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INFORMATION REPORT INFORMA

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CENTRAL INTELLIGENCE AGENCY

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NO FOREIGN DISSEM

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COUNTRY USSR

REPORT [redacted]

SUBJECT English Translation of Herald of Antiaircraft Defense, Issue No. 2

DATE DISTR. August 1963

NO. PAGES 1

50X1-HUM

REFERENCES [redacted]

DATE OF INFO. [redacted]

PLACE & DATE AC[redacted]

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[redacted]

1. An English translation of Issue No. 2, February 1963, of the Soviet publication Vestnik Protivovozdushnoy Oborony /Herald of Antiaircraft Defense/, published by the Military Publishing House of the Ministry of Defense, Moscow [redacted]

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2. In some cases, the articles were translated in their entirety; in other cases, they were summarized. [redacted]

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INFORMATION REPORT INFORMATION REPORT

Vestnik Protivovozdushnoy Oborony, No 2, February 1963

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/A captioned photograph by photo correspondent V. TALANIN on page 15 shows military personnel of a podrazdeleniye meeting with two factory workers, who took part in the November CPSU Plenum./

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(Pages 16 - 20)

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/A captioned photograph by I. SEREGIN on page 17 shows Officer Ye. PERFILOV talking to young soldiers about World War II. A captioned photograph by K. FEDULOV on page 20 shows Lt V. PETRENKO, secretary of a podrazdeleniye party organization, talking with Pfcs A. SKUBAK and N. BOCHARNIKOV, both candidate-members of the CPSU./

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Abstract:

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/A captioned photograph by K. KONSTANTINOV on page 299 shows Capt N. KALIN, radar company commander, and Lt A. KUDINOV, who is KALIN's deputy for political affairs, working out a training schedule./

Tactical Training of Officers of Radiotechnical Troops -- by Engr-Col Ye. I. GORBACH (Pages 30 - 33)

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Abstract:

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Abstract:

This brief article describes equipment innovations which were developed by personnel in a radar company commanded by Capt MALAKHOV. /The article is accompanied on page 33 by a photograph which shows Lt I. LEBEDEV working out an innovation suggestion.7

The Oscillation of an Airplane and Ways of Preventing It -- by Engr-Lt Col A. A. D'YACHENKO, Candidate of Technical Sciences (Pages 34 - 37)

The oscillation /raskachka7 of an airplane is its involuntary oscillation in respect to its angle of pitch (longitudinal oscillation) and its angles of roll and yaw (lateral oscillation) in the process of precision piloting. Longitudinal and lateral oscillation of an airplane may appear jointly or separately. Their simultaneous appearance is possible during flights at high altitudes. During flights at low and medium altitudes lateral oscillation does not usually appear, but longitudinal oscillation may occur during the execution of precision maneuvers at flying speeds approaching the speed of sound.

It should be noted that the probability of the appearance of longitudinal oscillation at low and medium altitudes is especially great in fighter planes with non-reversible booster controls and in those which are not equipped with devices for the automatic regulation of stick force. In these airplanes stick force is produced artificially with the aid of a simple spring mechanism and therefore changes only in relation to the travel of the stick. At speeds below Mach 1 an increase in flying speed facilitates the manual control of the plane, which lowers the piloting accuracy, one of the factors needed for the appearance of longitudinal and lateral oscillation of an airplane.

Flying theory and practice show that the oscillation of an airplane during inaccurate piloting occurs only in those flight conditions (maneuvers) during which the angles of attack, yaw, and roll, in the initial moment following a deviation of the controls, fluctuates according to the law of fluctuation /po kolebatel'nomu zakonu/, so that their period of fluctuation T is between 1-2 seconds. If that period is less than 1 second or greater than two seconds, piloting inaccuracy does not usually result in the oscillation of the airplane.

The question arises: why does piloting inaccuracy result in oscillation only when the period of a plane's fluctuation is between 1-2 seconds? In order to answer this question it is necessary to examine schematically the process of controlling an airplane. While flying, a pilot controls the accuracy of his maneuvers by means of variations in the linear and angular dimensions characteristic of a plane's motion. Thus, during high altitude flights, pilotage, etc., the movement of the plane is controlled mainly by variations of the angles of pitch, roll, and yaw. The disparity between the required and actual variations of these angular dimensions is eliminated by manipulating the controls. Let us examine how this process occurs with respect to control of the angle of pitch.

Suppose that in reference flight conditions a plane is flying with an angle of pitch ϑ_{act_0} (figures 1 and 2). Flying conditions require that the plane transfer to a different angle of pitch $\vartheta_{req.}$. Before doing this the pilot visually determines the difference between $\vartheta_{req.}$ and $\vartheta_{act.}$. He then ascertains the amount of elevator deflection needed to transfer the plane to a new angle of pitch in a given period of time. The pilot next makes the necessary elevator adjustment and the plane begins to change its angle of pitch as shown in the curve ABCD in Figures 1 and 2. It can be seen that following the deflection of the elevator, the plane's angle of pitch ϑ_{act} changes according to the law of fluctuation with periods of fluctuation T_1 = 1 second (see figure 1) and T_2 = 2.5 seconds (see figure 2). Following the deflection of the elevator in the process

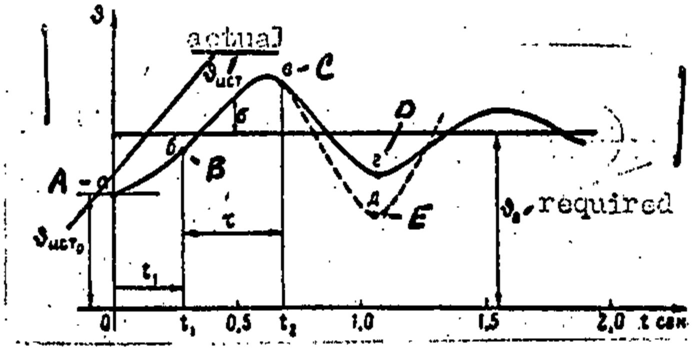

Figure 1. Change in an airplane's angle of pitch following deflection of elevator (T 1 sec.)

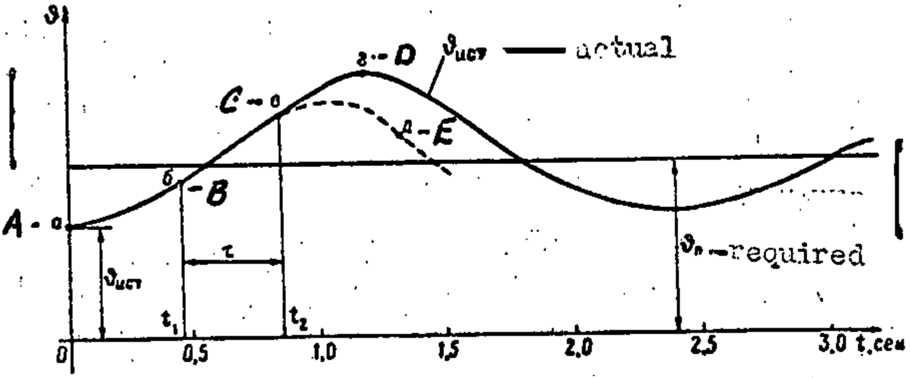

Figure 2. Change in an airplane's angle of pitch following deflection of elevator (t 2.5 sec.)

of precision piloting, the pilot carefully watches the change in the angle of pitch (in the case being considered) and notes not only the difference between the actual and required values of the angle of pitch $\sigma = \vartheta_{act} - \vartheta_{req}$*, but also the speed of its change (in figures 1 and 2 the speed of change in the actual angle of pitch may be represented by the slope of curve ABC). Therefore, when a certain period of time t_1 has passed since the beginning of the change in the actual angle of pitch, the pilot again notices the necessity of correcting the elevator deflection in order to check the increase in the actual angle of pitch ϑ_{act}, and proceeds to make the necessary correction.

In view of the fact that there is a certain delay in the reactions of the plane and pilot from the moment the pilot notices the necessity of correcting the original elevator deflection (point B in figures 1 and 2) until the moment the change in the angle of pitch begins under the influence of that correction (point C in figures 1 and 2), there elapses a certain period of time τ, which is called the total time lag in the reactions of the pilot and plane.

Let us assume that length of time is 0.4 seconds. In this case the pilot's correction of the elevator deflection results in a disproportionate effect. In the case of a change in the angle of pitch according to the law of fluctuation with the period $T_1 = 1$ sec., this correction is accompanied by an increase in the amplitude of fluctuation of the angle of pitch (curve CE in figure 1), i. e. the oscillation of the plane. If the

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* The size of σ in a given situation may characterize the piloting accuracy in respect to the angle of pitch.

inherent characteristics of the plane are such that the period of fluctuation of the angle of pitch is equal to or greater than 2.5 seconds, correction of the original elevator deflection when τ 0.4 seconds results in a decrease in the amplitude of fluctuation and, consequently, an increase in the piloting accuracy (curve CE in figure 2).

From figure 1 it may be seen that the intensity of longitudinal oscillation of an airplane depends on the length total time lag in the reactions of the pilot and plane τ, on the period (T) of the fluctuation of the angle of pitch, and also on the ability of the pilot to execute a given precision maneuver. In figure 1, the pilot's skill may be characterized by the amount of time t_1 and the degree of variation in the angle of pitch $\sigma_1 = \vartheta_{act} - \vartheta_{REQ}$ in the moment of time t_1. An insufficiently trained pilot will notice the necessity of correcting the original elevator deflection later than an experienced pilot. This means that, in the case of a plane piloted by an inexperienced pilot, point B on the curve ABCD will be located to the right of that for a plane piloted by an experienced pilot in figure 1.

The total time lag of the pilot and airplane $\tau = \tau_p + \tau_a$ depends in turn on the pilot's training, his physiological make-up, the flying conditions, and also on the aerodynamic characteristics of the plane and its control system. From figures 1 and 2 it can be seen that in order to raise the piloting accuracy of a plane it is desirable to reduce the total time lag of pilot and plane. Pilots better trained in the execution of a given precision manuever have a smaller time lag in reaction to a variation than pilots who are not as well trained. On the average, the period varies in length from 0.4-0.8 seconds; therefore the oscillation of a plane in flight appears during a period of rapid fluctuation of 1-2 seconds.

The size of this period of rapid fluctuation depends on the aerodynamic composition of the airplane and on the flying conditions. Mathematically this may be expressed as follows:

$$T \approx \frac{K}{\sqrt{\frac{\rho V^2}{2}}}$$ [illegible]

where

K -- coefficient of proportionality (Its size depends on the composition of the plane and the Mach number of flight, and for a specific plane, only on the mach number);

$\bar{x}_f = \frac{x_f}{b_a}$ -- coordinate of longitudinal focal point of an airplane in units of a mean aerodynamic chord. (It changes during the transition from subsonic to supersonic speeds);

$\bar{x}_T = \frac{x_T}{b_a}$ -- coordinate of plane's center of gravity in units of a mean aerodynamic chord.

$\frac{\rho V^2}{2}$ -- dynamic head

From the formula it can be seen that a pilot can change the period of fluctuation of a plane's angle of pitch by changing the amount of dynamic head, i.e. by changing the instrument flying speed. This means that if the pilot finds his plane in a state of oscillation, he can eliminate longitudinal oscillation by changing his instrument flying speed. The formula may also be used for determining, on the ground, flying conditions under which longitudinal oscillation is possible.

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Calculations show that certain fighter planes which have smal 50X1-HUM gins of overload stability at subsonic flying speeds have a period of rapid fluctuation in the angle of pitch T = 1-2 seconds at low and medium altitudes when the Mach numbers 0.7-0.85. A further increase in the Mach number of flight while flying at a constant altitude decreases T to less than 1 second because it increases the dynamic head and the overload stability, which is characterized by $\chi_f - \chi_T$. With low values of T (less than 1 second) a pilot is not in a position to react to each fluctuation in the angle of pitch. He visually estimates the angle of pitch by averaging the fluctuations and then flys the plane as he would under normal conditions.

These planes can also have a T value of 1-2 seconds during high altitude flights at supersonic speeds. The distinguishing characteristic in the oscillation of an airplane during high-altitude flights is the large amplitude of the plane's oscillation. Let us point out that during high-altitude flights planes which are not equipped with semi-automatic (or automatic) devices have low damping and, consequently, a small decrement of damping. Therefore, following a deviation in the controls, these planes experience a prolonged period of fluctuation.

Figure 3 shows the effect of the size of decrement of damping ξ on the change in a plane's actual angle of pitch following deflection of the elevator. It can be seen that a decrease in ξ substantially impairs the plane's reaction to the deflection of the elevator. This reaction at high altitudes (with a small ξ) increases its tendency toward oscillation. From the drawing it can be seen that for $\xi \neq 1$ the angle of pitch varies according to an aerodynamic law, i.e fluctuations disappear and the plane's tendency toward oscillation also disappears.

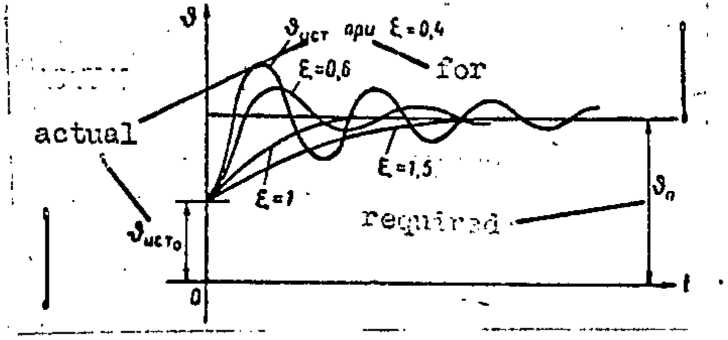

Figure 3. Effect of the sixe of the damping decrement on the change in a plane's angle of pitch following deflection of the elevator.

The preceding statement would be completely accurate if the pilot could accurately determine and execute the required control adjustments during the transition from to with a limited time. In flying, mistakes in controlling a plane always occur. As shown in figure 1, it is possible to graphically and analytically show that mistakes in manipulating the controls increase a plane's tendency to oscillate, even with relatively good damping (0.7) of its angular movement.

The size of the error in manipulating the controls depends on both the pilot and the plane. In planes with excessively light and sensitive controls requiring small changes for piloting and little force on the stick and pedals as well as small balancing deviations of the latter (i. e. with a small margin of static stability, high control effectiveness and a small gradient of force in stick travel and pedal control), the relative error in "measuring out" the required deviation of the controls is much greater than in planes with normal control characteristics. An increase in friction and play in the control system also increases the

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relative error in "measuring out" the required deviation of the controls owing to deterioration in the centering ability of the stick and pedals and the appearance of "free movement" in them called the zone of insensitivity.

From what has been said, it is possible to make the observation that at the basis of a plane's oscillation lies a short period of characteristic rapid fluctuation and a relatively large time lag in the reactions of the pilot and plane. A decrease in the decrement of damping the angular movement of a plane (a decrease in its damping properties) and an increase in the relative error in "measuring out" the required deviation of the controls strengthens the plane's tendency toward oscillation.

Let us examine the work of a pilot while flying in the state of fluctuation or near it. If for some reason the plane enters the state of fluctuation it is necessary to counter each individual fluctuation of the airplane for this only makes the piloting worse. It is necessary to fix the organs of control in a position which will facilitate the transition of the plane to another instrument flying speed. If the pilot discovers that at speeds approaching that of sound and at low altitudes the controls become excessively free even though the plane is still controllable, it is necessary to slow down to a safe speed, smoothly taking the plane into a climb, but in no case permitting air braking. In doing this the pilot must avoid abrupt deceleration or a sudden movement of the controls, i. e. any movement which would result in a disturbance of the plane's balance. While flying at high altitudes and speeds at which the period of a plane's rapid movement is greater than in the state of oscillation, it is possible to damp the fluctuation of the angles of pitch, roll, and yaw by vigorous movements of the controls (see figure 2). This means, in part, that to ensure more or less accurate piloting of a plane at high altitudes the pilot must work harder (i. e. more frequently adjust the controls), which is desireable.

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A good understanding by flight crews of the causes and nature of oscillation of a fighter plane, and also the means of preventing it, will promote the further improvement in the mastery of aviation equipment and raise the level of combat training.

/A photograph of Capt. S. CHERNEGA, a GCI controller, and Capt. A. ZAIKO, a navigator, appears on page 37/.

Bravery and Skill -- Capt. M.A. YEFIMOV (Page 38)

Abstract:

This brief article describes how Capt Yu. KOLESOV, pilot first class and flight commander, was able to safely land his jet fighter aircraft by restarting the engine of the air craft several times after a malfunction had caused engine temperatures to increase to a critical level. /A photograph of KOLESOV by A. KOZOBROD accompanied the article./

Programmed Teaching with Special Machines -- by Maj Gen Arty T.I. ROSTUNOV (Pages 39-43)

Text:

The Communist Party is greatly concerned with the training of highly qualified officers. This concern is explained best when it is considered that to conduct contemporary combat operations, which require complex combat equipment and weapons, demands a great amount of knowledge, skill, and experience. This was pointed out by N. S. KHRUSHCHEV at the Kremlin

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reception for military academy graduates on 5 July 1962. At this meeting, the head of the Soviet government presented an assignment to the workers of higher military educational institutions - to perfect training methods and to employ the latest technical advances in this matter.

The rapid progress of science and military technology has aggravated the contradiction which exists between the growth in the volume of knowledge, which is necessary to a military specialist, and the possibility of mastering this required knowledge within an established amount of training time. The present system of training by means of lectures cannot resolve this contradiction. Therefore, an acute necessity has arisen to change over to essentially new training methods, which include the best of what has been learned through training experience and yet would make possible far-reaching advances in the training of military specialists, allow consideration of the latest scientific achievements, and conform to, or even shorten, the amount of time presently required for training.

The principal shortcoming of the present training method is that it is basically active in respect to the lecturer, but passive in respect to the student. In other words, there is no full measure of responsive communication in the training process. Also, after he has delivered the lecture material, the instructor does not immediately receive any knowledge concerning how much of the material has been mastered by the students. As a rule, the instructor obtains this information over large spans of time - by questioning 2 or 3 students during a lecture period, during laboratory sessions, and from semester examinations when final evaluations concerning subject mastery are made.

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This sort of information does not allow any judgements to be made about, the level of subject knowledge of any one student during the training cycle, nor does it allow for corrective interference with the training process. Finally, as a consequence of all this, the instructor proceeds "blindly" through the training process and required training results are not achieved.

A serious shortcoming of present training methods is the absence of individual training aids. It is well known that lectures and other similar methods of training are not differentiated, either in content or in form, in conformance with the knowledge and perceptive ability of different groups of learners. Also, one student group may range from the outstanding to the weak. Again, present training methods do not allow for the organization of differentiated training. As a consequence of this, the most capable students do not work at full capacity throughout their courses of study in a higher military educational institution and less capable students fall behind.

Also, technical training aids, which are currently employed, offer no possibility for systematic and objective checking of student progress, nor do they allow the student to check his progress during independent work periods. In the absence of any self-checking process, the student frequently goes to testsand examinations without being sure of the strength of his knowledge in any single subject.

Another problem appears when the work of individual students is considered. Of course, command and professorial staffs, and Komsomol and party organizations pay much attention to this problem, but we cannot say with any validity how well an individual student independently masters his assigned material. A reason for this is that some students study listlessly during the semester and then attempt to make up for lost time by cramming for examinations. As a result, many of them enter examinations with only a superficial knowledge of subject matter.

A major shortcoming of current training methods is that conducting examinations, quizzing students on laboratory work, and correcting homework require a great deal of unproductive time. Is it not possible to automate this process? Of course, it is. However, up to now, a logical mathematical-teaching theory and optimal methods of checking training have not been worked out. Statistical data, based on systematic and objective investigations and on evaluation of student progress are necessary for such a study.

Some shortcomings of teaching literature should also be pointed out. Contemporary text books, manuals, and monographs are too voluminous and contain much information, which, although it is applicable, is superfluous for students. In order to help students to gain understanding of subject matter, instructors spend a large amount of time composing and delivering lectures on themes which are already in the textbook.

Also, it is impossible to remain silent concerning the fact that teaching plans for course study and for the conducting of separate activities in higher military educational institutions, until now, have been built on insufficient scientific bases. As a result, individual questions are scattered about in different course, which creates parallelism in the work of many chairs.

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A finding of an analysis of teaching processes and their results at the Kiev Higher Engineering Radiotechnical School [KVIRTU] was that it is necessary to change over to a programmed method of teaching with maximum use of teaching machines for successful resolution of the crucial tasks which are presently before higher military educational institutions. It is understood that this given method evinces no change in the subject content of any course, but of the actual program of the teaching process. Thus the most rational sequence of course study and of checking questions and assignments is determined; the teaching process is enlivened; and simultaneous checking of mastery of material by instructors (external responsive communication) and by the students, themselves (internal responsive communication), is allowed. In the opinion of the professorial staffs of many higher military educational instutions, such a method of teaching will largely eliminate the shortcomings of present teaching methods, increase productivity of learning activity, and shorten the time required for learning.

The essence and content of programmed teaching, using teaching machines, are as follows:

The subject matter of a course is presented in parts in order that each student can have his progress evaluated in an individual manner after he has completed each part. This segmented presentation should be done by means of an algorithm, which, according to subject matter, should indicate a firm, scientifically founded order for a logical, sequential presentation of theme and, then, of the course. This sequence separates subject matter for its most expedient mastery. The teaching sequence must also indicate the relation between courses.

Much has already been done in our school toward changing over to programmed teaching. Teaching algorithms have been composed for individual courses. In order to achieve a logical connection between the algorithms of reciprocal courses,

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a need for a general algorithm to teach students of a single profile. It seems to us that such a general algorithm can be programed and checked by electronic computer, which will scientifically substantiate the planning of the whole teaching process and will improve learning significantly.

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At the present time, we have worked out about 25 teaching algorithms for courses in radio circuitry, electric poser supply, transmitting equipment, pulse technology, basis of equipment use and maintenance, automated control systems, automation, foreign languages, mathematic analysis, descriptive geometry, and other subjects. Many of the algorithms have been checked on universal computers and teaching machines.

Of course, the preparation of algorithms is not yet perfect and requires extensive improvement, bu the first step has been taken in the development of programed teaching. Presently, a group of schools is working on the contents of an algorithm for all courses. They are checking them on computers and in practice in order to devise a general teaching algorithm.

A positve aspect of programed teaching is that this method allows teaching machines to be employed, i.e., it creates the conditions for a sharp increase in the productivity of learning activity. This is achieved because teaching machines, in apposition to othertechnical means, have responsive communication from the student to the instructor. When teaching machines are used with any special program, any amount of information (within reasonable limits) can be obtained concerning the degree of subject mastery by each student. Thus, learning shortcomings of an individual

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can be readily detected and corrected. In other words, programed teaching with teaching machines is controlled teaching.

The reception of information by responsive communication will present the material necessary for the creation of a scientifically based theory of teaching. This will allow the whole teaching process to be placed on a fundamental scientific basis.

We have too little experience to consider whether the use of programed teaching methods and teaching machines will raise the level of learning of military cadres. Actually, this will not depend on the methodological and scientific qualifications of individual instructors to any great degree, but will be determined chiefly by the independent work of students and the good qualities of the programing manual and the teaching program.

A teaching machine allows the instructor to instruct each student on an individual basis with consideration of the student's prior knowledge and capability. Consequently, students can complete the learning session more quickly and with good results, and scientific research work can be carried on simultaneously with teaching.

Teaching machines can be divided into 2 basic clases: small teaching machines, which are constructed on an electromagnetic basis; and cybernetic complexes of large efficiency, which have electronic computers for their basis. In our opinion, the small machines appear to be the basic means for automation of certain stages of learning in higher military educational institutions, in schools, and in line units.

The employment of small teaching machines in schools allows: self teaching and checking of the amount of mastery of material by the students;

testing and examining over parts of a course or over the whole course; rapid checking of knowledge learned during laboratory sessions; simultaneous demonstrating of circuits, sketches, and formulae with the delivery of lectures; and checking of learning by means of control questions which are presented by machine.

We have constructed 23 various types of small teaching machines in our school with essentially our own available resources. In one class, each student position is equipped with a small teaching machine. A continuous stream of information concerning the work of each student at his teaching machine is supplied to a lighted tableau which is mounted on both the wall and a table. Thanks to this, the instructor can follow the progress of each student and, if he deems it necessary, can interrupt the teaching process.

The small teaching machines operate according to a linear program and only a few of them have large ramifications. Teaching according to a ramified program is possible on teaching complexes which are based on electronic computers with large external memories.

A group at the school has worked out and checked algorithms for several subjects on the Ural-1 electronic computer. The achieved results indicate that there are important possibilities in the employement of large electronic computers for teaching. However, there were also some indicated shortcomings. Since the Ural-1 machine has a small rapid action capability and an insufficient internal memory, it is necessary to rely on its operational memory for teaching purposes.

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Practice has further shown that it is impossible to teach 20 t [redacted] 50X1-HUM people in the same class because of the noise of the telegraphic equipment which is used to feed information into the electronic computer. Also, the machine "language" is not convenient to work with. Therefore, one of the next problems is to develop a noiseless and more economical input and output in the machine. Our group has already worked out such equipment, which seems to be a key piece of apparatus for electronic computers UMShN /type of computer/institute?/.

For the most effective employment of such complexes, it is most necessary to compose algorithms for the simultaneous and individual teaching of tens and hundreds of students, and to develop a convenient machine "language" for intercourse between the student and the machine.

A change over to programed teaching, using teaching machines, is also possible when teaching aids are used, if they are adapted for this purpose. They must be separated into parts which are convenient for self teaching, self checking, and for checking by the instructor. The number of parts must then be defined according to volume and course difficulty, and the amount of student mental activity. These parts must then be followed by check questions, assignments, and methodical advice. The written teaching material must be brief and clearly written, and, with regard for the teaching algorithm, it should summarize the theoretical basis of the subject, introduce the more important numerical data, and corroborate the basic course positions.

It is necessary to exclude minor material, unimportant information, and some examples which explain the scientific basis of the course, from the teaching literature. These examples are expediently inculcated in the program at the progress level of the student. However, the brevity of the textbook or aid must not complicate the study of the subject.

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The use of special machines for self teaching, self checking, and also for constant control on the instructors part, is impossible without teaching programs. It is necessary to compare them for each complex question which is separated in its turn into smaller parts. These programs must conform in content and structure to the textbook and the teaching material. Each section of a textbook can be from one or from several teaching programs, whose enumeration must conform to the numbered part of the programed textbook. The composing of programs is a laborious task. They can best be worked out after the textbook has been written, but since no one yet has much experience in writing these textbooks, it is expedient to prepare the programs and the textbook simultaneously.

An opinion exists that, with a change-over to programed teaching, the role of the instructor in the training officer cadres is reduced. It is impossible to agree with this. With programed teaching, the instructor remains the central figure in the teaching process. Not only is his role not decreased, it is increased, although his functions are changed considerably. With the inculcation of the new method of teaching, the instructor will have more time for actual instruction and aiding students. It is possible for him to constantly perfect algorithms, programed texts, and teaching programs; and to collect statistical data which can be utilized as a basis for improving the teaching process.

It must be understood that the machine, by itself, cannot teach the student. It facilitates the instructor's working conditions and frees him from noncreative work, for example, checking written work, collecting examinations and quizzes, etc. All of this allows the strength of the professorial staff to be concentrated on resolving a most important problem - the increase of teaching quality.

Programed methods of teaching and teaching machines can also be used in line units, for example, in training radar operators or other specialists. In our opinion, this teaching is as effective in chasti as in higher military educational instructions. Many course assignments in combat training, which are related to the individual training of crew members, can already be programed for training with small teaching machines. Since these machines are simply constructed, they can be prepared in line units.

The use of teaching machines in schools for specialists allows for the improvement of individual training, for decrease of the expense of using powered combat equipment, and for the reproduction of aerial situations, which closely approximate actual conditions, during training.

An advantage of this method is that a programed assignment for a teaching machine can be used many times for each soldier or sergeant. This allows the accumulation of a high level of knowledge during shorter training periods with minimum expenditures of material parts. It must be kept in mind that, in schools for specialists, soldiers with various technical and general backgrounds are being trained in the same periods of preparation, can complete the training course in shorter time periods.

How should the inculcation of programmed teaching be begun in line units?

Out collective believes that it is necessary to begin by making a choice of the best type of teaching machine according to the ability of the chast' for their manufacturing; by working out training programs and algorithms; and by selecting an organization for the centralized preparation of better developed teaching machines.

It is evident that to change over to programmed training, it is necessary to consider a wealth of scientific research. The basic direction should be according to a line based on the primary theory of this method of training, on the investigation of possibilities for utilizing the principles of cybernetics and bionics for more effective complexes, and on the composition of methods for using existing electronic computers for teaching. Obviously, work in the same direction will be carried on by professorial staffs who will be analyzing teaching plans and disciplines; composing programing textbooks and aids; working out theories for the composition of teaching algorithms and criteria for the evaluation of their utility; constructing highly favorable, economic, and reliable teaching machines and complexes, and making use of existing electronic computers.

Naturally, no one educational institution or foundation can accomplish all of this work. Therefore, it is expedient to centralize the resolving of the above enumerated assignments in the Anti-Air Defense. The first successes of our collective in the manufacture of teaching machines have given bases to confirm that the necessity for this changeover cannot be put off and that all the conditions for a new and perfected method of teaching are in existence. This is the conclusion arrived at in the scientific and methodological conference, which was held at our school. Taking part in this conference were: soldiers, and representatives from higher military educational institutions, from many different kinds of institutes, from the RSFSR Academy of Pedagogical Sciences, and the Ukraine Academy of Sciences.

The caption to a photograph on page 41 of Capt ORZHEKHOVSKIY by I. RYBIN describes a training exercise involving the launching of a surface-to-air missile at a simulated aerial target, which was carried out by ORZHEKHOVSKIY on an automatic training device.

Combat Employment of Air-to-Air Missiles -- by Col A. I. DROZHZHIN and Engr-Lt Col V. F. ROMASEVICH (Pages 44 - 49)

Abstract:

This article, which is based on material from foreign press sources, presents an analysis of the advantages and disadvantages of semi-active homing radar guidance systems and infra-red guidance systems for air-to-air missiles; discusses methods of carrying out attacks with air-to-air missiles; and considers various means of war head armament for air-to-air missiles. The following foreign press sources were reportedly used for the article: Flying Review, December 1961; Missiles and Rockets, December 1960; Interavia No 4767; 1961; and Aviation Week, January, April, and August 1961.

/Brief reviews of the brochure, Neupravlyayemoye raketnoye oruzhiye (Unguided Rocket Weapons) by N. V. KARTASHOV, Voyenizdat 1962, 80 pp., 15 kopeks; and the book, Skorosti, uskoreniya, nevesomost' (Speed, Acceleration, and Weightlessness) by P.K. ISAKOV and R.A. STASEVICH, Voyenizdat 1962, 152 pp., 26 kopeks, are presented on page 49./

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Equipment and Its Use

A Rating Is an Indication of an Officer's Combat Maturity (Pages 50 - 54)

Abstract:

This editorial emphasizes the importance of training and earning higher ratings for better command qualities, better knowledge of equipment, higher operational efficiency, and, consequently, combat readiness. The editorial also discusses training methods.

/A captioned photograph of Sr Lt KOCHNEV, "master operator", by I. RYBIN, appears on page 52. The caption to a photograph of Capt N. RYBAKOV, pilot first class, by K. FEDULOV on page 53, stated that RYBAKOV is capable of executing any flight assignment in any weather conditions, day or night./

Maintenance of Antenna Mast Equipment Under Conditions of the Far North -- by Engr-Capt G. N. SKORODUMOV (Pages 55-56)

The reliability of radiotechnical equipment, including antenna mast equipment, is greatly affected by climatic conditions, topography, ground conditions, and other characteristics and phenomena of nature. For example, strong winds and soft ground considerably reduce the stability of antenna systems. This type of ground permits settling and requires frequent checking and realignment. Low temperatures have an adverse effect on radar stations as a whole. Sharp drops in temperature under conditions of high humidity cause ice to form on antenna systems and wave guides, which in turn results in a certain loss of radiated power and reflected energy. All this explains the interest of officers of radiotechnical troops in questions concerning the maintenance of radar stations, especially antenna mast equipment, under conditions of the Far North.

The climate of the Far North is characterized by a long winter, large amount of annual precipitation, high humidity, strong winds, heavy frost, and a rather large number of cloudy days. The texture of the soil is also peculiar. Layers of peat moss and sand are usually encountered at depths of 0.8 to 1.5 meters. Sandy loam, loam, and dense layers of clay are found at greater depths. The water table, as a rule, is located at a depth of 1 or more meters. Bedrock is located at depths of 8 to 15 meters.

All this must be taken into account in the maintenance of radar equipment in general, and of antenna mast equipment in particular.

Since the texture of the soil in the North does not provide sufficient support for antenna systems, it is necessary to employ means of reinforcement. In a number of podrazdeleniya, wooden beams 1-2 meters in length and 15-20 centimeters in diameter are used to anchor the stakes to which antenna guy wires are fastened. The beams are wrapped in tarred felt or calcined to a depth of 0.5 centimeters to prevent them from decaying. The beam is fastened by wire to the eye of an ordinary iron stake. At a distance of 2-3 meters from the stake the log is buried in the earth at a depth of 1-2 meters. This arrangement is shown in the drawing.

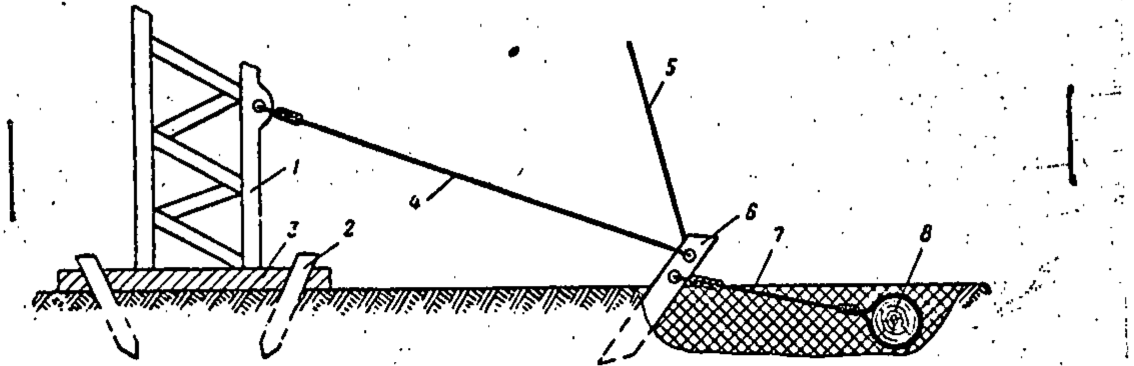

Diagram of System for Bracing Antenna Mast

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1 - antenna mast; 2 - stakes for securing base of ma 50X1-HUM se of mast; 4 - lower guy wire; 5 - upper guy wire; 6 - stake for fastening guy wires; 7 - wire; 8 - wooden beam.

Sometimes in place of ordinary iron stakes it is expedient to use wooden piles approximately 2 meters in length and 17-20 centimeters in diameter. A log 1.5-2 meters in length and 15-20 centimeters in diameter is set into the ground on the antenna side of the pile to a depth of 20 centimeters. It is set up against the pile, perpendicular to the projection of the guy wire on a horizontal plane. This type of reinforcement is somewhat cumbersome but completely reliable.

To prevent the antenna base from sinking into the ground, an occurence which has been observed in certain areas, it is expedient to lay a concrete foundation under the base.

Areas of perma-frost are characteristic of the Far North. Radar antennae which are erected without taking this into account will soon go out of order. Therefore, in regions which have only isolated areas of perma-frost, it is necessary to exclude them when selecting locations for erecting antennae. The presence of perma-frost is indicated by a combination of mounds and depressions in the earth's surface resulting from the deformation of the outer layers of the earth. The profile of the terrain changes from year to year. If outward signs of perma-frost are not evident, it is necessary to investigate the area by excavating or drilling holes. Special steps are taken before beginning construction in areas of solid perma-frost.

The embankments for the PPX /transliteration of Russian letters/ of radar stations require special attention. For protection against the

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action of rains and winds the embankment is covered with sod, and 50X1-HUM upper part is completed in the form of a wooden framework. The approach ramp is reinforced with a frame of thick planks or logs. The slope of the embankment should be no greater than 45 degrees and the approach ramp, approximately 20-25 degrees. In some areas it is necessary, during annual preventive maintenance, to fill in the embankment because, as a result of its weakness, it is gradually settling.

Radar antenna masts require careful watching during rapid thaws in spring. During this period it is necessary to daily check the condition of the guy wires and stakes and the position of the mast.

The timely change of oil in the reducer plays an important role in ensuring the reliability of antenna mast equipment. Maintenance instructinns specify that No. 10 oil mixed with transformer oil at a ratio of 2 : 1 should be used in the reducer during temperatures down to -30 degrees. At lower temperatures a mixture of No. 10 oil and kerosene at a ratio of 7 : 3 is recommended. However, experience shows that this mixture corrodes the gaskets and seeps into the synchro group, causing it to malfunction. Besides that, the mixture freezes at temperatures below -45 degrees. From the standpoint of maintenance, it is better to use MVP oil (All-Union State Standard 1805-51) which has a freezing temperature of -60 degrees. At temperatures below -25 degrees this oil thickens somewhat; however, the margin of safety of the motors used to rotate the antenna ensures their continued operation. The antennae for radar sets having automatic safeguards against overloading the motors which rotate them do not rotate when the oil thickens at low temperatures.

Experience shows that in order to ensure the reliabil 50X1-HUM enna mast equipment it is necessary to follow instructions closely. Special coverings should be used for warming reducers. In order to avoid reducer breakdowns and malfunctions of electric motors in winter, it is necessary to regulate the rate of scan smoothly, without jerks or sudden reverses, and to pull /turn over?/ the PPK by hand before switching it on.

The radar crew must constantly watch the conditions of the cable joints, contacts, and waveguides, and not allow moisture to accumulate. Finally, it is necessary to remove snow and ice from relectors, vibrators, and other elements of the antenna system, being careful not to damage the antenna. Chipping ice is, of course, forbidden.

These are some recommendations which may be given on the basis of experience in the maintenance of antenna mast equipment for radar sets under conditions of the Far North.

The Effect of Usage Factors on /Servo-/ Hydraulic Booster Operation -- by Engr-Maj D. P. OGLOBLIN (Pages 57 - 60)

Abstract:

This article discusses factors, which are detrimental to the operation of hydraulic boosters for aircraft control systems, their detection, and correction.

/A captioned photograph of Tech-Sr Lt V. KOZACHKOK, technician 1st class, by K. FEDULOV on page 59, shows KOZACHOK performing pre-flight maintenance on an aircraft./

Negative Feedback and Its Use in Electron Amplifiers -- by Engr- Capt Yu. V. ANOSOV (Pages 61 - 67)

Text:

Feedback, i. e., additional communication between the output and the input of a circuit, is widely used in various branches of technology, most of all in automation, telemechanics, and computers. As an example, it can be used in a multiple circuit for the regulation of speed, temperature, pressure, etc. Various manufacturers of automatic equipment include a feedback circuit, as one of the most important parts, in such devices as autopilots.

Requirements, which are basic for most devices are operation stability, lack of sensitivity to external influences, and distinct relationships between input and output parameters. Feedback is used to satisfy these demands.

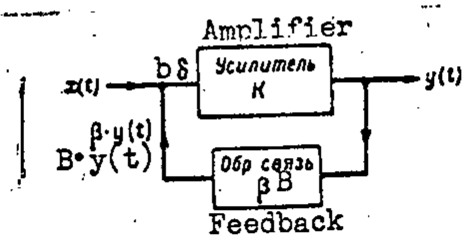

Рис. 1.

Figure 1.

A system with feedback is shown by the skeleton circuit in figure 1. This circuit and the following output are valid for various electrical, electromechanical, and mechanical systems. Here, x(t) is the parameter of the system input (in the function of time); y(t) is the parameter

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of the system output; k is the gain coefficient; B is the feedback coefficient, which is shown as part of the output parameter which is feeding back to the input; b is the gain parameter, which is supplied to the input. Evidently, $b = x(t) \pm B \cdot y(t)$. In this case, when an addition to the input parameters occurs, feedback is called positive feedback which we shall not consider here. With the subtraction of these parameters, negative feedback occurs.

Thus, $b = x(t) - B \cdot y(t)$, i.e., the feedback is supplied in such a manner that it is subtracted from the input parameter. At the system output, we have $y(t) = bk$ or, by substituting for the value B, we derive $y(t) = k[x(t) - B \cdot y(t)]$. Solving with regard to y(t), we derive:

$$y(t) = \frac{x(t)k}{1 + Bk} \qquad (1)$$

With

$$Bk \text{ greater than } 1, \; y(t) = \frac{x(t)}{B}. \qquad (2)$$

It is evident from the formula (2) that the relation of the output and input parameters depends only on the feedback coefficient B and does not depend on the gain coefficient, nor consequently on its change. Negative feedback makes it possible to stabilize the system and significantly improves its qualitative index.

Methods of utilizing feedback can be completely variegated. It can be used in a linear regime when its intensity is porportional to output satisfy a given variable intensity. Feedback can connect both single

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parameters, for example voltage with voltage, speed with speed, tem50X1-HUM ture; and dissimilar parameters, for example pressure with speed, current with temperature, etc. Feedback is the most characteristic and common feature of all controlled systems. It is frequently used in various electron amplifiers, mostly in low frequency amplifiers.

Use of feedback in low frequency amplifiers. One of the basic demands, which are required of an amplifier, is high stability. However, due to oscillation of supply voltage, preaging of components, electron tube replacements, temperature and humidity fluctuation, and other reasons; amplification is not always strictly uniform. The introduction of negative feedback aids in bringing about amplifier stability and also often produces a favorable influence on other amplifier characteristics. The significance of negative feedback is that part of the output voltage is supplied to the amplifier input, whereupon, in the case of negative feedback, this voltage is supplied in antiphase to the input voltage, i.e., subtraction of the voltage, which is supplied in the amplifier input, occurs.

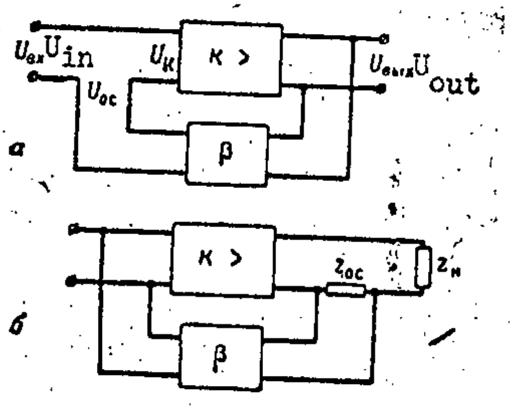

Рис. 2.

Figure 2.

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A skelton amplifier circuit with negative feedback is shown in figure 2a. Here K is the coeffiecient of amplification of an amplifier without negative feedback; U_{in} is input voltage; U_{out} is voltage at the output; U_{oc} is negative feedback voltage; and B is the feedback coefficient

$$B = \frac{U_{oc}}{U_{out}}$$

It is apparent that the voltage $Uk = U_{in} - U_{oc}$ will be supplied directly to the amplifier input. In its turn

$$k = \frac{U_{out}}{U_{in} - U_{oc}} ,$$

or $U_{out} = k. \ U_{in} - k \cdot U_{oc}$.

Substituting, in place of U_{oc}, a value, equal to $B \cdot U_{out}$, we derive that $U_{out} = k \cdot U_{in} - k \cdot B \cdot U_{out}$ or

$$\frac{U_{out}}{U_{in}} = \frac{k}{1 + Bk} ,$$

defining $\frac{U_{out}}{U_{in}}$ by k_{oc}, we have finally

$$k_{oc} = \frac{k}{1 + Bk} , \qquad (3)$$

wher K_{oc} is the coefficient of amplifier amplification with negative feedback.

This formula results from the earlier introduced general formula (1). If it is accepted that $x(t) = U_{in}$, and $y(t) = U_{out}$, and this expression is placed in formulat (1); replacing $\frac{U_{out}}{U_{in}}$ by k_{oc}, we derive formula (3).

It is completely evident that with kB greater than 1, formula (3) takes the aspect

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$$k_{oc} = \frac{1}{B}. \qquad (4)$$

It is evident from formula (4) that amplification by an amplifier with negative feedback (when kB is greater than 1) does not depend on the properties of the amplifier itself and, consequently, a change in the amplification coefficient k does not evoke a change in k_{oc} (within definite limits, of course). Thus amplification by an amplifier with negative feedback depends only on the feedback circuit. Since there are no tubes, feed sources, or other elements for elimination of resistance in this circuit, such an amplification with negative feedback is completely stable.

The physical influence of negative feedback might be explained as follows: with reduction of amplifier amplification, voltage at the output is decreased and, consequently, there is a reduction in voltage U_{oc}. As a consequence of this, voltage Uk at the amplifier input begins to increase, evoking an increase of output voltage which compensates for the drop in amplification. Negative feedback is correspondingly self controlling with an increase in amplification. But it must not be forgotten that it is self controlling in a similar manner only when Bk is greater than 1. Practically, this condition is not difficult to fulfill, since the coefficient of a cascade amplification of contemporary tubes lies within the limits of several hundred or even thousand. Consequently, the intensity of B might lie within limits of 0.05 to 0.2. Since k_{oc} is approximately equal to $\frac{1}{B}$, then it is evident that a large value for B is disadvantageously taken from a reduction in amplification.

Negative feedback also improves other characteristics of an amplifier and is used: for increasing amplifier stability; for achieving a required amplifier input or output resistance when necessary; for decreasing extraneous amplification due to source feed pulsation, temperature change, magnetic field influence, etc.

The shortcomings of a circuit with negative feedback are: the amplifier amplification is decreased by 1 + Bk times as is seen from formula (3); the amplification circuit and its adjustment are complicated; and there is a possibility in some cases of parasitic generations being formed, especially with an incorrect choice of a circuit and its elements.

When a negative feedback circuit is connected with a part of an amplifier circuit, a closed circuit is formed, which is called a feedback loop. The intensity of Bk is called the loop gain (sometimes, it is called the feedback factor). Since $B = \frac{U_{oc}}{U_{out}}$, and $k = \frac{U_{out}}{Uk}$, then $Bk = \frac{U_{oc}}{Uk}$, whereupon Uk conforms to voltage at the Uk loop input, and U_{oc} to its output. Finally, the intensity A = 1 + Bk is called negative feedback depth indicates the amount of reduction in amplification of an amplifier with feedback.

Classification of negative feedback, methods of obtaining it, and standard circuits. According to the method of achieving negative feedback, it is subdivided: according to voltage when the intensity of U_{oc} is protional to U_{out}; according to current when U_{oc} is proportional to I_{out}; and as combined or composite when U_{oc} is proportional to U_{out} and I_{out}. A negative feedback circuit is shown in figure 2a according to voltage,

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and in figure 2b according to current.

Negative feedback, according to the method of input supply, is in series when Uin and Uoc are introduced to the circuit in series (figure 2a), in parallel when these voltages are supplied in parallel (figure 2b), or composite (sometimes bridge according to input) when the voltage connection is combined in series and in parallel.

In some comparatively complex circuits, it is not east to determine the aspect of negative feedback. In order to determine the method of obtaining feedback, it is necessary to first mentally short-circuit the load, and then to break this circuit. To determine the means of supplying negative feedback to the input, it is necessary to first mentally short-circuit the input of the alternating electromotive source, and then to cut it off. According to the presence or the absence of Uoc, the circuit is visualized by using the following table.

Determination of Negative Feedback by Derivation of Uoc			Determination of Negative Feedback by Supplying Uoc to Input		
Negative Feedback	Load		Negative Feedback	emf Alternating source	
	Short-circuit	Cut Off		Short-circuit	Cut Off
by Voltage	No Uoc	Uoc	Series	Uoc	No Uoc
by Current	Uoc	No Uoc	Parallel	No Uoc	Uoc
Composite	Uoc	Uoc	Composite	Uoc	Uoc

An amplifier might have one or several negative feedback loops. If there is one loop, the connection is called single loop; if there are several, it is called multiloop. Depending upon whether one loop includes another or not, they are called dependent or independent. Finally, loops, which encompase individual amplifier steps, are called individual or local negative feedback loops.

A few circuits for the derivation and supply of negative feedback in amplifier cascades are shown in figure 3. For simplicity in the illustration, some circuit elements, which have no part in the operation, are omitted. Figure 3a is a circuit for derivation of negative feedback according to voltage with a potentiometer (divider) R_1R_2. Voltage Uoc is precipitated to resistance R_2 and supplied in series to the input. This feedback is called in series according to voltage. Capacitor C is a separating capacitor. Its magnitude must be sufficiently large. Feedback in series according to voltage is also shown in figure 3b. Here, Uoc is removed from the auxiliary winding of the output transformer. Negative feedback according to voltabe is also shown in figure 3b. Here, Uoc is removed from the auxiliary winding of the output transformer. Negative feedback according to voltage is shown in figure 3c, but in this circuit it is supplied in parallel. The separating capacitor C must not generate a frequency dependence, therefore its capacity must be comparatively large. The magnitude of Uoc depends on the magnitude of R.

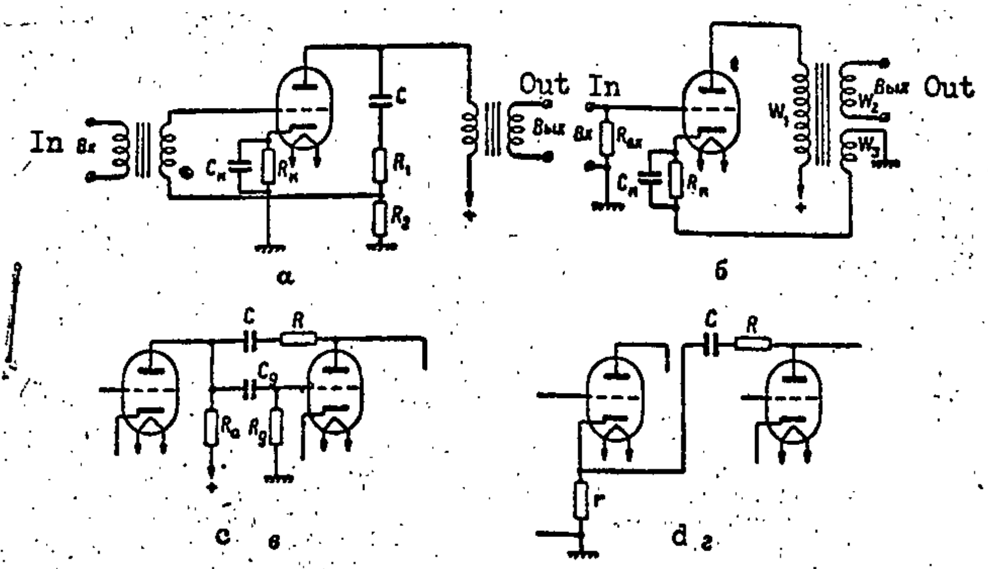

Рис. 3.

Figure 3.

The feedback circuit can supply /feedback/ to the first tube anode or to the second tube control grid. With this, it is necessary to remember that the tube changes the phase of supplied voltage by 180 degrees. Therefore, negative feedback is shown in figure 3c. If this communication disseminates to two cascades, a phase shift of 360 degrees is obtained and an example of positive feedback will be observed. In order to avoid this, it is necessary to change the phase, which is achieved by transferring the feedback circuit from the anode (or grid) circuit to the cathode circuit as is done for the iterated network R,C in figure 3d. Here, the (local) negative feedback is in series according to current, due to resistance r; and it is in series and interstage according to voltage, due to circuit R,C.

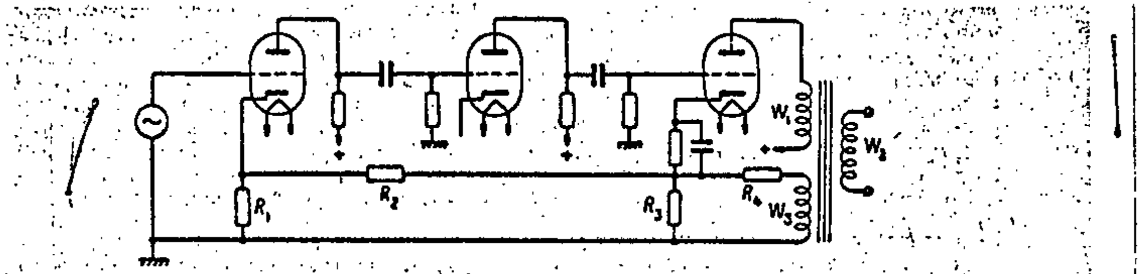

Рис. 4.

Figure 4.

The three-cascade amplifier circuit with resistance coupling, shown in figure 4, is a little more comples. In the first step, the local negative feedback is in series according to current, due to R_1; in the third, it is local composite, in series according to the input, due to divider R_3R_4; and, finally, all three steps are enveloped by series feedback according to voltage, which is generated by the third transformer winding and the dividers R_1R_2 and R_3R_4. The basic value of this circuit is namely its feedback.

Negative feedback is also used in cathode follower circuits. Here B is equal to 1 and k_{oc} is close to the value of 1. A cathode follower circuit gives very little distortion, a large input resistance, and a small output resistance. With this, the input and output voltages coincide in phase. Because of these qualities, the cathode follower circuit has found wide usage.

If a negative feedback circuit is composed of resistances, its magnitude does not depend on frequency. Such feedback is called frequency-independent. Sometimes, it is desireable to obtain frequency-dependency feedback, for example, in order to compensate for frequency distortion and inserted lines with an amplifier or by other means. Then, the circuit is composed of a combination of resistances and reactances which are selected according to a frequency characteristic.

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Non-linear elements may also be introduced into negative feedback circuits. This is done in those cases when, for example, it is necessary to preserve voltage stability at the output while voltage magnitude is being changed at the input. Especially well related to these are multiple automatic gain control circuits (agc) which are widely used in radio receiving equipment.

If, in the circuit, there is no bridging capacitance for resistance bias in the cathode circuit, we receive an additional feedback in respect to current, which reduces amplification. Finally, if the bridging capacitance has insufficient magnitude, there is feedback for low frequencies and amplification at these frequencies will be reduced. That, which was mentioned earlier, is also related to the capacitance in the screen grid circuit. It is necessary to select a bridging capacitance so that the resistance capacitance for the lowest frequency ranges is 5 to 10 times less than the resistance value.

Analogous negative feedback circuits are used in push-pull amplifiers, but the feedback is usually employed symmetrically to each tube. Sometimes, feedback is used for amplification control. Variable resistance is introduced into its circuit for this (for example, replace amplifier R_1R_2 with a potentiometer in the circuit shown in figure 3a). However, it is not possible to recommend such a method of gain control, since with alteration of negative feedback, input and output resistances will be changed; and with small feedback values, the stability and the distortion compensation capability of the amplifier will be decreased.

The infludence of negative feedback on amplifier characteristics. This influence is essentially manifested on all basic parameters of an amplifier. Therefore, by selecting any feedback circuit, we can find an amplifier with the characteristics which we are interested in. Let us examine this in more detail.

Input amplifier resistance dependes on the method of supplying feedback voltage to the cascade input and does not depend on the method that is used to remove it from the circuit output. It is increased with negative feedback in series and decreased with negative feedback in parallel. This is explained by the decrease of the voltage, which is supplied directly to the amplifier cascade ($U_k = U_{in} - U_{oc}$) and, consequently, by the decrease of input circuit current, which equivalently increases input resistance.

In a majority of cases, it is desireable to have a high input resistance. Therefore, negative feedback in series is often used. It is found in parallel only in intermediate amplifier steps and in a few special types of equipment. Thus, for example, several voltages are supplied simultaneously to a computer circuit; so a circuit with a negative feedback in parallel is, for this situation, more suitable.

Amplifier output resistance depends on the method of taking feedback voltage from the output and does not depend on the method used to supply it to the input. With feedback according to voltage, the output resistance is decreased; and with feedback according to current, it is increased. This is explained by the output voltage being decreased in the first case, and by the current being decreased in the second case.

In terminal cascades used for improvement of amplifier load adjustment it is desireable to have a small output resistance. Therefore, feedback according to voltage is usually used in these cascades, but feedback according to current is used more often with initial cascades.

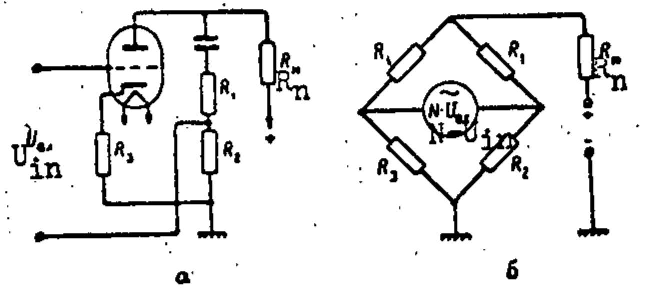

Рис. 5.

Figure 5.

In order that feedback voltage does not depend on load and its oscillations, and consequently, in order that load does not affect the amplification coefficient and the output resistance, the bridge circuit, which is shown in figure 5a, is used. Here, feedback is removed according to voltage from the divider $R_1 R_2$, and according to current from resistance R_3. By placing the tube with an equivalent generator, which has the voltage mU_{in} and internal resistance R_i, where m is the coefficient of tube amplification, we obtain a circuit in the shape of a bridge which is shown in figure 5b. During conditions of equality, contrasting arms are formed, i.e., when $R_i \cdot R_2 = R_1 \cdot R_3$, this bridge is in equilibrium. Having chosen the conforming resistances R_1, R_2, and R_3, in order that this condition would be fulfilled, it can be expected that the operation of the circuit does not depend on the magnitude of load R_n, which is connected to the bridge diagonal.

Various types of distortion are common in amplifiers. Non-linear distortion usually is formed in terminal cascades, and frequency and phase distortion in all other cascades. Negative feedback, in all parts of the circuit which is encompasses, greatly improves the relationship between the effective signal level and the level of harmful components. This is especially important for terminal cascades, where one and the same coefficient of non-linear distortion can significantly increase the voltage, which is supplied to the input, and consequently, can increase output power.

Until this time, we have assumed that phase shifts in a feedback loop were equal to zero since it is only under this condition that U_{in} and U_{oc} will be in antiphase. However, due to reactive elements, which enter into the circuit in the negative feedback loop, voltage can achieve a phase shift, especially at low and high frequencies, which, in its turn, evokes a decrease in feedback and an increase of interference and distortion. Therefore, from amplifier circuits, which are encompassed by negative feedback, as well as in the feedback itself; it is desirable to exclude reactive elements, especially transformers which have sharp expressions of amplitude-frequency and phase-frequency characteristics. With this point of view, it is more expedient to select an amplifier circuit with resistance coupling.

It was said earlier that, due to reactive elements (capacitors, choke coils, transformers), phase shifts for individual frequencies can appear in the loop, which, in certain conditions, might lead to amplifier stability disturbance, which is formed by positive feedback, i.e., is generated. With this, distortion and interference are increased for frequencies where phase shifts are significant. The most dangerous frequencies are the cut-off frequencies of a band.

In practice, it is difficult to achieve identical phase shifts for input voltage and feedback voltage at all frequencies. Therefore, it is always necessary to consider the possibility of generation formation. The greater its probability is, the greater is the feedback encompassment and the more significant its depth.

Special frequency-phase correction circuits are usually connected into multistage negative feedback amplifiers, where the phase shift along the loop reaches 180 degrees. Such a circuit is shown in figure 6. Here, the circuit R_1 C_1 decreases amplification and shift at low frequencies and R_2 C_2 decreases amplification and shift at high frequencies. The approximate values of the circuit elements are: R_1 = from 2 to 5 megohms; R_2 = from 1,000 to 5,000 ohms; C_1 = from 0.1 to 0.5 microfarads; and C_2 = from 200 to 2,000 picofarads.

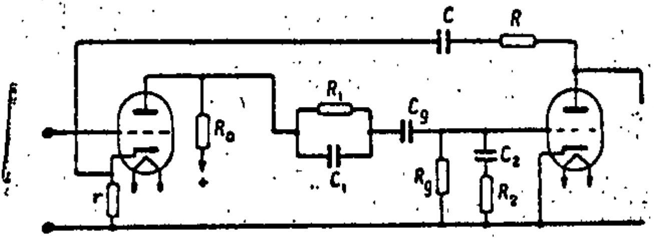

Рис. 6.

Figure 6.

It is always necessary to consider the possibility of the emergence of feedback due to spurious capacitance, inductive coupling, or resistance coupling. In case it arises, it is necessary to attempt to nullify its influence on the general properties of the amplifier and especially on its stability.

The construction of a circuit with negative feedback in amplifiers, achieved by semiconductor triodes, is not essentially different from amplifiers on electron tubes; however, there are a few differenc[illegible]re caused by the peculiarities of the semiconductor devices. One of them is the significant instability of the semiconductor parameters, which is dependent upon temperature changes and the spread of characteristics, even for one quality, which leads to amplification change. Therefore, the employment of feedback is considered an important method for bringing about amplifier stability.

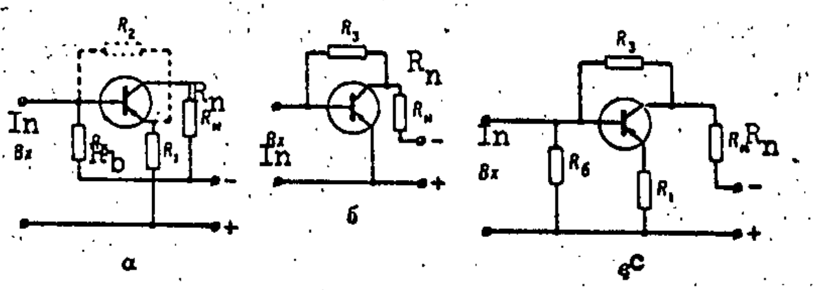

Рис. 7.

Figure 7.

The simplest negative feedback can be used in circuits where voltage at the output is shifted 180 degrees in phase in relation to the voltage at the input. This condition of a circuit is fulfilled by a master /obshchiy/ emitter, which is available for this and for other qualities. A standard circuit, which connects feedback in amplifiers at semiconductor triodes with a master emitter, is shown in figure 7. A given circuit with negative feedback in series (according to current) is shown in figure 7a. In order to increase the stability of the given circuit, it is necessary to increase the magnitude of R_1. However, it must not be forgotten that an excessive increase of this resistance, finally, leads to a restriction of the circuit operation according to voltage. Inclusion of resistance R_2 allows the same stabilization coefficient to be achieved with small resistance values of R_1.

A circuit with negative feedback is parallel (according to voltage) is shown in figure 7b. Here, stability is improved with an increase of the ratio $\frac{R_n}{R_3}$, although too great a value of this ratio leads to a decrease of amplification. And, finally, a circuit with combined feedback, where stability is achieved by matching resistances R_1 and R_3, is shown in figure 7c.

All of these circuits are almost equivalent in respect to their qualities. The most convenient elements of the circuits can be achieved by the use of negative feedback in series in primary cascades, and by the use of negative feedback in parallel in terminal cascades. In the most responsible cases, as well as ordinarily, interstage feedback can be used, but, in this case, it is necessary to consider the comparitively small input resistance in order not to allow shunting of the output circuit. Also, in tube circuits, feedback voltage with the use of semi-conductors in amplifiers can be achieved from the auxiliary winding of an output transformer.

Consideration of what has been said here, can produce the conclusion that the use of negative feedback in electron amplifiers improves all of their characteristics significantly. Distortion is decreased in all of their aspects and stability is increased. A conforming choice of a feedback circuit allows the amount of input and output resistance of an amplifier to be changed within necessary limits, which also has an important significance. The use of negative feedback is especially effective in terminal cascades where delivered amplifier power is significantly increased and amplifier efficiency is improved by use of negative feedback.

Decrease of amplification in an amplifier with negative feedback is comparatively easily compensated for by increasing amplification in primary cascades or by increasing the number of primary cascades. Of course, the additional complication of the circuit is a drawback but the virtues of negative feedback are so significant that it has found wide usage.

Relay Regulator Adjustment -- by Engr-Lt Col N. P. KHARITONOV (Pages 67-69)

Text:

As is well known, the ESD-75 diesel-electric station uses the G-731 generator charger, which operates in conjunction with the RRT-24 relay regulator. The RRT-24 relay regulator differs from automobile regulators in that it has five parts instead of three: two voltage regulators, two current limiters, and one reverse current relay. The generator oscillator winding is divided into two parallel circuits. An individual voltage regulator and current limiter which have special compensation windings for simultaneous operation are connected in each of them. However, a shortcoming here is that the contacts of the regulators and limiters operate under identical conditions. If one of the regulators has a large spring tension, its contacts will be broken by a large current, which will quickly bring on burning of the points and lead to their going out of order prematurely.

Identical currents in parallel arms of the generator oscillator windings can be achieved by correctly adjusting the voltage regulators and current limiters.

Adjustment of the RRT is usually done on a special stand, but it can be done immediately at the power plant. For this, it is necessary

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to prepare a frame rack to place the relay regulator in a vertical position and to prepare connections to connect it to the generator, the storage battery, and the framework.

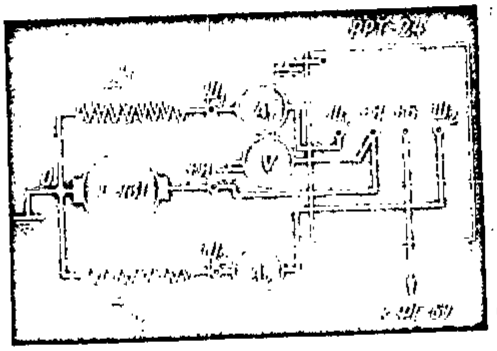

Figure 1.

For adjustment, the RRT-24 is removed from its shock absorbers and placed in a vertical position without its covers. Then the leads from the terminals +Ya, Sh_1 and Sh_2 of the generator are disconnected, and the lead, which goes from the terminal +B of the relay regulator, is disconnected from the FG-57 filter. Then the relay regulator is connected to the generator according to the circuit which is shown in figure 1. The size of the leads, which are intended to connect the relay terminal +Ya and the relay regulator and the FG-57 filter, must not be less than 10 square millimeters. The size of the remaining leads are 2.5 square millimeters. The following direct current measurement instruments are used in the circuit: multirange ammeters with measuring limits of up to 2 amperes, a voltmeter with a measuring limit of up to 30 volts, and the multirange ammeter from the diesel control panel.

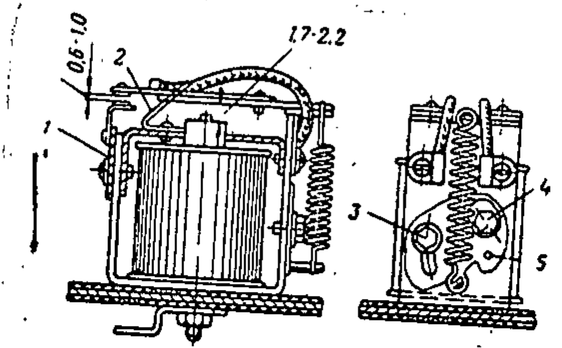

Figure 2. 1. - plates; 2. - arresting [illegible] stop screw; 4. - cam E; and 5. - axis.

At the beginning of the adjustment, gaps are checked. The gap between the armature and the core, with open reverse current relay contacts (figure 2), must be within the limits of 1.7 to 2.2 millimeters; and with closed voltage regulator and current limiter contacts. (figure 3). within 1.8 to 2 millimeters.

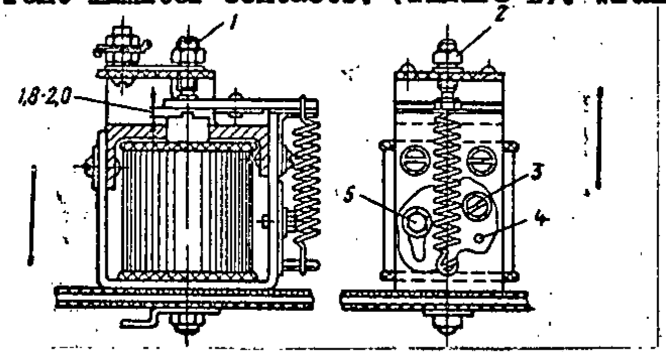

Figure 3. 1.- contact adjustment screw K; 2.- lock nut; 3.- cam E; 4.- axis; and 5.- stop screw.

The reverse current relay gap is adjusted by changing the position of the arresting device U (see figure 2). The voltage regulator and current limiter gap is adjusted by tightening screw K, after loosening the lock nut.

The allowable size for the gap between the open reverse current relay contacts is from 0.6 to 1 millimeters for each pair of contacts. This gap is adjusted by adjusting the insulation plate P (see figure 2), after the lock nuts have been loosened.

The engine is started in order to check and adjust the reverse current relay. While its revolutions are smoothly increased, the voltage connection of the relay is determined (connected voltage /U vkl/ = 24.5 to 26.5 volts). Then, as the number of diesel revolutions is decreased, reverse current is determined by the multirange ammeter on the control panel while the relay is disconnected (1 revolution = 2 to 8 amperes).

Adjustment of the connection voltage can also be accomplished by changing the spring tension with cam E, after loosening lock nut V. To increase the tension of the spring, and, consequently to increase connection voltage, the cam is turned in a counter clockwise direction; and for decrease, vice versa.

Change of intensity of reverse current is done by moving the insulation plate P which has fixed contacts. In order to decrease intensity, the plate is moved upward; and for increase, it is moved downward.

After the arresting device is adjusted, the gap between the open contacts is within 0.6 to 1.0 millimeters, and all fixed details are fastened with stop screws; everything is checked again in the manner recommended above.

If the electric parameters of the reverse current are within the norm, adjustment of the voltage regulator can be carried out. For this, the voltmeter is connected from terminal +Ya to terminal +B, and diesel revolutions are set equal to 1,500 RPM. Then, the voltage, which is sustained by the voltage regulators, and the current in the oscillator winding circuits OSh_1 and OSh_2 are determined. The voltage must be within the limits of from 26.6 to 28.5 volts, with a load current no greater than 43 amperes and the currents in the oscillator winding circuits equal ($i_1 = i_2$).

Voltage regulators and current regulators can operate with unequal currents in the oscillator winding circuits, but the contacts, which break the large current, will be overloaded and will go out of order prematurely. Therefore, parity of currents in the oscillator winding circuits is determined during regulator operation by the accuracy of voltage regulator and current limiter adjustment.

If the voltage, which is sustained by the regulators, is lower than the norm, it is necessary to increase the spring tension of that regulator which has the lower oscillation current in its circuit. With equal currents, it is necessary to do this for either of them until generator voltage reaches a specified intensity.

Then, the current in the oscillation winding circuits is determined with the multirange ammeters A_1 and A_2. If i_1 is smaller than i_2, the smaller oscillation current intensity is subtracted from the larger and divided by half $(\frac{i_2 - i_1}{2})$. Then, the tension of the spring is increased on the voltage regulator, where the oscillator current in the circuit is lower, until that current is increased to the intensity $(\frac{i_2 - i_1}{2})$ and the stop screw is tightened. Then, the spring tension of the second voltage regulator is decreased for parity of currents in the oscillator winding circuits and that stop screw is also tightened. If the voltage, which is sustained by the regulators, exceeds the norm; it is necessary to decrease the spring tension of the regulators.

A 50 ampere rheostat with a maximum resistance of 0.7 ohms is necessary for checking and adjusting current limiters. In order to use the multirange ammeter of the control panel, the rheostat is connected with a storage battery in the circuit while the diesel is in operation (when the lead is disconnected from the plus terminal of the storage battery, the starter will not operate). When the diesel is operating at 1,500 RPM and rheostat resistance has been decreased, the current, where the limiters begin to operate (1 limiter /ogr/ = 43 to 53 amperes), is determined by the multirange ammeter on the control panel. The currents in the oscillator winding circuits must be equal, as during operation of the voltage regulators.

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If the limiters begin to operate at too low a current level, they are adjusted by an increase in spring tension; and if the current is too large, spring tension is decreased. The method of adjustment here is the same as for adjustment of the voltage regulators.

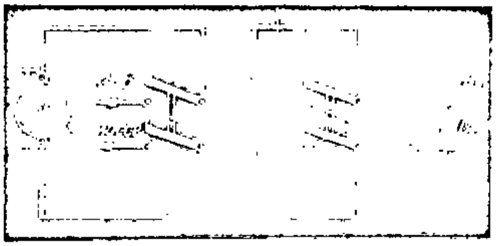

Figure 4.

Adjustment of voltage regulators and current limiters by the methods, which are described above, can be done with two voltmeters or even with one voltmeter if it has a switch-over device.

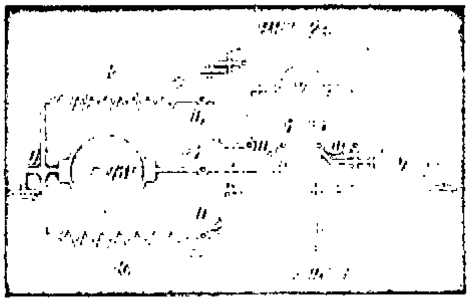

Figure 5.

For clarification of this, let us examine the circuit which is shown in figure 5. If a voltmeter is connected to the terminals Sh_1 and Sh_2 of the relay regulator, which is operating in common with the generator; it will indicate the difference between the decrease of voltage at section OSh_1 and the decrease of voltage at section OSh_2 $(i_1R_1 - i_2R_2)$. Since individual oscillator windings of the generator tend to operate with identical revolutions it can be considered that their resistances are equal. In this case, if the currents in the oscillator winding circuits are also equal, the voltmeter, which is connected to the terminals Sh_1 and Sh_2, will indicate zero.

Consequently, when one voltmeter is connected to the 50X1-HUM +B and "mass", and the second voltmeter is connected to the terminals Sh_1 and Sh_2, the intensity of the voltage, which is sustained by the regulators, can be determined; and the current in the oscillator winding circuits can be adjusted in the same way. They must be adjusted whenever it is necessary.

If the voltage, which is sustained by the regulators, does not correspond to the norm, it is necessary to achieve the desired voltage by changing the spring tension on either regulator. Then, the voltage must be measured at the terminals Sh_1 and Sh_2, the voltmeter reading must be divided by half, and, by changing the spring tension of the same regulator, the voltmeter arrow must be guided to half of the previous reading. Then, the stop screw is tightened. The spring tension of the second voltage regulator must be changed so that the voltmeter indicates zero. Then, the stop screw is tightened again. Adjustment of the current limiters is accomplished in the same way.

The degree of misalignment of the voltage regulators and of the current limiters, and the condition of their contacts can also be determined without removing the relay regulator covers by measuring the voltage at the terminals Sh_1 and Sh_2, which is especially important while the relay regulator is in use. If the currents in the oscillator winding circuits differ by 20%, voltage at the terminals Sh_1 and Sh_2 will ideally be 1 volt.

It must also be noted that there can be different currents in the oscillator winding circuits also as a result of burning or of significant fouling of the contacts. Therefore, it is recommended that they be cleaned before adjustment is attempted. It is necessary to check the voltage at the terminals Sh_1 and Sh_2 after every 100 hours of power plant operation.

<u>This is How We Teach Radar Set Tuning to Officer Candidates</u> -- by Engr-Lt Col I. M. KRASNYY (Pages 70 - 71)

Abstract:

This article explains the mechanics of teaching radar set tuning as done by KRASNYY's school. After careful classroom preparation, the officer candidates complete a sequence of practical activity, which is followed by checking and reviewing sessions.

Innovations and Inventions

<u>Loudspeaker Adapter</u> -- by Pfc Ye. I. RUMYANTSEV and Pvt G. I. VASIL'YEV (Pages 72 - 73)

Abstract:

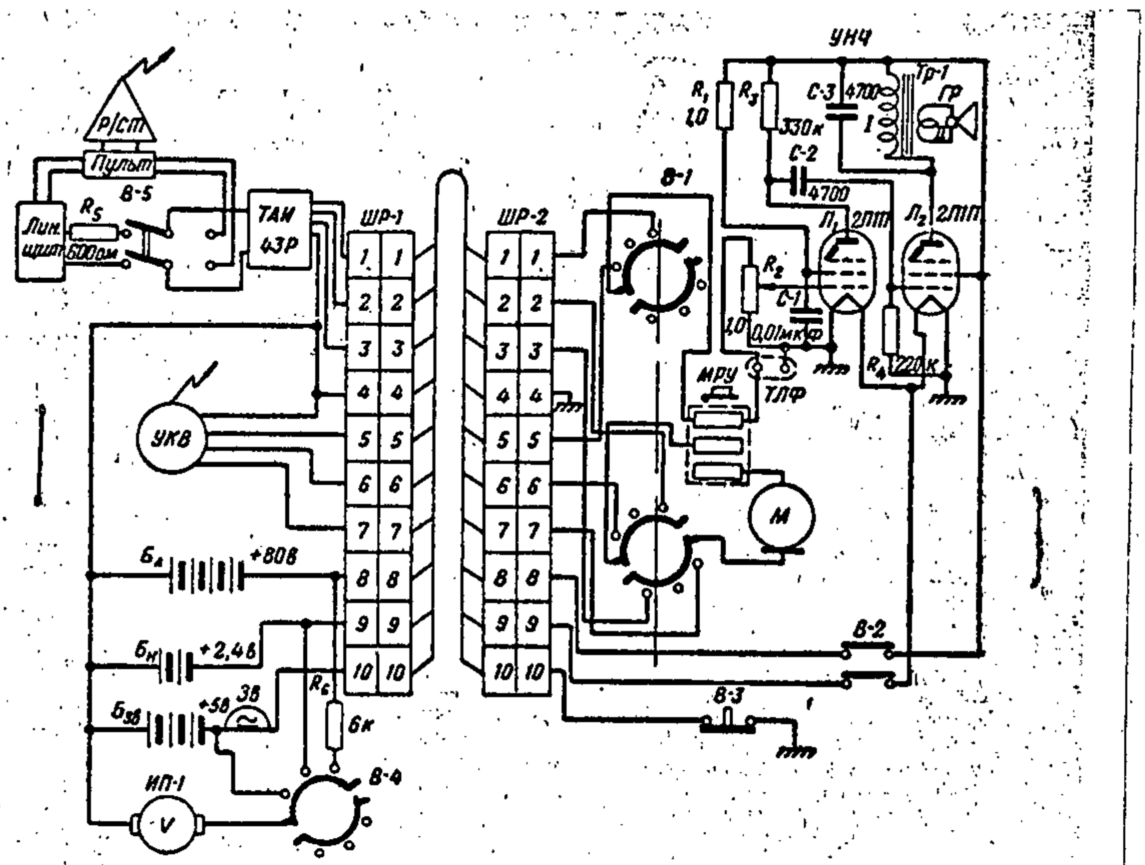

Рис. 2. Принципиальная схема приставки громкоговорящей связи для дистанционного управления радиостанциями.

This article describes the uses and construction of a remotely controlled loudspeaker adapter. A schematic diagram of the adapter is given.

Crossover Box -- by Engr-Maj V. T. ZAVIDEYEV (Page 74)

Abstract:

This brief article describes the operation of a crossover box, used for different kinds of current. The box measures 70 by 25 by 3 centimeters. Two illustrations show the physical construction of the box.

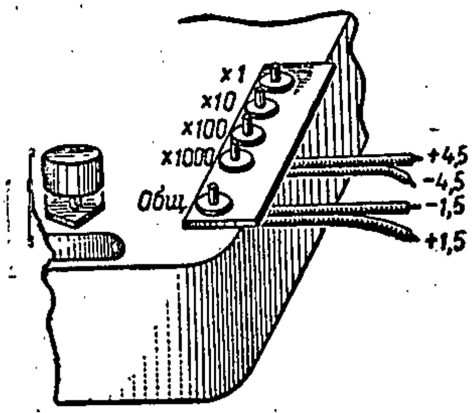

Рис. 1.

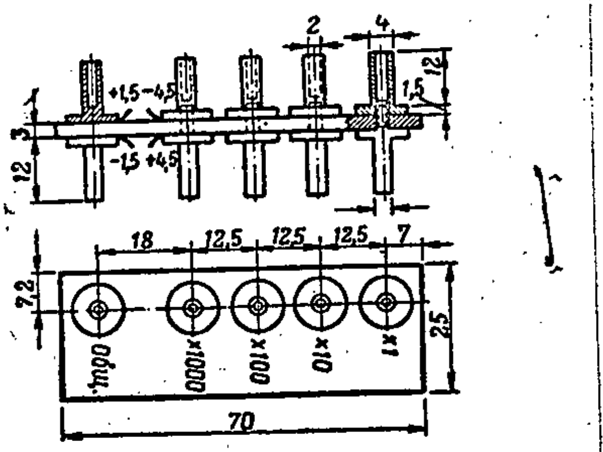

Рис. 2.

/The caption to a photograph on page 74 of Capt M. POLYAKOV by Z. SORKIN praised Capt POLYAKOV for his innovation achievements./

In the Field of Science and Technology

The Employment of Plasma for Detection -- by Candidate of Physical and Mathematical Sciences K. I. KONONENKO and V. S. ZABELINA (Pages 75 - 77)

Text:

The detector is a basic element of almost every radiotechnical apparatus. The history of radio began fundamentally with the development of a electromagnetic wave detector. With the development of electron tubes, the electron tube detector proved itself to be most effective for long waves and it assumed a domineering position in radiotechnology. In the course of its development, when decimetric and microwave ranges were adopted, electron tube detectors were no longer suitable since their sensitivity dropped sharply with raised frequencies. Because of this, the employment of crystal detectors was begun in decimetric and microwave ranges. They were more suitable because of their small size, their sufficiently fine sensitivity, and their independence from power supply sources. But it was soon discovered that these detectors had serious shortcomings.

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Therefore, study was subsequently begun of what are called plasmic detectors. First experiences already have shown that these detectors successfully execute their functions in a range of from 50 cycles per second up to 6,000 megacycles per second without a loss of sensitivity. Their operation is almost completely independent from frequency. Therefore, they are called wide range. There are two possible detection mechanisms and, in conformance with this, there are two types of detectors.

What is a plasmic detector? It is a gas-discharge tube of special construction, in which a gas-discharge plasma is formed and maintained in a stationary condition due to the energy of an external source. Operation of the detector is based on the use of the non-linear properties of the plasma, which is a highly ionized gas containing a small quantity of neutral molecules and an identical number of positive ions and electrons. In this manner, this system is, on the whole, electrically neutral.

It would be a mistake to consider that plasma is a rare phenomenum which is studied only by scientists in their laboratories. We meet with it in neon advertisement tubes, in electric arc welding, in the aurora borealis. Our Earth is encircled by a plasmic blanket at an altitude of a few hundred kilometers, which is called the ionosphere. Scientists, who are occupied with studying outer space, have come to the conclusion that only one 1,000th part of the mass of our Galaxy is firm matter. All the other matter is gas, of which a large part is in a plasmic condition.

Currently, the properties of plasma are widely used both in science and in technology. Of special interest is the development of plasmatrons. With their employment, thermal energy has been successfully transformed directly into electric current energy.

The employment of plasma for detection is based upon the usage of one of its multitudes of qualities - non-linearity. The condition of the plasma is determined by its parameters which are primarily related to the electron temperature, which reaches a level of several tens of thousands of degrees in ordinary gas-discharge tubes; to electron density, i. e., their quantitative value in a single cubic centimeter; to plasmic potential; to potential gradient; etc.

The two types of plasmic detectors, which were mentioned earlier, differ from each other in their mechanisms for interaction of the electromagnetic wave field with the plasma and also in their construction. The first detection mechanism is used in a detector with probes. If a probe, which represents a metallic electrode (flat, cylindrical, or spherical), is located in the plasma; it is negatively charged. As a consequence of this, the electrons in the plasma will be repelled from the probe and positive ions will be attracted to it. As a result, a layer, which is devoid of electrons and which is called the Langmuir /dark space7, is formed in the vicinity of the probe.

If voltage, which is alternating in respect to the cathode, is to the probe during a certain constant potential at the probe; electrons being to be attracted to the probe from the realm of undisturbed plasma during a positive half-period, and positive ions are repelled. This results in an electron current being supplied to the probe. During a negative half-period, the process will come about inversely: electrons will be repelled, ions attracted, and an ionic current will be supplied to the probe. However, since the ionic mobility is significantly less than that of the electrons, this current will be extremely small in comparison to the electron current and, consequently, is usually disregarded (figure 1). The resulting current at the probe will have a direct component with an intensity dependent upon the intensity of a supplied high frequency voltage.

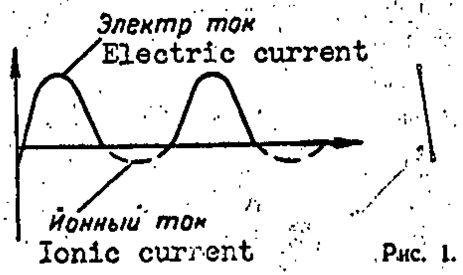

Figure 1. Рис. 1.

The construction of this type of detector is shown in figure 2. It is a glass bulb with an internally located small cylindrical anode. A tungsten filament, which serves as a cathode, travels along the axis of the anode. The tube is filled with an inert gas and discharge is maintained by a constant voltage between the cathode and the anode. In this way, the plasma is concentrated in the anode internal cavity. Disks, symmetrically located at the ends of the anode, serve as detecting probes. They are fastened to the wires of a two-wire line, which is soldered into the tube bulb. A signal is supplied along the line, which can be extended into an antenna for reception in free space or else terminated as a loop coupler.

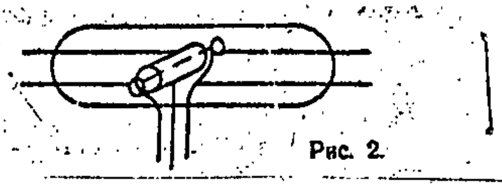
Рис. 2.

Figure 2.

The second type of detector differs in its simplicity. Its operation is based on the direct interaction of the high frequency field of a traveling wave with plasmic volume. Electrons are the most sensitive plasmic elements. Under the influence of a high frequency field, which penetrates the plasma, the speed of the electrons is increased, the plasmic temperature is raised, and this, in its turn, alters the discharge current which is flowing through the detector. Between the power intensity of the applied high frequency field and the intensity of current change, there is a determined quantitative relationship which makes possible an evaluation of field power according to the change of the discharge current.

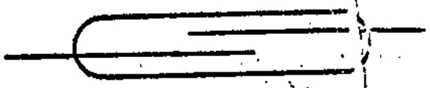
Рис. 3.

Figure 3.

Constructively, a detector of the second type is a small diameter glass tube which is sealed at both ends. Two rod-electrodes are soldered to its ends and are separated from each other by a few millimeters. The tube is evacuated and filled with an inert gas to a pressure equal to a few tens of millimeters of a column of mercury. The optimal pressure of the gas in the tube, which is suitable for each tube in respect to its narrow diapason of detected wave lengths, is selected by experimental means. The plasma is "ignited" by constant voltage which is suppli 50X1-HUM to the electrodes. The tube is exposed to the current of ultra-high frequency power in a free space or else is inserted into a circular aperture which is made in the wide walls of the waveguide. A low frequency signal can be removed from the electrodes and observed by the level of conforming detector noise with an oscillograph. The change in discharge current is also an indication. Its strength can be verified by any measuring circuit.

Such detector operation is observed when the power of high frequency oscillations does not exceed a certain critical value. An increase of the power above the critical level evokes a supplementary ionization of the gas in the discharge tube. Then, the stationary condition of the plasma is disturbed and the relationship between the applied power and the detector current becomes unstable. Thus, for example, if neon tubes are exposed to an impulse power with a gas pressure of from 0.5 to 2 millimeters of mercury and a discharge current of from 7 to 50 milliamperes, the critical power will be found within the limits of 17 to 250 watts.

There has been much interest in the sensitivity of plasmic detectors. The sensitivity depends on many factors, in particular: the accuracy of evacuation and preaging of the tube, the gas composition, the operation regime, the peculiarity of the construction of the tube, stability of operation of the detector itself, gas pressure in the tube, etc. One of the conditions, which are necessary for the achievement of high sensitivity and of a low noise level of a plasmic detector is the stability of discharge. Here, especially rigid demands are made of the detector. High stability of discharge is achieved by accurate evacuation and preaging of the tube, by selecting conforming discharge regimes, by replacement of a constant feed voltage with a highfrequency alternating voltage, and by the addition of a certain number of impurities, in particular mercury, to the basic gas.

The resonance qualities of plasma can be used for a sharp increase in sensitivity. Different levels of resonance can be observed in plasma: electronic, ionic, and cyclotronic. Cyclotronic resonance requires the use of a magnetic field. The employment of resonance phenomena can increase detector sensitivity two or three times. The shortcoming of resonance detection is its narrow-band property. The frequency of electronic and ionic resonances can be regulated within certain limits by change of the density of the plasma. The frequency of cyclotronic resonance can be regulated by changing the magnetic field. The sensitivity limits of plasmic detectors according to power are presently from 0.001 to 0.1 amperes per watts in conditions where the resonance qualities of the plasma re not utilized.

In using plasmic detectors for the detection of impulse power, the inertness of the detectors is of great significance, i. e., it is a plasmic property that it is extremely slow in regaining an original undisturbed condition. Inertness of plasma is determined by the ultimate time necessary for establishing an equilibrial distribution of electron speed and density. The time necessary for reestablishment of a concentration is significantly greater than the time necessary for reestablishment of speed distribution. The time for reestablishment of electron speed distribution has a basic role for small subcritical powers. This am 50X1-HUM of time depends upon the duration of the induced impulse and the pressure and type of utilized gas and impurities. This amount of time can be shortened by using a gas which has a large electron trapping profile. An infinite reduction in detector inertness cannot be anticipated, but a limiting value of impulse frequency succession and duration, which makes plasma detection possible, has not yet been established.

We have discussed two types of plasmic detectors. Which of them is the best? Both are suitable for use. The first type of detector possesses fine sensitivity, operates on any frequency, and detects both constant and pulse oscillations equally well. The second type of detector is distinguished by its simplicity and is small in size, which makes it especially suitable for use in waveguides. Its sensitivity is as fine as that of the first type.

In conclusion, it should be noted that plasmic detectors are not repetitions of other detectors, for instance of crystal detectors. They possess new qualities and peculiarities, which are inherent only in them. Chief among these are: a wide diapason, an operation independence from external atmospheric temperature, the ability to use resonance detection, and the ability to endure large power loads. Plasmic detectors with their new qualities might also be used in checking equipment used for measuring voltage and power at high and ultra-high frequencies.

Reviews and Bibliography

Concerning Fearless and Brave People -- by Col (Res) V. N. MATAKOV, HSU (Pages 78 - 80)

Abstract:

This article review two historical brochures: Aerial Ramming (Vozdushnyy taran) by F. A. VAZHIN, Voyenizdat 1962, 94 pp., 10 kopeks; and Defenders of the Capital's Skies (Zashchitniki neba stolitsy) by N. N. DMITREVSKIY, Voyenizdat 1962, 94 pp., 9 kopeks.