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DIA review(s) completed.

TU-16 AIRCRAFT

AIRCRAFT SERVICE MANUAL

Book II

Navigation Equipment, Autopilot, Oxygen, Electrical, Photo, and Radio Equipment

GROUP 1
Excluded from automatic downgrading and declassification

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TU-16 AIRCRAFT SERVICE MANUAL

Book Two

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TV–16 AIRCRAFT SERVICE MANUAL

Book Two

Navigation Equipment. Autopilot. Oxygen, Electrical, Photo, and Radio Equipment

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CONTENTS

The book contains 261 pages.
Besides, there are seven inserts on seven sheets, and figures on forty three sheets at the end of the book.

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The Aircraft Service Manual comprises three books:

Book One includes: aircraft ground servicing; care and maintenance of airframe, emergency and rescue equipment, aircraft control system, landing gear, hydraulic systems, power plants, high-altitude equipment; packing and shipment of aircraft.

Book Two includes: care and maintenance of navigation equipment, autopilot, oxygen, electrical, photo, and radio equipment.

Book Three includes: care and maintenance of bombing equipment.

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NAVIGATION EQUIPMENT AND ENGINE INSTRUMENTS

GENERAL

1. The navigation equipment includes:

(a) the Pitot-static system;

(b) the Pitot-static instruments, namely: type КУС-1200 airspeed (I.A.S. and T.A.S.) indicators, type ВД-20 altimeters, type ВАР-30-3 rate-of-climb indicators, type ССН-3 velocity head warning units, type МС-1 machmeters (with warning lights), type ВС-46 cabin pressure warning units, type УВИД-15 cabin altimeters;

Note: Apart from the above-listed instruments, the Pitot-static system actuates the T.A.S. transmitter belonging to the НИ-50Б air position indicator set and the altitude and speed transmitters of the ОМБ-11р optical bombsight set.

(c) the electrical instruments, namely: type ДГМК-7 and type ДАК-ДБ-5 compasses, type НИ-50Б air position indicator, type АГБ-2 gyro horizon, type ГИК-52 directional gyro, type ТУЭ-48 tachometers, type ЭУП-53 turn indicators;

(d) the autonomous instruments, namely: type КИ-12 magnetic compass, type АК-53 hand-operated astrocompass, type НАС-51 aircraft sextant, type АМ-10 accelerometer, types АЧХО and АВР-М clocks.

2. The engine instruments comprise the electric pressure gauges, thermometers, and tachometers.

The arrangement of instruments on the instrument panels is shown in Figs 1 to 7 inclusive.

PITOT-STATIC NAVIGATIONAL INSTRUMENTS

GENERAL

The instruments, types КУС-1200, ВАР-30-3, ВД-20, МС-1, ССН-3, УВИД-15, and ВС-46, are actuated by the Pitot-static pressure system.

For installation on and removal of instruments from the instrument panels refer to the Book "Repair of Aircraft".

Altimeters

Altimeters are mounted on the instrument panels of both pilots, navigator, navigator-radar operator, and radio operator, i.e. five altimeters in total.

The ВД-20 altimeters operate in the temperature range of +50 to -60°C and indicate a relative (barometric) flight altitude within the limits of 0 to 20,000 m. One full revolution of the larger pointer corresponds to 1000 m. One full revolution of the smaller pointer corresponds to 20,000 m.

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Airspeed Indicators

The KVC-1200 airspeed indicators are installed on the instrument panels of both pilots, navigator, navigator-radar operator, and radio operator. The KVC-1200 airspeed indicators function in the temperature range between +50 and -60°C and read I.A.S. from 100 to 1200 km/hr and T.A.S. from 400 to 1200 km/hr at a flight altitude ranging from 0 to 15,000 m. The scale graduation value is 10 km/hr, each 100 km/hr division being numbered.

Rate-of-Climb Indicators

The rate-of-climb indicators are mounted on the instrument panels of both the left-seat pilot and the right-seat pilot. The rate-of-climb indicators operate in the temperature range of +50 to -60°C and give the vertical component of the rate of climb or descent within the range of 0 to 30 m/sec. both towards climb or descent.

Machmeters

The machmeters are installed on the instrument panels of both the left-seat pilot and the right-seat pilot. The machmeters function in the temperature range of +50 to -60°C and read the Mach number within the limits of 0.5 to 1 at a flight altitude ranging from 0 to 18,000 m. At Mach number equal to 0.86 (the instrument is adjusted for this value) the warning lights with red light filters, mounted near the machmeters, go on. Under the warning lights there is a caption "SPEED TOO HIGH". The warning light warns the pilot that the aircraft is approaching the critical Mach number equal to 0.9 for this type of aircraft.

Velocity Head Warning Units

Two warning units are mounted on the aircraft behind the pilot s seats. The warning units operate in the temperature range of -50 to +60°C.By sending electrical signals when the velocity head of q=2300 kg/m^2 or Mach 0.86 are reached, the warning units warn the pilot that the aircraft is approaching the maximum allowable flight speed.

Limitations for velocity head q and Mach number for various flying weights versus flight altitude are given in the graph (See Fig.8).

Cabin Altimeters

Two cabin altimeters, type УВИД-15, are mounted on the instrument panels of the right-seat pilot and the radio operator.

The cabin altimeters operate in the temperature range of +50 to -60°C. They are intended to indicate the "altitude" in a pressurized cabin and the difference between the cabin pressure and the outside air.

Pitot-Static System

Schematic diagrams of Pitot and static pressure systems are shown in Figs 9 and 10.

Table 1 gives the necessary data on the connection of instruments to pressure sources.

Table 1

Connection of Instruments to Pressure Sources

Nos	Name of pressure source	Connected instruments
	On Aircraft (See Fig.9)	
1	Pitot tube, front, left-side	Type KVC-1200 airspeed indicator and type MC-1 machmeter on left-seat pilot's instrument panel; type KVC-1200 airspeed indicator on navigator's instrument panel; type CCH-3 velocity head warning unit, left-side
2	Pitot tube, rear, left-side	T.A.S. transmitter of type HM-50Б air position indicator set; speed transmitter of type ОПБ-11р optical bombsight set; type KVC-1200 airspeed indicator on operator's instrument panel
3	(Flush-type) static vent, upper, left-side	Type KVC-1200 airspeed indicator and type ВД-17 altimeter on instrument panels of navigator and operator
4	Static vent, medium, left-side	Type CCH-3 velocity head warning unit, left-side; type KVC-1200 airspeed indicator, type ВД-17 altimeter, type ВАР-30-3 rate-of-climb indicator, type MC-1 machmeter on left-seat pilot's instrument panel
5	Static vent, lower, left-side	T.A.S. transmitter of type HM-50Б air position indicator set; speed and altitude transmitters of type ОПБ-11р optical bombsight set
6	Pitot tube, right-side	Type KVC-1200 airspeed indicator and type MC-1 machmeter on right-seat pilot's instrument panel; type CCH-3 velocity head warning unit, right-side; type KVC-1200 airspeed indicator on radio operator's instrument panel
7	Static vent, lower, right-side	Type KVC-1200 airspeed indicator, type ВД-17 altimeter, type ВАР-30-3 rate-of-climb indicator, type УВИД-3 cabin altimeter on right-seat pilot's instrument panel; type CCH-3 velocity head warning unit, right-side; type ВД-17 altimeter, type УВИД-3 cabin

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Nos	Name of pressure source	Connected instrument
8	Static vent, upper, right-side	altimeter, and type KVC-1200 air-speed indicator on radio operator's instrument panel For type APA-54 automatic cabin-pressure regulator (if type APA-50 automatic cabin-pressure regulator is installed, the static pressure outlet will be blanked off)

Installation of Type K2-75 Speed and Altitude Recorder

1. Type K2-75 recorder is mounted between frames No.9 and No.10 on the right side (Fig.11).

The recorder is connected to the Pitot-static system in the following way: insert tee-piece H7705-3/8 (available in the spare parts set) between the static line and the CCH-3 velocity head warning unit, connect the recorder hose to the tee-piece.

The recorder supply hoses are connected to tee-pieces 1026A50-4 cut into static line H7702-100-22 and Pitot line H7702-29-6 (the right-seat pilot's mains).

ACCESS

There are free accesses to Pitot-static instruments mounted on instrument panels. The instrument panels of both pilots and navigator flap back thus giving access to the rear side of the instruments.

Access to the Pitot-static system line is difficult in the following places:

(a) between frames Nos 5 - 9 on both sides;

(b) between frames Nos 9 - 12 on both sides. Moisture traps for collecting moisture from the Pitot-static system are located in this section on both sides of the fuselage;

(c) in the F-3 fuselage section, starboard;

(d) in the F-4 fuselage section, starboard;

(e) in the region of frames Nos 49 - 57;

(f) in the F-6 fuselage section, starboard.

To reach the line between frames Nos 5 - 9, starboard, proceed as follows:

(a) open the access panels of the right-hand engine instrument board;

(b) remove the glass heating distribution box.

To reach the line between frames Nos 5 - 9, port, do the following:

(a) flap back the left-seat pilot's instrument panel;

(b) remove the access panels of the left-hand engine instrument board.

To reach the line between frames Nos 9 - 12, starboard:

(a) remove the thyratron interrupters from the starboard rack in the operator's cabin;

(b) remove the dynamotor of the PCB-70 aircraft radio set from the starboard rack;

To reach the line between frames Nos 9 - 12 port, remove the high-voltage rectifier of the radar bombsight.

In order to reach the line in the F-3 fuselage section, starboard, proceed as follows:

(a) open the hatch door at the bottom section of frame No.12;

(b) open the hatches of the containers of fuel tanks No.1 and No.2;

(c) remove fuel tanks No.1 and No.2;

To get at the line in the F-4 fuselage section in the region of frames Nos 27 - 34, starboard, do the following:

(a) open the hatch in the F-4 fuselage section between frames Nos 27 - 29;

(b) remove starting fuel tank H6154-120;

(c) remove air-cooler H5601-380;

(d) remove drain pipe H6152-38/1;

(e) slacken the yoke on pipe H6152-38/3 and turn the branch pipe;

(f) remove high-altitude equipment pipes H7605-0/23.5.

To reach the line in the F-4 fuselage section in the region of frames Nos 49 - 75, proceed as follows:

(a) open the hatches of the containers of fuel tanks Nos 4 and 5;

(b) remove fuel tanks No.4 and No.5;

(c) lift up the hatches in the containers of fuel tanks.

To gain access to the pipes in the F-6 fuselage section, remove the PCHV radio set equipment from the bottom section of frame No.69.

PRE-FLIGHT INSPECTION

Prior to each flight:

1. Remove protective covers with red warning flags from the Pitot tubes.

2. Take the blanking plugs out of the static vents.

3. Make visual inspection of the instrument panels (check the instruments for cover glass cracks, luminous paint for intactness, instruments for proper attachment, etc.).

4. Drain moisture from moisture traps in rainy weather.

5. Check the position of the selector cock for switching the left-seat pilot's instruments to emergency supply and the presence of safety wire with a seal on the cock. (The selector cock is installed on the left-hand engine instrument board).

The cock must be set and sealed in the NORMAL position.

Before each flight, check the efficiency of the Pitot-static system in the following manner:

1. Set the hands of two-pointer altimeters to zero and the barometric scales for the pressure check.

2. Wind up the clocks and see that they are in good repair.

3. Build up a pressure in the Pitot tubes equal to 60 - 75 mm Hg (which corresponds to a speed of 400 to 550 km/hr).

4. Connect a vacuum source of 85 - 160 mm Hg (which corresponds to an altitude of 1000 - 2000 m.) to the flush-mounted static vents.

When the Pitot-static system is serviceable the instruments will react to supply as follows:

Airspeed indicators - with pressure increase in the Pitot line the hands will rotate clockwise.

Altimeters and cabin altimeters - with vacuum increase the hands will rotate clockwise.

Rate-of-climb indicators - with vacuum increase the hands will deflect upward, while at constant vacuum of any magnitude the hands will return to zero.

5. Check to see that the CCH-3 velocity head warning unit sends a warning signal. To this end:

(a) connect in turn a pressure source of the KIV-3 test set type to the

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TM-156 Pitot tubes for both the left-hand and right-hand instrument panels of the pilots;

(b) build up a pressure in the Pitot-static system equal to 169 ± 4 mm Hg. At this the CSH-51 warning lamp will light up on a respective panel of the pilot.

6. Check to see that the MC-1 machmeter sends a warning signal. To this end:

(a) disconnect the impact pressure lines from the CCH-3 velocity head warning units; blank off the pipe line ends;

(b) connect in turn a pressure source of the KIV-3 test set type to the TM-156 Pitot tubes for both the left-hand and right-hand instrument panels of the pilots;

(c) build up a pressure in the Pitot-static system equal to 473 ± 19 mm Hg. At this the warning lamp will light up on the pilot's instrument panel, whereas the MC-1 machmeter needle will be on the red line.

Note: If atmospheric pressure does not equal to 760 mm Hg, then during the check create a pressure of 760 mm Hg in the static system.

PROBABLE TROUBLES OF NAVIGATIONAL INSTRUMENTS AND THEIR REMEDIES

The Pitot-static system troubles include:

(a) unserviceable condition of Pitot-static instruments;

(b) leakage or clogging of the Pitot-static system proper.

To draw a conclusion on good or bad repairs of an instrument, if obvious defects are not available, check the instrument as indicated below.

Leakage of the Pitot-static system is eliminated by tightening the nipple joints and replacing the rubberized hoses (in case the latter are worn out). Clogging is eliminated by blowing the system.

Checking the Instruments

Altimeter

The altimeter check-up includes visual inspection of the instrument, checking its readings for errors and its case for tightness. The altimeter case tightness and the errors in altimeter readings can be checked in situ by means of the KIV-3 test set and master mercury barometer.

To check the altimeter, proceed as follows:

(a) set the pointers of both the master barometer and the altimeter under test to zero;

(b) disconnect the altimeter to be checked from the aircraft static pressure line and join it to a tee-piece connected with one end to the master barometer (Fig.12) and with the other end to the KIV-3 test set;

(c) using the KIV-3 test set, create a rarefaction in the altimeter corresponding to definite altitudes as read off the master barometer. Take into account the altimeter instrumental corrections;

(d) record the readings of the altimeter under test in the check list and compute the errors. In doing so, take into consideration the corrections of the master mercury barometer;

(e) compare the obtained corrections of the altimeter under test with the corrections entered into the altimeter correction card.

If these corrections vary, compile a new correction card and use it in flights.

The altimeter admissible errors (total instrumental errors) are given in the altimeter Certificate. If during the altimeter check it is found out that the

altimeter errors exceed the maximum permissible values, the instrument should be replaced by a new one and the defective altimeter should be sent for adjustment to a special workshop.

After the errors and the instrument case tightness have been checked, check the lines for leakage.

Airspeed Indicator

1. The operating efficiency of the airspeed indicator is determined by visual inspection and check test.

2. The static system is checked for leakage at normal temperature by connecting the instrument to a vacuum source. When rarefaction, corresponding to the 1200 km/hr instrument reading, is created, the vacuum source is shut off with a cock. By clamping the hose at the pipe connection of impact pressure line, watch the instrument pointers, the readings of which should not change during one minute.

3. Errors in the instrument readings are checked at normal temperature in the following manner (Fig.13):

(a) connect a pressure source to the instrument pipe connection with index P(Д) and a vacuum source to the pipe connection with index Б (С);

(b) check the error value for each numbered division of the dial by building up a pressure (as read off a pressure gauge) corresponding to the dial readings;

(c) take the readings of the values to be checked both clockwise and counter-clockwise at one and the same dial mark.

Maintain pressure at each dial mark being checked for not less than 1 minute.

Maximum pressure, corresponding to the 1200 km/hr dial mark, should be maintained for not less than 15 minutes. Error value will be determined by comparing the readings of the airspeed indicator under test with that of the master pressure gauge;

(d) maintain vacuum (when checking the instrument at various altitudes), corresponding to the altitude under check as read off the master barometer, taking into account the calibration card given in the Service Manual of the airspeed indicator;

(e) compare the data obtained during the check with that entered into the correction card for speed and altitude. Correct the card should any difference occur;

(f) replace the airspeed indicator if the corrections obtained exceed the permissible errors given in the instrument Certificate.

The correction cards are furnished with the speed and altitude indicators mounted on the instrument panels of navigator, navigator-radar operator, and both pilots.

The values to be determined by formula

$$V_{indic} = \delta V_{instr} + \delta V_{aer} + \delta V_{compr}$$

will be entered into column V_{indic},

where V_{indic} is I.A.S. (indicated airspeed);

δV_{instr} are the errors in instrument reading determined as stated above

δV_{aer} is an aerodynamic correction. It is a constant value for I.A.S. and equals to 13 km/hr;

δV_{compr} is a compressibility correction to be taken from tables.

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The values to be determined by formula

$$\Delta V_{true} = \delta V_{instr} + \delta V_{aer}$$

will be entered into column ΔV_{true},

where V_{true} is T.A.S. (true airspeed), δV_{aer} at standard atmosphere will be taken from the graph (Fig.14). The data obtained for δV_{aer}, determined at an altitude of H = 8000 m., will be entered into the third column, whereas the data for δV_{aer}, determined at an altitude of H = 12,000 m., will be entered into the fourth column.

Corrections for type ВД-20 altimeter will be entered into column ΔH.

It is said on the reverse sides of the tables: "Aerodynamical and instrumental corrections and compressibility corrections are accounted for in ΔV_{indic} Aerodynamical and instrumental corrections are taken into account in ΔV_{true}".

For the table of aerodynamical corrections see the aircraft Service Log.

Rate-of-Climb Indicator

The instrument check-up includes visual inspection and airtightness check. The instrument should be so tight that at a rarefaction of 380 mm Hg the rate of pressure drop during one minute would not exceed 2 mm Hg. Vacuum should be created gradually without sharp jerks of the climb indicator's pointer.

Machmeter

The instrument check-up comprises visual inspection, check of static pressure line for tightness, and check for errors in readings.

The static system should be so tight at a rarefaction of 380 mm Hg, supplied to both pipe connections, that the rate of pressure drop during one minute would not exceed 8 mm Hg.

The machmeter will be checked as shown in Fig.15.

The machmeter may be checked in situ. The machmeter is checked by the numbered divisions of the dial, namely 0 km. and at altitudes of 2, 6, 10, 14, and 18 km. To check at these altitudes use the calibration card of the machmeter Certificate. The Mach number readings will be taken both clockwise and counter-clockwise. The error value will be determined by comparing the readings of the machmeter being tested with the reading of the master pressure gauge at an altitude of 0 km. If atmospheric pressure does not correspond to 760 mm Hg, then build up a pressure of 760 mm Hg in the static system when checking the instrument at an altitude of 0 km.

To check the machmeters at an altitude of 0 km., proceed as follows (Fig.15): close cock 7, open cock 9, and using cock 1 supply the line with pressure which should be read off pressure gauges 2 and 3 and which corresponds to the dial divisions under check. In doing so maintain a pressure of 760 mm Hg as read by the barometer. Simultaneously take the machmeter readings.

To check the machmeter at different altitudes, proceed as follows: close cock 1, open cocks 7 and 9, and using cock 8 create controlled by the barometer a rarefaction, corresponding to the altitude at which the machmeter should be checked. Rarefaction should be read off barometer 4. This done, close cocks 7 and 8, and using cock 1 build up in the line pressure which should be read off pressure gauges 2 and 3, and which corresponds to the main dial divisions (according to the calibration table in the machmeter Certificate). Simultaneously take the machmeter readings.

Upon completion of the machmeter check at a given altitude, close cock 1 at the final reading of the pressure gauge, gradually open cocks 7 and 9 and then through cock 8 create a rarefaction corresponding to the subsequent altitude.

Velocity Head Warning Unit

The instrument check comprises visual inspection, checking the pitot-static system for tightness, checking the operation of warning lamp for errors, as well as checking the electric circuit insulance.

1. The static pressure line is checked for tightness at normal temperature by connecting the impact and static pressure pipe connections to a pressure source of 300 mm Hg (Fig.16). The pressure source will be blanked off with a cock. Pressure differential rate per minute should not exceed 0.5 mm Hg.

The impact pressure system (Fig.17) is checked by connecting the dynamic pressure pipe connection to the pressure source.

Airtightness should be preserved for 5 minutes at a pressure of 330 mm Hg. No pressure differential is allowed during this time.

2. Operation of the warning lamp at normal temperature is checked for errors in the following way. The warning unit is connected to the pressure source (Fig.17). By gradually increasing pressure, watch the moment the circuit is closed (the warning lamp goes on). When taking the reading counter-clockwise, gradually decrease pressure and watch the moment the circuit is open (the warning lamp goes off). The error value is determined by the readings of the master pressure gauge at the moment the warning lamp lights up.

3. Insulance of the current-carrying elements at relative humidity of 30 to 80% is checked by means of a megger, one wire of which is simultaneously connected to three pins of the plug, while the other wire of the megger is connected to the warning unit case. Insulance should not be less than 20 megohms.

Cabin Altimeters

The instrument check includes visual inspection and testing the instrument case for tightness. The instrument case is tested for tightness by connecting the case pipe connections to a vacuum source. At a rarefaction corresponding to an altitude of 8 km. as read by the instrument, the vacuum source is blanked off with a cock. Then, by clamping the hoses at the pipe connections, watch rarefaction decrease in the instrument case. The rate of pointer drop should not exceed 400 m.per minute.

Airtightness of the instrument diaphragm assembly is checked by connecting the pipe connection with index C to the vacuum source. At a rarefaction corresponding to the instrument reading of 0.6 kg/cm^2, read off the excessive pressure scale, the vacuum source is blanked off with a cock. Then, by clamping the hose at the pipe connection, watch the pointer, the reading of which should not change during one minute.

The altimeter readings are checked for errors using the method of checking the instrument case for tightness by creating rarefaction in the instrument corresponding to the readings of the dial numbered divisions under check.

Rarefaction should be maintained at each dial mark being checked for not less than 1 minute and at a maximum rarefaction - for not less than 15 minutes.

The differential pressure gauge operation should be checked in the same manner as the diaphragm assembly is checked for tightness.

To determine the instrumental errors, the altimeter readings are compared with the readings of the master mercury barometer, while the readings of the

differential pressure gauge are compared with the readings of the master mercury pressure gauge which are both connected to the test set.

Checking the Pitot-Static System for Tightness

Testing the Static Lines for Tightness

(a) Disconnect the rate-of-climb indicators from the static lines and blank off the ends.

(b) Insert in turn the hose, connected to the vacuum source, into the holes of all five static vents and create rarefaction (vacuum) corresponding to 700 km/hr as read off the airspeed indicator.

Note: It is allowed to check the static pressure lines for tightness with the rate-of-climb indicators connected to the line. However, in this case create vacuum, corresponding to an airspeed of 700 km/hr, and equalize it with the atmospheric pressure gradually and for not less than 2 minutes.

(c) Clamp the hose running from the vacuum source. Note the reading of the airspeed indicator pointer and then determine the rate of airspeed drop per minute.

(d) Permissible leakage of the static pressure lines corresponds to a value at which the rate of drop in the readings of the airspeed indicators does not exceed 5 km/hr per minute.

Testing the Impact (Dynamic) Pressure Line for Tightness

(a) Fit a rubber hose, connected with the pressure source, onto the Pitot tubes (see to it that the drain hole is closed). Create a pressure in the line corresponding to an airspeed of 700 km/hr read by the airspeed indicator.

(b) Clamp the hose running from the pressure source. Take the reading of the airspeed indicator pointer and then determine the rate of airspeed drop per minute.

Permissible leakage of the impact pressure line corresponds to a value at which the rate of drop in the readings of the airspeed indicators does not exceed 2 km/kg per minute.

POST-FLIGHT OPERATIONS

If during the flight the Pitot-static instruments worked without failure, then after the flight do the follwing:

(a) put the covers on the Pitot tubes;

(b) insert the blanking plugs into the static vents;

(c) make visual inspection of the instruments on the instrument panels (instrument glasses, attachment of instruments, etc.);

(d) drain moistness from the moisture traps in rainy weather.

Should any malfunctions be detected in the operation of the instruments during the flight, such as, for example, erroneous readings of the instruments, fluctuation of pointers, different readings of identical instruments (for instance type KYC-1200 airspeed indicators), installed on various instrument panels, etc., blow the Pitot-static system, check the system for airtightness and efficiency as indicated above.

ELECTRICAL INSTRUMENTS OF NAVIGATION EQUIPMENT

GENERAL

The electrical instruments of navigation equipment include: type ДГМК-7 remote-reading gyromagnetic compass, type ДАК-ДБ-5 remote-reading astrocompass, type НМ-50Б air position indicator, type АГБ-2 gyro horizon, type ГМК-52 directional gyro, and type ТУ3-48 thermometer.

Type ДГМК-7 Remote-Reading Gyromagnetic Compass

The ДГМК-7 compass is a basic magnetic compass on the aircraft. It is intended to determine the magnetic and true courses of the aircraft.

The ДГМК-7 compass complete set (Fig.18) comprises:

type ПДК-3 transmitter	1 pc;
type П-2 gyro unit	1 pc;
type У-10 amplifier	1 pc;
type УИМ master indicator (navigator's indicator)	1 pc;
repeater (additional indicator)	3 pcs;
type ВК-53РБ erecting cutout	1 pc;
type СК-8 junction box	1 pc;
type 5k fast slave button	2 pcs;
type ПТ-125 inverter	1 pc

Basic Specifications

1. Power supply	27 ± 2.7 V D.C., 36 ± 3.6 V, three-phase A.C., 400 ± 40 c.p.s.
2. Power consumed from D.C. mains	
with inverter	not over 250 W
without inverter	not over 25 W
3. Power drawn from A.C. mains	not over 110 W
4. Navigator's indicator error by the scale of compass course	not over 4°
by the scale of true course (after measurement method error, instrumental error, and compass deviation have been eliminated)	not over 1°
5. Additional error in compass readings for each minute of turn	not over 0.6°
6. Error in repeaters' readings	not over 3°
7. Permissible angle of bank of aircraft, at which the compass readings can be taken without using the fast slave button	65°
8. Temperature range (except for master indicator and repeaters)	from +50 to -60°C

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9. Temperature range for master indicator and repeaters	from +50 to -35°C
10. Altitude limit	up to 15,000 m.
11. Compass is ready for operation	in 3 min. after power supply is on

Under unfavourable combination of flight corditions (bank with angular speed less than 0.2° per second, altitude change, longitudinal acceleration, etc.) the error in compass readings may reach 10°.

All the assemblies, which go to make the ДГМК-7 compass complete set are interchangeable. In case the ПДК-3 transmitter or master indicator are to be replaced, correct an installation error and remove deviation on 24 compass points.

Air Position Indicator НИ-50Б

The НИ-50Б air position indicator is designed for continuous indication of the aircraft position in rectangular axes, the drift being taken into account.

The НИ-50Б set (Fig.19) includes:

(a) T.A.S. transmitter - 1 piece;
(b) automatic course device - 1 piece;
(c) wind setter - 1 piece;
(d) D.R. computer - 1 piece;
(e) distribution box - 1 piece;
(f) supply-line filter СФ-2 - 1 piece;
(g) supply-line filter СФ-4 - 1 piece;
(h) inverter ПАГ-1Ф (Fig.20) - 1 piece.

Basic Specifications

1. Power supply	D.C., 27 ± 1 V, A.C., three-phase, 36 ± 3.6 V, 400 ± 40 c.p.s.
2. Range of operating speeds	300 to 1200 km/hr
3. Range of wind speed	0 to 150 km/hr
4. Altitude	up to 15,000 m.
5. Coordinate system	rectangular with any arrangement of the axes
6. Maximum error at normal temperature (altitude up to 8000 m., speed from 300 to 1100 km/hr)	5.5% max.
7. Course indication error at 24 points (repeated readings of ДГМК-7 compass main indicator)	1° max.
8. Power consumed:	
direct current	25 W max.
alternating current in most loaded phase	35 W max.

The units of the НИ-50Б set are interchangeable. But in case of replacement of any unit except the inverter and filters, it is necessary to determine

the total error of the set and the new correction to the change-over table of the distribution box. After replacement of the distribution box or automatic course device, do not fail to adjust the zero signal anew and to match the readings of the ДГМК-7 compass main indicator with those of the НИ-50Б automatic course device.

Gyro Horizon АГБ-2

The АГБ-2 electric gyro horizon with slide indicators are designed to determine the position of the aircraft in the space relative to the true horizon, as well as to determine aircraft sideslip.

The АГБ-2 gyro horizon makes it possible to check the following aircraft acrobatics:

(1) aircraft circle turns with up to 80° banks;
(2) diving and climbing at angles up to 60°

The peculiarity of the АГБ-2 gyro horizon lies in the fact that the lateral erecting mechanism is cutout at an angular velocity of aircraft turning exceeding 0.2 deg/sec. In this connection, the АГБ-2 gyro horizon operates in conjunction with a ВК-53-РБ erecting cutout.

The gyro horizon and erecting cutout are supplied from the ПАГ-1Ф inverter.

Basic Specifications

1. Power supply	alternating three-phase current, 36 ± 3.6 V, 400 ± 40 c.p.s.
2. Error in horizon determination	1° max.
3. Time of initial erection at ambient temperature of:	
50 ± 5°C	3 min.max.
20 ± 5°C	3 min.max.
-60 ± 5°C	6 min.max.
4. Erection time from lateral and longitudinal tilts	6 to 12 min.
5. Time difference in gyro erection from opposite tilts	3 min.max.
6. Errors in circle turns and turns lasting not more than 6 min.	2°

The АГБ-2 gyro horizon units are interchangeable.

Erecting Cutout ВК-53-РБ

The purpose of the erecting cutout is to cut out the erecting mechanism of the gyro horizon when performing circle turns at an angular velocity exceeding 0.2 deg/sec.

The erecting cutout of the ДГМК-7 compass cuts out the gyro erecting unit at a turning velocity exceeding 0.3 deg/sec.

On some aircraft the cutout of the erecting unit of the gyro horizon and ДГМК-7 compass is performed with the help on one common erecting cutout which is adjusted to operate at a turning velocity exceeding 0.2 deg/sec.

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Basic Specifications

1. Power supply	.....	alternating three-phase current, 36 ± 3.6 V, 400 ± 40 c.p.s. direct current, 27 ± 2.7 V
2. Maximum power consumed in A.C. circuit	.....	0.45 A per phase
3. Maximum power consumed in D.C. circuit	.....	3 W
4. Sensitivity	.....	0.2 or 0.3 deg/sec.
5. Time of erecting cutout lag	.....	5 to 15 sec.
6. Maximum erecting cutout lag time asymmetry	.....	8 sec.

Note: The erecting cutout should be so mounted on the aircraft that the twin shock-absorbing springs are located on top and index "E" on the erecting cutout casing is also on top.

Electric Resistance Thermometer TV3-48

The TV3-48 resistance thermometer is designed to measure the outside air temperature. The instrument includes the following units:

(a) indicator - 1 piece;
(b) transmitter - 1 piece.

Basic Specifications

1. Power supply	.....	27 ± 2.7 V
2. Range of measurement	.....	-70 to +150°C
3. Error of instrument does not exceed:		
at 20 ± 5°C	.....	±5°C
at 50 ± 5°C	.....	±7°C
at -60 ± 5°C	.....	±8°C

The thermometer units are interchangeable.

MAINTENANCE INSTRUCTIONS

During service check the instruments of the navigation equipment before and after the flight observing the instructions given below. Check also the instruments in those cases which are specially prescribed for each instrument individually.

Pre-Flight Inspection

The pre-flight inspection comprises visual inspection of the aircraft and a check of their readiness for operation.

Visual Inspection

In inspecting the instruments visually make sure that their outer surfaces are not damaged, that the instruments are reliably secured to the instrument board or to the respective bracket and that the plug connectors or wires are reliably connected to the respective terminal blocks. See also that the safety fuses are in their places, that they are used in conformity with the diagrams and reliably secured in their seats. Check the amplifier valves for proper installation and the wires for good condition, especially in places of attachment to the plug connectors or respective terminal blocks. Make also sure that the

respective knobs and spur racks rotate smoothly, that the dials move properly, that the switches are reliably fixed in their positions, etc.

In performing visual inspection of the navigation equipment observe the following sequence:

(a) examine, on the instrument board of the left pilot, the gyro horizon, directional gyro indicator, indicator of the ДГМК-7 compass, and fast slaving button of the ДГМК-7 compass;

(b) examine, on the instrument board of the right pilot, the gyro horizon, directional gyro indicator, and the ДАК-ДБ-5 compass course indicator;

(c) examine, on the navigator's instrument board, the ДАК-ДБ-5 compass course indicator, track corrector of the ДАК-ДБ-5 compass, main indicator of the ДГМК-7 compass, fast slaving button of the ДГМК-7 compass, T.A.S. transmitter, automatic course device, wind setter and D.R. computer of the НИ-50Б air position indicator;

(d) inspect the distribution box of the НИ-50Б air position indicator and the amplifier of the ДГМК-7 compass;

(e) examine the ПАГ-1Ф, ПТ-70 and ПТ-125 inverters through which the gyro horizons, the ГПК-52 directional gyro, air position indicator НИ-50 and the ДГМК-7 compass are energized;

(f) inspect the computer of the ДАК-ДБ-5 compass;

(g) examine the transmitters of the ДАК-ДБ-5 compass, and the ДГМК-7 compass;

(h) clean the transparent hood of the ДАК-ДБ-5 compass transmitter of dust and dirt. To avoid scratches wipe the hood with a piece of soft fabric soaked in alcohol;

(i) check the colour of the silica gel crystals in the dehydrator of the ДАК-ДБ-5 compass transmitter. If the silica gel crystals have turned pink or brown, replace the dehydrator by a spare one.

Remote-Reading Gyromagnetic Compass ДГМК-7

1. Switch on the ДГМК-7 compass circuit breaker on the circuit breaker panel of the navigator.

2. Cut in the switch of the ДГМК-7 set on the upper electric board of the navigator.

3. In 2 - 3 min. after switching on power supply, press the fast slaving button located on the instrument board of the navigator or left-seat pilot and release the button after 10 - 15 sec.

4. Check the readings of the main indicator compass course scale with those of the magnetic compasses. The difference in the readings must not exceed 10°, the magnetic compass corrections being taken into account.

5. Turn the main indicator magnetic variation scale to make sure that the pointers of the auxiliary indicators repeat the readings of the main indicator pointers, the error not exceeding 3°.

6. Turn the compass transmitter card with the aid of a permanent magnet to check the movement of the main and auxiliary indicator pointers, with the fast slaving button pressed.

7. Release the slaving button and take the magnet away from the transmitter.

8. Check the follow-up rate of the navigator's indicator pointer with the slaving button not pressed. The follow-up rate should be within 1 - 4° per minute

9. Cut off the power supply from ДГМК-7 compass.

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Air Position Indicator НИ-50Б

1. On the circuit breaker panels of the navigator switch on the circuit breakers of the ДГМК-7 compass and НИ-50Б air position indicator.

2. On the upper electric board of the navigator put the ДГМК-7 compass switch and two switches of the НИ-50Б indicator in position ON.

3. In 5 minutes after the line has been energized, turn the magnetic variation spur rack of the ДГМК-7 compass main indicator to make sure that the pointer of the automatic course device follows the readings of the main indicator; then cut out the ДГМК-7 compass power supply switch. When this is done, the pointer of the automatic course device must not shift. This will indicate to the fact, that the zero signal has been adjusted correctly. Should the pointer of the automatic course device shift, use a screw-driver to turn the adjustable resistor screw located in the distribution box to the left (if viewed from the terminal blocks, See Fig.21). The screw must be turned until such a position is found at which movement of the pointer ceases.

4. Set the chart angle on the automatic course device just by 45° less than the reading of the automatic course device pointer. Set the wind speed knob of the wind setter to zero.

5. Use a КПУ-3 testing device or a special pressure producer which belongs to the УНМ-50 testing installation to create gradually a pressure in the dynamic system of the T.A.S. transmitter corresponding to a speed of 1150 km/hr. As the speed changes from 300 to 1150 km/hr check the rotation of the D.R. computer check indexes, the turning rate of the check indexes should change smoothly without sharp jumps or binding.

6. At a speed of 1150 km/hr change gradually the value of the chart angle of the T.A.S transmitter from 0 to 360°.

The turning rate of the D.R. computer check indexes should change gradually.

7. Reduce the pressure in the dynamic system of the T.A.S. transmitter to zero.

8. Shift the wind speed knob on the wind setter gradually from zero to division 150 km/hr. The turning rate of the D.R. computer check indexes should change smoothly.

9. Change gradually the wind direction on the wind setter from 0 to 360°. The turning rate of the check indexes should change smoothly.

10. Switch off A.C. and D.C. supply from the НИ-50Б air position indicator.

Gyro Horizon АГБ-2

1. Switch on the power supply of the gyro horizon.

2. Turn the starting handle located on the front of the gyro horizon to the left. This done, a red bulleye should appear in the zone of the port.

Not later than 3 min. after energizing the instrument, the horizon line should assume the horizontal position, the permissible deviation being ±1°.

Make sure that the skid indicator fluid contains no air bubbles.

Note: With the ambient temperature below zero, the gyro erecting time may increase up to 6 min.

Electric Turn Indicator ЭУП-53

1. Switch on the power supply of the turn indicators.

2. Wait 2 - 3 minutes, then press against the edge of the pilot's instrument board to turn it about its vertical axis as far as the shock absorbers

permit. When this is being done, the moving index of the turn indicator should deflect from its central position.

3. Make sure that the skid indicator fluid contains no air bubbles.

4. Switch off the power supply from the instrument.

Postflight Inspection

The postflight inspection of the navigation equipment comprises the following operations:

1. Examine visually the units of the navigation equipment in the same way as during preflight inspection.

2. Cover the transparent hood of the ДАК-ДБ-5 compass transmitter with a protective casing.

3. Check the colour of the silica gel of the ДАК-ДБ-5 compass transmitter. If the silica gel crystals have turned pink or brown, replace the dehydrator with a spare one, since pink or brown silica gel is not capable of absorbing moisture. The silica gel can be reconditioned by drying, for which purpose it must be poured on a metal sheet and dried on a moderate fire until it turns blue again. After the dehydrator is placed on the transmitter, do not fail to open the hole in the dehydrator bottom.

In addition to the visual inspection of the instruments, find out the causes of the defects which have been revealed in the flight. Sometimes the defects and their causes may be found in the course of the check carried out in the sequence adopted for the preflight inspection. Therefore this inspection must be performed immediately after the flight. Sometimes a more careful check is required. The scope and sequence of this check is described below.

Besides, trouble-shooting is facilitated by the fault finding chart which contains the most frequent defects of the navigation instruments, their causes and remedies.

Checking the Instruments for Correspondence to Their Basic Specifications

Such a check is to be carried out as soon as you begin to doubt whether the readings of some instruments are correct, and not less than once every three months.

Taking into consideration that special installations for checking some instruments may not always be available under service conditions, the checking method has been so worked out as to reduce the number of the instruments to be removed from the aircraft to the minimum and to carry out the entire check directly on the aircraft.

When special testing equipment is available it is used for checking the instruments in accordance with the Instructions of the respective installation (if available) or in compliance with the given Instructions.

In addition to the method of checking the instruments for correspondence to their Specifications, this Section contains some special instructions on mounting, care and maintenance of the navigation equipment instruments.

Remote-Reading Gyromagnetic Compass ДГМК-7

1. Disconnect the plug connectors from the transmitter and check, using a megger, the insulance between the terminals of the plug connectors and the transmitter body. The insulance must not be below 20 megohms.

2. After having slightly tapped against the cover of the transmitter casing,

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note the reading of the transmitter scale, then use a permanent magnet to deflect the transmitter card by 10° to the right and take away the magnet. Take again the readings off the scale of the transmitter. The difference between the last and first readings will be the card lag.

In the same way check the lag of the transmitter card when the latter is deflected to the left. The absolute lag value of the transmitter card must not exceed 7°.

3. Disconnect the double-terminal plug connector from the transmitter.

4. Disconnect the plug connector from the gyro unit and check the insulance between the following pins of the gyro unit plug:

(a) the insulance between pins 3 and K must be from 100 to 130 ohms;

(b) the insulance between pins K and M must be from 400 to 600 ohms;

(c) the insulance between pins A and Б , Б and B, A and B should be from 355 to 586 ohms;

(d) the insulance between pins 3 and И should be from 450 to 580 ohms.

5. Using a megger check the insulance between the following jacks of the plug located at the end of the wire bundle: A and И , A and M, A and Г , as well as between jacks A and the aircraft framework.

The insulance must be not less than 1 megohm.

6. Check the insulance between jacks A and Б , Б and B, A and B of the gyro unit plug located at the end of the wire bundle. The insulance should be equal (accurate within ±20 ohms) and at least 100 ohms each.

7. Connect the plug connectors to the gyro unit and to the transmitter.

8. Supply power to the ДГМК-7 compass.

9. Wait 2 and 3 min. and press the fast slaving button. Release the button after 15 - 20 sec. The readings of the compass course scale of the main indicator and the scale readings of the magnetic transmitter should agree within 3°, whereas the readings of the auxiliary indicators should agree with those of the main indicator also accurate within 3°.

10. Using a permanent magnet turn the transmitter card and check, every 30 - 40°, to see that the readings of the compass course scale and those of the repeaters correspond to the readings of the transmitter scale and main indicator pointer respectively.

With the compass operating, oscillation of the main and auxiliary indicator pointers within ±0.5° is permissible.

11. Check the follow-up rate of the navigator's main indicator pointer with the slave button not pressed. The follow-up rate must be within 1 - 4° per minute.

CAUTION: 1. It is strictly prohibited to use in the junction box a safety fuse other than type ПК-0.15 A.

2. Prior to cutting the compass into the electric mains after some units have been replaced or defects in the aircraft diagram have been eliminated, do not fail to check the insulance in conformity with Item 6 of the given Section.

3. Prior to energizing the compass make sure that plug connectors Nos 8 and 11 of the ОПБ-11р sight computer are not confused to avoid failure of the compass.

Air Position Indicator НИ-50Б

Checking total error of the set. Prior to checking the set for total error, make sure that the static and impact pressure lines of the T.A.S.

ansmitter are airtight. Check also the zero signal and serviceability of the

1. The set is checked for airtightness as follows:

(a) use a КПУ-3 test set to create a pressure in the T.A.S transmitter namic system corresponding to a speed of 700 km/hr. Pressure drop in the stem must not exceed 2 km/hr per one minute;

(b) use a КПУ-3 test set to create a vacuum in the T.A.S. transmitter atic system corresponding to a speed of 700 km/hr. With pressure supply cut f, leakage must not exceed 5 km/hr per min.;

2. The zero signal and the serviceability of the set are checked in cordance with the method adopted for preflight inspection.

3. The total error in the set readings is determined at four different urses selected so that the error may be found by one of the selected courses the intervals from 0 to 90°, from 90 to 180°, from 180 to 270° and from 270 360°.

4. Switch on the A.C. and D.C. power supply of the compass and НИ-50Б air sition indicator.

5. Measure the voltage across terminals "Г" of the distribution box of the НИ-50Б air position indicator. The voltage is to be measured with a voltmeter ving reading corrections within the range of 24 to 30 V. Taking the corrections to consideration, ensure exactness of voltage readings within ±0.1 V.

6. Switch off the power supply from the НИ-50Б air position indicator d the compass. Change over the internal wiring diagram of the indicator dis- ibution box to a voltage of 27 V.

7. Switch on the power supply of the НИ-50Б air position indicator and mpass.

8. Create a pressure in the T.A.S. transmitter dynamic system corresponding a speed of 700 km/hr, which is to be checked by the КУС-1200 airspeed dicator having corrections for indication errors.

When applying the pressure, take into consideration the corrections for mospheric pressure given in Table 2.

Table 2

Speed of 700 km/hr with Corrections for Atmospheric Pressure

Atmospheric pressure, mm of mercury	Airspeed, km/hr
1	2
715 - 720	718.7
720 - 725	716.45
725 - 730	714.25
730 - 735	715.0
735 - 740	709.8
740 - 745	707.6
745 - 750	705.4
750 - 755	703.2
755 - 760	701.05

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1	2
760 - 765	698.95
765 - 770	696.8
770 - 775	694.7
775 - 780	692.65
780 - 785	690.6
785 - 790	688.55

9. Place a permanent magnet closely to the compass transmitter and turn the main indicator magnetic variation spur rack to set the course automatic device scale to a course equal to 45° or divisible by 10 deg, within an interval of 0 to 90°.

10. Set the wind setter to a wind speed of 60 km/hr and a direction divisible by 10° or equal to 45°.

11. Set the chart angle on the course automatic device and on the wind setter to zero.

12. Switch off the D.C. supply from the НИ-50Б air position indicator and set the D.R. computer pointers to zero. Send the pointers to zero position by moving them in a direction opposite to their usual movement (in this case - counter clockwise).

13. Switch on the D.C. supply of the НИ-50Б air position indicator and start simultaneously a stopwatch.

14. Wait 8 min. and 34 sec., then switch off the D.C. power supply of the НИ-50Б air position indicator and take the readings of north and east pointers of the D.R.computer.

Notes: 1. In case the voltage across terminals B of the distribution box is other than 27 ± 0.1 V and if it is impossible to bring it to this value, multiply the testing time (8 min.34 sec.) by coefficient K:

$$K = \frac{27}{V_{ind}}$$

where V_{ind} - is the voltage measured across terminals B of the indicator distribution box.

2. During the test maintain a pressure in the dynamic system of the course automatic device which corresponds to a speed of 700 km/hr.

15. Using Table 3 determine the rated changes in the D.R. computer pointer readings for a flight in calm weather.

16. Using Table 4 determine the rated changes in the D.R. computer pointer readings depending on the direction of the wind.

17. Determine the rated changes in the readings of the north pointer L_N and east pointer L_E for a flight with drift correction introduced.

$$L_N = l_N + l'_N ;$$

$$L_E = l_E + l'_E .$$

Values l_N, l_E, l'_N and l'_E should be taken with the signs indicated in Tables 3 and 4.

Table 3

Rated Changes in Readings of Pointers l_N and l_E Depending on Course in Calm Weather

Course	0°	10°	20°	30°	40°	45°	50°	60°	70°	80°
l_N km.	+100	+98.5	+94	+86.6	+76.6	+70.7	+64.3	+50	+34.2	+17.4
l_E km.	0	+17.4	+34.2	+50	+64.3	+70.7	+76.6	+86.6	+94	+98.5
Course	90°	100°	110°	120°	130°	135°	140°	150°	160°	170°
l_N km.	0	−17.4	−34.2	−50	−64.3	−70.7	−76.6	−86.6	−94	98.5
l_E km.	+100	+98.5	+94	+86.6	+76.6	+70.7	+64.3	+50	+34.2	+17.4
Course	180°	190°	200°	210°	220°	225°	230°	240°	250°	260°
l_N km.	−100	−98.5	−94	−86.6	−76.6	−70.7	−64.3	−50	−34.2	−17.4
l_E km.	0	−17.4	−34.2	− 50	− 64.3	−70.7	−76.6	−86.6	−94	−98.5
Course	270°	280°	290°	300°	310°	315°	320°	330°	340°	350°
l_N km.	0	+17.4	+34.2	+50	+64.3	+70.7	+76.6	+86.6	+94	+98.5
l_E km.	−100	−98.5	−94	−86.6	−76.6	−70.7	−64.3	−50	−34.2	−17.4

l_N – change in readings of north pointer

l_E – change in readings of east pointer

Table 4

Rated Changes in Readings of Pointers l'_N and l'_E Depending on Wind Direction

Course	0°	10°	20°	30°	40°	45°	50°	60°	70°	80°
l'_N km.	+8.6	+8.4	+8	+7.4	+6.6	+6.1	+5.5	+4.3	+2.9	+1.5
l'_E km.	0.0	+1.5	+2.9	+4.3	+5.5	+6.1	+6.6	+7.4	+8	+8.4
Course	90°	100°	110°	120°	130°	135°	140°	150°	160°	170°
l'_N km.	0	−1.5	−2.9	−4.3	−5.5	−6.1	−6.6	−7.4	−8	−8.4
l'_E km.	+8.6	+8.4	+8	+7.4	+6.6	+6.1	+5.5	+4.3	+2.9	+1.5
Course	180°	190°	200°	210°	220°	225°	230°	240°	250°	260°
l'_N km.	− 8.6	−8.4	−8	−7.4	−6.6	−6.1	− 5.5	−4.3	−2.9	−1.5
l'_E km.	0	−1.5	−2.9	−4.3	−5.5	−6.1	−6.6	−7.4	−8	−8.4
Course	270°	280°	290°	300°	310°	315°	320°	330°	340°	350°
l'_N km.	0	+1.5	+2.9	+4.3	+5.5	+6.1	+6.6	+7.5	+8	+8.4
l'_E km.	−8.6	−8.4	−8	−7.4	-6.6	−6.1	- 5.5	−4.3	−2.9	−1.5

l'_N – change in readings of north pointer

l'_E – change in readings of east pointer

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18. By comparing the actually obtained changes in the D.R. computer readings L'_N and L'_E with the rated values L_N and L_E determine the absolute errors in the readings of the D.R. computer north pointer ΔL_N and east pointer ΔL_E.

$$\Delta L_N = L'_N - L_N ;$$

$$\Delta L_E = L'_E - L_E .$$

19. Using the graph presented in Fig.22 determine covered distance L by the rated indications of the D.R. computer, i.e. L_N and L_E.

For example, a change in the readings of the north pointer L_N is 82 km. and that of the east pointer L_E is 78 km. Lay off 82 and 78 km. on the axes L_N and L_E respectively. From these points erect perpendiculars to the axes until they mutually intersect. Lay off the distance from the intersection point to the beginning of the coordinates on one of the coordinate axes (in this example it is axis L_E). This distance will determine in the adopted scale the covered distance L in km. (in the given example the covered distance is 114 km.).

20. Making use of the graph given in Fig.23 determine the absolute error ΔL by the covered distance.

For instance, the absolute error of the north computer ΔL_N is 6.15 km. and that of the east computer ΔL_E is 4.7 km.

From these points draw lines until they mutually intersect.

Lay off the distance from the intersection point to the beginning of the coordinates on one of the axes and determine the absolute error of the set (in this example the absolute error of the computer ΔL is 7.75 km.).

21. Determine the total error of the set Δ from the formula:

$$\Delta = \frac{\Delta L}{L} \ 100\% .$$

22. Following the same routine determine the complete errors of the set at courses within the intervals from 90 to 180°, from 180 to 270° and from 270 to 360°.

The total errors obtained during the tests should be within the limits given in Table 5.

Table 5

Permissible Amounts of Total Errors

Ambient air temperature, °C	Total error of HM-50E set, %					
	altitude 0		altitude above 0 to 8000 m.		altitude from 8000 to 12,000 m.	
	speed 300 km/hr	speed from 300 to 1000 km/hr	speed up to 1100 km/hr	speed up to 1200 km/hr	speed up to 1100 km/hr	speed up to 1200 km/hr
1	2	3	4	5	6	7
+20 ± 5	7	5	5.5	7.5	6.5	7.5
+50 ± 5	9	8	-	-	-	-
-60 ± 5	9	8	8	9	8	9

Should the total error of the set exceed the permissible value, determine the correction to the inner diagram change-over table of the indicator distribution box.

Determination and Account of Correction to Inner Diagram Change-Over Table of Indicator Distribution Box

"Correction" is the value which is to be algebraically added to the value of the air position indicator supply voltage (which is measured across terminals B of the distribution box) in order to determine the corrected voltage value and to change over the distribution box inner diagram correspondingly.

The correction is accounted for by the formula:

$$V_{cor} = V_{supply} \pm \Delta V \text{ (volts)}$$

where: V_{cor} - is the corrected voltage value, for which the distribution box inner diagram is to be changed over;

V_{supply} - is the supply voltage to the air position coordinator, as measured across the terminals B of the distribution box;

ΔV - is the correction, volts.

If it is required, depending on the total errors obtained during the check, to increase the change in the readings of the D.R. computer pointers, take the correction with the sign "-", and if it is required to decrease the value, take the correction with the sign "+".

The correction value must be divisible by 0.5 V. A correction value equal to 0.5 V changes the readings of each D.R. computer pointer by 1.85%.

After determining the amount of correction for voltage, it is recommended to make sure that the selected correction to be introduced is correct, for which purpose correct algebraically the previously obtained values L'_H and L'_E (See Item 18), at which the total error proved to be in excess of the permissible value, by the value $\pm 3.7\ \Delta V$ in %, where ΔV is the correction (in volts) to be introduced.

Determine by the new corrected values L'_H and L'_E the absolute error values of the north pointer ΔL_N and east pointer ΔL_E (See Item 18) and use them to calculate the total error of the set (See Items 20, 21 and 22), which will be obtained after this correction has been introduced.

If the calculated total error meets the requirements, change over the inner diagram of the distribution box in accordance with the selected correction and check the set again.

In case the set total error exceeds the permissible value and cannot be decreased to the value indicated in Table 5 no matter what value ΔV is taken, it is required to check each unit of the set separately. The units must be checked on a YHM-50 installation only employing the method described in the Operating Instructions of this installation. On detecting a faulty unit, replace it and check the set again for the total error and correction to the change-over Table of the distribution box inner diagram. In changing over the diagram observe the instructions which are placed on the inner side of the distribution box cover.

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Checking the ДГМК-7 and НМ-50 Instruments for Synchronous Operation

1. Switch on A.C. and D.C. power supply to the ДГМК-7 compass and НМ-50Б air position indicator.

2. Wait at least 5 minutes, then adjust the zero signal employing the method described in Section "Preflight Check".

3. Place a permanent magnet closely to the compass transmitter and rotate the magnetic variation spur rack of the main indicator to check the readings of the automatic course device for conformity to those of the compass main indicator at headings 0, 15, 30°, etc., every 15°. The readings of the automatic course device must not differ from those of the main pointer by more than 1°. Otherwise, match the readings by turning the respective deviation screws which are accessible through the holes in the rear wall of the automatic course device (Fig.24).

Gyro Horizon АГБ-2

The АГБ-2 gyro horizon is checked on type УПГ-48 installation ensuring a turn of the gyro horizon with respect to the three mutually perpendicular axes: vertical, longitudinal and lateral.

The horizontal base of the turning table should be checked against a level. In addition to the УПГ-48 installation, checking of the АГБ-2 gyro horizon requires the employment of an electric panel whose diagram is presented in Fig.25.

The check is performed in the following sequence:

1. Place the gyro horizon on the turning table and connect it to the electric panel.

2. Switch on the power supply to the gyro horizon and start a stopwatch at the same time.

3. The line of the horizon should assume the horizontal position (accurate within ±1°) not later than three minutes after the power supply has been switched on.

4. In 5 or 6 min. after having energized the gyro horizon measure the voltage between the inverter phases. The voltage should be 36 ± 1 V.

If the voltage is other than specified, adjust it by changing the voltage of the supply inverter, type ПАГ-1Ф.

5. Match the miniature airplane with the fixed indices on the front flange of the instrument.

6. Turn the casing of the gyro horizon about the longitudinal and lateral axes to match the horizon line with the miniature airplane.

With the instrument in this position, tap it slightly to make sure that the slip indicator ball is located between the two central marks made on the slip indicator; see that there are no air bubbles in the slip indicator fluid. Remove air bubbles, if any, by turning the instrument casing clockwise about the longitudinal axis.

7. In 5 minutes after complete erection of the gyro match the vertical mark on the gyro horizon spherical shield with the zero division on the instrument bank scale. The gyro horizon error is characterized by the misalignment between the miniature airplane and the horizon line. This error must not exceed ±1°.

8. Turn gradually the gyro horizon casing with respect to the longitudinal axis until the gyro unit contacts the rest to create a lateral tilt exceeding 80°; in this case the tilt of the gyro unit will be in the longitudinal direction. Then return the instrument casing to initial position and turn it through 90°

with respect to the vertical axis. Thus, the longitudinal tilt of the gyro unit is transferred into a lateral tilt (with respect to the gyro horizon casing). The lateral tilt in this case should be at least 30°. If the tilt is less than 30°, repeat tilting the gyro as indicated above.

9. Turn the gyro horizon casing through 30° with respect to the longitudinal axis (by the scale available on the turning table) in the same direction in which the gyro is tilted.

10. At the moment the horizon line coincides with the miniature airplane start the stopwatch.

The time from the moment the stopwatch is started to the moment the gyro returns to its initial position is considered as the gyro erection time from the lateral tilt.

11. Check the time required for gyro erection from the opposite lateral tilt in the same way.

The gyro erection time from lateral tilts must not exceed 4 - 8 min.

12. Check the gyro for erection time from longitudinal tilt. A longitudinal tilt is established by creating a lateral tilt through 30° and turning subsequently the instrument casing through 90° with respect to the vertical axis.

The time required by the gyro to erect from longitudinal 30° tilts should be within 6 - 11 min. The difference in the erection time when the gyro erects from opposite tilts must not exceed 3 min. When erecting from a longitudinal tilt the gyro must not tilt in the opposite direction by more than 3°, and when erecting from a lateral tilt its pitch must not exceed 4°.

Erecting Cutout, Type ВК-53РБ

The erecting cutout may be checked on type УПГ-48 installation used to check gyro instruments. The check is performed with the aid of an electric panel whose diagram is presented in Fig.26. The erecting cutout is supplied from the ПАГ-1Ф inverter, which should be so adjusted as to produce a linear voltage of 36 ± 1 V, 400 ± 10 c.p.s. in 3 - 5 min. after the inverter is energized with D.C. 27 ± 1 V current. The 3 - 5 minute time period is required for placing the gyro under working load (well-racing gyro , warmed up instrument).

The voltage and frequency are regulated by means of a variable resistor located in the inverter baseplate.

The erecting cutout is checked as follows:

1. Place the erecting cutout along with the shock absorbers on the turning table of the УПГ-48 installation and connect it to the electric panel.

2. Set up a turning rate for the installation table of 0.2 or 0.3° per sec. depending on the adjustment of the erecting cutout to be checked. This adjustment value is to be found in the cutout Certificate.

3. Turn switch 2 to supply power and start simultaneously a stopwatch. Determine the time during which current in phase 1 will drop to 0.5 A. As this is done, the circuit of button 9 must be open. This time period must not exceed 3 min.

4. In 5 min. after power has been switched on, check the current in phase 1. The current must not exceed 0.45 A.

5. Use selector switch 11 to connect terminals А and Б of the electric panel to terminals 6 and 7 of the erecting cutout. Make sure, with the aid of an ohmmeter, connected to terminals А and Б , that the latter are disconnected through the inner circuit of the erecting cutout.

In connecting terminals А and Б respectively to terminals 8, 9, 10, 11 and 12, 13 of the erecting cutout plug connector, terminals А and Б should be shorted.

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6. Make the installation table rotate at a rate of 0.2 or 0.5° per sec. starting the stopwatch simultaneously.

The time elapsed from the moment the table was started to the moment terminals A and B close if they are connected to terminals 6 and 7 or open if they are connected to terminals 8 and 9; 10, 11 and 12, 13 of the erecting cut-out plug connector must be within 5 to 15 sec.

7. Not earlier than 30 sec. after checking the erecting cutout for its functioning time as it is rotated in one direction, check its functioning time when the cutout is turned in the other direction.

The difference between the time found under Item 6 and that found under Item 7 must not exceed 8 sec.

Resistance Thermometer, Type TM3-48

The thermometer indicator is checked for accuracy of operation by cutting it in a circuit equivalent to the resistance thermometer (Fig.27) in which the transmitter is replaced by any resistance box, that will permit to cut into the circuit resistance equivalent to the resistance of the transmitter accurate within 0.1 ohm.

The transmitter resistance values for various temperatures are given in Table 6.

Table 6

Transmitter Resistance versus Measured Temperatures

Temperature, °C	Resistance, ohms	Temperature, °C	Resistance, ohms
-70	68.36	50	108.81
-60	71.06	60	112.78
-50	73.86	70	116.96
-40	76.86	80	121.22
-30	79.96	90	125.56
-20	83.16	100	129.96
-10	86.56	110	134.41
-0	90.26	120	138.96
10	93.76	130	143.56
20	97.36	140	148.36
30	101.06	150	153.26
40	104.86	160	158.26

The error of the instrument is determined by the difference between the indicator reading and the actual temperature corresponding to the resistance cut into the circuit.

The indicator error at an ambient temperature of +20 ± 5°C must not exceed ±5°C.

ENGINE INSTRUMENTS AND GAUGES

GENERAL

The set of engine instruments and gauges included: T3S-2 and T3-45 tachometers, TBT-11 and TCT-29 thermometers, 3MV-3 pressure gauge and 3MI-3P engine gauge unit. This section contains also information on type TMT-13 thermometer of air temperature in the wing de-icing system duct.

Remote-Reading Electric Tachometers T3S-2 and T3-45

The T3S-2 and T3-45 tachometers are designed for continuous measurement of the aircraft engine and turbostarter shaft RPM respectively. Each of the instruments is a set consisting of a generator and single-pointer indicator.

Specifications

Tachometer T3S-2

1. Range of speed	from 0 to 5000 r.p.m.
2. Division value	50 r.p.m.
3. Instrument error should not exceed:	
(a) at +20 ± 5°C	
500 - 3500 r.p.m.	±1% (±50 r.p.m.)
3500 - 4800 r.p.m. (inclusively)	±0.5% (±25 r.p.m.)
4800 - 5000 r.p.m.	±1% (±50 r.p.m.)
(b) at +50 ± 5°C	
500 - 3500 r.p.m.	±1.6% (±80 r.p.m.)
3500 - 4800 r.p.m. (inclusively)	±0.8% (±40 r.p.m.)
4800 - 5000 r.p.m.	± 1.6% (±80 r.p.m.)
(c) at -60 ± 5°C	
500 - 3500 r.p.m.	±2.6% (±130 r.p.m.)
3500 - 4800 r.p.m. (inclusively)	±1.3% (±65 r.p.m.)
4800 - 5000 r.p.m.	±2.6% (±130 r.p.m.)

Tachometer T3-45

1. Range of speed	from 400 to 3500 r.p.m.
2. Division value	50 r.p.m.
3. Error at ambient temperature of +20 ± 5°C at divisions 600, 1000, 2000, 2600 and 3000 r.p.m.	±35 r.p.m.

Exhaust Gas Thermometer TBT-11

The TBT-11 exhaust gas thermometer is intended to measure the mean temperature of the gases leaving the air-jet engine nozzle. It is a thermal electric set comprising the following units:

indicator TBT-1	1 piece
transmitter, composed of:	
(a) thermocouples T-1	4 pieces
(b) connecting wires	1 set

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Basic Specifications

1. Measurement range	300 - 900°C
2. Range of operating temperatures	450 - 750°C
3. The reading error of the set must not exceed:	
(a) at +20 - 5°C	
450 - 640°C	±15°C
650 - 750°C	±12°C
on remaining portion of scale	±25°C
(b) at +50 ± 5°C	
450 - 750°C	±18°C
on remaining portion of scale	±36°C
(c) at -60 ± 5°C	
450 - 750°C	±22°C
on remaining portion of scale	±44°C
4. Resistance of thermometer external circuit at ambient temperature of -20 ± 5°C	2.5 ± 0.1 ohms

The indicators and transmitters are interchangeable within one graduation group. The connecting wires are interchangeable as a single set.

Exhaust Gas Thermometer TOT-29

The TOT-29 exhaust gas thermometer is designed for measuring the temperature of the exhaust gases leaving the air-jet engine turbostarter.

The instrument is a thermal electric set comprising the following units:

indicator TOT-2	1 piece
thermocouple T-9	1 piece
connecting wires	1 set

Basic Specifications

1. Range of measurement	0 - 900°C
2. Range of working temperatures	600 - 800°C
3. Reading error of the set must not exceed:	
(a) at +20 ± 5°C	
600 - 800°C	±20°C
on remaining portion of scale	±35°C
(b) at +50 ± 5°C	
600 - 800°C	±30°C
on remaining portion of scale	±55°C
(c) at -60 ± 5°C	
600 - 800°C	±40°C
on remaining portion of scale	±75°C
Error within 0 - 200°C	not checked
4. Resistance of external circuit at +20 ± 5°C	9 ± 0.06 ohms
5. Indicator pointer oscillations with the engine running	±10°C max

The indicators, thermocouples and wire set are interchangeable.

Thermoelectric Thermometer TUT-13

The TUT-13 thermometer is employed for measuring the air temperature in the wing de-icing system duct. The instrument set is composed of the following units:

- thermocouple	1 piece
- indicator	1 piece
- compensating wires	1 set

Basic Specifications

1. Range of measurement	from -50 to +350°C
2. Reading error of set must not exceed:	
(a) at +20 ± 5°C	
100 - 260°C	±8°C
on remaining portion of scale	±16°C
(b) at +50 - 5°C	
100 - 260°C	±13°C
on remaining portion of scale	±26°C
(c) at -60 ± 5°C	
100 - 260°C	±18°C
on remaining portion of scale	±36°C
3. Resistance of thermometer external circuit	7.15 ± 0.05 ohms

The indicator and set of compensating wires are interchangeable.

Three-Pointer Electric Engine Gauge Unit SMM-3P

The SMM-3P engine gauge unit is used for remote check of jet engine operation. The purpose of the SMM-3P gauge unit is to check:

(a) oil pressure in engine oil line;
(b) fuel pressure in idling rating manifold;
(c) oil temperature at engine inlet.

The SMM-3P set (Fig.28) consists of the following units:

- oil pressure pick-up unit	1 piece
- fuel pressure pick-up unit	1 piece
- temperature pick-up unit	1 piece
- electric remote indicator	1 piece

The indicator comprises three metering gauges in one housing, each of which constitutes along with its pick-up unit an independent metering circuit.

Basic Specifications

1. Power supply	27 V ± 10%
2. Range of measurement:	
oil pressure gauge	from 0 to 10 kg/sq.cm.
fuel pressure gauge	from 0 to 100 kg/sq.cm.
oil thermometer	from 50 to +115°C
3. Maximum reading errors at ambient air temperature of +20 ± 5°C:	
(a) oil pressure gauge at divisions 0, 2, 4, 6 and 8	±0.4 kg/sq.cm.
at division 10	±0.6 kg/sq.cm.

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(b) fuel pressure gauge at divisions 10, 20, 40, 60, 80 and 90 ..... ±3 kg/sq.cm.
at divisions 0 and 100 ..... ±5 kg/sq.cm.

(c) oil thermometer at divisions -40, 50, 0, 100 and 130 ..... ±4°C
at divisions -50 and +150 ..... ±6°C

4. Permissible overload;
for oil pressure gauge pick-up unit ..... 15 kg/sq.cm.
for fuel pressure gauge pick-up unit ..... 120 kg/sq.cm.

The units of the ЭМИ-3Р set are interchangeable.

Remote-Reading Electric Pressure Gauge ЭДМУ-3

The ЭДМУ-3 pressure gauge is used to check the fuel pressure before the high-pressure fuel pumps. It is a set comprising a pressure pick-up unit and a remote-reading electric indicator.

Basic Specifications

1. Supply voltage ..... 27 ± 2.7 V
2. Range of measurement ..... 0 - 3 kg/sq.cm.
3. Working portion ..... 0.6 - 2.4 kg/sq.cm.
4. Maximum error on working portion at ambient temperature of +20 ± 5°C ..... 4% from measurement limit
5. Permissible overload ..... up to 4.5 kg/sq.cm.

The units of the ЭДМУ-3 set are interchangeable.

MAINTENANCE ISTRUCTIONS

In service the engine intruments and gauges should be checked before flight in compliance with the methods described below, as well as in cases specially specified.

Preflight Inspection

The preflight inspection of the engine instruments and gauges is confined to visual examination of the units belonging to the sets of the instruments and gauges.

During visual examination of the instruments make sure whether they are not damaged on the outside, that they are reliably secured to the instrument boards or respective attachment brackets. See also that the plug connectors are well connected and the wires are properly terminated. Check to see that the wires are not broken at places of termination, and that the compensating wires make a reliable connection at their joints, etc.

Checking the Instruments for Correspondence to Their Basic Specifications

This check is to be carried out as soon as doubt arises as to the correctness of operation of some instruments, and at least once every three months.

In addition to the description of this check, the section contains a Table dealing with the most frequent faults, their causes and remedies.

Remote-Reading Electric Tachometers ТЭ5-2 and ТЭ-45

Check the tachometers in service on a special tachometer installation at least once every 6 months. The check consists in comparing the readings of the tachometer under test with those of a reference tachometer. The reading error of the tachometer must not exceed the values given in the "Basic Specifications" for the ТЭ5-2 and ТЭ-45 tachometers.

Thermometer ТВГ-11

The connecting wires are checked for resistance as follows:

1. Disconnect the plug connector from the indicator.
2. Using additional wires connect the terminals of the disconnected plug connector to terminals R_x of the УМВ-49 electric bridge or some other bridge ensuring measurement of resistance within the range of 0 to 10 ohms with an exactness of ±0.01 ohm.
3. Determine the resistance R_{total} of the wires connected to terminals R_x of the bridge.
4. Determine the resistance R_{add} of the wires by means of which the plug connector terminals have been connected to the terminals R_x of the bridge.
5. Determine the resistance of the thermocouple connecting wires from the formula:

$$R_{wire} = R_{total} - R_{add}$$

where R_{wire} - resistance of thermocouple connecting wires.

The resistance of the ТВГ-11 thermometer connecting wires at ambient temperature of +20 ± 5°C should be 2.5 ± 0.1 ohms. If this resistance is other than specified, it must be adjusted by changing the value of the series resistor placed inside the socket of the indicator plug connector.

The indicator is checked for reading errors as follows:

Cut the indicator into an electric circuit equivalent to the thermoelectric thermometer and employing a dry cell with a potentiometer as a source of electromotive force (See Fig.29).

The voltage fed to the indicator terminals, is measured with the aid of millivoltmeter of an accuracy class not less than 1.0. When performing this check, it is well to bear in mind that the resistance of the wires connecting the reference millivoltmeter to the indicator under check depends on the ambient temperature as well as on indicator scale division to be checked. This resistance must correspond to the values indicated in Table 7.

Table 7

Wire Resistance as Function of Temperature and Indicator Scale Division to Be Checked

Scale division to be checked	Resistance of external circuits, ohms, at ambient temperatures of		
	+20°C	+50°C	-60°C
1	2	3	4
300	2.6	2.6	2.4

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1	2	3	4
400	2.7	2.7	2.5
500	2.7	2.7	2.5
600	2.8	2.8	2.6
700	2.8	2.8	2.6
800	2.8	2.8	2.6
900	2.9	2.9	2.7

The value of the electromotive force applied to the indicator terminals depends on the scale division under check and on the calibration of the thermocouple. This value is to be found in Table 8.

Table 8

Electromotive Force as Function of Indicator Division under Check and of Thermocouple Calibration

No.	Calibration index	Value of electromotive force in mV for temperatures of						
		300°C	400°C	500°C	600°C	700°C	800°C	900°C
1	2	3	4	5	6	7	8	9
1	O	-	-	7.16	13.48	20.0	26.64	33.76
2	P	0.96	4.16	10.24	17.88	25.08	33.04	41.08
3	T	-	5.46	11.31	17.76	24.26	30.92	37.52
4	M	-	3.36	8.92	15.32	21.84	28.52	35.2
5	N	-	3.68	9.32	15.56	22.08	28.56	34.92
6	H	1.44	6.56	13.68	21.72	30.04	38.04	46.2
7	A	1.52	6.6	13.76	21.48	29.56	37.68	45.48
8	E	-	6.48	13.08	20.72	28.92	36.96	44.58
9	E	-	6.04	13.4	21.08	29.16	37.28	45.44
10	B	1.4	6.36	13.36	21.08	29.16	37.28	45.48
11	F	1.32	6.16	12.96	20.68	28.76	36.88	44.8
12	1	1.68	6.68	13.92	21.72	29.84	37.92	45.96
13	2	1.52	6.4	13.64	21.44	29.56	37.64	45.68
14	3	1.36	6.12	13.36	21.16	29.28	37.36	45.4
15	K	1.84	6.72	14.12	22.16	30.64	38.92	47.12
16	M	-	6.12	13.36	21.32	29.56	37.8	45.96

The value of the reading error is determined as the difference between the indicator reading and the actual temperature value at the given electromotive force. The indicator error must not exceed the values presented in Table 9.

Table 9

Permissible Reading Error of TBT-11 Thermometer

Ambient temperature, °C	Indicator error, °C		
	450 - 640°C	650 - 750°C	Non-working range
+20 ± 5	±10	±7	±18
+50 ± 5	±13	±13	±26
-60 ± 5	±15	±15	±30

CAUTION: The TBT-11 are manufactured with transmitters (thermocouples) of various calibration. Each calibration group has its own thermal electromotive force which differs from that of the other groups.

To distinguish one calibration group from another, each of them is given its own index indicated on the scale, thermocouple cap as well as in the Certificates.

The indicators and transmitters are mutually interchangeable in one and the same calibration group only, except groups B and B and groups A and 2 which are mutually interchangeable.

In performing the check see to it that the indicator is kept for at least 2 hours at the temperature at which the check is to be performed.

Thermometer TCT-29

The resistance of the connecting wires is checked as follows:

1. Disconnect the plug connector from the indicator.

2. Connect, with the aid of additional wires, the terminals of the disconnected plug connector to terminals R_x of the electric bridge, type MMB-49, used for measuring the resistance or some other bridge ensuring measurements accurate within 0.01 ohm.

3. Determine the resistance R_{total} of the wires connected to the terminals R_x of the bridge.

4. Determine the resistance R_{add} of the wires by means of which the terminals of the plug connector are connected to the terminals R_x of the bridge.

5. Determine the resistance of the thermocouple connecting wires from the formula:

$$R_{wire} = R_{total} - R_{add}$$

where R_{wire} - resistance of thermocouple connecting wires.

The resistance of the connecting wires at ambient temperature of +20 ± 5°C should be 9 ± 0.06 ohms.

The indicator error is checked as follows:

Cut the indicator into an electric circuit equivalent to the thermoelectric thermometer and employing a dry cell with a potentiometer as a source of electromotive force (See Fig.30). The voltage applied to the indicator terminals is measured with a millivoltmeter of an accuracy class not below 1.0. The resistance of the wires connecting the reference millivoltmeter with the indicator under check must be equal to 9 ± 0.6 ohms.

The value of the electromotive force applied to the indicator terminals

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depends on the indicator scale division to be checked and on the ambient temperature at which the check is performed. This value is to be found in Table 10.

The error value is determined as the difference between the indicator reading and the actual temperature at the given electromotive force. The indicator reading error must not exceed ±12°C within a reading range of 600 to 800°C and ±22°C on the remaining portion of the indicator scale.

CAUTION: In performing the check see to it that the indicator is kept for at least 2 hours at the temperature at which the check is to be performed.

Thermoelectric Thermometer TMT-13

The resistance of the connecting wires is checked as follows:

1. Disconnect the plug connector from the indicator.

2. Connect, with the aid of additional wires, the terminals of the disconnected plug connector to the terminals R_x of the electric bridge, type VMB-49 , used for measuring the resistance or any other bridge ensuring a measurement accuracy up to 0.01 ohm.

3. Determine the resistance R_{total} of the wires connected to the terminals R_x of the bridge.

4. Determine the resistance R_{add} of the wires, by means of which the plug connector terminals have been connected to the terminals R_x of the bridge.

5. Determine the resistance of the thermocouple connecting wires from the formula:

$$R_{wire} = R_{total} - R_{add}$$

where R_{wire} - resistance of thermocouple connecting wires.

The resistance of these wires at an ambient temperature of +20 ± 5°C should be 7.15 ± 0.05 ohms.

The indicator error is checked as follows: cut the indicator into an electric circuit equivalent to the thermoelectric thermometer and employing a dry cell with a potentiometer (Fig.30) as a source of electromotive force. The voltage of the potentiometer must be fed to a reference millivoltmeter whose accuracy class is not below 1.0. The indicator to be checked is connected to the terminals of the reference millivoltmeter through wires whose resistance is 7.15 ± 0.05 ohms.

The value of the electromotive force which is determined by the millivoltmeter depends on the scale division to be checked, as well as on the ambient temperature. This value can be found in Table 11.

The error value is determined as the difference between the indicator reading and the actual temperature value at the given electromotive force. The indicator reading error must not exceed ±5°C within the range of 100 to 260°C and ±10°C on the remaining portion of the scale.

CAUTION: In performing the check see to it that the indicator is kept for at least two hours at the temperature at which the check is to be performed.

Table 10

Electromotive Force as Function of Indicator Scale Division under Check and of Ambient Temperature

Scale division to be checked	Electromotive force in mV at ambient temperatures of										
	15°C	16°C	17°C	18°C	19°C	20°C	21°C	22°C	23°C	24°C	25°C
200	7.53	7.49	7.45	7.41	7.37	7.33	7.29	7.25	7.21	7.17	7.13
300	11.61	11.57	11.53	11.49	11.45	11.41	11.37	11.33	11.29	11.25	11.21
400	15.79	15.75	15.71	15.67	15.63	15.59	15.55	15.51	15.47	15.43	15.39
500	20.04	20.00	19.96	19.92	19.88	19.84	19.80	19.76	19.72	19.68	19.64
600	24.30	24.26	24.22	24.18	24.14	24.10	24.06	24.02	23.98	23.94	23.90
700	28.54	28.50	28.46	28.42	28.38	28.34	28.30	28.26	28.22	28.18	28.14
800	32.71	32.67	32.63	32.59	32.55	32.51	32.47	32.43	32.39	32.35	32.31
900	36.76	36.72	36.68	36.64	36.60	36.56	36.52	36.48	36.44	36.40	36.36

Table 11

Electromotive Force as Function of Indicator Scale Division and Ambient Temperature

Indicator scale division to be checked	Electromotive force in mV at ambient temperatures of										
	15°C	16°C	17°C	18°C	19°C	20°C	21°C	22°C	23°C	24°C	25°C
50	2.37	2.30	2.24	2.17	2.11	2.04	1.97	1.91	1.84	1.78	1.71
100	5.97	5.90	5.84	5.77	5.71	5.64	5.57	5.51	5.44	5.38	5.31
110	6.71	6.64	6.58	6.51	6.45	6.38	6.31	6.25	6.18	6.12	6.05
150	9.71	9.64	9.58	9.51	9.45	9.38	9.31	9.25	9.18	9.12	9.05
190	12.86	12.79	12.73	12.66	12.60	12.53	12.46	12.40	12.33	12.27	12.20
200	13.67	13.60	13.54	13.47	13.41	13.34	13.27	13.21	13.14	13.08	13.01
250	17.78	17.71	17.65	17.58	17.52	17.45	17.38	17.32	17.25	17.19	17.12
300	21.92	21.85	21.79	21.72	21.66	21.59	21.52	21.46	21.39	21.33	21.26
350	26.17	26.10	26.04	25.97	25.91	25.84	25.77	25.71	25.64	25.58	25.51

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Three-Pointer Electric Engine Gauge Unit ЭИМ-3Р

The purpose of the check is to:

(1) find the error of the instrument at an ambient temperature of +20 ± 5°C;

(2) find the insulance of the electrical elements of the pick-up units (transmitters) and indicator;

(3) determine the airtightness of the pressure gauge pick-up unit casing;

(4) determine how tilts of the indicator affect its readings;

(5) determine the resistance of the heat-sensitive element of the pick-up unit at 0°C and at +100°C.

The following equipment is required for performing the check:

1. Wire bundles for interconnecting the units belonging to the ЭИМ-3Р set in accordance with the diagrams given in Figs 31, 32 and 33.
2. Reference pressure gauges up to 15 and up to 150 kg/sq.cm.
3. Resistance box, type МСО , or any other box ensuring selection of resistances accurate within 0.1 ohm.
4. Pressure feed cocks.
5. Wheatstone bridge of УМВ type or any other bridge, ensuring measurement of the resistances accurate within 0.2%.
6. Megger with a voltage of 500 V across the feelers.
7. Mercury pressure gauge rated for 1 kg/sq.cm.
8. Source of pressure up to 120 kg/sq.cm.
9. Source of direct current, 27 V.
10. Fittings (T-pieces, pipes, etc.).

Oil Pressure Gauge

The oil pressure gauge is checked as follows:

1. Assemble the ЭИМ-3Р set in accordance with the diagram given in Fig.34.
2. Making use of the cocks create a pressure in the oil pressure gauge system of 0, 2, 4, 6, 8 and 10 kg/sq.cm. consecutively (the pressure is to be checked by a reference pressure gauge).
3. Keep the system under a maximum pressure of 10 kg/sq.cm. for 15 min.
4. Reduce the pressure in the system consecutively in the reversed order.
5. The reading error is determined as the difference between the readings of the reference gauge and those of the gauge under check.

Before taking the reading tap slightly against the indicator casing and the casing of the respective pressure pick-up unit.

The influence of inclination of indicator 2 on the readings of the set is checked simultaneously with the check for reading errors. With the indicator inclined through 90° to the right or left, the error must not exceed ±0.4 kg/sq.cm. at divisions 0, 2, 4, 6 and 8 kg/sq.cm. and ±0.6 kg/sq.cm. at division 10 kg/sq.cm.

In order to check the casing of the pressure gauge pick-up unit for airtightness, assemble the set in accordance with the diagram in Fig.35.

Open the inlet cock and create a pressure of 850 mm of mercury in the pick-up unit casing and in the sensitive element simultaneously. Close the inlet cock and watch the mercury level during one minute. Drop of the mercury level for one minute must not exceed 8 mm.

The insulance of the current-carrying elements of the pick-up units and indicators with respect to their casings should be at least 20 megohms at an ambient temperature of +20 ± 5°C and relative humidity of 30 to 80%.

Fuel Pressure Gauge

The fuel pressure gauge is checked in the same way as the oil pressure gauge. The reading error of the fuel pressure gauge at divisions 10, 20, 40, 60, 80 and 90 kg/sq.cm. must not exceed ±5 kg/sq.cm.

Oil Thermometer

In order to perform the check, cut the temperature indicator into the circuit shown in Fig.34. Set resistance on the resistance box which would correspond to the indicator scale division to be checked. The resistance values are to be found in the respective table.

The error is determined as the difference between the reading of the temperature indicator and the temperature value for which the resistance has been selected in the resistance box. The error must not exceed ±4°C at divisions -40, 0, 50, 100 and 130°C, and ±6°C at divisions -50 and +150°C.

The resistance of the heat-sensitive element of the oil thermometer is determined with the aid of an УМВ Wheatstone bridge or any other instrument which will ensure a measurement accuracy within ±0.2% . Submerge first the temperature pick-up unit into a vessel with thawing ice, measure the resistance of its sensitive element, then submerge it into boiling water and measure the resistance again. The resistance is to be measured not earlier than in 5 min. after the pick-up unit was submerged into the respective medium. During the check the entire thin cylindrical portion of the pick-up unit must be submerged in the medium under check.

The resistance of the pick-up unit sensitive element must correspond to the resistance indicated in the Certificate of the given pick-up unit.

CAUTION: 1. Pressure must be supplied to the fuel pressure gauge pick-up unit through a plate damper only. Inobservance of this condition leads to premature failure of the pick-up unit.

2. Prior to installing on the aircraft a damper that was already in use, it must be checked as follows:

(a) connect it to the compressed air system and apply a pressure of 2 - 3 atm.;

(b) if the air passes through the damper, the latter may be installed on the aircraft.

Remote-Reading Electrical Pressure Gauge ЭДМУ-3

The ЭДМУ-3 pressure gauge is checked in the same way as the oil pressure gauge of the ЭИМ-3Р set. The wire bundle diagram for checking the ЭДМУ-3 oil pressure gauge is given in Fig.31. The error of the ЭДМУ-3 set within the measurement range of 0.6 to 2.4 kg/sq.cm. must not exceed ±4% from the rated value of the scale.

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TROUBLES AND REMEDIES

Trouble	Probable cause	Remedy
1	2	3
Tachometers T3-45 and T35-2		
With the engine running the instrument pointer will not start from zero	(a) Broken wires between generator and indicator (b) Wires from generator to indicator short-circuited	Find faulty place and remedy the wires Find and remedy fault
Indicator readings too low	Faulty indicator	Replace indicator
Thermometer TBT-11		
Indicator pointer stands against zero division when temperature in inner cone differs considerably from instrument reading	(a) Thermocouple or connecting wires open-circuited (b) Connecting wires contact each other (c) Thermocouple ends in junction box are connected in opposition (d) Faulty indicator	Find and remedy fault Find and remedy fault Rearrange the thermocouple ends in accordance with the diagram given in the description Replace indicator
Indicator pointer deflects to left from zero	Polarity in junction box or indicator plug connector reversed	Connect wires in accordance with diagram given in description
Indicator pointer dances	Poor contact in connecting wires	Find and remedy fault
Indicator reading too low as compared with actual temperature in inner cone	(a) Wires of one or several thermocouples closed (b) Polarity of one thermocouple reversed (c) Indicator circuit faulty (d) Poor contact in connecting wires	Find and eliminate fault Connect wires in accordance with diagram Replace indicator Find and eliminate fault
Indicator reading too high as compared with actual temperature in inner cone	Faulty indicator	Replace indicator
Thermometer TOT-29		
Gauge pointer stands against zero division when temperature in inner cone differs	(a) Connecting wires open-circuited (b) Indicator plug connector open-circuited	Find and eliminate fault Find and eliminate fault

1	2	3
considerably from instrument readings	(c) Thermocouple open-circuited (d) Faulty indicator (e) Connecting wires short-circuited	Replace thermocouple Replace indicator Find and eliminate fault
Instrument readings too low	(a) Faulty indicator (b) Poor contact in connecting wires	Replace indicator Find and eliminate fault
Instrument readings too high	Faulty indicator	Replace indicator
Instrument readings not stable	Defective contact in places of connecting wire joints	Find and eliminate fault
	Thermometer TMT-13	
With thermocouple cut in, instrument indicator will not operate	(a) Compensatory wires open-circuited (b) Faulty indicator (c) Connecting wires contact each other	Find and eliminate fault Replace indicator Find and eliminate fault
Instrument readings not stable	(a) Defective contact in places of connecting wire joints (b) Faulty indicator	Find and eliminate fault Replace indicator
Instrument readings too low	(a) Poor contact in places of connecting wire joints (b) Faulty indicator	Find and eliminate fault Replace indicator
Instrument readings too high	Faulty indicator	Replace indicator
	Engine Gauge Unit EMM-3P	
	Fuel Pressure Gauge	
When power supply is switched on, pointer remains in position OFF	(a) No power in mains	Check power supply line and remedy it if it is broken
	(b) Faulty contact in plug connector terminals B	Remedy plug connectors
	(c) Flexible wire in pressure pick-up unit broken	Replace pressure pick-up unit
	(d) Faulty brush contact in pressure pick-up unit	Replace pressure pick-up unit
At no pressure pointer shows 70	Reversed polarity	Reverse polarity

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1	2	3
At no pressure pointer will not come to stand against zero division	(a) Pick-up unit potentiometer turns shorted (b) Membrane swollen	Replace pressure pick-up unit Replace pressure pick-up unit
At no pressure pointer will not stand against division 6 kg/sq.cm.	Wire running to plug connector terminal A broken	Find and remedy fault
When pressure is increased up to 100 kg/sq.cm. pointer stops against division 40 kg/sq.cm. and returns to 6 kg/sq.cm.	Faulty contact in plug connector terminals A	Find and remedy fault
At no pressure pointer stops against division 100 kg/sq.cm.	Wire running to plug connector terminal Б broken	Find and eliminate fault
When pressure is increased, pointer goes to division 60 kg/sq.cm. and returns then to 100 kg/sq.cm.	Faulty contact in plug connector terminals Б	Find and eliminate fault
At no pressure pointer stands below zero division	Wire running to plug connector terminal Г broken	Find and eliminate fault
When pressure is increased pointer moves between divisions 0 and 100 outside the scale	Faulty contact in plug connector terminals Г	Find and remedy fault
At no pressure pointer stands at division 30 kg/sq.cm.	Wire running to plug connector terminal Д broken	Find and correct fault
When pressure is increased, pointer shifts to 70 kg/sq.cm. and then returns to 30 kg/sq.cm.	Faulty contact in plug connector terminals Д	Find and correct fault
Oil Pressure Gauge		
When power supply is switched on pointer will not start from low division, but this happens when indicator is shaken	(a) No power in supply line (b) Brush contact in pressure pick-up unit broken	Check power supply line and remedy it if it is broken Replace pressure pick-up unit
With power supply switched on pointer is pressed to lower rest and will not	(a) Reversed polarity (b) Wire running to plug connector terminal В broken	Reverse polarity Find and correct fault

1	2	
move away from it when indicator is shaken	(c) Faulty contact in plug connector terminals В	Find and correct fault
With power supply switched on, pointer is pressed to upper rest	Broken wire or faulty contact in plug connectors	Find and correct fault
In checking instrument for error corrections are beyond permissible limits	(a) Wrong adjustment of pressure pick-up unit (b) Amount of indicator adjustment resistances has changed	Replace pressure pick-up unit Replace indicator
Oil Thermometer		
When power supply is switched on pointer will not move away from lower rest	No power in supply line	Check power supply line and remedy it if it is broken
Pointer leaves lower rest when indicator is shaken	Faulty contact in indicator plug connector	Find and correct fault
With power supply switched on, pointer is pressed to lower rest	Broken wire or faulty contact in plug connector	Find and remedy fault
With power supply switched on, pointer is pressed to upper rest	(a) Sensitive element broken (b) Broken wire	Replace temperature pick-up unit Find and remedy fault

ELIMINATION OF COMPASS DEVIATION ON INSTRUMENTS ДГМК-7 , АРК-5 NOS 1 AND 2 AND КИ-12

Checking ДГМК-7 Compass for Synchronous Operation with НИ-50Б Air Position Indicator

In case faulty compasses are replaced by new one, as well as when wrong readings have been discovered in the flight or in case of compass misalignment, check the compass for operation on the ground and calibrate the compass.

Ground swinging is performed also when replacing:

(a) engines;
(b) ДГМК-7 compass transmitter;
(c) УШ navigator's indicators of ДГМК-7 compass;
(d) frames of АРК-5 compass Nos 1 and 2.

Compass calibration on the aircraft is performed in order to determine and correct semi-circular deviations and to determine or compensate the residual deviation.

The automatic course device of the НИ-50Б air position indicator is checked for synchronous operation with the navigator's main indicator УШ of the ДГМК-7

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compass in order to determine the mismatching angle. If this angle exceeds 1°, use the deviation adjusting screws to synchronize the pointer readings.

General

1. Before bringing the aircraft to the deviation correcting ground, check the operation of the instruments, which are to be used during elimination of deviations.

2. Operations related to elimination of deviations are to be performed on special ground located at least 300 m. away from steel structures, underground power cables, metal tubes, buildings, H.T. lines, forests and other objects causing a change in the earth magnetic field.

3. The attending personnel who takes part in operations on correcting devi tion should not use any tools made of ferromagnetic materials (steel screwdrivers, flat pliers, etc.).

4. Deviations are to be eliminated with the engines stopped.

5. KI-12 and ДГМК-7 compasses are to be calibrated simultaneously (both compasses must be checked without fail).

Calibrate АРК-5 compasses Nos 1 and 2 separately.

6. Supply the electric mains of the aircraft from a ground source of power through a special plug connector. The mains voltage is 27.5 - 28 V D.C. and 115 ± 0.5 V A.C., 400 c.p.s. (through airborne inverter ПО-4500).

7. Before starting to correct deviation do the following:

(a) switch on the СПУ-10 interphone set;

(b) switch on the ЗУП-53 turn indicator;

(c) switch on two АГБ-2 gyro horizons (the АГБ-2 gyro horizon mounted on the right-hand board and one of the АГБ-2 gyro horizons installed on the left-hand board;

(d) switch on the ГМК-52 directional gyro;

(e) unlock the controls, place the pedals and control wheels in neutral position;

(f) set the РЕП-4 indicator of the navigator in stowed position;

(g) switch on the АП-5-2М autopilot;

(h) set up the clock (working);

(i) place the armament and sight post in stowed position;

(j) set the ОПБ-11р sight.

8. In addition to the above-said follow the instructions given in the descriptions of the АРК-5 , КИ-12 , ДГМК-7 and НИ-50Б instruments.

Installation of Direction Finder on Aircraft and Position of Aircraft When Turning to Assume Required Headings

1. The aircraft is headed with the aid of a ДП direction finder.

Note: To head the aircraft it is advisable to use the method of "tail" direction finding at a distance of 150 - 200 m. In this case the ДП direction finder must be placed at the above distance from the rear cabin of the aircraft on a tripod.

2. The sequence of heading an aircraft is given in the description of the deviation direction finder. This description is supplied with the instrument along with the Service Log.

3. When the aircraft is headed the L.H. wheel of the main landing gear

should describe the circumference marked off on the deviation ground, the right ing being inside the circumference.

4. The aircraft is turned by a towing truck with the aid of a drawbar.

Note: In case the truck and drawbar influence the readings of the compasses they should be taken away from the aircraft each time the aircraft is turned to a new heading.

Elimination of Deviation of ДГМК-7 Remote-Reading Gyro-Magnetic Compass

Correction of compass deviation consists of:

(1) elimination of permanent and semi-circular deviation by means of the deviation instrument of the ПДК-3 transmitter (first stage);

(2) elimination of quarter deviation and remote-reading errors of the ПДК-3 transmitter with the aid of a mechanical compensator (profiling device) located in the navigator's indicator (second stage).

Elimination of Permanent and Semi-Circular Deviation

Permanent deviation is corrected as follows:

(a) switch on power supply to the compass;

(b) in two-three minutes after switching on power supply to the compass proceed to correction of permanent deviation for which purpose place the aircraft at magnetic courses of 0, 90, 180 and 270° in turn;

(c) at each of the magnetic courses determine the deviation as the difference in the readings of the magnetic course of the aircraft and the compass course scale of the navigator's indicator.

Each time before taking the readings, align the navigator's indicator and the transmitter by pressing the slaving button. Keep the slaving button pressed not less than 15 sec.

The algebraic deviation sum at all four courses divided by four will produce the setting error.

If permanent deviation exceeds 2°, it should be eliminated by turning the ПДК-3 transmitter, for which purpose ease off the screw and turn the transmitter casing in the ring with respect to the base through an angle equal to that of the permanent deviation. The casing turning angle is counted by the scale available on the ring.

Semi-circular deviation is corrected by permanent magnets of the deviation instrument at all four magnetic courses (0, 90, 180 and 270°). The semi-circular deviation at the given four magnetic courses is determined in the same way as when correcting permanent deviation. Here we usually encounter two cases:

First case. At courses 0 and 90° the initial deviation exceeds 10°. In this case place the aircraft at zero° and turn the extension piece (magnet) N - S to zero the deviation; at magnetic course 180° turn the same extension piece to halve the deviation value; at magnetic course 90° turn the extension piece E - W to zero the deviation; at magnetic course 270° turn the same extension piece to halve the deviation.

Second case. At courses 0 and 90° the initial deviation is less than 10°. In this case determine and record the deviation at magnetic courses 0 and 90°. At magnetic course 180° bring the deviation value to $\frac{(C_0 + C_{180})}{2}$. At magnetic course 270° bring the deviation value to $\frac{(C_{90} + C_{270})}{2}$.

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Elimination of Total Quarter Deviation and Remote-Reading Error

The total error is corrected as follows:

(a) place the aircraft at one of the 24 courses (0, 15, 30, 45°, etc.), at which the compass error is the least;

(b) align the indicator with the transmitter by pressing the slaving button;

(c) making use of the handle of the navigator's indicator, place the magnetic variation scale to zero, setting index S against zero;

(d) turn off the adjusting wrench and remove the pad to give access to the 24 adjusting screws;

(e) eliminate the compass error at the given course by turning that screw at which the pointer of the navigator's indicator indicates. The screw is turned with the aid of the adjusting wrench.

Example. The aircraft is placed exactly at 180°, the slaving button is pressed, the indicator pointer shows 181°. Turn the screw at which the pointer indicates to place the pointer exactly against division 180°, and the compass error at the given point will be eliminated.

The compass errors at the other points are eliminated after each turn of the aircraft through 15° in the same sequence as indicated above.

After elimination of deviation, the instrument pad must be put in place and the adjusting screw turned into its seat.

Simultaneously with residual error elimination and making charts of the navigator's indicator residual errors, make also charts of the repeaters residual errors.

Notes: 1. When eliminating deviation, with the engines stopped, take the indicator reading only after correcting the lag of the magnetic transmitter which is achieved by tapping the instrument on the casing.

2. The maximum error which can be eliminated with the help of any adjusting screw is 8°.

Elimination of Deviation of KI-12 Magnetic Compass

Prior to eliminating the deviation of the KI-12 magnetic compass, do not fail to switch off the fans and the glass electric heaters. Elimination of deviation of the KI-12 compass consists in determining and correcting the setting error, eliminating the semi-circular deviation and in determining and correcting the residual deviation.

Determination and Elimination of Setting Error

(a) Place the aircraft at the four main magnetic courses (0, 90, 180 and 270°) and calculate the setting error as the algebraic sum of the four deviation readings divided by 4.

(b) Correct the setting error of the navigator and pilots' compasses by turning the brackets through the value of the setting error. Turn the bracket to the left in case of a plus error and to the left in case of a minus error.

Elimination of Semi-Circular Deviation

(a) Place the aircraft at zero magnetic course. Use magnet N - S to make the compass read zero.

(b) Place the aircraft at magnetic course 180°. Use magnet N - S to halve the deviation $\frac{(C_0 + C_{180})}{2}$

(c) Place the aircraft at magnetic course 90°. Use the E - W magnet to set the compass exactly at 90°.

(d) Place the aircraft at magnetic course 270° and use the E - W magnet to halve the deviation: $\frac{(C_{90} + C_{270})}{2}$.

Determination and Elimination of Residual Deviation

Residual deviation is determined and corrected at eight points: 0, 45, 90, 135, 180, 225, 270 and 315°.

Correct the deviation charts. Residual deviation must not exceed ±5°.

Elimination of Radio Deviation of APK-5 Radio Compasses Nos 1 and 2

General

1. The azimuth rings of the APK-5 compass No.1 have black-painted numerals, whereas those of APK-5 compass No.2 are painted red. On some aircraft the numerals on the rings of both compasses are painted black.

2. The frames of APK-5 compasses Nos 1 and 2 should be compensated in accordance with Tables 12 and 13.

Note: The difference in the tables is a result of different installation of the frame of APK-5 compass No.2.

Table 12

Standard Correction Compensating Angles at Eliminating Radio Deviation of APK-5 Compasses Nos 1 and 2

Radio station course angle, deg.	Averaged ΔP for compensation, deg.		Radio station course angle, deg.	Averaged ΔP for compensation, deg.	
	APK-5 No.1	APK-5 No.2		APK-5 No.1	APK-5 No.2
0	0	0	180	0	0
15	+12	+6	195	+11	+6
30	+18	+11	210	+16	+12
45	+19	+14	225	+16	+15
60	+16	+14	240	+13	+16
75	+10	+10	255	+7	+10
90	+3	+1	270	0	+1
105	-5	-6	285	-7	-6
120	-9	-10	300	-13	-10
135	-14	-12	315	-16	-11
150	-13	-9	330	-16	-9
165	-10	-6	345	-12	-5

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Table 13

Standard Correction Compensating Angles
at Eliminating Radio Deviation of APK-5
Compasses Nos 1 and 2

Radio station course angle, deg.	Averaged ΔP for compensation, deg.		Radio station course angle, deg.	Averaged ΔP for compensation, deg.	
	APK-5 No.1	APK-5 No.2		APK-5 No.1	APK-5 No.2
0	0	0	180	0	-1
15	+12	+12	195	+11	+11
30	+18	+16	210	+16	+16
45	+19	+16	225	+16	+16
60	+16	+12	240	+14	+12
75	+8	+7	255	+8	+6
90	+3	+0	270	0	0
105	-6	-9	285	-6	-8
120	-9	-13	300	-13	-14
135	-15	-18	315	-16	-17
150	-13	-18	330	-15	-18
165	-10	-13	345	-12	-12

3. In correcting radio deviation, see that the aircraft is placed from ty
НАР or МПАР radio station at a distance of at least three wave lengths. I
the power of the radio station exceeds 10 kW, the aircraft should be placed at
a distance of at least 100 km. from the station.

4. Radio deviation must be performed not earlier than 1 hr 30 min. after
rise and not later than 1 hr 30 min. before sun set.

Elimination of Radio Deviation of APK-5
Compass No.1

1. Determine and correct the setting error as follows:

(a) place the aircraft by the compass at a course which is approximately equal to the magnetic bearing of the radio station which is used for deviation correction;

(b) using the deviation direction finder place the aircraft exactly at the magnetic course equal to the radio station magnetic bearing;

(c) tune the APK-5 compass in the radio station frequency, fine and recom the inverse radio bearing. If the latter is not equal to zero, the frame has a setting error;

(d) to eliminate the setting error, turn off the six bolts and turn the frame base through an angle equal to the setting error: in case of a plus error turn the frame base clockwise, in case of a minus error turn it counter-clockw

2. In order to determine and eliminate radio deviation, do as follows:

(a) position the aircraft at the magnetic course;

(b) adjust the radio compass receiver for the selected radio station, all it to warm up during 5 minutes and correct the deviation at 24 inverse radio bearings: 0, 15, 30, 45°, etc.;

(c) in case the deviation error exceeds ±3° remove the frame of the APK-5 compass No.1 and balance it. Then correct the deviation again at 24 inverse ra bearings;

(d) residual radio deviation must not exceed ±3°, including the frame setting error.

Note: At course angles 0 and 180° residual deviation must not exceed ±1°.

Elimination of Radio Deviation of
APK-5 Compass No.2

1. Determine, in flight, the setting error with the radio station course angle being equal to zero.

2. Correct the frame setting error on the ground, for which purpose remove the frame from the bracket, turn out the 6 bolts and turn the frame base through an angle equal to the setting error: in case of a minus error, turn the frame base clockwise, and in case of a plus error turn it counter-clockwise, watching at the same time the readings of the pointer of the APK-5 compass No.2 on the navigator's selsyn indicator.

3. During the next flight (with the landing gear retracted) check compasses Nos 1 and 2 for correct readings at eight points by the ГПК-48 directional gyro or a landmark (at any altitude). The difference in the readings of the compasses tuned to one and the same radio station at radio station course angles equal to 0° and 180° must not exceed 2°, and at the remaining course angles this difference must not exceed ±3°, the radio deviation of APK-5 compass No.1 taken into account.

Notes: 1. The radio station course angle is to be taken by compass No.1 tuned to a distant radio station (300 - 400 km.) or to an airfield homing station of НАР-3Б type (100 - 150 km.).
2. Take the readings off the navigator's selsyn indicator of compass No.2 with antenna No.1 cut in and vice versa.

4. When approaching for landing (with landing gear extended check compasses Nos 1 and 2 for differences at radio station course angles equal to 75, 120, 240 and 285°. See that the difference in the readings of the compasses tuned to one and the same radio station does not exceed 13° with the deviation error of compass No.2 being taken into account.

Note: The radio station course angle is to be taken by compass No.1 tuned to a distant or homing station, and the results are to be entered into the aircraft Log Book.

5. Check the entries in the aircraft Service Log relating to the readings of APK-5 compass No.2 at radio station course angles equal to 75, 120, 240 and 285° with the landing gear extended.

6. With the landing gear retracted, the residual radio deviat for APK-5 compass No.2 must not exceed ±3°; for course angles equal to 0° and 180° the residual deviation must not exceed ±1°.

Alignment of Automatic Course Device
Indicator of НИ-50Б Air Position Indicator
with Navigator's Course Indicator of ДГМК-7
Compass

After eliminating deviation of ДГМК-7 compass check the pointer of the ДГМК-7 compass navigator's indicator for synchronous movement with the automatic course device indicator of the НИ-50Б air position indicator. The courses on both indicators should be aligned, the pointers should move in the same direction. The alignment check is to be performed at courses from 0° to 360° every 15°.

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Alignment is considered satisfactory, if the difference in the readings of the automatic course device and the compass indicator at courses divisible by 15°, does not exceed 1°, otherwise align the courses with the aid of the adjusting screws of the НМ-50Б air position indicator automatic course devi (Fig.24). After adjustment is over, repeat the adjustment check at all points from 0° to 360° every 15°.

AUTOPILOT АП-5-2М

GENERAL

The АП-5-2М autopilot serves:

(1) for automatic stabilization of the aircraft with respect to the three axes in a straight flight;

(2) for performance of an automatic compensated turn and aircraft additional turns during lateral aiming;

(3) for ensuring stabilization of the sight in azimuth.

Complete Set and Arrangement of АП-5-2М Autopilot Units on Aircraft

The directional stabilizer is arranged on a special bracket on frame No.1 in the front pressurized cabin (Fig.36).

The vertical flight gyro is installed on a special bracket in the front pressurized cabin behind the seat of the left pilot (Fig.37).

The precession gyro unit and ПАТ-1Ф inverter are positioned at the left wall between frames Nos 19 and 20 (Fig.38).

The servo units of the ailerons are located on frame No.33, those of the rudder and elevator are positioned on a special wing on frame No.68. The elevator servo unit is located to the left and the rudder servo unit is positioned to the right.

The control panel is located on the upper electric board of the pilots (Fig.39).

The pilot director indicator (P.D.I.) is arranged on the instrument board of the left-seat pilot (See Fig.110).

The turn remote control handle is located on the right-hand side of the electric panel of the navigator-radar operator.

The amplifier, НО-45 inverter, distributing box, relay box, resistance box for changing the pitching moment are positioned on the left-hand rack of the navigator-radar operator.

Emergency disengaging buttons are located on the spokes of ailerons control steering wheel of the left and the right pilots.

The formation stick and the control transfer are located on the swivelling bracket on the middle panel of the pilots (See Fig.40).

The directional stabilizer attachment bracket is ar anged on frame No.1.

The pitching moment limit switch, type ВК2-1418, is positioned on frame No.33 in the mechanism of the bomb bay limit switches.

Specifications of АП-5-2М Autopilot

1. The autopilot employs direct current, 27 ± 2.7 V.

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2. Power consumed by the АП-5-2М autopilot from the aircraft mains at 27 V at rated load of the servo units (110 kg/cm. on the cable drum) does not exceed 500 W.

3. Power consumed by heating hoods from the aircraft mains does not exceed 250 W.

4. The operating temperature interval of the autopilot set is -45 to +50°C.

5. The autopilot operates normally within a temperature range from -20 to -45°C only when its heating system is switched on.

6. Departure of the directional stabilizer from the course at any point during 15 min. of operation of the "yawing base" does not exceed 3.5°.

7. Total departure of directional stabilizer from the course at the four main points during 15 min. of operation at each point on the "yawing base" does not exceed 8°.

8. Resistance between the contact brush and the aileron pick-up potentiometer centre tap on the directional panel of the directional stabilizer does not exceed 5 ohms; the difference between the resistances of the rudder pick-up potentiometer winding arms does not exceed 5 ohms.

9. The contacts of the vertical flight gyro erecting mechanism cutout close when the F.D.I. potentiometer pointer deflects 1 - 1.5° to the left and right from the zero position.

10. The total deflection of the vertical flight gyro rotor axis in both directions from the vertical at normal temperature does not exceed 1.4°.

11. Maximum deflection of the rotor axis from the vertical of the vertical flight gyro is 1.2°.

12. The erecting time of the vertical flight gyro cardan unit from 45° tilts in each of the four quadrants is 2 - 10 min., the difference between the maximum and minimum erecting time from tilts at normal temperature must not exceed 4.5 m

13. Power consumed by servo unit at normal temperature, 27 V and 110 kg/cm. load moment on cable drum does not exceed 80 W.

14. The braking effort developed by the servo unit on the cable drum at normal temperature is from 75 to 100 kg.

15. Servo unit potentiometer. Tension:
(a) potentiometer winding brushes (total) - 25 to 45 gr;
(b) slip ring brushes (total) - 20 to 40 gr;
(c) limit switch plates - at least 150 gr.

Resistance of working portion of potentiometer winding is 1100^{+200}_{-150} ohms.

16. Power supply of amplifier circuits:

(a) valve filament	D.C., 27 ± 2.7 V;
(b) transformers	A.C., 125 ± 15 c.p.s., 17.5 ± 2.5 V;

(c) voltage in secondary windings of bridge transformers at supply voltage of 17.5 V and frequency of 125 c.p.s. - 27 ± 2 V;

(d) throttling voltage:	
maximum	80 - 20 V
minimum	25.5 ± 7.5 V

17. Power consumed by amplifier:

(a) valve filament	30 W maximum
(b) transformers	40 VA maximum

18. Control panel resistances:

(a) centring potentiometers	200 ± 20 ohms;
(b) sensitivity potentiometers	0.33 ± 0.066 megohms;

(c) ratio rheostat	600 ± 60 ohms;
(d) trimming potentiometers	250 ± 25 ohms;
(e) compensating potentiometer	2000 ± 200 ohms;
(f) control transfer potentiometer	2000 ± 200 ohms;
(g) turn control potentiometer	1000 ± 100 ohms.

19. Inverter ПО-45:

(a) output power	43.5 VA;
(b) A.C. voltage	18.3 ± 0.5 V;
(c) A.C. frequency	$125^{+5}_{-7.5}$ c.p.s.;
(d) duty of operation	long-time

20. Inverter ПАГ-1Ф

(a) load current	0.32 A;
(b) A.C. voltage	36 ± 4 V;
(c) A.C. frequency	400 c.p.s.;
(d) number of phases	3

21. The alternating current in the gyro motor phase of the precession gyro must not exceed 0.35 A.

22. Precession gyro sensitivity must meet the following requirement: at an angular velocity not exceeding 0.1°/sec. voltage should appear and be registered by the voltmeter.

23. The precession gyro operates within an angular velocity range of ±3°sec. +0.5°/sec.

24. Time required for formation stick to return to neutral position from any extreme position is from 0.3 to 1.5 sec. both for the "aileron" and "elevator".

25. The contacts of the formation central switch close before the signal comes from the aileron potentiometer.

26. The button serving to switch off the aircraft control from the autopilot has normally closed contacts. When the button is pressed the contacts open.

27. The brush surface contacting the commutator should constitute at least 85% of the brush section.

28. The time required for the navigator to additionally turn the aircraft, with the autopilot coupling engaged at 4 to 6°, must not exceed 18 sec.

29. With the autopilot in operation the control surfaces should deflect:

(a) ailerons	±4 ±0.5°;
(b) rudder	±5 ±0.5°;
(c) elevators	±5 ±0.5°;

30. The elevator neutral position corresponds to a deflection of the elevator by 2° downward.

31. Elevator deflection when the bomb bays are opened at a speed of 450 km/hr is equal to 20 ± 5 angular minutes.

32. The АП-5-2М autopilot set employs the following valves:

(a) 6 x 5	1 piece;
(b) 6Н8М	3 pieces;
(c) 6Н6М	3 pieces.

33. The insensitivity zone of the АП-5-2М autopilot with the sensitivity handles shifted to minimum position is as follows:

(a) aileron	at least 1.5°;
(b) rudder	at least 0.50°;
(c) elevator	at least 1.0°.

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34. The insensitivity zone of the AP-5-2M autopilot with the sensitivity handles shifted to maximum position is as follows:

(a) aileron ..... not in excess of 0.4°;
(b) rudder ..... not in excess of 0.25°;
(c) elevator ..... not in excess of 0.4°.

35. The temperature inside the electric heating hoods is maintained by a thermal relay within the range of from 10 to 45°C.

36. The minimum length of the brushes at which they should be replaced is given in Table 14.

Table 14

Minimum Length at Which Brushes Should Be Replaced

Name of unit	Mark of brush and index	Length of brush, mm	
		minimum	rated
1	2	3	4
Directional stabilizer:			
gyro	MTC-7	22	28
erecting motor	MTC-7	11 - 12	18.5
Vertical flight gyro:			
gyro	MTC-7	18	24
servo unit	MT-4A-A6	15 - 16	24
Inverter PO-45:			
A.C. commutator	MT-4A-A6	4.5 - 5	10.5
D.C. commutator	MT-4A-A6	6 - 6.5	13.5
Inverter PAT-10:			
D.C. commutator	MC-6	10	14

CHECKING AUTOPILOT FOR INSTALLATION ON AIRCRAFT AND OPERATION UNDER CURRENT

EXTERNAL INSPECTION

Directional Stabilizer

1. Check the bracket for proper attachment and see that the directional gyro is reliably secured to the bracket.

2. Engage and disengage the autopilot and sight couplings several times to make sure that the engagement mechanism functions correctly. When disengaged, the couplings should rotate freely on their drums without binding or dragging the drums along with them.

3. Examine the locking mechanism unit to make sure that the locking mechanism plunger is locked with its nut. Shift the solenoid plunger several times downward to make sure that the return spring returns the entire lever system and the plunger to the initial position. As the plunger goes downward, the lever of the autopilot coupling must be pressed. Remove dirt and foreign particles.

4. Make sure that the locking mechanism does not interfere with the movement of the autopilot coupling lever; see also whether there is a clearance between the "jaws" of the locking mechanism and autopilot coupling.

5. Take out the course panel cover and make sure that there is no dirt or dust inside the casing or on the potentiometers.

6. With the sight mounted, check to see that the wire bundles do not interfere with free movement of the sight with respect to the drift angles.

7. Make sure that the handles of the directional stabilizer bracket rotate without binding and allow the stabilizer to be set by a level.

8. Using a dynamometer check the tension of the autopilot, sight and drift gear couplings in accordance with Table 15.

Table 15

Spring Tension on Directional Stabilizer Couplings

Name of coupling	Spring tension by dynamometer, kg	
	minimum	maximum
Autopilot coupling	6	7
Sight coupling	8	9
Drift gear coupling	4	5

Control Panel

1. Check the handles for reliability of attachment on the shafts.

2. Check the rotation of all control panel handles within their turning limits. All handles should rotate smoothly and without binding except:

(a) turn control handle; when the pointer approaches the shaded portion of the scale and the zero position, a resistance to handle rotation should be left.

(b) turn compensator control drive handle; when the pointer approaches the position "Pilot", rotation of the handle becomes more difficult.

3. Check the plate of the switches for correct functioning and for proper attachment to the switches.

4. Make sure that all the pointers of the control panel handles are reliably secured and move only when the handles are turned.

Notes: 1. After the check handles "RATIO", "TURN COMPENSATOR", "INCREASE BANK", "TO DECREASE SKID" and "UP ELEV." must be placed in position determined in the air.

2. After the test is over set the drive control handle of the turn compensator into position "Pilot".

Pilot Director Indicator (P.D.I.)

1. Check the instrument for reliability of attachment.

2. Check the condition of the glass.

3. Check the pointer and instrument scale for presence of luminous compound.

Autopilot Switch-Off Button

1. Check the button for reliability of attachment in the splines of the aileron control wheels.

2. Press the buttons several times to make sure that they return to their initial position without binding.

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Formation Stick

1. Make sure that the stick after being deflected and released returns t its central position.

2. Check to see that the buttons on the stick do not bind when being pra and return to the initial position.

Formation Stick Control Transfer

1. Check the stick for reliability of attachment on its shaft.

2. Set the control transfer in all positions and make sure that control transfer is performed without considerable efforts and that the stick is firml held in the selected position.

Vertical Flight Gyro

1. Check the attachment of the vertical flight gyro and see that there ar no cracks on the shock absorbers.

2. Examine the plexiglass cover in the upper part of the vertical flight gyro and make sure that the cover is placed in a position at which the vertica flight gyro is uncaged. The plexiglass cover must not be cracked or have any deep scratches.

Amplifier

Check the amplifier for reliability of attachment, good condition of shoc absorbers and bonding.

Inverters

Check the inverters for reliability of attachment.

Distribution Box

1. Check the distribution box in accordance with the requirements presori ed in Section "Aircraft Electric Mains" (See "Care of Split Boxes and Electric Boards").

2. Check the external condition and correctness of installation of series resistors on terminals E-1 and E-3 , as well as on terminals E-6 and E-8 which are equal to 400 ohms.

Relay Box

1. Check the relays for reliability of attachment in their seats.

2. Make sure that there are no metal chips, dust or any foreign objects inside the boxes.

3. Examine tightening of the nuts and attachment shoes of the wires.

4. Check to see that all the wires and their insulation are in good condi tion.

Precession Gyro Unit

Check to see whether the precession gyro unit is reliably secured and that its surface has no dents or scores.

Servo Units

1. Check tightening of the bolts which secure the servo units.

2. Deflect the rudder and elevators into both sides and make sure that th cable is wound around the drum and that it permits shifting of the rudder and elevators into both directions.

3. Press the tension springs of the braking solenoids and make sure that,

after pressure is removed, the rods and levers of the braking solenoids return to their initial position.

4. Make sure that there is no dirt or oil on the potentiometer contact brush and winding. Check the tension of the potentiometer contact brush.

5. Check the potentiometer brushes for reliability of attachment on braking drum.

6. Place the rudder and elevators in neutral position and make sure that the contact brushes of the follow-up system are centred, whereas the slide moving along the potentiometer is in its down position.

Turn Remote-Control Button

1. Check to see that the handle is reliably attached on the potentiometer shaft.

2. Make sure that the handle rotates freely, without binding, except in position "0" and in the shaded portion of the scale where a resistance is felt in turning the handle.

Resistance Box for Changing the Pitching Moment

1. Check the resistance box for reliability of attachment.

2. Check the wires for reliability of attachment to the resistance box.

Note: When inspecting the autopilot units, examine the condition of the plug connectors of the units. The plug connectors should be tightened as far as they will go, have no considerable play and be locked with safety wire.

Checking Operation of Energized Autopilot

CAUTION: Prior to checking the autopilot for operation, do not fail to unlock the aircraft controls and remove the service ladders, covers and other objects. Stop any operations on the aircraft controls.

1. Switch on the A3C-15 autopilot circuit breaker on the circuit breaker board of the left-seat pilot and the A3C-2 "Servo" circuit breaker on the circuit breaker panel of the navigator.

2. Actuate the plate on the panel to switch on the master switch and the "Stab." switch; then make sure that:

(a) the gyro motors of the directional stabilizer and vertical flight gyro, the precession gyro unit, inverters and servo unit motors are already operating; this is determined by the peculiar noise of the running motors;

(b) the erecting roller rotates properly.

3. After cutting in the master switch wait 5 to 8 minutes and then switch on the "Servo - P.D.I." switch on the control panel. This will cause the directional stabilizer erecting motor to operate.

4. Disengage the autopilot coupling and shift it to the left and right to check whether shifting of the P.D.I. potentiometer brush causes the P.D.I. pointer to deflect. When the potentiometer brush is moved to the left, the P.D.I. pointer should gradually deflect to the right and vice versa.

5. Place the P.D.I. potentiometer brush at zero. The P.D.I. pointer should also be at zero. Then engage the autopilot coupling.

6. Shift the aircraft control surfaces (rudder, ailerons, elevators) manually from one extreme position to the other. Repeat this movement several times. Make sure that the controls move freely.

7. In shifting the control surfaces manually check operation of the control panel pilot lamps. When the control surfaces are in the neutral position, the

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lamps must not light, when they are in any other position, one of the lamps must burn without blinking. Blinking of the lamps when the control surfaces are not in the neutral position means that the servo unit potentiometers are dirty. In this case clean the potentiometer of the respective servo unit.

Note: On some aircraft the slide of the servo unit potentiometer may come off the potentiometer winding when the control surfaces are in the extreme positions. In this case both pilot lamps will not burn.

8. Turn the centring knobs on the control panel to the right or to the left; the position of the control surfaces at which both lamps go out will be changed.

9. Set the knobs "Centering" so that the pointers face upward.

10. Without centering, switch on the following switches on the control panel: "AILERON", "RUDDER", and "ELEVATOR". When some of the mentioned switches are cut in, the respective stabilization pilot lamp must light up and then go out in some time since the control surfaces will be set in the neutral position by the operating servo unit.

11. As the centering knob is slowly turned to the right or to the left as far as it will go, the respective stabilization channel control surface should deflect.

The control surfaces should deflect with interruptions, but evenly, each time the control surface displaces, the respective pilot lamp on the control panel should blink.

Turning the centering knob "AILERON" clockwise should cause the right-hand aileron to go up (the steering wheel rotates clockwise)and vice versa: turning the knob "AILERON" counter-clockwise will cause the left-hand aileron to go up (steering wheel rotates counter-clockwise).

Turning the centering knob "RUDDER" clockwise will cause the rudder to shift to the right-hand turn position (the right pedal goes forward). Turning of the same knob in the opposite direction should cause the rudder to shift to the left-hand turn position (the left pedal goes forward).

Turning the centering knob "ELEVATOR" clockwise should cause the elevator to move upward (the control column moves backward). When this knob is turned counter -clockwise, the elevator will go down (the control column moves forward). With the knob "ELEVATOR" in the extreme positions, the pilot lamp may not burn.

12. Set the centering knobs to "Pointer Up" position.

Note: As the centering knob is turned, not more than two simultaneous blinkings (pulses) of both pilot lamps are allowed on separate sections.

13. Disengage the autopilot coupling on the directional stabilizer and turn the coupling lever into the extreme left-hand position. The steering wheel should turn to the right, the right pedal should go forward and the P.D.I. pointer should deflect to the right.

14. Set the lever of the autopilot coupling in the extreme right-hand position. The steering wheel should turn to the left, the left pedal should move forward, whereas the P.D.I. pointer should displace to the left.

15. Return the autopilot coupling lever into the central position; after the contact brush of the P.D.I. potentiometer assumes its zero position, engage the autopilot coupling.

16. Set the control transfer to position "Pilot" and make sure that the pilot lamp does not burn.

17. Turn the turn control knob on the control panel to the right so that
knob indicator should be at the beginning of the shaded portion of the
le and make sure that the steering wheel has turned to the right and the right
al has displaced forward. Turn the control knob to the same position, but to
left and make sure that the steering wheel has turned to the left and the
t pedal has displaced forward.

Set the knob in position "0", first to the right and then to the left, to
e sure that the solenoid of the directional stabilizer locking mechanism is
aged and locks the autopilot coupling lever, whereas the top erecting roller
the vertical flight gyro has ceased rotating.

18. Set the turn control knob in position "Centre", and then to the right-
left-hand positions "0". This done, place the knob in position "Centre" again
e steering wheel and pedals should not move) and make sure that the solenoid
the locking mechanism has disengaged and set the autopilot coupling lever
se, whereas the top erecting roller of the vertical flight gyro begins to
tate.

19. Set the turn control transfer on the control panel into position
avigator" to make sure that the transfer position indicating lamp is on. Use
e turn remote-control knob to carry out the checks described in Items 17 and 18.

20. Place the aircraft controls in neutral position as indicated by the
lot lamps on the control panel.

21. Set the formation stick control switch in position "ON".

22. Shift the formation stick to the right as far as it will go and make sure
at the steering wheel has turned clockwise and that the right pedal has displaced
rward. With the formation stick in this position the locking mechanism
lenoid of the directional stabilizer should be engaged and lock the autopilot
upling lever.

23. Release the formation stick and make certain that it returns to the
utral position. With the formation stick in the neutral position, the solenoid
the directional stabilizer locking mechanism must automatically disengage
d unlock the autopilot coupling lever in 3 to 9 sec. after the stick has
turned to the neutral position.

24. Shift the stick to the extreme left-hand position and make sure that
e steering wheel has turned counter-clockwise and that the left pedal has
ved forward. Release the formation stick. Make sure that the stick, steering
eel and pedals return to the neutral positions. With the formation stick in
e neutral position, the solenoid of the directional stabilizer locking mecha-
sm must automatically disengage and unlock the autopilot coupling lever in 3
9 sec. after the formation stick has returned to the neutral position.

25. Shift the formation stick backward as far as it will go and make certain
at the control column has moved rearward. Release the formation stick and make
re that the stick and column return to the neutral position.

26. Push the formation stick forward as far as it will go to make sure
at the control column moves forward. Release the formation stick and see
ether the formation stick and control column return to the neutral position.

27. Set the switch in position "Only Elevator ON". Deflect the formation
ick forward and rearward to make sure that the control column follows the
rmation stick. When the formation stick is moved to the right and to the left
he pedals and steering wheel must not move.

28. Press the autopilot disengaging button of the left-seat pilot for
- 2 sec. and displace the steering wheel, control column and pedals to make
ure that the autopilot servo units are disconnected and that the aircraft

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controls move freely. Using the plate cut out the master switch on the control panel and cut it in again. Cut in the switches "AILERON", "RUDDER" and "ELEVA Displace the booster control handle to make sure that the handle actuates the aircraft controls.

29. Press the autopilot disengaging button of the right-seat pilot for 1 - 2 sec., with the booster control switch in position "OFF", and shift the steering wheel, control column and pedals to make sure that the autopilot ser units are disengaged and that the aircraft controls move freely. Using the pl cut out the master switch on the control panel and cut it immediately in again Cut in the switches "AILERON", "RUDDER" and "ELEVATOR" and check to see that controls are deflected by the turn control knob on the control panel. Make su that the controls are actuated by the knob.

Note: If the autopilot disengaging button is released after it was pres the servo units should not engage the aircraft controls before th master switch on the control panel is switched off and on again with the aid of the plate.

30. Check the sensitivity adjusting knobs on the control panel for prope operation of each stabilization channel separately, for which purpose:

(a) cut in one of the switches "AILERON", "RUDDER" or "ELEVATOR" on the control panel;

(b) set the centering knob of the cut-in stabilization so that its poin should face upward (both pilot lamps will be out); turn the sensitivity adjus knob counter-clockwise;

(c) turn the sensitivity adjusting knob on the control panel clockwise. The steering wheel, control column and pedals will begin to oscillate, whereas the pilot lamps on the control panel will begin to blink in turn.

31. Check operation of the pitching moment counteracting mechanism for w purpose:

(a) adjust the neutral position of the steering wheel by the elevator;

(b) open the bomb bays. When this is done, the steering wheel should mo forward. When the bomb bays are closed, the steering wheel should again assu its neutral position. With the bomb bay open the elevator should be deflected 9 - 10 mm with relation to the inner face of the trailing edge, the blade bein not taken into account. The way of measuring the deflections of the aircraft control surfaces is described in Section "Controls" (See Book I).

32. Check operation of the autopilot heaters, for which purpose cut in th A3C-10 circuit breaker of the autopilot heater. The circuit-breaker is locat on the circuit-breaker panel of the left-seat pilot. Then switch on the heatin system switch on the upper electric panel of the pilots and the A3C-10 circ breaker of the rudder and elevator servo unit heaters. This done, make sure th the lower covers of the servo units and vertical flight gyro warm up.

33. After the check is over cut out the switches on the autopilot control panel making use of their common plate, cut out the A3C-10 circuit breakers the rudder and elevator servo unit heaters, as well as the heating switch on the upper electric panel of the pilots.

Faults and Remedies

Fault	Probable cause	Remedy
1	2	3
When controlled by autopilot aircraft deviates from given course	Directional stabilizer gyro unbalanced	Replace directional stabilizer or balance its gyro on a stand
	Improper braking moment of servo unit braking solenoids	Adjust the braking moment of the servo unit braking solenoids by even distribution of the efforts to the left and right sides
Periodical jerks in control surface movement	(a) Unstable operation of time relay	Replace time relay in relay box
	(b) Wrong adjustment of locking mechanism of directional stabilizer	Adjust the locking mechanism of the directional stabilizer
When aircraft is controlled by formation stick, with switch placed in position "ON", the locking mechanism fails to operate or operates twice	No contact on servo unit potentiometer	Clean surface of potentiometer with a brush out of the AH-5-2M autopilot set. The brush should be soaked in clean gasoline
When the centering knob is actuated, the control surface lags	Wrong adjustment of time relay	Replace time relay in relay box
Locking mechanism solenoid does not keep time (3 to 9 sec.) after the formation stick has been turned	Wrong centering of potentiometers on direction panel of directional stabilizer	Centre potentiometer slide on direction panel with the aid of an ohmmeter
Unequal bank when control is exercised through directional stabilizer	(a) Wrong tension adjustment of directional stabilizer coupling	Adjust tension of directional stabilizer coupling
Aircraft turns spontaneously	(b) Erecting mechanism of directional stabilizer and vertical flight gyro out of order	Eliminate fault of erecting mechanism
Aircraft comes out of turn spontaneously	Locking mechanism on directional stabilizer is loose	Adjust tightening of the locking mechanism on the directional stabilizer. Note: When the autopilot coupling lever is tightly locked, there should

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1	2	3
		be a clearance a 2 - 3 mm betwee the bottom and armature of the locking mechanis solenoid
When autopilot is engaged the aircraft tends to turn sharply	Gyro of directional stabilizer or vertical flight gyro is out of order	Remove directional stabilizer and vertic flight gyro and check their operation on a stand
Servo unit braking solenoids will not engage	Autopilot is disconnected from buttons on aileron control steering wheel	(a) Using the master switch on the autopil control panel engage completely and disen the autopilot (b) Check operation of the engaging butto serving to engage the autopilot for aircraft control

OXYGEN EQUIPMENT

GENERAL SPECIFICATIONS

The oxygen equipment ensures normal oxygen supply for the aircrew during high-altitude flights and bailing out by ejecting the seat.

The oxygen system (Fig.41) includes the following elements:

1. Two liquid oxygen converters, type KHK-30 , designed for storage and gasification of liquid oxygen and delivering gaseous oxygen to the line which supplies the aircrew (the arrangement diagram of the KHK-30 liquid oxygen converter is given in Fig.42).

2. Six oxygen stations. Each of them includes:
   (a) stationary oxygen regulator, type KH-24M;
   (b) pressure gauge, type MK-13M
   (c) oxygen-flow indicator;
   (d) excessive pressure gauge, type M-1000;
   (e) oxygen valve, type KB-5;
   (f) oxygen hose, type KM-24;
   (g) oxygen mask, type KM-30M, with the mask-to-face tightness compensator and a lock;
   (h) yellow warning lamp (only in four stations).

3. The aircraft charging system consisting of aircraft charging connection and pipe lines of the AMrM-T12x14 material connecting the charging connection to the KHK-30 liquid oxygen converter.

4. Six tee-pieces with non-return valves. The tee-pieces ensure oxygen supply to each working station from both KHK-30 converters simultaneously and prevent oxygen from being released from both converters simultaneously in case one of the sections of the oxygen system is damaged.

5. Six parachute oxygen apparatus, type KH-23 , with hoses.

All these elements are connected to one another by means of pipe lines of the AMrM-T6x8 material and aircraft fittings.

The vessel of each converter, type KHK-30 , has a capacity of 28 litres. The amount of liquid oxygen filled into both converters is 64 kg. The amount of consumed oxygen is 60 kg.

The minimum operating pressure is 8 atm. gauge, the maximum operating pressure is 10 atm. gauge.

The maximum oxygen consumption from one converter is 6 kg per hour.

The pressure required for the operation of the safety valve is from 11.0 to 11.8 atm. gauge.

The evaporativity of each converter must not exceed 250 gr per hour.

ACCESSIBILITY FOR INSPECTION

Oxygen panels with instruments both in the front and rear pressurized cabins are easily accessible for inspection.

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To inspect the pipe lines in certain places it is necessary to remove the neighbouring units. Such places are:

(1) Pipe line in the area of frames Nos 4 - 9 on the starboard and port sides.

To obtain access to the pipes, remove from this section: from the starboard side - the shut-off valves control panel, from the port side - the interphone set panel of intercommunication system CMY-10 , and the IFF transponder pan

To obtain access to the pipes on frame No.4, remove the fuse panel and flap back the navigator's instrument board.

(2) Pipe line in the area of frames Nos 9 - 12 on the starboard and port sides. To obtain access to the pipes of this section remove the following fro the starboard side:

(a) converter, type PCE-70 , on the operator's panel support;

(b) thyratron interrupter on the operator's panel support (starboard).

from the port side:

(a) block, type P-6;

(b) P-6 block panel.

(3) Pipe line on the bottom of frame No.12.

To obtain access to the pipes, it is necessary to detach the operator's electric panel (central panel).

(4) Pipe line in the Ф-3 cabin on the starboard and port sides.

To obtain access to the pipes, do as follows:

(a) open the container hatches of fuel tanks Nos 1 and 2;

(b) remove tank No.1;

(c) remove tank No.2;

(d) remove hatches in the containers of tanks Nos 1 and 2.

(5) Pipe line in the Ф-4 cabin from frame No.26 up to frame No.34 on the starboard and post sides.

To obtain access to the pipes, proceed as follows:

(a) open the hatch in the Ф-4 cabin between frames Nos 27 - 29;

(b) remove the starting fuel tank between frames Nos 27 - 29;

(c) remove the cooler between frames Nos 30 - 31.

Besides this, to obtain access to the pipes of the starboard side, do as follows:

(a) remove the drain pipe;

(b) remove the pipe of the high-altitude equipment;

(c) loosen the yoke on the drain pipe and turn the branch pipe.

To obtain access to the port side pipes, remove the drain pipe.

To obtain access to the pipes in the area from frame No.34 up to frame No.49, it is unnecessary to remove the neighbouring units.

(6) Pipe line in the Ф-6 cabin.

To obtain access to the pipes, it is necessary to remove th. PCHY-3M radio set from the bottom of frame No.69.

(7) Aircraft charging pipe line in the area of frames Nos 19 - 22.

To obtain access to the charging pipe union and charging pipe line:

(a) open the aircraft oxygen charging hatch;

(b) open the hatch in the nose wheel well on the starboard side between frames Nos 19 - 22.

(8) The pipes laid in the area of frames Nos 49 - 57 are not accessible.

(9) To obtain access to the liquid oxygen converter, type KHK-30 , at frame No.13 and the pipe line at the converter use the hatch on the bottom of frame No.12.

PREPARATION FOR FLIGHT INSPECTION

The pre-flight inspection consists in thorough examination of all accessible units and pipe lines of the oxygen system. For this, do as follows:

1. Open the entrance hatches in the pressurized cabins (if they are closed).

2. Open the doors of the bomb bay hatches and of the hatch between frames Nos 27 - 29.

3. Remove cases from the oxygen regulator, type KHw24 .

4. Examine the oxygen panels with instruments and make sure that they are not damaged.

5. Check to see that the instruments are securely fastened to the panels.

6. Examine the pipe line in all accessible places; make sure that the pipe lines are securely connected to the oxygen flow indicators, MK-13M pressure gauges, M-1000 excessive pressure gauges, KП-24M economizer, KB-5 oxygen valves, BOTTOM (НИЗ) and TOP (ВЕРХ) transmitter pipe unions, pipe unions of the KB-5 valves on the KHK-30 converters and check the pipe lines for secure attachment.

7. Examine the KHK-30 converters (Fig.43); check whether the safety valve case is securely attached and whether the KB-5 valves and the pressure release valves of the KHK-30 converters open easily.

8. Examine the places of connection of the KM-24 hoses to the KП-24M economizer.

9. Check whether the oxygen adapter in the operator's seat turns easily (Fig.44).

10. Check the presence of liquid oxygen in the KHK-30 converters. Add liquid oxygen if necessary.

11. Put the KHK-30 converters to the operating condition and check them for serviceability.

12. Check the operation of the КП-24М set.

Charging KHK-30 Converters with Liquid Oxygen

To save liquid oxygen, prior to each flight the KHK-30 converters should be charged with the amount of oxygen necessary for the flight only.

The amount of oxygen required for the flight is to be determined by the formula:

$$G_n = G_н + tq ,$$

where G_n is the required amount of liquid oxygen in kg;

$G_н$ is the stock of oxygen not taken into account in kg (6 kg per each converter, type KHK-30);

q is the rated oxygen consumption for all the aircrew in kg per hour (5 kg per hour for all the aircrew);

t is the time of flight in hours.

Calculate the amount of oxygen necessary for the flight and then measure the amount of oxygen on the aircraft turning on the switch, type 2ШИ-250, with the ПО-4500 inverter operating. Add the readings of both indicators and compare the amount obtained with the amount of oxygen required for the flight.

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If the measured amount is less than the rated value, charge the converters with additional amount of oxygen.

CAUTION: Flight with oxygen supply below the rated value is prohibited.

The converters should be charged with liquid oxygen in the following manner:

1. Open the pressure release valves (if they are closed) on the КИЖ-30 converters and equalize the pressure in the converter vessels with the atmospheric pressure (Fig.45a).

Note: To uniformly charge the КИЖ-30 converters with liquid oxygen, open the pressure release valve on the converter at frame No.13 by 0.5 of a turn only and that on the converter at frame No.22 completely.

2. Close the valves, type КВ-5, before the automatic pressure increase units and after the evaporators.

3. Open the cover of the aircraft charging pipe union hatch and unscrew the plug on the pipe union (Fig.46).

4. Wipe the charging pipe union with a piece of gauze soacked with alcohol.

5. To the charging pipe union connect the pipe line from the "Tank" and the vacuum flask (СД-15).

Note: When unscrewing the plug and connecting the pipe line, see that no moisture and dust get into the filler pipe.

6. Switch on the АЗС-2 circuit breaker on the operator's electric panel in the inverter circuit, set the inverter switch on the generator panel to the OPERATING (РАБОТИТ) position and turn on the oxygen level indicator switch, type 2ИИ-250 , on the pilot oxygen panel.

7. Pressure in the "Tank" reaching 3 or 4 atm. gauge, open the valve on the "Tank" and fill the vessels of the КИЖ-30 converters with liquid oxygen.

8. Fill the converters until liquid appears in the drain holes which indicates that the vessels are charged completely (32 kg in each vessel). Besides this, check filling the vessels with liquid by the pilots' oxygen level indicators. With the vessels charged completely, the indicator pointers must be within the limits of 28 to 32 kg.

9. If the converters are not charged with oxygen to their full capacity, check the amount of oxygen filled by the oxygen level indicators only.

Note: When charging the converters with liquid oxygen, see that excessive pressure is equal to 3 or 4 atm. gauge as decreased excessive pressure may cause the non-return valve to get frozen in the КИЖ-30 converter filler neck. In this case stop charging and knock on the valve cover with a wooden stick.

10. If the converter is filled with liquid oxygen from vacuum flasks, prior to connecting the pipe from the vacuum flask to the aircraft charging pipe union do as follows:

(a) bring the cylinder with gaseous oxygen to the aircraft, connect the oxygen reducer to the cylinder and check the presence of oxygen in the cylinder;

(b) open the valve on the cylinder and scavenge the reducer with the hose with gaseous oxygen;

(c) remove the plug from the vacuum flask, fit a rubber packing gasket over the vessel neck, insert the filler pipe and fasten the extension dampers to the handles of the vacuum flask;

(d) connect the low-pressure hose to the filler pipe;

(e) connect the adapter pipe to the vacuum flask;

(f) after the adapter pipe of the vacuum flask has been connected to the ...raft charging pipe union, slowly open the valve on the cylinder with gaseous ...gen, create excessive pressure of not less than 4 atm. gauge and fill the ...verters.

Note: To charge the КИЖ-30 converter to full capacity, it is necessary to have six full vacuum flasks.

11. Make sure that the vessels are charged completely, close the valve on "Tank" or on the cylinder with gaseous oxygen, if charging is done from the ...uum flasks.

12. In two or three minutes after the liquid has been filled disconnect ...m the aircraft charging pipe union the pipe line connecting the vacuum flask ...the "Tank" and plug the disconnected pipe line.

13. Screw a plug on the aircraft charging pipe union and close the hatch.

14. Switch off the 2ИИ-250 oxygen level indicator switch, the inverter ...itch and the АЗС-2 circuit breaker.

15. The charging completed, disconnect the filler pipe from the adapter pipe. ...move the filler pipe from the vacuum flask, plug its upper end and fit a rubber ...p on the lower end.

Disconnect the low-pressure hose from the filler pipe and plug its free end; ...ose the vacuum flask with a plug.

Checking Operation of Distant-Reading Liquid Oxygen Level Indicator, Type ДУЖК

Check the operation of the oxygen level indicator, type ДУЖК , when ...arging the КИЖ-30 converter with liquid oxygen.

With the vessels filled completely, the indicator pointers must be within ...3 to 32 kg. With the pressure increased, the indicator pointers may fluctuate ...at the indicator readings after pressure rise must differ from those under no ...pressure by not more than ±1 kg. If after pressure rise the indicator pointers ...ove towards increase in readings, this is indicative of leaks in the "Oxygen ...evel Indicator Top" connections; if they move towards decrease in readings, this ...s indicative of leaks in the "Oxygen Level Indicator Bottom" connections. If on ...pressure increase the pointers do not move at all, this shows that the ДУЖК ...xygen level indicator circuit is de-energized. This being the case, ring out ...he circuit and eliminate the damage.

Putting КИЖ-30 Converters to Operating Condition

Put the charged КИЖ-30 convertors (See Fig.45) to the operating condi...ion as follows:

1. Close the pressure release valves (if the converters are put to the ...operating condition immediately after charging ...d the pressure release valves ...are open).

2. Open the КВ-5 valves ahead of the automatic pressure increase units.

3. Open the КВ-5 valves after the evaporators.

4. Pressure in the converters must first increase rapidly and then stop at 8.3 or 8.5 atm. gauge. If the converter contains not less than 26 or 27 kg, the time of pressure increase to 8.3 or 8.5 atm. gauge must not exceed 10 minutes (usually this time is equal to 3 to 5 minutes).

The pipes before the automatic unit get frozen and then in 10 or 15 minutes when pressure increase stops, begin to warm up.

Increase pressure not less than 30 minutes before flight.

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Checking Serviceability of КИК-30 Converters Before Flight (See Fig.45)

1. When opening the KB-5 valves ahead of the pressure increase automatic units, pressure in the converters must rise up to 8.3 or 8.5 atm. gauge during or 10 minutes, after this pressure increase must stop (the pipes ahead of the automatic units get warmed). If the pipes ahead of the automatic pressure incr valves fail to get warmed during 10 or 15 minutes, this testifies to a loose valve-to-seat fit. This being the case, reduce pressure and then increase it a If this does not cause the valve to close, it is necessary to close the valve ahead of the defective automatic unit and then open it by 1/8th of a turn afte it has warmed up.

Note: When no gaseous oxygen is consumed, pressure in the system increas due to evaporation of oxygen in the converter vessel and in some th reaches 11.5 or 11.8 atm. gauge, that is the safety valve relief pr sure. If the automatic units are in good repair, this must take up less than 45 minutes.

2. Check the gastightness of all the converters connections accessible fo inspection. Pay attention to the gastightness of the charging pipe union.

3. Open the oxygen valves, type KB-5, (See schematic diagram 6 , Fig.45) ahead of the economizers, type КП-24М , at all stations.

4. Check oxygen delivery to oxygen stations by the pressure gauges, type МК-13М, which must indicate operating pressure in the supply line from 8.3 to 10 atm. gauge.

5. Check oxygen delivery to the supply line from each vessel of the КИК-3 converter separately. For this close in turn the KB-5 valves after the evaporat of the КИК-30 converters. Check oxygen delivery by the pressure gauges, type МК-13М, installed at oxygen stations. Prior to checking oxygen delivery from ea vessel release pressure in the supply line through the emergency cocks of the КП-24М economizers.

Checking Operation of КП-24М Economizer

1. Check the gastightness of the high-pressure system of each oxygen stati For this open the KB-5 valve on the oxygen station and then close it. If the pressure gauge pointer does not show pressure drop during not less than 2 minu the system is gastight.

2. Check the gastightness of the low-pressure system of the КП-24М econo mizer (from the economizer valve up to the plug on the КП-24 hose). For this purpose do as follows:

(a) release the remaining oxygen from the system by means of the manual regulator on the КП-24М apparatus;

(b) set the handle of the air dilution switch to the CLOSED (ЗАКРЫТО) po tion;

(c) remove the plug on the КП-24 hose and make an inhalation. If it is impossible to make an inhalation, the system is gastight;

(d) after checking the gastightness, set the handle of the air dilution switch to the OPEN (ОТКРЫТО) position.

3. Check oxygen delivery of the mask by the КП-24М economizer without excessive pressure and with excessive pressure setting the economizer cock to MIXED (СМЕСЬ) and PURE (ЧИСТЫЙ) positions successively.

Checking Operation of КП-24М Economizer without Excessive Pressure

1. Put on the mask, type МК-30Ф, and connect it to the hose, type КМ-24.
2. Open the KB-5 valve of the oxygen station.
3. Close the manual regulator on the КП-24М apparatus as far as it will go.
4. Make several inhalations and exhalations setting the manual switch of the air dilution automatic device first to the OPEN (ОТКРЫТО) and then to the CLOSED (ЗАКРЫТО) positions. If this causes the flow indicator flaps to get together, the КП-24М apparatus functions properly.

Checking Operation of КП-24М Economizer with Excessive Pressure

1. By means of the manual regulator build up excessive pressure equal to 250 mm W.G. on the КП-24М economizer (watch the pressure by the М-1000 excessive pressure gauge).

2. Put on and remove the plug from the КП-24 hose several times. If this causes the flow indicator blinkers to get together and depart, the КП-24М economizer operates normally.

Note: When the apparatus operation is checked under excessive pressure on the ground, the flow indicator flaps might fail to operate.
In this case watch the pointer of the excessive pressure gauge. If during the opening and closing of the КП-24 hose plug the pointer of the М-1000 pressure gauge oscillates, the apparatus functions properly.

3. Check emergency oxygen delivery by setting the emergency cock of the КП-24М economizer to the OPEN (ОТКРЫТО) position.

Note: When checking emergency delivery oxygen, pressure in the system must not drop below 8.3 atm.

Check emergency oxygen delivery by listening, holding the end of the КП-24 hose close to the face and opening the plug in the hose.

After the entire oxygen system has been checked and if there is a sufficient supply of liquid oxygen available, the technician reports to the commander on the readiness of the aircraft for flight.

If the flight is cancelled for some reason, do as follows:

(a) close the KB-5 valves ahead of the pressure increase automatic units and after the evaporator on the КИК-30 converters;

(b) release pressure from the pipe lines through the emergency cocks of the КП-24М economizers. This done, close the valves, type KB-5, on the aircrew oxygen panels.

CAUTION. To avoid fire and accidents, it is necessary to observe the following rules:

1. When releasing oxygen from pipe lines all the entrance hatches and ports must be open.

2. The clothes of the personnel handling oxygen equipment must be free from oil and grease.

3. When releasing oxygen, it is prohibited to perform any other work in the aircraft.

4. It is strictly prohibited to smoke.

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POSSIBLE FAULTS OF OXYGEN SYSTEM AND MEANS OF THEIR ELIMINATION

The oxygen system may have the following defects:

(a) leakage, clogging of the system;

(b) faults of the instruments included in the system. Leakage in the system should be eliminated by additional tightening of the union nuts in place of oxygen leakage while clogging of the system should be eliminated by scavenging.

Checking System for Leakage

To check the system for leakage, do as follows:

1. Open the hatch of the aircraft charging pipe union.

2. Unscrew the plug from the end of the aircraft charging pipe union and screw the union nut of the charging hose on the charging pipe union.

3. Connect the pipe line from the stand (a cylinder with nitrogen) to the other end of the hose.

4. Charge the vessels of the KUK-30 converters and the pipe line with nitrogen whose purity and humidity correspond to those of medical oxygen increasing pressure to 10 atm. gauge. Charge the system slowly from forty-litre high-pressure (150 kg/sq.cm.) cylinders. During charging the pressure release valves of the KUK-30 converters must be closed, while the valves after the evaporators must be open.

Note: With the pressure increased, take particular care to see that the pipe lines joining the AUKK oxygen level indicator and the KUK-30 converter are tightly connected.

5. The charging over, disconnect the pressure source and note the indications of one of the pressure gauges.

6. In no less than 12 hours measure pressure in the system again by means of the same pressure gauge.

The gastightness of the system is considered to be satisfactory if with the KB-5 valves open, the pressure in the system decreases not more than by 6.5 kg/sq.cm. during 12 hours or with the KB-5 valves closed, not more than by 5.2 kg/sq.cm.

Note: 1. When checking gastightness, take into consideration the effect of temperature.

2. To avoid errors due to possible hysteresis of the mechanism, slightly knock on the instrument case with the finger prior to taking readings.

7. If the system is found leaky, detect the leaky place first of all. For this smear all the places of connection of the pipe line to be replaced with soap-suds. In the event of considerable leakage the leaky place can be detected by the hissing of emerging gas. Examine all the connections and mark the detected leaky places to eliminate the leakage.

8. Slight leakage can be eliminated by careful tightening of the threaded connections without releasing nitrogen from the system. Bear in mind that over tightening the threaded connections of pipes made of aluminium alloy often causes jamming and stripping of thread.

9. In the event of considerable leakage of nitrogen completely release pressure from the system. This done, start eliminating the leakage. To eliminate jamming of threaded connections and to ensure their gastightness, use special oxygen-proof lubricant.

10. After gastightness has been checked up, scavenge the system. For this purpose through the aircraft charging pipe union apply a pressure of 10 atm. gauge to the system from the ground cylinder with pure oxygen. Open the economizer emergency valve at each oxygen station in turn and scavenge each station during 30 or 60 seconds. A strong jet of gas will clean the system from nitrogen.

When applying pressure, the pressure release valve of the KUK-30 converter must be closed while the valve after the evaporator must be open.

11. When scavenging the entire system with medical oxygen, check the operation of the KUK-30 converter safety valves. For this:

(a) close the KB-5 valves after the evaporators on the KUK-30 converters;

(b) smoothly build up a pressure of 11.0 to 11.8 atm. gauge in the KUK-30 converters from the cylinder with medical oxygen. Under this pressure the safety valves must open (operate);

(c) reduce pressure in the KUK-30 converter vessels to one atm. gauge; opening the pressure release valve on one of the KUK-30 converters make sure by listening that the vessels are gastight; at this pay attention to the gastightness of the AUKK oxygen level indicator pipe lines.

12. Release pressure from the KUK-30 vessels and disconnect the hose from the aircraft charging pipe union.

13. Screw the plug on the pipe union and close the hatch.

CAUTION. 1. When scavenging the system with oxygen, use of fire (smoking, lighting up matches, etc.) and presence of oil on pipe unions, valves and oxygen system units are absolutely prohibited.

2. To avoid accidents, open the oxygen valves slowly.

3. After the test and the elimination of faults in the system, thoroughly wipe each connection with a piece of clean gauze moistened with rectified alcohol.

4. Scavenging the system with pure oxygen should be done out-of-doors.

Effect of Temperature Change during Check of System Gastightness

When determining the system gastightness, take into consideration pressure change in the system caused by a change of gas temperature in connection with ambient air temperature change.

Gas pressure is directly proportional to the absolute temperature at constant volume, that is on condition of complete gastightness of the system, pressure increases at temperature rise and decreases at temperature drop. This relation is expressed by the formula:

$$\frac{P_1}{P_2} = \frac{T_1}{T_2},$$

therefore

$$P_2 = \frac{P_1 T_2}{T_1},$$

where T_1 and T_2 - absolute temperature equal to:

$$T_1 = 273 + t_1^{\circ}C; \quad T_2 = 273 + t_2^{\circ}C;$$

P_1 and P_2 - gas pressure at temperatures T_1 and T_2.

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To take into account the influence of temperature upon pressure in the system, using the above given formula determine pressure to the moment of secondary pressure (in 12 hours after the measuring of initial pressure) and compare it with the original indications of the pressure gauge. If the difference of these pressures with the valves closed exceeds the amount of leakage permitted for this time (5.2 kg/sq.cm. per 12 hours), the gastightness is insufficient.

Example of Calculation

Example 1. Initial pressure in the system: p_1 = 10 kg/sq.cm.
Pressure by the reference pressure gauge: p_k = 6 kg per sq.cm.
Initial temperature: $t_1 = 20^{\circ}C$.
Temperature in 12 hours: $t_2 = 10^{\circ}C$.
The system is to be tested with the valves closed.
Pressure in the system with no leakage:

$$p_2 = \frac{p_1 T_2}{T_1} = \frac{10(273+10)}{(273+20)} = 9.65 \text{ kg/sq.cm.}$$

Pressure difference:

$$\Delta p = 9.65 - 6 = 3.65 \text{ kg/sq.cm.}$$

The difference thus determined is less than the permissible value of leakage (5.2 kg/sq.cm. per 12 hours). The system gastightness is satisfactory.

Example 2. Initial pressure: p_1 = 10 kg/sq.cm.
Initial temperature: $t_1 = 10^{\circ}C$.
Temperature in 12 hours: $t_2 = 5^{\circ}C$.
Pressure as indicated by the reference pressure gauge:

$$p_k = 3.5 \text{ kg/sq.cm.}$$

The system should be tested for leakage with the valves open.
Pressure in the system with no leakage:

$$p_2 = p_1 \frac{T_2}{T} = \frac{(273+5)}{(273-10)} = 10 \frac{278}{263} = 10.57 \text{ kg/sq.cm.}$$

Pressure difference:

$$\Delta p = p_2 - p_k = 10.57 - 3.5 = 7.07 \text{ kg/sq.cm.}$$

The pressure difference obtained Δp = 7.07 kg/sq.cm. exceeds the permissible leakage (6.5 kg/sq.cm. per 12 hours), therefore, the system is insufficiently gastight.

Checking Shut-Off Valves

After the leakage test, prior to scavenging the system, check the operation of the shut-off valves.

Check the shut-off valves with nitrogen for shutting off the KHK-30 converters and for equalizing pressure in the converters.

1. To check the converters for pressure equalizing, do as follows: fill the KHK-30 converters with nitrogen under a pressure of 10 atm. gauge. Then slowly release pressure from one converter through the pressure release valve by one or two atm. gauge; in this case pressure in the second converter must become equal to that in the first one in one or two minutes.

Pressure must be released from both vessels in turn.

2. To check the converters for shutting off the vessels, do as follows: fill the KHK-30 converters vessels with nitrogen under a pressure of 10 atm. gauge. Then sharply release pressure from one converter through the release valve to 0 atm. gauge. Pressure in the second converter must not drop more than by 4 atm. gauge during 5 minutes.

Note: Checking the operation of the shut-off valve should be performed with the valves after the evaporators closed.

Faults of KHK-30 Converters

1. If the connection is found leaky, tighten it up. In case tightening is of no effect, replace the gasket.

2. If the safety valve is leaky at 10 atm. or fails to operate at 11.0 - 11.8 atm. gauge, remove and replace it by a new one.

3. If the automatic pressure increase valve fails (fails to close at 8.3 to 8.5 atm. gauge), replace it by a new one.

Prior to fitting the emergency valve, wash the line up to the automatic unit with liquid oxygen. For this do as follows:

(a) remove the oxygen valve;

(b) plug the line after the valve running to the receiver;

(c) by means of the second automatic unit increase pressure in the converter and force out liquid oxygen through the KB-5 valve ahead of the removed automatic unit.

4. If considerable evaporativity of oxygen from the KHK-30 converter is detected, check the converters for evaporativity using the Description of the KHK-30 converters.

5. If oxygen coming out of the converter has an unpleasant smell, the converter must be removed and washed.

6. Prior to the installation of a new converter on the aircraft in the event of replacement of the KHK-30 converter, check the new converter according to the Description of the KHK-30 converter.

Washing the Vessel of KHK-30 Converter

On detecting unpleasant smell of oxygen coming out of the KHK-30 converter wash and degrease the converter. For this do as follows:

1. Disconnect the pipe of the line from the KB-5 valve after the evaporator, the pipe of the shut-off valves from the cross-piece, pipes from the pressure release valve, the safety valve and the oxygen level indicator transmitter.

2. Remove the converter from the aircraft having unscrewed the attachment bolts.

3. Disassemble the converter and remove the vessel and the evaporator from the casing.

4. Fill the vessel with 6 litres of tetrachlorated carbon or pure gasoline; tilt the vessel and turning it round its axis during 10 minutes wash the vessel walls.

5. Force out the liquid with nitrogen through each pipe in turn.

6. Fill the evaporator completely with tetrachlorated carbon and then blow out the carbon. Repeat the procedure three times.

7. After the vessel has been washed with tetrachlorated carbon wash it with alcohol as described above. Washing with alcohol should be done not less than two times until the alcohol coming out of the vessel is quite transparent.

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8. After washing the vessel with alcohol thoroughly scavenge it with dry, oxygen or nitrogen (free from oil) till no smell is felt any more. Scavenge vessel through each pipe in turn plugging the rest.

9. The fittings and pipes should be washed with alcohol and scavenged to

10. During scavenging check whether the washing is done properly. For this hold a piece of white linen cloth against the stream of emerging gas and chec it for dark deposit.

11. The washing completed, assemble the converter.

12. Apply paste, grade ИИО-22 , to all threaded connections. Dilute the paste just before the assembly of threaded connections. Paste, grade ИИО-22, contains 15 gr of glycerine, 4 gr of dextreen and 32 gr of litharge.

To prepare the paste, fill a mortar with glycerine, add dextreen and thoroughly grind the mixture. Then add litharge and grind it to obtain unifor compound.

Cover the pipe union thread (but not the nut thread) with a thin uniform layer of paste. This done, assemble the threaded connection.

When screwing the threaded connection again, remove the old paste from the face of the thread.

13. The assembled converter should meet the following requirements:

(a) the evaporator must be arranged concentrically inside the case. The rubber stops must uniformly expand the evaporator relative to the vessel;

(b) the vessel must not move crosswise or lengthwise inside the case;

(c) the pipes must not come in contact with the nearest parts and each other;

(d) after assembly check the converter for leakage by means of dry medic oxygen or nitrogen under a pressure of 10 atm. gauge. Check the gastightness means of soap - suds. This done, wipe the connections with a clean piece of cloth moistened with rectified alcohol.

14. Fill the completely assembled converter with liquid oxygen and check the operation of the automatic pressure increase valves.

15. When checking the serviceability of the converter, do as follows:

(a) plug the non-return valve and the pipe unions OXYGEN LEVEL INDICATOR TOP (УРОВНЕМЕР ВЕРХ) and OXYGEN LEVEL INDICATOR BOTTOM (УРОВНЕМЕР НИЗ); connect a pressure gauge and the pressure release valve to the pressure releas pipe communicated with atmosphere;

(b) increase pressure in the converter. For this close the pressure relea valve and open the valves ahead of the automatic pressure increase valves;

(c) watch pressure increase; in the converter filled by not less than 90 per cent, a pressure of up to 8.3 to 8.5 atm. gauge is reached during 3 or 5 minutes (but not in excess of 10 minutes); then pressure stops increasing.

In 10 or 15 minutes after pressure increase the pipes ahead of the automatic unit must get warm as at such a pressure the automatic pressure increas valves are closed;

(d) note the time up to the moment the safety valve starts bleeding; with the sound automatic pressure increase valves this time must be not less than 45 minutes;

(e) in an hour after the beginning of the safety valve bleeding set the amount of consumption to 0.5 kg per hour. At this pressure must drop to 10 atm gauge and leakage through the valve will stop;

(f) set oxygen consumption to 6 kg/sq.cm.; pressure in the converter must not drop below 8 atm. gauge.

16. Check the evaporativity of the converter without pressure. Evaporativ

without pressure is the amount of oxygen in grams lost per hour during the orage of oxygen under atmospheric pressure due to warm air coming from the tside. To check evaporativity, fill the converter with 30 or 32 kg of liquid ygen and in four hours weigh it for the first time (during the first four ours evaporativity is increased due to the thermal capacity of the vessel). The cond weighing of the vessel should be done in 16 or 20 hours after the first e; the difference of weight in grams divided by the time in hours between the eighings is the evaporativity of the converter. The evaporativity must not xceed 250 gr per hour.

Note: When checking evaporativity, take particular care to plug the non-return valve and the OXYGEN LEVEL INDICATOR BOTTOM (УРОВНЕМЕР НИЗ) pipe union because leaks greatly increase evaporativity. It is recommended to fit conical plugs of aluminium foil packing over the conical surface of the pipe union or flat plugs of the АМгМ material.

17. All the operations and test results must be recorded in the Service Log.

Care of КИК-30 Converter

1. Prior to flight and after flight it is necessary to subject the converters o careful examination for mechanical damage.

2. See that the vessels of the КИК-30 converters contain not less than 2 kg of liquid oxygen at all times.

3. It is not recommended to leave a small amount of liquid oxygen in the vessel because during evaporation in the remaining oxygen there are concentrated impurities, in particular substances of unpleasant smell which will be absorbed by newly filled oxygen.

4. Take care to protect the converters from oil and grease.

5. Liquid oxygen always contains lubricating oil which gets into oxygen during the production of the latter. During the service of the converters this oil settles down on the vessel walls therefore the vessels should be washed (degreased) periodically.

Faults of Distant-Reading Liquid-Oxygen Indicator, Type ДУЖК (Fig.47)

1. With the power supply switched on and pressure drop changed in the transmitter, the indicator pointer does not move. This may take place if there is no proper contact in plug connectors. To eliminate this fault, check the supply line and repair it if broken.

2. If the instrument reading errors exceed the permissible values, tighten up the union nuts where the pipe lines are connected to the vessel and check the system for leakage or check the bunched conductors lines and eliminate the defect.

Checking КИК-30 Converters for Evaporativity

After the КИК-30 converters have been installed in the aircraft, as well as every three months and on expiration of the guaranteed period of service life, the КИК-30 converters should be tested for evaporativity.

Check the converters for evaporativity by means of the КУ-4 testing device as follows:

1. Close the КВ-5 valves ahead of the automatic pressure units and after the evaporators.

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2. Open the pressure release valve of both vessels of the KHK-30 converte

3. Fill the KHK-30 converters with the amount of liquid oxygen required the next flight as prescribed in the Section "Filling the KHK-30 Converters with Liquid Oxygen".

4. After filling, disconnect from the cross-piece the KHK-30 converters pipes connecting the shut-off valves to the KHK-30 converters and plug the ca piece pipe unions.

5. From the tee-piece in the pressure release line disconnect the pipe running to the pressure gauge and connect the pipe union of the tee-piece to t of the KV-4 testing device rheometer.

6. In four hours after fitting the vessels with liquid oxygen close the pressure release valve and during two hours every 15 minutes measure by the rh meter the amount of gas coming out of the converter (in litres per minutes). Average the results of all measurings.

7. Convert the average capacity of losses thus obtained (in litres per minute) to units of weight (in grammes per hours) using the graph of Fig.55 tak into account the ambient air temperature. The permissible amount of losses cau by evaporativity is not in excess of 250 grams per hour at a temperature of 15 ± 5°C. At a temperature of 30 to 50°C the amount of losses increases by 50 to 90 grams per hour, while at temperature of -20 to -30°C it decreases by 3 or 60 grams per hour.

8. After checking the converter for evaporativity, open the pressure rele valve, connect the pipes joining the shut-off valves with the cross-piece on t KHK-30 converter and connect the pipe running to the pressure gauge with the tee-piece in the pressure release line.

Note: On completing the test of the vessels for evaporativity make record in a special Log; indicate the number of the aircraft, the number o the KHK-30 converter vessels and the amount of evaporativity.

Faults of KI-24M Economizer

1. If the high and low-pressure cavities are out of repair, replace the apparatus by a new one.

2. In case leakage is detected in the valve of the economizer, connect th KM-30M mask to the apparatus and make several deep inhalations. If leakage persists, replace the apparatus by a serviceable one.

Note: In the event of replacement of the KI-24M economizer prior to installation on the aircraft check the economizer by the Descripti of the KI-24M apparatus.

Faults of KI-24M Set

Repair of the KI-24M economizer set involving disassembly and adjustment is not permitted in field conditions. In this case the items to be repaired should be replaced by new ones; the removed items must be sent to repair shops.

Leakage in High-Pressure System

If during the high-pressure system leakage test the pressure gauge indica tions decrease, the system is leaky.

Detect leaky places by means of soap-suds.

As a rule, leakage is detected by tightening up the union nuts. However, leakage in the system is sometimes caused by a leaky economizer valve. This being the case, replace the faulty apparatus by a new one.

Leakage in Low-Pressure System

In case the low-pressure system is leaky, the best way of detecting the leak is to divide the low-pressure system into several sections. Suppose that the leaky low-pressure system is divided into three sections:

1st section - from the mask (with the mask-to-face tightness compensator connected to it) to the excessive pressure limiter.

2nd section - from the pipe union of the hose running to the KI-23 apparatus and to the elbowed pipe union with a union nut of the KI-24 hose.

3rd section - KI-24M economizer.

When checking the 1st section, close the hole in the excessive pressure limiter lock with a hand and make a long but not deep inhalation. If it is impossible to inhale, the 1st section is gastight.

The check over, connect the excessive pressure limiter lock to the pipe union of the hose running from the KI-23 apparatus.

To check the 2nd section, disconnect the KI-24 hose from the KI-24M apparatus, close with a hand the hole in the hose elbowed pipe union and make a long but not deep inhalation. If it is impossible to inhale, the 2nd section is gastight.

After the check-up, connect the KI-24 hose to the KI-24M apparatus. Before doing so, check to see that the apparatus valve is closed, the air dilution switch handle is set to the CLOSED (ЗАКРЫТО) position and the MK-13M pressure gauge pointer is at zero.

When checking the 3rd section, make a long but not deep inhalation. If you cannot do so, the 3rd section is gastight. If it is possible to make an inhalation, the low-pressure cavity of the KI-24M apparatus is leaky. This being the case, replace the defective apparatus by a new one.

Bear in mind that the gastightness of the low-pressure system depends to a great extent on the condition of the rubber gaskets fitted in each joint. Therefore, pay special attention to the joints and replace unserviceable gaskets by new ones in due time.

Faults of KM-30M Mask

1. A faulty exhalation valve. In most cases the leakage of the exhalation valve is caused by dust, sand and other foreign objects getting under the valve. On detecting leakage, wash the valve with a pad moistened with clean water or blow it with oxygen (without dismantling the valve and the mask). This done, retest the valve for leakage. If the valve is still leaky, replace the mask by a new one.

2. Leaky connections of the mask with the mask-to-face tightness compensator and the hose running from the KI-23 apparatus. In such cases replace the gaskets and then retest the connections for leakage.

3. Leakage in the mask body, corrugated hose and mask-to-face tightness compensator. In such cases replace the mask and the mask-to-face tightness compensator by serviceable ones.

4. Leakage in the excessive pressure regulator valve. This being the case, replace the mask by a serviceable one.

Faults of KI-24 Hose

Leakage in the hose (Fig.49) closed with a plug. This being the case, replace the gasket of the plug. If the leakage is not eliminated, replace the hose by a serviceable one.

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Faults of KI Flow Indicator of MK-13M Pressure Gauge and M-1000 Excessive Pressure Gauge

1. The glass is broken, the body is cracked, the luminous compound has come off.

2. The indicator blinkers fail to react to inhalations and exhalations.

In case one of these faults is detected, replace the flow indicator or the pressure gauges by serviceable ones.

Faults of KB-5 Valves

1. Leakage in the valves cavities.

2. Leakage in the valves flap.

If at least one of the faults is detected, the valves should be replaced by new ones.

Faults of Tee-Pieces with Non-Return Valves

Leaky non-return valves. To eliminate leakage, disassemble the unit with non-return valves, wipe the valves and seats with a piece of gauze moistened with pure gasoline (without oil); at this take care to see that all foreign particles (white or brown deposit) are removed from the valves and seats. Next, wash all the parts of the disassembled unit in pure gasoline (without oil), blow them with oxygen and assemble. Check the newly assembled unit for leakage.

If the unit with non-return valves is still leaky, do as follows:

(a) replace defective valves and seats in the unit by new ones or

(b) replace the entire unit by a serviceable one.

Faults of KI-23 Parachute Oxygen Breathing Apparatus

1. The apparatus is leaky.

2. The disconnector operation is improper (the box of the KI-24M economizer is disconnected with difficulty).

3. The non-return valve of the change-over switch is leaky (oxygen leaks out after the disconnector has operated).

If at least one of these faults is detected, replace the apparatus by a serviceable one.

POST-FLIGHT INSPECTION

1. Open hatches (if they are closed) to obtain access to the oxygen equipment.

2. Check oxygen pressure in the line by the pressure gauges, type MK-13M.

3. In accessible places examine pipe lines and their attachment, oxygen panels and instruments.

4. Check the amount of liquid oxygen remaining in the KHK-30 converter by means of the AVEM liquid oxygen level indicators. In case of necessity add oxygen.

5. Record pressure in the vessels of the KHK-30 converter by the pressure gauges mounted near the KHK-30 converter.

6. Check the gastightness of all connections on the KHK-30 converters (without releasing pressure).

7. Make sure that the safety valve is serviceable. If pressure in the apparatus amounts to 11 or 11.8 atm. gauge the safety valve must be open. If pressure in the apparatus is below 10 atm. gauge, the valve must be tightly closed.

The permissible leakage through the safety valve at 10 atm. gauge is not in excess of 200 cu.cm.per minute.

8. Check the KI-24M economizer set. For this:

(a) carry out outside examination of the KI-24M economizer mask, mask-to-face tightness compensator and the PM-24 regulator; check to see that the items are free from damage and moisture;

(b) check the operation of the KI-24M economizer.

9. Close the KB-5 valves ahead of the automatic pressure increase units and after the evaporators on the KHK-30 converters.

10. Release oxygen from the pipe lines and converters by opening the emergency cock of the KI-24M economizer at each oxygen station.

11. Close the KB-5 valves at oxygen stations.

12. Wipe the masks with a piece of gauze soaked with alcohol and place it together with the mask-to-face tightness compensator and the corrugated hose into special bags located at the working stations of each member of the aircrew.

13. Examine the parachute apparatus and send them out for storage at depots or to special workshops.

14. To save liquid oxygen, do not release pressure from the KHK-30 converters.

15. If it is necessary to add liquid oxygen to the KHK-30 converters, release pressure from the apparatus.

16. If any faults are detected during the flight or inspection, eliminate them in compliance with the Section "Possible Faults".

17. Put cases on the KI-24M economizers.

PRESSURE RELEASE

Open the pressure release valves by 1/4th of the knob turn and then slowly (during 3 or 5 minutes) open the valves completely.

Determine complete pressure release by the pressure gauge.

Note: During pressure release intensive evaporation of liquid oxygen in the vessel takes place. The amount of oxygen which has evaporated is directly proportional to the amount of warmth absorbed by the liquid oxygen. The maximum amount of liquid oxygen which may evaporate during pressure release is equal to 10 kg. This corresponds to pressure release when the apparatus vessel contains 25 or 27 kg of liquid oxygen completely heated to the boiling point at a pressure of the safety valve releasing. If the apparatus vessel contains less liquid oxygen, the amount of evaporating oxygen during pressure release will be proportionally less.

STORAGE OF LIQUID OXYGEN IN KHK-30 CONVERTERS

It is permitted to store liquid oxygen in the KHK-30 converters in sealed vessels under pressure and without pressure.

Storage of Liquid Oxygen in Sealed Vessels of KHK-30 Converters

If the KHK-30 converters are filled with liquid oxygen 12 or 16 hours before flight, it is recommended to close the KHK-30 converters in an hour after filling. For this close the pressure release valves and the valves after the evaporators (if they are open).

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Leave the converters in this condition as at evaporativity of 250 grams per hour no oxygen will be lost during this time because the entire amount of the warmth coming to the vessel from the outside will be spent for warming up liquid oxygen.

Pressure in the vessel will increase gradually. The storage period of liquid oxygen in the KIIK-30 converters closed vessels without losses is from 27 to 46 hours.

Note: The less liquid oxygen is contained in the apparatus, the less is the time of its storage in closed vessels without losses, because less heat is required for warming up oxygen to the boiling temperature at a pressure of safety valve releasing.

The approximate time required for increasing pressure in a closed vessel to a pressure of safety valve releasing depending on the amount of liquid oxygen in the converters is given in Table 16.

Table 16

Time Required for Safety Valve Releasing Versus Amount of Liquid Oxygen and Evaporativity

Weight, kg	Amount of warmth Q, cal.	Time required for increasing pressure to 10 atm. gauge at evaporativity, grams per hour		
		150	200	250
25	360	46 hours	35 hours	27 hours
20	280	35 hours	25 hours	21 hours
15	210	26 hours	20 hours	16 hours
10	140	16 hours	13 hours	10 hours

Here Q is the amount of warmth in calories required for heating liquid oxygen to 10 atm. gauge.

Storage of Liquid Oxygen in KIIK-30 Converters under Pressure

If the KIIK-30 converters are in the operating condition, liquid oxygen in the KIIK-30 converters vessels can be stored under pressure. For this close the KB-5 valves ahead of the automatic pressure increase unit and after the evaporators. Do not open the pressure release valves as during pressure release losses may amount to 10 kg.

When storing liquid oxygen on the KIIK-30 converters under pressure, looses do not exceed 6 kg a day.

Storage of Liquid Oxygen in KIIK-30 Converters without Pressure

If the vessels of the KIIK-30 converters are filled with liquid oxygen two days before flight it is recommended to leave the pressure release valves open for 16 or 20 hours and then close the vessels, that is close the pressure release valves.

PRECAUTIONARY MEASURES

1. Protect all pipe line joints and apparatus elements from oil and grease.

2. When filling liquid oxygen, fence the place where oxygen is drained (from the pressure release valve).

3. The overalls of the personnel engaged in filling the KIIK-30 converters with liquid oxygen and in testing the system should be clean and free from grease stains. The ground near the aircraft must be cleaned from oil and kerosene.

4. When filling the apparatus with liquid oxygen and testing the system, it is prohibited to smoke, to light matches, etc.

5. Be careful when filling the apparatus with liquid oxygen and see that no liquid oxygen gets onto the skin to avoid frost biting (burns).

6. Prevent moisture from getting into the vessels of the KIIK-30 converters and pipe lines as on filling the vessels with liquid oxygen water is turned into ice, which might cause failure of the apparatus.

7. Prior to filling liquid oxygen remove the case of the fuselage compartment (in the Ф-3 cabin) in the area of the pressure release drain holes.

8. Take care not to spill liquid oxygen as all organic substances moistened with liquid oxygen are explosive and inflammable until oxygen is completely evaporated.

Quality of Oxygen

Fill the vessels of the KIIK-30 converters only with medical liquid oxygen. Oxygen must have a Certificate indicating whether it meets the requirements specified by Item 2 of State Standards (ГОСТ) 6332-52

INSTRUCTIONS FOR PACKING PARACHUTES WITH KH-23 OXYGEN BREATHING APPARATUS

Fig.50 shows the position of the KH-23 oxygen breathing apparatus in relation to the seats of the aircrew members, which ensures safe and reliable disconnection of the KH-23 apparatus disconnectors during ejection.

To prevent the breathing apparatus hoses from being broken place them into the seats very carefully. In doing so observe the following order:

1. On the navigator's seat lay the short oxygen hose of the KH-23 breathing apparatus through the weight lightening hole in the seat right-hand arm rest as shown in Fig.51.

CAUTION. It is strictly prohibited to pass the oxygen hose through clamp 3 (Fig.51) as during ejection the snap hook of the KH-23 apparatus locking pins may stick in the clamp. As a result the oxygen disconnector will fail to get disconnected and the supply will fail to change over from the aircraft mains to the KH-23 apparatus.

2. On the pilots' seats when connecting the apparatus hoses to the aircraft hoses pass the short oxygen hoses into the seat arm rests through the cuts in the arm rests to prevent the apparatus hoses from being broken.

3. Prior to placing the parachute on the navigator-operator's seat pass the short hose of the KH-23 breathing apparatus through the hole in the rear part of the seat pan right-hand side. If the hose is passed into the hole of the side after the parachute is placed on the pan, the hose must be sharply beat which causes its rapid wear.

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4. On the gunner-radio operator's seat see that the parachute does n towards the seat back otherwise the oxygen hose will be crumpled by the r hand arm rest.

5. The parachute with the KM-23 breathing apparatus is freely arran the gunner's seat, and no special instructions on packing are required.

ELECTRICAL EQUIPMENT

GENERAL

The electrical equipment of the aircraft, model TY-16 , consists of D.C. and A.C. power supply sources, aircraft electric mains and electric power consumers.

The major D.C. power supply sources of the aircraft are four generators, type PGP-18000 , of 18-kW power each; the generators operate in parallel and are connected to the aircraft mains to produce a total power of 72 kW, 28 - 28.5 V.

Apart from the generators, the aircraft is provided with a starter-type storage battery, type 12CAM-55; the battery operates in parallel with the generators and serves as a stand-by power supply source.

For A.C. power supply the aircraft is equipped with two PO-4500 inverters which invert direct current into alternating current of 115 V, 400 c.p.s.

The aircraft electric mains consists of wires gauging from 0.35 to 95 sq.mm and incorporates switching equipment, as well as control and protective devices. The mains uses mainly non-shielded and shielded wires,mark BNBR, the airframe being used as the minus wire. In order to lighten the weight of the electrical equipment the D.C. electric power distribution lines are made of aluminium wire, mark BNBR.

Direct and alternating currents are consumed by various instruments and units provided with remove control facilities, as well as by complex automatic systems (the autopilot, cannon system fuel quantity and flow gauging equipment, etc.), signalization means, heating, de-icing, illumination equipment and radio equipment.

The aircraft electric mains is connected to ground power supply sources through two ground-supply plug connectors; one of the plug connectors is used for connecting D.C. ground supply sources, whereas the other - for connecting A.C. ground power supply sources.

AIRCRAFT ELECTRIC MAINS

The entire electric mains system of the aircraft consists of two major sections:

1. The D.C. circuit of 28-28.5 V supplied from the PGP-18000 generators and the storage battery, which is connected for buffer operation with the generators.

2. The single-phase A.C. circuit of 115 V, 400 c.p.s. which is supplied from the operating or stand-by inverter, type PO-4500.

To ensure effective all-condition operation of the aircraft, the D.C. circuit is divided into three subcircuits:

(a) the normal supply circuit;
(b) the emergency supply circuit;
(c) the dual supply circuit.

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As a rule, connected to the normal supply circuit are all the four generators and the storage battery (Fig.52). The generators and the storage battery are connected separately and therefore they may be connected to the normal supply circuit in any combination, for example: one generator and the storage battery or two generators and the storage battery, and so on.

Connected to the emergency supply circuit can be only one generator (either generator 2 installed on the left engine, or generator 3 installed on the right engine) and the storage battery.

With the aid of switching contactors, type КП (КП-200Д КП-400Д), the dual supply circuit is automatically connected either to the normal supply circuit (in case it is energized) or to the emergency supply circuit if the normal supply circuit is de-energized.

The schematic distribution diagram of D.C. supply system (of the aircraft mains system) is presented in Fig.53.

The normal, emergency and dual supply mains provide power supply to three groups of distribution busbars:

1. The normal supply busbars which are connected only to the normal supply circuit.

2. The dual supply busbars connected to the dual supply circuit.

3. The triple supply busbar which is usually connected through a special change-over switch to the dual supply circuit and, consequently, is energized from the normal or emergency supply circuit. In case of failure of the normal and emergency supply circuits this busbar is manually reset for direct supply from the storage battery.

The distribution busbars have no direct connection to the emergency supply circuit.

The normal supply busbars feed such power consumers which are necessary for normal operation of the aircraft but which can be done without in emergency conditions. Such power consumers are: the autopilot, de-icers, heaters, ventilators, camera equipment, part of the illumination system, etc.

The dual supply busbars feed such consumers which make it possible to fulfil the mission and to return to the home airfield even in case of the faulty normal supply circuit. Such power consumers are: the bombing system, flight control and navigating instruments, fuel system pumps, landing flap actuator, L.G. warning system, part of illumination system, etc.

The triple supply busbar (the busbar which provides battery supply of the instruments with the mains de-energized) supplies voltage only to such power consumers which are absolutely necessary for accomplishment of a forced landing of the aircraft in case of failure of the normal and emergency power supply circuits. These consumers are: the main gyro horizon, bank-and-turn indicator of the pilot, remote indicating astrocompass, type ДАК-ДБ-5 , heater of the upper left pitot tube, type ТП-156 , circuit No.1 of the interphone system and the emergency illumination system (the ultra-violet illumination lamps of the pilot's and navigator's instruments panels, the receptacle of the pilot's extension lamp and the illumination system of the КИ-12 compasses), automatic brake control unit, drag chute system, engine blow-off band control system, CO_2 bottle control system, fuel shut-off and stopcock control system and radio station, type РСИУ-3М.

Three consumers: the feeder of the in-flight engine starting, the feeder of the top emergency bomb dropping system and the radar transponder destructor feeds are connected directly to the storage battery and may be used at any moment without additional switching and change-over operations on the power supply sources.

additional switching and change-over operations on the power supply sources.

Operating Duties of Electric Mains

In view of the necessity of voltage supply to some power consumers even in conditions when separate sections of the electric supply mains are damaged the D.C. electric power distribution system is designed to allow three operating duties:

- normal;
- emergency;
- de-energized mains duty, when only consumers of vital importance are connected to the storage battery.

Normal duty. In the normal operating duty the electric mains, as a rule, connects all the four generators and the storage battery. In this case energized are all the busbars of the normal supply circuit, the busbars of the dual supply circuit and the busbar which supplies the instruments from the battery with the mains de-energized (the triple supply busbar).

To select the normal operating duty, it is necessary that the switches and selectors located on the generator control panel (Fig.55) at the radar operator's station should be placed to the following positions:

1. The switches of all the four generators and the battery-to-normal supply circuit blocking switch should be ON.

2. The storage battery change-over switch should be thrown to NORMAL (НОРМАЛЬНО).

3. The voltmeter change-over switch should be turned to NORMAL SUPPLY CIRCUIT (НОРМАЛЬНАЯ СЕТЬ).

4. The emergency supply circuit switch should be in the OFF position.

5. The change-over switch connecting the generators to the emergency supply system (bearing the inscription FROM GENERATOR (ОТ ГЕНЕРАТОРА) should be placed to LEFT No.2 (ЛЕВЫЙ)

6. The change-over switch bearing the inscription BATTERY SUPPLY OF EMERGENCY INSTRUCTIONS (ВКЛЮЧЕНИЕ АВАРИЙНЫХ ПРИБОРОВ НА ПИТАНИЕ ОТ АККУМУЛЯТОРА) should be thrown to OFF.

7. The switch with the label GROUND SUPPLY (АЭРОДРОМНОЕ ПИТАНИЕ) should be OFF.

Note: The storage battery blocking switch is rigidly fixed to the generator emergency switch connecting bar; this means that when at least one of the generator switches is ON, the storage battery blocking switch is also engaged.

In case of failure of part of the generators, connected to the normal supply circuit may be three, two or even one generator in combination with the storage battery. When connected to the normal supply circuit are three generators plus the storage battery, the number of connected consumers is unlimited, that is, the flight may be continued in the same conditions, as if all the four generators were operating. In case the normal supply circuit connects only two generators plus the storage battery connected simultaneously may be either the cannon system with continuously operating consumers or the tail unit de-icers with continuously operating power consumers. It is forbidden to connect the cannon system and the tail unit de-icer system simultaneously. When it is only the combination of one generator and the storage battery which is connected to the normal supply circuit, the total number of power consumers connected should ensure that the total load does not exceed 600 A.

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Emergency duty. In case a shorting appears in the normal supply mains (the trouble will be indicated by beyond-scale movement of the ammeter needles and by decreased-voltage indications of the voltmeter) or in case of another trouble which requires disconnection from the normal supply circuit, the radar operator should quickly select the emergency supply circuit which is de-energized in the normal operating duty serving as a stand-by circuit.

When flying with the supply mains in emergency duty, the circuit in operation connects one of the two generators (generator 2 on the left engine or generator 3 on the right engine) and the storage battery. In this case energized are: the emergency supply circuit, the dual supply busbar and the triple supply busbar. The normal supply circuit and its busbars are disconnected and de-energized.

To change from the normal to the emergency operating duty the following switching should be done on the generator control panel at the radar operator's station (Fig.54):

1. Operate the generator emergency disconnection lever to disengage all the four generators and the storage battery from the noraml supply circuit.
2. Turn the emergency supply circuit switch ON.
3. Place the voltmeter change-over switch to the EMERGENCY SUPPLY CIRCUIT position.
4. As a result (See the Diagram in Fig.54):

(a) the storage battery will get disconnected from the normal supply circuit;

(b) all the four main differential undercurrent relays, type ДМР-600 , will disconnect the generators from the normal supply circuit;

(c) generator No.2 will become connected to the emergency supply circuit through its additional relay, type ДМР-600.

When sure (by the ammeter and voltmeter readings) that the emergency supply circuit and generator No.2 operate normally, the storage battery change-over switch should be placed to the EMERGENCY POSITION (АВАРИЙНО); this action will connect the storage battery to the emergency supply circuit for buffer operation with the generator.

Notes: 1. In case le`t generator No.2 or its circuit is faulty, the generator change-over switch should be turned to the RIGHT No.3 (ПРАВЫЙ №3) position. In this position connected to the emergency supply circuit instead of generator No.2 (installed on the left engine) will be generator No.3 located on the right engine.

2. At the moment of the emergency supply circuit selection it is necessary to disconnect the inverter, type ПО-4500 , so as not to overload the generator with large starting currents during its connection to the circuit. Upon engagement of the generator it is necessary to re-engage the inverter.

In the course of emergency-duty flying it is allowed to use only those power consumers which are connected to the dual supply busbars (See Table 17) and to the triple supply busbar (See Table 18). Under these conditions the flying time has no specific limitations.

In case the emergency supply system is faulty it is necessary to select the de-energized mains operating duty.

De-energized mains operating duty. Under the headlined duty conditions the normal and emergency supply circuits will be de-energized, and the storage

battery will supply only those consumers which are vitally important for flight continuation (See Table 18). The following operations should be carried out on the generator control panel at the radar operator's station to select the duty in question:

1. Turn on the change-over switch labelled BATTERY SUPPLY OF EMERGENCY INSTRUMENTS (ВКЛЮЧЕНИЕ АВАРИЙНЫХ ПРИБОРОВ НА ПИТАНИЕ ОТ АККУМУЛЯТОРА).
2. Turn the emergency supply circuit switch off.
3. Turn the storage battery switch off.
4. Turn off the switches of the four generators and the blocking switch of the storage battery.
5. Turn the voltmeter change-over switch to STORAGE BATTERY (АККУМУЛЯТОР).

CAUTION: The storage battery, type 12-САМ-55, is capable of supplying the instruments listed in Table 18 for not longer than two hours.

Table 17

Consumers Connected to Dual Supply Busbar

No.	Description	Protector of consumer and type of fuse	Marking of feeder
1	2	3	4
1	Fuel flow controller, left	АЗС-5	АГ
2	Fuel flow controller, right	АЗС-5	АД
3	Bomb emergency dropping control	АЗС-5	ВА
4	Electric bomb release supply (release of bombs armed)	АЗС-15	ВБ
5	ARMED-SAFE system	АЗС-10	ВВ1
6	Armed emergency dropping system	АЗС-10	ВВ2
7	Fuze circuits, left front	СП-5	ВВа
8	Fuze circuits, right front	СП-5	ВВб
9	Fuze circuits, left rear	СП-5	ВВг
10	Fuze circuits, right rear	СП-5	ВВг
11	Bomb emergency dropping control relay	АЗС-2	ВИ
12	Bomb emergency dropping control relay	АЗС-2	ВЕ
13	Armed bomb release blocking relay	АЗС-2	ВЛ
14	Armed bomb release blocking relay	АЗС-2	ВМ
15	Emergency bomb dropping system supply	ИП-50	ВН
16	Sight supply	АЗС-15	ВП
17	Supply of bomb release variant selector box, type КЗСБ-48	АЗС-5	ВР
18	Rear adapter disconnecting relay	АЗС-2	ВФ
19	Starting system supply	АЗС-25	+3
20	Air cock of left engine	АЗС-5	1зА
21	Left engine starting system	АЗС-15	1зБ
22	Left engine starting system control	АЗС-5	1зН
23	Left engine ignition system	АЗС-20	1зП
24	Air cock of right engine	АЗС-5	2зА
25	Right engine starting system	АЗС-15	2зБ

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1	2	3	4
26	Right engine starting system control	АЗС-15	2аВ
27	Right engine ignition system	АЗС-20	2аП
28	Inverter, type ПО-4500, stand-by	ТН-200	
29	Fuel pump of left tank No.19	НН-15	НБа
30	Fuel pump of left tank No.16	НН-50	НБб
31	Fuel pump of left tank No.10	НН-75	НБв
32	Fuel pump of left tank No.2	НН-75	НБг
33	Fuel pump of right tank No.3	НН-75	НБд
34	Fuel pump of left tank No.4	НН-75	НБе
35	Fuel pump of right tank No.5	НН-75	НБж
36	Fuel pump of left tank No.6	НН-50	НБз
37	Fuel pump of right tank No.6	НН-50	НБи
38	Fuel pump of right tank No.10	НН-75	НБк
39	Fuel pump of right tank No.16	НН-50	НБл
40	Fuel pump of right tank No.19	НН-15	НБм
41	Fuel stopcock of left engine	АЗС-5	НБф
42	Fuel stopcock of right engine	АЗС-5	НБх
43	Fuel shut-off cock	АЗС-5	НБэ
44	Air position indicator (dead reckoning computer system , type НМ-50Б	АЗС-5	АК
45	Flap actuator, electric motor No.1	НН-150	НН
46	Flap actuator, electric motor No.2	НН-150	НУ
47	Ultra-violet illumination of pilot's instrument panel and overhead electric control board	АЗС-2	ОУ
48	Directional gyro of pilot	АЗС-5	ПА
49	Gyro horizon set of pilot	АЗС-5	ПБ
50	Gyro horizon set and directional gyro of co-pilot	АЗС-5	ПГ
51	Three-pointer indicator, type ЭМИ-3Р, of right engine	АЗС-2	ПД
52	Fuel quantity gauge of left engine tanks	АЗС-2	ПЕ
53	Fuel quantity gauge of right engine tanks	АЗС-2	ПЖ
54	Fuel flow gauge of left engine tanks	АЗС-2	ПЗ
55	Fuel flow gauge of right engine tanks	АЗС-2	ПИ
56	Fuel pressure gauge	АЗС-2	ПЛ
57	Three-pointer indicator, type ЭМИ-3Р, of left engine	АЗС-2	ПМ
58	Bank-and-turn indicator of co-pilot	АЗС-2	ПУ
59	Flap position and free air temperature indicator	АЗС-2	ПШ
60	Range-finder, type СД-1	АЗС-2	РД
61	Radio compass, type АРК-5, No.1	АЗС-2	РК
62	Radio compass, type АРК-5, No.2		РД

1	2	3	4
63	ILS equipment	АЗС-10	РМ
64	Aircraft transponder	АЗС-5	РО
65	Radar bomb sight, type РБП-4, (control)	АЗС-20	РП
66	Command radio station, type РСИУ-3М	АЗС-5	РЗ
67	Antenna duplexer of radar altimeters, types РВ-2 and РВ-17	АЗС-2	РШ
68	Left tank group fuel pump warning system	АЗС-2	СБ
69	Bombing equipment warning system	АЗС-5	СВ
70	Right tank group fuel pump warning system	АЗС-2	СД
71	Hydraulic system warning unit	АЗС-2	СГ
72	Cabin sound warning system	АЗС-2	СБ
73	Mach limit warning system	АЗС-2	СМ
74	Differential pressure warning unit of front cabin	АЗС-2	СО
75	Fire warning unit of left tank group	АЗС-15	СП
76	Fire warning unit of right tank group	АЗС-15	СУ
77	Follow-the-leader bombing procedure lamps	АЗС-15	СФ
78	Colour flare bomb normal release system	АЗС-20	СХ
79	Colour flare bomb bay doors warning system and release control interlock	АЗС-2	СЦ
80	Colour flare bomb emergency dropping system	НН-30	СЧ
81	Colour flare bomb station status indicator	АЗС-2	Сш31
82	L.G. warning system	АЗС-2	СЩ
83	Colour flare bomb emergency dropping control	АЗС-2	СЭ
84	Heaters of Pitot tube of co-pilot, radar operator, radio operator, НМ-50Б air position indicator and ОПБ-11р sight	АЗС-10	ТП
85	Control of stand-by pumps of tanks No.16	АЗС-2	УБд
86	Control of stand-by pumps of tank No.6	АЗС-2	УБе
87	Remote-indicating compass	АЗС-2	УД
88	CO_2 bottle control	АЗС-10	УЕ
89	Emergency fuel jettison valve system	АЗС-2	УЖ
90	Control of stand-by inverter, type ПО-4500	АЗС-2	УИ21
91	Bomb bay doors control (normal)	АЗС-5	УЛ
92	Bomb bay doors control (emergency)	АЗС-5	УП
93	Flap control,electric motor No.2	АЗС-5	УУ
94	Fuel flow control	АЗС-2	УЧ

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1	2	3	4
95	Flap control, electric motor No.1	A3C-5	ЗЩ
96	Control of first fuel pump group of left engine	A3C-5	Ъз1
97	Control of first fuel pump group of right engine	A3C-5	Ъз2
98	Control of second group fuel pumps	A3C-5	Ъз3
99	Control of third group fuel pumps	A3C-5	Ъз4
100	Control of fourth group fuel pumps	A3C-5	Ъз5

Table 18

Consumers Connected to Triple Supply Busbar for Storage Battery Supply of Instruments in Case of De-Energized Mains

No.	Description	Protector of consumer and type of fuze	Marking of feeder
1	Emergency ultra-violet illumination of front cabin and illumination of МН-12 compasses	A3C-5	ОА
2	Gyro horizon set, master	A3C-5	ИБ
3	Bank-and-turn indicator of pilot	A3C-2	ИИ
4	Interphone system channel No.1	A3C-5	РА1
5	Interphone sets СПУ-10	A3C-2	РА-20
6	Heaters of ТП-156 Pitot tube of pilot, navigator and velocity head warning unit ССН-3	A3C-5	ТН
7	Automatic brake control unit	A3C-10	АУ
8	Engine blow-off band control system		
9	CO_2 bottle control system	A3C-10	УЕ
10	Drag chute control system	A3C-5	УС
11	Fuel shut-off and stopcocks control system	A3C-5	М6
12	Radio station, type РСИУ-3М	A3C-5	Р7
13	Radio transponder destructor	No protection	ЗА51
14	De-energized mains bomb release	No protection	ЗС
15	In-flight engine starting system	No protection	ЗП

Protection of Electric Mains

The electric mains of the aircraft is built up of separate feeders. Termed "feeder" is a single consumer or a group of power consumers supplied through a separate protective device (a circuit breaker or fusible cutout).

The following protective devices are used for protection of the aircraft mains and power consumers:

(1) Automatic circuit breakers of А3С family.

(2) Glass fuses of СП family.
(3) Delayed-action fuses of ИП family.
(4) High-heat fuses of ТП family.

Automatic circuit breakers of А3С type (Fig.56) are employed for automatic disconnection of electric power consumers, as well as for protection of electric wires against dangerous over-loads and short circuits in electric circuits. The circuit breakers can be used for manual on-off switching operations on electric circuits, in which case they function as ordinary single-pole switches. However, the largest part of the circuit breakers installed in the aircraft act as fuses, and therefore they should be always turned on before each flight and held in this position throughout the entire flight. The automatic circuit breaker is engaged manually by its operating handle. In overload and short-circuit conditions the circuit breaker is cut out automatically; under normal loading conditions the circuit breaker is disengaged manually.

The circuit breakers are mounted in D.C. circuits with nominal voltage of 28 V, as a rule, in locations where they are easily accessible in flight. The following range of automatic circuit breakers is used on the aircraft: А3С-2, А3С-5, А3С-10, А3С-15, А3С-20, А3С-25, А3С-30, А3С-40 and А3С-50 (the hyphenated figure indicates the nominal voltage the circuit breaker is rated for).

Fuses, types СП, АП and ТП (Fig.57), are designed for protecting electric units from short-circuit currents and continuous, although small overloads. Delayed-action fuses ensure normal protection and at the same time withstand instantaneous current surges(300% and even 600% of rated currents) which are characteristic for the operation of some electric units.

Fuses, type СП, are installed in A.C. circuits, in permanent-load D.C. circuits, and at places difficult for in-flight access.

Fuses, types ИП and ТП, are installed in electric actuator supply circuits and are also used for group protection of the electric power distribution system and for the generators protection (See Figs 53 and 54).

Fuses of all the usable types are mounted on the aircraft in various-type boxes. The following ranges of fuses are used on the aircraft: СП-1а, СП-2а, СП-5, СП-10, ИП-5, ИП-10, ИП-15, ИП-30, ИП-35-2, ИП-75, ИП-100, ИП-150, ИП-200, ИП-250, ТП-600 and ТП-900 (the hyphenated figure denotes the nominal voltage the fuse is rated for).

Note: Fuses, type ИП, which have polarity marking should be installed in compliance with the polarity identification, i.e. attaching the fuse to the supply busbar with its hook lug which corresponds to the plus sign marked on the fuse cap. This is a must, as the operating characteristic of these fuses depend on the polarity of the current applied to them.

For the arrangement and layout of the protective devices on the panels and boards see Figs 58, 59, 60, 61, 62 and 63. The general layout diagram of the aircraft protective devices is presented in Fig.64.

Wiring

The electric mains of the aircraft consists of wires, marks БПВЛ and МГВЛ, coated with coloured insulation, and of aluminium wire, mark БПВЛА, with white insulation.

All the wires belonging to the armament system are of red colour, those

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of the radio equipment system - of light blue colour, the A.C. mains wire coloured yellow, and all the other wires are of white colour.

To ensure radio interference suppression, part of copper wires used a shielded (wire, mark БИВИЭ). For the same reason, part of copper wires is encased in common anti-interference braidings.

The wires are fitted in the terminal lugs, individual connectors and connections by means of upsetting, while their connection to plug connector terminals, to warning light fittings, miniature relays and other instrumen effected by soldering, use being made of ПОС-40 or ПОС-50 solders and ro For the types of wire fittings and terminations used on the aircraft see h in Fig.65.

The wires of the aircraft electric mains are coded in letters and fig Each wire should be coded over its entire length every 400 - 500 mm, and s bear at least six code markings every 50 mm by the wire end. Wires, mark are coded only at their ends: three code markings every 50 mm. Apart from put on the end of each wire prior to its fitting are vinyl pipes carrying wire identification marking.

Wires and vinyl pipes are marked in КЦ-52 paint with the aid of met stamps, the marking procedure being as follows:

1. Prior to marking an electric wire or vinyl pipe, clean the wire or surface from moisture and dust using a clean cloth for this purpose.

2. Stir up the КЦ-52 paint and pour it on to a felt pad (State Stand ГОСТ 288-53) contained in a metal case.

3. Inspect the stamp and in case it is fouled wash it in rectified al

4. Coat the stamp with the paint covering the pad and mark the wire o vinyl pipe.

5. The wire or the vinyl pipe marked, dry it during 20 to 30 minutes a temperature of 15 to 20°C.

The plotted markings should be well discernible. The marking may be a with use of special devices or with the aid of an automatic wire marker, if available.

Note: It is allowed not to mark the following wires:

(a) in bonding jumpers;

(b) in internal wiring jumpers of control boards, boxes, inst panels and other units if the wire does not run out of t respective unit and if the wire length does not exceed 15

(c) all wires whose length does not exceed 200 mm;

(d) wires connecting electric units to the airframe if it is p to trace them over their entire lengths from the unit to th structural member they lead to.

In conditions noted in Points (b) and (c) it will be the vinyl pipes f the end of each wire which are to be marked.

Separate wires of the aircraft electric system are ganged in bunches ("bunched conductors") with the aid of thread bandages. The bunched conduct numerical or compound numerical and letter markings which are placed on m rings fitted around the bunched conductors.

Metal tags are provided at points where the bunched conductors are br out of the electric units and over the entire length of the bunched condu at points most accessible for inspection. No tags are attached to bunched conductors of smaller-than-10-mm diameter.

Used as connecting links between separate wires and bunched conductor

cables. The term "cable" is used for a single wire or a group of wires which interconnect any two electric units. Cables have letter and numerical markings; identification letters stand for:

I - cables of the front pressurized cabin;
II - cables of the centre plane and the non-pressurized section of the fuselage;
III - cables of the left outer wing panel;
IV - cables of the right outer wing panel;
C - cables of the rear pressurized cabin;
VI - cables of the left engine;
VII - cables of the right engine;
X - cables of the tail unit.

The figure which follows the identifying letter denotes the ordinal number of the cable for the given electric unit of the aircraft.

The above-mentioned cable designations are indicated in all the feeder and schematic wiring diagrams available, but as a matter of fact these designations are present on the aircraft only in case of a single-cable conductor: the conductor tag in this case reads the cable designation. In all other cases, when bunched conductors consist of several cables, the identification tags carry only numerical data to indicate the line number of the given bunched conductor on the aircraft.

Laying and Removing the Cables

When laying or removing cables, keep it in mind that the electric system is built up as a single-wire circuit, the airframe being used as the minus wire. The single-wire circuit sets fourth the following requirements:

1. The plus wire should be insulated with utmost thoroughness. Any contact of an energized current-carrying element (wire lugs, plug connector terminals and the like) with the airframe results in short-circuiting.

2. The minus wire of the electric equipment should be reliably connected to the airframe. The connection should ensure minimum contact resistance (not in excess of 100 microohms) which is accomplished by cleaning the contact points from dielectric coatings and by secure attachment of the minus wire lug to the airframe.

3. The insulator maximum resistance of the aircraft mains relative to the airframe is the requirement to be fulfilled. For each feeder the insulator resistance of the plus wire (at the relative air humidity of 70%) should not be smaller than:

(a) 10 megohms if the feeder supplies up to three consumers;

(b) 8 megohms if the feeder supplies more than three consumers;

(c) the insulator resistance of the electric power distribution system wires should not be smaller than 1 megohm.

CAUTION. NEVER lay or remove wires when the electric system is energized.

Wires with damaged insulation are subject to replacement. To replace a wire:

1. Disconnect the damaged wire from the equipment.

2. Slacken the bunched conductor attachment yokes and loosen all the thread bandages on the section of the wire to be replaced.

3. Withdraw the damaged wire and lay the new one. The gauge, colour and the marking of the newly laid wire should be identical to those of the replaced wire.

4. Re-bandage the conductor with Mackay threads and fasten up all the slackened yokes of the bunched conductor.

In case of rupture or partial replacement of wires gauging from 0.35 t 8.8 sq.mm it is allowed to joint the wire ends by means of fixed connections shown in Fig.66. It is not recommended to butt-joint wires gauging over 8.8 As an exceptional measure, it is allowed to couple the wires by way of fitti the wire ends in terminal lugs with successive jointing of the lugs with th of a bolt and a nut; the jointing over, the connection should be thoroughly insulated with a vinyl pipe and vinyl tape.

In case all the wires of a bunched conductors are damaged, and the dama portion of a separate wire constitutes not less than 100 mm, the defective bunched conductor should be removed and replaced. The new bunched conductor should be made according to the respective Drawing or to the model of the bunched conductor to be replaced. To make a new bunched conductor:

(a) prepare and mark the required quantity of wires of corresponding gau and colours;

(b) collect together and bind the wires in a bunch according to the mod of the damaged bunched conductor;

(c) put vinyl pipes with respective marking on the wire ends;

(d) carry out termination of the wire ends.

The wire or the bunched conductor replaced, identify it with the aid of testing lamp or a voltmeter; then, referring to the feeder diagrams, check th insulator resistance of each feeder comprising the repaired bunched conducto For examples on circuits for testing separate sections of the electric syste see Figs 67 and 68.

Note: When checking by the diagram presented in Fig.68 the method of connecting the megohmmeter is the same as when testing with employ ment of the circuit presented in Fig.67.

The capacitors the puncture voltage rating of which is smaller than the voltage developed by the megohmmeter should be disconnected and tested separa ly.

When testing the continuity of the electric circuit of any electric unit, it is necessary to insulate the circuit from all the other electric circuits.

Before connecting the minus wires to the airframe, the contact place on the structural member should be thoroughly cleaned from its protective coatin this done, the lugs of the minus wires should be tightly bolted to the airfra and painted red.

Electric Wire Maintenance

After every two or three flights all the electric wires must be inspected and all the faults detected should be corrected.

The electric wire maintenance procedure consists of the following operatio

1. Wipe dry the wires covered with oil or hydraulic mixture. Fasten up th loose attachment fittings of shielded bunched conductors to prevent radio inte ference which is likely to appear due to insufficient tightness of attachment.

2. Check plug connectors for secure coupling and lock their union nuts.

3. Check the through bolts in power leads, pressurized cabin bottoms and contact blocks for secure fastening.

4. Check all the minus wire-to-airframe contact points. If the red lock- ing paint is deteriorated, it is required to tighten up the attachment screw,

to check the contact resistance value which should not exceed 100 microohms, and re-apply red paint to the contact point.

Note: When wires gauging 5.15 sq.mm and heavier are attached to the air- frame, the wire lug surface contacting the airframe structural member should be coated with a layer of anti-corrosion paste used in alumi- nium wire fittings; this done, it is necessary to reliably secure the lug, to wipe the place dry all around, to check the contact resistance value and to apply red locking paint.

5. When replacing a separate aircraft unit, make sure that the contact resistance of the newly installed unit does not exceed the value specified in Fig.69.

Maintenance of Junction Boxes and Electric Control Boards

Electric power is distributed within the aircraft electric system through different distribution arrangements (electric control boards, panels and junction boxes) which are provided with various-kind switching, control and protection equipment. The layout of electric control boards and panels, as well as of junction boxes, is presented in Fig.70, (a) and (b).

After a prolonged period of operation or parking of the aircraft it is necessary to check all the junction boxes, as well as electric control boards and fuse panels, the check-out procedure running as follows:

1. Check the cover locks for intactness and reliability.

2. Check the condition of wires' insulation at points where they are inserted into their boxes and electric control boards; inspect for adequate wire termina- tion.

3. Check the contacts for reliable coupling. Use a nut wrench to tighten up the nuts on contact bolts of plus and minus connections.

4. Check and, if such a necessity arises, tighten up the contact connections on the on-off and change-over switches, circuit breakers, etc.

5. Check the switching arrangements (on-off switches, change-over switches, rheostats, relays, buttons, contactors and the like) for secure attachment and sound operation.

6. Remove dust, dirt or moisture from the junction box or the electric control board and wipe it with a dry cloth.

7. Use a dry cloth to clean those portions of the supply busbars which bear traces of oxidation or dust.

8. Check all the fuses indicated in the attached diagram for availability, their integrity and for meeting the current intensity rating requirements, as well as for secure fitting of the СП -type fuses in their holders. If it is revealed that some fuses are missing or faulty, mount or replace the fuses.

9. Inspection over, close the cover of the box, panel or electric control board and lock the cover, if it was not locked before the inspection.

CAUTION: Never repair or check units mounted in junction boxes, electric control boards and panels when the aircraft electric system is energized.

Specific Features of Aluminium Wire Maintenance

With the view to lightening up the aircraft weight, the electric power distribution system is wired principally with aluminium wire, mark АПВЛА , gauging from 35.0 to 95.0 sq.mm. The current-carrying core of these wires is

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made of the material, grade AT, and consists of separate (twisted together) wires the gauge of which (1.08 to 1.4 sq.mm) is much heavier than that of co wires.

In clean and dry air it is characteristic of aluminium wires to get coat with a thin non-conductive oxide film which prevents the metal from further oxidation. However, moisture and gas contaminated air may become a favourable medium for intensive electro-chemical corrosion of aluminium. Apart from this, when in contact with some metals or alloys (copper, for example), aluminium makes up a couple prone to intensive corrosion.

Oxide film on the aluminium surface adversely affects the contact betwee the wire conductors and between the wire and the lug which may result in volt drop and excessive overheating at the wire termination point.

In order to preclude the probability of oxide film formation and corros the ends of aluminium wires are sealed by upsetting wire ends in special copp lugs which are hot-soldered (to obtain a heavier coating) and are filled with special anti-corrosion paste (a mixture of petrolatum with zinc powder).

CAUTION: NEVER use electrolytically treated copper lugs with holes for aluminium wire termination.

Upon upsetting the terminal lug and checking the contact resistance, th bare portion of the wire is to be wrapped with sealing tape, mark Y20A.

Next to their terminal lugs the aluminium wires are provided with identi tion marking: a red ring on a vinyl pipe or a red vinyl pipe fitted on the wi

If it occurs that in the course of operation the terminal lug of an alum wire breaks or the lug gets out of contact with the wire, the repeated wire f should be carried out as follows:

1. Remove the wire from the aircraft.

Note: It is allowed to terminate (fit) aluminium wires directly on the aircraft only in top urgency cases, for example, when removal of wire from the aircraft calls for large-scope demounting operation other equipment.

2. Cut off the broken conductors of the wire or the defective lug, and remove the insulation from the wire end, having previously shifted the vinyl with the label along the wire. The insulation should be removed from the wir only with the aid of an electrothermal tool since no cuts and other mechanical damage are tolerated on the wire conductors.

3. Having stripped the wire end, coat it from outside with a thin layer of anti-corrosion paste and then clean it with a special metal brush to remov oxide film from the wire conductors.

4. Half-fill the lug sleeve with anti-corrosion paste (to expell air fro it) and fit the lug onto the wire.

5. Using a special device for fitting aluminium wires of the given gauge, upset the lug on the wire.

6. Check the degree of lug upsetting; the dimensions of the pressed rece (Fig.71) should be within the limits specified in Table 19 below.

Table 19

Key to Values Indicated in Fig.71

Wire gauge, sq.mm	Dimension, mm		
	A	B	C
35	12	5.2 - 5.6	13 - 15
50	12	6.8 - 7.2	15 - 17
70	16	7.2 - 7.6	16 - 18
95	16	8.2 - 8.6	17 - 20

7. Measure the contact resistance between the upset lug and the wire using n ammeter and millivoltmeter according to the circuit diagram presented in ig.71. To measure:

(a) connect the wire under check to a D.C. power supply source with rated oltage of 28 to 28.5 V and power not exceeding 7.5 kW;

(b) using an excitation rheostat, determine the intensity of current through reference to the ammeter) flowing in the wire. The intensity should not xceed 140, 180, 200 and 225 A for wires gauging 35, 50, 70 and 95 sq.mm, espectively;

(c) place one of the probes of the millivoltmeter in the middle of the pset portion of the lug and connect the other probe to the yoke fitted around he bare section of the wire;

(d) calculate the contact resistance according to the formula: R = V/I, here I is the current passing in the wire at the moment the measurement is eing taken (as read by the ammeter), and V is the voltage drop in the wire ermination point (as indicated by the millivoltmeter). The contact resistance hould not exceed the limits specified in Table 20. If the contact resistance till surpasses the indicated limits, the lug should be cut off, the wire should e terminated anew, and contact resistance should be checked once more.

Table 20

Tolerated Contact Resistance Values for Aluminium Wire Lug Terminations and Tolerated Bend Radii of These Wires

Wire gauge, sq.mm	Contact resistance (in microhms) at temperature of 20 to 22°C	Tolerated bend radius of wire, mm	
		1	2
35	up to 20	50	30
50	up to 15	60	40
70	up to 12	100	60
95	up to 10	150	100

8. Use a clean piece of cloth or gauze to remove superfluous anti-corrosion aste from the portion to be tapesealed. Tightly wrap tape, mark 20 A, around he bare portion of the wire until completely covered, and then use a 10-mm de tape to wrap around the lug and the insulation so that the tape would verlap them 2 to 3 mm. Cover to tape surface with talc and fit the vinyl pipe ith the tag over the lug.

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Note: Due to the fact that aluminium is an easily corroded material, all the operations covering the lug-to-wire fitting and sealing of the termination should be completed during not longer than one hour.

9. Record the work done in the aircraft Service Log, with indication of the contact resistance of the fitted lug.

10. Mount the wire on the aircraft. In view of the fact that aluminium wires are much less flexible than copper wires, no sharp bends should be involved in their mounting.

Small-radius bends of aluminium wires result in displacement of conductors of the wire at the fitting point and in increased contact resistance at the wire point. Therefore the bend radii of aluminium wires should be not smaller than those specified in column 1 of Table 20.

If it proves impossible to maintain the specified radii during mounting operations (at the inlets into boxes, control panels and the like), resort may be made to the radius values specified in column 2 of Table 20. In the latter case the lug should be put onto the wire bent to the radius indicated in Table 20, and the wire should not be bent after the fitting operation.

Regulation and Check-Out of Bonding Arrangements

Due to the fact that the airframe is used in the function of the minus wi all the units and items of aircraft equipment are reliably bonded to ensure normal operation of electric power consumers, to reduce to the minimum radio interference, as well as to eliminate the probability of local overheating and electric corrosion of separate units and joints.

The following bonding methods are used:

1. Connection of all the aircraft structural members and equipment into an integral system by means of rivets and bolts.

2. Provision of special bonding jumpers which interconnect separate structural members of the airframe and connect the aircraft equipment to the airfra

The maximum allowable values of contact resistance between separate aircraft structural members are indicated in Fig.69. The maximum allowable contact resistance for all the other structural members and equipment units of the aircraft is divided into the following major groups:

(a) 50 microohms - at installation points of ballast resistors, type BC-1

(b) 100 microohms - for points of direct coupling of all the ignition system screens and for points at which the manifold pipes are connected to the engine body;

(c) 200 microohms - at installation points of decoupling capacitors and filters;

(d) 600 microohms - at points of direct coupling of parts and units;

Note: Tolerated in some cases for directly coupling parts is contact resistance as high as 2000 microohms (for covers, access panels, doors, etc.).

(e) 2000 microohms - for bonding jumper connections of parts and units.

However, in some cases it proves possible to obtain smaller contact resistance values which considerably improves the aircraft bonding characteristics.

Contact resistance is checked with the aid of low-resistance meters, type MMC-3, or with special microohmmeters of high accuracy class, with division value not more than 100 microohms.

It should be always remembered that poor bonding in any aircraft system creates even heavier radio interference (due to appearance of additional variable contacts) than a completely unbonded system. Therefore, unlike other types of aircraft mountings, the bonding system requires constant care. This specially refers to the engine bonding systems which should be paid the greatest attention since the engines carry large masses of metal and mount a great number of units which are sources of radio interference.

In the course of operation some bonding jumpers may get broken, or the bonding jumper-to-airframe contact may become loose. The other problem is absent-minded neglect of providing bonding arrangements for all the newly installed off-shelf items. There are other problems, too.

In view of all this, the aircraft bonding system should be systematically and thoroughly checked and maintained throughout the entire service life of the aircraft. The maintenance procedure consists in the following:

1. Checking all the electric cables of the engine group for secure attachment and reliable contact with the engine body.

2. Checking the integrity of all the bonding jumpers installed on the aircraft; special attention should be paid to the bonding jumpers installed on the aircraft engines.

3. Tightening up loose jumpers and check-out of static dischargers for cleanness.

4. Replacement of all unusable or broken bonding jumpers with due anti-corrosion provisions.

When installing a bonding jumper:

(a) use an end cutter or emery paper No.00 to clean bright the contact surfaces of the bonding jumper lugs and of the bodies to be bonded;

(b) mount the bonding jumper seeing to it that its resistance value and length are same as those of the replaced bonding jumper; make sure that the bolts attaching the bonding jumper to the airframe element are tight;

(c) measure the contact resistance;

(d) apply red paint, mark A-67, to the cleaned portion of the structural member, to the jumper lug and the bolt head in the same manner as it was done with the replaced bonding jumper.

5. For effective inspection, it is necessary to take regular selective measurements of contact resistance with the aid of low-resistance meters, type MMC-3. If it is revealed in the course of inspection that the actual contact resistance values considerably differ from the rated ones, actions should be taken to normalize the bonding system.

OPERATION PECULIARITIES OF D.C. POWER SUPPLY SOURCES

Generator Maintenance

Aircraft generators, type PCP-18000, operate in heavy vibration conditions and therefore need systematic and thorough care and inspection.

The generator maintenance procedure consists in the following:

1. Checking the bolts of the generator lead-out wires and all the threaded connections for tight fastening.

2. Checking the pipeline for secure attachment to the generator air delivery branch pipe.

3. Checking the cap for proper attachment to the commutator end shield of the generator; tightening up the nut attaching the cap with the branch pipe to the commutator end shield in case of necessity.

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4. Checking the commutator end shield for play-free attachment. The a
is likely to play in case of loose attachment of the air pipe to the gen
air delivery branch pipe or due to excessive length of the free portion of
lead-out wires.

5. Checking the commutator and brushes for condition.

To inspect the commutator and those brushes which are accessible, it
necessary to remove the cover band. When remounting the cover band, see t
that the body-mounted pin by all means coincides with the reference hole o
band.

If it has been revealed in the course of inspection that the commutato
severely burned and the brushes have been worn out down to a length of 18
the generator should be removed from the aircraft and thoroughly inspected
commutator should be cleaned with sandpaper, the faulty brushes should be r
placed, and the generator - tested on a laboratory stand.

Note: The length of brushes should be measured from the side of the
surface of the brush.

Maintenance of Voltage Regulator and of Equipment Operating in Set with Voltage Generator

In the course of operation of voltage regulators, type PYT-82 , the w
level adjustment and distribution of loads among the regulators operating
in parallel are effected by means of external resistors, type BC-20. It is
tely forbidden to employ any other method for adjusting the regulator.

Due to wear of the carbon pile and possible sagging of the springs th
pressure applied to the regulator carbon pile is likely to become weakened
incorrect operating conditions the wear of the carbon pile of the PYT-82 r
age regulator may be so severe that the regulator will be maladjusted to a
tion when the regulator begins to pop. It is forbidden to operate the reg
popping conditions since this leads to burning out and desintegration of th
bon pile.

To prevent popping operating conditions of the voltage regulator, the
lator should be subjected to regular inspection (approximately after every
50 hours of operation) on board the aircraft. The regulator adjustment test
carried out at high generator speed, and therefore it is advisable to comb
generator check with the engine maximum r.p.m. testing.

When the generator is operated with the storage battery disconnected,
cut-in and cut-out take place, the load variation being not less than 50% o
the nominal generator rating. If the regulator, due to maladjustment, opera
popping conditions, this operational instability will be detected by oscill
of the voltmeter needle.

The voltmeter check of the regulator allows to determine popping operat
conditions of the regulator. However, checking by this method fails to reve
close-to-popping conditions since in this case popping is present only unde
transient operating conditions and disappears quite rapidly. Therefore, con
tions allowing, it is best advisable to carry out the check by listening to
operation of the carbon pile through high-resistance earpieces. For operati
the earpieces should be connected to the wires running from the first and s
pins of the PYT-82 regulator plug connector (in a place easiest for access
to effect several load on-off cycles. If the regulator functions normally,
load cut-out is accompanied by a single click and changed tone in the earp
If the regulator load cut-out is characterised by wheeze, this testifies to

adjusted regulator. The faulty voltage regulator should be removed from the
craft and sent over for adjustment to the repair workshop.

CAUTION: NEVER try to adjust the PYT-82 voltage regulator on board the aircraft by changing the air gap of the electromagnet or by varying the carbon pile pressure.

Apart from voltage regulator adjustment checks, attention should be paid
the course of the aircraft service life to the integrity (condition) of the
res running from the second socket of the regulator plug connector to the
ternal resistor, type BC-20, and from the resistor to terminal Ш of the
ability transformer, type TC-8; terminal Ж of the stability transformer
ould be checked for proper grounding. Any breakage in the above-mentioned
rcuit results in a sharp generator voltage increase, in disturbances in the
rallel operating system, and in burn-out of the generator field winding.

Stable operation of the voltage regulator is ensured by the stability
ransformer, type TC-8.

CAUTION. It is forbidden to operate the voltage regulator, type PYT-82, without the stability transformer, type TC-8.

The differential undercurrent relay, type ДМР-600 , the stability transformer,
pe TC-8, the external resistor, type BC-20, and the capacitor, type КЕМ-51,
not require special maintenance. In operation, they will be checked only for
ntact tightness of their connected wires and for secure attachment.

CAUTION: NEVER clean the contacts of the ДМР-600 relay or adjust the relay in operating conditions.

Storage Battery Maintenance

When installing the capacity-charged storage battery on the aircraft, it is
ecessary to inspect it for condition of the sealing compound, terminals, group
ars and plugs. There should be no cracks in the sealing compound and group bars.
he terminal bolts should have intact thread, and the output busbar lugs as
ll as the surfaces of the terminals contacting the busbars should be cleaned
rom oxides.

External inspection over, the plugs (free from fouling) are screwed into the
ttery, and the functioning of the valves is checked. Never install plugs which
o not open when the battery returns to the normal operating position after being
ilted through 180 and 190°.

Battery Discharge Level Test

The level to which the storage battery has been discharged can be roughly
termined by the voltage produced by the battery under load or by the density
f the electrolyte, the second method being the most correct one.

The battery voltage is measured with the battery connecting (generators
eing OFF) one of the aircraft power consumers rated for a current close to 22 A.
he electrolyte density is gauged with a densimeter.

For the battery voltage and electrolyte density as functions of the battery
discharge level see Table 21 below.

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Table 21

Battery Voltage and Electrolyte Density as Functions of Battery Discharge Level

Battery discharge level relative to nominal capacity	Battery voltage (in volts) at 20 A load	Electrolyte density in cells, reduced to 25°C	Note
Charged battery	25 to 24	1.260 ± 0.005	Battery ensures 6 engine startings
Battery discharged by 25%	25 to 24	1.200 - 1.210	Battery ensures 3 to 4 engine startings
Battery discharged by 50%	24 to 23	1.170 - 1.160	Battery may fail to start engine
Battery discharged by 75%	23 to 22	1.120 - 1.110	Engine starting failure to be expected
Battery fully discharged	22 to 21	1.080 - 1.010	No engine starting

After each flight it is necessary to check the battery discharge level. If the battery has been discharged completely or partially (by over 25%), it is necessary to send it for charging to the charging station in not longer than an eight-hour period. After each flying day (night) it is necessary to check the battery discharge level by the electrolyte density. All the charging cycles and the number of engine startings effected by the battery should be recorded in the Service Log of the storage battery.

Inoperative storage batteries should be additionally charged with a current of 3.5 A at least once in a month.

Once in every three months all the storage batteries (both operating and inoperative batteries) should be subjected to a procedure charge-discharge cycle as a measure against sulphating. The results of the operation should be entered in the Service Log of the storage battery.

In the course of operation it is necessary to regularly check the level and density of the electrolyte and add distilled water to the cells. It is forbidden to add electrolyte or acid in the cells unless it is known for sure that the level decrease is due to electrolyte spilling. In the latter case it is necessary to add battery sulphuric acid solution of the same density as the density of the electrolyte contained in the cells.

Never expose storage batteries to direct sun rays or place them one onto another.

If cracks are detected in the sealing compound, eliminate them by the melting method. Hot-treat the sealing compound only with the battery discharged and plugs removed, making use of a soldering torch, hydrogen flame or other means.

Storing the Battery

Storage batteries which are in active service and which have been in operation for not longer than half the guaranteed service life period, as well as storage batteries which have passed the Manufacturer's electrical tests (marked with a red strip on the group bar) should be stored with electrolyte in the charged state.

CAUTION: IT IS ABSOLUTELY FORBIDDEN TO STORE ELECTROLYTE-FREE 12-CAM-55 STORAGE BATTERIES WHICH HAVE BEEN IN OPERATION OR HAVE PASSED ELECTRICAL TESTS.

Storage batteries should be placed for storage as follows:

1. Charge the storage battery to capacity.
2. Check and carry out necessary operations to obtain the normal density and level of electrolyte.
3. Install the vent plugs in all the battery cells and wipe the battery surface with rags soaked in a solution of soda or ammonia hydroxide.
4. Wash the battery surface with water and wipe the whole battery dry with clean rags.
5. Clean the clamps and intercell connections of the battery and coat them with a thin layer of petrolatum or grease. This done, the battery may be considered ready for storage.
6. Every month it is necessary to give the battery an additional charge with a current of 3.5 A till there are indications that the battery is charged to capacity. At least once in every three months the battery should be subjected to a procedure operating cycle.

Prior to beginning the operation of a storage battery just removed from storage, it is necessary to give it an additional charge with a current of 3.5 A to obtain constant electrolyte density and voltage.

The storage battery can be stored with electrolyte charged for not longer than six months.

When there is no possibility of storing the battery with charged electrolyte, the storage batteries, type 12-CAM-55, which have been in operation for some time and are not intended to be used during long period of time may be stored discharged, without electrolyte. Before the storage battery is placed for storage, it is subjected to one procedure operating cycle, and then it is discharged with a current of 11 A till the voltage in one of the battery cells drops to 1.7 V. The discharged batteries are turned with their plug holes down and are left in this position during three hours. For complete removal of electrolyte from the battery it is necessary to slightly tilt the battery and give it light shake-ups. It is forbidden to wash the battery out with water before placing it for storage.

Batteries are placed for long-time storage with their blank plugs tightly screwed in and with their surfaces thoroughly wiped dry with clean rags. To prevent bulging of the sealing compound during its storage, the cells should be closed with blank plugs at a temperature of 30 to 45°C inside the battery, for which purpose the battery should be either placed in the corresponding ambient temperature conditions, or warmed up with hot water from the outside.

CAUTION: One-time used storage batteries, type 12-CAM-55, can be stored without electrolyte for not longer than three months.

Main Storage Battery Troubles

All the troubles which are probable to develop in the storage battery can be divided into three categories:

1. Troubles of electrochemical character which can be eliminated by electrochemical methods (by using specially selected charging-discharging conditions).
2. Mechanical troubles which can be eliminated on the spot, by available means.
3. Troubles related to defective plates and group bars; these faults are corrected in special workshops.

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Troubles in the storage battery can be detected either by external inspection or by pertinent measurements during electrochemical tests.

Detected by visual (external) inspection are: cracks in the vessels and b bars, leakage of electrolyte, cracks or softened spots in the sealing compou fouling of the external surfaces, breakage of the output pins and intercell connections, poor contact between the output pins and intercell connections, b seal of the covers, as well as breakage or fouling of the plugs. The majority these troubles is eliminated right in the using unit.

The troubles mentioned under Items 1 and 3 above can be detected by the battery voltage and voltages of separate cells in the course of the charge-di charge cycle, by the density and temperature of electrolyte and by gas evolvi during the charging half-cycle. These troubles can be eliminated only at specia ropair workshops or at a charging station.

Following should be the characteristics of a sound battery by the end of its charging:

(1) voltage at each cell - 2.45 to 2.6 V (when alive);
(2) specific weight of electrolyte - 1.260 ± 0.005;
(3) electrolyte temperature - not over 45°C;
(4) almost simultaneous "boiling" and gas formation in all bettery cells;
(5) neutral-colour, transparent electrolyte, free from any sediment.

When test-discharged, a sound storage battery should manifest a capacity which is not smaller than 75% of normal capacity.

Peculiarities of Storage Battery Operation in Subzero Temperatures

In those cases when the storage half-battery cells are left in their containers with the aircraft parked at temperatures down to minus 40°C, prio to flight it is necessary to engage the electrical heater system of the containers.

The electrical heater system of the containers can be energized only fro a ground supply source (See the diagram in Fig.54) which is connected to the ground supply plug connector of the aircraft.

When already in flight, i.e. when the storage battery is connected for buffer operation with the PUP-18000 generators, there is no need in electri heating of the containers even when the ambient air temperature is below zero and down to minus 60°C. This is explained by the fact that while in flight th temperature of the electrolyte in the storage battery cells remains above zer due to operation of the storage battery. The effect of the ambient air temper ture is considerably reduced due to the use of heat-insulator which lines th interior of each container.

To engage the container heater system, proceed as follows:

1. Connect a D.C. ground power supply source to the aircraft mains.
2. Tightly close the covers of both storage battery containers.
3. Turn on the heater switch located above the left storage battery conta

The heater system is disconnected automatically by means of thermal switch type 777B, which are connected to the minus circuit of the heaters of each container. The switches operate as soon as the temperature at the surface of t heating plates reaches 80 ± 10°C.

Connecting D.C. Ground Supply Source

To energize the aircraft electric mains at parking and for engine startin

purposes, the aircraft is equipped with a ground supply plug connector the plug of which is secured in the nosewheel leg well, port side, at frame No.16.

The plug and the mating detachable receptacle of the ground supply plug connector have three pins and three sockets. Two thicker pins are power pins, and they are longer than the third (thinner) pin which is used as a guide element. Such a construction ensures that the power contacts are energized only after the full contact is obtained, which precludes burning of the power contacts when connecting the receptacle.

To connect the ground supply source to the aircraft electric mains, act as follows:

1. Couple the ground supply receptacle (with the ground supply source connected to it) with the ground supply plug.
2. Place the voltmeter change-over switch on the generator control panel at the radar operator's station to GROUND SUPPLY RECEPTACLE (РАП),
3. When sure (through reference to the voltmeter) that the voltage across the terminals of the ground supply plug connector is normal, select the NORMAL SUPPLY CIRCUIT (НОРМАЛЬНАЯ СЕТЬ) position of the voltmeter change-over switch.
4. Turn on the ground supply switch.
5. As soon as the voltmeter begins to indicate that the aircraft mains is energized, it is allowed to begin connecting power consumers, checking their operation by the ammeter and voltmeter.

Ground supply sources are connected to the aircraft electric mains through a contactor, type K-400Д (See Ref.No.32 in the diagram of Fig.54) which operates only with the ground supply switch cut in (See Ref.No.31 in the same Figure).

To disconnect the ground supply source:

1. De-energize all the power consumers.
2. Turn off the ground supply switch on the generator control panel at the radar operator's station.
3. Disconnect the ground supply receptacle.

CAUTION. When the aircraft mains is energized from a ground supply source, it is not advisable to impose a simultaneous load which would exceed 500 A. In case the aircraft mains requires a current larger than 500 A, it is necessary to withdraw the fuses from the storage battery ammeter and ground supply circuits which are installed in the storage battery junction box. In overload conditions use should be made of a special ground ammeter with a scale range exceeding 500 A.

Control over D.C.Power Supply Sources and Electric Mains

Control over the operation of the power supply sources and over the continuity of the electric circuits is effected by means of five ammeters. Four ammeters, type A-3, with scales reading to 100 - 0 - 1000 A are installed in the generator circuits, while the fifth ammeter, type A-2, with its scale reading to 50 - 0 - 500 A is provided in the aircraft storage battery and ground supply circuit.

The ammeters are provided with extension shunts which are located on the distribution panels of the engine compartments and in the storage battery junction box (Fig.72).

The operation of the power supply sources and functioning of the electric

circuit are checked by a voltmeter, type B-1, rated for 30 V. By means of a selector switch, type П-46 , the voltmeter can be connected to each of the generators to the normal supply circuit, to the emergency supply circuit, to ground supply plug connector and to the storage battery.

In flight, under normal electric power supply conditions the voltmeter should be connected to the normal supply circuit, and in emergency power supply conditions it should be connected to the emergency supply circuit; in de-energized mains conditions the voltmeter should be connected directly to the storage battery.

All the above mentioned instruments, as well as the selector switch, type П-46 , of the voltmeter are mounted on the generator control panel installed at the radar operator's station (See Fig.55). In addition, the radio operator's instrument panel mounts a voltmeter, type B-1, which measures the normal supply circuit voltage in the rear pressurized cabin.

Basic Technical Characteristics of Ammeters. Types A-1. A-2. A-3 and of Voltmeter. Type B-1

Description	Type of instrument	Measuring range	Graduation value	Scale graduation numbering
Ammeter	A-1	40 - 0 - 400 A, with shunt rated for 300 V	20 A	0, 1, 2, 3 and 4
Ammeter	A-2	50 - 0 - 500 A, with П-2 shunt rated for 500 A	25 A	0, 1, 2, 3, 4 and 5
Ammeter	A-3	100 - 0 - 1000 A, with П-3 shunt rated for 1000 A	50 A	0, 2, 4, 6, 8 and 10
Voltmeter	B-1	0 - 30 V	1 V	0, 1, 2 and

1. The main error of the ammeter without shunt under normal conditions and at nominal resistance of the connecting wires does not exceed ±2% of the sum total of the nominal scale values.

2. The shunt is accurate within ±0.5% of the shunt nominal current rating.

3. The main error of the B-1 voltmeter under normal operating conditions should not exceed ±2% of the nominal scale value.

4. The additional error for every 10°C ambient air temperature variation within plus 50 to minus 60°C should not exceed ±0.5% of the sum total of the nominal scale values for the ammeter, and of the nominal scale value for the voltmeter.

Maintenance of Ammeters and Voltmeters

When the power supply sources are disconnected, the needles of the instruments should indicate zero.

If the instrument needle does not respond to the connection of a power supply source, it is necessary to check the wires for condition and to check whether the contacts at the wire-to-instrument (or to shunts in case of ammeter) connections are reliable.

In short-circuit conditions the ammeter needles swing to the extreme right position (beyond the scale range) and the voltmeter needle indicates reduced voltage. If, at the moment of connecting a power supply source, the instrument

needle moves in the reverse direction, it is necessary to change the places of the wire ends leading to the indicating instrument.

In case troubles develop inside the indicating instrument, it should be replaced. There is no need in removing the ammeter shunt (if it is intact) since all the ammeter shunts are interchangeable.

If in the course of operation there appears a necessity to replace the connecting wires in a certain section between the indicator and the ammeter shunt, the length and the gauge of the newly selected wires should be identical to those of the replaced wires. Changes in the length and gauge of the wires result in changed resistance of the connecting wires, and other-than-nominal resistance leads to additional instrument errors.

Adjustment of D.C. Power Supply Sources

The generator system adjusting procedure should be started from individual voltage adjustments on each generator with the view to obtaining a voltage of 28.5 V with the aid of the external resistors, type BC-20, and the B-1 voltmeter mounted on the generator control panel at the radar operator's station (See Fig.55).

CAUTION. It is allowed to connect the generator to the aircraft mains only after it has been adjusted for the voltage of 28.5 V.

Generator Voltage Adjustment in Ground Conditions

In ground conditions the generator voltage will be adjusted with the engines running; in the course of the adjusting procedure, the power consumers of the engine accessories group should be energized from a ground power supply source.

To adjust the generator voltage:

1. Place the voltmeter change-over switch to the position corresponding to the generator subject to adjustments.

2. Obtain the engine speed of 3750 r.p.m.

3. Obtain the voltage of 28.5 V by rotating the knob of the BC-20 external resistor of the generator to be adjusted.

4. For a short period of time advance the engine speed to 4100 r.p.m. As a result, the generator voltage should not vary by more than 0.5 V.

The voltage adjusting procedure for all the other generators is absolutely identical to that described above.

Connecting Generators to Aircraft Mains

To connect the generators to the aircraft mains act as follows:

1. Disconnect the power consumers leaving the minimum number of connected consumers which ensure normal operation of the engines.

2. Disconnect the ground supply source and quickly connect all the four generators, one after another.

3. Cut in all necessary power consumers.

CAUTION. Before connecting the generators, see to it that the 12-CAM-55 storage battery is installed in its container.

Adjusting Parallel Operation of Generators

The parallel operation of the generators will be adjusted in flight, in 30 to 40 minutes after the take-off, i.e. as soon as the voltage regulators and the generators are warmed up sufficiently.

The adjusting procedure runs as follows:

1. Connect all the de-icer and heater devices. The current load in this case will total:

permanently connected consumers	430 A (approx.)
electric heaters of cabins	340 A
glass panel heaters	190 A
tail unit de-icers	470 A (approx.)
amplidynes and dynamotor of cannon armament system	250 A (approx.)
Total	1680 A (approx.)

Hence, the average load per one generator amounts to approximately 420 A.

To avoid dangerous overloading of any one generator, all the large loads (de-icers and heaters) should be applied in turn.

Upon connection of a power consumer it is necessary to check, through reference to the generator ammeters, whether the current is equally distributed among all the generators. In case the generator current is unbalanced by more than 120 A, it is necessary to level off the generator loading with the aid of the BC-20 external resistors; the voltage of the generators bearing the smaller load should be increased, and the voltage of the heavier-loaded generators should be reduced.

2. Place the П-46 selector switch of the voltmeter to the NORMAL SUPPLY CIRCUIT (НОРМАЛЬНАЯ СЕТЬ) position and check the aircraft mains voltage; the voltmeter should read within 28 to 28.5 V. In case of other readings, the voltage level of all the generators should be either raised or lowered by the required magnitude. This is effected by rotating the ВС-20 resistor control knobs through one and the same angle.

3. Disconnect the power consumers which are not required for normal flight procedure and check the generator loading by the ammeters. Unbalanced loadings of the generators in small-load conditions is no problem to bother about; however, all the generators should supply current to the aircraft mains. In conditions of very small loading some generators can be disconnected by their respective relay type ДМР-600 This presents no trouble, since, as the load increases, the ДМР-600 relay will reconnect the generator to the mains.

Note: It is necessary to adjust the parallel operation of the generators in each flight. The adjustment should be repeated only if the generator current is unbalanced by more than 150 A at a load amounting to 25 – 50% of the nominal loading, and 120 A at loads exceeding half the nominal rating of each separate generator.

In flight, all the generators should be connected. A generator may be disconnected in flight only in case a trouble has developed in it. In this case the radar operator should report his actions to the aircraft commander.

If fire breaks out on the engine or in the engine nacelle, the fire-fighting system of the aircraft is engaged into operation automatically. In synchronism with the fire-fighting system actuation the engine cowl vent pipe is automatically shut off which stops the generator blowing. Therefore all the generators installed on the engine located in the fire area should be quickly disconnected from the aircraft electric mains. Having disconnected two of the generators, make sure that the total load applied to the operating generators is not in excess of their performances. In case of excessive loading, part of the power consumers should be disconnected.

CAUTION: In conditions when two generators are disconnected from the aircraft mains, it is forbidden to effect simultaneous connection of the cannon system and the tail unit de-icer system.

Disconnecting Generators from Aircraft Mains

To disconnect the generators from the aircraft mains prior to stopping the engines, act as follows:

1. Disconnect three generators from the aircraft mains.
2. Disconnect all the power consumers from the aircraft electric mains but for channel No.1 of the intercom.set, the stand-by pumps and the engine control instruments.
3. Disconnect the storage battery from the aircraft mains.
4. Stop the engines.
5. Disconnect all the consumers which were left connected.
6. Disconnect the fourth generator from the electric mains.

OPERATION PECULIARITIES OF A.C. POWER SUPPLY SOURCES

Connection of ПО-4500 Inverters and of Ground A.C. Power Supply Source

Connection of ПО-4500 inverters is effected from the generator control panel at the radar operator's station (See Fig.55) by means of a change-over switch, type ЗПНН-45 , which precludes simultaneous connection of both inverters.

The operating inverter is supplied with direct current through the storage battery junction box from the normal supply busbar, and the stand-by inverter is energized through the dual supply circuit junction box (mounted at frame No.17) from the dual supply busbar.

For the key circuit diagram of A.C. power supply sources refer to Fig.73.

When connecting the inverter for operation from a ground D.C. power supply source, see to it that at the inverter starting moment the voltage across its terminals is not lower than 20 volts.

CAUTION. NEVER start the ПО-4500 inverter for operation from a ground D.C. power supply source which reduces the voltage across the inverter terminals to below 20 V at the inverter starting moment.

The inverter connecting circuit (See Fig.73) makes it impossible for the inverter to be engaged with its voltage regulator, type Р-25В, disconnected.

If (in ground operating conditions) the inverter fails to get disconnected when the ЗПНН-45 change-over switch is turned off and the respective АЗС-2 circuit breaker is opened, and goes on operating, it is required to de-energize the D.C. circuit, i.e. to disconnect the ground supply source.

CAUTION. It is FORBIDDEN to uncouple the plug connectors until the ПО-4500 inverter is de-energized.

With the inverter disengaged, it is necessary to check the external supply circuits; if they are faulty, remove the inverter from the aircraft and send it over to the repair workshop.

For A.C. supply of the aircraft electric mains on the airfield, provided in the nosewheel well, starboard, at frame No.16, is a ground A.C. supply circuit junction box with a two-pin plug connector of ШР28П2НШ7 type. The ground supply source is connected by means of a switch, type В-45, located on the

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generator control panel at the radar operator's station. The design of the ground supply circuit (See Fig.73) makes it impossible to connect the ground supply after one of the aircraft inverters, type ПО-4500, has been engaged.

Inverter Maintenance

To ensure reliable operation of the inverter, type ПО-4500, it is required to carry out its inspections after every 100 operating hours; the inspection procedure will include condition checks of the commutator, slip rings, brushes, brush holders and scavenging with compressed air to remove dust from the brushes.

In case traces of burning are detected on the slip rings or commutator, the elements should be cleaned with sandpaper No.00. During this step of the maintenance operations it is necessary to differentiate uniform dark-colour deposit from real burning; the deposit in question has no adverse effect on the inverter operation and therefore it is not subject to removal.

Should the length of the commutator brushes be worn out down to 16 mm, and the slip ring brushes - down to 14 mm, the brushes are to be replaced. The new brushes should be lapped to the commutator and slip rings with the aid of sandpaper No.00 or ground in at idle running of the inverter during 5 to 6 hours.

The inspection of the inverter over, it is necessary to push the centrifugal switch return button as far as it will go, and to make sure that the inverter is ready for starting.

In case of failure of the voltage stabilizer (which is indicated by higher-than-nominal output voltage and absence of glow in the voltage stabilizer) the faulty stabilizer should be replaced.

The voltage stabilizer replacement procedure is as follows:

1. Open the access hole in the top part of the box having previously unsealed the access panel fastening screw and turned it by 90°.

2. Carefully lift the voltage stabilizer. To replace the voltage stabilizer with your left hand pull back the cap which holds down the voltage stabilizer. Exerting pressure with the index finger of the right hand, move the voltage stabilizer aside, holding it up while doing this. Then, operating with the left hand, install the new stabilizer and fit the cap on.

When replacing the voltage stabilizer, see to it that the coil springs which secure the voltage stabilizer are not expanded excessively and that they are positioned correctly. The axis of the springs should run normal to the horizontal plane; the position of the springs is adjusted by turning the cap on the voltage stabilizer to one or another direction.

3. Close the access hole panel of the box and seal.

4. Enter the reason for the replacement and the number of pre-installation operating hours of the new inverter in the Service Log of the inverter.

If after the replacement it proves impossible to obtain the nominal output voltage value (115 V) with the aid of the voltage level adjusting rheostat, the inverter should be replaced and subjected to thorough inspection at the repair workshop.

CAUTION. NEVER adjust ПО-4500 inverters on the aircraft.

Inverter Probable Troubles Constituting Reason for Its Replacement

Trouble	Indication
In frequency control circuit	
Electric connection of magnetization winding of ДО-25-170 choke with neutralizing winding	Sudden r.p.m. drop, somewhat reduced voltage
Breakage of one A.C. winding of choke	Somewhat increased frequency at idle running (approximately 435 c.p.s)
Breakage of magnetization winding of ДО-26-170 choke	Frequency increases to 500 c.p.s.
Breakage of neutralizing winding of ДО-26-170 choke	Frequency drops to 300 c.p.s.
Shorted turns of ДК-11 mesh choke	Increased frequency
Confused ends of control winding	High frequency, large current of electric motor, heavy starting
No A.C. voltage in the circuit	High frequency, large current intensity of electric motor
In voltage control circuit	
Electric connection of magnetization winding of ДО-12-25 choke with neutralizing winding	Voltage drops to 70 V
Shorted (punctured) capacitor rated for 2x0.5 mF	Voltage stabilizer fails to fire, low voltage level
Breakage in magnetization winding circuit of ДО-12-25 choke	Voltage increased to 150 V at idle running and to 130 V under load
Loose contact in voltage stabilizer panel	Voltage increases to 135 V under load and to 165 V at idle running
Breakage in neutralizing winding circuit of ДО-12-25 choke	Voltage drops to 57 V both at idle running and under load
Wrong connection of A.C. coils of ДО-12-25 choke	Inverter voltage is 70 V
Confused interconnections of magnetization and neutralizing windings	Low voltage (55 V), high frequency
Confused connections of ТС-11 stability transformer	Voltage elevated to 160 V, negative drop up to 10 V
Mixed polarity in connections of magnetization and neutralizing windings of ДО-12-25 choke	High voltage - up to 130 V
Confused polarity in connections of neutralizing winding of ДО-12-25 choke	Low voltage (55 to 60 V), high speed
Confused polarity in connections of magnetization winding of ДО-12-25 choke	Low voltage (60 to 65 V), high speed

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Control over A.C. Power Supply Sources and A.C. Mains

For control over A.C. voltage of 115 V the radar operator's generator control panel (See Fig.55) is provided with a ferrodynamic voltmeter, type B9-150.

Specifications of Voltmeter, Type B9-150

1. Measuring range	0 to 150
2. Main error	±2.5%
3. Additional error for every 10°C temperature variation from normal (+20°C)	±0.6%
4. Additional error for a ±50 c.p.s. frequency variation from mean frequency of 400 c.p.s.	±1.2%
5. Power consumption	2.5 W
6. Operating temperature range	from -60°C to +50°C
7. Weight of instrument	400 gr

Note: Voltmeter errors are given in per cent of full scale.

Maintenance of Voltmeter, Type B9-150

To ensure correct operation of the instrument, the pre-flight preparation procedure should include a check-up of the voltmeter needle for correct zero position. The check should be carried out before energizing the instrument. The voltmeter needle should be zeroed by means of the corrector screw located on the face panel of the instrument; in the course of zeroing the instrument must be de-energized.

CAUTION. The B9-150 voltmeter should be checked for its needle position before each flight.

If the voltmeter needle fails to respond to the connection of the ПО-4500 inverter, it is necessary to check the condition of the connecting wires, as well as the integrity and reliability of contact connections. Should other troubles be detected in the course of the voltmeter operation, the faulty instrument should be removed and replaced.

Adjusting and Checking the Operation of ПО-4500 Inverter

It is allowed to connect the inverters for operation with the aircraft A.C. mains only when the aircraft D.C. mains is energized from a ground power supply source or from aircraft generators, type ГСР-18000.

The inverter adjusting and checking procedure is as follows:

1. With the АЗС-2 circuit breakers of the operating and stand-by inverters open, place the generator selector switch on the generator control panel to OPERATING (РАБОЧИЙ). This action should engage the operating (starboard) inverter.

2. At least 5 minutes after, check the inverter voltage by the aircraft A.C. voltmeter. If the gauged voltage differs from the nominal voltage of 115 V by more than 0.5 V, operate the respective inverter voltage rheostat to obtain the voltage of 115 ± 0.5 V.

3. Connect the permanently engaged A.C. power consumers (the radar bomb and gun sights).

4. Check the voltage of the operating inverter, and correct it if the voltage is other than 115 ± 0.5 V.

5. Disconnect the A.C. power consumers.

6. Throw the generator selector switch to the STAND-BY (РЕЗЕРВНЫЙ) position; check and adjust the voltage of the stand-by inverter repeating steps (2), (3), (4) and (5) above.

Note: For uniform expenditure of the service lives of the inverters it is advisable to connect them to the aircraft mains during ground adjustments and to engage them in flight in turn.

ELECTRICALLY HEATED GLASS PANELS

Electrical heating of glass panels prevents their external icing and internal fogging thus providing adequate visibility conditions under any flight conditions encountered.

Electrically heated are the two forward glass panels, type П-13 , (right and left) of the pilots and the lower glass panel, type П-13 , of the navigator. Each glass panel is an assembly of two hardened silicate glasses butvar-mounted between which is a heater element consisting of thin constantan wires.

The power requirement of the heaters depends on the heated area and constitutes 0.5 to 0.64 W per one square cm. of the heated glass surface. This specific power (0.5 to 0.64 W/sq.cm.) is so large that should there be no sufficient heat dissipation, the operating heater would raise the glass temperature to such a degree which might result in deterioration of the glass. To meet these conditions, provisions are made for temperature regulation. This work is done by thermistors press-fitted in the glass panels and by an automatic temperature controller, type АОС-81М. The АОС-81М controller is installed at the starboard side of the front pressurized cabin in the area of frame No.5. The electric heaters of the glass panels of both the pilot and co-pilot are engaged by means of two В-45 switches located on the overhead electric control board of the pilots (See Fig.90), while the heater of the navigator's glass panel is cut in by the В-45 switch mounted on the navigator's overhead electric control board (See Fig.63). The current energizing the pilots' glass panel heaters is supplied through two К-50П contactors (See the diagram in Fig.74), while the navigator's glass panel heater is energized through a К-100П contactor. The power supply lines are protected by delayed action fuses of ИП type (two fuses rated for 75 A each and one fuse - for 100 A).

The fuses and contactors are housed in the glass panel heater junction box (Fig.75) which is installed at frame No.6, starboard.

Maintenance of Heated Glass Panels

When replacing equipment items of the electrically heated glass panel sets, make sure that the equipment is mounted and wired correctly. Special attention should be paid to correct connection of glass panels which have additional lead-outs (the navigator's glass panel, type П-13). The continuity check will be carried out in compliance with the existing rules, using the methods of identification and measuring the insulation resistance value.

The connections of the thermistor circuits are of no lesser importance. Thermistor No.1 of each glass panel is its operating thermistor. Thermistor No.2 is a stand-by instrument and it is engaged only in case of failure of thermistor No.1.

Note: Thermistor No.1 corresponds to lead 1 on the terminal block, and the operating lead for thermistor No.2 is lead 3. Lead 2 is common for both.

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If the terminal lead-outs are not numbered, the left lead should be considered as the lead of thermistor No.1, and the right lead (as viewed from the down-oriented block side) should be taken as corresponding to thermistor No.2.

Adjusting the Glass Panel Heating Degree

When through with the circuit continuity check, it is necessary to adjust (regulate) the degree of glass panel heating; this procedure consists in testing the channels for correct connection and in adjusting the automatic temperature controller, type АОС-81М. The АОС-81М controller has three independent channels each of which controls its connected glass panel.

The adjustment procedure runs as follows:

1. Disconnect the wires from the terminal block of the navigator's glass panel.

2. Connect a test lamp between the plus wire and the airframe.

3. Engage the NAVIGATOR'S GLASS PANEL HEATER (ОБОГРЕВ СТЕКЛА НТУРМАНА) circuit breaker, type АЗС-2 , on the navigator's circuit breaker control panel.

4. Engage the NAVIGATOR'S GLASS PANEL HEATER (ОБОГРЕВ СТЕКЛА НТУРМАНА) switch, type В-45, on the overhead electric control board of the navigator. As a result, the test lamp connected to the plus wire of the glass panel heater should flash.

5. Close (through a resistor of 1000 to 2000 ohms) the wires disconnected from the thermistor of the navigator's glass panel heater. This action should result in going out of the lamp connected to the plus wire.

Note: Used in the function of the resistor may be a calibrating resistance rheostat (Fig.76).

6. With the navigator's glass panel heater switch disengaged, connect the thermistor wires and the plus wire to the terminal block without disconnecting the test lamp.

7. Place the slide of the navigator's glass panel heater channel rheostat of the АОС-81М controller to the extreme left position and turn on the switch of the respective glass panel heater.

8. Moving the rheostat slide to either side, check to see if the test lamp flashes up when the rheostat slide is turned to the right and goes out as soon as the slide is moved to the left from the centre.

9. By turning the rheostat slide to the left, and then slowly returning it to the right and farther on, determine the position in which the lamp flashes. At this moment the К-100Д contactor will be engaged and the heater will start its operation. After a certain lapse of time the АОС-81М controller will disconnect the navigator's glass panel heater. As soon as the glass cools down to the pre-established degree, the АОС-81М controller will re-engage the heater.

All the time during the check it is necessary to watch the temperature of the outer surface of the glass panel referring to the thermometer, type ГОСТ 2045-43 . The thermometer ball should be applied to the hottest spot on the glass (See Fig.74), holding it tight against the glass by means of a piece of cotton wool or felt.

10. After two or three operating cycles of the contactor, the glass surface temperature can be considered to be stable. If the temperature is other than 32 ± 2°C, it is necessary to carry out additional adjustments which is done by turning the slide of the respective rheostat on the АОС-81М controller.

11. Adjustments of the АОС-81М controller over, determine the value of the resistance the АОС-81М controller is adjusted for, and make the corresponding

entry in the controller Certificate with the indication of the system resistance and of the glass surface temperature. To do this:

(a) disconnect the wires from the terminal block, and connect a test lamp to the glass panel electric supply cable and the calibrating resistance rheostat to the other two wires;

(b) set a resistance value of 9000 ohms on the rheostat, and then gradually decrease the resistance until the test lamp goes out. The resistance at which the lamp goes out will be the resistance for which the АОС-81М controller is adjusted; the value of this resistance should be within 1500 to 8000 ohms. In case the obtained resistance value is other than 1500 to 8000 ohms, it is necessary to regulate the glass surface temperature by means of the stand-by thermistor, since the conditions indicate failure of thermistor No.1.

12. The heater channels of the АОС-81М controller for the glass panels of the pilot and co-pilot will be adjusted with the same methods as those described above.

13. Once all the three controller channels are completely adjusted, seal the covers closing the rheostats of the АОС-81М controller.

CAUTION. 1. During the check, NEVER short-circuit the wires running to the thermistor and NEVER set a resistance smaller than 1000 ohms on the rheostat, since this will result in failure of the automatic temperature controller, type АОС-81М.

2. IT IS ABSOLUTELY FORBIDDEN to engage the glass panel heaters if the thermistor is disconnected or the АОС-81М controller is maladjusted; same is true when thermistors have internal breakdowns.

3. The automatic temperature controller, type АОС-81М, should be adjusted with employment of a thermometer at ambient air temperatures of minus 10 to plus 25°C as at lower temperatures it may occur that glass surface temperature measurements will be erroneous, while at higher-than-specified temperatures the glass cools down very slowly after its heater has been automatically disconnected.

Use of Glass Panel Heaters

In flight the glass panel heaters will be engaged if icing or fogging conditions are about to be encountered (before cloud-breaking, in haze and mist). When flying in adverse weather conditions, it is advisable to keep the heaters engaged throughout the entire flight.

At parking sites and when taxiing to the take-off position, the glass panel heaters should be engaged only in icing or fogging conditions.

Before going down for landing, as well as prior to taxiing to the take-off position it is recommended to switch off the glass panel heaters for when the heaters are engaged, the additional strains (deformations) resulting from bumpiness (vibration) of the aircraft may render the electrically heated glass panels unserviceable.

CAUTION. Never engage the glass panel heaters with thermistor disconnected or АОС-81М automatic temperature controller maladjusted.

TAIL EMPENNAGE DE-ICERS

Brief

The fin and stabilizer leading edge sections are provided with electrically-operated de-icers. Each de-icer consists of sections, parts and heaters.

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The stabilizer de-icer is divided into two sections:

(a) inner section heating the basic (butt) parts of the left and right stabilizer leading edge sections;

(b) outer section heating the end parts of the stabilizer leading edge sections.

The fin de-icer has one section consisting of one part. The inner and outer sections of the stabilizer consist each of two parts located on the left- and right-hand surfaces of the stabilizer. In each section the parts of the stabilizer left- and right-hand surfaces are connected to each other in parallel (See diagram in Fig.93). Each part consists of several heaters connected to each other in series.

Each part of the de-icer sections is provided with bimetal thermoswitches, type 777 B, which cut out the de-icer section when at least one of the parts is heated to a temperature of 80 ± 10°C in the place where this thermoswitch is mounted.

The de-icer sections are energized during 40 seconds and de-energized during 90 seconds. The cycle is ensured by the distributing electrical mechanism, type MKA-3A, switching on the de-icer sections in turn through the K-600Д contactors.

The beginning of switching on the de-icer sections varies in time and depends on the position of the MKA-3A contact device at the moment the MKA-3A electrical mechanism stops; the order of switching on the sections is always the same. The switching on of the inner section of the stabilizer de-icer is always followed by that of the stabilizer de-icer outer section, then by that of the fin de-icer, then again by that of the stabilizer de-icer inner section, etc.

The MKA-3A mechanism is mounted on the port side of the fuselage tail unsealed section at frame No.63. The power contactors, type K-600Д, and fuses, type ТП-600 , of the de-icer sections power circuits are located in the junction box of the tail empennage de-icers (Fig.78) which is also mounted on the port side of the fuselage tail unsealed part between frames Nos 63 and 63a.

The de-icers are switched on by means of the B-45 switch on the pilots' upper electric board. The de-icer operation is checked by a white lamp, type СМН-51 , which every 80 sec. flashes up for 40 sec. thus warning of the operation of the stabilizer outer section de-icer. The lamp is mounted on the right-seat pilot's instrument panel.

Basic Specifications of MKA-3A Electric Mechanism

1. Nominal voltage	27 V
2. Operating voltage range	27 ± 2.7 V
3. Nominal current at the moment the commutator contacts open	5 A (of inductive load)
4. Nominal current consumed by the mechanism motor	0.8 A
5. Duty of mechanism operation	continuous
6. The electric mechanism must operate normally under the following conditions:	
(a) at relative humidity of ambient air	up to 98 per cent
(b) at change in ambient air temperature	from +50 to -60°C
(c) at vibration and shaking with acceleration	4 g
(d) at sea level altitude	up to 15,000 m.
7. Mechanism service life	300 hours of continuous operation in the course of two years from the moment the mechanism is installed on the aircraft
8. Weight of the electric mechanism	not in excess of 2.4 kg
9. Commutator ensures switching on the contactor windings under voltage according to the following cycles:	
(a) two 60 ± 9-sec. switchings with an interval between them	not in excess of 4 sec.
(b) three 40 ± 6-sec. switchings with an interval between them	same
(c) six 20 -3-sec. switchings with intervals between them	same

Notes: 1. The connection diagram of the MKA-3A electric mechanism ensures the latter operation only according to the cycle indicated in Item "b".

2. The interval between the switchings is included in the time during which the commutator contacts are closed. Two contacts of one cycle cannot be closed simultaneously.

Care of MKA-3A Electrical Mechanism

During service the MKA-3A electrical mechanism does not require adjustment, maintenance or special care. The attending personnel must only periodically check the quality and reliability of the electrical mechanism attachment, as well as the locking of the plug connector and attachment bolts. On detecting a fault in the MKA-3A electrical mechanism replace it by a new one.

Checking Tail Empennage De-Icer System on the Ground

The ground check of the tail empennage de-icers should be carried out only with the aircraft mains supplied from the ground D.C. power source connected through the ground supply plug connector.

CAUTION. To avoid overheating of the skin and damage to the protective coating, it is not permitted to switch on the electric de-icer with the aircraft mains supplied from the ПСР-18000 generators and with the engines running on the ground.

The de-icer ground test makes it possible to check:

1. The condition of the circuit and the serviceability of the de-icers.
2. The sequence of switching on the de-icer sections.
3. The duration of the de-icer sections switching cycles.
4. Current consumed by the de-icer separate sections at a voltage of 26 V across the heater terminals, that is, provided the de-icers are supplied from the aircraft generators.

Check to see that the surface of the de-icer boots is heated and the de-icer sections are switched on in correct sequence by hand feel. Besides this, the surface of the de-icer boots can be checked for warming up by means of a special instrument which is a thermocouple mounted on a tubular rod adjustable in length. Inside the rod a wire running to the temperature indicator is laid.

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When checking temperature by means of the special instrument (thermocouple) the temperature on the surface at any point of any de-icer boot section must exceed ambient air temperature approximately by 30 to 50°C during one cycle of the de-icer section operation.

Check the duration of the switching cycles by means of a stopwatch, with the TII-600 fuses in the power circuits of the de-icer sections removed.

Consumed current is checked by means of the 2 aircraft ammeter connected to the storage battery and ground power supply source.

Complete check up of the tail empennage de-icer system on the ground shall be performed in the following manner:

1. Remove the TII-600 fuses from the power circuits of all the three sections in the junction box of the tail empennage de-icers.

2. With the de-icer A3C-5 circuit breaker (on the right-seat pilot's circuit breaker panel) switched on, turn on the tail empennage de-icer switch on the pilot's upper electric board. In this case the MKA-3A electrical mechanism must be brought into operation which is indicated by the warning lamp on the right-seat pilot's instrument panel flashing up periodically.

3. Check the operation of the K-600Д contactors by means of pilot lamps connected to the winding terminals of all the three contactors. The lamps must periodically flash up.

4. Check the duration of the switching cycles by the pilot lamps.

5. Turn off the de-icer switch at the moment the warning lamp on the right-seat pilot's instrument panel goes out.

6. Install the TII-600 fuse in the power circuits of all the three de-icer sections.

7. Connect a voltmeter between the aircraft body and the plus terminal (power bolt on the terminal block) of the fin leading edge heater.

8. Turn on the de-icer switch and measure the current consumed by the section of the fin leading edge heater and voltage at this section.

9. As soon as the fin leading edge heater is out, turn off the de-icer switch.

10. In a similar way measure current and voltage on the inside and outside sections of the stabilizer de-icer.

11. When checking according to Items 8, 9 and 10, simultaneously check by hand feel the serviceability and sequence of switching on the de-icer sections. Make sure that the inside or outside sections of the stabilizer leading edge heaters start operating simultaneously. Asymmetric operation of the de-icers is not permitted.

CAUTION. It is prohibited to switch on the tail empennage de-icers on the ground for a longer period than one operation cycle of the MKA-3A electric mechanism.

12. Determine the current consumed by each section of the de-icers at a voltage of 26 V across the heater terminals. The current is to be determined by the formula:

$$I_{26} = \frac{I \text{ measured} \cdot 26}{V \text{ measured}},$$

where I_{26} is the current consumed by the de-icer section at 26 V across the heater terminals;

$I_{measured}$ is the current measured during the test of the given section;

$V_{measured}$ is the voltage measured during the test of the given section.

For the fin de-icer the value I_{26} must be within 480 A $\pm$ 10 per cent, for the inside section of the stabilizer de-icer - within 450 A $\pm$ 10 per cent and for the outside section - within 494 A $\pm$ 10 per cent.

If for any section of the tail empennage de-icers the value I_{26} exceeds the permitted limits, make sure that the taken measurements and calculations are correct and only after that replace the defective leading edge sections by new ones.

It is not permitted to eliminate the defects caused by short circuit and the open circuit of the heaters during service.

Instructions for Operation of Tail Empennage De-Icers during Flight

The tail empennage de-icers should be switched on during flight prior to entering the zone of probable icing. The de-icers must be switched off if the surface of the tail empennage leading edge sections is quite free from ice.

Note: When checking the serviceability of the tail empennage de-icers during flight in case no ice formation takes place, it is permitted to switch them on for not more than 5 minutes.

This being the case, the de-icer operation is checked by the warning lamp and consumed current (as measured by the generator ammeters).

WARNING SYSTEM

The aircraft is provided with light and sound warning system. The light warning system consists of warning lamps, type САЩ-51, of various colour mounted on desks, boards and instrument panels.

The light warning devices are designed for signalling:

1. preparation of the engines for starting;
2. oil pressure in the turbostarter;
3. operation of fuel pumps and determination of the order of fuel consumption;
4. fire and opening the fuel shut-off cocks;
5. release of the brake parachute;
6. pressure drop in the hydraulic system and operation of the brake automatic unit;
7. landing gear and tail support position;
8. trim tab neutral position;
9. SPEED TOO HIGH (СКОРОСТЬ ВЕЛИКА);
10. switching on the АПБ-2 gyro horizon;
11. armament position prior to aircraft landing;
12. camera tilting mount and camera hatch position;
13. operation of the tail empennage de-icers;
14. charging cocks open position and FUEL DELIVERED (ТОПЛИВО ПОДАНО) warning unit;
15. pressure drop in the pressurized cabins;
16. outside signalling by signal flare launcher.

The types of warning lamps, their arrangement on the aircraft and nature of operation are indicated in Table 22.

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Light Fitting CSH-51

The light device, type CSH-51 , (Fig.79) is designed for signalling inside the aircraft or for use as a light indicator of the aircraft separate units and mechanisms operation. The light device ensures the possibility of operation under day- and night-time conditions. The reduction of signal brightness by turning the device cover to the right as far as it will go during the night time makes it possible to preserve the adaptation of the aircrew member's eyes to the low brightness background. The position at which all the four holes in the end face walls of the device head and cover are open (the cover with the light filter is turned to the left as far as it will go) corresponds to the day time conditions. Besides the two extreme positions, the cover with the light filter can be set to any intermediate position which corresponds to partial opening of the three triangular holes in the end face walls of the device head and cover.

The aircraft is provided with devices of five colours: red, green, yellow, blue and white.

The CSH-51 fitting is intended for use with a special aircraft lamp (rated for 28 V and 0.17 A), type CM-30, with a single-contact base Ie-9-1.

The sound signalling is performed by continuous and intermittent buzzing of aircraft horn, type C-1 (Fig.80). The aircraft has two C-1 horns; the arrangement, use and nature of operation of the horns are given in Table 23.

The transmitters of intermittent sound signals are cabin pressure warning units, type BC-46.

The transmitters of continuous sound signals are:

(a) in the event of aircraft take off with the flaps retracted or extended by an angle below the rated value - mechanism, type MKB-2, mounted on the flap transmission shaft (at frame No.33) and limit switches, type BK2-142 (front), mounted on the right-seat pilot engine control panel;

(b) in the event of throttle control retraction (aircraft landing) with the landing gear unextended - blocking contacts, type BK2-142 (rear), mounted on the right-seat pilot engine control panel and the landing gear extended position limit switches.

Specifications of C-1 Horns

1. Voltage range	20 to 30 V
2. Nominal voltage	26 V
3. Nominal duty of operation	intermittent (one-minute operation, one-minute interval)
4. Maximum current consumed at 26 V	0.85 A
5. Sound intensity at 26 V (as measured at a distance of 1 m. from the horn)	not less than 80 db
6. Frequency of contact opening at 26 V	200 to 310 c.p.s.
7. Horn weight	not in excess of 1.25

The cabin pressure warning unit is designed for closing the electric circuit of the sound and light signal system warning the aircrew of the necessity of using oxygen apparatus.

The warning unit, type BC-46, is a unit of four aneroid boxes connected to the electric circuit moving contact. If pressure drops below the rated value, the boxes unit closes the circuit contacts and sends electric signals to the PM-12 buzzer relay. The warning unit is adjusted for signal transmitting at altitudes from 1000 to 5000 m.

Specifications of BC-46 Cabin Pressure Warning Unit

1. The cabin pressure warning unit must continuously send out light and sound signals from the moment pressure decreases in the cabin to a value corresponding to the altitude set at the dial.	
2. Range of adjusting the unit for the beginning of the signal transmission according to pressure in the pressurized cabin corresponding to altitude in compliance with the international standard atmosphere	from 1000 to 5000 m.
3. Instrument temperature range	from +50 to -60°C
4. Instrument error during signal sending out at normal temperature at scale marks: ..; 2; 5; 3; 3.5; 4; 4.5; 5 km.	not in excess of ±150 m.
5. Unit must operate during vibration within the frequency range	from 20 to 80 c.p.s. and overload of 2.5 db.
6. Reliability of the electric contacts must ensure	up to 1000 switchings
7. Instrument weight	not in excess of 450 gr (with the plug connector)

Cabin pressure warning units are mounted in the front cabin at frame No.5 (starboard side) and in the rear cabin at frame No.75 (starboard side).

To obtain intermittent light and sound signals, connected to the circuit of each cabin pressure warning unit is a buzzer relay, type PM-12 , with two capacitors, type KB-1A-50 $\frac{50}{\text{ohms}}$ - V . The relay and capacitors are installed in the boxes of the sound signal relays (Figs 81 and 82). The relay boxes are mounted in the front pressurized cabin on the navigator-radar operator left-hand rack and in the rear pressurized cabin on the starboard side at frame No. 73.

The relay is switched on by the operation of the cabin pressure warning unit contacts and ensures intermittent duty of operation.

Specifications of PM-12 Relay

1. Nominal voltage	26.5 V
2. Frequency of relay operation at nominal voltage	3 to 5 switchings per second
3. The relay operates normally under the following conditions:	
(a) ambient air temperature	from +50 to -60°C
(b) ambient air relative humidity	up to 98 per cent
(c) sea-level altitude	up to 15000 m.
(d) aircraft vibration	
4. Operating voltage when operating under load (continuous operation)	not in excess of 14 V
5. Armature attraction voltage	not in excess of 12 V
6. Armature drop-out voltage	2 to 5 V
7. Relay weight	not in excess of 195 gr

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Table 22

Light Signalling

Nos	Purpose	Number of lamps	Signal devices				Note
			Type of device	Conditions under which the device operates	Nature of operation	Location of device	
1	2	3	4	5	6	7	8
1	Signalling of the engine readiness for starting	2	SCHSh-51, green	With the turbostarter exhaust gas shutters open	Constant glow of the lamps	On the engine starting panel on the left-seat pilot's engine control console	
2	Signalling of oil pressure in the turbostarter	1	SCHSh-51, green	At oil pressure in the turbostarter exceeding 3.5 atm.	Constant burning of the lamps	On the turbostarter control panel	
3	Signalling of fuel consumption sequence	4	SCHSh-51, blue	1st group lamp flashes up when the fuel consumption control switch is set to the AUTOMATIC (AVTOMATIKA) position and the amplifiers switches turned on. The rest of the lamps flash up in sequence after 200 lit. of fuel is left in the previous tank group	Constant glow of the lamps	On the fuel supply panel	
4	Signalling of fuel available for 30- or 15-minute flight	4	SCHSh-51, red	Two lamps flash up with fuel available for a 30-minute flight, the other two lamps flash up with fuel available for a 15-minute flight	Constant glow of the lamps on the left-seat pilot instrument panel	On the fuel supply board	
5	Signalling of fuel pumps operation	12	SCHSh-51, green	With the pump operating and pressure in the system reaching 0.3 or 0.35 kg per sq.cm.	Constant glow of the lamps	On the fuel supply board	
6	Signalling of engine shut-off cocks open position	2	SCHSh-51, green	With the engine shut-off cocks open from the beginning of engine starting to its stopping	Constant glow of the lamps	On the fuel supply board	
7	Fire signalling	6	Red	With the fire-fighting system switched on, when temperature in the area of the fire-sensitive units reaches 140 to 170°C or on pressing the button	Constant glow of the lamps	On the fuel supply board	
8	Signalling of the brake parachute release	2	SCHSh-51, green	With the brake parachute released	Constant glow of the lamps	On the instrument panels of the right- and left-seat pilots	

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1	2	3	4	5	6	7	8
9	Signalling of pressure drop in the normal and emergency hydraulic systems	2	CHH-51, red	At pressure in the normal hydraulic system less than 100 kg per sq.cm. and in the emergency hydraulic system less than 130 kg per sq.cm.	Constant glow of the lamps	On the pilots' denimal electric board	
10	Signalling of the brake automatic unit operation	1	CHH-51, blue	With abrupt braking of the wheels, with the brake automatic unit switch turned on	Blinking of the lamp	On the pilot's central electric board	
11	Signalling of the armament position during landing	2	CHH-51, blue	With the armament bar-rels of the lower and rear sighting stations in the lowered position	Constant glow of the lamps	On the left-seat pilot instrument panel	
12	Signalling of the tail support and landing gear position	8	CHH-51, five green and three red lamps	The three green lamps indicate the landing gear legs extended position, the three red lamps - the landing gear legs retracted position	Constant glow of the lamps	On the pilots' central electric board, on the gunner - radio operator's and gunner's electric board	
13	Signalling of the rudder and aileron trim tabs position	3	CHH-51, white	With the rudder and aileron trim tabs in the neutral position	Constant glow of the lamps	On the left-seat pilot's instruments panel, in the aileron synchronization panel	

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1	2	3	4	5	6	7	8
14	SPEED TWO HIGH (CHOPOTS BEHMAL) signalling	2	CHH-51, red	With pressure head amounting to 2300 kg per sq.m. at low altitudes; at M=0.86 at high altitudes	Constant glow of the lamp	On the pilot's instrument panels	
15	Signalling of the stand-by gyro horizon switching	1	CHH-51, red	With the stand-by gyro horizon switched on by the left-seat pilot or navigator-radar operator	Constant glow of the lamps	On the left-seat pilot's instrument panel	
16	Signalling of the camera hatch in the open position, camera tilting mount position during air survey and shooting	3	CHH-51, green, white, yellow	(a) The green lamp is on with the hatch open (b) The white lamp flashes, when the camera tilting mount passes the zero position, in SURVEY MODE OF OPERATION (PASSENA) (c) The yellow lamp is on with the camera tilting mount operating in CHECK mode (KONTROL) at tilt angles of 0, 10, 15, 20 and 25°	Constant glow of the lamp Blinking of the lamp Constant glow of the lamp	On the navigator's right-hand console	
17	Signalling of the tail empennage de-icers operation	1	CHH-51, white	On switching on the de-icer outer sections	Blinking of the lamp (40-sec. glow followed by 80-sec. interval)	On the right-seat pilot instrument panel	

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1	2	3	4	5	6	7	8
18	Signalling of the fuel supply cocks open position and FUEL DELIVERED (TOPLIVO PO TOMARU) signal	5	GSH-51, four green lamps, one yellow lamp	(a) The green lamps are on when the fuel supply cocks are switched on for opening (b) The yellow lamp is on when the FUEL DELIVERED (TOPLIVO POMARU) warning unit is switched on	Constant glow of the four lamps Constant glow of the lamp	On the fuelling control board	
19	Signalling of pressure drop in the cabins	5	GSH-51, yellow	When pressure drop corresponds to the altitude set at the dial within 1000 to 5000 m.	Blinking of the lamps	On the navigator's oxygen panel, on the left-seat pilot instrument panel, the navigator-radar operator's oxygen panel, the gunner-radio operator's instrument panel, the gunner's electric board	

Table 23

Sound Signalling

Nos	Purpose	Signal devices					Note
		Number of devices	Type of device	Conditions under which the device operates	Nature of operation	Location of devices	
1	2	3	4	5	6	7	8
1	Signalling of flap position during take off	1	Horn, type O-1, of the front pressurised cabin	With the flaps not extended to the take off angle, that is to a value from 19 + 1° to 23 + 1° and with both throttle controls set to the position corresponding to the aircraft take off	Constant bussing of the horn	On the port side at frame No.9 of the front pressurised cabin	
2	Signalling of landing gear retracted position during landing	1	Horn, type O-1, of the front pressurised cabin	When at least one landing gear leg is not extended and at least one throttle control is set to low throttle (during landing)	Constant bussing of the horn	On the port side at frame No.9 of the front pressurised cabin	
3	Signalling of pressure drop below the value rated for pressurised cabins	2	Horn, type O-1, of the front pressurised cabin Horn, type O-1, of the rear pressurised cabin	When air pressure in the pressurised cabin is below the value set at the dial of the cabin pressure warning unit, type SO-46	Intermittent bussing of the horn	On the port side at frame No.9 of the front pressurised cabin. On the starboard side at frame No.71 of the rear pressurised cabin	

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Care and Maintenance of Light and Sound Signal Units

The light, type СМЦ-51 , horn, type С-1, cabin pressure warning units, type ВС-46, and the buzzer relay, type РМ-12, do not require special care and maintenance. During service take care to see that these units are securely attached, and the contacts of the connected wires are in good condition and properly tightened.

Maintenance of the light signal fittings in the main consists in replacing burnt out lamps. To replace a lamp in the СМЦ-51 fitting, it is necessary to unscrew the head with the light filter, fit a new lamp into the holder and screw up the head again. When soldering the wires to the fitting, observe polarity (the plus wire must be soldered to the fitting central contact). If polarity is incorrect, short circuit may take place during the replacement of the lamp under voltage.

In case the С-1 horn is being replaced or the supply conductors are being connected to the horn during installation of the horn cap, when the attachment screw is being tightened, ensure not only proper attachment of the cap but also normal sounding of the horn. The horn is adjusted by the Manufacturer. During service the horn does not require any additional adjustment.

As the signal fittings under voltage are checked only in conjunction with the operation check of the mechanisms included in the systems provided with the signal fittings, the data concerning the methods of adjusting the limit switches are given in the sections of the Instruction dealing with the operation of corresponding mechanisms, units and devices.

As a rule, various types of light signal devices are cut in when the corresponding units and mechanisms are switched on by means of cutout and change-over switches located on the instrument panels and electric boards.

Sound signal devices are switched on by means of switches, type В-45, mounted on the rheostat panel (Fig.83) of the right-seat pilot engine control panel and on the gunner-radio-operator's electric board (Fig.84).

AIRCRAFT INTERIOR LIGHTING

For aircraft interior lighting the following fittings are used:

(a) dome lights, type ПС-45 and ПСМ-51 ;
(b) light fitting, type КЛСРК-45;
(c) ultra-violet scale illumination lights, type АРУФСМ-45

In addition to this fitting extension lamps, type ПМ-10-36, are used to illuminate dark places on the aircraft.

Dome Lights, Types ПС-54 and ПСМ-51

The dome light, type ПС-45 , (Fig.85) without a special lens but with a reflector and a single-contact holder for the СМ-25 lamp of 28 V and 20 W is intended for illumination of the pressurized cabins and unpressurized fuselage compartments. The bulb of the СМ-25 lamp has a bowl of plate glass to protect the aircrew from the blinding effect of the lamp rays. Therefore, it is not recommended to use luminaires with other lamps (with open bulbs).

The inner surface of the dome light body which serves as a reflector is covered with white enamel or aluminium paint dispersing light. To ensure the proper operation of the luminaire, it is recommended to wipe the inner surface of the reflector with a clean moist piece of cloth or cotton wool.

In addition to the dome lights, type ПС-45 , for general illumination of landing gear compartments the aircraft is provided with small dome lights, type ПСМ-51 , which are used by the aircrew or attending personnel during repair or maintenance operations in the landing gear compartments. The ПСМ-51 dome lights differ from the ПС-45 dome lights in that they are not provided with protection from the blinding effect of direct lamp rays as these dome lights are within the sight of the aircrew for a short time.

The main parts of the smaller ПСМ-51 dome light (Fig.86) are: body, protective transparent glass and reflector whose neck mounts a single-contact socket for the СМ-24 lamp of 28 V and 20 W. The second pole for the ПСМ-51 dome light as well as for the ПС-45 dome light is the dome light body and aircraft frame.

To replace the lamp in the ПСМ-51 dome light or the entire luminaire, first of all remove the protective glass. When mounting the protective glass, take care to see that the spring retaining the glass and the reflector is mounted correctly. The spring must pass between two lugs on the glass bowl. To retain the glass in position , bend the spring when it is weakened in the central part to ensure reliable attachment of the cap. For maximum glow keep the protective glass clean by wiping it regularly with a clean piece of cloth.

When using the ПС-45 and ПСМ-51 dome lights, check to see that the union nut of the nipple on the dome light inlet pipe union is tightened up at all times, as loosening of the nut may result in poor contact and flickering or dying out of the lamp.

The location of the dome lights, types ПС-45 and ПСМ-51, as well as the location of the switches designed for switching these dome lights on and off is indicated in Table 24.

Light Fitting, Type КЛРСК-45

For illumination of panels, boards, dark places and instruments the aircraft is provided with fittings, type КЛСРК-45, with a rheostat and a button, which have СМ-30 lamps of 28 V and nominal current of 0.17 A.

The aircraft has ten cabin lamps altogether (two of them are mounted at the navigator's seat, three lamps - at the pilot's seats, two - at the navigator-radio operator's seat, two - at the gunner-radio-operator's seat and one - at the gunner's seat).

Cabin lamps, type КЛРСК-45 , are mounted on special hinged brackets (Fig.87) which make it possible to use these lamps for directed illumination of several places. On some of the hinged brackets the cabin lamps are mounted together with ultra-violet illumination fittings. If necessary the КЛРСК-45 fitting can be removed from the hinged bracket or from its base and used as an extension lighting device for temporary illumination of some section in the cabin within the length of the cord.

The rheostat for adjusting the lamp light and the button by means of which the rheostat can be short circuited temporarily and the lamp caused to flush at full glow are located on the fitting case. By changing the distance between the lens and the lamp which is ensured by moving the cylindrical nozzle on the fitting it is possible to obtain more dissipated and more directed lighting.

The cabin lamp, type КЛРСК-45 , is switched on and off and its filament is adjusted by means of the rheostat handle made of colour plastic and mounted on the fitting body. Replace lamps in the КЛРСК-45 fitting in the following manner:

(1) turn out the stop screw fastening the cylindrical nozzle;
(2) remove the cylindrical nozzle;
(3) replace the lamp;
(4) mount the cylindrical nozzle and turn in the stop screw. When fitting the stop screw, see that a metal washer is placed under the screw head.

Table 24

Location of PO-45 and PGM-51 Dome Lights and Their Switches on Aircraft

Nos	Type of dome light	Place of dome light installation	Place of switch installation	Note
1	2	3	4	5
1	PO-45	On the ceiling of the front pressurized cabin between frames Nos 4 and 5	On the dome light mounting panel	For the navigator
2	PO-45	On the ceiling of the front pressurized cabin at frame No.9	On the dome light mounting panel	For the pilots
3	PO-45	On the ceiling of the fuselage unpressurized portion at frame No.14	On the navigator-radar operator electric panel	For lighting the hydraulic panel
4	PO-45	On the ceiling of the fuselage unpressurized portion at frame No.20	On the starboard side on the bracket of the PO-4500 inverter support	
5	PO-45	On the ceiling of the fuselage unpressurized portion at frame No.34	On the navigator-radar operator's electric board	For lighting the bomb bay
6	PO-45	On the ceiling of the fuselage unpressurized portion at frame No.38	On the navigator-radar operator's electric board	For lighting the bomb bay
7	PO-45	On the ceiling of the fuselage unpressurized portion at frame No.42	On the navigator-radar operator's electric board	For lighting the bomb bay
8	PO-45	On the ceiling of the fuselage unpressurized portion at frame No.46	On the navigator-radar operator's electric board	For lighting the bomb bay
9	PO-45	On the ceiling of the fuselage unpressurized portion at frame No.49	On the navigator-radar operator's electric board	For lighting the bomb bay
10	PO-45	On the starboard side of the fuselage unpressurized portion at frame No.66	On the starboard side at frame No.62	
11	PO-45	On the ceiling of the rear pressurized cabin at frame No.71	On gunner-radio-operator's electric board	For the gunner-radio-operator
12	PO-45	On the ceiling of the rear pressurized cabin at frame No.71	On the gunner's electric board	For the gunner
13	PO-45	In the landing-gear port leg well		
14	PO-45	In the landing gear starboard leg well		
15	PO-45	In the nose leg well on the starboard side at frame No.20	On the navigator-radar operator's electric board	
16	PO-45	In the landing gear nose leg well on the port side at frame No.20		
17	PO-45			

Extension Lamps, Type ПЛ-10-36

For additional lighting of dark places on the aircraft the latter is provided with extension lamps, type ПЛ-10-36, (Fig.88). The ПЛ-10-36 extension lamp has a 10-m. cord and a filament lamp, type СМ-15, of 26 V and 10 W. The extension lamps, type ПЛ-10-36, are switched on and off by means of the switch mounted on the handle of the lamp carbolite body.

The aircraft has three extension lamps altogether kept in special bags located in the following places: on the rear wall of the pilots' central console; on the wall of frame No.9 (starboard side) and in the rear pressurized cabin on the port side at frame No.73.

Extension lamps, type ПЛ-10-36, are connected to the aircraft mains by means of two-pin plugs. Receptacles, type 47К, for these lamps are mounted in various places of the aircraft. The aircraft has 13 receptacles, type 47К, altogether; four receptacles are mounted in the front pressurized cabin, four receptacles - in the fuselage unpressurized portion, two receptacles - in the engine nacelles compartments, two receptacles - in the landing gear main legs wells and one receptacle - in the rear pressurized cabin. The location of receptacles, type 47К, is described in Table 25.

Table 25

Location of Plug Connector Receptacles 47k for ПЛ-10-36 Portable Lamps

Nos	Place of receptacle installation	Note
1	2	3
1	On the navigator's right-hand console	
2	On the pilot's central console	
3	On the port side at frame No.5	For illuminator of the sight; it is switched on through a special rheostat from the set of this sight. The rheostat is mounted on the left-seat pilot's instrument panel
4	On the wall of the upper part of frame No.9	For illumination of the aircraft sextant
5	On the bracket of the ПО-4500 inverter rack (starboard side)	
6	On the fuel pumps starboard junction box at frame No.33	
7	On the junction box of the extension lamp mounted on the distribution board of the port engine nacelle	
8	On the junction box of the extension lamp mounted on the distribution board of the starboard engine nacelle	

1	2	3
9	On the junction box of the extension lamp mounted on the port side at frame No.5 of the landing gear starboard leg well	
10	On the junction box of the extension lamp mounted on the starboard side at frame No.5 of the landing gear port leg well	
11	On the fuel pumps junction box at frame No.49 (starboard side)	
12	On the starboard side at frame No.62	
13	On the port side of the rear pressurized cabin at frame No.72	

КИ-12 Compass Illumination

For illumination of two compasses, type КИ-12 , mounted at the navigator's seat in the upper part of frame No.1 and at the pilots' seats on the cabin canopy frame, special lamps are provided. The lamps are mounted right into the body of these compasses. Each compass illumination lamp is switched on by means of the switch, type В-45. The navigator's compass illumination switch is mounted on the navigator's upper electric board, while the pilots' compass illumination switch is on the pilots' central electric board. Both lamps are supplied by the triple-duty supply busbar through the automatic circuit breaker, type АЗС-5, mounted on the right-seat pilot circuit breaker panel, that is the КИ-12 compass illumination is ensured when the aircraft mains operates in all duties.

The triple-duty supply busbar supplies through the same АЗС-5 circuit breaker one of the receptacles, type 47К, mounted on the pilots' central panel.

The rest of the circuits of the light fitting are supplied from the normal supply busbars and are protected by the automatic circuit breakers mounted on panels and boards of the front and rear pressurized cabins. The extension lamps receptacles mounted outside the pressurized cabins and dome lamps are protected by glass fuses.

Luminaire, Type АРУФОШ-45

The cabin luminaire, type АРУФОШ-45 , is designed for ultra-violet illumination of the instruments and the control units (electric boards and instrument panels) to cause luminescence of the luminous compounds as well as for lighting purposes. Ultra-violet illumination is performed by means of special aircraft luminescent mercury lamps of low pressure with rated power of 4 W, type УФО-4А.

The luminaire, type АРУФОШ-45 , is used in conjunction with the РУФО-45 rheostat designed to switch on the ultra-violet illumination lamp and to control its light intensity. The АРУФОШ-45 fitting is provided with special twin-conductor in a common copper braiding which serves as a third conductor. One of the ends of the twin-conductor has white insulation, the other end has white insulation with a black thread. The conductor having white insulation with a black thread is excluded from the lamp connection circuit and is insulated. The braiding of the fitting cord is connected to the aircraft framework either directly or through the aircraft conductor, type ВПВЛ, connected to this braiding.

The lamp plastic body has a cylindrical nozzle with two light filters of black uviol and a hinged base for the luminaire. The upper light filter may turn

together with the nozzle ring within 90°. By rotating the nozzle ring it is possible to:

(a) match the slots of the both light filters; in this case white light of the lamp passes through these slots;

(b) overlap the slots; in this case only ultra-violet rays pass through the uviol light filters. The ultra-violet rays cause luminescence of luminous compounds.

Most of the luminaires, type APF∅∅M–45 , are mounted on special hinged brackets (See Fig.87) which make it possible to use this lamp for directed illumination of several places. On some of the hinged brackets the luminaires are mounted together with the KMPCK–45 fitting. If necessary, the fitting may be removed from the hinged bracket or from its base used as an extension luminaire for temporary lighting of some area in the cabin as far as the cord permits.

The aircraft is provided with APF∅∅M–45 fittings with rheostats, type PF∅∅–45 . Three APF∅∅M–45 fittings are mounted in the rear pressurized cabin, the rest of them are installed in the front pressurized cabin.

The arrangement of the ultra-violet illumination devices and PF∅∅–45 rheostats is shown in Table 26.

Table 26

Arrangement of APF∅∅M–45 Luminaires and PF∅∅–45 Rheostats

Nos	Place of luminaire installation	Place of rheostat installation	Note
1	2	3	4
1	On the starboard side of the front pressurized cabin on frame No.2	On the navigator's upper electric board	For lighting the sight, the instrument panel and the navigator's right-hand console
2	On the ceiling of the front cabin on frame No.3	Same	
3	On the ceiling of the front cabin at frame No.4	Same	
4	On the right-seat pilot's steering wheel	On the right-seat pilot's engine control panel	For lighting the pilots' instrument panel
5	Same	Same	
6	On the left-seat pilot's steering wheel	On the left-seat pilot's engine control panel	
7	Same	Same	
8	On the port side at frame No.8	Same	Together with the KMCPK–45 fitting it serves to light up the pilot's instrument panel

1	2	3	4
9	On the ceiling of the front cabin on frame No.8	On the left-seat pilot's engine control panel	Together with the KMCPK–45 fitting it serves to light the pilots' upper electric board and the fuel supply panel
10	On the starboard side at frame No.8	On the right-seat pilot's engine control panel	Together with the KMCPK–45 fitting it serves to light the right-seat pilot's panel
11	On the fuel supply panel	On the right-seat pilot's engine control panel	To light the pilot's central panel
12	On the left-hand side of the upper blister	On the navigator-radar operator's instrument panel	Together with the KMCPK–45 fitting it serves to light the instrument panel and the navigator-radar operator central panel
13	On the right-hand side of the navigator-radar operator's central panel	Same	Same
14	On the port side of the rear pressurized cabin at frame No. 74	On the gunner's electric board	For lighting the instrument panel, board and the gunner's panel
15	On the starboard side of the rear cabin at frame No.70	On the gunner-radio-operator's electric board	Same
16	On the rear cabin circuit breaker panel on the port side at frame No.71	Same	Same

Basic Specifications of the PF∅∅ Set

1. Total resistance of the PF∅∅–45	35 ohms
2. Rheostat resistance in the cutoff position	22 ohms
3. Normal current of lamp operating duty	0.35 A
4. Lamp resistance with the rheostat cut off	0.5 to 0.6 A
5. Luminous compound brightness adjustment range of the PF∅∅–45 rheostat	from 150 to 30%

100% is as ... to be the bri... ness of lumino... compound illu... nated by a la... operating ... nominal cond... tions (at 0.5...

6. УФО-4А lamp flashes up	in no more th... 12 seconds af... switching
7. Lamps which were on for not less than 10 min. at nominal current of 0.35 A flash up again on switching	in no less th... 2 minutes fro... the moment of switching

Switching On УФО Lamp

The УФО lamp is switched on by means of the rheostat, type РУФО-45. In the idle position the rheostat handle must be set to the OFF (ВЫКЛЮЧЕНО) position at all times. The УФО-4А lamp is switched on automatically in no more than 12 sec. after the rheostat is set to the ON (ВКЛЮЧЕНО) position; it is not necessary to set the РУФО-45 rheostat handle to the right as far as it will go.

On switching on the lamp, adjust as required the brightness of the scales and stencils covered by luminous compound or the degree of illuminance during operation with the light filter open. The rheostat handle being turned to the left, the brightness decreases, the handle being turned to the right, the brightness increases.

Replacement of Lamp in АРУФОШ-45 Fitting

1. Remove the cylindrical nozzle with the light filters. To detach the cylinder from the body, press with the finger the lower part of a special plate riveted to the cylinder. This done, turn the fitting cylinder counter-clockwise and remove it from the body.

2. Replace the lamp. When fitting a new lamp, type УФО-4А , bear in mind that the lamp has a bayonet base with pins (type 2с-15А-1); the base pins are located at various height due to which the lamp can be inserted into the socket only in one definite position ensuring correct polarity of switching.

3. Fit the cylindrical nozzle with the light filters. When fitting it on the body turn the cylinder clockwise until the elastic pin clicks in the hole.

EXTERIOR LIGHTING

The aircraft exterior lighting consists of the following light fittings:

(a) taxiing lights, type ФР-100;
(b) landing lights, type ЖФСВ-45;
(c) formation lights, type НСГО-45;
(d) navigation lights, type БАНО-45 , and ИС-39.

Taxiing Lights, Type ФР-100

The aircraft taxiing lights, type ФР-100 , are designed for illumination of the ground during taxiing in the night time. For the landing gear nose leg the landing light is mounted right on the landing gear strut while for the landing gear main legs the landing lights are mounted on the struts.

The taxiing light, type ФР-100, (Fig.89) consists of a case with a reflector and a single-contact socket for the СМ-21 lamp of 27 V and 2.7 A. The landing lamp protective glass which is a colourless transparent disperser ensures angle of dispersion in the horizontal plane equal to 30°. The maximum luminous intensity of the taxiing light is 5000 candles.

With the aid of the adjustable bracket each taxiing light can be set to the position which ensures illumination of part of the landing strip at a distance of 15 or 20 m. from the pilots' cabin in the direction of flight. The taxiing light is fixed in the required position by means of a nut and a lock nut.

All the three taxiing lights are switched on simultaneously with one switch, type В-45, mounted on the pilots' upper electric board (Fig.90).

Landing Lights, Type ЖФСВ-45

To illuminate the place of aircraft landing in the night time, the aircraft is provided with two retractable landing lights, type ЖФСВ-45 , installed in the lower part of the nose unpressurized section of the fuselage at frame No.13. The retractable part of the landing light consists of a casing and a special reflector lamp, type СМФ-2М , of 28 V and 600 W. The СМФ-2М lamp consists of a filament lamp proper, a reflector and a protective glass.

The landing light control electric mechanism, type МИФ-2 consists of a reversible electric motor of series excitation, a reducer and a cutting off contact device.

The landing light is supplied from a single-line mains; the second pole for the light and for the electric drive is the landing light body and the aircraft frame. The light is switched on automatically when the landing light is extended. Switching off is performed automatically too when the landing light is retracted.

The landing lights are controlled by means of a switch, type 2ПП-45, from the pilots' upper electric board (Fig.91).

Specifications of Landing Light, Type ЖФСВ-45

1. Maximum luminous intensity	not less than 350,000 candles
2. Landing light angle of dispersing:	
in the horizontal plane	not less than 12°
in the vertical plane	not less than 8°
3. Landing light extension angle	86°30' ± 30'
4. Time required for extension or retraction of the landing light	not in excess of 12 sec.
5. Permissible continuous glow of the landing light	not in excess of 5 min.
6. СМФ-2М lamp service life guaranteed by the Manufacturer	5 hours of burning
7. Operating voltage range for the МИФ-2 electric mechanism	24 to 30 V

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8. Current consumed by the electric mechanism ..... 2.8 A
9. Maximum moment ..... 220 kg-cm
10. Duty of the electric mechanism operation ..... intermittent
11. Weight of the landing light with the electric mechanism ... 3.5 kg

The landing lamps, type ЖОСВ-45, installed on the aircraft in the extended position ensure illumination of part of the landing strip at a distance of 40 to 60 m. from the pilots' cabin in the direction of flight.

Maintenance of Landing Lights, Type ЖОСВ-45

To check the operation of the landing lamps on the ground, it is permitted to switch them on for not more than 5 minutes. The landing light may be switched on again only after they have been cooled during not less than 5 minutes.

Avoid shaking and knocking to prevent crack formation and failure of the landing lights.

When checking the landing light in a workshop the supply voltage must not exceed the nominal value of 28 V, otherwise the lamps may burn out.

To prevent decrease in the landing light luminous intensity, clean the part of the lamp surface which serves as a protective glass.

Replacement of СМФ-2М Lamp

The СМФ-2М lamp is a changeable element of the landing light and is replaced by the unit technician in the event of failure. To replace the lamp in the ЖОСВ-45 landing light, do as follows:

1. By means of the 2ПП-45 switch extend the landing light with the burnt out lamp; at this the circuit breakers, types АЗС-5 and АЗС-30, mounted on the left-seat pilot circuit breaker panel for the serviceable landing light must be switched off.
2. Switch off the supply circuit breaker, type АЗС-30, of the unserviceable landing light on the left-seat pilot circuit breaker panel.
3. Unscrew four screws 3 (Fig.91).
4. Remove retaining ring 4 and draw the lamp out of the streamlined case.
5. Disconnect the supply conductors from the lamp terminals and remove the lamp.
6. Installation of a new lamp is performed in the reverse order.

When replacing the lamp, see that the rubber shock absorbers supporting the lamp bowl in the case are intact.

Re-Adjustment of Turning Units of the МПФ-2 Electric Mechanism Sector

The МПФ-2 electric mechanism is adjusted for a turning angle of the sector (landing light) equalling 75° ± 30' For the aircraft, model ИЛ-16 , the landing light extension angle of 86°30' ± 30' is necessary. Therefore, when replacing the ЖОСВ-45 landing light during service, bear in mind that it is impossible to mount a new light on the aircraft without preliminary re-adjustment of the sector turning angle of the МПФ-2 electric mechanism.

Re-adjustment of the electric mechanism is performed in the following manner:

1. Remove the seal and the check wire, turn out the screws fastening the cover to body 2 and turn the cover aside according to Fig.92.
2. Loosen screw 3 and by moving limit switch 4 together with plate 5 along the guide grooves see that the contacts of limit switch 4 are opened by stop 6 at an angle of the sector (landing light) turning equal to 86°30' ± 30'.

3. Tighten up screw 3 again.
4. Check the operation of the electric mechanism.
5. Place cover 1 in position, turn in the screws fastening the cover to the body and seal the electric mechanism again.
6. Make corresponding entries in the Certificate of the МПФ-2 electric mechanism.

The re-adjustment of the electric mechanism should be made by trained personnel, no damage to the inner connecting conductors, limit switches and other elements of the electric mechanism is permitted.

Installation of ЖОСВ-45 Landing Light on Aircraft

Install the landing light on the aircraft so that the body of the landing light electric mechanism is pointed in the direction of flight while the dimmer located inside the lamp and designed for screening the direct rays looks with its prominent portion towards the aircraft centre line.

The landing light is fastened in position with 15 screws 4 mm in diameter passing through the holes in the landing light flange.

Formation Lights, Type ПСС0-45

Formation lights, type ПСС0-45 , are used during group flights in the night time or under conditions of poor visibility to allow the aircraft flying in the rear to form up and to keep their proper places in formation.

When forming up above the leading aircraft, the upper formation lights are used; when forming up below the leading aircraft, the lower formation lights are used. The upper and the lower formation lights are installed over the axis along the fuselage and over the wing span on the landing gear fairings so that during the flight the illuminated aircraft resembles the letter T. The formation light attachment is made flush with the skin by means of bolts and self-locking anchor nuts. The upper and lower formation lights are switched on by means of corresponding switches, type В-45, mounted on the pilots' upper electric board (See Fig.91).

The ПСС0-45 formation light (Fig.92) consists of the following main parts: aluminium body, the inner electrically polished surface of which serves as a reflector of the socket holder with a single-contact socket mounted in it for the СМ-30 lamp of 28 V and 0.17 A, and a prismatic light refractor of blue polystyrene serving as a light filter at the same time.

Specifications of ПСС0-45 Formation Lights

1. Maximum luminous intensity ..... not less than 5.5 colour candles, with the formation light in the horizontal position; it is directed backward at an angle of 45 to 50° up from the direction opposite to the direction of flight
2. Lights visibility range in the direction of maximum luminous intensity in the night time in clear weather ..... about 3 km.

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3. Angular width of luminous beam ..... about 20°

This arrangement of formation lights enables the aircraft flying behind somewhat higher to keep its place in the formation taking bearing on the brightest of the leading aircraft.

Maintenance of Aircraft Formation Lights, Type NCCO-45

To avoid decrease in the formation lights luminous intensity, clean the reflector and light refractor from dirt with a clean piece of soft cloth or cotton wool. It is prohibited to wipe the aluminium reflector or plastic refractor with coarse material.

CAUTION: The NCCO-45 formation lights are designed for operation only during flights. To prevent the plastic light refractor from overheating and damage, switching on the lights for a long time during parking is not permitted.

Polystyrene of which the light refractor is manufactured swells and dissolves almost in all solvents - acetone, ethyl-acetate, ether, chloroform, benzol, benzine (containing benzol), toluene.

The vapours of these solvents also produce a harmful effect on plastics: the solvents are absorbed by polystyrene and then slowly evaporate causing the appearance of irregular dimming in the light filter and the formation of small cracks near the surface.

If such a light filter is held up against the light, some silvery brilliance may be noticed in the plastics.

These phenomena considerably reduce the coefficient of the light filter total passing capacity, its transparency and, therefore, change the light distribution of the NCCO-45 formation lights. Therefore, to avoid harmful influence of solvent vapours upon the plastics do not paint and dry the bomb bay doors with the light refractors of the NCCO-45 formation lights mounted on them. If the formation lights are already mounted, prior to painting remove the light refractors and tightly close the reflectors with some plug. To protect polystyrene refractors, take care to see that they are not splashed with solvents.

Replacement of NCCO-45 Fitting and Replacement of Lamp in the Fitting

To remove the NCCO-45 fitting, turn out the fitting attachment screws and disconnect the plus conductor.

When mounting a new formation light, see that the installation is precise: the plane passing through the lamp axis perpendicularly to the refractor prism must be parallel to the aircraft longitudinal axis and the socket holder must face downward (upward for the lower lights) and forward with flight. The formation lights are fastened in position with five screws 3 mm in diameter (passing simultaneously through the holes and anchor nuts in the aircraft frame) in the body of dome lamp 1 (See Fig.93), rubber gasket 3, light refractor 4 and retaining ring 5 holding the refractor in place. Thus, the formation light is assembled simultaneously with its installation on the aircraft. The asymmetrical location of attachment holes in the formation light excludes incorrect position of the blue light refractor in relation to the reflector, nevertheless, see that the refractor prisms look inside the formation light. If the locating diameter of the NCCO-45 formation light dome lamp does not correspond to the cut in the aircraft frame recess, it is permitted to fit washers measuring

1x0.5 under the dome lamp attachment bolts and the recess bottom. In this case the dome lamp may project in relation to the skin outer surface by up to 1 mm.

The dome lamp installed, fill the clearance between ring 5 and the aircraft skin with packing sealing thiokol putty.

To replace the lamp in the NCCO-45 fitting, do as follows:

1. Turn out the attachment screws of the formation light fitting, remove the retaining ring and the light refractor.
2. Replace the lamp.
3. Mount the light refractor and the retaining ring in place, screw in and tighten up the attachment screws.

Navigation Lights, Type BAHO-45

The navigation lights, type BAHO-45, are designed to be shown by aircraft in the air during flight and on the ground during taxiing.

The fairing of each wing mount front and rear navigation lights. Two red lights, type BAHO-45, are located on the port wing-tip fairing, two green lights are located on the starboard wing-tip fairing. The navigation lights are installed in recesses closed with plexiglass and are fastened in position with three bolts, 3 mm in diameter. The fitting is provided with lamps, type CM-22, of 28 V, 24 W with luminous intensity of 21 candles.

The navigation light, type BAHO-45, has asymmetrical light distribution. The maximum luminous intensity in the direction of flight is not less than 33 colour candles which ensures the visibility range in the night time of about 5 km under normal conditions. In the horizontal plane light is emitted within 110° outside from the direction of flight; in the vertical plane - within ±90° up and down from the horizon.

Replacement of Lamp in BAHO-45 Fitting

1. Turn out the plexiglass fairing attachment screws and remove the fairing.
2. Turn out screw 7 fastening the light filter (Fig.94) and remove the glass.
3. Unscrew the lamp and replace it.

When replacing the lamp, take into consideration that the pins of the lamp base are located at various heights; this makes it possible to insert the lamp into the socket only in the definite position: the amalgamated surface of the bulb must face screw 7.

4. Mount the glass light filter and fasten it in position with screw 7.

When mounting the light filter, it is recommended that the glass end face should be slightly covered with sealing thiokol putty to prevent moisture from getting inside the device. During the assembly take care to see that packing gasket 2 is fitted under the glass and lead washer 6 is fitted under the head of attachment screw 7, otherwise the glass might break when the screw is being tightened. After the light filter has been installed, it is recommended to cover the head of screw 7 with putty or paint.

5. Mount the plexiglass fairing and fix it with screws.

Removal of BAHO-45 Fitting

1. Remove the plexiglass fairing.
2. Turn out the light filter attachment screw and remove the glass.
3. Turn out the three fitting attchment screws.
4. Unscrew socket union nut 4 and disconnect the supply conductor.
5. Remove the BAHO-45 fitting.

Installation of the navigation light is performed in the reverse order.

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Tail Light, Type XC-39

In the fuselage tail section the rear fairing lower part mounts a tail navigation light, type XC-39, with the CM-15 lamp of 26 V, 10 W. The tail light is switched on by means of the same switch, type B-45, which is designed for switching on wing-tip navigation lights, type SAHO-45 . The switch is mounted on the pilots' upper electric board (See Fig.90).

Replacement of Lamp in the XC-39 Fitting

1. Unscrew the attchment screws of the wire lattice and remove the latter.
2. Loosen the glass shade attachment screws 7 (Fig.95) and remove the shade.
3. Replace the lamp.
4. Mount the glass shade in position and tighten up the screws.
5. Fit the wire lattice.

Removal of XC-39 Fitting

1. Remove the wire lattice.
2. Remove tail light fitting attachment screws 7 and remove the fitting from the recess in the fairing bracket.
3. Disconnect the supply conductors.

Installation of the tail light fitting is performed in the reverse order.

FIRE FIGHTING EQUIPMENT AND FIRE WARNING ELECTRIC SYSTEM

With the aid of the electric system:

(1) CO_2 is delivered to the area where fire occurs in the aircraft;
(2) fuel delivery to the engines is cut off;
(3) the fuel system is being filled with neutral gas.

The aircraft electric system includes the following units:

- fire-sensitive unit TM - 28 pieces;
- electromagnetic shut-off cocks unit (unit 635900) - 2 pieces;
- push-button type lamp with a red light filter - 6 pieces;
- electromagnetic air valve 2512800 - 2 pieces;
- relay, type PM-2 - 1 piece;
- warning lamp with a greeen light filter - 2 pieces;
- fuel cross-feed cock with the MZK-2 electric mechanism - 1 piece;
- firing mechanism - 10 pieces (four of them are intended for CO_2 cylinders and six - for neutral gas cylinders);
- CO_2 cylinder switch button 5K - 1 piece;
- fuel shut-off cock with the MZK-2 electric mechanism - 2 pieces.

The units of the system are located in the following places:

1. Fire-sensitive units on special brackets:

(a) in the area of the fuselage nose section fuel tanks: two-fire-sensitive units are located on frame No.17, one unit is located on frame No.22, one unit is located on frame No.25 and four units are located on frame No.33;

(b) in the area of the fuselage tail section fuel tanks: two units are located on frame No.50 and two - on frame No.56;

(c) on the engines under the collapsible cowls: four fire-sensitive units are located on each engine;

(d) in the area of fuel tanks between ribs Nos 3 - 4, 6 - 7, 8 - 9 and 12 - 13 along the rear wall of the wing second longeron - four fire-sensitive units are located in between each pair of the ribs.

2. The electromagnetic fual shut-off cocks units are located on the ceiling of the bomb bay between frames Nos 37 and 38.
3. CO_2 cylinders switching and warning push-button type lamps (Fig.112) are mounted on the pilots' upper electric board.
4. The electromagnetic air valve 2512800 is mounted on the engine.
5. The relay, type PM-2 , and the warning lamps with green light filters are located on the pilots' upper electric board.
6. The fuel cross-feed cock with the MZK-2 electric mechanism is located on frame No.33.
7. The firing mechanism designed for opening the CO_2 cylinders is installed on frame No.22, that designed for opening the neutral gas cylinders is mounted on frame No.15.
8. The 5K button for switching on the CO_2 cylinders is located on the pilots' upper electric board.
9. The starboard and port engines fuel shut-off fire cocks are installed on the engines behind the fire wall.

Specifications of Electric Units Included in System

1. Fire-sensitive unit TM (Fig.113):	
operation range	140 to 170°C
insulance	not less than 2 megohms
2. Fuel shut-off cocks unit:	
operating pressure	up to 100 kg/cm^2
nominal voltage	27 V
current on switching	not in excess of 7 A
current with cocks open	0.5 A
time unit is energized	not in excess of 20 min.
minimum pulling effort at the beginning of travel with 6.5 mm clearance, at nominal voltage and time unit is energized not exceeding 15 sec.	9 kg

The Specifications of the MZK-2 mechanism are given in the Section "Fuel Pumps Control and Fuel Quantity Measuring Electric System".

Checking Installation and Operation of Fire-Fighting Equipment Electric System

Carry out the outside inspection with the aircraft mains de-energized. During the inspection make sure that:

1. The fire-sensitive units attachment is in proper condition, the diaphragms are free from dents and are not deformed, there are no foreign matter and no moisture between the body and the fire-sensitive unit diaphragm.
2. The glass of the push-button type lamp is not broken and is securely fixed in position.
3. The CO_2 cylinder button, type 5K, operates without jamming and is in good repair.
4. The firing mechanisms on the discharge bonnets of the CO_2 and neutral gas cylinders are screwed up and locked with the MM-3 explosive charges inserted (Fig.98).

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CAUTION: During service it is prohibited to touch the fire-sensitive unit contact screw with the nut, to re-adjust the contact screw and press the diaphragm.

5. The plug connectors of the fuel shut-off cocks units must be connected in compliance with the marking (the plug connector bodies and the fuel shut-off cocks units are marked) and locked with wire.

Checking Operation of Energized System

CAUTION: The neutral gas switch, type B-45, is turned on only when neutral gas is delivered to the system.

Neutral Gas HT

The system is checked by connecting an extension pilot lamp to the firing mechanisms. For this:

1. Unscrew all the six firing mechanisms from the neutral gas cylinder discharge bonnets and remove the explosive charged.

2. Switch on the neutral gas circuit breaker on the right-seat pilot circuit breaker panel and turn on the B-45 switch on the pilots' upper electric panel. In this case the extension pilot lamp whose one conductor is connected to the body and the other conductor is connected to the mid contact of the firing mechanism must be lit.

3. The check up over, turn off the neutral gas switch, type B-45, on the pilots' upper electric board.

4. Charge the firing mechanisms with explosive charges, screw them to the neutral gas cylinder discharge bonnets and lock the firing mechanism nuts with wire.

Fire-Fighting System

1. On the right-seat pilot circuit breaker panel switch on two starboard and port engines tanks fire warning circuit breakers, type A3C-15.

CAUTION: The CO_2 cylinder opening circuit breaker, type A3C-10 , must be in the OFF (ВЫКЛЮЧЕНО) position.

2. On the pilots' upper electric board turn on the fire-fighting system switch; the lamp must be dead.

3. Press in turn all the push-button type lamps mounted on the pilots' upper electric board. Each push-button type lamp must flash up and the cock of the fuel shut-off cocks unit corresponding to this lamp must operate. Simultaneously the CO_2 cylinder opening relay, type PП-2, must operate. Prior to each pressing of the push-button type lamp, turn off the fire-fighting system switch and in 1 or 2 seconds turn it on again; the push-button type lamps must go out. On pressing the push-button type lamp of the starboard and port engine besides flashing of the push-button type lamp and operation of the PП-2 relay, the electromagnetic air valve of the shutter in the system designed for scavenging the space under the engine cowl with air must operate.

4. On the left-seat pilot circuit breaker panel switch on the air control circuit breaker and press one of the push-button type lamps. On throttling down one of the engines the blow-off band must operate for closing and the shutter of the undercowl recess air scavenging system must get closed.

Fuel Shut-Off and Engine Fuel Cross-Feed Cocks

1. On the right-seat pilot circuit breaker panel switch on two fuel shut-off cock circuit breakers, type A3C-5 , two fuel pump operation warning system circuit breakers, type A3C-2 , and the fuel cross-feed cock circuit breaker, type A3C-5.

2. On the pilots' upper electric board set the fire shut-off cock switches and the fuel cross-feed control switch to the OPEN (ОТКРЫТО) position; in this case the fuel shut-off cocks green warning lamps (OPEN) on the pilots' upper electric panel must flash up. With the cock switches in the CLOSED (ЗАКРЫТО) position the warning lamps must go out.

The system operation should be checked during the engine operation by the aircraft technician or mechanic, who opens the fuel shut-off cocks prior to engines starting and closes them after switching them off.

Possible Faults of Fire-Fighting System and Their Elimination

Fault	Cause	Remedy
1	2	3
One of the push-button type lamps is on when there is no fire	(a) Closing of contacts in the fire-sensitive unit	Check the entire group of the push-button type lamp fire-sensitive unit. On detecting a fault inside the fire-sensitive unit replace the latter
	(b) Closing of contacts inside the push-button type lamp	Replace the push-button type lamp
The push-button type lamp continues glowing after pressing the lamp when turning the fire-fighting system switch on and off	The change-over system in the fuel shut-off cocks unit is out of repair	Replace the fuel shut-off cocks units. Note: The defects eliminated, check the firing mechanisms and if they have operated, replace the explosive charges
The warning lamp is dead with the fuel shut-off cocks open	(a) The lamp is burnt out	Replace the burnt out lamp
	(b) The adjustment of the limit switches in the M3K-2 electric mechanism is disturbed	Replace the fuel shut-off cock
	(c) The pump operation warning system circuit breaker, type A3C-2 , is not switched on on the right-seat pilot circuit breaker panel	Switch on the circuit breaker. Note: To determine the fault of the fuel shut-off cocks warning system,

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1	2	3
		disconnect the plug connector from the M3K-2 electric mechanism and connect terminal 4 to the aircraft frame by means of a conductor; if the warning lamp is serviceable and the wiring is in good repair, the warning lamp must be on
The fuel shut-off cocks or the cross-feed cock fail to open or to close	(a) The fuel shut-off cocks circuit breaker, type A3C-5 , or the cross-feed cock circuit breaker, type A3C-5 , on the right-seat pilot circuit breaker panel is OFF	Switch on the circuit breaker
	(b) The connecting wires are broken, or there is no contact in the plug connector	Detect the places of damaged wiring by ringing out the wires and eliminate the damage. This done, check the operation
	(c) The electric mechanism, type M3K-2 , is out of repair	Replace the M3K-2 electric mechanism with the cock
The fuel shut-off cocks or the cross-feed cock let the fuel through in the closed position	The adjustment of the limit switches of the M3K-2 electric mechanism is disturbed	Replace the M3K-2 electric mechanism with the cock

FUEL PUMPS CONTROL AND FUEL GAUGE ELECTRIC SYSTEM

The system is designed for:

(a) checking the total quantity of fuel in five tank groups;

(b) checking the quantity of fuel in each group of tanks separately;

(c) automatic control of the fuel consumption sequence so as to preserve the aircraft centring within permissible limits during flight and landing;

(d) manual control of the fuel pumps when the automatic control of fuel consumption fails;

(e) warning of fuel available for 30-minute and 15-minute flight;

(f) aircraft fuel filling control;

(g) measuring the amount of fuel consumed by each engine;

(h) signalling of the fuel pumps operation of each group of tanks separately.

The system includes the following instruments and units:

1. Capacitive fuel level gauge, type CSTC-60M.

The fuel level gauge set includes:

indicators	2 pieces
measuring device amplifiers, type UT-88M	2 pieces
automatic units, type BAC-52-12	2 pieces
switches, type MT-7	2 pieces
main transmitters (with signalling)	10 pieces
additional transmitters (with signalling)	5 pieces
additional transmitters (without signalling)	2 pieces

2. Summing fuelmeter, type PTC-16 (two sets). The fuelmeter set includes:

transmitter	1 piece
indicator	1 piece
thyratron interrupter, type UT-51T	1 piece

3. Fuel pump, type ЭЦН-Т , with the МВ-650А electric motor — 12 pieces

4. Contactor, type K-50 — 12 pieces

5. Relay, type РП-2 — 10 pieces

6. Relay, type РП-6 — 1 piece

7. Warning lamps, type СЦЦ-51 :

with a red light filter	4 pieces
with a blue light filter	4 pieces
with a green light filter	12 pieces

8. Fuel-pressure warning unit, type СД-3 ТУ — 12 pieces

9. Resistor, type ПО-10-5 — 8 pieces

Arrangement of Electric Units Included in the System

1. The fuel pumps operation warning lamps and control switches are located on the fuel supply electric board (Fig.99).

2. The arrangement of fuel pumps, fuses, switching contactors, ПО-10-5 resistors and РП-3 relay designed for changing the fuel pumps over to the forced conditions is indicated in Table 27.

3. The fuel gauge amplifiers (Fig.100) are located on the navigator-radar operator's rack on the starboard side.

4. The automatic units (Fig.101) are mounted in the landing gear nose leg well on frame No.22.

5. The 30- and 15-minute flight fuel remain warning lamps are located on the left-seat pilot instrument panel and on the fuel supply panel.

6. The location of the fuel level gauge transmitters is shown in Table 28.

7. The fuel-level gauge switches and indicators are installed on the right-seat pilot instrument panel (Fig.102).

8. The fuel gauge A.C. supply fuses, type СП-1 , are mounted on the navigator's upper electric board.

Table 27

Arrangement of Fuel Pumps and Units and Their Switching by Groups

Name of tank group	Fuel pumps in the tank	Place of installation: Pump supply fuse	Pump switching contactor	MO-10-5 resistor	Pump PN-2 junction relay
1	2	3	4	5	6
1st group left	No.2 - 2 pieces	MN-75 fuse in the additional pump junction box of tank No.2 (on frame No.35)	K-50M contactor in the additional pump junction box of tank No.2	In the additional pump junction box of tank No.2	In the additional pump junction box No.2
		MN-75 fuse in the fuel pumps left junction box (on frame No.33)	K-50M contactor in the fuel pumps left junction box	In the fuel pumps left junction box	In the fuel pumps left junction box
1st group right	No.5 - 2 pieces	Two MN-75 fuses in the fuel pumps junction box (on frame No.49)	Two K-50M contactors in the fuel pumps junction box	Two resistors in the fuel pumps junction box	Two resistors in the fuel pumps junction box
2nd group left	No.4 - 1 piece	MN-75 fuse in the fuel pumps junction box (on frame No.49)	K-50M contactor in the fuel pumps junction box	In the fuel pumps junction box	In the fuel pumps junction box
2nd group right	No.3 - 1 piece	MN-75 fuse in the fuel pumps starboard junction box (on frame No.333	K-50M contactor in the fuel pumps right junction box	In the fuel pumps right junction box	In the fuel pumps right junction box

1	2	3	4	5	6
3rd group	No.10 - 1 piece	MN-50 fuse in the distribution panel of the port and starboard engines	One K-50M contactor in the landing gear junction box and one contactor in the fuel pumps relay junction box (in the port and starboard landing gear wells)	In the landing gear junction box and the fuel pumps relay	In the landing gear junction box and the fuel pumps relay
4th group	No.16 - 1 piece	MN-50 fuse in the distribution panel of the left and starboard engines	One K-50M contactor in the landing gear junction box and one contactor in the fuel pump relay junction box (in the port and starboard landing gear wells)		In the landing gear junction box and the fuel pumps relay
5th group left	No.6 - 1 piece	MN-50 fuse in the fuel pumps left junction box (on frame No.33)	KM-50K contactor in the fuel pumps left junction box		
5th group right	No.6 - 1 piece	MN-50 fuse in the fuel pumps right junction box (on frame No.33)	K-50M contactor in the fuel pumps right junction box		

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Table 28

Arrangement of Fuel Level Gauge Transmitters

Name of tank group		Transmitters	
		main transmitters in tank No.	additional transmitters in tank No.
1st group	left	2	-
	right	5	-
2nd group	left	4	-
	right	3	3
3rd group		10	7
4th group		16	12
5th group		6	6

9. The fuel level gauge D.C. supply circuit breaker, type АЗС-2 , is located on the right-seat pilot circuit breaker panel.

10. The automatic unit A.C. supply fuses, type СП-1 , are mounted on the navigator's upper electric board.

11. The automatic unit D.C. supply circuit breaker, type АЗС-5 , is installed on the right-seat pilot circuit breaker panel.

12. Right- and left-hand circuit breakers, type АЗС-2, of the 4th and 5th fuel pump groups are located on the right-seat pilot circuit breaker panel.

13. The fuel consumption control switch АВТОМАТ-MANUAL (АВТОМАТ-РУЧНОЕ) and relay is in the fuel-level gauge junction box on frame No.22.

14. The fuel-pressure warning units, type СД-3ТУ , cutting in warning lights are located near each fuel pump; they are connected to the fuel line.

15. The ИТС-16 fuel-level gauge indicators are mounted on the pilots' central instrument panel.

16. The ИТС-16 fuel-level gauge transmitters are mounted in the fuel lines of the engine lower part.

17. The thyratron interrupters, type ИТ-51, are located on the navigator-radar operator right-hand rack (Fig.103).

Checking Operation of Fuelmeter System on Aircraft

Prior to checking the fuel pumps automatic control and fuelmeter system make certain that on the navigator's upper electric board СП-1 fuses are mounted in the fuel-level gauge A.C. supply circuits.

1. The aircraft mains must be supplied with 28 or 28.5 V D.C. from the ground power supply and with 115 V A.C. from the aircraft operating or standby inverter, type ПО-4500.

2. Switch on two FUEL-LEVER GAUGES (ТОПЛИВОМЕРН) circuit breakers, type АЗС-2 , on the right-seat pilot circuit breaker panel.

3. Cut in two port and starboard engine fuel-level gauges supply switches, type ЗНН-250, on the right-seat pilot's instrument panel.

4. Set the handle of the port fuel-level gauge switch to the 1 position. This done, in two or three minutes the pointer of the port fuel-level gauge indicator must indicate the amount of fuel filled in the 1st tank group with permissible error of ±320 lit. by the lower scale marks. Press the button on the indicator case; the indicator pointer must stop at the zero scale mark, the permissible error being ±160 lit.; then release the button; in this case the pointer must indicate the amount of fuel filled in the 1st tank group.

After the fuel-level gauge has been checked with the switch in the 1 position, perform checking with the switch in the 2 , 3 , 4 and 5 positions. The instrument pointer must be in the same position as with the switch in the 1 position.

5. Set the handle of the port fuel-level gauge switch to the TOTAL (СУММА) position; the instrument pointer must indicate the total amount of fuel filled in all the five tank groups with permissible error of ±960 lit. by the upper scale marks.

Press the button on the indicator case; the indicator pointer must stop at the scale zero mark; then release the button; the pointer must read the total amount of fuel in all the five tank groups.

6. Set the handle of the port fuel-level gauge switch to the 1 position and press the GROUP CHECKING (ПРОВЕРКА ГРУПП) button on the port group fuel-level gauge amplifier. The pointer of the fuel-level gauge left indicator must indicate the amount of fuel in the group (6000 lit.) with permissible error of ±320 lit. After the fuel-level gauge has been checked with the switch in the 1 position, perform checking with the switch in the 2 , 3 , 4 and 5 positions; the instrument pointer must be in the same position as with the switch in the 1 position.

7. Set the port fuel level gauge switch to the TOTAL (СУММА) position and press the TOTAL CHECK (ПРОВЕРКА СУММЫ) button on the port group fuel-level gauge amplifier. The pointer of the fuel-level gauge port indicator must indicate 16,000 lit. with permissible deviation of ±320 lit.

Notes: 1. The starboard group fuel-level gauges are to be checked in the same manner as the port group fuel-level gauges.

2. After the fuel-level gauges have been checked for proper operation, turn off the switches of the fuel-level gauges starboard and port groups on the right-seat pilot's instrument panel and the ПО-4500 inverter.

Checking Operation of Fuelmeter, Type ИТС-16

1. Prior to checking, set the indicating instrument pointer precisely to the amount of fuel filled in the fuel tanks starboard and port groups.

2. Prior to checking, make sure that the ИТС-16 fuelmeter A.C. supply fuses, type СП-1А , are mounted on the navigator-radar operator's electric board.

3. Make certain that the ИТС-16 fuelmeter D.C. supply circuit breakers, type АЗС-2 , on the right-seat pilot's circuit breaker panel are on.

4. Check the operation of the system with the engines switched on. The accuracy of operation is determined by the fuel consumption per hour.

5. After the ИТС-16 fuelmeter has been checked for proper operation, switch off the АЗС-2 circuit breaker on the right-seat pilot's circuit breaker panel.

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Checking Operation of Fuel Pump Manual and Automatic Control System and Their Warning System

1. Switch on the fuel pumps warning system circuit breaker, type АЗС-2, on the right-seat pilot's circuit breaker panel; the green and blue warning lamps must be dead.

2. Set the fuel flow control switch to the MANUAL (РУЧНОЕ) position and on the pilots' upper electric board turn on the switch of the 1st front tank group fuel flow manual control АЗС-5 circuit breaker. The green lamps of the 1st front tank group on the pilots' upper electric board must flash on.

3. Switch off the 1st front tank group fuel flow manual control АЗС-5 circuit breaker (operating as a switch); the warning lamps must go out.

4. Switch on the 1st rear tank group АЗС-5 circuit breaker; the lamps of the 1st rear tank group must flash on. Then turn off the 1st rear tank group АЗС-5 circuit breaker switch; the warning lamps must go out.

5. Turn on the 1st rear and front tank group АЗС-5 circuit breakers; the warning lamps must glow constantly without flickering.

6. Switch on the 2nd group АЗС-5 circuit breaker; the warning lamps of the 2nd group on the upper electric board must flash on, while the 1st group pumps must change over from the nominal to the heavy duty.

7. Switch off the 1st front and rear tank group АЗС-5 circuit breaker; in this case the 1st group warning lamps must go out.

8. Switch on the 3rd group АЗС-5 circuit breaker; the 3rd group warning lamps must flash on, while the 2nd group pumps must change over from the nominal to the heavy duty.

9. Switch on the АЗС-2 circuit breaker of the 4th and 5th group fuel pumps supply on the right-seat pilot's circuit breaker panel.

10. Turn off the switch of the 2nd group АЗС-5 circuit breaker; the 2nd group pumps and warning lamps must get switched off.

11. Turn on the stand-by pumps switch, type 2В-45, on the pilots upper electric board; the 4th group pump warning lamps must flash on.

12. Turn on the 5th group switch, type 2В-45; the 5th group warning lamps must flash on, the 3rd group pumps must change over from the nominal to the heavy duty and the 4th group pumps must change over from the stand-by to the nominal condition.

13. When checking the operation of the fuel pumps, pay attention to the amount of current consumed by them which must be within the data given in the Certificate of the fuel pump.

14. Set the fuel flow control switch on the pilots' upper electric board to the AUTOMATIC (АВТОМАТ) position and the fuel flow manual control АЗС-5 circuit breaker switch to the OFF (ВЫКЛЮЧЕНО) position.

15. Switch on the fuel automatic line АЗС-2 circuit breaker on the right-seat pilot circuit breaker panel.

16. On the pilots' upper electric board turn on the supply switch, type 2ШИ-250 , of the starboard and port engines automatic control line amplifier; make sure that the fuel pumps automatic control operates correctly with the given amount of fuel in the aircraft tanks. The flashing of the blue and green warning lamps and the switching on of the fuel pumps depend on the amount of fuel in each group separately. The operation of the automatic control versus the amount of fuel filled is described in the Section "Operation of РД-3М Engines", Book one, "Operating Instructions of ТУ-16 Aircraft".

17. The fuel flow automatic control is performed through two channels independent of each other. The left tank group fuel flow automatic control is

duplicated by the right tank group automatic control and vice versa. Therefore, when checking the operation of the automatic control, check the operation of each group separately, that is by switching the 2ШИ-250 automatic control amplifiers on and off in turn. The flashing of the warning lamps on the pilots' upper electric board when the amplifiers are switched on and off in turn testifies to serviceability of the amplifiers.

Notes: 1. After the operation of the automatic control has been checked up, switch off the ПО-4500 inverter, if other units operating from the A.C. power supply are inoperative.

2. Set all the switches of the automatic control system on the pilots' upper electric board to the OFF (ВЫКЛЮЧЕНО) position.

3. In case faults of the automatic control are detected during the check up, it is necessary to check the system by means of the УПА-53-60 installation as prescribed by special instructions appended to the installation.

Specifications of Fuel Pumps Control and Fuel Gauge Electric System

Fuel-Level Gauge

1. The fuel-level gauge set operates:

(a) within ambient air temperature range of -60 to +50°C;

(b) at A.C. voltage of 115 ± 11.5 V, 400 - 28 c.p.s. and D.C. voltage of 27 ± 2.7 V;

(c) with outside pressure changed from 760 to 90 mm of mercury, that is at altitudes from 0 to 15,000 m.;

(d) in conditions of relative humidity from 30 to 98 per cent.

2. The error of the fuel-level gauge reading when bench tested under normal conditions (at temperature of 20 ± 5°C, pressure of 760 mm of mercury, relative humidity of 30 to 98 per cent and voltage of 115 V, 400 c.p.s.) does not exceed ±2 per cent at the zero mark and ±4 per cent of the scale nominal value at the other scale marks.

3. The error of the fuel-level gauge reading at -60°C does not exceed ±6 per cent at the zero mark and ±8 per cent at the other scale marks; at temperature of +50°C the error does not exceed ±3.5 per cent at the zero mark and ±5.5 per cent of the scale nominal value at the other scale marks.

4. The error of the signal unit operation checked by means of the bench does not exceed 10 mm of the float travel in the transmitter.

5. The additional error of the fuel level gauge reading at voltage change of ±10 per cent does not exceed ±1 per cent; at frequency change of $^{+5}_{-7}$ per cent it does not exceed ±1 per cent of the scale nominal value.

6. The insulance of transmitters and switches, type ПГ-7 , at normal temperature and relative humidity of 30 to 80 per cent is not less than 100 megohms and at relative humidity of 95 to 98 per cent - not less than 20 megohms.

7. The insulance of the indicating instrument is not less than 20 megohms at normal temperature and relative humidity of 30 to 80 per cent and not less than 2 megohms at humidity from 95 to 98 per cent.

8. The similar elements of the set within one group are interchangeable.

9. The additional error is ±1 per cent of the fuel-level gauge scale nominal value (taking into consideration possible difference in the capacity of the tanks included in the groups).

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10. The first warning signal 30-MINUTE FLIGHT-FUEL REMAINDER (ОСТАТОК ТОПЛ. НА 30 МИН. ПОЛЕТА) is sent when the fuel left in one of the 4th tank groups is equal to 600^{+300}_{-100} lit.

11. The second warning signal 15-MINUTE FLIGHT-FUEL REMAINDER (ОСТАТОК ТОПЛ. НА 15 МИН. ПОЛЕТА) is sent when the fuel left in one of the 5th tank groups is equal to 1600 ± 100 lit.

12. The electrical capacity of "dry" transmitters is given in Table 29.

Table 29

Capacity of Dry Transmitters (Initial Capacity)

Nos	No. of tank and transmitter	Capacity of transmitters, pF	Nos	No. of tank and transmitter	Capacity of transmitters, pF
1	2	3300	7	6Д	1000
2	3	2300	8	7	1000
3	3д	1000	9	10	2300
4	4	3300	10	12	1000
5	5	3300	11	16	2300
6	6	2300			

FRC-16 Fuelmeter of Fuel Consumed by Each Engine

1. The summing fuelmeter, type FRC-16, operates within a range of 1200 to 16,000 lit. per hour.

2. The error of the fuelmeter set under normal conditions does not exceed ±2.5 per cent.

3. The fuelmeter set at temperatures of +50 and -60°C does not exceed ±4.5 per cent of the indicating instrument scale nominal value.

4. Pressure drop by the transmitter at fuel viscosity of 15 + 1 c.s. (corresponding to fuel temperature of -40°C) and maximum fuel flow of 16,000 lit. per hour does not exceed 0.25 kg per sq.cm. with the impeller operating and 0.4 kg per sq.cm. with the impeller inoperative.

5. The inner chamber of the transmitter body, as well as the connections of the branch pipe with the transmitter body, are gastight and withstand a testing pressure of fluid (kerosene) of 9 kg per sq.cm.

6. Power consumed by the set is 40 W.

7. The thyratron fires with delay of 100 or 200 milliseconds.

Fuel Pumps Automatic and Manual Control

1. The pumps-switched-on signals of the subsequent groups – the transmitters lower warning unit operate when 350 ± 150 lit. remain in one of the tank groups of the same name.

2. The pumps-switched-off signals of the previous groups – the transmitters upper warning unit – must operate when the following amount of fuel remains in one of the tank groups of the same name:

2nd left group, tank No.4	2450 ± 250 lit.
2nd right group, tank No. 3	2250 ± 250 lit.
3rd group	5000 ± 250 lit.
4th group	2300 ± 250 lit.

3. The fuel pump, type ЭЦН-Т , with the МВ-650А electric motor:

(a) Electric motor power supply	27 ± 2.7 V D.C
(b) Current consumed by the electric motor:	
main duty	not in excess of 31 A
light duty	not in excess of 19 A
(c) Fluid pressure drop produced by the unit at the output of 14,000 lit. per hour and voltage of 27 V across the electric motor terminals on the ground :	
main duty	0.8 to 0.9 kg per sq.cm.
light duty	0.25 to 0.45 kg per sq.cm.
(d) Pressure produced by the pump at light duty with the cock closed and voltage of 27 V across the electric motor terminals	not on exceed of 0.8 kg per sq.cm.

Note: Check these parameters at ambient air and pressure fluid temperature of 15 to 35°C.

(e) Period of continuous operation	prolonged
(f) Permissible temperature of ambient air during the operation of the unit	from +50 to -60°C
(g) Minimum permissible length of the electric motor brushes	18 mm

Note: The pump heavy duty continuous operation during 60 minutes (15 minutes of them at zero output) is performed by connecting a 5-ohm resistor to the main duty winding circuit.

CAUTION: Change-over to heavy duty can be performed only from the main duty. It is not permitted to start the pump at heavy duty.

4. The fuel pressure warning unit:

(a) At pressure change from 0.35 ± 0.05 to 2 kg per sq.cm. the warning lamp flashes on.

(b) The device operates within the range of +50 to -60°C.

(c) The device warning lamp power is 3 W, its supply voltage is 27 ± 2.7 V.

(d) Errors of the warning unit operation:

at normal temperature	±0.05 kg per sq.cm.
at temperature of +50 and .. -45°C	±0.075 kg per sq.cm.

(e) The gastightness of the device must meet the following requirements:

(1) at air pressure of 5 kg per sq.cm. no pressure drop as indicated by the reference pressure gauge must take place in the warning unit sensing element;

(2) the gastightness of the device body ensures that on delivering air under a pressure of 300 mm of mercury simultaneously to the static and dynamic systems pressure drop does not exceed 8 mm of mercury during one minute.

(f) The device can withstand pressure overload of 5 kg per sq.cm. during 5 minutes.

(g) The device insulance at normal temperature and relative humidity of 30 to 80 per cent is not less than 20 megohms.

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Possible Faults of Fuel Pumps Control Electric System and Their Elimination

Fault	Cause	Remedy
1	2	3
The indicator pointer is pressed to the left-hand limiter	(a) The transmitter circuit is open	Detect the faulty transmitter by switching on the transmitters or a group of transmitters in turn and check its connection in the plug connector. Eliminate the fault
	(b) The outer connecting wires of the transmitter circuit are broken	Check the connecting wires and eliminate the fault
	(c) Break inside the amplifier circuit running to the transmitters	Replace the amplifier
	(d) There is no contact on the PN-3 relay located in the amplifier	Replace the amplifier
	(e) Short circuit of the 6H-9 lamp grid wire to frame in the amplifier	Replace the amplifier
	(f) Shorting to frame of the circuit connecting pin 11 of the switch plug connector to pin 9 of the amplifier plug connector to earth	Check the connecting line and eliminate the circuit
	(g) There is no contact between the transmitter plates and the plug connector pins	Check the contact and replace the transmitter
The indicator pointer is beyond the scale maximum	(a) Shorting between the transmitter plates	Detect the faulty transmitter or the group of transmitters by switching them on in turn. Remove the faulty transmitter from the tank. Check the insulance between the plates and between each plate and frame. If the insulance is less than 100 megohms, wash the faulty transmitter with clean fuel and dry it. Then re-check the

1	2	3
		insulance. If the insulance exceeds 100 megohms, mount the transmitter in place. In case the insulance is less than 10 megohms replace the transmitter
	(b) Break of the self-balancing bridge constant capacity arm	Replace the amplifier
When switched over to the TOTAL (СУММА) position, the indicator pointer overshoots the scale maximum	(a) Break in the D.C. supply circuit. The A3C-2 circuit breaker on the right-seat pilot circuit breaker panel is not switched on	Switch on the A3C-2 circuit breaker on the right-seat pilot's circuit breaker panel or eliminate the break of the outside connection circuit wires
	(b) The relay, type PN-6, fails to operate	Replace the amplifier
The indicator pointer fails to move	(a) Break in the A.C. supply circuit	Check the CN-1 fuse on the navigator's upper panel
	(b) The amplifier lamps, types 6H-9 and 6H-9, are out of repair	Replace the lamps and check the serviceability of the set by pressing the CHECK UP (ПРОВЕРКА) buttons on the amplifier front panel. These buttons pressed, the indicating instrument pointer must move towards the scale maximum. The button released, the pointer must return to the initial position
Poor sensitivity of the indicating instrument	(a) The insulance between the transmitter plates and frame is less than 100 megohms	Detect the faulty transmitter or the group of transmitters by switching them on in turn and remove them from the tank. Check the transmitter insulance between the plates and frame. If the insulance is less than 100 megohms, dry the transmitter and re-check the insulance. If the

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1	2	3
		insulance is still low, replace the transmitter. Check the fuel for presence of moisture
	(b) Loss of emission of 6H-9 and 6H-8 lamps	Replace the lamps
	(c) The turns of the output transformer primary winding are shorted	Replace the amplifier
With the tanks empty, the indicating instrument pointer shows the presence of fuel in the tanks	The insulance of the line or transmitters is too low	The means of elimination of the fault is the same as in the event of poor sensitivity of the indicating instrument, Item A
The warning lamp fails to flash on	(a) The warning lamp burnt out	Replace the lamp
	(b) The D.C. supply line is damaged	Repair the line
	(c) The A.C. supply line is damaged	Repair the line
	(d) The relay, type PM-6 , is out of repair	Check the transmitter coil by means of a tester Replace the transmitter
	(e) The special sensitive relay is out of repair	Replace the automatic unit
	Fuelmeter, Type PTC-16	
The indicating instrument fails to operate with fuel being consumed and the transmitter operating	(a) CH-1 fuses are not fitted on the navigator-radar operator electric board	Check the presence of the CH-1 fuse on the navigator-radar operator electric board
	(b) The A3C-2 circuit breaker on the right-seat pilot circuit breaker panel is not switched on	Switch on the A3C-2 circuit breaker on the right-seat pilot circuit breaker panel
	(c) Open circuit	Using a tester check the connecting wires and eliminate the fault
	(d) Jamming of the mechanism ir the indicating instrument	Replace the indicating instrument

1	2	3
	(e) The thyratron in the MT-51A thyratron interrupter fails to operate	Replace the thyratron
The transmitter fails to operate with fuel being consumed	(a) Clogging of the transmitter bearings in the guide mechanism - the impeller fails to rotate	Replace the transmitter
	(b) Clogging of the contact mechanism - the interrupter fails to rotate when the impeller is rotating	Replace the transmitter
The indicating instrument pointer fails to rotate when the setting wheel is rotating	The stop spring is damaged or deformed, the stop ball drops out	Replace the transmitter
Great positive error of the set (that is the indicated amount of remaining fuel is greater than the actual amount)	(a) Clogging of the transmitter	Replace the transmitter
	(b) Clogging in the indicating instrument mechanism	Replace the indicating instrument
Great negative error of the set (that is the indicated amount of fuel remaining is smaller than the actual amount)	(a) Poor contact in the connecting wires (most often at the plug connectors and leadins)	Thoroughly check the wiring and ensure reliable contact
	(b) The indicating instrument kinematic coupling is disturbed, when the driving pawl engages two teeth during one cycle of the relay operation	Replace the indicating instrument
The transmitter and the indicating instrument are in good repair but the set fails to operate with fuel being consumed	Failure of the thyratron interrupter elements	Replace the thyratron and, if after this the set does not operate, replace the thyratron interrupter

FLAP CONTROL ELECTRIC SYSTEM

The flap control electric system is designed for extending and retracting the flaps, indicating the angle of their deflection and transmitting the horn

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signals in the front pressurized cabin when the engine throttle control is set to the take-off rating while the flaps are not in the take-off position.

The system includes the following electric units:

- electric mechanism, type MIZ-3M;
- distant-reading electric flap position indicator, type UZP-47 ; the instrument set includes one UZP-47 indicator transmitter and two UZP-47 indicators;
- limit switches mechanism, type MKV-11;
- limit switches mechanism, type MKV-2;
- relay, type PP-2;
- two contactors, type K-250;
- switch, type 2PN-20;
- switch, type 3PPN-45;
- fuses and circuit breakers.

The electrical units are located in the following places:

1. The flap control electric mechanism, type MIZ-3M , is mounted on the centre plane between frames Nos 32 and 33.

2. The flap position indicators, type UZP-47 , are located on the right-seat and left-seat pilots' instrument panels.

3. The transmitter of the UZP-47 position indicators is installed on the MKV-2 mechanism.

4. The limit switch mechanism, type MKV-2, for switching on the warning horn is located on the flap transmission shaft.

5. The limit switch mechanism, type MKV-11, for switching off the electric motors of the MIZ-3M mechanism with the flaps in the extreme positions is on the flap driving shaft.

6. The contactor, type K-250, for switching on and off the supply of electric motors Nos 1 and 2 of the MIZ-3M mechanism and landing flaps junction box is on the bomb bay ceiling at frames Nos 34 and 35.

7. The fuse, type PP-150 , for electric motor No.1 of the MIZ-3M mechanism is in the double supply left-hand junction box and for electric motor No.2 is in the right-hand junction box.

8. The flap control switches, type 3PPN-45 , of the left-seat pilot, and type 2PN-20 of the right-seat pilot are mounted on the engine control panels of the left-seat and right-seat pilots respectively.

9. The relay, type PP-2 , for interlocking which prevents switching the flaps by one pilot for extension and by the other pilot for retraction is installed on the left-seat pilot's engine control panel.

10. The limit switches for switching on sound signalling are mounted on the engine throttle controls on the right-seat pilot's console (Fig.104).

Specifications of Electric Units

1. Electric mechanism, type MIZ-3M:

(a) mains nominal voltage	27 V
(b) range of mains operating voltage	24.3 to 29.7
(c) loading moment:	
nominal	10 kg-m
maximum	15 kg-m
(d) current with the mechanism operating with two electric motors:	
at nominal moment	not in excess of 190 A

at maximum moment	250 A
current with the mechanism operating with one electric motor:	
at nominal moment	100 A
at maximum moment	125 A
(e) speed of rotation of the mechanism output shaft at nominal voltage and nominal loading moment:	
with the mechanism operating with two electric motors	not less than 240 r.p.m.
with the mechanism operating with one electric motor	120 r.p.m.
(f) speed of rotation of the output shaft in both directions of rotation at nominal voltage, simultaneous operation of two electric motors and a moment of 2 kg-m on the output shaft	not in excess of 420 r.p.m.
(g) friction clutch slipping torque reduced to the mechanism output shaft	18 to 25 kg-m
(h) when determining the direction of rotation of the mechanism output shaft from the side of the angle transmission larger diameter the rotation to the left corresponds to the flap extension and the rotation to the right corresponds to the flap retraction	
(i) mechanism operation duty	intermittent
with two electric motors operating after the extension or retraction of the flaps	5-minute interval; complete cooling of the engines is necessary after 5 cycles
with one electric motor operating after the extension or retraction of the flaps	10-minute interval; complete cooling of the engines is necessary after 2 cycles
(j) the electric mechanism operates normally at ambient air humidity of up to 98 per cent at temperature change from +50 to -60°C and at above-sea-level altitudes of up to 5000 m.	

2. Flap position indicator, type UZP-47:

(a) mains voltage	27 + 2.7 V
(b) the indicator operates at temperatures	from +50 to -60°C
(c) power consumed by the set	not in excess of 5 W

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(d) current consumed by the transmitter	not in excess of 100 mA
(e) set indications error	not in excess of ±1°
3. Limit switch mechanism, type MKB-2:	
(a) nominal voltage	24 V
(b) maximum current at ohmic load	15 A
(c) maximum load at inductive load	8 A
4. Limit switch mechanism, type MKB-11:	
(a) operating voltage range	23.4 to 30 V
(b) maximum current at ohmic load	15 A
(c) maximum current at inductive load	8 A
5. Full angle of flap extension	35 ± 1°
6. The sound signalling is switched off with the engine throttle control in the take-off rating position when by the УЗП-47 flap position indicator the flaps are extended by an angle	from 19 - 1° to 23 - 1°
7. Flap extension time with both electric motors operating simultaneously and at current not in excess of 155 A and voltage of 26 V	not in excess of 25 sec.
8. Flap retraction time with both electric motors operating simultaneously and at current not in excess of 160 A and voltage of 26 V	not in excess of 25 sec.
9. Flap extension time with one engine operating at current not in excess of 80 A and voltage of 26 V	not in excess of 50 sec.
10. Flap retraction time with one engine operating at current not in excess of 85 A and voltage of 26 V	not in excess of 50 sec.

Checking Flaps Operation under Voltage

1. On the left-seat pilot's circuit breaker panel switch on two LANDING FLAPS (ПОСАДОЧНЫЕ ЩИТКИ) circuit breakers, type АЗС-5 , and LANDING FLAPS INDICATOR AIR TEMPERATURE INDICATORS (УКАЗАТЕЛИ ПОСАДОЧНЫХ ЩИТКОВ И ТЕМПЕРАТУРЫ ВОЗДУХА) circuit breaker, type АЗС-2 ; on the right-seat pilot's circuit breaker panel switch on the HORN (СИРЕНА) circuit breaker, type АЗС-2.

CAUTION: 1. Prior to switching on the circuit breakers on the right and left pilots' console, check the position of the flap-control switches which must be in the neutral position.

2. Prior to extending or retracting the flaps make sure that the flaps and the flap driving gear are clear of personnel and that the ladders and the cases are removed.

2. With the flaps in the retracted position, set the left-seat pilot switch to the RETRACTED (УБРАНО) position. This done, by short pulses set the right-seat pilot switch to the EXTENSION (ВЫПУСК) position; the flaps must not get extended.

3. By means of the left-seat pilot switch extend and retract the flaps completely (Fig.105). When extending the flaps by operating the left-seat pilot switch, set the right-seat pilot switch to the RETRACTED (УБРАНО) position by short pulses. The flaps must continue extending.

4. The flap control operation is checked from the left-seat control switch and from the right-seat control switch by means of both electric motors and by each electric motor separately. Check the flap control operation from the right-seat pilot console after the flaps have been checked for complete extension and retraction from the left-seat pilot console.

When checking the flap control from the right-seat pilot console, do not extend and retract the flaps completely (Fig.106).

5. When extending and retracting the flaps, set the engine throttle control to the take-off rating; the horn must hoot all the while. When the flaps are deflected from 19 to 23° during extension and from 23 to 19° during retraction the horn must not hoot.

6. When checking the flap control operation check the operation of the flap position indicators. During the extension and retraction of the flaps the pointer of the УЗП-47 indicators must move without noticeable jerks and jamming. The difference in the flap position indicators reading of the right-seat (Fig.107) and left-seat pilots must not exceed ±1°.

TAIL SKID CONTROL AND LANDING GEAR WARNING ELECTRIC SYSTEM

The tail skid control and landing gear warning electric system is designed for:

(a) sending out signals of the landing gear legs extended and retracted positions separately;

(b) control of the tail skid extension and retraction;

(c) sending out sound signals in case the throttle control is in the off position and the landing gear is not extended.

The system includes the following units:

МП-250 electric mechanism;
СЗП-51 warning lamp - 8 pieces (5 green lamps and 3 red lamps);
ВК-44 limit switch - 6 pieces;
ВК-2-140В limit switch - 1 piece;
ВК-2-14Г limit switch - 2 pieces.

The electric units are located as follows:

1. The tail skid electric mechanism, type МП-250 , is mounted on frame No.65.

2. The landing gear extended and retracted positions warning lamps, type СЗП-51 , are located on the pilots' central instrument panel.

3. The tail skid retracted position warning lamps, type СЗП-51 , are installed in the rear cabin on the gunner-radio-operator's and rear gunner's electric boards.

4. The blocking limit switches, type ВК-2-142Г , designed for switching on sound signalling in case the throttle control is in the off position with the landing gear retracted are mounted on the right-seat pilot engine control panel.

5. The ВК-44 limit switches (Fig.108) designed for switching on the landing gear main legs extended position warning lamps are located on the landing gear starboard and port legs struts.

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The BK-44 limit switches designed for switching on the main and nose legs retracted position warning lamp are mounted on the landing gear legs up-locks. The BK-2-140B nose leg extended position limit switch is mounted on the nose leg down-lock.

6. The BK-44 limit switch serving to switch the tail skid for retraction and extension is located on the nose leg up-lock.

7. The MN-5 fuse in the MN-250 electric mechanism supply circuit is in the double supply left-hand junction box on frame No.17.

Specifications of Electric Units

1. Tail skid control electric mechanism, type MN-250:	
(a) supply voltage	27 ± 2.7 V
(b) rod load	
nominal	250 kg
maximum	375 kg
(c) current	
at nominal load	not in excess of 3.4 A
at maximum load	not in excess of 3.8 A
(d) rod travel	180 ± 1 mm
(e) rate of rod travel at voltage of 27 V and nominal load opposite to the rod travel 6.2 ± 0.62 mm/sec.	
(f) duty of operation at nominal data	intermittent, consisting of 5 cycles followed by an interval of one hour at least
(g) brushes A-12 measuring	4x5x7
(h) altitude	15,000 m.
2. Limit switch, type BK-44:	
(a) rod travel downward before the contacts are changed over	5 + 1.8 mm
(b) rod reserve travel downward after the contacts are changed over	not less than 1.5 mm
(c) travel of the additional device downward after changing over	4 + 1.5 mm
(d) full travel of the rod and the additional device button	from 10.5 to 15 mm
(e) reverse travel of the rod upward after the contacts are changed over	not in excess of 4.5 m
(f) reserve travel of the rod upward after the contacts are changed over	not less than 1.5 mm
(g) force applied to the rod to change over the contacts	4 to 6 kg

(h) force applied to the rod at the beginning of compression of the additional device spring	5 to 7 kg
(i) difference between the forces	not less than 1 kg
(j) force applied to the rod at the end of compression of the additional device spring	11 to 15 kg
(k) operating voltage	27 ± 2.7 V current flowing through the contacts 10 A
(l) the switch operates within the ambient air temperature range	from -60 to +50°C
(m) operating altitude	from 0 to 15,000 m.
(n) range of the rod total length adjustment	7.7 mm

Checking Operation of Tail Skid Control and Landing Gear Warning System under Voltage

Checking the Operation of the Warning System without the Landing Gear Kinematics Adjustment

1. Switch on the L.G. legs position warning system circuit breaker, type A3C-2 , on the left-seat pilot's circuit breaker panel and the sound signalling circuit breaker, type A3C-2 , on the right-seat pilot's circuit breaker panel. The three green warning lamps mounted on the pilots' instrument panel must flash on.

2. Press the limit switches, type BK-44, on the L.G. main legs up-locks and the left-hand limit switch, type BK-44, on the L.G. nose leg up-lock. The three green warning lamps on the pilots' central electric board must flash on.

Checking the Operation of the Tail Skid Control and Warning System with the Landing Gear Kinematics Adjustment

1. Switch on the L.G. legs position warning system circuit breaker, type A3C-2, on the left-seat pilot's circuit breaker panel and the sound signalling circuit breaker, type A3C-2 , on the right-seat circuit breaker panel; if the landing gear is extended the green warning lamps must flash on.

2. As soon as the landing gear legs start rising, the three L.G. extended position green warning lamps must go out. The legs reaching the extreme retracted position, the three L.G. retracted position red warning lamps on the pilots' central electric board must flash on. The L.G. nose leg reaching the extreme retracted position, the tail skid control mechanism must get automatically on for retraction.

With the tail skid completely retracted, the electric mechanism must get automatically switched off; simultaneously the two green warning lamps of the tail skid retracted position must flash on; one of the lamps is mounted on the

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rear gunner's electric board; the other lamp - on the gunner-radio operator's electric board.

3. Pull up in turn both throttle controls on the right-seat pilot's control panel as far as they will go. In this case the horn in the front pressurized cabin must hoot. Switch off the horn by pressing the button on the right-seat pilot throttle controls designed for mechanical disconnection of the horn.

4. As soon as the L.G. legs start extending all the three L.G. retracted position red warning lamps must go out and the tail skid electric mechanism must get switched on for extension; after the tail skid has been completely extended the electric mechanism gets switched off and the two green lamps of the tail skid retracted position go out.

5. Pull up both throttle controls as far as they will go. The horn must be silent.

During the landing gear check make sure that the adjustment of the limit switches is not disturbed. The adjustment of the landing gear limit switches is described in the Section "Landing Gear", Book one, "Service Manual of the Aircraft, Model TU-16".

TRIM TAB ELECTRIC CONTROL SYSTEM

The trim tab electric control system of the aircraft is used for remote control of the aileron, elevator and rudder trim tabs, and at the same time as a system providing light indication of the neutral position of the aileron and rudder trim tabs.

The system comprises the following units:

- two electric actuators, type МП-100А-60;
- one electric actuator, type МП-100А-36;
- one electric actuator, type УТ-11;
- aileron synchronization console;
- limit switches, change-over switches and circuit breakers;
- three tell-tale (warning) lights with white screens.

The electric units are located as follows:

1. The electric actuators, type МП-100А-60 , of the aileron trim tabs - between ribs 18 and 19 of the right and left wings; the actuators are accessible through the underwing access holes.

2. The electric actuator, type МП-100А-36, of the rudder trim tab - between ribs 2 and 3 of the fin; the actuator can be reached upon removal of the adjacent skin portion of the fin.

3. The electric actuator, type УТ-11 , of the elevator trim tab and its ВК-141В limit switches of the up and down positions - at fuselage frame No.69; the units are accessible upon removal of the stabilizer access hole panels.

4. The aileron trim tab control change-over switch, type 2ПН-20 , and the rudder trim tab control change-over switch, type ПН-45М , - on the trim tab control panels (stations) of the pilot and co-pilot.

5. The elevator trim tab control change-over switch, type ПН-45М, - on the control wheel spokes of the pilot and co-pilot (Fig.109).

6. The В-45 switch used for emergency disconnection of the elevator trim tab electric control system - under the red cap on the overhead electric control board of the pilots.

7. The white СЦ-51 tell-tale lights indicating neutral position of the aileron and rudder trim tabs - on the pilot's instrument panel (Fig.110).

8. The aileron trim tab synchronization console (Fig.111) carrying the trim

tab control change-over switch, type ПН-45 , white СЦ-51 light indicating the left aileron neutral position and auxiliary (blocking) contact, type КЭ-6, - between frames Nos 9 and 10, port side.

Technical Characteristics of Electric Actuators

Electric Actuator, Type МП-100А

1. Voltage requirement	27 ± 2.7 V
2. Current requirement:	
at nominal rod load of 100 kg	not over 1.35 A
at maximum rod load of 150 kg	not over 1.4 A
3. Rod speed at 27 V voltage and nominal rod load	1.65 mm/sec.
4. Tell-tale light glow duration with rod midposition travel restricted by limit switch within ±1 mm	0.5 to 2 sec of travel length
5. Operating duty in nominal conditions	intermittent, consisting of 6 cycles followed by obligatory complete cool-down of the actuator
6. Brushes, mark А-12, sizing	4x5x7 mm
7. Motor speed	4100 ± 410 r.p.m.
8. Operating altitude	up to 15,000 m.
9. Working travel length of МП-100А-36 actuator rod	36 mm
10. Working travel length of МП-100А-60 actuator rod	60 mm

Electric Actuator, Type УТ-11

1. Operating voltage range	23.4 to 28.6 V
2. Current requirement:	
at nominal load of 180 kg/cm.	not over 2.8 A
at maximum load of 260 kg/cm.	not over 3.3 A
3. Output shaft speed	7 r.p.m. ± 0.7%

Voltage Check of Trim Tab Electric Control System

1. Turn on the АЗС-5 aileron, elevator and rudder trim tab control circuit breakers on the pilot's circuit breaker control board.

2. Prior to beginning the trim tab operation check, make sure that the aileron and elevator covers are removed, and there are no obstacles under the aircraft to hinder the trim tab movement.

3. Engage the В-45 elevator trim tab electric control emergency disconnecting switch on the pilots' overhead electric control panel.

4. Hinge out the lock on the pilot's control wheel which secures the ПН-45М elevator trim tab change-over switch.

Operating the switch in pulses and engaging it for continuous operation, move the elevator trim tabs from one extreme position to the other. With the trim tabs in motion, the elevator trim tab control handwheel will be rotating.

5. Operate the ПН-45М elevator trim tab change-over switch on the scale of the elevator trim tab control handwheel to set the trim tab neutral.

6. By operating the trim tab switch, type ПН-45М , on the left-seat pilot's steering wheel switch on the УТ-11 mechanism, then switch off the В-45 trim tab

emergency cutout. This done, the trim tab electric mechanism stops operating; it begins to operate after the cutout is switched on.

7. Close the stop on the elevator trim tab switch, with a slight movement pull and push the switch; the electric mechanism must not operate.

8. By means of the rudder trim tab switch, type ПН-45М , and the aileron trim tab switch, type 2ПН-20 , on the left-seat pilot trim tab control panel (Fig.112) shift the trim tabs in both directions till they are completely deflected, then set the trim tabs to the neutral position. The trim tab neutral position warning lamps must flash on.

9. Open the aileron synchronization panel cover. With the aileron trim tabs in the neutral position, the neutral position warning lamp on the panel must flash on. On pressing on the blocking contact, type КВ-6, the warning lamp must go out.

10. Shift the ПН-45М switch on the trim tab synchronization panel to the right or to the left. This causes the L.H. wing aileron electric mechanism to operate, the R.H. wing aileron mechanism being inoperative.

11. The aileron trim tabs must be synchronized. For this turn on by pulses the aileron tabs control switch on one of the pilots' consoles till the aileron trim tab neutral position lamp flashes on the left-seat pilot instrument panel, and the left aileron trim tab control switch on the synchronization panel till the lamp on the synchronization panel flashes on. Synchronization is ensured if both lamps on the left-seat pilot's instrument panel and on the synchronization panel glow simultaneously.

12. After the operation of the trim tab control from the left-seat pilot's console has been checked, check the operation of the trim tabs control from the right-seat pilot's console as prescribed in Items 4, 5, 6, 7 and 8.

13. When checking the trim tabs operation, make sure that:

(a) the trim tab switches on the left-and right-seat pilots' console have guards and that the stenciled markings are intact and not dirty (Fig.113);

(b) the elevator trim tabs are deflected upward when the elevator trim tabs control switch is pushed forward and that they are deflected downward when the elevator trim tabs control switch is pulled backward;

(c) the rudder trim tab is deflected to the left when the rudder trim tabs control switch is shifted to the right and the trim tab is deflected to the right when the control switch is shifted to the left;

(d) the right aileron trim tab is deflected downward and the left one upward when the aileron trim tab control switch is shifted to the right; the right aileron trim tab is deflected upward and the left one downward when the aileron trim tab control switch is shifted to the left.

CAUTION: It is prohibited to turn on the trim tab switches simultaneously on the consoles and steering wheels of the right- and left-seat pilots.

14. The operation checked, set the trim tabs to the neutral position, fix in position the trim tab switches on the steering wheels and close the synchronization panel with the cover.

Possible Faults of Electrical Part of Trim Tab Control System and Their Elimination

Fault	Cause	Remedy
The trim tab deflects in one direction and fails to deflect in the other direction	(a) Jamming of the mechanism (b) Failure of the electric motor	Replace electric mechanism
The neutral position lamp is flickering	(a) Poor contact in the plug connector for switching on the mechanism (b) Poor contact in the mechanism warning lamp switching on system	Eliminate the defect in the plug connector Replace the electric mechanism

BRAKE SYSTEM PUMP CONTROL ELECTRIC SYSTEM

The electric units mounted in the system regulate the pump operation thus maintaining pressure in the brake hydraulic system within certain limits and transmit signals at minimum permissible pressure.

The electric system includes the following main units:

- hydraulic pump 465 K with the electric motor, type А-4500К;
- pressure drop warning unit, type СПМ-130;
- pressure switch, type ПДМЭ-150;
- contactor, type К-400Д;
- relay, type РП-2;
- fuse, type ИП-250;
- warning lamp, type СМЦ-51 , with red light filter (2 pieces).

The electric units are located as follows:

1. The hydraulic pump 465 K, the СПМ-130 pressure drop warning unit and the ПДМЭ-150 pressure switch are located in the hydraulic panel at frame No.15.

2. The contactor, type К-400Д , designed for switching on the hydraulic pump electric motor, the intermediate relay, type РП-2 , for switching on the hydraulic pump and the fuse, type ИП-250 , are connected in the hydraulic pump electric motor supply circuit and are mounted in the hydraulic panel junction box at frame No.15.

3. The pressure drop warning lamps, type СМЦ-51 , of the normal and emergency hydraulic systems are mounted on the pilots' central electric board.

Checking Operation of Hydraulic System Electric Control

1. On the left-seat pilot's circuit breaker panel switch off the two hydraulic system control and warning circuit breakers, type АЗС-2, and release to zero hydraulic pressure from the main and emergency hydraulic accumulators of the brake hydraulic system. From the main hydraulic accumulator pressure is released by the operation of the main brake system valves (by pressing the pedals) or through the shut-off valve in the hydraulic panel on frame No.15; from the emergency hydraulic accumulator pressure is released by the operation of the emergency brake valve on the pilot's central panel.

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2. Switch on the two hydraulic system control and warning circuit breakers, type ABC-2 . The two red lamps warning of pressure drop in the normal and emergency systems on the pilots' central electric board must flash on.

3. Turn on the hydraulic pump control switch on the pilots' central panel. The hydraulic pump must start operating and increase pressure in the hydraulic system.

With the hydraulic system pressure not exceeding 35 kg per sq.cm., release the switch handle; the hydraulic pump must continue operating. At a pressure of 100 ± 5 kg per sq.cm. the normal system pressure drop warning lamp must go out; pressure reaching 130^{+5}_{-2} kg per sq.cm., the emergency system pressure drop warning lamp goes out. At a pressure of 150^{+5}_{-2} kg per.sq.cm. the hydraulic pump gets automatically cut off.

4. By means of the main brake valve, release pressure in the normal hydraulic system. With pressure dropping to 120^{+5}_{-2} kg per sq.cm., the hydraulic pump starts operating; at a pressure of 150^{+5}_{-2} kg per sq.cm. the pump gets cut off.

5. By means of the emergency brake valve release pressure from the emergency system. Pressure reaching 130^{+5}_{-2} kg per sq.cm. the emergency hydraulic system pressure drop red warning lamp must flash on.

Note: 1. The operation of the brake hydraulic system pressure control electric system should be checked by the aircraft technician together with an electrician.

2. When checking the operation of the hydraulic system, see that proper operation duty of the hydraulic pump is maintained.

3. During the operation of the hydraulic pump make sure that the current consumed by the pump electric motor is within the rated limits.

Specifications of System Electric Units

Electric Pump 465 K and Electric Motor A-4500K

1. Direction of rotation	left
2. Nominal voltage	27 V
3. Voltage operating range	24 to 30 V
4. Consumed current:	
at operating pressure of 150 kg per sq.cm.	not in excess of 180 A
at maximum pressure of 180 kg per sq.cm.	not in excess of 260 A
5. Permissible peaks	not in excess of 300 A, up to 2 sec.
6. Operation temperature range	from +70 to -60°C
7. Electric motor operating altitude	12,000 m.
8. Brush minimum length	14 mm
9. Operation duty on the ground	60-min. operation followed by complete cooling (not less than 1 hour)
at altitudes	30-min. operation followed by complete cooling

Pressure Drop Warning Unit, Type СПМ-130

1. Operation pressure	130 kg per sq.cm.
2. Error of the contact operation at normal temperature	not in excess of $^{+5}_{-2}$ kg per sq.cm.
3. The instrument operates at 0.5 A and 27 ± 2.7 V	
4. Maximum vibration overload	not in excess of 2.5 g, with error not exceeding $^{+6}_{-2}$ kg per sq.cm.

Pressure Switch, Type МДИ9-150

1. Pressure operating range	from 0 to 150 kg per sq.cm.
2. Error of contact operation at normal temperature:	
at points 30 and 100 kg per sq.cm. ± 5 kg per sq.cm.	
at points 120 and 150 kg per sq.cm. ± 5 kg per sq.cm.	
3. Maximum vibration overload	not in excess of 1.5 g
error of operation:	
at points 120 and 150 kg per sq.cm.	$^{+5}_{-5}$ kg per sq.cm.
at points 30 and 100 kg per sq.cm.	±6 kg per sq.cm.
4. The instrument operates at 27 ± 2.7 V and 0.5 A.	

CABIN HEATING ELECTRIC SYSTEM

The cabin heating electric system is designed to prevent the glass pains from dimming, as well as for additional heating of the cabin by means of electric heaters "Unit 107". In the front cabin the heater is installed at the starboard side near frame No.5; the switches are mounted on the pilots' upper electric boards. In the rear cabin the heater is installed on the port side near frame No.73 (Fig.114), the switches being mounted on the radio operator's electric board (Fig.115).

The fuses, type НН-150 , of the electric heater circuits are located as follows: for the front cabin on the starboard side at frame No.6 in the glass pain heating system junction box, for the rear cabin on the port side at frame No.74 in the rear cabin junction box.

Specifications of the Heater "Unit 107"

1. Voltage	D.C. 27 ± 2.7 V
2. Current in the heating element circuit at V = 27 V (with 3 heating elements cut in)	not in excess of 135 A
3. Current in the ventilator motor circuit at V = 27 V	not in excess of 30 A
4. Heating value:	
(a) at altitudes from 0 to 7000 m.	3000^{+120}_{-510} Kcal per hour

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(b) at altitudes from 7000 to 15,000 m. ..... 2000^{+80}_{-340} Kcal per hour

5. Brushes, type МТС-7 ; minimum length ..... 10 mm

6. Operating altitude ..... up to 15,000 m

Checking Operation of Cabin Heating Electric System

1. Switch on the heater control circuit breaker, type АЗС-30, on the right seat pilot's circuit breaker panel.

2. Turn on the НАГНЕТ-ВЕНТИЛЯТОР (ОБОГРЕВАТЕЛЬ-ВЕНТИЛЯТОР) switch on the pilots' upper electric board. The heater ventilator must force air through. On switching on the 1st section warm air must start coming out of the heater in some time; when the 2nd section is switched on in addition to the 1st section still warmer air comes out of the heater. Make sure that air from the slot of the pipe line nozzles of the navigator's, pilots' and blistera glass panels comes at constant pressure.

Check the operation of the heater in the rear cabin in a similar manner as the operation of the heater in the front cabin.

When checking the operation of the heater "Unit 107", measure the current consumed; normal current consumption testifies to the proper operation of the heater.

Notes: 1. In case the electric motor, type А-400А , fails, it is prohibited to switch on the heater.

2. Prior to switching on the power supply, make sure that there are no foreign objects at the ventilator window and on the body of "Unit 107". Remove foreign objects, if any.

3. Switch off the heater after its operation has been checked.

Possible Faults of Cabin Heating Electric System and Their Elimination

Fault	Cause	Remedy
1	2	3
The heater body is overheated during operation	(a) The ventilator window is closed by foreign objects	Remove the foreign objects
	(b) The non-return valve operates with jamming	Check the operation of the non-return valve in the tube connecting the heater with the pipe line. If jamming is detected, eliminate it
	(c) The thermoswitch fails to operate	Remove "Unit 107" from the aircraft. Check the operation of the thermoswitch. In the event of its improper operation replace the thermoswitch

1	2	3
	(d) The altitude relay fails to operate	Remove "Unit 107" from the aircraft and check the operation of the altitude relay. In case the latter fails to operate properly, replace it.

PREFLIGHT PREPARATION

Systematic maintenance operations on the aircraft electrical equipment are absolutely necessary to ensure normal operation of the equipment; the main elements of the maintenance procedure are the preflight preparation, postflight inspection and scheduled maintenance operations.

The scope of the preflight preparation depends on the scope and results of the previous postflight inspections and the thoroughness with which the troubles detected in flight and during the ground check have been eliminated.

The preflight preparation and postflight inspection of the aircraft electrical equipment consist in inspecting the electric wiring and units for condition and in voltage testing of the units.

It is advisable to adhere to the following ground check inspection procedure (walk-around) during the preflight preparation and postflight inspections of the electrical equipment:

(1) front cabin and fuselage between frames Nos 12-14;
(2) L.G. nosewheel well;
(3) L.G. left strut nacelle;
(4) navigation lights of left outer wing panel;
(5) stern cabin and tail skid;
(6) accessories compartment between frames Nos 56-69, fuselage belly section and bomb bays;
(7) L.G. right strut nacelle;
(8) navigation lights of right outer wing panel;
(9) top sections of fuselage and wings;
(10) nacelles of right and left engines.

Preflight Preparation before Energizing Electrical Equipment

Front Cabin and Fuselage between Frames Nos 12-14

1. Make sure that the storage battery switch on the radar operator's electric control board is OFF.

2. Carry out the following checks at the radar operator's station:

(a) check the ON-OFF and change-over switches, circuit breakers, rheostats and operating knobs of the cabin light and ultra-violet illumination system for proper functioning; the check is done by manually engaging and disengaging the above-mentioned items; check for proper attachment;

(b) make sure that the glasses of the ammeters, voltmeters and lights are intact and that the instruments are securely attached in their mounting positions;

(c) see to it that the voltmeter and ammeter needles are zeroed and that the fuel system boosters are reliably fastened to their mounting platforms.

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3. The following checks should be carried out at the stations of the pilots and navigator:

(a) check (by engaging and disengaging with the hand) the ON-OFF and change-over switches, as well as the circuit breakers, operating knobs and rheostats for sound operation;

(b) check the signalization and illumination equipment for condition and secure attachment;

(c) make sure that the cabin heater (Unit 107) and the AOC-81M automatic glass panel temperature controller are reliably attached and that their shock absorbers function properly.

4. When through with the checks, place all the ON-OFF and change-over switches and the circuit breakers (which serve as switches) to OFF (ВЫКЛЮЧЕНО) or NEUTRAL (НЕЙТРАЛЬНО).

5. Make sure that spare bulbs and fuses are available in the flight maintenance kit.

6. See to it that the hydraulic control panel connections from the units of the hydraulic system automatic control equipment are intact.

7. Inspect and make sure that the union nuts on plug connectors and fire extinguisher discharge bonnets at frame No.12 are properly tightened up and lockwired.

L.G. Nosewheel Well

1. Check to see that the glasses of the landing, taxiing and well illumination lamps are intact and that the lamps are attached securely.

2. Check to see if the limit switches on the lock and brace strut of the L.G. nosewheel are intact and reliably attached; inspect for secure wire connections.

3. Check the fuel system boosters and ПО-4500 inverters for secure attachment and see that the firing (discharge) mechanisms on the discharge bonnets of the CO_2 and inert gas bottles are properly locked.

Right and Left L.G. Strut Nacelles

1. Check the limit switches on the locks and shock absorbers of the main L.G. legs for secure attachment and sound operation.

2. Check the wires for proper attachment and connection to the limit switches, taxiing lamp and automatic brake control units, type УА-16

3. Check the bottom formation light and illumination equipment for sound operation.

Navigation Lights of Left and Right Outer Wing Panels

1. Inspect the attachment fittings of the navigation light equipment and make sure that the cover glasses of the lights are intact.

2. Make sure that there is no water, ice or dirt under the light common glass.

Stern Cabin and Tail Skid

1. Operating the switches, control knobs, circuit breakers and rheostats manually, make sure that they function properly.

2. Make sure that the cabin heater and the warning (signalization) equipment are attached reliably.

3. Place all the switches and rheostats OFF.

4. Check the voltmeter for condition and make sure that the instrument and its cover glass are securely held in place.

5. Inspect the tail navigation light system and make sure that the glass covers and the attachment fittings are intact.

6. Check the tail skid actuator and its electric wires for condition and attachment.

Accessories Compartment between Frames Nos 56 and 60, Fuselage Belly Section and Bomb Bays

1. Check to see if the МКА-3А actuator, the de-icer junction box and the circuit breaker of the autopilot servo-unit heater system are attached securely.

2. Check electric wires for condition and secure attachment.

3. Inspect the bottom formation light system.

4. In the bomb bays: check the electric wires for condition, and the junction boxes and landing flap actuator, type МП3-3М, for reliable attachment.

5. Check the РС-18000 ballast resistor for secure attachment and proper wiring.

Top Section of Fuselage and Wings

Check the top formation light system for condition and reliable attachment.

Right and Left Engine Nacelles

Check the electric equipment of the engines for proper attachment and the electric wires for condition; check to see if the ГСР-18000 generators, РУТ-82 voltage regulators, ТС-8 stability transformers and the overheat warning units are attached securely.

During external inspections of the equipment in all the aircraft sections make sure that the fuses on the control panels and in boxes meet the Specifications indicated on the respective nameplates and are reliably attached, that the covers of the connector boxes are tight at their edges, and that the locks are lockwired and reliably retain the covers against vibration and falling out in flight.

Autopilot, Type АП-5-2М

1. Carry out condition and voltage checks of the autopilot units. Inspect externally to check whether the autopilot units are free from moisture, dust and breakdowns in connections to aircraft structural members. Remove the covers from the formation stick and directional stabilizer.

2. The autopilot preflight preparation procedure is obligatory before each flight. If several flights take place during one day, it is sufficient to carry out the preflight preparation before the first flight.

3. If the ambient air temperature is below minus 20°C, the autopilot heaters should be engaged for one hour before the flight.

4. Turn on the АЗС-15 circuit breaker of the torque motor assembly on the navigator's circuit breaker control panel, the АЗС-5 circuit breaker on the pilot's circuit breaker control panel, and the master switch on the autopilot control panel, and check the autopilot operation under voltage.

Check the clutch tension by hand, employing the following procedure:

(a) engage the bomb sight and autopilot clutches;

(b) turn the bomb sight so that the autopilot clutch lever would reach its stop. In this position the autopilot clutch begins to slip on its drum; during the further rotation the clutch should not slip;

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(c) turn the switches on the autopilot control panel off.

Voltage Test of Electrical Equipment

1. Carry out external inspection of the storage half-batteries, type 12-CAM-55. If the batteries are operative, install them on the aircraft, fasten in place and close the container covers.

2. Place the storage battery change-over switch to the NORMAL (НОРМАЛЬНО) position, and check for loads by the ammeter on the radar operator's electric control board. Engage the gyro horizon sets of the pilot and co-pilot and the interphone set which will correspond to a 10 to 12 A load on the battery, and check the battery voltage. The indicated voltage should not be smaller than 24 V. Disconnect the gyro horizon sets and the interphone system, and set the storage battery change-over switch to the neutral position.

3. Connect the storage battery in turn to the normal supply circuit and to the triple supply busbar. To make certain that the storage battery energizes these circuits, engage the gyro horizon sets of the pilot. When the storage battery is connected to the normal supply circuit, both gyro horizons should operate. When the battery is connected to the triple supply busbar, it is only the stand-by gyro horizon which should operate. The operation of the gyro horizons will be indicated by the noise of the inverter.

4. Disconnect the gyro horizon sets and the storage battery.

5. Connect the aircraft electric mains to a ground supply source.

6. Operating collectively with the aircraft technician or mechanic, check the following:

(a) operation of the control system of flaps, elevator and rudder trim tabs and of ailerons. Synchronize the operation of the aileron trim tabs;

(b) operation of the tail unit de-icers;

(c) glass panel electric heating system;

(d) L.G. warning system: hand pressure upon the limit switches corresponding to the L.G. retracted position should result in flashing up of the red warning lights; at the same time the green L.G. position warning lights should go on burning;

(e) operation of the main and stand-by inverters, type ПО-4500 , with reference to the aircraft A.C. voltmeter;

(f) operation of the fuel automatic control system and of the fuel flow gauges;

(g) operation of the cabin ventilators and heaters.

7. Check the operation of the unit of fire-fighting system electromagnetic valves; while checking, do not engage the A3C-10 circuit breaker which opens the CO_2 bottles and the inert gas system switch, type B-45, on the overhead electric control panel of the pilots since otherwise the discharge bonnets (firing mechanisms) will be actuated.

8. When testing the operation of the engines, check the operation of the generators; if necessary, adjust the generator voltage and check the generator-to-emergency supply circuit voltage supply.

POSTFLIGHT INSPECTION

Gain information on the in-flight operation of the electrical equipment from the crew members.

De-energize the aircraft electric mains and disconnect the storage batteries. This done, proceed to inspecting the system. The sequence of inspections is the same as that authorized for the preflight preparation.

Subject to inspection will be: the electrical equipment, the warning (signalization) system, the illumination equipment, the electric actuators, the bunched conductors and junction boxes. When inspecting, make sure that:

1. All the equipment fittings, rheostats, switches, relays, bulbs, receptacles, circuit breakers and other equipment items are securely attached to their mounting panels and boards.

2. All the nameplates and instruction plates which concern the function or operation of separate units and switches are in good condition (are neither erased nor fouled).

3. The clearance between the bunched conductors and moving parts is at least 10 mm.

4. The union nuts of the plug connectors are adequately tightened up and lockwired.

5. The mounting areas of the plug connectors and special wire adapters have no damaged portions of cabin-sealing cement.

6. The gaps between the power contacts and the airframe members gauge at least 5 mm. Special attention should be paid to insulating the wires from the mass ("airframe") as any contact of a bare plus wire with the airframe results in short-circuiting.

7. Reliable contact is ensured at the connections of power contacts.

8. In case of dirt, dust, oil or moisture on the electric wires or equipment items, wipe them with a clean cloth.

9. Carry out external inspection of the storage half-batteries and make sure that:

(a) the half-batteries are clean from the outside;

(b) there are no cracks and breakdowns in the electric contacts and intercell connections;

(c) the monoblock, cover and vent plugs are free from fouling and damage; clean fouled spots, if any.

Note: If the storage battery is damaged, send it over for detailed inspection and correction of faults.

10. Check the condition of the storage battery containers:

(a) see to it that the felt is not moistened with electrolyte;

(b) check to see if the wires in the container are intact;

(c) see to it that the container cover locks are intact;

(d) make sure that the storage battery connectors connecting it to the aircraft electric mains are sound.

The inspection over and the detected troubles eliminated, turn off all the switches but for the interlock switch operating with the generator switch connecting bar; place the storage battery change-over switch neutral, connect the ground supply source and carry out the voltage check of the electrical equipment.

Correct all the troubles detected during the voltage check. Troubles should be eliminated with the aircraft electric mains de-energized.

The inspection and trouble eliminating procedure over, report the electric equipment readiness for operation and termination of the operations to the aircraft technician and the special equipment technician.

Checking Instruments for Serviceability

1. Turn on the A3C-2 circuit breaker and the cabin air temperature regulator on the circuit breaker control panel of the co-pilot.

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2. Place the CABIN AIR SUPPLY TEMPERATURE (ТЕМПЕРАТУРА НАДУВА КАБИН) selector switch mounted on the co-pilot's instrument panel to the HOT (ГОР) position. In this position the MPT-1 actuator of the turbine-driven cooler should close the cooler and open the cabin air temperature regulator.

3. With the selector switch thrown to COLD (ХОЛ.), the electric actuator should operate in the reverse direction.

4. Set the change-over switch to the AUTOMATION (АВТОМАТ) position.

5. Set the cabin air temperature regulator thermostat scale of the first cabin to read 3 to 5°C lower than the ambient air temperature. In this position the MPT-1 electric actuator should cut out the cabin air supply temperature regulator and engage the turbine-driven cooler.

6. Set the thermostat scale to read 3 to 5° above the ambient air temperature. In this position the MPT-1 actuator should engage the cabin air supply temperature regulator and cut off the turbine-driven cooler.

7. The thermostat of the rear cabin will be checked with employment of the same procedure.

8. If the ambient air temperature does not permit to set the thermostat scale at a temperature higher or lower than the original one, it is necessary first to heat up or cool down the thermostat to a temperature of 19 - 23°, and then to carry out the check according to steps 4 - 7 above.

Due to the fact that the regulator check for meeting the Specifications requires bulky fixtures which are not in quantity production, it proves impossible to carry out the checks directly in the using unit. Therefore adequate operation of the temperature regulator will be judged upon by its satisfactory functioning to maintain the pre-assigned cabin air temperature in the course of the flight.

Automatic Cabin Air Temperature Regulator, Type PTRK-45

The regulator, type PTRK-45, is designed for automatically maintaining the pre-assigned air temperature in the pressurized aircraft cabin.

The regulator set includes:

- one thermostat, type TPTRK-24;
- one electric actuator, type MPT-1.

Basic Characteristics

1. Nominal voltage requirement	27.5 V
2. Temperature control range	16.5 to 26.5°C
3. Accuracy (no-response zone)	±1°C
4. Degree of feedback irregularity	4°C
5. Current requirement by MPT-1 actuator	not over 1 A
6. Nominal shaft load of MPT-1 actuator	120 kg/cm.
7. Rotation angle of MPT-1 actuator output shaft	135° ± 3°
8. Time required for MPT-1 actuator output shaft to turn through 135° ± 3°	not longer than 45 sec.
9. Operating duty of MPT-1 actuator	intermittent
10. Resistance of MPT-1 actuator potentiometer	400 ± 20 ohms

All the units of PTRK-45 are interchangeable.

PHOTOGRAPHIC EQUIPMENT

GENERAL

The photographic equipment carried by the aircraft includes:

- set of cameras АФА-33/50М , АФА-33/75М and АФА-33/100М intended for daytime photography of the ground targets;
- set of cameras НАФА-3с/50 or НАФА-6/50 for night time photography of the ground targets;
- camera ФАРМ-1 for photographing the screen of the cathode-ray tube of radar bomb sight РБП-4;
- automatic tilting mount АКАФУ-156Н for all daytime cameras;
- camera mount (frame НАФА) for night time cameras;
- camera hatch;
- camera hatch and tilting mount control panel.

Arrangement of the photographic equipment on the aircraft is shown in Fig.116.

The aircraft may carry only one of the aforementioned cameras (besides camera ФАРМ-1 which is never removed) and one camera mount.

The camera mounts (tilting mount АКАФУ and the frame) are installed on spring-loaded shock absorbers selected according to the camera weight. Furnished with the aircraft are shock absorbers coming in three variants to fit cameras АФА-33/100М , АФА-33/75М and НАФА-33/50М ; НАФА-3с/50 and НАФА-6/50.

The automatic tilting camera mount АКАФУ-156Н ensures two-strip vertical and oblique photography. In the case of two strip photography (AERIAL RECONNAISSANCE mode of operation), the camera mount departs from the vertical plane through 6°30' to both sides when carrying camera АФА-33/100М and through 8°30' when carrying camera АФА-33/75М.

Note: Camera АФА-33/50М is not employed on aircraft ТУ-16 with the AERIAL RECONNAISSANCE mode of operation because only part of the light rays of the camera vision field (34°) pass through the camera hatch hole.

During the oblique photography (BOMBING CONTROL mode of operation), the automatic tilting camera mount АКАФУ-156Н deflects against the flight through the angles of 0; 10; 15; 20 and 25°.

Aerial cameras for daytime photography can be operated at various altitudes depending on the scale of aerial survey.

Minimum survey altitude depends on the flight speed and is calculated by the formula:

$$H_{min.} = \frac{1}{360} \text{ EFV},$$

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where: $H_{min.}$ - minimum altitude of flight in km.;
E - exposure time in seconds;
F - focal length of aerial camera in km.;
V - speed of flight in km/hr.

Specifications

Daytime Photography Cameras AΦA-33/M

1. Picture size	30x30 cm.
2. Number of pictures	190 to 195 pcs
3. Size of film to be threaded up	32x6000 cm.
4. Photography cycle time:	
at 15 to 25°C temperatures	not exceeding 2 sec.
at -60°C temperature	not exceeding 2,5 sec.
5. Power consumed	
at 15 to 25°C temperatures	up to 13.5 A
at -60°C temperature	up to 16 A
6. Focal length:	
camera AΦA-33/100M	100 cm.
camera AΦA-33/75M	75 cm.
camera AΦA-33/50M	50 cm.
7. Interframe space	10 to 25 mm
8. Camera controller intervals	2 to 60 sec.
9. Thermoregulator:	
engagement temperature	3 to 13°C
disengagement temperature	20 to 30°C
10. Camera controller ensures functioning of the camera upon keeping electric bomb release button SGBP pressed for 0.2 - 0.3 seconds	
11. Exposure time (expressed in fractions of second):	
cameras AΦA-33/50M and AΦA-33/75M	1/75; 1/150; 1/300
camera AΦA-33/100M	1/75; 1/125; 1/200

Camera HAΦA-30/50

1. Focal length	50 cm.
2. Picture size	18x24 cm.
3. Number of pictures	approx.150 pcs
4. Shutter	louvre type
5. Exposure time (expressed in fractions of second)	1/25; 1/50; 1/100
6. Power consumed:	
at 10 to 30°C temperatures	12 A
at -60°C temperature	13.5 A
7. Photography cycle time	not exceeding 3 sec.
8. Shutter operation optical exposure	2 to 15 luxes of photocell

Camera HAΦA-6/50

1. Focal length	50 cm.
2. Picture size	18x24 cm.
3. Shutter	louvre type
4. Exposure time in fractions of second	1/25; 1/50; 1/100
5. Power consumed:	
at 10 to 30°C temperatures	12 A
at -60°C temperature	not exceeding 15 A
6. Photography cycle time	not exceeding 3 sec.
7. Camera operation temperature range	+50°C to -60°C
8. Shutter operation optical exposure	1 to 15 luxes of photocell

Camera ΦAPA-1

1. Focal length	100 mm
2. Picture size	13 cm.in dia. (13x18 cm. frame)
3. Film, perforated	
width	19 cm.
length	28.5 m.
4. Number of pictures taken without loading the film magazine	approx.200
5. Cycle of camera operation	alternative, depending on the antenna revolutions or sector scanning angle
6. Power consumed:	
with heater off	5.3 A
with heater on	15.6 A
7. Camera operation temperature range	+50°C to -60°C

Technical and Adjustment Data of Automatic Tilting Mount AKAΦV-156M

1. Original position of the automatic tilting mount AKAΦV is the vertical zero position of the aerial camera AΦA set within +0°30' to -1° tolerance.

2. The tolerance for the tilting angle should stay within: +0°30' to -1° for 6°30' and 8°30' tilting angles in the AERIAL RECONNAISSANCE mode of operation; ±0°30' for 0; 10; 15; 20; 25° tilting angles in the BOMBING CONTROL mode of operation.

3. In the zero position, the play of the automatic tilting mount should be within ±0°30' (without taking into account the play in the reduction unit of the electric mechanism MΥΦ-2).

4. Time of changing the automatic tilting mount from one extreme position to the other:
in the AERIAL RECONNAISSANCE mode of operation - 0.9 to 1.5 sec.

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in the BOMBING CONTROL mode of operation when tilting from 0 to 25° and from 25 to 0° - 1.9 to 3.5 sec.

5. Minimum permissible interval between exposures in the AERIAL RECONNAISSANCE mode of operation - 3 sec.

6. Current pulse sent by the contact-pulse mechanism of camera АФА should not last longer than 0.5 sec.

7. The automatic tilting mount АКАФУ must reliably operate at temperatures from +50°C to -60°C and relative humidity up to 98%, withstanding vibrations of 10 to 80 cycles.

8. Service life of the automatic tilting mount АКАФУ guaranteed covers 2 years including 21,000 cycles of operation (20,000 cycles in the AERIAL RECONNAISSANCE mode of operation and 1000 cycles in the BOMBING CONTROL mode of operation).

9. Current in the circuit of electric mechanisms МУФ-2 in the AERIAL RECONNAISSANCE and BOMBING CONTROL modes of operation with camera АФА installed in the automatic tilting mount АКАФУ should not exceed 10 A when the voltage applied is within 27 ± 2.7 V.

10. During the BOMBING CONTROL mode of operation, reverse movement limit switch must function at the moment when the frames moving from the lower position pass the zero by 1 to 1.5°.

11. The limit switch labelled STARTING FROM EXTREME POSITIONS (ТРОГАНИЕ ИЗ КРАЙНИХ ПОЛОЖЕНИЙ) must function in the zero position of the AERIAL RECONNAISSANCE mode of operation, keeping OFF all the time the frame remains in the extreme positions.

12. Accuracy of operation of the limit switches of all fixed positions for the tilting angles - ±0°30'

Technical and Adjustment Data of Mount (Frame НАФА) for Night Time Photography Cameras

1. The mount may accommodate either camera НАФА-3с/50 or camera НАФА-6/50.

2. The mount (frame НАФА) is intended to change the camera tilting angle from 0 to 25° against the flight every 2°30'.

3. The camera is set at the required tilting angle on the ground.

4. Frame НАФА is fixed in the lower attachment sleeves of camera mount АКАФУ-156Н . The shock absorbers should be free of vertical play.

5. The inner frame of the camera mount (frame НАФА) must be fixed without play at all tilting angles of the camera.

6. The camera cables should not be in the way of the camera (frame НАФА) tilting irrespective of the angle.

Main Technical and Adjustment Data of Camera Hatch

1. The camera hatch doors are opened inside the fuselage with the aid of the remote-controlled mechanism УР-7М.

2. Strain of band pulls - 8 to 12 kg.

3. Door opening and closing time - 40 sec.

4. The current consumed by mechanism УР-7М should not exceed 8 A under the rated voltage.

5. Coat all friction parts of the camera hatch actuator with lubricant ЯЗ State Standard ГОСТ 3276-54 . There is no need to apply lubricant to the rails surface on which the doors and rod bearings move.

PREFLIGHT PREPARATION

Preflight preparation of the daytime photography cameras includes:
(1) checking of the camera hatch;
(2) installation of the automatic camera tilting mount АКАФУ;
(3) mounting of the camera and its preliminary checking;
(4) checking of the tilting mount operation;
(5) preparation of the cameras for surveying.

Preflight preparation of the night time photography cameras includes:
(1) installation of frame НАФА;
(2) installation of the night time photography cameras and their preliminary checking;
(3) preparation of the cameras for surveying.

Preflight preparation of camera ФАПЧ-1 includes:
(1) installation of camera ФАПЧ-1;
(2) checking of the camera mechanism functioning;
(3) preparation of the camera for flight.

Preflight Preparation of Daytime Photography Cameras.

Checking of Camera Hatch

Check the camera hatch doors for proper closing and opening (Fig.117) by turning the switch mounted on the control panel (Fig.118) 2 - 3 times on and off. Having made sure the camera hatch functions properly, proceed to installing the automatic camera tilting mount АКАФУ or frame НАФА.

Installation of the Tilting Mount АКАФУ-156Н

When doing survey jobs with the aid of camera АФА-33/100М , install the tilting mount (Fig.119) with the shock absorbers, having on the cover marking Ф-1000 , on the upper row of the sleeves; in the case of cameras АФА-33/75М and АФА-33/50М , install the tilting mount with the shock absorbers, having on the cover marking Ф-750 , on the lower row of sleeves. The tilting mount having been installed, tighten the shock absorber sleeves as far as they will go with the aid of union nuts 1.

Notes: 1. For installing the automatic tilting mount, remove the partition separating the nose leg well from the camera bay.
2. Install the tilting mount horizontal accurate within +0°30' to -1° with the aircraft in the line-of-flight position.

Set the crank of the mount tilting mechanism with the aid of locking screw 11 at 6°30' when camera АФА-33/100М is to be installed and at 8°30' when camera АФА-33/75 М is to be installed. Mount the bonding strips.

Camera Installation

To install the camera:
1. Release hinged clamps 7 (See Fig.119).
2. Bring the camera trunnions in the seats of the tilting mount АКАФУ and fix them with the aid of clamps.

Note: . The chamber portion must be brought to the position shown by the arrow marked on the film magazine (with the cardan shaft of the driving unit set right of the aircraft fore-and-aft axis).

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3. Arrange the driving and delivery unit on plate 6 and connect it to the reducing gear on the chamber portion with the aid of cardan shaft 3. The shaft bends in this event should not exceed 25° at the hinge joints.

4. Use flexible hose 4 to connect the air blower volute chamber to the chamber portion pipe connection.

5. Actuate screws 2 to zero the automatic tilting mount AKA@V accurate within +0°30' to -1°.

6. Connect all the units with electric cables.

7. Mount camera controller KIV-2 on the navigator's panel and join plug connectors to it.

Checking of Cameras AOA-33/100M, AOA-33/75M and AOA-33/50M Functioning

1. Take the levers all the way out of the chamber portion and remove the protective cover from the latter.

2. Set 5 – 7 sec. interval on the camera controller dial (Fig.120).

3. Press the green button START (ПУСК).

As the chamber portion of the driving and delivery unit operates, check the air delivery to the chamber portion, functioning of the shutter and the objective protective covers, and the illumination of the recording instruments at the moment of the shutter operation.

4. Arrange the film magazine loaded with the exposed waste film on the chamber portion and take the cover off the film magazine.

Press button START (ПУСК) on camera controller KIV-2 As camera AOA operates, check the film for proper rewinding watching the indicating lamp labelled REWINDING (ПЕРЕМОТКА), the pressure plate for proper rising and lowering and the camera controller meter for proper operation. This done, deenergize the camera controller by pressing the STOP (ОСТАНОВ.) button.

5. Disconnect the cardan shaft from the chamber portion reducing gear and the reducing gear driving unit.

6. Connect the hand drive to the input shaft of the chamber portion reducing gear.

7. Slowly rotate the hand drive handle clockwise to check the functioning of the shutter (accompanied by a click).

8. Beginning with the moment the shutter starts functioning count the number of the hand drive handle revolutions up to the closing and opening moments of the protective covers.

9. Check the air pressure in the chamber seeing that it is at least 1% m of water.

The aerial camera is considered ready for employment on the aircraft if the check-up has proved positive.

Checking of Operation of Automatic Tilting Mount AKA@V-156H

During the BOMBING CONTROL (КОНТРОЛЬ БОМБОМЕТАНИЯ) mode of operation:

1. Set the continuous operation switch on camera controller KIV-2 at OFF (ВЫКЛЮЧЕНО), the BOMBING CONTROL (КОНТРОЛЬ БОМБОМЕТАНИЯ) switch at INTERVAL (ИНТЕРВАЛ) and turn the setting dial at 5 – 7 second inter-exposure interval.

2. Set the mode-of-operation selector on the control board (See Fig.118) located on the navigator's panel at the BOMBING CONTROL (КОНТРОЛЬ БОМБОМЕТАНИЯ).

3. Press the START (ПУСК) button with the camera hatch closed and make sure the red indicating lamp labelled CURRENT ON (ТОК ВКЛЮЧЕН) goes on but the camera does not operate. The REWINDING (ПЕРЕМОТКА) lamp must be either ON or OFF depending on the position of the rewinding indicating contacts. Press the STOP (ОСТАНОВ.) button.

4. Open the camera hatch. To this end, set the switch on the control panel to the CAMERA HATCH OPENED (ФОТОЛЮК ОТКРЫТ) position and make certain that green indicating lamp 4 on the control panel glows when the camera hatch is fully opened.

5. Press the START (ПУСК) button again and make certain the camera operates at preset intervals every 5 to 7 seconds and the green indicating lamp marked REWINDING (ПЕРЕМОТКА) flickers. After making 4 to 6 exposures, disengage the camera controller by pressing the STOP (ОСТАНОВ.) button.

Note: If the ambient air temperature is below 15°C, cut in the heater switch on camera controller KIV-2 at least 15 minutes before proceeding to the check-up.

6. Check the functioning of the camera tilting mount AKA@V during the BOMBING CONTROL (КОНТРОЛЬ БОМБОМЕТАНИЯ) mode of operation as set at 0; 10; 15; 20; 25° tilting angles. For this purpose: bring angle-of-tilt selector 2 (See Fig.118) on the control panel to every angle setting, successively; then press button 6 and let go of it. Make sure the electric mechanism has operated, inner frame 10 (Fig.119) has turned around semi-axle 5 together with intermediate frame 8 to set the camera at the desired tilting angle, and yellow indicating lamp 5 on the control panel (See Fig.118) is on.

To return the automatic camera tilting mount AKA@V to the original (zero) position, set angle-of-tilt selector 2 at 0° and press button 6. After a while, yellow indicating lamp 5 goes on to show the tilting mount has assumed its zero position.

7. If it is necessary to set the mount at a greater tilting angle (e.g. changing it from 15° to 20°), first return tilting mount AKA@V to the zero position, wait till the yellow indicating lamp has gone on and only then bring the mount to the tilting angle required. There is no need to return the automatic tilting mount to the zero position should it become necessary to set it at a smaller tilting angle (e.g. changing it from 20° to 15°).

Checking of Tilting Mount AKA@V-156H in BOMBING CONTROL Mode of Operation (Actuated by Electric Bomb Release)

Prior to checking, make certain the bombing equipment circuit is absolutely faultless. Then:

1. Set the electric bomb release to drop single bombs.

2. Cut in the bomb release circuit breaker and the bomb release main switch; make sure all other switches, selectors and bombing equipment circuit breakers are OFF.

3. Bring the yellow index of the setting dial on the camera controller opposite 4-km. altitude. Tilt the mount through the required angle.

4. Press the START (ПУСК) button on camera controller KIV-2 After that, the green indicating lamp labelled READY FOR BOMBING CONTROL (ГОТОВ К КОНТРОЛЮ БОМБОМЕТАНИЯ) and the red indicating lamp labelled CURRENT ON (ТОК ВКЛЮЧЕН) must go on.

5. Press button KCB-49. After that, electric bomb release button

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ЭСЕР-49 must operate, and the green indicating lamp on the camera controller goes off. In 20 seconds (i.e. 10 seconds before the "burst" of the bomb) this lamp should go on again to flicker in the course of 25 ± 2 seconds (the camera performs continuous survey).

The aforementioned period lapsed, the lamp should go off and then light up again (mechanism of camera controller КПУ-2 has come to the original position).

Note: If continuous photography is imperative, set switch 12 (See Fig.120) to CONTINUOUS PHOTOGRAPHY (НЕПРЕРЫВНАЯ РАБОТА), selector 13 to INTERVAL (ИНТЕРВАЛ), and adjust setting dial 7 to bring infinity symbol (∞) marked on the camera controller dial opposite the white triangular index. In that instance, the camera will function continuously until the STOP (ОСТАНОВ.) button on camera controller КПУ-2 is pressed. During 25-sec. period of continuous survey done in the BOMBING CONTROL (КОНТРОЛЬ БОМБОМЕТАНИЯ) mode of operation, the camera takes 11 - 13 pictures in all (5 - 6 pictures before the "bomb burst" and 6 - 7 pictures after it). The aerial camera cycle is repeated during the next "bomb run".

6. The surveying operations having been completed, return the automatic camera tilting mount АКАФУ to the zero position.

Checking of Automatic Tilting Mount АКАФУ-156Н in AERIAL RECONNAISSANCE Mode of Operation (Two-Strip Photography)

1. Set the mode-of-operation selector on the control panel at AERIAL RECONNAISSANCE (РАЗВЕДКА) and make sure the camera mount has tilted through $6^{0}30'$ or $8^{0}30'$ sideward off the zero(original) position depending on the position of the locking bolt on the crank mechanism.

2. Set 5 - 7 sec. interval between the exposures on the camera controller dial, turn the continuous photography switch at OFF (ВЫКЛЮЧЕНО), and the BOMBING CONTROL (КОНТРОЛЬ БОМБОМЕТАНИЯ) switch, at INTERVAL (ИНТЕРВАЛ).

Note: When the automatic tilting mount АКАФУ is engaged in the AERIAL RECONNAISSANCE (РАЗВЕДКА) mode of operation, 2-sec. inter-exposure interval and CONTINUOUS SURVEY (НЕПРЕРЫВНО) mode of operation are not allowed.

3. Press the START (ПУСК) button on camera controller КПУ-2 . The camera starts functioning at preset intervals and the contact-pulse mechanism sends pulse of current to relay РП-2 . Make sure electric mechanism МУФ-2 intended to govern the camera operation has functioned to change the tilting mount to the opposite position. Watch the indicating lamp on the control panel to make certain the automatic tilting mount functions properly.

The normal operation of aerial camera АФА is shown by flickering of the green indicating lamp labelled REWINDING (ПЕРЕМОТКА) on the camera controller and by proper functioning of the exposure counter.

4. At the chosen mode of operation of the tilting mount, make a 8 to 10-exposure series and then disengage the camera controller.

5. During the AERIAL RECONNAISSANCE mode of operation, the tilting mount may be checked without the camera controller and camera АФА . The check-up is performed by pressing and releasing button 9 (See Fig.119) labelled CHECK UP OF TILTING

MOUNT OPERATION (ПРОВЕРКА РАБОТЫ КАЧАЛКИ) and arranged on the inner frame. The button is pressed to move the frame from one extreme position to the other where it stops. Upon pressing the button for the second time, the tilting mount comes back to its original position. As the tilting mount passes the zero position, respective cam closes the supply circuit of the indicating lamp on the control panel. The lamp flickers to indicate normal functioning of the automatic camera tilting mount during the AERIAL RECONNAISSANCE mode of operation.

Preparation of Aerial Cameras for Flight

1. Take the protective covers off the objective.
2. Wipe the objective using a special piece of cloth.
3. Install an appropriate light filter and set the required exposure.
4. Zero the exposure counters of the chamber portion and camera controller.
5. Mark on the film magazine panel the navigator's name, data and the aircraft number painted on its tail using a lead pencil, wind the aerial camera clock and synchronize it with the aircraft clock.
6. Load the film magazine with the film required for the survey mission. Perform the loading job in a special case (furnished with the aircraft) or in a special room. If the aerial film spool has a leader, the film may be loaded directly on the aircraft in daylight.

Prior to loading, carefully examine the film magazine, select a set of film spools to fit, mark the camera number on the spool flanges and load the magazine with these spools only.

7. Arrange the film-loaded magazine in its place, lock the latches and open the film magazine gate all the way out until four red marks are aligned.

Preflight Preparation of Cameras НАФА

Prior to mounting frame НАФА on the aircraft, check the operation of the camera hatch.

Installation of Frame НАФА

1. Remove the partition separating the nose leg well from the camera bay.
2. Set frame НАФА on the lower row of sleeves (Fig.121).

Bring frame НАФА horizontal accurate within ±15' using washers 23А50-1-8-16 placed between the shock absorbing roller and the shock absorber (with the aircraft in the line-of-flight position).

3. Coat all flexible joints with lubricant УНВМ State Standard ГОСТ 3276-54.
4. Set the bonding strips.

Mounting of Cameras НАФА

1. Unscrew the bolt wing nuts from the camera brackets.
2. Bring the bolts into the slots of the sliding frame and screw the wing nuts on.
3. Mount the camera controller, converter 1 and automatic release 28 (the two latter for camera НАФА-3с/50 only) on the dome-tails.
4. Connect all members of the camera for night photography with electric cables.

Checking Camera НАФА for Proper Operation

1. Open the camera hatch and check the interlocking microswitch for faultless closing.

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2. Pull out the locking latches as far as they will go and remove the protective cover from the camera attachment frame.

3. Cut in the camera controller common switch (Fig.122) and press the CHECK-UP (ПРОВЕРКА) button 1 – 2 minutes later.

4. As the camera functions, check the operation of the shutter and exposure counter.

5. Discontinue the power supply and fit the magazine loaded with exposed waste film in the camera.

6. Remove the film magazine cover and open the gate.

7. Energize the camera, press the CHECK-UP (ПРОВЕРКА) button and as camera НАФА functions check the film rewinding, lowering and raising the pressure plate, going on and out of the REWINDING (ПЕРЕМОТКА) indicating lamp in the camera controller, glowing of the CURRENT ON (ТОК ВКЛЮЧЕН) and ILLUMINATION (ПОДСВЕТКА) lamps at the moment the button is pressed.

Checking Units of Camera НАФА for Timely Functioning during Operation Cycle

1. Press the button labelled CHECK-UP (ПРОВЕРКА) to check the shutter operation aurally.

2. Perform 8 – 10 successive cycles of the camera to check the film rewinding mechanism performance. The film rewinding should start after the pressure plate has gone up and end before the pressure plate has lowered all the way down.

Pay more than ordinary attention that the camera does not operate spontaneously without pressing the button.

3. Press the button marked CHECK-UP (ПРОВЕРКА) and keep it pressed to make sure the camera does not operate after the shutter has functioned.

The camera must perform one operation cycle upon releasing the button.

4. Disconnect the connector plug from the camera.

5. Unscrew the threaded plug and connect the camera crank to the input shaft.

6. Slowly rotate the camera crank in the direction indicated by the arrow and count the revolutions up to the moment the pressure plate starts moving upward (the number of the camera crank revolutions should keep within 42 to 10).

7. Engage the common switch, press the CHECK-UP (ПРОВЕРКА) button to perform 2 – 3 cycles and keep it pressed while turning off the common switch; this done, release the button.

When the common switch is turned off, the camera must function to bring the pressure plate all the way upward.

8. Close the gate and disconnect the connector plug from the camera.

The above operations performed, camera НАФА is considered ready for flight survey.

Preparation of Cameras НАФА

1. Take the protective cover off the camera blind.
2. Wipe the objective lens with a piece of flannelette.
3. Set the exposure time required.
4. Tilt the camera through the required angle.
5. Connect the camera to the aircraft mains.
6. Fill the magazine with the film.
7. Press the locking hooks and take the locking latches all the way out.
8. Mount the film magazine on the chamber portion and secure it with the aid of locking latches.

9. Open the gate all the way out.

10. Try the camera operation by snapping 2 – 3 shots.

Check the film for being properly rewound (by flickering of the indicating lamp on the camera controller) and the shutter for proper functioning (by watching the shutter from the objective side, or aurally by a click).

11. Check the heater of the camera controller for proper operation. For this purpose, cut in the heater switch and make sure the heater is operative.

12. Remove the cover of the automatic release AC and wipe the protective glass of the photocell (for camera НАФА-3с/50).

Preflight Preparation of Cameras ФАПА-1

Mounting of Camera ФАПА-1

Cameras ФАПА-1 (Fig.123) are furnished with sets and mounted on the plane by the aircraft works.

The installation Instructions for this camera are set forth should the necessity arise to substitute the camera or install it after maintenance.

To mount camera ФАПА-1:

1. Take middle-portion jacket 3 from the camera.
2. Take lower focusing ring 9 of the taper portion.
3. Carefully unscrew guiding pins 10 attached to the housing where the objective is secured.
4. Take out the upper focusing ring.
5. Take the nut and locknut from the bottom part of the chamber portion.
6. Install the chamber and taper portions of the camera on the camera mount and lock it with nuts.
7. Mount the focusing rings, guiding pins and middle-portion jacket in the reverse order.
8. Install the assembled camera mount on the aircraft between the radio operator's stand and the main control panel and secure it by means of quick-release locking studs 6.
9. Connect cathode-ray tube 1 to the camera middle portion jacket. Fit clamps 11 onto the shock-absorbing lugs of the cathode-ray tube instead of the shock absorbers with a view to attaching the tube to the frame posts. See that the indicator is set without misalignment and securely tightened by the jacket clamp. Pay attention that the jacket lugs closely adhere to the glass or to the light filter.
10. Set the bonding strips.
11. Set the spring braces and adjust the springs so that they are uniformly tightened.
12. Connect the electric cable parts.
13. Connect one of the branches of cable PA to the 27 ± 2.7 V D.C. source so that one pole of the branch should be periodically closed by hand thereby sending pulses to the cam relay.
14. Connect the fuse link of MAINS (СЕТЬ) cable to the camera controller.
15. Set the camera controller common switch to the lower position marked OFF (ОТКЛЮЧЕНО).
16. Zero the camera controller counter.
17. Set the sector scanning and circular scanning indicator switches to the position the branch of cable PA is connected to at the present moment.
18. Connect the supply plug to the 27 ± 2.7 V D.C. source.
19. Proceed to checking the aerial camera.

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20. Connect the aerial camera and the camera controller by means of electric cables.

Checking the Camera Operation

1. Press the latch and shift it to make sure the drive loading axle sinks all the way down and then comes back to the original position.
2. Set the antenna multiple frequency control at interval 5 .
3. Change the gang switch to ON (ВКЛЮЧЕН) and make sure the red lamp on the camera controller and the digital drum illumination lamp are glowing.
4. Send pulses to the cam relay regularly closing the circuit. Make certain that after application of the first pulse the yellow lamp goes on to indicate that the shutter is opened, the second pulse showing that the film has been rewound.
5. Set the selector at О (ОДИНОЧНЫЙ)* and check the camera by pressing the single exposures button.
6. Discontinue the power supply and install the magazine loaded with exposed waste film on the chamber.
7. Take off the film magazine cover.
8. Check the mechanism functioning by turning the camera crank and watch the film rewinding process.
9. Cut in the gang switches and occasionally send pulses to the cam relay.

While the camera is operating, watch the camera controller for glowing of the green indicating lamp (film rewinding), of the yellow lamp (shutter opening) and for the raising and lowering of the pressure plate crosspiece. This check-up requires that the end of the lever keeping the pressure plate in the upper position should be pressed.

Checking Units of Camera ФАРП-1 for Timely Functioning during Operation Cycle

1. Open the side cover of the camera and take out electric motor МА-40А.
2. Insert the driving crank.
3. Remove the film magazine and the cover from the change speed gear box.
4. Slowly rotate the handle of the hand drive clockwise until the contacts of the recording instruments illumination system have closed, count the number of the revolutions up to the starting moment of the pressure plate rising.
5. Mount the film magazine loaded with exposed waste film on the chamber.
6. Take the cover off the film magazine. Turn the driving crank to actuate the mechanism. Be sure to manually disconnect the lever keeping the pressure plate in the upward position.

Starting from the moment the contacts of the recording instruments illumination system are closed, count the number of the driving crank revolutions up to (a) raising of the pressure plate, (b) termination of the film rewinding process, (c) initial point of the table lowering. The revolutions counted must correspond to the Table coming under "Adjustment and Technical Data" of the Manual furnished with the camera.

Preparation of Camera ФАРП-1 for Flight

1. Open the side holes made in the jacket for cleaning the cathode-ray tube, open the shutter and fix the shutter opening lever in position with the aid of the pawl.

*) Single exposures setting

2. Bring the ground object images yielded by the screen of the cathode-ray tube to their sharpest definition, place a diffusing glass on the flattening glass, focus the camera and bring the image to sharp focus adjusting the objective with the aid of the focusing rings.

Note: Place the diffusing glass on the flattening glass with the frosted surface facing downward.

3. After focusing, be sure to check if the rings are locked and uncage the shutter opening lever.
4. Load the magazine with the film.
5. Let go of the latch, draw the catch out and take the protective cover off the camera.
6. Install the film magazine and lock it with the catch.
7. Turn the actuator handle to make one or two operation cycles.
8. Set the antenna multiple frequency per exposure in accordance with the air survey mission.
9. Set the sector scanning and circular scanning selector to the required position.
10. Zero the counter drums.
11. Check the camera for proper functioning by taking 2 - 3 shots, make sure the film is being rewound watching the indicating lamp and the film rewinding mechanical indicator arranged on the film magazine. Follow the shutter opening by watching the indicating lamp.
12. Set the sensitivity potentiometer knob to fit the type of film loaded in the magazine.
13. Make sure the silica gel cells are available in the chamber.
14. Wind and set the clock.
15. Try the camera operation by taking two-three pictures.

POSTFLIGHT OPERATIONS

General

After taxiing the aircraft to the parking site, the photographic equipment technician must:

(1) Try the camera operation in the presence of the navigator by taking one or two pictures with the camera hatch opened. If the whole of the film has been exposed during the flight, the camera operation will be checked aurally.

(2) Ask the navigator about the operation of the photographic equipment in the air and fill in the standard form.

(3) Close the camera hatch and the gate, and take out the film magazine. It is PROHIBITED to close the gate with the film magazine pressure plate in the downward position.

(4) Put the protective cover on the camera.

(5) Protect the blind and the automatic release window (for НАФА-3с/50 camera) with the covers.

(6) Place the film magazine in its container, remove the automatic release of camera НАФА-3а/50 to be kept in dry premises.

(7) **Unload the magazine and send the exposed film to be processed.**

(8) Carry out thorough outer inspection and clean the photographic equipment of dust and fouling. While doing this, the technician should check:

- condition of the camera units and parts accessible without disassembly of the mechanisms;

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- attachment of the camera mounts to the aircraft members, and that of the cameras to the camera mounts; attachment of the camera controller and indicating lamps; attachment and condition of the camera hatch doors and camera hatch door actuating mechanism; condition and attachment of the electric cables to the camera, camera controller, etc.

Note: After high altitude flights, special attention should be paid to the aircraft optics.

(9) After examination of the camera, eliminate all the defects revealed during the flight and during the inspection.

(10) Load the film magazine with the film and install the former in the camera.

(11) Disconnect the cameras (with the exception of camera ФАПЕ-1) from the aircraft mains, loosen the shutter spring, set the maximum exposure value, cap the camera objective with the cover and close the camera hatch doors.

Unloading Film Magazines of Day and Night Photography Cameras and Cameras ФАПЕ-1

Unload the film magazine in the dark room or in a special cover.

To this end:

1. Place the film magazine on a clean table so that the actuating head stands to the right.
2. Turn off the light in the dark room.
3. Take off the film magazine cover and disengage the metering roller.
4. Press the film magazine locking mechanism lever and remove the spools from the container.
5. Rotating the idle gear, wind over two-three frames of the unexposed film and then cut the film off the take-up spool.
6. Take out the take-up spool.
7. Mark the date of aerial survey and the navigator's name on the end portion of the exposed film using a frame free from pictures.
8. Wrap the film-loaded spool in black paper and put it into the film can.
9. Mark on the can containing the exposed film the size, grade and sensitivity of the film, the date of unloading, return card number and the name of person responsible for unloading the film magazine.

Loading Film Magazines of Day and Night Photography Cameras

Load the film magazine in the dark room or in a special cover designed for the purpose.

In case the film is loaded in the dark room, it should be handled on a clean and dry table free of foreign objects.

Loading Procedure

1. Take the film magazine from the film magazine holder and place it on the table.
2. Prior to loading, open the film magazine cover. Load the film either by non-actinic light, or in complete darkness. If the film is provided with a leader, the loading may be done in diffused light, too.
3. Remove the film spool from the film can and fix it to the semi-axles so

that the film should come toward the operator with the emulsion layer outside. Turn the movable semi-axle all the way in.

4. Make sure the spool freely rotates on the semi-axles playing but slightly.
5. Raise the film magazine mechanism and pass the film around the guiding roller so that it is arranged between the fillets. Then bring the film under the pressure plate and between the metering rollers having previously disconnected the latter by applying pressure to the draw-out clamp. Pass about 20 to 25 cm. length of film between the metering rollers.
6. Loop the film over the take-up spool fixed in place, pass it around the bobbin and insert the film end into the slot so that the film is arranged symmetrically relative to the spool flanges.
7. Rotating the idle gear counter-clockwise, transport approximately two frames seeing that the film is properly arranged relative to the flanges and keeping it against warping. Stop rotation as soon as the pressure plate has come to the upward position.
8. Replace the cover to the film magazine.

Loading the Film Magazine of ФАПЕ-1 Camera

Load the film magazine with the film on the dry and clean table. Place the magazine so that its base rests on the table with the film rewinding mechanical indicator to the right. If the film spool is provided with a paper leader, the film magazine may be loaded in diffused light, too. In case no leader is available, the loading should be done in complete darkness.

Loading Procedure

1. Take the cover off the film magazine and then hand-press the centre of the pressure plate.
2. Turn the safety latches and draw the semi-axles out.
3. Insert the film-free take-up spool in the film magazine.
4. Insert the film-loaded supply spool.
5. If the leader of the film is not ready for threading, cut it with scissors at 45°. The leader should clear the spool and pass in the direction to the operator. Take up from the spool 30-40 cm. of the film and pass the threading end into the slot between the guiding roller and the edge of the light trap. Turn the film magazine over and place it between the metering roller and the light trap.
6. Again put the film magazine on the base, fix the leader to the take-up spool, make sure that the film is properly aligned and the metering roller perforation teeth have entered the film perforation holes.
7. Holding the supply spool, give the take-up spool two-three turns in. The taut film must closely adhere to the take-up spool.
8. Replace the cover to the film magazine according to the marks made on the film magazine housing. After that, securely lock the cover by means of the screw.
9. Place the film magazine in its jacket.

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RADIO EQUIPMENT
BRIEF INFORMATION

The aircraft radio equipment includes radio communication, radio navigation and radar facilities.

The radio communication facilities include:

(a) aircraft interphone system СПУ-10;
(b) communication radio set 1-РСБ-70 with receiver УС-9;
(c) command radio set 1-РСБ-70М with receiver УС-9ДМ;
(d) command ultra-short wave radio set РСИУ-3М with two receivers.

Arrangement of elements of the radio communication facilities is shown in Fig.12.

The radio navigation facilities include:

(a) radio compasses АРК-5 Nos 1 and 2;
(b) radio altimeters РВ-17 and РВ-2;
(c) course radio receiver КРП-Э;
(d) glide-slope receiver ГРП-2;
(e) marker receiver МРП-48П;
(f) radio range finder СД-1.

The radar facilities include:

(a) airborne transponder СРО;
(b) radar bomb sight РБП-4;
(c) radar gun sight ПРС-1.

PREFLIGHT CHECK

CAUTION. 1. Before making a check take measures against shocks by H.V. current, prevent the equipment from being switched on by its own accord. Make so that men and foreign objects may not touch the radio set antennas.

2. Inspect the units, cables, antennas with the equipment deenergized. The aircraft and airfield power supplies must be switched on only upon permission of an electrician.

3. Before flight the aircraft crew members must make such checks of the radio equipment which do not require use of special ground simulators.

4. If the equipment is installed on the aircraft immediately before flight, it must be fully checked and adjusted by technical personnel[1] before the crew members made a preflight check.

Radio Communication Equipment

1. Check the fastening and soundness of the antenna insulator and antennas of the command and communication radio sets on the fuselage.

2. Check the antenna fairleads and bonding jumpers for fastening and reliable connection; check the fastening, shock absorption and outward soundness of the radio sets and cables.

1/ The equipment check technique is outlined in Section "Check of Live Radio Equipment".

3. Check the operation of selector switches, switches and control knobs of the radio communication equipment in the following scope:

(a) СПУ-10 - for two-way communication between all members of the crew in position NETWORK No.1 (СЕТЬ № 1) and NETWORK No.2 (СЕТЬ № 2) and for possibility of the output connection to the radio sets attached.

(b) The transmitters of the command and communication radio sets - by the indications of the check meters and for monitoring their own operation.

(c) The receivers of the communication and command radio sets - by listening through the operation of the radio sets over the working bands.

(d) The ultra-short wave radio set - for two-way communication with the airfield radio station or with the radio set of another aircraft on the working channels and by monitoring its own operation on the other channels.

The check made, place all the switches and other controls in the original position and switch off the equipment.

Radio Navigation Equipment

1. Check the fastening and soundness of the radio altimeters antennas, range finder and dome of the marker receiver antenna.

2. Check the fastening and connection of the antenna leads of the glide-slope receiver and radio compasses, external view and fastening of the pointer and light indicators.

3. Check the operation of the controls and the overall performance of the radio navigation equipment in the work positions of the crew members in the following scope:

(a) The radio range finder - for two-way communication with the airfield transponder on the working channel.

(b) Course and glide-slope receivers - for reception of signals from the respective ground radio beacons on the working channel.

(c) The marker receiver - for reception of signals from the simulator.

(d) Radio compasses - for reception of signals and indication of course bearings of the precision approach radars and broadcast stations.

(e) Low altitude meters - for deviation of altimeter ИРВ-46 pointer after switching on and over the bands.

(f) High altitude meters - by the pulses on the indicator screen and operation of the controls.

(g) Receiver-indicator unit - by the signals of the radio stations or simulator.

The check made, set all the switches and other controls to the initial position and switch off the equipment.

Radar Equipment

1. Check the fastening and soundness of the transponder antennas and the dome of the radar sight antenna.

2. Check the locking of the protective cover of button ARMED (ВЗВЕД), condition of the inertia switch, external view and fastening of the light and pointer indicators.

3. Check the units and waveguides for hermetic sealing and then the functioning of:

(a) the radar sight - by operation of the controls and by appearance of echo signals on the tube screens;

(b) the radar sighting station - by the control system and joint operation with its installation;

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(c) the transponder - by operation of the controls.

Before flight insert the plug of the ARMED circuit into the fuze socket and withdraw it after the flight.

The check made, set all the switches and controls to the initial position and switch off the equipment.

POSTFLIGHT INSPECTION

Visual Inspection of Radio Equipment

The radio equipment should be inspected visually after the flight to determine whether the equipment is ready for operation in flight conditions and to locate possible troubles in separate units, bunched conductors, fastenings and shock absorbers.

The visual inspection of the radio equipment should be made in a definite order so that all the elements are subjected to inspection.

In doing this proceed as follows:

1. Set the equipment controls to the initial positions.
2. Check for evidence of the required seals and locking.
3. Make sure that all the connectors, cables, antennas and individual wires are connected and fastened properly.
4. Check for evidence of spare fuses.
5. Check whether the switches and controls are fastened properly.
6. Check for evidence of damage to units and cables.
7. Check the condition of the antennas, antenna leads and earthing wires as well as the soundness and cleanliness of the antenna insulators.
8. Clean the radio equipment of dust and dirt.
9. If some units are discovered to be spilled by oil, ice-covered or snow-bound, they should be removed from the aircraft and sent to the repair shop for checking.

CAUTION. If some elements of the radio equipment are repaired or replaced on the aircraft it is necessary to carefully check the quality of the mounting of the newly installed elements.

Access to Elements of Radio Equipment

The majority of elements of the radio equipment have open access for their inspection, removal or installation on the aircraft.

To reach the assemblies of the radio equipment, access to which requires removal of separate elements of the aircraft or near-by cables, pipes or separate units of the equipment, do as indicated in the respective sections.

Radio Communication Equipment

1. Check the fastening and soundness of the antennas and antenna insulators of the command and communication radio set.
2. Check the external view and fastening of the radio station units, interphone system and fairleads; completeness of valves, correct installation of fuzes inserted during flight; performance of the equipment and operation of the switches and knobs on the working places if the equipment was not used in flight or there are remarks on its functioning.
3. Check the operation of the controls and the performance of:

(a) The transmitters of the command and communication radio sets - by the indications of the check meters, monitoring their own transmission and by switching on the transmitters on the working places.

(b) The receivers of the command and communication radio sets - for reception of signals of radio stations over all bands and for monitoring the receiver operation on the working places.

(c) The ultra-short wave radio set - for establishment of two-way communication on all the channels with the airfield radio station and those of other aircraft from working place No.2 and for monitoring its own operation on other working places.

(d) Aircraft interphone systems - for establishment of communication between the working places, establishment of communication from the pilots seats with other working places by means of interphone system buttons and for monitoring their operation on each working place when the interphone system is switched by buttons or foot-operated switches.

Place all the switches and control knobs in the initial positions and switch off the equipment.

Radio Navigation Equipment

1. Check the fastening and soundness of the antennas of the radio altimeters, radio range finder, the dome of the marker receiver antennas, radio compass loops.
2. Check the external view and fastening of the units of the radio altimeters, radio range finder, radio range finder supply box, marker coarse and glide-slope receivers, radio compasses, their leads and points of connection to the antennas, light and pointer indicators.
3. Check the performance of the navigation equipment and operation of the switches and control knobs of:

(a) The radio range finder - by the simulator on all the channels.

(b) The marker receiver - by the simulator.

(c) Radio compasses - for reception of signals from precision approach radars and broadcast stations as well as by checking their course bearings over all the bands. Monitor the operation of the radio compasses from the working places.

4. Check the low altitude meter for deflection of the indicator pointer after it has been energized and when changing the bands.
5. Check the high altitude meter by the pulses on the indicator screen and the operation of the control knobs.

Radar Equipment

1. Make sure that the plug of the ARMED circuit is out of the fuze socket.
2. Check the soundness and fastening of the interrogator and transponder antennas and radar domes.
3. Check the external view and fastening of the radar units, light and pointer indicators; locking of the fuses of the ARMED button cover; completeness of spare fuses and valves; installation of the fuses inserted in flight.
4. Check the operation and soundness of the switches and control knobs of the radar equipment (make a check if the equipment was not used in flight and there are remarks on its operation) and performance of:

(a) The radar sight - by the operation of the control knobs and by the presentation of the echo signals on the indicator screen.

(b) The radar sighting station - by the control system and by the joint operation with the installation.

(c) The transponder - for operation of the controls and correctness of signals of the sound and light signalling systems.

The check made, set all the controls to the initial position and switch off the equipment.

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CHECKING OF LIVE RADIO EQUIPMENT

CAUTION. Before attempting to check the live equipment eliminate all the troubles in the equipment and wiring revealed in flight. When checking the live equipment pay special attention to the functioning of the equipment that has failed in flight.

The check of the live radio equipment shall be made after the visual inspection in the scope and order prescribed by the respective sections of the present Instructions.

Prior to checking the live radio equipment proceed as follows:

1. Make sure that the power supplies required are switched on.

2. Make sure that the supply voltage of the aircraft mains is within the limits of 28.5 - 28 V for D.C. and 115±0.5 V, 400 c.p.s. for A.C.

3. Make sure that all the troubles revealed during previous inspections are remedied.

CAUTION. If radio range finder СД-1, course receiver КРП-Э, glide-slope receiver ГРП-2 and marker receiver МРП-48П are checked on the airfield with the use of special truck carrying instruments КИПД-1,КИПД-3,КИРМ-Э, ГИРМ-2 and МИП-48, this truck should be placed in front of the aircraft 2 to 5 m. away from it so that the left side of the truck faces the aircraft antennas of the ra[illegible] equipment to be checked. In this case, there must be no obstructions (ladders, men, part of the aircraft body, etc.) between the truck and antennas. When checking the marker receiver, place the truck in any spot, but external antenna МПШ-48 (from the truck spares set) should be placed 0.5 to 2 m. from inboard antenna МРП-48П.

The radio equipment is checked by the instruments installed on the truck in essentially the same way as by individual instruments described below.

If suspicious results are obtained in the course of checking of any piece of radio equipment, it is necessary to take the required simulator from the truck and use it to check the performance of the equipment concerned.

Checking of Pumping System of Hermetically Sealed Units of Radar Station РЕЦ-4

To check the unit pumping system proceed as follows:

1. Disconnect tubes from the cross-piece near frame No.38, plug the end of the tube previously at unit F12 and build up an air pressure of 3 kg/sq.cm. in the pipeline.

2. Keep the system under the pressure for 30 min., air release being objectionable. The test made, assemble the system and seal the joints.

Interphone System СПУ-10

(feeder Н7200-26)

1. Energize transmitters 1-РСБ-70, 1-РСБ-70М and РСМУ-3М, adjust them for telephony and set at RECEPTION (НА ПРИЕМ).

Energize receivers УС-9ДМ ,УС-9,РСМУ-3М No.1 or No.2, АРК-5 Nos 1 and 2, tune them to well heard radio stations and set at maximum volume of reception.

Note: The order of energizing and tuning of stations 1-РСБ-70М,УС-9ДМ , РСМУ-3М, АРК-5 is outlined below.

2. Energize simultaneously the amplifiers of interphones Nos 1 and 2 by tumbler

switches of circuit breaker АЗС-5:

ТЕЛЕФОНЫ No. 1 (СПУ No. 1) and INTERPHONE SETS (АБОНЕНТСКИЕ АППАРАТЫ) on the circuit-breaker panel of the right pilot, INTERPHONE No. 2 on the circuit-breaker panel of the navigator, and switches INTERPHONE No. 1 and INTERPHONE No. 2 on the pilots' upper board.

3. Set the switches of the interphone sets (Fig.125) to positions NETWORK No. 1, TELEPHONE, turn the volume control fully clockwise (maximum volume) and check the operation of the interphone system adjusted for intercommunication through conversation from all the interphone sets. The speech transmitted must be loud, clear, without noticeable distortions.

4. Use meter МВ-4 to measure the voltage of the useful signal at the output of amplifier No. 1 when it is loaded by six pairs of telephones ТА-4 and two pairs of throat microphone ЛА-5. The mean speech voltage should not be less than 40 V at the maximum gain (the gain control on the amplifier is turned fully clockwise) and not less than 20 V at the normal gain (the amplifier gain control stands against the white notch) (Fig.126).

5. Check the operation of the interphone system adjusted for conference call from all the interphone sets. For this purpose press button CONFERENCE CALL (ПЕРЕГОВОРЫ) on the interphone set being checked. In this case, the voice of the caller from the set being checked must be heard in the remaining sets, whatever may be the position of the function switch, and the volume of the radio station receivers' operation must decrease materially.

6. Listen through the operation of receivers УС-9, УС-9ДМ, РСМУ-3М, АРК-5 No.1 and АРК-5 No. 2 from all the interphone sets setting the function switch on the set being checked successively in positions COM. RADIO SET (СВЯЗ/РС), COMMAND RADIO SET (КОМ/РС), USW RADIO SET (УКВ/РС), ADD. BOARD-АРК/1 (ДОП/ЩТ-АРК/1) and ADD. BOARD-АРК/2 (ДОП/ЩТ-АРК/2).

When monitoring any of these receivers it is allowed to slightly listen through the operation of the other receivers to which the position of the function switch being checked does not correspond. For instance, when monitoring receiver УС-9 (the function switch in position COM. RADIO SET) the operation of receivers АРК-5, УКВ-М, УС-9ДМ may be heard weakly. The noise voltage being not more than 0.1 V measured with the dead receiver to which the function switch position being checked does correspond).

7. Check the starting and modulation of the transmitters of the communication (1-РСБ-70), command (1РСБ-70М) and ultra-short wave (РСМУ-3М) radio sets from all the interphone sets by depressing the interphone buttons and switches which serve to switch on the transmitters and throat microphone of the radio set (button RADIOS on the pilots' control wheels). In this case check the operation of all the buttons and switches of the interphones.

When the interphone button is not depressed the operation of the receiver (signals of the transmitting stations being picked up, atmospherics, etc.) must be heard in the telephones connected to the interphone set being checked.

When depressing the interphone button (on control wheel RADIOS) the receiver calls must cease, but instead in telephones must be heard the operation of the transmitters (monitoring) of the radio set to which corresponds the position of the function switch on the interphone set being checked. When checking transmitters РСБ-70 and 1-РСБ-70М the pointer of the antenna current indicator on the front panel of the transmitter must deflect and swing in step with sounds transmitted through the throat microphones.

CAUTION. The transmitters of the radio sets must be started, modulated and monitored from the interphone sets:

1-РСБ-70 - from all the interphone sets, except those of the radio operator and gunner.

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1-PCB-70M – from all the interphone sets except that of the gunner.
PCHY-3M – from all the interphone sets.
The operation of all the receivers must be monitored from interphone sets:
УС-9ДМ – from all the interphone sets except those of the radio operator and gunner.
УС-9 – from all the interphone sets except those of the gunner.
PCHY-2M – from all the interphone sets.
АРК – 5 No. 1 and No.2 from the interphone sets of the pilots and navigator.

8. Check for possibility to change from external communication to internal from the interphone sets of the pilots. For this purpose set the switch of the interphone set at any position (except INTERPHONE) for instance at COMMAND RADIO SET and depress button INTERTHONE on the pilot's control wheel. In this case, the audio of the aircraft radio set receiver to which corresponds the selected position of the function switch must cease, the transmitter should not be modulated. The interphone set must change to intercommunication and operate in accordance with Point 3 of the present Section.

9. Set network switches on the interphone sets in position NETWORK No. 2 and check the operation of network No. 2 adjusted for intercommunication according to Point 3 of the present Section.

10. Switch off the receivers and transmitters of the radio sets.

Interphone System Trouble Chart

Trouble	Probable cause	Remedy
1	2	3
No audio through one of networks in interphone sets in position INTERPHONE.	(a) Faulty connecting wires (conductors 3 and 4 of connector) of amplifier in bunched wires	Remedy the fault
	(b) Poor contact in valve sockets	By inserting valves alternately find faulty contact and remedy it by bending socket jacks
	(c) Faulty one of amplifier valves	Check and replace faulty valve 6Н8С
	(d) Short in input or output circuits of amplifier	By isolating separate sections of network and interphone set in succession find trouble and remedy it
	(e) Discontinuity of input or output circuits of amplifier in connector or cable	Check cable conductors of right connector of amplifier, locate discontinuity and eliminate it
When depressing conference call button of one of interphone sets, conference call is not heard in other interphone sets	Conference call relay cannot be energized – faulty connecting wires (conductors 5 and 10 of 14-terminal connector)	Remedy fault

1	2	3
When depressing conference call button of one of remaining sets no call is heard	Relay of interphone set being called cannot be fed with 27 V (conductors 5 and 12 of 14-terminal connector)	Remedy fault
No audio is heard in one of interphone sets in all positions if function switch on interphone set	Discontinuity in telephone circuits in headgear or connecting cable running from set to headgear	Eliminate discontinuity of wires, replace faulty headgear

Command Radio Set 1-PCB-70M

(feeder Н7200-24)

1. Switch on transmitter 1-PCB-70M and receiver УС-9ДМ, for which purpose:
(a) Set circuit breaker А3С-5 УС-9 on the circuit-breaker panel of the navigator to position ON (ВКЛЮЧЕНО).
(b) Set the function switch on the front panel of the radio set first to position ТФН (ТЛФ) and in 30 sec. to position ТГФН (ТЛГ).
(c) Set switch АРС-ОFF-МРС (АРЧ-ВЫКЛ-РРЧ) located on the remote control panel of the receiver to position МРС (Fig.127).

2. Set the function switch of the interphone set of the right pilot to position COMMAND RADIO SET, turn knob LOUDER (ГРОМЧЕ) fully clockwise.
Connect a pair of earphones ТА-4 and throat microphones ЛА-5 to the interphone set.

3. Check the operation of receiver УС-9ДМ following procedure below:
(a) Match the tuning scale of the remote control panel with the receiver tuning, for which purpose turn knob TUNING on the remote control panel smoothly first counter-clockwise and then clockwise so that the tuning scale of the panel comes from one extreme position to the other.
(b) Place switch ТФН-ТГФН (ТЛФ-ТЛГ) in position ТФН, turn the volume control fully clockwise and tune the receiver to the well-heard radio station on each wave band.
CAUTION: Knobs В, Г and Д of transmitter 1-PCB-70M when tuning the receiver to the station whose frequency does not correspond to those fixed on the АРС channel of 1-PCB-70M, should be placed in the position of the frequency of the transmitting radio station. In this case, the АРС channel switch of radio set 1-PCB-70M must be shifted to the manual control position.
(c) Check the operation of the volume control; rotating knob VOLUME (ГРОМКОСТЬ) counter-clockwise must reduce the volume of the picked up signals. Volume should change continuously without crackling.
(d) Check the operation of buttons ANTENNA ADJUSTMENT (ПОДСТРОЙКА АНТЕННЫ). When depressing one of the buttons for a long time the volume of the picked up signals must vary periodically from maximum to minimum. When changing from one button to the other the nature of volume must alter, i.e., if volume increases in intervals between maxima and minimum upon depressing the first button, then it must decrease upon depressing the other, and vice versa.
(e) Check the receiver operation on telegraphy. For this purpose shift switch ТФН-ТГФН to position ТГФН; in this case, BEAT NOTE must be superimposed on the signals of the transmitting station.

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When one of buttons BEAT NOTE (ТОН БИЕНИЙ) on the remote control panel of receiver УС-9ДМ is kept depressed for a long period, the beat frequency must change periodically. If when pressing the first button the beat frequency increases, then it must decrease when the second button is depressed, and vice versa.

(f) Check the operation of the crystal filter. For this purpose set switch CRYSTAL (КВАРЦ) to position ON (ВКЛЮЧЕНО). In this case, the volume of the signal being picked up and the noise level must decrease, the signal must be heard more distinctly, the turn angle of the tuning scale at which the picked up signals are heard must decrease appreciably.

(g) Check the operation of switch AFC – OFF – MFC. When changing over from position MFC to position AFC the signal intensity of powerful radio station must be reduced appreciably. The intensity of poorly audible signals should not decrease noticeably (at the same position of the volume control).

(h) Check the operation of the scale illumination rheostat on the control panel. When rotating knob ILLUMINATION (ОСВЕЩЕНИЕ) the brilliance of the scale lamp must change steplessly.

(i) Tune receiver УС-9ДМ to frequencies according to the Table of radio set tuning.

4. Check the operation of transmitter 1-РСВ-70М of the command radio set following the procedure set below:

(a) Tune the transmitter on extreme frequencies for each section of the stub antenna following the "Operating Instructions for Transmitting Radio Set" that comes with every transmitter. Intermediate frequencies should be checked when the necessity arises. Location of the transmitter control knobs is shown in Fig.128.

CAUTION. 1. Take precautions to prevent the antenna of radio set 1-РСВ-70М from being touched by the crew members and various objects (ladders, covers, etc.).

2. The continuous operation of the transmitter into the antenna should not last more than 5 min. after which a 10-min. interval is necessary.

3. In case of precise tuning of the transmitter the pointer of the antenna current indicator is allowed to overshoot slightly on certain frequencies of the band, provided the indicator readings do not exceed 4 – 6 divisions in position TUNING (НАСТРОЙКА).

4. Knob Б is allowed to depart from the position indicated in the Table of tuning of "Operating Instructions for Radio Set 1-РСВ-70М", if the antenna current indicator pointer when set against the tabular data deflects from zero.

5. Knob Г is allowed to depart from the position indicated in the Table of tuning under the very same conditions, but by not more than 1 division.

(b) Check the operation of the automatic control system by changing over the channels from the transmitter remote control panel, having shifted switch LOCAL-REMOTE (МЕСТН.-ДИСТ.) on the front panel of the transmitter to position REMOTE (remote control of transmitter, Fig.129). Upon completion of the operating cycle of the automatic control system knobs А, Б, В, Г, Д on the front panel of the transmitter must automatically settle to the positions in which they were locked during tuning of the transmitter on the given channel.

CAUTION. Continuous operation of the automatic control system should not last more than 20 min. Every 20 min. of operation should be followed by 20-min interval.

(c) Check for evidence of modulation and monitoring on low frequency on any of the fixed channel. When depressing button RADIOS on the pilot's control wheel or the button on the remote control panel the transmitting station signals being picked up should not be audible at the output of receiver УС-9ДМ, but instead the

operation of the own transmitter must be heard in the earphones; the pointer of the antenna current indicator on the transmitter front panel should oscillate in step with sounds transmitted through throat microphones.

(d) Check the keying relay of the transmitter (in ТРМН, ТСРН and МТСРН) for proper operation during transmission of dashes and dots. In this case, it is necessary to see whether the transmission influences the operation of the receiver (disabling of the receiver, simultaneous audibility of the transmitting station and operation of the own transmitter, etc.).

(e) Check whether the transmitter of the command radio set can be operated by the telegraph key of the radio operator. For this purpose set the key switch to the respective position and press the key. In this case, a signal must be heard in the earphones which vanishes when the key is released.

Check the operation of the radio set with the switch on the key cover (Fig.13[illegible]) in position RECEPTION, SIMPLEX (ПРИЕМ, СИМПЛ.). The transmitter in this case must be disconnected (rotary converter is switched off). Receiver УС-9 must operate without being off upon depressing of the interphone buttons and telegraph key. The stub antenna of the radio set must be connected to its full length, since the relays switching over the stub sections must be deenergized.

5. Energize transmitter 1-РСВ-70 and receiver УС-9 of the communication radio set, for which purpose proceed as follows:

(a) Close circuit breaker АЗС-50 РСВ-70 on the circuit-breaker panel of the second cabin.

(b) Set switch SIMPLEX-HALF-DUPLEX (СИМП.-ПОЛУД) on the telegraph key panel to position HALF-DUPLEX.

(c) Set the function switch on the front panel of the transmitter to position ТСРН and in 30 sec. to СРН.

(d) Set switch АРС-ОФФ-МРС on the front panel of receiver УС-9 to position МРС.

6. Check the operation of receiver УС-9 against Items 2, 3b, c, d, e, f, g, h of the present Section using the interphone set of the radio operator and the appropriate controls on the front panel of receiver УС-9 (Fig.131).

7. Check the operation of transmitter 1-РСВ-70 in accordance with the Operating Instructions of transmitter 1-РСВ-70 by using the controls located on the front panel of the transmitter.

8. Check the operation of the monitoring switch. In position ON (low-frequency monitoring) and with the button of the interphone set depressed the signals of the transmitting station should not be audible, but instead operation of the own transmitter must be heard in the earphones. In position OFF (high-frequency monitoring) with the interphone set button in the press-down condition operation of the own transmitter must be monitored only during the precise tuning of the receiver to the frequency of the transmitting station; if the receiver is slightly detuned from the transmitter frequency, the transmitter operation should not be heard.

Command Radio Set Trouble Chart

Trouble	Possible cause	Remedy
1	2	3
Transmitter on, pilot lamp fails to come on	Blown fuse 20 A (or disconnected circuit breaker АЗ-10) in transmitter supply circuit	Replace fuse, cut in circuit breaker

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1	2	3
Transmitter on, dynamotor fails to start	(a) Blown fuse 40 A (or cut off circuit breaker A30-30)	Replace fuse, cut in circuit breaker
	(b) Open contact of starting relay interlock under transmitter cover	Close interlock of upper cover
	(c) Tumbler on telegraph key panel in position RECEIVER-SIMPLEX	Set telegraph key to position HALF-DUPLEX TRANSMITTER-RECEIVER
No grid current	(a) Blown fuse for 0.5 A in 400-V circuit	Replace fuse
	(b) Faulty master oscillator valve (Г-837) or one of multiplier valves	Replace valves in succession
Fuse in 400-V circuit burns out	Puncture of conductor insulation in cable running from dynamotor to transmitter	Remedy cable fault
Fuse in 1150-V circuit burns out	Puncture of conductor No.10 in cable running from dynamotor to transmitter	Remedy cable fault
Transmitter on, pilot lamp fails to burn	(a) Wrongly set switch LOCAL-REMOTE on front panel of transmitter	Set switch LOCAL-REMOTE to respective position
	(b) Pilot lamp burned out	Replace lamp
Transmitter is on, dynamotor operates, meter does not indicate modulation	(a) Microphone switch is not set at CARBON (УГОЛЬНЫЙ)	Set microphone switch to CARBON
	(b) Defective valves 6Н9С, 12СЖ3, Г-811	Replace valves 6Н9СТ 12СЖ3, Г-811 in succession
When radio set is operated on telegraphy, no note is heard in earphones	(a) Low-frequency monitoring is off	Set monitoring switch to ON
	(b) Monitoring control is off	Turn speech amplifier control fully clockwise
	(c) Faulty valve 6Н9С of tone generator	Replace valve 6Н9С
No anode current with transmitter on	(a) Blown fuse for 0.5 A in 750-V circuit	Replace fuse
	(b) Faulty valve ГУ-13	Replace valve
Dynamotor runs with transmitter operated on telephony	Closed circuit of telegraph key or interphone button	Check condition of key and button circuits and remedy fault

1	2	3
Transmitter cannot be tuned in one of bands: 4.8 to 9 Mc/s 9 to 13 Mc/s 1.3 to 18 Mc/s	Faulty relay PC shorting respective stub sections: 3-metre 1.5 -metre 0.75-metre	Replace faulty relay. When in flight switch transmitter to reserve wave in good band
No grid current on 7-12 band, but there is current on 1-6 bands	Faulty valve Г-1625 of 2nd multiplier (Л103)	Replace valve Г-1625 (Л 103)
No high-frequency oscillations	Faulty master oscillator valve ГУ-837(Л101)	Replace valve
Large anode and grid currents	(a) Excessive mains voltage	Check and adjust voltage of aircraft mains
	(b) Faulty power amplifier valve ГУ-13	Replace valve
Transmitter cannot be tuned, no antenna current	(a) Vacuum relay fails to operate	Replace vacuum relay
	(b) Faulty power amplifier valve ГУ-13	Replace faulty valve
	(c) Discontinued antenna circuit and lead	Correct antenna discontinuity, check contact resistances of antenna joints
No grid current, no beat note is heard at crystal points	Faulty valve Г-837 (Л 101)	Replace valve Г-837
No grid current, but beat note is heard	Faulty valve Г-1625 of 1st multiplier (Л 102)	Replace valve Г-1625 (Л102)
No modulation, monitoring is normal	One of valves Г-811 (Л105 or Л106) is faulty	Replace valve Г-811 in succession
Monitoring is weak or absent at all	Faulty valve 12Ж3 (Л202) or 6Н6С (Л203)	Replace faulty valves
No tone modulation in positions MTLG and TGPH, there is voice modulation. 1000 c.p.s. note is not heard at monitoring output	Faulty valve 6Н9С (Л303).	Replace faulty valve 6Н9С
No beat note of "crystal points" is heard during calibration	(a) Faulty valve 6Н9С (Л301) or 6А7 (Л302)	Replace valves 6Н9С, 6А7 in succession
	(b) Faulty crystal	Replace crystal

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Radio Set PCHY-3M

(feeder H7200-25)

1. Energize radio set PCHY-3M for which purpose cut in circuit breaker A3C-5 of the radio set on the circuit-breaker panel of the navigator and common switch 2HH-250 on the motor-panel of the left pilot.

2. Place the function switches of the pilots' interphone sets in position USW RADIO SET, turn the volume controls of the interphone sets fully clockwise.

3. Place switches 1-2 on the radio set control panels in position 2 (Fig.132).

4. Give the operational check on the first receiver for which purpose:

(a) Turn the volume control on the panel of the first receiver fully clockwise (position P-LOUDER) whilst on the panel of the second receiver fully counter-clockwise.

(b) Check the correct operation of the automatic control mechanism by pressing in succession communication channel buttons 1, 2, 3 and 4 on the control panel of the transmitter and the first receiver of radio set PCHY-3M.

(c) Listen to the receiver operation on all the channels through interphone sets. With button RADIOS depressed, the receiver noise and atmospheric interference must be heard in the earphones.

(d) Check the operation of the volume control of the control panel. Rotating the volume control counter-clockwise reduces the noise volume in the earphones.

5. Check for evidence of modulation and monitoring of the transmitter on all the channels. In doing this proceed as follows:

(a) Press button RADIOS on the pilot's control wheel. In this case, atmospheric noise should not be heard in the earphones.

(b) Say a few words abruptly through throat microphones which must be heard in the earphones with the button depressed, and disappear with the button released. The speech transmission must be loud without noticeable distortions.

6. Give the operational check on the second receiver for which purpose:

(a) turn the volume control on the control panel of the second receiver fully clockwise (position P-LOUDER) and on the panel of the first receiver fully counter-clockwise.

(b) check the operation of the second receiver according to Points 4 b, c, d of the present Section.

7. Check the operation of radio set PCHY-3M on all the channels for two-way communication with two airfield (or aircraft) radio stations simultaneously operating on various channels. In doing this proceed as follows:

(a) Listen to the operation of the airfield transmitters on the corresponding receivers of the aircraft radio set being tested having set switches 1-2 on the control panels to position 2, and volume controls fully clockwise (maximum volume). In this case, operation of both transmitters must be heard in the earphones.

Rotating the volume control on the panel of one of the receivers will somewhat change (noticeably by ear) the volume of the other receiver operation. The transmission of ground transmitters must be heard well without noticeable distortions.

(b) Simultaneously check the operation of the transmitter of the station under test by monitoring its operation on the receiver of the airfield station. The transmission must be loud, without noticeable distortions; speech intelligibility must be not less than 100 per cent.

ATTENTION! 1. When setting switches 1-2 on the radio set control panel to position 1 operation of the first receiver must be heard in the earphones.

2. Check (if necessary) the operation of the sensitivity control and noise limiter of the receiver. Rotating the sensitivity control clockwise will increase the volume of signal (noise) at the receiver output.

When setting the noise limiter to the ON position, and the sensitivity control for maximum volume (fully clockwise) the noise at the receiver output should disappear.

3. Check the tuning of the transmitter and receivers of the radio set against test instrument M (Fig.133) or KCP-1 (Fig.134), the radio set operation for two-way communication with the airfield radio station on all four channels when the engines are running. Tune the radio set, if necessary. Location of the controls of radio set PCHY-3M is shown in Fig. 135 and 136.

4. Switch on the radio set intermittently: 2 min. for transmission, 2 min. for reception. The radio set is allowed to continuously operate on transmission not more than 15 min.

Radio Set Trouble Chart

Trouble	Possible cause	Remedy
1	2	3
All receiver and transmitter valves are not heated	Broken wires in heater circuits of valves	Identify cable wires from rectifier to receiver. Remedy wire fault
No modulation and monitoring of own operation	Faulty throat microphones. Throat microphones are not supplied because of broken leads	Replace faulty throat microphones. Remedy faulty leads
1st knob of transmitter cannot be tuned by unit M	Channel is not selected, faulty crystal. Faulty one of valves: Л 101, Л102, Л154, Л155, Л103	Press button of corresponding channel. Replace faulty crystal and valves
Power amplifier cannot be tuned by unit M	Broken high-voltage circuit. Faulty output valve ГУ-32	Correct wire fault. Replace defective valve
No tuning indications on unit M in position ANTENNA (АНТЕННА)	Defective valve 6Ж3П	Replace defective valve
Pointer of unit M overshoots in position ANTENNA	Discontinued antenna circuit	Eliminate discontimuity
Automatic control devices cannot be operated from buttons on unit M	Wrong connected plugs Ф-106 and Ф-206	Connect plugs according to markings
On pressing button on unit M automatic devices operate continuously	Automatic devices reset button on panel is not depressed	Depress reset button on panel

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1	2	3
1st knob of receiver cannot be tuned by unit И	Defective crystal. Defective crystal oscillator or multiplier valve	Replace defective crystal or valve
2nd knob of receiver cannot be tuned by unit И	Defective indicating lamp 6x6C	Replace defective lamp
Receiver sensitivity below rated	Defective one of I-F amplifier valves. Sensitivity control is not set at maximum	Set sensitivity control at maximum. Replace defective valves
No signal applied	Defective valve 6Г2. Break in telephone circuit	Replace defective valve. Eliminate break
Receiver valves are not heated	Broken conductors in cables (2 or 3)	Eliminate trouble
Crackling in earphones in one of receivers operating on reception or periodical fading of picked up signals during flight. Operates normally on ground	Hidden loose contact in circuit of antenna feeder. Disturbed soldered joint in high-frequency connector	Restore contacts in connectors. Eliminate breaks in feeder.

Radio Compasses АРК-5 Nos 1 and 2

(feeder Н7200-23)

1. Close the circuit breaker of radio compass No. 1 on the navigator's left-hand circuit-breaker panel.

2. Set the control knobs of the interphone set and additional interphone panel of the navigator to position "LOUDER ADD. PANEL" (АРК No. 1). Connect telephones ТА-4 to the set.

3. Energize radio compass АРК-5, for which purpose turn control VOLUME (ГРОМКОСТЬ) on the control panel of radio compass АРК-5 No. 1 of the navigator fully clockwise and set the function switch to position COMPASS (КОМП.). In this case a green lamp must light up on the control panel, a characteristic noise of the receiver must be heard in the earphones, the tuning indicator pointer must deflect from the extreme right to the extreme left position (scale zero). The course indicator pointers must start moving. With no reception of signals from radio stations check the position of the tuning indicator pointer. If the latter rests on the left stop of the scale use a screwdriver to set the sensitivity control of the indicator on the control panel to such a position at which the pointer will leave the stop and settle against the first division of the scale. Location of the controls on the remote control panel is shown in Fig.137.

CAUTION: If the green lamp on the control panel fails to light up upon energizing the radio compass, press and release button CONTROL (УПРАВЛЕНИЕ).

4. Operate knob TUNING to tune to a few radio stations in each of the three bands. With fine tuning to a well heard radio station the tuning indicator pointer must deflect to the right, and pointers of course indicators (pointer No. 1 on УКАЗ-1) must occupy a definite position, i.e. indicate the course bearing of the transmitting station. The course indicators are shown in Figs 138 and 139.

When rotating knob VOLUME the volume of the signals being picked up should not change. The tuning indicator pointer should remain in place oscillating about the main position in step with the signals of the transmitting station.

Check the operation of switch ТРНМ-ТСРН in position ТСРН, in the presence of a signal of the transmitting station (carrier frequency) note of about 800 c.p.s. frequency must be heard in the earphones.

5. Repeat the operation indicated in Point 4 when setting the function switch on the control panel to positions АНТЕННА and ЛООР (РАМКА). In this case the course indicators should not respond to the signals of the transmitting stations being received. The volume of signals in the earphones and position of the tuning indicator pointer must change in step with rotation of knob VOLUME.

6. Set the function switch to position LOOP, press knob LOOP towards the face of the panel and move it to the right (position П). In this case, the pointers of the course indicators must rotate clockwise. Move knob LOOP to position Л - the pointers of the course indicators must rotate counter-clockwise. The speed of the pointer rotation in both directions - 20 to 45° per second. If knob LOOP is moved to the right or left without being pressed, the pointers of the course indicators must rotate slowly at a speed of 1 to 8° per second; the pointer rotation must be smooth and jumpless.

Make sure that there is no seizing of the course indicator and tuning indicator pointers.

7. Check the operation of the illumination rheostat. Rotating knob ILLUMINATION (ОСВЕЩЕН) clockwise will increase illumination of the tuning scale and scale of the tuning indicator.

8. Do operation indicated in Points 2, 3, 4, 5, 6, 7 using the control panel of the first radio compass and the interphone set of the left pilot. When changing over the control press and release button CONTROL on the control panel АРК-5 No. 1 of the left pilot. Check the operation of course indicator КУРП-1 on the instrument panel of the left pilot.

CAUTION: 1. To check the second radio compass set the switch on the additional interphone panel to position АРК-2. The second radio compass should be checked according to Points 2, 3, 4, 5, 6, 7 of the present section. Check the output of the radio compass (АРК-5 No.2) by pointer No.2 of course indicator УКАЗ-1 of the navigator and by the pointer of indicator КОУП on the instrument panel of the right pilot.

2. On some aircraft when radar station РБП-4 is energized the supply blocking relay РБ-2 of the second radio compass must disconnect 115 V, 400 c.p.s. from the radio compass.

3. Checking the first and second radio compasses on the aircraft positioned close to large metal structures, buildings or inside the hangar may result in unstable operation of the radio compasses (fading of the transmission being picked up, large difference in readings of АРК-5 No.1 and No.2 when tuned to the same radio station, oscillation of pointers, etc.)

9. Adjust sensitivity of both radio compasses (No.1 and No.2). In doing this proceed as follows:

(a) Tune the radio compass to a frequency close to 50 c.p.s. free from the station noise.

(b) Disconnect the antenna from the receiver and bridge terminals АНТЕННА and ЗЕМЛЯ (ЗЕМЛЯ).

(c) Turn the volume control on the control panel of the radio compass fully clockwise.

(d) Set the gain control marked RECEIVER GAIN (УСИЛ. ПРМ) on the front panel of the radio compass so that the set noise voltage at the output of the radio compass is 20 V. Disconnect terminals АНТЕННА and ЗЕМЛЯ. Connect the antenna in place.

The front panel of the radio compass receiver is shown in Fig.140.

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Radio Compass Trouble Chart

Trouble	Probable cause	Remedy
1	2	3
No switching of operation modes and frequency band	Discontinued 27.5-V supply circuit; blown 27.5-V supply fuse	Restore connection, replace fuse
Upon energizing radio compass pilot lamp fails to light up and receiver valves are not heated	Discontinued 115-V supply circuit; blown fuse in 115-V supply circuit	Replace fuse, restore connection of wires. Check change over contacts in relay box.
After tuning indicator has been cut in its pointer does not deflect	(a) Open- or short-circuited wires running to tuning indicator	Restore connection or remove short circuit
	(b) One of valves 6B8C, 5Ц4М is defective	Replace defective valve
There is no noise in earphones on any band after switching on	(a) Open- or short-circuited wires of earphones	Restore connection or eliminate short circuit
	(b) One of receiver valves is defective	Replace defective valve
There is noise, but no reception of radio station in earphones	(a) Open- or short-circuited antenna circuit	Restore connection or remove short circuit
	(b) Defective valve in R.F. or I.F. amplifier stages	Replace defective valve
No tone modulation in ТФРН condition	Broken wire running to tumbler switch ТФНН–ТФРН	Restore connection
Continuous rotation of band switching motor when set at 2nd band	Short circuit-to-earth fault of one of wires running to band switch	Eliminate short circuit
Inoperative manual control of loop rotation	Fault in loop rotation reversal circuits	Restore connection
Loop rotates, pointers of course indicators are motionless or move only within one sector of scale	Break in one of wires connecting fixed windings of selsyns; wrong connection of selsyn windings	Restore connection of wires according to feeder diagram
In position LOOP there is noise in earphones, but no reception or signal in any position of loop	(a) Defective feeder of loop	Remedy feeder fault
	(b) Defective valve 6K7(1) or 6H7 (Л3)	Replace defective valve
In position COMPASS (КОМПАС) course indicator pointers rotate rapidly in one direction	One of valves (6П3С) is defective	Replace defective valve

1	2	3
In position COMPASS low-frequency tone of local modulation is not heard in earphones. Loop cannot be set in bearing position	(a) Defective valve 6H7 (Л2), 6K7 (Л1) or 6H7 (Л3)	Replace defective valve
	(b) Broken wires in loop feeder	Restore connection
Picked up signals are heard in earphones, loop cannot be set in bearing position, local modulation tone is heard. Loop rotates slowly in one direction	Defective valve 6B8C (Л10) of compass output amplifier	Replace defective valve
Same, but loop is motionless	Defective valve 6П3С (Л13)	Replace defective valve

Marker Receiver МРП-48

(feeder Н7200-23)

1. Close circuit breaker А3С-2 of the first radio compass on the left circuit-breaker panel of the navigator.

2. Cut in radio compass АРК-5 No.1 and make sure that it is in operable condition by superheterodyne noise in the earphones and by the deflection of the tuning indicator.

3. Connect the antenna to the simulator of marker beacon ИМП-48 (Fig.141); install ИМП-48 near the aircraft 0.5 to 2 m. away from the antenna of the marker receiver so that the simulator antenna is in parallel with the aircraft axis.

4. Check whether the cover of the inboard antenna of the marker receiver (МРП-48) is dirty. If it is, wipe the cover with a clean dry cloth or cloth moistened in alcohol.

CAUTION. Never wipe the cover with oil-moistened rags.

5. Energize simulator МРП-48 by operating tumbler СЕТЬ; approximately in 1 min. the pointer of the simulator meter must deflect from its zero position.

6. Set the control knob of simulator ИМП-48 in the following positions:
(a) Switch MODULATION FREQUENCY (ЧАСТОТА МОДУЛЯЦИИ) in position 3000 c.p.s.
(b) Switch CRYSTAL-BAND (КВАРЦ–ДИАПАЗОН) in position BAND.
(c) Switch DOTS-CONTINUOUS (ТОЧ.–НЕПР) in position CONTINUOUS.

7. Tune simulator ИМП-48 to 75 Mc/s frequency by means of knob MARKER-FREQUENCY SETTING (МАРКЕР–УСТАНОВКА ЧАСТОТЫ) against the diagram available on the front panel of the simulator.

Upon coincidence of the tuning frequency of the simulator and marker receiver, pilot lamps MARKER located on the instrument panels of the left and right pilots must come on and the marker receiver bell installed on the port side must ring at a time.

CAUTION. 1. With the receiver energized see that the MARKER lamp circuit is not shorted, for this will result in the burning out of the current carrying jumper between the contact and the armature of the relay inside the receiver.

2. If the frequency of the marker receiver is not equal to that of the simulator (lamps are dark), tune the simulator to the receiver frequency using knob MARKER – FREQUENCY SETTING.

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8. Set switch DOT-CONTINUOUS on the simulator to position DOT. As a result pilot lamps MARKER on the instrument panels of the pilots should start flickering and the bell of the marker receiver should ring interruptedly in step with signals of the simulator.

CAUTION. If the lamps burn and the bell rings continuously, the simulator is allowed to be carried away from the aircraft to such a distance at which the bell will ring interruptedly in step with the signals from the simulator.

9. Do as instructed under Point 7 when setting switch MODULATION FREQUENCY to position 400 and 1300 c.p.s.

10. Check the frequency of the marker receiver by the crystal, for which purpose:

(a) Set switch CRYSTAL - BAND to position CRYSTAL.

(b) Connect the simulator antenna to radio-frequency connector entitled СИМУЛЯТОР АНТЕННА КВАРЦА (АНТЕННА КВАРЦА).

If the receiver frequency equals the crystal frequency of the simulator, pilot lamps MARKER must burn and the bell ring.

CAUTION. 1. If the receiver frequency differs from the crystal frequency, tune the receiver for which purpose:

(a) Plug a milliammeter (from the simulator spares or the like) into socket CHECK (КОНТРОЛЬ) on the front panel of the receiver.

(b) Use a screwdriver to rotate controls CIRCUIT I (КОНТ 1) and CIRCUIT II on the front panel of the marker receiver until the maximum deflection of the milliammeter pointer is obtained (Fig. 142).

2. If the receiver tuning does not yield positive results adjust the inboard antenna for which purpose:

(a) Remove the protective cap from the antenna tuning control (Fig.137).

(b) Unlock the antenna tuning control and set it by a screwdriver to such a position at which the deflection of the milliammeter pointer is at maximum.

(c) Lock the antenna tuning control and make sure that the antenna tuning is as it should be by the milliammeter readings.

(d) Put the cap of the control in place.

11. Deenergize the first radio compass and circuit breaker A3C-2.

12. Check the operation of the marker receiver against Point 7 of the present Section when it is fed from the second radio compass for which purpose energize radio compass APK-5 No.2 and make sure that it is in operable condition against Point 2 of the present Section.

13. Deenergize the second radio compass APK-5.

14. Deenergize simulator МИЛ-48.

Marker Receiver Trouble Chart

Trouble	Probable cause	Remedy
1	2	3
On operation of receiver relay lamp MARKER fails to burn	Break in filament circuit of pilot lamp; break of flexible jumper of relay; no contact in lamp holder	Check supply circuit of lamp; eliminate trouble
No reception of signals from simulator or marker beacon	(a) Break in antenna circuit (b) Poor contact in connectors of radio-frequency cable (dirt, loose point in connector)	Check antenna circuit and correct trouble Check cable and correct trouble

Trouble	Probable cause	Remedy
1	2	3
	(c) Detuned tuning circuits (CIRCUIT I or CIRCUIT II	Tune circuits as instructed under Section "Marker Receiver МРП-48П"
Variable sensitivity of receiver; pressing front panel changes relay current	Poor contact between front panel and cabinet of receiver	Tighten up screws on front panel of receiver, check rivets
Pick-up currents of relay do not comply with standards (0.4 and 0.6 mA)	Poorly adjusted relay	Adjust relay
Marker receiver does not operate	Anode voltage (220 V) is not supplied to valves from radio compass APK-5	Check 220-V supply circuits of receiver (conductor No.2) in receiver connector. Eliminate trouble

Radio Altimeter РВ-17

(feeder Н7200-22)

CAUTION. The radio altimeter must be checked with radio altimeter РВ-2 deenergized.

1. Energize radio altimeter РВ-17 for which purpose turn on tumbler A3C-2 ВЫСОТОМЕР АНТЕННЫЙ ПЕРЕКЛЮЧАТЕЛЬ АНТЕНН РАДИОВЫСОТОМЕРОВ) on the circuit-breaker panel of the left pilot and tumbler ON-OFF (ВКЛ-ВЫКЛ) on indicator РВ-17. As a result, a red pilot lamp must light up on the indicator and, after the station has been warmed-up, the indicator screen should display the sweep ring. Indicator РВ-17 is shown in Fig.144.

2. Check and adjust the sweep display on the indicator screen. In doing this proceed as follows:

(a) Set the range-scale selector on the indicator to position SCALE x10 (МАСШ.Х10).

(b) Rotate knob RING SIZE (РАЗМЕР ОКРУЖНОСТИ) to match the sweep ring with the black ring of the scale on the indicator screen so that the sweep ring projects over its outer edge. The trace of the sweep ring must be bright, clear, with no interruptions and spots and have the correct form concentric to that of the scale.

If the brightness, centring and focusing of the sweep is insufficient, adjust them by rotating controls BRIGHTNESS (ЯРКОСТЬ), FOCUS (ФОКУС), HORIZONTAL CENTRING (ГОРИЗОНТАЛЬНАЯ ЦЕНТРОВКА) and VERTICAL CENTRING (ВЕРТИКАЛЬНАЯ ЦЕНТРОВКА) located at the lower side of the indicator with the help of an insulated screwdriver.

The indicator should be removed when making adjustment on it.

(c) Set knob GAIN (УСИЛЕНИЕ) on the indicator to such a position at which the initial pulse will be presented in the indicator near the zero mark of the scale. In this case the screen may display the grass (the clear sweep trace is blurred, its ends are fluttering);

Note: When varying gain from minimum to maximum the sweep form should not change in radius by more than ± 2 mm.

(d) Use knob DIRECT PULSE AMPLITUDE CONTROL (РЕГУЛ. АМПЛ. ПРЯМ. ИМП.) to adjust the pulse height equal to 6 mm and set it to the scale zero.

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(e) Rotate knob ZERO ADJUSTMENT x10 (РЕГУЛ. НУЛЯ x10) to check whether the direct pulse can be moved along the scale. The pulse must move to the right a left of the scale zero at least 400 m., in this case the diameter of the sweep rin should not change by more than ± 4 mm.

(f) Check the value of change of the sweep ring form having placed range-sca selector in position SCALE x1 (МАСШ. x1). The radius of the ring form should n change by more than ± 2 mm.

If the ring changes by more than ± 2 mm, use control SCALE x1 CORRECTOR (КОРРЕКТОР МАСШ. x 1) on the upper panel of the indicator to adjust the sweep rin to normal sizes.

(g) Set the range-scale selector on the indicator to position SCALE x1 an check the quality of sweep in accordance with Points 2 b, c, d, e, f. In this case, rotating control ZERO ADJUSTMENT x1 will move the pulse to the right and le of the scale zero at least 40 m. The diameter of the sweep ring should not chang by more than ± 2 mm.

Recheck the change of quality and form of the sweep ring when switching ove range scales.

3. Check the antenna radiation for which purpose:

(a) Set the range-scale selector to position SCALE x1;

(b) Install power indicator M-1 on the transmitting antenna; the pilot la on indicator M-1 must burn;

(c) Disconnect the cable of the transmitting antenna from the transmitter an instead, connect the cable of the receiving antenna. Install indicator M-1 on the receiving antenna; the indicator pilot lamp must burn.

(d) Connect the cables in position.

4. Check the overall sensitivity of radio altimeter PB-17 for which purpose

(a) Connect the radio altimeter to tester T-1 (Fig. 145) for a delay equivale to 100-m. height according to the diagram in Fig. 146. Energize the radio altimete and allow the valves to warm up (for 3 - 5 min.).

(b) Set the draw-out part of the attenuator to such a position at which the total attenuation of the tester (attenuator reading + attenuation of coils) may be 100 to 106 db.

(c) Set the range-scale selector to position SCALE x1.

(d) Set knob GAIN on the indicator to such a position at which noise appears on the outer edge of the sweep ring;

(e) Set knob DIRECT PULSE CONTROL (РЕГУЛИРОВКА ПРЯМОГО ИМПУЛЬСА) to a positio corresponding to fading of the direct pulse on the indicator screen, and set knob GAIN as instructed under Point d.

(f) Set the attenuator slider to such a position at which the pulse delayed is 6 mm high (size of big mark) and determine the altimeter sensitivity which is the sum of the readings of the attenuator and attenuation of the tester coil. The sensitivity of radio altimeter PB-17 must be at least 106 db (allowing for attenu tion inserted by antenna selector АП-1).

(g) Repeat the operations indicated in Points d, e, f when measuring sensitivi on range-scale SCALE x10.

5. Measure the radiation power of transmitter PB-17, doing this proceed as follows:

(a) Connect the radio altimiter to tester T-4 as shown in Fig.147.

(b) Energize the radio altimeter and allow the valves to warm-up.

(c) Set the switch of tester T-4 (Fig. 148) to position + A and adjust (if necessary) the aircraft mains voltage so that the anode voltage as measured by the tester meter is 305±5 V.

(d) Set the switch of tester T-4 at position POWER - FREQUENCY (МОЩНОСТЬ-ЧАСТОТА).

(e) Set output control A of the radio altimeter transmitter (Fig.149) to a position at which deflection of tester T-4 meter pointer is a maximum, not below the red line of the scale when the radio altimeter operates at SCALE x1 and not below the blue line at SCALE x10.

6. Deenergize the radio altimeter by switch ON - OFF on indicator PB-17 and switch А30-2 R. ALTIMETER ANTENNA SWITCH on the circuit-breaker panel of the left pilot.

Radio Altimeter Trouble Chart

Trouble	Probable cause	Remedy
1	2	3
Radio altimeter is not energized, pilot lamp fails to burn	(a) 115 V, 400 c.p.s. are not supplied to radio altimeter	Check 115 V, 400 c.p.s. wiring (conductors 11 and 12 in indicator connector). Remedy trouble
	(b) Blown fuse	Replace fuse
Fuse blows	(a) Shorted 115 V A.C. circuit	Check A.C. circuits (conductors 12 and 11 in indicator connector) Remedy trouble
	(b) Defective valve 5Ц9С	Replace valve
	(c) Shorted D.C. circuit (conductor 7 in junction cable)	Remedy trouble
Indicator does not present sweep on both range scales	Defective valve: Л13 or Л18, type 6Н1П, or Л22, type 5Ц9С	Check valves; replace faulty ones
Short sweep radius	Low gain of valves Л13 and Л18, type 6Н1П	Check valves and replace defective ones
Sweep is off centre	Maladjusted potentiometers К-222 and К-225 (centring)	Adjust potentiometers
Unsatisfactory brightness and focusing of presentation on indicator	(a) Maladjusted potentiometers R-57 and R-60	Adjust potentiometers R-57 and R-60
	(b) Defective cathode-ray tube	Replace tube
Sweep distortion	(a) Poor pin-socket contacts of C.R.T.	Make closer contact between C.R.T. pins and panel sockets
	(b) Defective C.R.T.	Replace tube
No presentation of pulse on indicator screen	(a) Defective valve: Л14, type 6Н1П or Л15, type 6Н1П	Check valves. Replace defective ones
	(b) Broken wires No. 4 in junction cable	Restore connection

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1	2	3
Echo pulse decreases when direct pulse is suppressed by knob DIRECT PULSE CONTROL	Shield is not earthed in one of connectors of junction cable	Connect shield reliably with connector body
Insufficient suppression of direct pulse	Defective valve Л17, type 6Н15	Replace valve

Radio Altimeter РВ-2 (Low-Altitude)

(feeder Н7200-22)

1. Move foreign objects (ladders, trucks, etc.) capable of causing reading errors away from the aircraft antennas РВ-2.

2. Energize radio altimeter РВ-2 for which purpose:

(a) Close circuit breaker А3С-5 of the radio altimeter and А3С-2 R. ALTIMETER ANTENNA SWITCH on the circuit-breaker panel of the left pilot.

(b) Turn knob ON on indicator ИРВ-46 fully clockwise (Fig.150).

3. Check the performance of the radio altimeter on the first and second bands for which purpose set knob BAND (ДИАПАЗОН) successively to positions 0-120 and 0-1200 m the scale of indicator ИРВ-46. 2 - 3 min. after the radio altimeter has been energized the indicator pointer must come to stand against the scale zero mark. The pointer setting accuracy: ± 2 m. on the first band; on the second band the pointer deflection from the scale zero may reach 300 m.

4. Check the antenna and antenna feeders РВ-2 for radiation. For this purpose mount indicator И-1 on the transmitting antenna; in this case the indicator lamp must burn.

Disconnect the feeder of the transmitting antenna from the transmitter-receiver and instead connect the receiving antenna feeder. Check the receiving antenna and feeder for radiation in the same way as the transmitting antenna. Connect the receiving and transmitting antennas to their sockets.

5. Deenergize the radio altimeter following Point 2 in the reverse order.

Checking Overall Sensitivity of Radio

Altimeter РВ-2

1. Connect the radio altimeter and tester Т-1 as shown in Fig.151.

2. Set switch BAND on indicator ИРВ-46 to position 0-120 .

3. Energize the radio altimeter and allow the valves to warm up for 5 to 6 min.

4. Draw out slowly the movable part of the attenuator until the indicator (ИРВ-46) pointer deflects downwards by 7 m. from the initial reading. The attenuator reading must be at least 52 units (when using the tester coils with 28 db attenuation).

Note: If, according to the tester Certificate, attenuation of the coils is 28 + n db, then the attenuator should read not less than 52 - n db.

5. Deenergize the radio altimeter

Calibration of Radio Altimeter РВ-2

Within the range of low altitudes

1. Energize the radio altimeter.

2. Connect the radio altimeter with tester Т-1 as shown in Fig.151. Set the attenuator at maximum coupling and lock it. Check the readings of the radio altimeter

at the end of the scale of indicator ИРВ-46 on the first band, for which purpose place the band switch located on the indicator in position 0-120 . In 5 - 6 min. the indicator pointer settles in the position corresponding to the equivalent altitude of tester Т-1 (100 m.) (See Service Log of tester Т-1) minus the aircraft residual altitude (12.5 m.); the reading accuracy of the radio altimeter must be at least ± 2 m., i.e. the indicator pointer must show the altitude

$$100 - 12.5 \pm 2 = 85.5 - 89.5 \text{ m.}$$

3. If the readings of indicator ИРВ-46 do not correspond to the data in Point 2, open cover CALIBRATION - HIGH - LOW ALTITUDES (КАЛИБРОВКА - БОЛЬШИЕ - МАЛЫЕ ВЫСОТЫ) and use a screwdriver to adjust control CALIBRATION - LOW ALTITUDES so that the indicator pointer shows the altitude according to Point 2 (average reading 87.5 m.).

4. Connect the radio altimeter to tester Т-1 as shown in Fig. 152 and check the radio altimeter readings at the beginning of the indicator scale on the first band. In this case the indicator pointer must settle at the beginning of the scale in the position corresponding to the equivalent altitude of tester Т-1 (20 m.) for the connection shown in Fig.152 (See Service Log of tester Т-1) minus the residual altitude of the aircraft; the reading accuracy must be at least ± 2 m, i.e.

$$20 - 12.5 \pm 2 = 5.5 - 9.5 \text{ m.}$$

5. If the readings of indicator ИРВ-46 do not correspond to the data in Point 4, open cover ZERO ADJUSTMENT (УСТАНОВКА НУЛЯ) on the transmitter-receiver РВ-2 and use a screwdriver to set control ZERO ADJUSTMENT - LOW ALTITUDES (УСТАНОВКА НУЛЯ-МАЛЫЕ ВЫСОТЫ) so that the indicator pointer shows the altitude according to Point 4 (average reading 7.5 m.).

6. Repeat operations indicated in Points 2, 3, 4 and 5 until the indicator pointer settles in both positions to within ±2 m.

Note: 1. Altitude equivalent (time delay) when connections are made as shown in Fig.151 corresponds to 100 m., and as in Fig. 152 to 20 m.

2. The residual altitude for mounting the radio altimeter on the aircraft equals 12.5 m.

Within the range of high altitudes

7. Connect the radio altimeter to tester Т-1 as shown in Fig.151. Set the band switch on indicator ИРВ-46 to position 0-1200 and check the readings of the radio altimeter at the beginning of the scale on the second band. In this case, the indicator pointer must settle in position corresponding to the tester equivalent altitude (100 m.) (See Service Log of tester Т-1) minus the residual altitude of the aircraft; the reading accuracy must be at least ± 20 m., i.e.

$$100 - 12.5 \pm 20 = 67.5 - 107.5 \text{ m.}$$

8. If the readings of indicator ИРВ-46 do not correspond to those in Point 7, use control ZERO ADJUSTMENT - HIGH ALTITUDES to set the pointer to a position corresponding to the altitude in Point 7 (average reading 90 m.).

9. Connect the radio altimeter to tester Т-2 as shown in Fig.153 and check the accuracy of the radio altimeter readings at the end of the indicator scale on the second band. In this case, the indicator pointer must settle in a position corresponding to the tester equivalent altitude (500 m.) (See Service Log of tester Т-2) minus the residual altitude of the aircraft; the reading accuracy must be at least ± 20 m., i.e.

$$500 - 12.5 \pm 20 = 467.5 - 507.5 \text{ m.}$$

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10. If the readings of indicator ИРВ-46 do not correspond to those in Point 9, use control CALIBRATION - HIGH ALTITUDES to set the pointer to a position corresponding to the altitude indicated in Point 9 (average reading 490 m.).

11. Repeat operations indicated in Points 7 - 10 until the indicator readings at the beginning and the end of the scale will correspond to the required altitudes within ± 20 m.

12. Deenergize radio altimeter PB-2.

Notes: 1. Equivalent altitude of tester T-2 equals 500 m.

2. Location of controls ZERO ADJUSTMENT and CALIBRATION on transmitter-receiver PB-2 is shown in Fig. 154.

Radio Altimeter Trouble Chart

Trouble	Possible cause	Remedy
1	2	3
On energizing radio altimeter, dynamotor fails to operate (armature does not rotate)	(a) Blown fuse in supply circuit of radio altimeter	Replace fuse
	(b) Break in supply circuits dynamotor relay (pin No. 1 in cable dynamotor - transmitter-receiver)	Remedy cable fault
	(c) Break in L.V. supply circuit of dynamotor (conductors 2 - 4 of dynamotor cable)	Remedy cable fault
	(d) No contact between brushes and commutator of dynamotor	Clean contacts or replace brushes (if necessary)
On energizing radio altimeter, pointer does not deflect from left limit	(a) Break in cable of H.V. circuit (conductors of dynamotor cable 3 - positive, 2 - negative	Remedy cable fault
	(b) Blown fuse	Replace fuse
When changing over to 2nd band indicator pointer remains motionless	Break of conductors 4 and 5 in indicator cable	Remedy cable fault
Dancing of indicator pointer - unstable readings	Dirty H.V. commutator in dynamotor	Clean commutator, make closer contact between commutator and brushes
Radio altimeter fails to ensure required sensitivity margin in altitude during flight	(a) Defective antenna feeders, not matching	Replace defective feeders and antenna. Check power of tester T-1 by indicator
	(b) Cracked steatite insulators of antenna	Replace antenna

Radio Range Finder СД-1

(feeder Н7200-22)

CAUTION: During checking the supply voltage of the radio range finder must be within: 27.5 - 28 V D.C., 115 ± 0.5 V, 400 c.p.s. A.C.

Checking Performance of Radio Range Finder

Set knobs MODE OF OPERATION (РОД РАБОТ) and BAND on range indicator ИРД-50 located on the instrument panel of the left pilot to position КМ (range measurement) and 0-150 (second band).

Energize the range finder, for which purpose close circuit-breaker АЗС-2 RANGE FINDER (ДАЛЬНОМЕР) on the circuit-breaker panel of the navigator and set knob RANGE FINDER on remote control panel СД-1-3 of the left pilot to position 1 (first communication channel). In this case, pilot lamp ON on control panel СД-1-3 must light up. Approximately 2 min. after energizing the indicator pointer must start smoothly to the end of the scale and swing smoothly within the range of the right portion of the scale (with no reception of reply signals from the transponder). Lamp CALL SIGNAL (ПОЗЫВНОЙ СИГНАЛ) on control panel СД-1-3 must burn continuously with slight variation of light intensity. The time of one complete swing of the indicator pointer (search time) during range measurements and orbiting must be within 1 and 1.8 sec.

Checking Performance of Time Selector

(calibration of range finder СД-1)

1. At least in 10 min. after range finder СД-1 has been energized, press knob ZERO ADJUSTMENT on control panel СД-1-3; the pointer of indicator ИРД-50 must come slowly to the scale zero. If the pointer fails to settle against zero turn knob ZERO ADJUSTMENT to adjust the pointer exactly to the scale zero mark.

2. Press knob ADJUSTMENT 30 - 150 km. on the control panel; the indicator pointer must come slowly to mark "30" on the first band or to mark "150" on the second band. If the indicator pointer fails to settle against the required mark of the scale, turn the knob to adjust the pointer exactly to mark "30" or "150").

Repeat operations under Points 1 and 2 until the indicator pointer settles exactly against the extreme marks of the scale "0 and 30" (or 150).

3. Set knob MODE OF OPERATION of the range indicator to position ORBITS (ОРБИТЫ). Press knob ORBIT SETTING (УСТАНОВКА ОРБИТ) on the control panel and rotate it so as to place it in such a position at which the indicator pointer comes to stand against the middle of the triangular mark of the scale.

Location of the range finder controls on control panel СД-1-3, and indicator ИРД-50 are shown in Figs 155 and 156.

CAUTION: When doing operations indicated in Points 1, 2, 3 (adjustment of indicator pointer to marks "0", "30" and "150") there must be control margin left, i.e. the control knobs should not reach their extreme positions.

4. Check the antenna of transmitter СД-1-2 for radiation of radio-frequency energy on the first, second and third channels. For this purpose bring a power-level indicator (from the complement of tester КИПА -1 and keep it in parallel alignment with the antenna (Fig.157) near the aircraft skin 15 cm. from the transmitting antenna.

In case of radiation the indicator neon lamp must glow.

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Checking Radio Range Finder СД-1 by Testers КИПД-1 and КИПД-3

1. Check the supply voltage of the range finder. For this purpose install tester КИПД-1 (Figs 158 and 159) on the aircraft and connect it to transmitter СД-1-2 by aid of a cable with T-joint (from the tester complement) as shown in Fig.160.

Connect converter МА-100 to 27.4-28 V supply taking into account its polarity.

CAUTION: Wrong connection of the converter to the supply source will result in a short circuit in the aircraft D.C. mains.

Energize the tester using the ON - OFF switch on the front panel of the tester.

Energize the range finder for which purpose set switch RANGE FINDER located on control panel СД-1-3 to position "1" (first communication channel).

Measure the D.C. supply voltage of the range finder. To do this, set switch SUPPLY VOLTAGE (НАПРЯЖЕНИЕ ПИТАНИЯ) of the tester to position "27 V" (27в). If the readings of the tester voltmeter come beyond 27.5 - 28 V, adjust the voltage of the aircraft mains (airfield supply) to the specified values.

Measure the A.C. voltage for which purpose set switch SUPPLY VOLTAGE to position "115 V, 400 c.p.s. " (115в , 400гц). If the voltmeter reads the value other than 115 V, adjust the voltage to 115 ± 0.5 V.

Measure the voltage in 250-V circuits. When doing this set switch SUPPLY VOLTAGE to position "250 V" (250в) and press button 250 V CHECK (КОНТРОЛЬ 250в); the tester voltmeter must read 250±5 V.

2. Check the operation of the decoding circuit. For this purpose install the tester and converter МА-100 that feeds it on the right or left of the aircraft so that the distance from the receiving and transmitting antennas of the range finder to the tester is not less than 5 m., and the line of the tester antennas is in parallel with the aircraft axis. Energize the range finder and tester. Set knob BAND on indicator ПРД-50 to position "0-30 km". Set knob RANGE BAND (ДИАПАЗОН ДАЛЬНОСТИ) on tester КИПД-1 to position "1". Set knob RANGE AND ORBIT (ДАЛЬНОСТЬ И ОРБИТА) of the tester to position "10 KM" on the first band scale.

1 - 2 min. after the range finder has been energized the pointer of indicator ПРД-50 on the instrument panel of the left pilot must settle against scale mark 10 allowing for error. Simultaneously left-hand lamp CALL SIGNAL on control panel СД-1-3 must go out.

Depressing button CODE (КОД) on the tester must cause lamp CALL SIGNAL to light up simultaneously with the depressing of the button.

Make a check on the first and second bands, and in the orbiting mode.

3. Check the operation of the tuning out circuit. For this purpose set knob of indicator ПРД-50 to the second band (0 - 150 km.) and press button RETURNING (ПЕРЕСТРОЙКА) on control panel СД-1-3; pressing the button will stop the locking, the pointer of indicator ПРД will have to search and come back immediately to read the previous range; lamp CALL SIGNAL must light up when the pointer starts searching and go out when it comes back.

4. Check the operation of the communication channel selector. For this purpose set the tester knobs RANGE BAND to position 1 (first band), and knob RANGE, KM (ДАЛЬНОСТЬ В КМ) to mark 15 km. Operate knobs COMMUNICATION CHANNELS (КАНАЛЫ СВЯЗИ) on control panel СД-1-3 and MODE OF OPERATION on the tester to set by turns similar channels. In this case the pointer of indicator ПРД-50 should read 15 km. each.

Set these knobs to different position; the indicator pointer must stop reading range and start searching. Lamp CALL SIGNAL should burn.

5. Check the reading errors of the range finder on the first band. For this purpose set knobs BAND and MODE OF OPERATION of range indicator ПРД-50 to position "0 - 30 km". Set knob RANGE BAND of tester КИПД -1 to position "1", knob RANGE AND ORBIT to such a position at which the indicator pointer settles exactly against scale mark "5 KM". In this case, the reading error read on the tester scale RANGE AND ORBIT should not come beyond the limits given in Table 30 and calculated by formula

$$\Delta n_1 = \pm 0.6 + 0.02\, n_1,$$

where Δn_1 = the maximum permissible error for the range measured in km. on the first band

n_1 = reading of range indicator ПРД-50 in km.

Check similarly the reading errors on the following marks of the indicator scale: "10", "15", "20", "25" and "30" km. using Table 30.

Table 30

Errors of Indicator Readings at Check Points of First Band

Points of range measurement (km.) on first band	5	10	15	20	25	30
Permissible reading errors, km.	±0.7	±0.8	±0.9	±1.0	±1.1	±1.2

6. Check the range reading error of the range finder on the second band (0 - 150 km.). For this purpose set knob BAND of the range indicator to position "0 - 150 km.", knob RANGE BAND of the tester to position II (second band). Determine the reading error of the indicator on the scale marks: "25", "50", "75", "100", "125" and "150" when knob RANGE AND ORBIT is set according to Point 5.

The reading error should not come beyond the limits of values given in Table 31 and calculated by formula

$$\Delta n_{11} = 3.0 + 0.02\, n_{11},$$

where n_{11} = the maximum permissible error for the range measured in km. on the second band.

n_{11} = reading of indicator ПРД-50 in km.

Table 31

Errors of Indicator Readings at Check Points on Second Band

Points of range measurement (km.) on second band	25	50	75	100	125	150
Permissible reading errors, km.	±3.5	±4.0	±4.5	±5.0	±5.5	±6.0

7. Check the range reading error of range indicator ПРД -50 in the orbiting mode. For this purpose, set knob MODE OF OPERATION of the indicator to position

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ORBIT, knob RANGE BAND on tester КИПД-1 to position ORBIT. Operate knob RANGE AND ORBIT on the tester to set 9 km. range (9th orbit). Set knob ORBIT on control panel СД-1-3 to position "9" (9th orbit). In this case the indicator pointer should approach the middle of the scale smoothly and stop within the limits of the triangular mark.

Check similarly the indicator reading errors on orbits 11, 13, 15, 17 and 19.

If the indicator pointer fails to settle within the limits of the triangular mark, operate knob RANGE AND ORBIT on tester КИПД-1 to bring the pointer to the nearest extremity of the triangular mark and find on scale RANGE AND ORBIT of the tester the reading error which should not exceed ±0.25 km. of all No. of orbits.

Note: The sector of the indicator pointer swinging in the search mode during orbiting is displaced on the scale from left to right with orbit number increasing in numerical succession. On orbits "9" and "11" the indicator pointer can reach the left stop of the scale.

8. Check the frequency of transmitter generator СД-1-2. For this purpose install tester КИПД-3 and converter МА-100 near the transmitting antenna. Connect a rod antenna to R.F. receptacle TO RECEIVER (К ПРИЁМНИКУ) on instrument КИПД-3 using a cable from the spares set of КИПД-3. Set the function switch on instrument КИПД-3 to position FREQUENCY OF TRANSMITTER СД-1 (ЧАСТОТА ПЕРЕДАТЧИКА СД-1). Energize the instrument.

Bring the antenna of instrument КИПД-3 to transmitting antenna СД-1-2 and keep it vertically 0.5 - 0.7 m. away from the aircraft body on the line between the transmitting and receiving antennas of the range finder. Find the generator frequency, rotating the wavemeter tuning knob on the instrument until maximum deflection of meter "КВ" pointer on instrument КИПД-3 is obtained. Read the generator frequency (in Mc/s) on the limb scale marked FREQUENCY Mc/s (ЧАСТОТА В МГЦ). The frequency of the transmitter generator must be within 845±1 Mc/s.

9. Check the frequency of the receiver local oscillator. To do this, bring the antenna of instrument КИПД-3 close to receiving antenna СД-1-1 and keep it near the aircraft body so that the antennas are in parallel alignment with each other. Set the function switch of instrument КИПД-3 to position RECEIVER FREQUENCY (ЧАСТОТА ПРИЕМНИКА).

Determine the local oscillator frequency in accordance with Point 8. The oscillator frequency must be within 855 ± 1 Mc/s.

CAUTION: Operations indicated in Points 8 and 9 should be done in case of unstable operation of the range finder.

10. Deenergize the range finder and testers КИПД-1 and КИПД-3.

Localizer Receiver КРП-Ф and Glide-Slope Receiver

РРП-2 of Instrument Landing System

(feeder Н7200-22)

1. Check mechanical "zeroes" of instrument ПСП-48.

2. Energize receivers КРП-Ф and РРП-2, for which purpose turn on tumbler АЗС-10 of the ILS of the circuit-breaker panel of the left pilot and the tumbler on the ILS control panel.

3. Install simulators КИРМ-Ф and ГИРМ-2 5 - 15 m. in front of the aircraft and energize them.

4. Check the performance of the localizer receiver for which purpose:

Set switches of simulator КИРМ-Ф (Fig. 161) to positions: COURSE (КУРС), OPERATION (РАБОТА), MODULATION (МОДУЛЯЦИЯ), FIXED WAVE No.1 (ФИКСИРОВАННАЯ ВОЛНА No.1); set the channel selector on the ILS control panel to position "I"

(first channel). This will cause operation of the drop indicator of the COURSE channel emergency signalling system (the black bullseye drops) and right- or left-side deflection of the vertical pointer of indicator ПСП-48 depending upon the position occupied by the phase shifter limb on simulator КИРМ-Ф. The indicator pointer must overshoot when the limb is turned by 90°.

Check the operation of the localizer receiver on the other channels setting the wave switches on simulator КИРМ-Ф and control panel simultaneously in positions "2", "3", "4", "5" and "6".

Control panel М-50 and indicator ПСП-48 are shown in Figs 162 and 163.

Make sure that the pointer does not deflect and the drop indicator does not operate when the simulator and receiver operate on different fixed waves. For this purpose switch over the receiver channels alternately (from the first to the sixth) for each position of selector FIXED WAVE (ФИКСИРОВАННАЯ ВОЛНА) on simulator КИРМ-Ф.

CAUTION: The pointer of indicator ПСП-48 is allowed to deflect within the black circle in the absence of signals from simulator КИРМ-Ф.

5. Check the electrical zero (balancing) of the localizer receiver. For this purpose press button ZERO CHECK (КОНТРОЛЬ НУЛЯ) on the front panel of the receiver; the vertical pointers of indicators ПСП-48 should come to stand against zero (boundary between the blue and yellow sectors of the indicator scale). Check in the like manner the electrical zero by pressing button CHECK on control panel М-50.

If the indicator pointers fail to settle against zero, open the cover labelled ADJUSTMENT on the front panel of the receiver (Fig.164), loosen the locking nut of control knob BALANCE (БАЛАНС), turning by means of a screwdriver control knob BALANCE adjust the indicator pointers exactly to the scale zero and then lock the control knob.

6. Check the localizer receiver sensitivity. In doing this turn the limb of the simulator phase shifter through such an angle that the meter pointer on the simulator may stop at the end of the yellow-blue sector of the scale. In this case, the vertical pointers of indicators ПСП-48 should also deflect to the right and stop at the end of the yellow sector. Turn the phase shifter limb counter-clockwise until the pointer of the simulator meter comes to stand at the end of the yellow-blue sector. As a result the indicator pointer must deflect to the left.

CAUTION: 1. The pointer is allowed to deflect asymmetrically to either side by 20 per cent.

2. The difference of pointer deflection of both indicators is allowed to be 20 per cent towards one side.

7. At larger or smaller deflection of the indicator pointers with respect to the end of the blue or yellow sector of the scale, adjust the receiver sensitivity by control SENSITIVITY (ЧУВСТВИТЕЛЬНОСТЬ) located on the front panel of the receiver so that the indicator pointer stops at the end of the yellow or blue sector of the scale.

Lock the sensitivity control and shut cover ADJUSTMENT of the localizer receiver.

8. Check the performance of glide-slope receiver РРП-2. In doing this proceed as follows:

(a) Set switch H.F. LEVEL - L.F. LEVEL (УРОВЕНЬ В.Ч. - УРОВЕНЬ Н.Ч.) on simulator ГИРМ-2 (Fig.165) to position L.F. LEVEL switch MODE OF OPERATION to position 90 c.p.s. LEVEL (УРОВЕНЬ 90 ГЦ) and rotate knob 90 c.p.s. LEVEL to adjust the meter pointer of simulator ГИРМ-2 to mark LEVEL.

(b) Set the function switch to position 150 c.p.s. LEVEL and rotate knob 150 c.p.s. LEVEL to adjust the meter pointer to mark LEVEL.

(c) Reswitch as indicated in Point 8 a, b, and make sure that the meter pointer settles exactly against mark LEVEL after every operation.

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(d) Set the fixed-wave switch on the simulator to position "1".

Set switch H.F. LEVEL - L.F. LEVEL to position H.F. LEVEL and operate knob H.F. LEVEL to adjust the simulator meter pointer to mark LEVEL.

Set the channel selector on the control panel of receivers PPH-2 and KPH-2 successively to positions "1", "2", "3", "4", "5" and "6". In this case the horizontal pointer (glide-slope indicator) must deflect, and the drop indicator of the emergency signalling system must operate only when the channel selector on the receiver control panel is set at positions "1" and "2".

Depending upon the setting of switch MODE OF OPERATION on simulator PKPH-2 to positions marked with signs showing the direction of the pointer deflection the horizontal pointer of indicator NCH -48 must deflect up or down respectively.

(e) Repeat as instructed under Point 8, d for the remaining positions of the wave switches, taking into account that positions of the switch on the control panel of the receivers correspond to those of the fixed-wave switch of simulator PKPH-2 in the following order:

Positions of switch on simulator	1	2	3
Positions of switch on control panel	1 and 2	3 and 4	5 and 6

9. Check the electrical zero (balancing) of glide-slope receiver PPH-2, for which purpose set the function switch on simulator PKPH-2 to position CHECK; in this case, the horizontal pointers of indicators NCH-48 must settle against zero, along the horizontal dotted line on the scale.

If the balancing is upset, open the cover labelled ADJUSTMENT on the glide-slope receiver (Fig.166), slacken locking nut of control BALANCE and operate the control with a screwdriver to set it so that the horizontal pointers of the indicators settle against zero. Lock control BALANCE.

Note: The electrical zero is allowed to be checked directly through the low-frequency channel of the receiver. For this purpose connect socket RECEIVER on simulator PKPH-2 through a special cable from the complement of the simulator to socket TESTER (TECTEP) on the localizer receiver and do operations indicated under Point 9.

10. Check the glide-slope receiver sensitivity. For this purpose set switch MODE OF OPERATION on the simulator alternately to the positions showing the direction of the pointer deflection (Positions 4 and 5). In this case, the horizontal pointers of indicators NCH-48 must settle respectively between the first and third dots of the upper or lower vertical line of dots on the indicator scale, and the drop indicators of the emergency signalling system must operate. If the pointers fail to settle within the given limits, unlock control SENSITIVITY on the glide-slope receiver and turn it with a screwdriver so that the indicator pointers will stand against the second dot (from the centre) in the vertical row.

Lock the SENSITIVITY control and shut cover ADJUSTMENT on the glide-slope receiver.

CAUTION: 1. The pointers are allowed to deflect asymmetrically up and down by 20 per cent as well as to differ in deflection by up to 20 per cent towards one side on both indicators.

2. The sensitivity is allowed to be checked with the receiver directly connected to simulator PKPH-2 through radio-frequency cable PRB-82 taken from the simulator complement. In this case, disconnect the antennas of the receiver and simulator and check the sensitivity as instructed under Point 10.

Receivers Trouble Chart

Trouble	Probable cause	Remedy
1	2	3
	Localizer receiver KPH-2	
On energizing receiver, dynamotor fails to operate	Blown fuse in supply circuit. No contact in tumbler ON on control panel. Poor contact in terminal block connecting dynamotor with receiver. Break in wires of supply circuit. Defective dynamotor	Replace fuse. Check and make tighter contacts in supply connectors. Replace dynamotor
Dynamotor operates, but pointer fails to deflect when rotating control BALANCE	Defective valve Л10 (6Н8М)	Replace defective valve
Indicator pointer deflects and overshoots to one side only	Maladjusted control BALANCE	Adjust control BALANCE
With simulator KПРЧ-2 operating the indicator pointer fails to deflect to both sides. SENSITIVITY control has no effect on pointer deflection, but drop indicator operates normally	Shorted contact ZERO CHECK or relay Р7. Control SENSITIVITY is at minimum	Eliminate short circuit. Adjust sensitivity
Receiver fails to operate, no negative voltage across pins 4 - 5 of valve Л13	Defective valve Л13 (12Г1)	Replace valve
Receiver fails to operate on one of channels	Defective crystal. Poor contact in switch on control panel	Replace crystal. Restore switch contact
Relay of one or two of channels fails to operate	Break of relay supply circuit. Punctured winding of channel relay in receiver PPH-2	Eliminate break or poor contact in supply circuit of relay winding. Replace defective receiver PPH -2
Drop indicator of emergency signalling system fails to operate	Poor contact, break or short in drop indicator supply circuit	Check supply circuit, eliminate trouble
With simulator operating, pointer of indicator NCH-48 deflects little	Interelectrode short in one of valves	Check valves, replace defective one

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1	2	3
	Glide-slope receiver RPM-2	
On energizing receiver dynamotor fails to operate	Blown fuse of receiver in distribution box. Poor contact in supply connectors on receiver or control panel. Poor contact in dynamotor terminal block. Broken supply wires	Identify supply circuit. Make tighter contacts in connectors. Restore wire connections
Pointer of indicator PSP-48 fails to deflect when simulator GRM-2 operates. Drop indicator does not operate	One of valves is defective. Poor contact in terminal block of dynamotor	Replace defective valve. Make tighter contact in terminal block
Receiver fails to operate on one of channels	Poor contact in channel selector. Defective crystal. Break in supply wire of relay winding	Make contact tighter. Replace crystal. Restore wire connection
Pointer of indicator PSP-48 does not deflect. Drop indicator operates	Poor contact in indicator connector. Defective indicator	Make contact tighter. Replace indicator PSP-48
Low sensitivity of receiver	Low voltage of aircraft mains. Loss of emission by one or several valves	Adjust aircraft mains voltage to 27.5 - 28 V. Check valves, replace defective ones
During joint operation of both receivers receiver KPI-2 does not operate on one of waves	Winding of one of relays of receiver RPI-2 shorts relay winding of receiver KPI-2	Send receiver RPI-2 to repair shop to have defective relay replaced

CAUTION: With the receiver energized do not remove the valves from their sockets as it may result in good valves being damaged due to overheating.

Airborne Transponder CPO

(feeder N7200-20)

CAUTION: Do not insert the fuze plug into ARMED socket on the transponder transmitter-receiver (do it only before flight).

1. Check the ARMED circuit of the station, for which purpose (if there is a battery in 6-2):

(a) Connect a 28-V lamp to the pins of the fuze plug.

(b) Press button EMERGENCY ARMED - TRANSPONDER (АВАРИЙНЫЙ ВЗРЫВ - РАДИООТВЕТЧИК) on the instrument panel of the left pilot; in this case the lamps on the ARMED button and that indicating connection to the fuze plug light up.

(c) Disconnect one pole of the lamp from the fuze plug and connect it to the aircraft body; the lamp should not burn. Check similarly the second pin of the fuze plug.

2. Check the inertia switch. In doing this proceed as follows:

(a) Turn out the upper transparent cover of the contactor.

(b) Connect the pilot lamp to the contactor plug.

(c) Move the pendilum lever until a sharp click is heard. In this case, the lamps on the ARMED button body and pilot lamp on the contactor plug must come on.

(d) Cock the inertia contactor again. For this purpose turn out the transparent cover on the right side, insert a screwdriver in the screw slot and turn the screw fully counter-clockwise. The pendilum lever must settle and fix itself in the vertical position. The lamps on the button and contactor plug must go out.

(e) Seal the contactor covers.

Checking Airborne Transponder on the Ground

1. Energize the transponder by tumbler A3C-5 TRANSPONDER located on the circuit breaker panel of the right pilot and by the TRANSPONDER switch on the control panel of the left pilot. In this case, a code illumination lamp must light up on the code panel of the left pilot.

2. Have the ground interrogator positioned at the control post energized. This is done by challenging over the radio from the aircraft being checked.

3. Set tumbler READY - RESPONSE (ГОТОВНОСТЬ-ОТВЕТ) to position RESPONSE.

4. Check the code system for proper operation by placing the code selector on the code panel successively from the first to the fourth position. In this case morse code signals corresponding to preset code must be heard in the earphones connected to the TGPH sockets on the code panel. At the same time the code lamps on the code panel must flash in step with the signals. During transmission of a short signal (dot) one lamp must light up, during transmission of a long signal (dash) - two lamps.

The sequence of short and long signals during transmission of codes is tabulated below.

Table 32

Transponder Codes (Pulse Sequence)

Codes	Letters	Cycle				
		1	2	3	4	5
1	X	Narrow	Narrow	Narrow	Narrow	Interval
2	C	Narrow	Narrow	Narrow	Interval	Interval
3	B	Narrow	Narrow	Wide	Wide	Interval
4	J	Narrow	Narrow	Wide	Interval	Interval

5. Switch on tumbler DISTRESS SIGNAL (БЕДСТВИЕ) on the code panel. This will cause transmission of distress signals instead of intervals alongside with code signals. Both code lamps must light up simultaneously with distress signals.

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Radar Bombsight PBP-4

The preflight preparation of the sight comprises:
(1) Visual inspection.
(2) Checking air-tightness of the waveguide system and units P2 and P12.
(3) Checking and adjustment of the live equipment of the navigator-operator.
(4) Checking the pulse length for automatically switching on optical sight OMB-11p.
(6) Checking and adjustment of the live equipment of the navigator.

Visual Inspection

When inspecting the sight visually proceed as follows:
(1) Check the presence of all the units and inspect their surface for evidence of mechanical damage.
(2) Check that the units are secured reliably on shock-mounted frames.
(3) Check the connection of cables and feeders to all the units according to their numbers; make sure that the cable and feeder connectors are closely tightened with nuts.
(4) Check for presence and good condition of all the fuses (working and spare) in connection box P-15 (See Table 33).
(5) Check for complete set of spare equipment and radio valves.

Fuses

Table

No.	Fuse No.	Unit	Current, A	Voltage, V
1	2	3	4	5
1	15-1	P3	2	115
2	15-2	P4	2	115
3	15-3	P5/1	2	115
4	15-4	P11	10	115
5	15-5	P10	2	115
6	15-6	P14(P5/2, P7, P8)	5	115
7	15-7	P2 and P12	10	115
8	15-8	P1	5	115
9	15-6	Control (P3 and P6)	15	27
10	15-10	P14(P7, P8, P9, P11p, P5/2)	5	27
11	15-11	P2 and P12	10	27
12	15-12	P1 and P5/1	10	27
13	15-13	Azimuth 1	2	27
14	15-14	Azimuth 2	2	27

Checking Air-Tightness of Waveguide System and Units P2 and P12

The waveguide system and units P2 (Fig.168) and P12 is checked for airtightness by means of device 137-M that comes with the equipment.

ATTENTION: When making a check do not shut the pipe connection of the intake valve on unit P12.

Connect the nipple of the rubberized hose of device 137-M to the outlet nipple of unit P2 through reducer RM-950. Build up an excessive air pressure of 0.8 atm. in the airtight system. Switch on the continuous rotation of the antenna for 30 min. and then sector swinging for 30 min. changing the antenna tilt periodically. After an hour check the pressure in the airtight system by the low-pressure gauge of device 137-M. The gauge reading should not differ from the initial value by more than 0.03 atm.

Checking and Adjustment of Live Equipment of Navigator-Operator

CAUTION: 1. Voltages dangerous to human life exist in the operation of the equipment; removal of the cases and disconnection of the cables with power on should be allowed on no circumstances.

2. The bombsight is allowed to be energized on the ground if at least 5-kW airfield power supply is available.

3. Prior to changing over converters PO-4500 it is necessary to switch off circular scanning and sector scanning to prevent unphasing of the bombsight indicators.

4. Make various adjustments except those in 27-V circuit only after the equipment has warmed-up for 15 min.

5. Switch on the transmitter only 2-3 min. after power has been tursed on.

6. In case of elevated ambient air temperature do not switch on the equipment for a long period. At +50°C the continuous operation of the equipment should not be longer than 50 min. The equipment is allowed to be energized 1 hour after it has been deenergized.

7. At ambient temperatures below -10°C the transmitter may be energized after the equipment has been warmed-up for 15 min.

8. To avoid cocking of the covers and damage to the case collar, turn in and out the bolts and nuts during installation and removal of the covers of units P2 and P12 gradually in the sequence shown in Fig.169.

9. When tightening the covers set all the bolts previously into the cover holes and centre the cover in reference to all sight bolts.

10. When working on the ground with the transmitter energized tilt the antenna by -25° if there is no need to obtain presentation.

1. Set the equipment controls in the positions indicated in Table 34.

2. Make sure that 27.5 V D.C. are applied. If necessary, give instructions to the electrician to adjust the ground supply voltage to 27.5 V.

3. Set the converter switch to position OPERATING (РАБОЧИЙ) (in special cases, to position STAND-BY (ПЕРЕКРЕВ)).

4. Close the circuit breaker of converter PO-4500 on the circuit-breaker panel of the navigator-operator.

5. Consult the 115 V A.C. airborne check voltmeter to make sure that A.C. voltage is applied and to measure its magnitude. If the voltage is outside the 113 - 117-V range bring it to normal (115 V) by means of the converter adjusting screw located on the electric panel of the navigator-operator.

6. Close circuit-breaker A3C-20 RADAR SIGHT (ПРИЦЕЛ) on the circuit-breaker of the navigator-operator.

7. Use the interphone system to warn the technician who is now at the aircraft navigator's position about the bombsight to be energized and get an answer as to its being ready for energizing.

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8. Press button SUPPLY ON (ПИТАНИЕ ВКЛ.) on unit P6 (Figs 170 and 171). Green pilot lamps must light up on the panel of the navigator-operator (P6) and bomb aimer's panel P3. Consult voltmeter SUPPLY on unit P6 to make sure that it reads 115 V, 400 c.p.s.

Make sure that voltmeter CHECK (КОНТРОЛЬ) on unit P6 reads +300 V D.C. If necessary operate potentiometer +300-V ADJUSTMENT (УСТАН. НАПР. +300в) on unit P11 to adjust the voltage to +300 V.

Set switch CHECK on unit P6 to position "-300 V" (-300 в). Make sure that this voltage is within -290 to 320 V (the pointer overshoots not more than 2 mm). This done, set the switch to position MAIN CRYSTAL CURRENT (ТОК КРИСТ.ОСН.).

Table 34

INITIAL POSITIONS OF CONTROLS ON UNITS

P6П-4 and ОПБ-11р

Unit	Controls	Position
1	2	3
Navigator-operator s panel P6	Switch CHECK	+ 300 V
	Switch AFC-BEACON	AFC - OFF
	Switch RANGE, KM	"10 - 70"
	Switch SWEEP DELAY,KM (ЗАДЕРЖКА РАЗВЕРТКИ КМ)	0
	Switch ROTATION (ВРАЩЕНИЕ)	OFF
	Switch COURSE LINE (ЛИНИЯ КУРСА)	OFF
	Switch SECTOR SCANNING (СЕКТОРНЫЙ ОБЗОР)	OFF
	Switch FREQUENCY	"1"
	Knob ALTITUDE DELAY (ЗАДЕРЖКА НА ВЫСОТУ)	Extreme counter-clockwise position. Middle position
	Knob RECEIVER TUNING	Extreme counter-clockwise position
	Knob "10-70"	Middle position
	Knob POSITION CONTROL (РЕГ.ПОЛОЖ.)	Extreme counter-clockwise position
	Knob RANGE MARKER BRIGHTNESS (ЯРКОСТЬ МЕТОК ДАЛЬН.)	Middle position
	Switch MARKERS (МЕТКИ)	Scale zero is matched with zero index
Operator s and photoattachment indicator P5/1, P5/2	Azimuth scale rotation knob	Central vertical line on light filter is matched with zero index
	Light filter rotation knob	Extreme counter-clockwise position
	Knob SCALE ILLUMINATION (ПОДСВЕТ ШКАЛ)	Extreme counter-clockwise position
	Knob BRIGHTNESS	OPERATION
Bomb aimer s panel P3 (Figs 172 and 173)	Switch CALIBRATION (КАЛИБРОВКА)	Extreme counter-clockwise position
	Knob SCALE ILLUMINATION	

1	2	3
	Scale SLANT RANGE CORRECTION (ПОПРАВКА НАКЛОННОЙ ДАЛЬНОСТИ)	"0"
	Switch SEARCH - HOMING (ПОИСК -НАВЕДЕНИЕ)	SEARCH
	Switch SPEED GENERATOR (ГЕНЕРАТОР СКОРОСТИ)	OFF
	Knob POSITION (ПОЛОЖЕНИЕ)	Extreme counter-clockwise position
	Knob TRACK SPEED (ПУТЕВАЯ СКОРОСТЬ)	200
Bomb aimer's indicator P8 (Figs 174 and 175)	Knob BRIGHTNESS	Extreme counter-clockwise position
	Knob SCALE ILLUMINATION	Extreme counter-clockwise position
	Switch AZIMUTH (АЗИМУТ)	ON
	Light filter	To be turned until the lock operates
	Azimuth scale	Scale zero is matched with central vertical line on light filter
Range unit P3 (Fig.176)	Switch CALIBRATION - OPERATION (КАЛИБРОВКА - РАБОТА)	OPERATION
Navigator-operator lock unit P4 (Fig.177)	Knob LOW LEVEL (НИЗКИЙ УРОВЕНЬ)	1/4 of turn from extreme counter-clockwise position
	Knob HIGH LEVEL (ВЫСОКИЙ УРОВЕНЬ)	1/4 of turn from extreme clockwise position
	Knob RECEIVER GAIN	Extreme counter-clockwise position
Optical sight ОПБ-11р	Index of sighting angle scale	"0"
	Scale ALTITUDE (ВЫСОТА)	"14 КМ"
	Index of drift angle scale	"0"
	Lock of vertical gyro	LOCKED (ЗААРЕТИРОВАНО)
	Switch CORRECTION (КОРРЕКЦИЯ)	ON
	ON-OFF switch on altitude unit	OFF
	Handle LAG (ОТСТАВАНИЕ)	"0"
	Handle SERIES (СЕРИЯ)	"0"
	Other controls	According to operating instructions for optical sight ОПБ-11р

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9. Gauge PRESSURE IN TRANSMITTER (ДАВЛЕНИЕ В ПЕРЕДАТЧИКЕ) on unit P6 should read normal pressure of 1 + 0.2 atm. After the equipment is warmed up the pressure may rise to 1.4 atm.

10. Make sure (by ear) that the fan motors in units P2 and P12 are started.

11. Turn knob SCALE ILLUMINATION on indicators P5/1 and P5/2 until the scale is properly illuminated.

12. Turn knob BRIGHTNESS on indicators P5/1 and P5/2 clockwise until appearance of the sweep trace. Turn switch RANGE,KM on unit P6 to positions "10", "20", "10-70", "100" and "200" and then return it to position "10-70". Do in the like manner when setting switch AFC-BEACON to position BEACON, the sweep should not varnish from the indicator screens at all positions of switches RANGE,KM and AFC-BEACON on unit P6.

The sweep brightness is controlled by knobs BRIGHTNESS on units P5/1 and P5/2.

13. Use knob FOCUS on the indicators to focus the sweep trace so that it may be as thin and contrast as possible. To avoid the interference of the screen after-glow displace the sweep trace by momentarily pressing switch SEARCH on unit P6.

Note: Focusing on indicators P5/1 and P5/2 is obtained noticeably better than that on indicator P8.

14. Set switch SWEEP DELAY,KM in all positions from "0" to "400"; the sweep should not varnish from the indicator screens. Reset the switch to the zero position.

15. Set switch ANTENNA TILT (НАКЛОН АНТЕННЫ) first to position UP (ВВЕРХ) and then to position DOWN (ВНИЗ). Make sure by the tilt indicator on unit P6, that the antenna is tilted up by $5\pm1^{\circ}$ and down by $25\pm2^{\circ}$ from the horizontal position. Establish a tilt angle of $0\pm2^{\circ}$ as read by the tilt indicator.

16. Set switch SEARCH on unit P6 to position RIGHT (ВПРАВО) and allow the antenna to make 2 - 3 revolutions, then to position LEFT (ВЛЕВО); the sweep trace must rotate jerkless in the direction corresponding to the switch position at a speed of 9.5 to 14.5 r.p.m. Release the switch.

17. Turn on switch ROTATION located on unit P6. In this case, the sweep trace must rotate smoothly clockwise at a speed of 16 - 24 r.p.m.

The start of the sweep should be matched with the light filter cross-hairs. When displacing the sweep it is necessary to match the start of the sweep with the centre of the indicator filter by means of knobs HORIZONTAL CENTRING (ЦЕНТРОВКА ГОРИЗ.) VERTICAL CENTRING (ЦЕНТРОВКА ВЕРТ.) on units P5/1 and P5/2.

Note: Make centring on indicator P5 so that the outer end of the sweep may be concentric in relation to the inner circle of the azimuth scale with the antenna rotating.

There may be a discrepancy between the start of the sweep and centre of the light filter at which the start of the sweep describes a circle of not more than 3 mm in diameter with the eccentricity not exceeding 0.5 mm.

18. Turn on switch COURSE LINE and make sure that there is a course line on the indicator screen. The course line must coincide with the vertical index line of the light filter and azimuth scale zero accurate to $\pm1.5^{\circ}$.

Note: Course line is not traced on the screen of indicator P8.

Turn off switches ROTATION and COURSE LINE.

19. Turn on switch SECTOR SCANNING. As a result, the sweep trace on the indicator screen must swing within a sector of $45\pm10^{\circ}$ with a frequency of 40 - 60 oscillations per minute.

Rotate knob POSITION CONTROL fully clockwise and then fully counter-clockwise; make sure that the sector is displaced in azimuth in the front zone limited by angles $305 - 55^{\circ}$ - on the azimuth scale of the indicator.

Turn off switch SECTOR SCANNING.

20. Turn potentiometer RANGE MARKER BRIGHTNESS on unit P6 clockwise until range markers appear on the indicator screens. Check the presence of range markers on the

screens in all positions of switch RANGE KM on unit P6. Range markers should appear with 2-km. intervals with switch RANGE KM in position "10", with 10-km. intervals in position "10-70" and 20 km., and with 20-km. intervals in positions "100" and "200" km.

Note: The marker brightness should be so inserted as to avoid backward journey of the markers on the sweep trace; potentiometer RANGE MARKER BRIGHTNESS should not be placed in the extreme clockwise position.

21. Check the sweep range scale when setting switch RANGE KM to position "10", "20", "100" and "200". If the markers are not in the respective number in one of the switch positions, adjust the amplitude and range of the sweep on the screen of the navigator-operator's indicator following the procedure below:

(a) Set switch RANGE KM in position 20.

(b) Turn knob SWEEP AMPLITUDE (АМПЛИТУДА РАЗВЕРТКИ) on unit P4 fully counter-clockwise.

(c) Adjust potentiometer RANGE CONTROL (РЕГУЛИРОВКА ДАЛЬНОСТИ) on unit P4 so that two range markers are visible on the sweep trace and the sweep trace does not come beyond the second range marker.

(d) Adjust the sweep by potentiometer SWEEP AMPLITUDE so that the second 10-km. marker is coincident with the inner circle of the indicator azimuth scale.

(e) Set switch RANGE KM on unit P6 successively to position "10" and "20" and make sure that 2 and 5 markers respectively have appeared on the sweep trace (counting the markers just after the start of the sweep).

(f) Set switch RANGE KM on unit P6 successively to position "100" and "200" and make sure that 5 and 10 range markers respectively have appeared on the sweep trace.

(g) If the operation (Points e and f) does not cause the required number of markers to appear, readjust potentiometer RANGE CONTROL on unit P4.

(h) If the sweep amplitudes on indicators P5/2 and P8 differ from that on the navigator-operator s indicator, remove the cover of unit P4 case and make an additional adjustment of the sweep amplitude of the indicators by potentiometers P4-15 and P4-16 located at the rear wall in unit P4.

(i) Set all the control knobs to the initial positions.

22. Set switch RANGE KM to position "10-70", turn knob "10-70" fully counter-clockwise. In this case only one marker is allowed to appear on the indicator screen at the very end of the sweep trace. Turn knob "10-70" fully clockwise; this will cause 7-10 ten-km markers to appear on the indicator screen.

23. Set switch CALIBRATION - OPERATION on unit P3 to position CHECK 5:1, switch RANGE KM on unit P6 to position "10-70". In this case four 2-km. range markers with adjustable brightness must locate on the indicator screen between all bright 10-km. markers. If the division is not in line with 5:1 ratio, rotate potentiometer FREQUENCY DIVISIONS 5:1 (ДЕЛЕНИЕ ЧАСТОТЫ 5:1) on the front panel of unit P3 to obtain correct and clear division.

When setting frequency division 5:1 proceed as follows:

(a) Set 40 - 50 km. range by turning knob "10-70" on unit P6.

(b) Turn potentiometer FREQUENCY DIVISION 5:1 clockwise until division 5:1 is out of alignment; note this position.

(c) Turn potentiometer FREQUENCY DIVISION 5:1 counter-clockwise until division 5:1 is out of alignment; note this position as well.

(d) Set the potentiometer mid-way between the marked positions.

24. Set switch CALIBRATION - OPERATION on unit P3 to position CHECK 6:1, switch RANGE KM on unit P6 to position "200". In this case five 20-km. range markers must locate between two 6:1 division marks. If the frequency division is not in line with 6:1, obtain the correct division by rotating potentiometer FREQUENCY DIVISION 6:1

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on the front panel of unit P2. Frequency division 6:1 is set in the same way as division 5:1.

Note: When setting frequency division 6:1 potentiometer RANGE CONTROL on unit P6 is allowed to rotate until stable markers are obtained on indicator screens.

After the frequency division (6:1) has been checked make a check on the sweep range as instructed in Point 20.

25. Set switch CALIBRATION - OPERATION on unit P3 at OPERATION, switch RANGE KM on unit P6 to position "10-70", knob "10-70" to the maximum clockwise position, knob POSITION on unit P9 to the mid position, tumbler MARKERS on unit P6 to position CALCULATION (ВЫЧИСЛ.). Set a shorter range on the RANGE scale on unit P6 than the range corresponding to the indicator sweep.

Under normal operation in the SEARCH mode indicators P5/1, P5/2, and P8 will display a range marker being off the centre at a distance corresponding to the range indicated on scale RANGE.

26. To check the operation of the step delay set switch CALIBRATION - OPERATION on unit P3 to position FREQUENCY DIVISION 6:1, switch RANGE KM on unit P6 to position "200". When setting switch SWEEP DELAY KM to position "0" and "20", four 20-km. markers should appear on the sweep forward of the first bright marker. If they do not, use potentiometer ZERO to adjust the step delay. Rotating switch SWEEP DELAY KM on unit P6 clockwise must cause the bright mark of frequency division 6:1 to move towards the centre of the indicator screen. The mark moves by 20-km. steps upon every switching, except the first one (from 0 to 20).

If in any position of the switch, 6:1 frequency division mark fails to cover 20 km. with respect to the previous position, adjust step delay by potentiometer ZERO and RANGE SCALE on unit P3. If you experienced in doing this operation make an adjustment without using an oscillograph. Otherwise adjust the delay of the sweep start by steps up to 400 km. following the procedure below:

(a) Connect the oscillograph input to grid 1 of coincidence valve Л3-9 in unit P3.

(b) Set oscillograph knobs in the following positions:

- switch SYNCHRONIZING (СИНХРОНИЗАЦИЯ) - in position INTERNAL (ВНУТРЕННЯЯ),
- switch SWEEP - in position "250 - 500 microsec."

Set switch CALIBRATION - OPERATION on unit P3 to position OPERATION, switch RANGE KM on unit P6 to position "200", switch AFC - BEACON to position BEACON - ON.

Turn switch SWEEP DELAY KM and watch the marker on the pedestal of the oscillograph screen. If the marker is moved off the middle of the pedestal, move it back by rotating step delay potentiometers ZERO and RANGE SCALE. Rotate potentiometer ZERO with switch SWEEP DELAY KM in positions from 0 to 100 km. At greater delays, rotate step delay potentiometer RANGE SCALE. Make adjustments until the marker is at the middle of the pedestal (but no farther than 1/4 width of the pedestal from the middle) in all positions of switch SWEEP DELAY KM.

Connect the oscillograph input to cathode 3 of coincidence valve Л3-9 in unit P3. Turn switch SWEEP DELAY KM successively from one position to another to make sure that every switch-over, except the first one (from 0 to 20) causes the marker to cover one interval; otherwise repeat adjustments.

27. Set switches located on unit P6:

-CHECK to position MAGNETRON CURRENT (ТОК МАГН.)

-AFC - BEACON to position AFC - OFF.

Press button TRANSMITTER ON (ПЕРЕДАТЧИК ВКЛ.). As a result a red pilot lamp must light up on unit P6.

Set switch RANGE KM to positions "10", "20", "10-70", "100", and "200". Note the readings of meter CHECK on unit P6.

Set switch FREQUENCY to position II and note the readings of meter CHECK again in all positions of switch RANGE KM. For all the ranges the magnetron current should be

within 9.5 to 15 mA.

Set switch AFC-BEACON to position BEACON-ON. Note the readings of meter CHECK located on unit P6 in all positions of switch RANGE KM and in both positions of switch FREQUENCY on unit P6.

Notes: 1. Rare (non-systematic) self-disconnections of the transmitter do not indicate that the equipment is defective. Such a self-disconnection has occurred, press button TRANSMITTER ON again and proceed operating.

2. If high voltage is not applied upon pressing button TRANSMITTER ON, check the condition of fuses ПР15-7 and ПР15-11 in distribution box P15.

28. Set switch AFC - BEACON to position AFC - OFF, switch CHECK to position MAIN CRYSTAL CURRENT and rotate knob RECEIVER TUNING in both directions until the meter reads the maximum value. The crystal current must be within 0.4 to 1 mA with the transmitter energized.

Set switch FREQUENCY on unit P6 to position II and check crystal currents on the second channel.

Notes: 1. When energizing the transmitter the currents of the main and AFC crystals are allowed to vary by 0.2 mA.

2. At low temperatures the crystal current may rise to 1.3 mA.

3. At the tuning point the currents of the main and AFC crystals must be not less than 80 per cent of the maximum currents of the crystals.

29. Set switch AFC - BEACON on unit P6 to position AFC - OFF. Turn knob RECEIVER TUNING from one extreme position to the other. In this case the crystal current must reach the maximum value with the knob in the middle position. In the extreme positions of the knob the crystal current may differ from zero. Operate potentiometer AFC VOLTAGE (НАПРЯЖЕНИЕ АПЧ) to obtain the maximum crystal current with knob RECEIVER TUNING in the mid-position.

30. Set switch CHECK on unit P6 to position AFC VOLTAGE with the crystal current at maximum; in this case the meter reading must be 160±30 V.

31. Set switch AFC - BEACON on unit P6 to position AFC - OFF. Rotate knob RECEIVER TUNING from one extreme position to the other. This should cause the AFC voltage to vary within 30 to 40 V.

32. Turn knob RECEIVER GAIN located on unit P8 fully clockwise and make sure that there is clutter on the sweep trace of the indicator after which turn the knob back to the initial position, i.e. fully counter-clockwise.

33. Set switch AFC - BEACON to position AFC - OFF, aim the antenna at the known object or with the antenna rotating tune the equipment to an echo signal from any object by means of control knobs: RECEIVER TUNING on unit P6, RECEIVER GAIN on unit P8, BRIGHTNESS on the indicators. To obtain better display choose optimum positions of switches RANGE KM and ANTENNA TILT. As a result clean echo signals reflected from the objects must appear at certain distances.

34. Set switch AFC - BEACON on unit P6 to position AFC - ON. The presentation of the echo signals on the indicator must be the same as during optimum manual tuning when the switch is set at AFC - OFF.

Place switch CHECK on unit P6 to position MAIN CRYSTAL CURRENT. Rotate knob RECEIVER TUNING all the way in both directions; in this case the pointer of the CHECK meter must be motionless and read the crystal current within 0.4 to 1 mA, and the presentation on the indicator screen should not fade. Check this with switch FREQUENCY in both positions and antenna rotating.

Note: If, during AFC operation after different kinds of change-over (changing over frequency, range, step delay), the AFC voltage appears to be lower than the normal rated value, turn knob RECEIVER TUNING clockwise to bring this value to normal (in this case the voltage is varied by jumps). This operation done, set knob RECEIVER TUNING to the mid-position.

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35. To check and adjust the range delay, place switch CALIBRATION - OPERATION on unit P3 in position RANGE CALIBRATION (КАЛИБРОВКА ДАЛЬНОСТИ), switch RANGE KM on unit P6 in position "10-70", turn knob "10-70" on unit P6 until 30-40 km. sweep range is obtained.

Turn knob RANGE on unit P6 and watch matching of the range marker with the appropriate calibration markers (on ranges divisible by 2). A divergency of ±100 m. is allowable. If this is not so, adjust the range delay following the procedure below:

(a) Rotate scale RANGE located on unit P6 in the direction from 2 to 30 km., count how many times the range marker is matched with calibration markers on the indicator screen.

(b) Adjust potentiometer RANGE-SCALE on unit P3 to match the lower edge of the range marker with that of the 14th calibration marker on the indicator screen with the RANGE scale set at 28 km.

(c) Set scale RANGE on unit P6 to position "2 km". and match the lower edge of the range marker with that of the first calibration marker on the indicator by adjusting potentiometer RANGE-ZERO on unit P3.

(d) Set scale RANGE on unit P6 to position "28 km". and obtain precise adjustment of the range scale.

(e) Repeat operations indicated in Points b and c a few times to obtain precise adjustment.

(f) Set scale RANGE successively to positions 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28 km. and make sure that the range markers are matched with the appropriate calibration markers accurate to ±100 m.

36. Press button TRANSMITTER OFF; in this case the transmitter is not fed with power, the magnetron current is absent, the red pilot lamp on unit P6 goes out.

37. Make sure that there is a sweep trace and range markers on the screen of indicator P8 in the SEARCH mode.

Checking Pulse Duration for Automatic Connection of Optical Sight OPB-11p

Apply 220 V, 50 c.p.s. to instrument ПВ-52 via relay contact K7-7 as shown in Fig.179.

Connect one end of the relay winding to terminal 1448 in unit P14, the other - to the body.

Set switches located on unit P9: CALIBRATION to position OPERATION and SPEED GENERATOR to position ON.

Determine the pulse duration by a stopwatch at the moment when lamp SIGHTING BUTTON ON (КНОПКА ВКЛЮЧЕНИЯ ВКЛ.) lights up on unit P9. The pulse duration must be within 0.25 to 0.8 microsec.

Checking and Adjustment of Energized Navigator s Equipment

1. Set all the control knobs to the initial positions as shown in Table 34; prior to checking and adjusting the navigator s equipment see that divisiton 6:1, step delay zero and altitude zero of the search part of the equipment are set properly.

2. See that a green pilot lamp labelled SUPPLY ON lights up on unit P9 upon energizing the equipment and adjust the brightness of the pilot lamp by means of a shutter.

3. Adjust the required illumination of the indicator scale by smoothly rotating knob SCALE ILLUMINATION on unit P8. Adjust the required illumination of scales SLANT RANGE CORRECTION M and TRACK SPEED KM/HR located on bomb aimer a panel P9.

4. Set switch ANTENNA TILT on unit P9 first to position UP, then to position DOWN.

Make sure by means of the antenna tilt indicator on unit P6 that the antenna tilts up by $5\pm1^{\circ}$ and down by $25\pm2^{\circ}$. Set switch ANTENNA TILT to the mid-position when the tilt indicator reads 0° or -2°.

5. Rotate knob BRIGHTNESS smoothly clockwise (located on unit P8), adjust the brightness of PPI display to the required level.

6. Set switch SEARCH - HOMING (ПОИСК-НАВЕДЕНИЕ) located on unit P9 to position HOMING; make sure that the sweep brightness is approximately the same as that in the SEARCH mode.

Note: If there is no sweep trace in the HOMING mode, check in what direction (in azimuth) the antenna is installed and, if need be, adjust the sweep to "0" of the azimuth scale of indicator P5/1.

7. Rotate knob FOCUS on unit P8 to focus the sweep trace so that it may be as thin and contrast as possible.

8. Set switch SEARCH - HOMING located on unit P9 to position SEARCH and make sure that the sweep trace starts from the centre of the light filter. If this is not so, operate knobs HORIZONTAL CENTRING and VERTICAL CENTRING PPI on unit P8 to match the start of the sweep with the centre of the indicator light filter.

9. Rotate knob POSITION on unit P9 clockwise; in this case the sighting pip on the screen of indicator P8 must move from the side of the sweep towards the centre of the screen.

10. Make a horizontal centring of the sweep trace on the screen of indicator P8 in the homing mode following the procedure below:

(a) Set switch SEARCH - HOMING on unit P9 to position HOMING.

(b) Adjust the antenna exactly to "0" of the azimuth scale of indicator P5/1.

(c) Make sure that the sweep trace in the SEARCH mode is exactly coincident with "0" of the azimuth scale and central vertical line on the light filter of indicator P8.

(d) Make sure that the drift angle index of the optical bombsight is exactly coincident with "0" of the drift angle scale on the course stabilizer; if necessary, bring them in precise alignment.

(e) Make sure that the vertical gyro of the optical bombsight is locked, whilst switch AZIMUTH on unit P8 is set at OFF.

(f) Make sure that "0" of the indicator azimuth scale - the central vertical line on the light filter - is matched precisely with the white index on the front of indicator P8; if necessary bring them in line.

(g) Operate knob HORIZONTAL CENTRING to precisely match the sweep trace with the central longitudinal line on the light filter. Matching done, tighten the union nut of the knob.

11. Make a vertical centring of the sweep trace following the procedure below:

(a) Make sure that switch CALIBRATION on unit P3 is set at OPERATION, switch SEARCH - HOMING on unit P9 at HOMING, and switch RANGE KM on unit P6 is set at "10-70".

(b) Set switch AZIMUTH on unit P8 at ON.

(c) Switch on sector scanning; in this case knob POSITION CONTROL on unit P6 must be set at the mid-position.

(d) Match the upper edge of the sighting line with the transverse line of the light filter by smoothly rotating knob VERTICAL CENTRING, B. Care should be taken to bring the sighting line upwards. Tighten the nut of knob VERTICAL CENTRING on unit P8.

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12. When checking the drift angle compensation circuit proceed as follows:

(a) Set the sweep trace at the course line, place switch COURSE LINE located on unit P6 in position OFF. Bring the scale zero on the screen of indicator P5/1 in line with the sweep trace.

(b) Make sure that the PPI display on the screen of indicator P8 is adjusted to 0°. Turn on and off switch AZIMUTH on unit P8 several times watching simultaneously the homing sweep trace on the indicator screen. The sweep trace must be motionless in relation to the longitudinal axis of the light filter. If it is not, make the B display motionless by changing over switch SEARCH. Make a check with the optical sight (OПБ -11p) adjusted.

(c) Check the horizontal centring.

(d) Turn on switch AZIMUTH located on unit P8.

(e) Turn the antenna through 20° to the right.

(f) Turn the sight toward the antenna until the vertical sweep is coincident with the central longitudinal line of the light filter on indicator P8.

(g) Read off the drift angle from the drift angle scale located on the course stabilizer. The reading must be equal to the antenna turn angle with a tolerance not exceeding ±2°.

(h) Make a similar check when turning the antenna through 20° to the left.

(i) If the value read off the drift angle scale comes beyond the limits of ±2°, check the adjustment of the drift correction potentiometer following the procedure below:

- disconnect cable No. 16 from the altitude unit of sight OПБ-11p;
- set switch AZIMUTH to position ON and make a horizontal centring of the homing sweep on unit P8. Set the sight at zero on the scale of the course stabilizer, lock the gyro;
- connect cable No. 16 to the altitude unit of sight OПБ-11p. The B display on the screen of indicator P8 should be motionless or is allowed to move within ±0.5°. The sweep displacement in excess of ±0.5° testifies to faulty operation of sight OПБ-11p;
- remove the dome;
- turn the antenna through 20° to the right as measured by the scale mounted on a crown gear, turn the sight (OПБ-11p) in the same direction through a drift angle equal to the antenna turn angle and operate potentiometer DRIFT CORRECTION on unit P8 to match the vertical sweep trace with the longitudinal central line on the light filter;
- turn the antenna through 20° to the left and do the same operations as during turning of the antenna through 20° to the right;
- make a check when the drift angles are ± 10°;
- the accuracy when matching the sweep with the longitudinal line on the indicator light filter must be at least ±1°;
- tighten the locking nut of the drift correction potentiometer shaft on unit P8.

13. Check and adjust the bomb side deviation system and bank compensation following the procedure below:

(a) Make sure that the vertical gyro of sight OПБ-11p is locked.

(b) Set all the controls on sight OПБ-11p to positions indicated in Table 35.

Positions of Controls on OПБ-11p Sight with Corresponding Antenna Turn Angle by Scale Mounted on Crown Gear of Antenna

Table 35

No.	Antenna turn angle (drift angle +φ side)	Lag, %	Sighting angle, degrees	φ side	Drift angle, degrees
1	+22°30'	51	45	7°30'	+15
2	-22°30'	51	45	7°30'	-15
3	+25°	25.5	45	5°	+20
4	-25°	25.5	45	5°	-20

(c) Turn the antenna through drift angle + φ_{side} (degrees) to the right (or left).

Note: The antenna turn angle is taken from column DA + φ_{side} in Table 35.

(d) Turn the sight to follow the antenna until the sweep trace is matched with the central longitudinal line of the light filter of indicator P8 and at the moment of matching note the reading of the drift angle index of sight OПБ-11p on the drift angle scale. The drift angle value should correspond to that specified in Table 35 with a tolerance not exceeding ±2°.

(e) Make a similar check of all the drift angles given in Table 35.

If the drift angle value does not correspond to that given in Table 35 (with a tolerance of ±2°), adjust the transverse stabilization as follows:

-turn the antenna through angle DA + φ_{side} as measured by the scale mounted on a crown gear of the antenna as indicated in Table 35;

-turn the optical sight to follow the antenna through a drift angle (Table 35) corresponding to the antenna turn angle DA + φ_{side};

- rotate potentiometer TRANSVERSE STABILIZATION (ПОПЕРЕЧН. СТАБ.) on unit P8 to match the sweep trace with the central longitudinal line of the light filter;

-make a check of all drift angles indicated in Table 35. Accuracy in matching the sweep with the longitudinal line on the light filter should be at least ±1.5°;

-tighten the locking nut of the shaft of potentiometer TRANSVERSE STABILIZATION on unit P8;

-place the antenna dome in position.

14. To adjust zero and range scale proceed as follows:

(a) Set the controls to the positions indicated in Table 36.

(b) Energize the transmitter.

(c) Turn the slant range correction scale clockwise if the sighting marker is above the calibration marker and counter-clockwise if the sighting marker fails to reach the calibration marker. See that the lower edge of the sighting marker is coincident with that of the calibration marker. The reading of the slant range correction scale must be within 0±15 m. If the scale readings exceed the tolerance make an adjustment by means of knob RANGE ZERO ADJUSTMENT on unit P3. This should be done as carefully as possible while matching the lower edge of the sighting marker with the lower edge of the calibration marker. In this case the readings of the slant range correction scale approximate zero despite the existing tolerance.

(d) Shift switch CALIBRATION on unit P9 to position RANGE, adjust the slant range correction scale to 0.

(e) Set switch SEARCH - HOMING to position SEARCH and make sure that the sighting marker is close to the fourteenth 2-km. calibration marker or matched with it.

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(f) Shift switch SEARCH - HOMING back to position HOMING, turn the slant range correction scale and make sure that the sighting marker is matched with the calibration marker on the screen of indicator PS when the slant range correction scale reads within 0 to 100 m. If this is not so, operate potentiometer RANGE SCALE on unit P3 to make adjustment until the sighting marker is properly matched with the calibration marker. If the sighting marker fails to reach the 14th calibration marker, turn the potentiometer knob clockwise. If the sighting marker overpasses the 14th calibration marker, rotate the potentiometer knob counter-clockwise.

Table 36

Initial Positions of Controls on Units of Bombsight PBH-4 and OMB-11p when Adjusting Zero and Range Scale

Unit	Controls	Position
Bomb aimer s panel P9	Switch CALIBRATION	RANGE ZERO
	Switch SEARCH - HOMING	HOMING
	Switch SPEED GENERATOR	OFF
	Slant range correction scale	0
Optical sight OMB-11p	Scale ALTITUDE on computer	14 km.
	Scale SIGHTING ANGLE	0°
	ON -OFF switch on altitude unit	OFF
Navigator-operator s panel P6	Switch RANGE KM	10-70
	Knob "10-70"	Turn knob until 30-km. sweep is obtained
Range unit P3	Switch CALIBRATION - OPERATION	Range CALIBRATION
Lock unit P4	Knob RECEIVER GAIN	Extreme counter-clockwise position

(g) Set switch CALIBRATION on unit P9 back to position RANGE ZERO and operate knob RANGE ZERO ADJUSTMENT to match the sighting marker with the calibration marker. The above adjustment should be made until the sighting marker is fully coincident with the calibration marker.

Note: During calibration when matching the calibration marker with sighting marker at 28th kilometre, keep them at a distance equal to half the maximum error.

15. To check the accuracy of slant range injection proceed as follows:

(a) Set the controls in positions indicated in Table 37.

Table 37

Initial Positions of Controls on Units of Bombsights PBH-4 and OMB-11p when Checking Accuracy of Slant Range Injection

Unit	Controls	Position
Bomb aimer s panel P9	Switch CALIBRATION	RANGE
	Switch SEARCH - HOMING	HOMING
	Switch SPEED GENERATOR	OFF
	Slant range correction scale	0
Navigator-operator s panel P6	Switch RANGE KM	10-70
Range unit P3	Switch CALIBRATION-OPERATION	Range calibration
Lock unit P4	Knob RECEIVER GAIN	Extreme counter-clockwise position
Optical sight OMB-11p	ON - OFF switch on altitude unit	OFF

(b) Set scales ALTITUDE and SIGHTING ANGLE on optical sight OMB-11p alternately at the values indicated in Table 38.

Table 38

Position of Controls on Bombsight OMB-11p when Checking Accuracy of Slant Range Injection

No.	Altitude H, m.	Sighting angle, degrees	Slant range, km.
1	2000	0	2
2	4000	0	4
3	6000	0	6
4	8000	0	8
5	10,000	0	10
6	12,000	0	12
7	14,000	0	14
8	16,000	0	16
9	9848	10	10
10	9397	20	10
11	10,392	30	12
12	10,725	40	14
13	10,284	50	16
14	11,000	60	22
15	12,000	60	24
16	14,000	60	28
17	16,000	60	32

Notes: 1. During range calibration the altitude should be set by means of knob ALTITUDE on the computer. When the flight altitude exceeds 14,000 m.

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make calibration setting the altitude by the altitude potentiometer located on the altitude unit having placed the ON - OFF switch on the altitude unit in position ON.

2. Rotate scale SIGHTING ANGLE in the direction from larger to smaller angles.
3. Rotate the slant range correction scale counter-clockwise until the lower edge of the sighting marker is matched with that of 2-km. calibration marker on the screen of indicator P8.

The readings on the slant range correction scale for all the points given in Table 38 should not differ by more than ± 100 m.

Note: If the bomb dropping height is known, the data for check on range calibration may be taken from Table 39.

Table 39

Bomb Dropping Slant Range

Flight altitude H, m.	Altitude set on sight OPB-11p	Sighting angle, degrees	Bomb dropping range, m.
6000	6087	41	8000
	6018	53	10,000
	6000	60	12,000
8000	7988	37	10,000
	8029	48	12,000
	8030	55	14,000
	8000	60	16,000
10,000	9948	34	12,000
	10,070	44	14,000
	10,068	51	15,000
	10,062	56	18,000
	10,000	60	20,000
12,000	12,000	31	14,000
	12,075	41	16,000
	12,043	48	16,000
	12,036	53	20,000
	11,976	57	22,000
	12,000	60	24,000
14,000	13,993	29	16,000
	13,987	39	18,000
	13,894	46	20,000
	14,137	50	22,000
	14,107	54	24,000
	14,159	57	26,000
	14,000	60	28,000

16. To adjust the speed zero proceed as follows:
(a) Set the controls to the positions indicated in Table 40.

Table 40

Initial Positions of Controls when Adjusting Speed Zero

Unit	Controls	Position
Bombaimer's panel P9	Switch CALIBRATION	SPEED ZERO (НУЛЬ СКОРОСТИ)
	Switch SEARCH - AIMING	AIMING
	Switch SPEED GENERATOR	OFF
	Slant range correction scale	0
	Scale TRACK SPEED	Any
	Knob POSITION	Extreme counter-clockwise position
Navigator-operator's panel P6	Switch RANGE KM	10-70
Block unit P4	Knob RECEIVER GAIN	Extreme counter-clockwise position

(b) Shift switch SPEED GENERATOR to position ON.

(c) Rotate knob POSITION clockwise, bring the calibration marker to the horizontal line on the indicator light filter. Note position of the calibration marker as minute after it has been matched with horizontal line on the light filter. The marker is allowed to displace by not more than the length of its diameter. If the displacement of the calibration marker is in excess of its diameter, make an adjustment of the speed zero.

(d) Turn knob SPEED ZERO ADJUSTMENT located on unit P9 counter-clockwise, if the calibration marker crawls up the horizontal line on the light filter. Turn the knob clockwise, if the calibration marker crawls down the horizontal line on the light filter.

Make a check again to make sure that the marker's crawl does not exceed the length of its diameter for one minute.

17. To adjust the speed scale proceed as follows:
(a) Set the controls to the positions indicated in Table 41.

Table 41

Initial Positions of Controls when Adjusting Speed Scale

Unit	Controls	Position
Bombaimer's panel P9	Switch CALIBRATION	SPEED (СКОРОСТЬ)
	Switch SEARCH - AIMING	AIMING
	Switch SPEED GENERATOR	OFF
	Knob POSITION	Extreme counter-clockwise position
	Scale TRACK SPEED	1200
Navigator-operator's panel 6	Switch RANGE KM	10-70
Block unit P4	Knob RECEIVER GAIN	Extreme counter-clockwise position

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(b) Turn on switch SPEED GENERATOR not less than 30 sec. after setting of the controls. Watch the movement of the calibration markers on the screen of indicator P8. Pass first 5 calibration markers, start the stopwatch at the moment of passage of the 5th calibration marker and stop it at the moment when the 10th marker passes the preset sighting marker.

(c) Adjust potentiometer SPEED SCALE so that the passage time of the five 2-km. calibration markers may be within 30±6 sec.

(d) Check the time taken by the five 2-km. calibration markers to pass the preset sighting marker for the following speeds: 1200, 900, 600, 300 km/hr.

The passage time of the five 2-km. calibration markers for the above-mentioned speeds should correspond to the time indicated in Table 42.

Table 42

Passage Time of 2-km. Calibration Markers for Various Speeds

Speed, km/hr	300	600	900	1200
Time, sec.	120±2.4	60±1.2	40±0.8	30±0.6

18. To check the change to the operating conditions from optical sight OMB-11p, proceed as follows:

(a) Set the controls to the positions indicated in Table 43.

Table 43

Initial Positions for Controls when Checking Change to Operation from Optical Sight OMB-11p

Unit	Controls	Position
Bomb aimer's panel P9	Switch CALIBRATION	OPERATION
	Switch SEARCH - HOMING	SEARCH
	Switch SPEED GENERATOR	OFF
	Knob POSITION	Extreme counter-clockwise position
Navigator-operator's panel P6	Switch RANGE KM	10-70
	Knob 10-70	Extreme clockwise position
	Knob RANGE MARKER BRIGHTNESS	Turn clockwise until range markers appear
Range unit P3	Switch CALIBRATION - OPERATION	OPERATION
Optical sight OMB-11p	Scale SIGHTING ANGLE	60°
	Scale ALTITUDE	14 km.
Lock unit P4	Knob RECEIVER GAIN	Extreme counter-clockwise position

(b) Turn on switch SPEED GENERATOR located on unit P9. Rotate knob POSITION clockwise to make sure of the change to operation from optical sight OMB-11p by the lighting up of the red lamp on unit P9 and green lamp on unit P8. See that the change to the main synchronizing takes place at a distance of 28 km.

19. To check the bomb drop warning signal follow the procedure below:

(a) Set the controls to the positions indicated in Table 44.

Table 44

Positions of Controls when Checking Bomb Drop Warning Signal

Unit	Controls	Position
Bomb aimer's panel P9	Switch CALIBRATION	OPERATION
	Knob POSITION	Extreme clockwise position
	Switch SPEED GENERATOR	ON
Optical bombsight OMB-11p	Sighting angle index	70°
	Aiming angle index	40°
	Scale ALTITUDE ON COMPUTER (ВЫСОТА НА ВЫЧИСЛИТЕЛЕ ПРИБОРЕ)	14 km.
	ON - OFF switch on altitude unit	OFF
	Knob AUTOMATIC DROP (АВТОСБРОС)	Cocked

(b) Energize the optical bombsight.

(c) Rotate the sighting knob located on the optical bombsight to make sure that the red lamp lights up on unit P8.

CAUTION: Prior to making a check, cut out the circuit-breakers of the bomb doors.

The check should be made on permission of the aircraft armament specialist.

20. When checking the quality of presentation in the HOMING mode proceed as follows:

(a) Set the controls to the positions indicated in Table 45.

Table 45

Initial Positions of Controls when Checking Quality of Presentation in HOMING mode

Unit	Controls	Position
Navigator-operator's panel P6	Switch RANGE KM	10-70
	Switch SECTOR SCANNING	ON
Bomb aimer's panel P9	Switch SEARCH - AIMING	SEARCH
	Switch CALIBRATION	OPERATION
Optical bombsight	Sighting angle index	0°

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(b) Obtain the target presentation on the indicator screens as instructed in Points 33 and 34 of Section "Checking and Adjustment of Live Equipment of Navigator-Operator".

(c) Operate knob ALTITUDE on the optical bombsight to bring the sighting marker under the target visible on the screen of indicator P8.

(d) Change to AIMING mode and make sure that the objects are visible on the screen of indicator P8.

21. To deenergize the equipment proceed as follows:

(a) Set the controls to the initial positions indicated in Table 34.

(b) Switch on the transmitter and the supply of radar bombsight PTB-4.

(c) Open circiut-breaker A3C-20 "Radio Sight" located on the circuit-breaker panel of the operator s cabin.

Postflight Inspection and Checking of Equipment

The postflight inspection and checking of the equipment are the main preventive maintenance jobs the aim of which is to ensure normal operation of the equipment.

When making a postflight inspection and check, proceed as follows:

1. Obtain information as to operation of the equipment in flight from the navigator-operator and aircraft navigator.

2. Inspect the equipment visually, check the tightness of the plug connectors, fastening of the cables to the aircraft sides, fastening of the units; check bonding of the units. Give special attention to the condition of the bunched cables and their screening.

3. Check reliability of operation of all the switches, interlocking contact in distribution box P15 with the radar bombsight supply off. Check for presence of spare fuses, spare valve complement and tools, replenish the complement with missing fuses and valves.

4. Make an entry into the Log as to all troubles revealed by inspection. Do not eliminate troubles until the inspection is finished.

5. Eliminate all the troubles located in flight and during inspection. The trouble eliminated, check the live equipment following the above technique.

6. Make an entry into the radar bombsight Service Log as to replacement of components.

Elimination of Possible Troubles

Troubles in the equipment are most frequently caused by the burning out of fuses, poor tightening of plug connectors, breaks or shorts in junction cables or wires.

Sometimes wrong setting of the control knobs is misleading. Therefore, when finding the cause of trouble in the equipment it is necessary first of all to carefully inspect the units and junction cables, tighten the nuts of the connectors, if necessary, check the condition of fuses and position of the controls. The defective units should be replaced in succession by good ones; if the cause of trouble is not revealed, find which unit is defective.

If, for any reason, the defective unit should be replaced in the given station, make complete adjustment and calibration of the equipment .

Troubles and Remedies

Trouble	Probable cause	Remedy
1	2	3
No 115 V A.C. are applied (illumination lamps do not burn, check instrument does not read 115 V, 400 c.p.s., valves are not heated)	Blown fuse CII-15A in fuse distribution box of navigator-operator. No contact in interlock button of unit P15	Replace fuse CII-15A in fuse distribution box of navigator-operator. Press interlock button with hand
Voltages -300 V, +300 V, +400 V cannot be applied	Blown fuse Пр15-4 in unit P15	Replace fuse Пр15-4
Voltages +300 V and +400 V are absent (very bright and wide spot existing on indicators, brightness and focus are not adjustable)	Defective valves Л11-1, Л11-2 and Л11-3 in unit P11	Replace defective valves in unit P11
No voltage of - 300 V	Defective valves Л11-5 Л11-13, Л11-14 in unit P11	Replace defective valves in unit P11
Voltage of ±300 V is unadjustable or unstable	Defective valve Л11-4 in unit P11	Replace defective valve in unit P11
Voltage of +400 V is too high or low	Defective valve Л11-1, Л11-2, Л11-3 in unit P11	Replace defective valves in unit P11
Fan motors fail to operate in units P2 and P12	Break of supply wires running to motors or defective motors	Eliminate trouble in supply wires of motors. 27 V D.C. must be across terminal 1304 in unit P13
Indicator P5/1 scale is not illuminated, valves of unit P4 are not heated	Blown fuse Пр15-2 in unit P15	Replace fuse in unit P15
Indicator P5/1 scale is not illuminated	Burned out scale illumination valves or short circuit in sockets	Replace blown out valves
Scale of indicators P5/2, P8 is not lighted, valves of unit P7 are not heated	Blown fuse Пр15-6 in unit P15	Replace fuse in unit P15
No sweep and electronic spot on all indicators	(a) Blown fuse Пр15-5 in unit P15	Replace fuse
	(b) Defective valve Л10-1 in unit P10	Replace defective valve
No sweep on one indicator	Burned out filament in cathode-ray tube	Replace cathode-ray tube

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1	2	3
Too bright and too wide spot (sweep trace), brightness is uncontrollable by knob BRIGHTNESS	+300 V are not applied to indicator (no contact in ball-type connector, break of wire in +300 V circuit)	Restore contact, eliminate trouble in +300 - V circuit
No sweep existing on indicators P5/2 and P8	Blown fuse Пр15-6 in unit P15	Replace fuse
No sweep existing on indicator P5/2	Defective valve Л4-26 in unit P4	Replace valve Л4-26
No sweep existing on indicator P8 in SEARCH	Defective valve Л4-27 in unit P4	Replace defective valve
No sweep on all range bands, but there is sharply focused spot in centre of indicator screen	(a) Blown fuse Пр15-1 or Пр15-2 in unit P15 (b) Defective valve Л3-4 in unit P3 (c) Defective valves Л4-20, Л4-21 and Л4-22	Replace fuse Пр15-1 or Пр15-2 Replace defective valve Replace defective valves
Sweep trace and blurred range markers on all indicators are generated	(a) Defective valve Л4-19 in unit P4 (b) Wrong repetition frequency	Replace defective valve Check frequency division 5:1 and 6:1, adjust with potentiometers CHECK OF FREQUENCY 5:1 and CHECK OF FREQUENCY 6:1 on unit P3
Antenna fails to rotate when switch ROTATION on unit P6 is set at ON	Blown fuse Пр15-12 in unit P15	Replace fuse in unit P15
Antenna rotates continuously when switch SECTOR SCANNING is set at ON	Blown fuses Пр15-13 and Пр15-14 in unit P15	Replace fuses in unit P15
Antenna is motionless when switch SECTOR SCANNING is turned on	Blown fuse Пр15-12 in unit P15	Replace fuse in unit P15
No range markers and clutter on indicators	One of valves Л4-9, Л4-10, Л4-11, Л4-12 is defective in unit P4	Replace defective valve
There are range markers, but no clutter on indicators	One of I.F. amp. valves Л4-1, Л4-2, Л4-3, Л4-4, Л4-5, Л4-6, Л4-7, Л4-8 in unit P4 is defective	Replace defective valve
There are no range markers on indicators	Defective valve Л3-3 in unit P3	Replace defective valve
There is no range marker on indicators	One of valves Л3-10, Л3-11, Л3-12 in unit 3 is defective	Replace defective valve
No crystal current when switch AFC - BEACON on unit P6 is set at AFC-ON	No voltage of -300 V (defective valve Л11-15)	Replace defective valve Л11-15 in unit P11

1	2	3
Pointer of meter CHECK on unit P6 is motionless, while it should swing	Defective valve Л4-17 in AFC circuit in unit P4	Replace defective valve
Transmitter-receiver P2 cannot be energized	(a) Apparatus had not time to warm up (b) Blown fuse Пр15-7 or Пр15-11 in unit P15	Allow apparatus to warm up Replace defective fuse
Weak or no target presentation when knob AFC - BEACON is set at AFC - ON	Defective valves Л4-13, Л4-14, Л4-15, Л4-16 in AFC circuit of unit P4	Replace defective valves in unit P4. Rotate potentiometer AFC VOLTAGE on unit P4 until target presentation is bright and knob RECEIVER TUNING until lamp burns bright
There is no sweep on screen of indicator P8 in SEARCH and HOMING modes	Blown fuse Пр15-6 of connection box P15 in unit P15. Therefore 115 V are not fed to unit P14	Replace fuse Пр15-6 in unit P15
There is no sweep on screen of indicator P8 in HOMING mode	Defective valve Л7-1 of square-pulse generator in unit P7	Replace defective valve
Short B display on screen of indicator P8	Defective valve Л7-9 or Л7-10 in sweep amplifier of unit P7	Replace defective valve
Scale of indicator P8 is not lighted	Blown fuse Пр15-10 in unit P15	Replace defective fuse
Pilot lamp SUPPLY ON located on unit P9 fails to burn	Blown fuse Пр15-10 in unit P15	Replace defective fuse
There is no target presentation on screen of indicator P8 both in SEARCH and HOMING modes with target presentation on screens of indicators P5/1 and P5/2	Defective video amplifier valve Л7-21, Л7-22, or Л7-32 in unit P7	Replace defective valve

MEASUREMENT OF RADIO NOISE LEVEL

General Instructions

1. Prior to measuring the radio noise level make sure that:

(a) The performance of the radio equipment and noise sources on board the aircraft is checked and complies with Specifications.

(b) Bonding of the aircraft, especially of radio facilities and noise sources, is checked and complies with Specifications.

(c) All temporary wiring systems and check instruments (oscillographs, recorders, etc.) are disconnected.

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(d) Sensitivity of the receivers is measured.

2. When measuring radio noise observe the following conditions:

(a) Have the aircraft positioned outside the zone of manmade interference.

(b) Measure radio noise when the level of atmospheric and industrial noise does not exceed the permissible level for the given receiver in line with its sensitivity.

(c) The aircraft mains should be powered from a storage battery of at least 500 a.h. capacity.

(d) The supply voltage of the aircraft mains should be 27.5 to 28 V D.C. and 112 to 116 V, 400 c.p.s. A.C.

Note: The supply voltage of the aircraft mains should be checked by the meters on the operator's panel.

CAUTION: 1. The aircraft mains may be fed by an airfield generator, provided the generator noise level does not exceed the permissible value for the given receiver.

2. The permissible level is allowed to rise on account of atmospheric and industrial noise at one or two points over the band to be measured, provided the main clutter is clear against the background of atmospheric clutter (upon switching on the noise source the output voltage of the receiver rises).

3. Depending upon the receiver sensitivity the rise of the measured noise level above the permissible value for the given receiver is determined by formula:

$$U_{rec.perm.} = \frac{U_{rec.}}{E_{rec.}}$$

which $U_{rec.perm.}$ = the permissible noise level at the receiver output, V;

$U_{rec.}$ = the permissible noise level at the receiver output for sensitivity $E_{rec.}$ = 1 microvolt. For receivers YC-9 and APK-5 $U_{rec.}$ = 18.5 V, for PCHY-3M $U_{rec.}$ = 37 V;

$E_{rec.}$ = the receiver sensitivity at a frequency of interference to be measured, microvolts.

4. To facilitate determination of the noise level allowable at the output of receivers YC-9, APK-5 and PCHY-3M use is made of the diagram of Fig.190 and Table 46 made up according to the above formula.

Table 46

Permissible Noise Levels at Output of Receivers YC-9, APK-5 and PCHY-3M Depending upon Receiver Sensitivity

Receiver sensitivity, microvolts	Permissible noise level (V) at outputs of receivers	
	YC-9, APK-5	PCHY-3M
1	2	3
1.0	18.5	37
1.1	16.8	33.6
1.2	15.4	30.8

1	2	3
1.3	14.2	28.4
1.4	13.2	26.4
1.6	11.6	23.2
1.8	10.3	20.6
2.0	9.3	18.6
2.2	8.4	16.8
2.5	7.4	14.8
2.7	6.9	13.8
3.0	6.2	12.4
3.2	5.8	11.6
3.5	5.3	10.6
3.7	5.0	10.0
4.0	4.6	9.2
4.5	4.1	8.2
5.0	3.7	7.4
5.6	3.3	6.6
6.0	3.1	6.2
7.0	2.7	5.4
8.0	2.3	4.6
10.0	1.85	3.7

5. The possible sources of noise on the aircraft are listed in Table 47.

Table 47

Possible Sources of Noise and Receivers at Output of which Noise is Heard

Source of noise	Operating duty of noise source during measurements	Receivers acted on by noise	Nature and amount of noise (in case of defective screening, bonding and filtering)	Remedy
1	2	3	4	5
PBM-4	Transmission on range 10-70	YC-9ДМ	Hum of about 1300 c.p.s. frequency is most loudly heard at tuning frequencies 4.5 - 6.0 Mc/s of the receiver YC-9ДМ	Bring to normal the screening of the units and cables of noise sources and receiver
			The permissible level is exceeded 2 - 4 times	Replace defective filters
НРС-1	When switching on hight voltage	YC-9	Same	Same

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1	2	3	4	5
АП-52М	When changing over control wheels	УС-9 and УС-9ДМ	Periodical crackling most loudly heard at frequencies 3.0 - 5.0 Mc/s. The permissible level is exceeded 2 - 2.5 times.	Same
ДВ-3,МВ-650,set "107", У-600	Normal operation	УС-9	Crackling over a frequency band of 3 - 9 Mc/s. The permissible level is exceeded 3 - 4 times at separate points of the band	Bring screening and bonding to normal. Clean the motor commutators
РСИУ-3М	Transmission on crystals A76, A172 and others	КРП-Э	Deflection of indicator ИСП-48 pointer by 1 - 2 mm when the aircraft flies on route and pointer swing toward zero mark when the aircraft is off the course line	Do not operate set РСИУ-3М in the TRANSMISSION mode in presence of interference from РСИУ-3М during landing by localizer receiver
РВ-2	During operation on the second band	СД-1	Locking by signals from radio altimeter РВ-2, change of readings of indicator ИРП-50, stopping of locking, unstable operation	Bring to normal the bonding and screening of the units and cables of radio altimeter РВ-2 and range finder СД-1, replace filters ВЧФ-2
РВ-17		СД-1	Same	Same

Measurement of Noise at Output of Receivers

УС-9 and УС-9ДМ

CAUTION: 1. Noise at the output of receiver УС-9ДМ should be measured through the interphone set of the right pilot, whilst at the output of receiver УС-9 through the set of the radio operator. In this case turn knob LOUDER (ГРОМЧЕ) on the interphone sets should be turned to a maximum (fully clockwise). Connect a pair of high-resistance earphones ТА-4 and output meter, type МВ-4, (Fig.181) to the output plug connector of the interphone set.

2. During noise measurements the switches of the other interphone sets should not be placed in the same positions as the switches on those sets through which the noise is measured.

3. Tune and fix on the APC channels of transmitter 1-РСБ-7СМ the following frequencies:

No. of channel	7	8	9	10	11
Frequency, Mc/s	3.0	5.6	9.0	12.8	17.2

1. Before attempting to measure noise set the receiver knobs to positions МРС, ТОН, CRYSTAL OFF, and the volume control - at maximum.

2. Tune transmitter 1-РСБ-7СМ to a frequency of 3.0 Mc/s (the 7th channel).

3. Tune receiver УС-9 (or УС-9ДМ) to a frequency of 3.0 Mc/s by the maximum deflection of the pointer of meter МВ-4 and maximum volume of atmospheric noise in the earphones.

Set the antenna adjustment knob at maximum sensitivity of the receiver by the maximum volume of atmospheric noise in the earphones.

4. Measure the atmospheric noise voltage at the output of receiver УС-9 (or УС-9 ДМ).

5. Set the noise sources to be checked (РПК-4 and ПРС-1, АП-52М and others) for normal operating conditions separately or simultaneously (if it is found necessary), measure the level of noise generated by them.

6. Repeat the operations indicated in Points 2, 3, 4 and 5 on tuning frequencies of УС-9 and РСБ-7СМ: 5.6, 9.0, 12.8 and 17.2 Mc/s.

7. If there is noise due to operating radio stations on the frequencies fixed by automatic tuning of station 1-РСБ-7СМ and it is necessary to determine the frequency of the maximum noise the receiver and transmitter should be tuned as follows:

(a) Tune receiver УС-9 (УС-9ДМ) to a frequency as close as possible to the frequencies indicated in Points 3 and 6, but free from the radio station noise (or any other frequency, for instance, to a frequency of the loudest noise), adjust the receiver antenna according to Point 3.

(b) Change over the automatic tuning of station 1-РСБ-7СМ to position MANUAL TUNING (РУЧНАЯ НАСТРОЙКА). Set knobs А, Б, Г and Д to positions corresponding to the tuning frequency of receiver УС-9: course - against the table of tuning of station 1-РСБ-7СМ (the table is supplied with every transmitter), fine - by the maximum deflection of the output meter pointer and maximum volume of noise in the earphones.

(c) Measure the noise level according to Point 5.

Measurement of Noise at Output of Radio Compass АРК-5

CAUTION: 1. Noise at the output of radio compass receiver АРК-5 Nos 1 and 2 should be measured through the interphone set of the navigator. In this case set the knob marked LOUDER (located on the interphone set) for maximum volume, and the function switch to position ADD. BOARD (ДОП/БТ). Set the switch of the additional board to position АРК-1 or АРК-2. Connect a pair of earphones, type ТА-4, and output meter МВ-4 to the output of the interphone set.

2. During measurements of noise at the output of the radio compass make sure that other interphone sets are not in position ADD. BOARD.

1. Set the function switch on the radio compass panel to position ANTENNA, knob VOLUME at maximum. Tune the radio compass to a frequency of 500 Kc/s, short terminal ANTENNA - EARTH (АНТЕННА - ЗЕМЛЯ). Operate control RECEIVER GAIN on the front panel of the radio compass to set the noise level at the output at 20 V. Unshort terminals ANTENNA - EARTH of the radio compass receiver.

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2. Tune the radio compass to 250 Kc/s frequency short terminals ANTENNA - EARTH of the radio compass receiver, operate the volume control located on the radio compass panel to set the noise level at the output at 2 V. Unshort terminals ANTENNA - EARTH of the receiver and measure the level of atmospheric noise at the output of the radio compass.

3. Energize the noise sources to be checked (PSH-4, GP3 and others) separately or simultaneously (if this proves to be necessary) and measure the level of noise generated by them.

4. Repeat the operations indicated in Points 2 and 3 on medium frequencies of the second and third bands of the radio compass - 500 and 1000 Kc/s, or on any other frequencies on which the noise level should be measured (for instance, on the frequency of the loudest noise).

5. Check against course indicator УКПБ-1 the effect of noise on the operation of the compass portion of radio compass АРК-5 during reception of weak signals (from remote radio stations).

Measurement of Noise at Output of Receiver of Radio Set РСИУ-3М

CAUTION: Noise at the output of receiver РСИУ-3М should be measured through the interphone set of the pilot. In this case set knob LOUDNR on the interphone set for maximum volume, and the function switch to position USW RADIO SET (УКВ/РС).

1. Set the volume control located on the panel of receiver No. 1 at maximum (to position Г), switches 1 and 2 to position "1". Set the sensitivity control on the front panel of the receiver at maximum sensitivity. switch off the noise limiter.

2. Measure the level of atmospheric noise on each channel of the receiver (No.1).

3. Energize the noise sources to be checked in normal operating conditions simultaneously or separately (if necessary) and measure the level of noise generated by them on each channel of the receiver.

4. Press the throat microphone button and measure the noise of the radio set operation at the monitoring output on each channel (400 c.p.s. hum).

Measurement of Noise at Output of Aircraft Interphone System СПУ-10

CAUTION: Noise at the output of the interphone system is measured through the interphone set of the operator by output meter ИВ-4.

1. Place the gain controls of the amplifiers in the position marked with a white line.

2. Energize receivers УС-9, УС-9ДМ, АРК-5 Nos 1 and 2, РСИУ-3М, tune them to well-heard radio stations, operate the volume controls of the receivers to set the output voltage of the signals from the radio stations to be received at 30 V.

3. Place the switches of all the interphone sets in positions NETWORK No. 1 and INTERPHONE, turn the volume control fully clockwise, connect a pair of earphones ТА-4 to each set.

4. Measure the noise level during simultaneous operation of all the receivers. The noise level at the output of the interphone system should not exceed 0.4 V.

When monitoring any of the receivers it is allowed that the operation of the interphone system and other receivers not connected to the output of the interphone set being checked is slightly heard. The monitoring voltage should not exceed 0.4 V

...h the receiver deenergized, which corresponds to the given position of the ...ction switch of the interphone set being checked).

Note: In order to detect electrical units - sources of high noise level-if the noise level exceeds the permissible one, monitor and measure the voltage of noise from each unit separately in all positions of the function switches on the interphone sets.

5. Repeat the operation indicated in Point 4 for position NETWORK No. 2.

6. Measure the hum voltage with the interphone button pressed and released ...ing operation of the electrical unit permanently acting in the aircraft. The hum ...tage should not exceed 0.4 V.

Operation of Electrical and Radio Facilities

...hen measuring the noise generated by the electrical units, the unit must ...ate under normal operating conditions.

...hen measuring the noise generated by the radio facilities, these facilities ...uld be operated at the main operating frequencies and ranges most commonly used ...ing simultaneous operation with the receivers which are acted upon by the given ...se sources. Switching on and tuning of the radio facilities is done according ...the Manufacturers instructions.

...hen measuring the noise generated by the electrical equipment of the tail and ...ter installations, it is necessary to release the action switch, set the sight ...the predetermined angle within the working control zone of the respective installa... (the installation when matched with the sight does not get on the limit stop) ...having pressed the action switch, make a change-over. After the installation ...tly matched with the sight make another change-over toward the other side (in ...h planes at a time). In this case note the noise level on the output meter ...34) connected to the output of receiver УС-9 ignoring separate short-time peaks ...e pointer kicks).

The given angle of the sight should be set and the action switch pressed at ...command of a person making noise measurements.

Do not measure the noise when the installations are operated in continuous ...erving conditions (swinging of the sights within greater limits (more than 10 ...25°) at a frequency of 2 - 3 oscillations per second as not complying with normal ...erating conditions).

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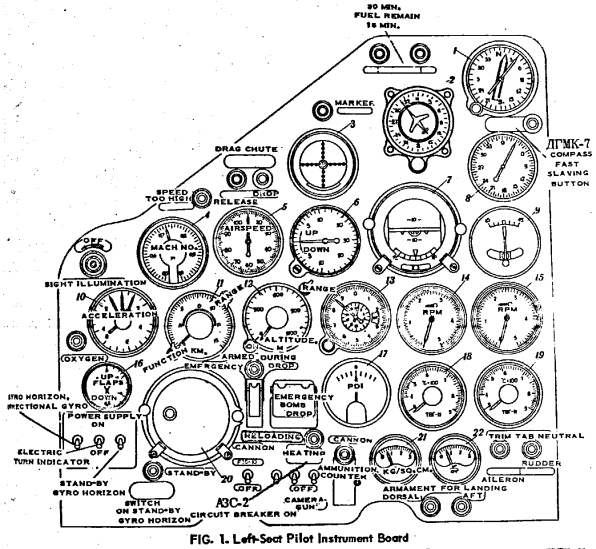

FIG. 1. Left-Seat Pilot Instrument Board

1 – indicator of ДГМК-7 remote-reading gyromagnetic compass; 2 – indicator of ГПК-52 directional gyro; 3 – ПСП-48 ILS indicator; 4 – МС-1 machmeter (with warning light); 5 – КУС-1200 airspeed indicator; 6 – ВАР-30-3 rate-of-climb indicator; 7 – АГБ-2 gyro horizon; 8 – БСУП-1 indicator of АРК-5 radio compass No. 1; 9 – ЗУП-53 turn indicator; 10 – АМ-10 accelerometer; 11 – РД-1 range finder indicator; 12 – РВ-2 low-altitude radio altimeter indicator; 13 – ВД-20 altimeter, 14 – indicator of left-hand engine tachometer, type ТЭ5-2; 15 – indicator of right-hand engine tachometer, type ТЭ5-2; 16 – УЗП-47 flap position indicator; 17 – pilot director indicator (PDI); 18 – ТВТ-11 exhaust gas temperature indicator of left-hand engine; 19 – ТВТ-11 exhaust gas temperature indicator of right-hand engine; 20 – АГБ-2 stand-by gyro horizon; 21 – ЭДМУ-3 fuel pressure gauge; 22 – ЭДМУ-3 fuel pressure gauge.

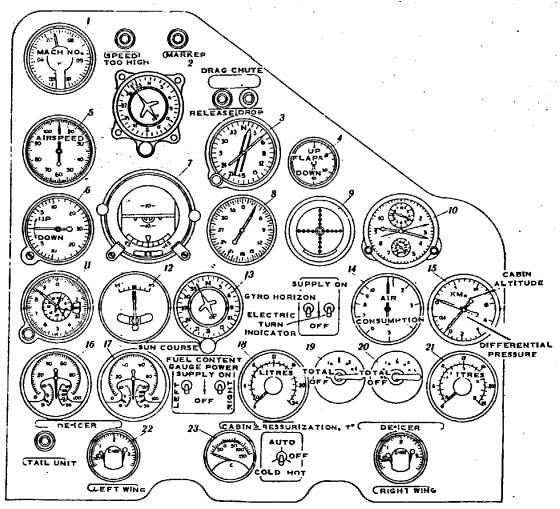

Fig. 2. Right-Seat Pilot Instrument Board

1 – МС-1 machmeter; 2 – indicator of ГПК-52 directional gyro; 3 – indicator of ДГМК-7 remote-reading gyromagnetic compass; 4 – УЗП-47 flap position indicator; 5 – КУС-1200 airspeed indicator; 6 – ВАР-30-3 rate-of-climb indicator; 7 – АГБ-2 gyro horizon; 8 – БСУП-1 indicator of АРК-5 radio compass No. 2; 9 – ПСП-48 ILS indicator; 10 – АЯХО clock; 11 – ВД-20 altimeter; 12 – ЗУП-53 turn indicator; 13 – indicator of ДАК-ДБ-5 set; 14 – indicator of РВУ-45У air flowmeter; 15 – УВИД-15 cabin altimeters; 16 and 17 – ЭМИ-3Р gauge unit indicators; 18 – fuel content gauge indicator of СЭТС-60М set; 19 and 20 – fuel gauge selector switches ПТ-7 of СЭТС-60М set; 21 – fuel content gauge indicator of СЭТС-60М set; 22 – air thermometer indicator ТИТ-13 of left-hand wing de-icer; 23 – cabin pressurization air thermometer indicator ТУЭ-48.

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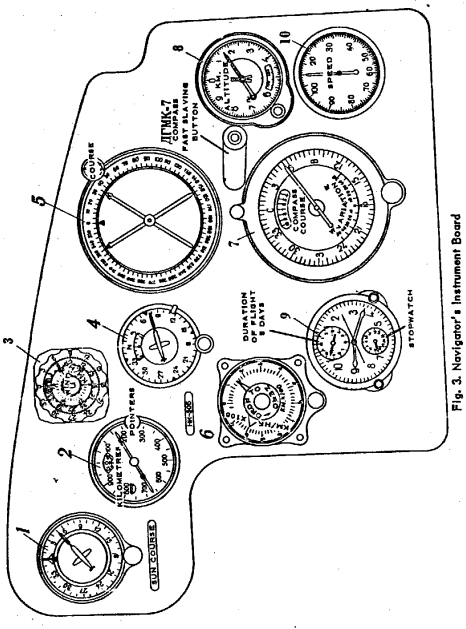

Fig. 3. Navigator's Instrument Board

1 – course indicator of ДАК-ДБ-5 set; 2 – D.R. computer of НИ-50Б set; 3 – wind setter of НИ-50Б set; 4 – automatic course device of НИ-50Б set; 5 – radio compass indicator УШЛБ-1; 6 – track corrector of ДАК-ДБ-5 set; 7 – indicator УШ of ДПМК-7 compass; 8 – altimeter ВД-20; 9 – clock АЧХО; 10 – airspeed indicator КУС-1200.

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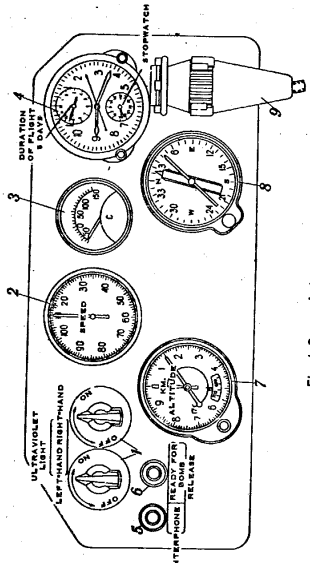

Fig. 4. Operator's Instrument Board

1 – rheostats of РУФО-45 ultraviolet lights; 2 – airspeed indicator КУС-1200; 3 – indicator ТУЗ-48 of external air thermometer; 4 – clock АЧХ; 5 – interphone button; 6 – warning lamp "Ready for bomb release"; 7 – altimeter ВД-20; 8 – course indicator of ДГМК-7 set; 9 – release button КСБ-49.

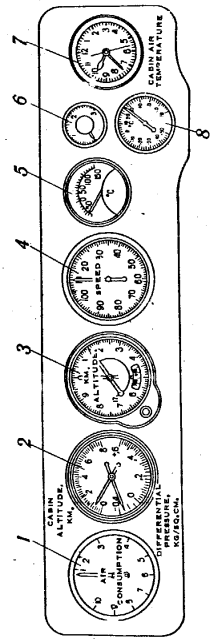

Fig. 5. Radio-Operator's Instrument Board

1 – air flowmeter РВУ-46; 2 – cabin altimeter УВПД-15; 3 – altimeter ВД-20; 4 – airspeed indicator КУС-1200; 5 – thermometer indicator ТУЗ-48 of external air temperature; 6 – voltmeter В-1; 7 – clock АЕР-М; 8 – cabin air thermometer ТВ-45.

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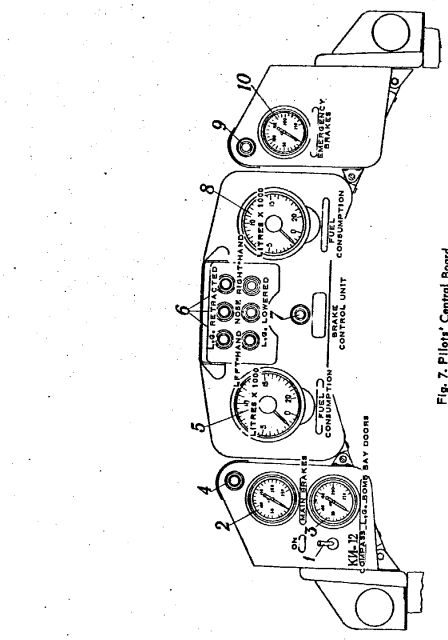

Fig. 7. Pilots' Central Board

1 – switch B-45 of KPS-12 compass; 2 – pressure gauge MP-250U of main brakes; 3 – pressure gauge MP-250U of landing gear – bomb hatch; 4 – warning lamp of pressure drop in main brake system; 5 – fuel flowmeter indicator PTC-16 of the left-hand group of fuel tanks; 6 – warning lamps "L.G. retracted" and "L.G. extended"; 7 – knob of control unit warning lamp; 8 – fuel flowmeter indicator PTC-16 of the right-hand group of fuel tanks; 9 – warning lamp of pressure drop in emergency brake system; 10 – pressure gauge MP-250U of emergency brakes.

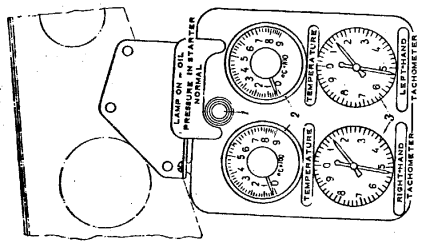

Fig. 6. Starter Instrument Board

1 – CHL-51 indicating lamp "Oil pressure normal"; 2 – TCT-29 tachometer indicator; 3 – TS-45 tachometer indicator.

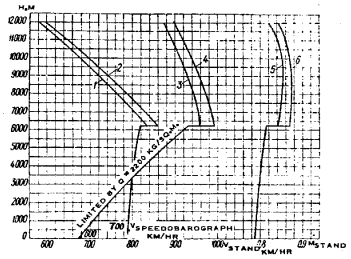

Fig. 8. Graph of Maximum and Horizontal Speeds Versus Altitudes

1 – maximum speeds by speedobarograph at normal engine rating; 2 – maximum speeds by speedobarograph at maximum engine rating; 3 – maximum speeds under standard conditions at normal engine rating; 4 – maximum speeds under standard conditions at maximum engine rating; 5 – Mach-number at normal engine rating; 6 – Mach-number at maximum engine rating.

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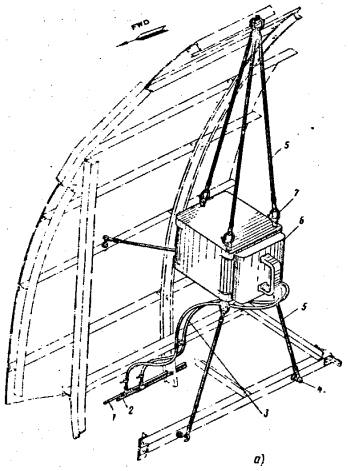

a)

Fig. 11. Suspension of Recorder K2-75

1 – dynamic pressure line; 2 – static pressure line; 3 – durite hose; 4 – suspension hook; 5 – shock-absorbing cord; 6 – recorder; 7 – removable ring;

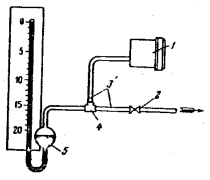

Fig. 12. Altimeter Checking Diagram

1 – altimeter to be checked; 2 – shut-off valve; 3 – pipeline; 4 – T-piece; 5 – barometer.

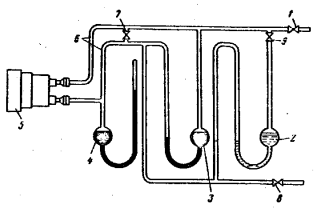

Fig. 13. Airspeed Indicator Checking Diagram

1, 7, 8 and 9 – shut-off cocks; 2 – water pressure gauge; 3 – mercury pressure gauge; 4 – mercury barometer; 5 – instrument to be checked; 6 – pipelines.

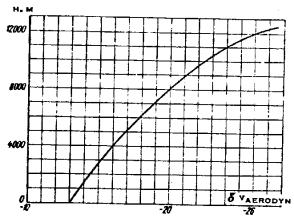

Fig. 14. Aerodynamic Correction Chart

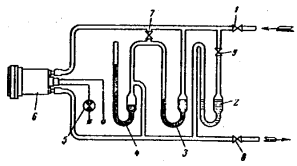

Fig. 15. Machmeter Checking Diagram

1, 7, 8 and 9 – shut-off cocks; 2 – water pressure gauge; 3 – mercury pressure gauge; 4 – mercury barometer; 5 – warning lamp; 6 – instrument to be checked.

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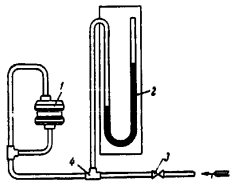

Fig. 16. Checking Diagram of CCH-3 Velocity Head Warning Unit of Static Pressure Line

1 – instrument to be checked; 2 – pressure gauge; 3 – shut-off valve; 4 – T-piece.

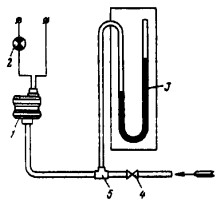

Fig. 17. Checking Diagram of CCH-3 Velocity Head Warning Unit of Pitot Pressure Line

1 – instrument to be checked; 2 – warning lamp; 3 – pressure gauge; 4 – shut-off valve; 5 – T-piece.

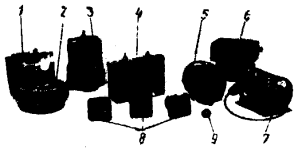

Fig. 18. Set of ДГМК-7 Compass

1 – junction box; 2 – transmitter; 3 – gyrounit; 4 – amplifier; 5 – main indicator; 6 – inverter; 7 – correction cut-out; 8 – auxiliary indicators; 9 – quick-slaving button.

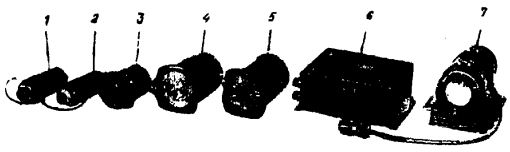

Fig. 19. Set of НИ-50Б Air Position Indicator

1 – line filter СФ-4; 2 – line filter СФ-2; 3 – wind setter; 4 – automatic course device; 5 – D.R. computer; 6 – distribution box; 7 – T.A.S. transmitter.

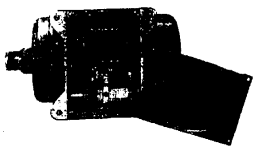

Fig. 20. Position of Adjustable Resistor Slide when Adjusting Inverter for Operation with Two Instruments

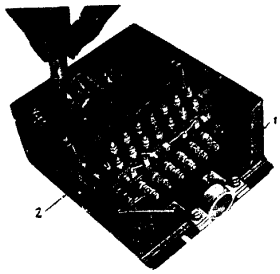

Fig. 21. Adjustment of Zero Signal

1 – distribution box; 2 – adjusting resistor.

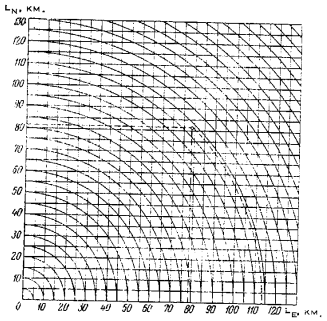

Fig. 22. Graph Used for Determining Covered Distance by Readings of D.R. Computer Pointers

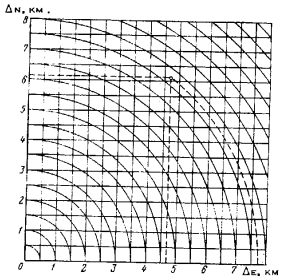

Fig. 23. Graph Used for Determining Absolute Error

Fig. 24. Matching of Readings of Automatic Course Device with Those of Compass Main Indicator

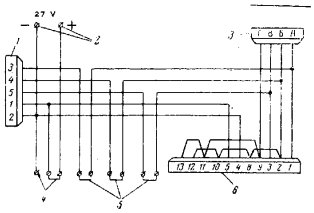

Fig. 25. Electric Panel Diagram for Checking АГБ-2 Gyro Horizon

1 – plug connector of ПАГ-1Ф inverter; 2 – supply terminals; 3 – plug connector of АГБ-2 gyro horizon; 4 – terminals for measuring currents and voltages in D.C. circuit; 5 – terminals for measuring currents and voltages in A.C. circuit; 6 – plug connector of correction cutout.

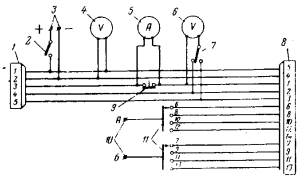

Fig. 26. Electric Panel Diagram for Checking Correction Cutout

1 – plug connectors of ПАГ-1Ф inverter; 2 – switch B-45; 3 – terminals; 4 – D.C. voltmeter, up to 30 – 40 V; 5 – A.C. ammeter, up to 1 A; 6 – A.C. voltmeter, up to 40 – 50 V; 7 – selector switch ПП-45; 8 – plug connectors ШР of correction cutout; 9 – button (normally closed); 10 – terminals for ohmmeter; 11 – selector switches.

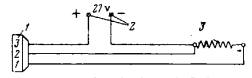

Fig. 27. Diagram for Checking ТУЭ-48 Resistor Thermometer Indicators

1 – plug connector of ТУЭ-48 indicator; 2 – supply terminals; 3 – resistance box

Fig. 28. Set of ЭМИ-3Р Gauge Unit

1 – indicator; 2 – fuel pressure pick-up unit П-100; 3 – oil pressure pick-up unit П-10; 4 – temperature pick-up unit.

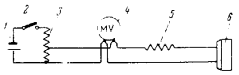

Fig. 29. Diagram for Checking Indicators of ТВГ-11 Thermometers

1 – source of electromotive force, 1 – 1.5 V; 2 – switch B-45; 3 – potentiometer; 4 – reference millivoltmeter; 5 – resistance box; 6 – indicator plug connector.

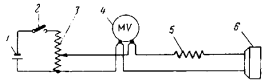

Fig. 30. Diagram for Checking Indicators of ТСТ-29 and ТНТ-13 Thermometers

1 – source of electromotive force, 1 – 1.5 V; 2 – switch B-45; 3 – potentiometer; 4 – reference millivoltmeter; 5 – series resistor; 6 – indicator plug connector.

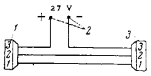

Fig. 31. Diagram of Wire Bundle for Checking Oil Pressure Gauge of ЭМИ-3Р Set

1 – plug connectors of oil pressure indicator; 2 – power supply terminals; 3 – pressure pick-up unit П-10.

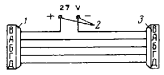

Fig. 32. Diagram of Wire Bundle for Checking Fuel Pressure Gauge of ЭМИ-3Р Set

1 – plug connectors of fuel pressure indicator; 2 – power supply terminals; 3 – pressure pick-up unit П-100.

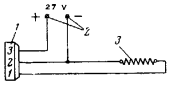

Fig. 33. Electric Diagram for Checking Temperature Indicator of ЭМИ-3Р Set

1 – plug connectors of oil temperature indicator; 2 – power supply terminals; 3 – resistance box.

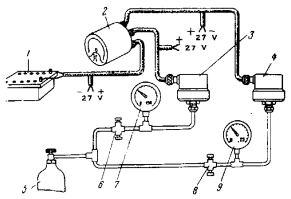

Fig. 34. Diagram for Checking ЭМИ-3Р Set

1 – plug resistance box; 2 – indicator; 3 – pressure pick-up П-100; 4 – pressure pick-up unit П-10; 5 – bottle with pressed gas; 6 – cock for feeding pressure into oil pressure gauge system; 7 – reference pressure gauge, up to 150 kg. sq.cm.; cock for feeding pressure into oil pressure gauge system; 9 – reference pressure gauge, up to 10 kg/sq.cm.

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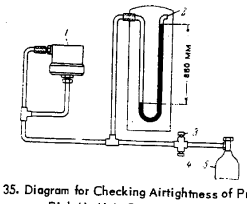

Fig. 35. Diagram for Checking Airtightness of Pressure Pick-Up Unit Casing

1 – pressure pick-up unit; 2 – mercury pressure gauge; 3 – pressure feed cock; 4 – pressure release cock; 5 – bottle with compressed air.

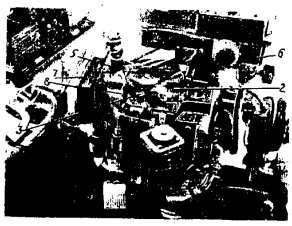

Fig. 36. Installation of АП-5-2М Autopilot Directional Stabilizer

1 – locking mechanism; 2 – turn control knob; 3 – autopilot clutch engaging knob; 4 – bracket with shock absorber; 5 – bombsight clutch; 6 – bombsight ОПБ-11Р ; 7 – directional panel; 8 – drift gear clutch disengaging knob.

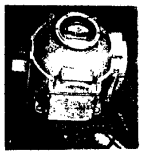

Fig. 37. Vertical Flight Gyro of АП-5-2М Autopilot

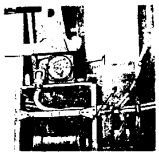

Fig. 38. Attachment Wing of Angular Rate Control Unit of АП-5-2М Autopilot

1 – angular rate control gyro; 2 – ПАГ-1Ф inverter.

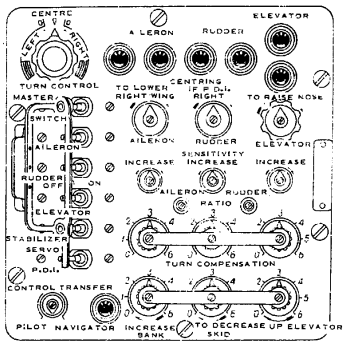

Fig. 39. Autopilot Control Panel

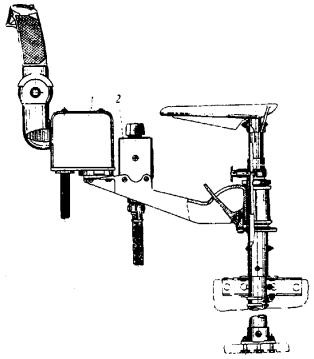

Fig. 40. Swivelling Bracket for Autopilot Booster Control Knob and Selector Switch

1 – booster control knob; 2 – selector switch.

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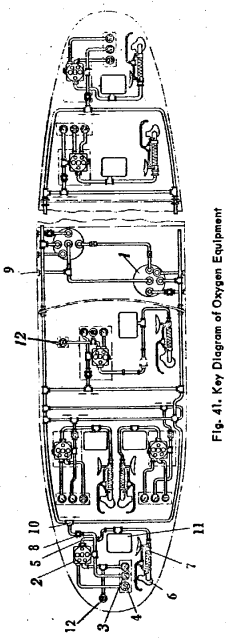

Fig. 41. Key Diagram of Oxygen Equipment

1 – liquid oxygen converter, type КПЖ-30; 2 – stationary oxygen economizer, type КП-24А; 3 – oxygen indicator, type ПК-24; 4 – excessive pressure gauge, type ИН-100; 5 – oxygen hose, type КШ-24, with mask-to-face tightness compensator and lock; 7 – pressure-breathing waistcoat; 8 – oxygen valve, type КЗ-5; 9 – aircraft charging pipe union; 10 – tee-piece with non-return valve; 11 – parachute-oxygen breathing apparatus, type КП-23; 12 – flow indicator".

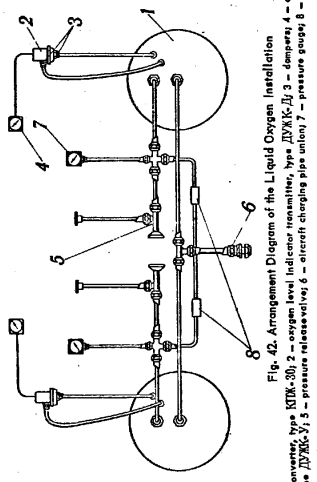

Fig. 42. Arrangement Diagram of the Liquid Oxygen Installation

1 – oxygen converter, type КПЖ-30; 2 – oxygen level indicator transmitter, type ДУЖК-Ду 3 – dampers; 4 – oxygen level indicator, type ДУЖК-У; 5 – pressure release valves; 6 – aircraft charging pipe union; 7 – pressure gauge; 8 – shut-off valves.

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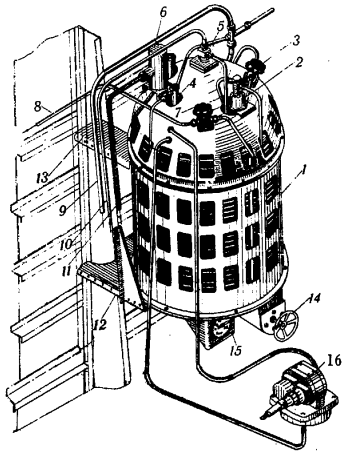

Fig. 43. КПЖ-30 Converter and Oxygen Level Indicator Installation at Frame No. 22

1 – oxygen converter, type КПЖ-30; 2 – automatic pressure increase valve; 3 – valve, type КВ-5, ahead of pressure increase automatic units; 4 – by-pass valve; 5 – non-return valve; 6 – safety valve; 7 – valve, type КВ-5, after evaporator; 8 – pipe; 9 – pressure release pipe; 10 – pipe for filling vessel with liquid; 11 – pipe from safety valve; 12, 13 – brackets securing converter to frame No. 22; 14 – pressure release valve; 15 – pressure gauge; 16 – liquid oxygen level indicator transmitter, type ДУЖК-Д.

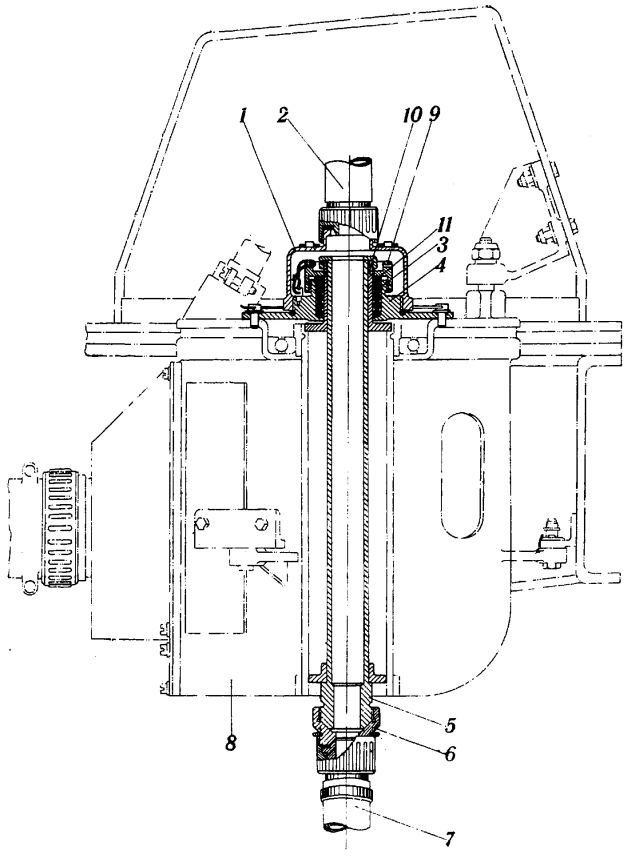

Fig. 44. Oxygen Adapter

...aver; 2 – hose, type КШ-10; 3 – packing rings; 4 – holder; 5 – pipe; 6 – adapter; 7 – hose, type КШ-24; 8 – current-collecting device; 9 – nut; 10 – limiter; 11 – ring.

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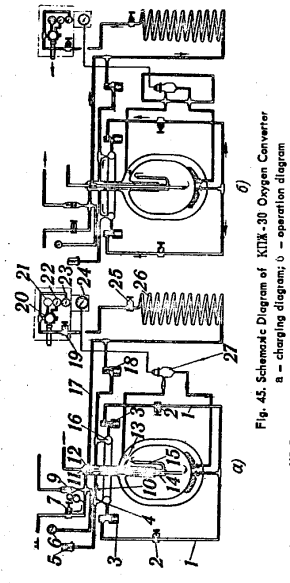

Fig. 45. Schematic Diagram of КПК-30 Oxygen Converter
а – charging diagram; б – operation diagram

1 – pipes; 2 – valve, type КР-5; 3 – automatic pressure increase valve; 4 – tee-pieces; 5 – safety valve; 6 – pressure gauge; 7 – pressure release valve; 8 – pipe; 9 – shut-off valve; 10 – pipe; 11 – vessel; 14 – control pipe; 15 – V-shaped pipe; 16 – receiver; 17 – pipe; 18 – automatic by-pass valve; 19 – КЗ-5 valve at oxygen station; 20 – КП-24Д1 economizer; 21 – oxygen indicator, type ИК-24; 22 – excessive pressure gauge; 23 – pressure gauge; 24 – liquid oxygen level indicator; 25 – КЗ-5 valve after the evaporator; 26 – evaporator; 27 – liquid oxygen indicator transmitter, type ДУЖК-Д.

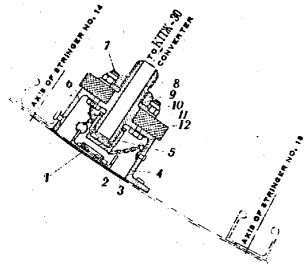

Fig. 46. Aircraft Charging Pipe Union

1 – hatch cover; 2 – packing gasket; 3 ÷ 6 – chains; 4 – aircraft charging pipe union attachment bracket; 5 – plug; 7 – bolt; 8 – aircraft charging pipe union; 9, 11 – nuts; 10 – washer; 12 – plate.

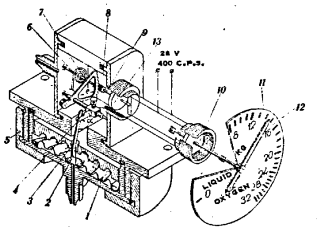

Fig. 47. Kinematic Diagram of ДУЖК Liquid Oxygen Indicator

1 – diaphragm; 2 – moving centre; 3 – rod; 4 – fork; 5 – sector axle; 6 – hairspring; 7 – sector; 8 – pipe; 9 – rotor axle; 10 – meter rotor; 11 – pointer; 12 – dial; 13 – transmitter rotor.

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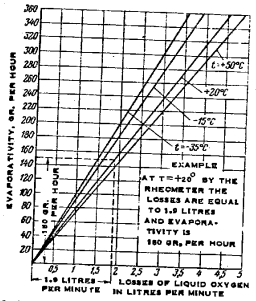

Fig. 48. Graph for Determining Losses Caused by Evaporativity by Measured Volumetric Amount of Oxygen in lit. per min. versus Ambient Air Temperature

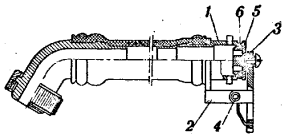

Fig. 49. Oxygen Hose, Type KIII-24

1 – pipe union; 2 – bracket; 3 – strip; 4 – axle; 5 – valve; 6 – rubber gasket.

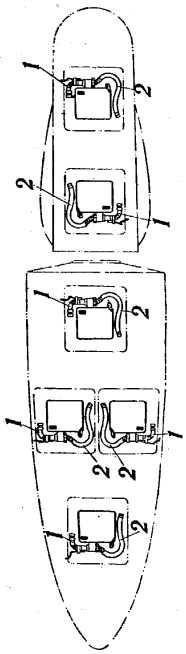

Fig. 50. Diagram of Arrangement of KII-23 Oxygen Breathing Apparatus on Aircraft Seats

1 – apparatus short hose for connection with aircraft oxygen hose; 2 – apparatus long hose for connection with mask.

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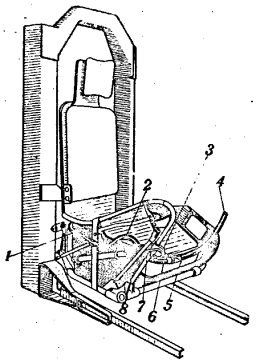


Fig. 51. Placing Oxygen Hoses on Navigator's Seat

1 – aircraft oxygen hose; 2 – short hose of KI-23 oxygen breathing apparatus; 3 – clamp; 4 – long hose of KI-23 oxygen breathing apparatus (to the mask); 5 – parachute; 6 – locking pin snap hook; 7 – cord; 8 – seat right-hand arm rest.

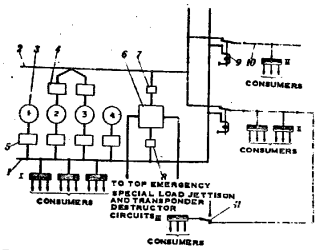
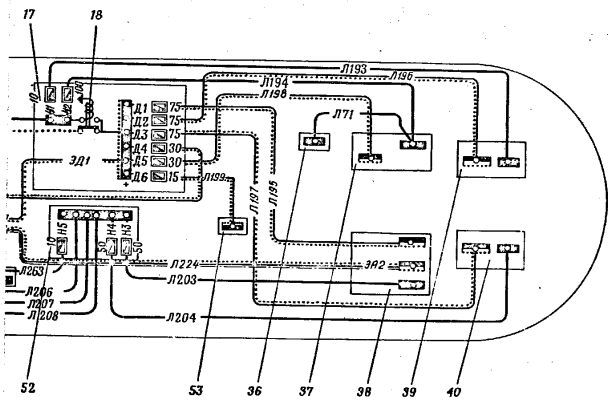


Fig. 52. Key Distribution Diagram of D.C. Supply System

1 – normal supply circuit; 2 – emergency supply circuit; 3 – generators, type ГСР-18000; 4 – emergency differential undercurrent relay, type ДМР-600; 5 – normal differential undercurrent relay, type ДМР-600; 6 – storage battery, type 12САМ-55; 7 – contactor, type К-300Д, for connecting storage battery to emergency supply circuit; 8 – contactor, type К-300Л, for connecting storage battery to normal supply circuit; 9 – selecting contactor, type КП; 10 – dual supply circuit; 11 – change-over switch, type ПП-45; I – normal supply distribution busbars; II – dual supply distribution busbars; III – triple supply distribution busbar



...supply
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... right-

hand circuit breaker control panel of navigator; 41 – ДСП-53 box; 42 – rounds counter; 43 – blister station control panel; 44 – lower gun mount supply box; 45 – power junction box; 46 – circuit breaker box of autopilot heater system; 47 – distribution panel, right; 48 – storage battery junction box; 49 – power lead-in of emergency supply circuit; 50 – generator control panel; 51 – fuelling control board; 52 – glass panel heater system junction box; 53 – fuel supply control board.

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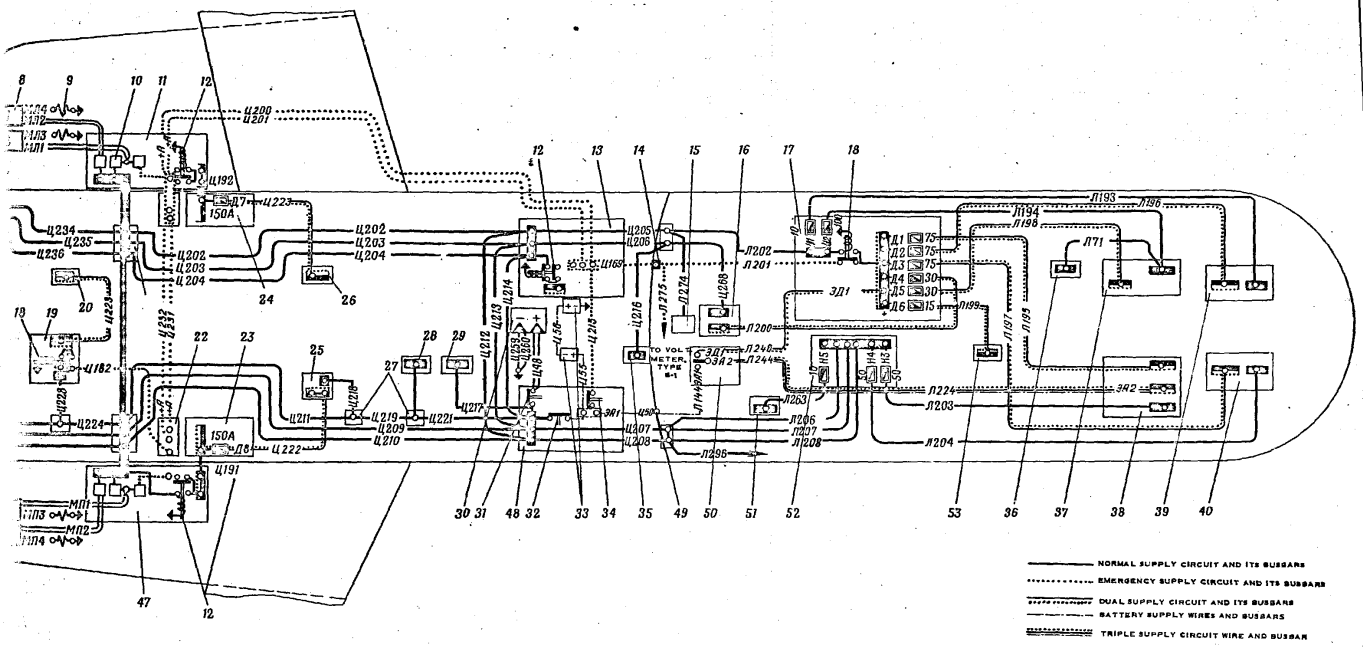

Fig. 53. Schematic Connection Diagram of D.C. Circuit Distribution System

power junction box; 4 – power lead-in ...x of tail gun mount; ...junction box; ...meter, type ..., type ДИР-600; ...tor, type ...ер No. 17; ... 15 – top station control panel; 16 – circuit breaker control panel at radar operator's station; 17 – dual supply circuit junction box at frame No. 6; 18 – selecting contactor, type КП-200Д; 19 – fuel pump junction box, rear; 20 – colour flare bomb emergency dropping circuit junction box; 21 – power junction box of normal supply circuit; 22 – power junction box of emergency supply circuit; 23 – dual supply circuit junction box, right; 24 – dual supply circuit junction box, left; 25 – fuel pump system junction box, right; 26 – fuel pump system junction box, left; 27 – power junction box; 28 – top gun mount supply box; 29 – camera equipment junction box; 30 – ground supply plug connector; 31 – contactor, type К-400Д, for connecting ground power supply source; 32 – contactor, type К-300Д for connecting storage battery to normal supply circuit; 33 – storage battery, type 12-САМ-55; 34 – contactor, type К-300Д, for connecting storage battery to emergency supply circuit; 35 – hydraulic pump system junction box; 36 – pilot's instrument panel; 37 – pilot's circuit-breaker control panel; 38 – co-pilot's circuit breaker control panel; 39 – left-hand circuit breaker control panel of navigator; 40 – right-hand circuit breaker control panel of navigator; 41 – ДСП-53 box; 42 – rounds counter; 43 – blister station control panel; 44 – lower gun mount supply box; 45 – power junction box; 46 – circuit breaker box of autopilot heater system; 47 – distribution panel, right; 48 – storage battery junction box; 49 – power lead-in of emergency supply circuit; 50 – generator control panel; 51 – fueling control board; 52 – glass panel heater system junction box; 53 – fuel supply control board.

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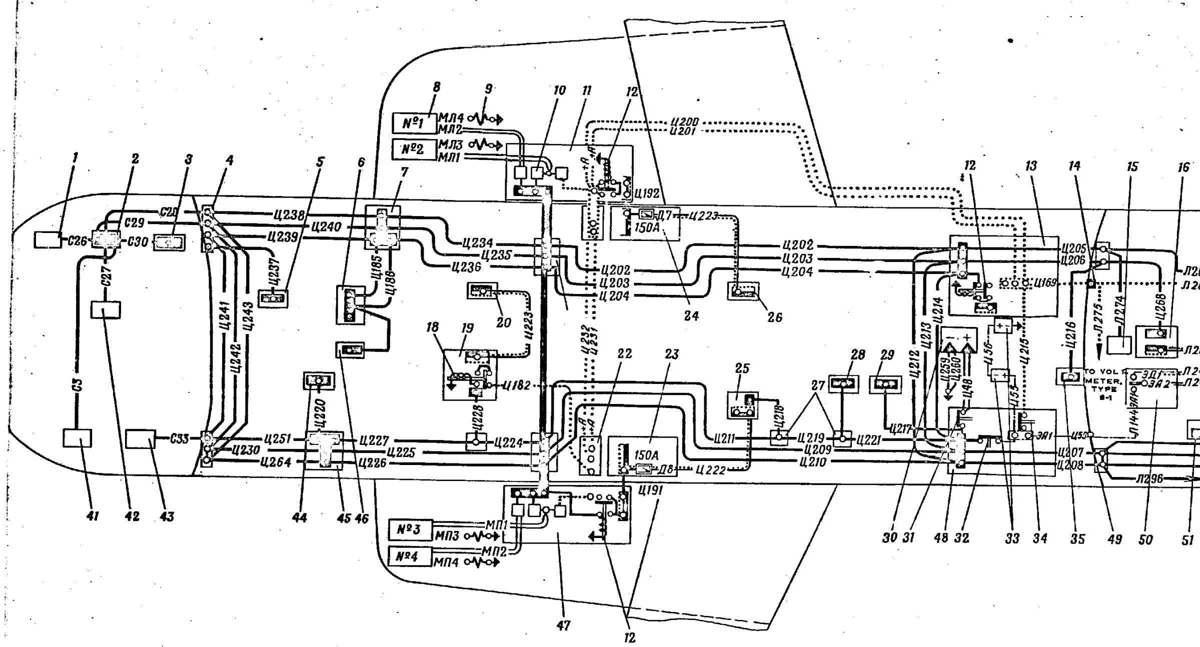

Fig. 53. Schematic Connection Diagram of D.C. Circuit Distribution System

1 – tail station control panel; 2 – rear cabin power junction box; 3 – circuit breaker control panel of rear cabin; 4 – power lead-in of normal supply circuit; 5 – supply junction box of tail gun mount; 6 – de-icer junction box of tail unit; 7 – power junction box; 8 – generator, type ГСР-18000; 9 – ballast resistor, type БС-18000; 10 – differential undercurrent relay, type ДМР-600; 11 – distribution panel, left; 12 – selecting contactor, type КП-400Д; 13 – dual supply junction box at frame No. 17; 14 – power lead-in of emergency supply circuit; 15 – top station control panel; 16 – circuit breaker control panel at radar operator's station; 17 – dual supply circuit junction box at frame No. 6; 18 – selecting contactor, type КП-200Д. 19 – fuel pump junction box, rear; 20 – colour flare bomb emergency dropping circuit junction box; 21 – power junction box of normal supply circuit; 22 – power junction box of emergency supply circuit; 23 – dual supply circuit junction box, right; 24 – dual supply circuit junction box, left; 25 – fuel pump system junction box, right; 26 – fuel pump system junction box, left; 27 – power junction box; 28 – top gun mount supply box; 29 – camera equipment junction box; 30 – ground [illegible] plug connector; 31 – contactor, type К-400Д, for connectin[illegible] power supply source; 32 – contactor, type К-300Д for con[illegible] storage battery to normal supply circuit; 33 – storage batte[illegible] 12-САМ-55; 34 – contactor, type К-300Д, for connecting [illegible] battery to emergency supply circuit; 35 – hydraulic pump sy[illegible] junction box; 36 – pilot's instrument panel; 37 – pilot's cir[illegible] breaker control panel; 38 – co-pilot's circuit breaker contro[illegible] 39 – left-hand circuit breaker control panel of navigator; 40[illegible]

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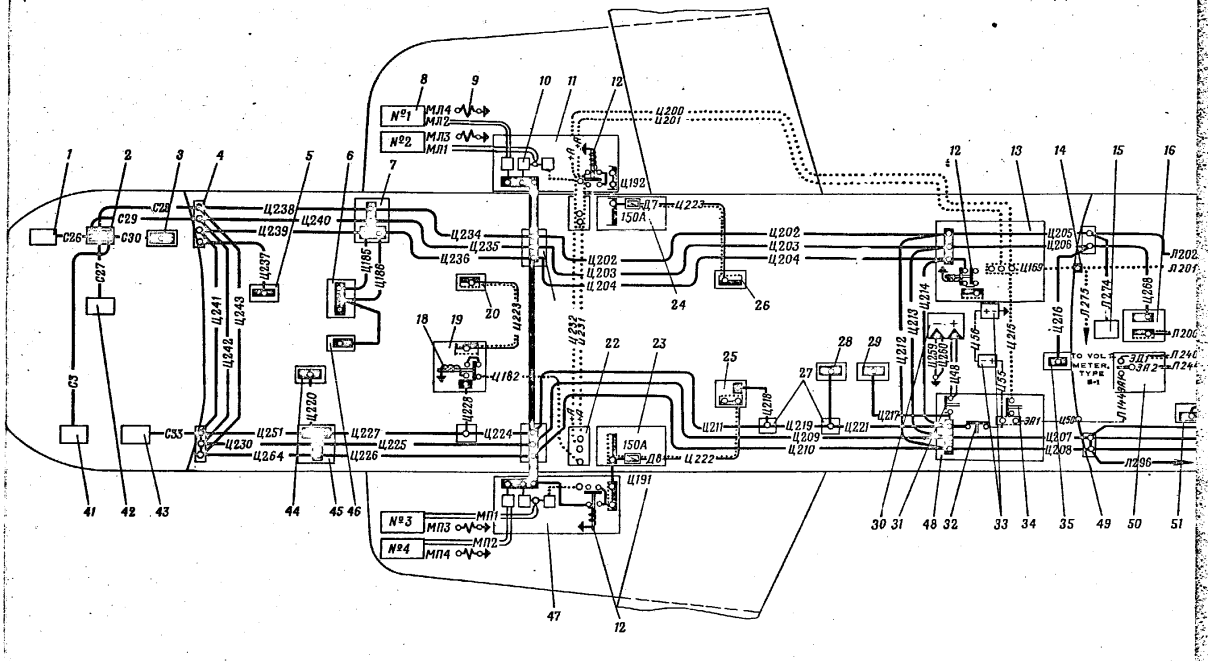

Fig. 53. Schematic Connection Diagram of D.C. Circuit Distribution System

1 – tail station control panel; 2 – rear cabin power junction box; 3 – circuit breaker control panel of rear cabin; 4 – power lead-in of normal supply circuit; 5 – supply junction box of tail gun mount; 6 – de-icer junction box of tail unit; 7 – power junction box; 8 – generator, type ГСР-18000; 9 – ballast resistor, type ВС-18000; 10 – differential undercurrent relay, type ДМР-600; 11 – distribution panel, left; 12 – selecting contactor, type КГ-400Д; 13 – dual supply junction box at frame No. 17; 14 – power lead-in of emergency supply circuit; 15 – top station control panel; 16 – circuit breaker control panel at radar operator's station; 17 – dual supply circuit junction box at frame No. 6; 18 – selecting contactor, type КГ-200Д. 19 – fuel pump junction box, rear; 20 – colour flare bomb emergency dropping circuit junction box; 21 – power junction box of normal supply circuit; 22 – power junction box of emergency supply circuit; 23 – dual supply circuit junction box, right; 24 – dual supply circuit junction box, left; 25 – fuel pump system junction box, right; 26 – fuel pump system junction box, left; 27 – power junction box; 28 – top gun mount supply box; 29 – camera equipment junction box; 30 – ground plug connector; 31 – contactor, type К-400Д, for connecting power supply source; 32 – contactor, type К-300Д for connecting storage battery to normal supply circuit; 33 – storage battery 12-САМ-55; 34 – contactor, type К-300Д, for connecting battery to emergency supply circuit; 35 – hydraulic pump system junction box; 36 – pilot's instrument panel; 37 – pilot's circuit breaker control panel; 38 – co-pilot's circuit breaker control panel; 39 – left-hand circuit breaker control panel of navigator; 40

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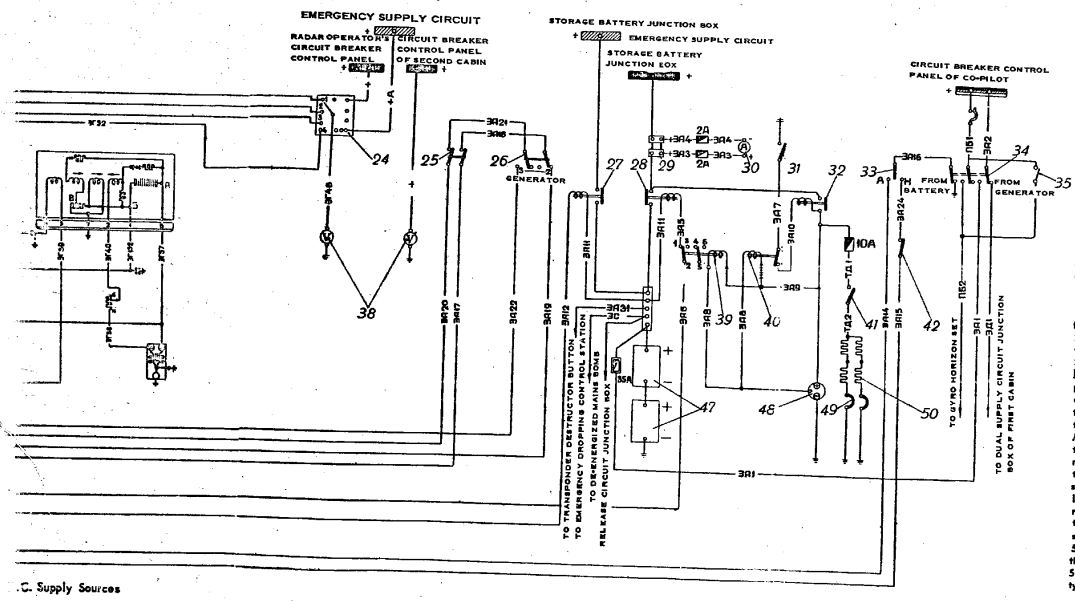

.C. Supply Sources

1 – ballast resistor, type БС-18000; 2 – generator, type ГСР-18000, No. 1; 3 – capacitor, type КБМ-31; 4 – shunt of ammeter, type A-3; 5 – differential undercurrent relay, type ДМР-600 for connecting generator No. 1 to normal supply circuit; 6 – contactor; 7 – auxiliary relay, type РД-5Б; 8 – limiting resistor; 9 – command relay; 10 – polarized relay, type РТР-2А; 11 – switch, type 2В-45 of generator No. 1; 12 – carbon regulator, type РУТ-82; 13 – parallel operation winding; 14 – automatic correction winding; 15 – temperature compensation winding; 16 – working winding; 17 – stabilizing resistor; 18 – adjusting resistor; 19 – temperature compensation resistor; 20 – carbon pile; 21 – relay, type ДМР-600, for connecting generator No. 2 to emergency supply circuit; 22 – relay, type ДМР-600, for connecting generator No. 2 to normal supply circuit; 23 – switch, type 2В-45, of generator No. 2 ; 24 – change-over switch, type П-46 of voltmeter; 25 – switch, type 2П-45, labelled EMERGENCY SUPPLY CIRCUIT (АВАРИЙНАЯ СЕТЬ); 26 – change-over switch, type 2ПП-45, labelled FROM GENERATOR (ОТ ГЕНЕРАТОРА) ; 27 – contactor, type К-300Д, for connecting storage battery to emergency supply circuit; 28 – contactor, type К-300Д, for connecting storage battery to normal supply circuit; 29 – shunt of ammeter, type A-1; 30 – ammeter, type A-1; 31 – ground supply switch, type В-45; 32 – contactor, type К-400Д, for connecting ground supply source to normal supply circuit; 33 – storage battery change-over switch, type ПТП-45; 34 – change-over switches, types ПП-45 and 2ПП-45, of triple supply busbar; 35 – switches, type В-45, of stand-by gyro horizon set; 36 – ammeter, type A-3; 37 – external resistor, type БС-20; 38 – voltmeter, type В-1; 39 – blocking relay, type РП-2 ; 40 – polarized relay, type РПП-А; 41 – switch, type В-45, of storage battery container heater circuit; 42 – switch, type В-45, for storage battery-to-normal supply circuit blocking; 43 – stability transformer, type ТС-8; 44 – generator No. 2; 45 – generator No. 3; 46 – generator No. 4; 47 – storage battery, type 12-САМ-55; 48 – ground supply plug connector; 49 – thermal switch, type 7778, of storage battery container heater circuit; 50 – heater element of storage battery container; 51 – schematic connection diagram of generator, type ГСР-18000; 52 – main pole; 53 – commutating pole; 54 – blocking relay, type РП-6, of generator No. 2; 55 – blocking relay, type РП-6, of generator No. 3.

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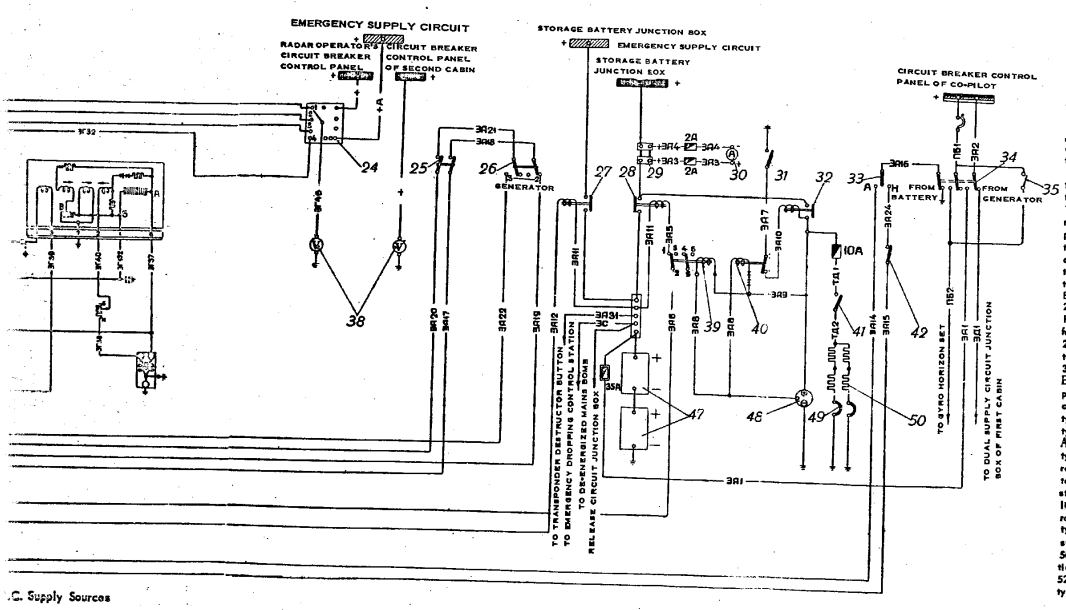

1 – ballast resistor, type БС-18000; 2 – generator, type ГСР-18000, No. 1; 3 – capacitor, type КБМ-31; 4 – shunt of ammeter, type A-3; 5 – differential undercurrent relay, type ДМР-600 for connecting generator No. 1 to normal supply circuit; 6 – contactor; 7 – auxiliary relay, type РЛ-5Б; 8 – limiting resistor; 9 – command relay; 10 – polarized relay, type РПР-2А; 11 – switch, type 2В-45 of generator No. 1; 12 – carbon regulator, type РУГ-82; 13 – parallel operation winding; 14 – automatic correction winding; 15 – temperature compensation winding; 16 – working winding; 17 – stabilizing resistor; 18 – adjusting resistor; 19 – temperature compensation resistor; 20 – carbon pile; 21 – relay, type ДМР-600, for connecting generator No. 2 to emergency supply circuit; 22 – relay, type ДМР-600, for connecting generator No. 2 to normal supply circuit; 23 – switch, type 2В-45, of generator No. 2; 24 – change-over switch, type П-45, of voltmeter; 25 – switch, type 2П-45, labelled EMERGENCY SUPPLY CIRCUIT (АВАРИЙНАЯ СЕТЬ); 26 – change-over switch, type 2ПП-45, labelled FROM GENERATOR (ОТ ГЕНЕРАТОРА); 27 – contactor, type К-300Л, for connecting storage battery to emergency supply circuit; 28 – contactor, type К-300Л, for connecting storage battery to normal supply circuit; 29 – shunt of ammeter, type A-1; 30 – ammeter, type A-1; 31 – ground supply switch, type В-45; 32 – contactor, type К-400Л, for connecting ground supply source to normal supply circuit; 33 – storage battery change-over switch, type ППП-45; 34 – change-over switches, types ПП-45 and 2ПП-45, of triple supply busbar; 35 – switches, type В-45, of stand-by gyro horizon set; 36 – ammeter, type A-3; 37 – external resistor, type ВС-20; 38 – voltmeter, type В-1; 39 – blocking relay, type РП-2; 40 – polarized relay, type РПП-А; 41 – switch, type В-45, of storage battery container heater circuit; 42 – switch, type В-45, for storage battery-to-normal supply circuit blocking; 43 – stability transformer, type ТС-6; 44 – generator No. 2; 45 – generator No. 3; 46 – generator No. 4; 47 – storage battery, type 12-САМ-55; 48 – ground supply plug connector; 49 – thermal switch, type 777В, of storage battery container heater circuit; 50 – heater element of storage battery container; 51 – schematic connection diagram of generator, type ГСР-18000; 52 – main pole; 53 – commutating pole; 54 – blocking relay, type РП-6, of generator No. 2; 55 – blocking relay, type РП-6, of generator No. 3.

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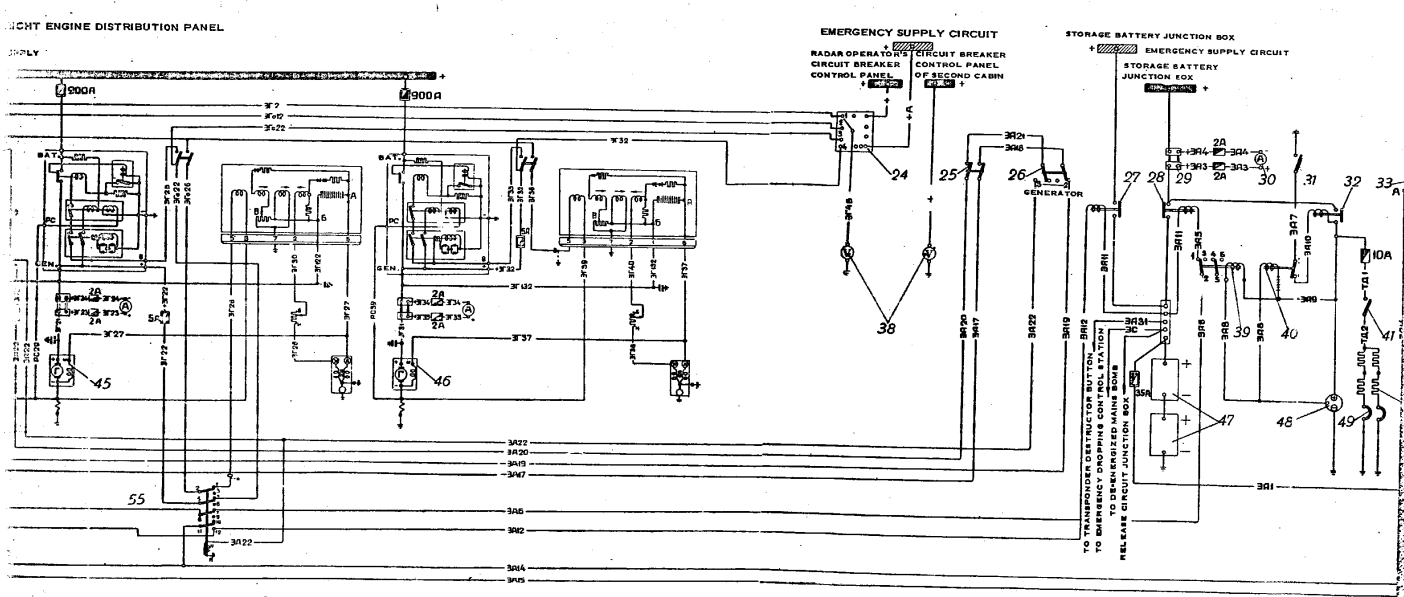

Fig. 54. Key Circuit Diagram of D.C. Supply Sources

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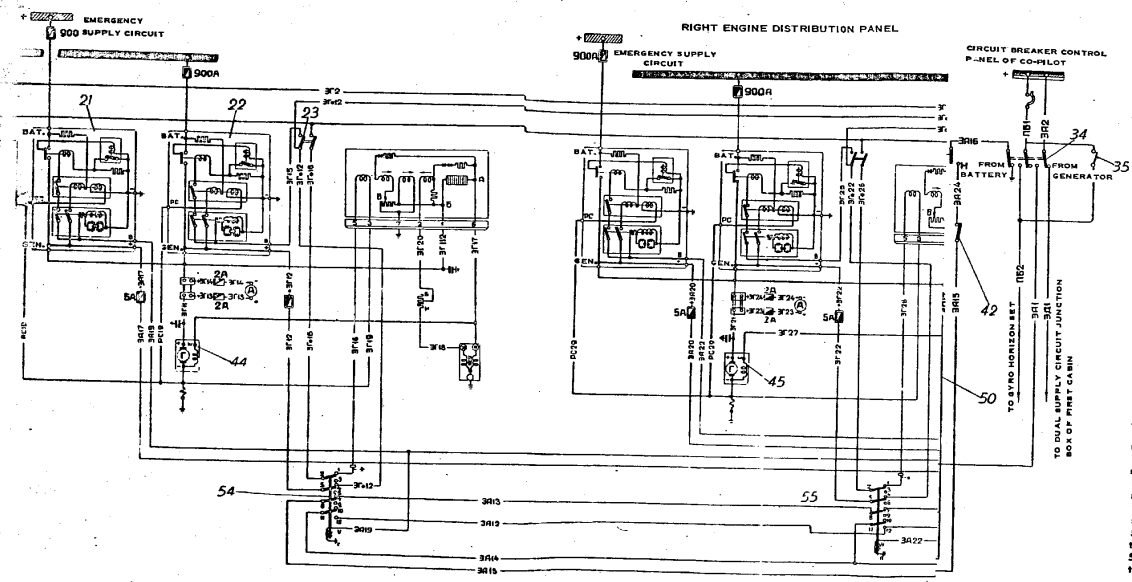

1 – ballast resistor, type БС-18000; 2 – generator, type ГСР-18000, No. 1; 3 – capacitor, type КБЧ-31; 4 – shunt of ammeter, type A-3; 5 – differential undercurrent relay, type ДМР-600 for connecting generator No. 1 to normal supply circuit; 6 – contactor; 7 – auxiliary relay, type РЛ-5Б; 8 – limiting resistor; 9 – command relay; 10 – polarized relay, type РПР-2А; 11 – switch, type 2В-45 of generator No. 1; 12 – carbon regulator, type РУГ-82; 13 – parallel operation winding; 14 – automatic correction winding; 15 – temperature compensation winding; 16 – working winding; 17 – stabilizing resistor; 18 – adjusting resistor; 19 – temperature compensation resistor; 20 – carbon pile; 21 – relay, type ДМР-600, for connecting generator No. 2 to emergency supply circuit; 22 – relay, type ДМР-600, for connecting generator No. 2 to normal supply circuit; 23 – switch, type 2В-45, of generator No. 2; 24 – change-over switch, type П-46 of voltmeter; 25 – switch, type 2Б-45, labelled EMERGENCY SUPPLY CIRCUIT (АВАРИЙНАЯ СЕТЬ); 26 – change-over switch, type 2П-45, labelled FROM GENERATOR (ОТ ГЕНЕРАТОРА); 27 – contactor, type К-300Л, for connecting storage battery to emergency supply circuit; 28 – contactor, type К-300Л, for connecting storage battery to normal supply circuit; 29 – shunt of ammeter, type A-1; 30 – ammeter, type A-1; 31 – ground supply switch, type В-45; 32 – contactor, type К-400Л, for connecting ground supply source to normal supply circuit; 33 – storage battery change-over switch, type ППН-45; 34 – change-over switches, types ПП-45 and 2ПП-45, of triple supply busbar; 35 – switches, type В-45, of stand-by gyro horizon set; 36 – ammeter, type A-3; 37 – external resistor, type БС-20; 38 – voltmeter, type В-1; 39 – blocking relay, type РП-2; 40 – polarized relay, type РПН-А; 41 – switch, type В-45, of storage battery container heater circuit; 42 – switch, type В-45, for storage battery-to-normal supply circuit blocking; 43 – stability transformer, type ТС-6; 44 – generator No. 2; 45 – generator No. 3; 46 – generator No. 4; 47 – storage battery, type 12-САМ-55; 48 – ground supply plug connector; 49 – thermal switch, type 7778, of storage battery container heater circuit; 50 – heater element of storage battery container; 51 – schematic connection diagram of generator, type ГСР-18000; 52 – main pole; 53 – commutating pole; 54 – blocking relay, type РП-6, of generator No. 2; 55 – blocking relay, type РП-6, of generator No. 3.

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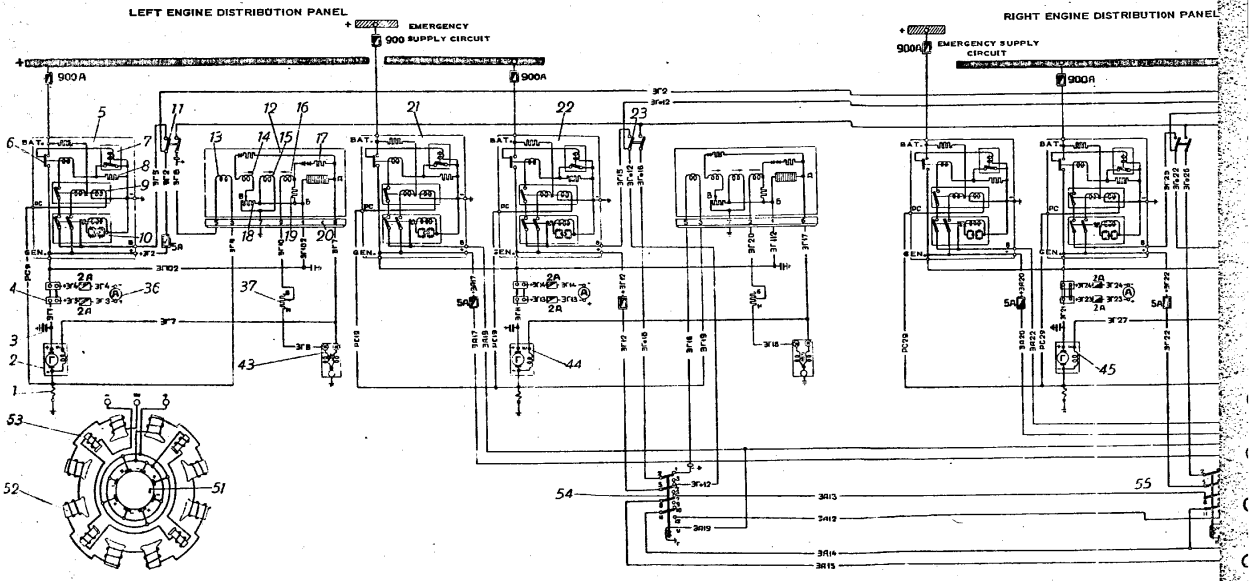

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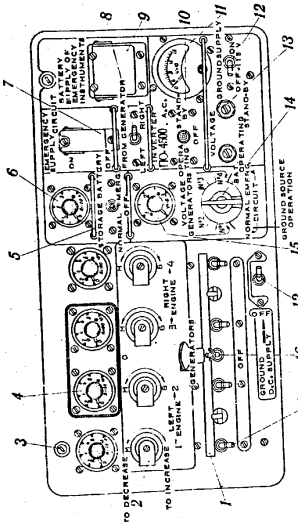

Fig. 55. Generator Control Panel

1 – master disconnecting bar of generator switches; type DC-20; 3 – panel attachment screw; 4 – ammeters, type A-3; 5 – safety bars; 6 – ammeter, type A-1; 7 – fuse of 2B-45 switch; 8 – change-over switch, type BB-150; 12 – switch, type B-45; 13 – switch, type 2TH-45; 14 – voltmeter, type TH-1; 15 – switch, type TH-1; 16 – switch, type B-46; 17 – switch, type 2TH-45 and TH-45; 10 – change-over switch, type 3TH-45; 11 – voltmeter, type TH-1; 15 – switch, type B-46; 18 – adjusting resistor, type PC-4N; 14 – voltmeter change-over switch, type TH-1; 15 – switch, type 2B-46; for storage battery blocking from normal supply circuit; 17 – generator switch type 2B-46.

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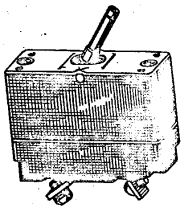


Fig. 56. Automatic Circuit Breaker, Type A3C

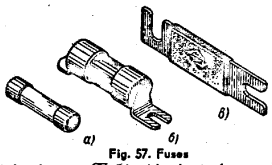
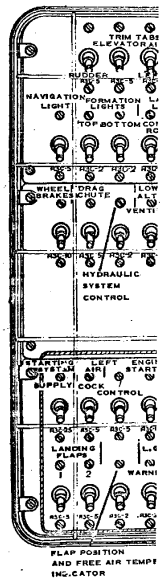


Fig. 57. Fuses
(a) glass fuse, type СП; (б) – delayed-action fuse, type ИП;
(в) – high heat fuse, type ТП.



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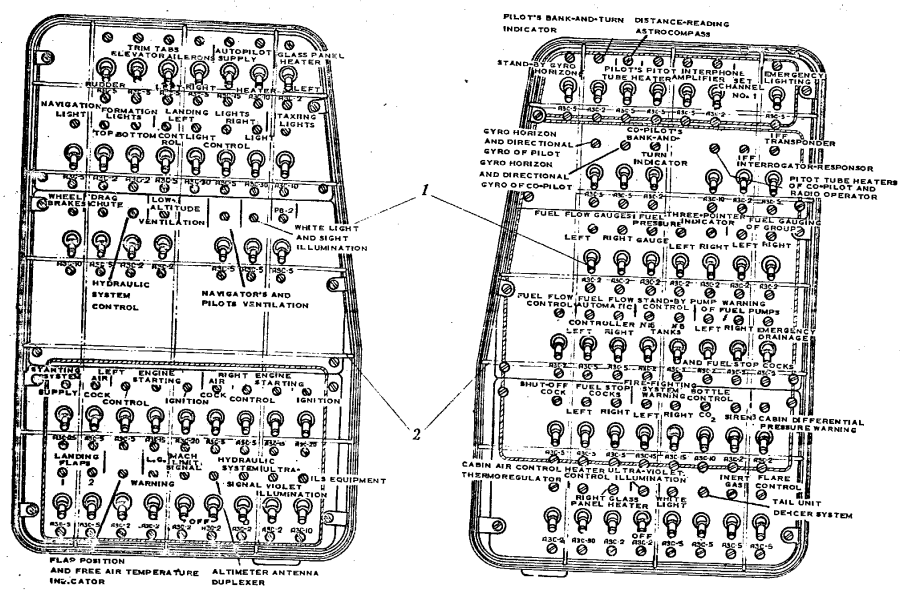

Fig. 58. Circuit Breaker Control Panels of Pilot and Co-Pilot

1 – automatic circuit breaker, 2 – safety screen.

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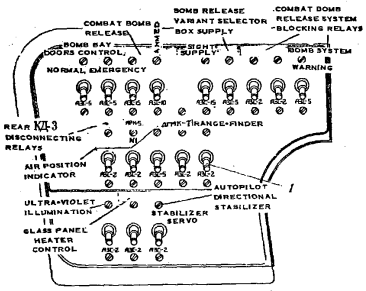

Fig. 59. Left-Hand Circuit Breaker Control Panel of Navigator

1 – circuit breaker, type A3C.

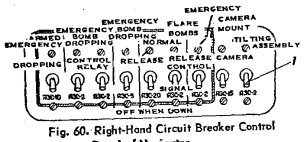

Fig. 60. Right-Hand Circuit Breaker Control Panel of Navigator

1 – circuit breaker, type A3C.

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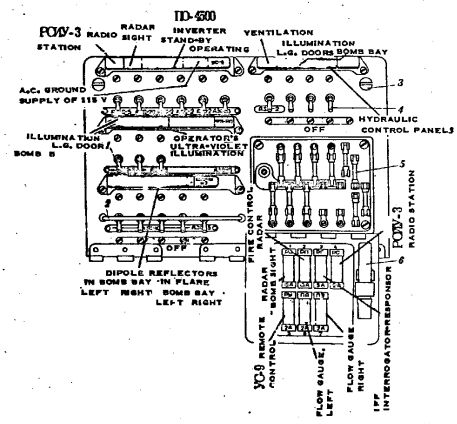

Fig. 61. Electric Control Board of Radar Operator

1 – circuit breaker, type A3C; 2 – safety bar; 3 – electric control board attachment screw; 4 – switch, type B-45; 5 – fuse, type СП; 6 – СП fuse remover.

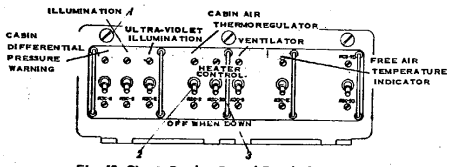

Fig. 62. Circuit Breaker Control Panel of Rear Cabin

1 – spring lock; 2 – circuit breaker, type A3C; 3 – safety bar.

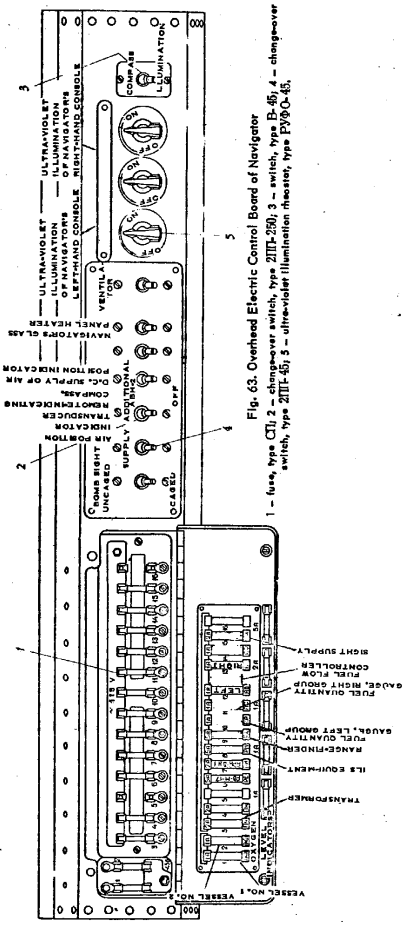

Fig. 63. Overhead Electric Control Board of Navigator

1 – fuse, type СП; 2 – changeover switch, type ZIIП-250; 3 – switch, type B-45; 4 – changeover switch, type ZIIП-45; 5 – ultra-violet illumination rheostat, type РУФО-45.

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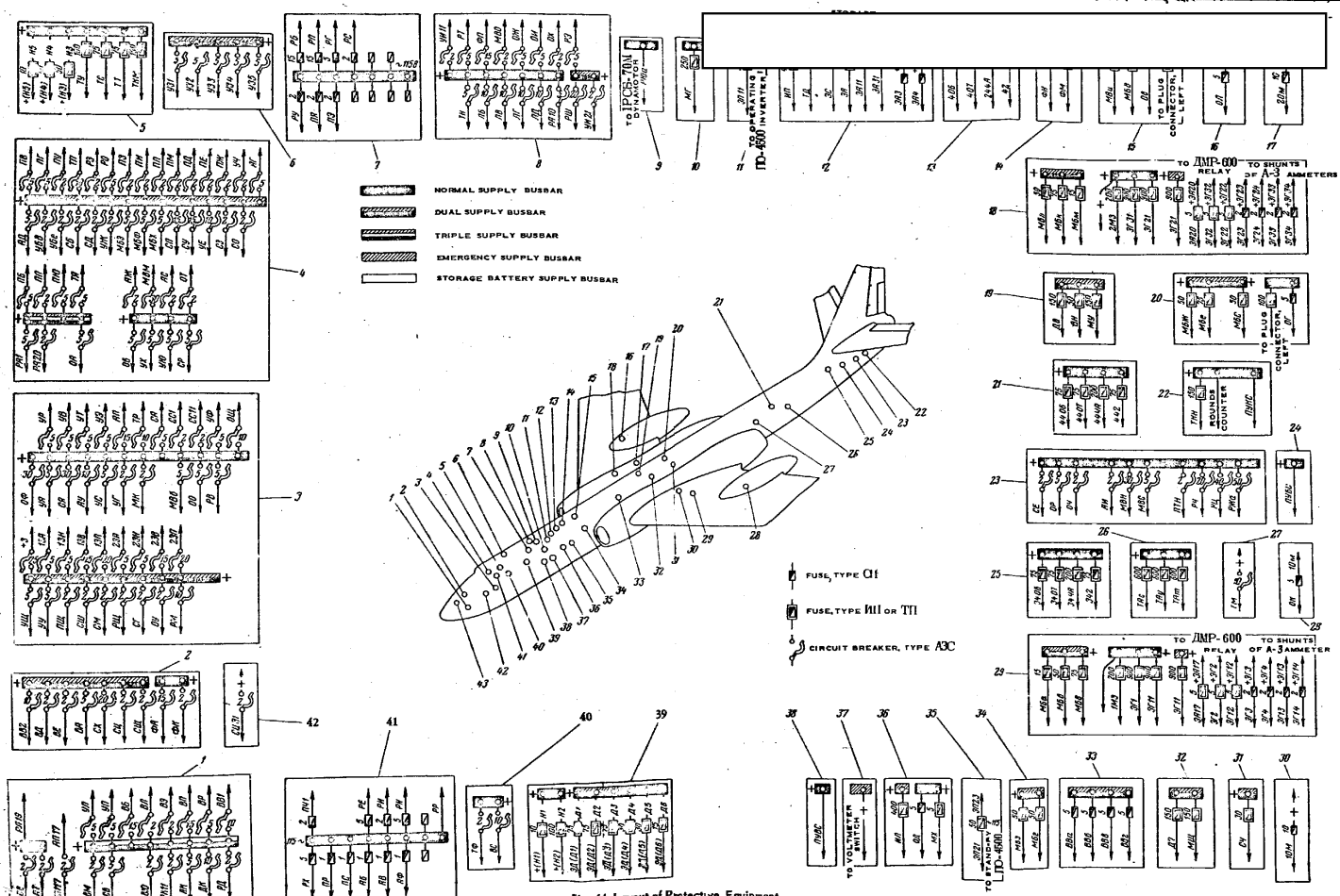

Fig. 64. Layout of Protective Equipment

1 – left-hand circuit breaker control panel of navigator; 2 – right-hand circuit breaker control panel of navigator; 3 – pilot's circuit breaker control panel; 4 – co-pilot's circuit breaker control panel; 5 – de-icer system junction box; 6 – overhead electric control board of pilots; 7 – radar operator's fuse box, 115 V A.C.; 8 – circuit breaker control panel of radar operator; 9 – power lead-in on frame No. 12, starboard; 10 – hydraulic pump junction box; 11 – junction box of operating inverter; 12 – storage battery junction box; 13 – top mount supply system junction box; 14 – camera equipment junction box; 15 – fuel pump system junction box, right; 16 – right junction box of L.G. well extension lamp; 17 – right junction box of engine compartment extension lamp; 18 – distribution panel, right; 19 – dual supply system junction box, right; 20 – fuel pump system junction box at frame No. 49; 21 – bottom mount supply system junction box; 22 – power junction box of rear cabin; 23 – circuit breaker control panel of rear cabin; 24 – left power lead-in on frame No. 69; 25 – tail gun mount supply system junction box; 26 – tail unit de-icer system junction box; 27 – autopilot heater circuit breaker box; 28 – left junction box of L.G. well extension lamp 29 – distribution panel, left; 30 – left junction box of engine compartment extension lamp; 31 – junction box of flare bomb emergency dropping system; 32 – dual supply system junction box, left; 33 – combat release system junction box; 34 – fuel pump system junction box, left; 35 – stand-by inverter junction box; 36 – dual supply system junction box; 37 – emergency circuit lead-in on frame No. 12, port side; 38 – power lead-in on frame No. 12; 39 – dual supply system junction box; 40 – instrument panel of pilot; 41 – navigator's fuse panel, 115 V A.C.; 42 – flare bomb control board.

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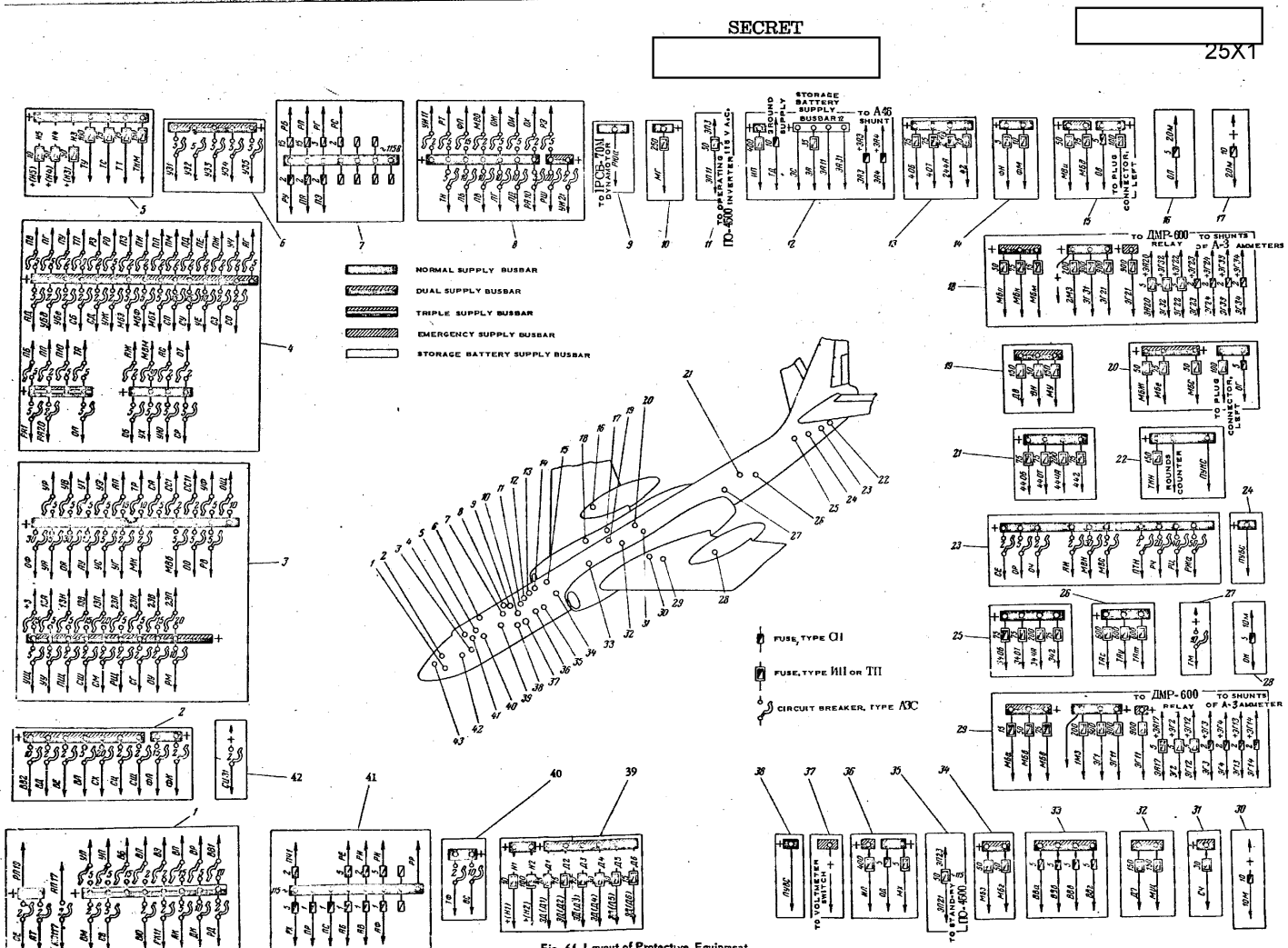

Fig. 64. Layout of Protective Equipment

1 – left-hand circuit breaker control panel of navigator; 2 – right-hand circuit breaker control panel of navigator; 3 – pilot's circuit breaker control panel; 4 – co-pilot's circuit breaker control panel; 5 – de-icer system junction box; 6 – overhead electric control board of pilots; 7 – radar operator's fuse box, 115 V A.C.; 8 – circuit breaker control panel of radar operator; 9 – power feed-in on frame No. 12, starboard; 10 – hydraulic pump junction box; 11 – junction box of operating inverter; 12 – storage battery junction box; 13 – top mount supply system junction box; 14 – camera equipment junction box; 15 – fuel pump system junction box, right; 16 – right junction box of L.G. well extension lamp; 17 – right junction box of engine compartment extension lamp; 18 – distribution panel, right; 19 – dual supply system junction box, right; 20 – fuel pump system junction box at frame No. 49; 21 – bottom mount supply system junction box; 22 – power junction box of rear cabin; 23 – circuit breaker control panel of rear cabin; 24 – left power feed-in on frame No. 69; 25 – tail gun mount supply system junction box; 26 – tail unit de-icer system junction box; 27 – autopilot heater circuit breaker box; 28 – left junction box of L.G. well extension lamp 29 – distribution panel, left; 30 – left junction box of engine compartment extension lamp; 31 – junction box of flare bomb emergency dropping system; 32 – dual supply system junction box, left; 33 – combat release system junction box; 34 – fuel pump system junction box, left; 35 – stand-by inverter junction box; 36 – dual supply system junction box; 37 – emergency circuit feed-in on frame No. 12, port side; 38 – power feed-in on frame No. 12; 39 – dual supply system junction box; 40 – instrument panel of pilot; 41 – navigator's fuse panel, 115 V A.C.; 42 – flare bomb control board.

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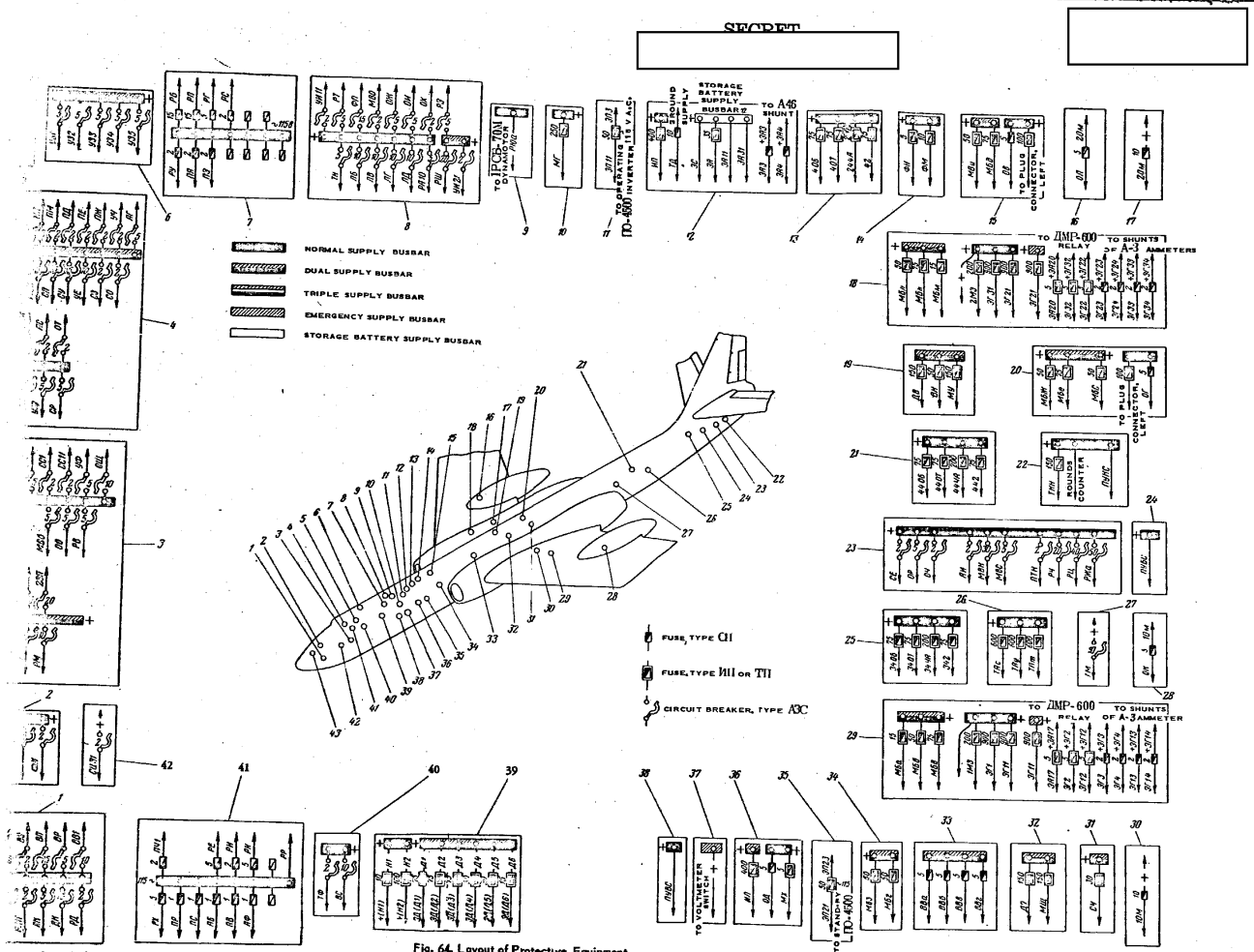

Fig. 64. Layout of Protective Equipment

...ontrol panel of navigator; 2 – right-...el of navigator; 3 – pilot's circuit ...ilot's circuit breaker control panel; ...; 6 – overhead electric control ...ot's fuse box, 115 V A.C.; ...el of radar operator; 9 – power ...ard; 10 – hydraulic pump junction ...ering inverter; 12 – storage battery junction box; 13 – top mount supply system junction box; 14 – camera equipment junction box; 15 – fuel pump system junction box, right; 16 – right junction box of L.G. well extension lamp; 17 – right junction box of engine compartment extension lamp; 18 – distribution panel, right; 19 – dual supply system junction box, right; 20 – fuel pump system junction box at frame No. 49; 21 – bottom mount supply system junction box; 22 – power junction box of rear cabin; 23 – circuit breaker control panel of rear cabin; 24 – left power lead-in on frame No. 69; 25 – tail gun mount supply system junction box; 26 – tail unit de-icer system junction box; 27 – autopilot heater circuit breaker box; 28 – left junction box of L.G. well extension lamp 29 – distribution panel, left; 30 – left junction box of engine compartment extension lamp; 31 – junction box of flare bomb emergency dropping system; 32 – dual supply system junction box, left; 33 – combat release system junction box; 34 – fuel pump system junction box, left; 35 – stand-by inverter junction box; 36 – dual supply system junction box; 37 – emergency circuit lead-in on frame No. 12, port side; 38 – power lead-in on frame No. 12; 39 – dual supply system junction box; 40 – instrument panel of pilot; 41 – navigator's fuse panel, 115 V A.C.; 42 – flare bomb control board.

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Fig. 65. Typical Wire Fittings

1 – soldered wire termination; 2 – loop termination; 3 – wire-to-capacitor attachment; 4 – lug termination of wire; (a) – for wires, gauging 0.35 to 0.5 sq.mm; (b) – for wires gauging 1 to 95 sq.mm; 5 – termination of plug connector wires; (a) – fitting the wires in plug connector pins and sockets; (b) – fitting the wires in plug connector pins and sockets with cutting off part of wire conductors; (c) – fitting the bunched conductor in plug connector; 6 – tagging the bunched connector; 7 – fitting bunched conductors consisting of six or more shielded wires in plug connectors; 8 – fitting the wires in fuel quantity gauge transmitter plug connector; 9 – fitting the wires in plug connectors with screw clamps; 10 – fitting the wires in flat plug connectors.

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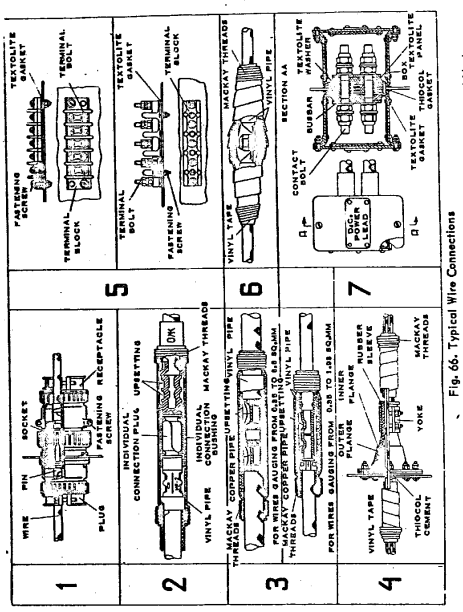

Fig. 66. Typical Wire Connections

1 – plug connector; 2 – individual connector; 3 – fixed connection; 4 – sealed lead; 5 – terminal block; 6 – bolt connection; 7 – power lead.

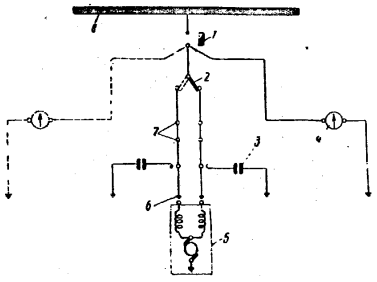

Fig. 67. Circuit Continuity Test without Commutating Relay

1 – fuse; 2 – change-over switch; 3 – capacitor; 4 – megohmmeter; 5 – mechanism; 6 – plug connector; 7 – terminals in junction boxes; 8 – plus busbar.

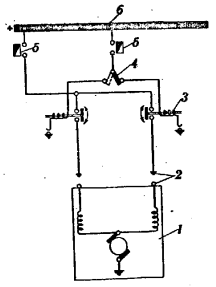

Fig. 68. Circuit Continuity Test with Commutating Contactor

1 – mechanism; 2 – plug connector; 3 – contactor winding; 4 – change-over switch; 5 – fuse; 6 – plus busbar.

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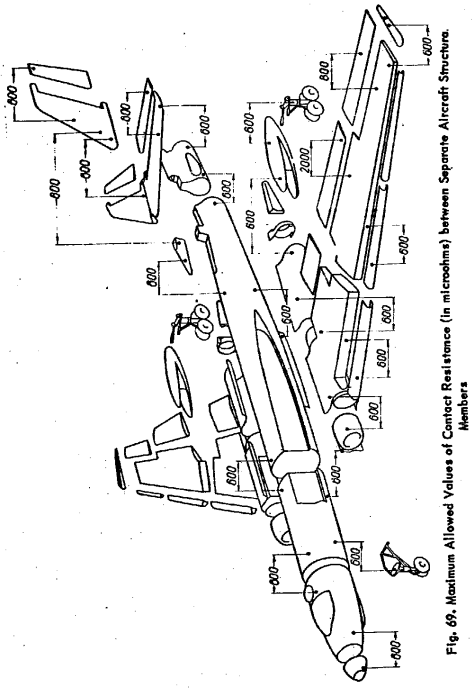
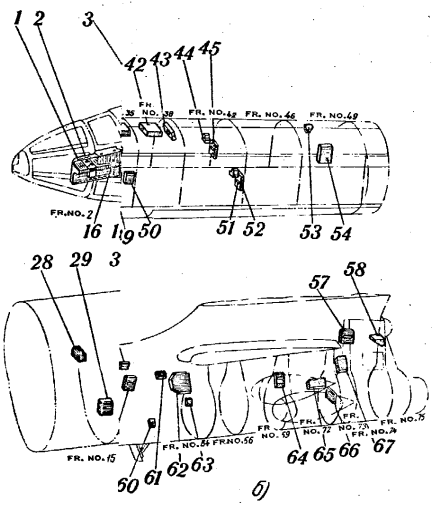


Fig. 69. Maximum Allowed Values of Contact Resistance (in microohms) between Separate Aircraft Structure Members



1 – bomb bay door control board and ge of navigator; 2 – navigator's interp breaker control panel of co-pilot; 4 dual junction box; 5 – trim tab control p violet illumination rheostat control ply control board; 8 – overhead ele 9 – fuelling control board at co-pilo stem synchronization control panel; 11 – ter, type ПО-4500; 12 – junction b inter- rol panel at radar operator's station tch 15 – relay box of stand-by inverter, release electric control board; 17 – box;

50 – auxiliary fuel pump junction box; 51 – emergency supply system junction box; 52 – dual supply system junction box; 53 – power junction box; 54 – fuel pump system junction box, rear; 55 – range-finder supply system junction box; 56 – power junction box; 57 – rear cabin sound signalization system junction box; 58 – gun operator's electric control board; 59 – blister mount fuse system junction box; 60 – switch and receptacle box of extension lamp; 61 – power junction box; 62 – tail unit deicer junction box; 63 – autopilot heater system circuit breaker box; 64 – tail gun mount fuse box; 65 – circuit breaker board of rear cabin; 66 – radio operator's electric control board; 67 – junction box of rear pressurized cabin; 68 – engine nacelle; 69 – L.G. fairing.

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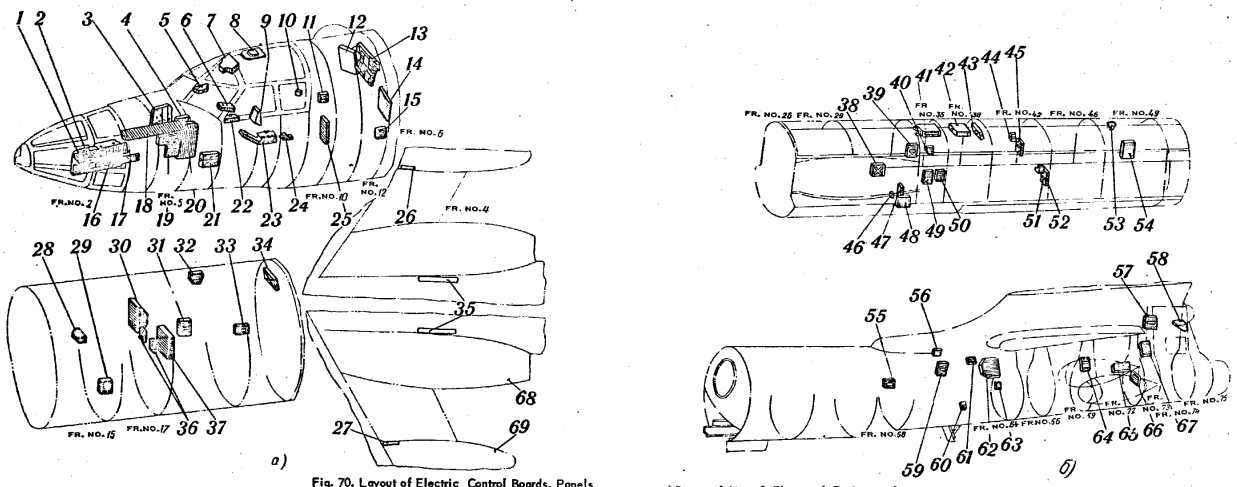

Fig. 70. Layout of Electric Control Boards, Panels and Boxes of Aircraft Electrical Equipment System

1 – bomb bay door control board and camera mount control board of navigator; 2 – navigator's interphone control board; 3 – circuit breaker control panel of co-pilot; 4 – glass panel de-icer system junction box; 5 – trim tab control panel of co-pilot; 6 – ultra-violet illumination rheostat control panel of co-pilot; 7 – fuel supply control board; 8 – overhead electric control panel of pilots; 9 – fuelling control board at co-pilot's station; 10 – trim tab synchronization control panel; 11 – relay box of operating inverter, type ПО-4500; 12 – junction box, right; 13 – generator control panel at radar operator's station; 14 – junction box, left; 15 – relay box of stand-by inverter, type ПО-4500; 16 – bomb release electric control board; 17 – lower bomb release electric control board on navigator's left-hand console; 18 – upper electric control board of navigator; 19 – left-hand circuit breaker control panel of navigator; 20 – circuit breaker control panel of co-pilot; 21 – dual supply system junction box of front cabin; 22 – trim tab control panel of pilot; 23 – electric control board of pilot; 24 – de-energized mains bomb dropping control station; 25 – front cabin sound signallization system junction box; 26 – right junction box of L.G. and fuel pump relay systems; 27 – left junction box of L.G. and fuel pump relay systems; 28 – hydraulic pump junction box; 29 – ground supply system junction box; 30 – storage battery junction box; 31 – top gun mount fuse system junction box; 32 – power junction box; 33 – camera equipment junction box; 34 – fuel quantity gauge junction box; 35 – distribution panels, left and right; 36 – junction box of operating and stand-by inverters; 37 – dual supply system junction box; 38 – fuel pump system junction box; 39 – emergency bomb dropping system junction box; 40 – power junction box; 41 – landing flap system junction box; 42 – bomb release system junction box; 43 – fuze system junction box; 44 – emergency supply system junction box; 45 – dual supply system junction box; 46 – bomb bay doors interlock limit switch mechanism; 47 – bomb bay doors limit switch mechanism; 48 – fuel pump system junction box; 49 – de-energized mains bomb emergency dropping system junction box; 50 – auxiliary fuel pump junction box; 51 – emergency supply system junction box; 52 – dual supply system junction box; 53 – power junction box; 54 – fuel pump system junction box, rear; 55 – range-finder supply system junction box; 56 – power junction box; 57 – rear cabin sound signallization system junction box; 58 – gun operator's electric control board; 59 – bliste mount fuse system junction box; 60 – switch and receptacle box of extension lamp; 61 – power junction box; 62 – tail unit de-icer junction box; 63 – autopilot heater system circuit breaker box; 64 – tail gun mount fuse box; 65 – circuit breaker board of rear cabin; 66 – radio operator's electric control board; 67 – junction box of rear pressurized cabin; 68 – engine nacelle; 69 – L.G. fairing.

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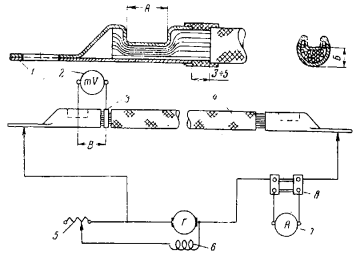

Fig. 71. Fitting the Aluminium Wire in Lug and Circuit Diagram for Measuring Contact Resistance At Aluminium Wire Fitting Point

1 – lug; 2 – millivoltmeter rated for up to 60 millivolts, class 0.5; 3 – contact yoke; 4 – wire, mark БПВЛА; 5 – adjusting rheostat; 6 – generator; 7 – ammeter, class 0.5; 8 – shunt of ammeter rated for up to 300 A

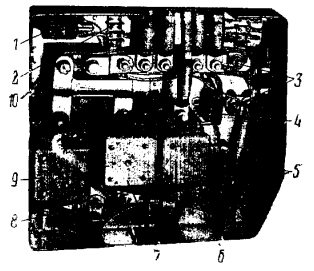

Fig. 72. Storage Battery Junction Box

1 – polarized relay, type РПП-А; 2 – terminal block; 3 – location of fuse, type ТП-400, for protection of operating inverter, type ПО-4500; 4 – blocking relay, type РП-2; 5 – locations of fuses, type ИП-35-2, for protection of instrument supply circuit in de-energized mains conditions; 6 – contactor, type К-300Д, for connecting storage battery to emergency supply circuit; 7 – contactor, type К-300Д, for connecting storage battery to normal supply circuit; 8 – location of fuse, type СП-10, for protection of storage battery heater circuit; 9 – contactor, type К-400Д, for connecting ground power supply source; 10 – shunt of ammeter, type А-1.

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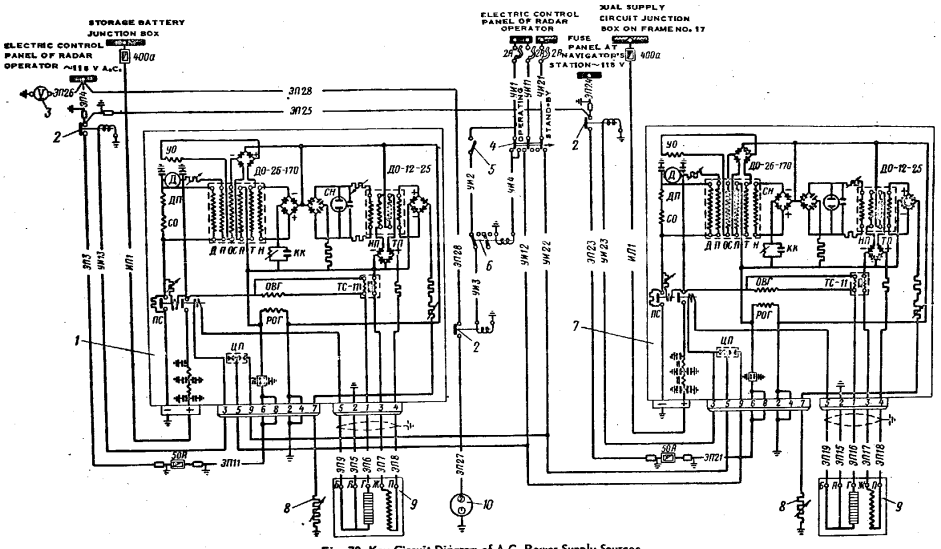

Fig. 73. Key Circuit Diagram of A.C. Power Supply Sources

1 – operating inverter, type ПО-4500; 2 – contactor, type К-50Д; 3 – voltmeter, type ВФ-150; 4 – change-over switch, type ЗПН of inverters; 5 – ground supply switch, type В-45; 6 – blocking relay, type РП-2; 7 – stand-by inverter, type ПО-4500; 8 – adjusting resistor (trimmer), type РС-4М; 9 – carbon voltage regulator, type Р-25В; 10 – plug connector of A.C. ground supply circuit; ПС – starting resistor; СО – series winding of motor; ДП – winding of motor commutating poles; УО – motor control winding; ДО-26-170 – magnetic amplifier of A.C. frequency stabilization; ДО-12-25 – magnetic amplifier of A.C. voltage stabilization; Д – damping winding; П – magnetization winding; ПТ – A.C. winding; ОС – negative feed-back winding; Н – neutralization winding; КК – resonant circuit; СН – voltage stabilizer; ОВГ – generator field winding; РОГ – generator working winding; ТС-11 – stability transformer; ЦП – centrifugal switch.

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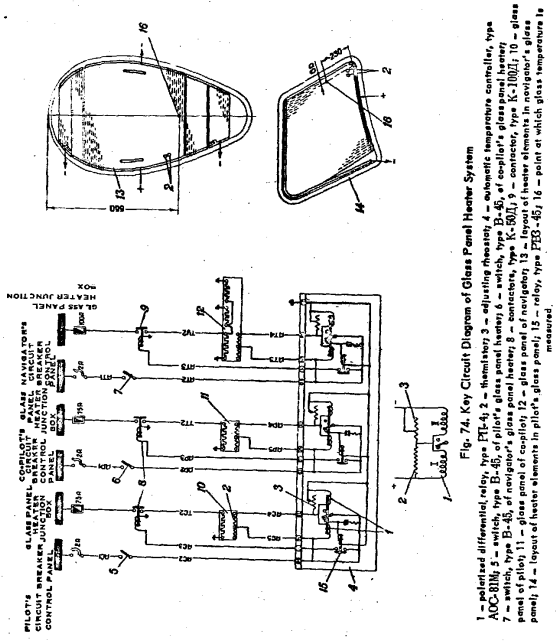

Fig. 74. Key Circuit Diagram of Glass Panel Heater System

1 – pointed differential relay, type PTR-4; 2 – thermistors; 3 – adjusting rheostat; 4 – automatic temperature controller, type AOC-3BN; 5 – switch, type D-45, of pilot's glass panel heater; 6 – switch, type D-45, of copilot's glass panel heater; 7 – switch, type D-45, of navigator's glass panel heater; 8 – contactors, type K-150U; 9 – contactor, type K-100U; 10 – glass panel of pilot; 11 – glass panel of copilot; 12 – glass panel of navigator; 13 – layout of heater elements in navigator's glass panel; 14 – layout of heater elements in pilot's glass panel; 15 – relay, type PEB-45; 16 – point at which glass temperature is measured.

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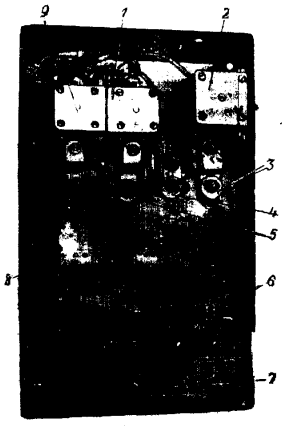

Fig. 75. Cabin and Glass Panel Heater System Junction Box

1 – contactor, type К50Д, of co-pilot's glass panel heater; 2 – contactor, type К-100Д, of navigator's glass panel heater; 3 – location of ИП-100 fuse of navigator's glass panel heater; 4 – location of ИП-150 fuse of front pressurized cabin heater; 5 – locations of ИП-75 fuses of glass panel heaters of pilot and co-pilot; 6 – locations of ИП-50 group protection fuses; 7 – location of ИП-10 group protection fuse; 8 – terminal block; 9 – contactor, type К-50Д, of pilot's glass panel heater.

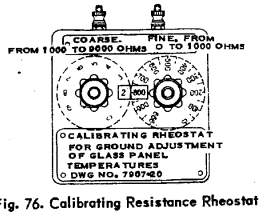

Fig. 76. Calibrating Resistance Rheostat

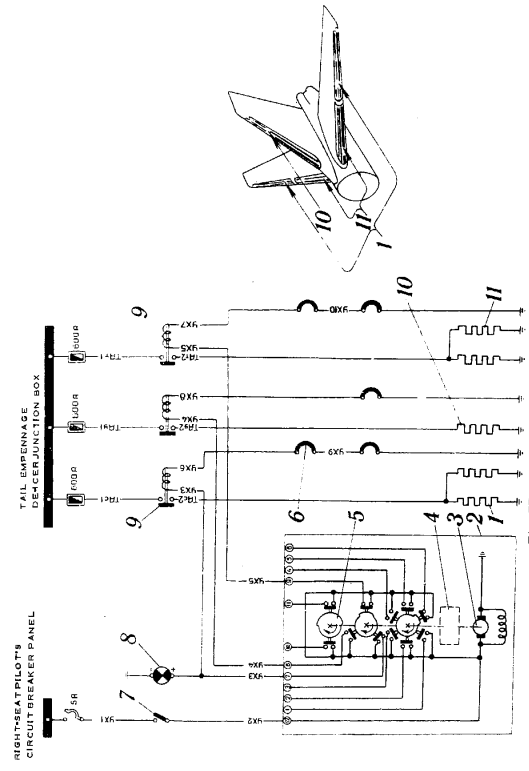

Fig. 77. Key Diagram of Tail Empennage De-Icers

1 – stabilizer de-icer outside sections; 2 – electric mechanism, type МКА-3А; 3 – electric motor; 4 – four-stage planetary reducer; 5 – contact devices; 6 – thermoswitch, type 7778; 7 – switch, type В-45; 8 – warning lamp; type СМН-51, with white light filter; 9 – contactor, type К-600Д; 10 – fin de-icer section; 11 – stabilizer de-icer inner sections.

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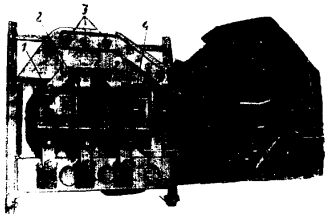

Fig. 78. Tail Empennage De-Icers Junction Box

1 – stabilizer outer section contactor, type К-600Д; 2 – fin section contactor, type К-600Д; 3 – attachment bolts of fuses, type ТП-600; 4 – stabilizer inner section conductor, type К-600Д.

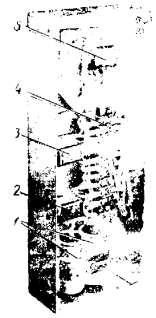

Fig. 81. Box of Front Pressurized Cabin Sound Signal Relay

1 – capacitor, type КЭ-1А-50 $\frac{50}{\text{ohms}}$ – V; 2 – alarm signal relay, type РП-2; 3 – intermittent signal switch relay, type РП-2; 4 – terminal blank; 5 – cabin pressure drop intermittent signal buzzer relay, type РП-12.

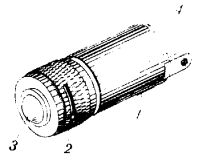

Fig. 79. Aircraft Coloured Warning Light, Type СШ1-51

1 – body; 2 – cap with nozzle; 3 – light filter; 4 – contact busbars.

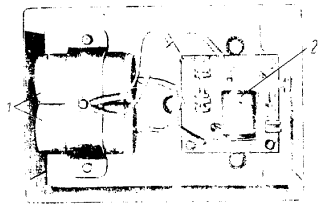

Fig. 82. Box of Rear Pressurized Cabin Sound Signal Relay

1 – capacitor, type КЭ-1А-50 $\frac{50}{\text{ohms}}$ – V; 2 – cabin pressure, drop intermittent signal buzzer relay, type РП-12.

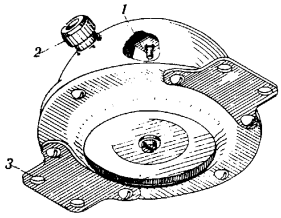

Fig. 80. Horn, Type С-1

1 – cap attachment bolt; 2 – inlet pipe union for conductors with a union nut; 3 – holes for attachment of the horn.

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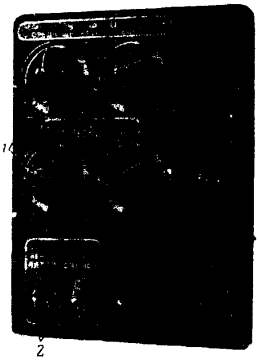

Fig.83. Right-Seat Pilot's Rheostat Panel

1 – rheostats, type РУФО–45; 2 – cutouts, type В–45.

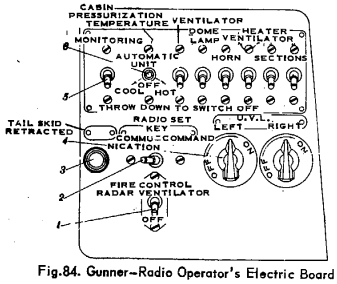

Fig.84. Gunner-Radio Operator's Electric Board

1 – switch, type В–45; 2 – change-over switch, type ПП–45; 3 – warning lamp, type СЦШ-51, with green light filter; 4 – rheostat, type РУФО-45; 5 – change-over switch, type 2ПП–45; 6 – change-over switch, type П2НПН–45.

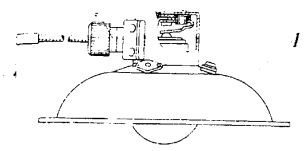

Fig.85. Dome light, Type ПС–45

1 – reflector; 2 – lamp; 3 – inlet pipe union for the conductor with union nut

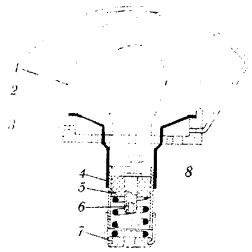

Fig.86. Dome light, Type ПСМ–51

1 – protective glass; 2 – glass and reflector attachment spring; 3 – dome light body; 4 – reflector; 5 – bush; 6 – contact pin; 7 – union nut; 8 – holes for the attachment of the dome light.

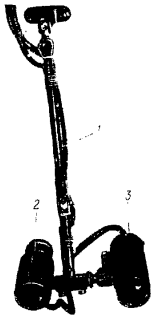

Fig.87. Lamp Hinged Bracket

1 – hinged bracket; 2 – ultra-violet illumination lamp, type АРУФОП–45; 3 – cabin lamp, type КПСРК–45

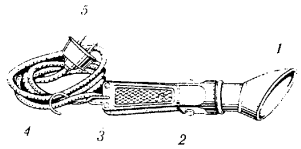

Fig.88. Extension Lamp, Type ПП–10–36

1 – reflector; 2 – switch; 3 – handle body; 4 – cord; 5 – plug.

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25X1

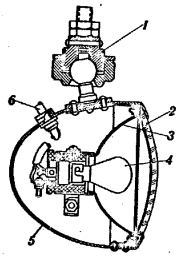

Fig.89. Taxiing light, Type ФР–100

1 – taxiing light attachment hinge bracket; 2 – protective glas; 3 – reflector; 4 – lamp; 5 – casing; 6 – cord

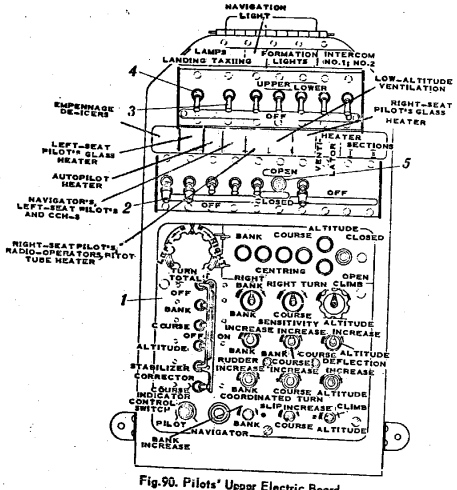

Fig.90. Pilots' Upper Electric Board

1 – АП–5–2М automatic pilot control panel; 2 – extension piece; 3 – switch, type В–45; 4 – change–over switch, type 2П–45; 5 – change–over switch type ПН–45М.

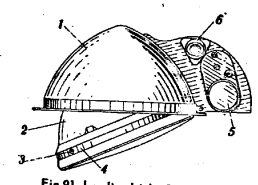

Fig.91. Landing Light, Type ЛФСВ–45

1 – landing lamp body; 2 – landing lamp retractible part; 3 – attachment screws; 4 – attachment ring; 5 – landing lamp control electric mechanism, type МПФ–2; 6 – plug connector.

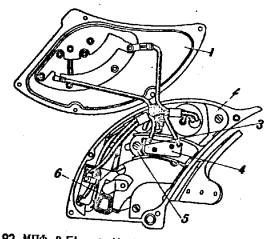

Fig.92. МПФ–2 Electric Mechanism Drive Box with Cover Open

1 – cover; 2 – body; 3 – screw; 4 – limit switch; 5 – plate; 6 – stop.

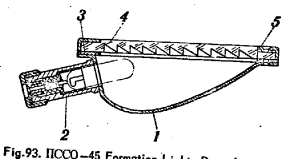

Fig.93. ПССО–45 Formation Lights Dome Lamp

1 – dome lamp body; 2 – socket holder with a union nut for the conductor; 3 – rubber gasket; 4 – polysterene light refractor; 5 – retaining ring.

25X1

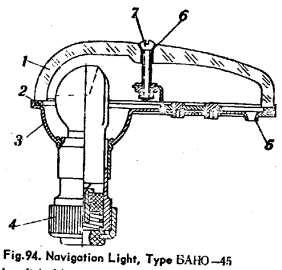

Fig.94. Navigation Light, Type БАНО–45

1 – glass light filter; 2 – packing gasket; 4 – base with socket; 4 – union nut; 5 – fitting attachment hole; 6 – lead washer; 7 – light filter attachment screw.

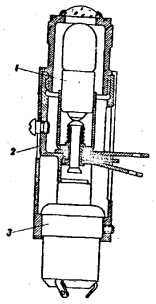

Fig.96. Push–Button Type Lamp

1 – lamp, type СМ–30; 2 – body; 3 – button.

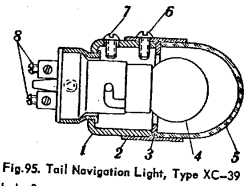

Fig.95. Tail Navigation Light, Type XC–39

1 – body; 2 – mounting; 3 – gasket; 4 – lamp; 5 – glass shade; 6 – glass shade attachment screw; 7 – fitting attachment screw; 8 – supply conductors attachment screw.

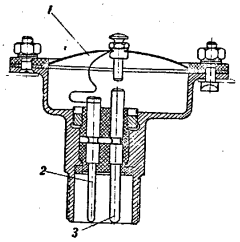

Fig.97. Fire Sensitive Unit

1 – diaphragm; 2,3 – fire–sensitive unit pins.

25X1

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Fig.98. CO_2 and Neutral Gas Cylinders Discharge Bonnet

1 – discharge bonnet; 2 – firing gun.

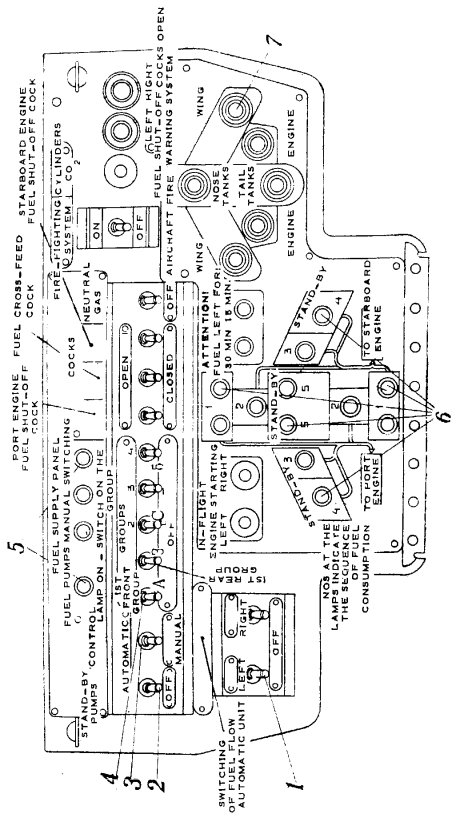

Fig.99. Pilots' Upper Electric Board

1 – fuel automatic control line switch; 2 – stand-by pumps switch; 3 – manual and automatic control switch; 4 – fuel pumps manual control circuit breakers; 5 – blue warning lamps; 6 – green warning lamps; 7 – fire warning and cylinder discharge bonnet switching push-button type lamp.

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25X1

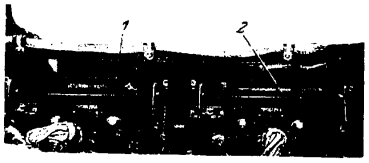

Fig.100. Fuel Gauge Amplifiers

1 – port group fuel gauge amplifier;
2 – starboard group fuel gauge amplifier.

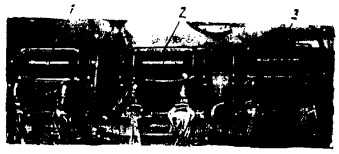

Fig.101. Fuel System Automatic Units

1 – port group automatic unit; 2 – starboard group automatic unit.

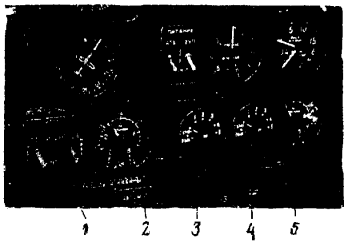

Fig.102. Right–Seat Pilot's Instrument Panel

1 –fuel–level gauge switches; 2 – port group fuel–level gauge indicator; 3 – port group fuel–level gauge change–over switch; 4 – starboard group fuel–level gauge change–over switch; 5 – starboard group fuel–level gauge indicator.

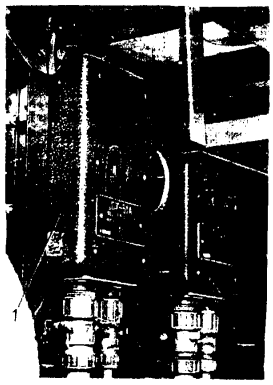

Fig.103. Thyratron Interrupters of the PTC–16 Fuelmeter

1 – port engine fuelmeter interrupter; 2 – starboard engine fuelmeter interrupter.

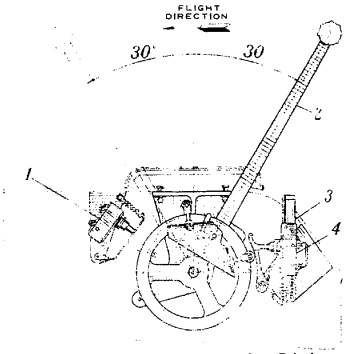

Fig.104. Throttle Control on the Right–Seat Pilot's Console

1 – flap sound signal limit switch; 2 – throttle control; 3 – horn cutoff button; 4 – landing–gear sound signal limit switch.

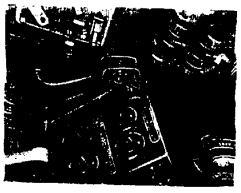

Fig.105. Left-Seat Pilot's Console
1 – flap change-over switch.

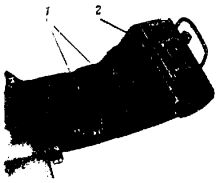

Fig.106. Right-Seat Console
1 – landing-gear sound signal cutoff button; 2 – flap change-over switch.

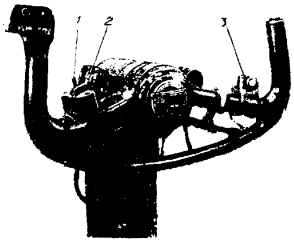

Fig.109. Right-Seat Pilot's Steering Wheel
1 – elevator trim tab switch; 2 – switch neutral position stop; 3 – automatic pilot emergency cutout button.

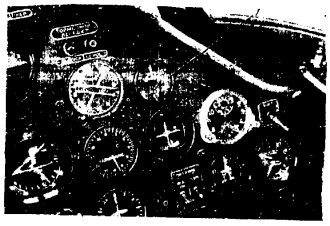

Fig.107. Right-Seat Pilot's Instrument Panel
1 – flap position indicator.

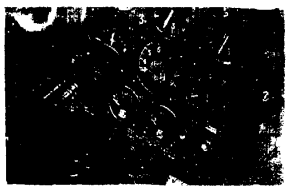

Fig.110. Left-Seat Pilot's Instrument Panel
– rudder trim tab neutral position warning lamp; 2 – aileron rim tab neutral position warning lamp; 3 – course indicator, type АП-5-2М КИЛ

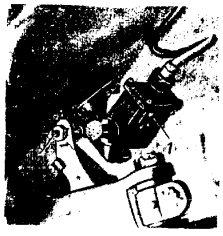

Fig.108. Limit Switch of Landing Gear Main Legs Extended Position Warning System
1 – limit switch; 2 – stop and adjusting screw of the limit switch.

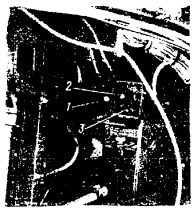

Fig.111. Aileron Trim Tab Synchronization Panel
1 – synchronization panel; 2 – warning lamp; 3 – control switch; 4 – limit switch of the trim tab neutral position warning lamp with the panel cover closed.

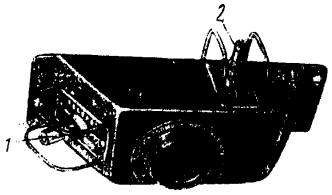

Fig.112. Left-Seat Pilot's Trim Tab Control Panel

1 – rudder trim tab control switch; 2 – aileron trim tab control switch.

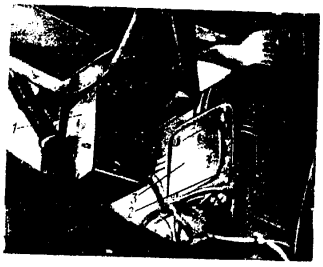

Fig.114. Rear Cabin Electric Heater (Unit 107)

1 – К-200Д contactor box; 2 – unit 107; 3 – hatch for access to unit 107.

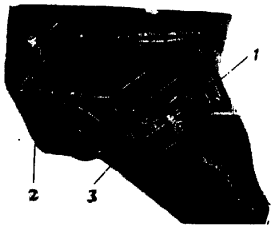

Fig.113. Right-Seat Pilot's Trim Tab Control Panel

1 – rudder trim tab switch; 2 – aileron trim tab switch; 3 – guard.

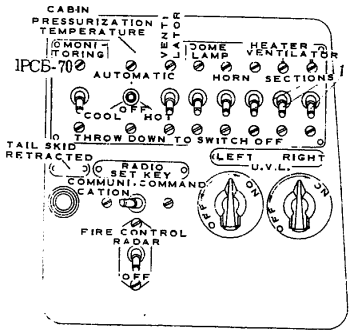

Fig.115. Gunner-Radio-Operator's Electric Board

1 – heater switches.

25X1

25X1

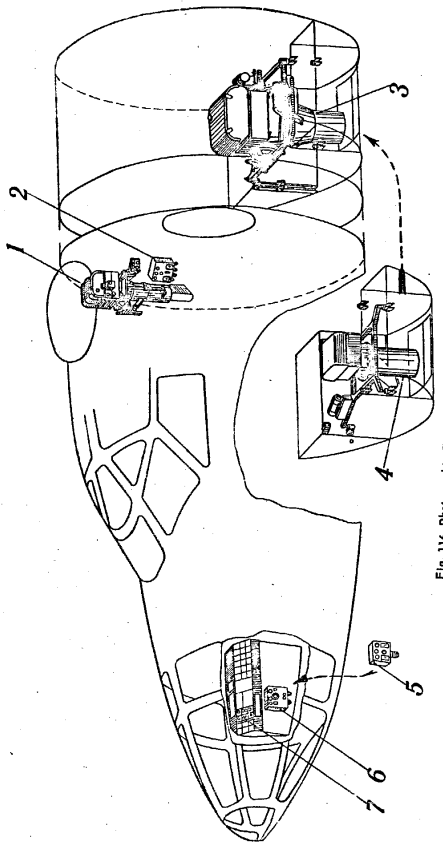

Fig. 116. Photographic Equipment Arrangement Diagram

1 – camera RAPID-1; 2 – RAPID-1 camera controller; 3 – mount of camera 1АФА-30/50; 4 – mount of camera АФА-33/45; 5 – camera controller КПУ-2 for camera АФА-33/45; 6 – tilting mount control panel; 7 – 1АФА camera

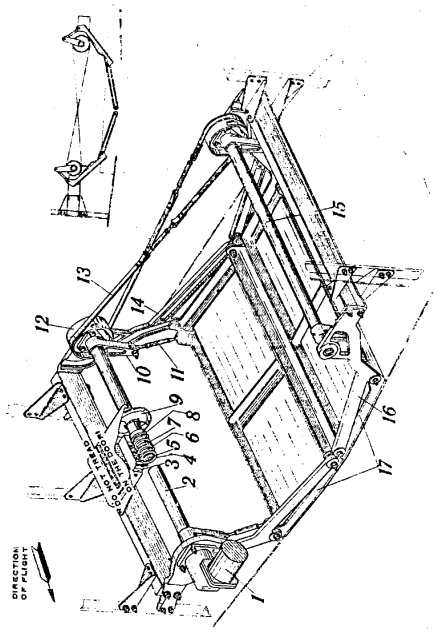

Fig. 117. Camera Hatch

1 – electric mechanism УЛ-7М; 2 – driving shaft; 3 – bracket; 4 – cam; 5 – CAMERA HATCH OPENED limit switch; 6 – CAMERA HATCH CLOSED limit switch; 7 – 1АФА camera interlocking microswitch; 8 – 1АФА camera interlocking microswitch; 9 – limiter; 10 – crankgear; 11 – turnbuckle; 12 – pulley; 13 – belt; 14 – guides; 15 – driven shaft; 16 – guide; 17 – camera hatch doors.

25X1

25X1

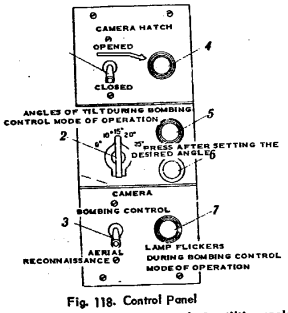

Fig. 118. Control Panel

1 – camera hatch door control switch; 2 – tilting angle change-over switch employed during the BOMBING CONTROL mode of operation; 3 – mode-of-operation selector; 4 – CAMERA HATCH OPENED (люк открыт) green indicating lamp; 5 – tilt angle setting indicating lamp during BOMBING CONTROL mode of operation; 6 – АФА camera tilt control button for BOMBING CONTROL mode of operation; 7 – camera tilting mount control indicating lamp for AERIAL RECONNAISSANCE mode of operation.

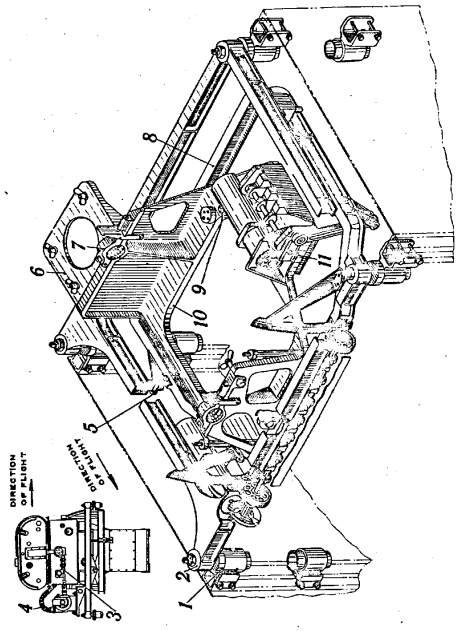

FIG. 119. Camera Automatic Tilting Mount AKA-9У-156Н

1 – union nut; 2 – setting screw; 3 – cardan shaft; 4 – flexible hose; 5 – semiaxle; 6 – plate for arranging the drive-and-pressure unit; 7 – clamp (cover); 8 – intermediate frame; 9 – buttery; 10 – inner frame; 11 – locking screw.

25X1

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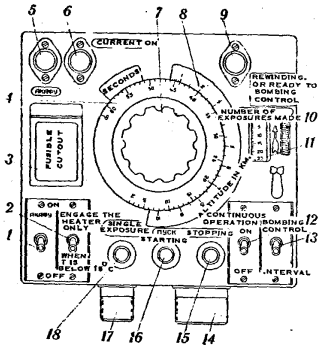

Fig. 120. Camera Controller КПУ-2

1 – АКАФУ mount operation switch; 2 – camera controller heater switch; 3 – fusible cutout cover; 4 – time interval setting scale (white colour); 5 – АКАФУ mount operation indicating lamp; 6 – CURRENT ON (ТОК ВКЛЮЧЕН) indicating lamp; 7 – setting dial; 8 – bombing altitude scale (yellow colour); 9 – REWINDING (ПЕРЕМОТКА) or READY TO BOMBING CONTROL (ГОТОВ К КОНТРОЛЮ БОМБОМЕТАНИЯ) indicating lamp; 10 – exposure counter setting disc; 11 – exposure counter; 12 – continuous functioning switch; 13 – BOMBING CONTROL (КОНТРОЛЬ БОМБОМЕТАНИЯ) – INTERVAL (ИНТЕРВАЛ) setting switch; 14 – camera controller cable connector; 15 – camera controller stopping button; 16 – starting button; 17 – two-pin plug; 18 – single exposure button.

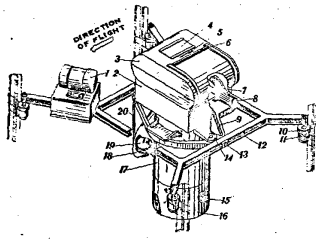

Fig. 121. НАФА Camera Mount

1 – converter; 2 – camera chamber portion; 3 – film magazine; 4 – plate; 5 – arrow indicating the flight direction; 6 – gate; 7 – sector; 8 – locking pin; 9 – movable frame; 10 – union nut; 11 – shock absorber; 12 – outer (fixed) frame; 13 – semi-axle; 14 – bracket; 15 – exposure setting knob; 16 – blind; 17 – camera taper portion; 18 – automatic release; 19 – photocell; 20 – suspension bracket.

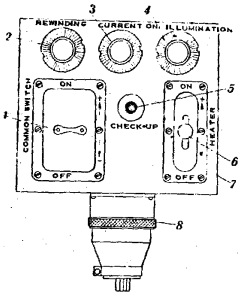

Fig. 122. НАФА-30/31 Camera Controller

1 – common switch; 2 – REWINDING (ПЕРЕМОТКА) indicating lamp; 3 – CURRENT ON (ТОК ВКЛЮЧЕН) indicating lamp; 4 – ILLUMINATION (ПОДСВЕТКА) indicating lamp; 5 – CHECK-UP (ПРОВЕРКА) button; 6 – heater switch; 7 – housing; 8 – connector plug.

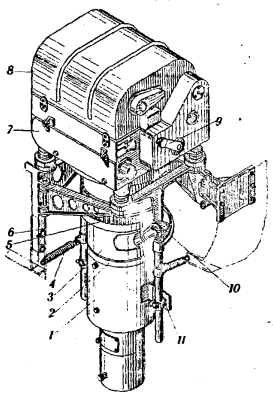

Fig. 123. ФАРД-1 Camera Mount

1 – cathode-ray tube; 2 – attachment ring; 3 – intermediate jacket; 4 – spring; 5 – focusing ring; 6 – locking stud; 7 – camera cover; 8 – film magazine; 9 – camera crank; 10 – guiding pin; 11 – clamp.

SECRET

25X1

25X1

SECRET

25X1

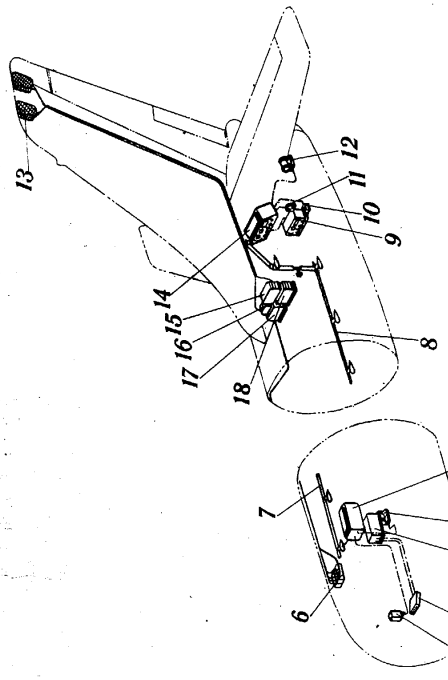

Fig. 124. Arrangement of Radio Communication Facilities

1 – remote control panel of command set 1-РСБ-70М; 2 – control panel of command set receiver УС-9; 3 – receiver УС-9; 4 – dynamotor У-600 of transmitter 1-РСБ-70М; 5 – transmitter 1-РСБ-70М of command set РСИУ-3М; 6 – control panels of command set РСИУ-3М; 7 – loop antenna of command set 1-РСБ-70М; 9 – receiver УС-9 of communication radio set; 10 – telegraph key panel of communication radio set; 11 – radio operator's electric board with monitoring switches and telegraph key; 12 – dynamotor У-600 of communication radio set transmitter; 13 – surface antenna РШ-3М; 14 – remote control panel of communication radio set 1-РСБ-70; 15 – receiver No. 2 of radio set РСИУ-3М; 16 – remote control panel of command radio set РСИУ-3М; 17 – transmitter of radio set РСИУ-3М; 18 – receiver No. 1 of command radio set РСИ-3М.

Fig. 125. Interphone Set СПУ-10

1 – volume control (knob LOUDER); 2 – network switch; 3 – conference call button; 4 – function switche

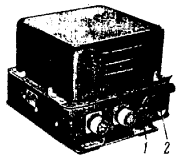

Fig. 126. Interphone System Amplifier

1 – white notch on gain control scale; 2 – gain control.

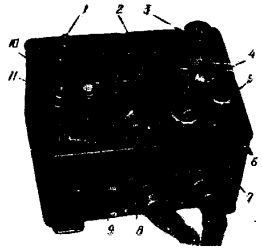

Fig. 127. Remote Control Panel of Receiver УС-9ДМ

1 – switch CRYSTAL; 2 – tuning scale window; 3 – scale illumination control; 4 – tuning knob; 5 – control BEAT NOTE; 6 – buttons ANTENNA ADJUSTMENT; 7 – volume control; 8 – band selector; 9 – switch AFC – off – MFC; 10 – voltage (115 V) indicating lamp; 11 – switch TGPH – TPHN

SECRET

25X1

25X1

SECRET

25X1

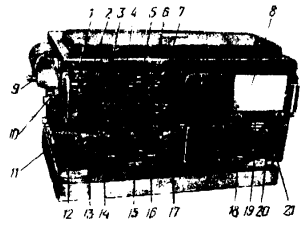

Fig. 128. Transmitter 1-РСБ-70М

1 – key CHECK; 2 – switch LOCAL – REMOTE; 3 – antenna current indicator; 4 – anode current indicator switch; 5 – anode current indicator; 6 – power selector switch; 7 – transmitter function switch; 8 – table to record results of transmitter tuning; 9 – terminal TRANSMITTER ANTENNA (АНТЕННА ПЕРЕДАТЧИКА); 10 – terminal RECEIVER ANTENNA (АНТЕННА ПРИЕМНИКА); 11 – channel selector; 12 – telegraph key socket; 13 – knob Д; 14 – jacks TELEPHONES no. 1 and No. 2; 16 – jack MICROPHONE; 17 – knob Г; 18, 20 – knobs А; 19 – knob А revolution counter; 21 – knob А corrector.

Fig. 129. Remote Control Panel of Transmitter of Command Radio Set 1-РСБ-70М

1 – button-type telegraph key; 2 – red pilot lamp - station on-indicator

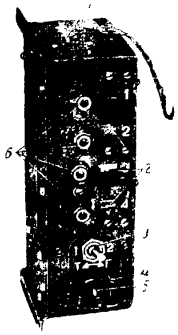

Fig. 132. Control Panel of Radio Set РСП У-3М

1 – channel reset button; 2 – channel on-signalling windows (the third channel is on); 3 – receiver telephone output switch (protective clamp is removed); 4 – volum control limiter; 5 – volum control; 6 – channel selection buttons.

Fig. 130. Telegraph Key

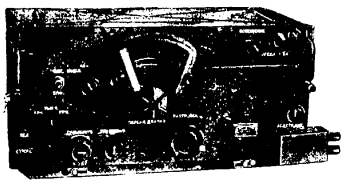

Fig. 131. Receiver УС-9

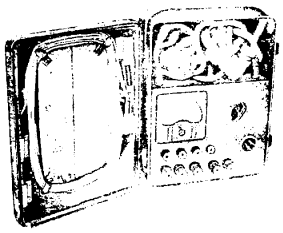

Fig. 133. Taster unit ПУ

SECRET

25X1

25X1

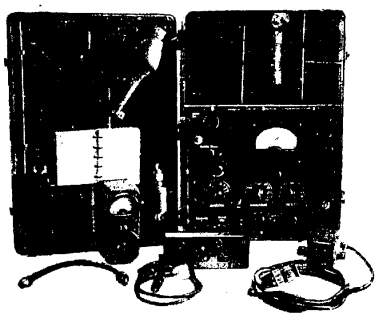

Fig. 134. Tester КСР-1

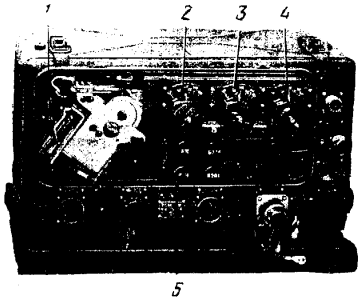

Fig. 135. Transmitter РСИУ-3М (unit A)

1 – channel reset button; 2 – tuning knob of master oscillator and first amplifier; 3 – tuning knob of second amplifier; 4 – tuning knob of power amplifier; 5 – crystals.

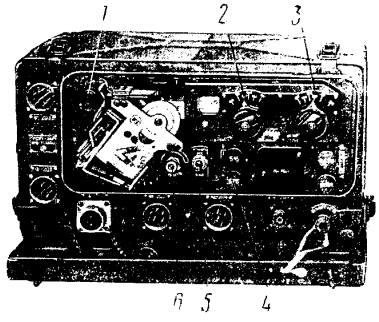

Fig. 136. Receiver РСИУ-3М (unit B)

1 – channel reset button; 2 – tuning knob of local oscillator and U.H.F.; 3 – tuning knob of tripler and second mixer; 4 – crystal; 5 – noise limiter switch; 6 – sensitivity control.

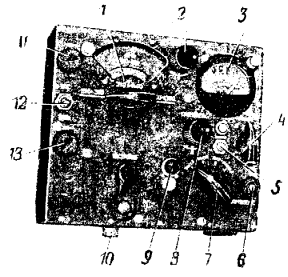

Fig. 137. Control Panel of Radio Compass АРК-5

1 – band switch and tuning scale АРК-5; 2 – scale illumination control; 3 – tuning indicator; 4 – loop antenna manual rotation switch; 5 – sensitivity control of tuning indicator; 6 – button to change over control from one panel АРК-5 to the other; 7 – function switch; 8 – volume control; 9 – green lamp indicates that panel is energized; beneath-spare scale illumination lamp; 10 – flexible shaft pipe connection; 11 – fuse for 28 V D.C. circuits; 12 – switch ТСРН–ТРНН; 13 – fuse for 115 V, 400 c.p.s. circuit.

25X1

25X1

25X1

SECRET

Fig. 138. Radio Compass Course Indicator БСУП-1

Fig. 139. Course Indicator УШДБ-1

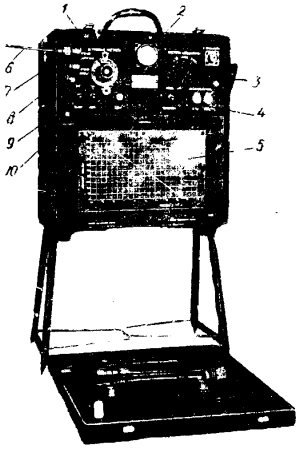

Fig. 141. Marker Beacon Simulator МИП-48

1 – frequency setting limb MARKER; 2 – indicator; 3 – modulation switch; 4 – function switch; 5 – simulator tuning chart; 6 – antenna; 7 – socket BAND ANTENNA (АНТЕННА ДИАПАЗОНА); 8 – socket ANTENNA–CRYSTAL; 9 – supply switch; 10 – R.F. oscillation keing switch.

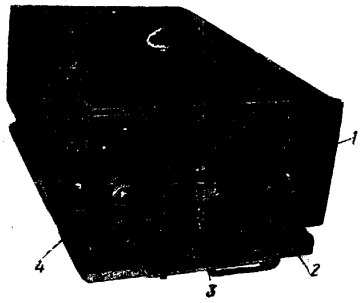

Fig. 140. Receiver of Radio-Compass APK–5

1 – sensitivity control APK–5; 2 – terminal ANTENNA; 3 – terminal EARTH; 4 – flexible shaft pipe connection.

Fig. 142. Marker Receiver МРП-48П

1 – circuit I tuner; 2 – circuit II tuner; 3 – jack for plug of check instrument for measuring relay current.

SECRET

25X1

25X1

[redacted]

25X1

Fig. 143. Inboard Antenna of Marker Receiver МРП-4МП

1 – cap of antenna tuning screw.

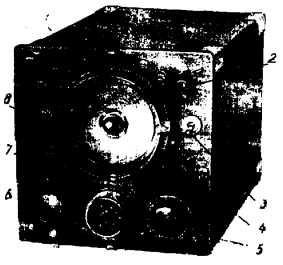

Fig. 144. Indicator PB-17

1 – screen; 2 – control knob ZERO CONTROL x 10; 3 – range scale switch; 4 – control knob ZERO CONTROL x 1; 5 – control knob DIRECT PULSE CONTROL–GAIN; 6 – control knob CIRCLE SIZE (РАЗМ. ОКРУЖ.); 7 – on-pilot lamp; 8 – supply switch.

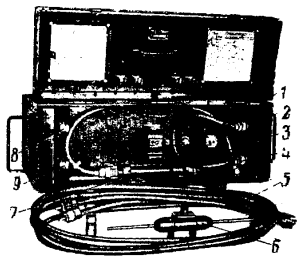

Fig. 145. Tester T–1

1 – bridging feeder Ф-3; 2 – socket Н-1; 3 – feeder Ф-2, 4 – socket В-1; 5 – two feeders Ф-1; 6 – antenna radiation indicator; 7 – attenuator; 8 – socket Н-2; 9 – socket В-2.

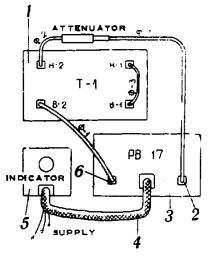

Fig. 146. Diagram Showing Connections of Radio Altimeter PB-17 to Tester T–1 for Measurement of Overall Sensitivity

1 – tester T–1; 2 – receptacle RECEIVING ANTENNA; 3 – transmitter-receiver PB-17 4 – cable connecting transmitter-receiver PB–17 to indicator; 5 – indicator of radio altimeter; 6 – receptacle TRANSMITTING ANTENNA; Ф1, Ф2, Ф3 – radio-frequency feeders; Н–1, Н–2, В–1 and В–2 - radio-frequency sockets of tester T–1.

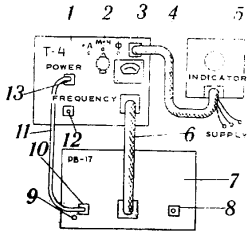

Fig. 147. Diagram Showing Connection of Radio Altimeter PB-17 to Tester T-4 for Measurement of Radiation Power of Transmitter PB-17

1 – tester T-4; 2 – switch POWER–FREQUENCY; 3 – receptacle TO INDICATOR (К ИНДИКАТОРУ); 4 – cable connecting tester T-4 to indicator PB-17; 5 – indicator PB-17; 6 – cable connecting tester T-4 to transmitter-receiver PB-17; 7 – transmitter-receiver PB-17; 8 – receptacle RECEIVING ANTENNA; 9 – control A; 10 – receptacle TRANSMITTING ANTENNA; 11 – radio-frequency cable connecting receptacle TRANSMITTING ANTENNA on transmitter-receiver PB-17 to receptacle POWER on tester T-4; 12 – receptacle FREQUENCY; 13 – receptacle POWER.

[redacted]

25X1

25X1

SECRET

25X1

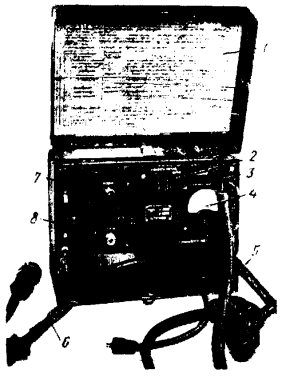

Fig. 148. Tester T-4

1 – instructions for tester; 2 – function switch; 3 – connector for cutting in indicator PB-17; 4 – power-level indicator; 5 – cable for connection to transmitter- receiver PB-17; 6 – T-joint; 7 – socket POWER; 9 – socket FREQUENCY.

Fig. 149. Transmitter-Receiver PB-17

1 – control A for tuning transmitting antenna.

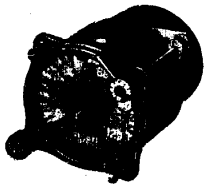

Fig. 150. Indicator ПРВ-46 of Radio Altimeter PB-3

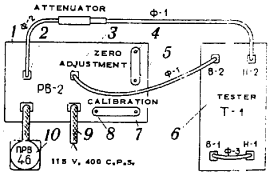

Fig. 151. Diagram Showing Connection of Radio Altimeter PB-2 to Tester T-1 for Checking Overall Sensitivity of PB-2 and Calibration of Readings at the End of Indicator Scale on 1st Band

1 – transmitter-receiver PB-2; 2 – receptacle RECEIVING ANTENNA; 3 – receptacle TRANSMITTING ANTENNA; 4 – control ZERO ADJUSTMENT - HIGH ALTITUDES; 5 – control ZERO ADJUSTMENT - LOW ALTITUDES; 6 – tester T-1; 7 – control CALIBRATION - HIGH ALTITUDES; 8 – Control CALIBRATION - LOW ALTITUDES; 9 – supply cables PB-2; 10 – altimeter indicator; Φ-1, Φ-2, Φ-3 - radio-frequency cables; B-1, B-2, H-1, H-2 – sockets of tester T-1.

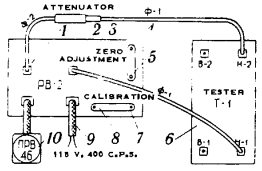

Fig. 152. Diagram Showing Connection of Radio Altimeter PB-2 to Tester T-1 for Calibration of Radio Altimeter Readins at the Beginning of Indicator Scale on 1st Band

1 – receptacle RECEIVING ANTENNA; 2 – receptacle TRANSMITTING ANTENNA; 3 – transmitter-receiver PB-2; 4 – control ZERO ADJUSTMENT - HIGH ALTITUDES; 5 – control ZERO ADJUSTMENT – LOW ALTITUDES; 6 – tester T-1; 7 – control CALIBRATION – LOW ALTITUDES; 8 – control CALIBRATION – HIGH ALTITUDES; 9 – supply cable; 10 – altimeter indicator; Φ-1, Φ-2 – radio-frequency cables; H-1, H-2, B-1, B-2 – sockets of tester T-1.

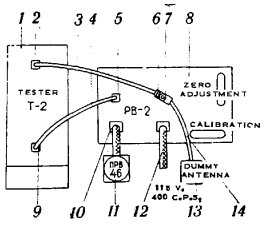

Fig. 153. Diagram Showing Connection of Radio Altimeter PB-2 to Tester T-2 for Calibration of Radio Altimeter Readings at the End of Scale on 2nd Band

1 – tester T-2; 2 – taster receptacle; 3 – radio-frequency cable to connect tester T-2 receptacle TRANSMITTING ANTENNA PB-2; 4 – cable connecting tester T-2 to receptacle RECEIVING ANTENNA PB-2; 5 – receptacle RECEIVING ANTENNA; 6 – red mark on adapter; 7 – adapter for connection of receptacle TRANSMITTING ANTENNA to tester T-1 and dummy antenna; 8 – transmitter-receiver PB-2; 9 – receptacle; 10 – receptacle TO INDICATOR; 11 – indicator of radio altimeter; 12 – supply cable; 13 – dummy antenna; 14 – radio- frequency cable.

SECRET

25X1

25X1

[redacted]

25X1

Fig. 154. Transmitter-Receiver of Radio Altimeter РВ-2

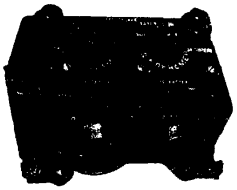

Fig. 155. Control Panel of Radio Range Finder СД-1

Fig. 156. Indicator ПРД-50 of Radio Range Finder СД-1

Fig. 157. Checking Radiation Power of Radio Range Finder

1 – transmitting antenna СД-1; 2 – power-level indicator; 3 – receiving antenna; 4 – aircraft skin.

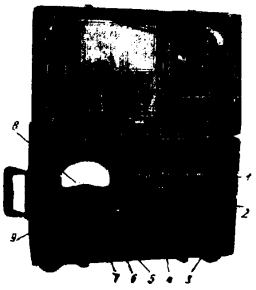

Fig. 159. Test Instrument КИПД-3

1 – tuning scale FREAUENCY Mc/s; 2 – tuning knob; 3 – socket for connection to receiver antenna; 4 – socket for connection to transmitter antenna; 5 – function switch; 6 – filament voltage control; 7 – supply switch; 8 – indicator; 9 – zero adjustment knob.

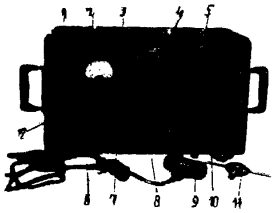

Fig. 158. Range Finder Test Instrument КИПД-1

1 – receptacle for connection to transmitter; 2 – voltmeter; 3 – voltmeter switch; 4 – communication channel selector (MODE OF OPERATION); 5 – scale RANGE–ORBIT; 6 – socket for connection to transmitter antenna (input); 7 – supply switch; 8 – switch RANGE BAND; 9 – cable with T–joint for connection of instrument КИПД-1 to transmitter СД-1; 10 – socket for connection of instrument КИПД-1 to receiver antenna; 11 – radiation indicator; 12 – button CHECK 250 V.

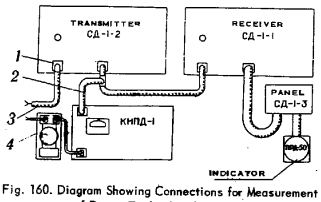

Fig. 160. Diagram Showing Connections for Measurement of Range Finder Supply Voltage

1 – supply receptacle of range finder; 2 – cable with T–joint for connection of instrument КИПД-1 to transmitter СД-1-2; 3 – supply cable СД-1; 4 – converter МА-100.

[redacted]

25X1

25X1

SECRET

25X1

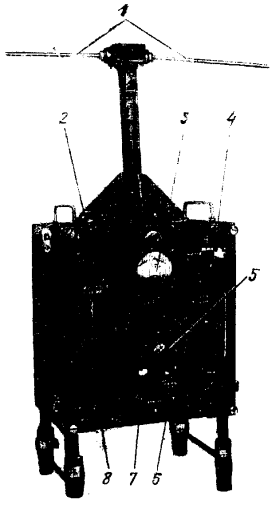

Fig. 161. Course Beacon Simulator КИРМ-Ф

1 – antenna; 2 – channel selector; 3 – indicator; 4 – function switch; 5 – limb for setting phase of modulation voltage; 6 – switch ZERO CHECK – OPERATION; 7 – switch COURSE – AZIMUTH; 8 – supply switch.

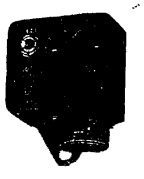

Fig. 162. Control Panel М-50

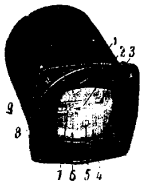

Fig. 163. Instrument Landing Indicator ПСП-48

1 – course pointer corrector; 2 – "black ring"; 3 – glideslope signalling indicator; 4 – yellow scale sector; 5 – course signalling indicator; 6 – blue sector of course scale; 7 – glide-slope pointer; 8 – glide-slope pointer corrector; 9 – course pointer.

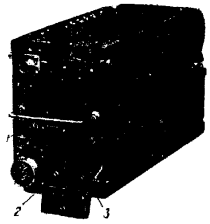

Fig. 164. Localizer Receiver КРП-Ф

1 – button CHECK; 2 – sensitivity control; 3 – control BALANCE.

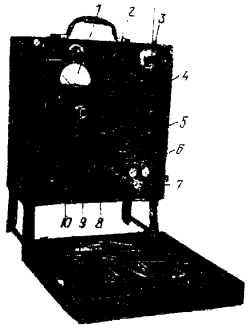

Fig. 165. Glide-Slope Beacon Simulator ГИРМ-2

1 – signal level indicator; 2 – R.F. signal level control knob; 3 – antenna; 4 – channel selector; 5 – control knob 150 c.p.s. LEVEL; 6 – socket for connection of simulator to glide-slope receiver, 7 – switch H.F. LEVEL – L.F. LEVEL; 8 – function switch; 9 – control knob 90 c.p.s. LEVEL; 10 – supply switch.

Fig. 166. Glide-Slope Receiver ГРП-2

1 – socket for connection of simulator ГРП-2; 2 – cover plate of controls BALANCE and SENSITIVITY.

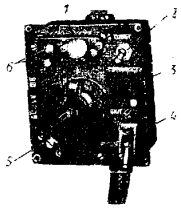

Fig. 167. Transponder Panel

1 – light control; 2 – switch READY-RESPONSE; 3 – code switch; 4 – switch DISTRESS SIGNAL; 5 – jacks PHONE; 6 – pilot lamps.

SECRET

25X1

25X1

SECRET

25X1

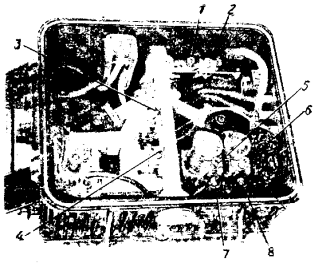

Fig. 168. Transmitter-Receiver P2, Inside View

1 – potentiometer R2–4 for adjusting AFC voltage on 1st channel; 2 – potentiometer R2–5 for adjusting AFC voltage on 2nd channel; 3 – screw for adjusting spark gap P3I1 on 1st channel; 4 – screw for adjusting spark gap P3I1 on 2nd channel; 5 – screw for adjusting crystal current on 1st channel; 6 – screw for adjusting crystal current on 2nd channel; 7 – screw for adjusting frequency of 1st channel klystron; 8 – screw for adjusting frequency of 2nd channel klystron.

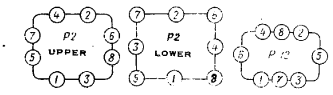

Fig. 169. Sequence for Screwing In and Out Bolts and Nuts on Units P2 and P12

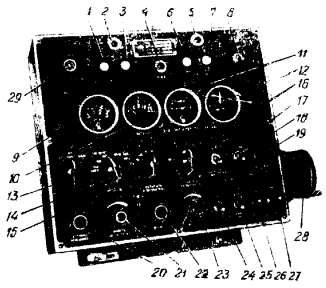

Fig. 170. Front of Operator's Panel P6

1 – button SUPPLY ON; 2 – button SUPPLY OFF; 3 – green pilot lamp to indicate that power is on; 4 – yellow lamp PRESSURE DROP SIGNALLING; 5 – red pilot lamp to indicate that transmitter is on; 6 – button TRANSMITTER ON; 7 – button TRANSMITTER OFF; 8 – switch FREQUENCY I–II; 9 – meter CHECK; 10 – meter SUPPLY; 11 – meter PRESSURE IN TRANSMITTER (ДАВЛЕНИЕ В ПЕРЕДАТЧИКЕ); 12 – meter ANTENNA TILT; 13 – switch AFC – BEACON; 14 – switch CHECK; 15 – switch RANGE KM; 16 – switch SWEEP DELAY KM; 17 – switch COURSE LINE; 18 – switch SECTOR SCANNING; 19 – knob potentiometer POSITION CONTROL R6–7; 20 – knob of potentiometer RECEIVER TUNING R6–8; 21 – knob of potentiometer RANGE MARKER BRIGHTNESS R6–5; 22 – knob of potentiometer "10–70" R6–3; 23 – knob of potentiometer ALTITUDE DELAY (ЗАДЕРЖКА НА ВЫСОТУ) R6–8; 24 – switch MARKERS; 25 – switch ROTATION; 26 – switch SEARCH; 27 – switch TILT; 28 – scale of potentiometer RANGE; 29 – adjusting screw of potentiometer ADJUSTMENT – 115 V R6–8.

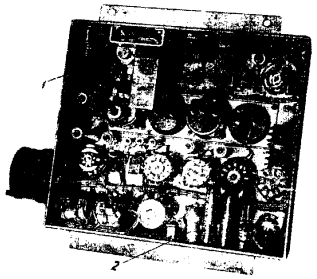

Fig. 171. Navigator-Operator s Panel as Viewed from Wiring Side

1 – potentiometer R6–65; 2 – potentiometer R6–57

SECRET

25X1

25X1

25X1

SECRET

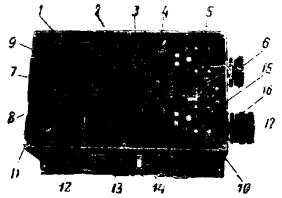

Fig. 172. Front of Bomb Aimer's Panel P9

1 – switch CALIBRATION; 2 – green lamp SUPPLY ON; 3 – red lamp SIGHTING BUTTON ON; 4 – knob of potentiometer SCALE ILLUMITATION R9–22; 5 – scale SLANT RANGE CORRECTION M; 6 – knob of potentiometer SLANT RANGE CORRECTION R9–12; 7 – knob of potentiometer RANGE SCALE R9–2; 8 – knob of potentiometer SPEED SCALE R9–2; 9 – potentiometer for adjusting slant range correction R9–13; 10 – switch SEARCH – AIMING; 12 – knob of potentiometer SPEED ZERO ADJUSTMENT R9–6; 13 – switch SPEED GENERATOR; 13 – switch ANTENNA TILT; 15 – scale TRACKING SPEED KM/HR; 16 – knob of potentiometer TRACKING SPEED R9–20; 17 – knob of potentiometer POSITION R9–23

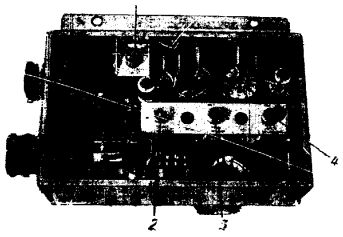

Fig. 173. Bomb Aimer's Panel P9 as Viewed from Wiring Side

1 – potentiometer R9–31; 2 – potentiometer R9–21; 3 – potentiometer R9–24; 4 – potentiometer R9–17.

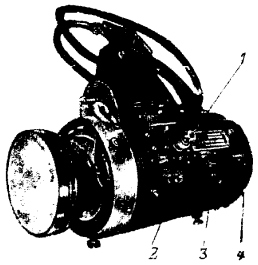

Fig. 174. Bomb Aimer's Indicator P8, Right Side View

1 – knob of potentiometer FOCUS R8–6; 2 – knob of potentiometer HORIZONTAL CENTRE R8–4; 3 – adjusting screw of potentiometer DRIFT CORRECTION R8–1; 4 – adjusting screw of potentiometer TRANSVERSE STABILIZATION R8–2.

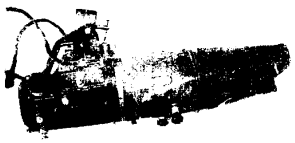

Fig. 175. Bomb Aimer's Indicator P8, Left Side View

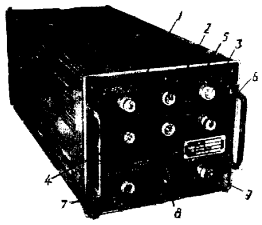

Fig. 176. Front Panel of Range Unit P3

1 – adjusting screw of range potentiometer SCALE R3–92; 2 – adjusting screw of step delay potentiometer SCALE R3–53; 3 – adjusting screw of altitude potentiometer SCALE R3–31; 4 – adjusting screw of range potentiometer ZERO R3–94; 5 – adjusting screw of step delay potentiometer ZERO R3–51; 6 – adjusting screw of altitude potentiometer ZERO R3–30; 7 – adjusting screw of frequency division potentiometer "5:1" R3–8; 8 – switch CALIBRATION–OPERATION; 9 – adjusting screw of frequency division potentiometer "6:1" R3–22.

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25X1

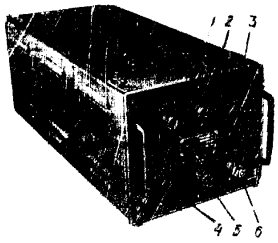

Fig. 177. Front Panel of Operator's Lock Unit P4

1 – adjusting screw of potentiometer AFC VOLTAGE R4–107; 2 – adjusting screw of potentiometer RANGE CONTROL R4–42; 3 – adjusting screw of potentiometer SWEEP AMPLITUDE R4–66; 4 – knob of potentiometer RECEIVER GAIN R4–106; 5 – knob of potentiometer LOW LEVEL R4–94; 6 – knob of potentiometer HIGH LEVEL R4–85.

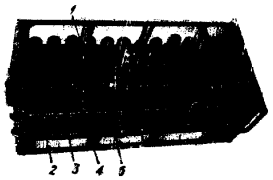

Fig. 178. Inside View of Bomb Aimer's Lock Unit P7

1 – potentiometer R7–130; 2 – potentiometer R7–40; 3 – potentiometer R7–138; 4 – potentiometer R7–139; 5 – delay line.

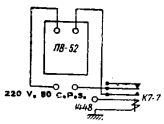

Fig. 179. Diagram Showing Connection of Device ПВ-52 when Determining Duration of Pulse for Automatic Switching of Optical Sight ОПБ-11Р

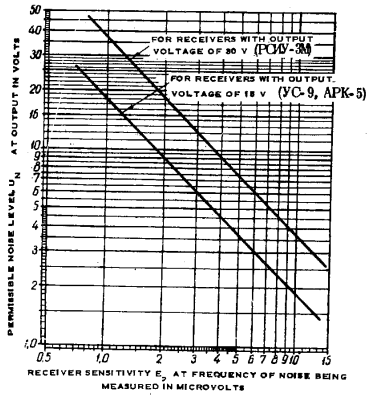

Fig. 180. Permissible Noise Level at Receiver Output as Plotted against Receiver Sensitivity

Fig. 181. Output Meter ИВ-4

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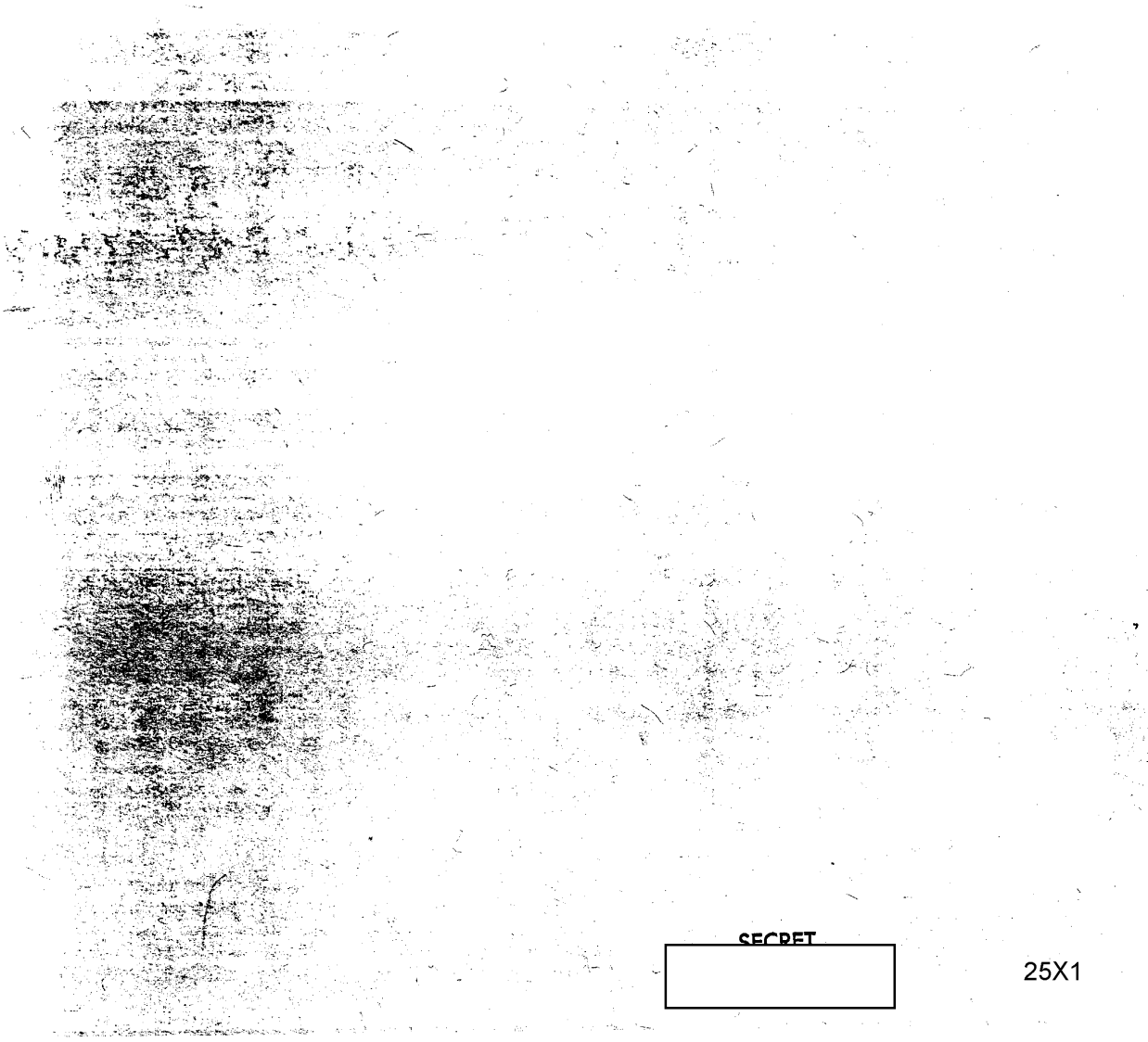

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