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INFORMATION REPORT INFORMATION REPORT

CENTRAL INTELLIGENCE AGENCY

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S-E-C-R-E-T

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SUBJECT	Additional Data on the Command Control System of the Soviet RSNA-75M (FAN SONG) Radar	DATE DISTR.	14 August 1964
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August 1964

COUNTRY : USSR

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[redacted]

2. Except for the designation of the radar, which has been transliterated in the Subject, above, the Cyrillic designation for all units has been retained.

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Control Boards

1. The controls and instruments are concentrated on control boards to permit centralization of such operations as: determining state of readiness of the equipment; switching the station and transmitter on and off; setting the combat and monitoring operation modes; giving permission for independent monitoring of the vans; performing functional monitoring of the video channel РЛК; selecting the proper guidance method; launching the missiles; and returning the coordinate units of the missile and command generating system to their original state.

2. Front panels of the И66А, И64, and И62М units mounted in the guidance cabinet of the УА van are used as control desks. The following devices are mounted on the front panel of unit И 66А: the station and transmitter signaling device for the switches, in the form of light registers and pilot lights which indicate the readiness of the station to be switched on from the remote control unit, and readiness of the station and transmitter power supply units. Station loud speaking communication switches and controls - telephone keys enabling switching the УА van telephone sets of [sic] any van, power plant and launcher without a switchboard. The switch providing for transmission of a command about preparation of this plant or that number of launchers, preparation or readiness of launchers, is indicated on this desk by the pilot lights. The switch changing over the guidance station transmission from the dummy antenna to the antenna proper. Located on the front panel of unit И64 are the following: devices allowing the station to be changed over to combat operation or to the centralized monitoring operating mode, and also to change over some vans to the local monitoring operating mode. Controls and instruments providing centralized monitoring of the station video channel and control command transmitter equipment. On the И62М unit front panel are located: angular and range guidance handwheels, launch controls and return commands applied through three channels of the missile coordinate units and command generating system with the respective signaling. Guidance method selectors. On and off switch buttons for synchronizing the launcher with signaling. The station range and band selector switch. On and off switches of the transmitter instantaneous automatic gain control with signaling system. Also located on the front panel of unit И 62М are scales of indicating selsyns showing the position of the station and launchers scan sector bisector and a launcher indication switch.[1]

Start [Launch] Control System

3. In the УА van of the PCHA-75M radar are located on ОП control desk and the РШ -А unit of the СА-75М batallion missile battery [sic]. These units represent part of the launch control system. The antiaircraft guided missile launch control system automatically performs by remote control the preparatory and starting operations.

The launch control system provides for: firing missiles from six launchers; maintaining continuous combat readiness of two launchers attached to the missile battery; bringing the missiles mounted on the launchers to launch readiness within two minutes, with simultaneous transition of launchers from loading angle to any angle required for firing at the target; launching the missile within not more than two seconds after the launch command has been given; transmitting signals to the guidance operator's control desk to provide data on the combat readiness of the missiles and launchers, and readiness of the missile battery control channel for firing; transmitting signals warning the launcher servicing crew, two minutes prior to the launch, about the beginning of preparation of the missile for launch.

Station Operating Conditions

4. The main combat operating conditions of the station are as follows: search for and detection of the target; guidance of the scan sector bisector and range gates to the target; target tracking (manual and automatic); launching and automatic tracking of the missile.

5. To detect targets at long range the station operates on a repetition frequency of 1250 cps. Under this condition the transmitter triggering pulses of 1250 cps are transmitted from the synchronizer and the receiving channel passband narrows to 3-4 Mc/s. The scan sector bisector is directed to the target by means of the ε and β handwheels of the guidance unit (И62М). In this operating condition, through a pair of selsyns (transmitting and receiving) operating as a transformer, the handwheel rotation produces an error signal voltage which is processed by the synchrodrives (И 62М and И 65М). The stable speed drive imparting the effort to the output shaft connected with the receiving selsyn is used as drives /sic/. The tracking drive output shaft carries /sic/ the transmitting selsyns, the rotation angle of which is followed up by the antenna power synchrodrive. In this case, the antennas are controlled only in position. When the target appears within the station scan sector the target mark should be observed on the guidance indicator scopes.

6. In the guidance operating mode, the indicator vertical marks are locked with the scan sector bisector. Alignment of vertical marks of the guidance indicators (in planes ε and β) with the middle of the target mark indicates that the scan sector bisector has been guided to the target. The circuit of the target angular coordinate unit servosystem (unit К73) is opened. The integrator input is grounded via a low value resistor. Voltage fixed value corresponding to the position of the tracking gates in the center of the scan sector is fed from the integrator output. The gates are set precisely in the center of the sector by the operator of the ЗА van, by comparing the position of the vertical marks from the coordinate units with the position of the

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vertical marks from the induction antenna transmitter on the manual tracking indicator scopes. The induction transmitter pulse corresponds to the middle of the scan sector. Range guidance is by means of handwheel 4, of unit И 62M. The handwheel is coupled with the potentiometer, the voltage of which is fed to the variable delay circuit of the opened range-tracking system (K71). In this the integrator is grounded via a low value resistor. When matching the horizontal mark with the echo blip the guidance operator, by varying the voltage level, changes the pulse time position, thus guiding the tracking gates to the target.

7. If the target azimuth is known only approximately, the target is detected by a sector search method. In this case the station scan sector swings in azimuth within an angle of ± 20°. Also, it is possible to swing the center throughout 360°. The azimuth synchrodrive (И 63M), in this case, acts according to the sum of two voltages: mismatching voltage between the guidance transmitting selsyn (И 62M) and the receiving selsyn (И 63M) and sinusoidally modulated voltage, obtained from the И 62M unit sector search rotating selsyn.

8. In cases where there are no data on the direction from which the target enters the effective range of the radar, a circular search method is used. In this case, constant amplitude voltage which drives the antenna transmitters and the ПАА van in a clockwise rotation at a speed of 16 degrees per second, is fed to the stable speed drive of unit И 63M.

9. After the target is detected and the station scan sector bisector is aligned with it, the guidance operator sends the command (by pushing the button) to the launchers to synchronize them with the antenna system. When the target comes within the required range, the antenna control is handed over to the manual tracking operators who track the target by moving the scan sector, keeping the target mark at the electronic mark cross lines. When the target comes within closer range, the guidance operator begins operating at a repetition frequency of 2500 cps and with the target receiving channel passband equal to 4.5 - 6 Mc/s.

10. In the manual tracking mode the vertical mark is also locked with the station scan sector bisector. In this case the summary values of the following two voltages are applied to the input of the stable speed drive: the voltage proportional to the rotation angle of the manual tracking unit handwheel, and that proportional to the derivative of this angle. Such a circuit provides target tracking in speed and in position. The angular coordinate unit operation in the manual tracking mode does not differ from that in the guidance operating condition except that the low value resistor coupling the integrator input with the chassis increases in value. When a previous operation mode is changed over to the target range manual tracking operation mode the guidance voltage is no longer applied to the open tracking system and the integrator is disconnected from the "ground". The range tracking of the target is carried out in speed and

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in position by means of the unit И 61 handwheel. The handwheel rotating action is imparted to the potentiometer from which the speed voltage is taken and fed to the error signal amplifier of unit K71. The position voltage is obtained from the same potentiometer and through the capacitor is introduced into the integrator circuit. The operator controls the range pulse position by aligning the manual tracking horizontal mark with the target echo mark (the range sweep scale being 60 km). In case the 5-km sweep scale is set, the operator keeps the target mark between two horizontal marks.

11. Under a condition free from jamming the manual tracking operators may switch to automatic tracking when the vertical mark locks with the center of the echo mark. The manual tracking operators control the scan sector position in elevation and azimuth so that the vertical mark is aligned with the notched mark on the indicator scope (the notch corresponds to the scan sector bisector). In the automatic tracking mode, the error signal amplifier input of the target angular coordinate unit is disconnected from the "ground" and the tracking system circuit is closed by connecting the integrator to the error signal amplifier output. The center of the tracking gates follows up the target packet center throughout the scanning sector. The position of the gate pulses is controlled by the signal voltage generated in the discriminator. The magnitude and sense of this voltage are determined by the direction of the misalignment and the value of the enveloping packet center with reference to the center of the gate pulses. When the range target automatic tracking is switched on, the manual tracking handwheel of unit И 61 is disconnected from the control circuit by means of the electromagnetic joint. Transmission of the speed voltage to the error signal amplifier input of unit K71 is stopped and the integrator is connected to the error signal amplifier output, thus closing the circuit of the range tracking system. The error signal voltage generated by the discriminator controls the position of the gates. The error signal is proportional to the value of the mismatch between the gate joint and the target video pulse center. If the target elevation is less than 5.5^{o}, it is guided and tracked in elevation by the manual tracking operator who displaces the angular gates with the antenna being fixed. In this case, the vertical mark is obtained from the middle of the raster and aligned with the target echo mark. When the scan sector bisector reaches an elevation of 5.5^{o} the pilot switch cuts out the circuit of the stable speed drive motor winding, thus fixing the position of the elevation antenna. The total value of two voltages is fed to the AC amplifier and then to the phase detector. One of these voltages is proportional to the rotation angle of the manual tracking handwheel and the other to its derivatives (unit И 65M).

12. The DC signal from the phase detector is fed to the angular coordinate unit integrator of the target (K73). From the integrator the voltage is fed to the comparison circuit which generates the pulse characterizing the vertical mark position with respect to the station scan sector. This pulse is fed to the pulse-shaping circuit, which generates the angular gates, the command generating system pulse and the vertical mark triggering pulse. All these pulses are locked with each other. Transition to automatic target tracking is accomplished in a way similar to that in other operating modes. The coordinate unit operation in the automatic tracking mode in the case of a low altitude target does not differ from the operation with an elevation exceeding 5.5°. In this case none of the signal from the phase detector of the manual tracking unit is applied to the integrator. When the target pip crosses the center of the indicator scope, it is necessary to depress the low altitude button of И65M unit which bypasses the pilot switch. When the low altitude button is pushed the elevation antenna is controlled by the handwheel И65M unit (it may also be controlled by handwheel Е of unit И62M). After the antenna is disconnected from the pilot switch the vertical mark in the manual tracking operation will be locked to the view sector bisector.

13. Having handed over the control of the target tracking to the manual tracking operators the guidance operator sets the switch (ПРП) on the unit И32 panel in one of the extreme positions. At this time there appears on indicators Е or β the image of the horizontal mark presented by the unit determining the range of the impact point (unit И87). If the unit И87 horizontal mark is within the destruction zone the guidance operator may launch the missile of the respective channel. When determining the moment of launch the guidance operator simultaneously selects the method of guiding the missile to the target. The selected method is set in unit И62M. Prior to launching the missile by any channel the guidance operator makes sure that the launcher is synchronized (light register "synchronize" should be on) and that the missile is ready to be launched (light register "ready" should shine). The missile takeoff is indicated by light register "ready" which should go out, and the missile tracking may be judged by the motion of the slave gate and the missile echo mark. When the missile approaches the target the single command (radio /proximity/ fuse arming command) is transmitted; this is indicated by the single command red light on unit И64 which should light up. In case the launched missile does not destroy the target, the operator may launch the next missile via another channel, after making sure that the horizontal mark of unit И87 is located within the destruction zone.

14. If the station has engaged a group target the operator may launch three missiles, with six-second intervals between launchings, observing the cycle circuit operation by the lighting of the light "cycle" on unit И62M. When the launcher (with missile) is ready to be fired, the "launcher readiness" (ground) command is

fed to the P3 and P4 relays (unit И62M). The relays operate and are then blocked, thus preparing the circuit for launch. When the button "launch" is pushed, a current of +26 volts is supplied through closed contacts 3 and 4 of relay P4 to the winding of relay P9, blocking through the return elements (button "return") and the normally closed contact of relay P10. When the combat operation command is sent, P1 and P2 of unit И 64 operate causing their contact to close. After relay P9 of unit И62M is energized, command "ground" is fed to the command transmitter system to change over the transmitter operation from the dummy to the antenna proper. Another current of +26 volts is applied via contacts 7,8,9, and 10 of unit И 62M (relay P9) to the AA van (command "launch") and, via relay winding (relay 168) of the ОП control desk. In this way the command "ignition" pass circuit is preapred. When the command transmitter is changed over to the antenna, +26 volts are fed to the P3 relay winding of unit И 64 making contacts 1, 2 close. Through these contacts the +26-volt current (ignition) is fed to the ОП control desk, and after successively flowing across the normally opened contacts of the "launch" relay, the signal ready blocking relay (relay 164), and the synchronization signal blocking relay (relay 163), is finally fed to the launchers in the form of command "launch".

15. After the missile has left the launcher, transmission of command "launcher readiness" to relays P4 and P3 of unit И62M is discontinued. The circuit is returned to the initial position by means of the return elements either automatically (when +26 volts are supplied from the command generating system time mechanism to relay P10 winding) or mechanically by button return. Prior to launching the missile the K72 missile range coordinate unit operates in the slave gate setting mode. The integrator is connected to the output of the slave gate setting circuit generating the voltage which provides the necessary fixed delay in the variable delay circuit. Thus, in the slave gate setting mode the tracking gates occupy the definite initial position. Unit K72 is changed over to the automatic tracking operating condition automatically with the help of the lock-on circuit at the moment the missile passes the point corresponding to the initial position of the range tracking gates. When the "launch" button of unit И62M is pressed, command "launch" is fed to the lock-on circuit. Five seconds after missile launch (missile independent flight time) the lock-on circuit is ready to lock-on the missile. After the missile signal is aligned with the second tracking gate, the discriminator generates the voltage to switch on the lock-on circuit. The latter feeds the command for switching on the automatic gain control circuit of the receiver and transfers the unit to the automatic tracking mode. One-half second later the lock-on circuit transmits the command for switching on the angular unit automatic tracking control and the command for switching the radio control which, in turn, switches the rotation mechanism in the command generating device and connects the command generating system output to the command transmitter input. Simultaneously the delay circuit (3.3 seconds) is triggered which sends the command to switch over the bands of

the angular unit and the range tracking system as well as to change the angular system from wide to narrow gates. Prior to launch of the missile, coordinate units (like the range unit) operate in the slave setting mode. The tracking system circuit is open at this time, the integrator input is grounded through the low value resistor and fixed voltage makes it possible to set the tracking gate center on the bisector of the scan sector. In the slave gate setting operation mode the width of the two tracking gates occupies the scan sector of the station. After the command for switching on the automatic tracking operation mode is received from unit K72, the tracking system circuit closes and the gates follow the missile signal.

16. In addition to the combat operating mode, the station may operate in the monitoring operating mode needed during operation monitoring, periodical inspection, maintenance, etc. Unlike the combat operation, in this operation mode the launch command is not fed to the launchers, the station centralized monitoring simulating equipment is connected and independent equipment tests may be performed for individual vans.

Comment:

1. This listing of equipment is essentially as received. Adequate punctuation between items was lacking in the original.

Attachment

CONTROL BOARDS

THE STATION CONTROL BOARDS CONCENTRATE THE CONTROLS AND INSTRUMENTS ENABLING TO CHECK THE STATION EQUIPMENT READINESS FOR CENTRALISED SWITCHING TO SWITCH ON AND OFF THE STATION AND TRANSMITTER IN A CENTRALISED WAY TO SET COMBAT AND MONITORING OPERATION MODES OF THE STATION TO PRESENT THE PERMISSION FOR INDEPENDENT MONITORING OF THE CABINS, TO PERFORM THE CENTRALISED FUNCTIONAL MONITORING OF VIDEO CHANNEL, PIK, TO SELECT THE NEEDED GUIDANCE METHOD, TO LAUNCH MISSILES, TO RETURN THE COORDINATE UNITS OF THE MISSILE AND COMMAND GENERATING SYSTEM TO INITIAL STATE. FRONT PANELS OF UNIT M66A, M64, M62M MOUNTED IN THE GUIDANCE CABINET OF CABIN YA ARE USED AS CONTROL DESKS. THE FOLLOWING DEVICES ARE MOUNTED ON THE FRONT PANEL OF UNIT M66A: THE STATION AND TRANSMITTER SWITCHES, SIGNALLING DEVICE, IN THE FORM OF LAMP REGISTERS AND PILOT LAMPS INDICATING THE READINESS OF THE STATION TO BE SWITCHED ON FROM THE REMOTE CONTROL UNIT READINESS OF THE STATION AND THE TRANSMITTER POWER SUPPLY UNITS. STATION LOUD SPEAKING COMMUNICATION SWITCHES AND CONTROLS -- TELEPHONE KEYS ENABLING TO SWITCH THE YA CABIN TELEPHONE SETS OF ANY CABIN, POWER PLANTS AND LAUNCHERS WITHOUT A SWITCH BOARD. THE SWITCH PROVIDING APPLICATION ACCOMMAND ABOUT PREPARATION OF THIS PLANT OR THAT NUMBER OF LAUNCHERS, PREPARATION OR READINESS OF LAUNCHERS IS INDICATED ON THIS DESK BY THE PILOT LAMPS. THE SWITCH CHANGING OVER THE GUIDANCE STATION TRANSMISSION FROM THE EQUIVALENT ANTENNA TO THE ANTENNA PROPER. LOCATED ON THE FRONT PANEL OF UNIT M64 ARE THE FOLLOWING: -- DEVICES ALLOWING THE STATION TO BE CHANGED OVER TO COMBAT OPERATION OR CENTRALISED MONITORING OPERATING MODE AND ALSO TO CHANGE OVER SOME CABINS TO LOCAL MONITORING OPERATING MODE. -- CONTROLS AND INSTRUMENTS PROVIDING CENTRALISED

Attachment

MONITORING OF THE STATION VIDEO CHANNEL AND CONTROL COMMAND TRANSMITTER EQUIPMENT. ON THE 1162M UNIT FRONT PANEL ARE LOCATED: -- ANGULAR AND RANGE GUIDANCE HANDWHEELS -- CONTROLS OF LAUNCH AND RETURN COMMANDS APPLIED THROUGH THREE CHANNELS OF THE MISSILE COORDINATE UNITS AND COMMAND GENERATING SYSTEM WITH THE RESPECTIVE SIGNALLING. -- GUIDANCE METHOD SELECTORS. --ON--OFF SWITCH BUTTONS OF SYNCHRONIZING THE LAUNCHER WITH SIGNALLING. --THE STATION RANGE AND BAND SELECTOR SWITCH. --ON AND OFF SWITCHES OF THE TRANSMITTER INSTANTANEOUS AUTOMATIC GAIN CONTROL WITH SIGNALLING SYSTEM. BESIDES ON UNIT 1162M FRONT PANEL ARE LOCATED SCALES OF INDICATING SELSYNS SHOWING THE POSITION OF THE STATION AND LAUNCHERS VIEW SECTOR BISECTOR AND A LAUNCHER INDICATION SWITCH.

START CONTROL SYSTEM. IN CABIN YA OF THE PCHA-75M STATION ARE LOCATED ON ON CONTROL DESK AND THE PU-A UNIT OF THE CA-75M BATTALLION MISSILE BATTERY. THESE UNITS REPRESENTS A PART OF THE START CONTROL SYSTEM. ANTI AIRCRAFT GUIDED MISSILE START CONTROL SYSTEM AUTOMATICALLY PERFORMS THE REMOTE CONTROL OF THE PREPARATORY AND STARTING OPERATIONS. THE START CONTROL SYSTEM PROVIDES: FIRING MISSILES FOR SIX LAUNCHERS CONTINUOUSLY MAINTAINING COMBAT READINESS OF TWO ALLOWANCES ATTACHED TO THE MISSILE BATTERY, BRINGING THE MISSILE MOUNTED ON THE LAUNCHERS TO FIRING READINESS WITHIN TWO MINUTES WITH SIMULTANEOUS TRANSITION OF LAUNCHERS FROM LOADING ANGLE TO ANY ANGLE REQUIRED FOR FIRING AT THE TARGET, PERFORMING OF THE LAUNCH OF A MISSILE WITHIN THE TIME NOT EXCEEDING 2 SECONDS AFTER THE LAUNCH COMMAND IS APPLIED, PRESENTING SIGNALS TO THE GUIDANCE OPERATOR'S CONTROL DESK TO PROVIDE SIGNALLING ABOUT COMBAT READINESS OF THE MISSILES AND LAUNCHERS AND READINESS OF THE MISSILE BATTERY CONTROL CHANNEL FOR FIRE,

SECRET

PRESENTING SIGNALS WARNING THE LAUNCHER SERVICING CREW TWO MINUTES PRIOR TO THE LAUNCH ABOUT THE BEGINNING OF PREPARATION OF THE MISSILE FOR LAUNCH.

STATION OPERATING CONDITIONS. STATION MAIN COMBAT OPERATING CONDITIONS ARE THE FOLLOWING: SEARCH FOR AND DETECTION OF THE TARGET, GUIDANCE OF VIEW SECTOR BISECTOR AND RANGE GATES AT THE TARGET, TARGET TRACKING (MANUAL AND AUTOMATIC TRACKING), START AND AUTOMATIC TRACKING OF THE MISSILE LAUNCHED. TARGET DETECTION AT LONG RANGE IS CARRIED OUT WHEN THE STATION OPERATES AT 1250 CPS REPETITION FREQUENCY. UNDER THIS CONDITION THE TRANSMITTER TRIGGERING PULSES OF 1250 CPS ARE PRESENTED FROM THE STATION SYNCHRONIZER AND THE RECEIVING CHANNEL PASS BAND GETS NARROW UP TO 3 -- 4 MC/S. THE VIEW SECTOR BISECTOR IS DIRECTED TO THE TARGET BY MEANS OF HANDWHEELS AND OF THE GUIDANCE UNIT (И 62М). IN THIS OPERATING CONDITION BY MEANS OF A PAIR OF SELSYNS (TRANSMITTING AND RECEIVING) OPERATING AS A TRANSFORMER THE HAND WHEEL ROTATION IS TRANSFORMED INTO ERROR SIGNAL VOLTAGE PROCESSED BY THE SYNCHRO DRIVES (И 62М AND И 65М. THE STABLE SPEED DRIVE IMPARTING THE EFFORT TO THE OUTPUT SHAFT CONNECTED WITH THE RECEIVING SELSYN IS USED AS DRIVES. THE TRACKING DRIVE OUTPUT SHAFT CARRIES THE TRANSMITTING SELSYNS WHOSE TURNING ANGLE IS FOLLOWED UP BY THE ANTENNA POWER #####SYNCHRO DRIVE. IN THIS CASE THE ANTENNA ARE CONTROLLED ONLY IN POSITION. WHEN THE TARGET APPEARS WITHIN THE STATION VIEW SECTOR THE TARGET MARK SHOULD BE OBSERVED ON THE GUIDANCE INDICATOR SCREENS. IN THE GUIDANCE OPERATENG MODE THE INDICATOR VERTICAL MARKS ARE LOCKED WITH THE VIEW SECTOR BISECTOR. ALIGNMENT OF VERTICAL MARKS OF THE GUIDANCE INDICATORS (IN THE PLANES ε AND β) WITH THE MIDDLE

OF THE TARGET MARK INDICATES THAT THE VIEW SECTOR BISECTOR HAS BEEN GUIDED TO THE TARGET. IN THIS CASE THE CIRCUIT OF THE TARGET ANGULAR COORDINATE UNIT SERVO SYSTEM (UNIT K73) IS OPENED. THE INTEGRATOR INPUT IS EARTHED VIA SMALL VALUED RESISTOR. VOLTAGE FIXED VALUE CORRESPONDING TO THE POSITION OF THE TRACKING GATES IN THE CENTER OF THE VIEW SECTOR IS PRESENTED FROM THE INTEGRATOR OUTPUT. THE GATES ARE SET PRECISELY IN THE CENTRE OF THE SECTOR BY CABIN ↘A OPERATOR BY COMPARING THE POSITION OF THE VERTICAL MARKS FROM THE COORDINATE UNITS WITH THE POSITION OF THE VERTICAL MARKS FROM THE INDUCTION ANTENNA TRANSMITTER ON THE MANUAL TRACKING INDICATOR SCREENS.

Attachment

THE INDUCTION TRANSMITTER PULSE CORRESPONDS TO THE MIDDLE OF VIEW SECTOR. RANGE GUIDANCE IS PERFORMED BY MEANS OF HANDWHEEL Δ OF UNIT И62М. THE HANDWHEEL IS COUPLED WITH THE POTENTIOMETER WHOSE VOLTAGE IS FED TO THE VARIABLE DELAY CIRCUIT OF THE OPENED RANGE TRACKING SYSTEM (К71). IN THIS THE INTEGRATOR IS EARTHED VIA A SMALL VALUED RESISTOR. WHEN MATCHING HORIZONTAL MARK WITH THE ECHO BLIP THE GUIDANCE OPERATOR BY VARYING THE VOLTAGE LEVEL, CHANGES THE PULSE TIME POSITION THUS GUIDING THE TRACKING GATES TO THE TARGET. IF THE TARGET AZIMUTH IS KNOWN ONLY APPROXIMATELY THEN THE TARGET IS DETECTED BY A SECTOR SEARCH METHOD. I THIS CASE THE STATION VIEW SECTOR IS SWINGING IN AZIMUTH WITHIN AN ANGLE OF $\pm$ 20°. BESIDES IT IS POSSIBLE TO MOVE SWINGING CENTRE THROUGHOUT 360°. THE AZIMUTH SYNCHRO DRIVE (И63М) IN THIS CASE ACTS ACCORDING TO THE SUM OF TWO VOLTAGES: MISMATCHING VOLTAGE BETWEEN THE GUIDANCE TRANSMITTING SELSYN (И62М) AND THE RECEIVING SELSYN (И63М) ,-- VOLTAGE MODULATED SINUSOIDALLY OBTAINED FROM THE UNIT И62М SECTOR SEARCH ROTATING SELSYN.

IN THE CASES WHEN THERE IS NO DATA ABOUT THE DIRECTION IN WHICH THE TARGET ENTERS THE STATION EFFECTIVE ZONE, USE IS MADE OF A CIRCULAR SEARCH METHOD. IN THIS CASE CONSTANT AMPLITUDE VOLTAGE DRIVING ANTENNA TRANSMITTERS AND CABIN ПАА TO ROTATE CLOCKWISE WITH THE SPEED OF 16 DEGREE PER SECOND, IS FED TO THE STABLE SPEED DRIVE OF UNIT И63М. AFTER THE TARGET IS DETECTED AND THE STATION VIEW SECTOR BISECTOR IS ALIGNED WITH IT THE GUIDANCE OPERATOR PRESENTS THE COMMAND (BY PUSHING THE BUTTON) TO THE LAUNCHERS TO SYNCHRONISE THEM WITH THE ANTENNA SYSTEM. AFTER THE TARGET REACHES THE REQUIRED RANGE THE ANTENNA CONTROL

IS HANDED OVER TO THE MANUAL TRACKING OPERATORS WHO TRACKS THE TARGET BY DISPLACING THE VIEW SECTOR KEEPING THE TARGET MARK AT THE ELECTRONIC MARK CROSS LINES. WHEN THE TARGET APPROACHES A POINT OF A SHORTER LINE RANGE, THE GUIDANCE OPERATOR STARTS OPERATING IN A MODE CONSISTING IN THE OPERATION WITH 2500 CPS REPETITION FREQUENCY AND WITH THE TARGET RECEIVING CHANNEL PASSBAND EQUAL TO 4.5 -- 6 Mc/s. IN THE MANUAL TRACKING MODE THE VERTICAL MARK IS ALSO LOCKED WITH THE STATION VIEW SECTOR BISECTOR. IN THE PRESENT CASE APPLIED TO THE INPUT OF THE STABLE SPEED DRIVE ARE THE SUMMARY VALUE OF THE FOLLOWING TWO VOLTAGES THE VOLTAGE PROPORTIONAL TO A TURNING ANGLE OF THE MANUAL TRACKING UNIT HANDWHEEL AND THAT PROPORTIONAL TO THE DERIVATIVE OF THIS ANGLE. SUCH A CIRCUIT PROVIDES TARGET TRACKING IN SPEED AND IN POSITION. THE ANGULAR COORDINATE UNIT OPERATION IN THE MANUAL TRACKING MODE DOES NOT DIFFER FROM THAT IN THE GUIDANCE OPERATING CONDITION EXCEPT FOR THE FACT THAT THE LOW VALUED RESISTOR COUPLING THE INTEGRATOR INPUT WITH THE CHASSIS INCREASES IN VALUE. WHEN A PREVIOUS OPERATION MODE IS CHANGED OVER TO THE TARGET RANGE MANUAL TRACKING OPERATION MODE THE GUIDANCE VOLTAGE IS NO LONGER APPLIED TO THE OPEN TRACKING SYSTEM AND THE INTEGRATOR IS DISCONNECTED FROM THE "GROUND". THE RANGE TRACKING OF THE TARGET IS CARRIED OUT IN SPEED AND IN POSITION BY MEANS OF UNIT N61 HANDWHEEL. THE HANDWHEEL ROTATING ACTION IS IMPARTED TO THE POTENTIOMETER FROM WHICH SPEED VOLTAGE IS TAKEN AND FED TO THE ERROR SIGNAL AMPLIFIER OF UNIT K71. THE POSITION VOLTAGE IS OBTAINED FROM THE SAME POTENTIOMETER AND THROUGH THE CAPACITOR IS INTRODUCED INTO THE INTEGRATOR CIRCUIT. THE OPERATOR CONTROLS THE RANGE PULSE POSITION BY ALIGNING THE MANUAL

TRACKING HORIZONTAL MARK WITH THE TARGET ECHO MARK (THE RANGE SWEEP SCALE BEING 60 KM). IN CASE 5 KM SWEEP SCALE IS SET THE OPERATOR KEEPS THE TARGET MARK BETWEEN TWO HORIZONTAL MARK.

UNDER INTERFERENCE FREE CONDITION THE MANUAL TRACKING OPERATORS MAY SWITCH ON THE AUTOMATIC TRACKING WHEN THE VERTICAL MARK WILL BE LOCKED WITH THE CENTRE OF THE ECHO MARK. THE MANUAL TRACKING OPERATORS CONTROLS THE VIEW SECTOR POSITION IN ELEVATION AND AZIMUTH SO THAT THE VERTICAL MARK IS ALIGNED WITH THE NOTCHED MARK ON THE INDICATOR SCREEN (THE NOTCH CORRESPONDS TO THE VIEW SECTOR BISECTOR). IN AUTOMATIC TRACKING MODE THE ERROR SIGNAL AMPLIFIER INPUT OF THE TARGET ANGULAR COORDINATE UNIT IS DISCONNECTED FROM THE "GROUND" AND THE TRACKING SYSTEM CIRCUIT IS CLOSED BY CONNECTING THE INTEGRATOR TO THE ERROR SIGNAL AMPLIFIER OUTPUT. THE CENTER OF THE TRACKING GATES FOLLOWS UP THE TARGET PACKET CENTRE THROUGHOUT THE SCANNING SECTOR. THE POSITION OF GATE PULSES IS CONTROLLED BY MEANS OF THE SIGNAL VOLTAGE GENERATED IN THE DISCRIMINATOR. THE MAGNITUDE AND SENSE OF THIS VOLTAGE ARE DETERMINED BY THE MISALIGNMENT DIRECTION AND VALUE OF THE ENVELOPING PACKET CENTER WITH REFERENCE TO THE CENTRE OF THE GATE PULSES. WHEN THE RANGE TARGET AUTOMATIC TRACKING IS SWITCHED ON UNIT И61 MANUAL TRACKING HANDWHEEL IS DISCONNECTED FROM CONTROL CIRCUIT BY MEANS OF THE ELECTROMAGNETIC JOINT. APPLICATION OF THE SPEED VOLTAGE TO THE ERROR SIGNAL AMPLIFIER INPUT OF UNIT K71 IS STOPPED AND THE INTEGRATOR IS CONNECTED TO THE ERROR SIGNAL AMPLIFIER OUTPUT THUS CLOSING THE CIRCUIT OF THE RANGE TRACKING SYSTEM. ERROR SIGNAL VOLTAGE GENERATED BY THE DISCRIMINATOR CONTROLS POSITION OF THE GATES. THE ERROR SIGNAL IS PROPORTIONAL TO THE VALUE OF MISMATCH BETWEEN THE GATE JOINT AND THE TARGET VIDEO PULSE CENTER. IF THE TARGET ELEVATION IS LESS THAN 5.5° THEN IT IS GUIDED AND TRACKED IN ELEVATION

BY THE MANUAL TRACK OPERATOR WHO DISPLACES ANGULAR GATES WITH THE ANTENNA BEING FIXED. IN THIS CASE THE VERTICAL MARK IS OBTAINED FROM THE MIDDLE OF THE RASTER AND ALIGNED WITH THE TARGET ECHO MARK. WHEN THE VIEW SECTOR BISECTOR REACHED 5.5° ELEVATION THE PILOT SWITCH CUTS OUT THE CIRCUIT OF THE STABLE SPEED DRIVE MOTOR WINDING THUS FIXING THE POSITION OF THE ELEVATION ANTENNA. THE TOTAL VALUE OF TWO VOLTAGES IS FED TO THE AC AMPLIFIER AND THEN TO THE PHASE DETECTOR. ONE OF THESE VOLTAGES ##########PROPORTIONAL TO MANUAL TRACKING HANDWHEEL TURN ANGLE AND THE OTHER TO ITS DERIVATIVES (UNIT Н65М).

Attachment

THE DC SIGNAL FROM PHASE DETECTOR IS APPLIED TO ANGULAR COORDINATE UNIT INTEGRATOR OF THE TARGET (K73). FROM THE INTEGRATOR THE VOLTAGE IS PRESENTED TO THE ##### COMPARISON CIRCUIT GENERATING THE PULSE CHARACTERIZING THE VERTICAL MARK POSITION WITH RESPECT TO THE STATION VIEW SECTOR. THIS PULSE IS FED TO THE PULSE SHAPING CIRCUIT GENERATING ANGULAR GATES, COMMAND GENERATING SYSTEM PULSE AND VERTICAL MARK TRIGGERING PULSE. ALL THESE PULSES ARE LOCKED WITH EACH OTHER. TRANSITION TO THE TARGET AUTOMATIC TRACK IS ACCOMPLISH IN SIMILAR WAY TO THAT KNOWN IN OTHER OPERATING MODES. THE COORDINATE UNIT OPERATION IN THE AUTOMATIC TRACKING MODE IN THE CASE OF LOW FLYING TARGET DOES NOT DIFFER FROM THE OPERATION WITH ELEVATION EXCEEDING 5.5°. IN THIS CASE NONE OF THE SIGNAL FROM THE PHASE DETECTOR OF MANUAL TRACKING UNIT IS APPLIED TO THE INTEGRATOR. WHEN THE TARGET PIP CROSSES THE INDICATOR SCREENS CENTER IT IS NECESSARY TO DEPRESS UNIT И 65М LOW ALTITUDE BUTTON WHICH BYPASSES THE PILOT SWITCH. WHEN THE LOW ALTITUDE BUTTON IS PUSHED THE ELEVATION ANTENNA IS CONTROLLED FROM UNIT И65М HANDWHEEL (IT MAY ALSO BE CONTROLLED BY HANDWHEEL Е OF UNIT И 62М). AFTER THE ANTENNA IS DISCONNECTED FROM THE PILOT SWITCH THE VERTICAL MARK IN THE MANUAL TRACK OPERATION WILL BE LOCKED TO THE VIEW SECTOR BISECTOR. HAVING HANDED OVER THE CONTROL OF THE TARGET TRACKING TO THE MANUAL TRACKING OPERATORS THE GUIDANCE OPERATOR SET SWITCH ##### (ПРП) ON UNIT И32 PANEL IN ONE OF THE EXTREME POSITIONS. AT THIS TIME ON INDICATORS Е OR β APPEARS THE IMAGE OF THE HORIZONTAL MARK PRESENTED BY THE UNIT DETERMINING THE RANGE OF THE IMPACT POINT (UNIT И87). IF UNIT И87 HORIZONTAL MARK IS WITHIN THE DESTRUCTION ZONE THEN THE GUIDANCE OPERATOR MAY LAUNCH THE MISSILE OF THE RESPECTIVE CHANNEL. DETERMINING THE LAUNCH MOMENT THE GUIDANCE OPERATOR SIMULTANEOUSLY

(10)

Attachment

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SELECTS THE METHOD OF GUIDING THE MISSILE TO THE TARGET. THE SELECTED METHOD IS SET IN UNIT И62М. PRIOR TO LAUNCHING THE MISSILE THE GUIDANCE OPERATOR BY ANY CHANNEL MAKES SURE THAT THE LAUNCHER IS SYNCHRONISED (LAMP REGISTER "SYNCHRONISE" SHOULD LIGHT.) AND THE MISSILE IS READY TO BE LAUNCHED (LAMP REGISTER "READY" SHOULD SHINE). THE MISSILE TAKE OFF IS INDICATED BY LAMP REGISTER READY WHICH SHOULD GO OUT AND THE MISSILE TRACKING MAY BE JUDGED BY MOTION OF SLAVE GATE AND MISSILE ECHO MARK. WHEN THE MISSILE APPROACHES THE TARGET THE SINGLE COMMAND IS PRESENTED (RADIO FUSE ARMING COMMAND) THAT IS INDICATED BY THE SINGLE COMMAND RED LAMP ON UNIT И64 WHICH SHOULD LIGHT UP. IN THE CASE THE LAUNCHED MISSILE HAS NOT DESTROYED THE TARGET THE [redacted] OPERATOR MAY LAUNCH THE NEXT MISSILE VIA ANOTHER CHANNEL PRELIMINARY MAKING SURE THAT THE HORIZONTAL MARK OF UNIT И87 IS LOCATED WITHIN THE DESTRUCTION ZONE. IF THE STATION IS ENGAGED WITH A [redacted] GROUP TARGET THE OPERATOR MAY LAUNCH THE THREE MISSILES WITHIN SIX SECONDS INTERVAL BETWEEN LAUNCHINGS OBSERVING THE CYCLE CIRCUIT OPERATION BY LIGHTNING OF LAMP "CYCLE" ON UNIT И62М. THE MISSILE START SWITCHING DIAGRAM IS ON FIG 31. WHEN THE LAUNCHER WITH MISSILE IS READY TO BE FIRED COMMAND " LAUNCHER READINESS" (GROUND) IS PRESENTED TO THE RELAY P3 AND P4 (UNIT И62М). AFTER THAT THE RELAYS OPERATE AND THEN THEY ARE BLOCKED THUS PREPARING THE CIRCUIT FOR PERFORMING THE LAUNCH. WHEN THE BUTTON "START" IS PUSHED +26 V VOLTAGE THROUGH CLOSED CONTACTS 3, 4 OF RELAY P4 SUPPLIED TO THE WINDING OF RELAY P9 BLOCKING THROUGH THE RETURN ELEMENTS (BUTTON "RETURN) AND NORMALLY CLOSED CONTACT OF RELAY P10. WHEN THE COMBAT OPERATION COMMAND IS APPLIED P1 AND P2 OF UNIT И64 OPERATE MAKING THEIR CONTACT CLOSE.

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AFTER RELAY P9 OF UNIT И62М IS ENERGIZED COMMAND "GROUND" IS FED TO THE COMMAND TRANSMITTER SYSTEM TO CHANGE OVER THE TRANSMITTER OPERATION FROM THE DUMMY ANTENNA TO ANTENNA PROPER. APART FROM THAT A VOLTAGE OF +26 V VIA CONTACTS 7, 8, 9, 10 OF UNIT И62М (RELAY P9) IS APPLIED TO CABIN AA (COMMAND "START") AND VIA RELAY P2 CONTACT (UNIT И64) THE START COMMAND IS APPLIED TO THE START RELAY WINDING (RELAY 168) OF THE ОП CONTROL DESK. IN THIS WAY COMMAND "IGNITION" PASS CIRCUIT IS PREPARED. WHEN THE COMMAND TRANSMITTER IS CHANGED OVER TO THE ANTENNA +26 VOLTAGE IS FED TO THE P3 RELAY WINDING OF UNIT И64 MAKING CONTACTS 1, 2 ARE CLOSED. THROUGH THESE CONTACTS +26 V VOLTAGE (IGNITION) IS FED TO ОП CONTROL DESK THEN SUCCESSIVELY FLOWS ACROSS NORMALLY OPENED CONTACTS OF RELAY "START", SIGNAL READY BLOCKING RELAY (RELAY 164) SYNCHRONIZATION SIGNAL BLOCKING RELAY (RELAY 163) AND IN THE FORM OF COMMAND "LAUNCH" +26 V IS FED TO THE LAUNCHERS.

AFTER THE MISSILE HAS TAKEN OFF APPLICATION OF COMMAND "LAUNCHER READINESS" TO RELAYS P4, P3 OF UNIT И62М IS CEASED. THE CIRCUIT IS RETURNED TO THE INITIAL POSITION BY MEANS OF THE RETURN ELEMENTS EITHER AUTOMATICALLY (WHEN +26 V VOLTAGE IS SUPPLIED FROM THE COMMAND GENERATING SYSTEM TIME MECHANISM TO RELAY P10 WINDING) OR MECHANICALLY BY BUTTON RETURN. PRIOR TO THE LAUNCHING OF THE MISSILE THE K72 MISSILE RANGE COORDINATE UNIT OPERATES IN SLAVE GATE SETTING MODE. IN THIS CASE THE INTEGRATOR IS CONNECTED TO THE OUTPUT OF THE SLAVE GATE SETTING CIRCUIT GENERATING THE VOLTAGE PROVIDING A NECESSARY FIXED DELAY IN THE VARIABLE DELAY CIRCUIT. THUS IN THE SLAVE GATE SETTING MODE THE TRACKING GATES OCCUPY THE DEFINITE INITIAL POSITION. UNIT K72 IS CHANGED OVER TO THE AUTOMATIC TRACK OPERATING CONDITION AUTOMATICALLY WITH THE HELP OF THE LOCK ON CIRCUIT

AT THE MOMENT WHEN THE MISSILE PASSES THE POINT CORRESPONDING TO THE INITIAL POSITION OF THE RANGE TRACKING GATES. WHEN UNIT И62М BUTTON START IS PRESSED COMMAND START IS APPLIED TO THE LOCK ON CIRCUIT. FIVE SECONDS AFTER THE MISSILE TAKE OFF (THE MISSILE INDEPENDENT FLIGHT TIME) THE LOCK ON CIRCUIT IS READY TO LOCK ON THE MISSILE. AFTER THE MISSILE SIGNAL IS ALIGHNED WITH SECOND TRACKING GATE THE DISCRIMINATOR GENERATES THE VOLTAGE SWITCHING ON THE LOCK ON CIRCUIT. THE LATTER PRESENTS THE COMMAND FOR SWITCHING ON THE AUTOMATIC GAIN CONTROL CIRCUIT OF THE RECEIVING DEVICE AND TRANSFER THE UNIT TO THE AUTOMATIC TRACKING MODE. 0.5 SEC LATER THE LOCK ON CIRCUIT PRESENTS THE COMMANDS FOR SWITCHING ON THE ANGULAR UNIT AUTOMATIC TRACKING CONTROL AND THE COMMAND FOR SWITICHING THE RADIO CONTROL WHICH IN TURN SWITCHES THE TWISTING MECHANISM IN THE COMMAND GENERATING DEVICE AND CONNECTS THE COMMAND GENERATING SYSTEM OUTPUT TO THE COMMAND TRANSMITTER INPUT. SIMULTANEOUSLY THE DELAY CIRCUIT (3.3 SEC) IS TRIGGERED WHICH PRESENTS THE COMMAND TO SWITCH OVER THE BANDS OF THE ANGULAR UNITS AND RANGE TRACKING SYSTEMS AS WELL AS TO CHANGE OVER TO THE ANGULAR SYSTEM FROM WIDE TO NARROW GATES. PRIOR TO THE START OF THE MISSILE COORDINATE UNITS (LIKE THE RANGE UNIT) OPERATEIN THE SLAVE SETTING MODE. THE TRACKING SYSTEM CIRCUIT IS OPEN AT THIS TIME, THE INTEGRATOR INPUT IS CONNECTED TO THE GROUND THROUGH THE SMALL VALUED RESISTOR AND FIXED VOLTAGE OBTAINED FROM THE DIVIDER IS FED TO ITS OUTPUT. THIS VOLTAGE MAKE IT POSSIBLE TO SET THE TRACKING GATE CENTRE ON THE BISECTOR OF THE VIEW SECTOR. IN THE SLAVE GATE SETTING OPERATION MODE THE WIDTH OF THE TWO-TRACKING GATES OCCUPIES THE VIEW SECTOR OF THE STATION. AFTER THE COMMAND FOR SWITCHING ON THE AUTOMATIC TRACKING OPERATION MODE IS RECEIVED FROM UNIT K72, THE TRACKING SYSTEM CIRCUIT CLOSES

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Attachment [redacted]

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AND THE GATES FOLLOW THE MISSILE SIGNAL. APART FROM THE COMBAT OPERATING MODE THE STATION MAY OPERATE IN THE STATION MONITORING OPERATING MODE NEEDED FOR OPERATION MONITORING PERIODICAL INSPECTION AND MAINTENANCE ETC. UNLIKE THE COMBAT OPERATION IN THIS OPERATION MODE THE START COMMAND IS NOT APPLIED TO THE LAUNCHERS, THE STATION CENTRALISED MONITORING SIMULATING EQUIPMENT IS CONNECTED AND INDEPENDENT EQUIPMENT TEST MAY BE ALLOWED FOR SEPARATE CABINS.

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