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(U) AVIATION AND COSMONAUTICS

(Aviatsiya i Kosmonavtika)

Nr. 1, 1965

FOREIGN TECHNOLOGY DIVISION

~~AIR FORCE SYSTEMS COMMAND~~

WRIGHT-PATTERSON AIR FORCE BASE

OHIO

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EXPLANATORY NOTE

This publication is a translation of Aviation and Cosmonautics (Aviatsiya i Kosmonavtika) formerly Herald of the Air Fleet, a monthly journal of the Soviet Army Air Force published by the Military Publishing House, Ministry of Defense, USSR.

Every effort has been made to provide as accurate a translation as practicable. Soviet propaganda has not been deleted, as it is felt that such deletion could reduce the value of the translation to some portion of the intelligence community. Political and technical phraseology of the original text has been adhered to in order to avoid possible distortion of information.

Users and evaluators of this translation who note technical inaccuracies or have comments or suggestions are urged to submit them to: Commander, Foreign Technology Division, Air Force Systems Command, Attention: TD-B, Wright-Patterson Air Force Base, Ohio.

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AVIATION AND COSMONAUTICS

MONTHLY JOURNAL OF THE SOVIET ARMY AIR FORCE

Forty-Seventh Year of Publication

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January

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1965

For Our Soviet Motherland!

Aviation and Cosmonautics

No. 1

Forty-Seventh Year of Publication

JANUARY

Monthly Magazine of the Air Force

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NEWS FROM ABROAD

HAPPY NEW YEAR, DEAR READERS!

OUR BEACONS are on the COMBAT COURSE

The Kremlin chimes informed our people about the coming new year of 1965. The count-down of the final year of the Seven-Year Plan began. We entered a new stage of achievements, labor feats, and creative victories.

Beginning the new year together with all the Soviet people are also the soldier-aviators, the reliable defenders of the Socialist Fatherland and the true sons of the Soviet Motherland. In the same ranks with the soldiers of the Army and Navy, they are vigilantly guarding the cause of peace and creation and reliably ensuring the security of their State and that of the countries of the socialist camp. Our air commanders, pilots, navigators, engineers, technicians, and soldiers of the Air Force rear area achieved many successes in mastering modern aircraft equipment and its combat employment in the past year.

Yes, the results of the past year are gratifying to us. We are proud of the fact that the ranks of Outstanding Men in Combat and Political Training have considerably increased in our units and subunits and that the number of first-class pilots, navigators, technicians, and other specialists has grown bigger. And, perhaps, the main thing lies in the fact that the experience of the best soldiers is being adopted by the broad masses of aviators who apply it in the practice of combat training.

Long-range flights are successfully being made by the crews of missile-carrying bombers led by Air Commander I. Fedorov. Under adverse weather conditions, pilots and navigators have learned to deliver powerful strikes against various targets, operating day and night.

Difficult roads to the heights of combat skill were passed by the pilots of the subunits commanded by P. Dolgarev, A. Fukalov, and V. Savel'yev. The experience of these subunits attests first of all to the fact that they managed to organize the training and indoctrination of personnel correctly and that the element commanders became true masters and are setting an example in carrying out combat training missions.

The experience of the best air commanders, pilots, navigators, and specialists of the various services becomes the property of an ever-increasing number of soldier-aviators. This leads to general improvement in the quality of combat training, to strengthening of military discipline, order, and organization in subunits, and to a decrease in the causes of flight accidents.

This is exactly what the results of the past year indicate. However, it is not characteristic of Soviet people to become self-complacent and not typical of them to revel in achieved victories. On the contrary, a goal achieved by a Soviet man in combat improvement is considered by him as a kind of springboard for a new jump ahead and for further raising the level of flight and combat skill. This is why, in noting the successes achieved during the past year, we turn our eyes to the tasks which have to be carried out tomorrow and to the shortcomings and gaps in flight training and discipline.

Aircraft equipment is improving, new models of weapons and new aircraft control facilities appear, and new tactical methods are being worked out. This means that one must not stand still for a moment but must keep abreast of the progress in aircraft technology and boldly look into the future. Such is the guiding principle of each commander and each crew member and aircraft specialist.

A brilliant example of continuous increase and improvement in military skill is set by our beacons and foremost men in combat and political training. During the past year some of them were given high government awards — orders and medals. We have read in the magazine about the achievements of those given awards and about how their experience is becoming the property of many aviators. More than six months have passed since then. What has changed during this period? What new heights in combat skills have been achieved by the recipients of awards and how is their experience being adopted in units and subunits? These questions are answered in the articles published in the present issue of the magazine in the section entitled "The Experience of Award-Winners Becomes the Property of Many."

Good work has been done by those given government awards, air commanders S. Perlifonov and Yu. Kropachev, who managed to develop many useful skills in the combat employment of present-day aircraft in young pilot-engineers. A new detachment of pilot-engineers was trained and indoctrinated by the subunit commander, Lt. Col. I. Ushakov, who made sure that the training flight program was carried out fully in spite of difficult weather conditions. A promotion has been given to the former commander of a foremost squadron, Officer V. Radkevich. This officer now has a wider scope of work and a broader field of activity, but, as previously, he works with each pilot painstakingly and helps element commanders to take their place in the overall system of combat training.

Such are certain features and examples of the maturity of air commanders who were given high government awards last year. These awards of the Motherland, the people, and our beloved Party were accepted by them as a call to achieve new heights in combat improvement.

The new academic year has begun. More complicated and responsible tasks are facing the soldier-aviators. Inspired by the successes of the Soviet people in Communist construction and warmed by the concern and attention of the Party and Government, the soldier-aviators must even further improve the combat readiness and combat capability of our units and subunits, become perfect masters of aircraft equipment and new methods of its combat employment, reduce the causes of flight accidents to a minimum, improve organization in flight work, strengthen discipline, and establish an exemplary service order.

Adverse weather conditions must become habitual for our crews who are obliged to pilot missile-carrying aircraft at full range, master flights at all altitudes, and know how to destroy mobile targets in the complex situation of present-day combat. The entire training process must proceed without oversimplifications or indulgences, an indispensable condition for any true increase in combat skill.

Commanders, political workers, and Party and Komsomol organizations are conducting extensive organizational and indoctrinational work in mobilizing the aviators to successfully carrying out the complex and difficult tasks of combat training. And, as ever, the models to be imitated are those who are marching in the front ranks, assaulting unexplored heights, continuously learning by themselves, and leading others.

Our beacons, full of creative enthusiasm and a warm desire to carry out honorably their patriotic duty to the Motherland and the people, are always on combat course and always in search of new things. Their example is a pledge of successes in improving the combat readiness and combat capability of air units and subunits. May the wonderful light of the beacons glow brighter and may their experience become the property of each crew and each soldier-aviator!

THE EXPERIENCE OF AWARD-WINNERS BECOMES THE PROPERTY OF MANY

WITH THE DIPLOMA OF A PILOT-ENGINEER

Lt. Col. P. SUPRUN;
Maj. A. KOLYADIN.

They had not yet come to the unit. They passed their last examinations and were waiting for an assignment order, but active preparations for receiving them had already begun in the squadron commanded by Maj. I. Fateyev.

Element commanders and pair leaders independently deepened their theoretical knowledge, instructors polished their methodological skills at rallies of instructor personnel, and commanders thought about ways of improving the planning and organization of flights. Each understood that the training and indoctrination of pilots who had an engineering education would need new knowledge and a great exertion of effort.

Then the pilot-engineers arrived. Everything was new and interesting for them here. They were told about the combat traditions of the unit. They were familiarized with the experience of pilots A. Anpilogov, N. Kulikov, and V. Topchiyev who had been awarded orders for successes in training and discipline. The young men had one desire — to begin flying as soon as possible.

Maj. Fateyev, the secretary of the Party organization of the squadron, as well as the command personnel of the regiment promised the young pilots every help, but strictly warned them that flights would be preceded by the most painstaking ground training as well as practice on training apparatus and in the aircraft cockpit.

The pilot-engineers took this as a must. Even in the school they had been imbued with a high sense of responsibility for flight training. Together with Party activists Zh. Korniyenko, V. Shichanin, G. Zrazhevskiy and others, they studied the exercises which had to be worked out in the immediate future and willingly conducted training sessions.

The squadron commander and the secretary of the Party organization, who took into account the high training level of the pilot-engineers, entrusted them with conducting theoretical studies. Some were against it and said: "They are young and have not yet flown". But the very first lectures of lieutenants V. Brykov and V. Shcheglov and others showed that this apprehension was in vain. Engineering education helped them to prepare their lectures with substantiation and with a profound analysis of the physical essence of phenomena.

The young officers distinguished themselves in passing examinations on equipment.

Regular flights began. They gladdened the veteran pilots: the novices piloted competently, precisely observing the documents governing the flight service. However, the experienced eye of the instructors did not miss errors and a certain stiffness and stereotype in their tactical actions. There still was no freedom, ease, or oneness with the craft.

In checkout flights element commanders tried to eradicate these shortcomings. During study and training hours between flights, the best pilots of the squadron and regiment told about the most advantageous tactical methods and emphasized the effect of a neat piloting technique on success in carrying out a flight mission. Particularly successful in such talks was Capt. S. D'yakov. Being a Military Pilot First Class and a Party leader, he knows how to talk about the most complex things simply and comprehensibly.

The attention of superiors and their sincere help inspired the pilot-engineers, while precise organization of flights disciplined them. They strove to fly as well as possible, but could not do away with disappointing slips. During one solo flight Lt. T. shut the cutoff valve instead of retracting the flaps during the run. Several others also had causes of flight accidents. This alerted the Communists. During the meeting of the Party Committee, measures of increasing the responsibility of each pilot for flight safety were discussed. The Communists of the technical engineering personnel were asked to improve the quality of studies and consultations and the element commanders to intensify indoctrinational work.

Flights in the airfield area finally demonstrated the training level and capacities of the pilot-engineers. This made it possible, before beginning to work out complex exercises, to differentiate the approach to training even further. Element commanders began drawing up individual training cards and analyzing the causes of any error more strictly. Established in the squadron was a strict record of logged flight hours and control over the progress of the young men according to the program. All of this made it possible to observe consistency of training precisely and conduct preventive work for forestalling causes of flight accidents.

Highly organized combat training and regular progress by the program created a spirit of competition among the pilot-engineers. They began assuming obligations for specific tasks and norms for each flying day. Upon advice from their superiors, many told their comrades about their mastering the most complex elements of piloting technique and combat employment.

It was with interest that the aviators listened to the speeches of pilot-engineers I. Timkov and V. Seleznev who shared their experience of bombing in twilight and told about the peculiarities of gunnery against ground targets.

The pilot-engineers had a high level of theoretical training. In order to incorporate them into the ranks as soon as possible, the subunit commanders organized lectures for them and conducted studies and tactical briefings. The young officers derived appreciable benefit from a series of lectures given by Officer V. Dmitriyev on overcoming enemy AA defense facilities as well as searching for and destroying small-scale targets at low altitudes.

During preliminary preparation, element commanders also demand that the pilots make well-grounded decisions and tell what tactical methods they would use in carrying out a scheduled exercise. Similar studies are conducted by Capt. V. Samoylenko with particular instructiveness. He ably uses visual aids, special literature, and the materials from military newspapers and magazines. All of this gives good results.

But it would be incorrect to consider that the making of pilot-cosmonauts proceeded without a hitch. There were also difficulties, especially in working out combat employment flights. Sometimes, bombing and gunnery results simply did not conform to the norms of a satisfactory evaluation. But the young men did not lose heart. And this was primarily due to the services of commanders who were experienced indoctrinators. At a difficult moment, they always came to one's aid, encouraged and taught. This is, for example, how Communist V. Tverdokhlebov acted when Lt. V. Shcheglov could not cope with gunnery against ground targets.

The lieutenant got out of the cockpit angry. Apparently, he understood even aloft that he again had not carried out the exercise. Tverdokhlebov did not begin to talk about the flight at once. Knowing the peculiarities of his subordinate's character, he was sure that the latter could miss important details in the heat of his agitation and he tried to distract Shcheglov from his unhappy thoughts. At first, they talked about trifles and remembered a funny case in a neighboring squadron. The lieutenant cooled off gradually, and a smile appeared on his face. And Tverdokhlebov switched to business.

They talked a long time, climbed into the cockpit, and drew on paper how a target appears on the canopy at various stages of flight.

"Let's fly dual", the commander said in conclusion and, during preliminary preparation, made Shcheglov study theory and train in working with the sight once more.

The flight confirmed his guess: Shcheglov did not know how to approach a target precisely. Tverdokhlebov assumed the controls and set up a maneuver over the bombing range with academic precision. Then Shcheglov imitated him, and more than once. Soon the young pilot received his first five for gunnery.

There was a different attitude in the squadron toward the errors made by S. Kruglov and G. Pogorelov. They incorrectly conducted radio communication with the flight controller at the tactical bombing range. In fact, this was not simply an error but a violation of the rules of radio talk, for which the pilots were strictly reprimanded. But this was not the end. During the flight critique and in the course of preliminary preparation, the rules of radio talk were gone over together with all the flight personnel.

Simultaneously with mastering complex types of maneuvers, they began flying under adverse weather conditions. They prepared for it as though for a great event and a Party meeting and a conference of the methodological council were held. They discussed the procedure and sequence of training the pilot-engineers on the basis of new exercises and outlined an approximate program for each. And, getting ahead of ourselves, we shall say that the individual approach to training justified itself completely. All the young pilots rapidly mastered flights in the day under complex conditions and now successfully carry out missions at night. By the end of the year the young officers raised their class-ratings.

BEYOND THE POLAR CIRCLE

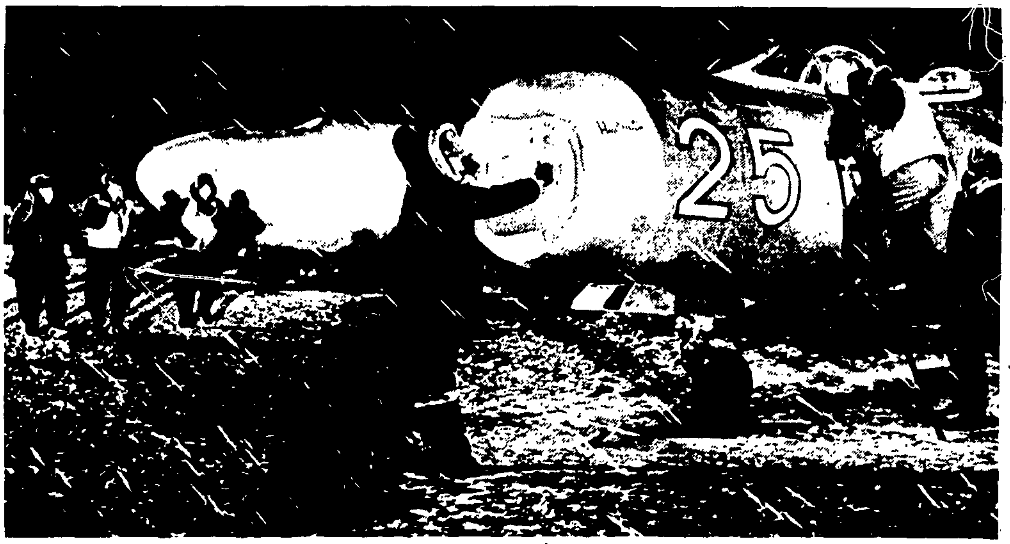
On geographic maps this zone is marked by a special line: the polar circle. Here are permafrost, blizzards, squalls, and endless night. It is difficult to fly without seeing the horizon but it is even more difficult if the frost is close to forty below and darkness continues for months. But the aviators do not complain about the climatic conditions. For them flights mean primarily work. There is a slight glimmer at daybreak. Whether you wait for the sun or not, there will be none: the polar night has come. In the morning and evening, it is the same — a twilight changing into wonderful arctic nights if there are no clouds. Fairy-tale nights with northern lights and the silent tundra. A few more minutes will pass, and the first craft will go aloft. They will be flown by pilots whose work has been marked with high government awards during recent years.

However, let us return to the beginning of flights under adverse weather conditions. In training for these, the pilot-engineers felt an even greater concern on the part of the commander and the Party organization.

Upon the recommendation of the methodological council, they decided to assign pilots to an instructor on a strict basis, prevent rush, carefully watch and correctly determine the readiness of pilots for solo flights under complex conditions, and give each as many flights in the combat training aircraft as necessary for fully practicing instrument-flight elements.

Party and political work was conducted in a different manner. Its main goal was ensuring high quality in flight training. At a Party meeting concerning the tasks of Communists in connection with the beginning of flights by the young pilots under complex conditions, they outlined specific measures for improving the quality of training the pilots and servicing aircraft equipment for flights. The Communists concentrated their efforts on individual work with the flight and technical personnel.

BEYOND THE POLAR CIRCLE



The approach of a snow shower had been forecast by the meteorologist even before the beginning of flights. Although everybody knew about it, it still came unexpectedly. The sky became dark and visibility was reduced to a minimum. But work did not cease on the airfield. The pilots of the squadron commanded by Lt. Col. V. Vashchenko will fly intercepts today. The commander has already carried out a mission. He has explained the flight peculiarities to one of the best pilots, Capt. I. Lukashevskiy. Meanwhile, Military Technician First Class E. Sokolovich once more inspected the craft and checked the fueling of the fuel system. Snowfall is no trouble to the able aviators. Now a snowflake got into the tank filler neck or the aircraft cockpit. After a precise report, the pilot took his seat in the cockpit and the aircraft specialists freed the aircraft of its protective devices.

Communist V. Rusin was entrusted with telling the young officers about the peculiarities and rules of carrying out a flight (pattern flight) over the homing radio station. Officer N. Golub gave a lecture and conducted practical studies with the pilots on air navigation by instruments in the clouds and above the clouds. Communist V. Zaytsev gave a lecture on the subject "The Physiological Phenomena of Illusion in Flight and the Fight Against Them."

Specific work was also done with the navigators of the command post and relief flight controllers. Their attention was called to the fact that they had to watch the flights of young pilots and be ready to give them help at any moment.

The center of training and indoctrinational work was in the units, i.e., where the success of flights is decided. Let us take, for example, the element commanded by Zh. Korniyenko which is the best element in the squadron. Here the pilots study practical aerodynamics profoundly and always "rehearse" a flight by sketching the most complex of its elements on the blackboard or on paper.

But the young officers and their subordinates do not live by flights alone. The Communists perfectly know that it is inconceivable to solve problems successfully without purposeful and aggressive work. This is why, along with flight work, the ideological indoctrination of officer cadres is constantly at the center of their attention. They strictly follow the demands of the Twenty-Second Congress of the Party and the decisions of the June Plenum of the CC of the CPSU which have outlined the practical problems of ideological work.

The special concern of commanders, political workers, and Party organizations is the Marxist-Leninist training of the young officers. After studying the interests of the pilots and consulting the commander, political workers G. Zrazhevskiy and B. Zhukov decided to include the young officers in the group for studying the classics of Marxism-Leninism. This subject aroused a lively interest among them for mastering Marxist-Leninist theory.

The Party and Komsomol organizations draw the young officers into active agitation and propaganda work. They regularly give lectures and reports not only on military and technical matters but also widely propagandize the demands of the moral code of the Communist builder.

They also do not forget here to propagandize the glorious combat traiditons of the Soviet Armed Forces. Recently celebrated patriots gave a talk to the personnel. They told about the combat deeds of the partisans. Often a talk is given to the young men by the famous pilot, Twice Hero of the Soviet Union Leonid Ignat'yevich Beda. He tells about the glorious feats of Soviet pilots.

The Party committee and the Party organization of the squadron conduct extensive work in indoctrinating the indoctrinators themselves and imbuing them with a high sense of responsibility for personal exemplariness in service and discipline. These questions were discussed many times by the Party committee and at Party meetings. In accordance with the plan of the deputy commander for political affairs and with the active participation of the Party committee, seminars were conducted with element commanders and group chiefs.

Although there were individual slips and omissions in training and indoctrinating the pilot-engineers and in improving their flight training, neither the commanders nor the Party organization remained indifferent toward these shortcomings. They immediately took the necessary measures and things moved ahead.

The commanders and Party organizations of the unit critically evaluate their successes and shortcomings and concentrate their efforts on carrying out the plans of combat and political training and on training and indoctrinating courageous, able, and ideologically convinced defenders of the aerial borders of our Motherland.

ANOTHER STEP FORWARD

Lt. Col. I. MAKSIMOV

It was crowded in the hall. Assembled were the officers of the entire school for summing up the results of work for the year. The speaker cited many interesting figures in characterizing the work of the collective. Then he named the best subunits.

As regards the results of combat training, first place was again won by the squadron commanded by Lt. Col. Ivan Vasil'yevich Ushakov (the secretary of the Party organization was Capt. Petr Appolinar'yevich Petlevannyy).

It was the fourth straight year that the squadron finished with such high showings and the fourth time that fellow servicemen congratulated Officer I. Ushakov upon his success.

The summer weather did not pamper the pilots. It was often necessary to postpone flights. A lag was noticed in carrying out the plan. How did the team of the foremost squadron and its commander feel? After all, only recently he had been awarded the Order of the Red Star.

If this was a squadron in a line regiment, flights could be continued until the end of the year. But it was a training squadron. Flights had to be made by students who had to pass state examinations early in the fall. This meant that flights could not be put off. This was known by the commander, the officers, and the sergeants.

And, when the weather stabilized, the sky over the airfield began to drone. But the arrears were made up with great difficulty. And then the commander said:

"We shall work in two shifts!"

In the language of students this means flying in the morning and in the evening. So far such a method had not been used in the school. The command of the school approved the undertaking. After this, Ushakov talked with the engineer and the technicians. After all, a heavy burden was placed on the shoulders of the technical personnel. It depended upon them how the aircraft would be serviced for flights.

But such is the nature of men who have learned the force of competition. Each year they outlined new goals and strove toward higher showings. The fact that the best way out of the situation was flights in two shifts had already been discussed in the school. And when the commander announced his decision to the subordinates, he read in their faces a readiness to do everything in order to carry out the plan.

And this is how they worked until the end of the year. The technicians stayed on the parking apron until late, the instructor-pilots themselves prepared for flights, trained the students, analyzed errors, and outlined ways for eliminating them. They wandered from airfield to airfield and flew day and night. The commander saw his subordinates off aloft, met them on the ground, rejoiced at their success, and punished them for negligence.

Very long ago, Ivan Vasil'yevich Ushakov became not only a pilot but also a commander-indoctrinator.

If one counts how many of his pupils are plying the air ocean, the figure will be rather impressive. He saw his students turn into outstanding instructors and detachment commanders.

Systematic work in training and indoctrination helps Lt. Col. Ivan Vasil'yevich Ushakov to study the students comprehensively and determine ways for further improving their skill.
In the photo: Officer I. Ushakov conducts a flight critique.

Photo by A. Kardail'skiy.

It does not seem long since he flew to the zone with Ivan Katsanov, the son of a combat pilot who had died over the approaches to the Caucasus; and today Ivan Katsanov is a lieutenant, serves under his command in the squadron, and will be, just as he is, an instructor pilot.

This is difficult work, especially in the senior year when a cadet is on the verge of entering upon an independent life. By this time, only those stay on who have become accustomed to dreaming about aviation. Failing to teach such a man or help him to correct an error means to arouse a doubt in his heart and undermine his faith. And if Lt. Dmitriy Triputen' is in the ranks of pilots today, he is indebted to Lt. Col. Ushakov and Capt. Zimin, the instructor pilot, for this.

Triputen' came to the flying school straight from secondary school. The Byelorussian lad was attracted by those whom the sky obeys. He began ardently studying aircraft theory. He mastered the first flights without special difficulties. Then the load began growing even heavier. He began flying in another aircraft, but mastered it with great difficulty. He tried, but the results were poor.

During the senior year, when each cadet develops the touch of a true pilot, Ushakov and Zimin noticed that Triputen' did not yet have such a touch. There still was some time left and the commander placed the student under special supervision. After that day he watched each of his flights. And once, when Triputen' taxied in the craft, Ushakov radioed:

"Report to the SKP [flight-line command post]."

Triputen' knew why the commander summoned him — his takeoff was not very neat and he had rounded out too high during landing. But he went to the commander without fear.

"Sit down", Ushakov said and had the student sit so that he could see the airfield.

And he sat and watched his comrades take off and come in for a landing. Ushakov was silent. Then he asked Triputen' to analyze the actions of one of the cadets who had made a landing. Triputen' spoke slowly, choosing the right words in order to explain the error which, in his opinion, the trainee had made.

"And how did you land? Analyze it."

This was no longer a report, but a joint analysis of a flight with consideration of all the details. Triputen' carefully listened to the first-class pilot who had taught all the officers of the squadron, including his own instructor, Capt. Zimin, how to fly. Many times the student heard the rather muffled and calm words: "Why? Explain!". He really became very tired during this unforeseen study session. But he understood many things.

Then the commander called his deputy:

"Mikhail Alekseyevich, make a flight with Triputen'. The three of us must discuss the question of his flight training and give recommendations to the instructor."

Many times Ushakov's deputy went aloft with the student. And then they got together — the commander, the deputy, and the instructor. The conclusion was the same: he could fly, but it was necessary to think what to do so that Triputen' could free himself from tenseness during flight and learn to watch.

"Perhaps I might not have become a pilot", Triputen' says, "if Lt. Col. Ushakov had not aided me and made me trust my abilities. It is true that I thought at first that they began making allowances for me. But when the chairman of the state board gave a five for a flight in the pattern during the examinations, I understood: this meant that I began flying better."

The concerns of Ivan Vasil'yevich do not only include flight training. Developing are crew commanders who must know not only how to fly but also how to indoctrinate subordinates. And this can be done only by those who study and who are disciplined and expeditious.

The commander will not pass by a single wrong step of a subordinate without giving him an evaluation. He knows how to correct a man and do this so that the latter remembers his slip. In this he does not single out men, but equally punishes the mediocre man who has "faults" as well as the squadron beacon who is followed by others.

That is how it was with Vladimir Kovynev. Being an outstanding student and good comrade, Kovynev overstayed his leave in the city without permission while returning from an official mission. The secretary of the Party organization came to the commander to inform him about the occurrence.

"Perhaps it will be enough to have a talk with him, Comrade Lt. Colonel?"

BEYOND THE POLAR CIRCLE

The snow shower gave additional trouble to the subordinates of Capt. D. Lobkov. They keep watch around the clock and reliably support landing safety. Before the beginning of flights, the company commander inspected all the assemblies. But it has begun snowing now. It is necessary to check the operation of the light beacon once more. Together with Junior Sgt. I. Konyukhov (right in the photo), Capt. D. Lobkov is making his usual rounds.

"No. Let us do something so that all the Communists may discuss this case. We shall not spoil Kovynev with this. Instead, everybody will understand that we make allowances for nobody."

And Kovynev had to answer to the Communists. There were some fifty of them in the squadron. All of them knew what roads had been passed by Kovynev into the family of aviators. He was not lucky in the first school: he hurt his leg during a cross-country skiing race, was hospitalized, and fell behind his comrades. Study had to be stopped, but only for a time. He received treatment and became stronger and went back to school. This time he went to the Balashov higher school. And there was not a student in the school who studied so diligently and enjoyed such a reputation among equals and seniors. And, in spite of this, the Communists censured his act strictly. He understood their comradely criticism and advice.

Here are some minor details of the great work done by the collective inspired by creative enthusiasm. Early in the year, it was faced by critical problems — how to train competent and disciplined pilots. They were solved jointly. There was joy when Triputen' began doing well, when Chulkov understood his errors and joined the others, and when the first specialists holding first-class ratings appeared.

They all felt sorry for the first steps of Private Vasil'yev who had a difficult time. At a meeting they strictly punished Officer Khosudovskiy who displayed negligence in checking the equipment. Both joy and sadness were common.

BEYOND THE POLAR CIRCLE

The two are talking animatedly at the other end of the parking apron. Military Pilot First Class Capt. V. Bastrakov (left) is telling Capt. V. Golovin about a target approach. Most of the flight will be over the ocean. And the captain remembers to remind him about this as well. A pilot must be ready for any emergency in flight and only under this condition will he be able to carry out a mission successfully and return to his base safely.

And here are the results of efforts by the collective. The flight program has been carried out completely. The overwhelming majority of students passed their examinations in piloting technique outstandingly. Six of them — Ivanov, Yeliseyev, Timoshkin, Safiulin, Yevdokimov, and Amel'kin — received honors diplomas. Both Kovynev and Shcherbatyuk were awarded gold medals.

Worthy replacements came to the unit. And many good things were brought into the combat teams by the graduates of the school. There was somebody whose example they could follow. Instructor Pilot Yuriy Yakovlevich Mel'nikov is a first-class specialist and a deputy to the city Soviet. The secretary of the Party Bureau, Capt. Petlevannyy, is a Military Navigator First Class. He helps to pilot precise routes not only in the sky but also on the ground in solving the tasks facing the subunit.

Those becoming first-class specialists this year were Maj. L. Zhak, Senior Sgt. V. Afanas'yev, Sgt. V. Ryashin, Junior Sgt. V. Prutovykh, and privates G. Pobudskiy, A. Shuderskiy and N. Kuryat.

There is another remarkable result of the commander's thoughtful work. In the squadron, almost every second officer is a correspondence student. Although it sometimes is difficult for the commander (such an army of correspondence students) he gives every encouragement to those who study. And it will be no exaggeration if one says that study gives much to Ushakov's assistants. They began organizing the training of the students more precisely and their general competence and methodological skill have increased. This is why the squadron has taken a new step forward.

THE COMMANDER'S EXAMPLE

Lt. Col. V. SIVTSOV;
Maj. V. KASHINTSEV

It was a hot day. But then the last aircraft taxied to the parking apron and the flights were over. Lt. Col. V. Radkevich unhurriedly rose from the desk and went to the porch of the command post. A gentle breeze cooled his hot face and put new strength into his body exhausted by the day's work.

A view of the evening airfield was revealed from the porch. This picture had been observed by Vladlen Gavrilovich many times. But today he felt its beauty with particular keenness. This was apparently caused by the flights of young pilots, especially Vladimir Ryzhov. Why Ryzhov! Others also flew outstandingly, but he was the pupil of Capt. Sushko and Vladimir Sushko was the pride of Vladlen Gavrilovich.

"After all, good men have come together in our regiment," Radkevich thought and smiled. It seemed to him previously that such eagles could be found only in his squadron. But when he became the deputy commander of the regiment, he was convinced that other subunits also had masters of the military profession and one only had to know how to find a way into each one's heart.

Let us take the same Vladimir Ryzhov...

...For the second day Capt. Sushko flew "dual" with the young pilot. One flight, another, a third...And each time there was disappointment: each time Ryzhov landed the aircraft with the nose wheel too low. Yet he well knew what had to be done and how. He knew but he still did it wrong.

"What is the reason for this?" he wondered.

Sushko had already determined the sources of the gaps and thought out ways for eliminating them, but he did not tell the pilot about them. He decided to consult his teacher. Last year Lt. Col. Radkevich was awarded the Order of the Red Star for successes in combat and political training and mastering complex combat equipment. ~~He willingly helped element commanders.~~ What advice would he give and would he approve the plan?

"Correct," Vladlen Gavrilovich nodded his head after hearing Sushko out. "Patience and training are the medicines which will cure Ryzhov. Act as always and have a heart-to-heart talk with him without fail. The main thing is that the lad must not lose heart."

BEYOND THE POLAR CIRCLE

It brightened up a little. And the members of the radar station crew took advantage of this. Technician Lt. V. Glebov and Operator First Class Junior Sgt. F. Yakovlev climbed up to the antenna at once. They carefully inspected each joint and stripped off the ice coating: the radar men always remember that their help is needed by the flight personnel. A long polar night. Severe cold. But the men in love with the sky are keeping watch. They are ready at any moment to go aloft in order to block the way of an unbidden aerial guest. The Northern border, just as any other, is under lock and key.

Text by A. Mikhaylov.
Photos by G. Omel'chuk.

There was a frank conversation, additional studies, and training in the aircraft cockpit. After flights in a combat training aircraft and a detailed demonstration of each element of piloting technique, the gap in the young man's training was eliminated. And, knowing this, Radkevich told Capt. Sushko:

"In training a pilot, the instructor must not only strictly observe consistency in the training but must also prevent him from getting stuck in one place."

Vladimir Sushko strictly followed the commander's advice and his method. He taught Ryzhov again, showed him how he should act, had heart-to-heart talks with him, and trained him. While aloft, he always tried to serve as an example for his subordinate and imbue him with confidence in achieving the intended goal just as Vladlen Gavrilovich had done in his time. Let us just recall the night flight when Radkevich intercepted a maneuvering target. After all, the difficulty of this mission was known only to the vectoring post and the pilot...

The fighter rushed along the runway, gathering speed, and passed out of sight in a few seconds. The clouds were so low that the aircraft seemed to enter them without leaving the concrete runway.

After receiving signals from the command post, the interceptor took up the prescribed course. The altimeter needles began moving rapidly. One thousand meters, another... Finally, the prescribed altitude was reached.

There were new signals — a turn to the right, another turn...

"I got an experienced one," Radkevich thought, referring to the "enemy". "Isn't he twisting! Never mind.buddy, you won't get away!"

The interceptor acted precisely according to signals from the ground and soon was within range of effective fire... One second, another... the fighter climbed steeply. The "enemy" was shot down at the prescribed line on the first attack.

That night Radkevich's subordinates acted the same way. All the intercepts were carried out with outstanding scores under the most complex conditions. In a word, Sushko really understood then the meaning of the word "the commander's example".

And then there came the morning long awaited by Vladimir Ryzhov.

"Lt. Ryzhov, make a check flight with Lt. Col. Radkevich," Sushko notified him the night before.

This information gladdened and alerted the lieutenant. Was it not too soon? After all, none of the young men had made a check flight yet.

"Do everything as always," the element commander said to cheer up the lieutenant after noticing his agitation.

He took off, climbed, and approached the zone. The aircraft described aerobatic maneuvers in the air. The examiner sat without saying a word. This worried the young pilot a little. When flying with Capt. Sushko, he always felt the instructor's presence, heard his encouraging voice and curt remarks. But now he heard nothing. It was even strange somehow.

"Go in for a landing," the examiner ordered suddenly.

Ryzhov made a turn and began letting down. The ground came closer and closer. The boundary lights were now in sight. The aircraft gently touched down on the runway. One second, another, and Vladimir smoothly pushed the stick forward.

"You fly well," the lieutenant colonel said. "As a student you would get five from me but as a pilot only four. Fly solo."

After some time, the fighter piloted by Lt. Ryzhov went aloft, climbed, and rapidly flew in the pattern. Lt. Col. Radkevich keenly watched each maneuver of the aircraft. But no help was needed. All of those who watched the flight of this young pilot believed that in time this lad would develop strong wings.

This is how young pilots are trained gradually and at the same time boldly and confidently in all the squadrons. The experience of Lt. Col. Radkevich became the property of the instructor personnel and it helps the aviators to achieve new goals in combat improvement.

In popularizing and adopting foremost experience, an exceptionally important role is played by the Party and the Komsomol organizations. They regularly arrange meetings between first-rate pilots and young men and organize exchange of opinions among instructors on the methodology of studying new aircraft equipment and flight training. Often young pilots also attend such conferences. They carefully listen to their senior comrades, ask questions, and sometimes enter into an argument. And this astonishes nobody but only indicates the good comradely relations between commanders and subordinates.

Military Pilot First Class Lt. Col. V. Radkevich after making an intercept flight.

Let us take this example. Young men had difficulty in studying the GIK-1 [gyro-induction compass]. In principle, everything was clear, but one of the operational questions of the induction compass could not be mastered. Some defended one opinion and others another. Arguments sometimes dragged out into the night. Senior comrades helped them to comprehend everything. They corrected those who were wrong and supported those who were right. The atmosphere of sincerity, efficiency, and friendliness helps the young men to master new equipment and polish their flight skills.

Lt. Col. V. Radkevich (center) and combat comrades are returning from flights.

Photo by M. Ryzhak.

But it is not only in training young men that the experience of first-rate pilots is used. The indoctrination of indoctrinators is a no less complicated skill. And, in order to make it the property of others, Lt. Col. Radkevich spares neither effort nor time. He tells squadron commanders simply and comprehensively about the methodology of training instructors and about the methods of eliminating any particular errors of pilots and element commanders and he helps them work out the most effective forms of training and indoctrinating the flight personnel on the ground and in the air. Systematic work favorably affects the improvement of the methodological training of instructor personnel and, consequently, the quality of combat training among rank-and-file pilots.

By the end of the academic year, the pilots retrained for an aircraft new to them and confidently worked out the elements of combat employment. Now they improve the tactical methods of modern combat and learn what is necessary in war. Experienced pilots did not mark time either, and this was convincingly indicated by the examination which the pilots of the regiment took last autumn.

The personnel of the regiment, particularly the pilots, had to work hard during those days. They assaulted "enemy" ground objectives, intercepted fast-flying and maneuvering targets, and flew day and night. And there was not a single abort of a flight mission. One could set one's watch by the precision with which the aircraft came out on target.

The combat work of the pilots was highly evaluated by the leaders of the exercises. Three combat friends of V. Radkevich — Maj. P. Ilyukhin and captains P. Shkurko and E. Nikitin — were awarded valuable gifts for outstanding actions during the exercises. And this is highly beneficial — after all, they were commanders and a good example by a commander (the experience of Vladlen Gavrilovich Radkevich indicates this convincingly) always exerts a strong impression on the soldiers.

THE RESULTS ARE GRATIFYING

Col. F. VAZHIN

The crews of pilot-engineers Yu. Kramarenko and B. Rassokha took part in exercises for the first time. They recently came to the line unit but they had already managed to receive thorough flight and tactical training there. And now they had to show their skills.

The first to go aloft was the aircraft flown by Military Pilot First Class Capt. G. Krasnov. The element commander carefully watched how the pilot-engineers took up combat formation. Now the bomber piloted by Lt. Kramarenko formated on. He rapidly overtook the leader and approached him slowly. Then the aircraft of Lt. Rassokha took up its position. "Good boys, they are flying well!" Capt. Krasnov thought.

The element continued to climb. There soon appeared clouds spread out in a solid undulating sea under the aircraft. Ground checkpoints were invisible, and this made it difficult to come out on the target.

The bombers were approaching the line where the "enemy" fighters would appear according to the tactical situation.

"Maneuver!" the element commander transmitted and turned his aircraft vigorously.

The wingmen who precisely maintained combat formation followed him relentlessly. The navigators continuously made calculations in order to come on the target precisely.

In carrying out fighter-evasion and missile-evasion maneuvers, the pilots well understood their physical essence and remembered how the commander analyzed theory with them and discussed different versions. For example, it was pointed out that a bomber changes its course by 15 degrees. The young pilots and navigators calculated how this would affect the maneuver of a fighter-interceptor and whether its attack could be foiled. In making their calculations, the officers became convinced of the effectiveness of various maneuvers and they themselves chose the most efficient of them.

Then the element commander flew dual with the crew and showed them how to carry out any particular maneuver. The pilots imitated him. At first they could not conform to the prescribed time norms. The commander explained to what this could lead. He demanded that flight safety measures be observed in carrying out a maneuver. And now the young pilots had to show their combat training in exercises.

The element commander maintained contact with the command post. Suddenly the contact was broken. Krasnov asked Lt. Kramarenko whether he heard the command post clearly.

"I hear well."

"Maintain contact with them. Inform me of all instructions."

"Roger!"

The young pilot excellently coped with this job. He precisely maintained contact with the command post and promptly transmitted all the orders to the element commander.

Meanwhile, the aircraft was approaching the target — an important objective in the combat area. How to find it when the ground surface was covered with overcast? They were helped by their good training for carrying out the flight mission. After receiving the mission, the pilots and the navigators studied the target area and the location of checkpoints in detail. All of this, undoubtedly, helped them come out on it precisely. But according to the mission, in order to deliver a strike, it was still necessary to identify the objective visually. But the element commander was faced with a difficult question: What to do? It was risky to penetrate the clouds: the overcast was low and there were several elevations in this area. However, the crews had studied the ground relief thoroughly. The commander believed in the capabilities of the subordinates. Using a break in the overcast and strictly maintaining combat formation, the bomber element came out on the target and delivered a "strike" against the prescribed objective precisely at the fixed time. The young crews passed a difficult examination. During tactical flight exercises they acted precisely and with tactical competence.

What then ensured the success of the pilot-engineers and navigator-engineers?

One can confidently say that much was derived from actively adopting the experience of senior comrades.

The speeches of foremost officers during the meetings of Outstanding Men and in military theoretical conferences as well as the propagandizing of their experience by the Party organizations and in the press. And, finally, their example has helped to increase the number of Outstanding Men in the unit and has helped to improve combat readiness.

Let us take, for example, the same Capt. Krasnov who took over an element of young crews from Kropachev. For several years now he has served with Kropachev in the same subunit. There was a time when Krasnov was not sufficiently exacting toward subordinates.

But, in watching the work of foremost officers, especially the work of Kropachev, and listening to their advice, Krasnov became ever more convinced that their exactingness, high-principled approach, and the ability to handle men helped to bring the elements into the lead. And, of course, the officer tried to develop in himself the qualities characteristic of the best commanders.

This was particularly noticeable when Krasnov assumed command of the element of young crews.

Of course, at first it was not so simple to work with the trainees of such an experienced element commander as Kropachev. The men unconsciously compared the methodology, working style, and the skill of the former and the new commanders. Krasnov justified the hopes of both the senior commanders and of his subordinates.

On the other hand, it was easy for the new element commander to work with the young pilots and navigators whom Kropachev had imbued with many positive qualities and flight and combat skills.

Capt. Kropachev and then Capt. Krasnov had trained the pilots beforehand for flights under adverse weather conditions.

At first they were given a check flight in a dual and in a cockpit under the hood. The element commander noticed that pilots did not always act as required in these flights. For example, the flaps are supposed to be completely extended over the outer homing beacon. The young pilots extended them sooner in order, supposedly, to simplify subsequent actions.

"Why did you extend the flaps too soon?" Krasnov asked one of the pilots.

"After all, there are normal weather conditions now. What is special about it? If there was overcast — the case would be different."

The element commander explained to the pilots the error of their opinion. The fact is that, in training for flights under adverse weather conditions, they must become accustomed to strict procedures.

After many years a definite training system has been formed in aviation. It must be observed. If, for example, a pilot does not learn to extend the flaps on time, he may forget to do this under adverse weather conditions, and this will complicate landing. It is therefore very important to observe strictly the established procedure which has been confirmed by the experience of many years.

The high level of theoretical training among the pilots and navigator-engineers undoubtedly helps them master the flight training program successfully and act correctly in a complicated situation.

Once the element of Capt. Krasnov went aloft in order to carry out a training mission. The pilots took up their combat formation and came out on the prescribed route. Suddenly an acrid smell appeared in the cockpit of the aircraft piloted by Lt. Kramarenko. "Brake fluid," the officer thought. "But wherefrom?" He immediately remembered the design of the hydraulic system of the aircraft and answered his own question: "From the brake system line which runs through the pilot's cockpit." After making sure that his assumption was correct, the pilot-engineer immediately reported the occurrence to his commander.

Kramarenko was ordered to return to the airfield. It was necessary to land the bomber, but how to do this? After all, the brakes would not operate, and this would make landing difficult.

The pilot decided to use the emergency braking system. As is well known, a pilot's actions here differ from the actions in braking under normal conditons. It is necessary to have certain skills.

Of course, a rather complicated situation was created for the young pilot, but he calmly brought the aircraft out on the landing course and estimated his landing precisely. His further actions were based on a good knowledge of practical aerodynamics. During the roll he manipulated the control wheel so as to prevent the aircraft nose from dropping as long as possible. This helped to achieve more rapid braking of the aircraft and made it possible, in combination with using the emergency brakes, to shorten the ground run. Thus, the pilot coped with a landing under complicated conditions.

An intercept

Photo by G. Omel'chuk

The crews of young pilots Kramarenko and Rassokha already fly in the day with higher weather minimums and at night under normal weather conditions. They successfully master the program of training for the second-class rating.

During a rally of Outstanding Men in Combat and Political Training, Lt. Kramarenko said: "We, the young officers, have somebody to learn from. We particularly wish to point out the great help rendered by captains Kropachev, Krasnov and others." And, perhaps, one may add to this: there is somebody here whose example young pilots can follow.

Let us just take one of the recent stories of Capt. Kropachev during exercises.

The crew received a difficult mission: in a prescribed quadrant of the sea it was necessary to find an "enemy" ship and deliver a strike against it. It was rather difficult to do this at night, especially in the absence of radar checkpoints on the open sea. It was very important to come out precisely on the prescribed point and set up a maneuver for target search correctly.

The pilot confidently flew the jet bomber to the prescribed quadrant. The radar searched the dark surface of the sea inch by inch. But suddenly there came a command from the command post revectoring the bomber. Probably a more important target had appeared in another quadrant. The route had to be changed. Capt. Klimenko quickly gave the pilot a new course and calculated a maneuver for searching for the "enemy" ship.

The crew watched the airspace carefully. They took into account the fact that the "enemy" might send fighters to intercept the bomber. Indeed, they soon discovered the appearance of "enemy" fighters.

The bomber made a vigorous turn, carrying out a fighter-evasion maneuver in heading and altitude. The timely discovery of the fighters made it possible to evade an attack. Meanwhile, the bomber crew persistently piloted the aircraft to the target at an altitude at which it was now difficult to revector the fighters.

Then there appeared the prescribed quadrant. With the aid of the radar, the navigator scanned the surface of the sea. A characteristic blip glowed on the screen. No doubt — it was the target. Then the bomber was on the combat course. On the first approach, as was later shown by the interpreted film, a precise and lethal strike was made.

This flight confirmed the fact that Capt. Kropachev continued to be in the ranks of foremost officers and masters of bomb strikes. Last year he was promoted he became the deputy commander of the squadron.

The active propagandizing of the experience of foremost officers of the unit — particularly Kropachev and Perlifonov who were honored with government awards — produced results. Many other crews, elements, and even squadrons became Outstanding. Among the foremost ones was also the crew of Pilot-Engineer Lt. Kramarenko.

The results of the academic year have been summed up. They gratify commanders, political workers, and all the soldiers of the unit. But the aviators understand that on the basis of the experience of foremost men one can achieve even further successes in improving combat skill and combat readiness.

WHEN THERE IS FIRM COMBAT FRIENDSHIP

Capt. V. Pilyay's service in the new subunit began with difficulties for him. In starting the engines during night flights he forgot to move the "Maximum Afterburner" switch. As a result one engine stalled at the moment of increasing the rpm in taxiing.

The error of the new comrade alarmed the pilots of the squadron. It was discussed during a flight critique and at a Party meeting. There was the same opinion: Capt. Pilyay had neglected training in the aircraft cockpit. And this was a serious violation of the established procedure. So they punished the new officer in full measure. But they did not limit themselves to this. They worked hard with Officer Pilyay and he constantly felt the support of his comrades and found strength in this.

A high level of Party principle distinguishes the pilots of the squadron which was commanded by Maj. A. Belous until recently. They are not afraid to mention to a comrade's face his shortcomings and they constantly fight for the quality and outstanding showings of each aviator.

The flight and technical personnel have high class ratings. The aviators have successfully mastered the new combat craft and have been flying without accidents for several years. There seems to be something to take pride in. They take pride but do not become conceited. And those who become dizzy with glory are promptly shown their shortcomiggs and helped to eliminate them.

The commander and the Party organization fight resolutely against signs of conceit, complacency, and self-satisfaction. Characteristic in this respect is the case of Capt. F. Khabirov who is one of the best interceptor pilots in the unit. Once, on the day of preliminary preparation, he did not come to the airfield for training in the aircraft cockpit. For his lack of discipline he was grounded by the element commander. Officer Khabirov took it very hard. But he himself was at fault, and he did not seek sympathy among his comrades, knowing full well that they would not support him.

Much work also had to be done with Capt. R. Bulygin at one time. Being a capable and well-trained pilot, he sometimes displayed a careless attitude toward the advice of more experienced comrades and relied on his old knowledge. And this could not but affect flight work.

Once Bulygin could not intercept a target on time. After landing, he tried to blame the command post. However, it was discovered during a careful analysis of the intercept diagram that the CP controller had acted correctly. The error was made by the pilot himself. Instead of a prescribed 30° bank he maintained a 45° bank and came out inside the turn on a course parallel with the target. It is true that he overtook the target and, judging by the film, had "destroyed" it, but time was lost.

It was here that Capt. Bulygin was made to pay for all his slips. There was a frank conversation. And the most remarkable thing is the fact that the comrades themselves and not others censured him for his conceit and overconfidence.

It does credit to Bulygin that he benefited by the criticism. He began care~~fully training for flights~~ and devoting much attention to training. And the element commander and all the Communists carefully watched his actions, since they knew that only truly high exactingness would help Bulygin to win back his good name and become an outstanding pilot.

One of the distinguishing features of the squadron is firm friendship among pilots and technicians. Pilots speak with great warmth about Senior Technician Lt. A. Sakharov. Being a first-rate specialist, he knows the aircraft to perfection and is always ready to share his experience.

Now a few words about exchanging experience. During the period of mastering new aircraft, they conducted discussions about piloting the aircraft at high speeds and altitudes, on intercepting targets at low altitude day and night, and on flying in the clouds with large bank and pitch angles. The leaders of such studies are the best-trained pilots like A. Staforkin, A. Belous, and others.

The squadron commander and all the Communists are trying to use every opportunity to improve the technical competence of the pilots. The aircraft is mainly studied on the airfield. And such a method gives good results. Pilots A. Komolov, D. Sudin, and others have taken tests for the right to service an aircraft for a repeat flight independently.

Special concern is displayed in the squadron for the ideological training of the officer personnel. Many pilots and technicians study in the evening University of Marxism-Leninism and constantly watch for new things in political and technical literature and belles-lettres, while the commander himself sets an example. He ~~completed his first course with~~ outstanding grades in all subjects.

No single cause of a flight accident and no error escapes the action of the commander and the community of the squadron. They well understand here that an unprincipled and liberal attitude toward men committing offenses does great damage to the cause of supporting flight safety.

For more than ten years there has been no flight accident through the fault of the flight personnel of the squadron, which is considered one of the best in the group. Three officers of the squadron, Aleksandr Galaktionovich Belous, Aleksandr Stepanovich Staforkin, and Nikolay Vasil'yevich Gur'yev were awarded the Order of the Red Star by order of the Presidium of the Supreme Soviet of the USSR for outstanding showings in combat and political training and for successfully mastering new complex combat equipment.

The firm combat friendship, the mutual aid, and the highly principled approach of the Communists as well as their creativeness and daring — this is what has enabled the squadron to become foremost.

Lt. Col. V. YABLONOVSKIY.

AERIAL COMBAT BETWEEN FIGHTERS

Col. A. DUBOVITSKIY

The continuous process of development and improvement in aircraft inevitably brings about a change in the methods of fighter combat employment in aerial combat. Partial and unobstrusive at first, these changes accumulate gradually and, in time, begin displacing habitual combat methods, putting in their places new and progressive methods of winning a victory over an aerial enemy.

During the last decade, fighter aviation was equipped with supersonic aircraft armed with guided missiles and radioelectronic facilities for searching and aiming. Simultaneously, the technical facilities for flight, communication, and radiotechnical support were improved. The processes of fighter control and vectoring from command posts became automatic. The precision and effectiveness of fighter strikes increased many times. All of this created material prerequisites for radical changes in the nature of aerial combat.

Briefly speaking, the main tendencies in the development of forms of aerial combat are the following: the group conducting a combat simultaneously is reduced in number, the maneuver of the attacking fighters becomes "straighter", and the importance of the first attack which terminates combat in the majority of cases becomes greater.

In actions against an individual or group aerial target in recent times commanders tried to bring into combat several fighters acting coordinately. This was explained by the comparatively low effectiveness of strikes by our aircraft armed with cannon and machineguns. The probability of an enemy bomber's being shot down with two or three bursts amounted to 0.1-0.2.

Naturally, in order to guarantee the destruction of an aerial target, it was necessary to detail two or four, or sometimes even more, of our fighters against each target aircraft. And if one considers the fact that an aerial enemy armed with conventional ammunition of low effectiveness had to act against target objectives with large numbers of aircraft flying in close combat formations of subunits and even units, one will fully understand why fighters had to conduct combat in large groups, simultaneously attacking aerial targets in a limited air space.

The effectiveness of such attacks was ensured by the comparatively low flight speeds which in turn enabled the fighters to divert their strikes from one target to another, change flight direction within wide ranges depending on the situation, rapidly concentrate power in the necessary range of space while reinforcing the striking groups, or, contrariwise, take fighters from the striking groups and include them in cover and reserve groups.

The necessity of dividing the fighters into groups of various tactical designation was dictated by the slow tempo of aerial combat, during which the situation changed many times. The sides were able to bring into combat fresh fighter crews which alternately changed the correlation of forces. The striking group attacking bombers needed support: the enemy fighters tried to counterattack our aircraft, the maneuver of which was contained at this moment. In order to repulse such counterattacks, a considerable number of our fighters was detailed to the cover group playing the role of a "shield", while the striking group played the role of a striking "sword".

The commander who was within the fighter combat formations directly controlled the aerial combat, allotted the targets, indicated the attack directions, changed the number of groups and the reserve, concentrated the forces in decisive strike directions, and organized the repulsing of the counterattacking enemy fighters. Of course the commander could do all this only due to the fact that he was personally able to observe the situation in the area of the aerial combat which was confined to a comparatively small area of space. However, if individual fighter groups moved beyond the limits of visual contact with one another during combat, the combat broke down into several focal points. In each of these there was established a separate system of coordination among groups and crews, the actions of which were organized and directed by one of the subunit commanders who assumed the initiative in directing the combat.

At the focal points, combat was organized on the same tactical principles; i. e., no matter how small the fighter group, it was invariably divided into aircraft of the striking group and those of the cover group — into the "sword" and the "shield". This principle applied down to a pair, where the leader attacked and the wingman covered.

Evidently, fighters will also have to carry out combat missions under present-day conditions in large compositions of forces; but these actions will be developed over a vast area.

Now aircraft (missile-carrying bombers and fighter-bombers) carrying powerful nuclear means of destruction do not need to concentrate their forces in order to destroy one specific target. And, although in order to overcome the counteraction of fighters it would seem more advantageous to enlarge the combat formations, this would actually increase the probability of losses from the fire of AA guided missiles — especially those with nuclear warheads. These contradictions finally lead to the fact that the aircraft crews of strike aviation in the majority of cases will apparently have to act in extended combat formations, echeloned in altitude and dispersed in depth, and proceed to targets individually and in small groups along various routes and at different altitudes.

Taking this into consideration and bearing in mind the fact that the probability of a target's being hit by one missile-carrying fighter has now increased several times, we should expect the fighters to be in turn forced to conduct aerial combat by individual crews, pairs, and elements, instead of in large groups.

Above all, we see here the influence upon the tactics of fighter aviation of the revolution in military science which was brought about by equipping all the branches of the Armed Forces with missile and nuclear weapons.

Thus, present-day aerial combat will be, in all probability, a combat of crews, pairs, and elements. However, this is only the first and purely outward characteristic of present-day combat.

Communist Boris Kindeyev, Military Pilot First Class, serves as an example in carrying out one's military duty.

Photo by D. Petryayev.

As has already been indicated, the second tendency of development in the forms of aerial combat lies in reducing curvatures in the maneuvers of attacking fighters. This directly follows from the simple relation between the turn radius and the flight speed. As is well known, the radius is directly proportional to the square of the speed, i.e., if the flight speed increases threefold, the turn radius with the same g-load will increase ninefold. And this leads to the "straightening" of the maneuvers of fighters in aerial combat.

At supersonic flight speeds, one can no longer expect an aerial combat to be, as previously, in the nature of a complex interlacing of curvilinear paths of vigorously maneuvering aircraft, alternately shooting at each other at short ranges, converging and diverging in horizontal, vertical, and the so-called "oblique" maneuvers, the scope of which is commensurate with the visual contact range of an aerial target.

Outwardly, the picture of present-day combat looks quite different. An enemy aircraft proceeding towards a target will have, as a rule, a flight speed close to the maximum. After the target has been spotted by radar facilities, a command is given from the CP to send an interceptor aloft. Simultaneously, the command post crew feeds the initial data into electronic computers which automatically calculate the flight regime and profile of the intercepting fighter and send the appropriate commands to the pilot.

Any changes in the flight regime of a target, including those in carrying out a deliberate maneuver for vectoring evasion, are immediately taken into account by radar station operators and fed to the computers which automatically correct the calculated data, and definitized commands are sent to the interceptor.

The task of the interceptor crew consists of strictly maintaining the flight program assigned by the CP, spotting the target with the aid of the airborne radar, switching promptly to automatic tracking of the target, approaching it to within a distance at which the target can be "acquired", and launching the missiles .

This process, which is simple at first glance, includes target search as well as such classical elements of aerial combat as closing in and attack.

Strictly speaking, one can argue that aerial combat consists of the same ~~stages as previously and that~~ nothing seems to have changed. However, the fact is that the accepted concept of "aerial combat" includes closing with a spotted target and not simply an attack but one or several attacks and maneuvers between them. This is exactly where the essence of the matter lies.

It is most characteristic of a subsonic cannon-armed fighter to make several attacks in combat while vigorously maneuvering between attacks.

And if we take a supersonic missile-carrying fighter, it will be a typical picture for it to complete a combat with the first attack. It is the only possible one in the majority of cases, since the fighter has, as is well known, a limited missile reserve and, in order to make a repeat target approach, the aircraft will have to maneuver with a turn radius measured in many kilometers. During this maneuver the pilot will inevitably lose the target and will have to be re-vectored; i. e. , it will be necessary to vector the fighter into an engagement which will be characterized by entirely new parameters.

Thus, aerial combat is reduced to a strictly regulated flight by a fighter on an intercept which is completed, as a rule, with a "dagger" thrust, the trajectory of which is close to that of a straight line. After launching the missiles, the fighter is no longer bound to the target and is free to choose a maneuver for withdrawing from the attack.

Under these conditions, an attacking fighter will apparently not have to be covered, since its possible enemy can only be a supersonic fighter also armed with missiles which are used, as a rule, at ranges exceeding the range of optical visi~~bility. If we wanted to give~~ the attacker a "shield" in the form of a second fighter,

"Military Pilot First Class A. Zakharyan is not a member of the combat crew of the squadron. But he is our frequent guest. Today he is checking our piloting technique. For us, the pilots, Lt. Col. A. Zakharyan has long become a kind mentor and a dear and intimate man", Senior Lt. G. Kopylov writes to the editors.

Photo by A. Grigor'yev

he would have to fly behind his "wingman" at a distance twice exceeding the range of missile launching. Any group flight with such a distance between fighters is, in our opinion, out of the question. The "wingman" aircraft will need to be vectored from the ground just as much as the "leader". Consequently, if there is a necessity to repulse enemy attacks against the attacking fighter, this will apparently not be decided by covering in the usual sense of the word,but by fighter-evasion support of our fighters.

Thus we have traced all the three tendencies in the development of forms of combat discussed above: reduction in the number of fighter groups down to an individual crew, the "straightening" of the maneuver into a rectilinear maneuver, and the role of the first attack which has become the only possible attack in the majority of cases.

Let us consider how all this has affected the general principles of conducting aerial combat which should include the offensive nature of the actions of fighters and the decisive role of the element of surprise and tactical teamwork.

Let us immediately point out that these main principles remain unchanged and will evidently exist as long as fighter aviation itself does.

It is well known that, regardless of the mission being carried out and the situation, aerial combat of fighters is always of a highly pronounced offensive nature. After all, fighters are intended for destroying an aerial enemy. Their high performance data in speed, rate of climb, and flight altitude are needed in order to "get" to the enemy , overtake him, and destroy him in a swift attack.

Under present-day conditions, when combat by a pair and the dogfight are typical for fighters, the necessity of active aggressive actions acquires paramount importance and makes increased demands on the indoctrination and training of a pilot who must be capable of destroying a wily and perfidious aerial enemy in single combat by himself. For this purpose, a fighter pilot must possess an unbending will for victory and a constant desire to seize the initiative. The cultivation of an aggressive spirit and initiative is a lengthy process. The entire daily work with the flight personnel must pursue this aim. One must subordinate to it the political and combat training of a pilot and the entire system of his training and indoctrination.

The second principle is the element of surprise as the most important condition for success in aerial combat.

This principle has lately often been called into question. Some pilots feel that, under the conditions of the bilateral use of radioelectronic facilities in spotting and vectoring, the element of surprise is practically unattainable and there is no sense, they say, to devote to it as much attention as it deserved previously.

Of course, if one considers the element of surprise as simply concealing from the enemy the fact of a forthcoming attack against him, it is really very difficult to achieve this. But, after all, the concept of surprise is considerably broader.

In the broad sense of the word, surprise is achieved by a high level of combat readiness of fighters and their capability of delivering an immediate strike against a spotted enemy. The shorter the interval between the spotting of the aerial target and the delivery of the strike against it, the more difficult it will be for the enemy to grasp the situation, evaluate it correctly, and organize effective counteractions. The time can be reduced by closing in swiftly and attacking. However, one cannot count on surprise alone, since, if the enemy has been warned of approaching fighters, he will be able to put up organized counteraction and foil the attack. In such cases, the most reliable method of achieving the element of surprise is to use tactical methods not anticipated by the enemy.

Consequently, even in cases when the crews of enemy aircraft know that they will be attacked by fighters after some time, the latter still have a chance for a surprise attack. Therefore, regardless of the conditions of an aerial combat and changes in its nature, the element of surprise still remains the surest and the shortest road to achieving victory in aerial combat.

The third principle of conducting aerial combat is tactical teamwork between the crews of the fighters carrying out a group attack.

The necessity of attacking by fighters in a pair and sometimes in an element may arise in a number of cases. First of all, a group attack is necessary in actions against several aircraft proceeding to the target in a combat formation with visual contact between the crews.

Often, a fighter pair can be sent, in our opinion, against a single target — for example a reconnaissance aircraft, the destruction of which must be guaranteed with a probability close to unity.

It is well known that fighters used to use three types of group attack: simultaneous, successive, and alternate.

In our opinion, simultaneous attacks by a pair or element can be used under present-day conditions as well. In this case, fighter crews conduct fire against targets practically at the same time, while each pilot aims independently and the crews launch missiles upon securing the most favorable conditions for destroying a target, regardless of the actions of neighboring crews.

Simultaneous attacks are possible from one or various directions. Attacks from one direction are usually made only in cases when it is possible to assign to each pilot a separate target in the combat formation of the aircraft on the other side and thereby prevent the attackers from getting in each other's way.

It is clear that simultaneous attacks have their advantages. They make it possible to destroy aerial targets within short time limits as well as to demoralize the crews being attacked and force them to scatter their defensive fire among several fighters. This lowers their effectiveness.

During successive attacks, one achieves more favorable conditions for aiming and launching missiles at a maximum flight speed.

Besides, successive attacks mostly correspond to fighter combat formations which are narrow in front and extended in depth.

Alternate attacks were usually used in the area of aerial combat in the presence of enemy fighters not engaged in combat and being really able to attack our aircraft at the time of the latter's attack. Under these conditions, one aircraft (pair) attacked a target, while the other aircraft (pair) maneuvered in the combat area, covering the attacker. If the target was not shot down by the first fighter and if the second (covering aircraft) was not engaged in combat with enemy fighters, the second, in turn, attacked the same target, while the first attacking fighter maneuvered in the endangered direction at this time.

As follows from the conclusions drawn in examining the "shield" and the "sword" tactics, alternate attacks are possible and expedient in cases when aerial combat is conducted at relatively low speeds, in a limited space, and for a comparatively long time and when the fighters are armed with means of destruction for close combat.

When flying at supersonic speeds in fighters armed with missiles, one no longer can count on the recurrence of identical situations in combat. Under such conditions, it will hardly be advantageous to use alternate attacks.

Thus, the development of forms of aerial combat proceeds along the road of reducing the composition of fighter groups simultaneously taking part in a combat limited in place, time, and objectives.

Let us take limitation in place. It should be understood in the sense that basic aerial combat is conducted in a space, the volume of which in all three dimensions is measured in magnitudes not exceeding the range of visual or instrument observation.

The limitation in time presupposes a combat, the duration of which does not exceed the total time necessary for a fighter (pair or element) for closing in with a target and attacking it.

In speaking about the limitation in objectives, we have in mind an aerial combat which has been begun for destroying a given single or group target consisting of aircraft, the crews of which can see each other.

All of these limitations are arbitrary to a certain extent. They are needed only in order to distinguish basic aerial combat from combat actions which can be conducted by large fighter forces for a long time over a wide front.

The second direction in the development of forms of aerial combat is the definitely pronounced tendency for "straightening out" fighter maneuvers in closing with a target and attacking it. At supersonic flight speeds a fighter maneuver in aerial combat can no longer look like a paper streamer tossed aloft.

Finally, the third direction in the change of forms of aerial combat consists in the decisive importance of the first attack.

~~In spite of all these~~ radical changes in the forms of aerial combat for present-day fighters, the most important tactical principles, such as the aggressive nature of actions, the decisive role of a surprise attack against an aerial enemy, and precise teamwork among the crews conducting a group attack, remain firm.

FIRING MISSILES against GROUND TARGETS

Lt. Col. G. VASIL'YEV;
Capt. Zh. TOKAR',
Military Pilots First Class.

Before the pilots began mastering missile attacks against ground targets, they, as usual, had studied the appropriate publications. In these it is explained in detail how to carry out a maneuver, approach a target, etc. At first, everything seemed to be clear and understandable.

However, as it often happens, difficulties were encountered in practice. Not everything went well with the pilots at first and they made errors for the most diverse reasons. When we began analyzing these errors, we saw that they mainly amounted to imprecisions in setting up a maneuver and in aiming.

Just as in an attack with the use of other weapons, it was very important here to set up a maneuver precisely; but apparently certain pilots either did not attach due importance to this or could not achieve the necessary results for various reasons.

In either case, certain pilots encountered difficulties in setting up a maneuver during training flights and this undoubtedly made it difficult to carry out other attack elements.

What is the aim of a maneuver? First of all, it involves coming out on the point of beginning the dive with sufficient precision at the prescribed altitude and speed. If a pilot observes these conditions, he will later find it easier to dive at a target and come out on the point of missile launching.

One must particularly try to begin the third turn in good time. This moment can be determined in different ways. At first, it is best to begin the turn 30 seconds after passing abreast of the target, providing, of course, the speed is maintained precisely. At the moment of beginning the turn, one must note the position of the target relative to the aircraft. When all the parameters are maintained precisely, the target will approach the wing's leading edge near the aerodynamic fin. Thereafter, after the appropriate skills are acquired, it is expedient to put an aircraft into a turn, orienting oneself by these signs.

The third and the fourth turns must be made as one in order to come out on the combat course precisely. When a pilot is late in beginning the third turn, he has to make it at a great angle and this complicates his actions during the fourth turn. Besides, target visibility deteriorates due to the long range.

Military Pilot First Class Yu. Kartenichev is a master of aerial gunnery. He successfully passes on his experience and knowledge to the flight personnel of the unit.

Photo by V. Bershov.

Experience shows that a pilot's visual estimation is of exceptional importance in setting up a maneuver. In the course of the entire maneuver, the pilot must determine his position relative to the target or characteristics checkpoints in order to make a correction when necessary by increasing or decreasing the bank angle or angle of the turn. This is particularly important in a wind which must be taken into consideration without fail when making corrections in the maneuver.

However, visual estimation must be based on precise calculation. Beforehand, while on the ground, the pilot must calculate how the wind will affect aircraft deviation from the prescribed track with any particular wind velocity and direction. And, in setting up a maneuver during flight, it is necessary to take these deviations into account. Orientation, especially over unfamiliar terrain, is best done in relation to the position of various aircraft components relative to the target or characteristic ground objects. A pilot must constantly polish his visual estimation skills during each flight.

The setting up of a maneuver is also affected by precision in coming out on the target. In order to reduce the time of stay in the area of its location, one can come out for the second and third turn at once, choosing the characteristic checkpoint at the necessary range from the target, fly from the second to the third turn so that the target moves to the wing's leading edge near the aerodynamic fin, and make the third turn precisely with the prescribed angle and a 50-degree bank.

The last turn is the critical stage in setting up a maneuver, since it ends with an approach to the point of beginning the dive. It is well known that we recommend that the fourth turn be made with a bank of up to 45° and with the first half in the horizontal plane, followed by aircraft entry into the dive. Here the pilot first brings the "birdie" to the target and then lines it up with the latter.

When, however, a pilot is obliged to make the last turn with a large bank or even with a negative g-load in order to superimpose the "birdie" on the target in entering the dive, he pushes the control stick forward, which causes overcontrol of the aircraft and makes aiming difficult. Such an error was made by one of the authors of this article during checkout flights. After analyzing its causes, the commanders advised beginning the third turn at the proper time and maintaining parameters precisely. In the future this error was eliminated and this facilitated aiming and improved launching precision.

A few words now about maintaining altitude. If it is too great at the point of beginning entry into the dive, one has to dive with a large angle. In this case, the speed increases more rapidly and one may be short of time in aiming and tracking. Besides, when the flight speed is higher than the prescribed speed, it is more difficult to keep the "birdie" on the target. One has to exert great efforts and the aircraft begins to "yaw". When beginning to dive at too low an altitude, the pilot's dive angle will be smaller than the prescribed angle, which will affect the launching precision and complicate ~~his actions.~~

In setting up a maneuver, it is no less important to come out on the combat course precisely. Thus, for example, Military Pilot First Class I. Peshchur hurried in one of the training flights to make the last turn and came out at an angle to the combat course. Of course, this led to deviation of the "missiles" from the target.

Thus the precision of a fighter in making a maneuver to attack ground targets with the use of missiles is one of the conditions of success.

Another no less important factor affecting the precision of attack is aiming. It is done easier by maintaining the prescribed angle and dive speed. But sometimes the "birdie" is not superimposed precisely at the moment of launching. It is here that inexperienced pilots make errors. In trying to correct the situation at the last moment, they abruptly operate the controls, turning the aircraft vigorously. This makes things even more difficult and may lead to failure in aiming.

Experience shows that if the "birdie" is not superimposed on the target precisely at the moment of launching, one must ignore this and launch the missile in any case. And when it begins moving steadily, one must smoothly bring the "birdie" to the target.

It seems to certain pilots that a missile deviates widely after being launched. Therefore they try to correct the situation by close piloting of the aircraft. As a result, the aircraft becomes "overcontrolled", aiming is made difficult, and the missile deviates from the target. Experience shows that one cannot "chase" the missile. One must only keep the "birdie" precisely on the target, especially at the last moment of ~~attack. Then the target will be~~ hit without fail.

In a missile attack, we particularly wish to emphasize the necessity of flying the aircraft precisely and, so to say, coordinately. The fact is that abrupt corrective turns and uncoordinated movements of the controls complicate the pilot's actions to such an extent that they may lead to failure of precision attack. Experience shows that pilots who fly their aircraft skillfully as a rule hit targets with missiles accurately. Let us take, for example, Military Pilot First Class V. Spiridonov. After mastering aircraft piloting to perfection, he correctly sets up his attack maneuver, aims precisely, and delivers accurate strikes.

One of the peculiarities of a missile attack is the mandatory timing in aiming. When all the maneuver parameters have been observed precisely, the aiming and recovery from the attack end at the prescribed altitude. This guarantees flight safety. When the prescribed time is not maintained in aiming and recovery from attack, the missile will wander from the target. This is what happened to Pilot A. Volkov in his first flight. He hurried to recover the aircraft from the dive and, as a result, the missile did not hit the target.

We carefully analyzed and found the causes of errors made by the pilots in attacks against ground targets with the use of missiles. Experience was accumulated gradually and skills were improved and consolidated. Now many pilots have become true masters of missile strikes against ground targets.

MAXIMUM SPEED in a GROUP INTERCEPT

Lt. Col. V. BARABANOV, Candidate of Military Sciences;
Engineer Lt. Col. V. ROMASEVICH, Candidate of Technical Sciences.

Present-day aircraft are, as we know, capable of flying at various altitudes, from the minimum to stratospheric. And they are not only capable of flying here but also of conducting combat operations within this altitude range both individually and in group.

In the course of carrying out aviation missions it is necessary to overcome the AA defense system of the enemy. For this purpose we must choose, in the appropriate manner, various altitudes and maximum speeds. The use of maximum speeds, especially in group flights and at low altitudes, has unique peculiarities. Thus, the speed of aircraft at low altitudes is limited by their strength, determined by the maximum permissible velocities of the dynamic head q. These limitations in the case of fighter aircraft of different types are approximately of the same value. Therefore, their maximal flight speeds at low altitudes are also almost the same.

Under such conditions even a slight excess of speed of the order of 30-50 km/hr is of essential significance for the achievement of success in intercepting aerial targets, especially group targets.

In order to intercept a group aerial target it is also necessary to send aloft a group of fighters. We know, however, that the maximum speed of group flight is noticeably lower than the maximum speed of a single aircraft, since each leader-wingman pair necessitates a reduction in the maximum speed of the group by 2-4%.

In Fig. 1, which shows the maximum flight speed as a function of the numerical makeup of the group, we see that in certain cases — for example, in pursuing an enemy flying at maximum speed — it is very difficult to execute a group attack.

If the target flies at low altitude, then the aircraft in the group must fly slightly above (or slightly below) each other. This leads to a reduction in the maximum speed of an element in the wedge combat formation (with two pair units) of 4-8% or of

6-12% during flight in a combat formation of a bearing of aircraft (with three pair units).

Therefore, it is necessary to apply creatively the various tactical methods involving the use of maximum flight speeds in the group makeup. These methods are determined above all by the specific flight conditions of the group of enemy aircraft and the group of fighter interceptors.

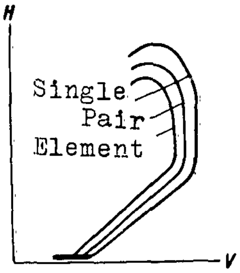


Fig. 1. Maximum flight speed as function of group composition.

At the same time, during interception of such a target, especially over friendly territory, there is no great necessity for the whole group of fighters to fly at the same altitude. However, stacking in altitude provides for the wingmen flying with an upward altitude differential of ΔH a speed excess of ΔV which is required for maintaining the combat formation (Fig. 2). As a result, the maximum speed of the attacking group does not drop and may, in effect, be equal to the maximum speed of a single aircraft. This is explained by the increase in true speed (with a constant dynamic head q) as the flight altitude increases. Also shown in Fig. 2 are these relationships with definite values of the maximum permissible dynamic head.

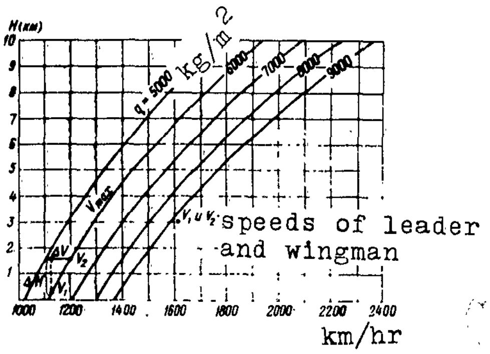


Fig. 2. Determining the speed excess which allows the wingman to maintain the combat formation.

Moreover, such stacking of the wingmen facilitates observation from the ground of the location of the group and its rough vectoring through the use of radar facilities.

It is not difficult to determine the required excess in altitude ΔH of the wingmen over the leaders. We can assume that, up to an altitude of 5 km, the air density changes almost linearly:

$$\rho_H = 0.125 - 0.01 \cdot H \text{ (km)}.$$

Then the magnitude ΔH, when the dynamic heads are equal, is determined by the formula:

$$\Delta H = 12.5 \left(1 - \frac{1}{a^2}\right) + H_1 \left(\frac{1}{a^2} - 1\right), \qquad (1)$$

where $a = \frac{V_1}{V_2}$, the given ratio between the true maximum flight speeds of the wingmen V_2 and of the leader V_1, must be greater than unity; and H_1 is the flight altitude of the leader.

As we see, the flight speed of the leader does not affect the excess in altitude, since the ratio between the true speeds with a constant dynamic head depends only on the ratio of air densities at different altitudes.

In Fig. 3 are shown the optimum altitude excesses of the wingman over the leader corresponding to their true speeds. We can see in the figure that, when the leader flies near the ground, the wingman, in order to have a speed reserve of, for example, 6%, must fly at an altitude of about 1200 m. The altitude excess required for such a speed reserve decreases somewhat as the flight altitude of the leader increases.

As we know, a speed reserve in itself does not determine the flight conditions in the formation. In group flight of importance also is good speed pickup, i. e., an acceleration reserve about equal to 4-6% which actually also determines the reduction in the maximum speed of group flight and its non-uniformity with respect to altitudes (see Fig. 1). At high altitudes, where maximum speeds are often limited by engine thrust, this reduction amounts to 8-10% and more. But at low altitudes, where the acceleration reserve is quite high and the maximum speed is limited mainly by aircraft strength, a maximum speed reserve of 2-3% is quite feasible. As we see in Fig. 3, an altitude excess of the wingman of 500-700 m in this case guarantees an adequate speed reserve in rectilinear flight.

However, during an intercept and especially during the search, the leader must maneuver quite widely and the wingman will sometimes be late in making his own maneuver; as a result, he will not always follow precisely the maneuver of the leader.

We must consider that the track of the wingman as compared with the track of the leader is increased during maneuvering because of the additional maneuvers he must make in order to maintain the combat formation (Fig. 4). In order that the wingman does not lag behind the leader, their speed ratio, as shown in Fig. 4, must satisfy the equation:

$$\frac{V_2}{V_1} = \frac{\phi + A}{\sin\phi + A\cos\phi}, \tag{2}$$

where $A = \frac{4.9 t_{rect} \cdot \tan\gamma}{V_2}$; t_{rect} is the time of rectilinear flight between corrective turns by the wingman; γ is the bank angle during corrective turns; and ϕ is the maximum difference between the courses of the leader and the wingman during corrective turns.

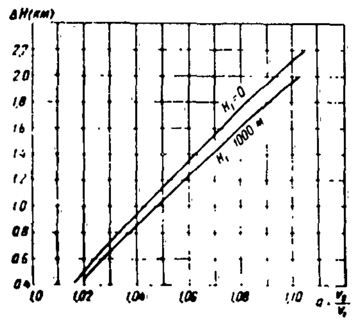


Fig. 3. Optimum altitude excesses of wingman over leader corresponding to their true flight speeds.

Since the time of retilinear flight t_{rect} usually does not exceed 3-5 seconds, the magnitude A is also small. Under these conditions, as we see in formula (2), the required speed excess for the wingman mainly depends on the possible difference in courses during turnaways in the maneuvering process.

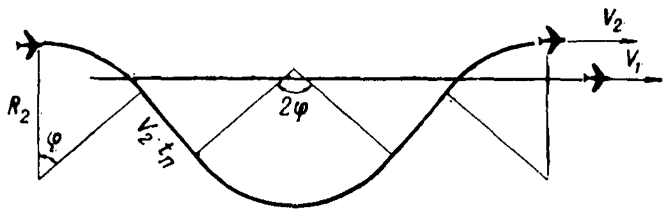


Fig. 4. Tracks of wingman and leader during maneuvering.

In Fig. 5. We see the speed of the wingman as a function of the speed of the leader when there is a difference between the courses during maneuvering $\alpha = 15^{\circ}$ and 30°, as well as the required excess in altitude of V_2 over V_1. With turnaways of

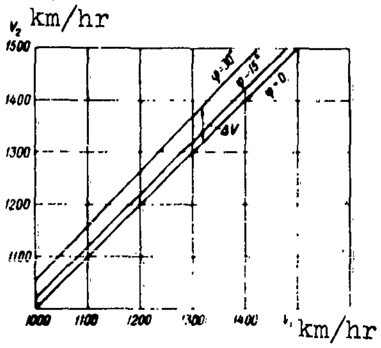


Fig. 5. Speed of wingman as function of speed of leader, when there is a difference in courses during a maneuver, and the required excess of altitude.

up to 15-20° the required speed excess of the wingman amounts to 1.0-1.5%. As we see in formula (2) and in Fig. 5, this magnitude depends little on other factors. It only increases slightly when there is an increase in the bank angle and it decreases when there is an increase in the flight speed of the leader. The absolute value of the wingman's speed is determined by formula (3) obtained from equation (2):

$$V_2 = \frac{(V_1 B - t_{rect} \cos \phi) + \sqrt{(t_{rect} \cdot \cos \phi - V_1 B \phi)^2 - 4 t_{rect} V_1 B \sin \phi}}{2 B \sin \phi},$$

where $B = \dfrac{1}{4.9 \tan \gamma}$.

Thus, the overall required speed reserve of the wingman, with account being taken of maneuvering, will be equal to 3-5% and, for ensuring him the required speed reserve during flight of the leader at the maximum permissible — as far as strength conditions go — speed, the required excess in altitude (with account being taken of maneuvering during intercept will amount to 700-1100 m. The combat formation of the element in this case will be a wedge of aircraft, stacked in altitude. The element commander will be at a low altitude — approximately at the flight altitude of the target. To the left and right of the leader, 700-1100 m above, are located his wingman and the leader of the second pair. The wingman of the second pair is located with the same difference in altitude relative to his own leader.

The intervals in a combat formation that is stacked in altitude are determined by convenience in observing the leader and, at the same time, searching for targets. The sighting angle to his leader amounts on the average to 30-40°.

Flight with such stacking is quite possible and, despite the fact that it makes certain specific demands on the wingmen, is primarily advantageous because it allows the group to maintain a speed close to the speed of a single aircraft. The element leader, flying at an altitude approximately equal to the flight altitude of the target, can also use his maximum permissible speed.

During the flight of a group which is stacked in altitude the probability of spotting a low-altitude target is considerably increased, since the element is deployed and can scan a much greater area. Here scanning is possible in different directions in a combat formation stacked in altitude (the leader scans in the horizontal plane or upward against the background of the sky, while the wingmen scan downwards against the background of the Earth's surface.

Viktor Bolyukh has the reputation in the squadron of being a remarkable aerial reconnaissance man. During the last tactical flight exercises he once again distinguished himself by carrying out a mission in reconnoitering the nuclear attack facilities of the "enemy".

In the photo: Military Pilot Second Class Capt. V. Bolyukh is ready for the next sortie.

Photo by Maj. V. Lobov

When the combat formation is stacked in altitude, the fighters can employ various attack methods in the horizontal plane and with an altitude differential.

Also of importance is the fact that, should the enemy attempt to evade the leader's attack by turning to the left or the right with a climb (a vertical maneuver), he will come under the fire of the wingmen. If, however, the enemy employs a horizontal maneuver, the wingman (or wingmen) can attack after closing with him in the rear hemisphere.

The stacking of small groups in altitude is an acceptable practical method in intercepting at low altitudes targets which have an advantage in speed.

However, the stacking of combat formations in altitude may be contradicted by weather conditions (inadequate visibility, low overcast), by the situation aloft, and other factors. In this case the principle of increasing the true speed by increasing the altitude may be used in bringing the group to the target area in tight combat formations. The required excess in altitude over the enemy is easy to determine by using Fig. 3. Finally, in order to overtake an enemy aircraft which is flying near the ground, the group, when maximum speeds are equal, in tight combat formation can employ the unique "rising wave" maneuver.

Of course, all these recommendations require further refinement and creative employment, depending on a specific situation and an evaluation of the combat capabilities of the aircraft of both sides.

ORIENTATION WITH THE USE OF THE NI-50 NAVIGATIONAL INSTRUMENT

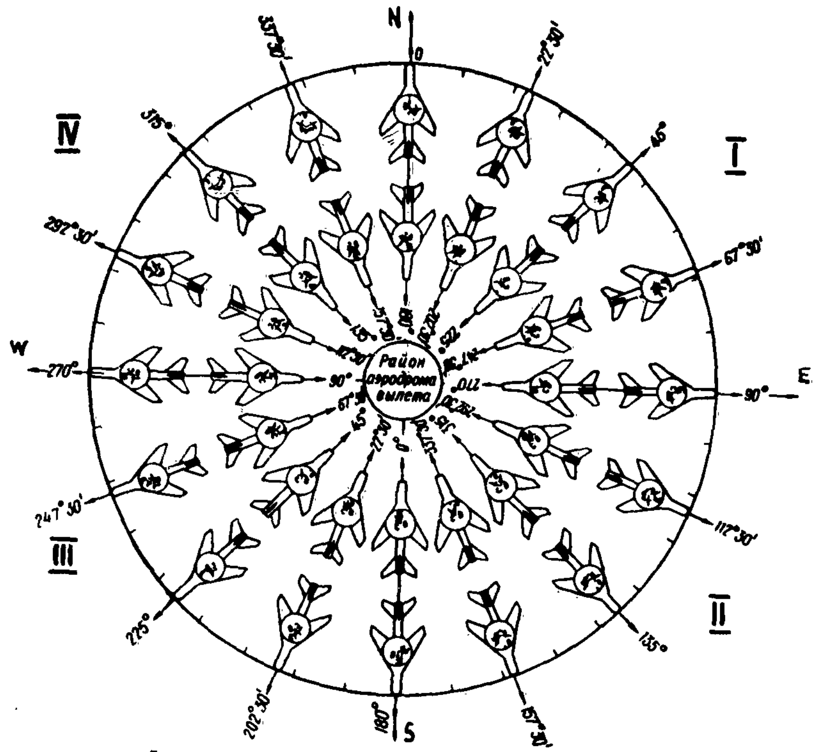
Lt. Col. V. KONDAUROV,
Military Pilot First Class

During flight with visual contact with the ground at low speeds and over a short distance and when there is an adequate number of large-scale checkpoints, the aircraft's location is determined by the simplest method — visual orientation. With the development of aviation, a number of other orientation methods came into use in aircraft navigation for determining an aircraft's position. These are based on the instrument measuring of various indirect parameters which are used for determining the computed position of the aircraft and for course computation.

Because of its autonomous nature, the most reliable and extensively used method is orientation by course computation. This involves computing the position of the aircraft by successively computing the magnitude and heading of the track from the point of origin. This problem is solved aboard an aircraft by the NI-50 navigational instrument which considerably facilitates for the pilot (or navigator) coming out on a prescribed checkpoint, thus freeing him from the necessity of maintaining constant visual orientation.

The NI-50 is especially valuable for the crews of present-day supersonic aircraft. It has proved its effectiveness as a supporting facility in coming out in the region of an airfield or some other characteristic checkpoint.

As we know, the NI-50 constantly computes the course and displays the results in the form of coordinates along two mutually perpendicular N and E axes. On the coordinate counter the N pointer shows the distance traveled by the aircraft on the N axis, while the E pointer shows the distance traveled by the aircraft on the E axis. If the point representing the origin of the coordinates is located at the point of the airfield and if the N axis is aligned with the meridian direction and, prior to takeoff, the pointers of the coordinate counter are set at zero, then during flight the N pointer will show the distance between the aircraft and the airfield along the N axis, while the E pointer will show the distance along the E axis. Here deviation of the former to the right of zero (clockwise) indicates that the aircraft is to the North of the airfield, while a deviation to the left (counter-clockwise) indicates that it is to the South of the airfield.



[In center:"Region of takeoff airfield"]

Diagram showing orientation with use of NI-50 by the method of "zeroing the counter pointers".

A deviation of the E pointer to the right of zero indicates that the aircraft is to the East of the airfield, while a deviation to the left means that it is to the West of the airfield. In coming out on the airfield of origin, both counter pointers should return to zero. Hence the problem consists of the crew's ability, in coming out in the area of origin, to determine the flight heading according to the readings of the NI-50 coordinate counter.

In the diagram showing NI-50 orientation by the method of zeroing the counter pointers are given the readings and the directions of coordinate counter pointer deviations during flights with different headings from and to the airfield.

In order to understand the diagram better, let us first examine a particular case: flight along the coordinate axes.

If the N pointer is on zero, then the aircraft is at some distance from the airfield of origin in the direction of the E axis, i. e., to the West or East. In this case the E pointer of the counter shows the distance to the airfield.

If the E pointer is zeroed, this means that the aircraft is to the North or South of the airfield at a distance indicated by the N pointer.

Experience in flights with the NI-50 shows that, for determining the flight heading to the airfield, it is more convenient to use the following conditions: when the N or E counter pointers deviate to the left of zero (counter-clockwise), they are "in front of" zero, while if they deviate to the right (clockwise), they are "behind" it. Under these conditions the aircraft crew determines the flight heading to the airfield of origin in the following way.

If the N pointer stands at zero and the E pointer is "in front of" zero, the flight is carried out in such a way that the East is in front, i. e., the aircraft flies with a 90° course. But if the E pointer is "behind" zero then the flight is carried out with such a heading that the East is behind, i. e., flight is to the West with a 270° course.

When the E pointer is at zero and the N pointer in front of zero, the aircraft is flying North with a 0° course. If the N pointer is behind zero, then the flight is to the South with a 180° course.

In flight, however, neither of the coordinate counter pointers will be zeroed. If both pointers are to the right or left of zero, then, regardless of their deviations and mutual positions, the aircraft will be in the first or third quadrant. But if they are positioned at both sides of zero, then the aircraft will be in the second or fourth quadrant.

Let us assume that the aircraft is in the first quadrant (both counter pointers are to the right of zero). In this case the crew must take up a 225° course and the aircraft will either come out on one of the coordinate axes (indicated by the fact that one of the counter pointers approaches zero) or immediately in the airfield region (indicated by the fact that both pointers will approach zero).

If the aircraft is in the second, third, or fourth quadrant, then the crew has only to take up, respectively, a 315°, a 45°, or a 135° course and the aircraft will come out either on one of the axis coordinates or immediately in the airfield region.

Thus, in a flight with one of the above courses, the crew tries either to zero simultaneously both counter pointers (which is the crew's final problem) or to zero one of them. Then, using the method described above, the crew zeroes the other pointer.

But the crew is faced by the problem of how to determine the flight heading by the readings of the coordinate counter pointers. Here we must use the rule set forth above.

When the aircraft is in the first quadrant, the N and E pointers deviate to the right of zero (behind zero). In this case it is necessary to fly to the airfield in such a way that North and East are behind, i. e., to fly Southwest on any of the courses - 202°, 225°, 247°.

When, however, the aircraft is in the third quadrant, the counter pointers deviate to the left of zero (in front of zero). Here the crew must fly to the airfield in such a way that North and East are in front, i. e., fly Northeast with a 45°, 22°, or 67° course.

But if the aircraft is in the second quadrant, then the N pointer will be to the left of (in front of) zero and the E pointer to the right of (behind) zero. Flight to the airfield is made in such a way that North is in front and East behind; that is, the crew must fly Northwest with a 292°, 315°, or 337° course.

If, again, the aircraft is in the fourth quadrant, then the E pointer is to the left of (in front of) zero and the N pointer to the right of (behind) zero. In this case the crew must fly to the airfield in such a way that East is ahead and North behind; that is, fly Southeast with a 112°, 135°, or 157° course.

Having determined the heading and having taken up the necessary course, the crew will have a clear idea of the direction in which it is approaching the airfield and what checkpoints should be encountered on the way. On the basis of that coordinate counter pointer which is further from zero, the crew estimates the approximate distance to the airfield.

In this method of orientation, we must not forget the following peculiarities of NI-50 operation. If both pointers together deviate to the right or left of zero, then flight is accordingly made with a 45° or 225° course. In order to come out on the airfield of origin (both pointers will be zeroed), a 225° course is assumed in the former case and a 45° course in the latter; if the N pointer deviates to the right and the E pointer to the left of zero, or vice versa, and both give the same readings in magnitude, then the aircraft is flying in the Northwest part of the airfield region with a 315° course or in the Southeast part with a 135° course. In order to come out on the airfield of origin (both pointers will be zeroed), a 135° course is assumed in the former case, and a 315° course in the latter.

In using this method of orientation, prior to flight the crew sets: the true map angle, the velocity and direction of the wind equal to zero on the input; the magnetic map angle on the automatic course device — the magnetic declination Δ_m (if Δ_m is East, then MUK [magnetic map angle] = $360^\circ - \Delta_m$; if Δ_m is West, then MUK = Δ_m); and the coordinate counter pointers at zero.

A SOLAR COURSE-ANGLE COMPUTER

Capt. B. SOLOV'YEV

In flight practice we may encounter on occasions situations in which the use of a magnetic compass and radio compass or other similar course instruments is precluded. In such cases a pilot can come out on the airfield by using the Sun, as was often done during the Great Patriotic War.

With two-way radio contact linking him with the CP, a pilot can come out on the airfield by using the RDF, even though its use involves a great number of radio-bearing requests. An aircraft can also be flown to the target airfield by using radar data.

It is very convenient to fly an aircraft to the airfield by using radar-station data. However, a situation may arise in which a radar station cannot be used for this purpose (when it is tied up, for example, with the job of vectoring fighters to aerial targets; when an aircraft is located outside its surveillance zone, etc.).

In this situation a CP ground controller on duty can make use of a computer which helps to determine the course angle of the Sun (KUS) rapidly and quite accurately for the purpose of proceeding to the target airfield if the magnetic bearing of the aircraft to the radio range station of the target airfield is known.

The computer is made up of two parts (figures 1 and 2). These parts are placed one on top of the other and have a common axis of rotation.

The lower part may be stationary and represents the time scale (relative to the CP clock). The concentric circles on it correspond to the various solar declinations, while the curves represent every hour of daylight.

The upper part has two circular scales: an inner scale of solar course angles and an outer scale of magnetic bearings (MPR). The upper part is transparent.

The solar course angle is read off after the lines representing the MPR values on the outer scale are aligned with the point of intersection between the solar declination circle and the line of time at the moment of reading (opposite the index triangle on the lower part of the computer).

The basis of the computer is the following relationship:

$$KUS = A - MPR - \Delta M, \tag{1}$$

where A is the azimuth of the Sun and ΔM is the magnetic declination in the area where the CP is located.

The magnetic bearing of the radio station MPR is known to the duty ground controller after the pilot requests it from the radio range station. The magnetic declination is also known. The most difficult thing is to determine precisely the azimuth of the Sun, this depending on the time of day, the altitude of the Sun, the latitude at which the CP is located, and the time of year (solar declination). The computer is usually prepared for a definite geographic latitude. The shape of the time curves takes into account the solar declination and the solar altitude. Each curve is plotted for a definite time of day (for each hour) and the figures are marked in hours.

When the computer is prepared, the solar azimuth A is taken from the "Table of Altitudes and Azimuths of the Sun, Moon, and the Planets" for the various hour angles and solar declinations as well as for a definite latitude (the latitude of the CP). For the sake of convenience, azimuth values are tabulated (Table 1).

Table 1

t° / T_{hr} / δ	0	15	30	45	60	75	90	105	120	135	150	165	180
	12	11;13	10;14	9;15	8;16	7;17	6;18	5;19	4;20	3;21	2;22	1;23	0.24
-23°27	180°	166°	152°.5	139°.5	-	-	-	-	-	-	-	-	-
-20°	180°	165°.5	152°	138°	-	-	-	-	-	-	-	-	-
-16°	180°	165°	150°	136°.5	124°	-	-	-	-	-	-	-	-
-...	...	...	...	...	...	...	...	...	...	...	...	...	...
+16°	180°	158°	138°	121°	106°	93°	81°	69°	-	-	-	-	-
+20°	180°	156°.5	136°	118°	104°	90°.5	78°	66°.5	54°	-	-	-	-
+23°27	180°	155°.25	133°.5	115°.75	101°.5	88°	76°.5	64°.75	53°	-	-	-	-

On the time scale, we mark concentric circles for the various declinations of the Sun and its azimuths. The points of intersection between the declination circles and the azimuth lines for the same values of the solar hour angles are connected with a smooth curve. Thus we obtain the curves of equal hour angles.

The position of the index triangle on the time scale takes into account the longitude distance of the CP from the mean meridian of the time zone and the magnetic declination. The distance is determined by the angle α which is read off the line T = = 12 hrs counter-clockwise:

$$\alpha = \lambda^{\circ}_{CP} + 15^{\circ}\,(12 - N) - \Delta M, \qquad (2)$$

where λ°_{CP} is the latitude of the CP and N is the number of the time zone. For example, when $\lambda_{CP} = 38^{\circ}$, $N = 3$, $\Delta M = +7^{\circ}$,

$$\alpha = 38^{\circ} + 15^{\circ}\,(12 - 3) - 7^{\circ} = 166^{\circ}.$$

The index triangle may be made movable, which makes it possible to alter angle α whenever the CP is moved to a different latitude.

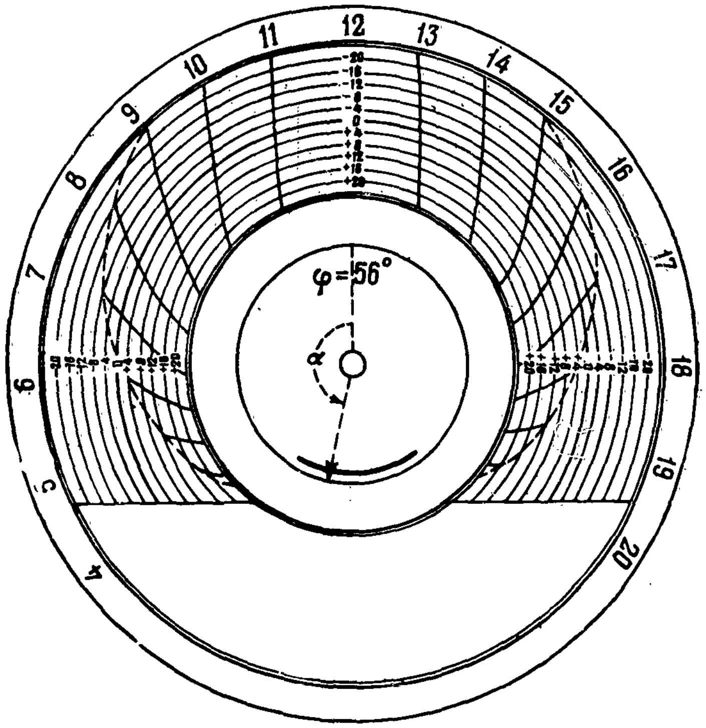


Fig. 1. Stationary part of computer . [legend on computer reads: Procedure for operating computer: 1. After pilot reports failure of course instruments, he is advised to interrogate the ARP [automatic radio range station] ; 2. Align the MPR line on outer scale of movable graduated circle with the point of intersection between the solar declination circle and the time line at the moment of reading: 3. Read off the KUS opposite the index triangle; 4. Make correction in time equation $KUS = KUS_{comp} - \Delta A^{o}_{r}$; 5. Issue appropriate instructions to pilot.]

The computer does not take into account the distance of the aircraft in longitude and latitude relative to the CP. Errors are possible due to lack of incidence between the mean and the true solar time.

The size of the error in the solar azimuth due to the longitude distance between the aircraft and the CP amounts to

$$\Delta A^{\circ}_{\lambda} = \frac{\Delta S^{\circ}\ \mathrm{km}}{111.2} (\tan \phi - \tan h \cdot \cos A), \qquad (3)$$

where h is the altitude of the Sun.

The results of the computations are tabulated as shown in tables 2, 3, and 4. The distance to the aircraft ΔS was taken as 300 km.

The error is a positive one if the aircraft is to the East of the CP and a negative one if it is West of the CP. This error increases with an increase in the solar declination; i. e., during the summer months it is larger than in the winter months. With an increase in the latitude of the CP the error also increases and has its greatest magnitude at midday (when the solar hour angle is equal to zero).

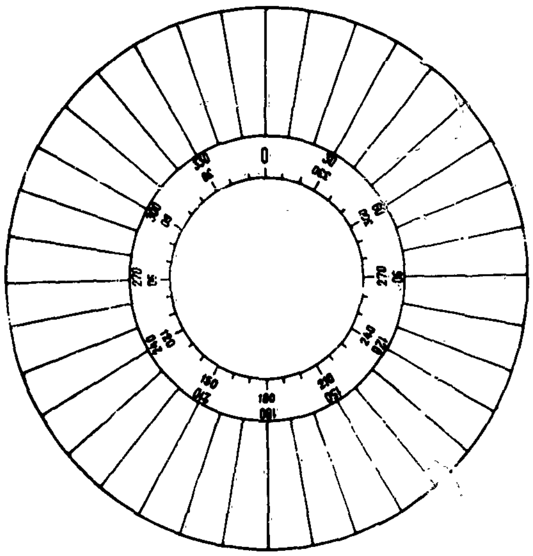


Fig. 2. The moving part of the computer.

Taking the value of the error as ΔA_{λ}, we can establish the latitude up to which ΔA_{λ} will not exceed the planned magnitude.

The error in determining the solar azimuth at the point of aircraft position depends also on the lack of incidence between the mean and the true solar time and amounts to

$$\Delta A^{\circ}_{\lambda} = -0.25\,\eta\ (\mathrm{min}), \qquad (4)$$

where η is the time equation (the difference between the mean and true hour angles of the Sun).

Table 2

$\delta = -23°\,27'$ (Winter)

t \ φ	40°	50°	60°	70°
0°	3°,65	4°,03	4°,98	—
30°	3°,17	3°,74	4°,82	—
60°	2°,43	—	—	—
90°	—	—	—	—

Table 3

$\delta = 0°$ (Spring, Fall)

t \ φ	40°	50°	60°	70°	80°
0°	5°,48	5°,65	6°,24	8°,40	15°,75
30°	4°,05	4°,66	5°,76	8°,1	15°,65
60°	2°,65	3°,59	5°,00	7°,65	15°,40
90°	2°,26	3°,22	4°,68	7°,43	15°,[illegible]

Table 4

$\delta = +23°\,27'$ (Summer)

t \ φ	40°	50°	60°	70°	80°
0°	11°,3	8°,6	8°,32	9°,95	17°,1
30°	4°,15	5°,56	6°,69	9°,24	16°,7
60°	2°,26	3°,47	5°,12	8°,05	15°,9
90°	0°,11	3°	4°,47	7°,27	15°,2
120°	—	3°,2	4°,5	7°,07	14°,8
150°	—	—	—	7°,18	14°,7
180°	—	—	—	7°,25	14°,7

It constitutes a correction which must be added to the true solar time in order to obtain the mean time.

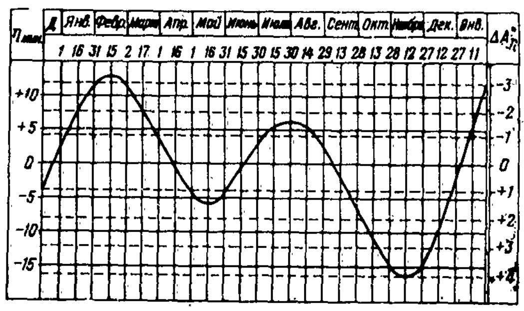
What the time equation and the error ΔA°_{η} look like is shown in the graph (Fig. 3). By using this graph, on the ΔA°_{η} scale we can compute the value of the error in determining the solar azimuth (and at the same time the solar course angle) due to the lack of incidence between the mean and the true solar time. As we see, the maximum magnitude of the error is equal to 4°. By using the time equation graph, we can consider the error ΔA°_{η} as follows:

$$KUS = KUS_{comp} - \Delta A^{\circ}_{\eta} \tag{5}$$

The magnitude of the solar azimuth error due to the distance between the aircraft and the CP is equal to

$$\Delta A^{\circ}_{\phi} = \frac{\Delta S \text{ km}}{111.2} \tan h \cdot \sin A. \tag{6}$$

Computations show that, when the aircraft flies a distance of 300 km to the North or the South of the CP, this error does not exceed 4° in the range of latitudes of 40° - 80°, while in the range of latitudes of 50°-60° it amounts to no more than 2°.



[On top: months from Jan. to Jan.]

Fig. 3. Graph of time equations and ΔA°_{η} errors.

When using the computer, the duty ground controller must know the solar declination for the given period of time which is determined with the use of the "Aviation Astronomic Yearbook" (AAYe) and he must have a graph of time equations with a ΔA°_{η} scale. The circle of solar declinations should be marked with a glass-marking pencil for the sake of convenience.

After the pilot reports the failure of his radio compass and compass (or other course instruments), he is instructed to interrogate the radio range station of his home airfield or that of the alternate airfield. The MPR line is aligned on the outer scale of the movable part of the computer with the point of intersection between the circle of the given solar declination and the time line at the moment of the read-out. Opposite the index triangle the value of the solar course angle required for proceeding to the airfield is read off. A correction is made for the lack of incidence between the mean and true solar time which is taken from the time equation graph. The solar course angle thus obtained is transmitted by radio to the pilot.

This procedure should be set down briefly in a blank space on the stationary part of the computer.

It is very important to determine precisely the needed solar course angle and for the pilot to maintain it. It can be maintained with maximum precision if the pilot knows the position of the Sun at several course angles by the Sun's position relative to some of the components of the cockpit canopy — the windshield, the frame joints, etc. With this in mind, it is best for the pilot to train on the ground for the purpose of determining the solar course angle. Such training sessions are very simple and are of great benefit.

By using the computer, it is possible not only to determine the solar course angle but also the azimuth of the Sun. For this purpose we superimpose the MPR =0 line on the point of intersection between the solar declination circle and the time curve, while the magnitude of the angle read off opposite the index triangle is increased by the magnetic declination.

If it is not possible to make use of the range station for the purpose of coming out on the airfield, the pilot must be given the value of the solar azimuth at the given moment of time. Then, knowing approximately the area of his location, he must determine the true course to the airfield and then mentally compute the solar course angle:

$$\text{KUS} = \text{A} - \text{IK [true course]}. \qquad (7)$$

Last summer at one of the air subunits missions were being carried out involving airfield approaches by the Sun. The course angles of the Sun were determined at the SKP [flight-line CP] by the duty ground controller who used this type of computer. All the aircraft came out on the airfield area successfully.

The computer we suggest is very simple to make. Its accuracy is adequate for the aircraft to come out on the target airfield.

FLIGHTS and PHYSICAL TRAINING

Capt. B. YEVSTAF'YEV

The scheduled route flight was coming to an end. Behind lay several hours of intensive work; a little further, and the home airfield would be reached... But at an altitude of 10,000 m the aircraft got into a jet stream which began tossing it about like a piece of driftwood. The crew put out a tremendous physical and mental effort in order to bring the aircraft out of the danger zone. The ship's commander, Military Pilot First Class P. Protsenko, came out victorious in his fight with the raging elements. What helped him was his self-restraint, courage, knowledge of his aircraft's capabilities, and his good physical training.

Flights in present-day aircraft demand an increasingly higher level of physical training on the part of the flight personnel with even greater specialization of this training, since the physical loads in flight depend on the type of aircraft involved, the duration and nature of flight, and the specialty of the crew member.

If the organism of a fighter pilot is mainly subjected to loads resulting from accelerations, then in extended flights in a long-range bomber the loads are different. Naturally, physical training must be carried out by taking into account the special features of flying.

Flights in present-day aircraft often last several hours and result in considerable fatigue for the crew. The so-called "flight fatigue" is due to a number of factors: emotional — the sense of responsibility, concentration of attention, unpleasant physical sensations, worry, etc.; and physical — cold, vibrations, noise, fluctuations in atmospheric pressure, hypoxemia, dynamic and static stresses.

Fatigue sets in first of all as a result of lack of movement and dynamic and static-dynamic stresses. The crew members are limited in their movements, being held in place by the straps of the safety harness.

Navigators, radio gunners, and commanders of firing installations, due to the specifics of their work, suffer mostly from fatigue in their back muscles, since they often have to work in a somewhat bent posture, "hunched up" (working with instruments, sights, the key, etc.). Due to retarded circulation when immobilized, the crew members also suffer from muscular numbness in the legs and pelvis.

The greatest general tension of will power as well as physical tension are experienced by navigators, radio gunners, and commanders of firing installations during the preparations for and execution of bombing missions, firing, working with the key, etc. After this there comes a drop in tension which permits them to "relax" and perform a number of exercises possible in flight.

Commanders of firing installations and radio gunners are also subjected to greater effects, as compared with other crew members, of loads on the vestibular apparatus, especially during severe turbulence and during takeoff and landing on dirt airfields.

One of the basic factors contributing positively to the success of a mission is the pilot's (ship's commander's) ability and skill in piloting an aircraft confidently in any weather and in any situation.

Moreover, pilots experience considerable dynamic and static-dynamic stresses in the hand muscles (especially the wrists), the arms, and legs (particularly the foot).

The pilot's hands are on the control column and his feet are on the pedals with his legs being constantly in the extended position which results in great fatigue in the muscles — the foot extensors.

Under adverse weather conditions — in the presence of heavy turbulence — pilots are constantly under the effect of physical loads on their arm and leg muscles. For example, if the trim tabs are not used, the force on the elevator control amounts to 60 kg, while on the pedals it amounts to 100 kg. During flights at an altitude of 12 km or more, especially when the aircraft gets into an updraft, the crew members need special training in order to be able to withstand sustained static-dynamic stresses.

It is common knowledge that an aircraft, getting into an updraft or a downdraft, may, in one swoop, climb or drop 50 to 800 m.

One of the tensest and most complex of flights is flying in formation or during in-air refueling. A pilot must here concentrate his attention to a maximum and strain his eyes (especially on a dark night when the silhouette of the lead aircraft cannot be seen). During such flights, the left hand of the pilot is placed on the throttle, while his right hand is on the control column. This results in a maximum load on the muscles of the right hand, thus causing numbness.

Regular flight activity is conducive to the development of will power and physical qualities, develops the strength of certain muscles, and increases dynamic and static endurance. The materials gathered in testing flight personnel according to special gymnastic norms (determining the dynamic and static endurance in certain muscle groups) show that ship's commanders have a higher level of endurance for dynamic and static stresses as compared with other specialists.

Flight personnel who regularly engage in physical exercises and sports tend to tolerate considerably more easily the dynamic and static stresses which are the most characteristic loads in extended flights.

A majority of officers correctly understand the necessity of regular physical training and they actively participate in the sports life of the unit. For example, officers V. Nikitin, Ye. Nikolayev, P. Protsenko, R. Shagimuratov and many others, because of their excellent physical conditioning, tolerate considerably more easily the loads and g-loads in flight and act more confidently in complex situations.

Excellent physical conditioning and a high degree of self-control have more than once helped these officers emerge victoriously from complex situations.

Pilot P. Protsenko has a diversified physical conditioning. He actively participates in sports competitions and is one of the strongest weight-lifters in the unit. He conducts physical training exercises with the pilots, striving to inculcate in his comrades a love of sports. A great physical strength and high moral qualities have on many an occasion come to his aid in a difficult situation.

Characteristics of flight activity along with an analysis of loads and g-loads generated in flight show that we must first of all develop the capacity among the long-range aviation flight personnel of tolerating extended dynamic and static stresses.

In order to determine the effect of static exercises on the development of strength and dynamic and static tolerances, we conducted an experiment over a period of 2.5 months. We organized three sections. The first of these did only dynamic exercises (Air Force program, gymnastics, topics 1-2); the second section did only static exercises; and the third was engaged in a mixed program. Altogether, 20 sessions of 50 minutes each were conducted with the experimental group.

At the beginning and at the end of the experiment strength tests were made for dynamic, static, and general endurance. In all the test exercises the section engaged in static exercises showed higher results than the section engaged in dynamic training. The highest results were achieved by the third section, the one following the mixed program. For this reason, the problem right now is not of replacing one regime with another but of actively employing static exercises for developing strength and dynamic and static endurance and of combining the dynamic and static regimes of training.

Taking into account the special features of flying, we can conditionally divide the specially directed exercises for the long-range aviation flight personnel into three groups. Special exercises for ship's commanders must be aimed first of all at developing strength and dynamic and static endurance for the arm muscles, especially the muscles of the wrists, upper arms, legs, and especially the feet. For navigators and operators we must develop strength and dynamic-static endurance of the body muscles, especially those of the back. For radio operators and commanders of firing installations we must develop the vestibular resistance to motion sickness as well as static endurance.

In the physical training publications we have a great number of exercises which promote the good development of definite groups of muscles. These are exercises designed for two men working together on the gym bench, the wall bars, rope pulling, rope climbing, chinning, various pull-ups on the horizontal bar, flexing and unflexing of the arms on parallel bars, front half lever, exercises with weights, and many others. At the same time, the physical training publications practically do not have any exercises aimed at improving dynamic-static endurance for individual groups of muscles. In our opinion the physical training program must include exercises of a static nature. The preparatory part must include 3-4 specially directed exercises, while the main part must include 8-10 minutes of static exercises for each one hour-long session with the use of various apparatus.

We also suggest a number of exercises which help to develop dynamic-static qualities of individual groups of muscles and which will tend to increase the body's resistance to various loads and g-loads resulting from extended muscle tension.

Exercises without apparatus. 1. Initial position — legs spread, arms extended. On the count of "One", flex arms at elbows vigorously, flexing the fingers into a fist. Hold tensed for count of 2-7 and, at the count of 8 drop the arms. 2. Legs spread, arms flexed at elbows, pressed tightly against the body. At count of 1, making a fist, tense the muscles of the arms, chest, and back. At count of 2-7 hold tensed, at count of 8 drop the arms. 3. At count of "One" bend the knees, put arms around knees, and tighten grip. For counts 2-7 continue "squeezing", holding muscles tense. At count of 8 resume initial position.

Exercises with the wall bars. 1. Facing the wall bars with flexed arms, put hands on bar at chest level. For counts 1-6 push against bar, shift weight from foot to foot (on toes), dropping arms on count of 7. . 2. With back turned towards wall bars, put hands on bar at level of head. For counts 1-6, tensing the muscles of the arms, legs, and torso, push against bar, dropping the arms on the count of 7.

Exercises on the gymnastic bench. 1. Sit down on bench using the back side of the hips (pelvis off the bench) with hands behind the head. Partner pushes your feet against the floor. On count of "One" drop body back and extend arms upward. For counts of 2-10 hold thus and, on count of 11-12, resume initial position. 2. Lying on bench face down, drop arms to floor. Partner holds down your legs. On count of "One", raise the body as high as possible with arms up. For counts 2-10, hold thus. On counts 11-12, resume initial position.

Exercises on horizontal bar. 1. Initial position — "hang". On count of "One", pull up, knees to chest. For counts 2-9, hold. On count of 10, resume initial position. 2. From position of "hang", lift flexed (extended) legs to bar, curving body slowly, and drop legs down. 3. Initial position — "hang". Pulling up, flex the legs, passing them between the arms; drop into "hang behind" position. Hold for count 1-9. At count of 10, jump down.

Exercises on parallel bars. 1. Up position, arms on bar. On count of "One", flex arms at right angles. For counts 2-10, hold. On count of 11, resume initial position. 2. From the up position on the arms, flex body. Curving the body, slowly drop to initial position. 3. From the up position on the arms, flexing the arms and legs, raise pelvis as high as possible (initial movement for handstand), hold for 3-4 seconds, and then resume initial position.

Each training session must include 3-4 such exercises, each being performed 3-6 times, alternating them with relaxing exercises of the shake or breathing type.

In addition to the exercises enumerated above, there are many other specially directed exercises which may also be included in the set of exercises performed at the sessions.

Thus in our unit we have developed a training apparatus (UTS-2) for developing strength in the wrists and upper arms in the flight personnel. This constitutes a knockdown assembly in five sections. A metal post on supports has pipes (one for each section) with the ends of cables braided to the pipe cleats, while the other ends of the cables are attached to bars of various weights — 10, 20, 30, 40, 50 kg.

By turning the pipes one after the other with his hands, the trainee winds the cable, thus lifting the corresponding weight.

For static exercises we have also developed a UTS-3 training apparatus which is a welded structure made up of five lengths of pipe with hooks welded to the vertical uprights.

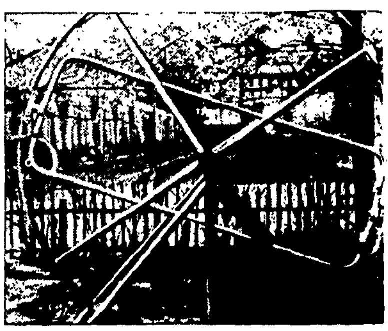
Here are some sample exercises for the UTS-3: 1. Assume initial posi- [illegible] weight-lifting, with the metal pipe below the bottom pair of hooks. Tense [illegible] muscles of the arms, legs, and torso. 2. Same exercise, but arms and legs [illegible] held straight. The pipe may be under the first, second, or third pair of hooks. Standing load". 3. Body straight, elbows bent, pipe under fourth pair of hooks grabbed from below. Tense arm extensor muscles. 4. Simulate pushing. The pipe may [illegible]ced at the level of the chest, above the head, etc. 5. Hang on flexed ar[illegible] aking a front half lever, etc.

Exercises involving dynamic and static tension are done intermittently [illegible] king breathing and posture exercises.

Further specialization of physical training with inclusion of isometric- [illegible] rcises in the training sessions will help to develop in the flight personnel [illegible] ysical strength as well as dynamic and static endurance.

READERS SUGGEST

A REVOLVING FRAME



Apparatus with revolving frame.

We have built a device for the special training apparatus, a "suspended gymwheel". It makes it possible to increase the effectiveness of the device and to train in it for the purpose of increasing the resistance to motion sickness. On the revolving frame it is now possible to make simultaneously revolutions and turns. Due to this fact, we can simulate variously directed combined accelerations with interchangeable signs. The device we suggest is no less effective in acting on the organism than the well-known "Triplex" gym apparatus. At the same time it is much cheaper, simpler to produce, and easier to operate.

The revolving frames are easy to build in the units and to employ for the specially directed physical training of the flight personnel, parachutists, and other specialists. Moreover, such frames may be used for studies of the functions of the vestibular analyzer. Here we can refine the dosage and observe standard loads.

The apparatus consists of two half-frames with hinges (ball bearings in races) and joints. To one half of the frame we weld foot rests and to the other we weld half-rings for the hands (see photo).

The parts are made of welded 20-30 mm steel pipes joined to each other by two metal shafts, each of which is welded to the half-frame at one end with the other end ~~being attached by means~~ of bolts.

The height of the assembled frame is 195 cm, the width is 75 cm. The trainee's arms and legs are strapped into position and for greater safety a safety belt is used which is attached to the lateral uprights at the waist.

The exercises may be performed either by the passive method (the trainer turns the wheel and the frame, controlling the size of the loads) or by the active method (the trainee performs the turns and revolutions himself by shifting the center of the body's gravity in the frame).

During the first stages of training and during studies, the passive method is used. Later, in the process of training the active method is used. To arrest the gym wheel, there is a brake provided for in the standard apparatus. At the bottom of the frame we attach a board and a lever, one arm of which is extended to the center upright. The brake is simple but works well.

K. BRYKOV;
T. DZHAMGAROV;
V. MARISHCHUK.

AEROSTATS and DIRIGIBLES

Engineer Lt. Col. A. GLUKHAREV;
Engineer Col. A. KO[illegible]OREZOV.

At the present time, when aircraft have achieved tremendous speeds, high altitudes, and long flight ranges and when mankind has entered the era of space conquest, the renewed interest in aerostatic flight vehicles may, at first glance, seem absurd. But this is not a return to the past nor conservatism. The fact is that simple solutions to problems always remain valuable. Flight on the basis of the static principle of generating lift is more easily achieved than on the basis of the engine principle. And this explains the fact that lighter-than-air vehicles are now coming back.

Present-day achievements in science and technology have revealed new possibilities both for dirigibles and aerostats. This first of all is the result of creating new synthetic materials: thin, strong, and translucent polymer films for aerostat envelopes. It is also the result of developments in automation and radioelectronics which make it possible for us to build light and reliable flight-control apparatus. An important role is also played by our increased knowledge of the laws and nature of the movement of the air masses in which aerostats travel.

On the basis of these achievements in science and technology designers are developing high-altitude aerostats (35-40 km ceiling) capable of drifting over vast distances and of remaining in the air for several weeks. They are capable of covering in this time tens of thousands of kilometers and of carrying a cargo of several hundred kilograms or, at lower altitudes, of several thousand kilograms. Such aerostats are extensively used in various fields of science and technology.

Further improvements in the design and the flight performance data of automatic aerostats will broaden even further the areas of their employment. Moreover, the low cost of the lift gas and the polymer films for the envelopes as well as the simplicity of production and of launching (there being no need of complex and expensive sites and equipment) explain the comparatively low cost of aerostats, the possibility of automating them, and of using them on a mass scale.

Aerostats being developed at the present time will be similar to their prototypes only externally, and sometimes not even in this respect either. They will carry no ballast, a supply of which determines the length of the flight and limits the lifting capacity and the altitude. The use of liquid hydrogen and new lift gases, of the latest automatic flight-control systems, and sophisticated envelope designs — these are a few of the actual lines of development in aerostats.

One of the principal lines of development involves perfecting the design of envelopes which determines the possibility of improving the principal characteristics of aerostats: lift capacity, altitude, and flight duration. For aerostat vehicles these characteristics depend on the magnitude of lift of the buoyant gas proportional to the volume of the envelope. With an increase in the volume of the latter, there is an increase in its weight, this increase "eating up" a great part of the lift capacity of the gas. Therefore, a reduction in the weight of the envelope material is a paramount problem for designers.

Ths use of new, thin, and strong plastic films provides tremendous possibilities. Now a basic material for envelopes is polyethylene films 30-60 microns thick and weighing 28-55 g/m^2. In the not-too-distant future we may expect the appearance of films which are tens of times stronger — as thin as 5 microns and weighing 7 g/m^2.

Even now in the USA work is underway in developing an automatic aerostat for studying the reaction of the human organism to the space environment and conditions for supporting human life activities. According to plans, such an aerostat can last several days at an altitude of 45-48 km.

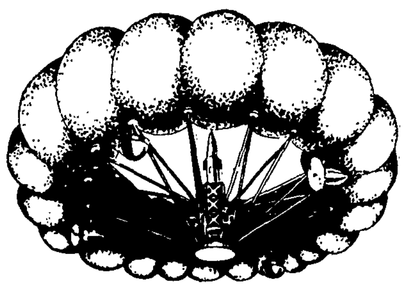


Fig. 1. Tauroidal aerostat used as a mobile launching platform for rockets.

According to the foreign press, a high-altitude automatic aerostat in combination with a rocket may be used for various types of research. It will be, so to speak, the first stage of the rocket, enabling the latter to pass through the densest layers of the atmosphere without expending energy.

Thus, aerostats and rockets — the oldest and newest type of vehicles — may together serve man in revealing the secrets of the upper layers of the atmosphere.

Offering great promise are dirigibles to be used in the national economy as transport facilities. This is primarily determined by the low cost of cargo hauling. Dirigibles can transport the most diverse cargoes, including the largest and heaviest ones. They will very advantageously transport cargoes over great distances and to regions of the country which are difficult of access by other facilities. The feasibility of using dirigibles for transport is due to their high flight economy, since the dirigible is supported in the air by static forces and fuel is consumed only for horizontal movement. Thus the expenditure of fuel for transport work per each ton-kilometer is some ten times less in the case of the dirigible than in the case of an aircraft or a helicopter.

As further improvements in the design of aerostats come about, there will be an increase in their lift capacity and broader fields of their use.

We read in the press about a number of projects being proposed abroad. For example, there is being developed in the USA a project for transporting and launching ICBM's weighing up to 45 tons by using an aerostat in the shape of a tauroid (Fig. 1). Such an aerostat with a volume of 100,000 m^3 in an envelope made of mylar film can carry a container with the rocket, gondolas with equipment and crew quarters, as well as engines for propelling the vehicle at a speed of 120 km/hr at an altitude of 6000 m.

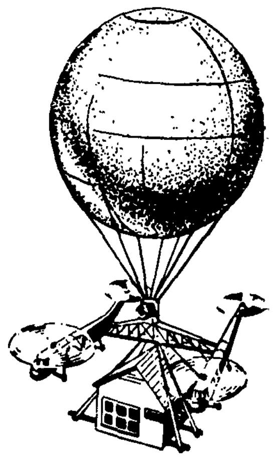


Fig. 2. Combination use of aerostat and helicopter.

No less interesting is a project for a "heliobarge" system, combining the lift of an aerostat and the thrust of a helicopter (Fig. 2). Tests of this system have shown that a helicopter with a load capacity of 200 kg and with the combined use of a spherical envelope with a volume of 1000 m^3 (with a lift of 800 kg) can additionally transport about a ton of payload at a speed of 25 km/hr.

Future aerostats, utilizing jet streams and staying aloft many weeks, will be able to make around-the-world flights. By using the jet streams, it will also be possible to hold the aerostat for long periods over a prescribed geographic region or to make flights to a certain region with a return to home territory in a stream moving in the opposite direction.

Judging by results of studies made in the USA, of great promise are automatic aerostats with low-thrust engines designed for correcting the flight heading and increasing the accuracy of the aerostat's coming out over a specified region. Obeying commands from an airborne automatic "navigator" which will establish the coordinates, the engine will change the flight heading at any time, put the aerostat on another "air route", or move it against the stream to a designated point. Serving as a possible power source for small engines, in addition to conventional fuel, will be the Sun as well as the hydrogen filling the aerostat's envelope.

An aerostat with an engine is, so to speak, a step towards a lighter-than-air flight vehicle of another type — the dirigible.

The dirigible occupies a special place in the family of flight vehicles, since it combines the characteristics of the aircraft, the helicopter, and the aerostat. Like the aircraft, it is able to fly horizontally in a given direction; like a helicopter, it is able to take off and land vertically and to hover; and like an aerostat, it can "swim" in the air, moving along with air masses. These qualities are inherent in the dirigible because, for lifting it and moving it in the air, aerostatic and aerodynamic forces are used, as well as the thrust forces of engines.

However, the dirigible is an aerostatic vehicle, since for it, as for an aerostat, the basic design characteristic is the volume. It is upon the volume in the final analysis that depend all the performance data of the dirigible: its lift capacity, its speed and its altitude, and its flight duration and range.

In the thirties of our century the volume (190,000 m^3) of the largest dirigible— the Hindenburg — seemed fantastic. Now, however, we can actually speak of volumes of the order of 300-500 thousand m^3. It we consider the fact that a dirigible can lift a load equal approximately to a third of its volume (and in the future this figure may be increased), then the load capacity of a dirigible with a volume of 300,000 m^3 is equal to 100 tons. In combination with large dimensions (a length of up to 250-300 m), such a load capacity will make it possible to use dirigibles for solving many problems insoluble by using aircraft or helicopters. A dirigible can lift a large and heavy cargo and transport it over tens of thousands of kilometers to practically any point on the globe.

Of course, such giants cannot be copies of earlier dirigibles with their heavy metal framework, difficult to build, and covered with a rubberized fabric. Future dirigibles will be more like giant rockets with a light metal or plastic envelope filled with a non-inflammable gas — helium. The use of new very strong and light synthetic materials will make it possible to build dirigibles with large volumes and with a non-rigid design (the envelope will simultaneously serve as gas container and main load-carrying element). The building of such dirigibles will be simpler and the cost considerably lower than rigid dirigibles.

A principal feature of the dirigible, in addition to its great load-carrying capacity, is its ability to stay aloft for long periods, either moving or stationary. This feature is explained by the fact that its lift is based on the aerostatic principle. Powerplants are required in a dirigible only for horizontal flight and therefore their power output may be tens of times less than in the case of heavier-than-air flight vehicles. Piston or jet engines or diesel engines, which consume a small quantity of fuel, will allow a dirigible to fly for ten days or more without refueling. Even now the world record for flight duration in a dirigible is 264 hours. Such duration, even at relatively low speeds (no more than 180-200 km/hr) makes it possible to cover distances of tens of thousands of kilometers.

Also finding answers are many other technical problems, including, for example, the problem of adjusting the lift capacity of the gas by heating or cooling it, a problem even anticipated by K. E. Tsiolkovskiy. And the solution of this problem will in turn allow us to make feasible the concept of controllable flight without engines put forward by our compatriot A. Snegirev.

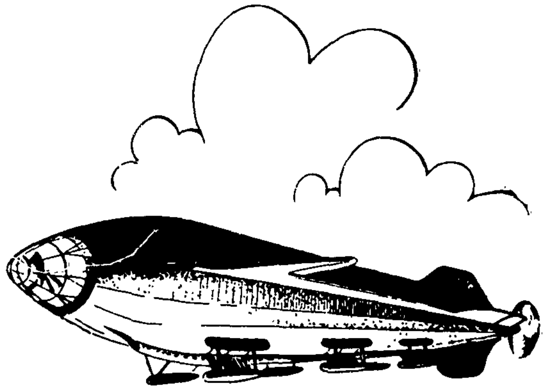


Fig. 3. Dirigible with wings.

According to Snegirev, a dirigible can be propelled by changing the buoyancy of the gas while at the same time deflecting a special control surface. In this way the dirigible acquires a speed component directed at an angle to the horizon; i. e., it will fly forward with intermittent climb and descent. A small dirigible of this type, the Aeron III, is being tested in the USA. It has still another interesting feature — three housings connected by airfoils that increase the dynamic lift. Such aerial giants are able to travel a long time aloft practically without expending any energy.

It is impossible to predict what types of dirigibles will appear in the future. It may be that we will have the famous all-metal dirigible with variable volume, a project developed by K. E. Tsiolkovskiy. We may have a "flying caterpillar" consisting of a series of sections which may be separated and left on the ground together with the cargo delivered. We may also see an "air train" consisting of light film "goods cars" hauling the cargo and themselves pulled by a simple "flatcar" with an engine. We may see, too, a combined dirigible-submarine, capable of diving under the water and then rising again into the air. But one thing is clear: the remarkable qualities of the airship — the dirigible — will for a long time to come attract the attention of scientists and designers.

PREVENTING FLIGHT ACCIDENTS

FORESTALLING EACH CAUSE

Col. K. GOL'BERG,
Military Pilot First Class

Flights were being made in the day under adverse weather conditions and with an increased weather minimum. Flight elements in the clouds and a landing approach by the straight-in system were being practiced.

In making a landing approach, Pilot Lt. A. Lebedev reported that the ARK-5 [automatic radio compass] operated unstably. At this time, his aircraft was 70 km away from the DPRM [outer homing radio beacon].

The flight controller gave a command to the CP crew to track the aircraft carefully and to the landing controller of the RSP [radar landing system] to direct the landing approach, and he limited radio communication among the crews aloft.

After assuming control of the aircraft, the landing controller gave precise commands. The direction finder gave a correct bearing to the requesting pilot. The pilot acknowledged with "Roger" the commands; however, he did not carry them out. He reacted incorrectly to the change in bearing, as a result of which he made a 90° turn from the landing course and, only after coming out under the clouds at an altitude of 2000 m, did he make a visual approach and landing.

In checking the ARK-5, they discovered that it was not tuned precisely to the DPRM frequency. A more powerful station operating on a frequency which was 8-10 kc different from that of the DPRM caused the unstable operation of the instrument.

One must remember that there are instances of frequency conincidence. And, in order to avoid interference, one should tune the ARK for DPRM frequencies very precisely.

It may seem that the case discussed here is not so characteristic as to require analysis in detail. However, the experience of many years of flights under adverse weather conditions shows that a flight accident or its cause is often brought about by the fact that the pilot is unable to determine and eliminate the cause of unstable operation of the ARK-5 and competently use the data of the direction finder in making a landing approach.

In the cited example, the pilot made a series of errors. They did not only consist of imprecise tuning of the ARK but also of an inability to determine the cause of its unstable operation.

At first, the ARK operated rather stably. Then, by the course angle indicator, Lebedev noticed that the needle oscillated considerably at the moment of beginning the maneuver to come out on the landing course and he reported this by radio.

Could the pilot himself have determined the cause of unstable operation of the ARK? Yes, he could have, if he had been adequately trained.

In the clouds when the ARK is precisely tuned, occasionally, and sometimes during the entire flight, the readings of the ARK will be unstable due to static charges of intensive precipitation. Here the call signs of the PRS [homing radio station] are not heard, but a continuous noise is audible. This is the first sign that the aircraft is in an air mass where the ARK operates unstably and where one cannot fully orient oneself by its readings.

Thus, in flying during unstable readings of the course angle indicator, a pilot must first of all hear the call signs of the PRS and make sure that the ARK is tuned precisely. If there are no call signs, but a continuous noise is heard, one should continue the flight by using the data given by the radio direction finder in combination with the readings of the DGMK [distant-reading gyromagnetic compass].

Some pilots limit themselves to checking the operation of the ARK-5 only on the ground. Before flight they often tune it imprecisely and do not check the tuning by the maximum deflection of the indicator needle and maximum audibility of the call signs. They only listen to the call signs and, since the aircraft are near the PRS, the call signs will be clearly heard even when the tuning is not precise. But as soon as the aircraft moves 80-100 km away from the airfield, the ARK-5 will begin giving unstable readings.

We make many flights with landings on other airfields and this is why the ability to retune the ARK-5 correctly aloft to the PRS of other airfields acquires great importance.

In the case described above the pilot neither checked the adjustment of the ARK nor tuned it correctly and thereby he himself made the landing approach more difficult. His further actions were also incompetent. One gets the impression that Lebedev was not quite ready to carry out the mission, although he had previously flown under more complex conditions.

In checking on the pilot's knowledge, it was discovered that he theoretically knew how to make a landing approach by the data of the direction finder. Checkout flights with an instructor under adverse weather conditions were carried out by him with the score of "good", but the failure of navigational and flight equipment was not simulated in a single flight. Checkout flights in order to practice piloting technique by using supporting instruments under the hood were carried out formalistically.

This is why the pilot became confused and did not carry out the commands of the flight controller in a complicated situation, although reporting "Roger".

In my opinion, even while drawing up the plan tables, they often introduce a certain amount of formalism into flight training under the hood by using supporting instruments and into making a landing approach by the data of the radio direction finder. As a rule, these flights are planned for normal weather conditions. In trying to log the greatest number of flight hours during a shift, commanders send aloft a great number of aircraft simultaneously. The pilots carry out various missions. Simultaneously, flights are carried out under the hood by the system.

First-Class Technician Khaleulin is well known in the X air unit of fighter bombers. He has to his credit hundreds of serviced aircraft-sorties and not a single disruption in the operation of aircraft equipment aloft and not a single cause of flight accident.

In the photo: Senior Technician Lt. R. Khaleulin inspecting the cockpit of an aircraft.

Photo by Maj. V. Lobov.

Sometimes several aircraft assemble in the pattern and this makes it impossible to make a straight-in landing approach by using the data of the direction finder.

In such cases the hoods are opened at a high altitude for safety. It is clear that such flights do not produce the necessary effect.

I consider that flights under the hood by using the supporting instruments must be planned at a time when the pilots are able to carry them out in accordance with the demands of the "Course"; and if they have not been carried out completely for some reason, they must be planned once more.

Sometimes everything is formally in order according to the record in a pilot's flight book: the number of checkout flights is sufficient and he has flown by using supporting instruments as well as under adverse weather conditions. But then he encounters a somewhat complicated situation and loses his head. A single conclusion suggests itself: a poorly trained pilot was sent up and it was only by accident that everything ended well.

The inadequate training of the pilot was the fault of the instructors — the element commander who trained the pilot and the squadron commander who checked out and admitted him for solo flights under adverse weather conditions.

Following this incident which happened to Lebedev, the methodological council held a meeting. Upon its recommendation, the peculiarities of piloting an aircraft in the clouds by using supporting instruments were analyzed during special study sessions, training sessions were carried out in aircraft cockpits, and the ability of the flight personnel to tune the ARK-5 and retune it aloft was checked.

They checked on the skills of the instructors and all the pilots in piloting by using supporting instruments and in making a landing approach by the radio direction finder on the trainer and then in a combat training aircraft. The attention of the instructor personnel was particularly drawn to strictly observing established norms.

Flights to practice piloting technique by using supporting instruments and landing approaches with the aid of radio direction finders were planned during specially allotted periods and this gave positive results.

Lt. Lebedev began flying more confidently and soon raised his class rating after obtaining sufficient training on the trainer and in the combat training aircraft.

The profound and comprehensive analysis and the search for the sources of the error helped not only to eliminate it but also to forestall others which might be more serious.

It has become our rule to forestall each cause of an accident. This helps pilots carry out successfully all the missions assigned them, no matter they may be.

THIS EXPERIENCE IS USEFUL

Engineer Col. N. KON'KOV;
Engineer Lt. Col. M. IL'INOV

The subunits in which the Aviation Engineering Service is led by officers N. Dikin and I. Mushko have many years of accident-free flight work. What are the reasons for their success? First of all, they are discipline, a high level of skill on the part of the pilots, and a profound knowledge of aircraft equipment. But we are speaking here about something else. The point in question is the selfless work of the technicians and engineers and, above all, the specialists for radioelectronic equipment. Their experience in forestalling failures in aircraft equipment deserves attention. During the last three years the operational reliability of aircraft radioelectronic equipment improved almost threefold due to the improvement in the quality of preliminary and preflight servicing, the adoption of step-by-step operational checking, and improvements in the technology of periodic regulation inspection work.

The flow-line group method of servicing aircraft equipment has become firmly established in the practice of the subunits. Upon the initiative of engineers M. Titov and A. Smirnov, the aging and the rejection-testing of electric-vacuum devices on a special installation and a vibrator stand has been adopted.

THE FLOW-LINE GROUP METHOD

How can we reduce the time of preflight and preliminary servicing of aircraft and, mainly, improve control over its progress? Engineers Dikin and Mushko found a way out in organizing the preliminary and preflight servicing of aircraft by the flow-line group method. What is its essence?

Preflight servicing is beginning. Before towing the aircraft, the technical personnel of the unit assemble on the flight line. Officer A. Zubov assigns a mission to his subordinates. Then officers A. Morozov and V. Kuz'min once more definitize the makeup of the specialist groups for radioelectronic and aircraft equipment assigned to preflight servicing.

Group No. 1 has received three specialists for radioelectronic equipment. Their work is led by the technician of the servicing group.

Two armament specialists make up Group No. 2. They will inspect the camera guns and, together with the radio men, check the radio range finders.

Two mechanics for electric equipment will install storage batteries in the aircraft, while two instrument specialists with a KPU-3 [checking and measuring installation] will check the aneroid-membrane instruments. This is Group No. 3.

The fourth group is represented by the mechanic for oxygen equipment attached to the AKZS-40 [airfield oxygen filling station] today.

A specialist for electric equipment and an instrument specialist come with the APA-2M [airfield starter unit]. They are entrusted with checking the equipment under current.

Preflight servicing begins on the first aircraft towed out. The technician removes the covers from the aircraft, opens the cockpit, installs the catches (safety pins for use in opening and closing the cockpit), etc. Then the radio men and the armament men begin their work (Fig. 1).

One specialist for radioelectronic equipment (usually the chief of the servicing group, V. Khmara, or the senior mechanic) is in the aircraft cockpit, while a second is in the upper nose section measuring the parameters of receiver amplification. He also switches on the "Explosion" circuit and inspects the inertial contactor.

The condition and attachment of antennas is checked by a third specialist. He also takes part in checking the efficiency of the identification system and of the marker radio receiver. The radio men and the armament men check the radio range finder jointly.

The work of the specialists for radioelectronic equipment is checked by the chief of an outstanding servicing group, Military Technician First Class Aleksandr Anatol'yevich Morozov. He carefully analyzes the causes of the spotted malfunctions and takes every measure to forestall failures. Once, during preliminary servicing Mechanic Levushkin reported that the signals of the homing and broadcasting stations were not being received by the automatic radio compass. The needle of the compass indicator did not assume the course angle position of the radio station.

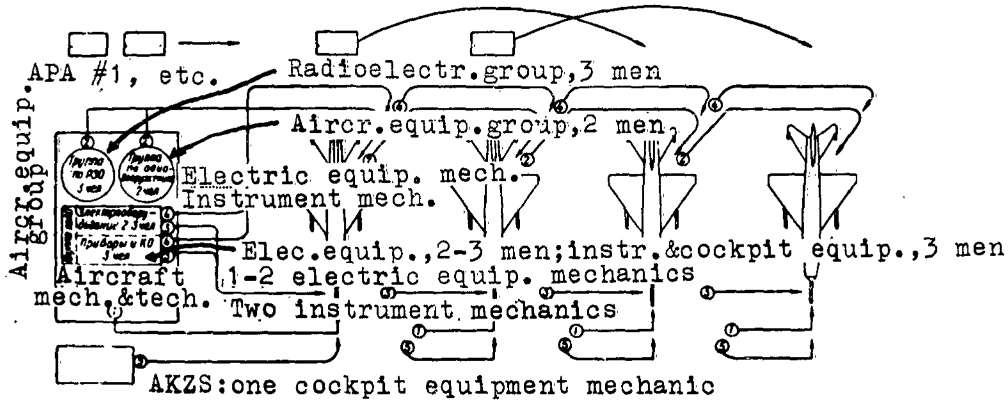


Fig. 1. Distribution of specialists in the flow-line group method of servicing.

The mechanic thought that a tube had failed. But there are many tubes in an automatic radio compass. Which tube had failed?

Morozov himself became convinced that the ARK was malfunctioning. But what was the cause? A profound knowledge of the basic circuits of aircraft electronic equipment and vast experience helped him find the answer to this question rapidly.

"Bring a 6 CZP tube. Apparently interelectrode contact has occurred in the tube of the antenna block."

This assumption proved to be correct. Indeed, after the tube was replaced, the ARK began operating stably.

The mechanic watched the actions of his chief with admiration.

"Do not be surprised, Levushkin. Two or three years ago, I had to eliminate such malfunctions rather often. You do not encounter them, since we now install in the aircraft tubes which have been aged on a special installation and a vibrator stand. Failures of tubes aloft are practically precluded."

Indeed, after many flight hours logged in the control sheets, there is not a single remark about the operation of radioelectronic equipment.

As is well known, the parameters of certain radio parts change with sharp changes in the temperature and humidity of the air. Circuits are detuned. Is it possible to forestall the appearance of malfunctions? Yes it is. And Morozov proved this in practice. Before flights under adverse weather conditions (or at night), he ages radio apparatus under current in order to warm, dry, and "break it in", spending only a few minutes on the entire operation.

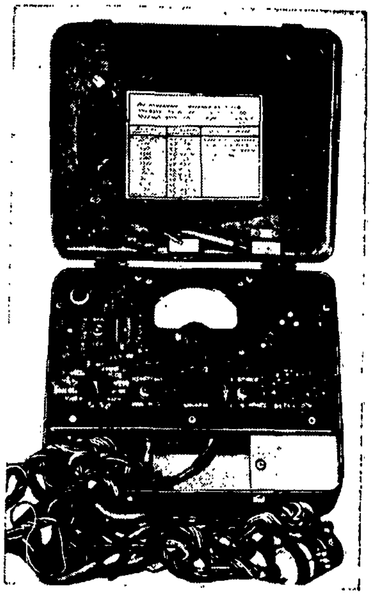


Fig. 2. Combination device for checking radioelectronic equipment.

It is true that at first there were difficulties with electric power, especially on a field strip where there is no central power supply. But the efficiency men extended the cables, making their diameters 3-4 times smaller than the standard cable of the APA, since the current magnitude for checking radioelectronic apparatus is several times smaller than for starting engines. Now with the aid of one APA, it is possible to check and age radioelectronic equipment in four aircraft simultaneously.

With the flow-line group method, it is most difficult to allocate the APA-2 among servicing groups effectively. The fact is that the efficiency of the radioelectronic equipment of aircraft can be checked on a field strip only by using mobile power sources. If the technical personnel have two APA-2M's at their disposal, they simultaneously service two aircraft. In one, preflight servicing is carried out by the specialists for radioelectronic equipment and weapons and, in the other, the aircraft equipment is serviced and the engine is tested by the technician.

During preliminary servicing the group makeup and the allocation of duties among the mechanics remain the same. It is natural that the volume of work increases, since one has to open the hatches and check the mounting of radio equipment.

What do the other mechanics of the servicing groups do? Let us take, for example, the same group under Morozov. His subordinates deliver spare parts and the installation for checking headsets to the flight line. In case of spotting a malfunction, they begin eliminating it upon instructions from Morozov.

After preflight and preliminary servicing in the aircraft, the group senior mechanic fills out the documents (the checklist or the servicing logbook).

The group chief works intensively: he must find time for many things. But is it not possible to make his work easier? Such an idea occurred to efficiency men N.

Kutuzov and N. Kalinichenko. They decided to replace several instruments used in the inspection of radioelectronic equipment by one, and this gave a considerable economy in time.

Indeed, with only one portable case, the group chief can measure the direct and alternating voltage, check the earphones and the throat microphones of the headset, tune the radio receiver set, and evaluate the efficiency of the receiver and the transmitter. The appearance and the basic electric circuit of such a combination device are shown in figures 2 and 3. How is it constructed?

Mounted in the case are a relay, a buzzer with KBS flashlight batteries, the head of a TT-1 [avometer] device, two blocks for connecting the headset, a pushbutton for switching on the buzzer, a socket for measuring the alternating voltage, two dial switches, three toggle switches, a pushbutton and a knob for setting the voltmeter at zero, a field indicator with a dial, a cuprous-oxide rectifier, a telescope antenna, and a cable system with plugs for switching the responder.

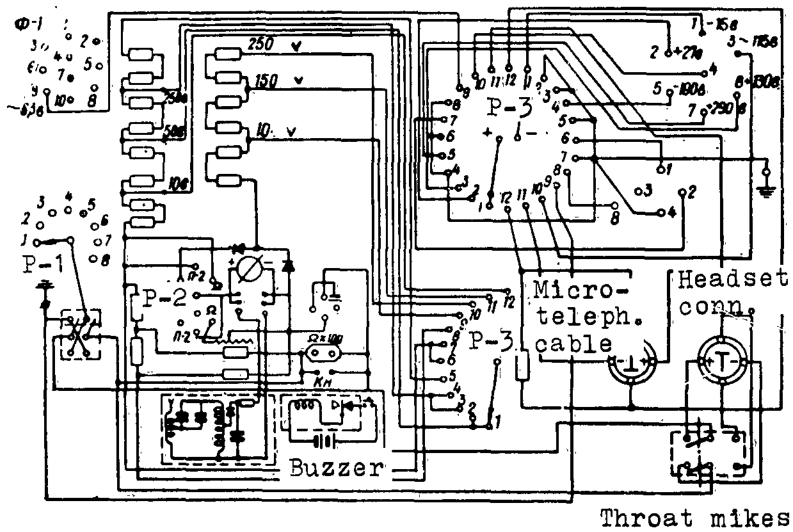


Fig. 3. Basic electric circuit of the combination device.

In order to check, say, the circuits of the headset earphones and throat microphones, they connect the headsets to the instrument block, set the "TLF - LAR" [Earphones-Throat mike] toggle switch in the "TLF" [Earphone] position and the dial switch in the "Ω" position. If the earphones are in good condition, the instrument will show the ohmic resistance of the throat microphones. If the earphone circuit is defective, the instrument needle will not deflect.

In order to check the throat microphones, they set the toggle switch in the "LAR" position. Tapping the throat microphones lightly or changing their position, they watch the instrument needle. It must swing between 1000 and 10,000 ohms. When the circuit of the throat microphones is broken, the needle does not deflect.

The instrument is also handy for tuning the receiver of the RSIU radio station. The headset is connected to the block of the aircraft mike-earphone cord (or the "I" block) and to the instrument. The dial switch is set in the "∞" position, and the "Measurement" toggle switch in the "Instrument Output" position; the voltmeter is connected in parallel to the headset earphones.

In order to evaluate the efficiency of the radio-set transmitter and check the modulation, they switch on the aircraft transmitter. Then the instrument needle deflects 3-4 calibrations (the transmitter is tuned to the appropriate wavelength which can be checked with the dial of the "Field Indicator"). The instrument is held up to 3 m away from the antenna.

When radio contact is made, the instrument needles swing within 2 to 5 calibrations. Depending on the crystal number, they choose the length of the instrument's telescopic antenna.

We shall not dwell in detail on the methodology of checking the rest of the radioelectronic equipment of the aircraft. Let us only say that with the aid of the device, a group chief can determine the radiation of the transmitting antenna of the radio altimeter, check the correctness of the actuation of the "Dangerous Altitude" warning device, the efficient condition of the receiver, and many other things.

OPERATION-BY-OPERATION CHECKING

As is well known the technology of each periodic regulation inspection job determines the procedure for carrying it out and names malfunctions and methods for eliminating them; but it does not say who must check what operations. Can, for example, a group chief or a technician check all the operations carried out by all the mechanics? Obviously not.

How then is operation-by-operation checking conducted in the outstanding group for periodic regulation inspection work led by Vladimir Il'ich Makarenko?

Established here are two stages of operation-by-operation checking. During the first stage, after the mechanic checks the mounting and conducts preventive work (relay cleaning, etc.), the apparatus is inspected by the group chief or the technician. During the second stage, which is the most critical, operation-by-operation checking is done after the mechanic checks those parameters of the apparatus which make it possible to judge its efficiency.

Now Mechanic V. Kuznetsov is finishing 100-hour periodic regulation inspection work on the automatic radio compass. Does Group Technician Bondarevskiy have to check on all his work from beginning to end? No. Upon the advice of Engineer A. Smirnov, they have singled out operations, the checking of which makes it possible to evaluate the quality of work as a whole. During the first stage, Bondarevskiy checks technological card number 4 and, during the second stage, cards number 17 and 18. There are only three operations. But they make it possible to evaluate the quality of periodic regulation inspection work. The operations to be checked in TECh [technical maintenance unit] are chosen with great care. The qua[illegible] of checking and of the work itself greatly depends on the correctness of the choice.

Using card number 4, Kuznetsov checks in the receiver the mounting, the tightness of the tubes in the panels, special devices, and the condition of the foil and mounting plates. The operation is over. But he does not begin the next one until his work is checked by Officer Bondarevskiy.

The technician inspects the wiring and the parts of the units dismounted from the receivers, seeing to it that there is no faulty insulation of the wires and no broken strands. He pays particular attention to cords and separate wires stretching behind the unit bodies or passing near the connector blocks. He makes sure that the transformers, capacitors, circuits, and other receiver parts are securely fastened to the unit chassis and that the capacitors mounted on their own leadouts have no traces of cracks, wire breakage, etc. Such great importance is attached to the quality of this operation because of the fact that failures can occur aloft during vibration due to defective wiring.

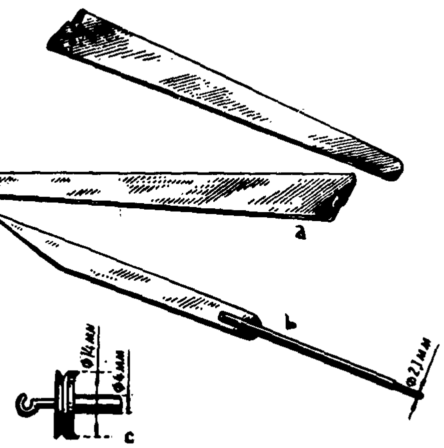


Fig. 4. Three devices made by the efficiency men: a-this makes it possible to remove electron tubes easily; b-this is intended for checking on the condition of terminals in the tube panels; c-with the aid of this device one can easily check the high-frequency connector.

In checking the wiring, a mechanic now uses a magnifying glass, a pair of tweezers, and various devices made by the efficiency men. With the aid of the magnifying glass, he inspects the resistor collars. Are there any cracks? He bends some parts with the tweezers and, using a mirror, inspects spots difficult of access.

Shown in Fig. 4, a is a very simple device. With the aid of it, one can easily remove a tube from a panel. This was previously done manually by shaking and loosening the bulb and the terminals. There is also another very handy device (Fig. 4, b). It is used in checking the condition of terminals in the sockets of the tube panels. For improving contact connection in the sockets, use is made of the wider part of the device (in the shape of a knife blade).

In inspecting the high-frequency connectors of radio apparatus, use is also very often made of a simple device — the calibrated probe (Fig. 4, c).

But what operations are envisioned in technological cards 17 and 18? The first is checking the maximum sensitivity for homing and bearing as well as the operation of the thermorelay. Using card number 18, Mechanic Kuznetsov checks the precision of graduation, the re-tuning of a frequency, the actuation time of the mechanism for preliminary frequency adjustment, etc. And the mechanic is, in turn, checked on by the group technician. And this is the second stage of operation-by-operation checking. Specific operation-by-operation checking and an improved technology of periodic regulation inspection work — all of these are links in the over-all chain of improving the operational reliability of radioelectronic equipment and forestalling its failures aloft.

A LITTLE ABOUT THEORY BUT MAINLY ABOUT PRACTICE

There is a concept called "reliability" in theory. This is not an abstract idea but the property of a manufactured item (element, unit, electron tube, etc.) to retain its parameters within prescribed limits under operational conditions. Reliability is the most important technical parameter of radioelectronic equipment and its inherent property. Moreover, it is of no less importance than such parameters as the amplification coefficient, power, sensitivity, etc. However, this parameter is so complex that, in order to express it numerically, one has to use various qualitative characteristics. Some of them are convenient for evaluating the reliability of parts — for example, radio tubes. Others are used for determining the reliability of systems. We shall not discuss all of them, since this question is beyond the scope of our article. Moreover, these characteristics are well known to specialists.

We shall point out that the reliability of radioelectronic equipment depends on operating conditions. Let us take the temperature of the ambient medium. Its fluctuations substantially affect the electrical parameters of circuit elements and the mechanical properties of parts. Besides deterioration in the mechanical strength of a structure, there may be a change in the original capacitive coupling between circuits and circuit detuning.

Increased humidity affects the electrical parameters of elements and causes the swelling of hygroscopic elements and metal corrosion.

The operation of radioelectronic apparatus is characterized by three stages (Fig. 5). The first may be called the initial, when the least reliable elements, i.e., those which have hidden factory defects, go out of service in the course of "breaking in". The initial stage ends in the factory. However, there may be cases when radio tubes are placed in operation before the long period of "breaking in" is over. It is therefore no accident that, due to an insufficiently correct rejection test and the rapid change of parameters, new radioelectron tubes are considered less reliable than those already broken in.

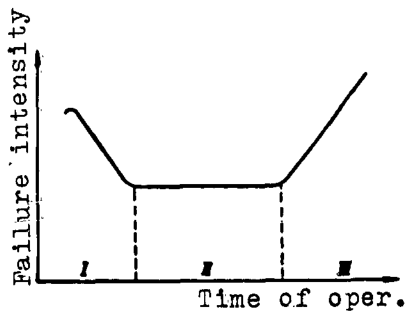


Fig. 5. Graph showing average intensity of failures of radio tubes as function of operating time.

The second stage (the longest one) is normal operation. At this stage the process of breaking in is over, while the wear and aging have not yet set in. The wear of elements which have a comparatively short service life does not manifest itself suddenly, since elements with deteriorated characteristics are replaced during periodic regulation inspection work.

Finally, the third section of the curve is the stage of wear and aging. Under operational conditions, this section as a rule does not manifest itself clearly, since apparatus undergo major overhaul at the beginning of it.

Engineer M. Titov and V. Titskiy well understand that all of this does not mean that malfunctions of radio apparatus, especially radio tubes, are unavoidable. But where is the main link with which, once grasped, it is possible to pull the entire chain, i.e., guarantee the reliable operation of radioelectronic equipment aloft? Obviously, it is in the initial stage at which the "childhood diseases" of radio tubes manifest themselves. The engineers decided to check all the radio tubes received from the depots or from the sets of spare equipment for long operation (for 20-25 hours) before installing them in the apparatus. This was exactly the key to solving the problem of increasing the operational reliability of radioelectronic apparatus.

But here is a question: where to get the necessary equipment? After all, subunits do not receive special installations for aging radio tubes. Just as in any new undertaking, there arose many difficulties. Engineer Titov was helped by efficiency men V. Volokhov and M. Zernov who built a special installation under his direction.

What is this installation? Shown in Fig. 6 are its main parts: the control and checking panel (1), two aging blocks (2), a vibrator stand (3), and a power supply block (4). Mounted in the blocks on the chassis of the ARK-5 radio compass are 56 sockets.

Both blocks are paired. They can be installed on a vibrator stand in two positions: vertical and horizontal. It is best to mount the installation so that the tubes may be located in a horizontal position.

Fig. 6. Installation for aging radio tubes: 1-control and checking panel; 2-blocks for radio tubes; 3-vibrator stand; 4-power supply block.

The installation receives power from two blocks of the RSIU-3M radio set, the input of which is supplied with a 115 v 400 c a. c. current (Fig. 7).

Mounted on the control and checking panel (Fig. 8) is a milliammeter, with which they check the voltage supply and determine the plate current of the electron tube being tested. The device is switched to five positions (1, P, NN, VN and ∽115). With normal supply voltage, the device needle is opposite the boss on the dial. The wide band is intended for checking plate current.

In case of short circuit inside a radio tube, plate voltage is cut off automatically. Here the 1000-ohm resistor limiting the current is switched on and one of the "Emergency" warning lights on the control and checking panel goes on. The light indicates the block where the faulty radio tube is located. By removing one radio tube after another, they find the faulty one, and the "Emergency" light goes out.

Located on the front panel of each block is a switch (for 28 positions) for connecting the miliammeter to the radio tube being tested, the power supply connector, and a fuse socket.

The basic connection diagram for triode, tetrode, diode, and kenotron radio tubes as well as the filament power supply is shown in Fig. 9. Other radio tubes are hooked up according to the same principle.

The control and checking panel was made by the efficiency men from the control panel of the ARK-5 radio compass. Mounted on it, besides the PMS-70 milliammeter for 1 ma, are the P_2 switch for 5 positions (Block I, Block II, d. c. voltage

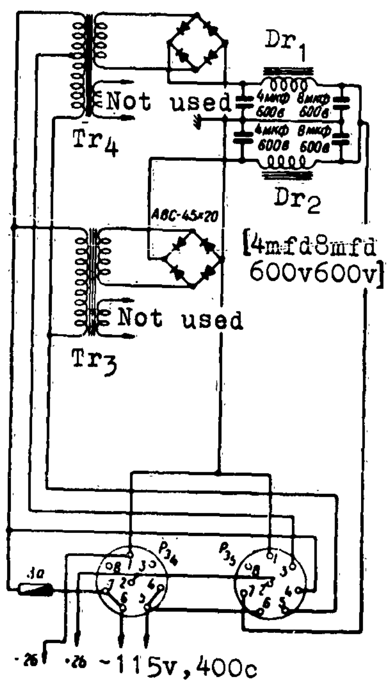


Fig. 7. Electric diagram of the power supply block of the installation.

control, 115 v high-voltage, and 400 c alternating current), jacks for connecting the earphones, two toggle switches for connecting the power supply and three plug connectors. Power supply control lamps Ls_1 and Ls_2 and "Emergency" warning lights Ls_3 and Ls_4 are installed on the panel.

The efficiency men made several installations. They sent one of them to the group for periodic regulation inspection work under Officer N. Kutuzov. They entrusted one of the experienced mechanics of TECh, Ivan Stepanovich Klepikov, with aging radio tubes.

It was not without excitement that Klepikov connected the installation to the power supply and flipped the switches on the control and checking panel. He set the switch in the 30 v, VN, and 115 v positions successively. The milliammeter needle pointed to the line on the red section of the dial. The voltage was normal.

The blocks were filled with radio tubes. It was now necessary to check their condition before beginning to age them. Klepikov mounted the block on the platform, set the vibration amplitude at 0.15-0.2 mm, and switched on the vibrator stand. Upon Engineer Titov's advice, he set the vibration frequency at 70 c.

Before beginning to age the radio tubes, Klepnikov checks the plate current of each tube with the milliammeter on the board. With normal plate curent, the device needle is in the prescribed (wide) section of the dial. If the needle moves to the left, this means that the emission current has decreased or the filament has burned out (the needle is in the extreme left position). During gas leakage or short circuit, the needle moves to the right.

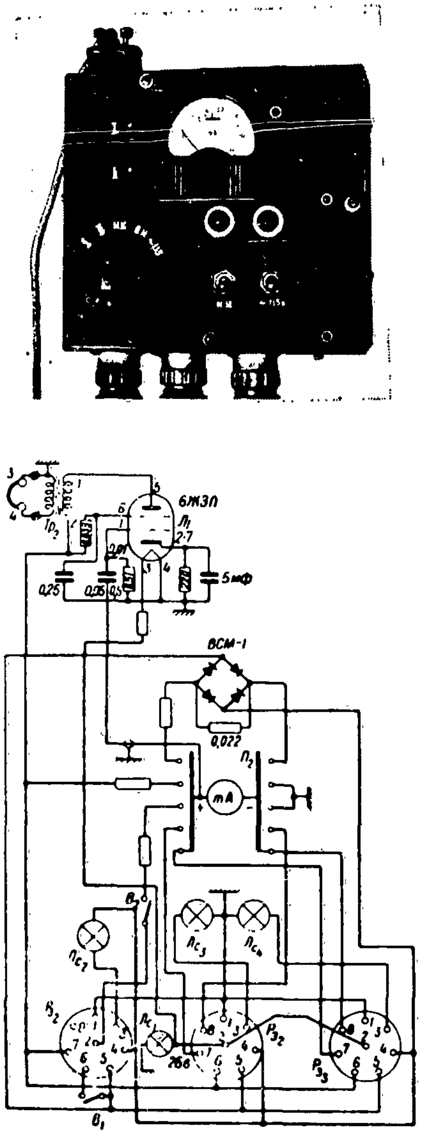


Fig. 8. The control and checking panel of the installation and the basic electric diagram of the panel.

With the earphones connected to the control and checking block, Klepikov made sure that there was no short circuit between electrodes (by monitoring the tone of sound vibration in the earphones). Later, this checking was improved on Engineer Titov's advice. In order to increase the noises taken from the device shunt, an amplifier was mounted in the control and checking block. The control grid of the amplifier was connected to the shunt of the radio tube being tested.

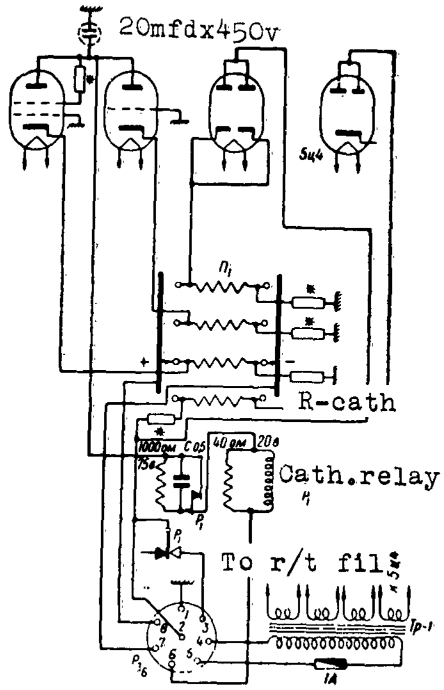


Fig. 9. Basic connection diagram for tetrode, triode, diode and 5Ts4 [kenotron] tubes.

Klepikov spends 15-20 minutes on such a checking of the conditon of radio tubes when the vibrator stand is in operation. After making sure that they are in good condition, he begins aging them. Then, after each 4-5 hours of aging, he repeats the shaking of the radio tubes on the vibrator stand and the checking on their condition.

After 20-25 hours of operation, Klepikov checks the radio tubes on the installation and then removes them from the blocks and begins their final check with the Il-14 or the MILU instruments. Klepikov once more makes sure that there are no breaks, short circuits, temporary contacts (by tapping the bulb of the radio tube with a cork hammer), or leakage between the cathode and the filament. He then checks on the vacuum and the emissivity of the cathode, and measures the transconductance at nominal and somewhat lower filament voltages.

A tube is considered faulty, if its parameters do not correspond to those indicated on the test chart and, when cathode emissivity is being evaluated, when the difference between the transconductance values measured at normal heating and underheating exceeds 30%.

There are different reasons why radio tubes were rejected in the course of aging. They include interelectrode contact, filament burnout, low transconductance, etc.

Klepikov paints the letter "T" on the radio tubes which have been aged. Such tubes are stored by Group Chief N. Kutuzov in a special cabinet.

Only aged tubes are now installed in the aircraft. Thus, it has been possible to increase sharply the operational reliability of radioelectronic equipment.

These are only the first results. But we see that the new practice has become established and is of great use. Nevertheless, Mikhail Ivanovich Titov continues to search for new more objective methods of checking radio tubes while aging them and is already thinking of how to improve the installation.

"The installation can be modified", he says. "A filament circuit bypass still has to be installed. There is a hum from filament voltage. How to eliminate it? It is necessary to install filters in the filament and plate-voltage circuits. We can then separate the plate voltage from vibration noises. The plate voltage will change, depending upon the oscillation frequency of radio-tube grids or their closeness, and it will be possible to evaluate the condition of radio tubes objectively with the aid of an oscilloscope."

Thus, in the subunit they answer with specific deeds the question of how to increase the operational reliability of radio tubes. One of the sure ways is aging and rejection — by testing them on the special installation and the vibrator stand.

PREPARING MAN for WEIGHTLESSNESS

A. YEREMIN, I. KOLOSOV, V. KOPANEV,
V. LEBEDEV, N. POPOV, G. KHLEBNIKOV

A factor which complicates man's stay in outer space is weightlessness.

The question arises regarding ways and means of increasing man's tolerance of weightlessness to a level at which he can live and work under such conditions. At first glance it may seem that the formulation of the problem contradicts accepted logic. Indeed, how can this be accomplished if man spends all his life within the sphere of the gravitational effect? It turns out, however, that this is possible. The experience of flights by the Soviet cosmonauts confirms this.

In order to elucidate the basic principles involved in the preparation of cosmonauts for weightlessness, we must first of all analyze the habitual activities of man on Earth and determine whether man ever encounters weightlessness under terrestrial conditions.

From an analysis of man's terrestrial activities we learn that man quite often experiences effects of so-called partial weightlessness. This occurs, for example, when man walks, runs, jumps, swings, etc. A biomechanical analysis shows that, during running and, all the more so, during jumping there is a brief phase of unsupported flight, i. e., man essentially for a certain time (fractions of a second) is in weightlessness.

During man's walking there occurs a change in gravitation at the beginning and at the end of each step and so on. According to data developed by V. Voyachek and K. Khilov, in the process of swinging, man is subjected to intermittent vertically directed g-forces of the order of $\pm$ 0.4-0.5 units. Let us recall our sensations during a ride in an elevator when the support seems to drop from beneath our feet. This, too, is a condition of brief partial weightlessness, as noted by Soviet scientists V. Gurfinkel', P. Isakov, and others. Moreover, weightlessness can be simulated by immersing man in water. It is possible to select a salt concentration which will keep man in a weightless state. Making use of this fact, scientists reproduce certain characteristics of the state of weightlessness by placing test subjects in various liquid mediums.

Thus every man constantly encounters brief partial weightlessness. We can even say that in the course of his terrestrial life there are generated in him and, under certain definite conditions, perfected physiological mechanisms which enable him to tolerate relatively prolonged states of weightlessness. This explains, to a certain extent, man's successful beginnings in space penetration as well as the fact that the first cosmonauts were fighter pilots.

However, a natural immunity alone is not enough. In order to preserve in man a normal ability to work under conditions of spaceflight, it is necessary to raise his tolerance of the weightlessness factor to a maximum. This can be achieved by special training, the nature of which is determined by a knowledge of the mechanism involved in the effects of weightlessness ~~on the organism.~~ The diagram shows the basic mechanisms of physiological reactions under conditions of weightlessness.

We arbitrarily differentiate between direct and indirect effects of weightlessness. The direct effects explain reactions which arise as the result of a sudden physical decrease ("disappearance") of weight in tissues and organs. Here the top limit of blood pressure drops about 10-15% relative to the initial value, the act of exhalation becomes more difficult (under terrestrial conditions it is performed passively, to a certain extent under the effect of gravity), there is a certain disordination of movements (under terrestrial conditions in his movements man unconsciously takes into account the weight of his limbs, while under weightlessness weight "disappears"; yet the stereotype of movements persists for some time), etc.

The sensory apparatus of an organism undoubtedly does not remain unaffected by such changes in physical conditions as the absence of weight and transmits signals to the central nervous system concerning these. The central nervous system receives a great number of unusual signals from almost all the receptors and, as a result of this, there occurs a change in the course of the basic nervous processes (stimulation and inhibition) and the coordinated work of the analyzers is disrupted.

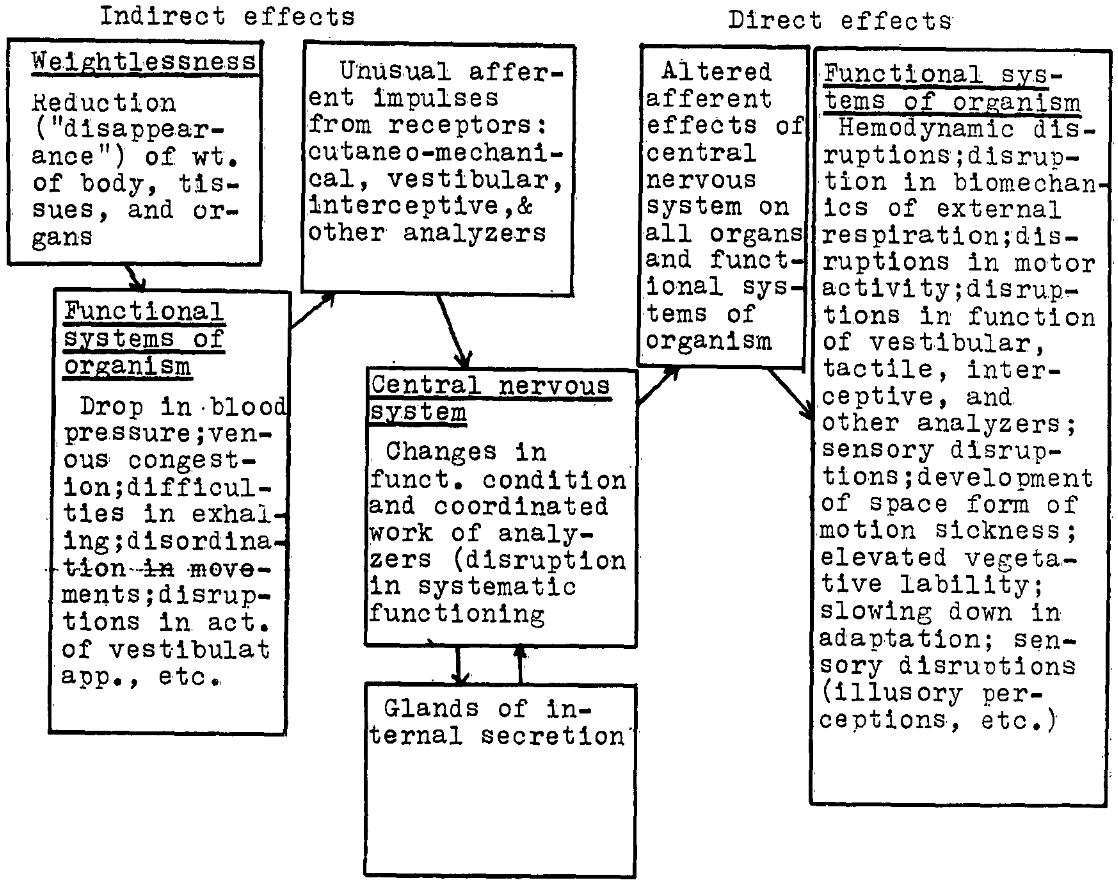
The fact of the matter is that, under habitual conditions, the central nervous system receives every second a continuous stream of information on the changing state or attitude of the parts of the body or organs.

As a result of innumerable practical tests in the course of daily activity, the central nervous system is capable of amazingly refined balancing of the organism in relation to the constantly changing conditions of the external medium. For example, the perception of gravity has always been reinforced by visual, muscular, and cutaneous sensations.

Under conditions of weightlessness habitual signalization almost disappears as a result of the absence of terrestrial gravity, yet the visual perception remains unchanged. Higher regulating mechanisms experience great difficulties: on the one hand weight is absent and there is also no clearly defined up or down; on the other hand the organs of sight generate the information that, with respect to surrounding objects, there is no change in attitude. And while this dissociation of perception persists, the central nervous system itself temporarily loses its control over the vegetative and other functions. There appears the space form of motion sickness, an instability of pulse, spatial illusions, etc. In such a case, we speak of the indirect effects of weightlessness on the human organism.

Investigations of the physiological mechanisms make it possible for us to outline the basic principles of a training program for men. The training must essentially be aimed at perfecting the regulating physiological mechanisms in a changing external medium under terrestrial conditions. If man can maintain his ability here to work at a sufficiently high level, then he will, to a certain extent, tolerate the effects of weightlessness in space. The entire training program for cosmonauts consists precisely of such elements. Let us give two examples in support of this proposition.

Effects of Weightlessness on Organism



For the purpose of studying the neuropsychic tolerance in cosmonauts under conditions of prolonged isolation from the outside world, studies are made with the use of an isolation chamber. Due to the limited size of the chamber, the limitation of movements and the absence of external stimuli, the stream of information reaching the central nervous system from the sense organs is reduced and this disrupts the habitual coordination of the brain analyzers as a whole. The overcoming of the new conditions and the setting up of new links between centers as well as new relationships, the changeover of the central nervous system to a new level of functioning — all this tends to increase the plastic characteristics of the central nervous mechanisms. This fact appears to be the basis for a more rapid and fuller adaptability of the organism to the changes in the external medium and especially to the unusual conditions of weightlessness.

And here is another example which includes the vestibular training with the use of various types of stands: the Khilov swing, rotating apparatus, stands with unstable support and with optic-kinetic stimuli. As a result of such training, there was an improvement not only in the tolerance of the vestibular analyzer to appropriate stimuli (if we consider that weightlessness tends to develop motion sickness) but also conditions developed for considerable changes in signalization from the various organs and systems. For instance, during swinging the vestibular, cutaneous, interceptive, and visual analyzers are stimulated. These phenomena are also observed during rotation and other effects. Here again the neuro-reflex mechanisms regulating the physiological functioning in the higher areas of the central nervous system (the brain cortex) are improved.

Table 1

Changes in the Pulse and Respiration Rates in Test Subjects During Introductory Training Flights on a Weightlessness Parabola

Test subjects	Indices	Before flight	"Zooms"	Horiz. flight	g's	Weightlessness in sec.			g's	Horiz. flight	After flight
						10	20	30			
KOMAROV, V.M.	Pulse	66	1	70	78	66	60	60	—	68	
			2	68	76	60	60	60	76	68	
			3	68	-	54	54	54	76	66	60
	Resp.	14	1	14	18	16	14	16	18	14	
			2	14	-	14	14	14	18	16	
			3	16	18	14	16	16	18	16	14
FEOKTISTOV, K.P.	Pulse	64	1	-	110	90	90	84	96	90	
			2	90	100	-	-	-	105	84	
			3	84	102	90	86	76	98	78	68
	Resp.	14	1	-	20	21	18	18	18	18	
			2	18	-	18	16	18	24	18	16
			3	18	21	20	18	16	18	16	
YEGOROV, B.B.	Pulse	72	1	108	126	98	98	102	-	100	
			2	100	110	96	84	90	-	90	
			3	90	114	84	84	84	-	-	69
	Resp.	16	1	-	20	24	24	24	-	20	
			2	22	20	-	-	-	-	22	
			3	22	30	-	-	-	-	-	18

An analysis of training programs in use makes it possible for us to conclude that, in a number of instances, they affect the same mechanisms of adaptation. In the course of training the tolerance of spaceflight factors increases and, at the same time, neuro-reflex mechanisms and the coordination in the functioning of analyzers are improved.

Table 2

Vestibular and Sensory Reactions in Test Subjects During Introductory Training Flights (data on three flights)

Test subjects	Vestibular react.				Behavior of test subject under condition of weightlessness (based on moving-picture data)	Subjective sensations of test subjects under condition of weightlessness
	Ill. of counter-rotating		Post-rot. nystagmus			
	Before flight	After fl.	Before fl.	After fl.		
KOMAROV, V.M.	10 8 8	10 6 4	12 11 15	7 9 9	Adequate to flight conditions Movements coordinated	In weightlessness had sens. of pleasant lightness. No deterioration in way he felt. Working ability no worse. Weightlessness flights seemed much like flight in zone
FEOKTISTOV, K.P.	4 4 4	2 4 3	14 15 15	15 12 15	Adequate to flight conditions. Moderate inhibition in movements. Slightly on alert	During flight felt well. Mood & working ability excellent. After flight also felt just as well
YEGOROV, B.B.	- - -	- - -	16 17 14	17 17 14	During first flight on alert and somewhat tense. In subsequent flights acted calmly	First flight did not produce pos. impression. Freq. shifting of g-forces left impression of "heavy physical labor. On second flight sensations more interesting. Performed work easily & quickly Noticed no illusions. Slight euphoria. On third flight felt well and ability to work was good

The medico-biological training of cosmonauts provides also for stages of direct familiarization with conditions of weightlessness. This is achieved during aircraft flights along a Keppler parabolic curve. Here the period of weightlessness lasts about 25-45 seconds. Such flights are very important in exposing the cosmonauts to weightlessness and for increasing their tolerance of this factor. The fact is that, during these flights, prior to and after the state of weightlessness, g-forces are in effect, i.e., there is an intermittent effect of g-forces and weightlessness. Here again the cosmonaut is exposed to unusual conditions, under which his neuro-reflex mechanisms improve. Hence it follows that aircraft flight along with other types of training effects comprise one of the ways of increasing tolerance of weightlessness.

In tables 1 and 2 there are some interesting data on the physiological reactions of subjects during their introductory flights on a weightlessness parabola after a preliminary cycle of ground training within the cosmonaut training program.

It is apparent that the physiological disruptions are very slight. This is not only the result of the specific training or reduction of the neuro-emotional tension but also the result of increased tolerance of weightlessness after the subject has undergone a broad program of ground training.

Of no small importance is the reduction of neuro-emotional tension during repeat flights. The novelty of sensations gradually disappears and such sensations become habitual. The sensation of unaccustomed free floating ceases to surprise the subject. Man adapts himself to these unusual conditions.

Journalists Ye. Manucharov and B. Konovalov interviewed a group of scientists on the topic of "Who Is Fit To Become a Cosmonaut?", this interview having been published in the newspaper Izvestiya for 17 October 1964, No. 249.

Participating in the discussion were: Active Member of the Academy of Medical Sciences A. Lebedinskiy, Doctor of Medical Sciences F. Gorbov, and Doctor of Medical Sciences Yu. Nefedov.

Generalizing the statements made by the scientists who participated in the discussion, journalists Ye. Manucharov and B. Konovalov recorded the following:

At the present time every able-bodied man in good health can become a cosmonaut, i.e., the conclusion being that supposedly the requirements in the professional selection of cosmonauts can be reduced.

In our opinion such an assertion is premature.

We feel that cosmonaut candidates must still pass a careful medical selection and undergo systematic and comprehensive special physical training.

In conclusion it must be pointed out that a high tolerance of weightlessness can be developed on the ground as a result of a purposeful medico-biological training program.

THE YURIY GAGARIN SCHOOL

On an autumn day in 1963 there assembled a group of high-school seniors, applications in hand, at the Orenburg Higher Military Aviation School for Pilots. What brought them here was an announcement published in the regional newspaper to the effect that a community school for young cosmonauts was opening, ready to register upperclass high-school students.

Administrators of the school for young cosmonauts, retired officers N. Maruyev, Hero of the Soviet Union V. Klimov, and I. Zubov.

Many candidates desiring to enter the school had gathered. The school organizers had not anticipated the difficulties involved in selecting the required number of students from among 832 youngsters. They saw tears appear in the eyes of Vitya Merzlikin who was "rejected" by the medical board. His tonsils were the reason. "Don't be discouraged," the physician comforted him. "Get rid of your tonsils, get yourself in shape, and you may be admitted next year." But this was no comfort! Vitya went straight to the hospital and asked that he be operated on immediately. Before this he had been offered such an operation many times but would not have it. Yet now, when his acceptance to the school for young cosmonauts depended on it, he asked for it himself. The operation was performed and he is now enrolled in the school. It was impossible to refuse this youngster who was so set on his goal.

Not every city has such "intimate" ties with aviation as Orenburg. After the Civil War, the citizens of Orenburg witnessed the beginnings of our glorious Soviet aviation. It was here, over the expanses of the steppes, that Valeriy Chkalov went aloft in his aircraft; and it was here that Sergey Gritsevets, Ivan Polbin, Anatoliy Serov, and many others who wrote pages into the annals of Soviet aviation with their glorious deeds learned to fly. One-hundred-and-seventy-two graduates of the Orenburg Aviation School have earned the lofty title of Hero of the Soviet Union. Twelve of these earned it twice. From the walls of this school also came the first cosmonaut in the world, Yuriy Gagarin. He too learned to fly in the skies over Orenburg.

This was precisely what was taken into consideration by the regional committee of the All-Union Young Leninist Communist League in trying to find ways of helping romantically-inclined lads who were dreaming of performing feats in the name of the Motherland. The first man to respond to the regional committee's invitation was a pilot who was well known in Orenburg — the indefatigable organizer, Hero of the Soviet Union Lt. Col. (Ret.) V. V. Klimov.

Vasiliy Vladimirovich is a graduate of the Orenburg Aviation School where he earned the title of Military Pilot. He entered the fight with the Fascist invaders as a squadron commander. He fought bravely. To his credit he has twenty-seven aircraft shot down. But his illness forced him to leave aviation. Twenty years passed and throughout all this time he never broke his contact with aviation. In his work he helps aviation, propagandizing its successes and the combat traditions of pilots.

Trainees Vladimir Shostak and Anatoliy Trokhov are becoming acquainted with a pressurized chamber.

A look of joy was sparked in the eyes of Klimov when he was offered the job of heading the community school for young cosmonauts. This was when he really got busy. He had a talk with the director of the school, Hero of the Soviet Union Maj. Gen. of Aviation I. A. Kulichev and with the chief of the section on political affairs, discussing with them the idea of organizing the school. He had meetings with instructors, trying to find among them volunteers and enthusiasts who would organize and conduct classes. He sought out retired personnel, endeavoring to determine who among these could assist him in this noble task.

The chief of the aviation school's political section, retired Col. Nikolay Semenovich Maruyev, joined the school. Retired Col. Ivan Prokof'yevich Zubov undertook the staff work and the school began to function.

...Only recently have the trainees left the classroom but the room did not long remain idle. It was soon filled with boys wearing dark blue uniforms which did not at all resemble those of the cadets. On their tunics the boys wear narrow shoulder straps with aviation insignia. These are the students of the young cosmonaut school.

The school developed all the environment necessary for the training of young cosmonauts. Experienced instructors are teaching them. For more than fifteen years

Engineer Lt. Col. O. Shlapintokh has been training aviation cadres. In the school he is known as one of the best methodologists. Among officers and students, instructors A. Pashkovskiy and I. Maslikov — men who love aviation — enjoy a fine reputation.

The school's deputy chief for political indoctrination, Nikolay Semenovich Maruyev, tells with great pride about his boys:

"They all found their places. Some of my acquaintances doubted the success of this undertaking. They felt that the boys would tire of it. But they were wrong. What boy can fail to respond to accounts of aviation, space, and flying? Our students frequent all the mass military and sports events at the school. They have also spent some time at camp, getting physically conditioned, and they also work on a sovkhoz. And by the way, they earned the money for an introductory flight in an aircraft themselves. I think it's pretty good when boys don't want to be supported by anyone."

Lt. Col. A. Pashkovskiy introduces the students to the equipment in a cockpit.

No, the students are not looking for an easy way out. It is not the uniform nor the name of the school that brought them here. We talked with Slava Gerasimenko, a tall, swarthy fellow with an open and smiling face, On his tunic Slava wears the chest insignia of a parachutist. The story of this insignia also involves dreams of feats and the romantic profession of a pilot-cosmonaut. Slava was aware of the fact that parachute jumping could facilitate his road into aviation. He joined an aeroclub and successfully combined his studies in two schools and the aeroclub. To make his jumps, Slava had to go to Orsk. But no matter what the difficulties nor how great the distances, nothing could stop him. Slava has his followers. When we talked with the students, I noticed several boys wearing parachutist's insignia.

"Do you like the school?" I asked the boys.

"And how!..." they all answered almost in unison.

"And what do you like best?"

"The classroom work," said Vitya Abakumov. "It seems to me that I have grown a little taller this year and can see far, far away. What did I know before about aviation? Almost nothing. In this school I have learned a lot about aviation and the work of a pilot. And what a lot of interesting things I have learned about the heroes who graduated from this school!"

Volodya Lukoyanov continued Vitya's remarks:

"You know what I like about this school? You don't feel like an ordinary schoolboy but you feel as though the road is open for you into the world of technology, into a heroic world. And others also feel that you are worthy of pursuing this road."

Volodya entered the school on the sly and his parents did not know anything about it. When the board decided that he was fit for flying and the airborne service, he then told his folks. At first his father and mother opposed their son's intent: they thought it would be difficult for him to study in two schools. But he proved that this could be done.

Among the enthusiasts there are quite a few who came to the school following a family tradition. Igor' Yakovlev's father and grandfather had both flown. Viktor and Vyacheslav Kryuchkov's father had been a military pilot. Following in their fathers' footsteps are Lupayev, Kosevanov, and Yashenin.

The boys in the young cosmonaut school are growing up. Their good reputation spreads throughout the city. The amateur concert which they presented had to be televised twice. In the general education schools there appeared unique propagandists of our Army's military traditions. On Aviation and Cosmonautics Day the students conduct conferences and give reports.

And when the school administration invited the parents to a meeting many words of gratitude were spoken addressed to the collective of the school for the tremendous work which it is doing in teaching the upperclass pupils. After all, there is not a single boy who failed to improve his scholastic standing.

Previously Volodya Zakharenko used to be reprimanded frequently. Often his behavior in the streets was not too good and his school record was poor. But now this lad is very well disciplined. He has been appointed the standard-bearer in the school of young cosmonauts.

"I don't recognize my son," Gena Nikitin's mother said. "He studies well now and helps me around the house. Nothing like this happened before. Now he brings in books about heroes and talks a good deal about pilots and cosmonauts. He says he wants to go to a military school." And Gena Nikitin is not the only one who thinks this way. For most of his classmates their road ahead is clear — a military aviation school. Which one? Of course, the same Orenburg school. The one where they were introduced to aviation and cosmonautics.

"It is a great joy for me, a graduate of this school," writes the First Cosmonaut, Yu. A. Gagarin, to these boys, "to realize that worthy replacements of Soviet cosmonauts are growing up and maturing. I wish you, the young cosmonauts, further successes in your studies and good health so that all your dreams may come true." And this admonition to the boys is like a good send-off and best wishes coming from a senior comrade.

And what about those who will not become pilots or cosmonauts and who will choose other roads? They, too, will benefit by their studies at the school, since they will always love aviation, have respect for their teachers, and gratitude towards the people who opened the door for them into the world of military and technical knowledge.

Lt. Col. I. ALEKSEYEV

POWERPLANTS for SPACEFLIGHT VEHICLES

SOME SPECIAL FEATURES OF FLIGHT

Maj. Gen. of the ITS T. MEL'KUMOV,
Professor, Doctor of Technical Sciences

From the time that man became interested in outer space, the stars, and the planets, he set out to seek for means of investigating these phenomena. The launching of Earth satellites and Moon rockets gave a new impetus to the development of space vehicles and engines for flights within the solar system and beyond.

Spaceflight vehicles may be of two types: those using only rocket engines (regardless of the principle of operation) for travel; and those having some sort of devices for aerodynamic (atmospherodynamic) maneuvering in the dense atmospheric layers.

For the purpose of travel and maneuver control in space, on-board powerplants are required. In one case these must be engines with a relatively high thrust which are capable of imparting high accelerations to the flight vehicle; here the duration of their operation will be limited, since the development of a high thrust involves high per-second consumption of fuel. A high thrust output capability will most probably be required for a space vehicle's liftoff from the Moon and other planets, for reaching the second cosmic speed in leaving the Earth's orbit, or developing appropriate speeds in leaving orbits of other planets, and so on.

In another case the problem of applying thrust over the entire period of vehicle travel in space for supporting an economical and fully controlled flight may be of paramount importance.

It is well known that, as a result of the effect of a small reaction force on a body, it is possible to develop the same speed as under the effect of large forces. True, in this case the force will have to be applied over an extended period of time.

If a rocket is launched from the Earth and must travel to the nearest planet and back, the duration of flight may amount to a year or more. In such a flight it may be well to employ even a small reaction force, since it is then possible to increase the speed and, consequently, cut down on the overall time of flight.

In many instances a spaceflight vehicle with a small thrust output and with the same initial weight as in a similar rocket with chemical propellant will be capable of hauling large cargoes in space. In order to have a vehicle with a circular orbit escape Earth's gravitation, it has to be imparted an escape velocity of 11.2 km/sec. In other words, it must be imparted a velocity increment of the order of $\Delta V \approx 11.2-8 = 3.2$ km/sec. The magnitude ΔV is called a characteristic velocity in the literature. This velocity determines the amount of energy which must be imparted to the vehicle for performing a planned maneuver. For the energy sources on board, the magnitude of this velocity is important because, with a definite economy of the powerplant, it depends on the consumption of the working body (propellant in the rocket engines). Depending on the consumption or the thrust output, we can determine the duration of the transitional process required for reaching the needed characteristic velocity, the latter being determined for the simplest case by the well-known K. E. Tsiolkovskiy equation.

Let us give the characteristic velocities (in km/sec) for certain specific space vehicle flights:

Course velocity near Earth	7.8
" " " Mars	3.4
Velocity of escape from Earth	11.2
" " " " Moon	2.4
" " " " Mars	5.27
" " " " Venus	10.4
Transition from circular Earth orbit to another with change in orbital plane from 0° to 5°	to 1.5
Transition from circular Earth orbit to another with change in orbital plane from 15° to 45°	1.5-6.0

In order to perform several maneuvers, it is necessary to sum up the characteristic velocities of each individual maneuver or each individual stage of the flight. From the point of view of power requirements, it is most important to select elements of maneuvering or flight which give us the minimum magnitude of the resultant or full characteristic velocity. Here the overall weight of the powerplant and the working body needed for carrying out the mission is minimum.

PRIMARY ENERGY SOURCES

After the successful insertion of heavy ships into Earth satellite orbits, the possibilities for mankind have become considerably broader. The problem of new engines which cannot be used on the surface of the Earth in practice but which may prove to be efficient in space has become urgent.

Such powerplants include the electrorocket (plasma and ion) engines. The ion engine, for example, may be described as consisting of two parts. There is a powerplant which generates primary energy (usually thermal) that is then converted into electrical energy. This electrical energy is ionized (in another part of the engine), accelerating the working body to very high velocities (up to 100 km/sec and higher).

Chemical, solar, or atomic energy may serve as sources of primary energy for shipborne powerplants.

Chemical energy is generated as a result of fuel oxidation. The heat of this reaction may serve as the source of thrust in liquid or solid fuel rocket engines. This method enables us to design the lightest powerplant which, even with a high velocity of travel, is the most economical of all the thermal engines which use chemical energy.

Chemical energy may be converted into mechanical energy and then into electrical energy in a turbogenerator system, this forming a closed process. However, such a powerplant will be inferior both in weight and economy to a rocket engine of a space vehicle.

Solar energy may be utilized in two ways: in the form of heat energy or by way of light pressure for immediate thrust. The heat of solar energy is focused in an accumulator and then directly converted into electrical energy or else the conversion is effected with the use of a special turbogenerator.

The use of the Sun (as the energy source) seems especially attractive. And this is understandable, inasmuch as solar energy is practically inexhaustible. Moreover, in this case use is made of an energy source which is not a component of the rocket. However, this involves unique difficulties. Thus, for example, the amount of energy reaching the accumulator surface per unit is, on the whole, quite small. This essentially depends on the distance to the Sun and the orientation of the vehicle.

In the immediate future, atomic energy will be obtained as a result of the fission of heavy nuclei (of uranium or plutonium) under the effect of neutrons in special reactors, a process developed within the field of energetics. Nuclear reactors with controllable fission are capable of great energy outputs. A tremendous power output can be obtained as the result of nuclear fusion of light matter. However, the realization of controlled thermonuclear reactions is still a matter of the future.

An even greater amount of energy will be generated in the process of annihilation, i.e., in the process of the complete conversion of matter into energy. The realization of this process involving accumulating, storing, and controlling the encounter of the required quantities of matter and anti-matter (for example, of protons and anti-protons) is even a more remote prospect.

Energy may be also obtained as the result of α- or β- decay of radioactive isotopes.

Here are some data which show the energy content of one kilogram of nuclear and chemical energy sources in kilowatt-hours. The data on solar energy naturally are given in other terms, namely: power output for 1 m^2 of surface in an Earth orbit. With the longer distance from or the shorter distance to the Sun the power varies inversely with the square of the distance. Thus for 1 m^2 of surface on Mars, which is approximately 1.5 times farther away from the Sun than the Earth, there is about 2.3 times less energy reaching it than per unit of the Earth's surface.

In Fig. 1 we give a diagram showing the energy conversion of primary sources into terminal energy in the required form. It may be seen from the diagram that

Energy Content of Various Energy Sources

Energy source	No. of kilowatt-hrs of energy per 1kg of energy source
Chemical energy	1.7-2.7
Fusion of light nuclei	$9.4 \cdot 10^7$
Fission of uranium nuclei	$2.4 \cdot 10^7$
Radioisotopes	$1.5 \cdot 10^3 - 5 \cdot 10^5$
Annihilation	$2.4 \cdot 10^9$
Solar energy at Earth's surface	$1.3 \frac{kw}{m^2}$

electrical energy can also be obtained from chemical and solar energy. The electrical energy is not the end goal in the conversion chain. For thrust generation, electrical energy is utilized as an effective means for accelerating a suitable working body up to very high velocities.

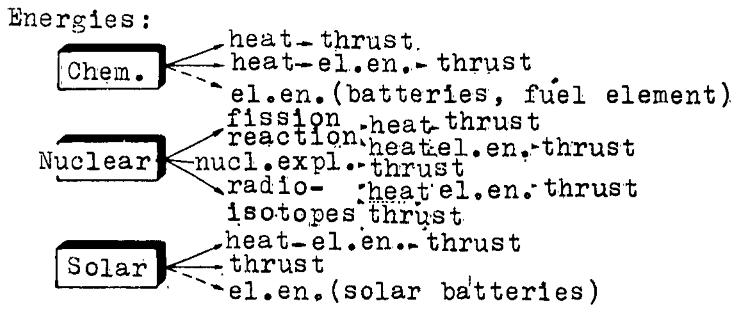


Fig. 1. Diagram showing energy conversion of primary sources into terminal form of energy (broken lines show the conversion processes of no practical interest).

Electrorocket engines use electrical energy for heating up and accelerating electromagnetically the plasma or for the purpose of accelerating the fully ionized working body in an electrical field. The electrical energy enables us to obtain the very high exhaust velocities of the working body and, therefore, values of specific thrust which would be unattainable in rocket engines utilizing chemical energy.

ENERGY CONVERSION

The conversion of heat into electrical energy is possible in principle by pursuing two different courses. The first of these involves the use of a thermal machine which produces the required thermodynamic cycle and which has a steam or gas turbine connected to an electric generator. The second course involves a direct (without machines) conversion of heat into electrical energy. With prolonged and continuous operation it is highly desirable to avoid designs which include moving or rotating parts. Otherwise the achievement of required reliability of the powerplant in the space vehicle might be doubtful.

We can quite definitely claim that, when the problem of direct conversion of heat energy into electrical energy (with high efficiency and reliability) is solved, the problem of heat machine application with the many chains and limited reliability involved will no longer exist.

For direct conversion of heat energy into electrical energy, thermoelectric, thermoelectronic, and magnetohydrodynamic generators as well as semi-conductors are used.

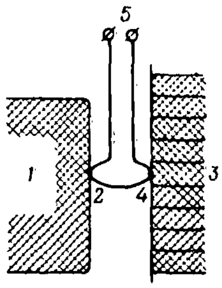


Fig. 2. Diagram of a thermoelectric generator (thermocouple): 1 - heat source; 2 - hot junction; 3 - heat radiator; 4 - cold junction; 5 - terminals for connecting load.

A thermoelectric generator is made up of a set of thermocouples, the hot junction of which is built into the heat source, while the cold junction is linked to the heat radiator. When there is a temperature differential between the hot and the cold junctions, an electromotive force is generated. The magnitude of this force depends on the properties of the metals which make up the thermocouple and the temperature differential between the hot and cold junctions. This principle is utilized in the Soviet "Romashka" in which nuclear energy is converted into heat and the latter converts directly into electrical energy. The output is 0.5 kw.

The schematic diagram of a thermocouple is shown in Fig. 2. The voltage and current which can be obtained by using a single thermocouple are very small. For this reason they are connected in series and in parallel in order to obtain the necessary voltage and current. Thus in one of the existing installations (SNAP-10A) with an output of only 0.5 kw there are 700 thermocouples. The top efficiency of this installation amounts to only 2-4%.

It is hoped that in the near future the power output of such installations will increase to the order of 50 kw and, with a selection of compatible couples capable of operating reliably with a temperature of the hot junction, the efficiency will rise to 20% or possibly 30%.

At the present time the attention of specialists is focused on thermoelectronic generators as energy sources of rather high power output. The simplest diagram of such an energy converter is shown in Fig. 3. The cathode and anode are separated here and placed in a vacuum or a highly rarefied ionized medium (cesium couples may serve as such a medium). The cathode is heated to such a point that, under the effect of heating, it becomes a source of electron emission. The anode, on the other hand, is cooled and serves as an electron collector. The energy of the electrons must be such that it can overcome the surface potential barrier and can reach the anode.

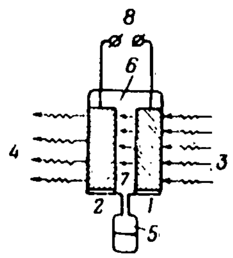


Fig. 3. Diagram of thermoelectronic generator: 1-hot cathode; 2-cold anode; 3-heat source; 4-heat radiator; 5-vessel with cesium; 6-vacuum chamber; 7-electron stream; 8-terminals for connecting external load.

The introduction of an ionized gas is one of the ways of reducing the space charge between the electrodes and thus increase their emission. For this purpose, it is possible to use also a high vacuum and a short gap between the electrodes.

The cathode temperature in prolonged operation goes up to 1400-1800°C, while in brief operation with a tungsten cathode it can rise to 2000-2200°C.

For a small power output (0.5-1.0 kw) the cathode is heated by radioactive isotopes or by solar energy, while for high power output it is heated by a nuclear reactor. The anode in cooling emits heat into the surrounding space.

The cathode and the anode in a thermoelectronic generator form a unique kind of diode.

Magnetic triodes have also been developed. Here an accelerating voltage is generated parallel to the electrodes, and a magnetic field is produced perpendicular to the electrical field. In this way a diminution of the negative effect from the space charge between the electrodes is achieved.

Magnetohydrodynamic generators of electrical energy use the following principle. When the working body-gas is heated to high temperatures, it ionizes. If a magnetic field is applied to a stream of such plasma perpendicular to the direction of movement, the electrons will hit the electrode (anode). The electron stream or electric current passes through the space between the electrodes then along the circuit to the outside load and back.

In such a way the primary energy in the form of heat generates plasma which acquires kinetic energy; the magnetic field forms an electron stream in the circuit. In order to reduce the temperature of the plasma and at the same time preserve the required electric conductivity, additives such as cesium or potassium salts are introduced into the gas stream.

The voltage of the magnetic field depends on the electrical conductivity of the gas stream and, together with the gas velocity, determines the voltage which is obtained in the electrical circuit. The efficiency of a magnetohydrodynamic generator increases with an increase in power output. For very high power outputs (several hundred thousand kilowatts) an efficiency of 50-60% is anticipated.

At the present time considerable success has been achieved in obtaining electrical energy directly from heat energy. For this reason we must regard the turbogenerator version of a powerplant as an intermediate stage — an unavoidable one, so to speak — in developing a spaceborne powerplant for a spaceflight vehicle.

NEW BOOKS

A book by I. N. Bubnov and L. N. Kamanin, entitled Manned Space Stations, has just appeared in print.

The book gives an account of the problems which must be resolved in creating manned space stations orbiting the Earth. In such stations extensive investigations of circumterrestrial space will be made as well as geophysical and astronomical observations and many different types of scientific experiments. Orbiting stations will become, so to speak, platforms for launching spaceships on trips to the other planets.

Very interesting is a book by Prof. V. V. Sharonov entitled The Moon — the First Station on the Way to Space. The author describes the nature of the Moon and the conditions an expedition will encounter there. The book discusses the Moon's movements in space, especially the changes in the lunar phases, as well as the effects of the Moon on Earth. We find an exposition of present-day information concerning the structure and origin of the lunar mountains and plains, the lunar climate, and the nature of the soil covering the lunar surface. A separate chapter is devoted to artificial moons, i.e., artificial Earth satellites, to the results of the photographs taken of the reverse side of the lunar sphere by the Soviet automatic interplanetary station, and to the prospects of man's reaching the Moon.

The reader will find basic data on flights to the Moon and the planets in a book by V. I. Levantovskiy entitled Paths to the Moon and the Planets of the Solar System.

Here we find a discussion of the factors determining ways of reaching the Moon, Venus, and Mars; of the things that complicate studies of Jupiter and the more distant planets by using automatic interplanetary stations; why it is not always possible to fly to Mars and Venus but only during certain favorable periods; how to develop a schedule of flights to these planets ; why it is much more difficult to approach the Sun than to leave the solar system forever; and what complicates a manned flight to the Moon. The author explains why, when an automatic station travels to Mars or Venus, it must be launched from an artificial Earth satellite and why, during a manned flight, it may be necessary to provide for in-orbit refueling or even in-orbit assembly of the interplanetary ship. The author also tells us how long a voyager must remain on Mars before a return trip to the Earth is possible, etc.

A. SHORIN

THE FIRST RAMJET ENGINE

PAGES FROM HISTORY

Engineer Col. N. CHEREMNYKH

On 25 January 1940 an aircraft flew over Moscow, leaving two long fiery trails behind it. The people of Moscow were alarmed at this unusual sight and several fire engines rushed to the M. V. Frunze Central Airfield in order to put out the fire that this burning aircraft would cause when it fell to the ground. But their assistance was not needed.

This flight was part of a program to test a new-type aircraft engine — the ramjet engine.

Therefore it has become customary to regard 25 January 1940 as the birthday of the ramjet aircraft engine which signaled a new achievement in the development of domestic scientific and technical thought and a new stage in the development of aircraft engines. Tests of this engine began back in 1939 when starting methods were developed and a stable burning process perfected.

It should be noted that air-breathing jet engines were tested in aircraft abroad later than in the Soviet Union. In Italy an aircraft with a jet engine, built by the Caproni firm on the basis of a Campini design, made its first flight in the second half of 1940. In Germany the first ramjet engines designed by E. Senger were tested only in 1942. During the Second World War work on ramjet engines was also done in the USA and Great Britain.

Major successes in building and developing jet engines — including ramjet engines — only became possible when their fundamental theory was worked out by our science.

Of great interest is the history of the development of the world's first ramjet engine. As we know, the struggle for flight speed is one of the basic problems in aviation development. Of decisive importance in this struggle is the power output of the aircraft.

Therefore, aircraft designers have always dreamed about the development of new types of aircraft engines capable of delivering great power with small dimensions and weight.

And so a group of designers decided to build a ramjet aircraft engine.

As theoretical calculations show, the thrust of such an engine at takeoff is equal to zero, at subsonic flight speeds it is not very economical, and its advantages are only apparent with supersonic speeds.

Engineer I. A. Merkulov suggested installing ramjet engines in an aircraft as supplementary engines in combination with the propeller-engine installation. Such light and small-size engines in an aircraft would, according to the designer, considerably increase the maximum flight speed. As his figures showed, a supplementary engine weighing only 40-50 kg, when installed in a fighter having a speed of the order of 700 km/hr, would develop a thrust output of 800-1000 hp and would make it possible to increase the aircraft's flight speed by 150-200 km/hr, i.e., to increase the speed of the aircraft to 850-900 km/hr. At the time this was quite an attractive proposition.

Engineer I. Merkulov reported his findings on 3 July 1939 at a meeting of the Scientific and Technical Council of the People's Commissariat of the Aviation Industry. The young designer's suggestion met with the enthusiastic support of outstanding Soviet scientists V. Vetchinkin, B. Stechkin, K. Putilov, A. Kvasnikov, N. Inozemtsev, A. Mikhaylov, K. Bayev, and others.

The management of a factory provided the young designer with working facilities and gave him material and moral support.

But the young and enthusiastic designers of the new engine also had enemies with considerable influence and authority. These latter did not believe in the new idea and interfered with its realization in every way.

In August of 1939 the first models of the engine were ready and, in September, static tests were begun. Here is an excerpt from one of the records:

"On 17 September 1939 tests of a jet engine took place.

"The aim of the tests was to check the reliability of the engine during long periods of operation.

"The engine was started at 1526 hours and operated continuously until 1557 hours. And thus the length of operation amounted to 31 minutes. After the test, the condition of the engine was checked and found to be excellent.

"(Signed) Chief of Testing and Checkout Dept., Kol'tsov; Engine Designer, Merkulov; Factory Designer, Maslov; and Aircraft Mechanic, Karev."

This first success encouraged the young designers. At the end of September 1939 three engines were ready. These were designated as DM-2 (supplementary) engines.

By using a special cooling system, the designers prevented the combustion chamber and the exhaust nozzle from burning through (as coolant they used the gasoline as it was fed to the engine). Moreover, they managed to achieve a stable gasoline flame in the airstream in the combustion chamber as well as quick ignition of the engine in flight at any temperature of the surrounding air.

The DM-2 engine had the following dimensions: length — 1500 mm; diameter — 400 mm; diameter of the exhaust pipe — 300 mm; weight of engine 12 kg; weight of engine frame — 7 kg.

In order to study the operation of the engines in all regimes, a special wind tunnel 15.2 m long was built at the factory. The diameter of its working part was 1000 mm, the diameter of the collector was 2.9 m, the diameter of the exhaust cross section of the diffuser was 3.0 m, and the length of the working part was 2.5 m. The maximum velocity of the airstream in the working part was 75 m/sec.

In one of the test reports we read: "On 22 October 1939 at the M.V. Frunze Central Airfield tests were performed on the jet engine designed by Engineer I. A. Merkulov...

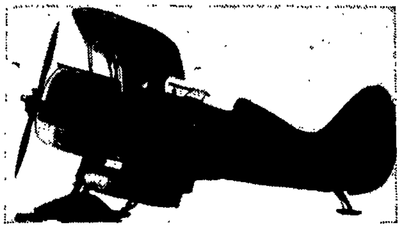


Fig. 1. I-152 aircraft with ramjet engines (side view).

"The engine operated on ordinary gasoline with ethyl fluid...

"The magnitude of the engine's thrust was determined by using a one-piece balance connected to a dynamometer with an indicator needle which clearly showed engine movement under the effect of thrust.

"During the tests the engine was started three times. The control elements functioned correctly. The engine showed complete reliability and safety with respect to explosions.

"During engine tests in the wind tunnel, a velocity of 120 km/hr was achieved. At this velocity the engine produced a thrust of 10 kg which corresponded to the computed figures."

After the successful tests of the engine in the wind tunnel, it was decided to conduct flight tests in the I-15-bis (the I-152 designed by N. N. Polikarpov) which were begun in December 1939 (figures 1 and 2).

The flight tests were made by Test Pilot Petr Yermolayevich Loginov. Prior to the tests, he carefully studied all the specifications and blueprints of the engine and observed the assembly and static tests of the engine. Just as carefully he observed the installation of the engines on the aircraft.

Having a good knowl dge of the design of this new engine and its operational peculiarities, Loginov quietly said in reply to warnings of the dangers involved in the tests: "I have faith in this undertaking and am ready to begin the flight tests..."

In December 1939 five flights were made without starting the engines for the purpose of studying the aerodynamics of the aircraft with underwing suspension of the supplementary jet engines. Also made was a series of flights for developing a starting technique and for checking on the reliability and safety of engine operation. After the successful completion of these jobs, on 25 January 1940 the official tests took place in the presence of representatives from the People's Commissariat of the Aircraft Industry. The flight tests lasted until July of 1940. Taking part in these, in addition to Loginov, were test-pilots A. Davydov and N. Sopotsko. The tests were conducted at speeds of 320-340 km/hr and, after the supplementary engines were switched on which developed a power output of 100-120 hp, a speed increment of 18-22 km/hr was achieved.

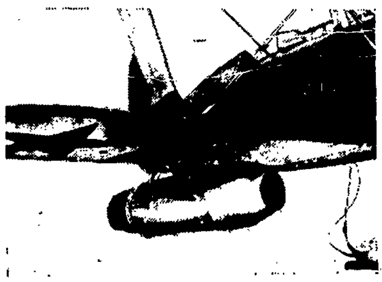


Fig. 2. Ramjet engine under wing of I-152 aircraft.

On 10 July 1940 Loginov made the following statement about the operation of the ramjet engines on the aircraft:

"1. The engines provided a perceptible speed increment in the I-152 aircraft.

"2. Control of engine operation is simple and easy (one control lever with a switch).

"3. Operation of the engines at all speeds was stable and, due to the metal protective covering on the lower surface of the aircraft, was safe with regard to fire hazards.

"4. Actuation of the engines was somewhat protracted, the time of actuation being equal to 40-50 seconds. It is necessary to reduce the engine actuating period down to 5-10 seconds.

"5. The engines were not tested in aerobatic maneuvers."

A special committee drew up a report on the results of the tests. Here it was stated that, in one of the factories, a jet engine was developed which increased the flight speed of an aircraft. The safety factors, the fire resistance, and the service life of the engine were tested on the ground and in the air.

The committee advised that tests be made in high-speed aircraft in which the jet engines would provide maximum effect.

In August of 1940 the new DM-4 jet engines were built which differed from the DM-2 in having larger dimensions (D=500 mm). After wind-tunnel tests, they were installed on an I-153 aircraft.

In September 1940 flight tests were begun of the DM-2 jet engines in an I-153 aircraft designed by Polikarpov. These tests were conducted by pilots P. Loginov, A. Zhukov, and A. Davydov. Due to the operation of the supplementary engines the aircraft's speed was increased by an average amount of 30 km/hr. The best results were obtained by Loginov on 12 September 1940 when the speed increment amounted to 33 km/hr with a base speed of the aircraft of 385 km/hr.

On 3 October at an altitude of 2000 m the speed increment with operation of DM-4 engines amounted to 42 km/hr (the base speed of the I-153 was 388 km/hr and, after the jet engines were switched on this increased to 430 km/hr). On 27 October at the same altitude a speed increment of 51 km/hr was achieved.

In the report on the results of the tests it states: "In October of 1940 the invention department of the factory conducted flight tests of the I-153 aircraft with jet engines designed by Engineer I. Merkulov. These were installed in the aircraft as supplementary engines under the lower wings and attached to the already provided bomb racks. The weight of the two supplementary engines was 60 kg...

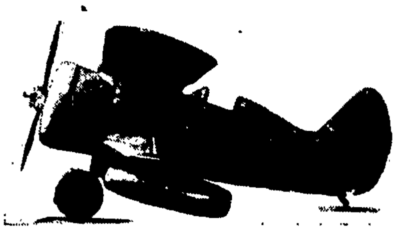


Fig. 3. I-153 Chayka aircraft with ramjet engines (side view).

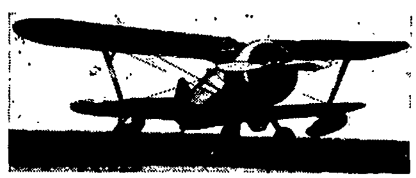


Fig. 4. I-153 Chayka aircraft with ramjet engines (front view).

"The test program contained 20 flights which provided for checking on the strength of the aircraft with the supplementary engines, testing the operation of the supplementary engines, and determining the maximum speed increments...

"The flight tests showed that the I-153 aircraft, during flight at an altitude of 2000 m and with the jet engines in operation, increases its maximum speed from 389 km/hr to 440 km/hr; that is, there is an increase in maximum flight speed of 51 km/hr. The power output of the jet engines at a flight speed of 440 km/hr amounted to 297 hp."

During the tests of the I-152 and I-153 aircraft with DM-2 and DM-4 jet engines, 74 flights were made in all without a single mishap (figures 3 and 4).

The results of the flight tests obtained a positive evaluation in an order from the People's Commissar of the Aircraft Industry of the USSR. This order outlined continued scientific research and experimental design work in perfecting jet engines.

In May of 1941 static tests of the DM-4 jet engine were conducted in the wind tunnel at TsAGI [Central Aerohydrodynamic Institute]. During the tests the engine operated for about three days. During this period, following one firing, the engine operated continuously for 16 hours. On the basis of the experimental data obtained during the test in the wind tunnel, appropriate changes were made in the design of the engines which improved the effectiveness of its operation.

In 1941 the DM-4 jet engines were installed in the I-207 aircraft as supplementary engines and test pilots made successful flights with these. In the same year new jet engines were designed for installation in the Yak-1 (figures 5 and 6) and other aircraft.

Fig. 5. Yak-1 aircraft with jet engines (front view).

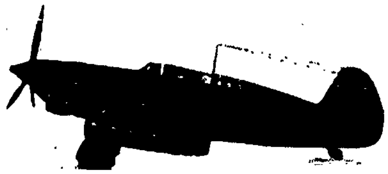


Fig. 6. Yak-1 aircraft with jet engines (side view).

All the work in designing and testing the first ramjet aircraft engines was done by a small design group in the invention department of the factory. This group included leading designer I. Merkulov, designer A. Maslov, young engineers, A. Mel'nikov and B. Nikolayevskiy, draftswomen A. Gonsovskaya and Z. Tolstikova, aircraft engine mechanic G. Rybakov — nine people in all. The engines were built by fitter-mechanic N. P. Yakob and sheet-metal workers G. L. Nikitin, V. T. Akulin, and L. L. Nikitin.

The sudden attack of the Hitlerite invaders of our Motherland on 22 June 1941 interfered with the productive work of this group of enthusiasts in perfecting ramjet engines.

However, under the difficult wartime conditions the work on ramjet engines continued, because of great help rendered the designers by the professorial and teaching collective of the Sergo Ordzhonikidze Moscow Aviation Institute. During the war years this institute carried on scientific and research work in modifying and testing special-type supplementary engines. In charge of this work was Professor K. Putilov. As a result of the comprehensive studies and modifications of the DM-4's supplementary engines done under his direction, these engines were installed in a Yak-7 which was successfully tested in the flight research institute.

Following the flight tests of the first ramjet engines, a series of Soviet designers designed and tested in the air ramjet aircraft engines of several types.

Thus, in the Soviet Union even before the Great Patroitic War there were developed the world's first reliably operating models of ramjet aircraft engines.

A REPLY FROM ACADEMICIAN B. S. STECHKIN

On Ramjet Engines for Flight Vehicles

Major successes in the creation and development of jet engines — including ramjet engines — became possible due only to the fact that their fundamental theory was worked out by our science.

In 1903 K. E. Tsiokovskiy published his now widely known work, "The Investigation of World Space by Reaction Devices". Here he stated the theory of jet flight and gave reasons why it was necessary to develop reaction engines for spaceflights. Another Russian scientist, I. V. Meshcherskiy, in his work entitled "The Dynamics of the Point of Varying Mass" set forth the fundamentals of the mechanics of bodies with varying mass, thus providing a theoretical basis for rocket dynamics. A profound treatment of the theory of reaction engines was given in the works of Prof. N. Ye. Zhukovskiy entitled "On the Reaction of an Outflowing and Inflowing Fluid" and "On the Theory of Marine Vessels Driven by the Reaction Force of Outflowing Water" as well as in his writings devoted to the vortex theory of screw propellers and axial fans.

An outstanding contribution to this field of science and technology was made by the Soviet scientist, Academician B. S. Stechkin. His work, "Jet Engine Theory", published in 1929, set forth the fundamentals of the present-day theory of jet engines and methods of estimating them.

We find further developments of the theory in the writings of B. S. Stechkin, F. A. Tsander, I. I. Kulagin, N. V. Inozemtsev, and others.

However, little attention was paid in the technical literature to the theory of, the computations involved in, and the methods of designing and conducting experimental investigations of ramjet engines. An attempt to correct this shortcoming was made in a book by Doctor of Technical Sciences M. M. Bondaryuk and Doctor of Technical Sciences S. M. Il'yashenko which was published in 1958 with the title "Ramjet Engines." This book provides rather complete data on the theory, the characteristics, and the design of subsonic and supersonic engines.

The authors also set forth methods of estimating the basic elements of the engine and the plotting of its thrust characteristics. The book contains a detailed discussion of the problems involved in selecting the fuel, the burning process, and the design of the combustion chamber. There is also a brief account of prospects for employing atomic ramjet engines.

The editors of Aviation and Cosmonautics asked Academician Boris Sergeyevich Stechkin to express his ideas on the problem of using ramjet engines in spaceflight vehicles. Below we publish the view of Academician B. S. Stechkin.

* * *

The ramjet engine (PVRD) has a definite field of application. It is felt that it is best to use it at flight speeds with a Mach number within $1.5 \leq M \leq 7$ and that there is reason to hope that the upper limit may be considerably increased (to $M \cong 10-12$). At $M < 1.5$ the thermal efficiency of the ramjet cycle is very low; as a result, the specific thrust and the fuel economy of the engine are too low for effective practical application. Moreover at high speeds ($M > 12$) the intake diffuser operates ineffectively and the temperature in the combustion chamber due to loss of kinetic energy by the air becomes excessively high. Progress is expected if it is possible to provide for burning at a high rate of air movement in such a way that the air striking the flight vehicle is at least partially decelerated. Thus high hopes are placed in using liquid hydrogen as fuel in the ramjet engine.

At cosmic flight speeds ($M \geq 28$) at an altitude of 90-100 km, as is necessary, for example, for accumulating oxygen, the use of the ramjet is still impossible. Foreseeable is the transition to external burning (outside the vehicle), this burning being realized at as high an air velocity as desirable.

Thus at the present time the ramjet engine can be used in space vehicles for accelerating rockets within the dense atmosphere to a speed of $M = 7-10$. Acceleration is possible either in a special flight vehicle which returns to Earth or directly in the rocket itself, in its first stage. The addition of air for additional burning of the gases in the rocket engines during the rocket's flight increases the thrust, but this will no longer be a ramjet engine.

We find a much wider field of application of the ramjet engine in the area of very high-speed aircraft and in rockets to be used elsewhere than in space.

A Pilot's Son

A TRUE STORY

Col. A. PYATKOV,
Military Pilot First Class.

There are pilots who do not like to fly as passengers. I belong to this group. I am ashamed to admit it, but what can I do? I am afraid to fly when someone else is at the controls. I don't know what the Latin for this is, but in Russian,we call it "lack of trust".

Right now I am seated in the pressurized compartment of a military transport aircraft, behind the backs of the pilots, and I am amazed at myself. What possessed me to come aloft as a passenger? I keep glancing through the port and keep thinking: Where am I going? What for? Could it be that my old ailment has disappeared?

The powerful engines are droning. A bright Sun glares in the blue of the sky. I can scarcely believe that, below us, it is winter, with its overcast skies, snowdrifts, and snow-covered trees. I shut my eyes and try to reconstruct events in my memory in their proper sequence. Again and again I remembered yesterday morning for the nth time. Yes, this flight began many hours ago when our gigantic ship lightly lifted off the concrete runway. This was twenty-four hours ago...

A door opened and suddenly I saw my long-past youth. A young officer with a swarthy complexion, who had an unusual resemblance to a regimental comrade of mine in the war years, Arkadiy Orlov, crossed the threshold of my study in a determined manner.

"Comrade Colonel", he uttered in a voice which I so often had heard twenty years earlier, "I am forced to speak to you personally... The doctor "chopped off" my mission... because of my temperature. And yet I must leave today without fail."

Inviting the pilot to be seated, I asked him to introduce himself.

He jumped up from the chair: "Captain Orlov! Forgive me for not having ~~introduced myself earlier~~. Today I ~~am not quite myself~~."

Then the pilot apologetically told me the reasons why he was not "quite himself". His troubles, in his own words, began at the medical post. During his preflight exam it turned out that he was running a temperature. Just one degree, that was all. But the surgeon categorically refused to sign the "slip" (this is what Orlov called the exam form for the flight personnel which had to be filled out before flight).

My silence apparently confused the young captain. He began an attempted justification of the surgeon whom, a minute before, he had called a formalist.

"Of course, by grounding me, the doctor carried out his service duties. Well, if everyone here were to carry out his service duties just as conscientiously..." the officer said, looking me square in the eye with his sparkling glance. "I have seen nothing more disgusting than the hotel here for the visiting crews. The heating plant is not working, the water is frozen, and there are drafts everywhere."

His bold look, his free-wheeling conversation, and the characteristic gestures of his right hand... all this was very familiar...

The name of Orlov I had noticed earlier when confirming the flight plan. It was typed at the bottom of a lined sheet the size of a small tablecloth. "He's a pilot from Siberia," the operations duty officer reported to me (he also named the air unit). "He landed yesterday to refuel. The district HQ postponed his takeoff for today."

A thought flashed through my mind: "Could he be Arkadiy's son?" But I immediately contradicted myself: "Hardly possible. Most probably he just has the same name. There are as many Orlov's in Russia as Ivanov's. You can't count them. And yet, how much he resembles..."

"I beg you," the young captain again broke the silence, "please call the duty officer and ask him to release me for flight." Orlov's eyes were seething. "My father, a former pilot, writes me that during the War even sick pilots had to fly combat missions. And I am well. Big deal! A temperature!"

"First of all, even then we did not send sick pilots on mission," I countered. "And, second, during the War everybody was well. Everybody, except the wounded and the dead..."

I wanted to prick him and to tell him that during the War no one caught cold. But I checked myself for fear of giving him the idea that I was justifying the lack of order in the garrison.

"So you will issue the order to the operations duty officer?" the young pilot continued.

I looked out the window. The snowflakes, whipping around, crossed diagonally the transparent squares of the panes. The day promised to be windy.

"No," I answered. "Today you will not leave. Tomorrow, if you are well."

Orlov dropped his head and then slowly raised it. His face, with its stubborn chin, showed no emotion. Only his voice betrayed his mood.

"Don't worry, Comrade Colonel, I am no daredevil. I understand that my request sounds wild and my persistence seems to indicate a lack of discipline on my part. But I do have a reason for being so persistent..."

The next day was a special one for him — it was his wedding day. In the far-off Siberian garrison (where he had been serving "for two whole years") his bride was waiting for him. Her relatives were due to come from Vladivostok. His father was to fly in from Magadan. Smiling sheepishly, the pilot added that meeting his father was worrying him more than the wedding itself. It was because he had not seen his father for a very long time, not since he was five years old...

"Your father's name is Arkadiy Petrovich?" I could no longer hold back.

"Yes, Arkadiy Petrovich," Orlov answered, showing no surprise at the question. We fell to talking. I told him that during the War his father and I flew wing to wing and slept next to each other — in the dugout the bunks stood flush, one next to the other. Actually it was not a real dugout but rather a well-built ancient burial vault in the Kronshtadt cemetery. Many pilots, technicians, and armorers lived in abandoned burial vaults at that time, where they were protected from artillery barrages. These were strong structures built by the widows of tsarist admirals and generals and designed to last for centuries.

Orlov listened to me attentively. He listened and looked with his eyes riveted on me. When I fell silent, he said: "Comrade Colonel, your name is Ivanov. Every soldier knows the name of the garrison chief and I am an officer. Your first name and patronymic are Yevgeniy Aleksandrovich..."

I nodded.

"But you do not look very much like the man that my father wrote so much about. According to his letters, you are supposed to be slender, tall, and black-haired..."

I burst out laughing. I rose to my feet and straightened up.

"You see, I used to be tall and still am. But the other distinguishing traits are no longer there... Twenty years ago I wasn't called Yevgeniy Aleksandrovich but Zhenka... And what's your name?"

"Fedor."

When Orlov was leaving the office I said to him, unexpectedly both for him and myself: "Tomorrow I'll fly with you to your wedding! Are you going to invite me?"

Smiling with restraint, Fedya shut the door behind him. He took my words as a joke and he was not far from the truth: it was not his wedding that I had on my mind but rather a meeting with Orlov senior.

* * *

Every man is capable of committing a thoughtless act at least once in his lifetime. I am convinced of this. In my last report there is an entry: Serious, rational, well-balanced, etc. In spite of these flattering words, I gave way to a sudden emotion like a boy and am now flying the devil knows where and what for... But, to tell the truth, I do know why I am flying. I want to know the truth and to lift a heavy weight from my heart. All through the years I had suspected Arkadiy Orlov of a crime. To this day I do not know whether he served out the term determined by the court or was paroled because he was rehabilitated... I could not ask his son about this.

Last night, when I told my wife about my intentions, she warmly agreed with me. She is an intelligent woman. Besides, she knows everything about my life, my thoughts, and my feelings.

This morning I called up the commander and asked for a three-day leave.

"What for?" he asked. I explained that I had the opportunity to see a front-line comrade. Apparently from the tone of my voice, the commander understood that this was no lark or whim and he permitted me to take leave and to fly with Orlov junior.

And now I was on my way. The compartment for the personnel accompanying cargoes is not the coziest place in a military transport aircraft. It's a little dark here. Light comes in through two ports on the right and left sides and through the narrow door of the pilot's compartment. From my place I can see the back of the ship's commander's head and his right shoulder. Sometimes I can see his face when he is talking to the copilot.

In profile, Fedor Orlov is an image of his father. The arches of his eyebrows protrude, his nose is straight, and his lips are a little thick. But then he has an ideal chin which is just long enough, like a typical movie hero. In his youth, Arkadiy was quite a personable young fellow... I wonder how he is now?

The last time I saw him was on 7 February 1944. I'll never forget the day. We flew reconnaissance in a pair of La-5 fighters. I was in the lead and Arkadiy was my wingman. The Sun was barely coming through the over-

cast. Icy needles glittered in the air. The whitish sky was deserted — not an aircraft in sight. We crossed the front line. From such a high altitude it was difficult to make out what was going on below. It seemed that all the roads were cluttered with fleeing Hitlerites. I was in tip-top mood. And I had good reason to feel so: I was flying daily combat missions and, for participating in breaking the blockade, I was awarded a third Red Banner order... For Arkadiy this was his first mission after a prolonged break. Two months before that he had returned from Fascist captivity. For two months he rested ~~in bed, ate his fill, and~~ gathered

strength. Today for the first time he was permitted to go on a mission as my wingman. I was glad to think that I was covered in the rear by an experienced aerial fighter rather than a fledgling. But above all I had a friend. Yes, my mood was excellent. And then suddenly... (in a combat mission this "suddenly" can happen any second) I heard the grinding of metal, saw smoke in the cockpit, and felt the ship shake. The aircraft became uncontrollable. I was wounded in the head and right arm. With terrible difficulty I managed to abandon the burning craft. I cannot recall how I managed to pull the ripcord. The chute opened and, like a sack, I hit the frozen ground.

About five days later the regimental deputy chief of staff, Maj. Kholodilin, came to see me in the hospital. He was very much surprised to hear that I did not see the Hitlerite aircraft which shot me down. According to Orlov, who had returned safely to the airfield, a Focke-Wulf 190, which apparently was returning from a mission, had attacked us out of the Sun, giving me a single burst. But then he was shot down immediately by my wingman. "Both aircraft plummeted to the ground, enveloped in flames," Orlov wrote in his report of the aerial battle. Towards the end of our conversation, the deputy chief of staff grew thoughtful and even absent-minded. He left me preoccupied with something. No. He wasn't simply preoccupied — he was very much disturbed.

A month later, upon my return from the hospital to the regiment, I found out that Orlov had been arrested. Perhaps he had even been shot.

On the basis of the scanty information reaching us, Orlov was enlisted to collaborate with the enemy while a prisoner of war, having even signed a pledge. Enemy intelligence had faked his escape. On orders from the Fascists, Orlov re-~~turned to the regiment. He~~ tried to carry out his first treacherous mission while flying with me...

The entire regiment was in a turmoil. Everyone was glad that by happenstance the traitor to the Motherland was unmasked. I did not rejoice. The monstrosity of Arkadiy's crime weighed heavy on me. "Whom then can we believe?" I kept asking myself during sleepless nights. Before he was captured we were like brothers and after his return our friendship remained as before. But was it like before? Didn't I sometimes feel that some of Arkadiy's answers to my endless questions about his life in Fascist captivity and about his escape sounded unconvincing somehow? Or was it only after this episode that suspicions were born in my heart?

Days, weeks, and months passed. The War was over. I fully recovered and regained my strength. But, alas, the medical board did not pass me for flying fighters. Since then I became a pilot in military transport aviation.

At the end of the forties I often had to fly to Leningrad. Once, when we landed at the Leningrad airfield, a young sickly-looking woman approached our Li-2 aircraft and asked: "Who is pilot Ivanov here?" My comrades pointed to me. She fixed her deep-set eyes full of grief on me and remained silent for a long while. I felt uncomfortable under her steady gaze. Finally the stranger broke the silence:

"Let's walk over in this direction, please". We walked away and she picked a juicy green blade of grass — the summer had been a rainy one — broke it and dropped it under foot. Then, in a barely audible voice, she said: "I am the wife of Arkadiy Orlov."

We talked for a long time. She had been working here in the shops as a book-keeper and then found out from her associates that the pilot who was shot down by her husband often came here. For a long time she had been thinking of having a talk with me. Today she finally made up her mind. Mrs. Orlov lived with her ten-year old son close to the airfield. She told me that Arkadiy was alive, serving his sentence somewhere in the Far East. She did not know when he would be back. Letters came from his very rarely...

I looked at her and thought: Why did she come to see me? What was the sense of this conversation?

As if in answer to my questions, Arkadiy's wife started to take leave. Walking off five paces, she suddenly turned and said:

"Do you really believe that he shot you down?" and without waiting for an answer, she quickly walked away. I looked at the blade of grass she had picked and which was already wilted. Then, hanging my head, I walked to the aircraft.

After this encounter, I began pondering the complexities of life perhaps for the first time.

On my next trip to Leningrad, I learned at the shops where Mrs. Orlov lived. The same day I stopped at the nearest post office and deposited several hundred rubles in her name. I kept doing this now and then until I got married. About a year after my marriage I told my wife the whole story. She attentively heard me out and then suggested that I keep on sending money to Mrs. Orlov. But my next money order came back stamped "Address Unknown".

Fifteen years is a long time in a man's life. I am now seated in an aircraft piloted by a mature and experienced pilot, judging by his "style". Fifteen years ago he was just a child. Today he is about to be married. Perhaps in a year he will be a father... The longer I live, the more I am convinced that time is a subjective category. For a young man the future is infinity and for an old man the past is but an instant...

It grew dark in the compartment. The aircraft entered the clouds. We were descending. I carefully watched Fedor Orlov's actions. I can't see but I know that with the fingers of his left hand the pilot is grabbing four white levers and pulling them back. Zero thrust. The aircraft streaks onward and downward. With barely noticeable movements of the control column, the pilot maintains a constant trajectory slope. From time to time he glances at the instruments. The closer we get to the ground, the more frequent are his glances. A soft impact and we streak along the concrete runway. Slower and slower, and then we stop. The flight is over. Dashingly, Orlov taxies off the runway. A smile of satisfaction spreads over his face.

I smile too, but in my heart the most contradictory emotions are in conflict. Joy, uncertainty, sorrow, and... envy. Yes, in a very good way I envy this young man. He flies a marvelous aircraft. I cannot fly such a ship. But he is only at the beginning of his professional career, while I, alas, am terminating mine...

* * *

It was now past midnight and we were in the kitchen. There is a bottle of wine on the table and the sound of music reaches us from the other room.

The bride rushed into the room.

"Arkadiy Petrovich, dearest, why is it that you and your friend stay here alone?"

"We're having a little talk here, Alochka, and we'll join you soon," Orlov answered. "Go and dance!"

She ran off.

Alas, our conversation somehow lagged. We talked about everything but

could not touch upon what what was most important for some reason... I found out that his wife had died long ago. She did not survive the complications of dystrophy. This was why my last money order was returned with the "Address Unknown" stamp on it. The grandmother raised his son in a village. When the boy was nineteen he entered flying school, from which he graduated at twenty-three. Now, at twenty-five, he was getting married. "All within the norms", said Arkadiy, smiling wryly. He knew well that I did not like this Air Force slang.

Fedor entered the kitchen. He was gloomy and pale and stared for a long time at Arkadiy, his eyes glistening with an unfriendly light. My heart skipped a beat with a presentiment of trouble. A thought flashed through my mind: Too bad if their first talk has to be here in my presence. Such a talk after what they both went through during the long terrible years of separation was better done without witnesses and without the assistance of drinking.

I got up, intending to leave. Fedya grasped my hand and almost forcibly seated me in my chair.

"You, you...I need you".

Without any preliminaries, Orlov junior asked Orlov senior:

"Tell me father,...tell me frankly, are you a traitor or an innocent victim? I cannot go on living without knowing what you really are".

Arkadiy answered calmly in a voice which is used when speaking to small children:

"I wrote you several times that a Focke-Wulf 190 shot down Yevgeniy Aleksandrovich."

Fedya pulled up a stool near the table and sat down on it heavily.

"Yes, you wrote. And now you tell me!" There was anger in his voice. He turned his stoney face in my direction, talking through his teeth;

"You...you only came here...to find out the truth."

I was silent. There was nothing to say.

"Son, you are a pretty poor prosecutor," Orlov senior said with a sad smile. He sighed. "A good prosecutor starts out on the premise that a man is not guilty. But you, on the contrary, consider me an evil-doer. You are looking for evidence of a crime. This is not right. You must always look for proof of innocence".

"But father," Fedya's voice trembled, "you wrote yourself that the Fascist fighter that you shot down after he attacked Yevgeniy Aleksandrovich had never been found. No one saw it. How can you explain this?"

"This same question was asked of me by the prosecutor, a good prosecutor." After a long pause, Arkadiy continued: "I don't know where the Focke-Wulf I set on fire disappeared to. Perhaps it glided down to the Gulf of Finland, since the fight took place close to the shore. Or perhaps it plummeted into a peat bog. There are many of these in Esthonia. Most probably my war prize has vanished forever in a bog."

"But then our tankmen would have seen a burning aircraft", the son countered.

"I don't doubt it," the father answered. "Undoubtedly someone did see two flaming aircraft aloft. A Fascist and a Soviet. Perhaps the prosecutor could have found eyewitnesses. But he didn't, and small wonder. In those days, when my case was started, the tankmen who might have witnessed this episode were already streaking along the roads of Fascist Germany..."

Then there was silence. Each one of us was thinking his own thoughts. Suddenly Arkadiy got up and, walking unsteadily, left the kitchen. I felt embarrassed for his son.

A few minutes later he returned, holding in his hands an old map case darkened with time. The celluloid lining of the case was tightly packed with papers. The father proffered the map case to his son.

"This is my whole file: copies of my statements, requests, and replies. There are some letters here and also some notes... Take them and read them," said Arkadiy and, controlling his legs with difficulty, walked towards the door. At the threshold he added:

"I'll go out on the porch for a breath of fresh air."

A few minutes later, hearing some noise and running footsteps along with excited voices, Fedya and I jumped up from the table and dashed through a narrow hallway. The door of the pre-fab cottage was wide open.

On the steps whitened with snow lay Arkadiy, dead.

He was brought into the house and laid out on a couch in the very room where people had danced and sung moments ago. The young people began quietly leaving. The older people gathered in a corner of the room. They were waiting for the doctor who had been summoned by phone.

The bride's mother, a woman with narrow slit eyes said with conviction: "Must be heart failure. After what this poor soul had to go through, no heart could stand up."

Her husband, a Pacific Merchant Fleet seaman of large stature, said only a few words:

"What a pity! He was a good man."

Alla was crying silently, while Fedya and I were just quiet. I do not know what his thoughts were, but something pounded in my brain, saying: Zhenka, you too are guilty! If you had not come... If it were not for this meeting with you... perhaps nothing would have happened.

The doctor came. He examined the deceased and established that it was an infarct.

* * *

After coming back from Arkadiy Orlov's funeral, I summoned that very day the commander of the airfield technical battalion, Maj. Gryazev.

"Why is it so, Semen Semenovich?" I began. "We have firewood and coal in your depot, but the heating plant in the hotel for visiting crews does not work. Pilots and navigators, all who stay overnight in the hotel catch cold."

The battalion commander stared at me in surprise. He was apparently at a loss, trying to understand why he had been summoned on such a trifling matter.

Looking at the placid face of the quartermaster, I pondered: So that's the kind of "leaders" we still have in our country. We talk about our cosmic era, about the moral aspects of the builders of Communism, and yet these people treat their jobs like professional bureaucrats.

After putting the heat on Gryazev and dismissing him, I tried to establish a common association amongst the recent events. If Capt. Orlov had not caught cold in the chilly hotel, he probably would never have come into see me and I would not have gone with him to the far-off Siberian garrison and would not have seen Arkadiy there. Perhaps Arkadiy would be alive and might have lived for a long time...

Arkadiy was dead, but my meeting with him was not over.

With these thoughts, I took out of my desk an old map case. Fedor Orlov gave it to me at the last moment. "Here you will find everything that father did not have time to explain." With a firm handshake, he quickly walked out of the luxurious Tu-104, which I was taking on my return trip.

Arkadiy's son was right. The contents of the map case helped me unravel one of the tragedies of the Patriotic War. More than that, it was precisely the "red tape" materials pertaining to Orlov senior that made me take up my pen to describe this whole episode.

In addition to copies of requests and applications, Arkadiy's map case contained four thin school copy-books with diary-like entries. I cannot help but quote some of the brief excerpts from these books:

"29 September 1943. I was shot down in an aerial engagement over enemy territory. After getting out of the cockpit, I came down with my chute. A Hitlerite pilot tried to shoot me while I was still airborne. But Zhenya Ivanov cut the scoundrel down. Ivanov Khizhnyak and Aliyev kept circling overhead until I touched down. But I had bad luck. The lines of the parachute got tangled in the top of a pine tree and I was left dangling upside-down. I was taken down from the tree by black-uniformed soldiers who came up. On their sleeves were the white skull-and-bones insignia. Later on I found out that a motorized SS division was stationed in the woods.

"On the first day the Fascists interrogated me, but they mostly praised my bravery and the daring of Soviet pilots in general. If one could believe the interpreter, one of the SS majors even censured the German soldier who tried to shoot me aloft.

"On the second day they not only interrogated me but they also beat me. The same 'noble' major of the day before was especially zealous. It was he who knocked out my two front teeth.

"On the third day confusion broke out in the woods. Apparently on alert, the division began moving towards the front. I was moved in a closed truck to the railroad station. There I was shoved into a freight car where there were more than fifty Soviet prisoners of war.

"The train was going West to Germany. All the way, especially at night, we sawed at the floor of the car. One of the prisoners, an indomitable elderly Ukrainian whose name was Kondrat, announced that he had a piece of a hacksaw as soon as the train started moving. Fifty men, spelling each other, worked with frenzy.

"On the third night the train stood at an abandoned siding. We decided to make a break. Eight men, including myself, crawled through the sawed hole one after the other. We hid ourselves in a drain ditch waiting for the others. But the guards noticed the ninth man, shooting the poor devil on the spot and raising the alarm. Kondrat, who was unusually daring, and I managed to slip away from the chase.

"We made our way homewards all through the autumn. We walked by night, feeding on wild berries, mushrooms, and vegetables we found in truck gardens. Several times we found unattended cows and milked them. We crossed the front line safely — we were not even wounded. After we were checked out, they sent us to the front. Kondrat went into the infantry and I returned to my air regiment..."

In another copy-book I found the following:

"...on 7 February 1944 Zhenya Ivanov died. I, his wingman, am to blame. How did it all happen? Too late I noticed overhead the dirty oil-splashed belly of a Focke-Wulf 190. He was diving from behind straight at Ivanov's aircraft. I realized that something irreparable was imminent. The blue of the sky, the brilliance of the

Sun, and the white of the snow-clad ground — everything disappeared. I could only see the black crosses on the wings. Trying to catch the enemy in my sight, I kept thinking: It's too late! He will shoot down the lead plane before I can press the trigger button. I radioed: 'Zhenya, a Focke is on your tail!' But Ivanov's aircraft kept going as if he were in an air show. Apparently Yevgeniy did not head my warning. The Focke-Wulf let out a long stream of fire. The streaking 'Lavochkin' fighter, as if stumbling over an obstacle, rolled from wing to wing. Then, bursting out in flame, it began plummeting down.

"Clenching my teeth, I carefully aimed. Now there was no need to hurry and I could not miss. No, not for anything!...I firmly pressed the trigger. A stream of incendiaries riddled the Fascist. Under the engine a sheet of flame appeared. A second later and another flaming torch was streaking towards the ground."

In leafing through the copy-book, I found this entry:

"15 February 1944. Hurrah! Zhenya Ivanov is alive! He was picked up by our tankmen. He was visited at the field hospital by the deputy chief of staff, Kholodilin, by Khizhnyak, and by Aliyev. When the deputy returned, he summoned me. 'How much time did you spend as a prisoner of war?' he asked, without looking into my eyes.

"'Six days,' I answered.

"He released me without another word.

"In the evening Khizhnyak and Aliyev talked about their trip. It turned out that they were not permitted to see Ivanov. 'I can permit only one man,' the surgeon grumbled. 'Only one man. Your comrade is very weak...'Because of consideration for military rank, Major Kholodilin went into the ward. Ivanov's friends were hurt, of course, but what can you do? It was a matter of rank..."

And then I read on:

"16 February 1944. Anton told me of a conversation he had overhead between the deputy regimental commander for political affairs, Lt. Col. Usov, and Maj. Kholodilin. Anton was on duty at the CP telephone. Usov and Kholodilin were arguing behind a plywood partition.

" 'You mean to imply that Ivanov was shot down by Orlov! Yes?' Usov asked heatedly.

" 'No,' Kholodilin answered cooly. 'I simply analyzed the whole matter in depth, making appropriate conclusions'.

" 'What are these?'

" ' First of all, Capt. Orlov must be immediately grounded...In the second place, the special section must investigate very carefully the circumstances of his return from captivity. He was away for more than two months, nobody knows where, and he claims that he spent only six days as a prisoner...In the third place, I suggest that you write a political report immediately in which you must give your reasons for the undesirability of using in the combat units men returning from enemy captivity...'

" 'Do you really believe that a Soviet officer, a Communist, is capable of killing his own comrade-in-arms?'

" 'Whether I think so or not is irrelevant. I am not claiming anything. But we have been taught that the enemy is capable of every rotten thing...'

" 'How dare you!' Usov raged. 'How can you call Orlov an enemy? He shot down four Fascist aircraft.'

" 'That was before he was captured, Comrade Colonel, before he was captured.'

" 'After his return, he shot down his fifth Fascist aircraft on the very first mission.'

" 'But maybe this was his first Soviet aircraft.' Kholodilin said venomously. 'For the time being, the matter is obscure...'

"This was the end of their conversation.

"...A fine man, this Lt. Col. Usov. A fine pilot, too. He indoctrinates his men not only with intelligent conversations but also with his courageous combat deeds. Our 'daddy Us' (this was the nickname given to the deputy for political affairs by Anton Khizhnyak) likes things to be clear. If there is an air battle, he likes to see it in a clear sky. If it is a conversation, he likes it without fog... We have lots of fine political workers like him. There are no fewer of these than good commanders. With such men, you need not fear any battles. I do believe that under the leadership of such chiefs, we cannot help but win victory..."

Further on Arkadiy's copy-books reflected a very difficult stage in his life. He was arrested and deported. There was hunger, cold, exhausting labor, everything. But he never gave up or showed lack of faith in people. Neither was there bitterness. On the contrary it was precisely during this period that his copy-book was filled with thoughts on friendship, faithfulness, and love. In the words addressed to his wife, he wrote:

"If I fail to return, if I should die among these dreary hills, do not torture yourself and do not curse your fate. Remember, once we were happy together. Our happiness will continue to live in our son, in his children, and grandchildren... If I should die, do not mourn me for long. As for myself, remember that even to the last second I will think of you!"

This story, I feel, may be best concluded in the words written by Orlov shortly before he died:

"The Party, the government, and the people believe me but my own son doubts. He tortures himself and me. But I am not angry with him. From vigilance to suspicion is but one step. There are times when even a man rich with life's experience has difficulty in knowing where to stop. Once, a long time ago, Maj. Kholodilin made this step. Even an old staff officer made a mistake. What then can we expect of a young men? His conscience was poisoned in his childhood by the vile words 'Your father is a traitor'. But I do not doubt that soon will come the day when my son will believe me..."

After reading the notes of a combat friend who has passed out of this life, I carefully put them back into the old Air Force map case. It was painful to think that not only I but his own son, too, suspected him of a monstrous crime.

(Drawings by Artist A. Shul'ts)

PILOT, COMMISSAR, COMMUNITY WORKER

When a man is over seventy and has devoted the greater part of his life to a beloved profession, he can recall and tell about many things. But there are in the lives of veterans events, the memories of which elicit deep and extraordinary emotions. For Lt. Gen. of Aviation (Ret.) Fedor Ivanovich Zharov such an event was his meeting with Vladimir Il'ich Lenin.

"This happened several days after the victory of the socialist revolution in Petrograd", recalls Fedor Ivanoch, "at a meeting of commissars and representatives of the soldier committees of the troop units in the Petrograd garrison. The brilliant speech by Il'ich, his passionate confidence, the clarity of his thoughts, and his profound trust in the powers of the people all helped me to choose definitely a career in life..."

Since that time the life of Fedor Ivanovich has been constantly connected with the making and development of our country's Air Fleet. A member of a working-class family and a soldier-pilot in the old army, Fedor Ivanovich was chosen to represent the soldier committee of the third battalion air base. The comrades sent him to Petersburg in October, 1917.

Upon his initiative, the committee adopted a resolution concerning the admittance of the air base into the ranks of the Red Guards.

In March 1919 Fedor Ivanovich Zharov was admitted to the Communist Party. His fellow servicemen sent him to the first and then to the second, third, and fourth All-Russian Aviation Congresses.

Fedor Ivanovich displayed stamina, bravery and daring during the years of the Civil War. As a member of an air detachment, he took part in engagements with kulak bands and with "Saving the Motherland" officer regiments. In May of 1919 he was appointed commissar of the 25th air detachment which was part of the First Revolutionary Army of the Eastern Front. On 26 June the People's Commissariat of the Army and Navy confirmed Fedor Ivanovich's appointment as commissar.

For many months, together with his element of Red pilots, he led successful engagements against the counter-revolutionary Cossacks in the Orenburg region. His bravery and skill were rewarded with the Order of the Red Banner.

Then there followed combat operations in Central Asia: Dushak, Ashkhabad, Krasnovodsk, Termez, Dushanbe, Kokand, Osh...And everywhere there were combat sorties, work with people, the propagandizing of revolutionary ideas, and the establishment of Soviet power. Fedor Zharov, now aviation commissar of the Turkish Front and an experienced political worker, came to the Central Asian village of Ara Mazar for peace talks with the leaders of the basmaches [counter-revolutionary robber bands]. By this time his military services were rewarded by still another gift — a gold watch from the Revolutionary Military Soviet of the Turkish Front.

After the end of the Civil War, Fedor Ivanovich gave much effort and energy as well as his tremendous military experience to the development of the Air Force and the training of air cadres. He was commissar and chief of various flight and technical schools.

In 1940 Zharov was given the military rank of Major General of Aviation.

The perfidious attack of the Hitlerite invaders on our Motherland moved Fedor Ivanovich into the post of Chief of the Main Administration of Air Force Weapon Procurement. In October of 1941 Gen. Zharov was appointed First Deputy Chief and then Chief of the Air Force Rear Area.

The difficult years of the war were filled with events: bitterness, failures, and the joy of victory. But one thing remained the same — concern for the uninterrupted support of the units and commands with all that was necessary for the struggle against Fascist Germany. Fedor Ivanovich spent much time at the front-line airfields...where he gave immediate assistance to commanders in carrying out their missions.

After the war Fedor Ivanovich became chief of one of the Air Force administrative departments. But the years took their toll and, in 1958, this veteran of aviation, Gen. Zharov, was forced to retire for reasons of health. However, he did not break off his connections with the Air Force. Fedor Ivanovich often gave talks to the aviators.

* * *

A few days ago, when these lines were being readied for publication, death snatched F. I. Zharov from our midst. Those who knew him will always retain the fondest of memories.

(Signed): A. ZHURAVLEV, Member of the CPSU since 1918;
I. KIRILLOV, Member of the CPSU since 1918;
M. CHUGUNOV, Member of the CPSU since 1918,
Veterans of the Air Fleet of the USSR.

RUSSIAN HEAVY AIRCRAFT

More than half a century ago there appeared in the skies over our country winged giants — the Il'ya Muromets airliners. Their appearance constituted an outstanding achievement of Russian aircraft design thought and a remarkable success on the part of our domestic aircraft building.

The creation of the first giant ship was begun in the summer and finished in December of 1913.

The Il'ya Muromets airliner with four Argus engines of 100 hp each weighed 3.5 tons and was 22 m long. With a wingspan of 32 m, the aircraft's lift surface measured 182 m^2. With a flying weight of 5 tons, the aircraft could climb to an altitude of over 1000 m. The world had heretofore not seen such an aircraft.

With flights over Petersburg at an altitude of over 400 m there began an era of heavy multiengine aircraft. In February 1914 a flight was made in the Il'ya Muromets with 16 passengers; this was an unprecedented success in aviation.

In the spring of 1914 a second Il'ya Muromets airliner was built. This aircraft had even more powerful engines, making possible an increase in payload capacity, speed, and ceiling.

In June of 1914 a flight was made in this aircraft from Petersburg to Kiev and back with a cargo of 1600 kg. For the time, this was an outstanding world record, calling forth great enthusiasm not only in Russia but abroad as well. In token of the successful accomplishment of this flight, the aircraft was honored with the title "Kievan".

The designers of the Il'ya Muromets aircraft dreamed of using this airliner for exploring the far North and the Northern Sea Route. The famous Russian military pilot, Lt. G. V. Alekhnovich dreamt about an expedition to the North Pole in a Muromets ship. However, the First World War which soon broke out determined in its way the fate of these airliners.

At the moment war was declared there were two Il'ya Muromets aircraft and these were quickly armed and equipped for military purposes.

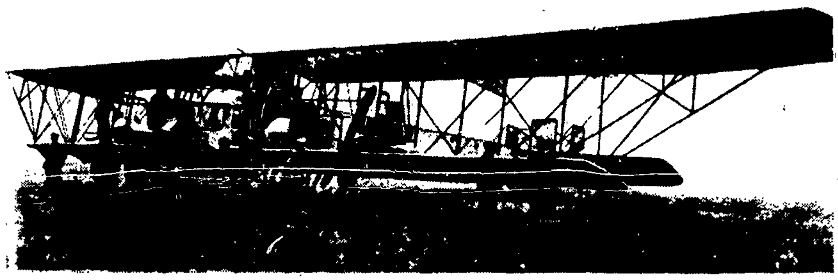
Appearing for the first time in the new Muromets aircraft produced on war orders was internal bomb suspension. An electric bomb release mechanism and a special sight were developed for bombing. These air ships were equipped with three gun positions.

For the first time in the history of aviation a giant-size aircraft was equipped with skis. In 1916, for the first time in aircraft-design practice, the gas tanks in the Muromets aircraft were equipped with a protective device — a thick outer rubber envelope which prevented gasoline leakage in case the tanks were perforated by bullets.

Heroic pages in the annals of the mastery and combat employment of the power of the Il'ya Muromets air ship were written by the remarkable Russian pilots I. S. Bashko, G. V. Alekhnovich, A. V. Pankrat'yev, A. K. Tumanskiy, and F. G. Shkudov.

Quite recently I. Bashko managed to discover in our country the "Flight Log of the Kievan Il'ya Muromets Air Ship". This is a unique document of the combat glories of this air ship and its crew.

The flight log of the Kievan Il'ya Muromets aircraft contains entries on the flights made by I. S. Bashko in 1915, 1916, and 1917. These entries are documentary evidence of the combat glories of this air ship. During the time he was in command of the Il'ya Muromets air ship. I. S. Bashko made more than 90 combat sorties and 24 round trip flights between fronts lasting up to 7 hours and 30 minutes each, as well as 70 other flights on orders from the command.



The Il'ya Muromets aircraft

For more than 3 years, until 26 May 1918, I. S. Bashko flew in this ship.

On the yellowed pages of the "Flight Log of the Kievan Il'ya Muromets Air Ship" we find entries concerning numerous combat flights. These are of great interest right now when we are celebrating the Fiftieth Anniversary of the Il'ya Muromets air squadron.

With its very first flights, the Kievan Il'ya Muromets air ship, piloted by I. Bashko, won glorious reknown.

News about each new sortie of the Kievan Il'ya Muromets aircraft reached the troops and this inspired the fighting spirit of officers and soldiers of the Russian Army. Thus, for example, on 7 April 1915 the Kievan Il'ya Muromets attacked the railroad station at Soldau where there were 15 railroad trains. The aircraft dropped bombs on the station and a locomotive that was standing under steam.

In the same month the crew of the Kievan Il'ya Muromets successfully bombed the railroad stations at Mlawa, Neidenburg, and other railroad junctions in East Prussia.

On 14 June 1915 the Kievan Il'ya Muromets, after a four-hour flight into the enemy rear, reached the station at Przeworsk and dropped bombs on 5 long trains on the sidings. Huge tongues of flame and clouds of smoke enveloped the station and the contiguous area.

On 6 July 1915 Pilot I. Bashko won an aerial victory against three German Brandenburg aircraft. Despite the fact that enemy fire put two of the four engines out of commission and punctured the fuselage in about 60 places, the wounded commander successfully brought the aircraft back over positions occupied by Russian troops and landed it on friendly territory.

The Kievan Il'ya Muromets often made successful strikes deep in the enemy's rear. Thus, on 12 September 1916, it reached an area in which the staff of a German reserve division was stationed and, with a successful bomb strike, set on fire the staff HQ of the enemy division.

During these years the Kievan Il'ya Muromets air ship successfully established a number of aviation records that were outstanding for the time.

On 13 January 1915, with 12 passengers aboard, the aircraft climbed to an altitude of 2500 m in 49 minutes. In this same year I. S. Bashko established a record in payload-flight duration.

On 6 April 1917, I. S. Bashko made a non-stop record flight with 3 passengers lasting 7 hours 30 minutes and, in the summer of the same year, he set a new world record of flight at an altitude of 4900 m with 5 passengers with a duration of 72 minutes.

With the victory of the Revolution, Pilot I. S. Bashko joined the Red Army. In 1918 when the Muromets aircraft were surrounded by the enemy at Vinnitsa, I. S. Bashko managed to escape being captured and flew in his Kievan Il'ya Muromets to territory occupied by the Red Army.

On the basis of the examples of the feats achieved by the pilots of the Il'ya Muromets air squadron, I. S. Bashko, A. V. Pankrati'yev, G. V. Alekhnovich, and others, a group of young pilots was reared, among whom was A. K. Tumanskiy, the famous pilot who is still alive. He was formerly a private in the tsarist army and earned four St. George's Crosses. Later he selflessly served the cause of the Revolution during the Civil War.

A. K. Tumanskiy was fortunate to be a friend of V. I. Lenin at Smol'nyy and to receive from him a mandate for the continued existence of the Il'ya Muromets Red Air Squadron.

V. I. Lenin paid a great deal of attention to the Muromets aircraft and showed a fatherly concern for the Red Muromets crews. In a resolution signed by V. I. Lenin, the Chairman of the Council of Labor and Defense during these difficult days of privations and collapse, we read:

"Our fellow workers in the Il'ya Muromets battalion who are actually performing the job of flying and air operations, must be taken care of in accordance with the norms and procedure stated in Order No. 1765 of the Revolutionary War Council of the Republic. The other workers of the same battalion at the front — at the front and in the rear — must be provided with rear-area food rations.

The Red military pilots in their formidable Muromets aircraft with honor and bravery responded to the concern of the leader. The participation of the Il'ya Muromets aircraft detachment in the air group under that famous pilot, I. U. Pavlov, was distinguished by aggressive combat operations. The Muromets aircraft especially distinguished themselves in attacks at the railroad station of Prishib. With accurate bomb strikes, the crew under the command of F. G. Shkudov destroyed railroad trains and supply dumps. In a repeat sortie the crews completely destroyed an enemy armored train.

Successful, too, were the attacks of the Muromets detachment on the railroad stations at Friedrichsfeld, where the Whites were getting ready for a parade, and at Jankau. In one of the flights A. K. Tumanskiy, in bombing a White airfield, destroyed four aircraft out of six, for which he was awarded the Order of the Red Banner.

The crews of the Il'ya Muromets aircraft wrote some very brilliant pages in the history of the combat glory of Russian aviation.

Engineer Col. (Res.) D. ZIL'MANOVICH

NEWS FROM ABROAD

THE AVIATION AND MISSILE BUSINESS

The losing candidate for the presidency of the USA, Goldwater, the leader of the "rabid ones", won his first victory in the pre-election campaign in California, a region where are located the factories of the largest aircraft and missile companies. The program offered by the "rabid ones" pleased the aircraft and missile businessmen. It promised them a new increase in military orders and, along with this, new profits as well as increased pressure on the leaders of the military departments.

Supplying the military, according to V. I. Lenin, has always been the "golden rain" that fills the pockets of the capitalists. A special place in the enrichment of the major magnates of war industry capital in the USA has been and still is occupied by the production and sale to the government of missiles, aircraft, and various types of equipment. The aircraft and missile business has become a regular and characteristic aspect of business life in the United States of America. In the course of many years it has determined the basic tendencies in the development of the country's budget.

We know that, in the post-war period, for the purpose of carrying out the aggressive plans of the imperialist circles, a huge army developed in the USA, armed with the latest equipment and weapons. This in turn put on a military footing a number of the most important branches of industry. Thereafter there occurred a militarization of the country's economy and an intensification in the power of government-monopoly capital.

The high cost of the technical equipping of the armed forces has led to a sharp rise in the US military budget. The sums being spent on military orders have increased at astronomical rates. According to official data, during the last five years (the 1961-65 fiscal years) 263.5 billion dollars have been used in the USA for direct military expenses alone, whereas these same expenses in 1939, when the second World War was already under way, amounted to only a little more than one billion dollars. Thus, within a period of 25 years, military expenses have increased (on an annual basis) fifty-fold!

It is worthy of note that the basic sum of the US military budget goes, year after year, to the Air Force, the striking arm of the American military clique. Thus, in the 1964 fiscal year, 20.7 billion dollars were appropriated for the needs of the Department of the Air Force; this amounted to 40.6% of all the expenses of the US Department of Defense. It comparison with 1951, this sum shows an increase of 3.3 times, while in comparison with 1948 the increase was 19 times.

Such a sharp increase in the expenditures for the Air Force is not accidental. The largest aircraft corporations, united in the powerful Aircraft Industries Association, with the help of the government and military organs which have directly financed the expansion of production and scientific research work, have under their control the majority of the government aircraft enterprises. With the appearance of missiles and satellites, some of these enterprises were switched to the production of new types of weapons. Thus, the largest aircraft corporations represent at the present time powerful monopolistic combines producing aircraft, missiles, satellites, and military electronics.

The Association of aviation industrialists, with its great influence on the decision of many questions in domestic and foreign politics, does not, of course, tolerate at all thoughts of cutting down the production of military aircraft, missiles, and satellites. To cut down on these types of production means the loss of huge profits. And indeed, according to former President of the United States, Eisenhower, the military pays such a large sum for every new aircraft that if this sum were expressed at the current rate in gold, it would be necessary to pay as much in gold as the aircraft weighs. This comparison may just as validly apply to missiles and satellites.

The demands of the aircraft and missile business magnates are listened to very carefully by the leaders of the military, and this is understandable. These latter represent the interests of the monopolies in the government apparatus. Their own aggressive plans for expanding the strategic striking forces coincide with the hopes of the leaders of the aircraft and missile business. In the military budget of the USA for 1965, approved by Congress, special attention is paid to programs for the further development of military aircraft, missiles, and satellites. Understandably a number of US newspapers call the 1965 military budget a missile and space budget. According to the military budget for 1965, the Air Force is provided with the following appropriations: for aircraft — 3,663 million dollars; for missiles — 1,730 million dollars; for special equipment — 230 million dollars; and for electronic equipment — 435 million dollars. The overall sum appropriated for the purchase of equipment, weapons, and property for the USAF amounts in 1965 to 13,756 million dollars. Moreover, 3, 205 million dollars will be used for scientific research in the field of aviation and missile building. And contracts will be concluded for this sum with the aircraft and missile firms.

The business of the aircraft and missile corporations is not merely limited to Air Force orders. In 1965 the ground forces will buy from them aircraft, helicopters, and various kinds of equipment for 4,436 million dollars. The Navy will purchase to the amount of 1, 855 million dollars. In addition, the Army and the Navy will buy 956 million dollars worth of missiles, while NASA will place orders in the amount of about five billion dollars.

In the 1965 budget huge sums are allocated for strategic missiles. According to plans, by 30 June 1965 there should be operational 16 Minuteman missile divisions, 12 Titan divisions, and 9 Atlas divisions.

The military agencies of the USA, in developing the war industry and war procurements, create all the necessary conditions for great profits on the part of the monopolies. In the area of aircraft and missile purchasing, the officials of the Defense Department provide a procedure involving direct and closed-door talks between the military higher-ups and a selected group of war-industry monopolies. Here the product of the war-industry corporations are paid for in accordance with the high monopolistic prices which are usually established on the basis of the cost involved in producing the first model of a weapon. But the savings gained through perfection of the production technique and the reduced cost of raw materials go into the coffers of the monopolists.

Despite the tremendous possibilities which official legislation affords the war-industry monopolies for growing rich on military orders, from time to time there appear data in the US press about the scandalous swindling machinations on the part of the aircraft and missile corporations. In evaluating this phenomenon, we must keep in mind the fact that official organs are not inclined to publicize the shameless robbery of the workers. Moreover, we must remember that the controlling organs of the Congress and the armed forces are not able to check on all the contracts and often rely on the information concerning expenses involved in filling an order supplied by the producer himself. The magazine Aviation Week and Space Technology recently reported that the Supreme Court of the United States, after many delays and legal actions, had finally ruled that the over-charges on military orders filled by the large aircraft and missile companies must be refunded to the tune of one hundred million dollars.

A special inquiry, conducted by the US Congress in connection with certain profits made by the Boeing aircraft and missile company, showed that these sums, as the result of crooked exaggeration of the data concerning the producer's expenditures on only two contracts in the amount of 180.5 million dollars for the production of the Bomarc missile, were raised by 2.3 million dollars. The commission noted that the entire program for the production of the Bomarc missiles being handled by the Boeing firm amounted to 915 million dollars and it may be safely assumed that the sum of the over-charges considerably exceeded the sum that it was possible to identify. All this indicates how closely the government and the military apparatus work with the higher-ups of the monopolies and how possible it is for them to grow rich at the expense of the military contract workers.

The magazine Missiles and Rockets gave, at the beginning of the current year, some data on the sum of military contracts for the 1963 fiscal year. This entire sum amounted to 25,834 million dollars. This constitutes more than 50% of all the expenditures of the Defense Department and about 30% of the entire US federal budget! Of this sum, 73.9% went into the hands of the 100 largest military industrial monoplies. Amongst these 100 companies, the first ten places are occupied by the aircraft and missile monopolies. These companies are: Lockheed Aircraft with 1,517 million dollars of military orders; the Boeing Company with 1,356 million dollars; North American Aviation with 1,062 million dollars; General Dynamics with 1,033 million dollars; General Electric with 1,021 million dollars, etc.

The acknowledged "leader" in the field of supplying the military is the Lockheed Aircraft Corporation. In 1963 this concern made a clear profit of 43.3 million dollars. This was 16% higher than in 1962, while the increase in sales amounted only to 10%. Thus an increase in profits was mainly achieved through lowered costs of production. Almost 85% of all activities at Lockheed involve military contracts. This corporation produces the F-104 fighter-interceptor, the C-130, and C-141 transport aircraft, and the Polaris missile. It has also profited greatly through the production of the special A-11 reconnaissance aircraft (replacing the U-2 which caused a world-wide scandal).

The second place, as far as the sum of military orders is concerned, is occupied by the Boeing Corporation. This is the prime supplier of strategic bombers, air tankers, the Boeing-707 transport aircraft, and missiles of various types.

The data on the profits made by the military aviation corporations eloquently testify to the possibilities of enrichment provided them by the aircraft and missile business. Thus North American Aviation made in 1963 clear profits that were 21% greater than those made in 1962. Aerojet General's profits were 27% greater, Grumann's 22% greater, Avco's 19% greater, and Douglas Aircraft's 15% greater. The well-known American writer W. Perlo points out in his book, Militarism in Industry, that the profits on military contracts, thanks to the government-monopolistic measures taken by government and military circles, were 1.5 times greater in recent years than the profits made by the major monopolististic combines taking a minor part in fulfilling military contracts.

When one learns of these figures, it is easy to understand why the representatives of the largest monopolies — especially the aircraft and missile monopolies — fly into a rage whenever the question of disarmament comes up of or reducing military expenditures. Their representatives resist with all their might the emerging relaxation of international tensions, taking measures to advance the arms race. The newspaper, The New York Times, recently noted that any prospects of reducing military expenditures or even of keeping them at the present level "alarms the military industrialists who do business with the government".

The USAF command, in fulfilling the will of the monopolistic circles. relates its policies very closely with the latter's demands. It is known that, in the US military high command, the top figures in the Air Force have always appeared and still appear as the striking arm of the most aggressive forces. Thus, the former Chief of Staff of the Air Force, Gen. Twining, gained fame through his war-mongering speeches. The same may be said of Gen. LeMay, the present Air Force Chief of Staff, and Gen. Power, the commander of SAC. The representatives of the general staff of the USAF have a direct, official interest in the arms race and in raising the prices for equipment and weapons, since they receive a definite pay-off from the military contractors and, after they retire, they obtain comfortable positions on the boards of the firms and corporations.

In order to scuttle the criminal plans of the extremely aggressive monopolistic and military circles in the USA, we must constantly follow their intrigues and promptly expose their plans.

A high degree of vigilance and combat readiness is necessary on the part of the Armed Forces of the USSR, standing guard over the peaceful creative labor of the Soviet people.

Lt. Col. S. YERMAKOV,
Candidate of Economic Sciences

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