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TRANSLATION

HERALD OF THE AIR FLEET

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1958

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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.

Users and evaluators of this translation who note technical inaccuracies or have comments or suggestions are urged to submit them to: Commander, Air Technical Intelligence Center, Attention: AFCIN-4B, Wright-Patterson Air Force Base, Ohio.

AIR TECHNICAL INTELLIGENCE TRANSLATION

(TITLE UNCLASSIFIED)

HERALD OF THE AIR FLEET

(Vestnik Vozdushnogo Flota)

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AIR TECHNICAL INTELLIGENCE CENTER
WRIGHT-PATTERSON AIR FORCE BASE
OHIO

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FROM THE EDITOR'S MAIL

AVIATION ABROAD

PERSONAL RESPONSIBILITY FOR FULFILLING ONE'S DUTY TOWARD THE MOTHERLAND

Soviet aviators are vigilantly standing guard over the air borders of our Socialist Fatherland. Religiously following the requirements of the Communist Party and the Soviet Government, they struggle indefatigably to intensify from day to day the combat readiness of the Air Force of the USSR.

Combat training at the airfields never ceases. Pilots, navigators, and aerial radio-gunners carry out complex combat training assignments, train in target interception, in long-range flights, learn to fire and bomb accurately, and master various methods of combat operations.

Intensive work is being done by the engineers, technicians, and junior aviation specialists who service equipment, and by representatives of numerous professions. They do everything to enhance their personal skill and to create the best conditions for the fruitful training of the flying personnel.

Our aviators are advancing ever onward, to ever newer heights of professional skill, striving for continuous intensification of the combat readiness of the VVS [Air Force].

What motivates the thoughts, feelings, and acts of our men? What helps them overcome all obstacles in the way of their goal?

There is only one answer to that: the boundless love of the soldier for his Fatherland, for his beloved Party and Government, for his people, his loyalty to his oath, the strictest discipline, and a highly developed feeling of responsibility for the defense of our country.

In the inculcation of every Soviet citizen with personal responsibility for the assigned task, the great Lenin saw the key to success: "...we must strive untiringly to bring it about", he taught, "that the personal responsibility of each one for a definite job or field of work should be in fact strictly and exactly spelled out." V.I. Lenin more than once stressed the fact that this is particularly important in Army life.

The Communist Party undeviatingly follows the precepts of its wise leader and teacher by organizing and directing the indoctrination of Army personnel.

As was noted by the October Plenum of the TsK [Central Committee] of the CPSU, the Party sees, in the further improvement of party-political work among the troops, the most important condition for solving the task formulated by the Twentieth Congress of the CPSU: to maintain our defense at the level of modern technique and science, and to guarantee the security of our Socialist State.

Imbuing the armed defenders of the Soviet State with high qualities of combat morale, the Party untiringly develops in them the best of traits, noble feelings of citizen-patriots, and trains conscientious, ideologically toughened soldiers.

Awareness by each serviceman of his military duty and personal responsibility for the defense of his Fatherland — the Union of Soviet Socialist Republics — is the basis of Soviet military discipline. And discipline, as is well known, is the guarantee of all victories both in combat and in training.

Good discipline and the sense of personal responsibility have a common basis — political conscientiousness, and a common goal—the best fulfillment of one's military duty. The strength of Soviet military discipline lies in the fact that it is conscientious.

The greatest responsibility for all aspects of life and combat activity, for the combat readiness and combat fitness of the sub-unit, the unit, and the group, and for the correct formulation of the training and indoctrination of personnel is borne by the commander in sole charge. The Fatherland has granted him great power, has entrusted to him the right to issue commands in its name, and has given an order by him the force of law.

To justify this great confidence by the Party and the People, the Air Force commander in sole charge must ensure the unity of will and actions in all his subordinates. And, for this purpose, working hand in hand with the political apparatus and Party and Komsomol organizations, he must inculcate in all his soldiers, sergeants, and officers a lofty sense of responsibility for the assigned task.

Fostering a lofty sense of personal responsibility for the assigned field of work among aviators is possible above all through intensifying their ideological and theoretical toughness.

The Party teaches that the ideas of Marxism-Leninism are our most powerful spiritual weapon. Sharpening this formidable weapon in every way possible means increasing our power. The Great Patriotic War proved clearly that the ideas of Marxism-Leninism and awareness of one's personal responsibility for the fate of the Fatherland give the Soviet soldier an insuperable moral strength.

High principles, wholehearted love for the Socialist Fatherland, devotion to the Communist Party and Soviet Government, and deep faith in the victory of our just cause led thousands and thousands of our glorious heroes to immortal deeds during the years of fierce battles.

The task of the commanders, political organs, and the Party and Komsomol organizations consists in training every aviator to be the same kind of selfless patriot, ready in case of necessity to give all his strength, knowledge — and, if necessary, his life as well — for the triumph of the great concepts of Communism.

This goal must be served by all forms of political and military training: the Marxist-Leninist training of officers, political classes for soldiers and sergeants, Party education, lecture propaganda, group and individual conversations, mass cultural work, the press, etc.

It is the officer cadres that are engaged in the training and indoctrination of the personnel in the Soviet Army, Air Force, and Navy. Consequently they themselves, above all, must be toughened in the ideological respect. Therefore the commanders, political organs, and Party organizations must give unabated attention to the Marxist-Leninist training of officer personnel. The time allotted for scheduled classes in Marxist-Leninist training must be utilized efficiently; the work day of the officer must be regulated efficiently and he must be imbued with a taste for independent work

in increasing his political knowledge; control must be intensified over independent work, theoretical seminars, and conversations; and help must be given in preparing for them. Such are now the practical tasks in improving the Marxist-Leninist education of the officer cadres.

And that is precisely the way they are understood by many of our commanders, as they display concern for raising the ideological level of the officer personnel. Let us take, for example, Hero of the Soviet Union I. A. Musiyenko, one of the foremost Air Force commanders. He gives a great deal of attention to raising the level of ideological theory among his officer personnel, gives lectures on questions of military theory, checks up on the independent work of the officers, and gives them practical assistance in mastering Marxism-Leninism.

The combat and political training schedule is carried out successfully wherever the Air Force commanders of all grades — from the group commander to the crew commander — strive persistently for the strictest observance, by all servicemen, of the regulations, directions, and instructions. Every deviation from the regulation requirements, which determine the order and sequence of training and of conducting and directing flights, creates conditions for flying accidents and lowers the quality of execution of the combat training schedule.

The experience of the best units and groups of the VVS shows that Air Force commanders and political workers must combine political-indoctrination work with an attitude of the strictest exactingness and intransigeance towards all deviations from the rules of flight service and military discipline. The entire work must be aimed at the unswerving intensification of the combat readiness of the Air Force.

While emphasizing that exactingness is constantly necessary in the training and indoctrination of personnel, the Communist Party decisively condemns administration by mere injunction and points to the intolerability of such a phenomenon in the Soviet Armed Forces. The exactingness of our commanders must be indissolubly associated with a just, tactful, and attentive attitude toward their men.

The strength of our army, V. I. Lenin used to say, is in the closeness of the command personnel to the masses of Red Army men. This closeness is created by the community of interests among the soldiers and by the ability of the leader to gain a deep understanding of his mens' needs. The Soviet military commander, while preserving a high exactingness, must look after his men and see to it that their needs are satisfied. This enhances the commander's authority and gives rise, among the soldiers, sergeants and officers to a desire to do even better work and to fulfil their duty even more zealously.

Taking care of one's men does not mean creating greenhouse conditions for them, or shielding them from the difficulties of combat training life. A modern war, if it is unleashed by the imperialists, will require of the soldier complete exertion of his entire moral and physical strength. Consequently, during the course of combat training it is necessary to train the aviators to endure deprivations and to surmount difficulties with fortitude.

In actual practice that means that the commander, without allowing any indulgence and superficiality, trains the aviators to operate in a situation closely approximating that of actual combat. The training process presents limitless opportunities for daily imbuing Air Force personnel with a sense of personal responsibility for carrying out an assigned task under any conditions and in spite of any obstacles.

The carrying out of combat training schedules must ensure the training of the flying personnel in conducting bold, energetic, and decisive operations in the struggle against a powerful and experienced enemy. The commanders, political workers, and Party and Komsomol organizations must strive to bring about a situation wherein every flight perfects skill, consolidates habits necessary for combat, toughens the will and courage of the aviators and in which every Party-political measure is purposeful and enhances the high principles and discipline of the flying personnel.

The development of a soldier's initiative has a direct bearing on the inculcation of a sense of personal responsibility for the assigned task. The aviator capable of displaying initiative is the one who knows his job well and is anxious to perform it. Such a person desires to improve his work and tries to find new tactical methods, new ways of utilizing Air Force equipment, and new efficient means for training and indoctrinating his men.

It is extremely important for the senior commanders and chiefs to give support to intelligent initiative in every way possible and lend an ear to the suggestions of their men. That is precisely the way things are done in the bomber unit commanded by Lt. Col. B. V. Sutyrin. The initiative of the pilots, navigators, and aviation specialists is supported there not in words but in deeds. For example, the crew of Senior Lt. Kuritsyn initiated a method of operating an aircraft along the orbit of a radar range-finder system with the help of the autopilot, and this improved the quality of bombing. The pilot's initiative was approved by the commander, and the new method became the property of the entire flying personnel of the group. Now all the crews here utilize the autopilot in bombing with a radar range-finder system.

At the present time a great deal depends on the engineering and technical personnel, to whom belongs the decisive role in servicing aviation equipment, in mastering it, and in ensuring flight work without accidents.

Our Air Force technical outfits have every opportunity at their disposal for regularly ensuring flight work. Only one thing is required: that every engineer, technician, junior aviation specialist, and worker in the Air Force rear display greater responsibility towards the task assigned him and that he be deeply aware of the fact that by conscientiously carrying out his duties, he contributes towards intensifying the combat readiness of the Air Force.

Officer V. P. Savin can serve as an example of skillful indoctrination of personnel with a sense of responsibility for the assigned task. After receiving the order to ensure flights, officer Savin personally instructs the outfit commanders and chiefs of services, briefs them on the nature of the forthcoming flights, indicates what technical equipment facilities are necessary, checks on the readiness of the personnel and the equipment for servicing flights. At the same time he makes it possible for each participant to operate independently, and he encourages intelligent initiative. There is no fuss here, no haste, and no lack of personal responsibility. All this makes it possible to ensure the flight work of the Air Force unit efficiently and systematically. An important means for intensifying the responsibility of the aviators for the assigned task is Socialist competition, now in progress. Its keynote is striving to arrange a worthy welcome for the 40th anniversary of the Soviet Army. Socialist competition contributes to the development of initiative among the servicemen, gives rise to new forms of comradely mutual assistance, and makes the experience of the best the property of all the soldiers.

Socialist competition among the personnel is skillfully organized in the unit commanded by M. A. Sirota. The commanders of the outfits and the engineering personnel, all relying on the Party Organization, systematically review the fulfillment of pledges which were made, and give extensive publicity to the experience of the foremost men.

Disseminating the valuable experience of foremost aviators means training the personnel through specific examples of a conscientious attitude towards one's task; and we have a large number of such examples. It was already during the postwar years that officer F. D. Bogdanov and E. M. Surikov entered service in the Air Force. After finishing flight school, they served in a combat unit and then became test pilots. They were awarded the title of Hero of the Soviet Union for high skill, bravery and heroism displayed during the testing of new Air Force equipment.

An example of model fulfillment of one's military duty to the Fatherland was shown by officer A. Ye. Lugovik. Under difficult conditions, officer Lugovik saved the life of his crew members and saved a combat craft.

Our Air Force is being constantly reinforced by young pilots, navigators, and aviation specialists who did not take part in the war; and for them an acquaintance with examples of heroism, bravery, and skill in hitting the enemy is of great educational significance and contributes towards enhancing personal responsibility for the combat readiness of the element, unit, and group.

Every officer, sergeant, and soldier is trained through examples of selfless fulfillment of one's military duty. The higher the sense of personal responsibility for the assigned task is developed in the aviator, the greater will be the success he achieves, and the higher will be the combat readiness of the Air Force.

BRAVERY, ENDURANCE, SKILL

During a combat training flight over the range area, the crew commander of a jet bomber, Senior Lt. A. Ye. Lugovik suddenly felt a sharp pain. It was extremely difficult for him to operate the craft. Grave danger threatened the lives of the crew, for they could not use their parachutes, since the plane was flying at a low altitude. Everything depended on the endurance and bravery of the pilot.

Overcoming the sharp pain and bending every effort, Lugovik started to land on the nearest strip. A high sense of military duty, respect and love for his comrades in combat helped him emerge honorably from the complicated situation which had developed. He managed to land the craft outside the airfield, saved the life of his crew and saved a combat aircraft.

For the bravery, endurance, and high flying skill that he displayed in carrying out his service duty, Senior Lt. A. Ye. Lugovik, by a Decree of the Presidium of the Supreme Soviet of the USSR, was awarded the Order of the Red Star.

In the photo: Military Pilot, Senior Lt. A. Ye. Lugovik.

Engineer Maj. R. N. Molotov is one of the best aircraft specialists in Group X.

Skilfully carrying out his responsibilities as deputy to the commander in the aircraft engineering service, officer Molotov correctly organized the work and training of his subordinates. High-quality servicing of aircraft for flights and timely carrying out of the check-list and preventive inspections assure unfailing operation of aircraft equipment in the air.

At the present time R. N. Molotov is serving as the bomber group engineer.

In the photo: officer R. N. Molotov.

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THE LEADING ROLE OF COMMUNISTS IN COMBAT AND POLITICAL TRAINING

Col. P. V. FIRONOV

Lenin's instructions for raising the calling and importance of the Party member has found its embodiment in the decisions of the Twentieth Party Congress and subsequent Plenums of the Central Committee of the CPSU. They were reflected in the Statutes of the Communist Party and in the Instructions, confirmed by the Central Committee of the CPSU, to the organizations of the CPSU in the Soviet Army and the Navy.

While mastering and explaining the Instructions to the Communists, we became convinced that there has not yet been sufficient purposefulness in the work of our Party organizations in inculcating a sense of deep responsibility among Party members and member candidates for all aspects of the life and activity of their outfits.

It must be said that the approach itself has not always been correct with regard to evaluating the results of the work of one Party member or other. This applies especially to the evaluation of the activity of Communist leaders. Some comrades have formed the following opinion. If, let us assume, the commander of a flight, squadron, or company has high personal ratings in training and discipline, he deserves the right to be an otlichnik [Outstanding Man] in combat and political training.

Yet sometimes it has been possible to observe a quite contradictory picture: an outfit lags behind on many points, but its commander is considered an Outstanding Man in combat and political training. Such was the case, for example in the Party Organization where N. V. Oleynikov is secretary. Communists L. V. Afanas'yev and P. S. Vasil'yev were considered Outstanding Men here, but the elements they headed lagged behind.

The Bureau members of the same Party Organization recommended Croup Party Organizer V. N. Ivanitskiy as an exemplary Communist. When, however, he was asked to tell about the condition of indoctrination work in his unit and about the training of Outstanding Men, he was unable to name a single toprank person in Socialist competition.

As the result of a superficial approach to the evaluation of the activity of Communists, the leaders of the Party Organization decided that, with the assurance of the leading role of their Party members and candidate members, all was well with them. Actually, however, the Party Bureau was approaching the evaluation of the activity of Communists formally, without taking into consideration the

Squadron Commander, Maj. G. T. Vishnevskiy, First Class Military Pilot, has mastered perfectly the operation of a heavy aircraft under various weather conditions.

Joining Socialist competition, the squadron under his command took first place in the unit. Communist Vishnevskiy is a thoughtful commander and an excellent instructor and methodologist in all aspects of flight training.

Photo: G. T. Vishnevskiy.

requirements of the Party Statutes and of the Instructions.

Similar facts (and they were observed in other Party organizations as well) compelled us to take up the problems of indoctrinating Outstanding Men at a special seminar with the deputy commanders for political affairs and with the secretaries of the Party Bureaus.

At that same seminar, Political Worker V. S. Bochagin told us how they were striving for exemplary work by Communists. The majority of Party members and member candidates in their unit are actually genuine leaders of the masses, foremost men in training and in discipline.

Flight Commander Communist V. T. Shostak not only serves as an example himself but he also organizes daily the training and indoctrination of the pilots of his flight. Consequently, the flight has received outstanding ratings on all points and has fulfilled with honor all the socialist pledges it had made.

An example of fulfillment of Party duty is really shown by TECh [Technical Electrical Unit] Chief, Communist V. I. Surovenkov. Being a member of the Party Bureau, he managed to organize the sharing of experience among his personnel. In the outfit, colorful stands have been set up, on which the progress of Socialist competition is shown every day. Working with exertion of every effort, the TECh servicemen have fulfilled the Socialist pledges they made, and by the Fortieth Anniversary of the Great October Socialist Revolution the entire outfit had become Outstanding.

At the seminar which was conducted, the attention of the Party organization leaders and of the political division workers was called to raising the demands placed upon Party members and member candidates, and to intensifying individual work. Moreover, we made a thorough study, on the spot, of the activity of Party organizations and helped them organize an effective struggle for a leading role by Communists. Then we conducted a seminar with the secretaries of the Party organizations of the squadrons. At it there was a discussion of how it was necessary to set up Party work in conformity with the requirements of the Central Committee of the CPSU. In all the outfits in which the secretary of the unit Party Bureau is Communist N. I. Sorokin, Party meetings took place at which there were discussions of the problem of Communists' fulfilling the requirements of the Party Statutes and of the Instructions of the Central Committee of the CPSU for assuring a leading role in combat and political training. The Communists, in an effort to raise combat and political training higher, have been boldly uncovering shortcomings and making proposals.

Communist V. F. Seregin proposed to the Party Bureau that indoctrination work be intensified among the personnel of the armaments service. Communist V. S. Malyshev justifiedly reproached the Bureau members for poor recruitment of worthy soldiers and sergeants with leading specialties into the ranks of the CPSU. Communist Comrade V. G. Mashchenko was subjected to sharp criticism for having checked up inadequately on his men with the result that there were instances of failure of separate assemblies on the aircraft. At a meeting of the squadron Party Organization, the Communists criticized comrade A. V. Babin because, although he himself was a good pilot, he had reacted weakly to the lack of discipline of some of his men.

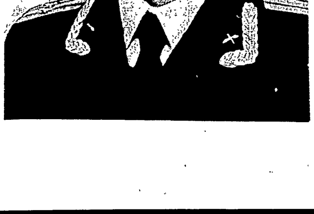
To overcome this fault, Comrade Babin was given assistance by Unit Party Bureau Member P. F. Kushnarev and Squadron Commander Communist I. A. Kochubey. Attending critiques of flying in his element as well as preliminary and preflight briefing, they would prompt him on how to approach each pilot individually and not to leave any instances of poor discipline without exerting his influence to counteract them. The advice of the comrades is helping Communist Babin become a resolute, exacting commander. Now the flight that he commands has, instead of being a backward one, become one of the foremost. The pilots are carrying out their assignments in flight training with good and outstanding ratings. At aerial gunner contests, Comrade Babin himself received the highest evaluation for firing at ground targets.

The Party Bureaus and the sec-

Lt. Col. V. A. Suvorov, First Class Military Navigator, skillfully leads heavy aircraft on long-range routes and makes accurate running attacks against assigned targets.

V. A. Suvorov is an Outstanding methodologist who has trained many bombardiers. Communist Suvorov takes active part in Party-political work.

Photo: V. A. Suvorov.



retaries of the Party organizations have intensified the struggle to bring about the leading role of every Communist and have increased the demands placed upon them. This has had a noticeable effect on the quality of combat and political training and on the tightening up of military discipline.

By the time that Party meetings were held to hear reports and elect new officials, the number of Outstanding flight formations, groups, sections, and crews had grown in numbers; high ratings of the flying personnel had risen; and the quality of work of other aviation specialists as well had improved. At the head of the Outstanding outfits and flights are Communists V. I. Surovenkov, S. I. Muskantsev, V. T. Shostak, D. S. Znoba, and others. The Communists of the foremost squadron in the group commanded by officer Muskantsev, where the Party organization secretary is Comrade V. P. Vakulenko, had all as one man become Outstanding Men in combat and political training by the Fortieth Anniversary of the Great October Socialist Revolution.

The imposing of greater demands upon the Communist intensifies their influence upon non-Party soldiers.

In connection with that, we may cite the following example. Young Communist P. Ye. Shkurko, an Outstanding Man in combat and political training, lives with Pilot B. N. Blinov who has more than once violated military discipline; but Shkurko paid no attention to his comrade's conduct. The Party Bureau (N. I. Sorokin, secretary) summoned Communist Shkurko to a meeting and demanded of him that he make an effort to exert influence on his comrade and help him join the ranks of leading pilots. The Bureau members also reminded him that a Communist has no right to disregard shortcomings.

Formerly the Party organizations did not react to an adequate extent to so-called "petty" violations of flying discipline by Communists, alleging that they were experienced experts in their field and that there was no point in "offending" them. But recently Flight Commander Communist I. M. Kul'guskin was guilty of carelessness in accepting an aircraft, and as a result he took off with a sheathed PVD [Pitot tube intake] pipe. The Party Bureau discussed this incident and reported its decision to all the Communists.

While calling the Communists to strict account for neglect in their work, at the same time the Party organizations give wide publicity to the experience of the best men. In their speeches at a report and election meeting, Party members told of the important work being done by Unit Bureau Member, Communist V. N. Gladyshev. The pilots under him are now carrying out their assignments with a rating of "good" and "excellent". Gladyshev is a good methodologist and has received many commendations for exemplary service from the Command. At aerial gunnery contests, he has received excellent ratings for all exercises and has taken first place in the group. The Party Bureau put out a special bulletin and arranged radio broadcasts in which accounts were given of Comrade Gladyshev's experience. At a report and election meeting of the Party unit he was again elected to Bureau membership.

High performance ratings have been achieved by the groups headed by Communists V. S. Urzhenko, O. G. Savich, A. I. Spirchagov, and P. N. Morozov. The Party members of these groups feel deep responsibility for carrying out their military and Party duty. They realize clearly that being a member of a voluntary

A heavy bomber was returning from its mission. Suddenly a fire broke out in the cockpit. Communist Maj. V. S. Koliush rushed to put it out. The fire flared up and the cockpit became filled with caustic smoke. In spite of burns, Koliush fought the fire selflessly. But his strength failed him and he lost consciousness. Crew Commander Capt. I. G. Shkondin ordered the crew to bail out. But Koliush was not able to do that. Shkondin decided to land the plane on a field and save his comrade. After landing, they managed to put out the fire. The comrade's life had been saved.

Photo: Maj. V. S. Koliush, First Class Military Navigator, a bombing and aeronavigation expert.

combat league of like-thinking Communists means fusing one's own wishes and activities with the wishes and desires of the Party.

The Statutes of the CPSU oblige the Communists to observe strictly Party and Government discipline, obligatory for all members alike. Good discipline is the most important characteristic of a man's Party spirit. Party discipline is a discipline of action. It demands efficient implementation of decisions and intransigence towards deviations from the Leninist norms of Party life. A Communist who looks with indifference upon violations of discipline by others becomes himself their accomplice.

Under Army conditions, the requirements of the Party Statutes for observation of Party and Government discipline mean that a Communist must serve as an example for fulfillment of the military oath, military statutes and orders of the commanders, and must help in intensifying the combat readiness of the unit and the sub-unit. While observing discipline and order in an exemplary manner and faultlessly carrying out his service responsibilities, the Communist is called upon to conduct indoctrination work among the men, as was required by the October Plenum of the Central Committee of the CPSU.

In solving this most important task, an example is being shown by Communists V. F. Seregin, V. G. Slesarenkov, I. A. Kochubey, A. S. Beketov, and N. N. Vospyakov.

Flight Commander Communist N. N. Vospyakov, an irreproachably disciplined, self-restrained, and modest officer, is one of the best leaders of political classes. He

works hard at indoctrinating and training his flying personnel; his men follow the example of their leader in every respect, and the entire flight is rightfully considered one of the best in the unit.

Understanding the importance of assuring the exemplary role of each Communist the political section and Party organizations have begun more frequently to conduct lectures, reports, and conversations on Party topics. Thus, the members of the Party committee — Hero of the Soviet Union V. M. Ziborov, and officers I. V. Telichev and A. B. Korniyenko — gave reports on the following topic: "Assuring the leading role of Communists is the main issue in Party Work". In these reports, they made use of important factual material from the life of their outfits.

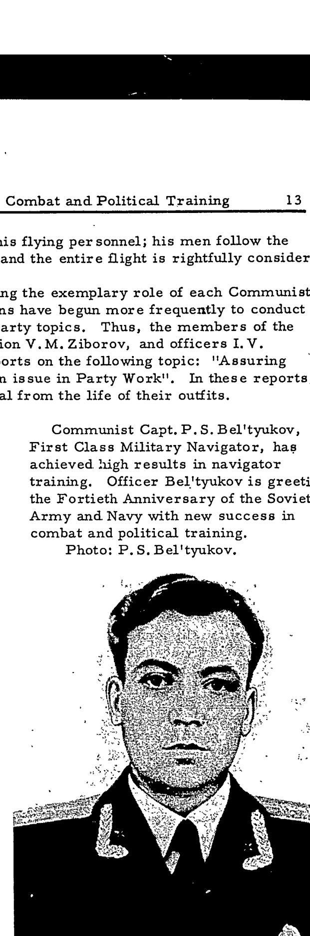
Since publication of the decision of the October Plenum of the Central Committee of the CPSU, the political section has been giving even greater attention to the development of criticism and self-criticism in Party work. The Party attitude towards criticism serves as an index of the lofty awareness of the soldier, of his ability to place the interests of society above his personal pride. Of course, criticism cannot but remind one of some experiences or other; one must be a person devoid of a sense of personal dignity not to have experienced, in one way or another, critical remarks at one's own expense. But Communists must understand correctly the extremely important requirements of the Party and must be able to see, in criticism by comrades, the attempt to help correct a shortcoming.

The Party organizations have been assigned the task of developing, at Party meetings, criticism of Party members and member condidates who are working inadequately at increasing their military and political knowledge, who commit amoral acts, who discredit the high calling of being a Communist, and who violate Party discipline. We are striving to bring to the consciousness of every Communist these requirements of the October Plenum and of the Instructions to the organizations of the CPSU.

The active Party membership and the Party meetings on the results of the

Communist Capt. P. S. Bel'tyukov, First Class Military Navigator, has achieved high results in navigator training. Officer Bel'tyukov is greeting the Fortieth Anniversary of the Soviet Army and Navy with new success in combat and political training.

Photo: P. S. Bel'tyukov.



October Plenum of the Central Committee of the CPSU speak for the fact that Communists correctly understand the requirements of the Party, ask questions on principle, and strive to improve the entire system of Party-political work and to assure the leading role of Communists. The Party members subjected M. S. Vasil'yev, A. V. Zharkov, and N. I. Tikhonov to sharp criticism for rudeness and demanded that they get rid of this shameful trait that was hampering the proper formulation of indoctrination work.

Assuring the exemplary role of every Communist is unthinkable without constant ideological toughening. That is why the question of improving the entire system of Party education during the new academic year is at the center of the political section's attention. Air Force commanders, Communists L. N. Novikov, G. A. Mel'nikov, A. S. Galkin, and others enrolled in the first course at the evening university. They are taking active part in seminar classes and have considerably improved indoctrination work with their men.

Speaking of the exemplary behavior of every Communist and of the spread of Party influence to the masses of non-Party men, we must not forget about such a well-tried form of intra-Party work as open Party meetings. Recently at such a meeting in the squadron commanded by officer B. A. Kryuchkov, consideration was given to the tasks of Communists in connnection with forthcoming toss-bombing flights. There are actually not so many Party members and candidate members in the outfit, but the open Party meeting drew almost the entire personnel. Soldiers and sergeants of the armaments service and the communications outfit, officers from headquarters and the landing security system, and workers from the range area came to listen to the advice of the Communists. The meeting proceeded in lively fashion and mobilized the entire flying and technical personnel for outstanding fulfillment of their obligations.

In carrying out the decision of the October Plenum of the Central Committee of the CPSU, the commanders, political organs, and Party organizations are indoctrinating Communists and the entire personnel in a spirit of devotion to the Communist Party and the Socialist Fatherland and are directing their efforts at further intensifying the combat readiness of the units and elements.

Brotherhood

(A TRUE STORY)

MIKH. MAKOVEYEV

I

Now a small valley, hemmed in by the green mountains of Northern Ossetia was to serve as airfield for the separate reconnaissance squadron. The noise of a great mass of water was the first thing the pilots heard here after the roar of the last plane to land had ceased. This noise came from the southern side of the mountains and one could feel in it an uncontrollable, a capricious force which involuntarily arrested one's attention.

"The Terek"... pensively uttered the navigator, 22-year-old Lt. Pimen Adamchuk, a native of Byelorussian Poles'ye.

That the noise was coming from the eternally indignant Terek, all the pilots knew well according to information in their flight map which they had studied to the last detail.

But at that time the Terek was not only a river which aroused one's imagination about a wonderful, romantic land sung by the greatest poets; in those days this was our last line of defense on the Fascists' road to the oil of Baku.

Having left the planes in the mechanics' care, the crew of the commander's squadron set off for the neighboring aul [Caucasian village] of Dulatovo to seek shelter for the night. They walked not in formation, but in order of seniority. In front was the broad-shouldered, taciturn inhabitant of the Volga region, Capt. Vasiliy Rogov, behind him jovial Lt. Adamchuk, always fascinated by something. Even now he kept looking around incessantly and often turned to the radio-operator gunner, Yakov Bunferman, who was walking behind, wishing to share with him his sincere delight in the unique beauty of the Caucasus.

"This place is fabulous! Isn't it, Yasha?" said the navigator excitedly.

The neat white little houses of the Ossetian aul of Dulatovo are fenced off from the street by a low stone wall. Within the enclosure it was everywhere green with acacia which had already shed its blossoms but still gave out a light and pleasant scent.

The pilots entered the yard of one of the small houses. Next to the porch with steep stone steps stood a two-wheeled bullockcart loaded to capacity with domestic goods. In the back of the yard an irrigation ditch was murmuring amicably.

As the men knocked, the door opened. A tall, strong man with a black, wiry beard stood on the threshold, leaning with his sun-tanned brown hand against the door frame. That the owner of the house was not glad to see his guests, one could understand from the tone of his voice when he asked: "What is it you want?"

Capt. Rogov explained briefly. While examining everyone with a searching look, the host let the soldiers into his house. Inside, the house was divided by a narrow hall into two equal parts. One part, whose windows looked out onto the yard, was demolished by a bomb.

"They have already come this far," thought Rogov with bitterness and walked into the remaining section which had been spared.

The host asked them to sit down. The conversation began with difficulty.

"Well, how are you"? Navigator Adamchuk asked the usual question in such cases, not knowing how to start.

"Still living", the host answered evasively while stroking the wiry bristles of his beard with his broad palm.

"And do the Fascists" — Adamchuk nearly said "bother you?", but, catching himself, asked, "visit you now and then?"

"They came once", answered the host and rested his gaze significantly on the door behind which was the demolished part of his dwelling.

The visitors, as if guilty of something, exchanged awkward glances. The brief mental embarrassment of those sitting in front of him did not escape the shrewd Ossete's attention. He felt immediately that they had taken his grief to heart — a grain of the great grief which had befallen the entire country.

"What is the news? Is Stalingrad still ours?" This time the host himself began to talk after a long pause in order to remove the tension.

"And it will always be ours", answered Adamchuk.

"But Hitler brags in his leaflets that he has taken it."

"Nothing of the sort! He took..."

The conversation became more lively. The host was interested in absolutely all fronts, but it seemed he deliberately avoided asking questions concerning things at the front closest to his native aul, to his own house. Maybe, as an old soldier, who understands what a military secret is, he simply considered it inconvenient to try to make them tell about the situation on the Terek right now.

Capt. Rogov noticed this reserve in the conversation of the elderly Ossete. The Terek and the Volga do not come together, thought the officer, but the fortunes and interests of people living near those rivers have met and flow along the same riverbed. Speech peculiarities hardly noticed by him until then suddenly acquired for the pilot the deepest meaning. All four of them — the Russian Vasiliy Rogov, the Ossete Khariton Fariyev, the Byelorussian Pimen Adamchuk, and the Jew Yakov Bunferman — were right now speaking in one Russian language about their common anxieties and hopes.

"No! He will break his teeth against the Caucasus!" said the host with unexpected ardor and rose from his seat. "Let us get ready for dinner," he added, heading for the door.

The guests washed with the cold water which pretty, black-eyed and slender Arinka, eighteen years old — Khariton's daughter — kept bringing them. She was shy and silent. Only in her large black eyes, shaded with long lashes, a ghost of a friendly smile was shining.

Adamchuk washed longer than the others. He could not overcome his desire to splash endlessly there in the crystal-clear water next to such a beautiful and evidently very good young girl.

Arinka, feeling with her sensitive girlish heart the cause of this nice — and a bit strange — lieutenant's emotion, became still more embarrassed and covered her big eyes with her dark lashes, as if in fear of betraying some secret hidden in them.

The host treated the pilots with mead and sour wine. Observing the local custom, everyone sat long at the table...

II

The aerial reconnaissance men spent three days and nights under the hospitable roof of Khariton Fariyev. On the fourth day an order was received to change base to a new spot closer to the Caspian Sea. Almost the whole day the crew was busy getting ready for takeoff, whereas Khariton was making preparation for his journey. He was making himself ready for guerilla warfare in the mountains.

Lt. Adamchuk was eager to see Arinka before starting, and towards evening he begged Capt. Rogov to let him go to the Fariyevs for a minute.

"It's awkward; at least one of us must drop in to thank them and take leave."

The pilot slyly glanced at his navigator and waved his hand, as if to say: "I see, go ahead."

But Adamchuk had to face disappointment. Approaching the familiar house he did not see the loaded bullockcart. Khariton had already gone to the mountains. The irrigation ditch sadly murmured in the back of the yard, reflecting a narrow strip of sunset. The lieutenant, still urged by some faint hope, hesitatingly pushed the door. It opened. A tall, thin old woman all dressed in black, Khariton's mother, came out to meet him. With a brief gesture she invited the officer to come in. Through narrow chinks of the closed shutters bright streams of light were breaking.

Stopping in the middle of the room, Adamchuk began to thank the old woman for her hospitality and to reassure her that all would change for the better. He held out his hand to say goodbye. But the old woman kept standing before him motionless, gazing at his face intently. Then, suddenly turning around, she approached the sofa with a firm step unusual for her age and took a naked dagger from a rug hanging over it.

"Here, take it," she said, handing him the family heirloom. "If you win, you will be my son. Go!" said the old Ossete woman almost severely.

The lieutenant kissed the cold steel of the dagger, hid it in his map-case, saluted and turning around abruptly, left the house.

Day was drawing to a close. The sharp shadows of mountains were slowly creeping from south to north. One half of the valley was already plunged in twilight. Only in the pink distance, to the south, lit by the evening-glow the Kazbek shone with its eternal snows like the facet of a diamond.

With an anxious glance at the mountains which had already become dear to him, listening to the noise of the river, the lieutenant involuntarily recited to himself a verse which he had learned by heart as a child:

> And the Terek, bounding like a lioness
> With a shaggy mane on her spine
> Roared; and the mountain beast and bird,

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With a shaggy mane on her spine
Roared; and the mountain beast and bird,

Circling in the azure heights,
Listened to his water's voice
And golden clouds
From southern lands
Followed him northward from afar...

The old familiar verses suddenly made a new and fascinating impression on Adamchuk. Formerly, whenever he recollected these lines of Lermontov, they first of all drew before his mind's eye a fabulous picture of nature. But now they painfully struck his heart strings. Adamchuk felt more deeply the meaning of the word Motherland.

"The tiny patch of the poor Poles'ye land where I was born is very dear to me. But what will happen to it if we do not hold it against the enemy, if we do not defend these mountain crests from him?"

Absorbed in his thoughts, he did not notice that he had come up to his plane.

"Well, have you said goodbye?" asked the pilot who had approached him.

"I did not find Khariton. He left for the mountains with his wife and Arinka. Only an old woman is staying home alone," Adamchuk replied slowly as if in a trance.

"Here is her gift." The lieutenant took the dagger out of his map-case and handed it to Capt. Rogov. "She said that if we win we shall be her sons."

III

Three months passed. During this time Rogov's crew flew many times on dangerous missions. Combat decorations glittering on the faded tunics of each crew member bespoke the success of their toil. Together with government awards, the crew piously kept the old Ossete woman's gift. The naked, double-edged dagger without a single rust stain always lay in Pimen Adamchuk's large map-case.

One day the crew was ordered to make an urgent reconnaissance flight and to photograph an important sector of enemy defense. The "Petlyakov-2" rose in the air escorted by a group of six fighters. On the bombing approach our planes first encountered a heavy barrage of enemy AA guns, and having broken through it, they encountered a large group of "Messerschmitts." An air combat among the fighter planes began. There was a three-fold numerical superiority on the enemy's side.

Without wasting time, Rogov made a target approach. Five enemy planes pursued him. They attacked the reconnaissance plane one after the other and from various directions. But the well-aimed fire of the aerial gunner and navigator, the skillful maneuvering of the pilot allowed them to beat off successfully four enemy attacks. Yet the fifth attack decided the issue of the unequal combat. One of the "Messerschmitts" approached from behind and, covered by the empennage of the "Petlyakov", opened fire at short range. The aircraft lurched sharply to one side. The right engine started smoking. A strong current of cold air rushed through a shell-hole into the pilot's and navigator's cockpit and struck their faces. At this moment the machine guns of the aerial gunner became silent.

"Bunferman, why don't you shoot?" shouted Rogov. There was no reply. The gunner was dead.

Meanwhile the enemy fighter planes ceased pursuit, supposing that all was over with the "Petlyakov". During this time pilot and navigator did not lose sight of the target. It slowly came into sight under the aircraft. Without turning away from their work, Rogov and Adamchuk gazed intently downward at the black cobweb of trenches and communication ditches of the enemy strongpoint. Now the cameras were switched on. Having become one with the control column, Rogov with difficulty kept the crippled aircraft on the combat course. The smoking "Petlyakov" was flying over the target.

The mission had been carried out, when smoke penetrated the cockpit and flames licked the right wing. Rogov switched off the ignition of the smoking engine and, making a steep turn, began his fight with the fire. Now he would abruptly throw his aircraft downward, now he would lay it on its left wing, trying to rid the aircraft of its flames. But it had already gained headway and threateningly began to burst into the cockpit. The aircraft obeyed the pilot less and less and was losing altitude. The ground was rapidly rushing up towards his plane, the horizon line now heaving up as a black peak, now sinking into a steep narrow gorge. There were no level valleys below the aircraft and a landing was out of the question.

"Let's bail out!" Rogov shouted into Adamchuk's ear and raised himself slightly. But something unforeseen came to light: the pilot's parachute was damaged by a fragment of enemy shrapnel. There was no time for hesitation. "Jump!" Rogov ordered his navigator.

"And what about you?" Adamchuk asked anxiously looking at the stone face of the squadron commander.

"Jump!" the commander repeated the order.

The lieutenant lingered with his head down so as not to see his commander. For a fraction of a second Adamchuk's glance was held by the silver dagger hilt, peeping out of the map case. And suddenly an amazing idea flashed like lightning.

"We'll do it together. You understand, on one parachute!" cried the exultant lieutenant wildly.

This suggestion was so unexpected that Rogov did not at once believe it was sensible. He was just about ready to force the navigator out of the burning aircraft, but Adamchuk without wasting time quickly fastened Rogov's parachute harness snap hooks to his own.

They bailed out of the plane at an altitude of some three or four hundred meters. Adamchuk immediately pulled the rip-cord ring. The parachute had hardly time to open when the ground was almost under their feet. The shock of the landing was violent — both lost consciousness.

IV

Rogov and Adamchuk recovered consciousness in a medical battalion tent. It seemed to them that a dull pain in the legs had brought them to their senses.

Lt. Adamchuk was the first to open his eyes. From the hazy mist outlines of objects slowly began to take shape — first the green wooden pole propping up the top of the tent, then the square little window behind which one could see a scrap of blue sky and a small cloud sailing over it. The reality of what they saw aroused their memory. Abruptly turning his head to the right the lieutenant caught sight of Rogov lying on the next cot.

"Vasiliy Petrovich!" exclaimed Adamchuk, leaning forward. But Rogov did not answer.

"Is he alive?" the lieutenant thought with alarm. But immediately he heard behind him:

"Don't worry, he is alive."

Adamchuk looked around and his heart stood still: before him stood Arinka, Khariton Fariyev's daughter, wearing a brand new soldier tunic, but with the same shy and sweet expression on her face.

"It's you?... Is this true?... the lieutenant spoke impatiently.

"It's me," Arinka replied smiling warmly and her long dark lashes covered the joy shining in her eyes.

The medical battalion to which Adamchuk and Rogov had been brought after their escape by parachute was stationed, as it appeared, in the Ossete aul of Dulatovo. After its liberation from the invaders, Khariton Fariyev returned home from the mountains and on the very next day joined the field forces as volunteer. Arinka begged the military chiefs to take her on as nurse. And when the two unconscious pilots had been brought to the medical battalion on a one-and-a-half ton vehicle, Arinka asked for permission to nurse them. Soon Rogov came to his senses too.

"What happened to the plane?" was his first question.

The special representative of the separate reconnaissance squadron, who by this time had arrived at the medical battalion, reported to Rogov that the aircraft had crashed but that the film magazines were safe and had been sent to their destination. It turned out that when the crippled "Petlyakov" began to withdraw from the target, two of our fighter planes followed it. Later one of them circled over the spot where the parachuting pilots had landed, while the other flew a bit farther and took the coordinates of the fallen plane.

Yet, though the combat mission had been carried out and the reconnaissance results were not lost, Bunferman's death grieved Rogov and Adamchuk.

"Pimen, my dear friend, tell me, how could the idea dawn upon you for the two of us to bail out on the same parachute?" For the first time Rogov, always reserved, put the question to Adamchuk so simply and eagerly.

"The gift from Arinka's grandmother prompted me," replied Pimen and glanced at the girl, sitting near his bed. Arinka was embarrassed.

"Yes, but where is my map case?" asked Adamchuk without addressing anyone. Arinka silently rose from the folding stool, left the tent, and in a few minutes brought the map case. Adamchuk opened it and took out the flashing dagger.

"When, in the plane, my glance happened to fall on its hilt," the lieutenant went on, "I suddenly understood that I could not leave you alone in the burning aircraft..."

Before leaving Dulatovo and the medical battalion, the pilots decided to visit Arinka's relatives. She also went with them, shy and silent as usual. The aul was half destroyed. Cars drove back and forth along its streets and, bunched along the edge of the road, a downcast grey-green column of German war prisoners was dragging itself along.

The officers stopped before Khariton Fariyev's house. The gate was torn off its hinges and hung loose, the yard was covered with rubbish. Only behind the house, reflecting the pink light of the morning sun rising over the mountains, the irrigation ditch was tinkling amicably. The door leading into the house was ajar. Arinka stopped in the street. Rogov and Adamchuk walked into the house. The Ossete woman they knew rose from the sofa to meet them. She looked for a long time at the faces of those who had entered. The officers understood that the Ossete woman did not recognize them. Then Adamchuk opened his map case, took out his dagger, and held it out towards the old woman.

"My son!" she exclaimed in a tremulous voice and pressed her head against the lieutenant's chest.

High Standards

I. V. DROZDOV

Squadron Commander G. V. Utkin was at the Headquarters when the alert signal sounded.

"To the aircraft!" Utkin gave the order and ran to the airfield. Looking back, he saw his wingman, Capt. A. P. Voytov running behind him and signalling to him: "Don't worry, I'll catch up with you."

Voytov was known to the whole regiment as a skier as well as an excellent swimmer and runner. He was always ready to defend the honor of the regiment by lending a helping hand in volleyball and basketball matches.

They ran up to the planes. The Major jumped into his cockpit, closed the canopy over his head and switched on the radio station. A familiar sound could be heard in the helmet earphones; the radio was working well. Now one could wait for the order.

A few meters away from the commander's plane stood Voytov's jet fighter ready to rush like a rocket into the boundless heights. Voytov, commander of a flight of jet fighters, was also ready for the takeoff. At present he was an air fighter in pair with his lead man. Voytov knew that the pilots of his unit, who had recently arrived from school, would be observing the takeoff of the pair and would follow its flight till it melted in the dark masses of rain clouds.

Capt. Voytov was a first-class pilot, but he was proud of his lead man Maj. Utkin who, in the years of the Great Patriotic War, already had gained the reputation of being a fearless air fighter. Utkin was well known, not only in the unit and the group, but indeed in the whole district.

Both pilots were waiting for the order to take off.

Finally in the earphones the order from the command post sounded:

"Start and take off!"

The roar of the turbines broke the neighboring quiet. The fighters moved down the runway simultaneously.

Before the takeoff the Major glanced once more at his wingman. Not because he was anxious for him — there was no reason for that; it was not the first time that Voytov was flying with him to accomplish a mission. Utkin glanced at him out of habit, as an instructor and teacher, as a commander who in every flight had to teach his subordinate something. Now both were anxious about something else: What was the target? A practice target or...? Either way, the flight had to be instructive — that was Maj. Utkin's rule.

Flights with the element commanders always seemed complicated to him. True, they were first-class pilots, and every day it became harder and harder to teach them, since ever greater demands were made on them. But instruction was necessary. And the harder it was for Maj. Utkin, the more he thought of it, striving to find means of increasing the flying skill of his immediate assistants.

Having rushed down the concrete runway, the planes began to climb. Before entering the clouds the leader turned off slightly to the right, then came back onto the original course. From time to time the Major looked in the direction of his wingman. Voytov could not be seen. The darkness around the planes was getting thicker and thicker.

Then suddenly it seemed to give way. Although dark scraps of clouds still enveloped the wings, ahead it was getting lighter. The needle of the altimeter pointed to 5000 m. Soon the sun would be visible. Its rays were already breaking through the dark gray mass. Another moment — and the aircraft broke through into the open. Below there remained fantastic piles of giant clouds. Like a shell from a gun the wingman's sunlit aircraft flew out of the clouds. Voytov immediately approached his leader and confidently took his place in the formation. The Major looked in his direction as a teacher would look at a bright and efficient student. "One can wage war with such a man", thought the squadron commander and reported to the command post: "Have penetrated cloud cover."

Then the order came: "Climb to 13,000, course 285."

Now they were flying in extended combat formation. Capt. Voytov was on the right. They were climbing at a steep angle. Not only their sight, but their hearing as well, was strained to the utmost. At any moment the ground controller's voice would be heard notifying them that the target was near.

The altitude was close to 13,000. On the ground radar screen the target and the fighters could be seen. The controllers were vectoring the pilots to the target. And the sooner the fighters could spot it, the more efficient their attacks would be.

An order sounded through the helmet earphones "Target in front to the left, 80 km. Prepare for left turn."

Having made the turn according to command, the fighters entered a collision course with the same heading. Utkin saw a plane. He wanted to report it to the ground, but at the same moment he heard the voice of his wingman:

"See the target. Course 120, altitude 13,200, identification signs — ours."

The Major's face lit up: he was pleased with the sharp sight of his wingman.

The crew of the bomber also saw the fighters and were taking measures for repulsing their attack. For several seconds the fighters flew behind, to the side and above the target. The decisive moment was near. It is hard to spot a target; it is not easy to catch up with it; but the hardest thing of all is to plan the correct maneuver, to open fire precisely and on time.

The leader attacked. The movable rhombs of the sight were already "hugging" the silhouette of the bomber. One burst, another... and Utkin withdrew to the side in a climb. Now he could take a look at his wingman. Capt. Voytov, following his commander's example, repeated the attack and took his place again. A second attack followed the first.

Having accomplished their mission, the pilots returned to the airfield. Now they had only one thing to worry about — penetrating the clouds and landing safely. The pilots landed one after the other. Over with were the anxieties, the expectations. One could quietly think over one's actions.

The Major was thinking about what was new and instructive in this flight. He wanted to take note of something and to suggest some new idea to the pilot that would help him, even if ever so little, further up the road of flying skill.

Leaving his cockpit, Voytov approached his commander and reported:

"Comrade Major, may I hear your observations?"

"Let's wait for the film," answered the commander, "but right now go to headquarters."

Reporting for duty the next day Utkin met Voytov who was already examining the developed film. The results were excellent.

"Well", said the Major happily, "we did good work."

"As far as you are concerned, that is so," replied Voytov. "But I committed an error in the first attack." Then, remembering that the commander had not pointed out anything to him, he added:

"Of course it was difficult for you to notice it, but in attacking the target I almost got into the backwash. I was badly bumped about. It is true that I finally licked it, but it could have been worse."

"But we've studied the nature of propagation and the action of backwashes", remarked the commander.

"We did study it, but I got carried away by the attack and did not realize that this was another target and that the backwash was of another nature."

The Major took out of his desk an album with pictures of planes and started to turn over the pages. In different bombers, the engines were installed in a certain way, and of course the strength of the backwashes, their propagation and action were different too.

He took out his notebook and noted: "Tell the pilots once more about the backwash." Then he stood up. But before leaving, he said to the Captain:

"Do you know what I was thinking just now? That every flight can supply every pilot with food for reflection and for searching out new ideas. In order to do that, one has to analyze one's flying, approach it more strictly, evaluate one's actions critically, and draw lessons from it."

The workday was beginning. The squadron commander decided to look in on the independent training in the element commanded by A. V. Solov'yev.

Utkin entered the room where the class was going on and saw that Solov'yev was holding in his hands "Instructions for Carrying out Flights" and was reading to his subordinates — young pilots having just finished school — the chapter on "Special Cases in Flight." They have read these "Special Cases" more than once, and perhaps because of this some were listening without paying much attention. Having reported to the commander, Solov'yev went on with his class.

Maj. Utkin wanted to reprimand Solov'yev and scold the pilots for lack of attention; but he did neither and left the class dissatisfied. He knew Solov'yev's nature, and therefore was loath to interfere with his activity and only did so tactfully. He knew that "a good word cools even a hot ' ead." But this word should be spoken at the right time and with finesse.

The conversation took place after dinner when there was no one in the squadron

Major G. V. Utkin conducting class

commander's room. The first to speak was Capt. Solov'yev.

"I see, Comrade Commander, that you did not like our class."

"No, I did not like it", said Utkin. "With your experience you could have conducted it better. I would like you to use more varied forms of class instruction. Today, for instance, in going through the flight, could you not have shown every maneuver of the aircraft on the simulator, or else have asked the pilots to do it themselves? Or, for instance, you read 'Special Cases in Flight'. Wouldn't it have been better to have asked the pilots to tell, in their own words, what they should do, and how, in similar circumstances? Then the class would have been more lively and more interesting."

"I always count upon disciplined and very conscientious listeners."

"But are your pilots undisciplined officers? Nor can you reproach them for having an unconscientious attitude toward their work. Rather it was boredom that lulled to sleep their attention and reduced their interest in class work. If I start explaining to you in the same dull way, will you always listen to me attentively? If you say 'Always', I will prove the contrary to you."

"Better don't prove it," laughed Solov'yev, "I agree with you."

Capt. Solov'yev left the room, but the Major still sat alone for some time and though about the conversation they had just had.

"Solov'yev is a complicated character, very complicated. But are there people who are not?"

Once Capt Voytov was reporting to the squadron commander about Lt. A. G. Davydovskiy:

"I have flown with him, but I obtained no results. Please, will you check him?"

Sometime later the squadron commander flew twice with the pilot and... allowed him to carry out the scheduled training exercise.

How did the major succeed in "turning loose" Davydovskiy so fast? This is what many of the pilots in the squadron wondered about. Well, in the first place the commander thoroughly studied the pilot's psychology, his training, the causes of the errors committed. He realized that the pilot regarded the aircraft with exaggerated apprehensiveness, and while flying did not feel sufficient self-reliance.

Having taken off with Davydovskiy, the commander allowed him complete independence, at the same time silently following the pilot's operations without interfering or making any observations.

In a combat turn Davydovskiy allowed a large bank, created excess acceleration forces, but did not gain the prescribed altitude. He put the plane into a loop with a bank and therefore he could not complete the loop correctly. All became clear to the commander.

"Now give me the controls," he said when the pilot had finished all the prescribed evolutions.

"Look how I make a combat turn."

The pilot followed attentively the commander's actions, the position of the aircraft which seemed to have come to life in skillful hands. While carrying out the combat turn, the Major pointed out to the pilot how to distribute his attention, when and by what instruments he should control the flight.

"What precision!" thought Davydovskiy.

"Now," said the commander, "let's make a steep turn." After the turn there followed a roll, a loop, a half-loop. Each figure of advanced piloting technique was executed by the Major at maximum regimes, with great accuracy.

On the same day the Major flew with Davydovskiy once more. He executed the figures himself and then turned the controls over to the Lieutenant and made him repeat the performance. Davydovskiy did so. In this he showed good results. When they landed the young pilot said:

"Request permission to solo."

"Permission granted," replied the Major, "but you must be master of your aircraft."

Davydovskiy felt exceedingly happy. On this day he began to trust himself and felt he had mastery over his aircraft.

This was a good lesson for Capt. Voytov and he decided to teach his subordinates exactly in the same way the commander did. But to achieve this goal he had to be a past master himself. And he applied his all to this end.

* *
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Recently a flight and technical conference was held in the unit at which Maj. Utkin read a paper on how to pull a plane out of a spin. The group commander, who attended the conference, exclaimed admiringly, "Yes, he is a true scientific worker!"

In the group there was not a single flight and technical or flight and tactical conference at which Maj. Utkin did not speak. He considered his reports as an essential and necessary part of his work.

"Yes, he is a true scientific worker!" These words describe as fully as possible Communist Utkin, jet fighter squadron commander — pilot-innovator, pilot-instructor, pilot-soldier.

SELECTING OPTIMAL FLIGHT REGIMES FOR AIRCRAFT

Engineer Lt. Col.
A. I. SMIRNOV
Candidate of Technical Sciences

The correct choice of flight regime facilitates the most complete utilization of the combat capabilities of aircraft. The choice of flight regimes is basically determined in the field units by tactical considerations: the nature of the assigned mission, combat operational methods, the tactical maneuvers of the enemy, etc., are all taken into account.

In choosing a flight regime, in our opinion it is important to insure the long and reliable operation of the aircraft equipment under the prescribed regime as well as economy and ease of piloting while in flight formation.

In the literature on the subject some flight regimes are very often called the most advantageous. By most advantageous climbing and descent regimes is meant, on the one hand, a regime of fastest climb and, on the other hand, a regime of maximum range in descent.

Thus the most varied meanings are included in the term "most advantageous regime", which not infrequently leads to confusion.

It is perfectly clear that in choosing a flight regime they primarily take into consideration the possibility of completing the assigned mission, the combat operational methods, and the existing conditions. But while striving for an increase in combat effectiveness we must not forget about flight safety, about considering the reliability and survivability of the aircraft and, in some cases, also about flight economy. This means that to each specific combat mission under definite conditions there corresponds a certain most advantageous flight regime or, more precisely, a profile and a complex of flight regimes. Therefore we consider it impossible to speak of most advantageous regimes in general; it is more correct to speak of optimum or efficient flight regimes, taking many factors into consideration.

Thus, for example, in the course of an intercept by our aircraft taking off from airfields the most advantageous regime may turn out to be, not that of a rapid climb (as it might seem), but one closer to maximum speed V_{max}. It is true that the necessary altitude is thus reached more slowly, but the aircraft closes in on the enemy more rapidly and the main thing is that the encounter takes place at a greater distance from the objective being defended. Besides this, flight at a greater speed during an encounter with the enemy insures initiative in combat and less vulnerability to his fire. It is important, however, to take into consideration how much the time spent by the aircraft in the air is shortened at the expense of a decrease in flight economy under a given regime and not to allow the engines to work long at maximum rpm and with augmentation.

In closing in on the enemy at great range from a defended objective, it seems the most advantageous regime will be near V_{max}; while in approaching the initial attack position, the most advantageous regime will be one in which it is possible to execute a maneuver with minimum radius or in the shortest time. Satisfying certain of these requirements, however, contradicts others (for example, at V_{max} maneuverability and economy deteriorate and the power plant works under more strenuous conditions, whereas tactical advantage and initiative in combat are guaranteed and vulnerability to the enemy's fire is reduced).

For the successful execution of a specific combat mission it is necessary, while selecting the flight regime (speed and altitude) of, for example, frontline bombers, to take into consideration the distance to the target or the maximum radius of operations R, the nature of the target, the possibility of its identification (contrast, dimensions), meteorological conditions, the time of year and day, the condition of the PVO [AA] defenses of the objective, the type and ballistic characteristics of the bombs, and the reliability and combat survivability of the aircraft power plants, assemblies, and systems.

On the basis of these considerations, the optimum flight regime parameters for the different legs of the flight route are selected; the limits in which the radius of bomber operations can vary due to the choice of flight altitude and speed, bomb load, composition and combat formations of the group are defined. This information must always be at the disposal of the unit commander.

Why is it so important to know the maximum operational radii of different aircraft groups for tactically advantageous combinations of flight speed and altitude? This is necessary in order to see whether the target can be reached at the maximum speeds and altitudes possible for the given group, to appraise the type of targets against which the bomber aviation units are capable of operating without changing bases, and to know how often and on what dates it will be necessary to change bases. Having chosen a correct flight regime we can increase the available operational radius of aircraft and consequently reduce the number of changes of base in the course of an operation. This permits economizing forces and facilities for the transfer of personnel, unit equipment, and the preparation of new airfields. Besides this, an increase in the operational radius will make possible a more effective utilization of the airfield net, better preparation for work from new airfields, and an increase in unit and group maneuverability. Let us consider which correlations of speeds and altitudes best satisfy the aforementioned conditions simultaneously and can be accepted as optimum for frontline bombers of the Il-28 type. Let us define the conditions in which aircraft of this type are capable of executing their primary missions without a change of base.

For the increase of combat survivability and the reduction of losses from all enemy PVO facilities, it will be necessary for bombers to fly at the highest speeds and altitudes. It is evidently more advantageous for them to fly in comparatively small groups, since with this composition the rate of climb and certain qualities of

maneuverability improve, which fact is very important in AA and radar evasion maneuvers, and in other maneuvers in the target area and in combat with enemy fighters. Besides this, the aircraft in trail will expend smaller excesses of thrust for maintaining the formation and this will permit the improvement of flight and technical formation characteristics, the more complete utilization of aircraft capabilities (speed and altitude), and the increase of flight safety.

In small groups, for example, the maximum velocity of Il-28 aircraft reaches 0.90 - 0.95 V_{max} and flight is possible at so-called optimum altitudes (H_{opt}), where the least consumption of fuel at the same speeds is reached.

With an increase in altitude and speed, however, it is more difficult to spot and hit the target. The probability of hitting the target, especially under complicated conditions and at night, depends on the quality of the navigational and bombsight systems and also on the skillful use of them. If these systems are used correctly, then, except for certain cases, there is no need for descending to any great extent in order to spot and hit the target.

It is known that the greatest operational radius of jet aircraft is reached in flight at optimum altitudes ("ceilings") under the regime of maximum range corresponding to the beginning of the flight at H_{opt}.

At optimum flight altitude, fuel consumption per kilometer under the regime of maximum range is 2.0 - 2.5 times less than at low altitudes and 1.25 - 1.5 times less than at medium altitudes. Let us note that at optimum altitudes the regime of maximum flight range for an Il-28 corresponds approximately to 0.85 V_{max}, i.e., it is of sufficiently high speed and is tactically advantageous.

At medium altitudes of combat employment the regime of maximum range corresponds to $V \geqslant 0.7\ V_{max}$, while an increase in speed to $V \approx 0.95\ V_{max}$ leads to a rise in consumption per kilometer of no more than 20% and the regime of engine operation does not exceed the nominal. With an increase in speed to 0.8 V_{max}, consumption per kilometer rises less than 5%.

Thus flight regimes of 0.80 - 0.95 V_{max} at medium altitudes are tactically advantageous and also sufficiently economical and favorable as far as operation reliability and power plant resource consumption are concerned.

It is expedient that a flight of frontline bombers with maximum radius be made at optimum altitudes, i.e., at 700 - 1000 m lower than the service ceiling, at the regime of maximum range (order of 0.85 V_{max}). Frontline bombers may fly at these altitudes in small groups. In case of need it is possible to fly at a regime of 0.9 V_{max}. Then the excess of fuel consumption in comparison with the regime of maximum range amounts to about 5% in all, which is completely covered by the emergency supply.

In flights with prescribed radius the choice of flight altitude and speed is primarily determined by the distance to the objectives, by meteorological conditions, and the possibility of using bombsight systems in bombing, and also by the greatest invulnerability to enemy fighters and PVO facilities. Flight altitude also depends on the importance of the objective and the type of bombs used. Economic considerations do not play the deciding role here, although with a smaller fuel supply and the use of more economical regimes it is possible to take a larger supply of bombs on a flight with the same radius.

Every pilot must undergo thorough training in the operation of cockpit equipment. Without this he cannot confidently pilot an aircraft by instrument without visual contact. This is why before every sortie along a flight route or for bombing purposes the flying personnel devote such great attention to training in the necessary flight elements.

The commander of a topnotch bomber aircraft crew, Military Pilot First Class Maj. A. G. Gamala (right) and co-pilot Senior Lt. V. F. Bashkirov are training in a cockpit for flight under adverse weather conditions. Photo by T. N. Mel'nik

A TACTICAL BRIEFING

T. A. TEREKHIN

Squadron commander Capt. N. A. Novikov was to conduct a tactical briefing with the flying personnel on the subject "Delivering a Night Attack by a Bomber Element against a Moving Tank Column". Time allotted for the briefing was one hour.

Setting out to organize the material, the officer in charge of the exercise first of all decided definitely what he had to teach the flying personnel. Taking into account the theoretical and practical training level of the pilots, Capt. Novikov decided to help them, in the course of the briefing, consolidate their knowledge and habits in the tactics of delivering a night attack by a bomber element against a moving tank column under normal weather conditions and in the presence of AA defense countermeasures. It was stipulated that the crews release their bombs with the aid of an optical sight and illuminating the target with SAB's [illuminating aerial bombs].

Then the squadron commander thought over the problems which he felt had to be worked out: target search, delivering the bomber attack. In addition, he decided to check how well the flying personnel applied in practice their theoretical know-how in a complex ground and air situation.

The officer in charge scheduled the allotted time as follows: announcing the topic and the training objective of the tactical briefing, checking knowledge of theoretical principles involved — 10 min; working out the first and second training problems — 35 min; analysis and summation of the exercise — 5 min.

In working out the tactical situation, Capt. N. A. Novikov endeavored to make it clear and to approximate it to conditions of actual combat. First he conceived and marked on a map the ground and then the air situation; he determined the time for the bombing attack, the weather, and the terrain in the area of the element's combat operations.

There may be several situation variants. The squadron commander, in seeking to achieve the most thorough kind of instruction, decided to hold the tactical briefing against a background of offensive operations carried out by friendly ground troops. Here is his model situation plan (see figure). The "enemy" is engaged in defensive operations. His tank battalion is moving from the area of concentration at point A to the line of deployment for counterattack close to the front line. The tank columns are moving in group formations of 15 - 20 tanks through points A, B, and C. Each group is covered by a single small-caliber AA artillery installation. In addition, in the area of B and C two medium-caliber AA batteries can conduct effective fire.

On the battlefield the troops are given air cover by fighters making sorties from airfields.

At night our ground forces break through the tactical zone of "hostile" defenses. Bombers are assigned the mission of holding back the advance of the "enemy" tank battalion and of disrupting his counterattack. They carry out the mission in scattered element formations and with stacked single aircraft.

The element received the mission at 0200: climbing to an altitude of 4000 m, to cross the front line and deliver a bomb strike against the tank column which was moving from point A to the front line.

From the intelligence furnished by the commander of an element which was operating here earlier, it was known that the column — consisting of twenty tanks — was approaching at 0150 the fringe of the woods 4 km west of point B. In order to illuminate the column, 1.5 - 2 min prior to the element's approach a specially assigned crew dropped a SAB.

The element's bomb ammunition consisted of racks with antitank bombs. The weather was clear, visibility 6 - 10 km; the terrain was broken, wooded, with many small inhabited points; time of the operation was June, past midnight. The battlefield was given air cover by single fighters of ours flying patrol at altitudes of 5000, 7000 and 9000 m.

Having worked out the situation, Capt. Novikov decided that it would be expedient in the course of the exercise to give the trainees the following as initial data for making their decision: the trace of the main line of resistance, AA battery locations, target data obtained from crews operating earlier in this area, as well as the weather and characteristic terrain features.

The officers received the data on the ground and air situation in a written order 2 - 3 days before the exercise began. However, it should be noted that in those cases when the trainees do not enter the situation data in advance on their maps, the written order is either entered in full or in part on the map of the officer in charge.

[There follows a specimen Operation Order outline]

Operation Order

for a tactical briefing with the squadron flying personnel

Subject: "Delivering a night attack by a bomber element against a moving tank column with the use of an optical sight and with targets illuminated by SAB's.
Map (scale, nomenclature, and publication date indicated).

Situation

1. The "enemy" is holding in check the vigorous advance of our troops by continually counterattacking with their tank elements in sector "N", "M" of the front.
2. Single "hostile" fighters, armed with unguided air-to-air type rocket missiles, are countering our bomber aviation at the approach to the front line and over the battlefield; they are taking off from "airfield alert" position. In addition, the battlefield is covered by medium and small caliber AA artillery.
3. The second element of the first squadron received the following operation order: 20 June at 0202 to deliver a bomb strike against a tank column moving from point A along the road A, B, C.
4. Flying in dispersed formation, at 0202 at an altitude of 4000 m the element crosses the front line, executing at the same time an AA evasion maneuver. The illuminating aircraft flies ahead of the element with a 1.5 min interval; the third element of the first squadron follows with a 2 min interval.

Reference data

1. Each plane is equipped with expendable bomb racks with antitank bombs.
2. Weather: clear; visibility 6 - 10 km; wind heading northerly.

Study Assignments

Before the tactical briefing exercise:
1. Study thoroughly the recommended literature.
2. Study thoroughly the situation and enter it on the map within the necessary scope.

Recommended Literature

Drawn up by ____________
signature

The squadron commander considered with special care the lead problems, endeavoring to keep them brief and seeing that they accurately reflect the air situation. He indicated the lead problems graphically on the map and also wrote them out in the margins. For the first training problem of the briefing —"the target search"— the officer in charge drew up the following lead problem "Time of operation — 0200. The element flies in a dispersed formation of single stacked aircraft. In the area of probable hostile AA countermeasures the element executes an AA evasion maneuver, altering its course, speed, and altitude. The element commander determines the front line configuration by the light check points, locates the road from points A to B and the wooded sector to the north of the road illuminated by SAB's.

"In the air over point B there are 4 - 5 flak bursts".

It is known that in bomber crews a target search is made jointly by the pilot and navigator. Therefore N. A. Novikov decided to assign the trainees first the role of navigators and then that of element commanders; to give a hearing to their situation evaluation and their decision regarding the target search. He wrote down on the map margin the last names of the officers scheduled to evaluate the situation and to report on their decisions in the case of each lead problem. The same procedure was followed in drawing up the other lead problems.

The trainees assuming the duty of element commanders had to evaluate the situation in the following sequence. Two minutes remain until reaching the operations' objective. The target area is marked by four illuminating flares. The tanks, however, are not visible on the road; they are still located in the woods and the distance to them is considerable. The illuminating aircraft flying ahead has been subjected to medium caliber AA battery fire. The illuminating flares continue to illuminate the target area for about 3 - 4 min longer. The wind carries them to the south and for that reason the road sector leading to the woods in a very short time will be illuminated even more brightly; this will facilitate the tank search.

The following decision resulted from this situation: to alter course in the direction of the target area, to drop down 200 - 300 m; to concentrate the attention primarily on scanning the road leading to the woods and on the tank column search, and for this purpose to make the approach along the road from point A to B. The search is to be made by the navigators of all the crews. The element navigator is to start his sighting in the middle of the sector of the road leading to the woods and to release his bombs there. Even if the tank column is not visible, the conflagration resulting from the bombs' bursting in the woods will check the tank movement.

Following the same order the next item as well was analyzed.

The officer in charge of the exercise did not outline in advance any of the possible decision variants, feeling that this would commit him to a decision and would fetter the initiative of the flying personnel. Thinking over the exercise procedure, he endeavored to organize the exercise in such a way as to create, using the lead problems, a situation which would enable the trainees to reach independently, by diverse methods, the most practicable solution to the given problem.

In order to sum up the briefing, the squadron commander suggested the following procedure: determine whether the object of the training exercise was achieved; elucidate the positive and negative aspects of the operations and the decisions of the trainees and show how the errors that were made could be eliminated; and, finally, issue orders for preparing the next scheduled exercises.

The commander presented the methodological material which he had worked out to his superior officer for examination and confirmation, obtained the latter's observations, and corrected the shortcomings. Careful preparation of the briefing enabled the officer in charge to conduct the briefing in a correct methodological manner, to the point, and efficiently. The purpose of the training was accomplished.

Recently a tactical briefing on the subject "Carrying out an AA evasion maneuver by an element within the zone of AA artillery countermeasures" was conducted by Capt. N. G. Berdichevskiy in a lively and instructive manner.

The trainees profoundly studied in advance the tactical and technical data of the AA artillery, of the radar warning and fire control stations, as well as their location at firing positions when covering the ground forces on the battlefield. All the trainees familiarized themselves with the principles and methods of conducting fire with small and medium caliber AA artillery. The officer in charge prepared aircraft models for the exercises and planned how he would use them.

It is characteristic that, due to lack of time, the officers did not on the eve of the exercise enter the ground and air situation on their maps.

The officer in charge allotted one hour to the tactical briefing. At the start he announced the subject and the purpose of the training: "To ready the flying personnel of the element for carrying out an AA evasion maneuver". After this, Capt. Berdichevskiy checked the officers' preparation for the exercise, having asked them several spot-check questions on the tactical and technical data of MZA [small caliber AA artillery] and SZA [medium caliber AA artillery]. The answers given by N. N. Sviridenko and B. A. Plakhinov satisfied the officer in charge of the exercise. It was apparent that they had conscientiously prepared for the briefing.

Capt. Berdichevskiy announced orally the ground and air situation. The officers entered the front line on the map, the fighter patrol zone and the anticipated location of the "enemy" AA artillery batteries, their zone of effective fire in altitude, the range of detection and of automatic target tracking at these altitudes by an AA fire director station. Having convinced himself that the trainees had correctly entered the situation on the maps, the officer in charge set up two lead problems.

The purpose of the first lead problem was to examine the AA evasion maneuver which was executed prior to entering the AA artillery zone of effective fire and designed to complicate the work of the "enemy" AA artillery KP [Command post] in readying their firing data.

"A three-bomber element in close 'aircraft wedge' formation, flying at an altitude of 7000 m to station N to deliver a bomb strike, at 1015 approaches point B located 30 km from the front line. Overcast 7 - 8 points, cloud deck is 5500 - 6000 m."

The officer in charge required all the trainees to evaluate the situation and to arrive at a decision as if they were element commanders.

The majority of officers correctly evaluated the situation and arrived at well-founded decisions. They could be summarized as follows.

The ZA [AA artillery] and ZURS [AA guided rocket missile] batteries with the help of radar stations can detect the aircraft of the element, can determine their flight parameters, and can track them automatically within fixed ranges.

It is with this in view that it is necessary to initiate an AA evasion maneuver in order to complicate the work of the ZA and ZURS control points and deny them the opportunity to prepare their firing data by constantly changing altitude, speed, and course of flight.

However, one of the trainees did not know precisely the ranges of detection and of automatic tracking by the SZA fire director stations and was not able to reach a timely decision as to when to initiate the AA evasion maneuver. Capt. Berdichevskiy analyzed the error committed and explained why the AA evasion maneuver had to be initiated prior to entering the AA zone of effective fire; he explained how the maneuver had to be executed in order to prevent the computing devices from producing the correct firing data and in order to avoid losses from the first salvo.

The second lead problem was set up in order to improve the trainees' techniques in executing the AA evasion maneuver in the AA zone of effective fire.

"Time of operation — 1017. The first element, continuing its AA evasion maneuver by changing course, speed, and altitude, approaches the front line. Altitude is 6500 m. The element commander notices flak 500 - 600 m to the left and 200 - 300 m above. On further observation he established that the salvos follow at 5 - 6 sec intervals and are nearing the bomber element's flight axis." Capt. M.N. Bykov in accordance with the lead problem decided to make two consecutive 10^o- 15^o turns to the right, and then to make a sharp left turn with loss of altitude in order to evade the bursts at increased speed and to cross the line of AA shell bursts at a 60^o - 80^o angle. The decisions of the other officers were also in accord with the situation.

As the trainees reported on their decisions, the officer in charge gave out new lead problems involving "enemy" AA artillery action.

The analysis of the trainees' decisions in connection with this lead problem proved that, in the main, they were correct. However, the omission on the part of the officer in charge was that he did not set up a more complicated air situation for the flight through the AA zone of effective fire, i.e., simultaneous firing by several AA artillery batteries and guided rocket missiles. Moreover, the necessity of dispersing the element with the necessary intervals and distances, taking into account the resolving capabilities of the radar stations of the AA fire control systems, was not made sufficiently clear. Yet, despite this, the exercise was of great benefit to the flying personnel.

The purpose of the exercise was accomplished. In summarizing, Capt. Berdichevskiy announced the names of the officers who had made the most competent decisions and who had most concisely reported on them. In conclusion, he demonstrated how important tactical briefings are for practicing the AA evasion maneuver in pending flights. He also recommended for the trainees literature which would enrich their knowledge in this field. The superior officer who was present at the exercise gave them a high evaluation.

The tactical briefings which were held helped the trainees to expand their knowledge in depth on the subjects that were examined and to improve their techniques of evaluating a ground and air situation and of making their decision. Doubtless such briefings bring about a more efficient organization in carrying out flights.

SAFE TIME INTERVALS FOR BOMBERS AT NIGHT

Lt. Col.
R. SH. BATALOV

Fixing and maintaining time intervals between aircraft is one of the primary conditions of flight safety at night. In instances when these intervals are shorter than those accepted the danger of an air collision sharply increases; but when they are too long the bombing attack is overextended.

Let us examine what the size of a safe interval depends on.

Let us assume that two aircraft have taken off from the same airfield at night and are flying the same flight route — the first plane having taken off several minutes ahead of the second. It follows that the first aircraft will have flown some definite distance from the airfield before the second takes off. The speeds and altitudes assigned both crews are the same.

In an ideal situation (flight speed and heading are maintained with absolute precision) the second plane should pass each check point as well as every other point on the flight route with exactly the same time lag with which it took off. But every pilot and navigator knows that, in flight, discrepancies between the actual and the prescribed flight elements are unavoidable.

Thus, no matter how well the crews are trained and no matter what navigational and ground control facilities they employ, time discrepancies are nevertheless unavoidable in flying the legs of the route. Consequently, the second aircraft may close in on the first and even catch up with it.

A flight at night under adverse weather conditions takes place with conditions of visibility being extremely limited. Therefore it is necessary to preclude the possibility of aircraft closing in to within dangerous limits. To this end it is also necessary to establish a certain time interval between the aircraft which under all conditions would preclude the possibility of one aircraft catching up with another (if both have been assigned the same route and altitude).

In some units they accept as a safe time interval when flying on a route a doubled value of the accuracy of target approach. They consider that if two crews with a definite level of training can approach a target with an accuracy of ± 30 sec., then the flight interval between them at night should be 2 x 30 = 60 sec.

But indeed the fact is that the target run approach is the result of a navigational flight along the route, in the course of which crews determine all errors possible in maintaining the time regime and take measures for eliminating them. Here the possibility is not excluded that they will fly over the intermediate check points with considerably greater time discrepancies than the prescribed accuracy of target run approach calls for. The crew may employ various means of dissipating excess time or of gaining necessary time and may thus achieve the required accuracy.

The fallacy of this method for determining intervals is explained also by the fact that it is not tied up in any way with such an important factor as flight duration. As we know, the longer the flight, the greater the accumulation of errors; and therefore the greater must be the size of the safe interval.

In some quarters another method of reckoning is widely used. It is assumed that, since aircraft closure may only occur when there is a difference between their speeds — and this is due to inaccuracy on the part of pilots in maintaining the established speed — the safe linear distance must equal flight duration multiplied by twice the value of the possible difference in speeds. The safe time interval is determined

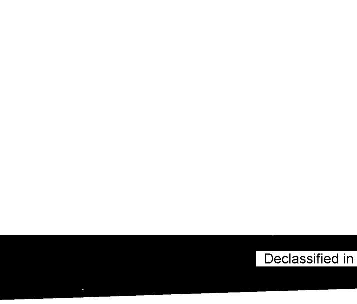

Fig. 1. Aircraft closure on a rectilinear leg.

by dividing the distance by the flight speed.

This method is also invalid, in the first place, because aircraft closure in the air occurs not only as the result of a flight speed differential but also as the result of route deviation, inaccuracy in maintaining the course, etc. In the second place, the speed differential itself occurs not only as the result of the pilot's navigational errors, but also as the result of other factors (instrument errors, inaccurate flight computation, inaccuracy in measuring ground speed, etc.). The pilot's navigational error, however, is, as a rule, averaged out.

A safe interval must encompass all the factors and conditions which lead to aircraft closure on the route.

Each flight route consists of rectilinear and curvilinear legs. For the sake of convenience and simplicity let us examine them individually.

In Fig. 1 is shown the rectilinear leg of the route between two check points A and B which are 150 km from each other. Let us assume that at the instant one aircraft passes the first check point, the second aircraft is 20 km away from him. If the speed is 600 km/hr, the time interval will be two minutes.

Fig. 1 shows three cases of closure. In the upper part it shows a closure resulting from the fact that the speed of the second aircraft was greater than that of the first one. Let us suppose that the second crew made an error in determining the speed, this error being equal to 30 km/hr (from here on in our calculations we will premise the capabilities of a crew with average training). The flight from one check point to the other lasts 15 min. During this time the distance between the aircraft will be reduced by 7.5 km, i.e., the time interval will be cut from 2 min. to 1 min. 15 sec. (by 45 sec.). Thus, the interval error which is due to the speed error for the given specific instance is equal to 45 sec. (Δt_1 = 45 sec.).

In the middle section of Fig. 1 there is shown aircraft closure resulting from the first crew's sheering from the flight path. At point D the crew noticed the deviation, introduced a course correction, and came out accurately at the next check point. However, due to the sheer the plane traveled a longer path. Let us assume that the deviation in the flight heading amounting to 15° arose as the result of the pilot's inaccurate maintenance of the course because of an error in determining the mean course and the drift angle. If the crew notices the sheer somewhere on the middle of the route, then the track of the first aircraft will be approximately 5 km longer, the distance between aircraft will be reduced to 15 km, and the interval will be reduced to 1 min. 30 sec. The interval error will amount to 30 sec. (Δt_2 = 30 sec.).

In the lower part of Fig. 1 there is shown aircraft closure which arises as the result of so-called wobbling on the course. In this case the plane's path will appear as a somewhat undulating line. Since a curved line is always longer than a straight line, flying along it will require more time. However, even if we were to take the amount of permissible oscillations along the given course as amounting to ± 5°, then too the time difference in traveling over the path would amount to only a few seconds. Actually this error may be completely ignored.

Thus maximum closure on a rectilinear leg occurs because of speed differences and sheering from the flight path. Interval errors resulting from these factors may be computed in accordance with the two formulas in Fig. 1.

But what happens on curvilinear legs, i.e., turns?

Let us assume that two aircraft, one following the other with a 2 min. interval (see Fig. 2) have approached the check point (point of initiating turn) and have begun a 120° turn (in order to avoid flying on a near-collision course, it is not recommended to make wider turns at night); speed is 600 km/hr, the bank angle on the turn is 15°.

It is apparent from Fig. 2 that the turn radius of the first aircraft, whose crew incurred a 5° bank angle error (bank angle 10°), is 16 km, while the turn radius of the second aircraft, whose crew has accurately maintained the prescribed regime, is 10.5 km. It follows that the track length of the first aircraft for the 120° turn will equal 33 km, while the track length of the second aircraft will be 21 km. By the time the second aircraft completes the turn (point 0_2), the first aircraft will be at point 0_1. The distance between them at this moment will be 12.5 km.

If, having completed the turn, the crews set a course to the homing radio sta-

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tion or the beacon (the track is represented in the figure by a solid line) located at the next check point, then they will approach the check point maintaining the same distance between them. The interval between the aircraft will be 1 min. 15 sec. (Δt_3 = 45 sec.).

If, on the other hand, after the completion of the turn, the flight proceeds on a previously computed course, the aircraft may close in on each other even more before reaching the next check point. This will take place because the first aircraft, after completing the turn, will not emerge on the anticipated track but will be to the left of it (see Fig. 2). This sheering will result in a corresponding lengthening of the track as in the instance already analyzed above.

The turn radius increases also in the event the speed on the turn is greater than the planned speed; but the increase in arc length in this instance is insignificant. Actually it will not lead to any change in interval (the greater the track, the greater the speed: time remains the same). A few seconds' change in the interval may be ignored.

Fig. 2. Reduction of distance between aircraft on a turn due to banking error.

Fig. 3 shows other cases of aircraft closures on a turn. The upper part of the figure shows the same turn radius maintained by both aircraft; but the first aircraft has approached the initial point of turn with an incorrect heading. The second aircraft has approached accurately. In order to travel correctly along the next leg of the route, the first plane will have, first of all, to make a wider turn. Moreover, the first plane's terminal point of turn (0_1) is much farther away from the next check point than is the second plane's terminal point of turn (0_2).

For our assumed conditions the speed is 600 km/hr, the turn angle 120°, and, if the heading error in approaching the check point is 15° with reference to the planned heading, the aircraft will be closer to each other by 4.8 km. The distance between them will be 15.2 km. Therefore the interval will be reduced from 2 min. to 1 min. 32 sec. (Δt_4 = 28 sec.).

The same thing will occur in case the second crew should fail to maintain the approach heading to the check point and should sheer in the opposite direction.

In the middle part of Fig. 3 we see how closure occurs when the crew of the first aircraft initiates a late turn — i.e., after passing the turn point — or when the second aircraft begins the turn too early. This happens when the crew roughly estimates the moment of reaching the initial point of turn without making use of the optical or radar sight. The error may be quite considerable. In our example, it amounts to 10 km. Then the aircraft will close in to within 5 km (a 15 km reduction). The interval will decrease to 30 sec. (Δt_5 = 1 min. 30 sec.).

Finally, aircraft closure is unavoidable if one of them starts turning over a point located to one side of the planned point (see lower part of Fig. 3). The possibility of sheering depends on the crew's experience and the length of the leg to the check point. If the leg is 150 km, then, for a crew with average training, the sheer may be as much as 10 km. That is, the distance between the aircraft will be reduced to 11.8 km. The time interval will be 1 min. 13 sec. (Δt_6 = 47 sec.).

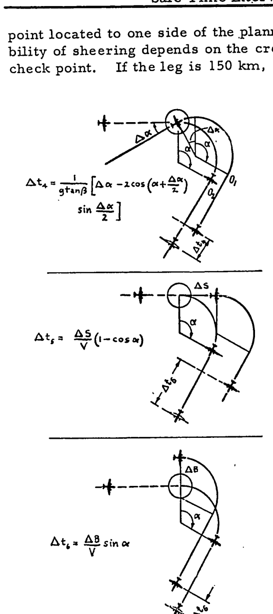


Fig. 3. Aircraft closure due to incorrect approach to initial point of turn.

We have analyzed the basic causes of aircraft closure on rectilinear and curvilinear legs of a route.

Let us determine now for our specific example a common time interval which would fully insure the aircraft against collision. We will assume that the leg of the route which is to be flown by the crews from one check point to the other consists of a 120° turn (see Fig. 2) and of a rectilinear segment 150 km long. At both check points the crews have the opportunity of checking the actual intervals and of introducing corrections.

At first glance, it may appear that a safe time interval must be equal to twice the sum of all the errors found above, since it appears possible to add them all up. Such a possibility, of course, is not completely precluded, but the probability of this is remote. As a rule, a considerable portion of the errors will cancel each other out. In fact, let us turn again to Fig. 2. As a result of the fact that the first crew maintained a bank angle 5° less than the one prescribed, the aircraft closed by 7.5 km (Δt_3 = 45 sec.). But let us suppose that, after completing the turn while flying on the rectilinear leg of the track, the speed of the first aircraft was 30 km/hr more than that prescribed (Δt_1 = 45 sec.). This means the aircraft should have recovered their original distance and the interval error would be compensated for in this manner.

In similar cases, when the total error (in our example, an interval error) is the combined result of a multitude of initial deviations which have different signs, it is common practice to define the value of the total error as the mean quadratic value of all the deviations. It is equal to the square root of the sum of the squares of all the initial deviations:

$$\Delta t_{mq} = \sqrt{2\Delta t_1^2 + \Delta t_2^2 + 2\Delta t_3^2 + 2\Delta t_4^2 + 2\Delta t_5^2 + 2\Delta t_6^2}$$

In this expression all the squares of the radicand values, with the exception of the second, are multiplied by two. The fact is that, in all the preceding discussions we started with the premise that only one aircraft deviates from the planned route, while the other travels without deviations. Actually, however, it is also probable that the other crew will have similar errors. In this connection the errors in each case may be both positive and negative.

As for the second error (Δt_2), since it is by nature single-valued (in cases of deviation from the route to both sides the interval either only increases or only decreases), it does not have to be multiplied by two.

For our example the mean quadratic error in the interval will be:

$$\Delta t_{mq} = \sqrt{2 \cdot 45^2 + 30^2 + 2 \cdot 45^2 + 2 \cdot 28^2 + 2 \cdot 90^2 + 2 \cdot 47^2} \approx 180 \text{ sec.} = 3 \text{ min.}$$

The probable mean quadratic deviation is 0.67. In other words, there is 67% assurance that aircraft flying at an interval which equals one mean quadratic deviation will not close in on each other. In the majority of cases such an assurance is inadequate. Then it is necessary to take the safe interval (t_m) as being equal to two mean quadratic deviations:

$$t_m = 2 \cdot \Delta_{mq}.$$

Such intervals fully assure flight safety.

For our example the safe interval will be:

$$t_m = 2 \cdot \Delta t_{mq} = 2 \cdot 3 = 6 \text{ min.}$$

The computation of the mean quadratic deviation in the interval may be made with sufficient accuracy for all practical purposes in accordance with the graph in Fig. 4. The graph enables us to determine quickly the square root of the sum of the squares of any number of values. To do this one has only first to lay off along the axes the first two radicand values (in our example 45 is taken twice), and to find the point of intersection of the perpendicular lines erected from the segment ends (point A in Fig. 4). Then along the circle which passes through the point of intersection of the perpendicular one drops down to the nearest axis (point B). Along the other axis the next radicand value is laid off (30), again the point of intersection of the perpendiculars is found, and along the circle running through this we go across to the nearest axis, and so on. Such operations must be performed until all the radicand expressions are used up (in the figure is given the graph solution of the problem used in this article as an example). The total value obtained from the

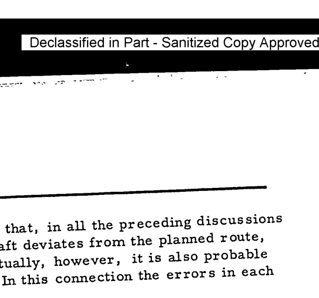


Fig. 4. Graph for determining the mean quadratic error in the interval.

graph must be multiplied by two.

In the example analyzed the initial deviations were determined by geometric construction which can be performed by any navigator. In order to do this, it is necessary to know the flight route, to have a sheet of graph paper, a drawing compass, and a ruler. The calculation can also be made by the formulas given in the figures. The error values in the formula are taken from known norms.

On the basis of flight conditions in one's unit, it is best to compute in advance the tables of interval errors for rectilinear and curvilinear legs of the route, and to use these tables for establishing the intervals before flights. The table for curvilinear legs is computed according to the values of Δt_1 and Δt_2 and a 15 sec. take-off error; the table for curvilinear legs is computed according to the values of Δt_3, Δt_4, Δt_5, and Δt_6.

Sometimes it is advantageous to draw up one common table of safe time intervals. Then it becomes unnecessary to use graphs. We give a specimen of such a table computed for our example for an altitude of 5000 m.

Legs of route		Speeds	
length of leg(km)	turn angle(°)	500	600
100 100	60 120	240 380	210 340
150 150	60 120	300 440	250 350

The safe intervals for flying at night and under adverse conditions obtained by us are quite large (6 min.). Would it not be possible to reduce them?

First of all let us note that the intervals come out very large if the crew's flight along the entire route takes place without a check on the mutual location of the aircraft aloft. Yet a check must be made without fail. In our unit, for example, we successfully employ a method of checking on the basis of the time distance to the lead plane and using also ground radar stations. In other units a time schedule is assigned each for passing the check points in order to maintain the intervals. The largest time interval errors — as we see from the example analyzed — occur because of incorrect approach to the initial point of turn (Δt_5 and Δt_6). But if the approach to the initial point of turn is determined by the optical (under normal weather) or the radar sight (under adverse weather), by radio compass (over a homing station), or by using a distance measuring radar system, then the error — though not completely eliminated — will be small.

In cases when flights are made over short distances, it would be expedient for all the crews to compute the flight elements on the basis of a single wind (determined by pilot balloon or received from a weather reconnaissance plane). During the flight itself time intervals are checked in accordance with the time distance to the lead plane.

The use of such a flight method enables us to eliminate many errors (disparate data on wind readings in flight, unequal track length due to deviation from the route). Of course, the wind taken into account may differ from the actual wind; but this inaccuracy will influence all the aircraft to the same degree, and will not affect their mutual position. Sheering from the track will, as a rule, be the same for all the crews; hence, in practice, they will not produce any variations in the length of the track flown by the planes.

The commander, by choosing wisely the flight conditions, may significantly reduce the size of the time intervals without sacrificing flight safety. But the most important factor is the training and experience of the crews. All the initial errors in speed, flight heading, maintaining bank angles on turns, etc., are the direct result of the flying personnel's training proficiency. At the beginning, when the crews are just starting to master night flights, exaggerated intervals must be used and then they must be gradually reduced. In connection with this, the commander every time makes a general evaluation and decides which of the initial errors may be reduced or completely disregarded.

CONTROL OF FLIGHT OPERATIONS ON BOMBING RANGES

Col. I. V. VOROB'YEV

Control and direction of flights on a practice range is exercised from the command post by a flight control officer who is assigned for each flying day (night, relief). According to the manual, those who have authority to control flights on a range are the range officer, his assistants who are permitted to control flights, and unit representatives. The latter are designated by the unit commanders from among members of the flying personnel who have had experience in flight control and who have learned thoroughly the appropriate instructions.

The flight control officers assigned from the units can be on the range even if the authorized flight control officer is present (they assist him and direct the work of the crews from their own units).

Air Force ranges are divided into different categories and are equipped with radar stations accordingly. In addition to those assigned to the range, the radar stations and automatic radio direction finders of the nearest airfields may also be used for flight control.

Among well-equipped command posts at Air Force ranges are those directed by officers Kh. M. Gopnik, V. A. Lakhno, G. F. Govorukhin, V. S. Filonov, and others. Many of these ranges have selector systems. Besides radar stations, some of them have automatic radio direction finders for control purposes. Combined utilization of these facilities gives favorable results in identifying aircraft making bomb runs.

It is very important to choose correctly the place for erecting the radar station on the range. As shown by experience, it is desirable to locate it 14 - 15 km from the range boundary. In this case, the aircraft will be controlled continuously over the entire bomb run.

On some large ranges, mobile radar stations are located in the immediate vicinity of the range command post, while fixed stations are installed at the command post, making it possible for the flight controller to observe the aircraft directly on the radar screen. However, in this case the aircraft are not controlled for the entire approach but only within the detection range (usually up to entry onto the bomb run or up to the bomb-release line). This means that it is necessary to use additional facilities.

On the range commanded by officer A. S. Prokhorov, the radar station is located near the range command post. The flight controller monitors the aircraft on the radar screen. To facilitate control, the bombing approach routes and the blips from local fixed objects are shown on the screen. In addition, a model of the range made by the range personnel and a movable model plane are used. The model plane moves steadily (driven by a small electric motor) along the bomb run at a speed corresponding (in scale) to the speed of the aircraft.

It is advisable to locate the different type radar stations at one point near the command post. One of them can be used for observing the entire area and the other for following the aircraft on the bomb run.

It should be noted that the organization of flight control depends in large measure on coordination in the operation and precision in the interaction of these stations. On the ranges, the areas of their control are usually delimited precisely and the method of transferring the aircraft from the plotting board of one station to that of the other is usually well worked out.

Well-instructed and trained personnel at both stations will insure precision in the organization of interaction and reliable control of the aircraft flying past, and will also resolve successfully a number of other problems (for example, training the crews in bombing real objects without dropping bombs, calculating the elements in the bomb run, determining the wind at flight altitude, etc.).

All the means of control will give results if they are properly installed, if they have uninterrupted two-way communication with the command post of the Air Force range, and if they are always in a state of combat readiness.

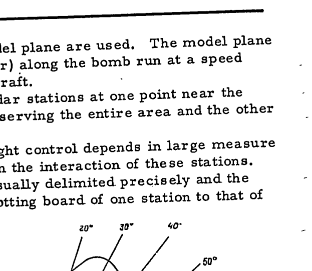


Diagram of use of automatic radio direction finder for aircraft identification.

Accurate identification of aircraft plays a major role in flight control at a range. In the area of the range and directly over it, there may be several aircraft at one and the same time: one (or more) approaching the range, another on the bomb run, a third in the "pattern", and so on. It is very important that the flight controller know just which planes (crew index numbers) there are and where. It may even happen that an aircraft at some distance from the range may take the blips of entirely different, non-range objects as the radar target and request permission for bombing. If the flight controller does not know the position of the requesting aircraft, or mistakes this aircraft for another, the bombs will be dropped outside the range.

Determining the position of an aircraft is quite a complicated matter. However, certain methods of identification, proven by experience, can be recommended — for example, with the aid of an automatic radio direction finder. If there is none at the range, the radio direction finder of one of the nearest airfields is used. For effective control, two-way communication is necessary between the direction finder and the range KP [CP], and the plotting board of the search radar station must be specially prepared (the position of the direction finder and the bearing lines in the sector overlapping a portion of the route under control must be accurately shown

on the plotting board — see fig.). Obtaining the data from the radio direction finder, let us say "315" (index) and "90" (bearing), the flight controller determines that the aircraft requesting information is on the "90" bearing line. The data from the direction finder are compared against all other data available at the KP.

The most widely used method of aircraft identification is information from the crew. In the approach and during operations on the range, the crew reports to the controller on its position and the fact that the target has been sighted. A uniform procedure for these reports has been established. If necessary, the flight controller can himself ask any crew about this.

In all cases, the controller on the range is required to compare all the information at his disposal on the position of the aircraft before giving the crew permission to drop the bombs or to fire.

The work of the controller on the range is facilitated considerably by models of the range made by the personnel and showing the approach "pattern". On these models, movable aircraft models are placed with the index number of the crews (in conformity with crew reports). By means of the model it is easy to show the air situation by day under ordinary weather conditions when there are 3 or 4 aircraft over the range (in the "pattern") at the same time. Such models are especially useful where the location of the radar stations does not permit control of the aircraft over the range.

Occasionally, if a running bombing is being carried out, only the bomb run of the aircraft is indicated on the range models. The flight controller starts the model moving at the moment the aircraft enters the NBP [start of bomb run], and then controls its position by reference to the model and the reports of the crew.

With skillful use, such simple devices facilitate the operation of ranges, graphically showing the air situation over the range and its surrounding area.

For successful flight control, proper equipment at range command posts is mandatory. The KP at an Air Force range is located in a safe zone and at the point most convenient for observation, inasmuch as it must provide for control and direction of aircraft flights over the range, observation of the target areas, receiving and transmission of orders, processing the results of taking fixes on bomb bursts, summation of the information on the results of bombing (or aerial gunnery), as well as convenient and safe work conditions for the personnel of the crew on duty. That is why it is necessary to prepare in advance some quarters for the crew on duty.

First of all, a place is designated for the flight control officer. It is located so that there is a good view of the target areas on the range, but not necessarily on a tower. It is provided with work space for the flight control officer, the range officer or the commander of the range platoon, the plotting personnel of the flight control radar station, and the communications man on duty. Nearby a room is provided for the computer section. Located in it are the detachment commander and the computing and plotting men.

If the range command post also serves as an observation post, a separate room is allocated to the senior observer for operation of the observation instruments. Finally, quarters are also necessary for the meteorologists, for fixed communications and radar facilities, and for the duty crew to rest in during the intervals between bombing and gunnery.

The range command post must have all communication and signaling facilities. Thus, in the flight control officer's room there should be a plotting board 1000 x 1000 mm in size for a long-range radar station. This board is basically a frame made of wooden strips and covered on both sides with plywood. The functional side of the plotting board is covered with a removable plexiglas cover on which two scales have been drawn (if the radar stations are located near each other): an outer scale in degrees, and an inner scale in angular graduations. Fastened in the center of the removable cover is a scale rule graduated in kilometers in conformity with the scale on the map.

For this plotting board, it is best to use a map with a scale of 1:500,000, plotting on it in advance the boundaries of the range and its vicinity, the approach routes, and the start of the bomb run, the location of the radars, air routes in the vicinity of the range, the waiting zone, entrance and exit corridors, etc. If the distance between the radars is greater than 5 km, an azimuthal scale is drawn on the map in angular graduations with respect to the locus of the radar station that is used for target designation.

The other plotting board serves directly for control and does not differ in structure from the long-range plotting board, but it should be somewhat larger — 1200 x 1200 mm. The map used for this board is on the scale of 1:100,000. Plotted on this map are the boundaries of the range and its vicinity, the entrance and exit corridors, the approach routes and the start of the bomb run, prohibited areas, waiting zones, the location of the targets, radars, and power facilities on the range. In addition, the boundary lines of safe bomb release under specific bombing conditions may be charted on the map or on the plexiglas of the board.

For either plotting board, when the map is inserted, the center of the board (the point at which the scale rule is affixed to the removable cover) must coincide precisely with the radar locus, and the map must be adjusted for direction.

At the KP there should be an extension interphone from the radio communication stations (an amplifier with a microphone and loudspeaker); wire or radio facilities for communication with the radar stations and with the radio and wire communication stations, with the beacons, the guard posts, the observation points, the dugout shelters, and all the sub-units of the range; a control panel for electrified night targets and signaling facilities (flare pistols and flares, smoke pots, pyrotechnic flare candles, and other facilities). There should also be optical observation instruments, watches, scale and navigational rules, maps of the flight area, instruction manuals on tactical training of the various air arms and on the VVS [Air Force] Range Service, instructions on bombing and gunnery at that particular range, message signal log, etc.

Let us now analyze the procedure followed by the aircraft crew in making a bomb run and the work of the range flight controller.

Approaching the area of the range, the crew or the group commander are required to establish two-way radio communication with the range command post, report on the approach altitude, the estimated time of arrival at the range, and the target they will bomb, and to request permission to approach the range.

The flight controller, having established contact with the crew (or group) checks that the index number of the aircraft corresponds to that on the planned schedule of bombing and gunnery, determines the position of the aircraft by all the means at his disposal, and evaluates the situation in the air. In doing this he takes into consideration the number of aircraft in the air above the range and its surrounding area, the type of aircraft, altitude and speed of flight, weather conditions, the condition of the range, and target visibility. Having determined the number of aircraft that will continue bombing, the flight controller gives the crew permission to approach and informs it of the situation. When the required safety conditions are lacking, the controller may send the aircraft for the time being to the waiting zone until the range is clear.

Having gone through the entrance corridor and entered the start of the bomb run (NBP), the crew, upon sighting the target, informs the KP of this and reports on the distance to the target.

From the time he establishes two-way radio communication with the aircraft, the flight controller on the range follows it on the plotting board of the radar station, which becomes operational 15 - 20 minutes before aircraft arrive on the range. The plotter, continually (every 20 - 30 seconds) receiving data on the position of the plane (azimuth and range), draws a line representing the plane's track and indicates its index number on this line. Well-trained operators and plotters can simultaneously draw several lines in different colors for the tracks of different aircraft.

The flight controller, comparing the position data received from the aircraft with data of the radar station, assures himself that the aircraft starting the bomb run is the one that has reported its entrance on the NBP. If the data from the crew and the radar data are widely divergent, he intently and constantly follows the flight of the aircraft, and if there are serious divergencies he forbids dropping the bombs and suggests making another approach. If on the second approach the crew again starts the bomb run with considerable deviations, the flight controller takes steps to vector the aircraft to the NBP (by switching on the homing radio station, beacons, or by giving commands from the ground, etc.) or forbids it to drop the bombs at all.

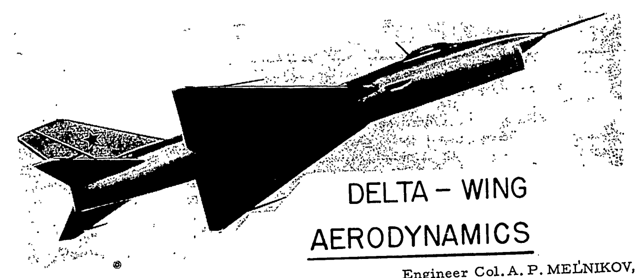
Recognizing the radar target at a time when ND [maximum range] is 30 - 50 km, the aircraft crew informs the flight controller of the slant range to the target, reports that it has sighted the aiming point and all the markers, and requests permission to bomb.

The flight controller, assuring himself once more that that particular aircraft is on the bomb run and that it is approaching the target properly, gives permission. But even after that he continues controlling carefully the movement of the aircraft by reference to the plotting board of the radar station or by the time and speed of its flight, so that the bombs will be dropped within the safe zone (it is desirable to plot in advance this zone on the plotting board for the assigned bombing conditions). If the aircraft has gone past the bomb-release zone and has not reported dropping the bombs, the controller immediately forbids bombing.

In making repeat approaches, the crew reports to the flight controller all turns made in the "pattern", and on entering the NBP it repeats all its actions in the previous sequence.

Bombing has been completed. The crew asks for the results. The flight controller can answer the request from the unified chart.

Proper organization of flight control, efficient arrangement and use of the means of control, reliable communications between the command post and the planes in the air, the radar and other facilities — all make it possible to increase the traffic capacity of the range, to prevent flying accidents, and to avoid cases of serious error in dropping bombs.



DELTA – WING AERODYNAMICS

Engineer Col. A. P. MEL'NIKOV,
Professor, Doctor of Technical Sciences

Aircraft with delta wings have begun making a more frequent appearance in military and civilian aviation in recent years. It is interesting to study in this connection the aerodynamic characteristics of such a wing which have an influence on the flight characteristics of the aircraft as a whole. The form of the wings influences above all the aerodynamic characteristics which, however, closely depend on the weight, strength, operational, and other characteristics.

The triangular wing form (the "delta wing") is not new to aviation. Experimental models of aircraft and gliders with such wings were designed and built long before WW II. As a rule, these were tailless aircraft and aircraft without fuselage of the "flying wing" type.

As early as 1923, the tailless gliders of B. I. Cheranovskiy, with the leading edge of the wing in the form of a parabola, were flown successfully at the First All-union Conference of Glider Pilots, as well as in subsequent years. The aspect ratio of the wings on the whole was extremely low for that time, and the form of the wings in plan view resembled a triangle. Because of this form, B. I. Cheranovskiy was able to come up with an exceedingly lightweight design. His glider was one of the lightest. At the same time, the wing had such absolute thickness that it accomodated the pilot.

An experimental aircraft with a delta wing of a very low aspect ratio ($\lambda \approx 1$) designed by A. S. Moskalev was successfully flown in 1936.

Tailless aircraft and glider bodies with delta wings were being also constructed in the same period in Germany, USA, and other countries. It was assumed that the delta and sweptback wing forms were preferable at flight speeds of that period for aircraft of the tailless and the "flying wing" type. Delta (and sweptback) forms permitted the designer to combine the aerodynamic focus of the wing with the center of gravity of the aircraft, or to move it somewhat to the rear with respect to the latter, which was necessary for equilibrium and stability of tailless aircraft in the air.

At the same time, the large dimensions of the root chords of the delta wing made it possible to achieve a thickness of the middle section which accommodated all necessary loads inside the wing.

Preliminary calculations showed that the best aerodynamics of the designs without fuselage could be realized fully only on aircraft of high flying weight (80-100 tons and more), which were built rather seldom before WW II. Therefore, the aerodynamic design of the tailless aircraft and aircraft with delta and sweptback wings could not be fully perfected at that time.

As long as maximum aircraft speeds did not reach the speeds of shock stall (M of the order of 0.7-0.8), the monoplane with a fuselage and a straight wing and empennage at the rear end of the fuselage was the predominant design.

The necessity of overcoming the "sound barrier" and the shock stall led to the transition to sweptback wings and sweptback empennage. At first, fighter aircraft, light bombers and, later, heavy bombers — including transports — took on the characteristic sweptback configuration. In addition, the wing aspect ratio $\lambda = \frac{l^2}{S}$ (where l is the span, S the area of the wing) has considerably decreased in many aircraft. Prior to 1945 aircraft with an aspect ratio of less than 5 were rare, whereas aspect ratios of 3-4 and even less are characteristic of the modern high-speed machines. By decreasing the aspect ratio, as is known, we lose in induced drag, but gain in the thickness of the wing and, consequently, in profile drag and weight. The designers ceased "to fear" wings of small aspect ratios and this promoted a more rapid transition to the delta wing, which by its nature is a wing of small aspect ratio. The aspect ratio of the delta wing depends on its half angle γ at the apex, given by the simple formula

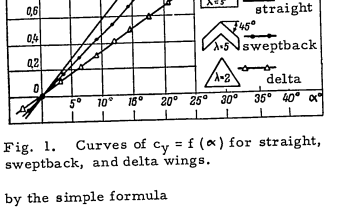


Fig. 1. Curves of $c_y = f(\alpha)$ for straight, sweptback, and delta wings.

$$\lambda_\Delta = 4 \tan\gamma .$$

At $\gamma = 45°$, which should be considered a sufficient magnitude of the angle, $\lambda_\Delta = 4$. In the case when the sweep is increased, i.e. when the angle γ is decreased to 30°, the aspect ratio becomes equal to 2.31, which at present is quite normal for this type of wing.

In the past, aircraft with delta wings of high aspect ratios were sometimes constructed, but the positive characteristics of such a design (great strength and rigidity with slight thickness and weight) could be realized in full measure only with wings of low aspect ratios (λ less than 3). As is well known, these have serious disadvantages at low flying speeds.

Figures 1 and 2 show for comparison the polars and curves of $c_y = f(\alpha)$ for the straight and sweptback wings of normal aspect ratio ($\lambda = 5$) and for the delta wing with an aspect ratio of $\lambda = 2$. All of them have identical symmetric profiles and were tested at low flow speeds ($M \approx 0.1$) when the compressibility is not effective.

As can be seen from these diagrams, a straight wing of sufficiently high aspect

ratio shows the best characteristics at low speeds. It has the greatest slope of the curve of c_y in relation to α $\frac{dc_y}{d\alpha}$, the highest value of $K = \frac{c_y}{c_x}$ (about 20), and the smallest induced drag at high values of c_y.

The characteristics of the sweptback wing are considerably lower. The decrease of the lifting force of the wing is approximately proportional to the cosine of the angle of sweepback ($c_{y_\chi} \approx c_{y_{st}} \cdot \cos\chi$); with c_y greater than 0.4 the drag, which depends on the angle of attack, begins to increase rapidly because of the separation of the air flow at the edges of the wing.

Even lower are the characteristics of a delta wing of low aspect ratio. Its only advantage is the high value of $c_{y_{max}}$; but it can only be attained at such angles of attack ($\alpha_w \approx 37°$) that it is impossible to take advantage in practice of the high values of $c_{y_{max}}$ in flight and especially during landing.

The situation is entirely different at Mach numbers close to unity. As is known, sweepback makes it possible to realize a large gain in drag and to improve the longitudinal stability and controllability characteristics at transonic speeds. The drag can also be considerably reduced in shock stall with the straight wing, but a sharp decrease in its thickness and aspect ratio is required for this. Fig. 3 shows the drag $Q = c_x \frac{\rho V^2}{2} S$ (or the required thrusts P_r) as a function of the Mach number for two straight wings of slight thickness (5 and 3%). The profiles of both wings ended in a sharp tip which led to the separation of the flow at the angles of attack as low as 8-10°. The separation of the flow causes a high increase in head drag in the direction of the small Mach numbers as well (see Fig. 3). This increase can be reduced if forward slotted flaps are employed. At Mach numbers either greater or equal to one, a wing of greater thickness (5%) gives a rapid increase in drag. Transition to the thickness of c = 3% sharply reduces the drag (by 70-75%) but the straight wing cannot be given such slight thickness because of the sharp decrease in strength and especially because of the rigidity of the wing.

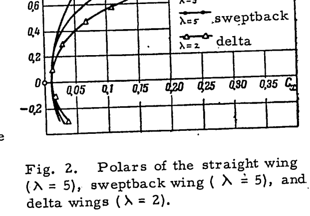


Fig. 2. Polars of the straight wing ($\lambda = 5$), sweptback wing ($\lambda \doteq 5$), and delta wings ($\lambda = 2$).

Sweptback wings are even worse from the standpoint of strength, rigidity, and weight of design. In the transition from transonic to supersonic speeds, the angle of sweepback must be continuously increased (from 45° to 60° and more). In this, the negative characteristics of such wings at low speeds (premature separation of the air flow at the tips, deterioration in the operation of wing mechanization, etc.), make themselves felt more and more. The speeds and maneuvering of aircraft with sweptback wings are limited, not by lack of thrust, but out of consideration for prevention of vibrations and large deformations which imperil the strength of the aircraft. The achievement, on the other hand, of the necessary rigidity to remove limitations on speed, altitude of flight, and excess G-forces requires such an increase in the weight of the wing and the fuselage as to make them aerodynamically and economically undesirable.

Thus, we arrive at the conclusion that it is advisable to utilize a triangular wing form of small aspect ratio. This form combines the ability of the sweptback wing to hold back the onset of the shock stall (up to $M \approx 0.93 - 0.95$) — with sufficient rigidity of design and load capacity of the wing — with the possibility of using small thickness of profile (2-4%) for a sharp increase of c_x at supersonic speeds.

Theoretical and experimental data show that delta wings are far from always being superior in the aerodynamic sense to the sweptback and the straight wings — given the same geometric parameters, i.e., the same thickness, aspect ratio, etc. At present, the aerodynamic characteristics of the wings are usually determined theoretically with the aid of the so-called linear theory. This theory cannot always be employed for precise calculations. However, the qualitative character of the functions and the order of magnitude of aerodynamic coefficients obtained from it agree in general with experiment. The maximum quality computed with the aid of this theory for wings of the three different forms is shown in Fig. 4. At Mach numbers in excess of 2.5 when the leading edge is supersonic and the air induction force is absent, the form of the wing has practically no bearing on the quality. At Mach numbers greater than one, but less than 2.5, the air induction forces acting along the leading edges of the wing are effective. In these conditions the delta wing occupies an intermediate position — as far as quality goes — between the sweptback and the straight wing (in this case rhomboidal).

Let us compare the wings according to yet a different characteristic, the relative coefficient of the minimum wave drag $\bar{c}_{xpwd} = \frac{c_{xpwd}}{c_{xpwd\infty}}$ (the coefficient of the "profile-wave" drag) where $c_{xpwd\infty} = \frac{K\bar{c}^2}{\sqrt{M^2-1}}$ is the coefficient of the drag of a wing of infinite span with the same profile. According to the linear theory, the coefficient K depends only on the form of the profile (for a rhombus K = 4, for a lens shape K = 16/3, etc.

As can be seen from Fig. 5 which shows c_{xpd} as a function of the effective aspect ratio $\lambda_e = \lambda\sqrt{M^2-1}$, the delta wing at Mach numbers slightly greater than unity (with λ_e less than 2) exhibits worse characteristics than the sweptback wings. Figures 4 and 5 show for comparison the characteristics of wings of different forms but with

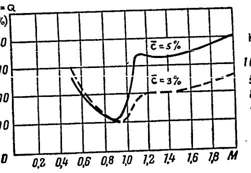


Fig. 3. Variation of the required thrust for thin straight wings of various thickness.

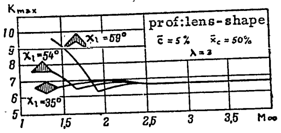


Fig. 4. Maximum wing quality (c = 5%) in a supersonic flow (calculated according to the linear theory).

approximately equal geometric characteristics (comparative thickness, aspect ratio).

Curves of minimum drag for two sweptback and two delta wings are displayed in Fig. 6. As can be seen, the drag of the sweptback wing with a large sweepback (χ = 60°) at Mach numbers from 0.8 to 1.5 is very low. The delta wing with the same sweepbacks (60°) and the same aspect ratio (λ = 2.31) yields a drag approximately twice as great at the same Mach numbers. Both wings had the same relative thickness of 6%. However, the weight and strength characteristics of the sweptback wing of such a thickness and sweepback are unsatisfactory. This, as has already been men-

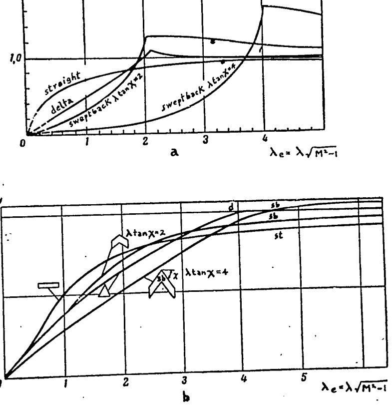


Fig. 5. Profile-wave drag (a) and coefficients of lift (b) for wings of different forms (calculated according to the linear theory)

tioned, leads to limitations on acceleration forces, speed, and altitude of flight. As a result, the better aerodynamic qualities of such wings cannot be realized. If, however, the angle of sweepback is reduced to 45°, the drag of the sweptback wing increases sharply as can be seen from Fig. 6, while at Mach numbers equal to 1.2 - 1.3 it exceeds that of delta wings of the same thickness.

Fig. 5 shows the comparison between the delta, straight, and sweptback wings in regard to the relative coefficient of lift $\bar{c}_y = \frac{c_y}{c_{y\infty}}$ where $c_{y\infty} = \frac{4\alpha}{\sqrt{M^2-1}}$ is the coefficient of lift of a wing of infinite span. This comparison is made on the basis of calculations performed according to the linear theory, which yields for c_y fairly good agreement with experiment.

From the discussion, it follows that the delta wing differs slightly in its performance characteristics from the straight and the sweptback wing with slight sweepback χ and aspect ratio λ. With an increase in χ and λ of the sweptback wing, with λ_e greater than 0 but less than 4, its lift decreases markedly as compared with the delta and the straight wings.

At Mach numbers greater than 2.5 the coefficient $\bar{c}_y$(as well as $\bar{c}_{x\,p\cdot i}$) of wings with different plan forms become gradually equal, approaching unity. This occurs because the conical turbulence waves originating at the leading and side angular points of the wing become narrow with an increase in the Mach number and the portions of the wing surface which are cut off by the turbulence cones become comparatively smaller and smaller.

Fig. 6. Experimental curves of the profile drag of wings ($\bar{c}$ = 6%, taking into account interference with a solid of revolution, the body of the rocket).

Under these conditions wing aerodynamic characteristics are not influenced primarily by the plan form but by the form of the profile and above all by its thickness. As we have already seen, the profile wave drag is proportional to the square of the relative thickness of the profile; but its lift is in the first approximation independent of it. This makes it clear what a great influence the relative thickness has on the quality of the wing. Modern aircraft industry has materials and technology at its disposal which make it possible to manufacture a delta wing considerably thinner and lighter in weight than any other wing. At Mach numbers of the order of 2-3 and greater, thin straight wings of small aspect ratio — of about 2 (Fig. 6) — can compete with it, especially if they are to be "relieved" by engine nacelles situated at the tips. In aircraft and rocket missiles flying at Mach numbers of the order of 2-3 and greater, the wings must be so thin that the use of their interior for accomodation of cargo is out of the question. The wings can be all made out of a metal (not hollow without internal frame — without ribs, longerons, and stringers) which has high strength and thermal characteristics (high alloy steel, titanium alloys, etc.) The technology of manufacture is considerably simplified in this way and the cost is lowered.

Let us dwell briefly on the moment characteristics of wings in a supersonic flow which have an influence on stability and controllability. As is known, the longitudinal stability and controllability depend on the relative location of the aircraft's center of gravity and the aerodynamic focus. The location of the aircraft's focus is determined mainly by the focus of the wing. At low speeds the focus of the straight wing is located approximately at one-quarter of its median chord, measuring from the edge. With an increase in the Mach number the focus at first moves somewhat forward, and then (at $M \approx 1$) is displaced backward at a rapid rate to a distance of about 50% of the wing's chord. Sharp fluctuations of the focus at shock-stall speeds and its movement backward at supersonic speeds have a very detrimental influence on the controllability of the aircraft with a straight wing (its stability becomes exceedingly

great). This leads to the necessity of making the whole empennage (stabilizer) moveable, especially since a deflection of the control surface in a supersonic flow has almost no influence on the lift of the stabilizer located in front of it.

The focus of the delta wing moves over a much narrower range with an increase in the Mach number, and in addition this occurs more smoothly.

At subsonic flows the focus of the delta wing is located at a distance of between 57% and 62% of the root chord, measuring from the wing apex. In a supersonic flow the focus moves to 65-67% and rests close to the center of gravity of the area of the triangle. With such small displacements of the focus it is easier for the designer to insure longitudinal stability and controllability than in the case of an aircraft with a straight or sweptback wing (if the motion of the focus of the delta wing is not considered with respect to the root chord, but with respect to SAKh [mean aerodynamic chord] it is somewhat greater). However, if we consider the dynamic stability of

Fig. 7. Bomber with a delta wing (design close to that of the "flying wing").

Fig. 8. Comparative characteristics of lateral (a) and directional (b) stability for aircraft with different wings.

the aircraft with a delta wing, the situation is somewhat worse.

In post-war years a number of transonic jet aircraft with delta wings were designed and constructed; some of these were series-produced. The majority had the tailless (Figures 7 and 9) aerodynamic form, or were close to it in form.

However, this circumstance does not yet mean that the delta wing is suitable for only such a design; rather the opposite. Preliminary calculations show that the negative qualities of the delta wing are especially strongly manifested in the tailless design. These negative moments are: bad damping of longitudinal vibrations at all speeds and especially at Mach numbers somewhat more than 1; considerable decrease in takeoff and landing characteristics because of the low value of c_y used at landing; and the impossibility of using normal wing flaps, which are replaced by elevons and the fuselage. In addition, bad characteristics of lateral and directional (weathercock) stability are inherent in every delta wing of small aspect ratio.

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Figure 8 shows the change in lateral and directional stability of aircraft with straight, sweptback, and delta wings. The lateral stability m_X^β can be visualized in concrete form as represented by the value of some (imaginary) effective angle of "lateral V" [dihedral] — ψ_e. It is known that positive (straight) sweepback in itself creates great lateral static stability which must be decreased; this is achieved by giving the wing some negative dihedral angle. In the delta wing the sweepback of the leading edge increases the lateral and directional stability even more than that of the sweptback wing. Lateral stability caused by the sweep is expressed by the equation:

$$m^{\beta}_{X\,sw} = -K_1 c_y \tan X ;$$

in other words, it changes proportionally to c_y, whereas the directional stability is given by the equation:

$$m^{\beta}_{X\,sw} = -K_2 c_y^2 \tan X .$$

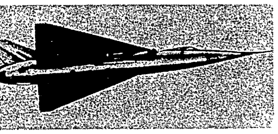

Fig. 9. Tailless aircraft with a delta wing.

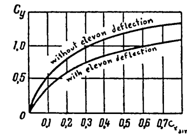

Fig. 10. The effect of elevon deflection on the polar of the tailless aircraft with a delta wing.

That is, it changes proportionally to c_y^2. This circumstance is especially undesirable in flight at various speeds and altitudes when the excessive stability of the delta wing comes into play. A high degree of lateral stability at high values of c_y can cause considerable lateral oscillating instability (of the "dutch roll" type) which leads to the necessity of large areas of vertical empennage and a negative dihedral angle. With great directional stability this leads to the so-called "spiral instability" of the aircraft which in itself is less dangerous than oscillating instability, but which requires additional automatic equipment to neutralize the continuously increasing deviations from the course and the bank angles.

One of the major disadvantages of tailless aircraft design with a delta wing is the drastically reduced maneuverability caused by the decrease of the range of c_y used, and the low effectiveness of mechanization in such an aircraft. In addition, the deflection of the elevons (i. e. of the control surfaces located along the trailing edge of the wing and serving the simultaneous function of ailerons and elevators) necessary to trim the aircraft at large angles of attack decreases c_y even more and considerably increases c_x of the wing. This can be seen in particular from Fig. 10 where the polars for a tailless aircraft with delta wing are shown without the deflection of the elevons, and with their deflection at the time of landing approach.

The disadvantage mentioned above are partially removed in the transition to the usual "tail" design of the aircraft with the delta wing. At present delta wings are installed in a number of aircraft and winged missiles with an empennage located far from the wing at the end of a long fuselage or missile body.

Thus, the delta form cannot be regarded as the optimum wing form for just any supersonic aircraft. It has positive as well as negative aspects. The advantage of using one or the other form can only be determined on the basis of an analysis of calculations made for every experimental model.

From Aerodynamic Flight to Space Flight

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In our time when definite steps have been taken towards penetrating interplanetary space, and Soviet intercontinental rockets and artificial earth satellites — the first in the world — have reached the altitude of many hundreds of kilometers, the problem of the interrelationship between conventional aircraft and vehicles for outer space flight has taken on great importance.

What are the distinguishing characteristics of space flight?

We shall attempt to consider this complicated and many-faceted problem, basing our discussion on the physical laws which determine the flight conditions.

The space surrounding the terrestrial sphere can be divided into three zones from the standpoint of the flight conditions: lower, middle, and upper.

The lower zone includes that part of the atmosphere, within which the force of gravity on an aircraft is balanced by the support of the air. This support is aerodynamic in those cases when the lift is the result of the interaction of the entire aircraft or its parts (propellers) with the air, or when the supporting force is determined by Archimedes' law. Flight speed in the atmosphere is limited. Even at velocities considerably below cosmic velocities high temperatures due to friction are developed. For instance, in a flight with a velocity of 3700 km/hr, i. e., three times faster than the speed of sound, the temperature reaches 560^o [C]. Consequently, a prolonged flight in the atmosphere at cosmic velocity is not possible; the flying body will burn.

In the upper zone air resistance is so slight that it can be neglected and heating need not be taken into account. At a height of about 300 km the ambient density is ten billion times less than at the surface of the earth. Flight is governed here by the simplest laws of ballistics or celestial mechanics.

The flight regions of conventional aircraft and spaceships are separated by a layer of air of considerable thickness, about 30 to 200 km. In this zone prolonged flight is not feasible, but space flight vehicles must traverse it. This is where a new and very difficult problem arises: How to pass through the above-mentioned zone of the atmosphere in the best way. In climbing, propulsion at a comparatively small velocity — not exceeding the speed of sound by more than 2-3 times — is obviously more advantageous. In this way it is possible to avoid excessive heating of the flight

vehicle. The required cosmic velocity can be reached outside the atmosphere by giving full power to the appropriate rocket engine. How should we visualize the high-speed and high-altitude flight of an aircraft and that of a space vehicle? What is the energy required for their propulsion?

It is known that the main requirement for horizontal flight is equality of the lift and of the weight of the flying body. Propulsion in such flight does not take place along a straight line but along the arc of a great circle whose radius — neglecting the elliptic form of the earth — equals the radius of the earth R plus the flight altitude H. This is why to the lift is added a centrifugal force equal to

$$\frac{V^2 \cdot G_o}{(R+H)\cdot g},$$

where V is the flight velocity, G_o the weight of the aircraft, and g the acceleration due to the force of gravity.

Assuming that the aerodynamic lift is equal to $\alpha\rho V^2$, and the weight of the aircraft is inversely proportional to the square of the distance from the center of the earth according to the law of gravitation, the following formula may be written

$$G_o\left(\frac{R}{R+H}\right)^2 = \left(\alpha\rho + \frac{G_o}{(R+H)\ g}\right)\cdot V^2, \qquad (1)$$

where G_o is the weight of the flight vehicle at sea level, α is a constant, and ρ is the density of air at a given altitude. From this it is easy to find the speed necessary for horizontal flight.

With an increase in altitude, the density of air ρ, decreases, which leads to an increase in flight speed.

Figure 1 shows the approximate change in speed, required for flight along an arc of a great circle, as a function of altitude. Because the ratio of the weight of the flight vehicle G_o and the value α can differ, a sheaf of curves differentiated by hatching is shown in Fig. 1 instead of one curve. Analyzing the diagram, we come to the conclusion that the atmosphere can also be divided into three zones on the basis of aerodynamic flight velocity data. In the lower zone, the speed of horizontal flight increases rapidly with an increase in altitude, this increase being inversely proportional to the square root of the air density. The conditions in this zone are typical of aerodynamic flight. In the second zone speed increases less rapidly.

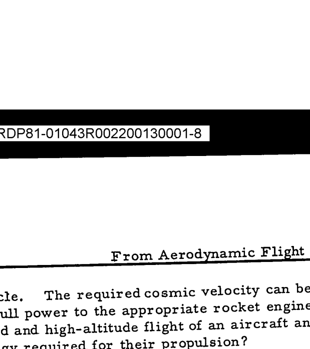

Fig. 1. Approximate change in flight speed in traversing conventional zones.

Here the characteristic peculiarities of aerodynamic flight disappear and the curve of velocity as a function of altitude is determined now, not only by aerodynamic, but also by ballistic forces.

Finally, in the upper zone the centrifugal force and the weight of the flight vehicle are for all practical purposes equal to each other:

$$\frac{G_0 \cdot V^2}{g \cdot (R + H)} = \frac{G_0 \cdot R^2}{(R + H)^2} \, .$$

From this can be found the value of the so-called first cosmic velocity:

$$V_{c1} = R \sqrt{\frac{g}{R + H}} \, . \qquad (2)$$

This is the velocity with which an artificial satellite travels along a circular orbit at an altitude H above the surface of the earth.

The lower zone may be called the zone of aerodynamic flight, but aerostatic flights are also possible in it. This is a classical branch of aviation and aerostation. The middle zone is a transitional zone, while the upper is the zone of space flights.

It is of course possible to fly in the transitional zone and in the space flight zone at speeds as low as may be desirable by using the vertical component of the jet or rocket engine thrust to counteract the force of gravity. Such an idea was first proposed by the famous scientist-revolutionary N. I. Kibal'chich in 1881 in a note written by him before execution, and the idea has not lost its importance today. As far as liquid rocket fuels are concerned, the simplest calculations prove their ineffectiveness at low flight speeds.

Fig. 2. $\frac{\rho V^3}{\rho_0 V_0^3}$ as a function of the flight altitude.

Long flights of greater or lesser duration in the transitional zone are obviously not feasible at all, due to considerable heating of the flight vehicle, especially if it is under the action of centrifugal and aerodynamic lift forces only.

The heating can be estimated approximately from the energy flux carried by the oncoming air per unit of transverse section. This value is equal to:

$$\frac{\rho \cdot V^2}{2} \cdot V = \frac{\rho \cdot V^3}{2} \, .$$

Its relative value $\left(\frac{\rho \cdot V^3}{\rho_0 \cdot V_0^3}\right)$ can be regarded as a conventional measure of the degree of heating of a body moving with a velocity V. The values of ρ and V_0 are determined under such conditions according to the sea level. It is easy to determine

the characteristic values of the velocity V for different altitudes H from Fig. 1 and, knowing the air density to be a function of H, to draw a curve $\frac{\rho V^3}{\rho_0 V_0^3} = \phi(H)$ (Fig. 2).

There is again no single-valued dependence here; therefore the zone of the most probable location of the curves is differentiated by fine hatching. The "heat-up zone" which approximately coincides with the transitional zone in Fig. 1 is emphasized in the graph. Of course heat-up at supersonic speeds can be combatted, but the transitional zone is nevertheless less convenient for prolonged flights and is therefore not characteristic.

Thus even though aerodynamic flight passes into space flight, these two zones are nevertheless separated by the heat-up zone, which in a number of cases makes them markedly different from each other.

In making a comparison between space and the aerodynamic flight, of great importance is the amount of energy required to travel a given distance. The energy can be most conveniently characterized by work per unit weight of the flight vehicle. This work is expressed numerically by the specific height of rise (in a uniform field of the force of gravity).

The thrust of modern aircraft is somewhat smaller than their weight; consequently the work done in moving such aircraft in a horizontal direction per unit weight is correspondingly smaller than their range of flight. However, thrust is not the total energy expended on propulsion. The fact is, an engine has a definite efficiency coefficient of less than unity. To take into account the total expenditure of energy in the simplest way, it is sufficient to multiply the weight of the fuel consumed by its efficiency and the mechanical equivalent of heat. In this way we will obtain a value of the effective thrust (equal to the expenditure of energy per unit length of flight path) close in magnitude to the weight of the aircraft. For calculations of a general character, when it is sufficient to use approximate values of the characteristics under consideration, it is sufficient to assume that the work of displacing a unit of weight is numerically equal to the length of the path.

Let us imagine that it is necessary to deliver a load by aircraft over a distance of the order of 15,000 km. Assume that the aircraft will fly at a speed exceeding that of sound. Under these conditions the effective thrust of the engine will equal approximately the weight of the aircraft. In this way, 15 million kilogram-meters of work will be expended for each kilogram of the total weight of the aircraft over the 15,000 km path. This is a great deal of energy.

The state of affairs is different in flight in outer space. In such a flight the energy is expended only to lift the flight vehicle to a given altitude and to impart to it the first cosmic velocity (V_{c1}). For instance, approximately 200,000 kilogram-meters of work are required to raise 1 kg to an altitude of 200 km. In addition we shall impart a velocity of 8000 m/sec to the displaced body.

The energy necessary to impart such a velocity to 1 kg is approximately equal to 3.2 million kilogram-meters. Taking into account the lifting work determined above for an altitude of 200 km, we obtain the total energy as equal to 3.4 million kilogram-meters instead of the 15 million kilogram-meters for the aircraft flight. Consequently, space flight proves to be approximately 4.5 times more economical than the high-speed flight of aircraft and at the same time is about 20 times faster.

The energy expended per unit weight is equal to:

$$E_{c1} = \frac{RH}{R+H} + \frac{R^2}{2(R+H)} = R\,\frac{\frac{1}{2}+\frac{H}{R}}{1+\frac{H}{R}}.$$

The expression $\frac{H}{R}$ is usually much smaller than unity and if it is disregarded we will obtain with sufficient accuracy $E_{c1} = \frac{1}{2}R$.

Consequently the energy actually required for space flight per unit weight is approximately equal to the work of raising it to a height equal to half of the earth's radius (in a uniform gravitational field).

However, the energy actually expended will be greater, since the efficiency of the rocket engine in this case differs considerably from unity.

The efficiency of a liquid fuel rocket engine can be determined approximately on the basis of overall ratios.

Fig. 3. Graph of minimum velocities

If the fact is taken into account that multistage rockets used for space flights are equivalent to single-stage rockets (with a modified ratio of the weight of the fuel to the weight of the nose section of the rocket), then, according to the well-known formula of K. E. Tsiolkovskiy, we obtain the efficiency coefficient

$$\eta = \frac{\left(\frac{V}{C}\right)^2}{e^{\left(\frac{V}{C}\right)} - 1},$$

where C is the exhaust velocity of the combustion products from the rocket engine and V is the first cosmic velocity computed according to formula (2).

The total energy necessary for space flight per unit weight is equal to $E_{c10} = \frac{E_{c1}}{\eta}$.

If, for instance, the exhaust velocity of the combustion products from the rocket engine is equal to C=3000 m/sec., the acceleration of gravity is $g=10\ m/sec^2$, and the radius of the earth R=6400 km, the total energy expended per unit weight is numerically equal to:

$$E_{c1} = 6,200,000\ m = 6200\ km.$$

If the range of the space flight is less than the full length of the circumference of the earth, and if it does not take place in a circular orbit but along elliptic arcs, the initial launching velocity of a space ship can be considerably smaller than V_{c1}.

Fig. 3 shows minimum velocities with which objects must be launched into airless space (at some optimum launching angle) in order that the range of flight measured on the surface of the earth along an arc of a great circle equal a given value.

To obtain the required velocities, compound rockets are required. According to the data obtained by K. E. Tsiolkovskiy one stage is still sufficient at velocities up to 3000 m/sec.; it guarantees a maximum range of flight of about 1000 km. At high velocities, however, (up to 6000 m/sec.), booster rockets with two stages will be required; this will permit a range of up to 6000 km.

Finally, for velocities in excess of 6000 m/sec (including the first cosmic velocity of 8000 m/sec), three-stage rockets are required. Then a flight around the world — amounting to 40,000 km — can be made.

If initial flight velocities V (Fig. 3) are taken into account, the energy expended to move a unit of weight is computed from the formula:

$$E_{10} = H + \frac{V^2}{2G}.$$

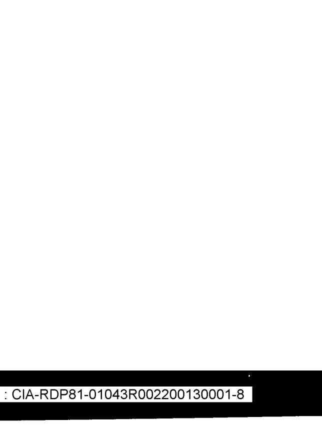

Fig. 4. Ratios between flight range and required energy.

Figure 4 shows E_{10} as a function of range, and, in addition, it shows a straight line for conventional aircraft. As can be seen from the graph, ballistic space flight, beginning with a range of 2000 km, becomes more economical as far as energy is concerned than the flight of a conventional aircraft. The flight of a satellite proves more advantageous with ranges in excess of 6200 km.

Even though the calculations given here are somewhat provisional, they nevertheless show that objective physical laws exist, on the basis of which the space flight over long distances will displace aerodynamic flight sooner or later. This process can already be partially observed in military technology where conditions exist for replacing piloted strategic bombers and pilotless aircraft by intercontinental rockets.

However, space flight is not easily controlled after brennschluss. Even if the flight vehicle had additional means of maneuvering at the expense of additional weight, the maneuverability would be exceedingly limited. The maneuverability of an aircraft supported by air, on the other hand, is rather extensive. Therefore, it is not possible to speak in principle of a complete changeover from aircraft to rocket ships. Such a changeover can only be considered in solving particular specific problems of military as well as civil aviation.

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THE FLIGHT DYNAMICS OF GUIDED MISSILES

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The flight dynamics of guided missiles — being the basis of their design and the starting point for research on their combat capabilities, on aiming them, and actually firing them — occupies the same position as ballistics does in relation to conventional unguided missiles, bombs, and mines.

The first problem we run into in flight dynamics is the method of missile guidance.

Let us assume that it is necessary to fire a guided missile from point 1 so as to hit a target situated at point 2 (Fig. 1). Since it is possible to alter the missile's trajectory even after it is launched, there is theoretically an infinite number of trajectories along which a guided missile may move to hit a designated target. However we must endeavor to maintain that specific trajectory which, under the given firing conditions, will most reliably insure a kill.

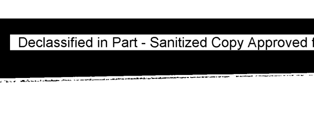


Fig. 1. Flight trajectories of a guided missile.

As we know, the motion of such missiles is controlled by an automatic system. The principle of such a system's operation in the case of homing missiles may be defined, for instance, by the following condition: in the course of movement the missile's axis must be at all times pointed at the target. This is accomplished by a control system which deflects the control surfaces in the requisite manner.

The very same principle is also used in automatized telecontrol (e.g., "by radio beam").

Thus, independent of the principle of control and its technical implementation, as a basis for the operation of the missile's flight control system we must posit a certain condition, namely, a definite programing, by carrying out which the control system guides the missile. Consequently, the guided missile's trajectory ceases to be

arbitrary, and the function of the control system superimposes on the missile's motion definite limitations — or, as they say, command links.

The condition posited as the basis of the control system's operation is called the guidance method. From a geometric point of view, it defines the theoretical trajectory of the missile's flight.

Before going on to a description of the specific methods of guidance for the various types of missiles, let us make several remarks in regard to aiming guided missiles.

If, in the course of the missile's flight to the target, there is the possibility of correcting the trajectory, then — within certain limits — it is possible to vary the heading of its initial velocity vector as well. Hence it must be concluded that aiming errors may be eliminated if they do not exceed a certain magnitude.

In order to launch a guided missile, it is necessary to select a suitable position. This is explained by the fact that the missile can by no means hit a rapidly moving (not to mention a maneuvering) target from just any point in space. The totality of missile launching points from which it is possible to guide the missile to the target is called the zone of possible attacks. The first limitation on the zone of possible attacks is the flight range of the missile itself. Even within the permissible ranges, guidance of the missile depends on the position of the launching site with respect to the velocity vector heading of the target.

Let us assume that a homing missile is launched from a certain point in the direction of a moving target. Let it be assumed that the guidance method involves the missile's velocity vector's being constantly directed at the target in the course of guidance. Since the target is moving, the missile's velocity vector turns in following the target, i. e., its trajectory curves. The launched missile has a definite wing area and at a given altitude (let us remember that the lift of a wing depends on air density) it is capable of describing a trajectory with a certain permissible maximum acceleration force. The moment may occur when the missile's control surface will be deflected to the maximum angle (the missile's angle of attack or slip will be maximal), while the magnitude of the maximum control force which arises in this instance will be insufficient to turn the velocity vector. From this moment on, the missile will begin to move along a circumference of minimal radius which corresponds to the maximum normal acceleration force. Missile guidance will cease since its velocity vector will not have time to turn in following the target. The vector will no longer be pointed at the target as the guidance method requires. After a certain time the target will escape the coordinator's field of view; thereafter missile guidance is out of the question.

For each guided missile used in aerial combat there exists a zone of possible attacks against a specific group of targets. We must endeavor to expand this zone to the maximum in order to assure successful attacks from any direction within range limits less than the missile's maximum range. The problem amounts to this: in the course of guidance, the acceleration forces under definite firing conditions must not exceed those permissible. The natural tendency is to increase the permissible acceleration forces. However, large wing areas are required on the missile for this purpose. Consequently, the permissible acceleration forces cannot be infinitely increased. Another more productive way is to select guidance methods, the employment of which does not require great acceleration forces even under the firing conditions which are, from this point of view, the most unfavorable.

For homing missiles, the simplest method is direct guidance. Essentially it involves the missile axis' being constantly aimed at the target in the course of guidance.

The target coordinator is rigidly mounted in the missile in such a way that both axes are aligned. Here the discrepancy angle is nothing else but the angle between the missile and the target heading. Consequently, in an ideal situation, when the discrepancy angle is zero, the missile axis will pass through the target. However, this method may be employed only for guiding a missile to a stationary target. It may be used only for controlled bombs and pilotless aircraft. This method, on the other hand, is not suitable for firing at rapidly moving targets (aerial targets).

Fig. 2. Direct guidance method.

Fig. 3. Missile trajectories in pursuit method guidance.

Let us assume that the target is moving from the right to the left. Then the missile's trajectory must curve to the left. Hence, the control force Y will be directed as shown in Fig. 2. The angle of attack α corresponds to its heading. The figure shows that the velocity vector lags behind the missile-target heading. Having changed the target's flight heading and that of the approach, it is possible to establish the fact that with such a guidance method the velocity vector always lags behind the missile-target heading. Consequently, the missile will not only fail to intercept the target, but will be constantly pointed at a definite point behind it.

It is possible to correct the situation somewhat by pointing precisely at the target, not the missile axis, but rather its velocity vector. In this case we have a new guidance method which is called the pursuit method.

In order that the missile's velocity vector be constantly pointed at the target, it is obviously necessary that the discrepancy angle be reckoned from the velocity heading, i.e., that the coordinator axis be aligned with the velocity vector. In practice this can be achieved if the coordinator is pivot-mounted on the missile and if by means of a vane it constantly is turned with respect to the airstream. Then the coordinator axis will at all times coincide with the velocity vector heading. A missile which is

guided by the pursuit method, independently of its position relative to the moving target at the moment of launching, always tends to assume the same heading — precisely on the target's tail. It is true that it assumes this heading in the very terminal stage of guidance at the exact moment of encountering the target. In this way it turns out that all the trajectories — irrespective of the initial position of the missile — are tangent to the target's heading at the moment of impact (Fig. 3.). There exists one trajectory which does not comply with this rule: — the trajectory of a missile launched precisely head-on. However, it is unstable and even in the case of the slightest maneuver on the part of the target the missile begins to home on the tail.

Another peculiarity of this guidance method is the increment of the required normal acceleration forces in proportion as the missile closes in on the moving target. Their magnitude may attain very considerable values (40, 60, and over). It is impossible to design a missile with such permissible acceleration forces; hence the pursuit method may be used only for guiding homing bombs.

Guidance with a constant lead angle ψ is more precise. If in the case of direct guidance the velocity vector lags behind the line of sight and the lead angle is negative and if when using the pursuit method the velocity vector coincides with the line of sight and $\psi = 0^\circ$, then using a guidance method with a constant lead angle results in a positive lead angle. The missile in this case intercepts the target. The technical achievement of such a method presents no difficulties. Actually all we need to do is to set the target coordinator axis at a constant angle to the missile axis pointing in a direction opposite to that of the target's flight (Fig. 4.). The trajectory of the missile which is being guided with a constant lead angle has a slighter curvature and the required normal acceleration forces are smaller than when using the pursuit method.

However, this method of guiding a missile to rapidly moving targets cannot be deemed satisfactory. If we imagine that in Fig. 4 the target is moving from right to left, then it is easy to understand that in this case the lead angle will be negative and that the missile trajectory will be considerably more involved. The missile approaches the target from the opposite direction (in the figure, from above), and in the terminal stage it is already being guided with a positive lead angle. The guidance time is

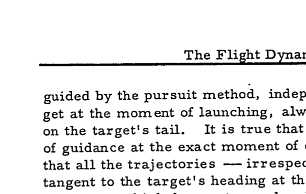


Fig. 4. Guidance scheme with constant lead angle.

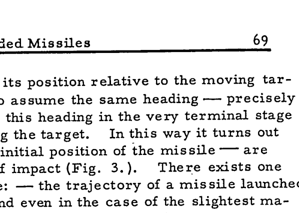


Fig. 5. Plotting of the lead angle.

greatly increased, the missile track is extended, and consequently its possible firing ranges are diminished.

It is true that, even under such unfavorable conditions, the required acceleration forces turn out to be less than when using the pursuit method. The solution to this problem may be found in a design where the necessary lead angle is preset prior to firing depending on firing conditions; this angle remains constant in the course of guidance. However, this design is complex and, furthermore, it does not solve the problem completely, since the target, after missile launch, may, by maneuvering, leave the missile in a position of disadvantage. But for guidance to a stationary target this method is quite suitable.

When firing at rapidly moving aerial targets the missile must be aimed at a predicted point.

The bore axis of the conventional artillery piece is not aimed at the target, but is traversed ahead of the target along its track. Thus during the shell's time of flight, the target must cover such a distance that they will meet (Fig. 5). When firing at a maneuvering target the predicted point constantly assumes a new position (instantaneous predicted point). The lead angle constantly changes also. Theoretically, one of the best methods of self-guidance is a method whereby the missile's velocity vector is at each instant aimed at the corresponding instantaneous predicted point.

If, with such a guidance method, we assume that, beginning at a certain moment, the target ceases to maneuver and travels in uniform rectilinear motion, then it becomes apparent that the missile will also travel a rectilinear path (if missile velocity is constant) and will hit the target, since the lead angle at the moment the target ceases to maneuver is — depending on the guidance method — equal to the required instantaneous value. This discussion suggests that a missile's minimum required acceleration forces are obtained if its velocity vector is at each moment pointed at the instantaneous predicted point.

The guidance method in which the missile's velocity vector at each moment — irrespective of the target maneuvers — is aimed at the predicted point is called the parallel closure method.

Let us assume that in the lead angle formula $\sin \psi = \frac{V_t}{V} \sin q$ the values V_t and q are constantly changing; this corresponds to the target's maneuvering in speed and heading. Obviously, the necessary lead angle will also be constantly changing, assuming at every moment an instantaneous value.

We can easily obtain from the lead angle formula the equation:

$$V \sin \psi = V_t \sin q$$

If in the course of missile guidance the given equation is constantly valid even when V_t and q change, then the lead angle at every moment will equal the required instantaneous value.

The left-hand member of the equation $V \cdot \sin \psi$ is simply the projection of the missile velocity vector perpendicular to the line of sight (Fig. 5), while the right-hand member is the projection of the target velocity vector also perpendicular to the line of sight.

Thus, in order that the angle ψ be constantly equal to the required value of the instantaneous lead angle (in other words, so that the missile velocity vector at any given moment be aimed at the instantaneous predicted point), the projections of the velocity vectors perpendicular to the line of sight must be equal. But this means that in the course of guidance the line of sight shifts always parallel to itself, i.e., it does not rotate. Hence the method is called parallel closure.

Let us mount the coordinator in the missile on a floating platform which is stabilized in space by means of a free gyro. Before missile launch let us aim the coordinator axis at the target and at the moment of firing let us uncage the gyro. The coordinator axis, while holding a constant position in space will shift always parallel to itself. In an ideal guidance situation the line of sight coincides with the coordinator axis; consequently, with such a coordinator setup in the missile, the line of sight will also shift parallel to itself and the missile will be guided by the parallel closure method.

Under actual conditions, when there are discrepancy angles, the line of sight will deviate slightly from the required heading. However, the control system, in accordance with the magnitude and sign of the discrepancy angle, transmits every time a command signal to the control surfaces in order to bring the line of sight into a position congruent with the coordinator axis (to zero the discrepancy). Inasmuch as the coordinator axis is gyro-stabilized, the line of sight — while coinciding with it — will assume a position parallel to the original position.

Of all the possible guidance methods, that of parallel closure — firing conditions being equal and missile velocity being constant — yields minimal required acceleration forces. Target maneuvering offers no threat at all to the parallel closure method, since it has been proved that, if target velocity is less than missile velocity (and this is always true), then the missile's required acceleration cannot exceed target acceleration.

The shortcoming of the parallel closure method is design complication in the control system.

As for telecontrolled missiles, the simplest guidance method in their case is the so-called coincidence (bracketing the target) or three-point method. Essentially it involves the necessity of the missile's being constantly located on a straight line connecting the control point and the target in the course of guidance.

The scheme shown in Fig. 6 makes provision for movement of both the control point and the target. This case is characteristic of firing telecontrolled air-to-air missiles. However, such a method is applicable also for a stationary control point and a moving target (e.g., AA missile guidance), as well as for guidance from a moving control point against a stationary target (controlled bomb guidance or air-launched pilotless aircraft guidance). Thus, the coincidence method may be widely employed.

The question arises whether,

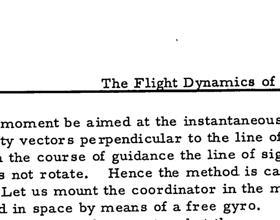


Fig. 6. Guidance of a telecontrolled missile by the coincidence method.

with such a guidance method, the missile will hit the target. Inasmuch as the straight line along which the missile is traveling passes through the target, in order to effect a hit it is necessary that the missile, in the course of guidance, close in on the target and not depart from it. The virtue of this guidance method is the utter simplicity of its technical implementation. As applied to visual guidance, the work of the operator involves superimposing the missile's visible image on the target image. Holding the missile "in line" with the target, the operator applies the coincidence method. Hence the method is called the coincidence or bracketing method.

Automatized beam-rider telecontrol may easily be tied in with the coincidence method. Actually, the axis of the equisignal zone is a straight line. Having switched the radar to automatic target tracking, it is possible to launch a missile which, as it moves through the equisignal zone, will be automatically guided by the coincidence method.

The shortcoming of this method is the complication of the missile trajectory. It must be kept in mind that the nature of the missile trajectory in this guidance method depends not only on the law governing target motion but also to a considerable extent on the nature of control point motion.

For example, when guiding an air-to-air missile by the coincidence method, it is possible to establish a situation in which the missile will travel along a parallel closure trajectory. All that is required is that the straight lines which connect the control point with the target be parallel to each other at discrete points of time. If the missile is at corresponding points of time on these straight lines — and the guidance method requires this, then it is obvious that the line of sight between the missile and the target will shift parallel to itself in the course of guidance, since in ideal execution of the coincidence method this line of sight coincides with the straight control point — target line.

Consequently, the aircraft must be piloted so that it will move relative to the target in accordance with the parallel closure method.

Let us note that in order to effect the coincidence method the parent aircraft does not necessarily have to close in on the target; on the contrary, he may depart from it. In particular, in the example analyzed above, the missile's parent aircraft may travel relative to the target in accordance with the "parallel departure" method. That is, it will depart from the target in such a way that the lines of sight between the parent aircraft and the target will parallel each other at discrete points of time. Unfortunately, such aircraft motion cannot be applied when guiding a telecontrolled bomb. Generally speaking, the coincidence method in bomb guidance is unsatisfactory. This is explained not by the fact that it is insufficiently accurate when used with bomb guidance, but by the extreme difficulty in bomb "vectoring" by using the coincidence method in the initial segment of the trajectory.

The bomb is released before the aircraft reaches the target. As a result, then, of air resistance, it lags behind the aircraft. It is clear that right here the basic principle of the coincidence method is violated. In order to correct the situation, specific measures have to be taken. One of the methods of vectoring an aerial bomb onto the aircraft-target beam involves speed-braking the aircraft. In particular, after the release of the German telecontrolled "Fritz-X" bomb used in World War II, the pilot throttled down to decelerate the aircraft, zoomed, and let down his flaps, thus allowing the bomb to go ahead.

However, aircraft deceleration when flying over the target is obviously undesirable, since the plane may be downed by AA artillery. Therefore the coincidence method is inexpedient for guiding controlled bombs.

A second method for guiding telecontrolled missiles is the so-called angle method. It requires separate tracking of the target and the missile. Between the control point-target and control point-missile lines there is an angle which changes according to a definite law. Hence the name: — angle method. As an example, let us examine the guidance of a telecontrolled bomb by this method.

We know that, immediately after bomb release, an angle is formed between the bearing lines to the target and to the bomb. If the bomb hits the target, this angle will be zeroed at the moment of impact. Knowing the law governing the movement of the parent aircraft and the trajectory of the free-falling bomb, it is possible to derive a law governing the change of angle between the target sighting beam and the bomb sighting beam in order to zero it gradually, but in such a way as to deform as little as possible the trajectory of the free-falling bomb.

Tracking the target and the missile by the angle guidance method may be achieved by various means: radar, thermal tracking, optical pelorus. When using radar there is no necessity of having a separate link with the missile for command signal transmission. The missile-tracking radar can direct it in its beam (automatized telecontrol).

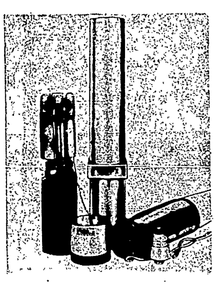
The angle method is more flexible. It provides a diversified means of achieving missile closure with the target. For example, if it is required to destroy an aerial target, it is possible to guide the missile by this means to a predicted point. The coincidence method represents a particular case of the angle method. Actually, if we consider that zeroing this angle continuously in the course of guidance is in fact the law governing the change of angle between the bearing lines to the target and to the missile, then we obtain the coincidence method.

We will make our final remark concerning guidance methods of telecontrolled missiles with a television control system. From the geometric point of view, there is no basic difference between the guidance of homing missiles and the guidance of television equipped missiles. In fact, the target coordinates measured by the homing missile's coordinator are used to generate a command signal within the missile itself. Now in television control these coordinates are transmitted to the command point where a command signal is generated and transmitted to the missile. In this way, telecontrolled missiles equipped with a "televisor" may be guided by any one of the methods for guiding homing missiles applicable to a given missile.

AN AIRBORNE NEPHELOMETER

The airborne nephelometer is designed for determining the altitude of the cloud deck and base of middle and low cloud layers and fogs which have water droplet structure at temperatures of +20° to -20° C. It is an expendable aerological instrument which is paradropped from an aircraft.

The nephelometer is based on the photoelectric principle. When the instrument reaches a cloud environment, the light emitted by the pulse generator diffuses and the



Droppable airborne nephelometer

result is altered illuminance of the photocell. Consequently, the frequency of the signal transmitted by the radio transmitter also changes. When the instrument emerges from the cloud, the signal resumes its original frequency. At the moment the instrument reaches the ground, the radio transmitter sends out a predetermined signal.

The design of the nephelometer makes it possible to vary its threshold depending on meteorological visibility over a wide range (from 0 to several hundred meters).

The altitudes of the cloud layer deck and base are determined in accordance with the time involved in frequency changes of the radio signals by means of special tables, on the basis of which the instrument's speed of descent is calculated.

The parachute rig and the device for dropping the nephelometer are the same as those used for an airborne radiosonde.

AIRFIELD MAINTENANCE IN WINTER

Engineer Maj. N. G. KOGAN
Engineer Maj. YA. B. GALKIN

The service life of artificial airfield surfaces, as is known, depends to a great extent on the methods of their utilization and maintenance during the winter months. It often happens that they are intensively used in all kinds of weather during the entire year and this inevitably necessitates premature repairs. At the same time experience shows that in a number of climatic regions the service life of artificial runways can be prolonged without detriment to flight operations.

What are the factors which affect the condition of artificial surfaces in the winter? Considerable damage is caused primarily by snow removal, surfaces being ruined not only by snowplow operations but also as the result of using chemical and thermal methods for combatting the glaze. The fact that the soil beneath such a surface freezes to a greater depth than that under snow also has a detrimental effect (Fig. 1 a). Decided damage to the condition of artificial surfaces, especially those of asphalt-concrete and cement-concrete, is also caused by severe temperature drops.

With the arrival of warm weather the bed beneath the surface begins to thaw sooner than that under the snow on the lateral safety strips and soil moisture here increases somewhat. The frozen layer of earth, forming, as it were, a trough, prevents moisture from penetrating the deeper strata (Fig. 1 b). The soil bed, saturated over a long period of time by excess moisture, cannot fully support the load of

Fig. 1. The freezing (a) and thawing (b) of the soil beneath a surface kept clear of winter snow.

aircraft. It is precisely during this period that the greatest surface damage occurs.

From the above we may conclude that in regions with steady negative winter temperatures it is better to use, not artificial surfaces, but dirt strips from which aircraft of all weight classifications can take off.

When artificial surfaces are protected by an undisturbed layer of snow their bed freezes less thoroughly. With well-timed spring snow removal they acquire a dependable service life in a shorter time because of the fast drying of the ground.

This method of maintenance has a favorable effect on the condition of the artificial surfaces, considerably reduces the need for repairs, and prolongs their service life.

The following example points up the inadvisability of using artificial surfaces in the winter. In unit X a metal runway was used quite intensively for an entire year. What was the result?

The soil beneath the metal matting which was kept free of snow froze hard and took a long time to thaw out in the spring. And since it was necessary to fly when it had not yet dried out, there was excessive soil seepage through the matting interstices and sagging of the plates occurred. In order to keep the strip in good condition it was necessary every year to pour hundreds of cubic meters of sand, crushed rock, dirt and other materials into its bed. Besides this, the metal plates were also seriously damaged by snow removal. On the basis of these facts, the unit came to the conclusion that winter clearance of an artificial runway is impracticable. Before winter a dirt strip is now carefully prepared and the metal one is kept under undisturbed snow. Just before the beginning of the spring thaw it is cleared, along with the taxiways and parking aprons, and is made ready for operation. This experiment has proved very worthwhile: the soil beneath the surface freezes to a lesser depth and thaws quite quickly, while mechanical damage is eliminated.

This system of winter maintenance of artificial surfaces should find widespread application on our airfields.

Also worthy of consideration is the fact that in aircraft operation from dirt strips, flight training conditions approximate those in combat, since in wartime the operation of frontline aircraft from artificial surfaces is a rare exception.

The question may arise as to what is to be done in the case of artificial surfaces with a permanent OSP [ILS] system. In such cases, surface snow removal is, of course, absolutely necessary, although it would be better to use a mobile OSP system and to take off from dirt strips.

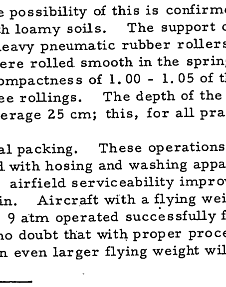
Sometimes it is advisable to leave a compact layer of snow 6 cm thick on artificial surfaces as a protective carpeting against mechanical damage. This "carpeting" has made it possible for us to use all types of snow removal equipment, including that attachable to caterpillar tractors, on metal surfaces.

The need for reconsidering the rules of airfield maintenance has at the present time come to a head. It is necessary to do this in order to increase the combat readiness of units and to prolong the service life of artificial surfaces. Daily flights should be conducted only from the dirt surfaces of the airfield and only in exceptional cases from the artificial surfaces. The possibility of this is confirmed by the experience of units working on airfields with loamy soils. The support capacity of the latter was increased with the aid of heavy pneumatic rubber rollers made from junked aircraft wheels. The strips were rolled smooth in the spring under more favorable conditions of moisture. Compactness of 1.00 - 1.05 of the maximum was attained as the result of two or three rollings. The depth of the soil processed to a compactness of 0.95 was on the average 25 cm; this, for all practical purposes, is quite sufficient.

In the summer the ground received additional packing. These operations were carried out after rains or after wetting the ground with hosing and washing apparatus.

Thanks to the increase in soil compactness, airfield serviceability improved and the ground began to dry out quickly after a rain. Aircraft with a flying weight of up to 30 tons and a tire pressure of as much as 9 atm operated successfully from dirt strips processed in this manner. There is no doubt that with proper processing of the soil the operation from it of aircraft with an even larger flying weight will be entirely feasible.

MULTIPURPOSE ELECTRONIC OSCILLOGRAPH UO-1



The multipurpose electronic oscillograph is for the observation and photographing of pulse and periodic electric oscillation patterns, and for measuring the amplitude and duration of the pulses under examination. It permits observation in all radar station blocks of pulses of both polarities with a duration of from 0.05 microseconds to 100 milliseconds, a frequency response of from 1 cycle to 20 kc and voltage of from 0.05 to

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250 volts. The vertical beam deflection amplifier has a pass band of up to 20 mc.

The oscillograph is provided with a slave-sweep trigger generator, which produces an impulse for triggering the external systems, with a duration of 0.5 microseconds, a frequency response of from 50 cps to 10 kc, and with an amplitude of from 5 to 40 volts. Sweeps are synchronized by the signal under examination and also by the external voltage source of from 1 to 100 volts of either polarity.

The oscillograph receives the signal directly on vertically and horizontally deflecting tube plates with minimum input capacitance. Its power supply is from an A.C. line with a voltage of 127 and 220 volts and a 50 cps frequency; intake is 450 watts, weight 25 kg. According to specifications the multipurpose electronic oscillograph is far superior to oscillographs of type 304-I, 41-I, 25-I, IO-4 and EO-7.

INDIVIDUAL ASSEMBLY INSPECTIONS

Lt. Col. Engineer
S. G. SHELUDCHENKO

Are inspections of aviation equipment by assemblies necessary? At first glance it seems that there is no necessity for this. After all, the aircraft and its equipment are inspected many times before takeoff: in the pre-flight and post-flight inspections. In addition, after the elapse of a definite flying time, check-list operations are performed on the aircraft.

This is all correct, but the modern aircraft and its equipment and armament are so complex that it is impossible to inspect all of its units and assemblies during the pre-flight and post-flight inspections. Nor is it necessary. The high reliability of performance of aviation equipment makes it possible to limit the inspection during pre-flight and post-flight servicing to checks of separate items in a sequence prescribed by the technical check-list for the given type of aircraft.

In this way we check from day to day only definite items. The rest of the systems and equipment are inspected during the check-list operations, the deadlines for which are determined either from the flying or the storage time. However, some of the parts and assemblies break down occasionally before their due date.

Consequently, it is necessary to make periodic checks mainly of those units and assemblies which are not inspected during preliminary and pre-flight servicing in order to gain complete confidence in the proper operation of the aircraft between check-list operations. It is recommended that the list of inspections be compiled in the process of the aircraft's operation, depending on the intensity of flying, its character, and meteorological conditions.

We will illustrate this by a few examples. Usually aircraft are stored with wing tanks attached. In order to inspect in detail the locking system of the jettisonable wing tanks it is necessary to detach them. When the locking system was checked on all aircraft in the unit where officer M. Ya. Romanov is engineer, it was found that in some of the systems the rod of the automatic release was binding in its guides because of corrosion of the rod and freezing of intrusive moisture. This defect could lead to failure of the locking system, since it could not be detected in post-flight checks with the tanks in position.

In a period of intensive flights wear and tear in the aircraft landing gear and control elements at points of articulation in these units is possible, leading to the appearance of excessive play, cracks, and other defects.

Fuel meters in the aircraft fuel system, from technical considerations, are checked only during the 100-hour check-list overhaul, although sometimes the float of the fuel transmitter prematurely springs a leak due to lack of airtightness. With such a defect the fuel gradually fills the inner cavity of the float in flight, causing it to sink to the bottom of the fuel tank. This defect can be spotted during a careful inspection by assemblies at the moment when the float begins to sink, making it possible to forestall the breakdown of the fuel meter in flight.

The assemblies of the power unit of the aircraft's electrical equipment (graphite voltage regulator DMR-400, and a number of others) cannot be checked during preliminary servicing because of limited access. And yet, they can break down before the check-list operation is due. Only with a painstaking special inspection of the power unit can the breakdown of these assemblies be forestalled.

In the process of preliminary and pre-flight servicing, no inspection is planned for the contacts of the pulse motor of the RSIU-3 m radio station, for the fuses of the block and the 401 relay, nor for the contact rings of the ARK-5 [automatic radio compass] loop antenna. However, corrosion of the contact rings on the loop of the ARK-5 antenna and burning of the contacts of the pulse motor were found during inspection by assemblies. Thus we were able to prevent failure of the equipment. This is why it is necessary to make periodic inspection of these assemblies, especially when the humidity in the atmosphere is high and there are sharp fluctuations in temperature.

All these measures show convincingly that inspections by assemblies of the aviation equipment are necessary — in addition to other types of inspection (pre-flight, post-flight, starting-line inspections). We have found, however, that they have the desired effect only when the entire personnel has been painstakingly trained for it. Such inspections are conducted regularly in our unit twice a month, on special days called prevention days. At first an order was issued to the unit on these days with an attached list of operations to be carried out. The lists for all the specialties were compiled every time anew; this took up the time of the unit and sub-unit engineers.

Officer A. V. Gridnev developed a different method of performing inspections by assemblies: The method simplifies preparation for the inspections and permits the unit engineer to schedule inspections of certain aircraft units and assemblies; this improves the quality of servicing aviation equipment for flight.

With a basis of experience in technical operations, officer M. Ya. Romanov has found that the following things must be inspected in the fuselage of the aircraft: the cockpit, the landing gear and the control elements, the fuel and hydraulic systems, the power units of the fuselage, the power plant. In addition, he picks items which require periodic inspection (aircraft armament assemblies, aircraft fittings, radio and electronic equipment). Plans are drawn up for all of these units and assemblies in which detailed instructions are given on what must be inspected during the working day. If officer Romanov earmarks two days a month for prevention, all the scheduled units and assemblies are inspected every three or four months. This approximately corresponds to the period between the time-consuming check-list overhauls. Of course, plans and lists worked out at the beginning of the year are modified and augmented in operation in accordance with orders and regulations. For instance, the necessity arose during an inspection of the control system of an aircraft to check the forked bolt of the stabilizer attachment as well as the correct placing of the bolts which fasten the connecting rods with the supporting brackets of the wing flaps; and during an inspection of the fuel system the necessity arose of checking the condition of the pipe lines since they can suffer friction breaks against the wall of the wing ribs.

Thus, changes are made in the plans during the year on the basis of experience in technical operation, and the methods of inspection are continually improved.

Com. Romanov has developed a technique of carrying out work on some units and assemblies which gives the order of inspection and the allowances made for given units and assemblies, in addition to describing the possible defects, the methods of their detection, the instruments and devices to be used during the inspection.

These plans and the technique worked out have made the preparation for the inspection considerably easier and have unburdened the engineers. However, development of a technique of inspection of all assemblies and units takes a lot of time. It is desirable that this be done by an appropriate research and scientific organization.

In order to prepare the personnel for inspections, Romanov schedules the study of the design of the appropriate units and assemblies for the day on which the equipment is serviced. Thus, for instance, training was given in the fuel system of the aircraft, the design of the landing gear, and in other topics. The instructor not only explained the design of the fuel system but also pointed out what defects can occur with a sharp change in temperature; he explained the methods of their detection and correction and set forth directives and regulations on operation. In studying the design of the landing gear, possible defects in the landing elements arising during intensive flights were also studied as well as methods of their prevention.

On inspection day the engineers of sub-units and the heads of maintenance groups instruct the technical personnel and show directly on the aircraft how the inspection should be carried out. After such training, each specialist has a sharp mental picture of the sequence of operations; this improves the quality of operation. Flying personnel as well as technical personnel take part in the inspections.

In planning inspections by assemblies and in checking their implementation in all specialties, officer Romanov prepares quarterly charts. The number of the plan is put into the corresponding square of the chart for each month; for instance, plan No. 1: inspection of the aircraft cockpit; plan No. 2: inspection of the landing elements; plan No. 3: inspection of the aircraft control, etc. After the inspection the corresponding squares of the chart are crossed out. Such a chart simplifies considerably the control over the implementation of inspections by assemblies.

The intensiveness of flying in the forthcoming quarter, the character and the conditions of the operation of the assemblies are taken into account in planning. For instance, one month when intensive flights involving a great number of landings were planned, Com. Romanov scheduled an inspection of the landing elements according to plan No. 2. He took into account the fact that in the previous month the front wheel shock absorbers broke down on some aircraft.

Aircraft armament sights were scheduled for inspection in connection with the planned flights for interception. Inspection of pulse motor contacts and the relay of the radio station were scheduled for the radio equipment since the long-range weather forecast had predicted precipitation and sharp fluctuations of the temperature.

However, everything does not always go according to plan. Sometimes it is impossible to inspect all of the aircraft of the unit simultaneously. Then the inspection is done by squadrons on different days.

The plans are repeated in different quarters, but their sequence can be changed. If it becomes known, for instance, that defects of the hydraulic system threatening the safety of the aircraft have been detected in other units, an inspection of the functioning of the hydraulic system must be made on the next prevention day. When necessary, preliminary servicing can be used for this purpose also.

Inspection by assemblies is carried out to check the condition of various design elements, units and assemblies of aircraft equipment and aircraft armament. In conjunction with other types of inspection, they make it possible to prevent release for flight of defective or unserviced aircraft.

A UNIFIED TACHOMETER

For each type of aircraft, usually a particular type of electric aircraft tachometer has been developed.

Industry has series-produced up to eleven various types of aircraft tachometers, differing from each other in range of measurement, weight, dimensions, method of attaching the sensing unit to the engine, etc. In order to reduce the nomenclature of electric aircraft tachometers and to make it easier to use them in combat units, at the present time a unified magnetic-drag tachometer with a percent scale has been developed.

It is designed to measure the speed of rotation of the main shaft of the engine, not in absolute figures, but in percent of the maximum number of rpm.

The tachometer's uniform scale is calibrated from 0% to 105% and the working range is 60% - 100%.

Unified tachometers are made either with one pointer (single) or with two (dual). They have gauges and sensing units which are interchangeable.

YEARS AND PEOPLE

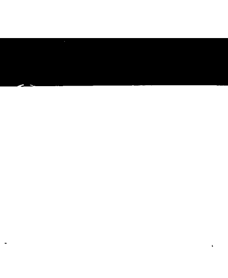
(Memories of the War Years)

Lt. Gen. of the Air Force (ret.)
N. S. ROMAZANOV

3. The Great Battle

On the evening of 4 July a few hours before the German offensive on the Kursk base of operations the enemy brought up large fresh forces. Two hundred and fifty bombers, as many fighters, and about one hundred ground attack planes flew over from the rear area to the forward airfields. They were deployed on the Rogan', Osnova, Poltava, Kirovograd, and Konotop airfields. Our reconnaissance planes aloft radioed: "Enemy planes are landing in groups; new echelons are constantly appearing in the air."

It continued thus until nightfall. All of our reconnaissance had established that one enemy fighter squadron was based at the Mikoyanovka, Tomarovka and Rogan' airfields. Two squadrons of dive bombers were located at the Sokol'niki and Osnova fields. Before the sector of the Voronezh front where our Second Air Army was operating, 400 enemy planes could be counted by 1 July and by the evening of 4 July the enemy brought up another 300 fighters and 60 ground attack planes.



S. A. Krasovskiy. (1943)

In the third year of the war the Hitlerites could no longer attain numerical superiority in combat equipment on all fronts, but here they succeeded to a certain degree, principally in tanks and bombers.

In all the staff sections of our front, work was in full swing. At the command post were front commander N. F. Vatutin, and member of the Military Council N. S. Khrushchev. All the changes in the Hitlerite troops were being reported to them. The unexpected transfer of large aviation forces to the front line most convincingly told of the approaching decisive hour.

The Soviet command had carefully prepared the operation. It knew well what the ene-

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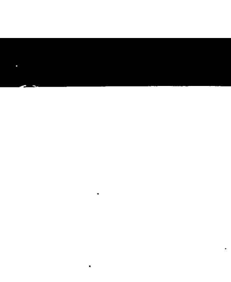

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Hero of the Soviet Union Lt. Gen. of the Air Force N. P. Kamanin, formerly commander of a ground attack air group which distinguished itself in combat against German-fascist invaders near Kursk.

my intended to do and when it would be done.

On the evening of 4 July the Supreme Command warned: "German advance will start tomorrow morning."

Front commander N. F. Vatutin ordered the Air Army commander to strike a concentrated blow before dawn against enemy airfields.

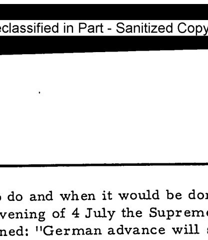
The pilots were already prepared for this important operation. They were close to their planes waiting for the moment to take off.

Day had not yet begun to break when the air was filled with the powerful roar of aircraft engines. Groups of Soviet ground attack planes, bombers and fighters, rose above the quiet earth. They rushed towards enemy fields at maximum speed. Somewhere AA guns started firing, submachine guns began to rattle, but the din of new groups of planes taking off was getting stronger and soon drowned out the rest of the noises.

Hysterical commands by Hitler's generals were heard on the air: "Cut off the Soviet planes... Don't let them through... Scatter... Destroy..."

But it was too late! Four hundred planes with red stars on their wings were approaching the Mikhaylovka, Pomerki, Sokolniki, and Rogan' airfields. The "Ils" were flying; they were covered by fighters. Several groups of 8 - 12 each of our fighters patrolled in areas where enemy encounter was possible. They cut off the enemy aircraft, preventing them from attacking groups of planes on ground attack missions.

It is true that a considerable part of the enemy crews did manage to get their planes into the air, but some of the enemy bombers and fighters remained where they were. There was an inconceivable commotion in the park-



Ground attack planes under the command of Hero of the Soviet Union Col. A. N. Vitruk boldly and decisively smashed enemy tanks. Many fascist "Tigers" and "Ferdinands" found their grave on Kursk soil from the fire of Soviet ground attack planes (1943).

ing areas. It was at such a moment that there appeared over the Rogan' airfield a group of 8 Soviet fighters under the command of Capt. Dmitriyev. Our pilots saw four German planes take off one after another from the runway, but in the parking areas there were still about 50 "Ju-88" and "He-111" bombers, several "Ju-52" transport planes and one four-engine bomber. People were running in streams along paths leading to the airfield.

Capt. Dmitriyev led the first group of four to the attack. Bombs started falling on the airfield. After the first group of four, the second group engaged in the attack. Again there were bursts on the airfield and on the aircraft parking areas. Our fighters made the next attack approach and simultaneously came down to strafing altitude. AA guns were covering them with flak, thin dotted lines of machinegun bursts stretched up into the gray sky of daybreak; but the pilots were seized with combat fever. In hedgehopping flight they again swooped at the airfield so as to riddle the enemy planes remaining on the ground with machinegun and cannon fire. Now they saw that a few bombers had started taking off. Capt. Dmitriyev caught in his sights the lead "Ju-52" taking off. A burst of fire... and the enemy plane exploded on the runway, blocking the way of the other planes.

At the same time, group pilot Senior Lt. Shumilov shot up two taxiing bombers and then a four-engine "Kurier" bomber. Our fighters had not yet left the battlefield when there appeared over the airfield a large group of fascist bombers which began approaching for a landing. Evidently the enemy had brought up to the front new groups of aircraft. Capt. Dmitriyev spotted them in good time and ordered an attack on the landing aircraft. Three bombers were downed while making a landing approach, and when the first column touched down Junior Lt. Belyakov dropped bombs on it and then shot it up.

It's difficult to estimate the number of enemy planes destroyed by Capt. Dmitriyev's group in this engagement, but one thing can be said for sure: the Rogan' group did not take part in the mass raid on the positions of the Soviet troops.

I had the opportunity to visit the Rogan' airfield. It was entirely ripped up by shell-holes and by aircraft explosions. At the edge of the airfield the Hitlerites hurriedly arranged a dump of destroyed machines. In a word, the large and well-equipped Rogan' airfield looked like a field ploughed by our bombs. This, of course, told most convincingly of the results of Soviet Air Force raids.

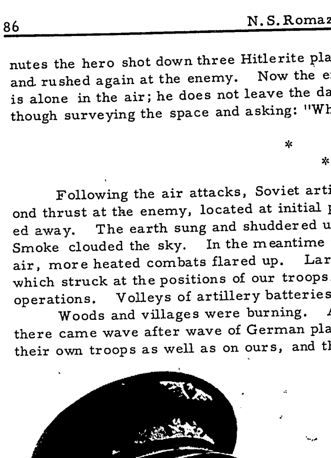
True, the raids were not everywhere so successful. In some places our pilots came late to the targets, in others they had to face powerful opposition by enemy fighters.

The aerial combat which started previous to ground battle seemed to announce major action. As the men-at-arms of Dmitriy Donskoy [14th cent. Russian military hero] followed with amazement the single combat between Peresvet [Russian boyar] and Chelubey [Mongol leader], so did thousands of our infantrymen raise their rapt gazes to the sky. Their brothers, their comrades-in-arms were fighting there. They fought, forgetting about danger, without thinking of death. Here, carried away by the combat, one of our fighter planes broke away from the group as a whole and faced a group of nine fascist planes. He rushed straight at the lead fighter and in a frontal attack he downed it. Four "Messerschmitts" simultaneously jumped the dare-devil. It is hard to relate how skilfully the Soviet fighter evaded the blows, how boldly he rushed at the enemy, and how accurately he struck him. In the course of a few minutes the hero shot down three Hitlerite planes; but he did not withdraw from combat and rushed again at the enemy. Now the enemy has been dispersed, the dare-devil is alone in the air; he does not leave the dangerous zone, but enters a turn — as though surveying the space and asking: "Who is next?"

* * *

Following the air attacks, Soviet artillery started to speak. This was the second thrust at the enemy, located at initial positions. Artillery on two fronts pounded away. The earth sung and shuddered under the weight of artillery explosions. Smoke clouded the sky. In the meantime there were more and more planes in the air, more heated combats flared up. Large groups of enemy bombers appeared which struck at the positions of our troops. The Fascist Air Force started active operations. Volleys of artillery batteries were mingled with bomb explosions.

Woods and villages were burning. Above clouds of smoke rising into the sky there came wave after wave of German planes, dropping bombs on the positions of their own troops as well as on ours, and the conflagration on the ground flared up with renewed violence. The Hitlerite command assigned a difficult mission to the Air Force: clear the way for tanks and infantry.



Hero of the Soviet Union Capt. V. P. Mikhalev. (1944)

This kept almost the entire Air Force of the enemy on the main line of resistance. The leading part was assigned to the bombers. In groups of 50 and even 200 planes they flew over the main line of resistance and tried to bomb the most important strong points. One attack followed the other. For instance, a small troop sector of ours defended by one of the Guards divisions was subjected to constant aerial attacks for 15 hours. Overexerting the strength of their Air Force, suffering heavy losses in aerial combat, the Hitlerites strove at any cost to achieve moral and material superiority in the air.

Information concerning enemy Air Force operations and its tactical methods and maneuvers was being continuously received at the CP of the second Air Army. The basic stratagem of enemy tactics was very soon found out, and urgent countermeasures were taken. Fighters were ordered not to join battle with the enemy fighters who had broken through into our rear, but to fight their way to the main

line of resistance and there deliver attacks on enemy bombers.

A. K. Gorovets (1939)

Aerial combat on many levels was flaring up with even greater fury over the battlefields. Disabled enemy bombers dropped to the earth like torches; since bombs started falling less often on the positions of ground units, assaults against attacking enemy tanks and infantry increased.

The first day of combat was coming to an end. Pilots of our Air Army downed 154 enemy planes. In these severe combats we lost 53 planes, and 50 planes were disabled and put out of action. Our sacrifices were not made in vain. By the end of the first day of the offensive, we had attained equality in the air and had undermined the offensive power of the Hitlerite Air Force.

The battle near Kursk is a heroic national epic in which thousands of Soviet people displayed wonders of valour and glory.

On 12 July, near Prokhorovka, an armored engagement took place, the largest in military history. Up to 1500 tanks from both sides participated in it.

The point of an enormous armored wedge was moving along the Belgorod highway. But here, as in other lines of advance, "Tigers" and "Ferdinands" met a well-armed opponent. Hundreds of Soviet antitank guns pounded at the caterpillar tracks and turrets of German machines; antiaircraft guns, antitank rifles, flame throwers fired at them. From the air, ground attack planes and bombers came down in a dive on tank columns. Steel, earth, and air — all were burning.

Having met with resistance, the enemy shied away like a wounded beast. Columns of German tanks piled up in a hollow close to a little stream which flowed through the Prokhorovka base of operations. It is here that tank battles, unprecedented in history, were fought. Our tank groups advanced against the fascist armored avalanche. Dozens of Soviet tanks vied in strength with "Tigers" and "Ferdinands", rammed and battered enemy machines to fragments. The bravery of the Soviet tankists, the skill of the Ural workmen who had forged the metal for tank armor were gaining a victory.

Hard was the steel smelted in the furnaces of Soviet factories, but harder still are the people of the country of socialism, defenders of the first socialist state in the world. Here, in the battle at the Kursk base of operations as well as in the battles

Fighter Pilot, twice Hero of the Soviet Union, N. D. Gulayev (1945).

near Moscow and Leningrad, near Sebastopol and Stalingrad, they amazed the world with their heroism, devotion to their Motherland, to the great Communist Party.

Our pilots multiplied their glory in these struggles. Here is a short paragraph from the army paper "Kryl'ya Pobedy"[Wings of Victory] of that time. Under the heading "Guardsman Alexandr Gorovets shot down nine 'Junkers' in one combat", we read: "A group of Guards fighters were returning from a combat mission.Guards Lt. Aleksandr Gorovets was bringing up the rear. Suddenly, to one side of the route, he noticed a group of nine 'Junkers' ready to bomb our combat formations. They had already reformed to a position in line for a target run. Each second was precious. There was no radio transmitter on Gorovets' plane and therefore he was unable to call anyone to his assistance.

"Gorovets, single-handed, attacked the 'Junkers'. This was a stunning lightning-like attack. In the heroic duel Guardsman Gorovets destroyed all nine 'Junkers' before the eyes of the admiring infantry men, amazed at his skill and courage, and then took a course for his home field.

"At this time six 'Messerschmitts' emerged from behind the clouds. They seized the solitary Soviet plane in a vise-like grip. Gorovets defended himself bravely. The ammunition supply was already exhausted, fuel was getting short. The pilot fought off the 'Messer' attacks to the very last shell and drop of fuel.

"The heroic exploit of Guardsman Alexandr Gorovets, who died the death of the brave, will never be forgotten by his Motherland.

"His comrades-in-arms took a Guardsman's oath — to strike the enemy still more violently and bitterly, to strike him until he was completely destroyed."

Alexandr Gorovets was a Communist. He fought and died as a Communist should. By his example the fearless pilot inspired thousands of fighters and summoned them to perform heroic deeds in the name of the Fatherland.

The Command recommended Aleksandr Gorovets for a high government award. On the awards list there was written in blue pencil: "Worthy to be awarded the rank of Hero of the Soviet Union. [signed]: Commanding the Voronezh front, General of the Army N. Vatutin. Member of the Voronezh front Military Council, Lt. Gen. N. Khrushchev."

Soon the Presidium of the Supreme Soviet of the USSR published a Decree stating that Alexandr Gorovets was being posthumously awarded the rank of Hero of the Soviet Union.

Recently, not far from the Zorinskiye Dvory farm, Ivnyanskiy district, Belgorod region, a plane was discovered in the ground, and in the cabin the remains of a pilot.

On the decayed tunic were visible the order of the Red Banner, tarnished with time and the Guardsman's badge. In the map-case they found a map, a faded photograph, a flight log, an identification card, a few letters. Time had done its work: many documents were already illegible.

In the breast pocket was a purple booklet stained with blood — the Party membership card. The photograph on it had faded but one could read the entry in black India ink: "Gorovets, Aleksandr Konstantinovich, year of birth 1915. Party membership card issued in 1939 by the Voroshilov Party District Committee in the city of Shakhty, Rostov region."

In the battle at the Kursk base of operations, as in many other combats for our Motherland, Communists were always in front. Though modest, they showed an exceptional firmness on the battlefield, and in so doing they were an example for everyone. I remember well the figure of a Communist pilot, an air fighter, whose fame had spread along the whole front.

Once I came to an Air Force unit to attend a tactical flight conference. There were many good fighters, but few wishing to tell about their experience. Someone asked Senior Lt. N. D. Gulayev to speak. From among the comrades there rose a young pilot, but he immediately became embarrassed and said: "Comrades, I have nothing to tell, I have no secrets", and he sat down.

But the pilots kept on insisting: "Come on! We have to know how you manage to intercept planes on almost every sortie."

Pilot Gulayev hesitatingly approached the table. He blushed.

"My stratagem is simple, Comrades. When they scramble me for an intercept, I do not fly to the region where the target has been located as some pilots do, but I take a lead angle. I know the target's flight course as well as the speed, and so I figure out where I can meet the enemy. As a rule I hit it just right."

With this he concluded his speech. But having thought for a while, he added: "Anyone who wishes can always meet the enemy. The rest... i. e. whether to circle around the reconnaissance plane, to down it or not — this is a matter of conscience. I prefer downing planes."

And when Gulayev said that he preferred downing enemy planes, his words sounded convincing. Many of his comrades could remember more than one aerial combat carried out by the Communist pilot. The fight over our Provorot' airfield is particularly memorable. At sunset, nine "Ju-87's" covered by 6 "Me-109's" approached the field. At the air signal alert ten "Yaks" took off for interception. After the very first attacks the enemy plane formation disintegrated. Having downed the lead bomber, pilot Gulayev rushed at the second "Junkers". Gulayev shot two bur[illegible]s of machine-gun fire at the engine and cabin of the enemy plane. And then he realized that his ammunition supply was exhausted; the bomber continued to fly away towards his own lines.

The fighter pilot used the last resort — ramming. With the left wing of his plane he struck a wing of the "Junkers" and the latter started falling. Gulayev's plane, too, became unmanageable. The pilot parachuted and landed amongst his own troops.

N. D. Gulayev understood that to gain victory over the enemy one has not only to fight skilfully and courageously, but help one's comrades become perfect air fighters as well, strengthen discipline, and raise a unit's combat ability. Once he applied to the Party Organization secretary: "I would like to do some regular Party work. For instance, I might follow newspaper and magazine articles dedicated to aerial combat experience and then acquaint my fellows with them."

The secretary supported this suggestion. Senior Lt. Gulayev began to collect articles on aerial combat and kept a special album which all the pilots liked to read. This was of great benefit.

This is the way each Communist worked. Battle is joined: the Communist precedes his comrades and fearlessly leads them onward. A minute of respite, and the Communist prepares for victory in the coming clashes.

The entire Soviet population, working heroically in the rear, followed the course of the Kursk battle with great attention and touching love. They not only followed it, but made every effort to send to the front as many weapons, as much combat equipment, rations, and clothing as possible. During the short intervals between combat, the pilots, as well as fighters of other branches of the service, received parcels from unknown citizens, letters from unknown but kindred people.

In reply to the solicitude of their Motherland, soldiers and officers displayed mass heroism. Not individual fighters, but entire outfits, regiments, and groups distinguished themselves in combats.

From the first days of defensive actions on the Kursk base of operations, loud and deserved fame followed General D. P. Galunov's Air Force fighter corps pilots. The corps regiments operated with great intensity. During two weeks the corps fighter planes carried out 250 aerial combats and downed 451 planes. One hundred and seventy-five enemy planes were downed by pilots of the Air Force fighter corps under the command of General I. D. Podgornyy. Our air fighters displayed not only unparalleled courage, but also skill in defeating a numerically superior enemy cleverly and with tactical competence.

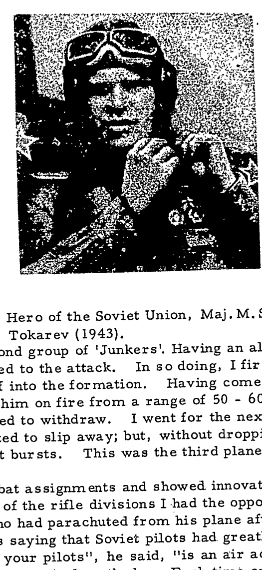
Pilots of the Air Force fighter group commanded by Maj. Gen. of the Air Force D. P. Galunov were models of courage and heroism (1945).

A group of nine fighter planes under the command of Capt. Podorozhnyy was famous for its perfect flight teamwork, its ability to preserve combat formation under the most difficult conditions of aerial combat and to make use of various tactical methods. Once over the battlefield this group of nine met 40 "Junkers" escorted by "Messerschmitts". Capt. Podorozhnyy immediately evaluated the situation and led the nine into the center of the bomber group. Under such a concerted and precipitous attack the enemy aircraft formation broke up.

In this engagement our fighter planes downed in fire 5 bombers and one "ME-109" without losing a single plane of their own. Junior Lt. Yevstigneyev particularly distinguished himself. He shot down 3 planes. Later on Yevstigneyev said about this aerial engagement: "We took off to cover our troops' main line of resistance. We approached the designated

area from above on two levels. The shock group of three fighter planes was flying below. Capt. Podorozhnyy was leading it. It had to destroy the bombers. The second group was to engage them in combat and create favourable conditions for the operations of its comrades.

"As soon as the bombers appeared, Capt. Podorozhnyy led his group of six to an attack. From above and with a left turn he approached the 'Junkers' from the rear and, together with his wingman, set fire to one plane in the first attack. I was flying to the lead plane's left, and after him I attacked the last 'Junkers' in the tail pair. I approached him from above from the left at an angle of 45°, and from a range of 50 m I downed him with the first burst of fire. To finish the enemy off, I dived with him, made a turn, and gave him one more burst. The plane fell.



Hero of the Soviet Union, Maj. M. S. Tokarev (1943).

"Right at this time there appeared a second group of 'Junkers'. Having an altitude advantage over them, I immediately rushed to the attack. In so doing, I fired a burst at the nearest plane and wedged myself into the formation. Having come out, I approached a 'Junkers' from the rear and set him on fire from a range of 50 - 60 m. The bomber formation broke up and they started to withdraw. I went for the next target. In abrupt descent, the enemy attempted to slip away; but, without dropping behind, I continued to pursue him, firing short bursts. This was the third plane I downed in this engagement."

Our air fighters ingeniously solved combat assignments and showed innovation in aerial combat. In the headquarters of one of the rifle divisions I had the opportunity to talk with an experienced German pilot who had parachuted from his plane after being downed by our fighter aircraft. He was saying that Soviet pilots had greatly improved during the war years. "Any one of your pilots", he said, "is an air ace. The main thing is that you have no set pattern in tactical methods. Each time one is confronted with a new surprise. The fact that I am standing before you is the result of one of your fighter planes' usual surprises. I approached him from the rear, climbed, and suddenly... he made a wing-over and raked me with a burst of fire before I had time to realize it. Such a maneuver is technically impossible — it seems."

Yes, Soviet pilots often did things which many considered impossible. Throughout the world there were many people for whom the victory of the Soviet Union over Hitler's Germany seemed impossible too.

Our fighter planes did not withdraw from battle so long as there was left at their disposal at least some means of combat. Fighter pilot V. P. Mikhalev carried out several ramming actions in the course of the war. During the air battle near Kursk, when he saw that a "Junkers" was making for home uninjured, Mikhalev — having no ammunition — overtook it and with his propeller chopped off the left part of the stabilizer. The "Junkers" soared down to earth.

In aerial combat for his Motherland, officer Mikhalev downed 26 enemy planes.

Speaking of our fighters' skill, one involuntarily recalls — one after another — the wonderful men who every day would take up into the air their impetuous fighter planes with the red little stars on their fuselages — the tokens of numerous victories in aerial duels. Time cannot erase the figures of these men — modest in behaviour, unselfish in friendship, and courageous in combat.

I remember meeting at one division fighter regiment commander and Hero of the Soviet Union, Maj. M. S. Tokarev. He was a man of heroic physique. The Major's manner with his comrades — particularly with his seniors — was modest, almost bashful. Noticing 14 stars on the fuselage of his plane, I asked him: "Surely not all have been marked?"

The Major kept in the background and did not reply. But I knew that — besides the 14 planes downed by Tokarev in the preceding combats and, first of all, in the Kuban' — he had already downed several planes at the Kursk base of operations.

Major Tokarev skilfully led fighter groups and in aerial combats he invariably displayed ideal courage and skill. Once a group led by him met a numerically superior enemy in the air. In the course of combat the Major found himself encircled by ten enemy fighter planes. The soldiers of our Air Force ground outfits saw how he downed four enemy fighter planes. But the forces were too unevenly balanced. The Soviet pilot was out of ammunition. His plane was hit and flew right to the ground in uncontrolled flight.

Such were the men who fought at the Kursk base of operations. It is not surprising that, though the enemy threw his main forces into the Kursk bulge, he was still forced to give up his mad plans.

After the failure of the offensive near Kursk, the enemy counted on consolidating his position on the attained lines. But he did not succeed in doing this either. Having bled the enemy white, the Soviet troops completely restored the original situation of the front line by means of powerful counterthrusts: — on 17 July on the Orlov front and on 23 July on the Belgorod front. Thus they entirely liquidated the advance of the German fascist army against Kursk.

Soon our front troops were given a short rest and started getting ready for an offensive.

Reserves were arriving. A number of Air Force fighter and bomber groups were assigned to the army.

Some of the recently arrived groups did not yet have any combat operations experience but the flying personnel quickly joined the training. Seasoned air soldier-pilots who had mastered the enemy's tactics were their instructors and teachers.

By that time front headquarters had worked out plans for coordinated troop action in the Belgorod offensive operation. Several possible variants of dealing the main blow were taken into consideration. And, of course, pilot combat training was set up according to these plans. Special attention was paid to the main combat operation thrusts. Leaning over maps, the pilots endeavored to learn them by heart, to remember road junctions, river patterns, outlines of woods and fields. Then they would get into training and combat aircraft and fly about the future combat areas. They studied with particular care the enemy main line of resistance. Flying over it, navigators and pilots scrutinized each natural feature, studied the least altera-

tion on the ground.

By order of the Army Commander, General S. A. Krasovskiy, the regiments' corps of officers visited infantry units for terrain reconnoitering, to see the defense line which had to be broken through.

Nor did the enemy slumber at the same time. The Soviet Information Office reported that in the Belgorod and Khar'kov areas Hitlerites had concentrated a huge grouping of armor, had created armament and supply dumps, built fortified defense lines. Enemy officers and specialists took great pains to make their defense impregnable. Even defective tanks were planted in the ground and made into pillboxes.

The enemy was licking his wounds behind the strong wall of defenses. Nor did his aviation show any signs of its former activity. The loss of 900 planes on our line of advance alone seriously affected the condition of the Air Force operating against our front. True, the enemy was greatly superior in bombers — 350 against 82; but, on the other hand, in ground attack aviation we had 250 "Ils", strength which the fascists did not possess. We had a decisive superiority in fighter planes.

Some groups in the enemy Air Force with which the pilots of the Second Air Army had been fighting during the July operations were continuing to operate. They were based on the same airfields: Mikoyanovka, Tomarovka, Konotop, and so on. Several fighter squadrons, mauled during the July battles had been transferred to airfields in the rear.

We were intensely busy reconnoitering during the first stage of offensive preparations. Recon aircraft had particularly much work to do.

Recon planes penetrated deep into the enemy's rear. The planned breakthrough zone was explored in great detail, enemy tactical and operational reserves were estimated. Recon aircraft of the Second Air Army photographed his entire defense zone. This was, if one may say so, an X-ray picture of enemy defense. On the basis of air reconnaissance data, the front headquarters topographic section published a disposition map of the enemy defense belt and distributed it among all the ground armies. Aviation corps and divisions were given maps of enemy artillery positions and of his strong points. These diagrams directed our aviation at objectives which prevented the advance of Soviet troops.

The following main communication lines were kept under the constant and unabated control of air reconnaissance: Khar'kov-Belgorod, Akhtyrka-Belgorod, Khar'kov-Sumy. The slightest movement of enemy troops was noted on a map and was made known to the front command.

On 3 August 1943 at 0600 the rumble of artillery announced the beginning of the Soviet troop offensive against Belgorod. Our guns pounded the enemy defensive strong points with sureness and precision. Barrage fire was rolling to the southwest, smashing enemy concrete pillboxes, earth-and-timber pillboxes, destroying dugout shelters and trenches. Our Air Force came to the "War God's" assistance. Till 0800 ground attack planes and bombers continuously rained down bombs and machinegun and cannon fire on enemy troops.

Following the artillery and air raids, infantry and tanks started advancing. They soon took possession of the enemy's main defense line.

The breakthrough was made on 5 August. Soviet Army troops liberated Orel and Belgorod.

The battle on the Kursk bulge ended in a brilliant victory of the Soviet people and of their Armed Forces.

After the battle of Belgorod and Kursk, in the summer of 1943 the Soviet Army drove the fascist armies off its soil towards the West, annihilating the enemy's troops and equipment.

THE NAME OF A HERO IS IMMORTAL

During the years of the Great Patriotic War Capt. Ivan Markovich Pilipenko was among the glorious defenders of the Soviet sky.

In the operations reports and in the combat operations journal of the unit where Pilipenko served brief but exciting entries have been kept of the fearless falcon's combat exploits.

It was 26 May 1942. Six of our I-16 fighter planes led by Capt. Pilipenko were giving air cover to troops in the Izyum region. There they met enemy bombers and fighters numbering up to 40 Ju-87, Ju-88, He-111, and Me-109 aircraft. An unequal fight lasted about 20 min. Pilots displayed genuine heroism and courage — particularly Capt. Pilipenko. In this engagement he downed two bombers and crippled four.

Capt. Pilipenko, having taken off in a pair on reconnaissance on 9 June 1942 in the region of Barvenkovo, spotted a camouflaged enemy airfield where up to 30 bombers and fighter planes were based. Making use of reconnaissance data the Command decided to strike an assault blow on this airfield. I. M. Pilipenko was appointed group leader. In the assault five enemy planes were burnt — three on the ground and two at takeoff.

On 27 July 1942 eight I-16's led by Capt. Pilipenko took off to give air cover to a Don River crossing in the Rostov region. In the air our pilots met a group of enemy planes: fourteen Me-110's and six Me-109's. An unequal combat began and our fighter planes downed two Me-110's and four Me-109's without any losses on our side.

These examples characterize Capt. Pilipenko's courage, bravery, and valour in his fight with the German invaders. He fought against the fascists for only one year and during this short time he made 470 combat sorties for reconnaissance, ground attack troop air cover, and bomber escorting. In 76 air combats the brave pilot personally downed 13 planes and 32 in group dogfights. He was famous not only as expert in air combat, but also in air reconnaissance. He flew 94 times on ground attack missions against enemy troops and airfields.

The pilot's services were highly valued by the Command and by the Soviet Government. I. M. Pilipenko was awarded two orders of the Red Banner, two orders of Lenin, and the lofty title of Hero of the Soviet Union was conferred upon him.

On 2 October 1942 the courageous pilot led a fighter group on a ground attack mission against a fascist airfield in the district of the Cossack village of Soldatskaya in the Kabardino-Balkarskaya ASSR. The group, camouflaged by the cloud cover, made a bombing target approach which surprised the enemy. The fascists were quietly strolling about the airfield. Suddenly, in hedgehopping flight, our pilots

opened fire with their machine guns, spraying the aircraft parking areas and the start line. A few planes and a fuel servicing truck caught fire. On the third approach the pilots saw that a pair of enemy fighter planes was trying to take off. But they did not succeed getting into the air. One of them was downed by Ivan Pilipenko. A few minutes later a shell hit the cockpit of the plane and the pilot-hero was fatally wounded. With a heavy heart the inhabitants watched the crippled Soviet plane coming down in the outskirts of the Cossack village. Late at night the women Kolkhoz workers, A. Sushkova and A. Grazhdankina, stole up to the place where the plane had fallen. Risking their lives, they dragged the dead pilot from the plane and secretly buried him. Soon the Cossack village was liberated by our troops. According to the Kolkhoz workers' wishes, Ivan Pilipenko was buried on the stanitsa [Cossack village] square.

The memory of the courageous pilot is piously revered by the inhabitants of the stanitsa. In the square bearing his name stands a granite obelisk, it's five-pointed star rising upwards. At its base is carved a dipped battle standard — symbol of combat glory.

Lt. Col. A. P. Kalinin

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REVIEW AND BIBLIOGRAPHY

A NEW AIR NAVIGATOR'S HANDBOOK

The Air Navigator's Handbook. Edited by Maj. Gen. of the Air Force V. I. Sokolov. Military Publishing House of the Ministry of Defense of the USSR. Moscow, 1957, 416 pp., price 7 rubles 45 kopecks.

The new "Air Navigator's Handbook" published in 1957 immediately attracted the attention of VVS [Air Force] pilots and navigators, commanders and navigational service specialists, and of teachers, students and cadets in aviation training institutes. It differs favorably from previous editions of a similar nature in the variety of material and the greater thoroughness of its explanations.

Along with data on air navigation, bombing and aerial photography, the Handbook gives important and necessary information on mathematics, physics, radio technology, cartography, astronomy, meteorology, etc.

The section entitled "Information from the Field of Mathematics, Physics and Radio Technology" makes it possible for the reader to study technical literature more easily without referring to special handbooks. The material in this section is quite simply presented and is methodically correct.

In our opinion, however, the Handbook contains very little information on radio technology in general and on radar in particular. Nothing is said about precision in the direction-finding methods employed in radio-navigational and radar systems. There is none of the information on directivity diagrams and other radio-navigational and radar antenna parameters of various kinds so extremely necessary to the navigator. The radar method in which frequency modulation is used is not presented, although a large quantity of radio altimeters are constructed on this very principle. There is none of the information necessary for understanding the operation of radar bomb sights, of relay radio range finders and other radio-navigational equipment.

The absence in the Handbook of brief but specific data of this sort deprives navigators of material needed for precisely the most current problems. Meanwhile radio electronics methods are at present penetrating ever deeper into all aspects of the work of the air navigator who has to be able to master this equipment, not only under ordinary conditions, but also in the face of countermeasures. All this forces us to think of the compilation of a special manual on the aforementioned subjects, or of a radical revision and augmentation of the material presented in the book under review.

Several inaccuracies should also be pointed out. The statement that the distance to the farthest target (subject to radar station detection) is equal to half the product of speed of pulse propagation times the period of their repetition can lead only to confusion. The term "power flux density" is replaced by the term "power density"

(p. 92), which can hardly be considered felicitous. The formula for determining the maximum range for the detection of a group target with an effective reflecting surface σ_t by using the known detection range of a single target is simply incorrect (instead of the root to the fourth power, the square root is given). Resolving power is formulated to conform roughly to a case in which 100 blips are packed into a range scan. More general correlations should have been given.

The second part of the Handbook is devoted to aerial cartography, astronomy and meteorology. The chapter on aerial cartography covers quite thoroughly a series of questions of interest to a navigator; the material is presented correctly and clearly.

The treatment of a series of concepts and definitions evokes several objections. On p. 101 the definition of the line of position is inaptly formulated as the geometrical location of the points of the aircraft's "equiprobable" position. Obviously the word "equiprobable" is here used as the result of a misunderstanding. On p. 111 the definition of scaling up as the deviation of a particular scale from the main one is not entirely correct. Scaling up is characterized by this deviation but is not the equivalent of it. On p. 112 a clear definition of the concepts "length distortion" and "direction distortion" is not given. In the correction formulas for passing from an orthodrome to a straight line (pp. 107 and 122) the correction sign turns out to be the opposite of what it actually is. This should be taken into account and the formulas themselves written accordingly. In the orthodrome equation (p. 105) the arbitrary values given at the beginning of the chapter are not maintained.

The classification of projections is presented quite thoroughly, although the group of azimuthal projections as well as the characteristics of the central and stereographic projections used in aviation should have been given in greater detail.

Quite a large space is assigned to aviation astronomy. But unfortunately almost nothing is said about the methods and peculiarities of flight with the aid of astrocompasses, about the general principles of their construction and operation, about periscopic sextants, their construction and use in flight.

The definition of the celestial sphere is somewhat inaccurate. It should have been pointed out that the radius of the celestial sphere is considered so large that it is possible to disregard the earth's dimensions and to assume the center of the earth to be the center of the celestial sphere. Then many concepts connected with the celestial sphere would be clearer and more graphic; for example, the universal axis is an extension of the earth's rotational axis, the equatorial coordinates are an extension of geographical coordinates, etc. In general, the principal points and circles of the celestial sphere should have been presented in fixed systems of celestial coordinates; then these concepts could be mastered more easily. Methodically unjustified is the explanation (p. 146) that "the determination of one's position ... is based on the equality of the radius of a circle of equal altitudes... to the zenith distance of a body..."

In the chapter on meteorology (Chapter VI) the composition of the atmosphere, the qualitative properties of meteorological elements, air masses, fronts and local weather characteristics are spoken of briefly. This chapter concludes with a description of the influence of meteorological conditions on aircraft flight and with recommendations for the identification of several dangerous weather phenomena while in flight.

However, the navigator will not find any information in it on how cloud zones and precipitations influence the radar detection of targets, or about the peculiarities and characteristics of the icing of present-day jet aircraft with their high flight speed.

Very little is said about barometric topographic maps. The inclusion in this chapter of a description of local weather characteristics cannot be considered fortunate, since in the form in which they are given they will hardly be of use to the navigator in the evaluation of meteorological conditions either in preparation for flight or directly in flight itself.

This chapter also contains several inaccuracies and misprints. On p. 161 it is erroneously pointed out that the ionosphere begins at an altitude of 60 km. In reality the ionosphere begins at an altitude of 80 km (see fig. 99). On the same page the assertion is made that strong winds are observed in the lower stratosphere as well as in the upper troposphere. This assertion can lead the reader to the wrong conclusion. From fig. 99 one can see that in the lower 25-kilometer layer of the stratosphere the wind velocity decreases with the altitude (from 80 km per hour in the upper troposphere to 40 km per hour at an altitude of 25 km). It is necessary to mention a discrepancy in estimating the vertical thickness of cirrostratus clouds (p. 167).

The cloud system in fig. 101 (p. 174) representing the vertical section of a second-class cold front is incorrectly placed and does not agree with the text. In the figure the clouds and zone of precipitation are located behind the front, whereas in reality behind the front there is a sharp decrease in cloudiness which sometimes reaches complete clearness, and there is a cessation of precipitation. There is a mix-up in the numbering of figures 102 and 102 a.

Then it is quite correctly pointed out that it is possible for high-speed aircraft to avoid icing by increasing flight speed (p. 182). However, this method for combatting icing is not always effective. It should have been noted that this method is applicable in horizontal flight through clouds when the aircraft has a great speed range. But in cloud penetration the speed reserve may not be sufficient for the removal of ice, and this will result in a more intensive accumulation of ice on the aircraft surfaces. Thus flight experience shows that instances are not infrequent in which the most dangerous sort of rime ice appears during cloud penetration as the result of an increase in speed, greatly impairing the aerodynamic qualities of the aircraft.

The third part of the Handbook is devoted to information on the theory and practice of air navigation. In it the basic problems in resolving the navigational velocity triangle, the methods for determining the navigational elements of flight, and the principles of the theory and practice of maneuvering aircraft are quite thoroughly elucidated. Successfully systematized, in our opinion, is the information on methods for determining the navigational elements which is given in the form of a table.

In this section the authors employ a systematically correct method when they somewhat depart from specific technical means and give general conditions valid for any type of the various navigational instruments. However, this is sometimes done to the detriment of quality in the presentation of the material. Thus, for example, the accuracy characteristics in determining certain lines of position (orthodrome line of equal altitudes, etc.) are cited rather incorrectly, without reference to any type of apparatus or instrument. This can sometimes be misleading.

Also in a series of instances accuracy in determining the aircraft's position is not quite correctly estimated by using several methods unrelated to specific flight conditions. For example, accuracy in the determination of an aircraft's position

by plotting its course or with the aid of a navigational indicator is estimated to involve an error of as much as 10% of the distance covered, although it is known that with careful wind computation this error will not exceed 5 - 6%.

In general it is necessary to say that individual ways and means for determining this or that navigational element in the Handbook are evaluated somewhat one-sidedly — only from the standpoint of accuracy. In flight itself the choice of any given technical means of air navigation, of the method of making navigational measurements, is often determined by other factors, such as the time necessary for carrying out measurement and computation, the nature of the terrain being covered, meteorological conditions, the conditions of the navigational and tactical situation, etc.

In the chapter "The Leading of Formations and the Maneuvering of Aircraft" the material, in our opinion, is not particularly well organized. It would have been more advisable at the beginning to give the basic principles in maneuvering an aircraft with respect to course, speed and altitude, and then their use in the solution of various air navigational problems. It seems to us that this chapter should be the basic one in the Handbook. But this is not the case.

Despite the fact that the material is of undoubted interest, the chapter as a whole suffers as a result of the inclusion of certain obsolete material and from specific omissions. There is, for example, a reference to a table of "navigational computations" (p. 260) which is not reproduced in the Handbook; obscure arbitrary values are encountered, particularly in the safe time interval formula, etc.

In examining the approach and calculation for landing under adverse meteorological conditions the authors quite correctly give as an instance of a straight-in-landing approach a turn-away maneuver with a computed angle; but for some reason they omit it when they speak of break-up methods when landing under adverse meteorological conditions. It seems to us that it was a good idea to give at the end of the "Air Navigation" section, if not all the methods, then at least the main conditions for the evaluation of air navigational accuracy and the determination of navigational elements.

In the chapter "Bombing", satisfactory as a whole for the reader, one would like to find not only sighting diagrams for bombing from a dive, but also the basic sighting principles for both determining the moment for going into a dive as well as for determining the moment for dropping bombs. Certain inaccuracies are encountered in the chapter as, for example, in the standard formulas for the calculation of probable deviations (p. 333).

In our opinion the chapter entitled "Aerial Gunnery", while on the whole good, is unjustifiably included in the Handbook. A special handbook on aerial gunnery — necessary not only for navigators but also for pilots and gunners — should be compiled.

Thus "The Air Navigator's Handbook", while having its undisputed merits, also has serious shortcomings. These shortcomings should be taken into account in the preparation of the second edition of the Handbook. Nevertheless, even the present edition is a considerable help to navigators. The Handbook may also be recommended as a training aid in aviation training institutes.

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FROM THE EDITOR'S MAIL

ON COMPUTING THE COMBAT CAPABILITIES OF FIGHTERS

1. An Unjustified Method

The Reader continues the discussion

The evaluation of the combat capabilities of both friendly and enemy aircraft is one of the most important problems of an air commander. Therefore the subject of the article by Col. V. Ya. Kudryashov and Lt. Col. P. G. Nikitin, "The Combat Capabilities of Fighters and a Method for Determining Them", published in the journal "Herald of the Air Fleet", No. 8 for 1957, is undoubtedly timely.

The authors quite correctly write that the combat capabilities of fighters, determined by the anticipated result of their operations, are conditioned not only by the characteristics of the aircraft's armament but also by other factors such as aircraft flight and tactical data and the morale and training of the flying personnel.

Unrestricted by the statement of these indisputable principles, Comrades Kudryashov and Nikitin propose their method for determining the combat capabilities of fighters. However, this method gives rise to objections.

The final computational formula proposed by the authors of the article looks like this:

$$N = CWKN_f,$$

where N is the anticipated number of destroyed enemy aircraft;
C is the degree of the fighter's superiority over the enemy;
W is the probability of hitting the enemy aircraft with the fire of one fighter;
KN_f is the number of active fighters operating against the enemy aircraft.

The coefficient C is assigned to allow for the influence of the flight characteristics of the aircraft on their combat capabilities. It is precisely in this element that that which is new in the article consists.

The introduction of such a coefficient does not by itself give rise to objections. If W is the probability of hitting the enemy with the fire of a fighter attacking him, then the coefficient C is the probability of the fighter's approach to an initial position of attack. Without a doubt the maneuvering and speed characteristics of the attacking and the attacked aircraft influence this probability. Let us also note that the coefficient C is dependent on other factors as well (not to mention the pilots' personal qualities): on the capabilities of the ground system of detection and vectoring, on the performance characteristics of the airborne search radar, etc.

In the light of the above, the designation "the degree of the fighter's superiority over the enemy" chosen for the coefficient C is hardly fortunate, since "superiority" can in principle be infinite, whereas probability cannot exceed unity.

How do the authors of the article determine the value of this coefficient?

One might reproach them for not taking into consideration such factors as, let us say, the tactical and technical capabilities of ground and airborne radars. But let us assume that these factors do not play an essential part (i. e., instances of interception are not considered) and that one can limit himself only to the consideration of flight and tactical data of the aircraft.

Let us turn to the article. "In order to find a criterion for determining the capability of fighters to destroy air targets", the authors write, "let us analyze aerial combat as a physical phenomenon. From this point of view it is possible to present it as the clash of two opposing forces."

But such a physical phenomenon as a "clash" of forces does not exist. Evidently the authors decided to liken aerial combat to a composition of oppositely directed forces. But if in mechanics the word "force" has a quite definite meaning and quantitative significance which permits carrying out composition, then the "forces" of the fighter and the enemy cannot be expressed so simply in kilograms. And if this is the case, then the ensuing reasoning gives rise to a series of questions. We read in the article: "The general result of the manifestation of superiority is an algebraic sum of the relations of the performance margins of certain flight and tactical characteristics of the fighter to the corresponding characteristics of the opposing aircraft."

Why is it necessary to take an "algebraic sum", or a "sum of the relations of margins"? Why, finally, is this sum represented by an unknown coefficient in connection with the probability of hitting the target? To all these questions the authors give no answer. Nor do they explain how they finally arrived at a sum of only three items, the relative margins of horizontal, vertical and angular speeds.

As we can see, the proposed method of computation does not have sufficient grounds. Nevertheless, is it possible to consider it at least as a method of first approach, imperfect, but giving more or less reliable results? The answer is no.

Let us take a simple example. Twenty of our fighters enter into an aerial combat with two enemy fighters in which the flight and tactical characteristics of the aircraft of either side are perfectly identical. According to the method of the authors of the article under discussion we get

$$C = O,$$

and consequently N = O.

It appears that in a case of aircraft identical in quality (friendly and enemy) the combat capabilities of the fighters are equal to zero regardless of any numerical superiority over the enemy.

Besides this, with definite correlations of aircraft flight data the value of C computed by this method turns out to be larger than one. It can also turn out to be negative (a negative number of downed enemy aircraft), whereas any conceivable value of the coefficient C must be located within the limits from zero to one.

Thus it is not possible to agree with the assertion of the authors of the article that the proposed methods permit "a more exact determination of the anticipated result of fighter operations."

Evidently for the computation of a fighter's combat capabilities it is necessary to work out a method for determining the anticipated number of fighter aircraft attacks in accordance with a certain type of enemy aircraft under the specific conditions of

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an air and meteorological situation. Depending on these conditions, it will be necessary in computing to take into consideration the characteristics of the aircraft and the various ground detection and vectoring facilities in order to show their quantitative relation with the probability of the fighter's approach to an initial position of attack.

Without a doubt the working out of such a method will require the use of rather complex mathematical apparatus and possibly a no less complex flight experiment, although the results of the computations in their final form (graphs, tables) may look quite simple.

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2. Continuation of the Search for a More Suitable Method

In their article Col. V. Ya. Kudryashov and Lt. Col. P. G. Nikitin, proposing a new method for computing the combat capabilities of fighters, introduce a new concept — the degree of the fighter's superiority over the enemy. It is expressed in the form of the coefficient C. If the degree of superiority C and the probability of hitting the target W are known, then the capability of the fighter in the destruction of air targets B is supposed to be determinable by the formula B = CW.

The question arises: How is the coefficient of superiority computed and what is its exact meaning?

The authors do not give either a methematical formula or an exact definition of this coefficient. But from the problem solved in the article one may conclude that it is the algebraic sum of the relative margin of the maximum flight speed δV, of the maximum angular speed $\delta\omega$, of the rate of climb δu, and the other basic flight and tactical data of the fighter over the enemy aircraft. That is,

$$C = \delta V + \delta\omega + \delta u + \ldots,$$

in which $\delta V = \frac{V_f - V_t}{V_t}$; $\delta\omega = \frac{\omega_f - \omega_t}{t}$;

$$\delta u = \frac{u_f - u_t}{u_t}, \text{ etc.}$$

However, in this form it is difficult to understand the physical and mathematical meaning of the coefficient of superiority.

It is hardly possible to add up mechanically the relative margin of speed, the relative margin of rate of climb, and other quantities. Indeed, each of these totaled items is not of equal value in aerial combat.

Let us show this by means of an example. A fighter attacks a bomber while having a superiority in speed of $\delta V = 0.1$, in angular speed of turn $\delta\omega = 0.3$, and in rate of climb of $\delta u = 0.5$. Then C = 0.1 + 0.3 + 0.5 = 0.9.

Let us assume that this fighter must attack a bomber with improved flight characteristics and with $\delta V = 0$, $\delta\omega = 0.3$, and $\delta u = 0.5$. The coefficient of superiority has been reduced: C = 0 + 0.3 + 0.5 = 0.8. If the computations are to be believed, the fighter has a considerable tactical advantage and his attacks will be successful. But in reality when the fighter does not have the advantage in speed ($\delta V = 0$), interception and attacking of the bomber are quite improbable.

It is also perfectly obvious that if the fighter does not surpass the target in maneuverability ($\delta\omega = 0$), then, regardless of the value of the coefficient C, attacks are either impossible or are rendered very difficult.

The authors themselves give an example which clearly shows the worthlessness of the coefficient of superiority proposed by them.

Aerial combat between two fighters is considered. The first has the advantage in flight speed (V_1 = 1100 km/hr, V_2 = 1000 km/hr), and the second in maximum angular speed of turn (ω_1 = 9 degrees/sec, ω_2 = 10 degrees/sec). Maximum vertical speed is identical.

The coefficient of superiority of the first fighter in relation to the second will be:

$$C = \frac{1100 - 1000}{1000} + \frac{9 - 10}{9} = -\frac{1}{90}.$$

What can be said about the coefficient of superiority obtained? Since C is a negative value the authors at first conclude that the second fighter will have an advantage over the first in mobile aerial combat. But then they suddenly reject this conclusion, declaring that the first fighter, having a greater speed, can counter the attacks of the second.

The use of the coefficient of superiority for combat computations with the formula B = CW especially gives rise to objections. This can be seen in the example cited in the article, where it is shown that the second fighter can realize his fire power to 1/90 of its maximum value.

Let us suppose that the probability of hitting the target in one attack is W = 0.3 and that four fighters are participating in aerial combat. On the average, they carry out 8 attacks on the target. With the usual computations the average number of aircraft downed will be M = 8 · 0.3 = 2.4 aircraft.

The authors suggest that the number of downed enemy aircraft be computed by the formula $N = BN_F$, or $N = CWN_F$, in which N_F is the number of active aircraft in the group.

In our example

$$N = \frac{1}{90} \cdot 0.3 \cdot 4 = 0.013 \text{ aircraft.}$$

The anticipated number of downed aircraft is quite insignificant. The results obtained contradict experience. Everyone knows that even in aerial combat between two small fighter groups there are usually losses on both sides.

In the article by Kudryashov and Nikitin an important question has been raised. It seems necessary to us to continue the search for a more suitable method for determining the combat capabilities of fighters.

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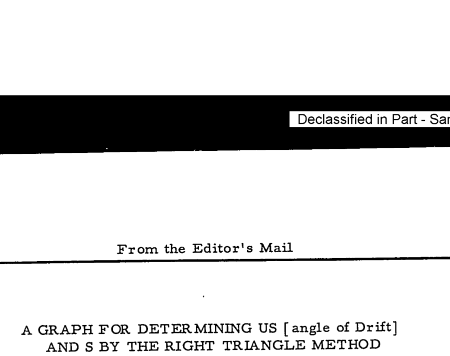
A GRAPH FOR DETERMINING US [angle of Drift] AND S BY THE RIGHT TRIANGLE METHOD

At the present time there have been developed and are being used several different methods of determining the drift angle US and the ground speed W by using panoramic radar bombsights. Noteworthy among them is the method of determining the US and the distance S traveled by the aircraft (and also the ground speed by the distance traveled and the time elapsed) on the basis of lateral radar check points by using the right triangle method.

The essence of this method lies in the fact that bearings are taken twice for the selected lateral radar check point: the first time on some ND_1 [slant ranges] and KUO_1 [check-point angles of approach]; and the second on ND_2 and $KUO_2 = 90^\circ$ or 270°.

In the opinion of officer D. P. Nagayts, there are some difficulties in solving a set problem on a navigation rule in view of the large number of operations required to make the calculations which take considerable time. He suggests a graph that facilitates the pilots' work in calculating the US and the S_{dt} [distance traveled] and makes it possible to obtain them in less time and with greater accuracy than in solving for them on the rule.

The graph consists of three parts. The upper right-hand portion makes it possible to obtain, from ND_1, marked out along the right horizontal axis, and from ND_2, marked out along the upper vertical axis, the coefficient:



Graph for Determining US and S (the sign of US is given for $KUO_1 = 0^\circ - 90^\circ$. If $KUO_1 = 360^\circ - 270^\circ$ the sign is opposite).

$$K = \frac{ND_2}{ND_1}.$$

The value of K is read off along the sloping lines at the point where they intersect straight lines that parallel the coordinate axes and that are drawn from the points of ND_1 and ND_2 (to facilitate interpolation, the K lines can be drawn on the graph as dotted lines at 0.05 intervals).

The upper left-hand portion of the graph makes it possible to multiply the coefficients K, which are marked out on the upper vertical axis on the left, by the secant of KUO_1.

The values of KUO_1 are marked off by sloping lines from $KUO_1 = 20^\circ - 80^\circ$ on the right side, and from $KUO_1 = 340^\circ - 280^\circ$ on the left side (to facilitate interpolation, the KUO_1 can be shown by dotted lines at 5° intervals).

The product $K_1 = K \cdot \sec KUO_1$, which is a component part of the US formula, can be read off along the lower scale on the left horizontal axis.

To solve a problem in determining US, as will be shown below, there is no need to reckon K_1.

With the aid of the upper left-hand graph, it is possible to convert ND to GD [horizontal range]. For this, the ND are marked out on the upper vertical axis, and the GD on the left horizontal axis, while the lines of altitude are represented by sloping curves between the coordinate axes of the left-hand graph. Given on the graph are the curves for altitude H = 10,000 and 12,000 m.

US° / S_1, Km	5	6	7	8
5	0,01	0,02	0,03	0,04
10	0,03	0,05	0,07	0,09
15	0,05	0,08	0,11	0,14
20	0,07	0,11	0,15	0,19
25	0,09	0,14	0,19	0,24
30	0,11	0,17	0,23	0,29
35	0,13	0,20	0,27	0,34
40	0,15	0,23	0,31	0,39
45	0,17	0,26	0,35	0,44
50	0,19	0,29	0,39	0.49
55	0,21	0,32	0,43	0,54
60	0,23	0,35	0,47	0,59
65	0,25	0,38	0,51	0,64
70	0,27	0,41	0,55	0,69
75	0,29	0,44	0,59	0,74
80	0,31	0,47	0,63	0.79
ΔS_1 KM	0,004	0,006	0,008	0,01

To convert ND to GD, it is necessary to draw a straight line from the point on the upper vertical axis corresponding to the magnitude of ND to the left until it intersects the line for the given flight altitude; then from this point to drop a perpendicular and to read the value of GD from the upper scale on the left horizontal coordinate axis.

By means of this same graph it is possible to multiply the GD by the cosine of KUO_1. The result of this multiplication is S_1.

$$S_1 = ND_1\ (GD_1) \cdot \cos KUO_1.$$

To obtain S_1, it is necessary to draw from the point on the left horizontal axis corresponding to the GD a straight line upward until it intersects line KUO, then from this point to draw a line to the right, and on the upper vertical axis to read off (by the graduations on the right) the magnitude $S_1 = GD_1 \cdot \cos KUO_1$.

Using the lower left-hand graph, it is possible to determine the US (from the magnitudes $K_1 = K \cdot \sec KUO_1$ on the left horizontal axis and KUO_1 on the lower vertical axis in graduations from 10° to 60° on the right side and from 300° to 350° on the left side) by the lines of drift drawn between the coordinate axes. The drift angle is read off at the point of intersection of the lines parallel to the coordinate axes drawn from points K 1 and KUO1.

The sign of the drift angle given in the graph is for $KUO_1 = 0^\circ—90^\circ$; with $KUO_1 = 360^\circ—270^\circ$ it will be the opposite of that shown in the graph.

Computed for the graph is a table of corrections for the distance traveled in relation to the value of the US.

With small values of US (to 5°) it is accurate enough for all practical purposes to consider $S_{dt} = \frac{S_1}{\cos US} \approx S_1$, since $\cos US \approx 1$.

As US increases, the error in the distance traveled — due to the fact that US is not considered — also increases; and, as can be seen from the table, it becomes significant for values of US = 5° or more.

The correction that must be added to S_1 to obtain the distance traveled, with consideration of US, can be found by means of the table (we have shown only a part of it, while the complete table is computed for values of US from 5° to 20°). For this purpose it is necessary to know the S_1 and the US.

Given in the bottom line are changes in the correction in relation to changes in S_1 by one kilometer to facilitate interpolation — if it should be necessary. For convenience in use, the table can be placed in the lower right-hand portion of the graph (see fig.).

In addition, a grid should be drawn on the graph. The grid lines should be at a distance of one kilometer from each other on the scale of the graph. For quantity reproduction, the graph is drawn on a large scale (for example, 1 cm = 2 km) and is then photographed. The most convenient size for the photographs is 24 x 30 cm.

To determine US and W it is first necessary to get a good image on the bombsight radar screen, to select a lateral radar check point ahead and to the left or right, and then to measure KUO_1 and ND_1 of the radar check point selected and start the chronometer.

As soon as the radar check point selected comes to $KUO_2 = 90^\circ$ or 270°, ND_2 is measured and the chronometer is turned off.

Then, by means of the graph, the US and the distance traveled by the aircraft in the interval between taking bearings are found.

The ground speed is computed on the NL [navigator's rule] by the S_{dt} and the t_{dt} taken from the chronometer.

Example. Given: H_{tr} [true altitude] = 10, 000 m; $KUO_1 = 40^\circ$; ND_1 = 60 km; ND_2 = 30 km; t_{dt} = 3 min 25 sec.

It is necessary to determine the US, S_{dt}, and W. The procedure for determining the US is:

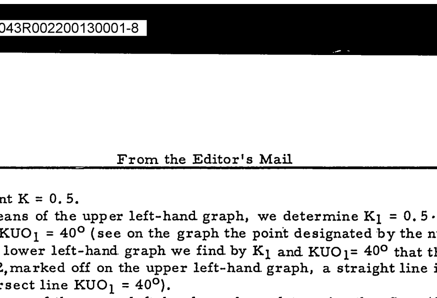
1. In the upper right hand graph we find that, for ND_1 = 60 km and ND_2 = 30 km, the coefficient K = 0. 5.
2. By means of the upper left-hand graph, we determine $K_1 = 0.5 \cdot \sec 40^\circ$ for K = 0. 5 and $KUO_1 = 40^\circ$ (see on the graph the point designated by the number 2).
3. In the lower left-hand graph we find by K_1 and $KUO_1 = 40^\circ$ that the US = + 11° (from point 2, marked off on the upper left-hand graph, a straight line is drawn downward to intersect line $KUO_1 = 40^\circ$).
4. By means of the upper left-hand graph we determine that S_1 = 45. 2 km for ND_1 = 60 km, H = 10, 000 m, and $KUO_1 = 40^\circ$.
5. For S_1 = 45. 2 km and US = + 11°, we find ΔS = 0. 85 km.
6. For $S_{dt} = S_1 + \Delta S$ = 45. 2 + 0. 85 = 46. 05 km and t = 3 min 25 sec, we determine on the NL that W = 805 km/hr.

On the graph, the solution of the problem is shown by dotted lines.

For greater accuracy, the coefficient K is determined not from ND_1 and ND_2 but from GD_1 and GD_2; then the ND are converted to GD by the upper left-hand graph.

CHECKING AN AIRBORNE RADIO STATION

In the post-flight inspection, the airborne and the ground radio stations are checked for two-way communication. The usual method of checking does not give a complete check of the operating efficiency of the airborne station, since the radio mechanics do not always attach the throat microphone to the throat connectors with the same pressure and do not always talk in the same tone of voice. To check the accuracy of tuning of the airborne station and its operating efficiency, officer A. K. Abramov has developed a small and convenient instrument. It consists of an alternating current voltmeter (the T-1 tester or the I-block instrument can be used), two receptacle blocks (one for plugging in the wire from the control panel, the other for plugging in the headset), and a toggle switch for switching on and switching off a resistance of 300 - 330 kilohms(see Fig.).



General view and lay-out diagram of instrument after modification (1 - signal switch, 2 - receptacle for microphone cord, 3 - receptacle for headset).

In checking the aircraft equipment, the radio mechanic plugs the cords from the control panel and the headset into the instrument and on one of the channels calls in to the ground station (the switch for the additional resistance is in the "off" position) and, after making the call, switches on the toggle.

When the toggle switch is on, the "positive" of the headphone is connected with the "negative" of the throat microphone, and the transmitter emits high-frequency oscillations modulated by a constant low-frequency tone. The operator of the ground station notes the readings on the instrument, and then, in the same way, sends a reply signal (duration of 5 - 6 seconds). This process is repeated for each channel. Then the operator of the ground station gives his notations to the mechanic on the aircraft. They both know in advance the voltage on each channel which the instrument is supposed to show.

A check is thus made not only of the tuning of the set, but also of its full operating efficiency.

AVIATION ABROAD

AIRCRAFT OF THE FRENCH AIR FORCE

In France, as in other nations participating in the aggressive NATO bloc, the bulk of the budget goes for military purposes. Special attention in the last 5-6 years has been devoted to the aircraft industry. In turn, the Air Force has been expanded to an unprecedented degree. This has been noted in many publications in the USA, England, and Germany. Expansion of the Air Force also involves considerable expense. Training each pilot in France costs about 35 million francs. To this are added the cost of maintaining and improving the airfields, as well as the operating costs, which comprise about 700 million francs per year per squadron. In addition, substantial amounts are required for maintenance of the ground services and facilities. In 1957 the expenditures for the Air Force amounted to 286.3 billion francs.

Thus, the armaments race, which brings enormous profits to the monopolies, is becoming an increasingly greater burden on the shoulders of the French working people and is seriously impairing the nation's economic situation.

The French Air Force is presently being reorganized. Part of it is included in the air forces of the aggressive NATO bloc and is called an air army; the other part is a branch of the armed forces of France.

There still are British and American planes in the French Air Force. However, they are now being crowded out by planes of French manufacture. Particular attention is devoted to building interceptor fighters, which have not only been adopted as standard equipment for the NATO armed forces but are also being exported to other countries.

Let us describe some of the experimental and series-produced aircraft manufactured by the French aircraft industry.

Fighters. This is the largest group. It comprises more than 20 models built by various French firms. Basically, there are two types of fighters: the light and fast interceptor with a high rate of climb; and the tactical fighter, which can carry an external armament load (bombs, rockets) and can engage in aerial combat at low and intermediate altitudes (to 10 km).

In France, there has been developed a number of fighters with a turbojet engine and a rocket engine used for takeoff, pursuit, and in aerial combat. These planes have speeds of the order of Mach 2. Their weight is about 4.5 tons, and they can take off almost vertically (the engine thrust is greater than the weight of the plane).

These fighters can take off from and land on slightly improved grass fields; this is made possible by using low-pressure tires, braking devices on the wings, and braking parachutes in the tail section.

Some of the fighter-interceptors have no armament other than guided missiles, since French specialists believe that at present-day flying speeds the target can be destroyed only by a guided missile. The design of these planes is very simple. The

Fig. 1. Fighter-interceptors (top to bottom) "Trident" II, "Super Mystère" B-2, "Mirage" III.

use of materials with cores and the production methods (metal bonding) make these fighters relatively cheap. Nevertheless, many aviation specialists consider these planes to be the last of the piloted types, because the future belongs to guided missiles.

The "Trident" fighter-interceptor (Fig. 1) has a combination power plant made up of one rocket engine and two turbojet engines, one at each wing tip. The wings are thin and straight (no sweepback) and of uniform profile throughout the entire span. The rocket engine is used at takeoff, for climbing, and at the moment of attack. At other times the wing jets are used, making for economical fuel consumption and greater endurance. Furthermore, the rocket engine provides maneuverability at high altitudes.

The wing is very stubby, its thickness/chord ratio is 4 - 5%; the core is a metal honeycomb type in the form of hexagonal cells made of corrugated metal 0.025 mm thick. This core is cut out to the shape of the wing directly from the honeycomb material, thus simplifying production considerably and reducing the cost of the plane. All the hydraulic, electrical, and radio equipment is located in a compartment in the fuselage behind the cockpit. In the middle compartment there are tanks for the fuel and the oxidizer which can be dropped. Located in the upper part of the rear compartment are two speed brakes, and in the lower part is the rocket engine. In addition to the ejection seat, the entire nose section of the plane in case of extreme necessity can be detached together with the cockpit.

The maximum speed of the "Trident" II is Mach 1.9. Its low landing speed (about 180 km/hr) makes it possible to land on a relatively unimproved field 450 - 500 m long. The landing gear of this plane is equipped with low-pressure tires.

The flying weight of this plane (about 5 tons) is nearly equal to the thrust of its engines. Its armament consists of only a single guided missile ("Matra"). The "Trident" has been adopted as the standard fighter-interceptor for the NATO Air Force. It is to be manufactured by four aircraft companies, of which two are French, one Belgian, and one German (FRG) [Federal Republic of Germany].

A characteristic feature of the "Durandal" light, single-seater interceptor is a combination power plant: an "Atar" 101-G turbojet engine with a thrust of 4500 kg with afterburning, and a SEPR rocket motor located in the lower part of the fuselage. The wing is delta-shaped; it is very thin, particularly at the leading edge. The speed of the plane attains Mach 1.5 and its rate of climb is 200 m/sec to an altitude

of 16 km. With a flying weight of 4.0 - 4.5 tons, the total thrust of the engines (6000 kg) is much greater than the weight of the plane. With a braking parachute and its low-pressure tires this plane can land on a short strip. Its armament is one guided missile under the fuselage.

Fig. 2. The "Etendard" IV experimental fighter bomber.

The "Ouragan" MD-450, which has been adopted by the French Air Force, is equipped with a "Nene" 104B turbojet engine with a thrust of 2770 kg. The "Ouragan" develops a maximum speed of 935 km/hr and has considerable endurance (about 1 hr, 10 min). Its armament is four 20-mm cannon and 16 rockets or 2 bombs of 500 kg each. A total of 350 such machines were built, 80 of them for India and a number for Israel. This model provided the basic design for the "Mystère" family of military aircraft. The latter have one turbojet engine with a thrust of 3000 to 4300 kg; these planes have a flying weight of about 7.5 tons, a maximum speed of approximately 1100 km/hr, and a ceiling of 15.0 - 16.5 km.

Fig. 3. Experimental Bréguet 1001 "Taon" fighter-bomber.

The "Mystère" IVA is essentially a completely redesigned aircraft. Its wing has a greater sweepback and a thinner profile with a thickness/chord ratio of 7.5% (instead of 9%). The twin air intake has been replaced by a single scoop; the rear portion of the fuselage has been changed. The armament of the "Mystère" IVA consists of two "DEFA" cannon of 30-mm caliber and 55 "Matra SNEB" rockets of the air-to-air type. In addition, either two napalm bombs of 480 liters or two conventional bombs of 450 kg may be suspended from it, or mounts of 19 rockets each or two tanks of 625 liters each. In 1955 and 1956, a considerable number of squadrons in the French Air Force were re-equipped with "Mystère" II and "Mystère" IVA aircraft.

Further modifications of these aircraft are the "Super Mystère" B and B-2. The latter has an "Atar" 101-G turbojet with a thrust of up to 4400 kg (with afterburning). It has a flying weight of about 8 - 9 tons, a maximum speed of 1385 km/hr at an altitude of 11,000 m, and a ceiling of 17 km. The B-2 type aircraft are now in series production and are to be used for equipping the Air Force.

A modification of the "Mystère" are the "Etendard" planes. These are multipurpose aircraft; they can be used as interceptors, as front-line fighters, or for escort duty. In view of this, they are equipped with a variety of armament.

The "Etendard" II is a standard fighter-bomber. It is powered by two turbojets with a total thrust of 2200 kg; by virtue of auxiliary tanks, it has a considerable range (up to 2200 km). This firm later began manufacturing a single-engine variant — the "Etendard" IV with an "Atar" 101-E turbojet of 3500 kg thrust (Fig. 2).

A later variant, the "Etendard" VI with an engine of less power ("Orpheus" — 2200 kg thrust) was built in conformity with NATO specifications for a lightweight jet fighter. A special variant with two turbojets of 750 kg thrust each is presently being developed for aircraft carriers. Its characteristic feature is a very sharply pointed nose and a high horizontal empennage. The weight of the "Etendard" models is about 4.5 tons; the wing has a sweepback of more than 45° and a thickness/chord ratio of 6%.

There has been developed a "Mirage" interceptor with a combination power plant: two turbojet engines and a SEPR liquid-fuel rocket engine with a total thrust of 3360 kg. It is anticipated that when the engine is replaced by the "Atar" 9 of 6000 kg thrust, the aircraft should attain a speed of Mach 2 and a ceiling of 25 km. The plane carries 2600 liters of fuel in the fuselage and 630 liters each in two wing tanks that can be replaced by conventional or napalm bombs or by rockets. The wing has elevons and speed brakes that open above and below the wing. The stabilizer and the horizontal empennage are absent. As reported in the British journal "Flight", a proposed variant of the "Mirage" IV is to be a high-speed bomber with two "Atar" 9 turbojets and a flying weight of up to 20 tons. This variant is intended for making studies of the problem of kinetic heating.

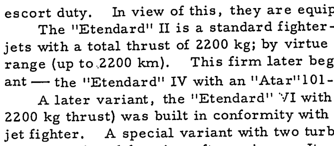


Fig. 4. "Vautour" multipurpose aircraft.

Two lightweight front-line (tactical) fighters have been developed in recent years — the 1001 "Taon" (Fig. 3) with a Bristol "Orpheus" turbojet engine (2200 kg thrust), and the 1100 "Super Taon" with two turbojets (1100 kg thrust each). Both these aircraft have a low flying weight (4.1 - 5.5 tons), a maximum speed of the order of Mach 1.15, and a high rate of climb.

The 1100 is armed with four Browning machine guns or two 30-mm "DEFA" cannon and a "Matra" missile or 35 "Mighty Mouse" unguided rockets inside the fuselage. In addition, four pylons carrying bombs or rockets are suspended under the wings.

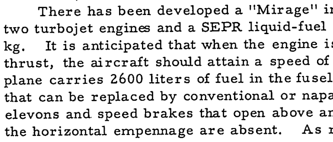


Fig. 5. "Magister" trainer

Several types of experimental fighters have also been developed for intercepting targets at high altitudes. These are the "Gerfaut" aircraft with "Atar" D-3 or 101-G turbojet engines with a thrust of 2800 and 4400 kg, respectively. They have a flying weight of about 5 tons and a speed in excess of Mach 1 at altitudes of 11 - 13 km; their ceiling is 16 - 17 km. The "Gerfaut" II climbs to an altitude of 15 km in 3 min, 56 sec and has a long range. The "Gerfaut" aircraft presumably will be armed with a single guided missile.

Also among the experimental aircraft are the 1500 and 1502 "Griffon". The most important design features of these planes and their later modification, the "Harpon", are a combination power plant (a ramjet and a turbojet engine, or a turbojet and a rocket engine) and the fact that the stabilizer is forward of the wing ("canard" type). In level flight only the ramjet is used, while on takeoff the turbojet operates. The "Griffon" was produced early in 1957.

The SE-5000 "Baroudeur" ground-attack fighter should also be noted. At first this plane was powered by an "Atar" 101-D turbojet engine with a thrust of 3000 kg, while the second model has an "Atar" 101-E with 3500 kg thrust. The flying weight of this plane is about 6 tons, its maximum speed is 1080 km/hr, and its landing speed is 185 km/hr. Its ceiling is more than 15 km. In takeoff the "Baroudeur" uses special carriages accelerated by rocket motors, while for landing it has skids that are lowered from the fuselage. By virtue of these devices, the plane can take off and land on loose and wet ground. The plane is armed with two 30-mm cannon. In addition, it can carry two bombs of 500 kg each and rocket missiles.

Light bombers. Noteworthy among the aircraft of this type are the "Vautour" machines (Fig. 4). Essentially, this is a multipurpose plane produced in three basic versions: A, B, and N.

The A version is a single-seat ground-attack plane, armed with four 30-mm cannon with 400 rounds of ammunition for each; this plane also has 38 rocket missiles, and 240 rockets in addition in the bomb bay.

The B version is a two-place light bomber (two cannon removed and a crew member added in place of them) armed with two cannon and bombs or guided missiles. Drop tanks can be installed under the wing. The nose of the fuselage is glassed in.

The N version is an all-weather fighter with the same armament as the A version. It can also carry under the wings four additional rocket installations, two of which can be replaced by drop tanks of 1220 liters capacity each.

The "Vautour" has two "Atar" 101-E or 101-E-3 turbojet engines developing a thrust of 6000-7000 kg. With a flying weight of 15 to 20 tons, it has speed of 1100-1150 km/hr and a ceiling of 15 km. It has a range of up to 2500 km. It is said that it can carry an atomic bomb.

Miscellaneous combat aircraft. There are reports of a "Potez" 75 two-place ground-attack or tactical aircraft for supporting ground troops and for anti-tank action. This aircraft has a single eight-cylinder engine of 520 hp with a pusher propeller. The cockpit is armored; the armament consists of four automatic cannon and anti-tank guided missiles. Carrying suspended missiles, the plane develops a speed of only 275 km/hr and has a range of 700 to 1400 km. Its takeoff and landing run is only 165 - 175 m, since its takeoff and landing speeds do not exceed 80 - 50 km/hr.

One firm is building the 856 A "Norvigie" for artillery reconnaissance, fire direction, and liaison. There are dual controls. The crew consists of two or three men. The plane has an air-cooled, inverted reciprocating engine of 140 hp. With a flying weight of about 1100 kg, it develops a speed of 192 km/hr (landing speed 70 km/hr).

The three-place 1050 "Alize" with a turboprop engine of about 2000 hp is intended for anti-submarine action and can be based on an aircraft carrier, for which purpose it has folding wings. With a flying weight of 6500 to 8000 kg, it develops a maximum speed of 450 km/hr and has a range of up to 2500 km; its endurance is 8 hours. It is presumed that the armament consists of bombs and unguided missiles. This plane has been adopted by the NATO Air Force as the standard for this class.

Trainers. The two-place CM-170R "Magister" training aircraft (Fig. 5) with two turbojet engines of 400 kg thrust each is intended both for basic training of students as well as for training flights and has been adopted as the standard trainer for the NATO countries. There are a number of modifications of it: deck-based, high-altitude, and others. In the deck-based version, CM-170M, the cockpit canopy is

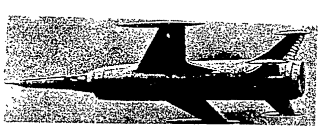


Fig. 6. The "Leduc" 022 experimental supersonic fighter-interceptor.

made so that it can be left open during takeoff. This version is also adapted for catapulting and for deck landing. The flying weight of the plane is about 3 tons, its maximum speed is 715 km/hr, and its ceiling is 12 km; its flying range is 900 to 1200 km. A characteristic feature of the "Magister" machines is the lateral dihedral of the horizontal empennage. The armament comprises two 7.5 mm machine guns; two air-to-ground missiles, and two 33 kg bombs.

Another French training plane is the three-place, single-engine "Alcyon" with a "Potez" air-cooled, six-cylinder reciprocating engine of 260 hp; it has dual controls. The flying weight is 1750 kg; maximum speed is 260 km/hr.

Produced by the same firm, the MS-755 "Fleuret" with two turbojet engines has a flying weight of 4650 kg and a maximum speed of 720 km/hr.

A modified version is the MS-760 "Paris" — a four-place jet liaison aircraft. Equipped as a two-place machine, it can be used as a trainer. This plane is equipped with two turbojet engines with a total thrust of 800 kg; its flying weight is about 3.5 tons, its maximum speed is 650 km/hr, and its range is over 1500 km. The landing gear is not retractable. There are mountings for machine guns, bombs, and rockets.

The "Alcyon" and "Paris" aircraft are in series production.

Helicopters. In recent years, in connection with wars waged in the colonies, the French imperialists have devoted considerable attention to helicopters. At present they are building the four- or five-place "Alouette" with a gas turbine of 400 hp and a three-blade rotor. Its flying weight is 1500 kg, speed is 180 km/hr, and range is 540 km.

A squadron in the French Air Force consists of 12 operating and 3 reserve helicopters.

The two-place "Djinn" helicopter with a two-blade rotor, the blades of which are driven by the reaction of compressed air, develops a horizontal speed of 128 km/hr with a flying weight of 700 kg. Its independent range is 200 km at a speed of 100 km/hr. Its purpose is varied; it is used primarily for ambulance service, but it can also be used for launching guided missiles and for other purposes. A distinctive feature of this helicopter is the absence of a tail rotor, which fact is explained by the use of reaction drive for the main rotor blades.

Experimental aircraft. Striving to produce fighter-interceptors with a higher rate of climb, and in fact to achieve vertical takeoff and greater horizontal speed, French aircraft firms have developed a number of experimental designs, including the "Trident" III and the "Leduc". Following the "Leduc" 016, there were developed the "Leduc" 020, the "Leduc" 021, and its current version — the "Leduc" 022 (Fig. 6).

The "Leduc" 022 is equipped with two ramjet and turbojet engines, providing a total thrust of 8000 kg in flight. According to press reports, its speed exceeds Mach 2 and its ceiling 20 km, while it attains an altitude of 15 km in less than three minutes. By virtue of the fact that the total thrust of the engines is considerably greater than the weight of the plane, it can climb almost vertically. The purpose of this aircraft is either fast interception or patrolling at an altitude of 10,000 m and then interception with a 30-second climb from 10,000 to 20,000 m. In the first case, the "Leduc" takes off with its turbojets, while the ramjets are cut in for attack. The duration of the entire operation is seven minutes. In the second case, takeoff and patrolling are effected with the turbojets, while the climb to 20 km and the "Lightning" attack are effected with the ramjets. The duration of such a flight is 45 minutes; this is achieved by increasing the amount of fuel carried.

The "Leduc" 022 is a cylinder 1.59 m in diameter and about 10 m long. Located in front is a conical glassed-in cockpit. The barrel-shaped fuselage serves essentially as a combustion chamber for the ramjet engines. The wings of the plane are small, sweptback (35°), with a span of 12.5 m and a thickness/chord ratio of 5.5 - 6.0%. The low-positioned empennage is in the form of an inverted lateral dihedral. Noteworthy is the smooth transition from the wings and the empennage to the fuselage. In the event of accident, the entire forward cabin can be released and dropped by three parachutes that open automatically. All the wings and the tanks at the wing tips and in the forward part of the fuselage are entirely taken up with fuel. The power of the ramjet engines could be increased considerably but is limited by the fuel consumption.

Guided missiles. One of the first missiles was the Nord SS-10. This is a ground-to-ground type of missile intended for anti-tank action. It has a rocket engine burning solid fuel and it is guided by means of electric wires. The weight of the missile is 16 kg; its range is 4 km. It can be launched from an aircraft. As reported in the press, the Nord SS-10 was used by Israeli troops during the aggression against Egypt. A further development of this missile is the two-stage 5210 missile, which can also be used as an anti-aircraft weapon of the ground-to-air class. The remaining models are esperimental; their range is not more than 100 km. Also known in the ground-to-air class is the "Parca" remote-control missile with a rocket engine operating on either liquid or solid fuel and with four booster rockets.

In the air-to-air class, the best known missile is the Nord 5103 with a rocket engine operating on solid fuel, a weight of 130 kg, and a range of 12 km. These missiles are guided by radio from the parent aircraft and are intended primarily for arming night fighters. The best known in this class is the "Matra" missile (three types: AA20, 04, and R015). The first two types have liquid-fuel rocket engines, while the third has a rocket engine operating on solid fuel. The weight of these missiles varies from 160 to 460 kg; the range of the AA 20 is 16 km. They are intended for arming the "Mystere", "Trident", and other fighter-interceptors.

Foreign aviation specialist point out that guided missiles in France are still in the stage of development and testing.

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French aircraft building, in the opinion of foreign specialists, now occupies fourth place in the world. In the French aircraft industry there is concentrated a very considerable number of workers (95,000) which tends to increase even more, because the aircraft industry of France is not only supplying its own Air Force but is also increasing its exports to other countries of the aggressive NATO bloc.

In 1956 there was organized a special "Center of Aviation Expansion" for the purpose of advertising French aircraft products abroad. At present French aircraft are purchased by such countries as India, the FRG [Federal German Republic], Argentina, Brazil, Israel, Cambodia, South America, Belgium, and Holland. In addition, some sountries have purchased patent rights for jet engines.

The total output of aircraft in France is in excess of 100 units per month, not including gliders or pleasure craft.

While formerly mass production was retarded because of small production orders from their own government and transportation companies and, most important, because of a lack of export, many firms are now striving to reorganize their technological process through replacement of equipment, rationalization, and organization of conveyor and assembly-line production.

Thus, the competitive position of the French aircraft industry is improving. But this does not in the least suit the American monopolists, who consider themselves the sole supplier of armament, especially to the member countries of NATO. The conflict of economic interests among the various groups of monopolistic capital which are making fortunes from the unrestrained armaments race intensifies even more the disagreement within the aggressive North Atlantic bloc.

Engineer Col. of Reserves A. P. Smolin