinging themselves after the ball, they fall to the ground.

Jests and laughter fills the court. And then one hears the characteristic sound of Gagarin. Yuriy banters with his unsuccessfully playing comrades:

"He is emotionally unstable: He plays like a girl."

And not far away, in the changing shade of the trees sit Sergey Pavlovich and Nina Ivanovna. Korolev had invited me to his

room this morning. And when I saw that they were on their way, I hurried after them. In the apartment, Sergey Pavlovich wore a white sport shirt and smiled, Nina Ivanovna and the commander of the cosmonauts...

The commander had just been in Bulgaria and said:

— There the houses are tiled.

Sergey Pavlovich interrupted his joke:

— So when I retire, I shall go to Bulgaria and tile roofs. I remember my youth and the construction school.

They began to speak about Yuriy. Sergey Pavlovich related how an American correspondent said to his colleague at a press conference:

— It is difficult with Gagarin. What can you say? You know he is clearly obvious: Everything he says is the truth.

It was felt that Sergey Pavlovich very much loves and thinks highly of Yuriy:

— In Yuriy are happily combined inborn courage, an analytical mind, exceptional diligence. I think that if he receives the necessary education, we shall hear his name among the most celebrated names of our scientists...

And following the wishes of his great friend and wise-with-experience teacher, Gagarin and his friends enrolled in the Air Force Academy im. Zhukovskiy.

In those days, Sergey Pavlovich was happily excited; he moved around cheerfully, sprightly, although it was emphasized to him that he was already 54 years old.

On that memorable day he recalled happy events from his youth. Somehow, riding on a motorcycle, he ran into a post and banged against the seat. In the process, his breeches were torn almost to the heel. He was thrown into confusion: how would he reach home? At this time a group of soldiers led by a sergeant came up to him. Taking him out of the seat of the motorcycle, they examined it — few repairs were necessary. They said: "For the present, let's go to the tea room". Sergey Pavlovich was abashed. "It's nothing, sit behind the table in the corner", — the sergeant reassured him. There was nothing else to do but go to the tea room. Suddenly, the sergeant noticed: "Your breeches are torn! Let me mend them?" — "But how?" — "Take them off!" — "At the table?" — "We will cover you with a table cloth". He had his way: He made him take off the breeches and took them away. It seems that before the war he was a tailor, and he mended the breeches so well that they could be worn for a long time.

The conversation was first joking and then serious. Sergey Pavlovich spoke about the prospects of conquering outer space. The future of space is first of all transportation. Today it takes 12 hours to fly to Australia. But through space — only thirty minutes. Or say, at any rate, one hour if not thirty minutes. We must allow for take off and slowing down without significant G-loads. Secondly, space in the immediate future will be used for long-distance communication.

Thus, that which seemed new and courageous is now obvious to everyone.

Satellites will be used for navigation of aircraft and ships, — continued Sergey Pavlovich. And weather forecasting? To study solar radiation from the Earth is primitive. We must dispatch one special satellite in the direction of Mercury. It would study radiation and send all the necessary data to us.

"Not long ago," said Sergey Pavlovich, "we were resting in Kislovodsk. Gnevyshev invited us to visit the mountain observatory and to observe what was taking place on the sun. We saw bursts.

But we saw it all through the atmosphere, and from a satellite there would be no barriers. And remember Tsiolkovskiy's suggestion for building transatmospheric greenhouses for cultivating wheat and corn. When I mentioned this idea in the Central Committee, I was in trouble. They said, and correctly: "Do not digress. There is still room on Earth".

Listening to the predictions of Sergey Pavlovich for the future, I was reminded of the words of Victor Shklovskiy that poets and scientists are optimists. They know the dates, but they rush time.

K. E. Tsiolkovskiy had also been asked when man would fly in outer space. Konstantin Eduardovich answered to those who had asked the question:

— Neither you nor I will fly.

Then he defined the time more precisely:

— There, a komsomol will fly.

He spoke about the young communist generation of that time.

If Tsiolkovskiy erred by ten years, might not then history make corrections to Korolev's optimistic predictions?

Our discussion ended just before dinner and after dinner Sergey Pavlovich had another meeting. Later I found that this was a conversation with the cosmonauts on the occasion of the dreamed of second manned flight into outer space.

The Second Dash

Still in Sochi Sergey Pavlovich gave no rest to his thoughts about the forthcoming manned space flight, the main question was how many orbits should be planned for the flight.

The medical personnel and other specialists were convinced that three flights must be made. Why? After the first three loops the landing could be made on our own territory. If a greater number of loops was made then the landing site would be that much farther away. From the 8th to the 13th orbit, the landing would have to be in the Atlantic Ocean. Only after twenty-four hours would it again be possible to land "at home". But such a lengthy flight had not been planned for.

N. P. Kamanin and the prominent physician, V. I. Yazdovskiy, travelled to Sochi with the recommendations of the physicians to make the second flight three loops duration.

They met with Sergey Pavlovich by the sea. The waves beat noisily against the shore and the May sky was gloomy, already occasional drops of rain fell. But they were so excited by the conversation that they did not leave. A deep probe was needed so that the cosmonaut would not simply appear briefly in space, but would live there and work. Only then can we say that we have remained in stable orbit". His lightly flushed face reflected adamancy.

At the end of the session, it was agreed that the flight would last a day. It was assumed that Yu. Gagarin's backup — German Titov — would be the one to fly. At the time when I left Sergey Pavlovich, he had gathered the first orbital travellers together to describe the forthcoming step into outer space. Among them was the suntanned German in a light blue sports suit, with a provocative lock of curly hair falling over his smiling face.

After resting with the cosmonauts at the Black Sea, Sergey Pavlovich returned to Moscow in June. Here the preparation of the rocket carrier and the ship was in full swing. At the very height of the preparation on July 17, 1961, Sergey Pavlovich was awarded the second Gold Star of a Hero of Socialist Labor. Happiness and surprise filled his heart. He became even more insatiable in his work.

From July 23 to 26, he tested new designs and already several days later on July 31, he flew to the space center for preparation of the second journey of man into orbit. Again, he followed the technology and saw to it that the cosmonauts were in the best shape for space.

German Titov loved and respected Sergey Pavlovich like a natural father and remembered well his words, spoken in passing:

— If a cosmonaut before flying into outer space feels that he is going on an heroic deed, it simply means that he is not ready for the flight.

And Titov prepared himself for the flight with the same exceptional calm that he had prepared himself for ordinary flights in jet aircraft.

Here is what German Stepanovich recalls about this fervent time: "After supper, Sergey Pavlovich came to us and, together with my backup man and myself, we walked about for a quarter of an hour. This was a business-like stroll. He gave us advice and directions. Once more he turned attention to the especially important elements of the flight. In the twilight darkness, we strolled on foot, almost hand in hand, I on the left, and cosmonaut number three — on the right of Sergey Pavlovich. His strictly out-of-place, dumpy figure and his firm steps seeming to implant themselves on the gravel of the path, automatically instilled in us a great confidence in the morrow".

And just before the flight itself, Titov, after exchanging glances with Sergey Pavlovich, noticed in his eyes both a father's love and a commander's demands. Later, German Titov glanced at the engineers and workers surrounding Korolev. In their midst, Sergey Pavlovich seemed to be not only calm, but collected to the utmost and, therefore, acting in cold blood. Then, Titov remembered: He also has dreamed about flying into outer space in his own ship.

German Titov's flight is known in detail — he completed 17 loops around the Earth, went more than 700,000 kilometers in outer space. In flight, German Stepanovich made the following note in his log: "Our rockets are powerful. And the glory of our space flights should be divided to an equal measure among the cosmonauts and those who design, equip and launch the rockets".

During the seventeenth loop, German heard the familiar voice of Sergey Pavlovich in the headphones:

— "Eagle! Are you ready for landing?"

"Ready!"

During his flight, German Stepanovich turned several times to the radio with questions for Sergey Pavlovich. G. S. Titov said later, — "He gave exhaustive answers to them. With a calm, even voice, he explained to me the order of events. The iron confidence of this man in a successful outcome of the final stage of the flight was transmitted to me.

"Act according to the program and everything will be all right," Korolev said again.

"Yes sir, act like I learned," I answered half-jokingly.

And the second flight of a Soviet cosmonaut was applauded by the entire world. "Returning to Earth yesterday morning, Major Titov not only opened a new era in cosmonautics, he did more: he set the beginning of applied cosmonautics", so, for example, wrote the French newspaper, "Combe".

After his space flight, German Stepanovich, along with Yuriy Gagarin and his other comrades, visited the designer of the ship, Vostok-2". The entire crew with Sergey Pavlovich at their head was there. Titov praised the ship highly and in conclusion said:

"I know how great is the labor of the scientists in the accomplishment of this flight, how great is your labor, dear comrades! Let me give to you as a present the ship's log from the "Vostok-2" which I carried during the flight..."

Sergey Pavlovich accepted the journal in a white binding with the emblem of the Soviet Union on the cover. They exchanged handshakes and embraced strongly.

After the meeting, Sergey Pavlovich conversed with the cosmonauts. He recalled the words of K. E. Tsiolkovskiy about space flights and again emphasized how they are real today. He recalled the Group for the Study of Jet Propulsion where the practical development of liquid-fuel rockets had begun. To the question, will women fly into space, he gave a positive answer. As far as future flights are concerned, Sergey Pavlovich said that they will be more complex and will require new knowledge on the part of the cosmonauts. In the future, cosmonauts must be not only pilots, but at the same time also be scientists and engineers. His words resounded invitingly.

— We must ready ourselves for new flights. The time will come that spacecraft will fly to the Moon and to the other planets of the solar system.

In Orbital Tandem

A year after Titov's flight, Sergey Pavlovich and his associates launched Andriyan Nikolayev into flight on the "Vostok-3".

On August 6 at the space center in the house where the cosmonauts lived, it was decided to celebrate the anniversary of the day the "Vostok-2" was launched. The time approached evening, the preparations were finished and the unbearable daytime heat dropped. German Titov whispered to Yuriy Gagarin and suggested that they must certainly invite...

Andriyan Nikolayev and Pavel Popovich recall: "We fervently supported German's suggestion and each after receiving his task rushed to fulfill it. It was most difficult to find flowers. We had to ask the owners of the small houses near which were flower beds. Soon our room took on a festive look".

Who was the guest for whom we had gone to all this trouble and had found the flowers?

— Will he come? — German's friends asked him impatiently.

— He promised. As soon as he is free.

And then the door quietly opened and on the threshold stood Sergey Pavlovich, with an expression of fatigue on his face, caused by the fever of the launch.

The young men welcomed him amicably and invited him to sit at the table where the only decoration were the flowers, making the table smart and festive. German was the first to speak. About how a year ago he had flown on the "Vostok-2". For the success of this flight, from his soul he congratulated Sergey Pavlovich and said that the new step would also be a triumph!

The fatigue gradually left the face of Sergey Pavlovich, the wrinkles smoothed out, his look was merry. He looked first at the flowers decorating the table and then at the cosmonauts. Finally, he began to talk.

"I thank you, my friends, you lads who have done this. I will never forget it."

And he spoke of what each launch means for him, how he worries and waits. And how this friendly concern helps.

This unusual celebration was brief. But for those moments invisible threads of emotional nearness extended between these people who were preparing for a new step into the unknown.

On the morning of August 11, the sun flooded the steppes with bright gold, sparkled with its rays on the metal of the rocket, the lift and on the ship raised high in the air. "The "Vostok-3" is delivered", they joked at the pad.

But the jokes did not even touch the corners of the leaders' mouths. On their faces was reflected all the significance of the emotional moment. Along with Nikolayev, outfitted in his space suit, were Sergey Pavlovich, other members of the Government Commission and the systems designers.

Moscow time, 11 hours 30 minutes. Liftoff! Smoothly and slowly the rocket goes up. Andriyan reports: "Everything is normal". In his voice is coolness. It was not without reason, when Korolev was asked what qualities he valued more than any other in Nikolayev, that Sergey Pavlovich answered: "Calmness and reliability".

When correspondents were interested in the goals of the "Vostok-3" launch, Sergey Pavlovich explained:

"They are numerous and diverse. The basic problem is to continue study of the influence of weightlessness on the human organism in prolonged flight. Those data which we have received are extremely significant for science, since each new cosmonaut is a new human individuality and naturally each new flight enriches our experimental factual data for further improvement of the spacecraft.

The second problem is for man to carry out a predetermined volume of scientific observations under conditions of space flight. For this purpose the "Vostok-3" is equipped with the necessary instruments. And, finally, the third problem is to study further the operation of all systems in the ship during flight, in order that the data obtained can be used in the design of new ships."

But in the first conference with the correspondents, Sergey Pavlovich did not say everything. Following Andriyan, Pavel Popovich

was launched into orbit. He lifted off from the Earth on August 12 at 11 hours 02 minutes on the ship "Vostok-4". Thus began the world's first group flight of Soviet cosmonauts.

In Sergey Pavlovich's presentation, the flight of A. Nikolayev and P. Popovich was significant in that the space rocket system operated such that the difference in inclination of the ships' orbits was only several minutes of arc, and the distance to the surface of the Earth was only a few kilometers, i.e., less than one thousandth of the orbital radius. The ships, during orbit, were found to be at a distance 6.5 kilometers from one another. Thus for the first time in the world ships were in tandem in space.

After the flight, it was clear that man may remain for a prolonged time in orbit. The vestibular apparatus of both cosmonauts seemed to be retarded, but the cosmonauts experienced no unpleasant sensations. This meant, Korolev concluded, that the training on the ground had been effective.

There was still another result which could not fail to please Korolev. This was the successful communication between the two cosmonauts. Very short waves were used for the communication, on which the correspondents on the ground could listen to each other only in the direct visible range. In outer space it was found to be possible to maintain communication up to distances greater than 10,000 kilometers. Such communication will end the feeling of isolation which the cosmonaut may experience in the infinite black ocean of space.

The pictures of the cosmonauts were transmitted for the first time over a television network and through "Intervision" to all the nations of Europe. Thus was born cosmovision — the viewing of cosmonauts in spacecraft on the screens of television broadcasting stations.

The year 1962 saw no fewer trips for S. P. Korolev than had 1961. But something new, both unanticipated and unpleasant, was added — he was in the hospital for almost a month.

Soon after the flight, A. Nikolayev and P. Popovich took him there with a sharp painful seizure in the rectum. On September 15, ne left the hospital in a cheerful mood and feeling well. He flew with Nina Ivanovna for a rest at Sochi. Then he began working intensely...

The year 1963 started with a mission for Sergey Pavlovich. He directed the next space launch. From the space center, he then flew to Kuybyshev. From Kuybyshev he went by train to Moscow — the weather was unflyable in a snowstorm.

In January he again flew to the space center. He was there again in March. At the beginning of April, the station, "Luna-4", was successfully launched. On April 3, he was already at the observation point.

On May 27, 1963, he travelled to the space center for launch of the ships which were to be piloted by V. Bykovskiy and V. Tereshkova.

"Seagull" and "Hawk"

Pondering over and analyzing the results of group flight, Sergey Pavlovich had for some time already planned another — a joint flight. And on this flight, there would be the first woman cosmonaut.

On June 14, 1953 at 1500 hours on the "Vostok-5", Valeriy Bykovskiy was launched. Even before the flight, the correspondents had seen Bykovskiy at the meeting of the Government Commission. In the hall it was noisy, but Valeriy had sat quietly and sternly.

"Today we must hear the report of the technical director on the preparedness of the technology and confirm the commander of the ship "Vostok-5" and his backup man" anncunced the Chairman of the Government Commission.

From the report of Sergey Pavlovich and other comrades, the flight assignment and the name of the ship's commander were confirmed.

On the following day, Sergey Pavlovich invited all the correspondents to the launch pad to look at general tests of the space rocket. Here occurred a joking conversation between Sergey Pavlovich and the journalists which was reported by the newspapers.

After characterizing Bykovskiy as being a well-trained, extremely competent cosmonaut, Sergey Pavlovich, according to G. N. Ostroumov, asked the puzzling question:

— And which of you journalists would like to fly? — And then he softened it somewhat to keep from puzzling them too much: — Not today, of course, but later.

One of the correspondents, a man of rather large size, stepped forward and searchingly commented:

— You would never accept me.

— Ah, don't worry, we shall send you into space. But only if the heart would permit.

— Take the cosmonauts training program, — his comrades egged him on, — and don't lose any time.

— But that is not necessary, — adds Sergey Pavlovich, with such comfort we shall send you, — better even than on an airplane.

One moment before launching the "Vostok-5", Sergey Pavlovich's intervention was required. One of the operations had been carried out with an error in the launching calculation and deviated from the technical documentation. Sergey Pavlovich was strongly disturbed and decided to climb up to the landing hatch. "Over the internal communication lines," recalls one of the specialists, "we were told that Sergey Pavlovich, while speaking softly, was very dissatisfied with us. We prepared ourselves for a "chewing out".

However, when Sergey Pavlovich came up to us, he was exceptionally calm and began to ask what had happened and what our suggestions were for correcting the error. After listening to us, he gave some advice and said not to rush, that there was still time and everything must be done accurately. He stayed with us until the defect had been corrected". And, as we know, the launch went off successfully.

Following Bykovskiy from the space center on June 16 at 12 hours 30 minutes, Valentina Tereshkova was launched on the "Vostok-6".

When Valentina was preparing for the flight, S. P. Korolev jokingly commented that everyone at the pad, including himself, envied her and her flight. Valya cheerfully replied:

"Cheer up. We still fly together. When we return from space, then we shall consider where we shall fly to, to the Moon or to Mars..."

And she handed Sergey Pavlovich a bouquet of wild flowers. This was so touching that he furtively rubbed his eyes, suddenly dimmed with tears.

While V. Bykovskiy and V. Tereshkova were in orbit, Sergey Pavlovich talked about the flight of "Vostok-5" and "Vostok-6". A Soviet cosmonaut, he responded, shortly before this flight had already experienced prolonged flight in the "Vostok-3" and "Vostok-4", but for further steps in conquering space, for still longer orbital flights, for the building of orbital stations and in the future for man to reach the nearest planets, this experience was not enough.

We can say that the flight of the Soviet interplanetary unmanned station, "Mars-1", required seven months, and the American station flew to the planet Venus in about four months. The duration of the orbit around the Moon may be from 8 to 12 days. It is natural that for the accomplishment of such a trip, it is necessary to prepare all the technology very well, to modify all the numerous parts of the spacecraft and its systems to ensure the vital activity of the crew.

In the combined flight of "Vostok-5" and "Vostok-6", many scientific and technical problems were resolved. In particular, the biological problems were very important.

In this plan, noted Sergey Pavlovich, it was of great interest to have the participation of a female cosmonaut in the flight. Until this time, the cosmonauts had been air force jet pilots, people who were hardened and accustomed to G-loads and high velocity. The commander of the "Vostok-6", Valentina Vladimirovna Tereshkova — a former parachutist in the air club — had encountered G-loads only in the process of readying for space flight.

Korolev also considered the social aspect in selecting a woman for the flight. The participation of a woman in the flight was one of the most graphic proofs of the equal rights of Soviet women, their activities and great courage, he commented. Along with this — there is the illustration of the high level of our space technology, obedient to the hands, not only of an experienced pilot, but also of those of someone who has not received considerable flying experience.

Now it is clear that the problem of readying cosmonauts had been resolved. We can prepare them as much as seems necessary. But, of course, it does not then follow that it is very simple to be a cosmonaut. In order for a cosmonaut to sufficiently fulfill his missions, he needs serious and prolonged training.

Sergey Pavlovich, at the space center, then called the flight of Yuriy Gagarin "the first serious probe", the flight of G. Titov, "the deep probe", that of A. Nikolayev and P. Popovich "a step ahead" and that of V. Bykovskiy and V. Tereshkova, "a new step ahead from the viewpoint of flight duration and scientific research missions".

Sergey Pavlovich noted that of extreme interest also were observations of the constellations, photographing of the Sun, its transition spectra at sunrise and sunset. Of scientific and practical significance will also be the actual measurements of the radiation background, the ionizing radiations at all altitudes

through which the ships, "Vostok-5" and "Vostok-6", orbited.

He paused on the significance of observations of Earth from outer space — both visual and with the aid of optical instruments — observations of the seas, the color of the Earth and the shadows on it, determinations of how the major rivers, mountain ranges and snow-covered peaks appear from space.

"You know I am great optimist," he said with a smile, "and I believe that in the not-too-far distant future, we shall see quite prolonged interplanetary manned flights. And when they return to Earth from this distant flight, the knowledge of such reference points will be very important.

Speaking about the combined flight of two men in space, Sergey Pavlovich emphasized the moral and psychological factors involved in such a flight. The cosmonauts maintained a continuous radio communication with one another, and you know th's fact has tremendous significance — to always have the feeling that you are not alone in outer space. Even Andriyan Nikolayev and Pavel Popovich commented how important in flight was the "feeling of fellowship". And in the near future in such flights, there will probably be a two-way television communication between the astronauts.

The correspondents asked Sergey Pavlovich what was the value of the tandem ships.

He gave them the following answer: "The problem of encounter and hookup, the so-called coupling of the spacecraft, is planned for the agenda of space travel. Resolution of this problem will require much: we must build large orbital stations which can serve both for research purposes and as landing sites for the spacecraft. Flights into outer space can be compared with travel on the sea. Both ocean and spacecraft leave land for a long time. And in order to replenish their equipment, fuel supplies and food or to obtain the necessary assistance, both types of crafts may either return to land or seek an encounter enroute.

The combined flights are successively bringing us to a solution of this problem. For the present, the spacecraft are flying in so-called self-braking orbits. This means that in all cases even if the braking apparatus fails, the motion of the ship will return slowly to Earth because of the resistance of the atmosphere and in a comparatively short period of time. The question is only one of time and landing site. The existence of landing sites in space and the possibility of ships' hooking up with each other permits us to use higher orbits and extend the boundaries of space exploration...".

In the meantime, V. Tereshkova and V. Bykovskiy were continuing their journey in space. Sergey Pavlovich participated directly in guiding the flight of the spacecraft. His calm, confident voice could often be heard over the loudspeaker. He gave advice to various officials and to the cosmonauts. Now and then, he quickly solved very complex theoretical and practical problems involving accomplishment of the program. When he spoke over the radio, there was an unusual quiet that spread over the command point. The operators turned off their own apparatus which was sending messages to distant and near observation and tracking stations.

"Please disconnect temporarily." Espe speaks softly.

At the end of the day of June 16, a different space evening check was made, noted even then in print. Sergey Pavlovich started it. He took, as they say, control of the communication and called the commander of the "Vostok-6" — "Seagull".

Tereshkova did not answer immediately, and Sergey Pavlovich began to worry. But he then thought to himself: "Well, she is alone there in the remote black of outer space", and he wanted an answer to her response, "Seagull here", to say something affectionate and like a father to call her "Dear Seagull"... But aloud he only asked her to report on her health, and the operation of the ship's systems. She answered:

— I fell asleep somewhat off schedule. I am sorry. I shan't do that again. I feel fine.

— It doesn't matter that you fell asleep — Sergey Pavlovich cheered her up and advised the temperature that must be maintained in the cabin.

— What are your plans for the future? — asked S. P. Korolev.

Valentina answered that she had decided to carry out the mission completely.

— We shan't stop you, — said Sergey Pavlovich good-naturedly, — sleep well, good night, be fresh for the morrow.

The magnetophone tape also recorded another conversation of Sergey Pavlovich — first with Bykovskiy and then with Tereshkova — on the evening of June 18.

— "Daybreak" here, "Daybreak" here. How do you feel?

— "Hawk" here (Bykovskiy's call sign). Everything is in order. I feel great. I hear you fine.

Sergey Pavlovich reported that on June 19, just as the flight program indicated, there would be a landing.

The cosmonaut answered.

— I can go longer. There is a power reserve, enough air and water. I am ready to continue the flight.

The conversation between Sergey Pavlovich and "Seagull" — Tereshkova began with a call from Earth to Valentina:

— "Seagull", "Seagull", "Seagull"!

— "Seagull" here". I hear you fine...

— How do you feel?

— Excellent... Everything is in order on the ship.

— We are pleased at your good mood. We wish you a successful completion of your flight.

— Thank you for the good wishes...

— Tomorrow the flight is over. Understand, understand?

— Understood, understood. I will be ready to execute.

"Seagull's" first flight had ended. She had remained in flight for 70.8 hours, completed more than 48 loops and covered a distance of about 2,000,000 kilometers. The "Vostok-6" landed on June 18 at 11 hours 20 minutes 620 kilometers northwest of Karaganda. Valentina Vladimirovna's flight was planned for one day with a possible extension to three days. She completed the maximum program. The joint flight of "Seagull" and "Hawk" continued for about three days. At the end of the "Vostok-6" flight, the ships seemed to be near one another. Then the distance between them varied. Radio communication was maintained stable.

The flight of Valeriy Fedorovich lasted for 119.4 hours. The ship completed 82 loops and covered a path of 3.3 million kilometers. The "Vostok-5" landed on June 18 at 14 hours 06 minutes, 540 kilometers northwest of Karaganda. The eject and landing systems worked smoothly. Telemetry brought to the scientists much extremely valuable data.

Sergey Pavlovich from the command point tracked the final stages of the flight. When the cosmonauts were located after landing, he contacted the rescue personnel by radio:

— Reach the cosmonauts carefully with maximal safety. Do you understand me, do you understand?

In the name of the Government Commission, he announced his appreciation to all services, units, stations for all the calculations that guaranteed an excellent flight. The responsible officer at the control point, who had remained continuously all the days at the console, answered briefly:

"Thank you for your appreciation."

And so the age of the "Vostoks" was completed. Yuriy Gagarin, German Titov, Andriyan Nikolayev, Pavel Popovich, Valeriy Bykovskiy and Valentina Tereshkova had spent in final count in headlong space flight on the "Vostok" ships more than 383 hours. These hours became a significant landmark in the study of outer space.

Even after the flight of V. Tereshkova and V. Bykovskiy, Sergey Pavlovich did not change tempo in his work. From November 8 to 14 of the same year 1963, he directed the next space launch. Just as in 1962, he spent more than 80 days away on missions.

From February 12, 1964, he underwent 10 days of medical checkup and six days later, again went to the hospital with an attack of cholecystitis. The attack came on during the night, and he was rushed to the hospital in an ambulance. His house was completely empty — Nina Ivanovna was also in the hospital at this time.

On March 17, after recovering from his illness, Sergey Pavlovich was again at the space center. He directed the next launch which soon took place. From the space center, he arrived tired, but directly from the airplane, he went to the command point, where a correction was made for the flight of the interplanetary station enroute to Venus.

Mission after mission, flight after flight. Thus passed the days.

But on the road, his mind worked unceasingly. He would carry his inseparable notebook. For notes, he invariably brought

with him several rolled-up sheets of clean paper, several stumps of a plain pencil (in the event his pen failed) and erasers.

"Whoever thinks of his work only during working hours, has no business in the design office," he loved to repeat.

Once along the way he met German Titov and Sergey Pavlovich was interested in what he was doing:

— What are you doing?

— I am studying and thinking about after graduation.

— What is there to think about? — Korolev's eyebrows raised. — Be a navigator, or better yet, be a celestial navigator...

It seemed that ideas literally swarmed in his head...

In the Summer of 1964 in the center of Sergey Pavlovich's meditations and worries was undoubtedly the second spacecraft, called the "Voskhod".

"Think, Think, Think!"

The ship, "Voskhod", just as the "Vostok", was born in heated discussions. Sergey Pavlovich unintrusively and tactfully directed the crew. For some reason, Sergey Pavlovich called to one of his assistants:

— Vladimir Pavlovich, come here quickly.

— I can come in 15 minutes.

— I need you now, I have dispatched a car. Bring your comrades.

When the summoned comrades arrived, Sergey Pavlovich led them all to the demonstration hall. There stood the "Vostok" ships.

Sergey Pavlovich went up to Gagarin's "sphere".

"We must think," began Korolev, "how to make a multi-seated ship better. There are studies being made, but they do not please me. Here, for example, is a suggestion for a device with two hatches for catapulting the cosmonauts from the ship and landing them by parachute. Something here is not..."

Those present had already been considering how the future ship would be made. Vladimir Pavlovich took the lead:

"There is a suggestion to make the ship a three-passenger one instead of just two. And with a soft landing."

"Yes," agreed Korolev, "with a soft landing would be better. Then no catapulting would be necessary. The ship must land."

And again, as usual, at the end came the words: "I make the suggestion..." A mockup of the three-seater ship was begun. When it was ready, Sergey Pavlovich called Kamanin: "Bring the cosmonauts and come see me". They arrived, looked at the mockup of the future "Voskhod". They figured out the approximate arrangement of seats. Sergey Pavlovich invited the cosmonauts: "Be seated. And tell me, will it seat three?". After the test, Sergey Pavlovich summed up: "In space we can. In weight, also. We shall plan for three!".

And the outlines of the "Voskhod" became increasingly clear on the drafting boards. This time, Sergey Pavlovich took the most important systems of the future ship under his personal control.

One of these was, of course, the soft-landing system. He considered it essential to guarantee its special reliability. He personally visited those who had developed the parachute system — of one or two canopies. The two-canopy was decided upon. Partial tests were first begun, then the overall tests. Difficulties arose, as well as failures. During one test, because of a fault in the landing system, the ship hit the Earth in a very hard landing.

After this accident, Sergey Pavlovich met with Konstantin Feoktistov, who had been chosen to fly on the "Voskhod" and asked:

— Kostya, are you not afraid to fly? The sphere crashed.

Konstantin Petrovich answered:

— No, I am not afraid. The design of the landing system is reliable. I am confident of it. In this case, it was simply some kind of error that occurred.

In fact, the reasons for failure of the ship to make a soft landing were soon found. But Sergey Pavlovich still decided not to plan the flight of the "Voskhod" until an unmanned ship could fulfill the entire program of the future flight with irreproachable precision. His words on this occasion are remembered by all his co-workers: "Before the flight, everything must be absolutely and completely worked out from 'a' to 'z'".

When it became known to Sergey Pavlovich prior to launching the ship, "Voskhod", that the landing system in the next experiment had worked faultlessly, he said:

— I did not expect otherwise. The previous case was the result of units not being joined together.

Sergey Pavlovich, although not afraid to undergo risks, never did so without purpose, thoughtlessly or futilely. For example, we can take the case when Komarov's crew was being readied for flight.

The flight had been planned for several loops, although it could be continued considerably longer. When the cosmonauts had asked from the ship for permission to remain longer in orbit, Sergey Pavlovich objected:

— There is no basis to change the mission, there is little reserve left. The purpose of the flight has been achieved. It would be better to wait for the next flight for innovations (he was

thinking of the experiment involving men leaving the ship in open space).

In working on the "Voskhod", there often appeared the definite earmarks of Sergey Pavlovich as the designer of this new technology. The extraordinary requirement resulting from the necessity of guaranteeing reliability of the most complex of systems gave rise to his ruthlessness for any failures and human weaknesses. He did not tolerate them in himself nor in others. He was especially strict concerning faults of those whom he valued the most.

"Be resourceful, and you feel that something in you has increased," now recall these who worked with him.

He constantly required of each specialist: "Think, think, think!".

He never "dictated". In solving scientific and technical problems he tried to let his immediate assistants express their thoughts regardless of his own opinion. Very often, one of his co-workers in the crew would receive a note saying approximately: "Dear Vladimir Pavlovich! As far as I understand the situation is such... If this is in fact so, please make suggestions... Discuss this with your associates and prepare your observations".

He had no vain anxiety as the honor of his mantle of leadership. In his creative process, he included a wide circle of specialists.

Two variations were being discussed for one of the systems. Those present almost unanimously supported the first variation. In the end, Sergey Pavlovich also expressed his support. But his deputy came up and expressed doubt as to the correctness of the first variation. He put forth his arguments and Sergey Pavlovich gave his. The former unanimity in evaluating the variations was no longer observed. Though it was unpleasant for Korolev, he left the question open for the present and commented with displeasure:

— Examine it again and find out where the problem is...

And he left.

After some time, the workers came to him with caution. And they saw an extremely peaceful picture. The board was covered with formulas. Red faced and disshelved, Sergey Pavlovich sat, leaning back in the chair, and... smiled.

"My opponent is right... Good lad, one against us all." He was not embarrassed.

At the end of March, 1964, Sergey Pavlovich was at the space center. Along with his comrades, he was preparing for the experimental launch of the "Zond-1" using an improved multi-stage rocket carrier. This was being done for the purposes of developing a space system for long-range interplanetary flights. Sergey Pavlovich wrote home during this time: "All of us here all the time have a heavy work load, of course, but the main thing is that there is no ethical holiday or even rest, the same thoughts are in everyone's head, all are devoted to one goal. In a couple of days, we shall test again our strengths in the battle with the great secrets of all-powerful nature. What awaits us?"

The "Zond" was successfully launched on April 2. The improved rocket carrier carried the heavy satellite into space orbit and then at a predetermined point, the "Zond" reached orbital velocity. From the "Zond", a current of scientific information flowed. Control of the "Zond" was carried out in flight.

Thus, in the searches for new solutions and in heated public debates, the time passed. Then it was the summer of 1964. Sergey Pavlovich, after assigning his associates their tasks, decided to go on vacation.

Sergey Pavlovich and Nina Ivanovna travelled to Czechoslovakia. They took a scheduled flight to Prague on Saturday, June 27, 1964.

Sergey Pavlovich had not intended this trip to be simply a vacation. He resolutely refused to go to Karlovy Vary: "I just want to become acquainted with the country, with the industry from the viewpoint of its organization and then rest a little later on", he said...

The first three or four days were devoted to sightseeing in Prague. Then Korolev visited the Scientific Research Aviation Institute and the test laboratory in Letnyany; there his attention was attracted to the training cabin for the pilot of the L-29 aircraft, which later the Soviet Union began to buy. Sergey Pavlovich also visited the aviation factory in Vodokhody.

He made his first prolonged visit in Pilsen. At the "Shkodovka" he studied the locomotives, constructed with plastics.

He visited the plant where the reactor for the first Czechoslovakian atomic power plant was built. He studied the reactor and the complex cover for it.

In Pilsen Sergey Pavlovich stopped at the famous "Prazdroye". Beer was brought to him to his taste.

The next stop was in Brno. There he examined the production of hunting arms with great attention. In the near-by town of Blansko, he visited the plant "Metra" and, in Gotval'dove, the plant "Svit". At the aviation factory in Kunovitsy on the invitation of the director, he sat alongside the pilot in the training airplane, L-200. In the air for a short time, he took control himself — after a long break, he again was flying an airplane.

Travelling to Morave, the Korolevs stayed in Motsokh. He looked over the famous battle field of Austerlitz*. He visited the Ostrav Combine Novaya Guta im. Klement Gottwald. Sergey Pavlovich was interested in the organization of work in the tool and steel rolling shops. But when the metallurgists bragged to him about the

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* Translator's Note: The Czech name is Slavkov.

press, which operated under a pressure up to 12,000 tons, Korolev simply waved his hand: He knew this was trivial because we already have a press with a much greater pressure. The Czech specialists thought that they had heard wrong because they knew that the most powerful press was in the United States. But Sergey Pavlovich confirmed that they had heard correctly about this colossus.

— This press of yours is not used especially often, is it? — Korolev commented. — There is not always work for it.

In Slovakia Sergey Pavlovich visited the scientific research Institute of Automation and Mechanization in Novoye Mesto (above Vag) and the Scientific Research Institute of Welding.

The travel around Czechoslovakia was finished with a holiday in a small house near Shtrbskiy pool in the Vysokiye Tatary. In the middle of July, the Korolevs were in Moscow.

Expedition in Orbit

In the meantime, the work on the "Voskhod" was approaching completion. This ship, incorporating all the best of the "Vostoks", in many respects surpassed them. The cosmonauts in it for the first time would be able to complete the flights without space suits. Nor was there a system for catapulting them out — the ship would make a soft landing. There was much new in the instrumentation. In particular, along with the previous navigation systems, it had a new system which had ion devices for directing the velocity vectors, new television and radio engineering instrumentation.

The experimental flight on the "Voskhod" approached — the first space laboratory.

At the end of August and September, 1964, Sergey Pavlovich left on his missions. Not until September 27 did he leave the space center for Moscow in order to solve the problem of the forthcoming operation on his wife, to calm and cheer her up.

The operation was planned for October 1. In the meantime, he returned to the space center. Affairs there seemed to fill his time. But an unexpected event again upset him. At the launch, he noticed that one of the top specialists seemed to be especially gloomy and depressed. He delicately interrogated his friends: "What is the matter?" — "His wife was in the hospital and was doing very poorly". Sergey Pavlovich called the specialist:

— Why didn't you say something about your wife's illness. We could have given you a leave of absence...

— How could I say something like that when your own wife is in the hospital? — answered the specialist.

Korolev's face instantly clouded over.

— That has nothing to do with it... — he said tonelessly. — You will take leave of absence...

On September 30, Sergey Pavlovich hastened to Moscow. After seeing that his wife's operation had gone favorably, on October 2 he flew back for preparation of the "Voskhod" launch.

Vladimir Komarov recalls thus the days of readying for the flight: "Sergey Pavlovich, on the night before the launch of the "Voskhod", came to the house where we were staying. Together we went out to the street and looked at the stars. Sergey Pavlovich spoke about the Moon: "I would like to go there myself, but my age does not permit it. You must fly there".

Most likely to calm the crew, he spoke more than anything else about abstract subjects. And in the morning, we found out that during the night, he had again gone to the doctor to ask how we slept and how we were acting.

Before the flight, he said: "Well, Volodya (he had always called me by my name and patronymic, and now he simply called me by my name which touched me very much), your hour has also come.

I wish you a good trip, we shall wait on Earth".

Such was the warm farewell that Sergey Pavlovich gave Konstantin Feokstistov and Boris Yegorov. The launch took place on October 12, 1964 at 10 hours 30 minutes.

And, again, the command point, again, the spacious room with graphs, charts, magnetophones, television. The next communication.

Sergey Pavlovich enters and speaks with the crew by radio:

— Give me a line to the "Ruby" (call sign for the "Voskhod" — P.A.).

He asks Komarov, Feoktistov and Yegorov how they feel. They answer:

— Excellent! Excellent! Excellent!

Korolev's next question to Feoktistov:

— How is the mission going?

— Everything is normal. Time flies quickly and there is much work.

— Very well, — says Sergey Pavlovich, — I'll put you on overtime. Only there isn't any overtime.

— I am ready for my social responsibilities.

Such communication sessions are carried out regularly. And each time, the microphone is found in the hands of Sergey Pavlovich.

"Sergey Pavlovich," later recalled Vladimir Komarov, "required of us clear reports from space about the operation of the instruments, about the ship's atmosphere. But he found the chance to reassure us and to joke. Thus, speaking with Boris Yegorov, he

said to him: 'And did you puncture everyone's fingers, you didn't forget? And your own, did you do that, too?"

During one of the conversations, Vladimir Komarov turned to Sergey Pavlovich with the request:

— We have seen much of interest. We would like to check somthing out, investigate it a little better. The entire crew asks that we can continue the flight for one more loop!

— There is much, oh friend, Horatio, that is wonderful in the world! — thus Sergey Pavlovich paraphrased Shakespeare in response. — Of course, there is much of interest. But... we shall finish the mission!

Sergey Pavlovich told journalists at the space center how the three-man ship would land:

The landing of any spacecraft is a difficult affair. It is hardly less complex than launching the ship into orbit. Essentially speaking, in a landing, we must solve the inverse problem — to decelerate the velocity which the rocket has imparted to it. First of all, we must remember that the ship enters the dense layers of the atmosphere at a tremendous velocity. Large thermal and dynamic loads set in. It is natural that as the ship enters into the dense layers, much depends on this.

Proper entry guarantees integrity of the ship. We know that the gas mantle of the Earth reliably screens it. The majority of meteorites entering the atmosphere are burned up. The ship must not burn up!

But this depends not only on the proper design of the ship. Also important is how it is launched or, so to say, the technology of the launch. Our ship will be launched in a predetermined trajectory which we shall select.

Of course, we think first about the people who are launched in the ship. We must maintain all life conditions and prevent high G-loads. And these G-loads, which we can not get rid of, must act in the necessary directions. In all this, there is the complexity of the launching part of the ship. You know that all spacecraft of the "Vostok" series have landed successfully. It is true the cosmonauts themselves basically have been catapulted from the ship with their seats. But the ship landed safely.

It is not planned to catapult the cosmonauts on the ship, "Voskhod". They will remain in the ship up to the moment of its contact with Earth. I want to especially mention that its velocity during touch down with the Earth will either be zero or very small. For this the "Voskhod" is equipped with a special system developed by Soviet scientists.

— And if the ship lands in water? — they asked Sergey Pavlovich.

— Good question. In this case, the velocity of the landing will also be equal to zero or very small. The ship is unsinkable. We can say that in developing the soft landing we landed the ship in a very strong wind and at sea in a strong wave.

Sergey Pavlovich did not like wordy cliches and often bantered with the correspondents. And this time he said: "I know you, instead of writing about facts, you write that the rocket is twice the height of Moscow University".

Approximately at this same time — in a conversation with the author of this book — Sergey Pavlovich said that a "correspondent must be reserved in his evaluation of the significance of individual personalities in modern space affairs. It is impossible to live in the primitive age of journalism when everything is attributed to one scientist"... I knew that for Sergey Pavlovich these were not merely words. I listened to him talk about one such episode. When Korolev was informed that it had been decided to award him a medal for his successes in conquering space, he asked:

— Just to me or the entire design group?

— Just to you.

— I think, — after a pause, he quietly answered, — that this would be disloyal...

The medal was awarded to a group of our leading designers.

"Success in space, — Sergey Pavlovich loved to repeat, is composed of many bricks. For me, for example, life is easy: everyone works, but only I reap the rewards".

There were three conversations that showed me how "life is easy" for him. The first conversation:

— Comrade B., — Korolev spoke severely to someone over the telephone. — That is not done. If you do it again, I shall take decisive measures against you. Do not explain, just correct it. I shall see you tomorrow morning...

The second conversation, again over the telephone:

— I looked at the flight plan. Everything was soiled. And the document about the mockup is quite unsatisfactory. What kind of mockup will we have if it is fully equipped with apparatus? And on two pages, you have used the word, "mockup", twenty times. It was slovenly done.

The third conversation:

— We need to appoint a new director. But I can appoint only a man who knows aviation very well as you have known it for the 30 years of our service together...

Carefully, exactingly, with a view ahead, Sergey Pavlovich considered all questions large and small and, on them, depended the success of each flight.

And the flight of the "Voskhod" crew, with satisfaction, Sergey Pavlovich commented after the landing of the "extraterrestrial laboratory", confirmed the worth of the design decisions, the reliability of the systems and equipment. The observations of Earth, space and heavenly bodies from the ship's cabin during the 16 loops around our planet contributed much. The three-man ship landed with a high degree of accuracy, almost at zero velocity. The crew experienced no large G-loads. The commander, engineer and physician felt magnificently without the space suits. For the first time, the entire crew remained in orbit united in one dream, fastly connected with the space researchers remaining on Earth.

A Voyage in a Black Ocean

The car maneuvers among the automobiles on the crowded highway, the driver is rushing. Korolev and Kaminin are seated in the car... Each thinks about the forthcoming flight. It is clear that it must have a new aspect — the possibility of leaving the ship. But what kind of ship and space suits must they have.

The car brakes smoothly at the entrance.

— All of you please come to me, — Sergey Pavlovich turns to his companions.

They climbed to the spacious office on the second floor. Nikolay Petrovich called the cosmonauts and invited them to come. They were quickly there. The conference began as to how better and more reliably to accomplish the exit of man from the ship while in orbit.

It was obvious that a two-man ship was necessary. In a two-man one, help and support could be ensured for the man outside by the second member of the crew. For the world's first experiment, this was very important.

And why do we need to walk in space? Sergey Pavlovich answered this question exhaustively[1]. Flying in space, he said, and not being able to walk in it is like travelling, let us say, in an ocean and not being able to swim if you fall overboard. This means that in order to walk in space, operations must be carried out which may be required in the encounter of ships, in carrying out special observations in space, — and of course finally in those cases when repairs must be made on the ship.

For example, we are seriously thinking about the fact, Korolev then emphasized, that the cosmonaut after leaving the ship must be able to carry out all the necessary repair and maintenance work all the way up to, let us say, where the necessary welding, etc., can be carried out there. This is not a phantasy, this is a necessity and, as more people fly in space, the greater will this necessity be felt.

We must also allow for the factor, continued Sergey Pavlovich, that we may ultimately encounter a situation when one ship must come to the aid of another. But how? The ships are heat shielded for safety. This means that it could approach a ship and be able to do nothing, essentially speaking, because if it is vacuum sealed only through the entry hatch, the people there will die.

This means that such a system of transfer must be developed along with the system of life protection and exit from the ship, which would make possible giving such assistance.

Ultimately, the ship, "Voskhod-2", appeared in the form that later became familiar to millions of people. The hermetically sealed cabin and the instrument compartment comprised the major parts. In the cabin is the crew and everything necessary to ensure life of the cosmonauts. It seems that everything that is required for control of the on-board systems, television cameras and other

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Footnote (1) appears on page 264

apparatus has been planned for. Just as on the ship's predecessors, the outer surface of the cabin is covered with heat insulation. The cabin has three hatches with heat-resistant glass. After landing, the cosmonauts can leave the ship through any of them.

Only the cabin returns to Earth. The instrument compartment is doomed to burn in the dense layers of the atmosphere. In it are the radio instruments, the liquid-fuel braking engine, the system of heat regulation, the current sources. The outer surface of the compartment is also covered: with antennas, tanks of compressed gas, engines for the navigation system and radiator...

A reserve solid-propellant engine is installed on the ship — a duplicate of the basic braking engine.

But the main difference from other ships is the transfer chamber. A hatch leads from the cabin to the chamber and from it into open space — another hatch. Both hatches may be opened manually or with the aid of an electric motor.

Movie apparatus have been installed inside and outside the cabin, which will record man's walk in the sixth ocean. After returning from "his walk in space" to the ship, the transfer chamber must be jettisoned. Its fate is to burn in the dense layers of the atmosphere.

The space suits for the man walking in space and for the man remaining inside are the same. The commander must also be ready to leave the ship and give help to his comrade. Special attention has been paid to the vacuum seal of the space suit — it is composed of several layers, the helmet has a double vacuum-sealed view plate and a screening filter. There is a special cover to protect from the heat of the bright Sun. The space walker has a special pack on his back with an oxygen supply.

This time the ship is planned for a soft landing.

And the duration of the flight has been given. The crew has been determined: the commander is Pavel Ivanovich Belyayev and the celestial pedestrian will be Aleksey Arkhipovich Leonov.

Several days before the flight of the ship, "Voskhod-2", Sergey Pavlovich confessed to Academician Blagonravov: "Even when it would seem that everything has been verified, there remains an element of risk, and this does not allow for calm".

And to Nina Ivanovna, he wrote on March 7, 1965:

"We are trying to do everything without rushing, thoroughly. Our motto is to take care of the people. God give us the strength and ability to attain this always, which, by the way, is contrary to the law of the knowledge of life. But nevertheless, I believe better in my efforts, and my reasons and the experiment is directed so as to plan and foresee the worst which may lay in wait for us at each step into the unknown".

The smallest details, apparently insignificant defects in the work of the technicians in Korolev's requirement, were subjected to the most meticulous analysis. One of the technicians recalls such a case: "In readying the next spacecraft for flight with automated equipment on board, on the signal panel of the checking apparatus, the signal transparency went dim. We quickly found out what was wrong. The failure did not affect the quality of the preparation and the operation of the ship in space. The defect was eliminated. The launch was accomplished. The apparatus operated fine".

The next day, Sergey Pavlovich saw me, came up to me and said: "Aleksandr Pavlovich! You analyzed the defect?". I again confirmed the correctness of yesterday's analysis. Then he said to me: (Let us go to the laboratory and reproduce the situation). We came to the conclusion that the measures taken were proper and the defect could not be repeated. Only after this did Sergey Pavlovich calm down".

And this time in the most crucial experiment, everything was stipulated just as it appeared on the graph. On March 18, 1965, at 1000 hours, the "Voskhod-2" was launched.

Aleksey Leonov recalls his preparation for the space walk: "A great intense preparation preceded the walk, my flight with Pavel Ivanovich Belyayev which greatly interested Sergey Pavlovich. He naturally considered the walk in space to be the most important phase of the flight mission. The space suit and the autonomous life preserving system had to be tested. He had to find out how the temperature differential from — 130 to + 140° would be manifested, how vacuum would affect man. He had to verify overall what man could do in open space. In the future you know he would be occupied with the assembly of orbital stations, with the erection of every possible kind of structure.

What is my space suit like? This is a complete spaceship, only small and reduced to the dimensions of the human body.

We practiced the operation of walking in zero gravity, in flights on the Tu-104, where the ship was housed, and in the transfer chamber. Weightlessness, as we know, can be maintained in an airplane no longer than 40-50 seconds. And then a G-load of 3-4 sets in. And we never found that weightlessness would disappear and the cosmonaut would fall to the floor in his equipment.

The ship was placed into a vacuum chamber where a vacuum was created corresponding to rarefaction of the air at an altitude of 80 kilometers. And under these conditions the walk was practiced. It was exactly the same as in outer space. In such a vacuum death would set in after 0.3 seconds. It was not simply weightlessness involved.

Yes, the crew was trained much and persistently. Sergey Pavlovich carefully followed the training, not missing any detail. In 1964, at the space center, a demonstration of space technology was organized. Belyayev and I had to demonstrate the walk in space. Over my clothes I wore a space suit, but I did not want to wear the

protective jacket since it was baggy and I looked awkward in it. But Korolev told me to wear it without fail, and why, I guess he himself knew. I had to do what Sergey Pavlovich said. The walk began and not once did I get caught on the projections or corners of the lock. And then I understood that it was a good thing that I was in the suit, and attached with the cords. For sure I would have been hung up on something if I hadn't listened to Korolev".

Before the launch of the "Voskhod-2", everyone tried to give the "last" instructions to the crew. But this only annoyed Belyayev and Leonov. Sergey Pavlovich noticed this and came up to Leonov and said: "You just walk out of the ship and come back. Records we don't need". Leonov did just this. After returning from space, he reported to Sergey Pavlovich. He said: "I saw, I even saw the capitalists. The communication was open". And he began to laugh merrily, infectiously.

And as to how the walk in space went, Aleksey Leonov said:

"When the ship was separated from the rocket carrier, we were ready to carry out the major part of the program — the walk. Over Africa, I opened the hatch of the lock. Inside a shaft of light burst that in brightness was no less than the brightness of electric welding.

Pavel Ivanovich cautions: "Don't rush, it is still early!".

The moment arrived — the ship "Voskhod' was in the range of the observation point. We were seen on Earth via television. "O.K. now, — says Pavel Ivanovich, — it is time!"

I stood at the lock and contemplated.

We knew that the two plates, built in a vacuum, were welded. And what is required of me? Would I not stick to the lock, could I undo the welded-together arms?

I felt my way with my hands and waved them around. I found nothing. From Earth I seemed to hear the voice of Sergey Pavlovich. I came to life and felt around with my hands.

I pushed away gently from the lock and started to swim. Even now I do not know how to better call this state. One joker said that I "leonoved" in space.

On one side, the sun is burning, the temperature is +136° centigrade and on the other side, frost -140°. The vacuum was 10^{-9} millimeters. This is greater than on the Moon — there it is only 10^{-7} millimeters.

While I swam, the ship and I together travelled a distance from the Black Sea to Sakhalin. I wanted to stay longer, but the ship would soon enter the shadow of the Earth and would flounder in pitch darkness. Therefore, Sergey Pavlovich gave the command: "End the walk!"

The first time I was unable to find the lock. I took the movie camera, shoved it into the lock and it came back. I would shove it in and it would come back. I can't leave it in space! It would be a pity to throw the film away. Now I look at the film and I cannot believe that it is I in open space.

And how beautiful Earth is from space! Fields can be seen — some brighter, some paler, depending on the degree of maturity of the grain.

Data on the course of sowing and gathering of the harvest can be collected from space after one revolution in orbit around the Earth.

How did I feel in free flight? The main thing was the feeling of responsibility. I felt that I could not fail to complete my mission for any reason".

As we know, the landing of the ship "Voskhod-2" was accomplished for the first time without automatic control.

— Land, land manually, — Yuriy Gagarin transmitted to the crew from Earth with S. P. Korolev's approval.

And they flew one more loop. They manually navigated the ship and anxiously turned on the rectropackage. If their navigations were wrong the ship might leave Earth.

But then the rectropackage was turned on. A noise resounded on board. Where would the ship go? From the descending particles of dust, they understood that everything had worked fine, the ship would reenter the dense layers of the atmosphere.

With entry into these layers, it was clear how the instrument compartment burned and was destroyed. Then the antennas melted from the heat, and the liquid metal covered the heat resistant glass of the hatch.

The time came for operation of the parachute system. A shot and the hatch fell away. A strong shock and the ship was suspended on parachutes and smoothly landed in a thick forest below Perma. Thus, the commander of the "Voskhod-2", Pavel Belyayev, was the first in history to accomplish a manual landing of a spacecraft.

After the flight, the results were analyzed. Leonov, walking in open space, went 5 meters from the ship, carried out various tasks — inspected the surface of the ship, observed space and the Earth and returned to the ship. He was gone for 10 minutes. The exit and return took the same time.

These twenty minutes are written in gold letters in the history of science. Television transmission, the first showing man walking in space,was broadcast by the Central Television System. This could be done with the aid of two cameras for outside viewing.

Sergey Pavlovich in one of his articles evaluated the flight of the "Voskhod-2":

"The flight of Yuriy Gagarin opened the age of space navigation. And the age of man working in free space began last year in 1965 on that March day, when Aleskey Leonov stepped out of the lock into open space and swam freely in it.

The crew ... was faced with a problem that was qualitatively different than in previous flights. Further development of cosmonautics depended on its successful solution to no lesser degree than on the success of the first space flight. Pavel Belyayev and Aleksey Leonov coped with it and the value of this feat is hard to overestimate: their flight showed that man may live in open space, leave the ship, and not feel that he is confined to his walls, he can work anywhere that it is felt necessary to do so.

Without such a possibility it would be impossible to think about opening new paths in space".

Sergey Pavlovich especially mentioned the method of exit that Aleksey Leonov used in space. As we know, Leonov went into free space through a transfer chamber, without breaking the vacuum seal of the entire ship. Pavel Belyayev remained all the time in the vacuum-sealed cabin under excellent conditions, he maintained communication with Earth, followed the movement and actions of his comrade and carried out the operation on controlling the flight.

"Such an experimental program, — concluded Sergey Pavlovich, — is the only proper and methodically grounded one... If the ship had to be depressurized, all the work would undoubtedly be made more difficult.

Of course, the exit into free space through a special lock is technically more complex to accomplish and mainly for this reason we must plan for a sufficiently large weight reserve on board. But this is the only way to fully solve the problem, for the sake of which the exit into free space was mainly done."

Sergey Pavlovich turned to new business. After meeting the cosmonauts on March 23 in Moscow, at the beginning of April he again flew off on a mission. He returned on the eve of the Day of Cosmonautics. On the evening of the 11th, he was in Zvezdniy village for a great rally, then he visited Gagarin for a cup of tea.

In May 1965, he directed the launch of the station "Luna-5". It reached the Moon in the region of the Mare Nubium.

If the routes of all the trips around the country that Sergey Pavlovich took were reproduced, the map would be covered with a thick network. It was not for nothing that the directors of the Civilian Air Fleet awarded him two memorial placques after he had flown for more than a million kilometers: "For Million Kilometer Flight" and "For Accident-Free Flight".

... The beginning of 1965. Sergey Pavlovich was again at the space center. The "Luna-6" station was planned for launching. In spite of the intense work, he often wrote home. Here is one of his letters:

"June 4, 1965. Baykonur... Everything is going normally for me here, according to schedule. Even the heat, and that is also on schedule: it was +36°, yesterday it was +37°, and today they promise +40° in the shade. As they say, on the average, I bear the heat load quite well".

June 8, the "Luna-6" had been launched on its way. At first it also followed the schedule. On June 8 and 9, there was the 12th communication session. At the end of the day on June 9, during a correction to the trajectory, the automatic equipment navigated the station and started the engine. But the command to turn the engine off was not carried out. The trajectory deviated from the computed one. The station passed by the Moon at 160,000 kilometers.

And this experiment brought nearer the solution to the problem of a soft landing on the Moon by an unmanned station...

Those who worked with Sergey Pavlovich marveled at the accuracy of his foresight. When they began to plan a station for a soft landing on the Moon, the designers asked him how to make the station so that it would not be buried in the lunar dust, about which so much was then being said and written; Sergey Pavlovich screwed up his eyes, as though he wished to look far into the distance, and softly but firmly said:

"The dust is no problem for landing..."

And the station "Luna-9", which was launched after his death, confirmed his prediction...

In June, after launching the station "Luna-6", Sergey Pavlovich and Nina Ivanovna left for vacation in the Crimea. They decided to fly through Odessa. An encounter with the town of youth pleased him.

On August 2, Korolev left for work, although even before this, he had already spent three of his "vacation" days in meetings, during which photographs were obtained of the dark side of the Moon from the "Zond-3". He returned satisfied. Rubbing his hands, he said:

"The photographs are successful..."

From December 3 to 8, he was at the observation point. He followed the landing of the station "Luna-8". He returned home feeling poorly.

At the Precipice

Plans and projects, ever more grand, drew his imagination. Much of what he dreamed about he accomplished, much was yet required of his understanding. And he continued to ponder about space every minute — both late in the evening when he returned home and early in the morning enroute to the theoreticians of cosmonautics, then to the cosmonauts, to the builders of the rockets, and then to the space center for preparation of the launches and flights.

And in his home everything breathed of space. In the entry hall a visitor was met by the sculpture of G. Postnikov, "To the Stars", with the autographs of the cosmonauts — frequent guests in this house.

Sergey Pavlovich, during those times, was so tired at the end of the day that coming home, he did not immediately climb to the second floor. He would sit on one of the steps which he called his "meditation step". On this, he would spend several minutes in peaceful contemplation.

In his home library on the second floor, were bookcases with books. In the room stood a table and, above it, hung portraits of scientists, whom Sergey Pavlovich especially liked and respected. At the top were S. V. Vavilov and I. V. Kurchatov, below in the center was K. E. Tsiolkovskiy. They all look in one direction, toward the stairs and seem to ask when Korolev is returning from work:

" So, are you successful? "

After resting on his "meditation step", Sergey Pavlovich climbs the stairs to his bedroom, changes clothes and goes to his office. Here the spirit of space is even sharper. Directly opposite the door to the cupboard stand skillfully done models of the satellites and ships which Sergey Pavlovich had sent into orbits. On the cupboard stands a small globe of the Earth, given to Sergey Pavlovich by one of the talented designers of the rocket engines with the significant inscription: "I send to you this globe, Sergey, with the deep hope that we can together see with our eyes the living Earth of such a size."

The engine designer expressed this hope on April 25, 1952, and on May 10, he made the following notation on a photograph presented to Sergey Pavlovich:

"Photo of the first Soviet liquid-fuel rocket engine ORM-1 (1930) in memory of the founder of Soviet rocket design, Sergey Pavlovich Korolev".

Here is reproduced in the form of a model the Soviet rocket with a hybrid engine which made the first flight on August 17, 1933.

Sergey Pavlovich worked at a desk or a small table standing here in his office. On the wall to the left of the desk are three photographs: The first showed the period of his enthusiasm with gliders — the photograph depicted the participants in the All-Union Glider competition in Koktebel', September 21, 1927. Slightly above is a group of rocket scientists. And, finally, at the top are three heroes of science: Sergey Pavlovich, Igor' Vasil'yevich Kurchatov and Mstislav Vsevolodovich Keldysh.

On the right from the desk is a brown writing board. A piece of chalk and a sponge still retain traces of the touch of his hands.

There are numerous models in the office. There would be a place here also for the model of the rocket plane — the prewar offspring of Sergey Pavlovich — but he placed it in the library.

Next to the office is his bedroom. Sergey Pavlovich would go to bed late at night, but already early in the morning, light could be seen in the windows of his office. He was especially occupied in his last days, he was rushing to do as much as possible.

There were many scientific and technical books in the office of S. P. Korolev. Like "mistresses" on the shelves of the bookcases were nuclear physics, mathematics and astronomy and, of course, cosmonautics. In a prominent place, were the scientific publications: "The Moon", "Rocket Flight", "Space Flight" and "Scientific Problems of Artificial Satellites". And isolated to one side was the two-volume works of K. E. Tsiolkovskiy. This was a popular work and was covered with the comments of Sergey Pavlovich. And other books retain traces of the tireless workings of his mind.

On the night table by his bed are those books which he was reading before going to the hospital. Here are "Memoirs of Lenin" by V. D. Bonch-Bruchevich, "Life, Independent of Time" (stories by Leningrad writers about Lenin), "Postyshev" by G. Maryagin, "Daring" by A. Koptyayeva, "The Traveled Path", by S. Budenniy.

Contemplating, making notes in a notebook, he is acquainted with the latest of the scientific and technical publications. Among them is the book by Ch. Kittel', "Basic Solid State Physics", the brochure of A. A. Abrikosov, "Academician Landau", the work by A. I. Oparin, "Life as a Form of the Motion of Matter", that by A. A. Fridman, "The World as Space and Time", and the magazine, "Questions of Astrophysics".

Himself a passionate dreamer, Sergey Pavlovich loved to read fiction. The book by I. A. Yefremov, "The Nebula of Andromeda", pleased him, and he wanted to talk to and become better acquainted with the author. On the hospital night stand, he had a collection of fantastic tales by Stanislav Lem and the adventure novel of Alexander Dumas, "Forty Five".

In the hospital, Sergey Pavlovich reread the "Etudes of Einstein" by B. G. Kuznetsov.

His wide interests and great love of life is shown by this latter list of books which Sergey Pavlovich read or reread.

His ill health was manifested more and more. He became tired so much more easily. Once he hemorrhaged but would not go to the doctor in spite of the insistence of his loved ones. He pleaded being busy: there were reports and conferences.

On December 14, 1965, he finally decided to go to the hospital for tests. He entered at 10 o'clock in the morning. He was in a depressed state, irritated. They suggested taking his temperature in the receiving room.

— Is that necessary? — he asked.

— Your address, — the nurse continued asking.

He answered reluctantly.

But his bad mood quickly passed. On December 17, he left the hospital to greet the New Year at home. Sergey Pavlovich was agreeable to this:

— It is the end of the year, and I must still finish up all my business.

On the eve of this latest visit to the hospital, Sergey Pavlovich was, as usual, at work. And on the next day in the morning when he had already decided to go, he looked in the pocket of his jacket and went up to Nina Ivanovna:

— Did you take two kopecks out of my pocket?

— No, — she replied.

— Did you clean my suit?

— Yes, with a vacuum cleaner.

— What happened to my two kopecks?

— For the telephone?

— No, not with kopecks.

The old rolling stone had a habit of keeping two small kopecks in his pocket — for luck! And when later Nina Ivanovna looked in the clothes closet — in almost all of his jackets and pockets were turned inside out. He was seeking his "talisman". He didn't find it...

This time in the reception room of the hospital, they asked him no questions. In the elevator, Sergey Pavlovich was met by the doctor. They rode up to the fourth floor.

Books were the first thing he was concerned about when he had been shown his room.

— You promised me Nikulin's, "Swell", he reminded his wife.

— I will bring it tomorrow.

On the 12th, Sergey Pavlovich's birthday, Nina Ivanovna and his mother, Mariya Nikolayevna, came to his room. The son and the mother recalled bygone years, people with whom their fate had collided. Sergey Pavlovich listened to tales by his mother and it was noticeable how his appearance warmed up and the tension in the expression of his face relaxed.

On January 13, Nina Ivanovna was seated with Sergey Pavlovich in the hospital when the doctor came into the room swiftly and began to talk about the histological analysis.

Sergey Pavlovich listened to him, expressing nothing outwardly. He sat on the bed, his hands under his knee. His head as usual bent slightly to one side. It seemed to Nina Ivanovna that he believes and he doesn't believe... Later he asked the doctor:

— Doctor, you are our friend (he had been on vacation in 1965 with the Korolevs in the Crimea. — P.A.), tell me, how long can I live with this?... and held his hand to his heart.

The doctor was taken back and diffidently said:

— Oh, I would say about 20 years.

Sergey Pavlovich lowered his head:

— Ten years would suffice, although I have much yet to do.

Behind the words "I have much yet to do" stood a large number of brilliant projects. One of the dearest — to write a fundamental work on rocket technology, to talk about the yesterdays, the todays and the tomorrows of it. Sergey Pavlovich had thought about this work for more than ten years. He had considered how to best formulate it, he accumulated and analyzed a wealth of material of scientific output.

The first notes on the work pertain to 1953. In 1959, he had already clearly decided that it would be in four volumes consisting of nine parts.

The first volume, he decided, must contain three parts. One of them, the introductory part was devoted, in Korolev's words, to a "history of the development of rockets and classification of modern types". Further on in the first volume, he proposed examining the characteristics of rockets from the single-stage ones to spacecrafts. And at the end of the volume, Sergey Pavlovich included a section on plans from the initial task to the selection of the theoretical scheme and justification of the design.

The second volume was mentally divided into two parts. One would be devoted to the design and partly to the technology, the second part — to on-board systems of all types.

In the third volume, he proposed describing the ground instrumentation, tests and usage, the work of observations and measurements in flight.

And, finally, the concluding, fourth, volume of the work would be devoted to the prospects of research in the field of space flights (the boundaries of the study he himself defined as: "from the satellites to the possibility of flight beyond the confines of the solar system"). Sergey Pavlovich proposed giving special attention to a description of interplanetary orbital stations and other space objectives for prolonged habitation of man.

A number of Sergey Pavlovich's notes have been kept which reflect his thoughts about this work. These comments were dated in 1959, 1964 and 1965. Thus, on January 17, 1965, he decided to add to the first volume a section on the analysis of power possibilities of rocket engines "in the range from the low-caloric solid fuel to the highest-caloric ones". On top of this, he thought about a section, so to say, of "the perspective analysis of power engineering and to define the place of rockets in it".

Lovingly and painstakingly he compiled material on the history of Soviet rockets. In his writings, there are many such comments: "To talk personally with Bolkhovitinov: how many completely successful flights were there of the BI-1" or "To find out from Dushkin, how the jet engine was prepared". And he spoke and he explained and, making every minute count, he wrote his cherished work.

And now only one goal of Sergey Pavlovich remained unfinished. He dreamed of writing a creative biography of Tsiolkovskiy. In his papers, an old notebook was found in which he had already started this biography. You can imagine for yourself how deeply the gaze of Sergey Pavlovich could penetrate into the creative laboratory of the scientist whom he admired and who was so similar to him in ideas.

Sergey Pavlovich collected many little-known and virtually unique materials about Tsiolkovskiy. He compiled a most detailed bibliography of his works, and noted where various rare works of the scientist could be found. In searching for the rare materials about Tsiolkovskiy, he had willing assistants. Thus, Academician A. Ishlinskiy sent Sergey Pavlovich a forgotten article about the "dreamer from Kaluga" and his own foreword to the scientist's works.

I would like to give at least one extract from the draft materials of Korolev about Tsiolkovskiy. For example, a phrase such as this attracts attention: "Tsiolkovskiy considered manned flight beyond the Earth's gravity to be a basic finite problem, and he can validly be called the greatest adversary of gravity and the father of the star travellers".

The projects of Sergey Pavlovich about which we have been talking would have to be found in the lines of his books and the other projects would have to lie with the new rockets for the launching devices and go with the ships into orbits.

Why did he feel that ten more years of life were essential to him...

The operation was planned for January 14. On the eve of the operation, Nina Ivanovna stayed in the hospital until dinner. Before she left, Sergey Pavlovich asked:

— Stay for the evening. Sit down and talk to me.

In the evening, he followed her to the stairs and kissed her with special tenderness. He said thoughtfully:

— I shan't go farther. And when you go down the stairs, take my hand and don't look at the steps, you can still fall.

But hardly had she arrived home when the telephone rang. Sergey Pavlovich said that he had already had a bath and that they had readied him for the operation.

In the morning at five of eight, he called once more. This was their last conversation. His voice was dull, weak as in a man asleep.

They have already given me a shot. I am already sleeping. You come as we agreed.

The agreement was the same as when he came to her in the hospital: he did not come before the operation, but immediately afterwards, he was already there.

At eight, Nina Ivanovna left for the hospital. And at a quarter of nine, Sergey Pavlovich called home for the last time. He asked:

— Where is Nina?

— She has gone to the hospital.

— Oh, all right.

It was clear that he wished to change their agreement and to ask her to come to him before the operation...

Nina Ivanovna waited, leaning against the cold wall. Now the stretcher came. On it lay Sergey Pavlovich, up to his chin covered with a sheet. He isn't sleeping, but his eyes are half closed. Behind the stretcher is a group of doctors, including an eminent Soviet surgeon, a professor.

The operation had been going on for an agonizingly long time. Still another surgeon, also a professor, arrived and quickly rushed to the operating room. Alongside Nina Ivanovna sat a nurse, who talked constantly with her and, from time to time, gave her tablets. Nina Ivanovna chewed them without tasting them.

But then it seemed that a wave surged along the corridor. The surgeons came out. They approached Nina Ivanovna. One stood in front of her, another sat down next to the large clock and, nodding his head, confirmed what his colleague had said:

— It was a grave operation.

— Is it malignant? — the words were torn from Nina Ivanova's throat.

— The problem now is whether we can save his life.

The surgeons went to the office of the chief of the division. From the faces of both, it was clear how tired they were.

After some time, the professor hurriedly returned to the operating room. Anguished minutes passed. Nina Ivancvna more felt than saw how one of the professors came up to her. He carried three words that were terrible for her:

— Be courageous, everything is finished.

She went to the deceased. On shaky legs, she went to him, pressed herself up against his head and felt — or it only seemed to her — how suddenly cold were his cheeks and his forehead.

And so Sergey Pavlovich Korolev departed this life during a very grave operation.

Yuriy Gagarin said about Korolev: "He can bend everyone to his own way". But he was unable to bend the illness...

January 16 was a frosty day in the capital. But the flow of people, standing in line to bid farewell to Korolev in the Hall of Pillars of the House of Soviets, extended all along Pushkin Street. The nation bowed its head by the coffin of its remarkable son. His funeral was held in Red Square, his ashes rest in a Kremlin wall.

The memory of the eminent designer of rocket space systems will live through the centuries. His bust overlooks the Avenue of the Conquest of Space. On the walls of the Moscow Higher Technical School is a memorial placque documenting that he studied here, and his profile is carved in stone. A memorial placque is also in Kiev on the building of the Polytechnic Institute.

In August 1968, on its first voyage, the "Academician Korolev" was launched —- a new scientific research ship designed for prolonged unmanned flight. On board, were almost thirty laboratories. Indeed, the life of S. P. Korolev was embodied

"in steamships,
in lines
and in other long-term affairs"

A memorial museum was opened in his hometown of Zhitomir. The cosmonauts sent letters there.

"... I just want to recall, wrote Yu. Gagarin," our recent great loss. We have interred one of the successors to Tsiolkovskiy, the eminent designer, Sergey Pavlovich Korolev. Our people value greatly the contribution of this man in the conquest of outer space. As far as we, those who worked alongside him, are concerned we consider him to be not only our mentor, but our father. Not once did I ask advice of Sergey Pavlovich, I exchanged ideas on some problem. I shall never forget how he admonished me on my first space flight".

Andriyan Nikolayev also wrote about his gratitude to Korolev: "Sergey Pavlovich was a real father to our large number of seven friendly cosmonauts".

The street next to that on which Sergey Pavlovich was born is now called Korolev. It extends as a wide avenue for five kilometers. Previously here had been the edge of town, now there are multistory homes, a row of plants, cultural institutions. The pride of the street is the Botanical Garden of the Agricultural Institute.

In the Pamirs in the western part of the "Top of the World" is a hard-to-reach peak, 6236 meters high. In August 1968, 14 Soviet mountain climbers reached it. The hitherto unnamed peak received a name — they called it Korolev Peak.

S. P. Korolev's services have also been commemorated in space. His name has been given to one of the small seas on the dark side of the Moon.

Dreams Become Reality

Much of what S. P. Korolev dreamed about has either become reality or is in the process thereof. The satellites "Molniya-1" ensure superlong-range radio communication and television. Here is what Sergey Pavlovich wrote about this in 1962:

"Further conquest of space will permit, for example, the establishment of satellite systems... and will ensure universal communication and rebroadcasting of radio and television transmissions. Such a solution may be found to be economically and considerably more advantageous than building radio relay lines...".

In the USSR, we have operating a space weather service guaranteed by the "meteor" system. Sergey Pavlovich wrote about this:

"The next problem will be weather service satellites. In the future, obviously there will be developed special methods for actively influencing climatic conditions, a system for forecasting weather, etc."

Soviet scientists were the first to accomplish a soft landing on the Moon of an unmanned station and an exploratory launch of a station to Venus. Sergey Pavlovich wrote about this several days before his death: "Difficult problems must be resolved by unmanned stations designed for a soft landing, and the statior itself and all its equipment must be fully safeguarded and able to function so as to carry out the assigned mission".

In the USSR, the first unmanned linkup in the world was accomplished of two spacecraft in orbit — an important step in the path of building orbital stations. S. P. Korolev wrote: "To solve these or other problems, associated with the conquest of space, it would not be feasible in all cases to launch a satellite into orbit each time. It is obvious that we must have a well thought out system of orbital space stations...".

As to possible flights on manned satellite ships, Sergey Pavlovich said:

"We can say in advance that I doubt now that only one-man ships will fly, I doubt it! And I think that I will not err if I predict the next step.

For sure the question will soon arise as to whether it makes sense to launch such expensive systems as spacecrafts into space for only a few days. For sure they must be launched into orbit and remain there for a quite prolonged period of time. And to equip these ships with all that is necessary and, also, to supply and change the crew must be done by means of simplified types of space apparatus...

And if we speak about more prolonged flights and farther flights, then, of course, you understand comrades that these ships cannot fly... alone".

And Sergey Pavlovich emphasized the value of mutual assistance, reliability, duplication and even the simplest of human contact and help. "Here we can, of course, dream a little and say that perhaps, especially if large ships exist, that they will be quite near and will even approach within tens of kilometers, and they will, we can say, be able to see each other by radio engineering means.

You ask how then can we transfer from one ship to another? For sure not in some space suit with a small engine. By then, we must already have some kind of space taxi, a space boat that will allow transportation for a long distance, say, 20 kilometers...".

How much courage is in these words and how much confidence in the ability of our Soviet science and technology! Here is how Sergey Pavlovich evaluates the future of cosmonautics with such optimism:

"The distances in outer space are without confines, but the conquest of outer space adjoining the Earth is a problem for the

not-too-distant future. Probably at first unmanned stations will fly to the Moon and land on its surface. Then man will visit the Moon. The building of a permanent scientific station on the Moon and, as a result, an industrial complex will permit using the as-yet-unknown resources of this ancient satellite of the Earth. Then — trips to the nearby planets of the Solar system — Mars and Venus. This, if you please, will be fully realized in a not-too-remote time.

The building of huge, weighing tens of tons, interplanetary ships with a crew consisting of several men, will permit carrying out prolonged (about two or three years) space flights. And then... It is, of course, now difficult to predict dreams because in our remarkable Soviet time it seems that life outstrips the dream. Only one thing is clear: cosmonautics has an unlimited future and its prospects are as infinite as the Universe itself".

In 1947, Korolev said about Tsiolkovskiy that he lived before his time. Now, knowing the writings and plans of Korolev himself, we can with complete validity say the same about him. In his outlines on the future, he speaks not like a shy little boy in space, but as the master of the sixth ocean. Just listen to the confident tone of just one of his writings: "It is essential that we move freely around the Earth and to the nearest planets". Or: "Then there is the questions of the velocity (100 km/sec, 1000 km/sec)". Let us recall that orbital velocity is only 8 km/sec. And he speaks of 100 or 1000 kilometers per second! Yes! He lived in the future, outstripping his own time, as is fitting to a real scientist.

Describing a rich future to the development of our cosmonautics, he proceeded from the possibilities created by our socialist system: "The Moon. Mars. Venus... The constellations of near and remote galaxies. We speak now about flights deep into the universe not in the language of a dreamer or a visionary, but about a completely real problem attainable to mankind and as the future of the development of Soviet science and technology, based on the advantages of the socialist system".

...At the conference devoted to oberserving the anniversary of S. P. Korolev's death, associate member of the Academy of Sciences USSR, B. V. Raushenbakh said:

— It seems that the door should burst open and Sergey Pavlovich will come in and say: "What are you sitting here for — there is work to be done!"

It is by this motto — to work and work on the frontiers of space in the interests of the Motherland, in the interests of mankind — that the crews of our scientists, designers, cosmonauts and laborers, readied under the guidance of Lenin's party now live to make new space exploits possible.

FOOTNOTES

Footnote (1) page 239 Korolev, S. P.: O nekotorykh problemakh osvoyeniya kosmicheskogo prostranstva. Iz istorii i kosmonavtiki. (Several Problems in the Conquest of Outer Space. From the History of Aviation and Cosmonautics.), Nauka Press, No. 5, p. 3, 1967.

IMPORTANT DATES IN THE LIFE AND ACTIVITY OF S.P. KOROLEV

1906, December 30 — S. P. Korolev was born in Zhitomir.

1922 (according to some sources-1923) — He entered the First Professional Design School in Odessa.

1923, June: He joined a glider group of the Odessa Seaport.

1924 — He completed a project for his first glider — the K-5.

1924 — Finished the First Odessa Professional Design School.

1924 — Entered Kiev Polytechnic Institute.

1926 — Went to Moscow and began studies at the Moscow Higher Technical School.

1927 — First trip to Koktebel' for the All-Union Glider Competetions.

1929 — Together with S. N. Lyushin he built the glider "Koktebel'".

1930, February — Finished the Moscow Higher Technical School and received his diploma as an engineer of aeromechanics. The theme of his thesis — design of the airplane SK-4.

1930 — Built the glider "Krasnaya zvezda", on which the pilot, V. A. Stepanchenok was the first man in the history of glider flight to complete three Nesterov loops.

1931, August 18 — Joined the staff of the Group for the Study of Jet Propulsion, created by the Central Committee of the Society for Assistance to the Defense, Aviation and Chemical Construction of the USSR.

1932, April — Headed organization of the Group for the Study of Jet Propulsion and became its chief.

1933, August 17 — Directed the launch of the first Soviet liquid-fuel rocket 09 designed by M. K. Tkhonravov and built in the Group for the Study of Jet Propulsion.

1933, November 25 — Directed the launch of the liquid-fuel rocket GIRD-Kh. (Group for the Study of Jet Propulsion).

1933, Fall — Started to work in the Scientific Research Institute of Jet Propulsion created on the base of GIRD and the Gas-Dynamic Laboratory located in Leningrad.

1934, May 5 — Together with Ye.S. Shchetnikov, he flight-tested the first USSR winged rocket 06/1, developed under his direction.

1934, March-April — Participated in and gave a report at the First All-Union Conference on Studying the Stratosphere.

1934 — S. P. Korolev's book, "Rocket Flight in the Stratosphere", was published by Voyenizdat.

1935, March 2 — Attended First All-Union Conference on the Use of Rocket Devices for Studying the Stratosphere and gave a report on the theme: "Winged Rocket for Manned Flight".

1935, January 29 and March 8 — The winged rocket 212 of the class "Earth - Earth", developed and built by S. P. Korolev, completed successful flights.

1940, February 28 — The rocket plane RP-1-318, built by S. P. Korolev, completed first flight.

1944-1945 — Flight tested liquid-fuel rocket boosters on airplanes.

1946, August 9 — Appointed Chief Designer of the Department of the Scientific Research Institute concerned with the planning of a powerful ballistic rocket.

1947, September 17 — Attended a ceremonial conference devoted to K. E. Tsiolkovskiy's 90-th birthday at the Central House of the Soviet Army im. M. V. Frunze.

1947, October-November — Tests of the first Soviet Powerful Ballistic Rockets.

1953 — Elected associate member of the Academy of Sciences USSR.

1953 — Joined the ranks of the Communist Party of the Soviet Union.

1956 — Awarded the honor of Hero of Socialist Labor.

1957, September 17 — Made a report on the creative heritage of K. E. Tsiolkovskiy in the Hall of Pillars of the House of Soviets, where the ceremonial conference was held devoted to the hundredth birthday of the scientist.

1957, Summer — Tests of the world's first intercontinental multistage rocket which was built under his direction.

1957, October-November — Preparation and launch of the world's first artificial Earth satellite and the first biological satellite.

1957 — Awarded the Lenin Prize.

1958 — Elected Academician and Member of the Presidium of the Academy of Sciences USSR.

1958, May — Launch of the third satellite — first laboratory in orbit.

1959, January — Launch of the unmanned station "Luna-1".

1959, September — Launch of the station "Luna-2", which placed on the surface of the Moon a flag with the Emblem of the Soviet Union.

1959, October — Launch of the station "Luna-3", which was the first to photograph the dark side of the Moon.

1960, May, August, December — Development of a satellite for manned flight into outer space by launching a device with animals on board into orbit.

1961, February — Launch of an interplanetary station to Venus. The station reached the region of the "planet of mystery" May 19-21, 1961.

1961, March — Preparation and accomplishment of two flights of satellites and return to Earth.

1961, April — Preparation and accomplishment of history's first manned flight in orbit around the Earth. The flight was made by Yu.A. Gagarin on the ship "Vostok".

1961 — Received second award of Hero of Socialist Labor. Awarded the Lenin Prize.

1961, August — Preparation and accomplishment of the 24-hour orbital flight of G. S. Titov on the ship "Vostok-2".

1962, August — Preparation and accomplishment of group orbital flight carried out by A. G. Nikolayev and P. R. Popovich on the ships "Vostok-3" and "Vostok-4".

1962, November — Preparation and launching of station "Mars-1".

1963, April — Preparation and launching of station "Luna-4".

1963, June — Preparation and accomplishment of combined flight of V. V. Tereshkova and V. F. Bykovskiy on the ships "Vostok-6" and "Vostok-5".

1964, April — Experimental launch of multi-stage rocket and unmanned space probe "Zond-1".

1964, October — Preparation and accomplishment of orbital flight of the ship "Voskhod", the first space scientific expedition with a crew composed of V. M. Komarov, K. P. Feoktistov and B. B. Yegorov.

1964, November — Launch of the spacecraft "Zond-2".

1965, March — Preparation and accomplishment of the flight of the ship "Voskhod-2", during which A. A. Leonov took a walk in space. The commander of the ship was P. I. Belyayev.

1965, April — Launch of the first Soviet communications satellite "Molniya-1", an active broadcaster.

1965, May — Launch of the "Luna-5" station.

1965, June — Launch of the "Luna-6" station.

1965, July — Launch of the "Zond-3" craft, which photographed and sent to the Earth pictures of those regions of the dark side of the Moon, which were out of range of the cameras on board the "Luna-3" station.

1965, October — Launch of the "Luna-7" station.

1965, October — Launch of the second communications satellite of the "Molniya-1" type.

1965, November — Launch of the stations "Venera-2" and "Venera-3".

1965, December — Launch of the "Luna-8" station.

1966, January 14 — S. P. Korolev is deceased.

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