TRANSLATION

HERALD OF THE AIR FLEET

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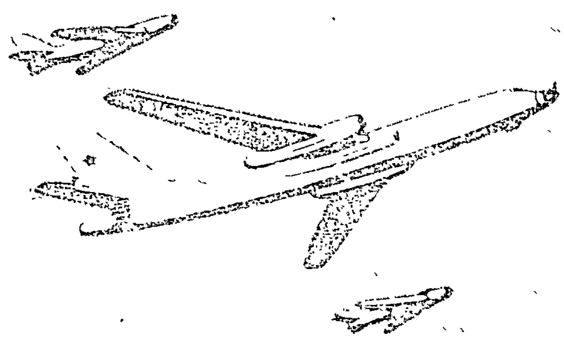

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1957

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EXPLANATORY NOTE

This publication is a translation of Herald of the Air Fleet, (Vestnik Vozdushnogo Flota) a monthly journal of the Soviet 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.

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AIR TECHNICAL INTELLIGENCE TRANSLATION

(TITLE UNCLASSIFIED)

HERALD OF THE AIR FLEET

(Vestnik Vozdushnogo Flota)

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FROM THE EDITOR'S MAIL

REVIEW AND PUBLICATIONS

A FITTING RECEPTION FOR THE FORTIETH ANNIVERSARY OF GREAT OCTOBER

The year 1957 is significant in the life of our Motherland: on 7 November it will be forty years since the day of the Great October Socialist Revolution carried out by the workers, soldiers, and peasants of Russia under the leadership of the Communist Party headed by V. I. Lenin, the great leader of the workers.

In 1917, for the first time in the history of humanity, on one sixth of the globe, a victorious revolution confirmed the political supremacy of the working class - the dictatorship of the proletariat, Soviet power - the highest form of democracy, democracy for the broadest masses of the people. The land, its resources, plants, factories, and railroads became the possession of the workers - the real masters of their country.

As opposed to all the revolutions of the past, when, to replace one form of exploitation, another would appear, the Great October Socialist Revolution destroyed all forms of social and national oppression and inequality. It saved our country from impending economic and national catastrophe, from the threat of dismemberment and enslavement by imperialist plunderers. It showed all the nations the way out of the bloody carnage which had been undertaken by the imperialists and it proclaimed a policy of peace as the firm policy of the Soviet State.

The Great October Socialist Revolution signified a most far-reaching upheaval in the economic system, in the class structure of society, in national relations, and in the political and cultural life of the peoples of the Soviet Union.

Forty years are a relatively short period of time for history, but during these years our country has achieved unprecedented successes and has convincingly proved to the entire world the insuperable power and advantage of the new Soviet social and state structure.

The chief capitalist countries required more than one hundred years for the creation of their massive machine industry. The Soviet Union created a massive technically first-class industry in an immeasurably shorter period of time. By 1957, the industry of the USSR had grown more than 30 times over by comparison with the prerevolutionary period, and heavy industry - the very foundation of the entire economic system - had grown more than 50 times over. The socialist path assured the swift growth of agriculture. Instead of an ocean of petty individual farms with their poor equipment and dominance by the kulak, the greatest socialist mechanized agricultural production in the world has been created in our country.

The revolution in Russia in 1917 provided fullest scope for the political and economic development of all the nationalities inhabiting the USSR, for the confirmation of their state sovereignty, and for the flourishing of their national, socialistic culture.

Unemployment and poverty have been done away with in our country during the years of the Soviet regime. The living standard and well-being of the workers in town and country are constantly rising. In a country where more than three quarters of the population were illiterate before the revolution, universal seven-year education has been put into effect everywhere and the transition to a universal ten-year course has been begun.

If we picture to ourselves what a backward agrarian country Russia was before the socialist revolution; if we take into account the fact that our country was the first to embark upon the new historical path and struggle for the victory of socialism - encircled as it was on all sides by hostile capitalist states; and if we take into account the fact that of the forty years of the existence of the Soviet Regime our people has been compelled for no less than eighteen to defend its freedom and independence against aggression from without and to restore the economy which was destroyed during the wars - then the powerful vitality of the socialist system and the inexhaustible sources of invincibility of the great cause which our people creates under the leadership of the Communist Party will become more convincing and clear to everyone.

In the area of economy, the October Revolution settled to all practical intents and purposes the historically ripe objective necessity for the transition from capitalist to socialist relations of production, after opening the door wide for the development of productive forces.

In sheer production of steel, oil, and electrical energy, the USSR has long since outstripped all the countries of Europe. Even the most malicious enemies of socialism cannot help but see that time is not working in their favor. In the progressive movement of society, rates of economic development are of decisive importance. The rates of development in the economic system of our country have no equals. For example in 1956 in the USA, 1.8 times more steel was smelted than in 1929, while in the USSR, it was 10 times more. The output of oil for this same period was increased 2.5 times in the USA, and 6 times, in the USSR; the output of electrical energy in the USA increased 6 times over, and 31 times in the USSR.

That is what the steadfast confidence of the Soviet people is based on - confidence in the fact that they will not only surpass all capitalist countries in volume of industrial production, but that they will carry out in a very short period of time the task set by the 20th Congress of the CPSU: to overtake and pass the most developed capitalist states in per capita production. The domestic policy of the Communist Party and the Soviet Government stems exclusively from the constant satisfaction of the material and cultural needs of society and is aimed at the well-being of the nation.

In the area of foreign policy, the Soviet Union is a bulwark of all the peace-loving and democratic forces of the globe. Its policy directed towards a peaceful solution of the sharpest international problems, towards guaranteeing contacts with large and small states, and towards preserving and strengthening peace, corresponds to the essential vital interests of humanity and consequently finds ever wider support in the entire world.

The Great October Socialist Revolution was carried out under the all-conquering banner of Marxism-Leninism. It inflicted a blow of tremendous power upon bourgeois ideology, and upon opportunism and reformism in the working movement in all their manifestations. With the victory of October and with the construction of socialism in the USSR, Marxism-Leninism became the ideology holding complete sway in our Soviet society.

The international significance of October, which exerted a definitive influence upon the entire course of historical development is tremendous. A powerful proletarian and national-liberation movement has developed in Europe and in Asia. Many

countries have embarked upon the path of construction of socialism and have formed a monolithic socialist camp headed by the Soviet Union. As a result of the victorious national-liberation movement, the largest states of the East gained independence, states which now play an important role in international relations, and in the struggle for peace.

The Great October Socialist Revolution opened up a new era in the history of mankind.

That is why Soviet men and women are preparing with such enthusiasm to celebrate the significant anniversary in the life of our socialist Motherland. The decree of the Central Committee of the Communist Party of the Soviet Union "Concerning preparations for the celebration of the 40th anniversary of the Great October Socialist Revolution" has found a very lively response in the heart of every Soviet man, of every soldier of the Soviet Army.

"To develop preparations for the celebration of the fortieth anniversary of the Great October Socialist Revolution as a nation-wide holiday of international significance, under the badge of mobilizing the creative activity of the mass millions of the nation for successfully putting into effect the historical decisions of the 20th Congress of the CPSU" - these words in the decree of the Central Committee of the Communist Party of the Soviet Union have evoked tremendous enthusiasm and a new upsurge of work energy on the part of the working class, kolkhoz peasantry, Soviet intelligentsia, and the soldiers of the Soviet Army, Air Force, and Navy.

In response to the call of the Party, a nation-wide socialist competition has developed widely in the country in honor of the fortieth anniversary of October. The efforts of the workers have been directed towards gaining an uninterrupted rise in the socialist economic structure, at carrying out ahead of schedule - according to all indices - the plan for the second year of the sixth five-year plan, at increasing even more the volume of agricultural production, and at assuring the further flourishing of Soviet science and socialist culture.

By a decree published on 22 April, Lenin prizes were awarded for the most outstanding achievements in the field of science and technology, literature, and art. Included among those who received the honor prizes are Academician A. N. Tupolev, General Designer for the Aviation Industry and the most prominent representative of aviation science, and also Pilot M. G. Surgutanov, of the air detachment of the Ural Geological Administration.

Inexhaustible creative energy, the striving to move forward constantly to new victories and progress in socialist construction - these features and noble qualities of the creative and heroic nation are characteristic also of Soviet soldiers trained by the Communist Party. Socialist competition is an important instrument in the hands of an experienced commander and of the party-political apparatus, and with its help they can achieve maximum results in working with the personnel and with outstanding men. We must develop in all our soldiers the striving to fight energetically for a better element, for a better unit.

Together with the workers of the USSR, the soldiers of the Soviet Army, including the personnel of the Air Force, are preparing actively for the fortieth anniversary of the October Revolution. Pilots, navigators, technicians, and all aviation specialists are struggling selflessly to master high quality aviation equipment, to heighten the quality of combat and political training, to strengthen discipline and order in every possible way, and to enhance the combat readiness of their elements and units.

Preparing to celebrate this glorious date with worthy deeds, the soldiers of the Air Force are increasing daily the ranks of men who are outstanding in combat and political training; they increase the number of first class military pilots and navigators - skilled men, who have mastered perfectly the technique of flying during weather minimum and who successfully carry out their missions by day and by night under adverse weather conditions.

The patriotic movement of aviators is widening, aimed at making every crew, element, and unit as a whole, outstanding. The work of the personnel of the fighter unit commanded by officer I. A. Kulakov is an interesting example. During the years of the Patriotic War, this unit received governmental awards and the title of Guards unit for exemplary fulfilment of its military duty to the Motherland. Under peacetime conditions, its new members have been continuing and increasing its glorious combat traditions.

The pilots have mastered high quality aviation equipment to perfection. The engineers and aviation specialists assure its reliable functioning. At the beginning of the current year one more group of officers raised the level of its first class ratings, and now the entire flying personnel cadre has the rank of first class military pilots. Surely that fact is indicative of the high combat readiness of the Guards regiment!

No less high results in training have been achieved by the element of officer N. V. Baranov, all the airmen of which fly in prescribed weather minimum day and night, step by step consolidating their habits in intercepting targets not visible to the eye. For success achieved in flight training, the highest governmental award - the Order of Lenin - was bestowed on Squadron Commander, Guards Captain N. V. Baranov, on his deputy, Guards Captain A. T. Osipov, and on officers V. V. Molin and I. A. Zakharov. The Order of the Red Banner was bestowed on pilots M. I. Zharov, I. N. Kovalevskiy, and N. S. Tsatsenko.

For faultless service, Guards Captain L. P. Levachev, first class military pilot, holds forty-six citations of thanks and three valuable gifts from the Command. It is not for nothing that people refer to him as the best fighter-interceptor in the unit. The Soviet Government has awarded him the Orders of the Red Banner and the Red Star for fulfilment of flight missions under adverse weather conditions. Officer and Communist Levachev combines flight work with important social-political activity: the workers have shown him great honor and confidence in having elected him as their deputy to the Municipal Council.

We can mention the names of many pilots and navigators, engineers and technicians, mechanics and representatives of all other aviation professions, whose intensive and inspired work is a model of fulfilment of one's military duty. Inherent in our soldiers is a feeling of deep personal responsibility for the defense of the socialist Motherland. Herein lies a powerful source of the strength and invincibility of the Soviet Army.

A very important criterion in the evaluation of the combat readiness of Air Force units and elements is not only the skill of the personnel in carrying out a mission under adverse conditions in any situation, but above all the degree of good organization in carrying out all of the flight work.

As has already been said, the overwhelming majority of Air Force commanders

have managed to achieve the fulfilment of flight training schedules without accidents and mishaps. Many commanders and their political officers have been awarded valuable gifts for progress or have been given citations of thanks by the Commander-in-Chief of the Air Force. Among them we may mention officers G. G. Agamirov, M. P. Burykh, P. K. Zosinets, and others, who organize their flight work with flawless efficiency, who conduct the training and ideological-political indoctrination of their personnel methodically, correctly, and consistently, who combine a high degree of exactingness with a skillful approach to their men, and who thoughtfully and carefully develop a high morale in them.

The success of any matter is determined by the cadres, dynamic men, by their striving and will to achieve the set task, their readiness to surmount any obstacles on the path to the designated goal. "Whatever powerful weapons armies may have at their disposal", said Minister of Defense G. K. Zhukov, Marshal of the Soviet Union, at an All Army Conference of Outstanding Men, "the decisive role in the achievement of victory over the enemy belongs to men who possess high morale and who know how to put weapons and equipment to full use. Our Army, having absorbed the moral force of the Soviet People, having developed and increased all the best and heroic characteristics of the Russian Army, has always distinguished itself and continues to do so, by its moral steadfastness and by the valor and bravery of its soldiers".

In savage battles with the enemies of our Motherland, the Soviet Armed Forces, led by the Communist Party, have honorably defended the gains of Great October, the freedom and independence of our socialist Fatherland. Tens and hundreds of thousands of soldiers of our Army, Air Force, and Navy have accomplished unfading exploits for the glory of the Motherland. Our people know the names of many Soviet pilots who, unsparing of their own lives, fought for their beloved Fatherland. And even now the annals of the Great Patriotic War continue to be supplemented by new names.

Recently, by a decree of the Presidium of the Supreme Soviet of the USSR, the title of Hero of the Soviet Union was bestowed upon Leonid Georgiyevich Belousov, for exemplary fulfilment of missions of the Command during the years of the Great Patriotic War and for the valor and heroism displayed in that connection.

No ordeals whatsoever broke Fighter Pilot Communist Belousov's will for battle. He steadfastly endured many months of torturing treatment after a crash in 1938, which took place while he was carrying out, under adverse weather conditions, an urgent combat assignment to render harmless the provocatory operations of an aircraft that had violated the air borders of the USSR. From the very first days of the Patriotic War, Belousov was in a combat formation of pilots defending Leningrad. And even when, as the result of complications that had set in after an illness, the doctors were compelled to amputate both legs of the pilot, the physical handicap did not break his will. At the cost of tremendous effort, tenacity, and toil, he again returned to his formation, again took off in a combat aircraft and struck at the enemy until complete victory.

"For me living means flying and flying means defeating the enemy", Belousov used to say to his fellow-officers. These proud words were confirmed by the deeds of this genuine Soviet man, whose entire life is a most striking example of selfless devotion to the Motherland.

The heroic history of the Soviet Army, its glorious combat traditions are one of the bases for the indoctrination of combat morale, a pledge of the successful battle for heightening under modern conditions the combat readiness of the Soviet Armed Forces, which are reliably defending the creative toil and security of Soviet men and women. While making ready for the glorious anniversary of the Soviet Fatherland, our people look with pride at the Army, Air Force, and Navy which they created and which are covered with the glory of victories. Constant concern for their Armed Forces, nation-wide love and confidence raise the initiative and activity of our soldiers to a new higher level.

The paramount duty and task of the Air Force commanders, political workers, and Party and Komsomol organizations consists of indoctrinating the flyers from day to day in the spirit of ardent Soviet patriotism and devotion to the military oath. The military oath obliges every serviceman to be honest, brave, disciplined, and alert, and to carry out unquestioningly the regulations, directives, and orders of their commanders and superiors. The whole process of training and indoctrination, all of the party-political work in the units must stem from the requirements of the military oath and regulations and must be aimed at bringing it about that the personnel of the Air Force is ready at any moment for decisive resistance to imperialist aggressors and for winning the victory over a powerful enemy.

High and constant combat readiness depends directly on their knowledge and on their training and ability to utilize the weapons given them against the enemy. Consequently the best gift which the soldier aviators can present their Motherland for the fortieth anniversary of October is the unswerving heightening of the quality of their combat training.

The Air Force equipment of our time becomes more and more varied and complicated from day to day. One must know a great deal in order to master it perfectly. It is especially important to have a high theoretical training and to know physics and mathematics well. Yes, and mathematics! But among some comrades there has been observed of late an incorrect attitude - in our opinion - towards evaluating the importance of a knowledge of mathematics. Some even flaunt their ignorance in the field of mathematics. "When I open a book or article on aviation and see mathematics there, I don't want to read it". This statement can sometimes be heard, unfortunately, from a person who claims to be a cultured and educated aviator. But after all, in a mathematical formula, in a flight computation, very valuable conclusions are almost always contained which frequently a person cannot even comprehend in any other way. What a tremendous and very rich opportunity for mastering equipment and weapons drops out of the lives of some aviators who do not know any mathematics, how much they lose! We must eliminate this shortcoming with all our efforts and resources.

Atomic weapons are now replacing the conventional kind. In the Air Force, we deal with supersonic jet aircraft, with complex radar and other modern equipment. Our Armed Forces have powerful rocket and jet weapons of various types, including long-range missiles. Such a qualitative change in our Army, especially the Air Force, required an expansion in every way possible of military science work, for otherwise it is impossible to solve even one serious problem. It is precisely for this reason that so much attention is being given to the development of the military science idea. In many units military science societies have been formed. Air force commanders, pilots, engineers, and navigators solve important problems aimed at developing the tactics of aerial combat, and at utilizing modern aircraft in combat.

However not all officer-leaders approach this big and extremely important job with due responsibility. It must be confessed, some commanders, after finding out about the formation of military science societies in other units, have themselves not undertaken any concrete steps in that direction. And to this very day we have not succeeded everywhere in overcoming the mistaken opinion that only academies are called upon to take up military science work, but that it is difficult to set up such a matter in line units. If we live by such ideas, we can mark time for years and thereby inflict great damage on combat training. A fitting place must be allotted for military science work, and on the basis of profound scientific generalizations, training methods must be improved, tactics must be developed, and we must try to bring it about that the entire combat training work is conducted at the level of modern requirements.

Our commanders will have to work a great deal to improve the organization of the process of training the flying personnel in aerial combat and aerial gunnery. It is very important to seek out new tactical procedures for combat operations at supersonic speeds and in the stratosphere, and to examine the advantages and develop the theory of barrage fire. In training the flying personnel of fighter aviation in aerial combat and aerial gunnery, we must give some thought to flying safety.

The pilots and navigators of bomber aviation must achieve increased bombing accuracy. Modern aircraft equipment makes it possible to solve this problem successfully under any weather conditions, day and night. However, in the methods of bomber training there are, in some units, a whole number of shortcomings which must be eliminated as rapidly as possible. For example, the existing methods of evaluating bomber training do not everywhere reflect to a sufficient extent the growth of skill of the crews. This shortcoming must be liquidated in order to achieve consistent improvement of the habits of all the members of the crew, for every pilot and navigator to receive an objective evaluation of his skill.

The entire personnel of the Air Force must give its attention to the increased importance of physical training. The nature of the work of our command cadres and of all military men has become complicated to a considerable extent in connection with the changed conditions of aviation work. Pilots who are not in good physical training condition will not be able to withstand the great physical strain in modern combat. Why even in time of peace in combat training work, physically weak people will not be able to cope successfully with their service duties. And we do have such people among us unfortunately. Going in only occasionally for physical culture and sport, some officers - even young ones - begin to put on fat and become sedentary, and this is a great defect for any military man.

Air Force commanders must devote more attention to the physical training of their men, and develop sport work more extensively. In the Air Force, physical training must be organized in such a way as to develop the muscular strength of the pilots, the resistance of the organism to serious overburdening, speed of reaction, and spatial orientation, which assure high endurance in carrying out rapid, high-altitude and long-range flights.

The preparation for the celebration of the fortieth anniversary of October gives the commanders and political workers the opportunity to make their work in the political indoctrination of their men even more interesting, concrete, and purposeful.

The glorious revolutionary traditions of the Communist Party, of our working class, and of the entire Soviet People, the combat traditions of the Soviet Army serve as a powerful instrument for indoctrinating the men. The propagandizing of our glorious combat traditions occupies a prominent place in the preparations for the celebration of the anniversary of the Great October Socialist Revolution. Lectures and talks are being conducted in the Air Force units and elements on the great role of the CPSU and of V. I. Lenin in the creation of the Armed Forces of the USSR, in the construction of the Army, Air Force, and Navy, and in the organization of victories over our enemies.

The commanders, political workers, and the Party and Komsomol organizations have been called upon to explain more extensively to the personnel, the political events of the October Revolution, its world-wide historical significance, and the achievements of the USSR and the countries of peoples' democracy in the struggle for socialism and for peace in the entire world. Talks must be systematically organized in the units, meetings with participants in the October Revolution, with veterans of the Civil War and the Great Patriotic War, with prominent men in industrial enterprises, kolkhozes, machine tractor stations (MTS), and sovkhozes, in order to become more thoroughly acquainted with the labor victories of the Soviet people. At the same time we should organize at the enterprises and kolkhozes speeches by the commanders, political workers, and outstanding soldiers, concerning the life and training of aviators, concerning their struggle for heightening the quality of combat and political training and for strengthening military discipline. We must practice more widely the exchange of amateur productions among the units, and we must conduct sports contests. The soldiers must give practical assistance to the enterprises, kolkhozes, and educational institutions in developing military work among the youth.

The preparations and celebration of the fortieth anniversary of Great October will rally the Soviet People and the soldiers of its Armed Forces more tightly round the Communist Party and the Soviet Government, and will serve as a powerful stimulus for the further movement of our country along the path towards Communism.

THE REVECTORING OF BOMBERS TO OTHER TARGETS

Military Navigator Second Class, Engineer Col. I. P. Petrukhin

The fluidity of present-day combat, in which all arms are combined, and the rapid change in the air situation make it necessary to vector bombers to the target with all speed. In this connection, it may be necessary in many instances to revector airborne aircraft to other targets.

It is known that for bombing with a range-finding system using initial data, the following set-in values are determined for the computing instrument: for the drift station R_{dr} and the speed station R_{sp}; magnetic heading of the bomb run $BMPU_{set}$; the angle between the stations ψ_{set}; positions of the bomb-release indicator and of the range scale for drift; positions of the "drift station" switches on the indicator and comparator; and the positions of the tumblers. In addition, for the SRP [RDF] setting, the drop time T and the bomb lag Δ are taken from tables.

If the crew aloft is given a new target for bombing, the setting calculations for it cannot be made by using full formulas and by the usual method within the limited time available both to the aircraft crew and to the ground command post. Consequently, it is necessary to seek time-saving and simplified methods for recalculating the set-in values for the new target.

Let us suppose that the bombers are to be revectored to targets which are located at such a distance that there is no need to alter the approach heading in the course of revectoring. If we then were to consider that the altitude and speed of bombing are to remain constant, then for the purpose of revectoring it will be necessary to recalculate the following set-in values: R_{dr}, R_{sp}, $BMPU_{set}$, ψ_{set}, and the positions of the bomb-release indicator and of the range scale for drift.

In addition, calculations show that (when there are fixed distances between the original and the new targets, and between the ground stations and the targets) the slant-range difference between the original and new targets can be replaced by the difference in geodetic distances between them; and the coefficient changes $\frac{A_o^2}{2R}$, $\frac{A_o^2}{2R}$ cos ψ_t, $\frac{57.3 A_o}{R}$, etc., may be disregarded in the computing formulas. If this is done, in the course of revectoring it will be possible to measure on a topographical map the extent of the shift in attack according to the stations of drift ΔR_{dr} and of speed ΔR_{sp}; while the set-in values for the new target may be recalculated on the basis of the settings obtained earlier for the original target according to the following formulas

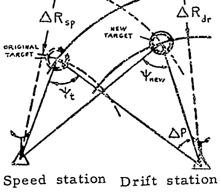

Fig. 1. Set-in values for revectoring.

$$R_{dr\ new} = R_{dr} \pm \Delta R_{dr},$$

$$R_{sp\ new} = R_{sp} \pm \Delta R_{sp},$$

$$BMPU_{set\ new} = BMPU_{set} \pm \Delta P \text{ [bearing]}$$

$$\psi_{set\ new} = \psi_{set} + \Delta\psi_t,$$

where R_{dr}, R_{sp}, $BMPU_{set}$, and ψ_{set} denote the set-in values for SRP for the original target;

ΔR_{dr} and ΔR_{sp} denote the shifts in attack with reference to the stations of drift and speed;

ΔP denotes the bearing difference between the original and new targets relative to the drift station ($\Delta P = P_{new} - P$);

$\Delta\psi_t$ denotes the station angle difference between the original and new targets

$$(\Delta\psi_t = \psi_{t\ new} - \psi_t)$$

The values ΔR_{dr}, ΔR_{sp}, ΔP, and $\Delta\psi_t$ are shown in Fig. 1.

It is advisable for revectoring to use a map which makes it possible to measure distances accurately within 25 m. The most suitable map for this purpose is one to the scale of 1:50,000 made up of four sheets glued together, since it embraces a sufficiently large area and is handy. It may be prepared in two ways.

The first method provides for laying on grids: a range-finding grid with 1 km intervals, and an azimuthal with 1-3° intervals, for each of the two ground stations of the system. The grids for each of the stations should be laid on in different colors; the range-finding lines - orbits - should be laid on in a solid line, the azimuthal - bearings - in a dotted line. The orbits and bearings of the grid are numbered.

Such a grid on the map is necessary not only for revectoring. It is known that for bombing calculations with a range-finding system the geodetic distances from the ground stations to the target M, as well as the target angles ψ_t and bearings P, are used as initial data. In a combat situation when there is a variety of targets, in most cases it will be impossible to obtain these data without the aid of the range-finding-azimuthal grid, since the preliminary geodetic calculations would be cumbersome.

A map may also be prepared by laying on it only the azimuthal grid for each of the two ground stations in the system. Bearing lines for each station are drawn in different colors at 1° intervals and are numbered. Such map preparation is not difficult and does not require much time. In this case the azimuthal grid is transferred to the revectoring map from a smaller scale map which includes the location of the ground stations in the system and the area of combat operations. For this purpose, bearing lines are drawn on a small-scale map every 5 - 2° (depending on the range), and are transferred to the revectoring map with the aid of a kilometric grid. In order to draw the intermediate bearing lines (at 1° intervals), the transferred bearings are distributed correspondingly.

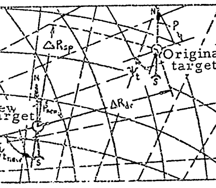

Fig. 2. Measured values when revectoring.

The shortcoming of such a method of preparation is insufficient accuracy of the azimuthal grid. Besides, the map also does not permit measuring the initial data, i.e., the geodetic distances M, as can be done on a map with a range-finding-azimuthal grid; that is, on a map prepared by the second method there must be at least one point with accurately known geodetic distances.

When recalculating $R_{dr\ new}$ and $R_{sp\ new}$ for the new target on the revectoring map, the values of the shift in attack are measured by the drift station ΔR_{dr} and the speed station ΔR_{sp} (Fig. 2).

In order to measure ΔR_{dr} and ΔR_{sp} quickly and to calculate the angle corrections $\Delta\psi_t$ and ΔP, it is advisable first to "lift" the original target, i.e., to measure and to draw on the map next to this target the distances to the nearest orbits, the station angle ψ_t, and the target bearing relative to the drift station P, approximately as shown in Fig. 3.

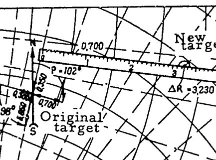

Fig. 3. Original target and measurement of ΔR_{dr}

As can be seen from Fig. 3, in order to measure ΔR_{dr}, the ruler is placed next to the new target in the direction of the drift station's azimuth in such a way that its zero calibration is 0.700 km away from the corresponding station orbit. Opposite the new target the value for ΔR_{dr} is immediately read off as 3.230 km.

Fig. 4 shows how the value ΔR_{dr} is measured on the map prepared by the second method. The protractor is laid along the azimuthal line of the drift station next to the target which is located closer to this station (the figure shows the protractor laid next to the original target). For the heading to the drift station we read off an angle of $90^{\circ} - \frac{\Delta P}{2}$; in our case it will be

$$90^{\circ} - \frac{98^{\circ} - 90^{\circ}}{2} = 90^{\circ} - 4^{\circ} = 86^{\circ}.$$

Then a line is drawn at an 86° angle until it intersects the azimuthal line of the farther target (in our case, the new target). The distance from point A to the target is the value of shift in attack with reference to the drift station ΔR_{dr}. In the same way is measured ΔR_{sp}.

Fig. 4. Measurement of ΔR_{dr} on a map with azimuthal grid.

The values for $R_{dr\ new}$ and $R_{sp\ new}$ are recalculated according to the formulas above, with the sign for ΔR being taken depending on the pattern approach heading, and on the position of the new target relative to the original in accordance with Table 1.

Sequence no.	Approach headings / Signs for ΔR_{dr} and ΔR_{sp} / Positions of new target relative to original	I ΔR_{dr}	I ΔR_{sp}	II ΔR_{dr}	II ΔR_{sp}	III ΔR_{dr}	III ΔR_{sp}	IV ΔR_{dr}	IV ΔR_{sp}
1	New target closer to drift and speed stations	−	−	−	+	+	+	+	−
2	New target farther from drift and speed stations	+	+	+	−	−	−	−	+
3	New target closer to drift station, farther from speed station	−	+	−	−	+	−	+	+
4	New target farther from drift station, closer to speed station	+	−	+	+	−	+	−	−

Analyzing the table, the following rule may be deduced: If the new target (relative to its approach heading) is located to the right of the original target, the correction ΔR_{dr} must be subtracted from R_{dr}; if, on the other hand, it is to the left, then it is added. When, however, the new target - relative to its approach heading - is located ahead of (farther from) the original target, then the correction ΔR_{sp} is added to the original value R_{sp}; but if it is closer, it is subtracted.

In recalculating $BMPU_{set\ new}$, the bearing difference ΔP is first of all determined. This presents no great difficulties if one uses maps prepared by either the first or second methods. Recalculations are made according to the formulas indicated above, and the sign of ΔP is automatically arrived at when calculating $\Delta P = P_{new} - P$. For example, if the drift station is on the right and the new target is farther away than the original target on the approach heading ($P_{new} > P$), then the sign of ΔP is positive; but if the new target is closer than the original, then the sign is negative. When the drift station is located on the left, the signs are reversed.

Seq. no.	Approach heading / Sign of difference	I & III	II & IV
1	$(\psi_{t_{new}} - \psi_t) > 0$	+	−
2	$(\psi_{t_{new}} - \psi_t) < 0$	−	+

For calculating $\psi_{set\ new}$, the angles $\psi_{t\ new}$ and ψ_t are first measured on the map and the difference $\Delta\psi_t = \psi_{t\ new} - \psi_t$ is calculated. The value $\psi_{set\ new}$ is calculated according to the formula stated earlier, and the sign $\Delta\psi_t$ is assumed depending on the target approach heading according to pattern, and on the sign of the difference $\psi_{t\ new} - \psi_t$ (Table 2).

When determining the positions of the bomb-release indicator and the range scale for drift for the new target, it is necessary to add (or subtract) ΔR_{dr} and ΔR_{sp} to (or from) the corresponding positions of these settings which have been calculated for the original target. The signs for these are selected on the basis of the fact that the change in distances to the ground stations corresponds to the change in the position of these scales. If, for example, the new target is located (relative to the original target) farther away from the drift station and the speed station, then, for the purpose of recalculating, the values of ΔR_{dr} and ΔR_{sp} - reduced to even kilometers - are correspondingly added to the original positions of the bomb-release indicator and the range scale for drift. Such recalculation of scale positions must be made when an attack is shifted over a considerable distance in order to preclude a gross error in the drift station range-finder and to achieve effective operation of the speed station's range-finder.

It is necessary to note that the set-in values for the SRP in a combat situation may be recalculated in a similar manner, not only when revectoring aloft, but also in the event the mission or the bombing objective is changed, when the commander will not have sufficient time to fully calculate the data.

When revectoring aloft, the navigator of the lead bomber will not be able to recalculate the set-in data, since this would require no less than 3-4 min; and meanwhile he will have to relinquish other tasks (course plotting, circumspection, etc.). Besides, it is very inconvenient to use the revectoring map in the navigator's compartment. The transmission from the ground to the aircraft of the data on the exact position of the new target for the purpose of plotting it thereafter on the map will involve definite difficulties. Furthermore, in order to locate the target on the map, the plane's navigator must spend additional time and engage in unnecessary radio communication.

On this basis, in order to perform the calculations for revectoring, it is sensible to assign to the unit's command post (KP - or KP of the bombing range) a controller who has a revectoring map - standard navigator's equipment; Tables 1 and 2 for selecting correction signs; and a form for revectoring calculations.

The form for revectoring calculations is set up for definite flight conditions indicating the calculated values for the original target (first horizontal line of the form). The values of corrections (second line) and the data for the new target (third line) are filled in and calculated in the course of revectoring.

The commander guiding the bomber operations from the KP, having decided to revector, determines the exact position of the new target and of the bombers on the map. Then he gives a preliminary command to the leader of the group concerning the shift in attack, and to the KP controller about making calculations for the new target.

Having received the preliminary command, the bombers change (when necessary) the flight course in order to approach the new target without changing the approach heading. It is apparent that, with comparatively slight changes in the position of the

Fig. 5. Revectoring bombers.

new target (up to 3-4 km), when it is not necessary to change the flight course for approaching the new target, no preliminary command need be given to the planes in the air.

Having decided to revector, the controller calculates the set-in data for the new target (if the calculated values are known for the original target). For this purpose he determines the corrections signs according to Table 1 and enters them on the revectoring form. On the revectoring map the controller measures the values of the shifts in accordance with the drift and speed stations ΔR_{dr} and ΔR_{sp}, and enters them on the form. Then he measures the angles ψ_t, calculates and enters on the form the value of $\Delta\psi_t$, having determined its sign by Table 2. He finds the bearing difference between the new and the original targets ΔP and enters it on the form with its appropriate sign, adds (or subtracts) in order to determine the new set-in values. In addition, the controller determines the settings for the bomb-release indicator and the range scale for drift, notes the time when calculations are completed, and hands the revectoring form to the commander of the KP (or to the operations officer at the bombing range).

The commander issues the command of execution to the leader of the group, reading the data off the form. Having received the command of execution, the plane's navigator enters the new set-in data on the third horizontal line of a form identical with the one used by the KP controller; then he transmits his acknowledgement to the ground, switches on the SRP, and sets in these values.

Sometimes, the revectoring controller at the KP will have no access to the settings for the original target. Then he will simply have to measure the correction values on the map (ΔR_{dr} , ΔR_{sp} , $\Delta\psi_t$, Δ P), and enter these on the form. In this connection, the corrections will be transmitted from the KP to the aircraft; and the plane's navigator will enter these corrections on the form, and will himself calculate the settings for the new target. This will require slightly more time as compared with the calculations on the ground.

Calculations show that this method allows for bomber revectoring in shifting the attack without sacrificing bombing accuracy.

When shifting the attack over a considerable distance, the commander at the KP must take into account the position of the new target relative to the original one, and the maneuverability of the bombers at the moment he issues the preliminary command for revectoring. The command must be issued in good time so that the crews can reach the initial point of the turn into the combat orbit of the new target without change of heading. For example, Fig. 5 shows a situation in which the revectoring command was given late to the bombers, and they will only be able to reach the combat orbit after prolonged maneuvering; this will subject them to additional enemy PVO [AA defenses] action.

Thus, the decision to shift an attack - as far as the time element is concerned - is made with due consideration being given to the mutual location of the original and new targets and relative to the approach heading to the latter, at the same time taking into account the position of the bombers aloft at the moment when the command is issued.

When bombing with the aid of the range-finding system, revectoring broadens considerably the tactical capabilities of the bombers.

CONTROL OF A FIGHTER ELEMENT IN AERIAL COMBAT

Candidate of Military Science, Lt. Col. N. G. Sopelev

As speeds of fighter aircraft increase, combat operations by small groups of aircraft become increasingly important. At the same time, the element commanders' responsibilities for combat organization and the control of subordinate crews multiply. This constitutes the distinguishing feature of control in present-day warfare which differentiates it from fighter control as it was practiced during the Great Patriotic War.

The space where the aerial combats take place has so greatly expanded that the pilots of an element are not always able to maintain visual contact with one another. Under such conditions, the lack of well-organized control, as a rule, results in uncoordinated operations which are immediately reflected in the outcome of the engagement.

In the course of an engagement the commanders of elements or pairs of aircraft have no time to give their subordinates detailed instructions on combat procedures. Having reached a decision,they are able to give only a brief order to define the objective of the operation, and the direction and method of attack. Only those pilots who have had sound tactical training and who have a good command of air situations will be able to comprehend their commander's plan through such brief commands and thus will be capable of operating skillfully in combat. In conjunction with this, the role of individual initiative and independent actions of a pilot becomes more important.

The greatly expanded space where the aerial combat takes place, the increasingly limited time available for making a decision and for giving out orders, greatly complicate the exercise of control in present-day aerial combat.

A plan of aerial combat which has been worked out on the ground in the course of preparing for the combat mission is of great help to the commander in controlling his element. After a thorough survey of the air situation, the commander establishes the enemy forces which might be encountered aloft, their formations, operational altitudes and tactical techniques. On the basis of these facts, he determines the most probable variants of the situation in which the combat will take place. There are a great many such variants, but only the most typical of these are studied with the pilots. At the same time, the experience gathered from previous combats is taken into account and a careful analysis is made of their positive and negative aspects.

We take one example. The enemy is operating in small groups (elements) of bombers under fighter cover, and flying in a "wedge of planes" formation at a 6000 - 8000 m altitude. The cover fighters are positioned behind on the flanks, in pairs and elements, at a distance of 2-4 km, and 600-800 m above. On this basis, with a consideration of mutual spatial position at the point of encounter (spotting), the commander determines the closing-in procedure, the order in which the initial position is taken, and the execution of the initial and subsequent attacks. He considers

carefully how best to ensure the attack against the opposition of the escort fighters and against the bombers' fire. Essentially, he is staging an aerial engagement with due consideration for the prevailing weather conditions. The plan of the aerial engagement is worked out and studied by the flying personnel in two separate versions: one - for adverse weather, the other - for normal weather. Before each mission the plan is checked for accuracy.

However, such a plan, no matter how thoroughly worked out and studied by the flying personnel, at best can only assist the element commander in controlling his subordinates. The decisive factor in the course and outcome of the aerial engagement, besides the firing skill of the pilots, will be provided by the commander's ability to effect an early detection of the enemy, to assess the situation quickly and accurately, to reach a decision promptly, and to give out the necessary orders.

In assessing a situation, the element commander takes into account the mutual spatial position, the types of enemy aircraft, their numerical strength, formation, altitude, distance to the target they cover, as well as the prevailing weather conditions. Each of these factors will influence the element commander's decision.

Haphazard actions without due consideration of the prevailing air situation result, as a rule, in failures. Thus, during a mission, a fighter element spotted a group of aircraft which were stacked between 1500-2000 m altitudes and were flying in pairs. Mistaking them for friendly fighters, the element continued on its course. Only at closer range did the commander identify the enemy. Instead of determining first the numerical strength of the enemy aircraft and of taking up a tactically advantageous position, he hurriedly turned in the direction of the nearest pair of aircraft and attempted to attack them on a head-on collision course. The attack was unsuccessful: the enemy, exploiting his formation stacked in depth, gained the tactical advantage.

The necessity of correctly assessing the situation can further be demonstrated by examples taken from combat training exercises. On one of the flying days a fighter element was scrambled to intercept a target (the element was flying a "bearing" formation). The pair in trail was 200-300 m to the right. On orders from the ground the leader began turning with a 40° bank angle. Having turned 20-30°, the fighters saw a group of "enemy" bombers in front and to the left at a distance of 3.5-4 km. After spotting the enemy aircraft, the leader kept on turning with the same bank angle. Only after the plane had turned more than 90° and the lag became apparent, did the leader sharply increase the bank angle and the engine's rpm. However, due to a late start in turning, it was impossible to eleminate the lag relative to the target. The leader was forced to trail the target in level flight, which took about 2 min., before he could take up his initial position for attack. When making the turn the pair in trail fell behind the lead pair by about 1500 m. As a result, only the lead pair was able to attack the "enemy" on the approach to the intended object of air cover. The second pair attacked the bombers right over the objective. A prompt interception was not achieved.

The combat mission aborted because the commander was not capable of assessing properly the mutual spatial position and of reaching an appropriate decision which would enable the element to effect the necessary maneuver in taking up its initial position for attack.

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In this instance, the leader, having spotted the "enemy", should have ordered an "all together" turn with a maximum angle of bank. After the turn, the pair in trail would have been in the lead position, and the element commander would have been the second to attack the target. This would have assured a well-timed interception of the "enemy".

The success of an engagement depends largely on the ability of the commanders, flying in combat formation, to reach their decisions on the basis of a thorough and comprehensive evaluation of the air situation, no matter how complicated it is.

Experience shows that skill is necessary for arriving at a quick evaluation of a situation, for maintaining circumspection and for sustaining the search, for tracking the enemy's position, and for observing his operations as well as the operations of the element's pilots. The earlier the element commander perceives the enemy's plan, the sooner he reaches an appropriate decision or revises the one he had reached earlier on his way to the intercept area, and thus is able to counteract the enemy action.

The commander's capacity for self-control plays an essential part in the matter of evaluating the situation correctly: his courage, resolution and confidence in achieving victory.

The commander's decision, which guides the pilots' actions within the limits of a single concept and plan, stems from his ability to evaluate the prevailing situation. As for the decision, it is an act of will indicating the pilot commander's level of professional development as well as his skill in the art of flying. By his decision he defines the objective, the method and direction of attack, he deploys his forces according to the targets and the problems involved.

In making his decision, the commander endeavors, above all, to assume a tactically advantageous position which will enable the fighters to attack the enemy effectively and by surprise and to maintain the advantage of initiative in the course of the engagement. In order to insure for themselves a tactical superiority over the enemy, the fighters frequently perform a definite maneuver (climbing for altitude, entering sectors where the opponent's visual contact is poor, etc.). Naturally, such maneuvers require time. But any loss of time will be justified if the enemy aircraft present no immediate threat to the objective which is being given air cover. If, on the other hand, a real threat of a bombing attack to the target develops, the fighters must engage in a prompt attack, disregarding any possible countermeasures which they may encounter.

Determining the range of the enemy aircraft to the objective under fighter cover poses a rather complex problem for the commanders aloft. The command posts assist them by also informing the fighters about the altitude and flight speed of the enemy aircraft, as well as their numerical strength, type, formation and any course changes relative to our fighters.

A distinguishing feature of present-day aerial combat and, consequently, of control, is the fact that the fighters find it difficult to carry out the search and to take up the initial position for attack unassisted. At the same time, the task of securing an advantageous position for the fighters in their encounter with the enemy becomes increasingly important. Such a position is achieved by the coordinated efforts of the ground radar crews and of the pilots aloft. At this point, the element commander's problem is that of having the pilots carry out precisely the instructions issued from the element's command post in order to reach precisely the area of encounter from

the desired direction. Having all this data at his disposal, and being certain of encountering the enemy from the most advantageous direction, the commander aloft can reach an early decision of engaging in combat. The commander of the fighter group can set up his formation in such a way as to enable it to make a running attack on the enemy.

It is quite important to have the commander's decision, in the form of a clear and brief command given over the radio or by means of an individual signal, reach those who are charged with executing the orders. Clearly - transmitted commands enable the pilots to visualize the combat problem, to understand the element commander's plan, and their own place and part in the aerial engagement. In this connection, the problem must be outlined prior to the point where the element reaches the initial position for attack.

When issuing the instructions, it is practicable to indicate first the method of attack ("simultaneously", "in train", " in sequence"), and then the objectives. When attacking in train and in sequence, the number of simultaneously attacking aircraft is indicated as well as the order in which the attack is carried out. After announcing the method of attack, the element commander assigns the firing objectives. For this purpose he can use reference numbers to designate enemy groups and aircraft in formation.

In the course of the attack, the element commander devotes all his attention to the technique of executing it, while the pilots in trail must watch with great attention for any changes in the air situation. Any attempt on the part of the element commander to guide the individual operations of the pair in trail would be wrong. This can restrict the initiative of those in trail, which fact will be immediately reflected on the outcome of the engagement. It is necessary to have the actions of the pilots stem from the element commander's decision at the outset of the engagement as well as from their own initiative as it develops in the course of the engagement. However, this does not imply that the element commander ceases to guide his pilots after the initial attack. He must keep on evaluating the situation, directing the engagement and guiding the operations of the pilots toward the solution of the basic problem.

Personal example is of great value in the matter of exercising control during an aerial engagement.

As a rule, visual contact is continuously maintained by the pair and by the element in the course of the engagement. Being in full view of his pilots in trail, the commander of the element (or pair), by dint of his own performance, prompts them to execute the necessary maneuver. The pilots in train can determine the commander's plan from the nature of the given maneuver and can operate during the engagement without disrupting the unity of the pairs or the coordination of fire.

The most important prerequisites for success are: good flight teamwork in the full range of speeds and at various altitudes, and the ability to grasp the air situation and to evaluate it competently. Weak flying techniques and insufficient practice in teamwork on the part of pilots in trail often results in their breaking away from the lead planes in the course of the engagement. Only by knowing the air situation and by observing its changes can the pilots in trail understand their commander and act accordingly in combat.

In aerial combat the personal example of the commander does not preclude the use of radio or other means of control. Actually, their choice in each case depends largely on the prevailing situation.

When executing a maneuver, the leader must know at any given moment what his wingman is doing, what his position is, and what his capabilities are.

In aerial combat, successful control of an element is determined by the commander's ability to assure for each pilot a position of advantage and tactical superiority over the enemy. Strong and steady control of an element in present-day combat is inconceivable in the absence of high moral and combat qualities of leadership, and of superior training in fundamentals on the part of the commanders.

TRAINING AND EDUCATION

THE EDUCATION AND TRAINING OF AIR FORCE REAR SERVICE MEN

Lt. Gen. of the Air Force N. P. Zhil'tsov

It is not difficult to imagine the changes which have occurred in the volume of work of Air Force rear service area elements, if we recall, for example, that for the refuelling alone of a modern heavy bomber, dozens of tons of fuel are required. This fuel must be transported to the dump, from the dump it must be delivered to the airfield, and its storage and transportation in the event of a change of base must be assured. For servicing modern aircraft, more and more oxygen, compressed air, and other servicing materials are required. A great deal of new construction equipment and flying safety facilities have appeared in recent years in the airfield maintenance engineer and Air Force technician elements. The personnel must be acquainted perfectly with all this equipment and must operate it skillfully.

The picture of work in the modern Air Force rear service areas will not be complete, if we do not take into consideration the mobile nature of modern combat operations. In the course of carrying out combat missions, Air Force units must be capable of changing their base very swiftly from one airfield to another. The bases of Air Force units must, as a rule, be dispersed. Under such conditions, the work volume of the airfield maintenance engineer and Air Force technician elements increases immeasurably, and their activity becomes considerably more diversified.

In connection with this, the role and significance of correct training and indoctrination of the personnel of the Air Force technician elements and the training of soldiers and officers for operations against the background of modern combat, become increasingly important. Above all, this concerns the officer personnel who are called upon to lead their men with skill.

Last year the commanders of many Air Force technician elements achieved great success in carrying out missions which had been assigned them. They supported and serviced flights perfectly, they organized the combat training of their men correctly, and skillfully combined this work with practical managerial activity. Among such officer leaders are N. S. Chinenyy, V. P. Zalipayev and many others. By training their men in the work of supporting the Air Force units - through the efforts of the airfield maintenance engineer, materiel, and Air Force technician elements - in brief periods of time and under adverse and rapidly changing weather conditions by day and by night, these commanders have won deservedly high authority among the flying personnel.

During 1956, as compared with 1955, the number of outstanding men in combat and political training grew considerably in the rear service units of the VVS [AF]. At the present time in the rear service units of the VVS every sixth serviceman is an outstanding man in combat and political training. The physical training of the men has also improved. By the end of 1956, for every rear service unit, there were up to 60-100 and even more wearers of 1st and 2nd class GTO ["Ready for Work and Defense"] badges and up to 10-15 sportsmen skilled in various kinds of sports.

However, despite the success in training and indoctrination of soldiers in the Air Force rear service area, it would be erroneous not to observe shortcomings, the elimination of which would contribute towards improvement of work as a whole.

Guiding themselves by the decisions of the 20th Congress of the CPSU, our commanders and political workers are obliged to indoctrinate servicemen in a spirit of high vigilance and constant combat readiness, devotion to the Motherland and to the cause of the Communist Party, and in a spirit of conscientious fulfilment of their military duty. As was observed at the All-Army Conference of Outstanding Men by Marshal of the Soviet Union G. K. Zhukov, Defense Minister of the USSR, the political awareness of our soldiers and their patriotism are manifested above all in a high displine, in their strict observance of the military oath and service regulations, and in unquestioning obedience to their commanders. Unfortunately, incidents still occur among us, when individual ill-bred soldiers and sailors violate military discipline and commit misdemeanors, bringing discredit on the honor and dignity of the high calling of serviceman of the Soviet Army and Navy.

Similar cases are also encountered in Air Force rear service units, the commanders of which underestimate indoctrination work or else shift it entirely onto the shoulders of their assistants. Shortcomings occur where ideological work is out of touch with the life of the element. At the same time it is well known that correctly organized indoctrination work contributes to a practical solution of the tasks of furthering combat readiness and strengthening military discipline.

What then must be done for this?

First of all, the men must be patiently and persistently indoctrinated in a spirit of Communist consciousness. It must not be forgotten that Socialist ideology does not come about spontaneously, through drift, of itself. It is established through implacable battle against manifestations of bourgeois ideology and as the result of active ideological and indoctrination work among the men. Our ideological work in all sectors must be of a strikingly militant nature.

For a successful solution to the problems of combat and political training the Marxist-Leninist education of the officer cadres is of tremendous importance. Under modern conditions, only that officer-leader will prove to be capable of leading his men competently and confidently who, on the basis of a thorough analysis, learns to evaluate a situation, draw correct conclusions from it, and determine exactly his own position and the position of his element in carrying out some problem or other. Consequently, the Marxist-Leninist education of the Air Force rear service officers must be drawn up in close connection with the combat training problems that are being decided, and the greatest efficacy of the theoretical knowledge obtained must be secured.

As always, for sergeants and soldiers, political classes are an important method for enhancing their political awareness. The commanders and political workers must fight for a high ideological level of the training being conducted. Those leaders act absolutely correctly who conduct indoctrination work through concrete examples of how soldiers conscientiously fulfil their service obligations, and who direct the edge of their criticism at shortcomings in the performance of duty. Only through carrying on such purposeful ideological work is it possible to indoctrinate the rear service area men with genuine Soviet patriotism and love for the Motherland and the Communist Party, and to contribute to an honest and conscientious fulfilment of the requirements of the military oath and military regulations.

It is well known that part of the task of Air Force technician elements is to provide flying units with materiel and airfield technician service, and that it must at the same time be reliable and continuous, even when the unit changes bases under field conditions. After all, we are training officers and soldiers in the essentials of combat. And that means that the flying units must under any conditions receive from the rear service elements a sufficient quantity of fuel and ammunition, spare parts for aircraft, various kinds of equipment and clothing, hot food, etc. On the combat airfields, one must be able to carry out swiftly the whole complex of measures for antiatomic and antichemical defense of personnel, equipment, and property.

The personnel of the airfield engineer and airfield operational elements are required constantly to perfect methods for the construction and operation of airfields, to build new fields in the briefest periods of time, and to maintain functioning ones in constant operational readiness. This work is very laborious, if we take into consideration the fact that under combat conditions a field may be put out of action as the result of an atomic attack by the enemy. That means it is necessary to study persistently how to conduct radiation reconnaissance, to eliminate traces of an atomic attack swiftly, and to assure uninterrupted servicing of flights.

Even these few duties of the men in the Air Force rear service areas - duties which have arisen as the result of the demands of modern combat conditions - place heavy obligations upon the personnel of the airfield engineer and Air Force technician elements. Under these conditions, it is very important to cultivate, among the officers, sergeants, and soldiers, firm practical habits and the ability to fulfil assigned tasks in a situation approximating real combat.

Through their daily high exactingness and also through persistent teaching and systematic training, leading commanders develop in their officer personnel a deep knowledge of the potentialities of their elements and services, the ability to orient themselves well in a general and in a rear area situation, and to carry out assigned tasks swiftly.

A good example in this regard is shown by Lt. Col. Z. K. Kulinich, a battalion commander. He personally spends a good deal of time teaching the officer personnel of his unit. Not a single class with soldiers and sergeants is conducted without supervision on the part of battalion headquarters. In the unit a model technical materiel base has been set up, and training classes have been well equipped. Every class with officer personnel is prepared painstakingly. Systematic supervision has been set up over self-training. A great deal of attention is given here to the field training of officers and men. After all, during field exercises, high qualities of combat morale are formed especially rapidly among the men.

During an inspection, officer Kulinich's battalion proved to be the best in the group as regards condition of combat equipment and motor transport, as regards storage and safe-keeping of military property, and the discipline and training of personnel. The headquarters of the unit being serviced rates the work of the battalion highly. For outstanding work in supporting flying units, officer Kulinich was promoted to a higher position.

Rear area briefings help cultivate high qualities of combat morale in the officers and inculcate in them habits of leading their men under adverse and rapidly changing conditions. If these briefings are conducted regularly and are well organized, then, when the rear service elements are deployed at new combat airfields, the officers do not display confusion and lack of administrative ability. And this is very important; after all, such shortcomings on the part of an officer-leader in a modern situation can have a harmful effect on the work of the service or even of the rear area element as a whole.

Let us imagine that a rear area element has been alerted. They must quickly change to another airfield and in a short period of time prepare to support the combat operations of the flying unit from this airfield. The rear area officers must organize the rapid loading of all valuable materiel, transfer it in good time to the new base site, and there disperse and conceal it. Then they must adjust to the conditions of field life in order to report at the airfield at the prescribed time to receive aircraft and support the routine combat activity of the flying personnel.

From the moment of winding up till the definitive installation of the Air Force technician element at the new site, the officer-leader must act under particularly difficult conditions. That is why, when cultivating high morale and combat qualities in our officers, it is recommended that they be placed as often as possible in conditions simulating those of combat, and that by all means and methods they be led to develop habits of operational efficiency in their work and of skillful leadership of their men.

Sometimes it is still possible to hear unfounded assertions to the effect that it is not always possible to create such conditions. Whoever thinks so is greatly mistaken. After all, even in peace time the rear area units have to carry out essentially the same work as in an actual combat situation. In fact, during the training exercises, the officer-leaders must create such a situation.

The same thing must be said also about the indoctrination of soldiers and sergeants. In our rear area elements there are many men in regular and in re-enlisted service with the most varied specialities. Training them to become valuable soldiers depends entirely on the extent to which the officer-leaders are able in their combat training to simulate the actual conditions of a combat situation. And, by the way, this is not too often done. We have a number of cases where individual soldiers and even sergeants were not able to pitch and strike a tent quickly, or to set up the simplest places of concealment for equipment and property at the airfield. Can such a soldier really be called completely fit for combat? Of course not.

Blame for the fact that such soldiers are still to be encountered amoung us rests above all on the sergeants and officers, their immediate chiefs and teachers. Extensive explanatory work must without fail be carried on among the soldiers, work which paints vividly the combat reality of the rear area soldier under conditions where new means of combat are employed. But it is even more necessary to cultivate high qualities of combat morale in the soldiers and sergeants when they are in the process of carrying out their service duties. Of course there must be an individual approach here to each category of serviceman. For example, it is very useful for drivers of transport and special vehicles to make convoy runs in motor columns for varying distances. For the itinerary, an unfamiliar route, and the most instructive one, should be selected. This will develop initiative in the drivers. When the columns are formed, it is recommended to organize the loading of property and equipment. All this can be done during a change of base in the course of training exercises or during the performance of the daily tasks of providing materiel and equipment for the units being serviced. If the vehicles have to be driven over snowy or wet dirt roads, they must be equipped with antiskid devices. During night trips, the rules of light discipline must be observed. It is difficult, of course, for the drivers to drive their vehicles at night with the lights out, but by way of compensation, what a training school that is!

Many specialists of the Air Force rear area elements spend most of their duty time at the airfield and are in direct contact with the men of the flying units. These are alert crews, radio and radar station teams, medical workers, drivers, and mechanics of the various technical facilities for servicing aircraft. It is very important to foster in these men a feeling of deep responsibility for the perfect execution of every mission by the flying personnel. Let these men - the real assistants of the pilots - be just as "sick" with anxiety about the results of every flight, as are also the mechanics of the aircraft, who are responsible for the preparation of Air Force equipment, and as are the pilot and the navigator who set out on a flight. This can be achieved if the indoctrination work of the Air Force rear area men is conducted in close connection with the training and indoctrination of the personnel of the Air Force unit. The commanders and political workers of the rear area elements must as often as possible inform their men of the progress and shortcomings in the work of the flying and engineering-technical personnel, particulary emphasizing, while so doing, the importance of the work of the men of the servicing elements.

Servicemen occupied in the direct servicing of flying units must learn to carry out efficiently all the instructions given them by the officer-pilots, engineers, and technicians. When an Air Force technician element arrives at a combat airfield, many officers require their sergeants and soldiers to study the airfield area with a view towards the best disposition and utilization of available materials for construction and reconstruction jobs at the field. This is very useful. Besides the necessary habits for solving an assigned task under any conditions, this fosters observation among the men, the capacity to find, under difficult conditions, the way out of any situation. When Air Force technician elements are deployed at a new airfield, the attention of the sergeants and soldiers must be called to setting up rooms for the personnel to warm themselves and in which to dry their clothing and footgear, especially under conditions of low temperatures, in rainy weather and slush. Constant concern for the best accommodations for the flying and technical personnel is the primary obligation of every man servicing the element. Thus, comradely mutual assistance is fostered, and the capacity of the men for intensive and prolonged work is enhanced.

In the struggle for high quality in combat training and a high level in indoctrination work among the Air Force rear area men, the sergeants and first sergeants are called upon to provide great assistance for the officers. The sergeant and the first sergeant are the closest and immediate superiors of the soldiers, their first teachers and mentors. That is why our officers strive to have every sergeant and first sergeant be exacting, thoughtful chiefs and sympathetic senior comrades, and serve as a personal example in training and in service.

Training and indoctrination work with sergeants and first sergeants is conducted well in the Air Force technician unit headed by Maj. P.F. Derenkov. The majority of sergeants and first sergeants here perform their duties in an exemplary manner, and train their men skillfully. In any situation whatever where the men have to carry out assigned tasks, the sergeants are always the first to come to assist the officers and lead the soldiers. The sergeant who is driver of the fuel truck can refuel the aircraft quickly and efficiently. The sergeant who is radio operator at the communications station provides reliable radio communication between aircraft and the ground. The sergeants systematically share their experience with the young soldiers and the main thing is that they require the latter to face any kind of difficulties and to carry out their assigned task skillfully. The commander himself, officer Derenkov, has proven himself to be a good methodologist and organizer of training and instruction. That is because he has a wealth of experience and good theoretical training behind him. After graduation from the academy, Derenkov was at first on headquarters duty and creatively mastered everything that was new in the practice of training and teaching Air Force rear area men. He was then assigned to the position of commander of an Air Force technician unit and in a short time he established it as one of the leading units.

There are many commanders like Derenkov in our Air Force technician units. The task consists of disseminating their advanced work experience as widely as possible. It is particularly important to disseminate rapidly and efficiently everything that is connected with new work conditions in the Air Force rear areas conditions dictated by modern means of combat and by new equipment.

The Soviet people are now preparing to greet in a fitting manner the fortieth anniversary of the Great October Socialist Revolution. There is good reason for the Air Force rear area men as well to observe this noteworthy date. We must put more effort and energy into all our work, so that after completing one's work for the day

the officer or the soldier can say to himself that today he worked better than yesterday, and that through his work he helped the flying personnel improve combat training. The work of training the men in our glorious combat traditions must be intensified. A maximum number of outstanding men - specialists in their fields - must be turned out by this noteworthy date in every Air Force technician element. It is very important to develop even more broadly socialist competition for skillful storage and maintenance of military property and equipment, and for an economical expenditure of material resources. It is very important to direct this socialist competition towards inculcating such qualities of combat morale in the men as are extremely necessary in modern warfare.

TAKEOFF AND LANDING OF AN AIRCRAFT EQUIPPED WITH BICYCLE GEAR

Hero of the Soviet Union, Test Pilot First Class,
Candidate of Technical Sciences, Col. M. L. Gallay

Until recently the so-called tricycle landing gear (with nose wheel) has been the one most widely used in aircraft design. In practice it had replaced its predecessor, the two-wheeled landing gear (with a tail wheel) because of a number of essential advantages.

General scheme of the bicycle gear

However, the new circumstances stemming from further development of aircraft have militated against the use of the tricycle landing gear design. In particular, the problem arose of retracting its main wheels into the thin wings of present-day fast-flying aircraft.

The search for the best method of retracting the main wheels of the landing gear of a high-speed aircraft has led to the development of the so-called bicycle design.

The bicycle design landing gear (Fig. 1) usually consists of two main and two outrigger struts. The main struts are located under the fuselage in the symmetrical plane of the aircraft. Most frequently the weight of the aircraft is in practice distributed equally between them. In order to utilize the midsection of the fuselage for cargo distribution and for fuel tanks, the main struts are usually set widely apart relative to the aircraft's center of gravity along the longitudinal axis.

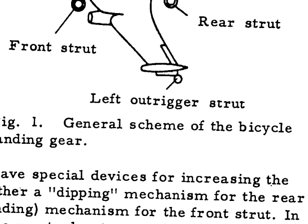

Fig. 1. General scheme of the bicycle landing gear.

Sometimes aircraft with bicycle gear have special devices for increasing the angle of attack prior to lift-off at takeoff: either a "dipping" mechanism for the rear landing gear strut, or a telescoping (or extending) mechanism for the front strut. In both cases, the ground run is effected with the most advantageous angle of attack corresponding to the minimal value of total resistance (aerodynamic resistance plus wheel friction). Upon reaching takeoff speed, the aircraft lifts off when the angle of attack increases sufficiently, just as is done during takeoff with so-called "blast".

A relatively small part of the total weight falls on the outrigger struts, which basically serve to keep the plane from heeling over when rolling on the ground.

Such, in general outline, is the design scheme of the bicycle gear.

The bicycle design has more advantages to its credit than the design with nose wheel. An aircraft equipped with a bicycle gear is apt to have more directional stability and does not tend to ground-loop when rolling on the ground. It provides for a greater range of vision during taxiing, and it even has advantages over a gear with nose wheel as far as strenuous braking is concerned, as will be shown later on. However, piloting such an aircraft has certain distinguishing characteristics.

Control on the ground and braking

Aircraft equipped with gear having a nose or tail wheel are controlled and braked, when traveling along the ground, with main wheel brakes. In order to change heading or else to avoid swerving from the assumed heading, the brakes of one of the wheels are applied. In order to reduce speed when rolling on the ground, both main wheels are braked at the same time.

Thus, the wheel brakes perform two different functions, which fact often leads to undesirable results. For example, if one of the wheels is braked somewhat during the ground run for the purpose of maintaining the takeoff heading in a crosswind, this braking impairs acceleration and results inevitably in a longer ground run. Applying the brakes during the run as a rule brings about swerving, since the brakes are not fully synchronized and because of the varying friction coefficients of the parts of the ground in contact with the wheels, etc. In order to recover the desired heading, it is necessary to resort to alternate releasing of the wheel brakes and, consequently, to a longer ground run.

In the bicycle gear the functions of braking and control on the ground are separate.

Braking, being independent of maintaining direction, may be applied with any intensity. It is limited only by the necessity of avoiding a complete stoppage of wheel rotation ("skidding") in order to reduce wear on tires and to maintain the greatest coefficient of friction, since, when skidding, the coefficient of friction — contrary to a popular but erroneous belief — does not increase, but rather decreases. In any case, both asynchronous adjustment of the brakes and tire pressure of both wheels, as well as when one of the wheels contacts a slippery or wet area of the runway, do not affect either directional movement or the aircraft's braking performance. This fact is certainly one of its positive performance characteristics, and, under stable and equal conditions, it reduces the length of the ground run.

Aircraft control on the ground with the aid of the front swivel strut also has obvious advantages over control by alternate pumping of the brakes. Above all, the swivel strut of the bicycle gear allows setting and maintaining the required radius of turn with greater accuracy than is possible by applying and releasing the brakes of a tricycle gear. In the first case, controlling the aircraft on the ground can be compared with steering an automobile, and in the second case with steering a caterpillar tractor. Besides, the front swivel strut provides for greater controllability, which is particularly apparent on a takeoff run or a landing run in a crosswind. In such cases, the pilot of an aircraft with a tricycle gear is sometimes obliged to apply the brakes of one of the wheels (on the downwind side) with full force and, in spite of this, he barely maintains the aircraft on the runway. In a strong crosswind an aircraft with a bicycle gear requires a comparatively slight (no more than one fourth of the full range) depression of the pedals which control the front strut in order to maintain the required heading.

Consequently, the separation of the control function on the ground and the braking function — which is characteristic of the bicycle gear — has resulted in an advantage to both of these functions.

Automatically increasing the angle of attack at takeoff by "dipping" of the rear strut or by extending ("rearing up") of the front strut, as indicated above, reduces the length of the ground run and assures constant takeoff characteristics of the aircraft, irrespective of the pilot's actions. However, it must be indicated that in the course of increasing the angle of attack, which is produced by the action of such devices, the aircraft's angular rate of pitching around the transverse axis reaches a definite magnitude and cannot be dissipated instantaneously. As a result of this, the aircraft continues to increase its angle of attack - even after lift-off - until the pitching inertia vanishes. Such a phenomenon is usually called "throw".

Longitudinal controllability on the takeoff run and lift-off

In designing an aircraft with bicycle gear, the designers must without fail take into account this phenomenon, so that the total increase in the angle of attack, together with the "throw", will not result in a dangerous approach to the critical angle, which may result in turbulent separation or loss in stability (Fig. 2). Nevertheless,

Fig. 2. Changes of angle of attack during takeoff of an aircraft with bicycle gear and with automatic increase of angle of attack for lift-off.

the pilot must also understand clearly that the actual angle of attack at takeoff involving "throw" is greater than the geometrical angle, which corresponds to the takeoff position of the gear struts.

The problem of the angle of attack at takeoff for an aircraft with a bicycle gear requires special attention and obliges the pilot to use certain new specific flying techniques; also because during takeoff run, up to the moment of lift-off, the angle of attack cannot be controlled, and depends solely on the design parameters of the aircraft.

This occurs because both main gear struts are spread out relative to the center of gravity; and for the purpose of enabling one of them to lift off during the takeoff run - for instance, the front one (without this the change in angle of attack would be impossible) - it would be necessary to overcome the force of gravity moment which

has a much greater magnitude than in the case of other types of gear.

Thus, in the general balance of longitudinal moments which act on the aircraft during the takeoff run, and which determine its position in the longitudinal plane, the horizontal empennage moment is secondary in comparison with the moment of load. Therefore, the longitudinal position of an aircraft with bicycle gear during the takeoff run does not actually depend on the deflection of the elevator.

This particular feature, on the one hand, is extremely useful, since it makes it possible always to obtain optimum takeoff-run performance data, irrespective of the pilot's experience, rating, and attentiveness. But, on the other hand, under such conditions the pilot cannot, while on the ground, position the control column to correspond with the aircraft's balancing at the required angle of attack. He is compelled to select this position — or at least to correct it — after lift-off when airborne. This should be done quite forcefully and accurately so that in case of appreciably imbalance of the plane he will have time to prevent it from touching the ground again or zooming.

Therefore the pilot must be particularly careful on the takeoff run — and especially in its terminal stage — to maintain the takeoff position of the control wheel required for normal procedure.

In order to facilitate maintaining the takeoff position of the control wheel, special devices must be developed in the future: retaining spring load mechanisms or visual indicators located within the field of vision of the pilot who looks ahead through the cockpit windshield during takeoff.

The position of the control wheel must be selected in such a way that after lift-off the aircraft will have a tendency toward decreasing somewhat the angle of attack, i.e., towards downwash, since this motion insures a quick recovery from the region of large angles of attack, and consequently assures greater takeoff safety. Even if the pilot does not succeed in reacting promptly to the presence of downwash and allows the wheels of the aircraft to touch the ground again, nothing dangerous will transpire, as practice has often shown. But the converse error — excessive backward pressure on the control wheel at takeoff and the resulting nose-high position after lift-off is dangerous. Sometimes an intermediate type of landing gear design is used for aircraft of light and medium tonnage. This is a tricycle gear in which the nose wheel is unaltered, while the main wheels have been, so to speak, brought together and retract into the fuselage in the form of a single undercarriage.

Longitudinal controllability of aircraft with "semi-bicycle gear" during takeoff

Out of consideration for the arrangement of aircraft assemblies and, particularly, in striving not to take up the central part of the fuselage for the landing gear, but to utilize it for housing cargo which varies in weight (fuel, bombs, etc.), the main wheels on such aircraft are brought together relative to the center of gravity somewhat further back than is usually the case in the classical tricycle design.

In contrast to aircraft with a purely bicycle design gear, aircraft with a landing gear of the above type can take off in the conventional manner, i.e., by lifting the nose wheel and by effecting the necessary longitudinal takeoff angle during the takeoff run. However, here certain specific features are observed which result from shifting the main landing gear wheels to the rear.

Fig. 3 shows a schematic diagram of the principle moments acting on the air-

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craft in the longitudinal plane as it travels on the ground on the main (rear) wheels and with its nose wheel lifted.

In this position the angular motions of the aircraft take place around the point of contact between the main wheels and the ground, which makes it convenient to examine the action of the moments of all the forces relative to this same point (as we know from mechanics, the equilibrium of a body does not depend upon the selection of the point in relation to the given acting moment). The moments are created by

1. Initial stage of takeoff run	2. Terminal stage of takeoff run
Deflection of elevator upward to overcome the load diving moment	Returning the elevator to downward position

Fig. 3. Equilibrium of the longitudinal moments of an aircraft with "semi-bicycle" landing gear during the takeoff run.

the force of gravity G, the lift y, the force of aerodynamic resistance x, the lift of horizontal tail surfaces y_{hts}, and by the propulsive force of the power plant P.

The force of friction between the wheels and the earth, as well as the normal ground force, do not yield any moments, since they are applied to the same point relative to which the equilibrium of moments is being examined. The propulsive force P yields a certain moment which actually does not alter during the takeoff run.

The force of gravity G, throughout the entire takeoff run with lifted nose wheel, yields a certain constant diving moment. This moment is considerably greater in magnitude than in the case of an aircraft with tricycle gear where the main wheels are located much closer to the center of gravity.

Therefore, during the initial stage of the takeoff run, when the aerodynamic forces y and x, together with their moments, which tend to pitch are still rather slight, lifting of the nose wheel and the support of the aircraft in this position are possible only with considerable upward deflection of the elevator. As pilots often put it, the plane's nose has to be "peeled" off the ground.

Later in the course of the takeoff run, as the speed increases, the aerodynamic forces increase, which gives rise to the pitching moment. The longitudinal equilibrium effected in the initial stage of the takeoff run is disrupted and the aircraft tends to pitch. At the same time, the effectiveness of the deflected elevator increases. Therefore, in order to maintain a constant longitudinal angle at the terminal stage of the takeoff run, the pilot must exert forward pressure on the control stick, at times doing this quite forcefully, otherwise the plane lifts off, not smoothly, but bounces

off the ground.

Such conformity of the required control-stick positions to physical laws during the takeoff run is usually assessed by the pilot as a sign of longitudinal stability. Strictly speaking, such an assessment must be recognized as being correct. But we must not lose sight of the fact that the concrete factor of instability in this case affects the aircraft only during the takeoff run when the nose wheel is lifted. Immediately after lift-off its effect ceases, and the longitudinal stability, characteristic of the given type of aircraft in free flight, is fully recovered.

Lateral equilibrium during takeoff and landing runs in a crosswind

It has been shown above that controlling an aircraft with a bicycle gear, when moving on the ground in a crosswind, is effected without any difficulties whatsoever. At the same time, there is one circumstance which affects aircraft with bicycle gear to a greater extent than it does those with other types of landing gear. We refer to the uneven distribution of load betweeen the left and the right wheels of the main gear struts.

Fig. 4. Equilibrium of lateral moments when moving on the ground in a crosswind.

In the event the aircraft travels on the ground in a crosswind, a lateral aerodynamic force Z (Fig. 4) always appears. It tends to tilt the aircraft sideways and produces an uneven distribution of load between the left and the right gear wheels. The value of force Z depends on a number of factors, of which the main ones are: the lateral component wind speed, the lateral surface area of the plane, and the coefficient of lateral resistance.

In this case, the effect of the force of reaction of the outrigger struts is not taken into account, since in most planes with a bicycle gear the struts come in contact with the ground only at low speeds: in the initial stage of the takeoff run and in the terminal stage of the landing run. The rest of the time the outrigger struts are not in contact with the ground as a result of deformation (upward bending) of the wings caused by lift.

Then the equilibrium of the moments acting on the aircraft in the lateral plane will be expressed by the function:

$$Z \cdot h + N_2 \cdot b - N_1 \cdot b = 0$$

where Z is the lateral aerodynamic force;

h is the distance from the point where force Z is applied to the ground;

b is one half the width of the landing gear tread;

N_1 and N_2 are the ground forces applied to the wheels.

Hence

$$Z \cdot h = (N_1 - N_2)\, b \text{, or } N_1 - N_2 = \frac{h}{b} Z .$$

In other words, all conditions being equal and stable, the unequal distribution of the load between the left and right gear wheels is an inverse function of the dimensions of the landing gear tread width. The width of the gear tread of the bicycle type gear is several times smaller than that of landing gear of other designs. Therefore, load distribution on the wheels in a crosswind may vary widely - even up to the point where it (the load) is placed fully either on the left or the right wheels of the main landing gear struts.

That is the reason why the pilot of an aircraft with a bicycle gear cannot disregard the possibility of heeling over in a crosswind during the takeoff or landing runs. It is necessary to counteract the lateral tipping by using ailerons.

Incidentally, it must be noted that sometimes, due to unequal crosswind load, it is not the downwind wheels - subjected to the greatest load - which are damaged, but rather the wheels on the upwind side which had a considerably smaller load. This phenomenon - which at first glance seems strange - may be explained by the fact that the force of wheel friction against the ground depends on the magnitude of the normal force, i. e., on the load upon the wheel. Therefore, in the "unloaded" wheel the friction force against the ground, which actually causes the wheel to rotate around the axel, will be quite small. And if, for example, the automatic braking device, whenever "skidding" occurs, by virtue of its design reduces the pressure in the braking system, not to zero, but only to a certain reduced value, then even this reduced pressure may be sufficient for overcoming such a slight friction force against the ground, and for preventing the wheels from rotating. The "skidding" motion of the wheel results in rapid wearing away of the rubber at the point of its contact with the ground, and damage to the tire.

The principle method of dealing with the above phenomenon involves the use of automatic braking devices which provide for a complete release of pressure the moment "skidding" appears, and which are installed separately on the right and left assemblies of the main bicycle gear wheels.

Landing of aircraft with bicycle gear

The ground force, which appears when the front landing gear strut contacts the ground, creates a moment, relative to the aircraft's center of gravity, which tends to increase the angle of attack. As a result, the lift builds up and the aircraft successively lifts off; the so-called "bumping" appears. In certain instances "bumping" may become progressive.

What has been said applies equally to aircraft with any type of landing gear. However, the parameters of the bicycle gear increase the possibility of bouncing. If we compare the bicycle gear front strut's contact with the ground with that of the main wheels of a landing gear with a tail wheel, then in the latter instance the ground force acts on the considerably shorter arm relative to the center of gravity. Consequently, the pitching moment will be correspondingly less.

The tricycle gear, in this respect, is at first glance inferior, since its nose wheel is located on the somewhat longer arm. Actually, flight experience confirms the fact that contact of the nose wheel with the ground during the landing of a plane with tricycle gear is completely out of the question, since it results in violent bouncing, in order to correct which the pilot must act in a particularly precise and well-coordinated manner. But we have to note that the very fact of increased difficulty in correcting "bumping" of an aircraft with tricycle gear was discovered only after they had been in wide use for several years. This happened for the simple reason that it is possible to touch down with the nose wheel before touching down with the main wheels of an aircraft equipped with tricycle gear only as a result of unusually gross errors in basic

flight procedures (failure to maintain gliding speed, leveling-off altitude, etc.). In a normal landing approach, the nose wheel is usually so much higher than the main wheels, that the pilot need not make any special effort to have the aircraft's main wheels touch down before the nose wheel.

It is quite another matter in the case of an aircraft with bicycle gear. Its front strut - in accordance with its design - is much higher than the nose wheel of an aircraft with tricycle gear; were this not so, it would be impossible to have the required angle of attack at takeoff. Therefore, when landing correctly, there is clearance between the front strut and the ground only insofar as the landing angle is greater than the takeoff angle.

Fig. 5. Position of the bicycle gear relative to the ground at takeoff and landing.

In the case of the majority of present-day aircraft with bicycle gear, the landing angle exceeds the takeoff angle only by 2 to 3°, i. e., by a radian of $\frac{1}{30}$ to $\frac{1}{20}$. This means that the pertinent clearance is 20 to 30 times less than the space between the gear struts (Fig. 5).

With such design ratios, it is sufficient to make a rather slight error in landing - for instance, slight "shortage" of the control column - to have the front strut touch down before the rear, with all the ensuing consequences.

Therefore, when flying an aircraft with bicycle gear, the pilot must be particularly careful to land on the rear strut or - analogously with a three-point landing of a plane with a tail wheel - to land on both struts simultaneously, but never on the front strut.

For their part, the design engineers, when designing a bicycle gear, give a good deal of attention to the shock-absorbing characteristics of the front strut and particularly to adequate hysteresis (work-absorption in the shock-absorber) so that, after the compression of the shock-absorber, the recovery will be smooth and will not give rise to violent pitching of the aircraft.

An apt selection of shock-absorbing characteristics of the front strut in a bicycle gear can greatly cut down on the "demand" of a so-designed aircraft on landing technique.

* * *

Thus, executing takeoff and landing in an aircraft with a bicycle gear has its own special features, the physical nature of which must be clearly understood by the pilot. Most of these special features are desirable. Among them one must include: an increased precision and smoothness of control when traveling on the ground; a good margin of controllability on takeoff and landing runs - this being particularly apparent in takeoff and landing in a crosswind; cutting down the length of takeoff and landing runs, there being no necessity for periodic braking at takeoff and releasing of brakes at landing in order to maintain heading (mutual independence of control and braking functions); independence of takeoff run from the pilot's piloting technique due to provisions for automatically maintaining and altering the angle of attack at take-off in accordance with physical laws.

Along with this, takeoff and landing of an aircraft with bicycle gear has some elements to which the pilot has not been accustomed and which require special attention. The principle ones are: the impossibility of selecting in advance a balanced position of the elevator on the takeoff run and the necessity of correcting this position after lift-off and when already airborne in order to avoid successive touch downs or to avoid zooming - which is even more dangerous; increased possibility of touching down during landing with the front strut before the rear one, and the accompanying tendency towards bouncing ("bumping") after touching down with the nose carriage before touching with the tail carriage ;the considerable effect of the crosswind on the distribution of load between the wheels when traveling on the ground.

SPECIAL FEATURES OF ATTACKS WITH ACCOMPANYING FIRE

Candidate of Technical Sciences, Engineer Lt. Col. G. G. Rastorguyev

(In reference to the aerial gunnery of Senior Lt. Yu. G. Mishchenko)

One of the basic methods of aerial target destruction has always been and continues to be accompanying fire. Nevertheless, the possibilities presented by this method have not yet been fully exploited. This fact is confirmed by the very instructive experience of Fighter Pilot Senior Lt. Yu. G. Mishchenko in tow-target gunnery which was described in the second issue of the journal "Herald of the Air Fleet" for 1957.

The excellent results achieved by officer Mishchenko cannot help but attract attention, and if there are some who are motivated by a natural desire to emulate his experience, then there are also those who express their scepticism in the matter.

Undoubtedly our flying personnel is anxious to master all the useful aspects of pilot Mishchenko's method. But in order that fighter pilots may assimilate this experience correctly, certain special features of attacks with accompanying fire must be reviewed.

Pilots know that the overall evaluation of an attack, in the final analysis, is determined by the firing results. But in order to hit the target with a maximum number of rounds, it is not only necessary to sight the target correctly, but to use the most advantageous angles-off and ranges.

It is also a known fact that fire effectiveness increases when the initial angle-off of the attack is increased, and that increasing the initial angle-off is possible only within the area of possible attacks (OVA). Therefore it is recommended to conduct fire from the attack curve which is located closer to the limits of OVA. Consequently, the pilot's primary concern is to enter the most effective attack curve. For this he must know his own capabilities and make proper use of them - and this is typical of Mishchenko's experience.

In planning any maneuvers with respect to the target, the pilot accordingly orients himself in reference to it either visually or else with the aid of the necessary instruments. Specifically, in order to initiate the attack at a definite range R_2 at an angle-off of q_2 (Fig. 1), the pilot must continually determine these values. He can achieve precise evaluation of the range and the angle-off only in straight and level flight, particularly when evaluating visually. In order to enter the attack curve, a turn is usually made, since the course on which the fighter is closing in on the target does not insure immediate entry into the desired attack curve. Therefore the start of the attack maneuver is determined by accurately reaching the point at which the turn to the target is initiated (point 1).

The accuracy with which the initial position for attack is reached depends on the errors in determining R_1 and q_1; due to this fact, the fighter actually begins the turn in each instance not at point 1, but at some other point lying within the limited area shown in Fig. 1 by the broken line. The dimensions of this area depend on the accuracy possible in determining range and angle-off. Thus, when visually determining his position relative to the target, the pilot finds that his maximum range error (four probable deflections) will equal:

$$d = \frac{0.005\, R^2}{1 + 0.005\, R},$$

where 1 is the characteristic linear target dimension - usually its wingspan.

In turn, the maximum angle-off error will be

$$\Delta q^{\circ} = \frac{0.15\, R}{1 + 5.8}.$$

Fig. 1. Diagram of attack approach.

In the first approach it may be considered that error distribution is circular with a radius d, and corresponds approximately to the standard principle.

Close examination has revealed that, as a result of the turn to the target, the pilot cannot in fact alter the dimensions of this area, i. e., that the accuracy of entry into the attack curve (point 2) is determined by the accuracy in reaching the initial position for attack.

Let us draw some practical conclusions.

In the first place, in order to make most of the attacks feasible, i. e., to have them accomplished within the OVA limits, while maintaining the mean (computed) angle-off for attack q_2, it is necessary to take into account the pilot's possibilities of planning his maneuvers accurately. In this connection, the actual value of q_2 is appreciably less than the theoretical. Thus when V=900 km/hr., V_t= 700 km/hr., and, when motion is begun along the attack curve, R_2= 1000 m, then instead of a 3/4 angle-off, the pilot can on the average initiate the attack with a 2/4 angle-off, and even then only on condition that he execute the turn to the target correctly. Should the turn be executed incorrectly, the mean angle-off for the start of attack becomes even smaller.

In the second place, the smaller R_1 is, the smaller the errors in the attack approach. Consequently, in order to increase the mean angle-off q_2 for initiating fire, it is necessary to start the turn to the target as close to the target as possible. Of course, in this case the turn itself will have to be executed more vigorously.

Pilot Mishchenko understood this well. In order to improve the accuracy of the attack approach, he brought the initial point of attack as close as possible to the target, cutting down R_1 to 100 m, thereby radically reducing probable errors. In this case, the necessarily complex maneuvers constituting a double turn (first away from the target, and then toward it) could be uniformly executed by Mishchenko because of his excellent piloting technique. Although the more complex maneuvers were supposed to increase somewhat the errors in entry into the attack curves, still these errors proved to be considerably smaller than those which a pilot would encounter in the course of the usual maneuver. The results were that officer Mishchenko increased the initial fire angle-off, i. e., he multiplied the possibilities of hitting the target.

Could such a method be applied in combat? As a rule, no. For in actual combat, both the speed of the fighter and that of the target will be greater, and the sweep of such a maneuver would increase to such proportions that the target itself could be lost during the turn-away. In addition, it is difficult to assume that the enemy would tolerate such lengthy maneuvering and would continue in straight and level flight. Therefore, in actual combat, a direct attack should usually be made.

Every pilot must know how to reduce his errors in the attack approach. In aerial combat it is necessary to achieve an increase in q_2 in order to multiply the possibilities of attack, which necessitates reducing R_1. This is accomplished by a more vigorous turn or by planning the closing-in maneuver in such a way as to permit direct entry into the attack curve without an auxiliary turn.

Another way of improving fire effectiveness consists in increasing the accuracy when determining R_1 and q_1 by using instruments. However, the equipment available in the units still does not fully replace visual evaluation, since, while it permits determining the range with greater accuracy, it does not indicate the angle-off to the target, and therfore requires artificial methods for planning maneuvers while executing the attack. All this radically impairs their accuracy. Besides, the indicator gives a rather provisory picture of the air situation and one which is often difficult to interpret. This compels the fighter pilot to change over to visual tracking of the target at the first opportunity.

In order to carry out accurately the maneuvers required for firing at an aerial target, thorough training is necessary, of course. Officer Mishchenko had achieved a high degree of skill in attack performance due to his meticulous training. Undoubtedly, the training must be carried out with singleness of purpose in order to improve the accuracy of executing the maneuvers. This is particularly important in the case of visual orientation. Although occasional errors in determining range and angle-off are affected only slightly by the pilot's degree of training, since they are basically conditioned by innate capabilities of the human eye, yet systematic errors (discrepancy between the intended value and the mean value which is actually obtained) may be greatly affected by a skillfully conducted training program.

If the pilot has studied thoroughly a small "scale" of standard angles-off, he will hardly ever make systematic errors in determining the angle-off to the target. The matter is entirely different with range, since often the pilot does not have any comparative scale handy. However, in the course of routine work he must develop his visual judgement in order to be able to determine ranges, particularly those which he needs when firing.

Depending on the type of flight work, every pilot usually gets used to determining accurately a definite range which may be called his "familiar" range. For fighter pilots this "familiar" habitual range is usually the sight's operating range (ASP [automatic aircraft sight] - 800 m). If, on the other hand, the pilot must work out a different range, as a rule, without special training, he makes errors in the direction of the "familiar" range. The greater the difference between the "familiar" range and the required range, the greater his errors. This is explained by the fact that the angular dimensions of the target, when the distance between the aircraft and the target changes, alter disproportionately relative to range, and hinder orientation.

The visible angular dimension of the target is $\delta = \frac{1}{R}$, i.e., it is inversely proportional to the range, and depends on the dimensions of the target. Hence, when the dimensions of the target change, the "familiar" range also changes, since the latter is associated with the definite angle δ.

Actual practice shows that even experienced pilots initiate their attacks at twice the range whenever, for example, the target dimensions are doubled, if they have not had special training. Air Force commanders should consider this fact, and conduct combat training using life-size targets. Moreover, they should use diversified targets in order to achieve not one, but several, "familiar" ranges (an ad hoc scale).

If, on the other hand, it is necessary to attack tow-targets which are smaller than actual targets, then it is practicable to decrease proportionately the scope of the maneuvers as much as is feasible. It helps to have even temporary markings on the cockpit canopy for the desired ranges in the form of target "dimensions".

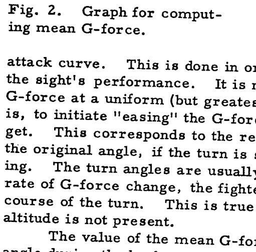


Fig. 2. Graph for computing mean G-force.

The regular turn to the target, in contradistinction to an ordinary bank, is made by the whole aircraft for the purpose of rough sighting. Hence, certain peculiarities emerge which are typical of such a procedure. First of all, there is an unusually rigid limitation of G-force rate of change, since in the course of making the turn the pilot must carefully track the target so as to coordinate piloting the plane with the change in the target's sighting angle. This procedure is sufficiently dynamic and proceeds with a rapidly changing bank angle. Experience shows that even trained pilots will execute the turn to the target only when the rate of G-force change does not exceed Δn=0.5-0.6 per second. In the second place, in order to effect an accurate turn to the target, it is necessary to combine the overall high rate of the bank with the smoothest possible entry into the attack curve. This is done in order to create favorable conditions for sighting and the sight's performance. It is most sensible to effect the increase or decrease of G-force at a uniform (but greatest possible) rate during the turn to the target; that is, to initiate "easing" the G-force approximately in the middle of the turn to the target. This corresponds to the reduced sighting angle of the target in a 1 to 3 ratio to the original angle, if the turn is started from a collision course with the same heading. The turn angles are usually small (no more than 50° - 70°); therefore, at this rate of G-force change, the fighter does not succeed in reaching the value n=4 in the course of the turn. This is true if a stronger aerodynamic limitation for the given altitude is not present.

The value of the mean G-force can be computed according to the requisite turn angle during the bank α_b, by using the graph (Fig. 2).

An inexperienced pilot usually increases the rate of G-force change in the course of the turn to the target in its terminal phase, which is quite normal, since the closer the target is to the center of the sight's reticle, the easier it is to track. But increase in the G-force rate of change in the terminal phase of the turn results in the

pilot's inability to line up the target with the sight's dot, and the target "shoots through" the central dot. This means that an additional corrective turn is necessary for entering the attack curve, i.e., the original angle-off will decrease and firing time will be cut down. Moreover, the sight's efficiency will drop, due to the accelerated change of the fighter's angular speed at the start of sighting.

Definite limitations in executing the turn to the target result in the fact that inaccurate determination of the start of the turn (mainly range error) cannot be compensated for by altering the original sighting angle. This has been duly noted by officer Mishchenko. In fact, if the original angle-off is reduced, then the angle-off of the start of attack will be cut down, while if it is increased, then "shooting through" is unavoidable, as is cutting down of the angle-off and of firing time. Any pilot can ascertain this by simple calculations.

After entering the desired attack curve, the pilot is confronted by the second problem: to implement the possibilities at his command, i.e., to sight accurately and to hit the target with the maximum number of missiles. Undoubtedly, it is essential to know how to use the sight and to know its operation thoroughly.

As is well known, the ASP [automatic aircraft sight] type sight gives the lead angle as the function of the fighter's angular speed and firing range. If we disregard the effect of range, which - in general - is less than that of the angular speed ω_f of the fighter and, since in the move improved types of sight, range is fed in automatically, then it is possible to consider the lead angle proportionate to ω_f. But the lead angle ψ can only be correctly determined according to ω_f when the fighter is traveling precisely along the attack curve. In the event this is not so, there will be no proportional relationship between the precise values of ψ and ω_f, i.e., the sight will "err" along with the pilot. Besides, the sight reacts to the change in with a certain lag, since its gyro has a certain degree of free play. Therefore, at the start of sighting, the sight must be given enough time to synchronize (1.5-2 seconds).

However, the sighting procedure is no less complex when traveling along the attack curve, since the pilot cannot pilot the aircraft with absolute accuracy along the attack curve. This is so, in the first place, because ω_f is changing all the time, and the pilot is not able to anticipate accurately what value ω_f will have at the ensuing moment, and therefore he cannot insure the necessary value through correct piloting. In the second place, the human eye has a terminal resolving power, and therefore the pilot becomes aware of the sighting error only after it has assumed a certain magnitude.

After the error is identified, a certain amount of time will be necessary to correct it. Therefore, even when sighting is done meticulously and piloting is effected skillfully, aiming errors will reach 8-12 thousandths. As a result, actual sighting consists in a fluctuating process of aiming error change. For a human, it is characterized by a half-period of from 3 to 5 seconds (this is the mean time between two adjacent accurate alignments of the target and the sight's dot). But essentially it is not even a matter of the pilot's inability to effect continuous accurate sighting. What is more important is that the fluctuating nature of aiming errors results in similar fluctuations of the lead angle ψ, given by the sight, accompanied by a certain time displacement. As a result, at the moment the pilot eliminates the aiming errors, the lead angle given by the sight does not correspond to the accurate value required in this case; and, conversely, the weapon is sighted accurately only when there is a definite aiming error, which very often approaches the maximum.

Such a phenomenon may not affect appreciably the firing results, if the angular target dimension δ for the given firing range exceeds the fluctuations in aiming errors (for example, over 10 thousandths). If, on the other hand, the angular target dimension is commensurate with or less than these fluctuations, then the firing results may be greatly reduced, especially if fire is conducted in short bursts and timed to the alignment of the target with the sights' mark. These very conditions are not likely to occur at high speeds, since in this circumstance fire has to be conducted at great ranges.

Carefully comparing the results of his firing with the various methods of sighting, pilot Mishchenko concluded from his own experience that it is advantageous to fire, not at the precise moment of alignment of the target with the sight reticle's central dot, but with a certain discrepancy, i. e., he determined through experience under what conditions actual sighting is most accurate. Senior Lt. Mishchenko not only discovered the discrepancy between precisely aligning the target with the dot and the results of firing, but he also was able to determine how all these factors vary, depending on the angle-off and the range, i. e., through practical observation he was able to determine how the G-force affected the joint performance of the pilot and the sight. He also found means of determining the very moment when the weapon is aimed accurately at the predicted point, even though the sight gives an erroneous lead angle.

Is Mishchenko's experience of any use? The results of his firing speak for themselves, and most eloquently. However, a pilot who wishes to master these results must consider the following circumstances.

Every pilot has his own peculiar manner of piloting and his own manner of sighting. Therefore he is accustomed to his own established routine as regards the aiming error change, as well as the specific reaction of the sight to these errors. In order to master Mishchenko's findings, the pilot must carefully analyze his own work with the sight and, first of all, achieve a reduction in size of these aiming errors, especially in that direction (along the vertical or the horizontal) in which the target has smaller dimensions.

Next, the firing moments must be offset from the moments of zero aiming errors, and the most advantageous offset must be obtained by checking the firing results. The smaller the half-period of aiming error fluctuations, the closer actual accurate sighting will correspond to the middle of this half-period, i. e., to the maximum error.

Of course, all this is very difficult for a pilot with poor flying technique, since Mishchenko's method involves, not general procedures of sighting, but rather a refinement upon this sighting procedure which requires a clear conception of the relationship between one's errors and the work of sighting. However, all this is particularly important at high flight speeds when firing ranges increase and, consequently, the angular dimensions of the target decrease, and when firing time diminishes, giving the pilot the opportunity to sight fewer times in a single attack.

To improve the firing results, it is also desirable to utilize the full gamut of ranges right up to the range of safe close-in.

For a more exhaustive analysis of Mishchenko's experience, a few words must be said about the use of slipping during firing. An insufficiently experienced pilot - especially one who is only beginning to master combat application - unconsciously

wants to use slipping, and it seems to him that by using it he will be able to eliminate the aiming error much more simply. On the other hand, the elimination of the aiming error without resorting to slipping requires complex coordination in operating the controls. However, in this instance, he does not take into account the fact that in resorting to slipping the pilot achieves curvature of the fighter's path, scarcely resorting to rolling the plane; i. e., he disrupts the correspondence between ω_f which is metered by the sight's gyro, and the position of the fighter relative to the target at this moment. Consequently, a crude application of slipping disrupts the operation of the sight, and apparent elimination of the aiming error does not result in accuracy of sighting. But this does not mean that all slipping is bad. Disregarding unavoidable minor slipping resulting from lack of coordination in operating the controls, as experience shows, even when traveling correctly along the attack curve, a very definite - although quite small - amount of slipping is essential. Of course, this can be made apparent only with the aid of instruments.

Moreover, the proper utilization of small amounts of slipping may somewhat counteract the dangerous effect of the pilot's aiming errors on the operation of the sight. For example, if the sight's dot "overtakes" the target, it means that the fighter is rolling at a greater angular speed than is necessary. At the same time, the sight gives a greater lead angle than necessary. If the pilot decreases the fighter's angular speed of roll in a coordinated manner (without slipping), then, as has already been pointed out, at the moment of aiming-error correction, the sight's readings will still be somewhat high, and accurate sighting will lag somewhat when the aiming error again will equal zero.

If, on the other hand, at the very start of eliminating the aiming error, a small amount of slipping is induced in the direction of the sight's dot and if then the error is eliminated as usual, then the slipping will reduce ω_f, which is taken into account by the sight's gyro; and, although we do not gain time for achieving accurate sighting, still the sight's errors will be reduced. Of course, in order to produce this precise amount of slipping, a good deal of effort will be required. More profound theoretical know-how will be of great help in achieving this.

We have examined only certain aspects of Mishchenko's experience, and very briefly at that. Of course, this is not sufficient for a fighter pilot who wants to master combat application and to utilize fully the capabilities of his aircraft. It would behoove Air Force commanders to acquaint pilots more fully with the possibilities of evaluating their position relative to another aircraft throughout the whole gamut of ranges, with due consideration being given to the effect of speed on visual orientation when closing in, using an accurate (but rather simple) method in planning the attack maneuvers, etc. The experience of Yu. G. Mishchenko demonstrates that thoughtful consideration of one's actions in the air, backed by good theoretical knowledge, can yield superior results.

A RADIOSONDE FOR STUDYING THE ATMOSPHERE

The airborne radiosonde is designed for measuring the temperature, pressure, and humidity of the air. It is an expendable aerological instrument which is dropped by parachute from a weather-reconnaissance plane.

The device is made up of two basic components: the casing with the parachute rig; and the meteorological unit with a radio transmitter, an encoder, and battery power supply.

The results of meteorological soundings are automatically transmitted by the sonde's radio transmitter on crystal frequencies encoded as telegraph signals which are received by the plane's radio operator or taped on a tape-recorder. The radiosonde's power source permits continuous operation of the radio transmitter for a period of two hours. The radiosonde's rate of fall is approximately 5.5 to 6.5 m/sec. The signals received from the radiosonde are decoded and interpreted with the aid of special tables.

A METHOD OF TEACHING PILOTS TO FLY HELICOPTERS ON INSTRUMENTS

Military Pilot First Class, Col. F. F. Prokopenko

When flying an airplane or helicopter on instruments, in order to determine their spatial position, the pilots must use a whole complex of various instruments (gyrohorizon, variometer, speed indicator, altimeter, DGMK [long-range gyromagnetic compass], etc.). A convenient and compact arrangement of all these instruments permits reading them in a minimum of time and in a definite sequence. However, the pilot must master certain techniques and must be well trained in instrument flying. The training process for instrument flying in an airplane or a helicopter is basically the same, but a helicopter pilot encounters a number of peculiarities which cannot be ignored.

It is well known that an airplane has definite stability, i. e., it is capable of regaining, of its own accord, lost initial equilibrium without assistance from the pilot. But the design of a helicopter is such that it has insufficient stability relative to its longitudinal and lateral axes in forward flight. The helicopter is even less stable when hovering.

When piloting a helicopter, it is necessary to make coordinated use of the control stick, the pedals, the rotor pitch controls, and the engine throttle. Any change in flight conditions greatly influences trimming the craft along all three axes. Along with an increase in speed, pulling forces appear at the control stick (diving). In straight and level flight the position of the helicopter's pedals varies widely, depending upon the operating condition of the engine and the speed. This occurs because of altered rotor torque and the required thrust of the tail rotor. For a beginner pilot, such changes in pedal positions is unusual in comparison with an airplane: he tends to hold the pedals in a neutral position; but in a helicopter this results in slipping, depending upon the flight conditions.

Any appreciable change in trim along all three axes, under various operating conditions of the engine and various flight speeds, complicates piloting. That is the reason why, when flying on instruments - and especially in the initial stage of training - it is imperative to train the pilot to distribute his attention properly. An especially high degree of attention is required when it is necessary to change flight conditions, i. e., to change over from level flight to climbing or gliding, etc.

Let us examine by what concrete features helicopter instrument flying differs from that of an airplane.

The basic airplane flight condition is level flight. It is well known that in this case the speed depends on the coefficient of lift and, consequently, on the airfoil's angle of attack. As a rule, all airplanes have a fixed angle of incidence (decalage), which means that the angle of attack in level flight is altered by rotating the airplane fuselage about its longitudinal axis. In this connection, the airplane's longitudinal axis will have a certain positive angle relative to the horizon (Fig. A).

With the speed increasing in horizontal flight, the airplane will continually reduce its angle of attack, i. e., its longitudinal axis will approach the horizontal position, so that at maximum speed, depending on the airfoil's angle of incidence, it will even coincide with it (B).

Thus, in horizontal flight, in the airplane's range of speeds from minimum to maximum, the angle between the longitudinal axis and the horizon changes from 10°-12° to 0°, i. e., it always has a positive value, and it approaches zero only at maximum speed.

In the case of every helicopter, the speed of horizontal flight depends on the rotor's angle of thrust deflection from the horizontal, or, in other words, on the angle between the rotor's swashplate and the horizon.

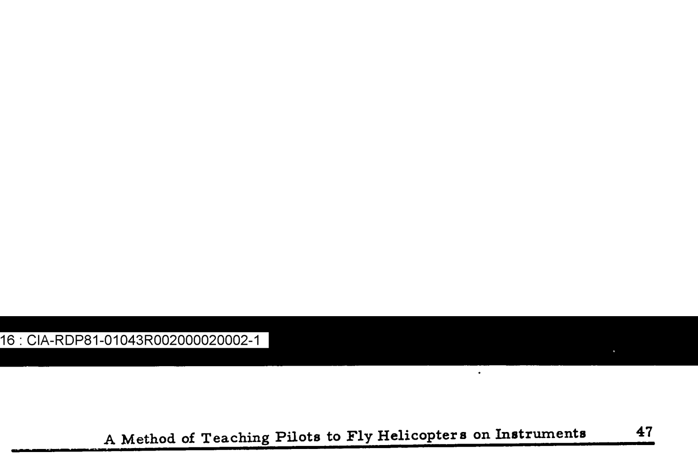
The helicopter will hover when flight speed equals zero. Rotor thrust at this point is vertical and the longitudinal axis of the fuselage is horizontal (C). When the rotor's swashplate is tipped forward by the control stick, the pilot makes the helicopter travel forward. In order to increase speed, the rotor's swashplate must be tipped even more. Since the rotor shaft is rigidly connected to the helicopter fuselage, the longitudinal axis tilts forward when flight speed increases, and has a 9-10° tilt angle (D) at maximum flight speed.

Thus we see that the behavior of an airplane and a helicopter in straight and level flight is virtually the same whenever flight speed changes. At the same time, there is a substantial difference. If, in the case of the airplane, the angle between the longitudinal axis of the fuselage and the horizon is positive within the full range of speeds and approaches zero only at maximum speed, then, in the case of the Mi-1 helicopter, this angle is always negative and approaches zero only when hovering, i.e.,

at minimum speed.

Consequently the readings of the gyrohorizon on the plane and on the helicopter will differ when flying at a speed corresponding to the maximum range of horizontal flight (E, F).

Climbing in the case of a helicopter also has its special features. In a uniform climb, every airplane's longitudinal fuselage axis points almost along the climb path, i. e., it is at a positive angle to the horizon (G). But in the case of the Mi-1 helicopter, the longitudinal fuselage axis will be at a negative angle to the horizon, since it climbs, as a rule, with forward speed (H). Therefore, under these flight conditions, too, the readings of the gyrohorizon on the plane and on the helicopter will substantially differ from each other (J, K).



In gliding, the position of the airplane and helicopter fuselage axes will be identical, i. e., the angle between the longitudinal fuselage axis and the horizon will always be negative (L, M) as will be the readings of the gyrohorizon (N, O).

All the special features which have been discussed are basically peculiar to the Mi-1 helicopter, while for the Mi-4 helicopter the gyrohorizon readings will be somewhat different.

The rotor reduction shaft on an Mi-4 helicopter is tilted 5° forward, due to which the swashplate is also tilted forward. Therefore, at a horizontal flight speed approaching the maximum, the tilt angle of the longitudinal fuselage axis of the Mi-4 will be 4-5°, no more. But if V_{hor} = 130-140 km/hr., then the fuselage angle of tilt will be even less. Consequently, on an Mi-4 helicopter in horizontal flight the silhouette of the gyrohorizon's "little plane" will be only slightly below the horizon bar, i. e., the readings will be the same as those on an airplane.

What general conclusion follows from the above?

The conclusion is this: the gyrohorizon on the airplane indicates not only the plane's spatial position but also flight conditions: in horizontal flight the silhouette of the "little plane" lies almost on the horizon bar, during climb it is above, and during a glide it is below this bar. It is an entirely different matter in the case of the helicopter. Here the gyrohorizon behaves differently, but actually it is consistent under all conditions of flight: on an Mi-1 the silhouette of the gyrohorizon's "little plane" is below the horizon bar in every case: on an Mi-4 it is also below this bar, but somewhat closer to it. Thus, in a helicopter the gyrohorizon readings correspond to its spatial position, but at the same time they do not give the pilot any information about the flight conditions.

At first glance, it may appear that, due to this, the use of the gyrohorizon for the purpose of piloting a helicopter on instruments is precluded. But actually this is not so. With the aid of the gyrohorizon it is possible, for example, to determine any banking of the helicopter just as in the case of an airplane.

It is a known fact that the flight speed of a helicopter depends upon the horizontal thrust component of the rotor. The tipping angle of the longitudinal fuselage axis relative to the horizon will alter if the speed is increased or decreased. But, inasmuch as the difference in speed of the helicopter in horizontal flight, in climbing, and in gliding is slight, the tipping of the fuselage axis and, therefore, of the gyrohorizon, are practically the same under all flight conditions. Hence it follows that the pilot can fly the helicopter without visual contact, orienting himself with the aid of the gyrohorizon. The essential difference, compared to piloting an airplane, will lie in the fact that the pilot must, in every case, keep the silhouette of the gyrohorizon's "little plane" in the same position relative to the horizon bar. The flight conditions may be determined by the readings of other instruments: of the variometer, the speed indicator, the vacuum pressure gauge, the tachometer, and partly of the altimeter.

Every pilot, no matter what his previous training in airplane instrument flying, must - as experience indicates - undergo considerable training when changing over to helicopter flying.

Executing regular turns as well as banks on instruments in a helicopter is not difficult. It is only necessary to remember that here, just as in horizontal flight, the silhouette of the "little plane" will be located below the horizon bar (on the Mi-1 farther, and on the Mi-4 closer, to it). Regular turns and banks are executed with no more than a 15° angle, in order to insure normal readings of the AGK-47 b [automatic gyrocompass].

The transition from one flight condition to another is more difficult when the trim of a helicopter changes along all three axes simultaneously. The engine rpm in this case must be increased or decreased smoothly, special attention being given to controlling the position of the helicopter in space in accordance with the gyrohorizon, compass, and flight speed. After establishing a new flight condition, it is necessary

to eliminate the pull at the control stick with the trim tabs.

In the course of training in instrument flying, the pilot must learn to execute horizontal flight correctly and confidently, while maintaining the intended course, speed, and altitude, to execute turns with planned headings, to climb and let down at a given speed, to execute spirals as well as banks, to effect recovery of the helicopter from any position and to return it to horizontal flight.

Depending on the degree of the pilot's training, the checkout flight in a closed cockpit entitles him to flight training in adverse weather. The object of further pilot training is to prepare them for flying a helicopter to a radio-navigational point without the benefit of visual contact, to penetrate the overcast and undercast, and to navigate in the cloud cover. Finally, in the terminal stage of instrument flight training, the pilots make landing computations and approaches in weather minimum with the aid of landing system equipment, provided for a given helicopter type and airfield.

Pilots who have thoroughly mastered the preceding exercises may be permitted to fly on instruments in a closed cockpit.

Beginning flight training on instruments in a closed cockpit, the flying personnel, during the period of ground training, studies the principles of operating the flight and navigational instruments, and weather in general. This enables them to read a synoptic chart fluently and to reach decisions in flight when encountering hazardous weather phenomena. They study the radio-navigational equipment and the techniques of helicopter flying without visual contact, as well as the electronic devices which they will have to use.

All the preliminary ground training is so programmed as to train the pilot for flying not only in a closed cockpit, but also in the cloud cover.

In connection with this, it is advantageous to have, in classes on preliminary instrument flight training, diagrams of flight and navigational instrument readings for various flight conditions, and a dummy helicopter instrument panel with operating instruments, the readings of which can be set with the aid of a control box on the side or back. It is desirable to have ready photographs of the instrument panel with instrument readings which correspond to the various flight conditions and positions of the helicopter in the air. These photographs, set up on a special stand, in an album or wound on a drum within a housing with a viewer, will benefit the pilots greatly, especially during the initial stage of training.

For the initial stage of training, a large plywood instrument panel, mounted on the classroom wall, will serve as an adequate visual aid. The instruments represented on it, blown up several times their size, have moveable pointers so that the instructor can control the instrument readings in order that all present in the lecture hall may read them.

During the period when the flying personnel is making ready for cloud penetration exercises, the relief model of the airfield and its environs will play an important part. The model will provide a visual means of interpreting the meaning of all the maneuvers connected with flying in the cloud cover and above the overcast, taking into account the terrain features, and such maneuvers, for instance, as the helicopter's approach to the homing radio station, penetration of the overcast and undercast, landing approach, etc.

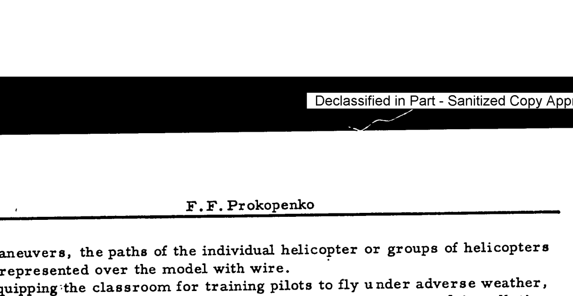
The model may be used in different versions. Specifically, for studying the various maneuvers, the paths of the individual helicopter or groups of helicopters should be represented over the model with wire.

In equipping the classroom for training pilots to fly under adverse weather, it is essential to have an operating ARK-5 [automatic radio compass] installation. It is advantageous to make this adjustable, which will permit visual demonstration of the virtues of the radio compass, namely the fact that its pointer is always directed toward the radio station irrespective of the position (course) of the helicopter. The ARK-5 installation is used to train pilots and navigators to tune in on a desired RNT [radio navigational point], for determining the operating stations by their call signs, the bearings of the radio stations (ShVRS[broadcasting stations], for determining course angles and the computed position of the helicopter.

It is necessary to have in the classroom a diagram of the location of the electronic devices with an indication of actual distances to the VPP [runway], frequencies and call signs of the radio stations (the latter data is variable, and the diagrams should provide for such changes), as well as diagrams of instrument flight zones in a closed cockpit and in cloud cover. This will enable the instructor to explain effectively and graphically to the flying personnel the sequence of radio communication, the flight sequence in the zone applicable to each flight exercise, and the actions of the trainee in special cases.

We have shown only the bare essentials of the visual aids necessary for classroom instruction of flying personnel and for training in scheduled exercises in a closed cockpit or in a cloud cover. The number and arrangement of the visual aids may be changed, depending on the problem under consideration and on the equipment facilities.

AG-DGMK-variometer
AG-DGMK-speed
AG-DGMK-altitude
AG-DGMK-MK(with ensuing shift to engine control instruments)



[AG:gyrohorizon;DGMK:long-range gyromagnetic compass;MK:magnetic compass]

Attention distribution in a closed cockpit during horizontal flight conditions.

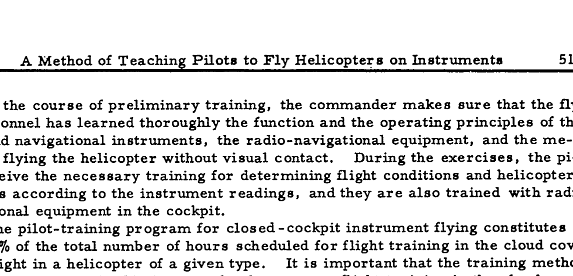
In the course of preliminary training, the commander makes sure that the flying personnel has learned thoroughly the function and the operating principles of the flight and navigational instruments, the radio-navigational equipment, and the methods of flying the helicopter without visual contact. During the exercises, the pilots receive the necessary training for determining flight conditions and helicopter positions according to the instrument readings, and they are also trained with radio-navigational equipment in the cockpit.

The pilot-training program for closed-cockpit instrument flying constitutes up to 50% of the total number of hours scheduled for flight training in the cloud cover and at night in a helicopter of a given type. It is important that the training methods and the organization in this instance be the same as flight training in the cloud cover. Then the transitional period between the closed cockpit and flying in the cloud cover may be shortened considerably, thus reducing the necessary number of proficiency flights in the cloud cover.

Instrument flight training must be begun in the most favorable weather (no turbulence, sufficiently high ceiling). The entire program consists of three basic phases: training in piloting technique in the zone; simulated penetration of the overcast and undercast by individual helicopters and then by groups; practicing approach and landing computation by using the OSP [ILS] system, as well as flying the helicopter on a flight path with the aid of electronic facilities.

Right from the first stage - during the check-out flights - the instructors try to inculcate in the trainees habits of accurately maintaining the desired flight time designated for accomplishing a mission, as well as establishing the habit of continually checking on the operation of the engine-rotor plant. The instructor teaches by demonstrating, by using dual controls, by giving advice over the SPU [intercom], and by always following closely the actions of the pilot. But at the same time it is most

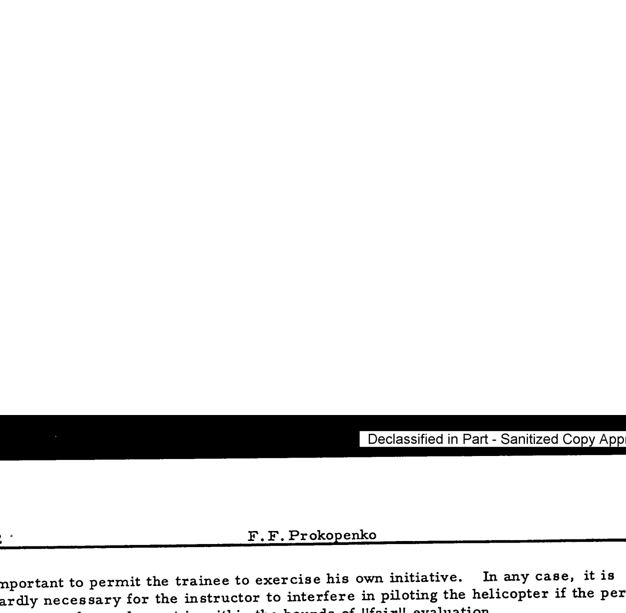
AG-DGMK-variometer
AG-DGMK-speed
AG-DGMK-variometer-altitude
AG-DGMK-variometer (engine operation control instruments)



Attention distribution in a closed cockpit in a climb important to permit the trainee to exercise his own initiative. In any case, it is hardly necessary for the instructor to interfere in piloting the helicopter if the performance of any element is within the bounds of "fair" evaluation.

Let us examine the instrument flight training sequence for the helicopter.

At the beginning, horizontal flight conditions are practiced - maintaining longi-



Attention distribution in a closed cockpit during gliding.

tudinal and lateral stability, and then stability about the vertical axis. So long as the trainee does not have sufficient experience in maintaining the intended altitude and heading, his attention must not be concentrated on these matters. As the pilot perfects his piloting technique, the instructor focuses the former's attention on such combined elements as maintaining the flight course and altitude.

Striving to maintain longitudinal and lateral stability, the pilot observes the gyrohorizon, the speed indicator, and variometer (with the required manifold pressure and rpm). Longitudinal stability is insured by keeping the silhouette of the gyrohorizon's "little plane" on the horizon bar without letting it fluctuate upwards or downwards.

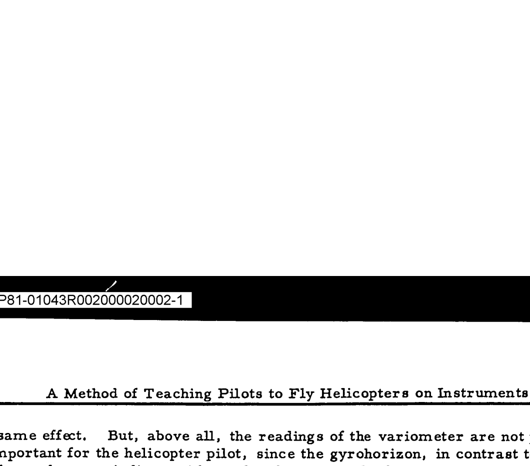
The pilot corrects any course deviation through coordinated movements of the stick and the pedals, and his movements at all times must be short and two-fold. Observation of instrument readings is made in a definite sequence; AG-DGMK - variometer; AG-DGMK - speed; AG-DGMK - flight altitude; AG-DGMK-MK. After this, the pilot turns his attention to the engine operation control instruments.

The suggested scheme differs from the one which is recommended for the airplane: gyrohorizon-GPK [directional gyro] (There is no directional gyro on the helicopter; therefore attention is switched to the DGMK.) - speed. What is the reason for this difference? Simply the fact that in flying the airplane it is very important to maintain speed and not to lose it. In the case of the helicopter, loss of speed does not have

the same effect. But, above all, the readings of the variometer are not particularly important for the helicopter pilot, since the gyrohorizon, in contrast to that of an airplane, does not indicate either a let-down or a climb.

After completing the necessary training in horizontal flight, the pilot begins practicing climbs, doing this by two different methods: climbing with and without altering the engine power.

The first method requires the pilot to know how to trim the helicopter in horizontal flight (V = 130-140 km/hr); then, smoothly pulling back the control stick, to drop speed without altering the engine operation (the gyrohorizon's silhouette will rise 5-7 mm and then will return to the bar when the speed is established between 140 and 100 km/hr. where it must remain during the entire climb). Climbing is controlled according to the variometer, speed indicator, and the engine operation. Vertical speed of climb is 2-3 m/sec.



Attention distribution in a closed cockpit at entry into a turn.

The change-over from climb to horizontal flight is effected by following the reverse sequence: with smooth forward pressure on the control stick, the gyrohorizon is "lowered" 5-7 mm; at V=130-140 km/hr. it will return to its original position and must be held there.

The second method of climbing requires an increased engine power, but here, too, as in the first instance, the pilot establishes a 100 km/hr. speed by a smooth backward pressure on the control stick. Return to horizontal flight is achieved in the same order as in the first instance. However, after the control stick is pushed forward and the speed is established at 130-140 km/hr., the pilot, through adjustments and by means of the "collective pitch" control, establishes the engine rpm and manifold pressure required for horizontal flight, depending on the helicopter's flying weight.

For more accurately maintaining climb conditions, the attention of the pilot shifts in the following sequence: AG-DGMK - variometer; AG-DG-MK - speed indicator; AG-DGMK - variometer-altimeter; AG-DGMK - variometer- engine operating control instruments, etc.

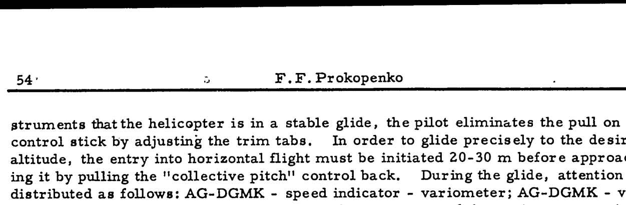
Gliding is achieved by trimming the helicopter and by the ensuing reduction of manifold pressure by means of the "collective pitch" control until it corresponds to a let-down vertical speed of no more than 3 m/sec. Having ascertained by the instruments that the helicopter is in a stable glide, the pilot eliminates the pull on the control stick by adjusting the trim tabs. In order to glide precisely to the desired altitude, the entry into horizontal flight must be initiated 20-30 m before approaching it by pulling the "collective pitch" control back. During the glide, attention is distributed as follows: AG-DGMK - speed indicator - variometer; AG-DGMK - variometer - speed - altitude - operating control instruments of the engine-rotor unit.

The transition from glide to climb, just as from climb to glide, is achieved each time with a preliminary entry into horizontal flight.

After the pilot has assimilated quite thoroughly the helicopter piloting techniques in horizontal flight, in climbing, and in gliding, he may proceed to practice corrective turns and regular turns with a planned angle and course.

Before entering a turn, it is necessary to trim the helicopter in horizontal flight, to remember the entry course, and to put the machine into the turn by using coordinated actions. The speed during the turn, in the case of a helicopter, must correspond to the flight condition which had been established before entering the turn. Recovery from the turn is started when the helicopter reaches a point as far from the planned course as the value of the bank during the turn. When practicing turns to a planned course, the trainee must be required to select the turn heading so as to execute it at a minimum angle. After recovery from the turn, horizontal flight conditions are established, and the accuracy of recovery is checked by compass.

The banking angle on the turn must not exceed 10°. The order of shifting attention when entering a turn is as follows: AG - speed - AG: AG - variometer - AG; in a steady turn: AG - speed - AG; AG - variometer - AG; AG - DGMK - AG; AG - altitude - control instruments of engine-rotor unit operation, and the same



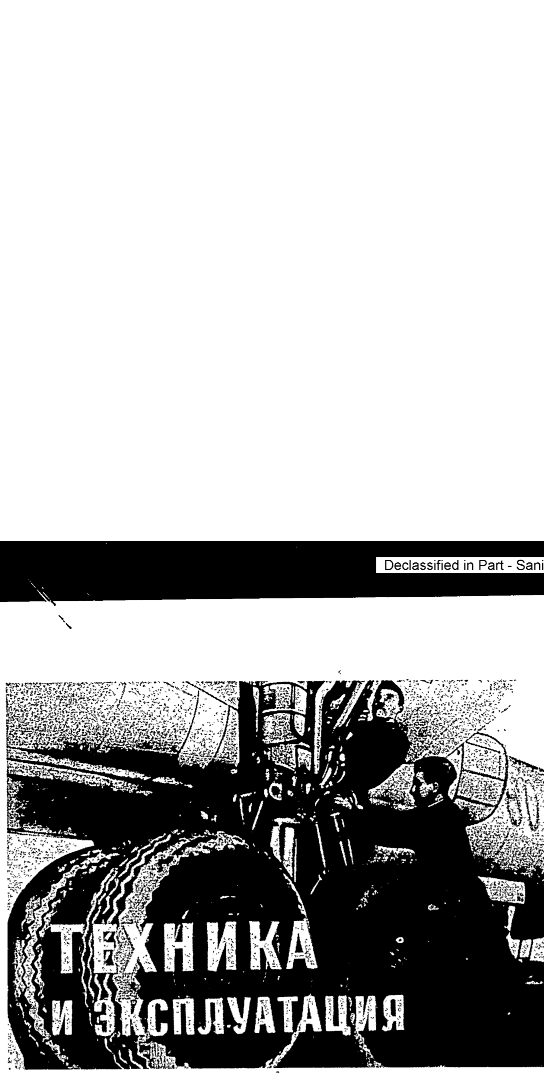
Attention distribution in a closed cockpit during a steady turn.

sequence is repeated. During recovery from the turn, the sequence of attention distribution is the same, except for DGMK, which follows immediately after the gyrohorizon.

When training pilots to fly on instruments in the helicopter's closed cockpit, it is imperative to remember that any change in engine operating condition or flight speed alters the helicopter's directional and lateral trim. Forward pressure on the stick induces bank and a right turn, while backward pressure results in a left bank and turn. In changing over into a glide, the helicopter tends to bank and turn to the right; conversely, when climbing or when increasing the engine power, the helicopter tends to bank and turn to the left.

Speeds and banking increase rapidly whenever there are rapid changes in the engine operating conditions. Therefore, the engine operating conditions should be changed more smoothly when flying on instruments, with special attention being given to precise coordination in manipulating the "Pitch-Gas" levers with the pedals and the control stick.

The suggested method cannot fully exhaust all the problems connected with flight personnel training in piloting a helicopter on instruments. However, the recommendations which have been made are confirmed by the actual experience of the units and, therefore, may be utilized by Air Force commanders, as well as by the instructors, in their work.



EQUIPMENT AND INSTALLATIONS

AND THEIR

OPERATION AND MAINTENANCE

GROUND RADIOLOGICAL RECONNAISSANCE

Candidate of Technical Sciences, Engineer Lt. Col. V. P. Syrnev

Radiation emitted by radioactive substances cannot be detected without dosimetric instruments. This is explained by the fact that such radiation, when acting on the sensory organs, causes no sensation. The radioactive substances themselves cannot be detected since they have no specific characteristics (color, smell, taste). In addition to this, their quantity is a negligible fraction of a gram per square meter even in strongly contaminated areas. The harmful effects of the radioactive substances are fraught with grave consequences if no measures are taken in time for their detection. Therefore one of the basic measures in atomic defense is a continual radiological reconnaissance and dosimetric radiation and contamination control.

The efficient organization of ground radiological reconnaissance requires that characteristics of nuclear radiation be taken into account. An atomic explosion, as is well known, is accompanied by the generation of great quantities of radioactive substances which contaminate the terrain, the air, as well as people, armament and materiel. In explosions on the ground strong radioactive contamination may also take

place along the path of the radioactive cloud.

However, a rapid decay of radioactive products takes place due to their transmutation into stable isotopes. For instance, after 24 hrs the activity is only 2% of the activity observed an hour after the explosion. Therefore the terrain, with the exception of rather strong contamination sources (the area around the center of ground or underground explosions), becomes with time weakly contaminated and safe for personnel.

Radioactive products represent a complex mixture of beta and beta-gamma active isotopes, i. e. substances emitting beta and gamma rays. These products also include a rather small quantity - as far as the activity is concerned - of alpha ray emitters - (the part of the atomic bank which has not taken part in the reaction: plutonium, uranium).

The radioactive substances used in combat may include some beta as well as beta-gamma radioactive isotopes. The decrease of activity of the combat radioactive substances with time takes place slower than that of the explosion products; therefore it is possible to achieve with their aid a comparatively longer-lasting contamination.

Thus the personnel in the contaminated area are exposed to the effects of gamma, beta and alpha radiation. The harmful biological effect of radiation is due to its ability to ionize the atoms and molecules in the living tissue. Radiation damage depends on its ability to penetrate and to ionize. The averge number of ion pairs created by a particle (quantum) along a 1 mm path is called the effective ionization. The effective range of alpha and beta radiation is usually defined as the full length of track of the $\alpha(\beta)$ particle in a substance, and that of the gamma radiation by the half-value layer, i. e., by the thickness of the substance, in passing through which the intensity of radiation is decreased by half. Alpha particles have the greatest ionization power; in the air the alpha particle creates an average of 3000 ion pairs in a 1 mm path.

Gamma rays which penetrate the human body cause damage to the vital organs. They are weakly absorbed in air and therefore damage to the body is possible at great distances from the source of radiation.

Development of individual means of protection from external irradiation by gamma rays (special suits, capes, etc.) is precluded because even a lead shield of 0.70 cm thickness reduces the intensity of radiation only by a factor of 2. The basic measure to prevent damage to personnel from this type of radiation is the observance of the time limit on the presence in a radioactively contaminated area or the use of shelters with protective thickness.

As for the alpha radiation, it is completely harmless as far as external irradiation is concerned because it is totally absorbed by clothing or by a layer of air several centimeters thick.

Beta radiation is to all practical purposes completely absorbed by the soles of the boots or any metallic screen of several mm thickness. It is rather strongly absorbed by air. The flux of beta particles at palm height of a standing man is reduced by air at least tenfold. Therefore the possibility of damage to personnel by air as a result of external irradiation by beta particles is considerably smaller than that due to gamma rays.

Damage to man in a radioactively contaminated area is possible as a result of

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external irradiation as well as through contamination of exposed skin areas by radioactive substances and through introduction of these into the body (internal irradiation).

There exists simple and reliable means of protection against the introduction of radioactive substances into the body or on the exposed skin areas: gas masks, protective suits, capes, etc. Therefore, when the difficulty of protection from gamma rays is taken into account, external irradiation is to be regarded as more dangerous than internal. Because damage by radioactive substances can be done in two ways, roentgenometric and radiometric measurements are carried out.

The ionizing action of external radiation is evaluated with the aid of roentgenometric measurements. This evaluation is given with respect to the human tissue. The degree of ionization of any substance is proportional to the amount of absorbed radiant energy per unit volume or unit weight of the substance; this amount is called the radiation dose. With increase in the radiation dose, the degree of ionization of tissue and damage to it increases.

Radiation dose per 1 gm of substance and for air are equal for most tissues of the human body. Therefore the degree of ionization of living tissue can be conveniently determined from the degree of ionization of air. On this fact is based the choice of the dose unit which was given the name of roentgen.

The roentgen is a dose of gamma radiation which produces about 2 billion (more precisely 2.08×10^9) ion pairs in a cubic centimeter of dry air under normal atmospheric conditions.

The extent of damage to the organism depends crucially not only on the magnitude of the dose, but also on the time during which it was produced and the kind of irradiation (local, general). A dose of gamma radiation of 400 r. received by a man over a period of a day may prove lethal, the same dose however received over a period of several decades is harmless.

The danger of radiation is characterized not only by the dose but by its intensity (i.e. the dose produced per unit time), which it is customary to call the radiation level when referring to field measurements. The radiation level is measured in roentgens per hour (r/hr). The higher the radiation level, the more dangerous the contaminated area. Since, from the point of view of external radiation, the most dangerous are gamma rays, it is customary to characterize the degree of contamination of an area by the radiation level. The area is considered contaminated when the radiation level is 0.5 r/hr, and dangerously contaminated at 100 r/hr. Dosimetric instruments intended for measuring the radiation level have been given the name of roentgenometers.

For checking the exposure to radiation of personnel working in the contaminated area, the second type of roentgenometric instrument is used: a dosimeter. The dose received by one man or a group of personnel located for a certain period in the contaminated area is obtained with its aid. After exposure to the tolerance dose, personnel must be isolated from the action of the radiation. Radiation check allows the evacuation of personnel from the contaminated area in time.

The height of the radiation level depends on the time elapsed after the explosion, the height of the measurement, and the local screening objects. Therefore the warning signs put up by the dosimetric patrols always give the time and the date of measurement; the measurement itself is made at a height of 0.5 to 0.7 m. The radiation level acting on a pilot in an aircraft is measured at the height of the cockpit or in the

cockpit.

Local screening objects have a marked influence on the value of the radiation level. For instance, the level may be several times lower in a trench or a pit than in the open terrain.

The radiometric measurements determine the activity of the radiation source or the degree of contamination (pollution) of various surfaces or solid objects by radioactive substances. The basic radiometric unit is the curie (1) (these measurements are sometimes called curiemetry). The degree of contamination can be expressed respectively: for surfaces: $\frac{\text{curie}}{\text{unit area}}$; for volumes: $\frac{\text{curie}}{\text{unit volume}}$. The curie is a rather large unit of the amount of the radioactive substance. Therefore, with a certain degree of contamination of clothing, surface areas of the human body, surfaces of combat materiel, water, air, etc., the amount of the radioactive substance is measured in terms of the number of atomic disintegrations per minute, where $1 \frac{\text{disintegration}}{\text{min.}} = 4.5 \times 10^{-13}$ curie. With this choice of unit of amount of radioactive substance, the degree of surface contamination is measured in $\frac{\text{atomic disintegrations}}{\text{cm}^2\,\text{min.}}$, that of liquids in $\frac{\text{atomic disintegrations}}{\text{cm}^3\,\text{min.}}$.

Radioactive substances distributed over the surface of some object may be completely harmless from the point of view of external irradiation but may be dangerous when direct contact is made with the contaminated surface, since in this case there is always the possibility of the radioactive substances finding their way into the body. Therefore aircraft and other combat equipment are dangerous to personnel even when removed from the contaminated area if no appropriate precautions are taken.

The degree of contamination by radioactive substances is determined with the aid of special instruments: radiometers. These are intended to determine the degree of pollution by alpha-active substances and are called alpha radiometers; those for beta-gamma emitters are called beta radiometers.

What is the connection between roentgenometric and radiometric contamination characteristics? It is easy to determine the value dose intensity (radiation level) of gamma radiation emitted by a point (2) source of a definite strength, if its gamma constant i_γ is known. To do this, the gamma constant is multiplied by the strength of the source Q (in curies) and divided by the square of the distance to the source (in meters), i.e., $P = \frac{i_\gamma \cdot Q}{R^2}$.

The gamma constant is the magnitude of the dose created by radiation from a point source of 1 curie per hour strength at a distance of one meter, and which depends on the amount of energy and the number of gamma-quanta emitted by the radioactive isotope in one nuclear disintegration. Its magnitude may be found experimentally or may be computed. If it is assumed that the average energy of the gamma rays

(1) A curie is the amount of radioactive substance in which 3.7×10^{10} atomic disintegrations take place in one second.
(2) A source is called a point source if its dimensions are small compared with the distance to the object being irradiated.

emitted in a radioactively contaminated area is 0.7 Mev and that every two disintegrations produce one gamma ray, the value of i_γ for radioactive substances is about equal to 0.2 r/hr at a distance of 1 m.

A radioactively contaminated area without folds may be regarded as a flat emitter.

When the contamination is uniform it is easy to determine the radiation level from the contamination density, i.e. from the amount of radioactive substance (in curies) per 1 m^2.

This is done by multiplying the linear absorption coefficient μ for gamma radiation in air (for the average energy of γ-rays of 0.7 Mev, $\mu = 1.0 \times 10^{-2}$ [1/M]) by the height of the measurement H in meters: the value of E_i is then found from the graph in Fig. 1 as a function of the product μH. Multiplying the value E_i by 1.256 and the density of contamination q, we obtain the radiation level in roentgens/hr. This method of computation permits a sufficiently accurate calculation of the radiation level if the distance between the point of measurement and the boundaries of the contaminated area is greater than 60-80 m and the height of the measurement does not exceed 5-10 m.

As an example let us calculate the radiation level at the height H=0.7 m and M=2.5 m (the height of an aircraft cockpit) if the contamination density is $q = 1 \frac{curie}{m^2}$ and the linear absorption coefficient $\mu = 1.0 \times 10^{-2}$ [1/M] .

P_1 = 1.256 x 4.4 = 5.53 r/hr
P_2 = 1.256 x 3.10 = 3.89 r/hr

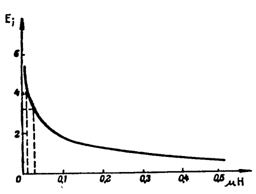

Fig. 1. Values of the function E_i vs. the product μH

All methods of dosimetric measurements of radioactive emission are based on the ability of radiation to ionize the surrounding substance. The ionization in turn may be the cause of a series of physical and chemical changes in the substance. In many cases such changes not only can be determined, but can also be measured quantitatively. The most important types of effects of radiation in various media and the methods of dosimetry based on these effects are given in the table.

Of the dosimetric methods given in the table only ionization chambers and Geiger counters have to date been adapted to field measurements. Photoindicators are not used in field dosimetry because of the time-consuming process of film treatment. Scintillation counters show great promise for future application as sensing elements in aircraft dosimetric devices. Chemical indicators as well as semiconductors are the most modern methods of dosimetry and the possibility is not excluded that they will find a widespread application in field dosimetry.

The field roentgenometer is the basic instrument of ground radiological reconnaissance (Fig. 2), designed to measure the level of gamma radiation between the limits of 0.04 to 400 r/hr. This instrument makes it possible to determine the level of beta radiation directionally. The range of the instrument is divided into four sub-

ranges. The weight of the instrument is 6.7 kg, and it is operated by one man.

The instrument consists of a detecting section (ionization chamber), an electronic amplifier, microammeter, and power supply (batteries). The bottom of the instrument case (under the ionization chamber) has a window covered by a metallic lid which is folded back when the level of beta radiation is evaluated.

The ionization chamber (Fig. 3) has an external electrode (rectangular plastic box) which forms the body of the chamber, and an inner electrode in the form of a letter T. A voltage difference of 300 volts is applied to the electrodes. The chamber is filled with air and hermetically sealed.

If there is no radiation, no current flows in the electrode circuit, since the air filling the space between the electrodes is a good insulator. With the appearance of ionizing radiation, ions are created in the air space and positively charged ions move under the influence of the electric field toward the cathode (the inner electrode) while negatively charged ions move toward the anode (outer electrode). The directed movement of the ions causes a current in the electrode circuit. The magnitude of the current is proportional to the intensity of the dose.

A so-called guard ring is located between the inner electrode and the insulator to protect the electrode from leakage currents across the insulator. The leakage

Item	The type of effect on the medium	Method of dosimetry (sensing elements of the dosimetric instrument)	Main purpose
1	Change in electrical conductivity of gases	Ionization chambers	Roentgenometric measurements
		Geiger counters	Radiometric measurements
2	Luminescence of certain substances	Scintillation counters	Radiometric measurements
3	Blackening of photographic film	Photoindicators	Roentgenometric measurements
4	Color changes of some solution	Chemical indicators	Roentgenometric measurements
5	Resistance changes in semiconductors	Crystal counters	Measurement of large intensities
		Photoconductive cells	

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currents are always flowing in the same direction as the ionization current and may lead to an increase in the readings. Since beta particles have small penetrating power, a window covered with aluminum foil is made in the chamber wall.

The ionization current is a billionth of an ampere even at high ionization levels and therefore amplification is required before measurements can be made. This is achieved by putting a high megohm resistor into the cathode circuit, and the voltage drop across the resistor is fed to the grid of the amplifier tube. The anode circuit contains the microammeter with the scale calibrated in roentgens/hr. Fig. 4 shows a simplified electric diagram of the roentgenometer. The subranges are switched by a stepwise change in the load resistance of the chamber circuit. For the first subrange (the most sensitive) the value of the load resistor is $R_1 = 47 \times 10^9$ ohm, for the other subranges the values are respectively 10, 100, and 1000 times less. The resistances are changed by the subrange switch P connected to a handle which is located on the front panel. The contact K is also brought out to the face of the panel and is used to check zero-level setting in the contaminated zone. When the contact is pressed, the load resistor is shortened and as a result no voltage drop is produced by the ionization current.

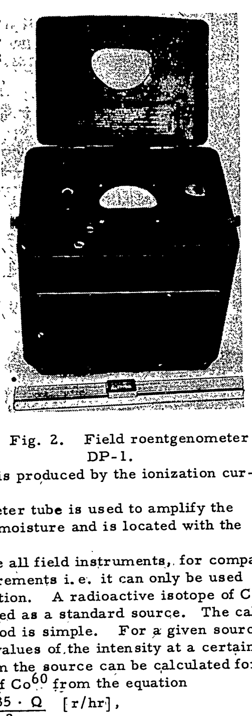


Fig. 2. Field roentgenometer DP-1.

A special electronic tube called the electrometer tube is used to amplify the ionization current. This tube is very sensitive to moisture and is located with the load resister inside the ionization chamber.

The roentgenometer DP-1 is designed, as are all field instruments, for comparison measurements i. e. it can only be used after calibration. A radioactive isotope of Co^{60} is usually used as a standard source. The calibration method is simple. For a given source activity the values of the intensity at a certain distance from the source can be calculated for the isotope of Co^{60} from the equation

$$P = \frac{1.35 \cdot Q}{R^2} \quad [r/hr],$$

where Q is the activity of the source in curies on the day of calibration; R is the distance to the source in meters.

In calibrating, the accuracy of the instrument reading is usually checked against the true radiation level at three points of the scale: at

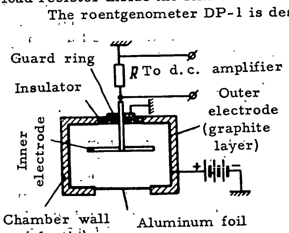


Fig. 3. The ionization chamber

the low end, at the middle, and at the high end of every subrange. The distance to the source, to which corresponds the given intensity of the dose P, is found with the aid of the equation

$$R = \sqrt{\frac{1.35 \quad Q}{P}}$$

The instrument is positioned with the base facing the source in such a way that the distance from the source to the center of the chamber (the position of the center is marked by the sign +) is equal to R. If the reading of the instrument in the most sensitive subrange does not coincide with the calculated value P corresponding to the middle of the scale, the sensitivity of the instrument is adjusted. In other ranges the accuracy of the reading is checked only against the calculated values of P.

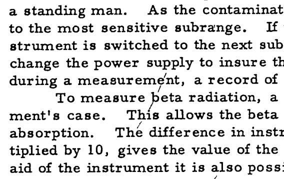


Fig. 4. Simplified electrical diagram of the roentgenometer

The filament voltage and zero setting are checked before taking measurements. Instructions for putting the instrument in operation are attached to the lid of the instrument case.

The measurements of radiation level are made with the instrument at a height of 0.5 - 0.7 m above the ground, which corresponds to the average dose intensity for a standing man. As the contaminated zone is approached, the instrument is switched to the most sensitive subrange. If the radiation level cannot be measured, the instrument is switched to the next subrange, and so on. In order to know when to change the power supply to insure that the instrument does not become inoperative during a measurement, a record of the running time of the instrument must be kept.

To measure beta radiation, a duralumin lid is opened in the base of the instrument's case. This allows the beta particles to reach the chamber without noticeable absorption. The difference in instrument readings with the lid open and closed, multiplied by 10, gives the value of the level of beta radiation in roentgens/hr. With the aid of the instrument it is also possible to determine whether an area is contaminated by radioactive substances at the measurement position. To do this, the lid in the base is opened and the instrument is brought close to the ground. If the terrain is contaminated by radioactive substances, the readings will increase by several times.

The portable dosimeter is designed for checking the exposure of personnel in a contaminated zone to external gamma radiation. The instrument unit includes miniaturized ionization chambers and a charge and measurement panel (Fig. 5).

With the aid of the same ionization chambers, the instrument can measure doses from 0 to 5 (first subrange) and from 0 to 50 (second subrange). The weight of the ionization chamber alone is about 15 gm. For more convenience in handling, the chamber is made in the form of a fountain pen and is carried in a pocket of the tunic.

The miniaturized ionization chamber is made in the form of an aluminum cylinder (the outer electrode) with an aluminum rod (inner electrode) positioned along the axis. The chamber contains a capacitor with one layer connected to the cylinder and the other to the aluminum rod. With the aid of the charge and measurement panel, the chamber capacitor is charged to a certain voltage. When the gamma radiation impinges on the chamber, ions are formed in its interior and move to the electrodes; this gives rise to a current which in turn leads to a decrease of the charge on the capacitor. The decrease of the charge and, consequently, of the voltage is proportioned to the radiation dose at the location of the chamber. By measuring the remanent voltage on the chamber with the aid of the charge and measurement panel, the magnitude of the dose may be estimated. The dial of the electrical meter is calibrated directly in roentgens.

The capacitor is subject to self-discharge as a consequence of unavoidable current leakage. Therefore the chambers are charged and issued to the personnel just before starting for the region of the contaminated area. The chambers should be handled carefully. The presence of moisture in the chamber may contribute to the increase of self-discharge.

Fig. 5. Portable field dosimeter

The field radiometer measures the degree of contamination, by beta and gamma active substances, of the surfaces of various objects, of the ground, as well the degree of contamination of food stuffs and water. In addition, measurements of low levels of gamma radiation in milliroentgens per hour are possible with it. The degree of surface contamination is estimated from the number of beta decays per 1 cm^2 per minute. The range of measurements of beta contamination is from 150 to 1,000,000 $\frac{\text{decays}}{\text{cm}^2\ \text{min}}$, that of gamma radiation from 0.03 to 20 $\frac{\text{mr}}{\text{hr}}$. The total range of measurements is divided into two subranges selected by a switch on the panel (Fig. 6).

To avoid damage to the instrument, it should not be used with radiation of great intensity. Its main purpose is to check for contamination of various objects upon exit from a radioactively contaminated area.

The radiometer consists of two units: the control panel and the probe. In addition, headphones are provided. The weight of the unit is 5.5 kg.

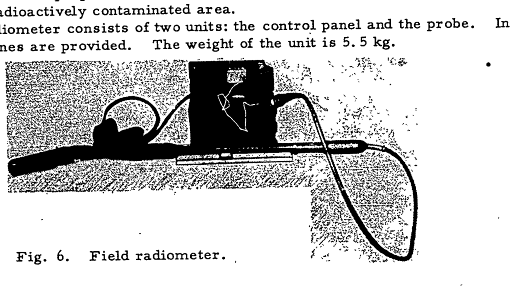


Fig. 6. Field radiometer.

The STS-5 Geiger counter is used as the sensing unit of the instrument (it is located in the top of the probe). In contrast to the ionization chamber, the counter works by gas amplification. If the passage of one gamma ray or of one beta particle produces even one pair of ions, an electrical discharge takes place in the counter which gives rise to a voltage pulse across the load resistor in the probe circuit. The discharge time is about 10^{-4} sec. After the termination of the discharge, the counter is ready to register the next particle. The number of voltage pulses in the circuit per minute is proportional to the intensity of radiation, and consequently proportional to the degree of surface contamination. After amplification, the pulses are converted to direct current, the value of which is proportional to the number of pulses per minute. The current is measured with the aid of a microammeter; its dial is mounted on the panel of the instrument. A calibration table is attached to the lid of the instrument. With the aid of this table, the readings of the microammeter can be converted into $\frac{\text{decays}}{\text{cm}^2\ \text{min}}$ (scale B, or B_2 of the calibration table) and for measurement into $\frac{\text{mr}}{\text{hr}}$ (scale G).

The probe of the instrument consists of the tip and the barrel. The tip is connected to the barrel by a swivel joint and can be in either of two positions: straight (the barrel and the tip form a straight line); or at an angle, as shown in Fig. 6. The tip includes a holder for mounting the counter, an airtight housing with slots covered by thin aluminum foil, and a rotary aluminum cover 4.6 mm thick. The latter may be rotated and fixed in certain positions designated on the tip of the probe (Fig. 8).

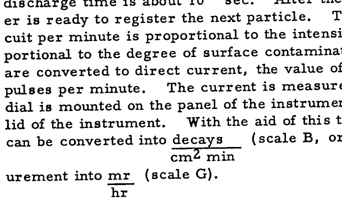


Fig. 7. Radiometer control panel

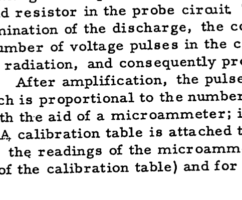


Fig. 8. Probe tip
a - measurement of gamma contamination
b - measurement of weak beta contamination
c - measurement of strong beta contamination.

When measuring weak contamination, the rotary cover is set to position B_1 (in this case the foil, which is painted violet, may be seen through the slots). When a comparatively strong contamination is measured, the probe tip is set in position B_2. In this case, the beta particles can reach the counter unhindered only through one narrow slot.

The rotary cover is set in position G for gamma measurements. In this case, the counter is covered by an aluminum screen 4.6 mm thick. Such a screen completely absorbs beta particles, but at the same time practically does not weaken the gamma radiation.

In preparation for measurements, the control panel is positioned on the chest with the aid of belts in such a way that the meter readings may be conveniently watched. Then the plugs of the probe and the headphones are connected to the control panel (at night the dial illumination is switched on) and the power supplies and the zero setting are checked.

If the instrument is in order, a weak sound is heard in the phones, which is caused by the operation of the high voltage generator, and infrequent clicks due to natural radioactivity and cosmic rays. When there is no contamination, the deflection of the instrument pointer does not exceed 8-10 scale units in the first range. For more complete checking of the operation, a standard source (specimen) furnished with the instrument may be used.

For making measurements, the probe is grasped and its tip is brought to the contaminated area to a distance of 1-1.5 cm. The tip should never be brought in contact with the contaminated surface, since this may lead to contamination of the tip with radioactive substances.

The degree of contamination can quite often be checked in the presence of considerable gamma background. This background may be caused by gamma radiation emitted by areas at a large distance from the surface area to which the counter is brought. For instance, when measuring the degree of surface contamination inside an aircraft, the instrument will be affected by gamma radiation emitted by substances which contaminate the equipment outside the cockpit.

Due to the great power of penetration of the gamma radiation, it is impossible to screen the counter from its effects. Therefore the degree of contamination is obtained as the difference in the measurements of the total flux of beta particles and gamma rays only (rotary cover in position G). If the gamma background is low (0.1 of the total beta-gamma radiation), the measurement of the total flux is sufficient. The use of the radiometer within the contaminated zone in the open terrain is impossible because of its high sensitivity. In such case, in order to take radiometrical readings, other instruments must be carried, or the screening effects of field structures (underground huts, bomb shelters) must be used. In making beta measurements inside structures, the gamma background which is caused inside the structure by the contaminated area should be taken into account.

The degree of contamination of foodstuffs is determined either by direct measurement of their surface contamination or by taking samples. From the results of measurements on a sample of a certain weight, the contamination per 1 gm of a given food product is determined. Dosimetric check of water is effected by immersing the probe tip in water. The tip in this case is covered by a thin rubber hood which protects it from radioactive contamination. From the results of the measurements is determined the contamination per 1 liter of water.

Well-organized and timely radiological reconnaissance helps to insure reliable

protection of personnel from damage by radioactive substances.

MAINTENANCE OF THE FRONTLINE BOMBER

Engineer Lt. Col. G. V. Kharebov

For several years our unit has been repairing frontline bombers. Having gained some experience, we were able to discover more efficient methods which we now use extensively when overhauling equipment in short supply. Of course, we frequently had to deal with a number of difficulties. We would like to tell about the ways of overcoming these difficulties, about the new repair methods, and about the creative work of our efficiency experts.

Many aircraft of the type Il-28 coming in for repair have such defects as pressure leaks in the cockpit. Usually a pressure of over 0.2-0.3 kg $/cm^2$ cannot be maintained in such aircraft even for several minutes. There were cases when leaks were discovered even in an overhauled plane because the troubleshooters did not make an accurate check of the positions of the leaks. We began a successive elimination of the leaks by using a sealing compound. After the cockpit has been pressurized to the required technical specifications, all the leaks which have been marked are itemized in a list; in accordance with this the defects are then repaired.

It was discovered that it is not necessary to open the airtight seam when there are leaks around one or two rivets, and we do not do this. The cockpits are repaired after troubleshooting in the standard way. This method of troubleshooting pressurized cockpits with a subsequent overhaul gives good results; the persons who receive the equipment no longer lodge complaints about leakages.

We pay close attention to the repair of the air radiator of the high altitude system of the aircraft. The technical manuals available in the units do not describe any kind of repair for them. But in the majority of cases the radiators do not come up to the technical requirements of being airtight, since they contain cracks, and are replaced by new radiators. Most frequently the cracks are not in the core but in the parts where the tubes are welded to the housing. Such cracks are easily welded. In cases where access to them is difficult, we cut off the flange with a cutter and then, having welded the cracks in the pipes, we weld the flange in place again. When the flange is cut off, the whole core section of the radiator may be replaced when necessary.

This work is not complicated even though it requires some experience. By this method of repairing radiators - which used to be replaced by new ones - we save up to 500 rubles on each of them.

In the course of maintenance, we ran into such defects as leaks in the bushing bosses in the union of the vacuum pump housing. In operation, the bushing bosses are tightened to remove leaks. But the unions have a tapered thread and when overtightened the least bit produce great stresses in the boss. This leads to the formation of microscopic cracks. Subsequently, under the influence of vibration and temperature changes, these cracks widen.

The cracks in the boss which do not go through are removed by the usual welding. Wide cracks and through-cracks are first carefully cleaned all the way through and widened.

To prevent the appearance of cracks in the welded boss, the boss is machined perpendicularly to the axis of the union to fit into a ring. The ring is machined out of steel and pressed over the groove in the boss. Such rings prevent the formation of new cracks and carry part of the stress caused when the union is tightened.

The maintenance of the bellows-type pressure regulators of the automatic weight consumption units must also be described. The maintenance procedures recommend replacement after the regulators have lost the vacuum. Experience in reconditioning has shown that it is not necessary to replace the units which show no visible defects. The leaks, as a rule, are at the junction where the evacuating tube has been soldered. Taking into account the scarcity of pressure regulators, our unit has gone about reconditioning them. The process of repairing the pressure regulators has been mastered by workers B. V. Zubarev and S. S. Grin'ko.

To recondition the pressure regulators, which, except for the loss of vacuum at soldered junctions, have no other defects, they are soldered at the leaks and evacuated. The degree of vacuum after repair is determined according to technical specifications by testing the opening force under the action of weight. If one of the rim sections of the bellows has cracks on the inside, it is removed, and the butt ends of the diaphragm are flattened out and soldered to the inner supports. The sections with the cracks on the outside are soldered and the bellows are evacuated.

The repaired bellows are checked for opening force and tested on a vibration stand. All pressure regulators with such bellows fall within the standards set by technical specifications.

The repair of oxygen and air bottles is done by us in a somewhat different way. As is known, corrosion of the inner surfaces of the bottles has usually been removed by chemical etching which lasts from several hours to several days. Innovator B. V. Zubarev has proposed a method of sand-blasting which removes the corrosion scales in a few minutes. The bottles are weighed before and after scale removal and if required by the regulation on the time of service, shown to the boiler safety representative.

After the removal of scales, all bottles undergo hydraulic test at pressures of 225 kg $/cm^2$ independently of the testing deadlines and are made corrosion resistant.

We ran into an interesting phenomenon while repairing the cylinders of the air system. In a number of cases, corrosion, scratches and scuffs had formed on their inner surfaces. Corrosion cannot be removed by hand; grinding is required. But we had no grinding machine for interior grinding.

Innovators came to the rescue. Lathe machinist V. A. Popov designed a jig for a lathe which permits the grinding of the inner surfaces. The body of the jig with a bar mounted in a pipe and the electric motor are mounted in place of the tool post. The longitudinal and lateral movements of the tool rest is used to feed the grinding stone. The cylinder to be machined is held by cams as the cylinder and the grinding stem rotate in opposite directions. The grinding is done in two steps: first the rough, then the fine grinding. The present specifications permit an increase in the diameter of the cylinder up to 0.5 mm. However, the cylinders cannot be overhauled again after such grinding and hence their useful life is limited to the first repair. The cylinders ground out less than 0.5 mm on the inside diameter may be unsuited for a repeated overhaul. What should be done in such cases?

To increase the useful life of the cylinders and to save money, we chrome-plate the inside surfaces to prevent corrosion or to maintain the size, if the cylinder was ground out because of corrosion or other mechanical damage.

In this way a cylinder of the bomb bay doors was ground out, chrome-plated, assembled and tested on the stand. After 500 working cycles the plated surface and the parts of the cylinder were in good condition. No lubrication was used during the test. A year later the cylinder was inspected again. This time the plated surface still showed no traces of corrosion. This proved that chrome-plated cylinders are more durable and do not require additional maintenance and lubrication after every 25-30 hours of service.

One more important question. As is well known, all coil springs - in particular in the spring cylinder of the emergency release of the front chassis strut - show a "set" after prolonged service and therefore change their free length. The springs working on compression are shortened, those working on extension are lengthened.

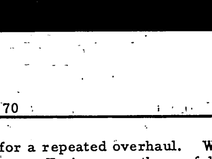
The springs which retained their characteristics are tested for compression. If the final deformation is absent, they should not, in our opinion, be rejected. We, for instance, accept shortened springs for installation: outside springs shortened by 8 mm and inside springs shortened by 7 mm with the usual set of 3-5 mm. Experience shows that such springs can be successfully used for two years.

In our opinion, some of the proposed methods may be used in maintenance of aircraft of other types if the special factors in their design and operation are taken into account, as well as the specific data on the function of the individual units.

ECHO-RESONATOR

The ER-1 echo-resonator is designed to check the working capacity of receiving and transmitting installations of airborne radar stations in the 3-centimeter band under laboratory and field conditions.

The ER-1 instrument is a closed volume resonator. A pulse of high frequency energy, radiated by the radar antenna, is fed to the input wave guide through a horn antenna. The wave guide is connected to the chamber of the volume resonator.



If the resonator is tuned to the radar frequency, the electromagnetic oscillations excited in it will reverberate for some time, exceeding considerably the duration of the transmitter pulse. During this time the chamber is sending into the horn antenna a response echo signal which is received by the radar receiver. This signal illuminates part of the screen of a scope with circular scanning, making a marker in the form of a bright radius. On the scope with vertical deflection, the response signal will look like a damped pulse.

The indicator mechanism (tuning mechanism) allows tuning and retuning of the echo-resonator at distances up to 15 m with the resonance indicated on the instrument mounted on the control panel. The maximum angular shift between the two indicator mechanisms does not exceed $\pm$ 0.2 scale units. Both indicators show maximum current during the tuning of the echo-resonator chamber. No additional adjustments are required when switching over to remote control.

OUR ENGINEER

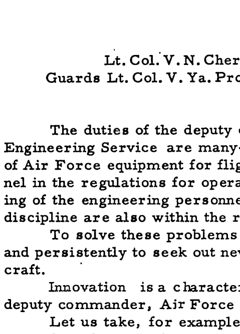
Lt. Col. V. N. Chernyshev, Commander, Air Force Unit X,
Guards Lt. Col. V. Ya. Proskurin, Deputy Commander for Political Affairs

The duties of the deputy commander of an Air Force unit in the Air Force Engineering Service are many-sided. He is responsible for the constant readiness of Air Force equipment for flights, and for the organization of the training personnel in the regulations for operating that equipment. The combat and political training of the engineering personnel and their indoctrination in a spirit of high military discipline are also within the range of his duties.

To solve these problems successfully means to display judicious initiative and persistently to seek out new ways and methods for the technical operation of aircraft.

Innovation is a characteristic trait in the work of officer G. A. Sumerkin, unit deputy commander, Air Force Engineering Service.

Let us take, for example, the preparation of aircraft for takeoff. Many engineers have been pondering over the question of how to cut down on the time for carrying out necessary work. This question disturbs Engineer Sumerkin as well. Taking into account the specific nature of the airfield and the favorable location of the VPP [runway], he came to the conclusion that time could be saved through eliminating the towing of aircraft to the takeoff position. Towing is eliminated as an element in preliminary preparation. This suggestion was supported by the unit command and the Party organization.



G. A. Sumerkin

Work carried out directly in the aircraft parking areas, without the aircraft's being taken out to the preliminary starting line, has made it possible to speed up their preparation for repeated flights and to cut down sharply on the time that the technical personnel spends on the airfield during flying days. Where formerly more than two hours used to be spent on towing aircraft to the preliminary starting line and back to the parking area, now this time is utilized for preparing aviation equipment and for training personnel.

It would seem that, with this, one could rest content. After all, a great deal had been accomplished - a saving of two hours in the preparation of aviation equipment. But G. A. Sumerkin

saw that the possibilities for a new work method had by far not been exhausted. He began thinking about a way to improve the method of refueling aircraft. The question arose: But isn't it possible to do without fuel trucks by organizing centralized refueling from fuel pumps directly at the parking area? The engineer personnel regarded this idea very distrustfully. Many years of practice had accustomed them to fuel trucks. Engineer Sumerkin had to display persistence in order to implement the new method of refueling. Efficiency experts came to his assistance by improving the system of centralized refueling. Where formerly the pump transferring the fuel worked on a gasoline engine, now an electric motor was set up. This is particularly important during the winter, when a gasoline engine has often to be warmed up.

Centralized refueling facilitated the work of the technical personnel, and made it possible to free a large number of fuel trucks. The time for refueling aircraft was cut down by almost two hours. The fatigue detail was curtailed, the movement of special motorized transport was decreased, and discipline and order at the parking area during flights were improved.

Or let us take the technical training of flying personnel. The exercises can be conducted in various ways. The simplest procedure, not requiring painstaking preparation and creative research on the part of the engineer, is to conduct the exercises through a detailed study of the construction of the individual assemblies of the aircraft right up to the structure and function of the ribs, longerons, units, and assemblies. All this is well known to an engineer. But G. A. Sumerkin felt that pilots never meet up with such problems in their practical work. After all, experience has shown that the pilot does not need to study in detail the construction of the individual parts and assemblies. He must know clearly the operating principles of the assemblies and instruments, and also the theoretical principles which help one understand one set of phenomena or another during flight. Consequently, in order for the exercise to be interesting and for it to be of maximum utility to the pilots, the engineer must prepare for it carefully and think through all the questions which must be dwelt upon. And that is just what officer Sumerkin is doing.

In the course of preparing the exercises, he consults with the commander and with experienced pilots, and he determines what training models of aviation equipment are required, what diagrams, wall charts, mock-ups, etc. and where the exercise can best be held, directly on the aviation equipment or in the classroom.

In the initial period of re-equipping our unit for a new aircraft, when the pilots had not yet made themselves sufficiently familiar with it, there were still quite a few errors in some of their work. Life itself required of the pilots a profound theoretical knowledge of the special features of piloting technique and of the combat application of an aircraft. During the studies in the classrooms and in the training exercises, a good deal of attention was given to mastering the special features of an aircraft which came to light in the course of its operation.

During the training exercises, the engineer selected the main items of the topic being studied, instead of simply repeating the figures on the aircraft's tactical performance data or reading off the articles of instruction, but he would examine them in detail, explain the physical nature and the theoretical principles on the basis of which the instruction requirements for the operation of aviation equipment are based.

Officer Sumerkin analyzed in detail the errors committed by the pilots during their study and operation of aviation equipment, and he would explain the reason for their occurrence. Such a method made it possible to prevent a repetition of these errors. Exercise after exercise was successfully carried out by the pilots. With every flight the new aircraft became more and more obedient in their hands.

The flying personnel has to the present time not ceased its study of aviation equipment. Technical training is conducted systematically, with reliable preliminary training of the leaders and students, and the locations of the training exercises and visual aids are clearly determined. However, life goes on, and Engineer Sumerkin began to observe that the prevailing forms of training, which had been effective during the period when the pilots were beginning to master the aircraft, were ceasing to meet their needs. What then was the way out? Apparently a form of technical training was needed which would best contribute to an increase in the knowledge of experienced pilots. Would it perhaps be expedient to conduct the exercises in the form of topical seminars? It is just such questions that are disturbing officer Sumerkin now.

Constant contact with people and a firm reliance on the Party and Komsomol organizations of the unit are characteristics of Comrade Sumerkin. During the current year, with the help of the Party Bureau, he organized and directed, among the personnel, the propagandizing of aviation and technical information and the exchange of work experience among the best aviation experts in accordance with their specialties (in TECh [technical electrical units], and in the service groups, among the technicians and mechanics).

Flight critiques are an important method for training flying and technical personnel. During discussions with the pilots, Comrade Sumerkin analyzes their errors in operating the aviation equipment; and with the technicians and mechanics, he analyzes both their preliminary preparation for the flights and the flying day itself, points out the best men, and analyzes the errors which have been made.

In preparing for a discussion, he constantly has talks with the activ [most active members of the Party]. At one time failures of special electrical equipment were observed. Comrade Sumerkin discovered their causes and after consulting with the commander and with the members of the Party Bureau, he called a technical conference on the following topic: "On mutual assistance in the work of aviation specialists in preparing for flights". The engineer's report was interesting and meaty. Aviation specialists participated actively. They introduced many sensible suggestions.

The conference made it possible to discuss extensively and to disseminate the work experience of the element where all the aviation specialists, headed by officer F. M. Sviridov, have been working as a team. It was at this same conference that the causes of failure in the work of Engineer L. V. Zharkov were brought to light. He had been teaching his men poorly and had neglected the preparation of special electrical equipment, by entrusting it to the ESO [special electrical equipment] service group. The experiment of organizing interchange of specialists in the element where officer Sviridov is the engineer has proved to be instructive. For the preparation of radar stations he enlists the services of technical personnel in other special fields. With this in view, aircraft technicians and junior specialists have studied the performance of necessary operations. The basic operations are, of course, carried out by radio and RTO [radio technical service] mechanics, and the auxiliary operations connected with the readying of the stations for flight are carried out by the technical personnel in other special fields.

Comrade Sumerkin also directs the work of the unit's efficiency experts. For last year alone the unit's Bureau of Efficiency and Invention succeeded in having 16 suggestions adopted which aimed at improving the methods for operating aviation equipment.

CONCLUSIONS PROMPTED BY EXPERIENCE

Engineer Maj. L. B. Bogomol'nyy

I would like to express my thoughts on certain statements in the articles by Engineer Lt. Col. B. S. Vinnik ("Herald of the Air Fleet", No. 10, 1956) and Engineer Lt. Col. V. Malygin (ibid., No. 6, 1955) and to share our on-the-job experience.

In order to maintain aircraft weaponry in a constant state of combat readiness, it must be continually cared for, preliminary and pre-flight inspections and checks must be competently carried out, and the weaponry must be efficiently operated during flights.

The time required for checking out the fighter weaponry is rather long; however, it should not be reduced at the expense of inferior quality of work. Therefore we cannot agree with comrades who recommend that, for simulating the "unsafe" condition of a weapon, the aircraft may be released for any flight mission when the recoiling parts of the gun are in the extreme rear position.

The work volume of the aircraft weapons specialists is large enough, especially when the entire complex of the fighter's weaponry is in use. Is it worth while increasing their load by some invented operations? Besides, releasing an aircraft for flight when the recoiling parts of the gun are on the sear lug is equivalent to violating the basic operating rules and to habituating the specialists to conditional standards when working with weapons.

As for dummy shells, there was a time when occasionally we used them; but soon we became convinced that sometimes they can cause gun stoppage and do not pay off. In our opinion, there is no reason to return to this practice.

We feel that it is also impracticable to use safety devices as a precaution when an aircraft returning from the bombing range is taxiing in. The only time when they are needed is while clearing a stoppage, when a shell is in the breech-block extractor. We are convinced that it is risky to tow an aircraft returning from the bombing range without a preliminary inspection of its weapons in a safety zone. This applies both to single flights and to group flights. Working with weapons demands strict observance of safety measures.

We have a regulation to the effect that no other tasks may be performed in the cockpit when the weapons are being serviced. Experience has shown that violation of this rule results in accidental firing, release of bombs or of drop-tanks. Therefore we cannot agree with those comrades who propose to cut down the necessary time for a weapon check-out before a repeat sortie by carrying out simultaneously work on the aircraft equipment and servicing the systems with air and oxygen. In such a case there must be another specialist working in the cockpit, which in our opinion is completely unacceptable. When dealing with work under combat alert conditions, the guns should be checked out the day before. Bombs and rockets should be readied only after all the other work is finished.

There is another extreme situation when an effort is made to insure safety by

increasing the number of blank reloadings "for firing" (i.e., reloadings, after which a shell will be fed to the breech-block extractor). It is recommended for this purpose to place a dummy shell as the first one in the belt which will provide only one reloading for firing.

If this method of weapon check-out is adopted for firing practive, how many dum-

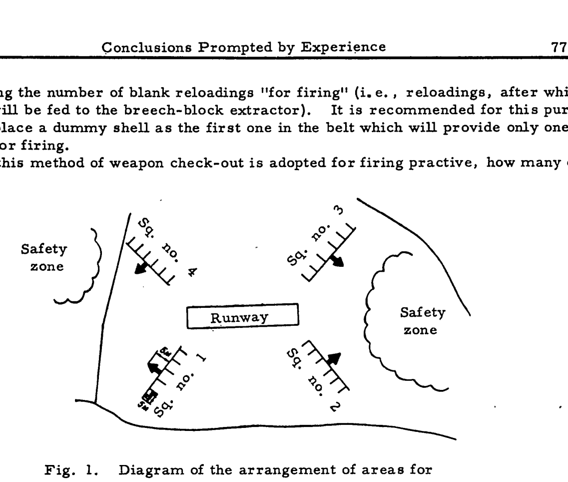


Fig. 1. Diagram of the arrangement of areas for weapon check-out.

my shells will be needed? After all, during reloading they are discarded. Besides, each additional reloading involves an unnecessary expenditure of the supply of air on board. Would it not be better to leave reloading to the pilot, in case he may find it necessary to clear a removable stoppage in the air? We consider that one reloading per firing completely insures ground safely of weapons.

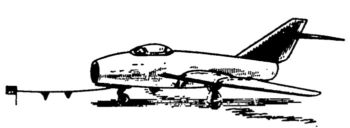


Fig. 2. Signal flag arrangement.

Inspection and clearing of guns on an aircraft returning from the bombing range, performed in the safety zone, constitute an obligatory part of the check-out procedure for the weapons executed by a specially assigned group of personnel. If the task is properly organized, the next sortie will not be delayed. For this purpose we have areas in the "clearing square" (as the safety sector is usually called) which are laid out (Fig. 1) and planned for clearing simultaneously 6 - 8 aircraft. When the whole element is flying, no more than 6 aircraft accumulate in the square.

Whenever single aircraft or small groups of them are flying, there is always an officer and 1 or 2 specialists on duty in the square. Whenever a request to land comes in at the SKP [alert crew post], the engineer selects an additional group of four or five men from amongst the junior specialists and officers present at the advance alert station in order to speed up the work in the "clearing square". Each of them simultaneously inspects and clears the guns on one plane. Then the group returns to the advance alert station and meets the same aircraft there. If by that time only a few of the aircraft have landed, then they are inspected by the regular group on duty in the square. We feel that there is no reason to differentiate between single aircraft and groups of aircraft in the work of clearing weapons in the safety sector's square.

In the complex of safety measures we have included the rule which forbids movement of personnel between the signal flag and the aircraft, the latter often occurring in practice. For this purpose we have added a cord with two pennants to the signal flag. One end of the cord is attached to the flagpost, and the other to the lugs of the front wheel flaps with a hook (Fig. 2). Now the specialists working on weaponry are relieved of the task of watching to see that personnel or a maintenance vehicle does not accidentally appear in front of the plane, since between the flag and the plane there are readily visible pennants.

As regards the pintles for bomb suspension which are recommended in the article by Engineer Lt. Col. Vinnik, we must take into account that despite all their advantages, they are too short, are only single-threaded, and they require cleaning of the bomb's eyehole.

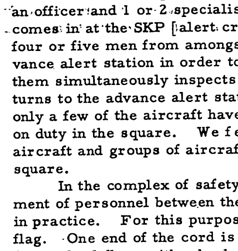


Fig. 3. Pintle rod for bomb suspension.

We use pintle rods as shown in Fig. 3. They are long enough to be used as levers in lifting aerial bombs. The threading at both ends allows them to be screwed into eyeholes of different diameters. Dirt and grease can be removed from the rods along the grooves which run the length of their threading.

When the guns are being operated their barrels become excessively fouled with copper after 80 - 100 rounds. The copper must be removed with metal cleaning rod brushes. There is great need for a simple copper remover. The most convenient way would be to build the copper remover into the shell itself.

In our unit we take special pains to see that tools are not lost or left in the cockpit of an aircraft. We keep the tools in special boxes. The compartments in the boxes are painted red and thus it is possible to determine whether all the tools are in place without taking an inventory.

The specialists working under officer N.S. Mironenko have selected the necessary tools at the TECh [Technical Electrical Unit] and maintenance outfits for the various jobs with weapons. The remainder they store in sealed packs.

Finally, a few words about work scheduling. A group of armorers, even when it consists of two specialists, is considered efficient irrespective of the number of planes which they service during the flying day or the day before. In our opinion, it is essential to determine the maximum number of aircraft which one specialist is able and obliged to service. In order to increase the sense of responsibility, it is practicable to make the rule that the same specialist who prepares the weaponry for flight will service it during the entire flying day. This will consolidate the outfits and will improve the quality of weapon check-out.

FROM THE HISTORY OF SOVIET AVIATION

THE COMBAT OPERATIONS OF THE SOVIET AIR FORCE ON THE EASTERN FRONT 1918 - 1919

Guards Maj. Gen. M. P. Stroyev,
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The Eastern Front was formed in the Summer of 1918 to repulse the armed attack of the imperialists of the Entente who were attempting to overthrow the rule of the Soviets in our country. For these purposes, imperialist circles made use of the Czechoslovak Corps, which was heading east and which was provoked by Entente agents into an anti-Soviet uprising.

The imperialists of the Entente armed the counterrevolutionary forces of the country in the east and formed White Guard units and groups. They aimed at seizing all of Siberia, the Urals, and the Volga Region, and then, together with the interventionists, who had landed at Murmansk and Archangel, to advance on Moscow and Petrograd in order to smother the Socialist Revolution.

Taking this danger into account, the Soviet Government reached the decision, in June 1918, to create an Eastern Front. New regiments and divisions of the young Red Army, as well as its Air Force squadrons, were formed in a short period of time when fierce battles were going on against the superior forces of the enemy. The best sons of the working class were sent to the Eastern Front: Communists, trade union members, and revolutionary youth.

Taking advantage of their numerical superiority, the White Guards, who had been armed by the Entente, continued their offensive and reached Kazan'. From 1 to 6 August, units of the Fifth Soviet Army, which had only begun to take shape at that time, fought intense battles for Kazan' but were compelled to fall back. On 6-7 August Kazan' and the gold supply of the republic, which was stored there, were seized by the enemy.

The subsequent advance of the Whites posed a threat to the existence of the Soviet Government. On 1 August 1918 V. L. Lenin wrote: "Right now the entire fate of the revolution depends on one card: swift victory over the Czechoslovaks on the Kazan' - Ural - Samara front." 1

In this difficult situation, the front line became stabilized. In all sectors the enemy encountered growing resistance by Soviet troops. The fighting in the Kazan'

1. V. I. Lenin. War Correspondence (1917-1920). Voyenizdat [Military Publishing House], 1956, p. 57.

area took on a particularly stubborn character.

The concern shown by the Communist Party and by V. I. Lenin and the bravery and heroism of the soldiers of the Red Army and its Air Force made it possible for the command of the Soviet troops to intensify the force of the blow against the enemy. The Eastern Front continued to receive more and more new units of the Red Army, including Air Force units.

But what was the Air Force of the Eastern Front?

By August 1918 there were five Air Force squadrons here, of which two operated in the Third Army (in the Perm' sector). In the Kazan' sector there was a combat detachment of the Fourth Socialist Air Squadron which had been activated in Petrograd. The main body of the squadron was in Nizhniy Novgorod (Gor'kiy), while its other component participated in the crushing of the SR [Socialist Revolutionary] rising in Yaroslavl'.

A few days after the seizure of Kazan' by the Whites, the following units had already been hastily transferred to the airfield at the Sviyazhsk railroad station where Fifth Army Headquarters was located: from Moscow, the First Soviet Combat Air Group under the command of pilot I. U. Pavlov; from Rostov, in the Yaroslavl' region, the 23rd Air Force Squadron, which up till then had been taking part in crushing the SR rising in Yaroslavl'; the HQ element of the Twelfth Air Force Battalion and several individual pilots. Altogether 20 crews assembled here, and this made it possible to maintain as many as 8-10 alert aircraft.

In September 1918 the following units also came to the Fifth Army: the Moscow Air Force Squadron of Communists, a combat squad of the Kaluga Air Force Group, and the 17th Balloon Squadron.

Everything necessary for combat operations was located on the airfield at the Sviyazhsk station at a distance of only 20 km from the front line.

Air Force combat operations became considerably more active with the arrival at the front of I. U. Pavlov's Air Force group. This group had been equipped with Nieuports and its pilots were for the most part former soldiers or officers who had received their commission for distinction in battle. It comprised the main combat core of the Air Force of the Eastern Front.

Headquarters and various military installations of the White Guards were concentrated in Kazan'. The Air Force squadrons of the Red Army were assigned the mission of striking blows at the headquarters and installations of the White Guards. This mission was rather complicated and had to be carried out under difficult conditions.

Our pilots appeared over the city almost every day. Precision bombing was promoted by painstaking preliminary air reconnaissance and also by the fact that the leading role in the raids on Kazan' was played by observer-pilot Ya. T. Konkin, a former laborer and resident of Kazan' who knew the city well.

The raids on Kazan' soon became intermittent: the pilots had to help the ground troops operating on the battlefield. Bombing and strafing were carried out systematically on the enemy's river transport facilities, on his infantry in the forward lines, and also on his artillery in the Verkhniy Uslon area, where his main forces were concentrated. Flights by pilot Vladimir Satunin are noted in a report on the combat operations of the Fifth Army Air Force for August. Together with Konkin he dropped the largest number of bombs on Kazan' (frequently they would load their Farman with as much as four poods [pood = 40 pounds], which was in excess of its normal load).

The Red pilots at Kazan' swiftly mastered the organization of combined group flights of aircraft of various types. Thus, on the evening of 19 August, seven aircraft carried out a group bombing sortie, dropping bombs on military objectives in the center of Kazan', in Verkhniy Uslon and on the Raifskaya wharf. On 22 August a group raid by six aircraft was carried out on Verkhniy and Nizhniy Uslon. These were the first ground attack operations of the Soviet Air Force with bombing and strafing of enemy troops, in direct cooperation with our advancing units. In the days that followed, raids on Verkhniy and Nizhniy Uslon were carried out repeatedly by groups of from three to seven aircraft. In the reports, special mention is made of the raid on 23 August. A low overcast and wind with gusts up to 30 m/sec made flying risky, even in fighter aircraft. However, the ground situation compelled the commander of the Fifth Army to assign the Air Force the mission of bombing in the Uslon areas. In the morning, pilots F. Ingaunis and I. Pavlov set out on their mission in Nieuports at an altitude of 600-800 m. Heavy turbulence and two 10 and 20 pound bombs lying on their laps made control of the aircraft very difficult. But the pilots managed to cope with this mission. After this, fighters flying with two bombs were used extensively. Both pilots received a citation of thanks and monetary rewards. The same objectives were bombed again on the evening of 23 August by two crews of fighter aircraft covered by Pavlov and Ingaunis, who made another sortie.

At the beginning of September, in connection with the increased traffic of river vessels and barges on the Volga and at the mouth of the Kama, the Air Force began to be employed much more extensively against enemy steamships and barges. However, the general intensity of bombing operations by our Air Force in September did not exceed that of August, since a great deal of attention had to be given to air reconnaissance and liaison.

During the period of the battles for the liberation of Kazan', air reconnaissance was not conducted to any considerable depth, since the command did not assign any missions to that effect. On 20-24 August, air reconnaissance craft noted a concentration of a large number of river transport facilities which were being moved to the left bank of the Volga in the area of Verkhniy and Nizhniy Uslon. On 28 - 29 August, when enemy units had infiltrated our rear as far as the area of the Shikhrany railroad station (80 km to the southwest of the Sviyazhsk station), the Air Force concentrated its efforts on reconnaissance and combat operations on the battlefield, particularly in the threatened zone. As a result of these Air Force operations, intelligence was brought to headquarters to the effect that there were no enemy concentrations worthy of serious attention on the right bank of the Volga, especially in the zone of the Tyurlema - Sviyazhsk stations and in the area to the south of this zone; and this suggested the thought that while preparing to fall back, the enemy was striking short blows, in order to facilitate his withdrawal along the Volga. During these days, reconnaissance was accompanied by bombing and sometimes by strafing.

On 4 - 6 September pilots informed the command of a large concentration of steamships and barges at Nizhniy Uslon and 10 to 15 km south of it. On 8 September the Air Force was assigned a mission of an operational nature - reconnaissance along the Volga up to the mouth of the Kama, and upstream along the Kama as far as Laishev. In the course of the three days as many as 17 steamships and 40 barges were spotted daily with retreating enemy troops.

On 10 September the Red Army liberated Kazan' from the White Guards. On that same day the pilots were assigned the mission of carrying out observation of the dirt roads to the south of Kazan'. On these roads our air reconnaissance craft spotted large columns of enemy rearguard infantry and cavalry units. An Air Force group delivered a bombing strike against these columns, dropping more than 11 poods of bombs and strafing the enemy with machinegun fire.

As early as January 1918, V.I. Lenin recommended that the Air Force be utilized for dropping leaflets and for liaison. In the battles at Kazan' this was actually carried out. Pilots would receive leaflets from a member of the Fifth Army RVS [Revolutionary War Council] and of the political section of the army, and would drop them in the course of reconnaissance and even of bombing.

Aircraft made frequent sorties for liaision. Thus, on 28 August, a flight was carried out to the Shikhrany railroad station and on 29 August, to the Tyurlema station to contact the commander of the Fourth Latvian Rifle Regiment; and on 5 and 8 September, to headquarters of the Second Army and the Arsk squadron. Almost all of these flights involved great risk for the pilots, since in three cases out of five the location of these headquarters was not even approximately known.

In the air, the enemy did not present any obstacles to the operations of our Air Force at Kazan'. Enemy AA artillery operated actively and one of our aircraft, for example, was shot down by its fire on 17 August.

The operations of the Soviet pilots on the Eastern Front received repeated mention in the orders of the command. In Order No. 37 of the RVS of the Republic, the following was stated: "Soldiers of the Red Air Flotilla of the Fifth Army! The entire Soviet Republic has been witness to your incomparable heroism in the historic battles at Kazan'. You have lost no time in pinning the treacherous pilots of the enemy to the ground. You terrorized White Guard Kazan from day to day. You carried on invaluable reconnaissance. You safeguarded communications between the Fifth Army and the Arsk squadron of the Second. You pursued the enemy fearlessly, introducing confusion and terror into his ranks. Honor and glory to you, valiant Red heroes of the Air Fleet!"

In connection with the liberation of Kazan', V.I. Lenin sent a greeting to the soldiers of the Red Army on 11 September, in which he stated:

"I salute with enthusiasm the brilliant victory of the Red Armies.

"May it serve as a pledge that the union of workers and revolutionary peasants will smash the bourgeoisie conclusively, break every resistance by the exploiters, and ensure the victory of worldwide socialism." [2]

Two days after the liberation of Kazan', the Whites were dislodged from Simbirsk. The soldiers of the First Army sent a telegram to V.I. Lenin:

"Dear Vladimir Il'ich! The capture of your native city is the answer to one of your wounds, and Samara will be the answer to the second!" [3]

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2. V.I. Lenin. War Correspondence (1917-1920). p. 72.
3. Ibid.

The enemy exerted every effort to hold his ground on the Volga, but under the onslaught of the troops of the Fourth, First, and Fifth Armies, he was compelled to fall back towards the east. On 4 October, Syzran' was liberated, and on 7 October, Samara. The troops of the Eastern Front relentlessly pursued the enemy, who was falling back towards the Urals. At the beginning of November, after crushing the anti-Soviet uprising in the Izhevsk-Votkinsk region, the Second Army went over to the offensive, and then the left-flank Third Army of the Eastern Front did so also.

The Fall offensive of the Eastern Front proceeded under weather conditions which were extremely difficult for the Air Force (incidentally, by this time, the Air Force already numbered more than 20 squadrons). The Red pilots carried on aerial reconnaissance, including photographing. Information received in good time by headquarters with regard to the enemy's destruction of railroad bridges made it possible to move up repair crews and to plan work for the restoration of the destroyed bridges at Melekes and of the Pogruzochnaya and Sergeyevsk railroad stations.

Reconnaissance was conducted over relatively great distances. Thus, the length of the reconnaissance trip of 24 October in the Melekes sector was more than 360 km, with 2 hours and 33 minutes of flying time.

Also of great interest was the search by the pilots for new methods of fighting the enemy in the air.

On the Eastern Front, for the first time in the world, captive balloons were employed in collaboration with river flotillas.

In November 1918 the forces of the eastern counterrevolution in the Yekaterinburg (the city of Sverdlovsk) region, formed a group containing approximately 45 thousand men and 100 artillery pieces for the advance on Perm'.

Holding out against the enemy here was our Third Army, the units of which were extended along a 400 km front and weakened by incessant combat. Altogether in the Third Army there were about 35 thousand men and 115 artillery pieces, 5 air squadrons and 1 balloon squadron. The troops of the Third Army were not able to contain the onslaught of the superior forces of the enemy and in December 1918, they fell back 300 km. Perm' was captured by the Whites. But in all the remaining sectors of the Eastern Front the initiative was in the hands of Soviet troops. Through the efforts of the Ce... l Party Committee and of the local Party organizations and through the heroism of the troops of the Eastern Front, the enemy's advance was brought to a stop right in the Perm' sector.

Aviation of the Third Army carried on active operations in these defensive battles under difficult weather conditions.

From August through December 1918 the Air Force of the Eastern Front carried out a total of 328 combat sorties with a duration of 787 hours, of which almost 300 fell to the share of the Third Army, and 210 hours to the share of the Fifth Army. One hundred and thirty-nine poods of bombs and more than 9 poods of leaflets were dropped. Our troops achieved important successes on the Eastern Front, liberating Ufa, Orenburg, and Ural'sk.

The Soviet command worked out a plan for further liberation of the Urals. However, by the Spring of 1919 the correlation and grouping of forces had turned out unfavorably for our troops. Kolchak had concentrated large forces before out left wing and center, planning one thrust in the direction of Vyatka and Vologda, and another

towards Ufa and Samara. In the beginning he had a total of 30 aircraft at his disposal. Subsequently, in connection with the influx of aviation equipment from England, France, Japan, and the USA, the number of aircraft grew to 70 (19 Air Force squadrons). Among the squadrons, one was British (of mixed complement), and two were White Czech; in addition, a Japanese squadron was located in the rear. At the beginning of March, his armies went over to the offensive.

In spite of stubborn heavy battles, the troops of the Fifth Army were compelled to fall back to the west. On 14 March the Whites occupied Ufa and began to advance on Bugul'ma, Belebey, and Sterlitamak. As a result of this advance, the forces of the Eastern Front were separated. The advance of the Kolchak armies towards the Volga created a very grave threat for the Soviet Republic. The "Theses of the TsK [Central Committee] of the RKP(b) [Russian Communist Party (Bolshevik)] in connection with the situation on the Eastern Front" were published 12 April 1919. In response to the appeal by the Party, many thousands of Communists and Komsomol members, tens of thousands of the best sons of the working class, poured into the ranks of the soldiers of the Red Army. Considerable reinforcements were moved to the East.

M. V. Frunze, the Commander of the Southern Group of the Eastern Front, worked out a plan for a counteroffensive. Through skillful regroupings, he succeeded in concentrating a powerful assault group in the region of Buzuluk. Important tasks were also assigned to the Northern Group of the Eastern Front.

The counteroffensive of the troops of the Eastern Front began on 29 April 1919. The thrusts of the Soviet troops were a total surprise for the command of the Kolchak armies, which had assumed that the Soviet troops had already been smashed and were incapable of serious resistance. During the course of the counteroffensive, the troops of the Eastern Front accomplished three successful operations: those of Buguruslan, Belebey, and Ufa.

The Air Force of the Eastern Front also took part in these operations.

By the beginning of the counteroffensive, the Eastern Front had 18 air squadrons, with 5-6 aircraft and pilots in each. But inasmuch as there was insufficient fuel, and equipment was badly worn, some squadrons did not carry out any combat operations.

Despite its extremely limited forces and resources, the Air Force of the Eastern Front managed to provide substantial help and support for the ground troops. The combat operations of the Air Force reached maximum intensity during the time of the Ufa operation.

Pushing forward irresistibly, the troops of the Turkestan and Fifth Armies routed powerful enemy groupings and hurled them back to the eastern bank of the Belaya River. Individual detachments of the Red Army crossed the river and established a beachhead there. Our Air Force carried on reconnaissance at this time and spotted a grouping of enemy forces in the zone of the army and the ford over the Belaya River.

The Kolchak forces tried at all costs to hurl our units into the river and to hold on to Ufa.

Red pilots rushed to help the ground troops. On 8 June, when the fighting for the beachhead had reached its greatest intensity, the pilots of the 11th, 30th, and 39th Squadrons, upon orders from M. V. Frunze, carried out a mass raid upon the enemy troop concentrations and artillery positions. Eleven aircraft took part in the raid. Through bombing strikes and machinegun fire they succeeded in crushing the enemy artillery and in introducing confusion into the ranks of his infantry. On this day, individual Soviet pilots carried out several combat sorties each.

In view of the extremely limited aviation facilities available at that time to our command, the Air Force carried out diverse combat assignments. During the period of the Ufa operation, our Air Force carried out, even though on a limited scale, the most varied combat assignments: reconnaissance, bombing, air cover for troops, escorting, ground attacks, pursuit of the retreating enemy, and liaison.

It is characteristic that the Ufa operation brought to light M. V. Frunze's aspiration to concentrate and utilize our Air Force resources in a decisive sector. In one of the telegrams that he sent to the Commander of the Eastern Front, M. V. Frunze announced that he had concentrated all the best troops of the Air Force at the Chishma railroad station to take part in a decisive battle for the seizure of Ufa.

The pilots of the Eastern Front justified the hopes that had been put in them. For purposes of reconnaissance and strikes against the enemy troops who were operating in the Ufa region, more than 50 combat sorties were carried out - more than in the entire area of the front for the first three months of 1919.

In a special report M. V. Frunze announced as follows: "During the Ufa operation, I personally assigned missions to the Air Force squadrons of the Southern Group which were concentrated at this point. In spite of difficult technical conditions, the pilots carried out all the missions assigned them, with an insignificant exception, and the Air Force contributed its important share in the above-indicated operation."[4]

The intense combat operations of the Red military pilots during the period of the Ufa operation were rated highly: pilots I. Savin and A. Tomashevskiy, and three aerial observers were awarded the Order of the Red Banner.

At the time that the center and the left wing of the Eastern Front were preparing and carrying on the counteroffensive against the main forces of Kolchak, on the right wing of the front the troops of the Fourth Army and local worker detachments were beating back fierce attacks by the White Cossacks. All the efforts of the Soviet troops were aimed at holding onto the main points: Ural'sk and Orenburg. Workers took active part in the heroic defense of these cities. The defense of Orenburg and Ural'sk was conducted in an extremely complicated situation. Orenburg had been invested on three sides by the White Cossacks. From the end of April to 11 July, the heroic defenders of Ural'sk fought while completely encircled.

Under such conditions, the 25th Squadron, upon assignment by the head of the Orenburg defense group, carried on aerial reconnaissance, dropped propaganda literature, and maintained liaision among the units of the group which were operating over a broad front. The tasks of communication with beseiged Ural'sk and the conducting of reconnaissance were basically carried out by the 26th Squadron. In old aircraft, carrying various kind of fuel mixtures instead of gasoline, the pilots made regular reconnaissance sorties, and supplied Ural'sk with combat documents, codes, medicines, and parts for radio stations.

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4. TsGAKA [Central Government Archives of the Red Army], stock 106, inventory 3, file 825, sheet 6.

While flying hundreds of kilometers over territory controlled by the White Cossacks, the Soviet pilots repeatedly made forced landings in the enemy's rear and, after making the necessary repairs, continued their flight.

The combat operations of the Air Force in the Ural'sk region have been quite vividly described in Order No. 224 of the Revolutionary War Council of the Republic, dated 10 September, 1919, in which it is stated that A. M. Labrents, chief of the 26th Squadron, was being awarded the Order of the Red Banner "for having contributed to the success of our troops in battles at Ural'sk, while taking part in the general attack of the Ural'sk garrison, by his flights which were unprecedented for bravery and courage, flights during which he would descend as low as six meters. By his flights between Ural'sk and Altata, Comrade Labrents maintained closest liaison between the isolated garrison of the city of Ural'sk and the army troops. He operated at all times under heavy machinegun fire from the enemy, he inspired the garrison with his flying, and he rendered great assistance to our troops".

The period when the counterattack by the troops of the Eastern Front was being prepared and carried out and when the heroic defense of Orenburg and Ural'sk was going on was the most intense for the Air Force in the East.

In the second half of 1919, the Southern Front became the main front of the Soviet Republic. Part of the forces had to be shifted from the Eastern Front to the south and to the Petrograd area. However, the task of liberating the Urals and Siberia remained, as before, one of the most important. Taking advantage of the success achieved in the counterattack, the armies of the Eastern Front opened a general offensive, as a result of which the city of Zlatoust and then the city of Yekaterinburg (Sverdlovsk) were liberated. Pushing forward rapidly, the armies of the Eastern Front emerged at the line of the Tobol River in the middle of August.

The combat activities of the Air Force in the operations for the liberation of the Urals and Western Siberia took the form only of reconnaissance and liaison flights. The Air Force squadrons of the Fifth Army, which played a leading role in these operations, carried out, for the period from 1 July through 1 October, 20 sorties in all, with a total flying time of 28 hours 30 minutes. The Eastern Front operated at that time with only four Air Force squadrons in its complement.

The subsequent offensive of our troops was renewed in October 1919 and continued uninterruptedly, with the active participation of our Air Force, until the complete rout of Kolchak's armies.

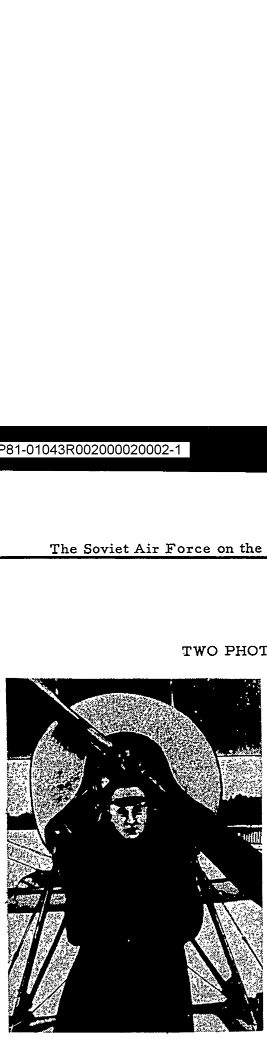
In the fight against Kolchak, the Red Army acquired a wealth of experience in conducting defense, counterattacks, general strategic advances, and unremitting pursuit of the enemy. Important also were the lessons in combat application of aviation. Among these we may include: the experience of organizational structure of regular Air Force units, defining the role of utilization of Air Force troops and resources, applying the principle of concentrating the Air Force in decisive combat sectors, organizing close collaboration between the Air Force and ground troops, effective assistance by the Air Force for the ground troops directly on the battlefield, expansion of the potentialities of the Air Force in a fluid war during execution of the most diverse combat assignments, and utilization of the Air Force as a means for propaganda among the troops of the enemy, which was of tremendous importance under the conditions of the Civil War.

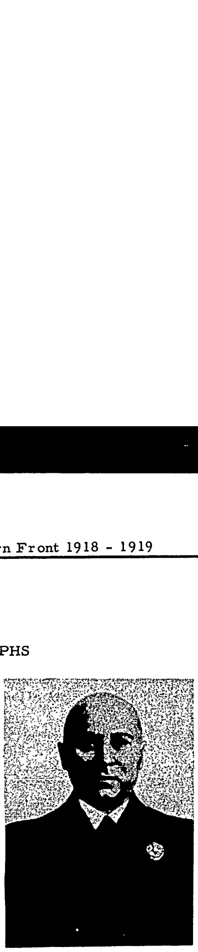
BIBLIOGRAPHY

1. V. I. Lenin, War Correspondence (1917-1920) [in Russian], Voyenizdat, 1956

2. TsGAKA [Central Government Archives of the Red Army - in Russian]

TWO PHOTOGRAPHS





Between them there are almost 40 years! In the Fall of 1917, pilot B. N. Kudrin cast off the epaulettes of the Tsarist Army and from the very first days of the formation of the Red Army became a military pilot of the Soviet Air Fleet. This [first] photograph was taken at the beginning of 1918, when Boris Nikolayevich was serving as a pilot of the 4th Combat Fighter Group for the defense of Moscow. He soon became commander of the 14th Separate Fighter Air Force Squadron, and in August he was appointed head of the Fighter Section and senior instructor for advanced flying at the Moscow Air Force School.

At this time begins also his combat flying on the Civil War fronts. He takes part in the crushing of the SR [Social Revolutionary] rising in Yaroslavl'; as a member of the Air Force Special Assignment Squadron, he carries out combat missions in fighting against the cavalry of Mamontov and Shkuro, and then participates in battles against the White Poles, Wrangel', and the White Georgians. Repeatedly B. N. Kudrin displayed heroism and courage in fighting against the enemies of the Socialist Fatherland.

In the citation awarding B. N. Kudrin the Order of the Red Banner, the observation is made that during the period of the Red Army offensive in the Caucausus (1921), he, "disregarding both the difficult weather conditions and the extreme decrepitude of his aircraft, and contemptuous of the mortal danger to his life, honorably and irreproachably carried out daring flights for the purpose of reconnaissance and bombing". At this same time, Comrade Kudrin, together with V. L. Mel' nikov carries out a difficult flight through mountain ranges, and delivers, as requested by S. Ordzhonikidze, gold for the purchase of provisions for several units of the Red Army, which were in a difficult position. The pilots also brought them the encouraging news that the Soviet troops were advancing towards them. The presidium of the TsIK [Central Executive Committee] of Armenia described this flight as "an exceptional exploit before the workers of the USSR".

B. N. Kudrin served more than 18 years in the Soviet Army, holding command positions after the Civil War: divisional commander, and assistant director of the Serpuxovskiy Advanced School for Air Gunnery and Bombing. In the course of his work, B. N. Kudrin studied persistently. He completed the Higher Academic Courses (VAK), studied at Khar'kov Aviation Institute, and mastered the English language.

For a long time Boris Nikolayevich had been attracted by test-flying work. And in 1932 he is entrusted with the testing of the first Fatherland aircraft with retractable landing gear (KhAI-1), which indeed he carries out successfully. In 1936 he is demobilized from the army and devotes himself completely to test-flying work. He flew chiefly in test models of new aircraft, and was a pioneer in the testing of the first Soviet jet aircraft.

B. N. Kudrin has dedicated thirty years of his life to flying. During these years he has accumulated more than 9000 hours of flying on a hundred different types of aircraft. He began his flying on Farman aircraft with a 50 hp Gnome motor and crowned his glorious flying career with flights on jet fighters and multiengine aircraft.

Boris Nikolayevich is now on an individual pension. He is conducting important social work, writing his memoirs, and teaching English.

BUREAU OF COMMISSARS FOR AVIATION

The activity of the Communist Party in preparing an armed uprising was indissolubly connected with the struggle to win over broad strata of soldiers and sailors to the side of the proletariat. Special military organizations of the Party were created for this purpose. On 20 March 1917 the Petrograd committee approved a plan for work among the troops and selected a military commission which later became known as The Military Organization of the PK RSDRP (b) [Party Committee of the Russian Social-Democratic Workers' Party (Bolshevik)]. In April it was changed to the Military Organization attached to the TsK [Central Committee] and the PK RSDRP(b). At this same time, military organizations of the Party rose up in other cities both in the rear as well as on the front. Under the leadership of the Party they carried out important work among the troops. Soldiers and sailors rallied round the Communist Party which was confidently leading the proletariat and the working peasantry towards the victory of the Socialist Revolution.

At that time soldier committees began to crop up in the Air Force units as well as in other units. With their organization, the unification of the entire soldiering masses was taking place: of the soldier-pilots, engine mechanics, and other specialists.

Many aviators with weapons in hand took active part in the armed October uprising in Petrograd. Two or three days later, the Petrograd Air Force units went over

to the side of the Soviet Government. Liaison with the Air Force units was established by field headquarters of the War Revolutionary Committee at Smol'nyy.

On 28 October 1917 the Bureau of Commissars for Aviation and Balloons was organized, consisting of 8 men. A. V. Mozhayev was elected chairman of the Bureau. On the same day, the Bureau held a meeting and the following decisions were made:

1. To subordinate the UVVF [Administration of the Air Force Fleet] to Smol'nyy, and to petition the War Revolutionary Committee to this effect after appointing commissars to the above-mentioned administration for this purpose.
2. To reelect the commanders and soldier committees in all the Air Force units, if the latter do not prove to be on the side of the Soviet Government.
3. To announce to all the Aviation-Balloon units on the fronts, through the War Revolutionary Committee of the Soviet of Worker and Soldier Deputies that they had joined the Soviet Government (Smol'nyy).
4. To set about forming Red Guard Aviation and Balloon Units out of reliable comrades and men devoted to the cause of the Revolution, who would without fail be able to take part, in case of necessity, on the civilian fronts.
5. To set up a small office staff at Smol'nyy with a room assigned to it (in Smol'nyy, Room No. 73 was assigned for the Bureau of Commissars for Aviation and Balloons).
6. To raise, at a general meeting of all the Aviation-Balloon units of the Petrograd garrison, the question of going over completely to the side of the Soviet Government, through a resolution and the signing of the minutes by all the comrades present at the meeting.
7. To disarm and disband Air Force units maintaining neutrality, if they do not reject it (the Sheremet'yevskiy Volunteer Air Force, located beyond the Narva gate in Petrograd was maintaining neutrality).
8. To charge the Bureau of Commissars with the task of forming new Air Force units, utilizing for that purpose the personnel of the Bureau of Commissars.
9. To propose to the Air Force Soviet that it define its political line. In the event of disagreement in defining quickly the political lines of the Air Force Soviet, to dissolve the Soviet; if the Soviet refuses to be dissolved, to arrest it.
10. To establish liaison with Marine Aviation and with the Administration of Naval Aviation.

These measures were approved by the War Revolutionary Committee. On 29 October the Bureau set about putting them into effect.

The Bureau of Commissars was the first revolutionary organ for the establishment of the Soviet Air Force. It formed Socialist Air Force squadrons capable of carrying out the missions of the Soviet Government. For the two months of its existence it formed the first 6 Soviet Air Force Squadrons (12 Aircraft in each). Included among them were: the 1st Socialist (Reconnaissance) Air Force Squadron and the 2nd, formed out of the 12th Army Air Force Squadron, the personnel of which was one of the first, after their return from the Northern Front, to go over to the side of the Soviet Government (December 1917); the 3rd Socialist Squadron, formed out of the former Kronstadt Air Force Squadron; the 4th Socialist Squadron, formed out of the Petrograd Air Force Squadron located in Tsarskoe Selo; the 5th Socialist Squadron, formed in Petrograd; and the 2nd Revolutionary Squadron of the War Revolutionary Committee of the Northern Front, formed in Pskov.

These Socialist Squadrons and also the new Air Force squadrons which were formed, took active part in the defense of Petrograd, in battles against counterrevolutionary troops in Finland, the Baltic Provinces, and subsequently in the Ukraine against the German invaders and Ukrainian nationalists.

READERS SUGGEST

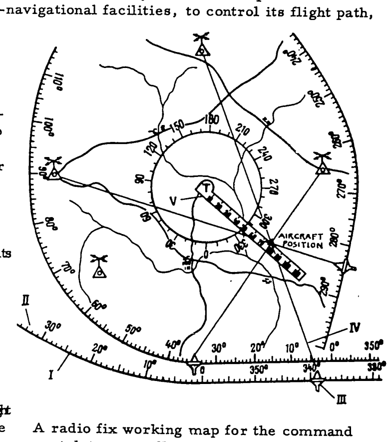
A RADIO FIX WORKING MAP FOR THE DUTY GROUND CONTROLLER

Officer V. G. Yermakov, suggests using a radio fix working map for the ground controller (dispatcher on duty at the command post. Such a map will enable the ground controller to determine quickly and accurately an aircraft's position on the basis of data supplied by the radio-navigational facilities, to control its flight path, and, whenever necessary, to compute the aircraft's coordinates in order to vector it to a target or guide it to a landing field.

A map of the flight area with the necessary radio fixes (RNT[radio-navigational points]) is glued to a plywood board, and the landing field is indicated in its center. For greater determining accuracy, it is advantageous to use a 1:50,000 or 1:1,000,000 scale map.

Then (see figure) 2 mm-in-diameter holes are made at the points used as RNT. On the sides of the map opposite each RNT there are fastened curves (I) made of aluminum or bronze strips. These curves are firmly fastened edgewise to the map with special tabs.

The length of each curve is so chosen as to include the whole flight region in its span. The height of the curves (i. e., the width of the strip) varies: the lowest being 5 mm, and each of the others being 2-3 mm higher than the preceding.



A radio fix working map for the command post duty controller.

When several curves are arranged in one and the same map area, the lowest curve should be placed toward the center of the map, and the highest towards the outside.

On the inner side of each curve a scale (II) is calibrated giving the values of the magnetic bearings of the radio fix (MPR), a "breaker" for the RNT for which the curve is set up. All the MPR scales for the RNT are given different colors.

On the edge of each curve a freely-moving slider (III) is placed. A thin cord (IV), the same color as its scale, is attached to the pointer of the slider. The other end of the cord is slipped through the opening of its own RNT and attached on the back side of the plywood board to a spring which is necessary to keep the cord continuously taut.

At the point on the map designating the landing (or takeoff) field, a revolving ruler (V), calibrated to the required scale, is attached. Around the point designating the airfield, at a 50 km radius, a scale is plotted giving the values of the MPU [magnetic course angle] of approach to the field.

To determine the position of the aircraft on the map, the sliders are set at the "breaker" MPR value of only those RNT from which these values have been obtained. If the MPR data from two or more RNT have been obtained and set, then the intersection of the cords will indicate the position of the aircraft.

In order to determine the polar coordinates of the aircraft's position relative to the landing field, the working edge of the ruler is lined up with the determined position of the aircraft and the MPU is read off, as well as the distance for the aircraft's approach to the landing field. These values are transmitted to the aircraft.

Determining the aircraft's position with the help of the map described above using the data of two or three RNT takes very little time. This fact is particularly important when the aircraft is flying at high speeds.

When using this map, it is best to determine the aircraft's position by the data from the automatic ground direction finders. But it would be desirable for the KP [command post] controller to have a radio receiver and to monitor the MPR values transmitted to the aircraft. This will improve accuracy and further cut down on the time necessary for calculations. If, on the other hand, the data of the homing radio stations are used for this purpose, the pilot must transmit the MK [magnetic compass] and KUR [radio station angle of approach] values to the KP controller.

Similar devices may be employed on maps at direction finding bases and on plotting boards at ground control and guidance stations.

THE EFFICIENT USE OF ELECTRODES

In arc welding, 10-15% of the length of the electrode is not utilized but represents an accepted loss as a "stub". This is due to the design of the electrode holders in use at present.

We can judge how important it is to achieve the full utilization of the electrode in maintenance of aviation equipment from the following fact: the electrodes used for welding of aircraft engine parts are made of alloy, or high alloy, steel and alloys which cost up to 100-150 rubles per kilogram.

Officers M. I. Skripov and V. A. Gorokhev have used a new efficient method of mounting the electrodes. In essence it involves the following (see fig.).

The electrodes (2) are fully covered by a coating, cleaned on both ends with a grind stone and mounted in a cylindrical holder (3), with a carbon or electrode graphite base (4). The holder is mounted on the welder table (5) or on the part to be welded which is connected to one of the terminals of the welding generator or transformer (see fig.). The other terminal is connected to a special electrode holder (1), which

consists of an insulated handle with a 10-12 mm diameter rod welded to it; the tip of the rod is ground to a cone.

To fasten the electrode it is sufficient to touch lightly the upper end of the electrode with the rod of the electrode holder. This causes a welding arc at the point of contact and insures a firm mounting of the electrode.

Welding of the Electrode

The feasibility of such mounting was checked on a steel electrode of 5 mm diameter with OMM-5 coating, also on wire electrodes of the type Ya-1T (1X18N9T) and EI-435 of diameter 1.6 and 3 mm with coating VI 12-6, on electrodes of copper and aluminum bronze of 4-6 mm diameter with special coating, and also on bare aluminum wire of 5 mm diameter. In all cases the mounting of the electrode was fully dependable and insured a 100 % use of the electrode. No significant heating, burning and slag formation on the rod of the electrode holder were observed in welding (currents of 150-200 amp).

Such method of electrode mounting can be successfully used by all maintenance units which make their own electrodes.

A NAVIGATOR'S TAKEOFF TRAINING CONSOLE

It is impossible to review with the students at takeoff the material covered in any course, including the course in navigation, without a minimum number of training aids.

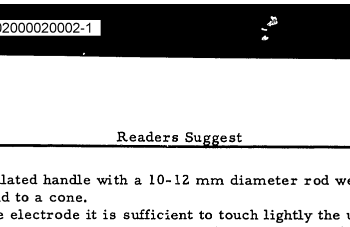


Fig. 1. Navigator takeoff console (overall view in operating position).

Officer S. L. Gavrikov proposes the development of a special version of the pilot trainer for takeoff procedures:"navigator's takeoff console".

The outside view of the console in operating position is shown in Fig. 1. The use of the console makes it possible to simulate flights, to study the sequence of carrying out flight procedures, to teach exemplary flight documentation, to find and elaborate reference data on practical problems of air navigation, and finally to conduct training in solving many particular problems of aircraft navigation by the method of approximate calculations.

The training aid is a flat box measuring 655 x 520 x 150 mm with compartments which can be locked.

The navigator's takeoff training console has three compartments: an accessory compartment located in the back left side; a working instrument panel with a mechanism for setting up radio navigation problems; and a compartment with various forms of flight documentation.

The accessory compartment contains the components included in the trainer: a combination takeoff blackboard, with the reverse side bearing the form of the flight computation table; a plotting board with duplicates of deviation graphs of all aircraft in operation on the airfield; a set of navigation equipment; a poster with the table of radii and the time for an aircraft making a 360 degree turn and several photographs of that table; a set of takeoff diagrams and posters from the current course in navigation; a mock-up of the mechanical radio bearing computer (see Fig. 1, left edge of the console).

The mock-up of the mechanical radio bearing computer is an enlarged lap computer for determining the values of radio bearings (MPR [magnetic bearing of the radio fix], MPS [magnetic bearing of the aircraft]), according to the magnetic course of the aircraft (MK) and the course angle of the radio station (KUR). It is used by the instructor during navigation training at takeoff for summing angular values, for rapid calculation of the magnetic bearing of the radio fix(on the basis of the given values of MK and KUR) and the predetermined KUR (according to MK and MPR).

The design of the mock-up is simple. The outer scale on the mock-up (the scale of the MPR or MPS, which is the same for the courses) is stationary and calibrated on the circumference from 0 degrees to 360 degrees (in 10^o steps). The inner scale (KUR scale) is rotated manually; it looks like the scale of the ARK-5 indicator with a triangular pointer on the zero mark.

After lining up the triangular pointer of the rotary scale on the mock-up with the MK value on the outer scale, the desired value of MPR can be read on it against the corresponding value of the KUR (on the inner scale) and conversely, the predetermined KUR is found against a given MPR value.

The accessory compartment always contains necessary reference literature, synoptic lecture notes on navigation, several copies of flight maps for simulating flights and training the navigator's power of visual estimation under airfield conditions, spare forms for log books, and writing paper.

The fundamental design and operation of the various assemblies of the navigation trainer are as follows. The scales of the main navigation instruments reproduced on photographic paper are glued to the face wall of the first compartment which is made of plywood. Their edges are framed with wooden rings and there is a hole in the center into which the instrument pointer pivots are inserted. Wooden pulleys of equal radii are fitted snugly on each pivot on the inside of the front wall. In two-

pointer instruments one pulley is fastened to a tubular pivot, the other to the projecting end of the central pivot. Each pulley is in turn connected, by means of a cord-belt, to other pulleys rigidly fixed to the knob pivot which rotates the instrument pointers.

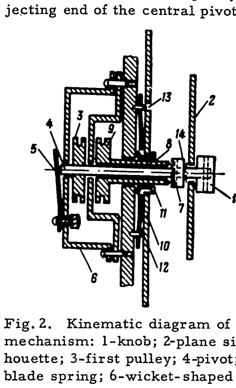


Fig. 2. Kinematic diagram of the mechanism: 1-knob; 2-plane silhouette; 3-first pulley; 4-pivot; 5-blade spring; 6-wicket-shaped support; 7-notched metal wheel; 8-tubular pivot; 9-second pulley; 10-radio bearing scale; 11-tubular sleeve; 12-mounting board; 13-access hole; 14-spiral spring.

A mechanism is mounted under the instruments, designed to train the students in setting up radio navigation problems and to show the simultaneous behavior of the indicator pointers of ARK-5 [automatic radio compass] and DGMK-3 [long-range gyromagnetic compass] during aircraft turns. The kinematic design of the mechanism is shown in Fig. 2.

With this type of mechanism design, at the moment knob (1) is rotated, the indicator pointer of the DGMK-3 "little plane" and of the ARK-5 are rotated through the same angle but in opposite directions. In the free position, spring (5) presses on pivot (4) and disengages the notched wheel (7) from the pivot (8). In this case the indicator pointer of the DGMK-3 "little plane" and of the ARK-5 may be rotated manually by their own knob control independently of each other. The silhouette of the plane(2) mounted on pivot (4) turns to any angle with respect to the mechanism when required and is held in that position by friction caused by knob (1), the notched wheel (7), and a spacer made of a loose spiral spring (14).

A disk with a radio bearing dial (10) is mounted on the pivot (8) (without any kinematic coupling to it) below the plane silhouette. A facsimile of the DGMK-3 dial is used for this scale. An arrow is riveted to the disk along the dividing line 0 degrees and 180 degrees to represent the position of the meridian of the aircraft location. The disk (with the scale and the arrow) is fastened with a hinge to the mounting board (12) by a tubular sleeve (11), flared at the ends, and the mounting board is fastened with wood screws to the plywood wall of the instrument panel through the access hole (13).

On the left front side of the console, beyond the instrument panel, is represented a landscape with the location of the homing station (PRS) visible ahead (to the left). The direction pointer to the PRS is drawn along the line connecting the location of the PRS and the center of rotation of the plane silhouette.

The proposed takeoff navigation trainer is a simple but a convenient aid in conducting courses with the students at the airfield.

FROM THE EDITOR'S MAIL

"FRONT" OR "BEARING"?

Despite the fact that at present fighters are vectored to the target by ground-based radar facilities, the importance of the search during aerial combat has not diminished. In group flight the success of the search is, to a great extent, determined by correctly patterning the formation. When flying in pairs, the pattern must be such as to enable the pilots to execute freely any maneuver in the horizontal or the vertical plane, and to maintain all-around vision in the course of the entire flight. The "front" is usually considered the most convenient formation for a pair on a search mission. One of its basic advantages is the fact that it affords greater observation over the air space. At first glance, this seems true, particularly when the intervals between the aircraft are considerable. But the advocates of this type of formation fail to consider that the greatest possible interval for a pair, at which the wingman can freely maintain his position in formation and at the same time conduct the search, is only 300-400 m. Present-day speeds being what they are, it is clear that the increase of observable air space to such an extent does not essentially affect the search and aerial combat.

At the same time, the wingman's capabilities in effecting the search are thereby greatly diminished, since he has difficulty in determining the heading of the lead plane when traveling at great intervals. He must concentrate all his attention on maintaining the intended formation. Thus, at 300-400 m intervals, both pilots will actually spot the target simultaneously. Therefore, the notion of increased observability of air space when flying "front" formation is incorrect.

It is considered that flying a "front" formation in a pair permits the parrying of hostile fighters which are attacking one of the planes from the rear hemisphere. This is possible only when the pair is flying with very large intervals; actually this is not feasible even at lower speeds.

Besides, flying "front" formation is too tiring for the lead pilot, particularly at high altitudes and speeds. When the pair is vectored to a target, the lead pilot must change course, speed, and altitude quite vigorously. At times he must even use speed brakes to shorten the radius of a turn whenever any turns must be made close to the target. Obviously, under such conditions, there can be no question of search for hostile aircraft by the leader of a pair when flying "front" formation. Consequently, during a search operation, the "front" formation presents no advantages; moreover, it hinders the wingman's operations.

In our opinion, a search operation for airborne enemy planes can best be carried out by a pair flying "bearing" (interval of 50-75 m, distance 100-150 m). This type of formation permits both the leader and his wingman to execute any maneuver in either the horizontal or vertical plane. It allows both pilots to carry on a continuous search, because the lead plane is constantly within the wingman's field of vision, and the latter is able to carry on uninterrupted all-around observation.

Periodically or in the course of the leader's tight maneuvers, the wingman can freely change from one "bearing" to another, while continuing his observation of the air space. The shorter interval with which the pair is flying a "bearing" does not reduce the size of observable air space. On the contrary, the search conditions actually improve for both pilots.

The flying personnel of our unit is using this formation pattern in the course of carrying out the most diversified types of missions involving search for aerial targets. Pilots A. P. Lipatov, V. S. Sinitsyn, M. Ye. Kulikov, V. N. Gushchin, A. D. Grachev, I. K. Bityukov, and others have learned to intercept aerial targets at high altitudes and maximum speeds while flying "bearing" formation. This formation enables the pilots to make vigorous 90° and 180° turns, vertical banks up to 60°, and combat turns - all in a minimum of time.

Military Pilot Third Class,
Engineer Maj. A. M. Mikhaylov

WHAT BOMBING METHOD IS BEST?

The most important guiding principle of combat and political training has been, and remains, the task of teaching the troops that which is essential for combat and only in that manner in which it is done in actual combat. In teaching the flying personnel, Air Force commanders are striving to set up each flight and flying exercise in such a way as to continually improve the pilots' and navigators' state of combat readiness.

In effect, there are several different methods of making an approach to a target. However, some of these methods promote to a greater extent the development of essential combat qualities in the flying personnel, while other methods do so to a lesser extent. Which method should be chosen? This question has been on my mind for a long time.

Frequently it is necessary to determine the bombing data by direct reference to the target. The essence of this method lies in the fact that, when 85-90 km away from the target, the navigator spots it and sets his course for it. At ND [maximum range] = 80 km he sets the stopwatch, takes the KU [angle of approach] of the target, and at ND = 40 km he switches off the stopwatch. According to base and time, he calculates W, then by KU_1 and KU_2 he finds US [drift angle]. Having determined the computed data, the navigator feeds these into the sight and switches over to automatic. In the course of these procedures, starting from ND = 80 km, and up to the moment of switching over to automatic, the aircraft must accurately maintain the intended flight conditions, otherwise the bombs will have to be dropped on the basis of faulty data or else not dropped at all.

What is the advantage of this method? Its advantage lies in the fact that in practice bombing on the range it enables one to obtain accurate values for the automatic equipment and thus to obtain superior results in bombing operation.

But does it fulfill the demands of a combat situation? I think not. As a matter of fact, the present-day level of development in PVO [AA defense] facilities being what it is, it is most important that a bon.ber avoid as much as possible straight and level flight on a target approach. But the above indicated method obliges the crew to maintain straight and level flight for no less than 5 minutes, beginning at a point 80 km from the target.

Even in ground trainers, and not in actual flight, i.e., in a much more tranquil environment, the navigator begins to pinpoint the sighting only 10-12 km prior to bomb release, since, after switching off the stopwatch at ND=40 km, the calculation and setting in of the data take up about 40 seconds, while the plane's corrective turn to the target takes another 20 seconds.

Thus, a surprise approach to the target appears to be out of the question. Any AA or fighter evasion maneuvers will be impossible, since the intended flight conditions will have to be maintained for a distance of 50 km of flight. Besides, in the immediate target vicinity the navigator shoulders a great responsibility in determining and setting into the sight the data, which is a complex operation and requires a definite amount of time, especially at night when there is very little light. Finally, the automatic equipment has its limitations, since it is switched on approximately 30 km before the target, i.e., 15-18 km before bomb-release.

Obviously, from the point of view of operations carried on under combat conditions, it is more practicable to determine the bombing data (first of all heading and velocity of wind) at a radius of 100-120 km from the target with a course which differs from the one to the target. As a base for measuring off the distance covered, we can take, not 80-40 km, but 60-30 km; this affords sufficient accuracy. After this, the automatic equipment may be switched on and any maneuver may be executed, while in the intervals between maneuvers the data may be pinpointed. The suggested method is also advantageous since it affords a surprise approach to the target.

Military Navigator Third Class,
Senior Lt. Yu. N. Kol'tsov

REVIEW AND PUBLICATIONS

THE CORRESPONDENCE OF N. YE. ZHUKOVSKIY[1]

In studying the life and works of outstanding persons, their correspondence is of great importance. From the letters we are able to see how the process of searching out a topic developed, how the author carried out his preparatory and incidental work, what his relations were with other people, with practical matters, and, especially, with life.

For the one hundred and tenth anniversary of Professor N. Ye. Zhukovskiy's birth, the workers of the Zhukovskiy Memorial Scientific Museum have collected and published new documentary materials from the scientist's correspondence. Some of the documents and letters were already known in 1954. Speeches, papers, character sketches, and reviews by N. Ye. Zhukovskiy were included in volume seven of his Collected Works which appeared in 1950.

The new materials in "From the Unpublished Correspondence of N. Ye. Zhukovskiy" consist of 78 letters. Of these, 34 are his and 42 are letters to him. Two letters and one telegram belong to correspondence between A. N. Krylov and S. O. Makarov, and directly concern N. Ye. Zhukovskiy. There is also included in the collection a speech by V. A. Steklov on the anniversary of the death of N. Ye. Zhukovskiy.

To the first group belong the letters of Zhukovskiy to his close friend, M. A. Shchukin; these cover the years 1868-1876. This was a very interesting and instructive period in the life of Zhukovskiy, who was continually striving in the direction of scientific and theoretical as well as practical inventive activity. It was just this striving which determined that fruitful union of practical interest with a profound theoretical analysis and an exceptionally vital conception of natural phenomena.

In 1868, having finished up at Moscow University, Zhukovskiy and his friend Shchukin decided to enter the second year of the Petersburg Institute of Railway Engineers. However, Zhukovskiy's talent as a scientist proved to be the stronger. The atmosphere at the Institute of Railway Engineers was different from that at the University. For the first year, drawings had to be submitted, and there was a great deal of other graphic work. Zhukovskiy worked hard hurrying to complete these tasks and his health was impaired. Then he went on his vacation, he did not come back to the Institute of Railway Engineers. From the letters of Shchukin - who continued his studies - we see how Zhukovskiy's inclination to continue his engineering instruction was gradually waning.

The tendency to make independent analyses of new problems has always been a

1 The Professor N. Ye. Zhukovskiy Central Aerohydrodynamic Institute. "From the Unpublished Correspondence of N. Ye. Zhukovskiy" (materials for a biography). 1957 115 pp.

characteristic of great scientists. Although in Petersburg Zhukovskiy failed after submitting his examination in the course in geodesy, still, after he had returned to Moscow and rested, he set about developing an original geodetic apparatus. Next, he switched over to the teaching profession and began to prepare his master's dissertation. From his letters we are able to gain an insight into several moments of Zhukovskiy's life during this period. Characteristic, for instance, are these lines: "I have now promised myself to get down to serious business, and I have put off carrying out all sorts of ideas upon which I have been wasting lots of time. Knowledge, knowledge is needed most of all. I am convinced my machines - all kinds of them (and a regular pile of them has accumulated, of leveling, embroidery, and hosiery machines) have so far only a schematic existence, and that in order to develop them fully I must have more practical knowledge than I now have. And these machines keep turning out to be the most miserable things; yet Lord only knows what I had in mind when I conceived them."

The second group of letters embraces correspondence with prominent scientists and engineers: F. A. Bredekhin, P. N. Lebedev, A. M. Lyapunov, V. A. Steklov, I. V. Meshcherskiy, N. B. Delone, A. N. Krylov, N. A. Morozov, Ya. M. Gakkel', and others. From correspondence with foreign scientists are included letters of J. Joubert, R. Emden, E. Bendemann, L. Prantl, and a photostat of a congratulatory letter from G. Darboux on the occasion of N. Ye. Zhukovskiy's fortieth anniversary in scientific and pedagogical work.

The majority of the letters belong to the correspondence between Zhukovskiy and the mathematician V. A. Steklov. In these letters concrete problems in mathematics and mechanics are discussed. The well-known designer Ya. M. Gakkel' asks Zhukovskiy to introduce him to some capitalist Maecenas who might offer him help in building an aircraft; for, despite the fact that Gakkel's machine met the stipulations of the competition organized by the War Office, Gakkel' was not awarded a prize and no one bought his plane. In this letter there is a description of an airplane built in 1911.

The correspondence with A. N. Krylov - later the famous scientist and academician - deals with the application of Zhukovskiy's vortical theory of airscrews to marine propellers. Of especial interest is a letter of Ye. F. Votchal in which he asks Zhukovskiy to publish a summary of information made by him in 1897 entitled "On a Mathematical Theory of the Movement of Sap in Plants", a notice of which had been published in a German botanical journal. This notice is included in the present collection.

A third group of letters includes correspondence in connection with preparations for the Aeronautics Subsection of the Tenth Congress of Russian Naturalists and Physicians at Kiev in August, 1898. In this group of letters is the correspondence with the organizers of the Congress and its participants. In the letters one can see what care Zhukovskiy gave to organizing a demonstration of the achievements in aeronautics. K. Ya. Danilevskiy - the famous inventor of aerostats - made ready his balloon with paddle wings actuated by muscle power. The aeronaut M. M. Pomortsev planned a demonstration flight of free balloons. The inventor and experimenters S. S. Nezhdanovskiy and A. Ye. Garut made preparations for a demonstration of original kites. Zhukovskiy attached great importance to all this.

From the correspondence of S. O. Makarov and A. N. Krylov we learn that Zhukovskiy was occupied with theoretical experiments on the movement of ice-breakers through ice and that Nikolay Yegorovich [i. e., Zhukovskiy] intended personally to supervise the work of the ice-breaker "Yermak" and to follow the ice-breaking process.

We have to greet the publication of the collection "From the Unpublished Correspondence". There is no doubt that even more valuable materials concerning the activities of Professor N. Ye. Zhukovskiy may be found. The works of the N. Ye. Zhukovskiy Memorial Scientific Museum are published by TsAGI [Central Aerohydrodynamic Institute], and are distributed free of charge. For this we must be very grateful to the management and to the staff of TsAGI. However, free publications have a limited distribution; whereas such materials as these should be put on the open market as well.

Honored Scientist and Technologist, Professor Lt. Gen.
V. S. Pyshnov, ITS [Engineering and Technical Service]

SPANISH WIND

BORIS SMIRNOV. Spanish Wind. From the Memoirs of a Volunteer. "Novyy mir" ["New World"], Nr. 1, 1957.

More than twenty years have passed since the time that the brave people of Spain rose up in battle against Fascism in defense of their republic. This event drew the attention of all of progressive mankind. Fascism had begun to act openly against the but recently conceived revolutionary Spanish Republic. The armed detachments of Hitler and Mussolini were trying at the time to drown the achievements of the Republicans in blood.

The Soviet Union was the first to raise its voice in protest against the arbitrariness of the Fascist aggressors. The best sons of the working class, peasantry, and intelligentsia moved from all corners of the world into Spain. Soviet volunteers too made their way here, in honorable fulfillment of their international duty.

It is to this very important event in history that the Soviet volunteer, pilot Boris Aleksandrovich Smirnov has dedicated his memoirs. The appearance of a work on the activities of Soviet volunteers in Spain is a gratifying event in our literature.

In his modest memoirs, the author succeeded in clearly and convincingly bearing witness to the activities of the Soviet volunteers, their work, their bravery, and their steadfastness. Our men understood very well that they were representing, on the battlefields of Spain, the country of victorious socialism and our glorious Communist Party. Nor did B. A. Smirnov depart from this line, and it threads its way clearly throughout the memoirs from beginning to end.

The author acquaints his readers with his comrades-in-arms - pilots Minayev, Ivanov, Butor, Serov, Yakushin, Senatorov, and others. Each one of them knew that "Fascism had embarked on its first campaign... that this campaign was only a prologue, only a rehearsal for a future war". To obstruct the path of the Fascists and to frustrate the insidious scheme of the imperialists was the combat slogan of the Soviet volunteers. With these thoughts they left for Spain on a difficult and grim assignment.

Reading page after page of the memoirs, somehow, in some special way, one perceives the heroic daily life of the volunteers, of which B. A. Smirnov gives such a truthful account.

To battle against the Fascist hordes, battalions arose at that time, which were named for Tellmann, Chapayev, Edgar André, Dombrowski, Lincoln, Garibaldi, and the Paris Commune. Into the ranks of the internationalist soldiers poured Germans, Italians, Russians, Poles, Czechs, Yugoslavs, Bulgarians, Hungarians, Austrians, men of various convictions and professions - Communists, Social Democrats, non-Party men, workers, sailors, pilots, writers. Spain became a battlefield where two forces had clashed: the forces of Democracy and Socialism and the forces of international reaction headed by Fascism.

The memoirs are dedicated to the small group of Russian pilots who fought bravely in the sky over Spain. We see here Anatole Serov, a prominent pilot and innovator. He is the first to be elected a squadron commander by the internationalists. Sasha Minayev is also elected a commander. The Russian pilots enjoyed honor and respect in the Republican Army, because they were "from the Soviet Union, that's the explanation", and because "the struggle for the freedom and happiness of peoples is life's goal" for these courageous and bold men.

The author describes his comrades as ideologically convinced, resolute, and brave men. By their deeds and acts it is obvious that they did not come to Spain "to stuff their pockets but to fight for the Spanish people". It is well known that payment was introduced in the Republican Air Force for every Fascist aircraft that was knocked down. The Soviet pilots refused this. The American pilot John pursued quite a different object. He did not refuse to take money for a destroyed aircraft but he quickly disappeared from the battlefield when he ran into difficulties at the front.

The combat operations of the Soviet and Spanish pilots are depicted in detail. The reader is thrilled by descriptions of the first aerial battles, the first victories, shell holes in the machines, and by the passions and experiences of combat. It is not easy for the pilots. After all, "almost every sortie is an aerial battle ... there would always be two, three, or four Fascists for each pilot". From this the author draws the conclusion: "to wage war means not to talk about war".

In the difficult battles, the Soviet pilots found wonderful friends - the Spaniards. Through the mouth of one grey-haired colonel, the author asserts that "Russians and Spaniards are one". There was no limit to their courage, and every internationalist, every Republican, envied their bravery. The word got around the entire front at the time: "Madrid began to feel calmer when the Russian pilots appeared in the sky".

But to attain this, as B. A. Smirnov writes, cost unbelievable effort, incredible tenacity and persistence. And the author does not entertain the reader with romance alone. No, he tells about the everyday life of battle. Is this not attested to by the fact that they made one hundred and twenty sorties for one month and "one hundred and twenty times they returned victorious without having sustained a single casualty for this period"? The sky over Madrid belonged to the Republicans, thanks to the high combat morale of the Soviet pilots.

A heroic feat was the flight of a small group of Russians and Spaniards, headed by the author, from the area of Madrid to the north, covering a distance of more than 300 km at an altitude of 7000 m. It was not so simple to carry out this air leap from Madrid to Asturias through enemy territory and mountain ranges. In the fuselage of Smirnov's plane at this time was his mechanic, the Spaniard Juan.

In Asturias, too, the small handful of pilots fights bravely, overcoming tremendous difficulties. The most important of these is the small number of the Republican Air Force. "There are but few of us - very few" recalls the author, "two squadrons for all of Asturias. The enemy has several air force groups." In addition to this we must also take the work load into consideration: many men have begun to stoop as a result of many hours of sitting in the cockpit of an aircraft. There are shell holes in the machines every day. Repairs are carried on at night, as a rule, and there are not enough necessary materials, instruments, and spare parts.

These difficulties, as the author points out, do not frighten the pilots. On the contrary, every success, every victory toughens them even more, and inspires them with a feeling of deep faith in victory.

The Soviet pilots develop new tactics of aerial combat, and create new means of defense. Anatole Serov applies a vertical maneuver in aerial combat: he disperses the aircraft at the airfield, in order to cut down on the takeoff time of the group; he carries out night aerial combat. "We Russians must be able to fly better than the Fascists", says Serov to his comrades. And he does everything so that the enemy should never be able to seize the initiative from the Soviet fighters. Serov introduced air liaison (a liaison aircraft for supplying information to the accompanying aircraft). An armored back rest is installed in the cockpit of aircraft.

In "Spanish Wind" there are many good passages which reveal the love of the Spanish people for the Soviet men and the beauty of their character. The Spaniards saw how self-effacingly the volunteers who had come from the Soviet Union were fighting for the independence of Spain. It was precisely on the basis of this example that they reached the conclusion that the USSR was pursuing an honorable policy in the question of the defense of Spain's interests, that it was wholly on the side of the Spanish people and of its accomplishments achieved in the battle against the Fascist dictatorship.

Countries like America, England, and France had a different attitude towards this very important international event. By many examples the author points out the insidious role of the rulers of these countries in the Spanish question. By treacherous methods they were paving the way for Fascism in Spain and thereby helped drown the Spanish Republic in blood. At the same time the leading circles of the USA were sanctimoniously publicising their "aid" for the Republicans.

The author met up again with such "aid" by the imperialist circles of America and England during the years of the Great Patriotic War, when he was a receiving agent of aircraft bought from them for the Soviet Union. They would drag out the delivery of transports, delay the unloading, assembling, and the test-flying of aircraft. Mechanisms which had to be assembled were delivered slowly. The author saw similar facts at every step. Knowing this, the Soviet specialists themselves set about assembling and test-flying.

A curious fact is cited in the memoirs. Without waiting for an American specialist, pilot Khramov gets into a "Tomahawk" and makes ready to test-fly it. At this point an interesting conversation took place with the representative of the American firm:

"Mr. Khramov is getting ready to fly?"

"Yes."

"But, after all, the 'Tomahawk' is a difficult plane; one must study it well before taking off ..."

"Don't worry. Khramov already knows this machine".

"At any rate, I disclaim responsibility for the favorable outcome of this flight", declared the American, almost threateningly.

Khramov grinned. "Don't fret, Mr. Lewis. I think this flight won't be my last one."

And the image of Spain rose again in the memory of the author, with its raw autumn winds, and its brave fighters wrapping themselves in homemade blankets. And this was at a time when American "gifts" were lying at the warehouses - jackets decorated with nickel, "monstrously expensive and mockingly useless".

The memoirs, "Spanish Wind", will undoubtedly be of benefit to pilots, particularly to young ones. Everyone that has read the memoirs of Boris Aleksandrovich Smirnov will get much that is interesting and instructive out of them.

Col. P. P. Pigorev

120 THOUSAND KILOMETERS ON THE AIRCRAFT TU-104

1. On the First Long-Range Flight

Military Pilot First Class, Lt. Col. A. K. Starikov

Pilots, my professional colleagues, frequently ask me to tell them about the TU-104 aircraft, about our flights along the air routes of the Motherland, and about our flights to far-off foreign countries. Especially often, young aviators turn to me and the members of our crew with such questions, young aviators who have not had the opportunity to fly in heavy jet planes nor had the occasion to spend time abroad. It was precisely this that prompted me to make the attempt to systematize all my impressions and to give an account on the pages of a periodical of the special features involved in operating the jet passenger plane, TU-104, and to tell about my brief, but, I think, useful experience on prescribed itinerary flights in this aircraft.

A new plane, a new crew

This took place in the Fall of 1955. The unit commander invited me to his office to inform me of an important decision. In the commander's office, I found Aleksandr Aleksandrovich Arkhangel'skiy, the well-known Soviet designer of jet aircraft. I knew that Arkhangel'skiy was the deputy of A. N. Tupolev, I knew what machine they were working on, and I surmised approximately what the topic of discussion was about, but nevertheless I was greatly agitated. Pilots will understand my situation without any difficulty. The shift to a new craft not only changes the nature of flight work directly, but, as frequently happens, changes the life of the pilot as well. In the given instance, the question was precisely about such changes in my entire flying and non-flying life.

"I have here a report on total flying hours on jet bombers", began the unit commander, as though not wishing to inform me of his decision at once but to lead up to it gradually. "And it turns out that you have almost the largest amount of flying time."

Aleksandr Aleksandrovich was looking at me attentively and chuckling. By the expression on his face I could judge that the outcome of our conversation had long since been decided in advance and that the General would announce his decision right away. And that is what happened.

"The command intends to transfer you to the TU-104", said the General. "Do you like that plane?"

The second part of the question perplexed me. But I did not hesitate long. I answered:

"I'm not acquainted with the aircraft, but I am well acquainted with the designer who created the machine and with many people who worked on its creation."

My answer was taken to be consent. The General gave me a brief account of how matters stood and told me about the tasks which would confront me and the mem-

bers of my crew from now on. If someone were to ask me to give the essence of these tasks briefly it would be best for me to cite the statement made by A. A. Arkhangel'skiy at parting.

"You must establish the viability of the first Soviet jet passenger aircraft. This matter is an extremely important one and in a certain sense it has historical significance."

Thus began a new page in my flying life. Within a week I was acquainted with my entire new crew and was able to set about, as we frequently say, whipping it into shape. The command, in my opinion, acted very wisely in selecting men for the crew who had mastered their specialty perfectly. Already at that time any one of the members of the crew could have been called an expert in his field. Lt. Col. Nikolay Yakovlevich Yakovlev, for example, was assigned to me as co-pilot. Him, too, I had formerly known well. He had flown on the most recent jet planes, had distinguished himself for his high personal discipline, and had a reputation as an outstanding military pilot. We were both glad that we had ended up in the same crew. From the first day, a firm friendship was established between us, which is helping us both in our work and in our lives. Col. Ivan Kirillovich Bagrich was assigned as navigator. I had also known him formerly, and had heard many flattering opinions about his being a master of flight navigation under any conditions. Bagrich was an experienced navigator, a man who had taken part in the Great Patriotic War, during which time he had carried out many responsible flights, including long-range ones under extremely adverse conditions. For bravery and skill Ivan Kirillovich had been awarded many combat decorations and medals. We were all also glad of the assignment of Nikolay Konstantinovich Belyayev as radio operator of the crew. He also enjoyed a reputation as a highly skilled expert in his field. For his excellent knowledge of radio technique, for his high speed and exactness of work with the key and finally for his ability to utilize all methods of radio traffic, many have called him an artist.

The crew of our craft is a large one. It is divided into those who fly - the flying crew, and into those who work on the ground - the ground crew. Approximately the same thing could have been said about each member of our family as I have said about the co-pilot, the navigator, and the radio operator. Each man was outstanding in high professional training. And perhaps it was precisely for that reason that the crew set about mastering the new aircraft with such diligence, as though we were all novices and were starting on a job which was totally unfamiliar to us.

Important missions in the offing

We soon knew about the important nature of the missions in store for our crew. We were frankly assigned the task of preparing for prolonged non-stop flights along international air routes. And this imposed even greater responsibility upon us, increased our energy and gave rise to the ardent aspiration to master the new aircraft perfectly. As crew commander, I not only studied the special aerodynamic features of the TU-104, the structure of the aircraft, but I interested myself in detail in foreign experience with the operation of jet passenger aircraft. And I must say that foreign experience in this regard was not very extensive. When we opened foreign aviation journals, we saw many new and very recent aircraft, we read detailed descriptions of their qualities, eulogistic reviews by various workers in the field. In particular, jet passenger planes of the "Comet" type (England), "Caravelle"

(France), and the American "Boeing" were publicized. Colored photographs of these aircraft were given, the conveniences created for the passengers were described, and praise was lavished on the speed, high altitude performance, and, as was affirmed by the correspondents, their absolute flying safety. But upon more careful acquaintance with the state of affairs, we succeeded in establishing that not one of the foreign jet passenger aircraft flew a regular course along the air routes. True, for some time, the English "Comet" had been flying on a regular route, but at the moment that the TU-104 appeared, it had left the route as the result of frequent accidents. The air transport companies rejected these aircraft, and they were transferred to the Air Force of England.

The French "Caravelle" was going through a testing stage. The periodicals were publicizing the aircraft, which was more a dream than reality. The American jet passenger aircraft were also experimental. Hence the particular responsibility which the Soviet aviators took upon themselves is understandable, since they were the first to test the viability of jet passenger aircraft.

I remember the day when for the first time we approached the TU-104 aircraft as a complete crew and for a few minutes, in solemn silence, we feasted our eyes on its "exterior". And it is magnificent. Much has been written about our aircraft in the newspapers, both Soviet and foreign. Abroad, perhaps, even more has been written, and also more praise has been expressed. And, perhaps, for this reason it is difficult for me to say anything new about the external experience of the aircraft, but nonetheless I would like to make a few observations of my own. Here it stands before us in the gleam of the autumn sun. The first impression we feel is one of joy. Joy because of our awareness of the majesty of our Motherland, because of the triumph of native technical thinking. The streamlined cigar-shaped fuselage, the sweptback wings, the entire apparatus, swift and light, gleaming with silvery-gray paint, recalls to mind the machine of the future which we have been accustomed to seeing, since childhood, in science fiction books, the machine which man has designed for conquering time and space. Stealthily I look at my comrades: their faces are shining with pride. They are proud both because of the fact that the Soviet land is the motherland of such an aircraft and because it was precisely to us that the honor has been given to fly it and to show it to people, to the entire world. And I feel that we have already fallen in love with the craft, sense with what great eagerness we will be working on it. And a military man knows well how important it is to love one's combat equipment, to be familiar with it and to take care of it.

Detailed acquaintance with the aircraft began. Our crew - and this was true of other of our comrades as well - was given the opportunity of associating with men who had participated in the designing and construction of the aircraft, and of spending time at the base where its separate components were being assembled. We listened to lectures by brigade chiefs on the manufacture of landing gear, engines, special equipment, hermetically sealed cabins, and aerodynamics. All this made it possible for us to master the construction of the aircraft in more detailed fashion, and to examine all its special features more deeply. One such special feature may be considered to be the sweptback wing, bold in its constructive design, and the strongly bent-back lines of the empennage, which contributes significantly to the development of high speeds and creates great maneuverability for the craft.

Also, the location of the engines on the aircraft was a great innovation by the designer. Even to the inexperienced man, their proximity to the fuselage is obvious. But, of course, not everyone knows the reasons for such a decision. In locating the engines as close as possible to the fuselage, the designer was concerned above all for the safety of the passengers and for the trustworthiness of his aircraft. Owing to such a location of the engines, in the event that one of them fails, the craft is able to continue the flight on the one that is in working order. During tests, the TU-104 showed its capacity not only to fly a straight course and to land with one engine functioning but also to take off in such a condition. Here we see the progress not only of the creators of the aircraft but also the outstanding achievements of our engine designers.

During the course of ground training, during the course of mastering the new aircraft, we thought highly of one more of its advantages over other aircraft: the presence of a controllable front wheel. A small innovation, it would seem, but how much it adds to the merits of the aircraft! The large aircraft becomes, in taxiing, just as easy to control as the most ordinary automobile. In moving about the airfield, the pilots do not have to exert great effort to guide the craft in the necessary direction. Fuel is conserved, and the operational efficiency of the engines is enhanced. In view of the controllable front wheel, it is not necessary to resort on every occasion to applying the brakes to the main wheels. And pilots know what harm such braking inflicts on the mechanism of the landing-gear.

It would be possible to speak a great deal and at length on the advantages of the TU-104 which became known to us during ground training. But I have allowed myself to dwell on those which were obvious to us upon first acquaintance with the craft. Subsequent training and, particularly, flights revealed other features of this aircraft, concerning which I will yet give an account.

First circling flight

Before allowing our crew into the air, the command ordered test flights. As crew commander, I felt some measure of agitation. I was agitated not so much for myself as for my men. We were very anxious to show both the commanders and our colleagues the excellent training of our crew and our ability to carry out practical missions. And I must say that our crew justified with honor the hopes of the command, of the Party organization, and of the entire team of our unit: the test flights were passed with distinction. The crew's navigator and the radio operator demonstrated particularly good training. The ground technical personnel displayed highly efficient servicing of the aircraft. The unit commander scheduled the first training flight for our crew.

And here we are in our places. The operations officer gives permission for the takeoff. I move out the aircraft. The craft takes off smoothly. The moment of lift-off approaches. The needle of the speedometer has not yet come close to the required figure, but some inner voice whispers to me: "Lift off". It seems to me all the while that the control surfaces will act sluggishly.

The large dimensions of the aircraft, its seventy-ton weight constantly suggest the though that it is impossible for the control surfaces to function at once. With an effort of will, I force myself to trust the technical specifications, the assurance of the designers, and finally, the numerous counsels of the test pilot, Yuriy Timofeyevich Alasheyev, who is sitting alongside me in place of the co-pilot; I force myself to trust them and I lift the machine from the ground only when the speedometer needle has shown the required figure. The control column took over smoothly and the aircraft at once confidently left the ground behind and rushed to gain altitude. This made me very happy. I hadn't thought at all that such a large and heavy aircraft could be obedient like a fighter. Mentally I marvelled at the wisdom of the designers, and above all, of course, of the chief designer, Andrey Nikolayevich Tupolev, who had managed to furnish the craft with such sensitive control instruments. I recalled how once in a conversation with Tupolev I had expressed perplexity because of the absence of hydraulic boosters on the TU-104. He said to me at the time: "Fly, and everything will be all right." And now it was pleasant for me to become convinced of the profound correctness of the designer's words. Incidentally, when later our crew flew to London, we had a chat with the pilot of a "Comet" aircraft. He too marvelled at the absence of hydraulic boosters on our craft, but he observed that that was very good: fewer opportunities for failure. The Englishman said bitterly: "If the hydraulic boosters fail, I've got to abandon the craft in midair".

During the takeoff, another special feature of the TU-104 became apparent. After the craft leaves the ground a great excess of engine thrust can be observed. In order not to exceed the speed limitations for the landing gear and flaps, it is necessary, after the takeoff, to cut the throttle to average turbine rpm. It is important to observe a strict standard here. One must see to it that the rpm are not cut down too drastically.

After retraction of the brake flaps and wing flaps, the craft possesses great vertical speed for gaining altitude. If we take into consideration that the TU-104 is an aircraft with high speed and high altitude performance, it will be understandable how important this quality is for it. The faster the craft gains altitude, the sooner it will take the most advantageous flight condition - hence a saving in fuel, time, and engine resources.

Our first training flight took place normally, the crew worked efficiently and harmoniously. But to me it was of incalculable benefit. In the past, while flying in aircraft resembling this type, I of course had acquired a certain amount of experience. But in the first flight on the TU-104 I succeeded in finding out its distinguishing features and in becoming convinced of the many advantages of the new craft.

Flight to Uzbekistan

At the end of 1955, a governmental delegation of the Soviet Union, headed by N. S. Khrushchev and N. A. Bulganin, was in India. The whole world was following the cordial welcome which the Indian people were extending to the leaders of our state. During those days we were assigned the mission of flying immediately to Uzbekistan. The mission was a responsible one, especially if we take into consideration the fact that our crew was taking off in a TU-104 craft for the first time on such a long trip. To this it must be added that the flight was set as a night flight.

We prepared for the flight in the most serious manner. We plotted the route with almost the entire crew present, we studied it thoroughly, we clarified the methods of navigation at every step, and arranged for mutual assistance among the members of the crew. Col. Bagrich, the navigator, studied perfectly the homing radio facilities along the route, and made supplementary inquiries about them; the radio operator, Sergeant Belyayev, a re-enlistee, filled in details on the communications diagram we had drawn up. The route was not only a long one but also, to a certain extent, a complicated one. It was comparatively simple to fly as far as the Volga,

but from the Volga on, the flight had to be carried out over sands, over a locality where there were insufficient radio facilities. We had to give some thought to utilizing auxiliary navigation methods and facilities. It's a good thing that there are such facilities on the TU-104 craft and that they are fully reliable.

The time for takeoff proved to be a poor one. It was a dark December night, and heavy storm clouds, sinking down almost to the ground, crept along the sky. At times, the snow fell in great flakes, and then visibility would become even worse However, we had firmly decided to take off exactly at the prescribed time, if, of course, permission were given to do so.

The aircraft took off at the designated time. We did not circle over the airfield, but gained altitude en route. We always try to reach the prescribed altitude as quickly as possible. We permit exceptions in instances where very old or young passengers are on board. Rapid drops in air pressure can cause unpleasant sensations in the organism. And even though the amount of unpleasantness is not great, due to the hermetically sealed cabin, still it is our task to create optimum conditions for our passengers.

The powerful turbo-jet engines function evenly and quietly. We select the most convenient condition for gaining altitude. I am assisted by pilot Lt. Col. Yakovlev. While still climbing, we shifted the turbines to nominal rpm. Even in this condition, however, enough excess thrust is created, and no more is even required in order to gain altitude.

At an altitude of 4,000 meters we turn on the autopilot. The altitude grows steadily; the craft continues to approach the prescribed altitude. Suddenly the darkness which had thickened around the craft begins to grow thinner, and we see that the stars have begun to shine in fantastic garlands. It's as though the upside-down moon has inclined its head, so to speak, and sinks into the dark abyss of the clouds. Our craft rushed farther and farther from the ground, higher and higher towards the stars.

Nodding to the co-pilot, I rose from my seat and approached the navigator. With the point of his pencil he showed me our position. Radioman Belyayev is reporting to the dispatcher of the Moscow RDS [air traffic control] that our craft has reached an altitude of 9000 meters and that we are moving at a ground speed of 800 kilometers an hour. I again took my seat at the controls. Turbulence had already begun, which indicated to us that the aircraft was entering the tropopause - a layer of air between the troposphere and the stratosphere. If one looks outside the cockpit, one can see only the stars and serenely calm and pure air. But this calm is deceptive. At such an altitude, masses of air rush by at tremendous speed, and whirlwind waves of air are tossed about furiously. The wind velocity here is, as a rule, no less than that of an engine-propeller craft. In order to penetrate the tropopause more rapidly, I turn off the autopilot and take over the controls. Before even 2-3 minutes have passed, the flying again becomes calm. We recover at the prescribed altitude.

And now the craft is in horizontal flight. Together with the co-pilot I select the most advantage flight condition, trim the craft with the trim tabs, and again turn on the autopilot. This remarkable mechanism on the TU-104 is equipped with a powerful gyroscope which reacts sensitively to the slightest deviations of the craft and, by means of little electric motors, adjusts the control surfaces. The instruments in the pilot's cockpit live their own life, as it were, and each one fulfills an important function in the complex organism of the aircraft. Here the signal lights of the automatic fuel system are burning dimly. Clever and very reliable mechanisms watch the consumption of fuel. At the necessary time, they automatically, without any human being participating, shift over the feeding of the engines from one group of tanks to another, and the light obediently reports this to the pilot.

"We're crossing the Volga" - reported the navigator, and I looked outside the craft. From the altitude of 12,000 meters at which we were flying, one could see this mighty Russian river with the naked eye. Before us lay the sands and steppes of Kazakhstan. Navigation now became significantly more complicated. The radioman was now asking the ground position-finding radio stations for bearings; these stations were located to the side of our flight course. Not relying on this method alone for determining actual position of the aircraft, we turn on the craft's radar. Soon the coast of the Aral Sea appears on the screen. The radar data confirm that the craft is proceeding along the prescribed course. This makes all the members of the crew happy and proves the ability of the navigator and the radio operator alike to make good use of all the facilities for navigation and aircraft communication.

The Aral Sea too is left behind us. Now the navigator utilizes the signals of the homing station beacons on the landing field. Dawn is breaking. The rays of the sun are more and more noticeably delineated on the southern horizon. We do not see the ground: it is concealed from our sight by a thick shroud of clouds, and where this shroud merges with the sky, a horizon is formed which is hardly different from the ordinary one on the ground. The southern edge of the sky begins to burn more and more brightly. We do not see the sun as yet, but the fiery-red fan of its rays has already risen in the path of the craft, and bright lights have begun to play iridescently in the window-panes of the craft. Landing time is approaching, the let-down begins - in the direction where the winter clouds are rolling about.

We come out on the landing course with a left turn. I compute the speeds of horizontal flight and let-down. I try to make it as exact as possible, for the slightest error in the landing computation can complicate subsequent actions - the more so since the craft is large, heavy, and has a high speed performance. And even though the TU-104 has excellent braking facilities, still the pilot will prove to be inefficient if he counts only on these emergency facilities.

The airfield comes closer and closer. The craft is already approaching the landing strip. I try to make a two-point landing. During the time that I worked on aircraft of a similar type, I became convinced that if a heavy craft is landed on two points and is not thrown onto the forward wheel of the landing gear during the first half of the landing run, it is possible to shorten the length of the run by a considerable amount through aerodynamic resistance. And if the necessity for applying the brakes arises, we can do so with a two-point landing as well.

Incidentally, a few words about the braking on this aircraft. It has its own special features. They consist above all in the fact that in case of any sharp emergency application of brakes, the tire covers on the drums will not become perforated. At the moment when the braking force reaches a critical magnitude, the brake-release apparatus takes over. True, it must be observed here, that the moment when the apparatus starts functioning is unpleasant for the passengers, for the operation of the apparatus is accompanied by a sharp jolt; but in special situations, the brake release device is very useful for the crew. However, the experienced pilot will always sense the braking limit and will not bring the braking to the critical point.

The craft makes a two-point landing, and past us drift the buildings of one of the airfields located in Uzbekistan. After taking a necessary load on board, we return to Moscow the same morning.

Our return trip passed just as favorably. With this trip the crew passed its maturity test, as it were. Greeting us at the Moscow airfield, the unit commander said:

"Now prepare for new flights, for new important assignments."

In prospect for us were long-range flights to foreign countries. But I shall give an account of these in the following article.