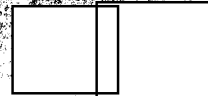


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AIRCRAFT TU-16  
Technical Description

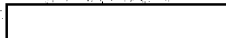
BOOK FOUR

Part 1

Electrical, Radio and  
Camera Equipment

DIA review(s) completed.

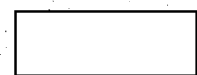
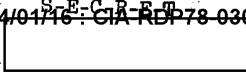
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GROUP 1  
Excluded from automatic  
downgrading and  
declassification.



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**AIRCRAFT Ty-16**  
**Technical Description**

**BOOK FOUR**  
**Part 1**

**Electrical, Radio and  
Camera Equipment**

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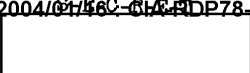
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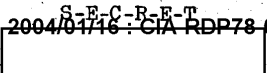
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Chapter I  
ELECTRICAL EQUIPMENT

GENERAL

The aircraft D.C. mains is powered by four generators, type ICP-18000, rated for 18 kW each. The generators are connected in parallel to the mains and produce a power total of 72 kW at 28 to 28.5 V. The generators are driven by the aircraft engines, type PD-3M.

In addition to the generators the aircraft is provided with a starter-type battery 12CAN-55, 55 ampere-hours capacity (at a discharge current of 11 A).

The storage battery operates in parallel with the generators, and also serves as a standby power source.

For current alternation the aircraft is provided with two inverters, type ПО-4500, which produce an alternating current of 400 c.p.s., 115 V. One of the inverters is operating, the other is standby.

The aircraft mains can be connected to ground power sources by means of two ground power supply plug connectors mounted on the aircraft fuselage. One of the plug connectors is used to connect a D.C. power source, while the other connects A.C. power sources.

The aircraft electrical circuit is a single-wire network; the wiring is done with non-shielded and shielded wire, type БНБЛ, the aircraft structure being utilized as the minus conductor. For the purpose of decreasing the weight of the electrical equipment the D.C. supply line is wired with aluminium wire, type БНБМА.

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The main electric power consumers on the aircraft are:

1. Engine starting system consisting of electric starting units and engine instrumentation.
2. Engine fuel supply electric units (fuel pumps, pump control electrical equipment, fire-fighting equipment, fuel gauge, etc.).
3. Aircraft control electric units (autopilot, actuators of flaps, trim tabs and tail skid, wheel automatic braking system, hydraulic pump, explosive charge mechanisms for releasing and dropping of the drag chute).
4. Flight control and navigating electric units (gyro horizons, directional gyros, remote-indicating induction compass, dead reckoning (aircraft position) instrument system and remote-indicating astrocompass).
5. Electric heating and de-icing arrangements (thermal de-icers of tail unit, pilots' and navigator's cabin glass enclosure, electric heaters of the front and rear pressurized cabins, electric heaters of battery containers, autopilot servo units and other instruments).
6. Aircraft internal illumination system (cabin dome lights, directed light fixtures and ultra-violet illumination arrangements).
7. Aircraft external light system (landing lamps, taxiing lamps, leader-initiated bombing lamps, as well as formation and navigating lights).
8. Aircraft system of light and sound signalization.
9. Bombing and cannon systems.
10. Radio and radar systems.

The total current consumed by the maximum number of simultaneously energized power consumers amounts to approximately 1700 A (the cabin heaters consume 340 A, the glass enclosure de-icers require 190 A, the tail unit de-icers take 470 A, the cannon system - 250 A, and the permanently engaged consumers require approximately 450 A).

Thus, the power which can be continuously picked up from the generators, is utilized by the aircraft power consumers

under adverse weather and combat conditions not more than by 70 per cent. This means that the aircraft has an excess electric power which adds to the reliability of the electric system operation in case of failure of one of the power supply sources available; this also ensures voltage stability in the aircraft mains when powerful consumers are supplied.

#### Section 1 C I R C U I T R Y

The aircraft electric circuit consists of electric wires, switching equipment, as well as of control and protection arrangements. The circuit employs a single-wire diagram, with the aircraft structure utilized in the function of the minus wire.

Minus wires of power consumers are connected to the aircraft structure in six points: in four points from the generators (on the fuselage port and starboard sides, at frame No.44), from the storage battery on frame No.17, port side, and from the ground supply plug connector in the nose wheel well, port side, at frame No.15.

Minus wires of separate power consumers are connected to the airframe in the installation area of each particular unit. The minus wire connection points are marked with red paint.

For better dependability of power consumer operation and as a measure against possible spot overheating and electrical corrosion of some units and joints, all the aircraft units and equipment items are reliably bonded.

The aircraft electrical circuit consists of separate feeders.

For the list of feeders and their protecting arrangements see Table 1.

The entire electrical circuit of the aircraft is divided into the following:

1. The direct current circuit, with voltage within 28 to 28.5 V, supplied from the generators, type ICP-18000, and storage battery, type 12CAM-55.

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2. The single-phase A.C. circuit, 115 V, at a frequency of 400 c.p.s., supplied from the two HO-4500 inverters (operating and standby).

In its turn, the D.C. circuit consists of:

- (a) normal supply circuit;
- (b) emergency supply circuit;
- (c) dual supply circuit.

Due to the fact that all these circuits are directly connected with the supply sources and with the power distribution system, the circuits are discussed in detail in Section 2 of the present Chapter.

The electrical wiring is done with copper wire, type BHEM, with colour insulation, and with aluminium wire, type BHEMA, with white insulation.

The radio equipment wires are light blue, the armament system wires are red, the wires of the aircraft A.C. mains are yellow, and all other wires are white.

To reduce radio interference and interference to the radar equipment, part of the copper wires in the interphone system is shielded, and wire, type BHEMS, is used. For the same purpose part of copper wires is encased in common shielding braidings.

For the types of wires and their total lengths see Table 2.

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Feeders and Circuit-Protecting Arrangements

Nos Group	Feeder group	Feeder supply bus bar	Power consumer	Protecting arrangement				
				type	current, A	location		
1	2	3	4	5	6	7	8	9
1	A	Automatic equipment	115 V, A.C.	Fuel flow controller, left	CU	1	1	Navigator's fuse panel, 115 V, A.C.
2	AB		115 V, A.C.	Fuel flow controller, right	CU	1	1	
3	AF		A	Fuel flow controller, left	ASC	5	5	Co-pilot's circuit
4	AF		A	Fuel flow controller, right	ASC	5	5	Breaker panel
5	AF		A	TPTEK thermostat of front pressurized cabin	ASC	2	2	
6	AF		H	TPTEK thermostat of rear pressurized cabin	ASC	2	2	Second on/in circuit breaker panel

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1	2	3	4	5	6	7	8	9
7			AK	A	Dead reckoning instrument system, type RH-50B	A3C	5	Navigator's circuit breaker panel, left
8			AI	H	Autopilot, type AI-5-2M	A3C	15	Pilot's circuit breaker panel
9			AP	H	Co-pilot's glass panel heater control	A3C	2	Co-pilot's circuit breaker panel
10			AC	H	Pilot's glass panel heater control	A3C	2	Pilot's circuit breaker panel
11			AT	H	Navigator's glass panel heater control	A3C	2	Navigator's circuit breaker panel, left
12			AIH16	-	Autopilot vertical flight gyro motor	A3C	5	Navigator's circuit breaker panel, left
13			AIH17	-	Torque motor of autopilot	A3C	2	
14			AY	T	Automatic wheel brake control	A3C	10	Pilot's circuit breaker panel
15	B	armament systems	BA	A	Emergency bomb release control	A3C	5	Navigator's circuit breaker panel, right

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1	2	3	4	5	6	7	8	9
16			BB	A	Combat bomb release power supply	A3C	15	Navigator's circuit breaker panel, left
17			BB1	A	ARMED-SAFE control system	A3C	10	
18			BB2	A	ARMED at emergency bomb release	A3C	10	Navigator's circuit breaker panel, right
19			BB3	A	Fuze circuits (left forward)	CH	5	Combat bomb release junction box
20			BB4	A	Fuze circuits (right forward)	CH	5	
21			BB5a	A	Fuze circuits (left aft)	CH	5	
22			BB5b	A	Fuze circuits (right aft)	CH	5	
23			BB6	A	Emergency bomb release control relay	A3C	2	Navigator's circuit breaker panel, right
24			BB7	A	Emergency bomb release control relay	A3C	2	Navigator's circuit breaker panel, right

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1	2	3	4	5	6	7	8	9
25			BI	A	Normal bomb release blocking relay	A3C	2	Navigator's circuit breaker panel, left
26			BM	A	Combat bomb release blocking relay	A3C	2	Dual supply junction box, right
27			BH	A	Emergency bomb release power supply system	III	50	Navigator's circuit breaker panel, left
28			BII	A	Bombight power supply system	A3C	15	Pilot's circuit breaker panel
29			BP	A	Bomb release variant selector box (HBCB)	A3C	5	
30			BC	H	Forward cannon power supply system	A3C	10	
31			BP	A	Rear bomb rack dismount power supply system	A3C	2	Navigator's circuit breaker panel, left
32	3	Starting	+3	A	Starting power supply system	A3C	25	Pilot's circuit breaker panel
33			13A	A	Left engine air valve	A3C	5	

1	2	3	4	5	6	7	8	9
34			13B	A	Left engine starting system	A3C	15	
35			13II	A	Left engine starting control system	A3C	5	
36			13I	T	Left engine in-flight starting valve	A3C	20	Pilot's circuit breaker panel
37			23A	A	Right engine starting system	A3C	5	
38			23B	A	Right engine starting control system	A3C	15	
39			23II	A	Right engine in-flight starting	A3C	5	
40			23I	F	Right engine in-flight starting	A3C	20	
41			30	H	Tachometers of turbo-driven starters	-	-	
42	II	Inverters	III	A	Inverter, HO-4500 type	III	400	Dual supply distribution box at frame No.17
43			III	H	Inverter, IC-4500 type (operating)	III	400	Storage battery distribution box

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1	2	3	4	5	6	7	8	9
44	M		MB	H	Extension system of dipole reflectors No.1	A3C	10	Radio operator's circuit breaker panel
45			MB	H	Extension system of dipole reflectors No.2	A3C	10	
46			MT	H	Extension system of dipole reflectors No.3	A3C	10	
47			MT	H	Extension system of dipole reflectors No.4	A3C	10	
48	H		MBa	A	Fuel pump of tank No.19 (left)	MH	15	Distribution panel of left engine nacelle
49			MBb	A	Fuel pump of tank No.16 (left)	MH	50	
50			MBb	A	Fuel pump of tank No.10 (left)	MH	50	
51			MBr	A	Fuel pump of tank No.2	MH	50	Fuel pump junction box, left
52			MBa	A	Fuel pump of tank No.3	MH	75	Fuel pump junction box, right
53			MBe	A	Fuel pump of tank No.4	MH	75	Fuel pump junction boxes on frame No.49
54			MBx	A	Fuel pump of tank No.5	MH	50	
55			MBs	A	Fuel pump of tank No.6 (left)	MH	50	Fuel pump junction box, left

1	2	3	4	5	6	7	8	9
56			MBm	A	Fuel pump of tank No.6 (right)	MH	50	Fuel pump junction box, right
57			MBk	A	Fuel pump of tank No.10 (right)	MH	50	Distribution panel of right engine nacelle
58			MBn	A	Fuel pump of tank No.16 (right)	MH	50	
59			MBm	A	Fuel pump of tank No.19 (right)	MH	15	
60			MBg	T	Fuel shut-off valve of left engine	A3C	5	Co-pilot's circuit breaker panel
61			MBx	T	Fuel shut-off valve of right engine	A3C	5	
62			MBs	T	Fuel stop valve	A3C	5	Pilot's circuit breaker panel
63			MBb	H	Fms of pilot, co-pilot and navigator	A3C	5	
64			MBm	H	Front pressurized cabin heater control system	A3C	30	Co-pilot's circuit breaker panel
65			MBh	H	Rear pressurized cabin heater control system	A3C	30	Rear cabin circuit breaker panel

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1	2	3	4	5	6	7	8	9
66			MBo	H	Radar operator's fan	A3C	2	Radar operator's circuit breaker panel
67			MBo	H	Fans of gunner, radio operator, and IPC-1 units	A3C	5	Rear cabin circuit breaker panel
68			MT	H	Hydraulic pump	III	250	Hydraulic control panel junction box
69			1W3	H	power supply	III	200	Distribution panel of left engine nacelle
70			2M3	H	Left engine starter actuation system	III	200	Distribution panel of right engine nacelle
71			MK	H	Right engine starter actuation system	A3C	2	Circuit breaker panel of pilot
72			MX	H	Low-altitude ventilation system of front pressurized cabin	III	5	Dual supply junction box at frame No.17
73			MEP	A	Tail skid actuator	III	50	Junction box of additional fuel pump of tank No.2

1	2	3	4	5	6	7	8	9
74			MBo	A	Additional fuel pump of tank No.5	III	50	Junction box of additional fuel pump of tank No.49
75			BY	A	Flap actuator (electric motor No.2)	III	150	Dual supply junction box, right
76			III	A	Flap actuator (electric motor No.1)	III	150	Dual supply junction box, left
77	0	Lighting	OA	T	Emergency ultraviolet illumination, extension lamp socket, KM-12 compass illumination	A3C	5	Co-pilot's circuit breaker panel
78			05	H	White light illumination of front pressurized cabin	A3C	5	
79			CB	H	Extension lamp socket	CH	5	Fuel pump junction box, right
80			OA	H	Illumination of fuselage compartment between frames Nos 17 and 22	CH	5	Dual supply junction box

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1	2	3	4	5	6	7	8	9
81	OE		H	Ultra-violet illumination of instrument panel, navigator's right-hand console and sight	A3C	2	Navigator's circuit breaker panel, left	
82	OM		H	Bomb bay lighting	A3C	5	Radar operator's circuit breaker panel	
83	OM		H	L.G. well lighting	A3C	5	Pilot's circuit breaker panel	
84	OO		H	White light illumination of radar operator, pilot and navigator's compartment	A3C	5	Rear panel circuit-breaker panel	
85	OP		H	Lighting of rear pressurized cabin and fuselage tail section	A3C	2	Co-pilot's circuit breaker panel	
86	OT		H	Co-pilot's ultra-violet illumination	A3C	2	Pilot's circuit breaker	
87	OV		H	Ultra-violet illumination of pilot's station and upper control board	A3C	30		
88	OQ		H	Left landing lamp power supply	A3C	30		
89	OX		H	Radar operator's ultra-violet illumination	A3C	2	Radar operator's circuit breaker panel	
90	OY		H	Ultra-violet illumination of rear pressurized cabin	A3C	2	Rear cabin circuit breaker panel	
91	2X		H	Warning lamps	A3C	10	Pilot's circuit breaker	
92	OH		H	Right landing lamp power supply	A3C	30		
93	OT		H	Extension lamp socket	CU	5	Fuel pump junction box at frame No.49	
94	OK		H	Extension lamp socket of left L.G. well	CU	5	Extension lamp junction box in left L.G. well	
95	OH		H	Extension lamp socket of right L.G. well	CU	5	Extension lamp junction box in right L.G. well	
96	1OM		H	Extension lamp socket of left engine	CU	10	Extension lamp junction box in left engine nacelle	
97	2OM		H	Extension lamp socket of right engine	CU	10	Extension lamp junction box in right engine nacelle	

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1	2	3	4	5	6	7	8	9
98	II	Instruments	IE	A	Artificial horizon (standby)	A3C	5	
99			IB	T	Artificial (stro) horizon of pilot	A3C	5	
100			IC	A	Artificial horizon of co-pilot	A3C	5	Co-pilot's circuit breaker panel
101			ID	A	3WH-5p indicator of right engine	A3C	2	breaker
102			IE	A	Fuel quantity gauge of left engine tanks	A3C	2	panel
103			IF	A	Fuel quantity gauge of right engine tanks	A3C	2	
104			IG	A	Fuel flowmeter of left engine tanks	A3C	2	
105			IH	A	Fuel flowmeter of right engine tanks	A3C	2	
106			II	A	115 V, Remote-indicating compass, type DMR-7	CH	2	Navigator's fuse panel (115 V, A.C.)
107			IJ	A	Fuel pressure gauges	A3C	2	Co-pilot's circuit breaker panel
108			IK	A	3WH-5p indicator of left engine	A3C	2	

1	2	3	4	5	6	7	8	9
109			IL	T	Engine tachometers	A3C	2	Co-pilot's circuit breaker panel
110			IM	T	Pilot's bank-and-turn indicator	CH	1	Navigator's circuit breaker panel, 115 V, A.C.
111			IN	115 V, A.C.	Fuel quantity gauge of left engine tanks	CH	1	
112			IO	115 V, A.C.	Fuel quantity gauge of right engine tanks	CH	1	
113			IP	H	Exhaust gas temperature gauges	A3C	2	Circuit breaker panel of rear pressurized cabin
114			IQ	H	Free air temperature gauges of rear pressurized cabin	A3C	2	Co-pilot's circuit breaker panel
115			IR	A	Bank-and-turn indicator of co-pilot	CH	2	Navigator's fuse panel, 115 V, A.C.
116			IS	115 V, A.C.	Oxygen level indicator transformer	CH	1	
117			IT	45 V, A.C.	Oxygen level indicator of vessel 1	CH	1	
118			IU	45 V, A.C.	Oxygen level indicator of vessel 2	CH	1	

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1	2	3	4	5	6	7	8	9
119			III	A	Airbrake and free air temperature indicator	A3C	2	Pilot's circuit breaker panel
120			II B	115 V, A.C.	Fuel flowmeter of right engine	CH	2	Radar operator's fuse panel, 115 V, A.C.
121			III D	F	Remote-indicating astrocompass	A3C	5	Co-pilot's circuit breaker panel
122	F	Radio equipment	III H	115 V, A.C.	Fuel flowmeter of left engine	CH	2	Radar operator's fuse panel, 115 V, A.C.
123			PA1	F	Interphone CIN-10, channel No.1	A3C	5	Co-pilot's circuit breaker panel
124			PA10	H	Interphone CIN-10, channel No.2	A3C	5	Radar operator's circuit breaker panel
125			PA20	F	Interphone call boxes CIN-10	A3C	2	Co-pilot's circuit breaker panel
126			PE	115 V, A.C.	Bombight, type PEH-4	CH	15	Radar operator's fuse panel, 115 V, A.C.
127			PE	H	Radio altimeter, type PE-2	A3C	5	Pilot's circuit breaker panel

1	2	3	4	5	6	7	8	9
128			PA	A	Range-finder, type CH-1	A3C	2	Navigator's left-hand circuit breaker panel
129			PE	115 V, A.C.	Altimeter, type PE-17H	CH	5	Navigator's fuse panel, 115 V, A.C.
130			PEa	H	Power supply of communications radio set 1-FCB-70M	A3C	50	Circuit breaker panel of rear pressurized cabin
131			PE6	H	Power supply of communications radio set, type YU-9	-	-	
132			PE	115 V, A.C.	Automatic radio compass AFK-5 No.1	CH	2	Navigator's fuse panel, 115 V, A.C.
133			PE	A	Automatic radio compass AFK-5 No.1	A3C	2	Navigator's left-hand circuit breaker panel
134			PE	A	Automatic radio compass AFK-5 No.2	-	-	
135			PE	A	IIS instruments	A3C	10	Pilot's circuit breaker panel
136			PE	A	Aircraft transponder	A3C	5	Co-pilot's circuit breaker panel

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1	2	3	4	5	6	7	8	9
137			PH	115 V, A.C.	Radar gunsight, type HPC-1	CH	15	Radar operator's fuse panel, 115 V, A.C.
138			PP	115 V, A.C.	Automatic radio compass AFK-5 No. 2	-	-	Navigator's fuse panel, 115 V, A.C.
139			PC	115 V, A.C.	Command radio station PCMV-3H	CH	2	Radar operator's fuse panel, 115 V, A.C.
140			PT	H	Radio receiver VC-9H of command radio station 1-PCS-70M	A3C	5	Radar operator's circuit breaker panel
141			PV	115 V, A.C.	Radio receiver JC-9H of command radio station 1-PCS-70M	CH	2	Radar operator's fuse panel, 115 V, A.C.
142			PX	115 V, A.C.	Range-finder, type CH-1	CH	5	Navigator's fuse panel, 115 V, A.C.
143			PH	H	Radar gunsight (amplidyne unit)	A3C	40	Circuit breaker panel of rear pressurized cabin
144			PH	H	Radar gunsight	A3C	20	

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1	2	3	4	5	6	7	8	9
145			PH	H	Bombsight PBI-4 control system	A3C	20	Radar operator's circuit breaker panel
146			PH	H	Antenna duplexer of radio altimeters PB-2 and PB-17H	A3C	2	Pilot's circuit breaker panel
147			PH	T	Command radio station PCMV-5H	A3C	5	Radar operator's circuit breaker panel
148			PHa	H	Power supply of command radio station 1-PCS-70M	-	-	Power lead-in on frame No. 12 (starboard)
149			PH	H	Control system of 1-PCS-70M command radio station folded dipole antenna	-	-	
150			CA	H	Navigation lights	A3C	5	Pilot's circuit breaker panel
151			CS	H	Left tank group fuel pump warning system	A3C	2	Co-pilot's circuit breaker panel
152			CS	H	Bombing equipment warning system	A3C	5	Navigator's left-hand circuit breaker panel

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1	2	3	4	5	6	7	8	9
153			CT	A	Hydraulic system warning unit	A3C	2	Pilot's circuit breaker panel
154			CA	A	Right tank group fuel pump warning system	A3C	2	Co-pilot's circuit breaker panel
155			CB	H	Cabin pressure warning unit of rear pressurized cabin	A3C	2	Circuit breaker panel of rear pressurized cabin
156			CC	A	Sound signalling system of front pressurized cabin	A3C	2	Co-pilot's circuit breaker panel
157			CM	A	Airspeed limit warning system	A3C	2	Pilot's circuit breaker panel
158			CO	A	Cabin pressure warning unit of front pressurized cabin	A3C	2	Co-pilot's circuit breaker panel
159			CI	A	Left tank group fire warning system	A3C	15	Co-pilot's circuit breaker panel
160			CP	H	Signal flares	A3C	5	
161			CC	H	Formation flight lights, top	A3C	2	Pilot's circuit breaker panel
162			CCII	H	Formation flight lights, bottom	A3C	2	
163			CY	A	Right tank group fire warning system	A3C	15	Co-pilot's circuit breaker panel

1	2	3	4	5	6	7	8	9
164			CO	A	Pattern bombing signal lamps	A3C	15	Navigator's left-hand circuit breaker panel
165			CX	A	Colour flare bomb normal release	A3C	20	Navigator's right-hand circuit breaker panel
166			CH	A	Colour flare bomb door warning and control interlock system	A3C	2	
167			CU	A	Colour flare bomb station status indicator	A3C	2	Navigator's right-hand control panel, flare bomb control board
168			CV	A	Colour flare bomb emergency release system	III	30	Flare bomb junction box
169			CH	A	L.C. warning system	A3C	2	Pilot's circuit breaker panel
170			CH	A	Colour flare bomb emergency release control	A3C	2	Navigator's right-hand circuit breaker panel
171	T	Heaters	CT		Trim tab warning system	-	-	



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1	2	3	4	5	6	7	8	9
172			T40	H	Stabilizer de-icer (external arrangement)	TH	600	De-icer junction box
173			T4F	H	Stabilizer de-icer (internal arrangement)	TH	600	
174			T4V	H	Fin de-icer	TH	600	
175			T4	H	Storage battery heater	CH	10	Battery junction box
176			T4M	H	Heater, Index 107, of front pressurized cabin	MH	150	Glass panel heater junction box
177			T4H	H	Heater, Index 107, of rear pressurized cabin	MH	150	Power distribution box of rear cabin
178			T4	H	Heater of AH-5-2M autopilot elevator and rudder servo units	A3C	10	Autopilot heater junction box
179			T4I	A	Heaters of TH-156 pitot tube of co-pilot, bombardier, MH-50E dead reckoning instrument system,	A3C	10	Co-pilot's circuit breaker panel.

1	2	3	4	5	6	7	8	9
180			T4P	H	OME-11P bombright and radio-gunner heaters of directional stabilizer, vertical flight gyro and aileron servo unit	A3C	10	Pilot's circuit breaker panel
181			T4C	H	Pilot's glass heater (defroster)	MH	75	Defroster junction box
182			T4T	H	Co-pilot's defroster	MH	75	
183			T4V	H	Navigator's defroster	MH	100	
184	Y		T4	T	Heaters of TH-156 pitot tube of pilot, navigator, and heater of CGH-3 (velocity head warning unit)	A3C	5	Co-pilot's circuit breaker panel
185			J5A	A	Control of standby pumps of tanks No.16	A3C	2	Co-pilot's circuit breaker panel
186			J5B	A	Control of standby pumps of tanks No.6	A3C	2	
187			J5	H	Elevator trim tab control	A3C	5	Pilot's circuit breaker panel
188			J5T	H	Hydraulic pump control	A3C	2	

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1	2	3	4	5	6	7	8	9
189	Y7A		A	Remote-indicating compass, type ДИМК-7	A3C	2	Navigator's left-hand circuit breaker panel	
190	Y7E		T	CO <sub>2</sub> bottle control	A3C	10	Co-pilot's circuit breaker panel	
191	Y7A		A	Emergency drainage	A3C	2		
192	Y7B1		A	Control of left engine group fuel pumps	A3C	5		
193	Y7B2		A	Control of right engine group fuel pumps	A3C	5		Overhead electric control panel of pilots
194	Y7B3		A	Control of second group fuel tanks	A3C	5		
195	Y7B4		A	Control of third group fuel pumps	A3C	5		
196	Y7B5		A	Control of fourth group fuel tanks	A3C	5		
197	Y7M11		H	Control of ИО-4500 inverter (operating)	A3C	2	Radar operator's circuit breaker panel	
198	Y7M21		A	Control of ИО-4500 inverter (standby)	A3C	2		

1	2	3	4	5	6	7	8	9
199	Y7A		A	Bomb bay door control (regular)	A3C	5	Navigator's left-hand circuit breaker panel	
200	Y7B		A	Bomb bay door control (emergency)	A3C	5		
201	Y7P		H	Rudder trim tab control	A3C	5		Pilot's circuit breaker panel
202	Y7C		T	Drag chute control	A3C	5		
203	Y7T		H	Left aileron trim tab control	A3C	5		
204	Y7F		A	Airbrake control (motor No. 2)	A3C	5		
205	Y7Q		H	Left landing lamp control	A3C	5		
206	Y7X		H	Tail unit de-icer control	A3C	5		Co-pilot's circuit breaker panel
207	Y7Y		A	Fuel flow control	A3C	2		
208	Y7B		A	Airbrake control (motor No. 1)	A3C	5		Pilot's circuit breaker panel
209	Y7B		H	Right aileron trim tab control	A3C	5		

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1	2	3	4	5	6	7	8	9
210			JD	H	Inert gas connection	A3C	5	Co-pilot's circuit breaker panel
211	Photo-graphic equipment		YH	H	Right landing lamp control	A3C	5	Pilot's circuit breaker panel
212			QA	H	Camera AQA-33M tilting unit control of AQA-33M camera	A3C	15	Navigator's right-hand circuit breaker panel
213			QK	H		A3C	2	
214			QJ	H	QA-11-1 camera power supply socket	A3C	15	Radnor operator's circuit breaker panel
215			QI	H	tilting unit actuator	MI	10	Photographic equipment junction box
216			QH	H	Camera hatch door actuator	MI	5	
217			4CT	H	Horizontal drive	MI	75	Upper mount
218			405	H	Vertical drive	MI	75	supply box
219			42	H	Converter	MI	75	
220			244A	H	Amplifiers	MI	200	

1	2	3	4	5	6	7	8	9
221			3405	H	Vertical drive	MI	75	Tail mount supply box
222			344A	H	Amplifiers	MI	200	
223			34CT	H	Horizontal drive	MI	75	Lower supply box
224			342	H	Converter	MI	75	
225			444A	H	Amplifiers	MI	200	supply box
226			4405	H	Vertical drive	MI	75	
227			442	H	Converter	MI	75	Fuel pump junction box on frame No.49
228			44CT	H	Horizontal drive	MI	75	
229				H	Winch plug connector	MI	100	Fuel pump junction box on frame No.49
230				H	Winch plug connector	MI	100	
231			+	H	Round counter	-	-	Power distribution box of rear pressurized cabin
232			+	H	Tail system control station	-	-	
233			+	H	Blister system control station	-	-	Right power lead-in on frame No.69
234			+	H	Upper system control station	-	-	
235			3T1	H	Generator TGP-18000 No.1 (left engine)	TI	900	Left power lead-in on frame No.12
236			3T1	H	Generator TGP-18000 No.2 (left engine)	TI	900	

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1	2	3	4	5	6	7	8	9
237			3M21	H	Generator ICP-18000 No.3 (right engine)	III	900	Right engine distribution board
238			3M31	H	Generator ICP-18000 No.4 (right engine)	III	900	
239			3T	A	Generator No.2 (left engine), emergency	III	900	Left engine distribution board
240			3T	A	Generator No.3 (right engine), emergency	III	900	Right engine distribution board
241			3M1	AK	Power supply of instruments, with mains de-energized	III	35	Storage battery junction box
242			3M31	AK	Transponder destructor	-	-	
243			3M11	-	115 V.A.C. supply from IO-4500 inverter (operating)	III	50	From operating inverter
244			3M21	-	115 V A.C. supply from standby IO-4500 inverter	III	50	From standby inverter
245			3C	AK	Emergency bomb release, with mains de-energized	-	-	Storage battery junction box

1	2	3	4	5	6	7	8	9
246			M1	A	Group protection fuses: For co-pilot's circuit breaker panel	III	75	
247			M2	A	For navigator's left-hand circuit breaker panel	III	75	
248			M3	A	For navigator's right-hand circuit breaker panel	III	75	
249			M4	A	For radar operator's circuit breaker panel	III	30	Dual supply junction box
250			M5	A	For pilot's circuit breaker panel	III	30	
251			M6	A	For overhead electric control panel of pilots	III	15	
252			M1	H	For navigator's left-hand circuit breaker panel	III	10	
253			M2	H	For pilot's circuit breaker panel	III	100	
254			M3	H	For co-pilot's circuit breaker panel	III	50	Defroster junction box

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1	2	3	4	5	6	7	8	9
255			H4	H	For navigator's right-hand circuit breaker panel	III	50	Defroster junction box
256			H5	H	For fuelling control board	III	10	Dual supply junction box, left
257			H7	H	For left junction box of fuel pumps	III	150	Dual supply junction box, right
258			H8	H	For right junction box of fuel tanks	III	150	Distribution board of left engine nacelle
259			+313 +314 313 314	-	Ammeter of generator No.1	CH	2	
260			+313 +314	-	Ammeter of generator No.2	CH	2	
261			3128 3124 +3128 +3124	-	Ammeter of generator No.3	CH	2	Distribution board of right engine nacelle
262			+3133 3133 3134	-	Ammeter of generator No.4	CH	2	

1	2	3	4	5	6	7	8	9
263			312	H	Relay IMP-600 (normal) of generator No.1	III	5	Distribution board of left engine nacelle
264			+312 312	H	Relay IMP-600 (normal) of generator No.2	III	5	
265			+312 312	A	Relay IMP-600 (emergency) of generator No.2	III	5	
266			+3122 3120	H	Relay IMP-600 (normal) of generator No.3	III	5	Distribution board of right engine nacelle
267			+3A20	A	Relay IMP-600 (emergency) of generator No.3	III	5	
268			3132 +3132	H	Relay IMP-600 (normal) of generator No.4	III	5	

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1	2	3	4	5	6	7	8	9
269			BA3 BA4	-	Ammeter of storage battery	СП	2	Battery junction box

Key to Table 1

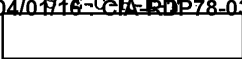
The designations in the columns of Table 1 stand for:

- Д - dual supply bus bar;
- Н - regular supply bus bar;
- ABC - circuit breaker;
- СП - fuse link, glass;
- Ш - fuse link, delayed-action;
- П - high-temperature fuse;
- Т - triple supply bus bar;
- А - emergency supply bus bar;
- AK - battery supply bus bar.

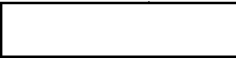
Table 2

Nos	Type and cross-section (in sq.mm) of wire	Total length of wire per one aircraft, m.			
		white	1/blue	red	yellow
1	2	3	4	5	6
1	БПВЛО.35	3592	1235	1031	238
2	БПВЛЭ0.35	875	596	-	116
3	БПВЛЭ2x0.35	17	447	10	-
4	БПВЛО.5	3970	1101	807	24
5	БПВЛЭ0.5	143	244	19	-
6	БПВЛ1.0	1512	473	1040	-
7	БПВЛЭ 1.0	29	25	7	-
8	БПВЛ 1.25	928	60	1277	-
9	БПВЛЭ 1.25	-	6	-	-
10	БПВЛ 1.5	429	47	312	-
11	БПВЛЭ 1.5	2	-	28	-
12	БПВЛ 1.93	218	27	218	12.
13	БПВЛЭ 1.93	9	-	-	-
14	БПВЛ 3.0	155	47	1544	13
15	БПВЛЭ 3.0	106	-	-	-
16	БПВЛ 4.0	25	-	-	-
17	БПВЛ 5.15	168	10	25	33
18	БПВЛ 6.0	-	9	7	-
19	БПВЛ 8.8	34	-	10	-
20	БПВЛ 10.0	3	-	-	-
21	БПВЛ 13.0	33	-	11	-
22	БПВЛ 16.0	21	-	-	-
23	БПВЛ 21.0	10	-	-	-
24	БПВЛ 35.0	31	-	11	-
25	БПВЛ 41.0	-	-	18	-
26	БПВЛ 50.0	13	-	-	-
27	БПВЛ 70.0	59	-	-	-
28	БПВЛ 85.0	35	-	13	-

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1	2	3	4	5	6
29	БПБЛ 35.0	19	-	-	-
30	БПВЛ 50.0	43	-	-	-
31	БПВЛ 70.0	122	-	-	-
32	БПВЛ 95.0	144	-	-	-

Note: The tabulated data do not include the lengths of wires supplied by the Manufacturer complete with the equipment items such as: the cannon mounts, some of the radio and radar sets, etc.

SWITCHING, CONTROL AND PROTECTION ARRANGEMENTS

Electric power is distributed in the aircraft electric system by means of distributing arrangements (boards, panels and boxes) provided with switching, control and protection appliances of various kinds.

For the layout of electric control boards, panels and junction boxes see Fig.1.

To reduce the weight, all the boards, panels, boxes and the like equipment items are made of thin sheet material, with the thickness usually ranging from 0.6 to 0.8 mm. With the same purpose widely used in the constructions of electric units are magnesium alloy sheets, shaped members, cast brackets, etc.

Part of nameplate, label and standard inscriptions on the aircraft is made in luminous compound of two colours: orange luminous mass for inscriptions of emergency character, and green mass for all the other inscriptions.

Used for switching operations on the D.C. electric circuit are various switches and change-over switches. For switching operations on the A.C. electric circuit of 115 V, 400 c.p.s. use is made of toggle switches, type 2ИИ-250.

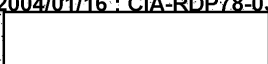
For the list of switches and change-over switches used in the aircraft, as well as for their major technical characteristics refer to Table 3.

Due to the fact that the switches and change-over switches are neither moist nor dust-proof by themselves those switches which are installed at water-hazardous areas are provided with special rubber protectors which keep moisture off the contact sections of the switches; the protectors are fitted over the switch knobs and levers.

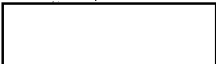
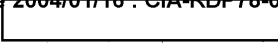
Apart from the OFF-ON and selector switches, the electrical system is provided with buttons of 5K and 204K types; these buttons are rated for voltages up to 30 V, the maximum operational current for 5K buttons being up to 5 A, and for 204K buttons - up to 20 A.

Table 3

Nos	Description	Type	Rated voltage, V	Maximum operating current, A
1	2	3	4	5
1	Switch, toggle	D-45	28	35
2	Switch, change-over, toggle	ИИ-45	28	35
3	Switch, push-type	ВН-45М	28	35
4	Switch, change-over, push-type	ВН-45М	28	35
5	Switch, change-over, toggle, with neutral position	ИИИ-45	28	35
6	Switch, toggle, two-pole	2В-45	28	20
7	Switch, change-over, toggle, two-pole	2ИИ-45	28	20
8	Switch, push-type, two-pole	2ВН-45	28	20



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1	2	3	4	5
9	Switch, change-over, push-type, two-pole, with neutral position	2ПН-20	28	2
10	Switch, change-over, with neutral position	2ПНН-45	28	20
11	Switch, change-over, toggle, three-pole, with neutral position	3ПНН-45	28	20
12	Switch, change-over, toggle, four-position, double-push-type, with neutral position	П2ПНН-45	28	35
13	Switch, change-over, toggle, two-pole	2ПН-250	250 120	2 5

Employed in the electric circuits of the aircraft automatic systems, remote control systems, as well as in the systems of blocking and signalization in the function of terminal and line limiters, blocking contacts and operating buttons are miniature switches of series BK-140 and KB-6, and limit switches, type BK-44. The above switches are used only in the D.C. circuits.

For the list of the miniature switches used in the aircraft and their main technical characteristics see Table 4.

Table 4

Nos	Description	Type	Rated voltage, V	Maximum operating current, A
1	2	3	4	5
1	Switch, change-over	BK1-140	28	15
2	Switch, change-over	BK2-140	28	15

1	2	3	4	5
3	Switch, change-over	BK2-140B	28	15
4	Switch, disengaging	BK2-141B	28	15
5	Switch, engaging	BK2-142A-1	28	15
6	Switch, engaging	BK2-142B	28	15
7	Switch, engaging	BK2-142Г	28	15
8	Switch, limit	BK-44	28	10
9	Switch, disengaging	KB-6-1	28	10
10	Switch, engaging	KB-6-2A	28	10

Apart from the above ON-OFF switches, change-over switches and buttons, the following switching and control equipment is used in the aircraft:

(a) contactors, types K-25A, K-50Д, K-100Д, K-250, K-300Д, K-400Д and K-600Д; these contactors are designed for remote on-off switching operation on the aircraft D.C. circuits (contactors, type K-50Д, are installed in the A.C. circuits, too);

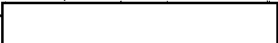
(b) relays, types KP-2, PT-40, PA-12 and PB3-45, which are also used for remote on-off switching operations on the D.C. circuits;

(c) miniature relay switches, types ПН-2, ПН-3 and ПН-6, which are designed for use in D.C. circuits with voltages up to 30 V and in single-phase A.C. circuits of the automatic remote blocking and signalization control systems designed for 208 (or 120) volts at a frequency of 400 c.p.s.;

(d) miniature relays, type ПННА, designed for use in the circuits preventing D.C. power sources from cutting-in in case polarity is wrongly applied;

(e) selecting contactors, types КП-400Д and КП-200Д, which are designed for automatic re-connection of the dual supply circuit from the normal supply circuit to the emergency one;

(f) terminal blocks are designed for connection and distribution of electric power.





For electric circuit protection in the aircraft use is made of the following protecting arrangements:

- (1) circuit breakers;
- (2) fuses, glass, type CH;
- (3) fuses, delayed-action, type MH;
- (4) high temperature fuses, type TH.

The circuit breakers are used for automatic disconnection of the power consumers, and for protection of supply wires in case of hazardous overloads and shortings in the electric circuit.

The operation of a circuit breaker is based on the property of a bimetallic strip to camber as a result of its heating by the current which flows through it (Fig.2). The construction of circuit-breakers makes it possible to connect and disconnect the circuit manually. In this case they function as ordinary single-pole switches. However, the majority of the circuit breakers installed in the aircraft functions as protectors, and, therefore, prior to the flight and in the course of flying the circuit breakers should be always ON.

The circuit breaker is turned on manually, with the aid of the operating lever. The circuit breaker is thrown off in case of overloads and short-circuiting automatically. If it is necessary to place the circuit breaker off at rated load, this will be done manually.

The circuit breakers are installed in D.C. circuits with a rated voltage of 28 V, their location providing easy access during the flight.

The following types of circuit breakers are used in the aircraft: A3C-2, A3C-3, A3C-10, A3C-15, A3C-20, A3C-25, A3C-30, A3C-40 and A3C-50 (the figure identifies the rated current of a given circuit breaker).

Fuses (fuse links), types CH, MH and TH, are designed for protecting electrical equipment and circuits against short-circuit currents and continuous, although small, overloads. The delayed-action fuses ensure normal protection and at the same time withstand short-time

current shocks (three-fold and six-fold current increases) which may occur during the operation of certain electrical units.

Fuses, type CH, are used in A.C. circuits and also in D.C. circuits characterized by constant loading conditions, and at points which are inaccessible in flight.

Fuses, types MH (Fig.3) and TH, are provided in the electric actuator feed circuits; they are also used for group protection of the electric power distribution system and for generator protection.

Fuses, types CH, MH and TH, are mounted on the aircraft in various-kind boxes, and are available in the following ranges: CH-1a, CH-2a, CH-5, CH-10, CH-15, MH-10, MH-15, MH-5, MH-30, MH-35-2, MH-50, MH-75, MH-100, MH-150, MH-200, MH-250, TH-400, TH-600 and TH-900, the figures designating current rating for each particular fuse.

## Section 2

### POWER SOURCES AND POWER DISTRIBUTION SYSTEM

#### 1. D.C. POWER SOURCES

##### Generators

The generator, type ICP-18000, is a shunt-wound D.C. machine with a wide operating speed range which makes it possible to pick up the generated voltage under all the engine operating conditions, beginning with the low throttle duty.

Two generators, type ICP-18000, are installed on each engine. They are driven by the engine shaft through the gear boxes with the reduction factor of 2.

The direction of the generator rotation is left-hand (counter-clockwise), as viewed from the generator drive side.

The generator armature is driven with a torsion shaft which smooths down dynamic loading bumps applied to the armature. Provision of the torsion shaft facilitates the generator-to-engine coupling (Fig.4).

Main Technical Data of Generator, Type TGP-18000

Rated power at 30 V ..... 18,000 W  
 Rated voltage ..... 28.5 V  
 Load current rating ..... 600 A  
 Speed range ..... 3800 to 9000 r.p.m.  
 Operating mode ..... continuous  
 Type of brushes used ..... MFC-9 (MFC-7X)  
 Brush dimensions ..... 8x2x26 mm  
 Weight of generator ..... 41.5 kg

The usable operating conditions of the generator are as follows:

Speed	Load, A	Time	Remarks
3800 - 9000	600	Unlimited	With engine operating in low throttle duty (at 3400 r.p.m.), 400 A can be picked up continuously from generator
4250 - 8200	750	1 min.	
4800 - 8200	900	10 sec.	
5600	1080	2 sec.	
8200	1200	2 sec.	

The generator can be operated for not longer than 8 minutes at 9300 r.p.m. and at a load of 100 to 600 A during the engine operation in one single flight. The above technical data are true for the generator cooled by the onrush stream of the free air. The generator can be also used on the ground (i.e. without air cooling). In this case a current of 200 A can be picked up from the generator operating at 3400 r.p.m. during 20 minutes.

Apart from this the generator can be operated in an emergency duty; during this kind of operation it is allowed to overload the generator with a current of 660 A for 20 minutes at a speed of 4250 to 8200 r.p.m.

After operation in the emergency duty upon return to the base the generator should be removed from the aircraft and subjected to thorough inspection, and, if necessary, to repair.

The generators are cooled through the air scoops located in the bifurcating nose section of the air duct, one air scoop in each engine nacelle. Each air scoop is connected by means of an air pipe with the air inlet sleeves of the two generators.

The above cooling system ensures that at least 235 litres of air are forced through the generator per second.

Storage Battery

The aircraft uses a starter-type storage battery 12-CAM-55 which consists of two half-batteries, type 6-CAM-55, which are connected together in series.

Main Technical Data of Storage Battery

Rated voltage ..... 24 V  
 Capacity at discharge current of 11 A:  
 before 100th engagement ..... 53 amp-hrs  
 between 101th and 170th engagements ..... 48 amp-hrs  
 Maximum discharge current permissible ..... 1350 A  
 Weight ..... 55 kg

Each half-battery, type 6-CAM-55, is housed in a heated container (Fig.5).

The container is provided with an electric heater which consists of two heating strips. Each heating strip is nothing but heating element 4 placed between two layers of glass

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fabric; the heating element consists of four series lengths of constantan wires with a total resistance of 4.1 ohms.

The strips of each heater are connected together in series, while the heaters of the two containers are connected in parallel.

Provided in the container for automatic temperature control is bimetallic thermal switch 6 (Index 777B) which operates to disconnect the heaters as soon as a temperature of plus 70<sup>+10</sup>C is reached. The thermal switch is series-connected to the minus circuit of the heating elements.

The battery container heaters can be energized only from a ground power source connected to the ground power supply receptacle.

The heater switch is located above the left container, and the protecting fuse of the heater (fuse, type CH-10) is installed in the storage battery junction box.

The containers are located in the non-pressurized section of the fuselage between frames Nos 17 and 19, both on the starboard and port sides.

Provided inside the container is fixed cast base 15 with guide rails 16 which carry removable sliding sledges 22. Mounted on the sledges and secured to them by means of hold-down straps 20 is half-battery 3 fitted into special metal bath 21. The bath is lined from inside with heat insulating material, mark ATNM, which is glued to the bath. Put on the top part of each half-battery is a special case made of ATNM heat insulating material. Both the bath and the case protect the container structure against corrosion by the battery electrolyte in case of its splashing or leakage. With the same purpose the inner surface and parts of the container are coated with acid-resistant paint before the heat-insulating material is applied.

The chamber of each battery container communicates with the atmosphere through a gas-discharge tube which is designed to expel electrolyte vapours from the container to the atmosphere.

The half-batteries are connected together and to the aircraft mains with the aid of floating pin-type contacts; contact pins 12 are secured in the fixed base, and contact sockets - on the carriages. Connected to the sockets by means of wires 1 and 19 are the terminals of the half-battery, and connected to the pins are the wires of the aircraft mains.

The battery-aircraft mains connection diagram is shown in the Schematic Circuit Diagram of D.C. Supply Sources.

#### D.C. Power Distribution System

The entire D.C. power distribution system (the aircraft mains) consists of three separate circuits. They are:

- (1) normal supply circuit;
- (2) emergency supply circuit;
- (3) dual supply circuit.

As a rule, the normal supply circuit connects all the four generators (I - IV), and the storage battery (Fig.6). The generators and the battery are engaged separately and therefore may be connected to the normal supply circuit in any combination: for instance, one generator and the battery, two generators, three generators and the battery, and so on.

Connected to the emergency supply circuit can be only one of the inboard generators (the second or the third one) plus the storage battery.

The dual supply circuit is automatically connected, by means of selecting contactors of KH type, either to the normal supply circuit if it is energized, or to the emergency supply circuit if the normal supply circuit is de-energized (Figs 6 and 7).

The above mentioned contactors are installed in the following points of the aircraft:

- (a) two contactors, type KH-400A - on the engine nacelle distribution boards (one - on the left, and the other - on the right panel);

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(b) one contactor, type КИ-200Д - in the fuel pump junction box at frame No.49;

(c) one contactor, type КИ-40СД - in the dual supply circuit junction box at frame No.17;

(d) one contactor, type КИ-200Д - in the dual supply circuit junction box at frame No.6.

From the three power supply circuits mentioned above power is fed to the following three groups of power distribution bus bars:

(1) normal supply bus bars which are connected only to the normal supply circuit;

(2) dual supply bus bars which are connected to the dual power supply circuit;

(3) triple supply bus bar which is usually connected, through a special change-over switch, to the dual power supply circuit, and, consequently, is fed either from the normal power supply circuit or from the emergency power supply circuit. In case of damage to both the normal and emergency power supply circuits this bus bar is manually re-connected for direct supply from the storage battery.

The distribution bus bars are not connected to the emergency power supply circuit directly.

The normal power supply bus bars feed those power consumers which are required for normal operation of the aircraft but which are not required in case of emergency. Such power consumers are: the heaters, de-icers, autopilot, fans, some lighting equipment, etc.

The dual power supply bus bars feed those consumers which make it possible to fulfil the mission and return to the base even if the normal supply circuit fails. These power consumers are: the bombing equipment, fuel pumps, flight control and navigating instruments, landing flap actuators, L.G. warning system, some items of lighting equipment, etc.

The triple power supply bus bar (the bus bar feeding the instruments from the storage battery when the aircraft mains are de-energized) feeds only those power consumers of vital

importance which make it possible to perform a forced landing. These power consumers are: the main gyro horizon set, pilot's bank-end-turn indicator, upper left ТИ-156 pitot tube heater, interphone channel No.1, emergency ultra-violet illumination of the pilots' and the navigator's compartments, automatic brake control unit, drag chute system, blow-off bend control system, CO<sub>2</sub> bottle control system, fuel shut-off and cross-feed valve control system, and radio set, type РСНУ-3М.

The feeders of the top emergency bomb dropping system and of the transponder destructor, as well as the engine in-flight starting system are connected directly to the storage battery and can be engaged at any moment without any additional connection and selection of power supply sources.

Thus, to ensure power supply to the consumers even in case of failure of separate sections of the aircraft electric supply main the D.C. power distribution system is so designed that it can be used in three operating duties:

- (1) normal duty;
- (2) emergency duty;

(3) with only vital-importance consumers connected to the storage battery ("de-energized mains" duty).

Normal power supply duty. In the normal supply duty the circuit connects, as a rule, all the four generators and the storage battery.

In such a case energized are all the normal supply bus bars, the dual supply bus bars, and the triple supply bus bar.

The ON-OFF and change-over switches on the generator control panel located by the radar operator (Fig.8) should be placed to the following positions:

(1) the switches of the four generators and the switch disconnecting the battery from the normal supply circuit should be ON (ВКЛЮЧЕНО);

(2) the storage battery change-over switch should be in the NORMAL (НОР.АЛБНО) position;

(3) the emergency supply circuit switch - OFF (ВЫКЛЮЧЕНО);

(4) the change-over switch connecting the generators to the emergency supply circuit (bearing the inscription FROM GENERATOR) (ОТ ГЕНЕРАТОРА) should be placed to the LEFT No.2 (ЛЕВЫЙ № 2) position;

(5) the change-over switch bearing the inscription CONNECTION OF EMERGENCY INSTRUMENTS TO BATTERY (СВЯЗУЮЩИЕ АВАРИЙНЫХ ПРИБОРОВ НА ПИТАНИЕ ОТ АККУМ) should be OFF;

(6) the switch bearing the inscription GROUND SUPPLY (АВРОПРОМНОЕ ПИТАНИЕ) should be OFF.

**Note:** The storage battery blocking switch is rigidly connected to the common generator switch bar. This means that if any single generator switch is ON, the generator blocking switch is also in the ON position.

In case of failure of part of the generators, it is possible to connect three, two and even one generator plus the storage battery to the normal power supply circuit. When three generators and the storage battery are connected to the normal power supply circuit, there are no limitations for the number of the consumers connected to the circuit. If two generators and the storage battery are connected to the normal supply circuit, engaged at a time may be only the cannon system with continuously operating power consumers, or the tail unit de-icers with continuously operating power consumers. It is prohibited to simultaneously engage the cannon system and the tail unit de-icer system. If only one generator and the storage battery are connected to the normal supply circuit, the power consumers can be connected only in such a combination which ensures that the total load does not exceed 600 A.

**Emergency duty.** In case of failure of the normal supply circuit it is possible to disengage it and to employ the emergency supply circuit.

During the emergency duty flight the circuit will connect one of the two generators (the second generator on the left engine, or the third generator on the right engine) plus

the storage battery. Energized will be the emergency supply circuit, the dual supply bus bars and the triple supply bus bar. In this case the normal supply circuit will be disconnected and de-energized.

To change from the normal to the emergency duty:

1. Operate the emergency generator disconnecting lever to disconnect all the four generators and the storage battery from the normal supply circuit.

2. Turn on the emergency supply circuit switch. This action will result in the following (Fig.9):

(a) the storage battery will be disconnected from the normal supply circuit;

(b) the four main differential undercurrent relays, type ДИР-600, will disconnect all the generators from the normal supply circuit;

(c) generator No.2, by means of its additional relay, type ДИР-600, will be connected to the emergency supply circuit.

When sure that the emergency supply circuit and generator No.2 operate normally (referring to the ammeter and the voltmeter), throw the storage battery change-over switch to the EMERGENCY (АВАРИЙНО) position. Thereby the storage battery will be connected for buffer operation with the generator to the emergency supply circuit.

In case left generator No.2 or its circuit is faulty, the generator selector (change-over switch) should be re-set to the RIGHT No.3 (ПРАВЫЙ № 3) position. In this position connected to the emergency supply circuit instead of generator No.2 of the left engine will be inboard generator No.3 of the right engine.

In the emergency duty those power consumers will be energized which are connected to the dual supply bus bar (See Table 5) and to the triple supply bus bar (See Table 6). When using this duty, the flying time is not limited.

Table 5

Power Consumers Connected to Dual Supply Bus Bar

				1	2	3	4
Nos	Description	Type of protector	Feeder marking				
1	2	3	4				
1	Fuel flow automatic control unit, left	A3C-5	AI	20	Left engine air valve	A3C-5	13A
2	Fuel flow automatic control unit, right	A3C-5	AI	21	Left engine starting system	A3C-15	13B
3	Emergency bomb release control	A3C-5	BA	22	Left engine starting control	A3C-5	13H
4	Combat bomb release power supply	A3C-15	BB	23	Right engine air valve	A3C-5	23A
5	Arming system	A3C-10	BB1	24	Right engine starting system	A3C-15	23B
6	AREMBD emergency bomb release system	A3C-10	BB2	25	Right engine starting control	A3C-5	23H
7	Fuse circuits, left front	CH-5	BBa	26	Standby inverter, type П0-4500	ТП-400	ИИ
8	Fuse circuits, right front	CH-5	BBb	27	Fuel pump of left tank No.19	ИП-15	MEa
9	Fuse circuits, left rear	CH-5	BBb	28	Fuel pump of left tank No.16	ИП-50	MEb
10	Fuse circuits, right rear	CH-5	BBr	29	Fuel pump of left tank No.10	ИП-50	MEr
11	Emergency bomb release control relay	A3C-2	BA	30	Fuel pump of left tank No.2	ИП-50 and ИП-50	MEr and MEp
12	Emergency bomb release control relay	A3C-2	BE	31	Fuel pump of right tank No.3	ИП-75	MEr
13	Combat bomb release blocking relay	A3C-2	BA	32	Fuel pump of left tank No.4	ИП-75	MEe
14	Combat bomb release blocking relay	A3C-2	BM	33	Fuel pump of right tank No.5	ИП-50 and ИП-50	MEr and MEo
15	Emergency bomb release power supply	ИП-50	BH	34	Fuel pump of left tank No.6	ИП-50	MEe
16	Sight power supply	A3C-15	BI	35	Fuel pump of right tank No.6	ИП-50	MEm
17	Bomb release variant box power supply	A3C-5	BP	36	Fuel pump of right tank No.10	ИП-50	MEx
18	Rear bomb rack disconnecting relay	A3C-2	BU	37	Fuel pump of right tank No.10	ИП-50	MEz
19	Starting system power supply	A3C-25	+3	38	Fuel pump of right tank No.19	ИП-15	MEm
				39	Air position indicator, type ИИ-50B	A3C-5	AR
				40	Flap actuator, electric motor No.1	ИП-150	MI
				41	Flap actuator, electric motor No.2	ИП-150	IS
				42	Ultra-violet illumination of pilot's instrument panel and upper (overhead) electric control board	A3C-2	OV
				43	Standby gyro horizon set	A3C-5	IB
				44	Co-pilot's gyro horizon set	A3C-5	IT
				45	Three-pointer indicator of right engine, type СММ-3P	A3C-2	IT

1	2	3	4	1	2	3	4
46	Fuel quantity gauge of left engine tanks	A3C-2	HE	68	Left tank group fire warning system	A3C-15	CH
47	Fuel quantity gauge of right engine tanks	A3C-2	HE	69	Right tank group fire warning system	A3C-15	CV
48	Fuel flow gauge of left engine tanks	A3C-2	HE	70	Pattern bombing signal lamps	A3C-15	CG
49	Fuel flow gauge of right engine tanks	A3C-2	HE	71	Colour flare bomb normal release system	A3C-20	CX
50	Fuel pressure gauge	A3C-2	HE	72	Colour flare bomb door signalization and release control blocking system	A3C-2	CH
51	Three-pointer indicator, type SMM-3p, of left engine	A3C-2	HE	73	Colour flare bomb emergency release system	HM-30	CY
52	Bank-and-turn indicator of co-pilot	A3C-2	HE	74	Colour flare bomb station status indicator	A3C-2	CH31
53	Flap position indicator, free air temperature indicator	A3C-2	HE	75	Landing gear warning system	A3C-2	CH
54	Range-finder, type CA-1	A3C-2	HE	76	Colour flare bomb emergency release control	A3C-2	CH
55	APK-5 radio compass No.1	A3C-2	PI	77	Heaters of TH-156 pitot tubes of co-pilot, radar operator, radio operator, and heaters of HM-50 air position indicator and ONE-11p sight	A3C-10	TH
56	APK-5 radio compass No.2	A3C-2	PI				
57	Instrument landing system	A3C-10	PI				
58	Transponder	A3C-5	PO				
59	Control of bombsight, type PBN-4	A3C-20	PH				
60	Antenna duplexer of radar altimeters, types EB-2 and EB-17M	A3C-2	PH	78	Control of standby pumps of tanks No.16	A3C-2	YBx
61	Left tank group fuel pump operation warning system	A3C-2	CE	79	Control of standby pumps of tanks No.6	A3C-2	YBe
62	Bombing system warning	A3C-5	CB	80	Remote-indicating compass, type ATAK-7	A3C-2	YA
63	Right tank group fuel pump operation warning system	A3C-2	CD	81	Emergency drainage	A3C-2	YK
64	Hydraulic system warning	A3C-2	CT	82	Control of standby inverter, type HO-4500	A3C-2	YH21
65	Cabin sound signalization system	A3C-2	Cs	83	Normal control of bomb bay doors	A3C-5	YI
66	Airspeed (mach) limit warning	A3C-2	CM	84	Emergency control of bomb bay doors	A3C-5	YJ
67	Front cabin pressure drop warning system	A3C-2	CO				

1	2	3	4
85	Flap control, motor No.2	A3C-5	Y7
86	Fuel flow control	A3C-2	Y4
87	Flap control, motor No.1	A3C-5	Y8
88	Control of first-group fuel pumps of left engine	A3C-5	Y31
89	Control of first-group fuel pumps of right engine	A3C-5	Y32
90	Control of second-group fuel pumps	A3C-5	Y33
91	Control of third-group fuel pumps	A3C-5	Y34
92	Control of fourth-group fuel pumps	A3C-5	Y35

Table 6

Power Consumers Connected to Triple Supply Bus Bar and Directly to Storage Battery Bus Bar

Nos	Description	Type of protector	Feeder marking
1	2	3	4
1	Emergency ultra-violet illumination of front cabin and illumination of KH-12 compasses	A3C-5	0A
2	Gyro horizon set, main	A3C-5	IB
3	Pilot's bank-and-turn indicator	A3C-2	III
4	Interphone channel No.1	A3C-5	PA1
5	Interphone call boxes	A3C-2	PA20
6	Heaters of pitot tube of pilot and navigator, and CCH-3 heater	A3C-5	TR
7	Automatic brake control unit	A3C-10	AY
8	Engine blow-off band control system		

1	2	3	4
9	CO <sub>2</sub> bottle control system	A3C-10	YE
10	Drag chute control system	A3C-5	YC
11	Control of shut-off and cross-feed valves	A3C-5	ME
12	Radio set, type PCHV-3M	A3C-5	PS
13	Transponder destructor	No protection	SA31
14	Bomb release, with mains de-energized	No protection	SC
15	In-flight engine starting	No protection	3II

Note: The first seven power consumers are connected to the bus bar which is energized from the storage battery through a fuse, type III-35. The total current consumed by these power consumers does not exceed 20 A.

In case of failure of the emergency power supply circuit it is necessary to select the "de-energized mains" duty.

De-energized mains duty. In this duty the entire mains are de-energized and the storage battery will supply only that group of power consumers which is absolutely necessary for the flight continuation (See Table 6). For this duty the switches on the radar operator's control panel (Fig.8) are placed to the following positions:

1. The change-over switch bearing the inscription CONNECTION OF EMERGENCY INSTRUMENTS TO BATTERY (ВКЛЮЧЕНИЕ АВАРИЙНЫХ ПРИБОРОВ НА ПИТАНИЕ ОТ АККУМУЛЯТОРОВ) should be ON.
2. The emergency supply circuit switch should be OFF.
3. The storage battery switch remains in the OFF position.
4. The switches of the four generators and the battery blocking switch should be in the OFF positions.



**WARNING:** The storage battery, type 12-CAM-55, ensures power supply for the consumers specified in Table 6 during not longer than two hours.

which are mounted on the generator control panel of the radar operator (See Fig.8).

The reliability and endurance of the power supply system are improved due to the following:

Voltage Regulator, Type PVT-82

(a) the normal power supply mains are laid along both port and starboard sides of the fuselage and the cables are interconnected at frames Nos 17 and 69 (See the Diagram, Fig.7) by means of aluminium wire jumpers, and in the area of frame No.42 - by means of a rubber-encased bus bar;

The carbon voltage regulator, type PVT-82, automatically maintains the generated voltage stability under variable speed and loading conditions and ensures uniform distribution of load between the parallel-operating generators.

(b) the normal supply mains are laid in the top part of the fuselage, while the emergency supply line is laid in the middle part of the fuselage; this lessens the probability of simultaneous breakage of both mains;

Each ICP-18000 generator is provided with its own voltage regulator (Fig.10); the voltage regulators are mounted on special cast brackets on the outer side of the non-pressurized section of the fuselage between frames Nos 36 and 37 below the top hatches of the engine nacelles. The two voltage regulators installed on the port side service the left engine generators (first and second generators). The two other voltage regulators installed on the starboard side operate with the generators (third and fourth) of the right engine.

(c) certain sections of the mains are provided with ground (selective) protection, i.e. with delayed-action fuses; this considerably lessens the probability of failure of the entire mains.

The operation of the voltage regulator is based on the principle of changing the resistance of the generator field winding by means of a carbon pile (consisting of separate carbon rings) which is series-connected to the field winding circuit (See the Diagram in Fig.9).

Functioning of Generators and Storage Battery

Main Technical Data of Voltage Regulator, Type PVT-82

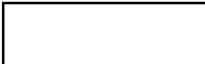
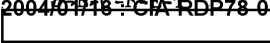
The four generators, type ICP-18000, and the storage battery, type 12-CAM-55, operate in parallel, i.e. they are connected to a common plus bus bar (See the Diagram, Fig.9).

Each generator operates in conjunction with the following equipment:

- (a) carbon voltage regulator, type PVT-82, with external resistor, type EC-20, capacitor, type KEM-31, and stability transformer, type TC-8;
- (b) differential undercurrent relay, type DMP-600;
- (c) ballast resistor, type EC-18000.

The rated voltage maintained by the regulator is 28.5 v. Voltage fluctuation (surge) within the generator speed range of 4000 to 9300 r.p.m. and ambient temperature varying from minus 60 to plus 50°C, at up to 15,000 m. above sea level, and with the generator loading changing from zero to rated, does not exceed 3.5 v. With the generator speed changing within 3300 to 3900 r.p.m., the other conditions remaining the same as specified above, the voltage surge amounts to 3.8 v.

The generators and the storage battery are connected to the normal or emergency power supply circuits, and the storage battery is engaged for de-energized mains power supply of instruments with the aid of ON-OFF and change-over switches



The regulator ensures voltage control under conditions of the generator current variations within 2 to 15 A.

The maximum power dispersed in the carbon pile is 170 W; the operating duty of the voltage regulator is continuous.

The extension resistor, type BC-20, operates in set with the carbon voltage regulator, type PVT-82; the resistor provides additional adjustment of the generator voltage level and equalizes the voltages and currents of the parallel-operating generators.

All the four extension resistors are mounted on the radar operator's generator control panel (See Fig.8).

Voltage control is effected by regulating the resistance in the circuit of the regulator working winding.

Main Technical Data of Resistor,

Type BC-20

Rheostat resistance ..... not less than 10 ohms
Rated current ..... 0.8 A
Voltage level control limits .... plus 1.5 V and minus 3 V
Mode of operation ..... continuous

The capacitor, type KBM-31, rated for 4 µF is connected to the plus wire of the PVT-82 voltage regulator to cut down the level of radio interference produced by the operating regulator.

The stabilizing transformer, type TC-8, operates in conjunction with the PVT-82 voltage regulator and is designed to ensure stability of the regulator operation under transient operating conditions of the generators. Each stability transformer operates in set with its respective voltage regulator. All the four TC-8 transformers are mounted on common brackets with the voltage regulators.

The differential undercurrent relay, type JMP-600, operates automatically; its functions are:

(1) connection of the generator to the aircraft mains if the generator voltage is 0.3 to 0.7 volts higher than the mains voltage;

(2) disconnection of the generator from the mains under conditions of a reverse current of 20 to 50 A;

(3) holding the generator disconnected from the mains in case of wrong polarity of the connected wires.

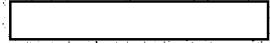
The relay, type JMP-600, consists of the following elements (See Fig.11): the contactor, differential command relay, relay PMP-2A, relay PH-5B and two glazed resistors. The above elements are mounted on a common base plate and are contained in a common housing (less the contactor).

There are six JMP-600 relays on the aircraft altogether; four of them are principal relays which connect the generators to the normal power supply circuit, and the other two relays are additional: they connect the second or the third generator to the emergency supply circuit (See the Diagram, Fig.9). The relays, type JMP-600, are installed on the distribution panels of the left and right engine nacelles, three relays on each distribution panel (Fig.12). The distribution panels are mounted on the outer side of the non-pressurized section of the fuselage between frames Nos 41-43, next to the brackets carrying the PVT-82 voltage regulators.

Main Technical Data of Relay, Type JMP-600

Supply voltage ..... 28.5-1.5
-2.5 V
Rated current flowing through contactor contacts ..... 600 A
Reverse current at opening ..... 20 to 50 A
Mode of operation ..... continuous

The ballast resistor, type EC-18000. The minus wires of the generators, type ICP-18000, are connected to the airframe through special ballast resistors, type EC-18000. These resistors are mounted on the fuselage plating in the



area of frame No.44: two resistors on the starboard wall and the other two - on the port side wall (Fig.13). The ballast resistors, type BC-18000, take part in the parallel operation of the generator and ensure the operation of the ДМР-600 differential undercurrent relay under reverse current conditions. The resistance of the ballast resistor is 0.000715 ohm.

#### Connecting the Power Supply Sources

The procedure of connecting the ICP-18000 generators and the 12-CAM-55 storage battery to the normal and emergency supply circuits, as well as employment of the battery as an emergency power supply source have been described earlier under the heading "D.C. Power Distribution System".

Engagement of the generator switches, type 2B-45 (See the Diagram, Fig.9) results in the operation of the РИР-2 relay which is a component part of each differential undercurrent relay, type ДМР-600. The РИР-2A relay 10 connects, through its contacts, the shunt winding of command relay 9; if the generator voltage exceeds the mains voltage, relay 9 operates to energize the winding of contactor 6 which, in its turn, connects the generator to the aircraft mains.

The closed position of switch 42 which blocks the storage battery is the preparatory position for connecting the battery to the normal supply circuit.

When storage battery change-over switch 33 is placed to NORMAL (НОРМАЛЬНО), the field winding circuit of contactor 28 becomes closed, and the contactor connects the storage battery to the normal supply circuit. The above ON-OFF operations ensure normal operating conditions, with emergency circuit switch 25, triple supply bus bar selector switch 34 (the switch connecting the emergency instruments to the battery), and ground supply switch 31 open. The power supply sources are disconnected in the reverse order, i.e. the storage battery is disconnected first, and then are the generators.

In case of faults or short circuiting in the normal power supply mains, use should be made of the generator emergency disconnecting switch bar to simultaneously open all the four generator switches, type 2B-45, and switch 42 which blocks the battery from the normal supply circuit. The storage battery gets disconnected from the normal power supply circuit as the minus circuit of the field winding of contactor 28 is broken by switch 42. All of the four main differential undercurrent relays, type ДМР-600, disconnect their respective generators from the normal power supply circuit, as opening the generator switches results in de-energizing relays, type РИР-2A.

When closing emergency circuit switch 25 depending on the position of change-over switch 26 bearing the inscription FROM GENERATOR (position LEFT (ЛЕВЫЙ) No.2 or position RIGHT (ПРАВЫЙ) No.3), РИ-6 blocking relay 54 or 55 of the second or third generator is tripped. At the same time the РИР-2A relay of the additional ДМР-600 relay is energized to connect generator No.2 or generator No.3 to the emergency power supply circuit.

Actuation of the contacts of the blocking relay, type РИ-6, 54 or 55 results in the following:

1. The field winding supply circuit of the РИР-2A relay of the main differential undercurrent relay, type ДМР-600, is additionally broken although the differential relay has already disconnected the given generator from the normal power supply circuit when the generator switches were open;
2. The parallel operation winding circuit of the РУГ-82 voltage regulator of the generator connected to the emergency supply circuit gets broken, too;
3. The field winding supply circuit of K-300D contactor 28 is broken additionally although the contactor disconnects the storage battery from the normal power supply circuit at the moment switch 42 opens;
4. The field winding circuit of K-300D contactor 27 is prepared for connecting the storage battery to the emergency power supply circuit.

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Upon closure of switch 25, provided that the emergency power supply circuit and generator No.2 (or No.3) function normally, storage battery change-over switch 33 should be placed to the EMERGENCY (АВАРИЙНО) position. This re-setting will close the field winding circuit of K-300Д contactor 27 which, while closing, will connect storage battery 47 to the emergency power supply circuit for buffer operation with the generator, thereby ensuring the emergency duty operation.

If, through one reason or another, the normal-to-emergency duty change-over procedure is violated, the blocking relays, type ПП-6, 54 and 55 will perform the following blocking operations:

(a) the relays will render it impossible for the storage battery to be connected to the emergency supply circuit until the second or the third generator is connected to this circuit;

(b) automatic disconnection of the storage battery from the normal supply circuit when the second or the third generator is connected to the emergency supply circuit;

(c) automatic disconnection of the second or third generator from the normal supply circuit when it is connected to the emergency supply circuit, with the 2В-45 switches of these generators closed;

(d) disconnection of the PVT-82 voltage regulator which operates in conjunction with the generator connected to the emergency supply circuit from the generator parallel operation system.

As stated above, the 12-CAN-55 storage battery is connected either to the normal or to the emergency supply circuit by means of respective contactors, type K-300Д, installed in the storage battery junction box (Fig.14). These contactors are controlled from the radar operator's generator control panel with the aid of the STORAGE BATTERY (АККУМУЛЯТОР) change-over switch, type ППН-45, which has three positions: NORMAL (НОРМАЛЬНО), EMERGENCY (АВАРИЙНО) and OFF (ВЫКЛЮЧЕНО) as shown in Fig.8.

To select the de-energized mains operating duty when only the instruments of vital importance are connected to the

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storage battery, the CONNECTION OF INSTRUMENTS TO BATTERY change-over switch provided on the generator control panel at the radar operator's station should be closed. As a result (See the Diagram, Fig.9) the following happens:

1. The triple supply bus bar is disconnected from the dual supply circuit and is connected directly to the storage battery through a delayed-action fuse, type ПНН-35-2, installed in the storage battery junction box (Fig.14).

2. The storage battery is automatically disconnected from the normal and emergency supply circuits if it has been connected to either of them.

3. Irrespective of the pilot's desire the emergency (standby) gyro horizon set becomes energized.

#### Ground Power Supply Receptacle

For electric supply at aircraft parking and at engine starting the aircraft is provided with ground power supply connector the plug of which is mounted in the nosewheel well at frame No.16, port side.

The plug and its mating detachable receptacle have three pins and three sockets. The two power pins are thicker and longer than the third pin which is used for guiding. This construction ensures that the power contacts are energized only upon complete mating. This eliminates the probability of burned power contacts.

When the ground power supply receptacle is connected, ПП-2 blocking relay 39 (See Fig.9) operates to disconnect the aircraft storage battery from the normal supply circuit; second ППН-А relay 40, with contacts 1 and 2 normally closed, prepares the circuit for engagement of K-400Д contactor 32. The K-400Д contactor operates only upon closure of switch 31 mounted on the radar operator's generator control panel; when actuated, this contactor connects the ground power supply source to the aircraft mains.

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PHN-A relay 4C also serves to prevent from connecting the ground supply source of wrong polarity: for this purpose the relay is provided with a selenium valve.

In case of wrong polarity of the ground power supply source this relay operates to open normally closed contacts 1, 2 and thereby de-energizes the winding of contactor 32 which does not allow to connect the ground power supply source to the aircraft mains.

Relays 39, 40 and 32 (Fig.9) are installed in the storage battery junction box (Fig.14).

#### Control Over Power Supply Sources and Electric Mains

To effect control over the operation of the power sources (to check the intensity of current they produce) and to check the circuits for continuity and for shorting-free operation, the electrical system is provided with five ammeters. Four ammeters 36; type A-3, with the scale range of 100-1000 A are connected to the generator circuits, while the fifth ammeter 30, type A-2, with the scale range of 50-500 A is connected to the aircraft battery and ground power supply circuit.

The above ammeters are provided with extension shunts 4 and 29 located on the engine nacelle distribution panels and in the storage battery junction box.

Provided for control over the electric system power supply sources is voltmeter 38 of B-1 type rated for 30 V; this voltmeter can be connected, with the aid of selector switch 24 of H-46 type to each of the four generators, to the normal power supply circuit or to the emergency supply circuit.

When the normal supply duty is used in the flight, the voltmeter should be connected to the normal supply circuit, and when the emergency duty is used, the voltmeter should be connected to the emergency supply circuit.

All these instruments and the selector switch are mounted on the generator control panel at the radar operator's station (See Fig.8).

Additionally installed on the radar operator's generator control panel is a voltmeter, type B-1, specially used for normal supply circuit voltage measurements.

#### 2. A.C. POWER SOURCES

For A.C. supply the aircraft is equipped with two inverters, type HO-4500; one of the inverters is operating, and the other is standby. The inverters are engaged separately.

The inverter, type HO-4500, (Fig.15) consists of a D.C. motor and an A.C. single-phase synchronous generator which are encased in a common housing.

The motor is of six-pole type, with mixed excitation and three commutating poles.

The synchronous generator has six fixed poles and a rotary armature with two slip rings for A.C. current commutation.

The HO-4500 inverter set includes a carbon voltage regulator, type P-52B, and a rheostat, type PC-4M.

The inverter control elements, but the voltage regulator and the voltage control rheostat, are housed in a box mounted on the inverter unit frame. In addition the box mounts a radio filter which localizes the radio interference produced by the operating units.

The inverter voltage is stabilized automatically by a magnetic amplifier which controls the winding of the carbon voltage regulator.

Frequency stabilization is also effected by the magnetic amplifier which feeds the motor shunt field winding which in this case is called the control winding.

Mounted on the inverter shaft on the side opposite to the fan is a centrifugal change-over switch which prevents racing and which disconnects the inverter as soon as it reaches a speed of 9700-300 r.p.m. and automatically engages the

standby inverter. The inverter disconnected by the centrifugal switch can be engaged repeatedly only upon pressing the return button which places the change-over switch elements in their initial position.

The inverter is designed for operation with single-wire brought to power supply systems. The minus points of the main D.C. circuit are connected to the inverter frame.

The voltage regulator, type P-25B (Fig.16), is mounted separately on a shock panel.

The rheostat, type PC-4M, which controls the A.C. voltage supplied by the inverter to the aircraft mains is mounted on the radar operator's generator control panel (See Fig.8).

When used at altitudes up to 15,000 m. the inverter may be operated with 10 per cent current overloads during 5 minutes in every operating hour.

In both cases described above the output voltage can be installed to its rated value by operating the voltage level

The NO-4500 inverters operate in set with P-25B carbon voltage regulators which are used for their regulation.

The inverters together with the voltage regulators are installed in the non-pressurized section of the fuselage

between frames Nos 17 - 19, the standby inverter being on the port side, and the operating generator - on the starboard side.

For the A.C. power distribution diagram see Fig.17.

Main Technical Data of Inverter, Type NO-4500

Rated voltage of D.C. supply ..... 27 V  $\pm 10\%$   
 Rated power, A.C. supply, at power factor of 0.9 ..... 4500 VA  
 Rated voltage of A.C. supply ..... 115 V  
 Rated frequency of A.C. power supply .. 400 c.p.s.  
 Number of phases ..... one  
 Current consumed from D.C. power supply not over 280 A  
 Rated current of A.C. supply ..... 39.1 A  
 Cooling ..... self-ventilated  
 Operational altitude range ..... up to 15,000 m.  
 Speed ..... 8000 r.p.m.  
 Mode of operation ..... continuous  
 Weight with P-25B voltage regulator inclusive ..... not more than 47 kg

With the supply voltage fluctuating from 24.3 to 29.7 V, the load current altering from zero to the rated value, and the ambient temperature changing within plus 50°C to minus 60°C, the generator output voltage should not differ from the rated value by more than  $\pm 4\%$ , and the frequency - by more than  $\pm 5\%$ .

Connection of A.C. Power Sources

The inverters, type NO-4500, are controlled from the generator control panel with the aid of a change-over switch, type 3MNH-45, which prevents simultaneous connection of both inverters.

The operating inverter is fed with direct current through the storage battery junction box from the normal supply circuit, while the standby inverter is fed with direct current through the dual supply circuit junction box (mounted at frame No.17) from the dual supply bus bar.

For the schematic circuit diagram of A.C. supply sources see Fig.18.

When 3MNH-45 change-over switch is placed to OPERATING (РАБОЧИЙ), current is supplied through the normally closed contacts of the centrifugal change-over switch, type ЦН, to the winding of the contactor located inside the operating inverter and connected to the plus supply line. The minus circuit of the coil of this contactor is blocked through the panel of carbon voltage regulator 9 to make it impossible for the inverter to be started with voltage regulator P-25B disconnected.

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Simultaneously with the current fed to the operating inverter contactor coil, voltage is also applied through the normally closed contacts of the III change-over switch to the field winding of contactor 2 (type K-50A) which connects inverter 1 to the A.C. mains. The working winding of the second contactor which is connected to the minus supply circuit of the inverter motor is closed to the motor terminals through a special resistor which is used to control the actuating voltage of this contactor. When the contacts of the first contactor (connected to the minus supply circuit of the motor) get closed, the inverter is connected to the aircraft electrical mains through a starting resistor, type II C, which limits the starting current of the motor. The second contactor by-passes (shunts) starting resistor II C as soon as the counter-electromotive force of the motor reaches 16 to 18 V.

The generator field winding is connected to the plus supply line next to the first contactor. The other end of the winding is connected to the minus supply line through the carbon pile of voltage regulator 9.

The inverter frequency is stabilized automatically by the magnetic amplifier, type A0-26-170, by way of current control in the control winding of the motor. If the inverter current frequency increases due to an increased voltage in the aircraft mains or decreased loading, the current in the neutralization winding will be decreased due to the fact that the inverter frequency approaches the resonance frequency of the circuit, while the current of the magnetization winding will not be altered (in case of decreased load) or will increase (in case of increased voltage in the aircraft mains). Under these conditions due to opposite connection of the discussed windings the resultant flux of the core will be intensified which will result in increased saturation of the amplifier and in reduced inductive reactance of the amplifier. As a result, the current flowing in the motor control winding will be increased to cut down the motor speed and to reduce the inverter frequency.

In case of a lower-than-normal frequency the frequency control procedure will be a reverse one.

Automatic stabilization of the generator voltage is effected by the magnetic amplifier, type A0-12-25, which controls the winding of voltage regulator 9 (type P-25B). The stability transformer, type TC-11, prevents clapping of the voltage regulator carbon pile during transient processes. Voltage is controlled by changing the inductive reactance of the amplifier through its magnetization with the resultant flux created by the magnetization and neutralizing windings.

In case of a lower-than-normal voltage of the generator the flux produced by the collective action of these windings will be weakened, and the reactance of the magnetic amplifier will be increased, which will result in decreased current in the working winding of voltage regulator 9. Plunged by the spring the carbon pile will be compressed, and the voltage will go up. In case of a higher-than-normal voltage the control process is the reversal of that described above.

To supply the aircraft mains with alternating current on the ground, the nosewheel well in the fuselage, starboard, at frame No.16, is provided with an A.C. ground power supply junction box with a two-pin plug connector, type MP28H2HM7.

The A.C. ground supply is controlled with the aid of switch 5 (type B-45) mounted on the generator control panel. When closed, the switch actuates K-50A relay 2 which connects the ground supply to the A.C. circuit of the aircraft.

Cut additionally into the K-50A contactor control circuit is ground supply blocking relay 6 (type PI-2) which breaks the control circuit of the K-50A contactor at the moment when one of the aircraft IO-4500 inverters (operating or standby) is engaged.

The contactor, type K-50A, and the relay, type PI-2, are mounted in the ground A.C. supply junction box.

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For control over the A.C. voltage of 115 V, the radar operator's generator control panel (See Fig.8) mounts a ferrodynamic voltmeter, type B4-150.

### Section 3

#### ELECTRIC POWER CONSUMERS

##### 1. ELECTRIC SYSTEM OF FIRE-FIGHTING EQUIPMENT

The electric system of the fire-fighting equipment (Fig.19) ensures automatic and manual control of power supply to the fire cocks which, upon actuation, fulfil the following functions:

- initiate the power supply to discharge the CO<sub>2</sub> bottles
  - connect the line running from the CO<sub>2</sub> bottles with the aircraft compartment in which fire has broken out.
- The system incorporates the following units:
1. Two fire cock units with three cocks 3 in each unit.
  2. Twenty eight overheat warning units 7 which produce alarm signals in case fire breaks out in close proximity to them.
  3. Six button lamps 4 which provide fire warning and also serve as fire cock manual engagement switches.
  4. PN-2 relay 2 which blocks the squib actuation circuits in the discharge bonnets of the CO<sub>2</sub> bottles.
  5. Button 1 (type 5K) which actuates the spare CO<sub>2</sub> bottles.
  6. Two electromagnetic air valves 8 to close the ventilation shutters of the undercowl space.
  7. Squibs 6 in the discharge bonnets of the CO<sub>2</sub> bottles.
  8. Switch 5 (type 2B-45).

The system functions as follows:

Closure of 2B-45 switch 5 mounted on the fuel control panel prepares the system for operation. The switch closed,

voltage is supplied from the ABC-15 circuit breaker to all the overheat warning units, the buttons of the button lamps and the fire cocks. The system can be actuated either automatically or manually.

Automatic engagement is effected by overheat warning units 7 (type TH). Due to the fact that the aircraft is structurally divided into six fire-isolated sections, all the overheat warning units (fire warning units) are arranged in six groups. Each fire-isolated section is provided with 4 to 8 overheat warning units.

The overheat warning unit, type TH, (Fig.20) is bimetallic diaphragm 1; as soon as the ambient temperature rises to 140 - 170°C the diaphragm cambers to interconnect central contact 3 and side contact 2 of the unit.

Note: The system is wired so that the closing of switch 2B-45 applies voltage to the central contact of the overheat warning unit.

The central and side contacts of each warning unit installed in the same section are connected in parallel; therefore, operation of any overheat warning unit of a particular section is sufficient for actuation of all the fire cocks. Through the contacts of the actuated warning unit voltage is supplied to the fire warning light (the button lamp, see Fig.21) and to the electro-magnet of the fire cock.

Mounted in the top part of the button lamp is lamp holder 2 for the warning light provided with a red light filter, and the bottom part of the assembly is button 3 (type 204K). The lamp holder can be moved along the assembly axis, so when pressure is exerted to its filter, it is depressed to engage the button. All the button lamps are mounted on the fuel control panel.

Each fire cock 3 (See Fig.19) consists of a valve, electro-magnet with the engaging and holding windings and of two microswitches.

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Main Technical Data of Fire Cock

Voltage ..... 27 V ±10%

Current consumed:

- at engagement ..... not over 6 to 7 A
- when engaged ..... 0.3 to 0.4 A
- Opening time ..... not longer than 1 s

As the electromagnet is energized, current is applied first to engaging winding B which ensures reliable valve opening to connect the line running from the CO<sub>2</sub> bottles to the corresponding section of the aircraft. When the valve is opened fully, the cock microswitches operate to do the following:

- opening of the engaging winding supply circuit as a result of which the valve remains open due to the action of holding winding "A";
- blocking of the holding winding supply circuit as a result of which the valve remains open even in case the contacts of the actuated overheat warning unit get accidentally open;
- current supply to PH-2 relay 2 which, in its turn, will apply current to squib 6 in the discharge bonnets of the CO<sub>2</sub> bottles. From these bottles the carbon dioxide will pass via the open valve of the actuated fire cock into the corresponding aircraft section to extinguish the fire.

The second pair of CO<sub>2</sub> bottles is actuated manually with the aid of button 1 on the fuel control panel if by the moment it is depressed the PH-2 relay (Ref.No.2, Fig.19) is closed, i.e. when at least one fire cock is open.

The relay, type PH-2, is also mounted on the fuel control panel.

**Note:** Due to the fact that when engaged the fire cock blocks its own supply circuit with the microswitches, the fire cock can be disengaged only by turning 2D-45 switch 2 off. Placing the switch

off will repeatedly prepare the system for operation if it has been used once in flight, with exhaustion of only one pair of CO<sub>2</sub> bottles.

If in case of fire the system fails to operate automatically, it can be hand-operated. For hand control it is necessary to press button lamp 4 of the corresponding aircraft. The contacts of the button are connected in parallel with the contacts of the overheat warning units, due to which the system operates in an exactly the same manner as when actuated automatically.

When the engine nacelle overheat warning units are actuated or when the button lamp connected to the aircraft section is depressed, energized in addition to the fire cock:

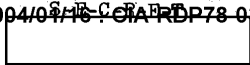
- electromagnetic air valve 8 which supplies compressed air to close the ventilation shutters of the undercowl space;
- the engine electric equipment system; due to this, with the throttle control lever in the STOP (STOP) position, the compressor air blow-off band is closed.

2. CIRCUITRY OF FUEL SHUT-OFF AND CROSS-FEED VALVES AND OF INERT GAS SYSTEM

The electric system ensures opening and closing of the fuel shut-off valves installed in the main fuel supply line delivering fuel to all the tank groups of the respective engine, and of the cross-feed valve which interconnects the main fuel supply lines of both engines; the electric system also provides for signalization of the open and closed positions of the fuel shut-off valves and opening of the inert gas bottles.

The electric circuit (Fig.22) comprises:

1. Electric actuators 5 and 14, type M3K-2, of the fuel shut-off and cross-feed valves.
2. Change-over switches 1 and 3, type PH-45, for valve control.



- 3. Signal lights 2 (type CIII-51) which indicate the open position of the fuel shut-off valves.
  - 4. Squibs 15 in the inert gas bottle discharge bonnets.
  - 5. Switch 4 (type B-45) which engages the squibs.
- The fuel shut-off and cross-feed valves are closed or opened by corresponding settings of their change-over switch mounted on the fuel control panel.

With one of the switches closed, voltage is applied through an ABC-5 circuit breaker to one of the windings of the D.C. series-wound reversible electric motor of the M3K-2 actuator of the corresponding valve. For the general view of the M3K-2 actuator see Fig.23.

The electric motor drives the output shaft through planetary reduction unit elements 8, 10 and 12 (See Fig.22).

Main Technical Data of Actuator, Type M3K-2

Operating voltage range ..... 23.4 to 28.6 V  
 Rated thrust ..... 2.5 kgm  
 Current required ..... not over 3.3 A  
 Output shaft rotation angle ..... not smaller than 95°

The fuel shut-off valve open position signal lights are mounted on the fuel control panel; unlike the other signal lights of the panel they are mounted so that it is possible to effect their dimmer control without opening the face board of the panel. This is done so because the above lights are used to indicate to the pilots only before the take-off that the valves are open.

Closing switch 4 provided on the fuel control panel simultaneously discharges all the inert gas bottles; the bottles are discharged when the aircraft enters an anti-aircraft fire-dangerous zone.

3. FLAP CONTROL

The flaps are extended and retracted by means of an electric system; the flap control is effected remotely, from the stations of the pilot and co-pilot with the aid of an electric actuator, type MN3-3M (Fig.24).

The electric actuator, type MN3-3M, consists of two identical series-wound reversible motors (top motor No.2 and bottom motor No.1) which both drive one reduction unit rotating the driving shaft of the flap control mechanism.

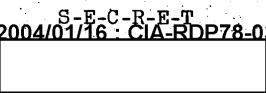
The planetary-type reduction unit of the actuator is provided with a differential and makes it possible to retract or extend the flaps with only one electric motor of the actuator in case of failure of the other.

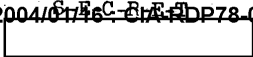
For the current required to drive the actuator motors, as well as for the flap retraction and extension time see the Table below.

Actuator duty	Maximum current required, A		Maximum operation time, Sec.	
	with both motors	with one motor	with both motors	with one motor
Extension	155	80	25	50
Retraction	160	85	25	50

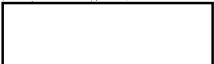
The actuator, type MN3-3M, is installed in the bomb bay above the port side wing. The electric motors are engaged by contactors, type K-250 (Fig.25), which are mounted in the flap control junction box (Fig.26); top electric motor No.2 is connected to the bus bar supplied from the fuse, type MN-150, installed in the left dual supply circuit junction box. Bottom electric motor No.1 is fed through the MN-150 fuse mounted in the right junction box of the dual supply circuit (the box is installed in the bomb bay at frame No.42).

The electric motors of the MN3-3M actuator are engaged by the limit switches, type MEB-11, installed on the flap





25X1



25X1

control driving shaft, as soon as the flaps reach one of their extreme positions.

The MKB-11 limit switch mechanism is designed for closing the electric circuits after the mechanism output shaft turns a certain predetermined number of revolutions. The operating moment of each limit switch is adjusted according to the existing operation instructions authorized for the aircraft, model TV-16. The flaps can be controlled both by the pilot and the co-pilot with the aid of the change-over switches installed on the engine control panels.

In order to prevent such a situation when one of the pilots engages the flaps for extension while the other initiates their retraction (which may result in failure of the MH3-3M actuator), the pilot's change-over switch is blocked from the co-pilot's switch by means of a PH-2 relay in such a way that the co-pilot can operate the flaps only when the pilot's change-over switch is in the neutral position (See the Diagram, Fig.25).

The relay, type PH-2, is mounted on the left-hand engine control panel. The change-over switch at the co-pilot's station is of a push type; when released, it returns to the neutral position.

Each of the MH3-3M actuator electric motors has its self contained control circuit protected by an ABC-5 circuit breaker. The circuit breakers are installed on the circuit breaker panel of the pilot.

The power circuits of the MH3-3M actuators and of their control systems are fed from the dual supply bus bars.

With change-over switch 13 (type 3MNH-45) placed for flap extension (DOWN position), power is applied (See the Diagram, Fig.25) through the closed contacts of MKB-11 mechanism limit switches 10 to the field windings of K-25C contactors 8 and 14. The contactors operate to engage electric motors Nos 1 and 2 of the MH3-3M actuator for flap extension.

As soon as the change-over switch is placed for flap extension or retraction, voltage is applied to the field wind-

ing of blocking relay 12 (type PH-2) which operates to break the flap control circuit operated from push-type change-over switch 11, type 2NH-20, installed at the co-pilot's station.

Therefore, with change-over switch 13 closed, it is impossible to effect flap control from change-over switch 11.

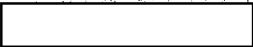
After the flaps are extended through the required angle (the position of the flaps is indicated by Y3M-47 flap position indicators 16), switch 13 must be set to the neutral (OFF position). The field windings of contactors 8 and 14 will be de-energized, and the contactors will disconnect the two electric motors of the MH3-3M actuators.

With the flaps being in their extreme positions, the electric motors of the actuator are disconnected by MKB-11 limit switches 10 which break the field circuits of contactors 8 and 14 or 9 and 15 when the flaps are either in the full DOWN or in the full UP positions irrespective of the positions of change-over switches 13 and 11. The flaps are retracted in a similar way, but K-25C contactors 9 and 15 are actuated to engage the electric motors for flap retraction.

The flaps can be controlled from change-over switch 11 only with switch 13 being in the neutral position; the control procedure is identical to that with use of change-over switch 13.

Main Technical Data of Actuator, Type MH3-3M

Nos	Description	Two-motor	One-motor
		operation	operation
1	2	3	4
1	Rated voltage	27 V	27 V
2	Operating voltage range	24.3 to 29.7 V	24.3 to 29.7 V
3	Rated thrust output	10 kg-m	10 kg-m
4	Maximum thrust output	15 kg-m	15 kg-m



25X1

[Redacted]

[Redacted]

1	2	3	4
5	Rated current, maximum	190 A	100 A
6	Maximum current	250 A	125 A
7	Mechanism output shaft speed at rated voltage and rated thrust conditions, min.	240 r.p.m.	120 r.p.m.
8	Mode of operation of actuator	intermittent:	
	(a) in two-motor operation: the output shaft rotates counter-clockwise (at rated voltage and rated thrust) during 30 seconds, then follows a 5-sec. interval, and the shaft starts into clockwise rotation (under the same operating conditions) which lasts 30 seconds, with a new 5-sec. pause to follow. The number of such operation cycles is 5, then follows complete cooling;		
	(b) in one-motor operation: the output shaft rotates counter-clockwise (under rated voltage and rated thrust conditions) during 60 seconds, then follows a 10-sec. break, and the shaft starts into clockwise rotation (under the same operating conditions) which lasts for 60 seconds, with a new 10-sec. pause. The number of such operating cycles is 2, after which follows complete cooling.		
9	Weight of actuator - not over 43 kg.		
	<u>Note:</u> The direction of the output shaft rotation is determined from the side of the larger diameter of the angular transmission system. Counter-clockwise rotation of the shaft corresponds to flap extension while clockwise rotation corresponds to flap retraction.		

Flap Position Indicator, Type Y3H-47

At take-off the landing flaps should be 19° to 23° DOWN. At landing the flaps are let down through 35° ±1°. For control over the flap extension angle the aircraft is provided with a flap position indicator, type Y3H-47. The instrument set consists of one transmitter and two indicators, type Y3H-47. The transmitter is installed on the LSP-2 limit switch mechanism mounted on the flap transmission shaft. The indicators are connected in parallel and installed on the instrument boards of the pilots. The instrument is fed from the dual power supply bus bar (See FIG. 25) and is provided with a circuit breaker, type A3C-2, which is installed on the pilot's circuit breaker control panel.

The operation of the flap position indicator is based on the employment of a ring rheostat connected to a three-phase permanent-magnet-type rotimeter.

Main Technical Data of Y3H-47 Instrument

Voltage ..... 27 ±2.7 V  
 Operating ambient air temperature range .. from plus 50°C to minus 60°C  
 Remote transmission error ..... ±2°  
 Power consumed by full set ..... not in excess of 5 W  
 Current required by transmitter ..... not over 0.1 A

4. TRIM TAB CONTROL

The trim tabs of the aircraft are controlled electrically. All the trim tab actuators are fed from the normal power supply bus bar of the pilot's circuit breaker control panel and are protected with A3C-5 circuit breakers.

[Redacted]

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Aileron Trim Tab Control

The aileron trim tabs are controlled by two actuators, type MN-1000A-60, mounted on the left and right ailerons. The actuator, type MN-100A-60 (Fig.27), is designed for actuation units and mechanisms performing motions of translation, the rated thrust being up to 100 kg.

The actuator construction employs a two-pole D.C. reversible electric motor, type A-4TH, with series excitation and an electromagnetic brake clutch.

The stroke length of the actuator stem screw equals 60 mm. Mounted inside the actuator (Fig.28) are: two limit switches 7, one blocking contact 6 to synchronize the neutral position of the actuating screw; the blocking contact of the left aileron trim tab actuator is connected with white signal light 9, and the blocking contact of the right aileron trim tab actuator is connected with white signal light 18. Blocking contact 6 operates (to close the contacts) only when the ailerons are neutral.

The electric actuators of the aileron trim tabs are controlled with the aid of push-type 2NN-20 change-over switches 12 mounted on the trim tab control stations of the pilot (Fig.29) and co-pilot. Closure of one of change-over switches 12 engages both MN-100A-60 actuators in operation; the actuators function as follows: when one actuator deflects its trim tab down, the other deflects its respective trim tab upward.

The neutral position of the aileron trim tabs is indicated by white light 18, type CII-51, installed on the pilot's instrument panel (Fig.28).

Installed in the top section between frames Nos 9 and 10 for pre-flight neutral positioning of the aileron trim tabs is an aileron trim tab synchronization station (Fig.30). Mounted on the station is push-type change-over switch 11 (type NN-45, see Fig.28) which is connected to the control circuit of the left aileron trim tab actuator and to the

circuit of white CII-51 signal light 9 which indicates the neutral position of the actuator.

The station is provided with a cover; when the cover is closed, KB-6-1 blocking contact 10 disconnects light 9.

Rudder Trim Tab Control

The rudder trim tab is controlled by means of an electric actuator, type MN-100A-36, which is installed in the rudder and is connected to the trim tab through a linkage system. The stroke length of the stem screw of the MN-100A-36 actuator equals 36 mm.

Mounted inside the actuator are two limit switches which restrict the stroke length of the screw, and one blocking contact to synchronize the neutral position of the actuating screw; the contact is connected with a signal light. The internal system of the MN-100A-36 actuator is similar to that of the actuator, type MN-100A-60 (presented in Fig.28).

The rudder trim tab is controlled by means of push-type change-over switches 13 (type NN-45) which are installed on the trim tab control stations of the pilot and co-pilot and are connected in parallel. The pilot's instrument panel carries white CII-51 light 17 which indicates the neutral position of the trim tab.

Basic Technical Data of MN-100A Actuators

Rated voltage .....	27 V
Operating voltage range .....	24.3 to 29.7 V
Rated current required .....	1.35 A
Maximum current .....	1.4 A
Rated stem load .....	100 kg
Maximum stem load .....	150 kg

Elevator Trim Tab Control

The elevator trim tabs are controlled by means of an electric actuator, type VT-11 (Fig.31), mounted in the non-pressurized section of the fuselage at frame No.69. The VT-11 actuator revolves the cable drum, thus changing the position of the elevator trim tabs through a cable system. The travel of the VT-11 actuator is restricted by two BK-2-141B limit switches 16 which are linked to the trim tab control cables.

The actuator is controlled from push-type NH-45M change over switches 15 mounted on the spokes of the pilots' control wheels and are connected in parallel.

The actuator, type VT-11, is provided with electromagnet clutch 24 with a cable drum; it is engaged only when the trim tabs are controlled electrically. In the interim the cable drum is disengaged from the VT-11 actuator and can be driven by the cables running from elevator trim tab control handwheels; these provisions ensure reliable control of the elevator trim tabs.

Mounted on the side wall of the fuel control board for emergency disconnection of the trim tab electric control system is switch 14 (type B-45) which makes it possible to disconnect the VT-11 actuator power supply in case of feeder failure.

The elevator trim tabs have mechanical position indicators mounted on the manual control handwheels.

Main Technical Data of VT-11 Actuator

Rated voltage .....	26 V
Operating voltage range .....	23.4 to 28.6 V
Rated shaft thrust (output thrust) .....	180 kg-cm
Maximum shaft thrust .....	260 kg-cm
Output shaft speed at nominal voltage ....	7 r.p.m. $\pm 10\%$
Current required at rated thrust .....	not over 2.8 A
Current required at maximum thrust .....	not over 3.3 A
Mode of operation .....	intermittent

5. LANDING GEAR WARNING AND TAIL SKID CONTROL

The landing gear is extended and retracted with the aid of hydraulic units and therefore they are not to be described in the present Section.

The landing gear position warning system uses GMI-51 signal lights (red lights for the L.G. retracted position and green lights for the L.G. extended position) mounted on the middle electric control board of the pilots; three green-screened and three red-screened lights.

Employed as L.G. position transmitters are limit switches, type BK-44, mounted in the wells of the corresponding L.G. legs.

The signal lights (Fig.32) are fed from the dual supply bus bar through an A30-2 circuit breaker installed on the pilot's circuit-breaker control panel.

Tail Skid Control

The retraction and extension of the tail skid are controlled by an electric actuator, type MN-250.

The MN-250 actuator is designed for control of units and mechanisms performing motions of translation, the stem (operating rod) load not exceeding 250 kg.

Used in the actuator is a two-pole D.C. series-excited reversible motor, type D-25T, with electromagnetic brake clutch which serves to reduce the inertia travel of the actuator stem.

For the reversing action the motor is provided with two self-contained field windings located at the opposite poles.

The MN-250 actuator is controlled automatically depending on the position of the nosewheel leg. As the nosewheel leg is being extended (See the Diagram, Fig.32), BK-44 limit switch 8 mounted on the nosewheel leg shock strut operates to engage MN-250 actuator 9 for tail skid extension.

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The tail skid retraction is carried out after complete retraction of the nosewheel leg, i.e. when limit switch 8 is re-set to engage the MN-250 actuator for L.G. nosewheel leg retraction. With the tail skid being in the extreme position, the MN-250 actuator is disengaged by means of limit switches.

The system ensures almost simultaneous extension of the L.G. nosewheel leg and tail skid. The retraction is performed in succession, i.e. the MN-250 actuator is engaged for tail skid retraction only after the landing gear nosewheel leg is fully retracted.

Retracted position of the tail skid is indicated by the lighting of two green CM-51 lights 7 provided on the electric control boards at the stations of the tail cannon operator and radio-and-cannon operator. When these lights are on, this means clearance for operation of the lower cannon mount.

The electric actuator, type MN-250, is fed from the normal power supply bus bar through a delayed-action fuse, type MN-5, located in the dual supply circuit junction box mounted on the port side at frame No.17.

Main Technical Data of MN-250 Actuator

Rated voltage .....	26 V
Operating voltage range .....	23.4 to 28.6 V
Rated load .....	250 kg
Maximum load .....	375 kg
Stem stroke length .....	180 ±1 mm
Stem speed .....	6 mm per second
Current required:	
at nominal load .....	not over 3 A
at maximum load .....	not over 3.5 A
Weight of actuator .....	not in excess of 4.2 kg
Mode of operation .....	intermittent; continuous extension and retraction operation followed by

a 1-min. break. The number of such cycles is 5. The interval after 5 cycles - at least 1 hour

6. HYDRAULIC SYSTEM CONTROL

The hydraulic system electric control is automatic. The pressure selector, type ПДМЗ-150, is designed for control and indication of the pressure of the hydraulic system mixture. The hydraulic mixture is delivered by an electrically operated hydraulic pump, type HM-29 (Fig.33), which is a hydraulic unit combining a gear pump and a drive, a D.C. electric motor, type А-4500, with compound excitation.

If the pressure in the main hydraulic system drops below the tolerated level, the HM-29 hydraulic pump is automatically engaged for mixture delivery by means of the ПДМЗ-150 pressure selector.

The electrically operated hydraulic pump (Fig.34) is set in operation by K-400II contactor 6 the field winding of which can be closed either through PH-2 intermediate relay 5 connected to ПДМЗ-150 pressure selector 1, or through push-type switch 7 (type BH-45M). Thus in case the automatic system fails the hydraulic pump can be engaged by pressing HYDRAULIC SYSTEM BOOST PUMPING (ПОЗНАЧКА ПЕРЕПОРУЧЕНИЯ) push-type switch BH-45M mounted on the middle control panel of the pilots.

In case of zero or lower-than-rated pressure in the main hydraulic system contacts B and F (See the Diagram, Fig.34) will be closed, and red CM-51 signal light on the middle electric control board will flash up. Contacts A and D, out into the field circuit of PH-2 auxiliary relay 5 will be open.

As soon as the pressure in the hydraulic system reaches 30 kg/cm<sup>2</sup> which happens by engaging the hydraulic pump with the aid of BH-45M push-type switch 7, contacts A and B close the field circuit of PH-2 relay 5 which operates

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to close the field circuit of K-400A contactor 6 which engages HM-29 hydraulic pump 8. The pressure in the system begins to increase (as soon as the hydraulic system pressure reaches 30 kg/cm<sup>2</sup>, BH-45M switch 7 gets open, and further control of the hydraulic pump is effected through the pressure selector, type ПДМЭ-150).

When the pressure rises to 100 kg/cm<sup>2</sup>, contacts B and F open and signal light 3 goes out to indicate the minimum working pressure in the hydraulic system.

When a pressure of 120 kg/cm<sup>2</sup> is reached, contacts D and E open, the circuit of contacts A and B remaining closed. The hydraulic pump continues its operation.

As soon as a pressure of 150 kg/cm<sup>2</sup> is built up, contacts E and K close to apply voltage to coil M of the relay. The relay armature will break the circuit of contacts A and B, PH-2 auxiliary relay 5 and K-400A contactor 6 will operate to interrupt the hydraulic pump operation.

Pressure drop below 150 kg/cm<sup>2</sup> results in opening of contacts E and K, but the armature will be still held in the given position due to the armature spring. As soon as the pressure drops to 120 kg/cm<sup>2</sup>, contacts D and E will close to apply voltage to coil M; the armature will close the circuit of contacts A and B, and the hydraulic pump will be engaged again. If the pressure in the hydraulic system drops to 100 kg/cm<sup>2</sup>, contacts B and F will close and the signal light will flash up to indicate that the pressure has reached its minimum value. As soon as the pressure drops to 30 kg/cm<sup>2</sup>, contacts A and B will be opened, and the hydraulic pump will be disengaged.

Pressure drop in the emergency hydraulic system is indicated by CHM-130 pressure drop warning unit 2 and red-screened CHM-51 signal light 4 which is also mounted on the middle electric control board of the pilots.

The operating principle of the warning unit, type CHM-130 is similar to that of the pressure selector, type ПДМЭ-150.

When the pressure in the warning unit connector is 130 kg/cm<sup>2</sup>, the contact strip moves away from the fixed contact to open the electric light signalization circuit.

At a pressure drop below 130 kg/cm<sup>2</sup>, the contacts will close and the signal light will flash up to indicate that the pressure in the emergency hydraulic system has reached its minimum value. The pressure selector, type ПДМЭ-150, and the pressure drop warning unit, type CHM-130, are located on the hydraulic control panel in the front non-pressurized section of the fuselage on frame No.15.

Main Technical Data of ПДМЭ-150 and CHM-130 Instruments

Rated voltage .....	27 V ±10%
Accuracy of operation of contacts:	
under normal temperature and	
relative humidity conditions .....	within plus 5 to minus 2 kg/cm <sup>2</sup>
at temperature of plus to minus 60°C .....	within plus 6 to minus 3 kg/cm <sup>2</sup>

The hydraulic pump, type HM-29, is fed from the normal power supply bus bar through a delayed-action fuse, type MH-250. The feed of the control and signalling circuits is accomplished from the pilot's circuit breaker control panel through A3C-2 circuit breakers; the hydraulic pump control circuit is fed from the normal power supply bus bar, while the signalling circuit is supplied from the dual power supply bus bar (See the Diagram, Fig.34).

The units engaging the HM-29 electrically operated hydraulic pump (the K-400A contactor, the PH-2 auxiliary relay and the MH-250 delayed-action fuse) are located in the hydraulic system control panel junction box (Fig.35) installed in the non-pressurized section of the fuselage, in the area of frame No.15.

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**Main Technical Data of Electrically Operated****Hydraulic Pump, Type HM-29**

Working pressure of delivery ..... 150 kg/cm<sup>2</sup>  
 Maximum pressure of delivery ..... 180 kg/cm<sup>2</sup>  
 Rated voltage ..... 26 V  
 Operating voltage ..... 23 to 29 V  
 Current required:  
   at working pressure of 150 kg/cm<sup>2</sup> ..... not over 180 A  
   at maximum pressure of 180 kg/cm<sup>2</sup> ..... not over 260 A  
   probable 2-sec. current peaks ..... not in excess  
     of 300 A  
 Operating ambient temperature range ..... +55°C  
 Maximum performance altitude ..... up to 12,000 m.

**7. DRAG CHUTE CONTROL**

To reduce the landing run, the aircraft is provided with a drag (tail) parachute. The chute release buttons are mounted on the trim tab control stations (See Fig.29). The right and left instrument panels of the pilots carry two green lights, type CMH-51, which indicate the drag chute release. Mounted beside the lights are the drag chute dropping buttons.

As soon as one of the drag chute release buttons is pressed (the release buttons, as well as the chute dropping buttons are connected together in parallel), the squibs, type HM-3, in the removal guns go off to open the doors of the chute container, and the drag chute is let out with the aid of the pulling (rip) parachute.

Closed at the same time are the contacts of the limit switch, type BK-2-141B, coupled with the linkage system of the drag chute release (the limit switch, type BK-2-141B, is installed in the fuselage tail section in the area of frame No.67). As soon as the contacts of the limit switch are closed, the green signal lights, type CMH-51, flash up to indicate that the drag chute is released.

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The chute is dropped by pressing one of the buttons which closes the circuit of the squibs in the remover guns of the drag parachute dropping system.

The drag chute control system is fed from the normal power supply bus bar controlled from the pilot's circuit breaker panel through an A3C-5 circuit breaker.

**8. DE-ICERS AND HEATERS****De-icer**

The leading edge sections of the fin and stabilizer are provided with electrically operated thermal de-icers. Each de-icer consists of sections, assemblies and heating elements.

The stabilizer de-icer is divided into two sections:  
 (a) the inner section which heats the root areas of the left and right L.E. sections of the stabilizer;  
 (b) the outer section which heats the tip areas of the stabilizer L.E. sections.

The fin de-icer has only one section which consists of one assembly. The outer and inner sections of the stabilizers consist of two assemblies each; the assemblies are installed in the left and right panels of the stabilizer.

The left- and right-panel assemblies of each stabilizer de-icer section are connected together in parallel (Fig.36). Each assembly incorporates several heating elements which are series-connected between each other.

The heating elements are mounted between the skin and the inner plating of the leading edge sections.

Each assembly of the de-icer sections is provided with a bimetallic thermal switch, type 777-B, which breaks the minus power supply circuit of the K-600A contactor disengaging the de-icer section as soon as a temperature of 70 +10°C is reached.

The de-icer sections operate intermittently; each cycle consists of 40 seconds during which the sections are energized and 80 seconds during which they are de-energized. The

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cycle is governed by an electric actuator, type MKA-3A, (Fig.37) which actuates the de-icer sections one after another through contactors, type K-600D.

The actuator, type MKA-3A, consists of the following three major parts: a shunt-wound two-pole electric motor, a reduction unit and a contact assembly.

The actuator is mounted in the non-pressurized tail section of the fuselage, port side, at frame No.63. The actuator is fed from the normal power supply bus bar through an ABC-2 circuit breaker mounted on the co-pilot's circuit breaker control panel. The de-icers are controlled from the upper (overhead) electric control board of the pilots by means of a B-45 switch.

The power contactors, type K-600D, and the fuses, type TP, rated for 600 A which are part of the power circuit of the de-icer sections are housed in the tail unit de-icer junction box (Fig.38) which is installed in the tail non-pressurized section of the fuselage, port side, between frames Nos 63 and 63a.

The control over the operation of the de-icers is effected by a white light, type CMC-51, which flashes up for 40 seconds after each 80-sec. interval to indicate that the outer de-icer section of the stabilizer is engaged. The light is mounted on the pilot's instrument panel.

When switch 7 (Fig.36) is closed, voltage is supplied to electric motor 3 of the MKA-3A actuator and, at the same time, through the closed contacts of contact assembly 5 - to the field winding of K-600D contactor 9 which energizes inner section 11 of the stabilizer de-icer.

Motor 3 through reduction unit 4 turns contact assembly and upon expiration of 40 seconds the closed contact of the MKA-3A actuator operates to break the field winding of the K-600D contactor which disconnects inner section 11 of the stabilizer de-icer. Immediately upon disconnection of de-icer section 11, the second contact of contact assembly 5 operates to close the field winding circuit of K-600D con-

tactor 9 which engages outer section 1 of the stabilizer de-icer. The engagement of section 1 is accompanied by flashing-up of white signal light 8 which will go on burning as long as outer section 1 is in operation and will go out as soon as the outer de-icer section is disengaged after a 40-sec. operation period. Disengagement of section 1 results in actuation of the third contact of contact assembly 5; this contact will close the field circuit of the K-600D contactor which engages section 10 of the fin de-icer.

Upon expiration of 40 seconds contact assembly 5 will disengage section 10, and the operating cycle of the MKA-3A actuator will be repeated. When switch 7 is opened, the MKA-3A actuator stops at any position of the contact assembly, i.e. the de-icers are engaged not necessarily beginning with the stabilizer inner de-icer section, but the sequence of the section-by-section engagement is strictly maintained by the actuator.

The section engagement order is presented in the Table below:

Nos	Description	Engage-ment sequence	Current required, A	Protec-tion	Supply circuit relay
1	Inner section of stabilizer de-icer .....	I	450	TP-600	K-600D
2	Outer section of stabilizer de-icer .....	II	494	TP-600	K-600D
3	Fin de-icer .....	III	480	TP-600	K-600D

Main Technical Data of MKA-3A Actuator

Rated voltage ..... 27 V  
Operating voltage range ..... 27 V ±10%

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Rated current required by actuator motor ... not over 0.8 A  
Rated current for switch contact opening ... 5 A (inductive load)

Mode of operation ..... continuous

The ground check of the de-icers is carried out by connecting the aircraft electric mains to a ground D.C. generator through the ground power supply plug connector.

An ammeter rated for 500 A is cut into the power supply circuit. The voltage is measured by the aircraft voltmeter. The heating degree is tried by hand or with the aid of a special instrument which consists of a thermocouple mounted on a telescopic stem with wires leading to the temperature indicator carried inside the stem. The cycle periods are checked with the aid of a stopwatch.

When checking the heating degree by means of the special thermocouple instrument, the indications will be considered normal if the surface temperature at any point of the given section of the de-icer leading edge section (boot) is about 30 to 50°C higher than the ambient air temperature (in the course of one cycle of the de-icer operation).

**CAUTION:** NEVER operate the de-icers for longer than 3 minutes on the ground.

The de-icer of the aircraft tail unit is engaged in the flight before the aircraft enters the ice-dangerous zone. The de-icer is engaged only if the de-icer boots of the tail unit are absolutely free of ice.

**IMPORTANT:** During a flight check of the tail unit de-icer, under icing-free conditions, the de-icer may be engaged for not longer than 5 minutes. In this case the operation of the de-icers is checked by the signal light and by the current consumed (with reference to the generator ammeters).

Electric Heaters

(a) Electrically Heated Glass Panels

To prevent frosting, the front glass panels of the two pilots and of the navigator are equipped with electric heating arrangements called the defrosters.

Each glass panel is an assembly of two hardened silicate glass panels with a heater element attached between them (Fig.39).

The glass panel heating degree is controlled by an automatic defroster control unit, type ACC-S1M.

Thermister 2 (Fig.39) of each heated glass panel is cut into an electrical bridge circuit. The two other arms of the bridge are formed up by coils I and II of PII-4 polarized differential relay 1. Coils I and II have equal numbers of turns and are opposite-connected between each other. The fourth arm of the bridge is control rheostat (trimmer) 3. The PII-4 relay and the trimmer are located directly in the ACC-S1M automatic defroster control unit.

If the glass panel temperature is too low, the thermister resistance will be large, and the currents in windings I and II of the PII-4 relay will be distributed in such a manner that the relay will operate to supply voltage to the heater elements of the glass panels.

The temperature will be rising while the thermister resistance will undergo gradual decrease, and at a temperature of 20 ±2°C for which the automatic defroster control unit is adjusted the thermister resistance change will be so great that due to re-distribution of currents in the bridge circuit the PII-4 relay will open its contacts to disconnect the defroster heating elements.

The automatic defroster control unit, type ACC-S1A, has three independent channels, each channel ensuring automatic control of the defroster arrangement of its respective glass panel. Each channel comprises a bridge circuit with polarized



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differential relay 1, type PH-4, and relay 15, type PB3-45, which relieves the load from the circuit of the polarized relay and is no part of the bridge circuit.

The trimmer (control rheostat) is used for adjusting the ACC-81M control unit for a certain glass panel temperature to be maintained ( $20 \pm 2^\circ\text{C}$ ). Connected in parallel with the contacts of the PH-4 relay is a spark-quench which consists of a resistor and a capacitor.

With B-45 switches 5, 6 and 7 of the pilots' and navigator's defrosters closed and with the resistance of thermistors 2 changing due to glass panel temperature changes the bridge circuits of the automatic unit become unbalanced. Thus, for instance, if the thermister resistance increases due to decreased glass panel temperature, PH-4 relay 1 of each channel operates to apply voltage to the coils of PB3-45 relay 15 which in their turn will connect power supply to the field windings of contactors 8 and 9 connecting the defrosters of the pilots and navigator.

Automatic engagement of each defroster is effected by PH-4 polarized differential relay 1 which, as soon as the temperature in the point indicated in Fig.39 reaches  $20 \pm 2^\circ\text{C}$ , breaks the field circuit of its PB3-45 relay. The PB3-45 relay operates to de-energize the field winding of contactor 8 or 9 which engages the defroster of the respective glass panel.

Provision of three channels in the ACC-81M automatic defroster control unit ensures independent control of each separate glass panel defroster.

The ACC-81M control unit is installed at the starboard side, in the area of frame No.5; the defrosters at the two pilots are controlled by means of two B-45 switches mounted on the overhead electric control board of the pilots (Fig.40).

The navigator's defroster is engaged with the aid of a B-45 switch located on the overhead (upper) electric control board of the navigator. The pilots' defroster current is supplied through two relays, type K-50A, and that for the

navigator's defroster is fed through a relay, type K-100A. The power supply circuits are protected with three fuses, type HH, two of which are rated for 75 A, and the third - for 100 A.

The fuses and the relays are located in the defroster control junction box (Fig.41) which is mounted on the starboard side of the front pressurized cabin at frame No.6.

The control circuits are fed from the normal power supply bus bars through three A3C-2 circuit breakers installed on the circuit-breaker control panels of the pilot and co-pilot and on the left-hand circuit breaker control panel of the navigator.

The adjustment of the ACC-81M unit and check-up of the entire system should be carried out in accordance with existing operating instructions of the aircraft, model TV-16.

#### (b) Cabin Electric Heaters.

To prevent dimming of the glass panels, as well as to provide additional heating of the cabins, each pressurized cabin is fitted out with one electric heater, Index 107, (Fig.42). In the front cabin the electric heater is installed at the starboard side in the area of frame No.5, and in the rear pressurized cabin the heater is mounted on the port side in the area of frame No.73.

The electric heater, Index 107, is a heating appliance with three electric heating elements and a fan. Each electric heater is controlled with the aid of three switches, type B-45; switch 9 (Fig.43) is used to control the heater fan, while the other two (10 and 11) are used to operate the sections of the heating elements. The first section consists of two heating elements 6, and the second section has one element.

The design of the heater makes it impossible to engage the heater sections unless the fan is on.

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To prevent overheating that may be caused by decreasing air density with altitude, the heater is provided with change-over switch 5 (Index 131A) installed in the heater; the switch disconnects one heating element of the heater (the second section) at an altitude of 7000 m.

Mounted inside the heater is thermal switch 4 (Index 128) which disconnects all the heating elements of the heater in case of their overheating. Due to the operation of PI-2 blocking relay 2, the heater is not re-engaged automatically after it cools off; to re-engage the heater it is necessary to open all the three heater control switches and then to close them again one after another.

Closing the switches of the first and second sections of the heater results in operation of three K-50M contactors 7 (See the Diagram, Fig.43) which are installed inside the heater. Each of these contactors connects or disconnects one heating element 6. The minus circuit of the field windings of all the three contactors can be broken by PI-2 blocking relay 2 which operates only after the automatic re-setting of bimetallic thermal switch 4 in case the heater is overheated. As the heater is being cooled down, the PI-2 relay remains energized as its field winding is fed through its own contacts. The voltage supply to the field winding of blocking relay 2 can be interrupted only by disengaging fan 9.

The minus circuit of the field winding of the K-50M contactor which connects the heating element of the second section is additionally broken by altitude change-over switch 5 (Index 131A) as soon as the altitude of 7000 m. is reached; this action disconnects the second section of the heater.

All the three heater control switches of the front pressurized cabin are located on the overhead electric control board of the pilots, and the control switches of the rear pressurized cabin heater are mounted on the radio operator's electric control board (See Figs 40 and 44).

Basic Technical Data of Heater, Index 107

D.C. voltage .....	27 V $\pm 10\%$
Total current of the circuit of three heaters at 27 V .....	not in excess of 135 A
Current of the fan motor circuit at 27 V .....	not in excess of 30 A
Air flow through heater on the ground, with air pressure head at heater outlet not less than 250 mm water gauge .....	not less than 230 kg/hr
Air temperature at heater inlet ...	20 $\pm 10^\circ\text{C}$
Time required for heating element automatic disconnection after the motor is disconnected .....	not longer than 180 sec.
Fan motor power .....	not over 650 W
Motor speed .....	5800 to 12,000 r.p.m.
Weight .....	not more than 12 kg.

Power is supplied to the heater sections, to the heater control circuits and to the fan motors from the normal power supply bus bars.

Used to protect the power circuits of the heaters are fuses, type MN-150; one of the fuses (protecting the front cabin heater) is located in the defroster control junction box mounted on the starboard side of the front pressurized cabin at frame No.6, and the other (protecting the rear cabin) is installed in the rear cabin junction box mounted on the port side at frame No.74.

Two A3C-30 circuit-breakers of the control circuits and of the heater fans are located in the following places: one (for the front cabin) - on the co-pilot's circuit breaker control panel, and the other (for the rear cabin) is mounted on the circuit breaker control panel of the rear cabin.

To decrease radio interference, cut into the plus circuit of the fans of both heaters are KEM-31 capacitors 8 (Fig.43).

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(c) Electric Heating of Pitot Tubes, Type TH-156

To prevent icing of the air intakes of the TH-156 pitot tubes, they are provided with electric heating arrangements. The heaters are controlled from two switches, type B-45, mounted on the overhead electric control board of the pilots.

The aircraft carries three TH-156 tubes: two on the port side between frames Nos 7 - 8 and at frame No.6, and the third - on the starboard side at frame No.6.

The left top pitot tube is used in conjunction with the instruments of the pilot and navigator and the velocity head warning units, type CCH-3. The heater is fed from the bus bar which supplies the instruments from the storage battery under de-energized mains conditions (the triple power supply bus bar through an A3C-5 circuit breaker located on the co-pilot's circuit breaker control panel.

The left bottom pitot tube operates in conjunction with the instruments of the radar operator, as well as with the HM-50B air position indicator (dead reckoning instrument system) and the bomb-sight, type ONE-11p. The right pitot tube operates with the instruments of the co-pilot and radio-gunner. The heaters of these two tubes are fed from the dual power supply bus bar through an A3C-10 circuit breaker mounted on the co-pilot's circuit breaker control panel.

The switch of the first heater and the master switch of the two other heaters are installed on the overhead electric control board of the pilots.

For the circuit diagram of the TH-156 pitot tube heating system see Fig.45.

(d) Electric Heating of Autopilot

Used for heating the servo units, directional stabilizer and vertical gyro of the autopilot, type AN-5-2M, are special heating covers which are provided with electric heating elements. The heating elements are supplied from the aircraft

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mains. To connect the heating system it is necessary to insert the plugs of the heating cover cables into the sockets located close to the above units of the autopilot.

To prevent overheating of the heated units, the heating covers are fitted out with thermostats (thermoregulators) which automatically disconnect the heating elements as soon as the critical heating temperature is reached.

The autopilot heating system sockets are located at the following points: the directional stabilizer socket - at frame No.1, the vertical flight gyro socket - at frame No.9 of the front pressurized cabin, and the sockets for the three servo units of the autopilot - in the non-pressurized section of the fuselage at frames Nos 33 and 68.

The sockets of the heater circuits of the aileron servo unit, directional stabilizer and vertical gyro are energized through an A3C-10 circuit breaker installed on the pilot's circuit breaker control panel; the power is supplied through a switch, type B-45, mounted on the overhead electric control board of the pilots.

The sockets supplying the heater circuits of the elevator and rudder servo units are energized through, and controlled from, a circuit breaker, type A3C-10, installed in a special box on the starboard side of the non-pressurized tail section of the fuselage, beside frame No.63a. All the sockets are energized from the normal power supply bus bars.

For the circuit diagram of the heating system see Fig.45.

## 9. ALTITUDE EQUIPMENT

For cabin temperature control the aircraft is provided with the following electric units:

1. Automatic cabin temperature controllers.
2. Low altitude ventilation actuators.

Automatic Cabin Temperature Controllers

Used in the function of automatic temperature controllers in the pressurized cabins of the aircraft are thermoregulators of type TPTEK-45.

The thermoregulator set comprises a thermostat, type PZ (Fig.46) and an actuator, type MPT-1 (Fig.47).

The thermostat is a controlling element of the regulator while the actuator, type MPT-1, is an actuating element which controls the bypass of the air supplied to the cabin through the turbine-operated cooler, type TXV or, when the cooler is passed by, through the cabin air supply regulator, type PKH.

Due to the isolation of the front and rear cabins from each other there are two identical temperature control systems in each cabin.

Principle of Operation of TPTEK-45 Thermoregulator

The sensitive element of thermostat 10 (Fig.46) is a bimetallic spiral 12. The spiral carries armature 13 which in case of cabin temperature fluctuations turns under the pressure of the spiral to close the corresponding contact and thus to engage one of the windings of reversible electric motor 14 of MPT-1 actuator 15. The actuator turns its attached shutter of the by-pass valve by this or another angle directing the hot air flow either through the turbine-operated cooler (if the cabin temperature is higher than normal) or to by-pass the cooler (if the cabin temperature is lower than normal).

The regulator employs a negative feedback circuit which comprises electromagnet 11 and balance potentiometer 19. The feedback (balance) electromagnet is located in the thermostat and acts upon the armature of the bimetallic spiral. The electromagnet voltage is picked up from the balance potentiometer installed in the MPT-1 actuator. The potentiometer wiper is rigidly attached to the output shaft (stem) of the actuator.

As to its direction the action of the feedback electromagnet upon the armature is opposite to the action of the bimetallic spiral upon the same armature. Therefore the MPT-1 actuator will go on turning the shutter until the voltage picked up from the balance potentiometer of the MPT-1 actuator is high enough to open the contacts of the bimetallic relay. The contacts can become open in an intermediate position of the by-pass valve shutter, i.e. when the hot air will be passing partially through the turbine-operated cooler and partially by-passing it through the PKH regulator directly into the cabin, thus ensuring the desired cabin temperature.

In the extreme positions of the shutter the electric actuator power supply circuit is interrupted by limit switches 18 which are mounted in the actuator proper.

The control of the electric actuator, type MPT-1, and, consequently, the regulation of the cabin air temperature, can be also effected manually, by means of ПЗННН-45 change-over switches 14. The change-over switch has four positions: throw-over (fixed) position AUTOMAT (АВТОМАТ), push-button selected positions HOT (ГОРЯЧИЙ) and COLD (ХОЛОДНЫЙ), and neutral position OFF (ОТКЛЮЧЕНО).

Main Technical Data of MPT-1 Actuator

Output shaft (stem) thrust .....	120 to 200 kgom
Rated voltage .....	24 V
Operating voltage range .....	20 to 28 V
Output shaft turn angle (less inertia run-out) .....	135° ±3°
Current required at rated thrust and voltage .....	not over 1 A

The thermostat for the front pressurized cabin is located on frame No.9 (starboard), and the MPT-1 actuator - in the front non-pressurized section of the fuselage at frame No.22 (starboard). The manual control change-over switch is mounted

on the co-pilot's instrument panel. The A3C-2 circuit breaker protecting the electric circuit is mounted on the circuit-breaker control panel of the co-pilot.

The thermostat for the rear pressurized cabin is located at frame No.72 (port side), and the MPT-1 actuator - at frame No.63 of the non-pressurized tail section of the fuselage (starboard). The manual control change-over switch is installed on the electric control board of the radio-gunner. The A3C-2 circuit breaker to protect the electric circuit is mounted on the circuit breaker control panel of the rear cabin. Both circuit breakers are fed from the normal power supply bus bars.

#### Low-Altitude Ventilation

Provided on the aircraft for cabin ventilation at altitudes up to 2000 m. is a ventilation system with air delivery through free air intake scoops. The air intake scoop control in the rear cabin is manual, while employed for this purpose in the front cabin is an electric actuator, type M3K-2. This actuator is controlled by means of PH-45M change-over switch 9 (See the Diagram, Fig.48) which is installed on the overhead electric control board of the pilots. Change-over switch 9 is of push-type and makes it possible to select the desired degree of the air scoop opening.

In the extreme positions the M3K-2 actuator is disconnected by means of limit switches 5 irrespective of the position of change-over switch 9. The actuator is fed from the normal power supply bus bar located on the pilot's circuit breaker control panel through an A3C-2 circuit breaker.

#### Fans

To improve the working conditions, provided at the stations of each member of the aircraft crew is a fan, type AB-3, with blades of soft rubber.

The fans of the pilot, co-pilot and navigator are fed through a common A3C-5 circuit breaker mounted on the circuit-breaker control panel of the pilot (See the Diagram, Fig.45).

Three switches 4, 5 and 6 (type B-45) of these fans are mounted on the engine control stations of the pilot and co-pilot and on the overhead electric control board of the navigator.

The fan of the radar operator is fed from an A3C-2 circuit breaker installed on the radar operator's circuit breaker control panel. The same circuit breaker does double duty as a switch. The fans of the gunner and of the radio-gunner are fed from an A3C-5 circuit breaker installed on the rear cabin circuit breaker control panel, and their switches 7 and 8 (type B-45) are mounted on the electric control boards of the gunner and radio-gunner.

Provided in the dome of the rear cabin for airing the units of radar sight NPC-1 under ground operating conditions are two fans, type AB-3. Apart from these the port side of the fuselage non-pressurized section between frames Nos 60 and 61 mounts an additional fan, type AB-3, employed for the same purpose.

All the three fans are fed simultaneously with the fans of the gunner and radio-gunner through an A3C-5 circuit breaker installed on the circuit breaker control panel of the rear cabin. The three fans are controlled from common B-45 switch 9 mounted on the electric control board of the radio-gunner operator. The plus circuit of these fans is broken by BK-44 limit switch 10 (See the Diagram, Fig.45) which is connected to the linkage system of the tail skid. When the tail skid is extended, the limit switch closes the fan power supply circuit, and with the tail skid retracted it opens the circuit, i.e. after the take-off all the three fans are automatically disconnected.

To decrease the radio interference level, cut into the plus circuit of each fan is capacitor 10, type KLC-31. All the AB-3 fans are fed from the normal power supply bus bars.



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10. LIGHTING SYSTEM  
Interior Lighting of Aircraft

The aircraft interior lighting system uses dome lights, ultra-violet illumination arrangements, directed-beam lights and extension lamps. Used for illumination of the KN-12 compasses is a separate lighting system with special lamps.

Employed for general lighting are dome lights, type NC-45 without a special lens; the dome lights have reflectors and single-contact lamp holders which adapt electric lamps, type CM-25, rated for 28 V, 20 W. Altogether the aircraft carries thirteen dome lights, type NC-45.

In addition to the general dome lights, type NC-45, used for illumination of the landing gear wells, are small dome lights, type NCM-51 which are used by the aircraft crew of maintenance personnel during maintenance operations performed in the landing gear wells.

Unlike NC-45 dome lights the dome lights, type NCM-51, are not glitter-proof since they are used by the crew only for short periods of time.

The major parts of a small dome light are: the shell, the transparent cover glass and the reflector; mounted in the reflector opening is a single-contact lamp holder for a CM-24 electric lamp rated for 28 V, 20 W. Serving as the second-pole of the lamp of the NCM-51 dome light (the same as the NC-45 dome light) is the dome shell.

For the locations of dome lights, types NC-45 and NCM-51 as well as for the installation places of switches which control these dome lights, see Table 7 below.

Table 7  
Location of Dome Lights, Types NC-45 and NCM-51, and Their Switches on Aircraft

No	Type of dome light	Location of dome light	Type of switch	Location of switch	Remarks
1	NC-45	3	4	5	6
1	NC-45	On ceiling of front pressurized cabin, between frames Nos 4 and 5	B-45	On dome light mounting panel	For navigator
2	NC-45	On ceiling of front pressurized cabin, at frame No.9	B-45	Do	For pilots
3	NC-45	On ceiling of fuselage non-pressurized section, at frame No.14	B-45	On radar operator's electric control illumination board	For hydraulic control panel
4	NC-45	Do, at frame No.20	B-45	Std, on NO-4500 inverter shelf	For illumination board
5	NC-45	Do, at frame No.24	B-45	On radar operator's electric control panel	For bomb bay lighting
6	NC-45	Do, at frame No.28	B-45	Do	Do

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1	2	3	4	5	6
7	IC-45	On ceiling of fuselage non-pressurized section, at frame No.42	B-45	On radar operator's electric control panel	For bomb bay lighting
8	IC-45	Do, at frame No.46	B-45	Do	Do
9	IC-45	Do, at frame No.49	B-45	Do	Do
10	IC-45	Do, at frame No.59	B-45	Stbd, at frame No.62	
11	IC-45	On stbd side of non-pressurized fuselage section at frame No.66	B-45	Do	
12	IC-45	On ceiling of rear pressurized cabin, at frame No.71	B-45	On electric control board of radar operator	For radio-gunner
13	IC-45	Do, at frame No.74	B-45	On electric control board of radio-gunner	For gunner
14	ICM-51	In L.G. left leg well		On electric control board of radar operator	
15	ICM-51	In L.G. right leg well		On electric control board of radio-gunner	
16	ICM-51	In nosewheel leg well, stbd, at frame No.20		On electric control board of radar operator	
17	ICM-51	In nosewheel leg well, port side, at frame No.20	B-45		

Used for illumination of control stations and panels, as well as of darker places and aircraft instruments is a lighting system, type KMCPK-45, provided with a rheostat, operating button and a set of bulbs, type CM-30, rated for 28 V, 0.17 A.

The aircraft is fitted with ten cabin lamps altogether. Two lamps are installed at the navigator's station, three at the pilots' stations, two for the radar operator, two for the radio-gunner, and one at the gunner's station.

Cabin lamps of the KMCPK-45 system are mounted on special hinged brackets (Fig.49).

Some hinged brackets, in addition to the cabin lamps, mount ultra-violet illumination arrangements.

The cabin light of the gunner has no hinged bracket and is mounted on the ceiling of the rear cabin.

In case of necessity the KMCPK-45 fixtures can be removed from their hinged brackets or from their bases and used as extension lamps.

Altogether the aircraft is fitted with three extension lamps which are kept in bags attached to the back wall of the middle control station of the pilots, on the web of frame No.9 of the front pressurized cabin (starboard), and on the port side at frame No.73 of the rear pressurized cabin.

The aircraft is provided with 13 power sockets, type 47K. For the locations of these sockets see Table 8 below.

Table 8

Location of Power Sockets, Type 47K, for Extension Lamps, Type ПЛ-10-36

No.	Location	Remarks
1	Navigator's right-hand console	
2	Middle console of pilots	

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Used for ultra-violet illumination are low-pressure fluorescent mercury lamps, type VVO-4A, rated for 4 V each. The ultra-violet illumination system, type APV.OE-45, is operated in set with a rheostat, type PV.O-45, which engages the ultra-violet illumination lamps and controls the radiative intensity of the lamps. The APV.OE-45 system is fitted with a special two-wire cable contained in a copper braiding which serves as a third conductor. The end of one of the two wires, when cleaned from its braiding, has white insulation and the end of the other wire has white insulation distinguished by a black thread. The wire having black-thread white insulation is not used in the lamp circuit and is insulated from it. The braiding enveloping the wires of the fixture is connected to the airframe either directly or through a piece of aviation wire, type EBHM.

The plastic case of the lamp has an extension sleeve with two light filters made of "black" uvioi glass and is provided with a hinged base.

All the inscriptions, indexes and nameplates of normal reference or instructive nature have green luminescence, and those of alarm and emergency nature have orange luminescence.

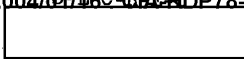
The aircraft is equipped with 16 APV.OE-45 systems with rheostats, type PV.O-45 (See Table 9).

Table 9

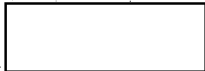
Location of APV.OE-45 systems and PV.O-45 Rheostats

Nos	Location of APV.OE-45 system	Location of PV.O-45 rheostat	Remarks
1	2	3	4
1	Starboard of front pressurized cabin, on frame No.2	Overhead electric control board of navigator	Used for illumination of sight, instrument panel and right-hand console of navigator

1	2	3	4
2	Front cabin ceiling, frame No.3	(overhead electric control board of navigator	Used for illumination of sight, instrument panel and right-hand console of navigator
3	Front cabin ceiling, frame No.4	Do	
4	Co-pilot's control wheel	Engine control station (console) of co-pilot	
5	Do	Do	
6	Pilot's control wheel	Engine control station (console) of pilot	
7	Do	Do	
8	At frame No.8, port side	Do	Together with KACPR-45 fixtures serves for illumination of co-pilot's engine control station
9	Front cabin ceiling, frame No.8	Engine control station of pilot	



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The lamp is fixed in the desired position by means of a nut and a locking nut.

All the three taxiing lamps are engaged simultaneously from a common switch, type B-45, (Fig.51) which is mounted on the overhead electric control board of the pilots. The taxiing lamps are fed from the normal power supply bus bar through an A3C-10 circuit breaker installed on the pilot's circuit breaker control panel.

Each CP-100 taxiing lamp installed on the aircraft illuminates the landing strip at a length of 15 to 20 m. ahead from the pilots' cabin.

Landing Lamps

The two extension landing lamps, type KCB-45, (Fig.51) are mounted in the belly section of the fuselage at frame No.11. The extensible part of the lamp consists of a case and a special reflecting bulb rated for 26 V, 600 W; the bulb incorporates a filament lamp, a reflector and a protective cover glass. The bulb of the lamp is parabolically-shaped, and the inner reflecting surface of the bulb is mirror-coated. The lamp actuator (See the Diagram, Fig.52) consists of a series-wound reversible motor, a reduction unit and a disengaging contact assembly.

The lamp is designed to be fed from single-wire aircraft electric mains. The lamp is automatically switched on when being extended, and switched off while being retracted. With the lamps in the extreme extended or retracted position, the electric motor of the actuator is automatically disengaged by means of limit switches provided inside the landing lamp actuator.

The landing lamps are controlled by means of a 2MM-45 change-over switch (See Fig.40) mounted on the overhead electric control board of the pilots. The landing lamps are fed from the normal power supply bus bar. The lamp control circuits are protected with two A3C-5 circuit breakers, and

the power supply circuits of the lamps are protected with two circuit breakers, type A3C-30. All the circuit breakers are installed on the pilot's circuit-breaker control panel.

Main Technical Data of Landing Lamp,  
Type KCB-45

- Maximum candle-power ..... not less than 400,000 candles
- Dispersion angle of lamp:
  - in horizontal plane ..... not less than 12°
  - in vertical plane ..... not less than 8°
- Extension angle (same for right and left lamps) ..... 86°30'
- Time of lamp extension and retraction ... not more than 12 sec.
- Maximum allowable time of continuous operation ..... 5 min.
- Service life ..... 6 hours of operation
- Weight of lamp with actuator ..... 3.5 kg
- When voltage is 10 per cent larger than rated, the lamp may be operated for 3 min.
- When extended, the landing lamps, type KCB-45, illuminate the landing strip of 40 to 60 m. ahead from the pilots' cabin.

Formation Lights

The top and bottom formation lights are installed along the fuselage and on the landing gear cowls along the wing span to form a burning Tee in the flight. The formation lights are mounted flush with the skin. Each formation light, type HCCO-45, consists of an aluminium case the inner surface of which serves as a reflector, a holder mounting with a single-contact lamp holder for a CM-30 bulb rated for 28 V, 0.17 A, and a dark-blue light prismatic refractor which at the same time serves as a light filter.



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Main Technical Data of Formation Lights,  
Type NC80-45

Maximum candle-power ..... not less than 5.5 colour  
candles. With light set  
horizontally, the beam is  
directed backward and 45  
to 50° upward from reverse  
flight direction

Light visibility range in maximum  
intensity direction under fair  
night conditions ..... some 3 km.  
Angular width of light beam ..... some 20°

To avoid overheating and damage to the refractor, never  
engage the lights at parking for long periods of time.

The top and bottom formation lights are controlled by  
means of B-45 switches installed on the overhead electric  
control board of the pilots (See Fig.40). The circuits of the  
top and bottom formation lights are protected with two A3C-2  
circuit breakers mounted on the pilot's circuit breaker control  
panel and connected to the normal power supply bus bar.

For the circuit diagram of the formation lights  
see Fig.52.

Navigation Lights

The tip fairings of each wing mount front and rear  
navigation lights. Two red wing navigation lights, type BAHO-45,  
are provided on the left wing tip, and two green wing naviga-  
tion lights of the same type are installed on the right wing  
tip. The wing navigation lights are bolted in recesses closed  
with plexiglass covers. The lights use CM-22 bulbs rated for  
28 V, 24 W with a candle-power of 21 candles.

Installed in the tail section of the fuselage below the  
stern cowl is a white tail navigation light, type XC-39, with  
CM-15 bulb rated for 26 V, 10 W.

The wing and tail navigation lights are controlled by  
means of a B-45 switch (See Fig.52) installed on the overhead  
electric control board of the pilots. The navigating light  
circuit is protected with an A3C-5 circuit breaker mounted  
on the pilot's circuit breaker control panel and connected to  
the normal power supply bus bar.

11. SIGNALLING SYSTEM

The aircraft is provided with light and sound signalling  
systems. The light signalling system uses various-colour  
signal (warning) lights, type GM-51, which are installed on  
the consoles, control stations, instrument panels, control  
panels and control boards.

For the types, locations and operating conditions of the  
signal (warning) lights see Table 10 below.

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Table 10  
Light Signalling System

No	Object of Indication	Number of lights	Type of light	Operating conditions	Nature of signal	Location	Remark
1	Engine starting readiness	2	CMH-51, green	Exhaust gas shutters of turbo-starter open	Continuous shining	Engine control board on pilot's engine control station	
2	Turbostarter oil pressure	1	CMH-51, green	Turbostarter oil pressure exceeds 3.5 kg/cm <sup>2</sup>	Do	Turbostarter control panel	
3	Tank connection order	4	CMH-51, blue	First-group light flashes up when fuel tank selector switch is placed to AUTOMATIC, and when boosters are engaged	Do	Fuel control board	
				Other lights flash up in turn as soon as 200 lit.			

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No	Object of Indication	Number of lights	Type of light	Operating conditions	Nature of signal	Location	Remark
4	Fuel remaining for 30 and 15 min. of flight	4	CMH-51, red	of fuel remain in previous tank group Two red lights flash up to indicate fuel remaining for 30-min. flight and two other lights to indicate fuel remaining for 15-min. flight	Continuous shining	Fuel control board and pilot's instrument panel	
5	Fuel pump operation	12	CMH-51, green	With fuel pump operating, as soon as pressure of 0.3 to 0.35 kg/cm <sup>2</sup> is built up in system	Do	Fuel control board	
6	Fuel shut-off valves open	2	CMH-51, green	With fuel shut-off valves open, from beginning of engine starting till engine stoppage	Do	Do	
7	Fire	6	red	As soon as fire-fighting system is engaged when tempera-	Do	Do	

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1	2	3	4	5	6	7	8
8	Drag chute release	2	CHL-51, green	When drag chute is released	Continuous shining	Instrument panels of pilot and co-pilot	
9	Pressure drop in normal and emergency hydraulic systems	2	CHL-51, red	As soon as pressure in normal hydraulic system drops below 100 kg/cm <sup>2</sup> , and in emergency hydraulic system below 120 kg/cm <sup>2</sup>	Do	Middle electric control board of pilots	
10	Operation of automatic brake control unit	1	CHL-51, blue	At sharp wheel braking, with control unit switch closed	Light is blinking	Do	

1	2	3	4	5	6	7	8
11	Cannon position while landing	2	CHL-51, blue	With lowered camion of lower and stern mounts	Continuously shining	Pilot's instrument panel	
12	Position of landing gear and tail skid	8	CHL-51, five green lights and three red lights	Three green lights indicate extended position of L.G. legs, and three red lights - retracted position of L.G. legs. Two green lights indicate retracted position of tail skid	Do	Middle electric control board of pilots and electric control boards of radio-gunner and gunner	
13	Neutral position of aileron and rudder trim tabs	3	CHL-51, white	When aileron and rudder trim tabs are neutral	Do	Pilot's instrument panel and aileron synchronization control station	
14	MACH LIMIT	2	CHL-51, red	At velocity head of 2200 kg/m <sup>2</sup> , low altitudes; at M-C.86, high altitudes	Do	Instrument panels of pilots	

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1	2	3	4	5	6	7	8
15	Engagement of standby gyro horizon set	1	CMI-51, red	When standby gyro horizon set is engaged by pilot or radar operator	Continuous shining	Pilot's instrument panel	
16	Uncaged remote-indicating compass	1	CMI-51, green	With switch set to UNCAGED (PARALLEL)	Do	Overhead board of electric control	
17	Camera hatch open, positions of camera tilting unit for RANGE BOMBING CONTROL	3	CMI-51, green, white, yellow	1. Green light is on, with camera hatch open 2. White light flashes up when tilting unit passes zero position in RANGE mode of operation 3. Yellow light shines when tilting unit is operating for RANGE CONTROL, at tilt angles of 0, 10, 15, 20 and 25°	Do Light is blinking Continuous shining	Navigator's right-hand console	

1	2	3	4	5	6	7	8
18	Operation of tail unit de-icers	1	CMI-51, white	When outer sections de-icers are engaged	Light comes on for 40 sec. to go out for 80 sec.	Co-pilot's instrument panel	
19	Cabin pressure drop	5	CMI-51, yellow	As soon as pressure drop reaches the value of altitude set on dial within 1000 to 5000-m. range	Light is blinking	Navigator's oxygen control panel, instrument panel of pilot, oxygen control panel of radar operator, instrument panel of radio-sumner, and electric control board of gunner	



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Signal Flare System

External light signalling is effected with signal flares of red, yellow, green and white colours. The signal flare system consists of three signal flare control stations and three signal flare launchers, type SKCP-46.

The signal flare control station is a metal box mounting four buttons and a switch. By turning the button head it is possible to set the flag of red, yellow, green or white colour to match the colour of the corresponding signal flare.

The flare control stations are installed on the signal flare control board which has rectangular openings, one for each control station.

The control stations are lettered A, B and C which designate the control stations to ensure correct use of the flare launchers.

The signal flare control board is installed on the navigator's right-hand console (Fig.53).

The signal flare launcher, type SKCP-46, is a metal case which houses the plastic body of the flare tube set. Each set is loaded with four signal flares and primers.

Two signal flare launchers (A and B) are installed in the front non-pressurized section of the fuselage between frames Nos 20 and 22, starboard, and the third container (C) is mounted between frames Nos 21 and 22, port side.

**IMPORTANT:** Upon loading the flare launchers with signal flares, set the flags of each control button so that their colour would correspond to their respective flare colours. The launchers must be loaded when the buttons are pulled backward, with the signal flare control station switch OFF.

The system is energized (See the Diagram, Fig.54) from the normal power supply bus bar through an A3C-5 circuit breaker installed on the co-pilot's circuit breaker control

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panel. Before launching the flares it is necessary to close switches 2 installed on the signal flare control station.

When button 3 of the flare control station is pressed, the primer is punctured by a special mechanism, and the flare is launched from the launcher.

Cabin Pressure Drop Warning and Flap  
and L.S. Position Indication

To warn the aircraft crew about dangerous pressure drop in the pressurized cabins in high altitude flying, the aircraft is equipped with two cabin pressure drop warning units, type BC-46, two sirens, type C-1, and five yellow warning lights, type CJM-51.

The cabin pressure drop warning unit closes the electric circuit of the sound and light signalling systems to warn the crew of the necessity of resorting to the oxygen equipment.

The warning unit, type BC-46, is a block of four diaphragm assemblies which is connected with the moving contact of the electric circuit. When the cabin pressure drops below the prescribed value the diaphragm assembly block closes the contacts of the circuit to apply electric signals to the buzzer relay, type PM-12.

The warning unit is adjusted to produce signals at altitudes from 1000 to 5000 m.

Main Characteristics of Warning Unit,  
Type BC-46

The warning unit should produce continuous light and sound signals beginning from the moment the cabin pressure drops to the value of altitude set on the dial.

The range of adjustment (the range of pressure with respect to the International Standard Atmosphere) to start the warning unit operation is 1000 to 5000 m.

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The operating temperature range of the instrument is from plus 50°C to minus 60°C. The instrument error at dial graduations 1, 2.5, 3, 3.5, 4, 4.5 and 5 km. under normal temperature conditions does not exceed ±150 m. The warning unit is operative under vibration conditions with frequencies of 20 to 80 c.p.s. and at overloads of up to 2.5 g.

The electric contacts are sure to withstand up to 1000 engagement cycles.

The weight of the instrument is not over 450 gr (the plug connector inclusive).

The pressure drop warning units are installed as follows: in the front cabin, at frame No.5, starboard, and in the rear cabin at frame No.75, starboard.

Cut into the circuit of each pressure drop warning unit to produce intermittent light and sound signalling is a buzzer relay, type PI-12 with two capacitors, type K9-1-5C- $\frac{50}{\text{ohm}}$  V.

The PI-12 relays and the capacitors are installed in the sound signalling system relay boxes. The relay boxes (Figs 55 and 56) are mounted in the front pressurized cabin on the left-hand shelf of the radar operator, and in the rear pressurized cabin at frame No.73, starboard.

For the electric supply circuit of the signalling system see Fig.57.

B-45 switches 3 and 5 of the signalling system are installed on the rheostat board (Fig.58) of the co-pilot's engine control station and on the radio-gunner's electric control board (See Fig.44).

When a differential pressure corresponding to the altitude set on the instrument dial is built up, the contacts of cabin pressure drop warning units 9, type BC-46, (Fig.57) close to energize the windings of respective PI-12 relays 8 and capacitors 7. The PI-12 relays operate to engage for intermittent operation three yellow lights 6 and C-1 siren 2 which are installed in the front cabin, or two yellow lights 6 and C-1 siren 4 installed in the rear cabin. Simultaneously with engaging the siren and warning lights, the PI-12 relay breaks

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the power supply circuit of its own field winding, and therefore the return spring forces the relay contacts back to their initial position to close the circuit of the field winding and of the capacitors again.

This ensures intermittent sounding of the siren and blinking of the warning lights.

The pressure drop warning lights of the front cabin are installed on the oxygen control panels of the navigator and radar operator, and on the pilot's instrument panel. The siren, type C-1, of the front cabin is mounted on the port side, at frame No.9. In the rear cabin the warning lights are located on the electric control board of the gunner (Fig.59) and on the instrument panel of the radio-gunner; the siren of the rear cabin is installed on the starboard, at frame No.71.

Sound signalling in the aircraft is accomplished with aircraft siren, type C-1, which sound either continuously or intermittently.

Intermittent signals are initiated by cabin pressure drop warning units, type BC-46.

Continuous signals are initiated by:

(a) the MKB-2 actuator installed on the flap transmission shaft at frame No.33 and the front BK2-142F limit switches installed on the co-pilot's engine control station - in case the aircraft takes off with flaps not extended or extended but not through the required angle;

(b) the rear blocking contacts, type BK2-142F installed also on the co-pilot's engine control station, and the L.G. extended position limit switches - in case of throttling down with the landing gear retracted at landing.

The limit switches of the MKB-2 actuator are adjusted so that one of them with its cam opens the contacts when the flap deflection angle reaches 19°+10' and closes them again when the flap is deflected through more than 23°. The second limit switch, by means of the second cam, opens its contacts when the flap deflection angle is less than 19° and closes them

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again as soon as the deflection angle reaches  $23^{\circ}_{-1^{\circ}}$ . Consequently, when the flaps are not extended through the take-off angle (between  $19^{\circ}+1^{\circ}$  and  $23^{\circ}_{-1^{\circ}}$ ), one or two limit switches of the MKB-2 actuator are always closed.

When taking off, the co-pilot or pilot moves the throttle control levers forward and, in this way, closes the contacts of front limit switches 12, type BK2-142T, installed on the co-pilot's engine control station. With these limit switches closed, current from the dual power supply bus bar of the co-pilot's circuit-breaker control panel is applied through the closed contacts of relay 1 and closed contacts of limit switches 10 of the MKB-2 actuator (when the flaps are not extended or are extended but not through the required angle) to the field winding of PH-2 relay 13 which disconnects the intermittent signalling. This relay operates to connect the C-1/2 siren of the front pressurized cabin for continuous sounding which will be on until the flaps are extended by the take-off angle.

As soon as the flaps are extended through  $19^{\circ}+1^{\circ}$  to  $23^{\circ}_{-1^{\circ}}$ , two limit switches 10 of the MKB-2 actuator will break the minus circuit of relay 13 and siren 2, and the siren will stop sounding. The siren can stop sounding also in case the circuit of siren 2 and relay 13 are broken by limit switches 11, i.e. when one or both of the throttle control levers are moved by the pilot away from the position corresponding to the take-off procedure.

If at least one of the L.G. legs is not extended, PH-2 alarm relay 1 operates to open the circuit of limit switches 10 of the MKB-2 actuator. When one or both of the throttle control levers are placed to the low throttle position (at landing), one or two BK2-142T limit switches 12 close their contacts to energize PH-2 relay 13 (disconnecting the intermittent signalling) which, like in the first case, engages siren 2 of the front pressurized cabin for continuous sounding until all the three L.G. legs are fully extended (See the Diagram, Fig.57). The siren sounding may be stopped in this

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case by retracting both of the throttle control levers from the positions corresponding to the landing procedure.

Then the aircraft glides at high altitudes with one or both of the throttle control levers placed to the low throttle positions, or in case of stoppage of one of the engines, the siren sounding can be discontinued by pressing one or both of the manual disengaging buttons of the siren which are installed on the right-hand engine console (control station). The two manual disengaging buttons are mechanically linked with the rear limit switches, type BK2-142T, each of them opens the minus circuit of siren 2 or relay 13 when the respective button is pressed.

The front BK2-142T limit switches are not provided with manual disengaging buttons since under normal flight conditions (L.G. retracted) during augmented power engine operation the minus circuit of siren 2 and relay 13 will be always kept open by PH-2 blocking alarm relay 1, i.e. siren 2 of the front pressurized cabin will be silent.

Chapter 2  
RADIO EQUIPMENT  
GENERAL

The radio equipment carried by aircraft Ty-16 is designed for communication, radio navigation, and radio detection and ranging purposes.

1. Communication facilities are intended to provide communication of the airplane with other aircraft and with ground radio stations, to provide the communication means for the aircraft crew, and to send the distress signals.

The airplane mounts:

(a) short-wave communication radio set 1-PCB-70 with receiver YC-9 for two-way air-to-air and air-to-ground communication;

[Redacted]

25X1

[Redacted]

25X1

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(b) short-wave command radio set 1-PCE-70M with receiver VC-9A for command communication within the aircraft formation and for air-to-ground communication;

(c) ultrashort-wave command radio set PCNV-3M for command radio set PCNV-3M for command communication within the aircraft formation and for communication with the flight control officer;

(d) aircraft interphone system CTV-10 for communication between the members of the crew and for external communication (See Table 11);

(e) emergency transmitter ABPA-45 for sending the distress signals.

2. Radio navigation equipment is intended for solving the navigation problems under various weather conditions.

The aircraft mounts:

(a) automatic radio compasses AFK-5 No.1 and No.2 for flying the aircraft by homing and broadcasting stations and radio beacons, for determining the position of the aircraft and for instrument landing judgment;

(b) radio altimeters PD-17M and PB-2 of low and high altitudes for determining the true altitude of flight;

(c) instrument landing equipment operating by the signal of the ground facilities. It comprises set of aircraft equipment of the CH-50 system (course receiver KPN-9, glide slope receiver IPN-2, receiver and transmitter of radar ranging unit CA-1, and marker receiver HFN-48H).

3. Radar equipment is intended for identification of aircraft, for aimed bombing and aimed firing.

Table 11

Control of Radio Equipment Installed in Aircraft

Radio facilities	Command set 1-PCE-70M	Communication set 1-PCE-70C	AFK-5 No.1	AFK-5 No.2	PCNV-3M	PD-17M	PB-2	IPN-2	IPN-4	IPN-6	IPN-9	CA-1	HFN-48H	CH-50 (ILS)	Transponder HPC-1	CTV-10
Navigator	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Co-pilot	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Pilot	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Radar operator	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Radio-gunner	++	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Gunner															+	+

Note: + stands for equipment that may be used by the crew member.

+ c stands for equipment that may be used and controlled by the crew member.

++ the radio operator may operate the transmitter of command set 1-PCE-70 with the aid of the key only (the tuning is done by the co-pilot).

The aircraft carries the following equipment:

- (a) IFF system consisting of a transponder;
- (b) radar bombsight IPN-4 intended for searching and detecting enemy objects under no optical visibility condition, for solving the navigation problems with the aid of ground radars and for aimed bombing and automatic bomb release;
- (c) radar gunsight HPC-1 for aimed firing at targets appearing in the tail zone under any visibility conditions.

Depending on the problems to be solved, every member of the crew can control or make use of the radio equipment installed in the aircraft according to Table 11.

[Redacted]

25X1

25X1

25X1

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Folded-dipole antenna is provided for short-wave set 1-PCB-70H, and stranded wire antenna for communication set 1-PCB-70. Ultrashort-wave set PCHV-3M having an additional receiver is provided with two surface antennas.

The antenna of glide-slope receiver IPH-2 is glued to the inside of the front glass panel of the navigator, and the antenna of radio compass AK-5 No.2, on the inner surface of the operator's blister.

Antennas of the course receiver KPH-9, radar sights PBN-4 and NPC-1 are installed under special fairings.

Loop antennas of automatic radio compasses AK-5 No.1 and No.2 and the antenna of marker receiver MPH-48E are mounted inside the fuselage and are not stream-lined by the airflow. Antenna of automatic radio compass AK-5 No.1 is placed inside of a semi-fairing made of textolite.

Altimeters PB-17M and PB-2 have a common antenna.

Antennas of transponder CPC, radar ranging unit CA-1, altimeter PB-17M and radio set 1-PCB-70H projecting from the fuselage are stream-lined.

For the layout of antennas of the aircraft radio equipment see Fig.60.

115 V, 400 c.p.s., A.C. is fed to the radio facilities from inverter NO-4500. The D.C. feed circuits of the radio equipment are protected by circuit breakers, and the A.C. feed circuits - by means of fusible cutouts CH placed on various panels of the aircraft power supply system. The radio facilities are protected by fusible links and cutouts set inside of them.

Filters HWC-9, O-14A, interphone system filter, capacitor KBM-31, KBN and others are used as additional noise suppression means. Receivers VC-D and VC-9D are provided with crystal filters for noise protection purposes, and receiver of PCHV-3M with electronic noise suppressor.

The radar gunsight NPC-1 employs noise suppression system which comprises special unit and ultrashort-wave delay lines.

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Section I  
RADIO COMMUNICATION  
FACILITIES

The aircraft is equipped with radio communication facilities to provide communication with ground radio stations and other airplanes, for command communication during formation flight, for communications with flight control officer, for intercommunication between the aircraft crew members, and for sending signals of distress.

The arrangement diagram of the communications radio sets is shown in Fig.61.

1. COMMUNICATION RADIO SET 1-PCB-70 (P-807)

Purpose and Delivery Set

Short-wave communication radio set 1-PCB-70 (Fig.62) is designed for long-range telephone and telegraph communication of the aircraft crew with ground stations and other airplanes.

The radio set includes:

- (a) transmitter 1-PCB-70;
- (b) dynamotor Y-600 with filter;
- (c) receiver VC-9;
- (d) stranded wire antenna;
- (e) telegraph key panel;
- (f) microphone;
- (g) box with spare valves for the transmitter;
- (h) box with spare valves for the receiver;
- (i) monitoring selector.

Radio set 1-PCB-70 is installed in the rear pressurized cabin in front of the radio-gunner who operates it (Fig.63).

The communication range of aircraft Ty-16 with ground stations POC-KE and receiver P-200 is up to 3000 km. at an altitude of 10,000 m.

25X1

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The power consumed by the transmitter does not exceed 1250 W.

The power in the antenna engaged for telephone or telegraph communication is within 70 to 100 W.

The speed of the telegraph keying is 30 words per minute. Non-linear distortion factor does not exceed 13%.

Frequency band range is from 2500 to 18100 kc/s (120 to 16.5 m.).

Additional medium-wave band ranges from 200 to 1500 kc/s (1500 to 200 m.).

Performance altitude of the set operating in depressurized cabin is up to 12000 m.

The set provides control of its operation by monitoring at high and low frequencies.

Types of communication:

- simplex (not used);
- half-duplex (transmission and reception at the same or adjacent frequencies).

The whole set weighs some 60 kg.

The radio set is operated from the front panels of the transmitter, receiver and from the telegraph key panel. Switching on and change from low-frequency monitoring to high frequency monitoring and vice versa are done with the aid of the selector on the radio operator's electric panel.

The transmission and reception are carried out through the throat microphones and telephones of the interphone system CNW-10 and from the telegraph key panel. If the intercom system is inoperative, the radio operator may use carbon telephone, or connect the throat microphones and telephones of his headset to the transmitter receptacles with the aid of extension cable.

#### Purpose, Installation and Principle of Operation of Radio Set Units

Short-wave transmitter 5 (Fig.63) is mounted on brackets in a tilted position, in the plane of frame 72. It is attached

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with the aid of removable shock mount consisting of a frame with four shock absorbing pads and limiters, and middle and upper carriers.

The transmitter may be used for telegraph communication through sustained oscillations, or voice-frequency carrier, and for telephone communication through a microphone.

The transmitter can be automatically set for eleven given frequencies (wave lengths) previously tuned and fixed.

Communication set I-PCB-70 (transmitter and receiver) is connected to the folded-dipole antenna.

In case the transmitter fails, the radio operator may connect his telegraph key to the command set by means of the selector on the electric panel and communicate with the ground via the command set transmitter at predetermined frequencies.

Dynamotor V-600 with filter feeding the high voltage circuits (screen grid plates of the valves and bias circuits) consumes 700 to 1250 W D.C. supplied from the aircraft mains. The high and low-voltage circuits of the dynamotor are protected with four fusible cutouts.

The dynamotor with a filter (Fig.63) is installed on the starboard side of the cabin on the pressurized pocket next to frame 75. It is mounted on the filter box whose bottom is provided with a shock absorbing fixture. The filter box is attached to the bracket riveted to the pressurized pocket with the aid of a crosspiece.

Receiver. Receiver VC-9 (15) (See Fig.63) is an eight-valve superheterodyne intended for telephone transmission and for sustained oscillation and voice-frequency carrier telegraphy. It has automatic and manual sensitivity controls and crystal filter for narrowing the transmission band when noises interfere with reception.

Receiver wave bands:

- short waves - 1.5 to 18 Mc.p.s. (20 to 16.66 m.);
- long waves - 200 to 500 Mc.p.s. (1500 to 600 m.).

All the frequency (wave) band is divided into 6 sub-bands, one of them for long waves.

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When engaged for telephony, the sensitivity of the receiver is not less than 15  $\mu$ V and 7  $\mu$ V (the input voltage being 15 V), and when engaged for telegraphy, not less than 6  $\mu$ V and 3  $\mu$ V for long and short waves respectively.

The housing of the receiver accommodates dynamotor V-18-2. The dynamotor is intended for power supply to the high voltage circuits when the VC-9 is operating (irrespective of the transmitter).

The receiver controls are concentrated on the front panel.

The receiver of the communication set is installed in the plane of frame 72 under the transmitter on radio operator's sliding table (Fig.63). The table can be shifted together with the receiver along the vertical guides from the lower operating position to the upper non-operating position and can be fixed in the extreme positions. The table also mounts the telegraph key panel.

The receiver together with the shock mount provided with four shock absorbers is secured to the table with the aid of eight bolts. The attachment of the receiver to the shock mount is of quick-release type. The pins fitted on the jacket (case) bottom enter the shaped slots of the shock mount upper frame, the two latches fixed to the angle piece in the lower front portion of the jacket locking the receiver (preventing its falling out).

Telegraph key panel. Telegraph key panel 11 (See Fig.63) is mounted on the radio operator's table to be operated by his right hand. It comprises a base plate and a cover plate. On the base plate is placed telegraph key and clamp with antenna mode-of-operation selector secured to it. The antenna selector is intended for changing from the transmission over to reception when engaged for simplex functioning.

The key panel is secured to the east table of the radio operator.

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Spare valve boxes 1 and 2 (Fig.63) of the transmitter and receiver are installed on a shelf over the transmitter and attached to the shelf by means of shock absorbing rubber cord.

Dynamotor V-600 of the communication radio set is fed from the aircraft mains (normal busbar of the circuit breaker panel, rear cabin) via circuit breaker A3C-50. The same panel also serves to feed receiver VC-9 (without a fusible cutout in the mains).

Wiring. The lead-in running from the antenna to the transmitter is made of bare BNSM wire, 21 sq.mm. It is insulated with R.P. plastic beads (textolite beads being furnished on the aircraft of earlier make).

Receiver lead-in 9 (Fig.63) running from terminal A to terminal AN of transmitter 5 is made of wire BNSM, c.s. 1.3 sq.mm, laid along the radio operator's instrument panel on ebonite insulators.

The feeding cables of communication set 1-PCB-70 running from the dynamotor to the transmitter are secured with metal clamps having rubber padding and bonding strips.

The cable runs along the starboard side of the rear pressurized cabin and is secured by means of attachment bolts that secure the electric cables, too, but the electric and feeding cables are separated with the aid of special bushings.

The wires running from the transmitter to monitoring selector 7 mounted on the port side are laid along the load-carrying beam together with the line of electric wires. Other cables also run along the path of the bunched electric wiring.

## 2. COMMAND RADIO SET 1-PCB-70M (P-806)

The command radio set 1-PCB-70M (Fig.64) is intended for telephone and telegraph communication with ground command radio stations and with other airplanes in flight.

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The radio set 1-PCB-70M includes:

- (a) transmitter 1-PCB-70M;
- (b) dynamotor V-600 with filter;
- (c) transmitter remote control panel;
- (d) remote control receiver VC-9A;
- (e) receiver remote control panel;
- (f) folded-dipole antenna;
- (g) box with spare valves for the transmitter;
- (h) box with spare valves for the receiver.

The set is installed in the front pressurized cabin on the starboard panel support of the radio operator between frames Nos 9 and 12 (Fig.65).

The set is operated by the co-pilot by means of the remote control panels of transmitter and receiver.

The set can be engaged for telephone and telegraph communication, the latter being done with the aid of the key on the remote control panel and of the radio operator's key.

#### Performance Data

Communication range when communicating with ground station PAC-KB is 120 km. at an altitude of 1000 m., and 350 km. at an altitude of 10,000 m.

Unlike the communication radio set, the command set is intended for half-duplex service and can be controlled from distance.

The operation of the set is checked (by monitoring) only at low frequencies and no monitoring selector is provided.

The transmission and reception are done with the aid of the throat microphones and the telephones of intercom CHV-10.

#### Purpose, Location and Operation of the Set Units

Transmitter. Transmitter 13 of the command radio set 1-PCB-70M has eleven fixed wave lengths (frequencies).

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The remote control system of the transmitter is intended to turn the transmitter ON and OFF and to set the desired mode of operation (telephony, telegraphy, and voice-frequency carrier telegraphy).

The change-over time from one fixed frequency to another is 25 - 30 seconds.

Note: The transmitter of the command set can be used, for duplex service only. The telegraph key panel is not mounted and wire "25" is shorted to the chassis.

The transmitter is secured to the panel support shaped members with 12 screws. The antenna lead-in of the transmitter is similar to that of the communication set transmitter.

Dynamotor V-600 with filter 20 (Fig.65) is mounted on the panel support under the receiver, the crosspiece of the filter box shock-mounted portion being fixed to the panel support shaped members with four bolts.

Transmitter control panel. The remote control panel of the transmitter (Fig.65) is installed on the starboard side between frames Nos 7 and 8 above the co-pilot's motor panel. The base (bottom) of the panel is secured to the board with the aid of three screws. The panel is held to the bottom by four ever-set screws.

The front wall of the panel mounts:

- (a) starting and mode-of-operation selector;
- (b) channel selector;
- (c) indicating lamp holder.

Mounted on the upper wall of the panel is contactor, and on the lower one, receptacle receiving the microphone plug.

Receiver VC-9A controlled from the distance is used for radio telephone and radio telegraph communication of the aircraft. Its dimensions and performance data do not differ from those of receiver VC-9. The shock mount of receiver 19 (Fig.65) is secured to the starboard panel support under the transmitter by means of eight bolts.



25X1

25X1

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The fairlead of the command receiver and communication set are of the same type. The fairlead is attached to the shaped members under the transmitter and to the front wall of the panel support with the aid of base insulators made of ebonite (or organic glass in the aircraft of earlier make). Remote control panel 25 allows to govern receiver VC-9 from a distance. It is installed on the tilted portion of the co-pilot's motor panel above the remote control panel of the transmitter.

Folded-dipole antenna. The folded-dipole antenna of the command set (Fig.66) is a silver-coated brass tube, 8x12 mm, 6-m. long, secured some 100 mm off the fuselage between frames Nos 10-22.

Power supply, protection and installation of the set.

Dynamo V-600 is fed from the aircraft mains, via the power lead-in on frame No.12.

The remote control system receives 115 V, 400 c.p.s., A.C. from the operator's fusible cutout panel via the fusible cutout CH-2. Direct currents is fed to the filter FVC-9 from the operator's circuit breaker panel.

Filter FVC-9 is mounted in the same way as the filter of communication set receiver VC-9.

All the bunched wires and cables of the command set 1-PCB-70M are laid along the starboard side between frames Nos 7 to 10 and along the right panel support of the equipment between frames Nos 10 to 11.

The bunched wires of the remote control panel are secured to the co-pilot's motor panel. The bolts are screwed into the motor panel.

The cable running from the transmitter to the dynamotor is secured to the panel support shaped member by means of clamps with bonding strips. Greater part of the radio set wires is laid along the electric wire line and has common attachment fixtures together with the electric wires.

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3. COMMAND RADIO SET PCWV-3M

Ultrashort-wave simplex transceiving radio set PCWV-3M is intended for telephone mode of operation of the command communication between the aircraft in the formation and the flight control radio set. The set is provided with quartz-crystal frequency control.

The PCWV-3M set (Fig.67) includes (a) transmitter; (b) two receivers; (c) supply unit; (d) two control panels; (e) three boxes with quartz-crystal sets; (f) measuring unit (in the set of one of four aircraft);

All units of the radio set, except the control panels, buttons and antennas, are located in the rear pressurized cabin. The set is operated by the pilot and co-pilot.

Performance Data

When communicating with the ground radio set of the PAC-VKB type, the ultrashort-wave set PCWV-3M covers the following ranges of communication depending on the flight altitude:

Flight altitude, m.	Communication range, km.
1000	120
2000	160
5000	230
10,000	350

At altitudes over 500 m., the air-to-air communication range covers 120 km. at least.

The frequency band of the set is 100 to 150 Mc.p.s. (2 - 3 m.) with quartz-crystal frequency control of the transmitter and receivers which ensures fixed frequency communication.

The remote control of the radio set is accomplished with the aid of buttons pressed on two remote control panels.

25X1

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The radio set allows pre-tuning to any four frequencies of the band so that any of them can be used for communication purposes while in flight.

Time of change-over from one wave to another does not exceed 3 sec.

The second receiver of PCNV-3M can be tuned to any four frequencies of the band differing from the tuning frequencies of the transmitter and receiver No.1.

The outputs of receivers Nos 1 and 2 are connected to the telephones of intercom CHV-10 through the control panels.

The reception is changed over to transmission by means of four-contact button TK-4M marked RECEPTION-TRANSMISSION (ПРИЕМ-ПЕРЕДАЧА) and set on the pilot's control column (name plate RADIO SETS). The button connects to the plug Q-301 on the control panel.

The time of change-over from reception to transmission is 0.5 second.

The power consumed when engaged for transmission does not exceed 415 W, and when engaged for reception, 270 W with normal voltage across the aircraft mains.

The microphone and telephone are connected to the transmitter and receiver via the interphone set of the co-pilot, the remaining interphone sets being parallel-connected to the latter.

Purpose, Installation and Operation  
of Radio Set Units

The eight-valve transmitter has 100 to 150 Mc.p.s. frequency band with quartz-crystal frequency control.

The transmitter power is 6 W.

The shock mount of transmitter 5 (Fig.68) is installed on the support between frames 69-70, starboard. The transmitter face panel is set vertical and faces backward. The face panels of the transmitter and receivers are protected with a cover.

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Receiver No.1 (Item 1 in Fig.68) is mounted in the port side portion of the aircraft on the support where the transmitter is installed.

Receiver of PCNV-3M is a 13-valve telephone superheterodyne with quartz-crystal frequency control. Four fixed frequencies (channels) should be adjusted in advance. The frequency band covers 100 to 150 Mc.p.s.

The receiver is remotely controlled, the channel being selected and the volume controlled on the control panel.

The receiver has an electron noise suppressor which automatically cuts off the receiver when there is no carrier frequency of the other party (locks the low frequency amplifying valve), and cuts it in when the carrier frequency appears.

The receiver can be tuned with the aid of unit "M" (measuring unit) without a signal generator.

Receiver No.2 (Item 1 in Fig.68) is arranged on the upper support over receiver No.1.

The receiver is used as a stand-by one to promote the functioning of the set, and also as a regular receiver.

Receiver No.2 is attached in the same way as transmitter and receiver No.1.

The supply unit comprises two selenium rectifiers 2 for providing direct current (from inverter HO-4500) and generating the following voltages:

(a) +310 V to be applied to the valve plates when the set is engaged for transmission and +275 V when engaged for reception;

(b) -105 V to be applied to the bias circuits when the set is engaged for reception and -120 V when engaged for transmission.

The valve filament current is supplied from the aircraft mains. The supply unit is installed on the upper support right of receiver No.2 (above the transmitter) and fixed to the support shaped members.

Control panel of transmitter and receiver No.1 and control panel of receiver No.2 are installed in the upper portion.

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(along the aircraft axis) on the canopy beam, within easy reach of the pilots. The control panels can be easily removed. Quartz crystal boxes 3 (Fig.63) are mounted on the spare valve box for transmitter 1-PC5-70, between frames Nos 72-73, on a common base which is secured to the support together with the transmitter spare valve box with the aid of two shock-absorbing cords.

Unit "H" (measuring unit) is intended for tuning the receiver without a signal generator, for tuning the transmitter according to the current values of the tripler, and for controlling the antenna current. Unit "H" is installed on the starboard side of the aircraft between frames Nos 63-64, on a special bracket with rubber gaskets, and is fixed by means of removable shock-absorbing flexible cord.

Transceiving and receiving antennas 4 and 5 (Fig.69) are installed on the aircraft fin. Radio set PCNV-3M employs concealed surface antennas made of brass gauze No.0.15 State Standard POCT 3584-53. They are shaped as triangles and glued to the fin tail cone made of aircraft plywood.

Buttons EK-4M on the control column (intercom system) are intended to engage the throat microphones and to connect the "ground" to relay PU-2 engaging the transmitter of PCNV-3M. The relay is set in the upper (overhead) electric panel of the pilots.

Power supply, protection and wiring of the set. The radio set receives direct current from the duplicate supply busbar of the operator's circuit breaker panel through circuit breaker A3C-5.

The A.C. supply is fed from the operator's fusible cut-out panel through fusible cutout CH-2.

The R.F. cables from the antennas to the transmitter and receiver No.2 are laid in a conduit along the rear spar of the fin. Upon leaving the conduit, the cables are attached with the aid of clips and sleeves. The cables are laid through the airtight wall of the cabin in special airtight inputs. Bunched wires and cables connecting the transmitter,

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receivers and rectifier, are laid along the front shaped member of the upper support and are fixed by means of metal clips with rubber padding. The wires running from the receivers and transmitter to the control panels are laid along the aircraft starboard side together with the electric wires.

4. AIRCRAFT INTERCOM CW-10

The aircraft intercom system CW-10 (Fig.70) is intended for communication between the members of the crew, for external communication done with the aid of the communication and command radio sets, and for receiving signals via the PK-5 radio compasses No.1 and No.2.

The aircraft intercom system comprises:

	No. req'd
- amplifier .....	2
- one-cord intercom set (without additional panel) .....	3
- two-cord intercomm set (with additional panel) .....	3
- additional panel .....	3
- dynamotor V-19 with filter .....	2
- supply line filter .....	2
- four-contact button EK-4M .....	13
- two-contact button 204K .....	2
- distribution box .....	8
- headset .....	6 (not furnished with the aircraft)
- extension cable, 1.4 m. long .....	6
- extension cable for work in rear cabin 1-4, 10 m. long .....	1

The intercom system CW-10 may be fed with A.C. and D.C. and has amplifier, dynamotor and supply-line filter for each line.

Technical Data

Rated voltage of D.C. source (aircraft mains) .....	28 V
Throat microphone feed voltage .....	4 - 5 V
Operating current consumed by one dynamotor with amplifier .....	not exceeding 1.8 A
Operating current consumed by one intercom set with one relay engaged .....	not exceeding 0.12 A
Average voltage while speaking over 14 pairs of telephones connected in parallel to the amplifier output, with two pairs of throat microphones Ja-5 connected to its input ...	not less than 50 V
Change of output voltage with the number of engaged telephones Ta-4 reduced from 14 pairs to 1 pair .....	not exceeding 15%
Amplification factor .....	about 200
Automatic improvement of amplification:	
at altitudes of 5 to 6 km. ....	about 1.8 times
at altitudes of 7 to 8 km. ....	about 2.5 times
Reduction of output voltage upon connecting the second pair of throat microphones Ja-5 .....	not exceeding 25%
Frequency characteristics of the amplifier have smooth rise by 15 <sup>+3</sup> decibels .....	from 30 c.p.s. to a range of 2500 to 3500 c.p.s.
Non-linear distortion factor under 50 V, at 1000 c.p.s. ....	not exceeding 5%

The plate circuits of the amplifier are fed from the dynamotor with the filters in the high and low-voltage circuits.

All intercom sets are connected in parallel, therefore the conversation of two members of the crew can be heard by all members who set the switches of their intercom sets for internal communication.

Weak signals of throat microphones are amplified by means of special amplifiers so that 14 sets can operate.

The intercom includes: intercom set proper, additional panel (furnished only for the pilots and navigator), four-contact button and additional two-contact button (for the pilots only), headset with a pair of throat microphones Ja-5 and telephones Ta-4.

Amplifiers Nos 1 and 2 of intercom system circuits are four-stage amplifiers of low frequency employing three twin triodes 6H8C. The amplifiers provide an automatic increase of the amplification capacity at two stages with the aid of a pressure relay 1.8 times at altitudes between 5000 to 6000-m., and 2.5 times at 7000 to 8000-m.

Amplifier No.2 is intended for circuit No.2, its power being sufficient for all consumers. Amplifier No.2 (Item 12 in Fig.65) is installed at the bottom of frame No.2 on the operator's panel support.

Amplifier No.1 receives voltage from the duplicate bus-bar and from the storage battery, i.e. circuit No.1 is fed even if the mains are de-energized because of some damage.

Amplifier 41 (Fig.71) of intercom circuit No.1 is installed on the port-side equipment support between frames Nos 11 and 12.

The amplifiers are installed on four rubber shock absorbers each. They can be quickly released as the shock mount secured to the support shaped members is provided with two latches that are taken apart to remove the amplifier.

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Intercom set. The intercom sets are intended for interior communication of the aircraft crew members with the aid of intercom system amplifier and for external communication carried out with the aid of the radio equipment.

Intercom sets are used for switching the throat microphones and headset telephones for various types of communication.

The intercom set ensures two-way communication through both circuits of internal communication and three radio sets; it is also intended for conference call by voice.

The vital portion of the intercom set is a multiple-contact mode-of-operation selector of wafer type designed for bringing the telephones and throat microphones to five positions.

The intercom sets intended for operation with an additional panel (two-cord) do not basically differ from the one-cord sets, but in addition to the four-core cable with connector for engaging the headset they are also provided with five core shielded cables with connector to be joined to the additional panel.

For cutting in the supply circuits of the throat microphones and for remotely switching the required relay (starting relays of the transmitters), the crew members must press four-contact buttons TK-4K to be handled by hand or foot. The design of the foot button switch is shown in Fig.72.

Table 12 deals with the arrangement of the intercom sets with the buttons for connecting the throat microphones.

Figures 63, 66 and 71 show the arrangement of the intercom sets, buttons of auxiliary panels, filters, dynamotors, amplifiers and connector boxes of the intercom system CHV-10.

Dynamotor V-18 is provided with M-shaped high voltage filters accommodated in common box for smoothing the ripple and for decrease of the noise during the operation of the amplifier.

Every member of the crew can operate the mode-of-operation selector on the intercom set to cut in the telephones

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and throat microphones of his headset for internal communication (refer to Table 11). Besides, the navigator, pilot and co-pilot can establish external communication operating the communication radio set 1PCB-70, command radio set 1-PCB-70M, command radio set PCHV-3M; they can also monitor the operation of automatic radio compasses APK-5 No.1 and No.2 using additional panel;

- the navigator-radar-operator can establish external communication employing communication set 1-PCB-70, command radio set 1-PCB-70M, and command radio set PCHV-3M;

- radio-and-cannon-operator can establish external communication employing the communication set 1-PCB-70 both for telephone and telegraph versions, employing command radio set 1-PCB-70M (for the telegraph version only) and radio set PCHV-3M (for the telephone version only);

- gunner can establish external communication employing the ultrashort-wave command set PCHV-3M.

These are the only application versions of the intercom system CHV-10 on the airplane Ty-16.

The intercom set telephones are connected directly to the circuit, while engagement of the throat microphones requires that one of the four remote-control four-contact buttons (hand-operated or foot-pressed) should be pushed. The location of the buttons is shown in the table.

Through the button fed are the throat microphones and dynamotor starting relay of the radio set where the wafer switch for five positions is installed.

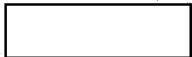
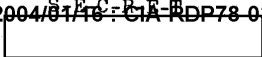


Table 12

Location of Intercom Sets and Buttons

Crew member	Location		
	intercom set	additional panel	throat microphone cut-in button
1	2	3	4
1. Navigator	Right portion of operating panel	Next to intercom set	Foot button switch located on the floor next to frame No.1, left side; a button on course stabilizer; a button on left console
2. Pilot	Port side, between frames 6 and 7	Do	Internal and external communication buttons located on the control column wheel, right horn; button and lever on the autopilot formation stick
3. Co-pilot	Starboard, between frames 6 and 7	Do	Internal and external communication buttons located on control column wheel, left horn
4. Navigator-radar operator	Upper part of fuselage, on operator's panel support	Do	Button on operator's instrument panel; foot button switch on foundation; button on sighting station
5. Radio-gunner	Port side, between frames 72 and 73	Do	Two buttons on sighting stations; button switch under right foot

1	2	3	4
6. Gunner	Starboard, between frames 73 and 74	Next to intercom set	Button on sighting station; button switch under right foot

When the selector is set to "CIV", the telephones connect to the amplifier output of circuit No.1 or circuit No.2, depending upon the position of the circuit selector (located left of the mode-of-operation selector on the intercom set). This circuit selector is also used for changing over the circuits.

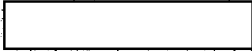
For convenience in carrying out the internal communication, all intercom sets mount conference call buttons labelled "MPK.BUS." If necessary, every crew member can call upon other members by voice irrespective of the circuit it forms part of. There is no need in this event to press the four-contact button.

Having told what he wanted to, the user releases conference call button, and all the other users come back to the communication mode they employed before the call was sounded.

The crew members called upon should set the selectors of their intercom sets to CIV and carry out communication using one of the internal communication circuits specified by the calling customer.

The intercom system CIV-10 ensures for the pilots a quick change from the external communication to the internal communication irrespective of the position of the mode-of-operation selector on their intercom sets.

For this purpose, two-contact buttons of the 204X type labelled "CIV" are located on the control column wheel horns next to four-contact buttons TK-4M. The CIV buttons provide change-over to internal communication irrespective of the position of the mode-of-operation selector (relay incide



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the intercom set functions). The communication is carried out through the circuit to which the circuit selector is brought. During the conversation the button is kept pressed. Releasing the CIV button, the pilot comes back to the kind of communication he had used before the button was pressed.

One need not press the four-contact button when using the two-contact one.

Cast handles on the steering wheels with buttons TK-4K and 2C4X are provided with inscriptions RADIO SETS (PAIEM) and CIV engraved on them (respectively).

The pilot operating the formation stick of the autopilot AN-5-2M can govern the lever provided in the upper forward portion of the handle for closing the throat microphone circuit and for starting the dynamotor of any radio set.

There are airplanes where the pilot's switching diagram differs from the one described above. The difference is as follows:

(1) relays inside the intercom sets are not installed and the switching is accomplished with the aid of relays PII-6 and PII-2 installed inside the relay boxes;

(2) connection of four-contact button (marked CIV) and of two-contact button (marked CIV npr JKB) differs from the one described here:

(a) button CIV or CIV npr JKB may be pressed on the control wheel for carrying out internal communication with the mode-of-operation selector set to CIV;

(b) when the mode-of-operation selector is set to COMMAND RADIO SET (COM.PC) or communication RADIO SET (CB9.F), the external communication is established (power supply fed to the throat microphones and transmitter starting relays) by pressing any of the buttons in question (CIV or CIV npr JKB);

(c) for changing over from external to internal communication, with the mode-of-operation selector set to ULTRAHIGH-FREQUENCY RADIO SET (JKB PC), CIV npr JKB button should be pressed.

(d) the external communication can be changed over to the internal communication only when the mode-of-operation selector is set to JKB.

Switch No.1 of intercom system CIV-10 is mounted on the overhead electric panel of the pilots, circuit breaker A3C-5 on the circuit breaker panel of the co-pilot. The dynamotor amplifier of circuit No.2 are supplied through circuit breaker A3C-5 from the normal mains via the radar-operator's circuit breaker panel. Switch P-45 of circuit No.2 is located on the pilots' overhead electric panel.

The wiring of the intercom system CIV-10 is laid together with electric cables, wires, types BMB39 and BMB41 of light blue colour, being used for the purpose. The wires of the aircraft intercom system are laid as far from the A.C. cables as possible.

#### 5. EMERGENCY RADIO SET ABPA-45

Emergency radio set ABPA-45 (Fig.73) is intended for sending distress signals or bearing data in case of forced landing.

The radio set assembly includes:

- (1) transmitter;
- (2) trailing antenna;
- (3) unit rotation crank;
- (4) kite;
- (5) two generators for filling the balloons with hydrogen;
- (6) two rubber balloons for raising the antenna;
- (7) signalling lamp;
- (8) parachute;
- (9) soft packing;
- (10) counterweight.

The radio set ABPA-45 with the parachute is installed in the pressurized cabin on the starboard side between frames 9 and 110 above the modulating unit of radar bomb sight PBI-4.

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The emergency radio set ABPA-45 can be engaged for transmission at fixed frequency of 50 Mc.p.s. only. The antenna power of the transmitter is 5 W. The transmitter is fed from the generator mounted inside the transmitter housing. The generator is rotated by hand. Depending on the position of the mode-of-operation selector, the radio set can automatically send out distress signals S.S., or bearing signals AA. Besides, the button type telegraph key can be used for sending telegraphic radio signals or light signals from the lamps. The radio set housing is made watertight and can float when dropped into water.

### Section II

#### RADI NAVIGATION EQUIPMENT

The radio navigation equipment installed in the aircraft is provided for determining the coordinates, for in-bound and outbound flight, taking bearings of the housing stations, determination of the true altitude of flight, determination of the distance to the airfield, carrying out the flight in the holding zone, ILS approach and landing. As these missions require, aircraft TV-16 mounts the following radio navigation equipment: radio compasses APK-5 No.1 and No.2, altimeters EB-17N and EB-2, radar ranging unit CA-1<sup>x/</sup>, marker receiver MPH-48N, course equipment MPH-3, and glide-path equipment FPH-2.

The lay out of the radio navigation equipment in the airplane is shown in Figs 74 and 75.

#### 1. RADIO COMPASS APK-5(No.1 and No.2) Designation and Set

The APK-5 automatic radio compasses are designed for navigating the airplane by homing and broadcasting radio

<sup>x/</sup> To be also referred to as D.M.L. (distance measuring equipment).

stations and radio beacons, for determining the estimated position of the airplane, the approach and landing with the aid of the instrument landing system.

The automatic radio compass is designed for solving the following navigation problems:

- (a) inbound flight with the visual indication of course;
- (b) inbound flight with aural indication of course;
- (c) outbound flight (auxiliary facilities);
- (d) determination of drift angles and wind vector;
- (e) automatic determination of the radio station bearings by the radio compass indicator and also aurally;
- (f) flight by the radio beacon sending the modulated pulses and operating for bearing and zone versions.

Mounted on the airplane are two radio compasses APK-5 No.1 and No.2. As there are two compasses, there is no need to re-tune the radio compass when determining the location of the airplane on the basis of the bearing values provided by two radio beacons. Besides, automatic radio compass APK-5 No.2 is a spare one to be used when radio compass No.1 gets out of order.

#### Radio Compass APK-5 No.1

The set of automatic APK-5 No.1 (Fig.104) includes:

- (1) pick-up unit;
- (2) inboard loop;
- (3) navigator's control panel;
- (4) pilot's control panel;
- (5) navigator's two-pointer indicator (GEB-1);
- (6) pilot's indicator (BCVM-1);
- (7) relay box;
- (8) silica gel cell;
- (9) flexible shaft tee-piece;
- (10) rod antenna.



S-E-C-R-E-T  
25X1

25X1

Characteristics  
.....

The continuous band of the radio compass ranging from 150 to 1300 Kc.p.s. (2000 to 230 m.) comes in three subbands:

- 150 to 310 Kc.p.s.;
- 310 to 640 Kc.p.s.;
- 640 to 1300 Kc.p.s.

Errors to be tolerated:

- (a) not exceeding  $\pm 3^\circ$  for bearing irrespective of frequency;
- (b) not exceeding 2.5% at any point within the band for calibration with 2-m. length of flexible shaft. The margin along the scale ends should be at least 1% of the extreme specific values of every subband.

The oscillations of the indicator pointers must not exceed  $5^\circ$ , and the loop must invariably come back to the original position with an accuracy of  $\pm 3^\circ$  at minimum.

If radio compasses No.1 and No.2 are tuned to the same radio station, the permissible mismatching should not exceed  $6^\circ$  ( $\pm 3^\circ$  for each compass).

Sensitivity of the pick-up unit is 1 to 12  $\mu$ V, and the extreme sensitivity for housing is 5  $\mu$ V/m.

The operating range of the radio compass at 1000-m. altitude is 18 km., and at 500-m. altitude, 24 km. when operating with housing radars of the MAP-3B type. The compass is fed from the 28.5 V, D.C. mains and from 115 V, 400 c.p.s., A.C. mains of the aircraft.

Except the inboard loop, radio compass APK-5 No.1 is located in the front pressurized cabin.

The radio compass is operated by the navigator and the pilot. The navigator tunes the radio to the specific frequencies, determines the location of the aircraft by taking bearing of two ground stations, and solves other navigation problems.

The receiver is tuned from the remote control panels of the navigator and the pilot with the aid of flexible shafts. The pilot can flight his airplane according to the

readings of his indicator. The co-pilot can tune the compass to homing stations without changing his position (from the pilots' control panel) and navigate the airplane consulting his indicator.

Principle of Operation

The automatic radio compass has two antennas, one being directional (loop), and the other non-directional or open. The electromotive force taken over by the loop is amplified by the loop channel amplifier to be fed to the phase commutator.

Besides the R.F. pulse the phase commutator receives I.F. voltage (about 50 c.p.s.) from the tone generator. The electromotive force generated by the phase commutator reaches the antenna circuit of the receiver. The receiver antenna circuit also receives the R.F. pulse taken over by the non-directional antenna.

The electromotive force obtained as a result of interaction of the loop pulse (via the phase commutator) and the antenna signal is amplified by the receiver, rectified, amplified by the low frequency circuit and then delivered to the control circuit of the radio compass. The control circuit generates voltage actuating the motor and the loop connected to it to rotate until the longitudinal axis of symmetry of the loop gets aligned with the direction to the radio station. In this instance, the electromotive force induced in the loop will be equal to nil, and the voltage, making the motor rotate will be also nil.

The rotation of the loop is imparted to the axle of the transmitting selsyn through the gear train. The indicating selsyns follow the rotation of the transmitting selsyn axle and show the angle between the aircraft fore-and-aft axis and the direction to the radio station.

There is provision for manual rotation of the loop - by means of the switch PAUKA M-E (LOOP L-R) when the mode-of-operation selector is set to LOOP (PAUKA).

S-E-C-R-E-T

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When the compass is engaged for operation, joint functioning of the loop channels and non-directional antenna is ensured.

When operating for the antenna only, the radio compass functions as an ordinary superheterodyne receiver, and when for the loop only, as aural direction finder.

#### Units of Radio Compass APK-5 No.1

Receiver APK-5 employs a superheterodyne circuit with 15 tubes. The compass portion is provided with loop rotation automatic control set at its output.

The receiver is mounted behind the pilot's seat on the equipment rack between frames Nos 9 and 10. The receiver is secured to the rack with five bolts locked to the shock mount having four shock absorbers.

Loop. The inboard loop is adjusted for upper location. The loop antenna unit includes the loop proper, loop rotation electric motor, and the radio deviation compensator.

The loop has a magneto-dielectric core with a winding. The winding ends are passed through three commutator rings attached to the loop axle and taken as far as the peg of the cable connecting the loop with the receiver.

The loop of automatic radio compass APK-5 No.1 is placed on the shock mounts in the upper portion of the non-pressurized compartment next to frame No.13.

The slot between the loop and the body at the dielectric disc is screened with flexible gauze No.004, State Standard 6613-53.

Navigator's control panel is located over the navigator's table, next to frame No.3, port side. The panel ensures complete remote control of the automatic radio compass. All controls are mounted on the front board of the panel.

The pilot's control panel is similar to the navigator's panel. It is installed on the pilot's hydraulic control panel between frames Nos 6 and 7.

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The YVMB-1 two-pointer course indicator of the navigator is a receiving mag-slip with the needles of radio compasses No.1 and No.2 fixed to the two axles of the mag-slip rotors. It is electrically connected to the loops of radio compasses No.1 and No.2 which is respectively marked on the pointer. The indicator is installed on the instrument panel of the navigator. The errors of the mag-slip indications should not exceed:  $\pm 0.5^\circ$  on the zero mark and  $\pm 1.5^\circ$  on other marks for the short-shafted pointer (pointer No.1 of indicators YVMB-1 and BCVM-1;  $\pm 1.5^\circ$  on the zero mark and  $\pm 2.5^\circ$  on other marks for the long-shafted pointer (pointer No.2 of indicator YVMB-1). Pilot's mag-slip pointer indicator BCVM-1 is mounted on the pilot's instrument panel.

Relay box (distribution box) of automatic radio compass serves for switching the receiver over from one control panel to the other. The box is located above the receiver of automatic radio compass No.1 between frames Nos 9 and 10. It is attached to two vertical shaped members of the panel support.

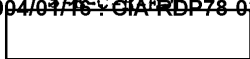
Silica gel cell made of plexiglass is set in the clamps near the frame to which it is connected by means of a rubberized hose.

The receiver is tuned from two control panels with the aid of a tee-piece located on the left rear bracket of the vertical flight gyro of the autopilot AP-5-2M, and with the aid of flexible shafts.

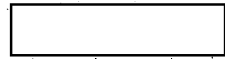
Antenna feed-in No.1 is made of wire HBJ, cross section 1.3 sq.mm.

The wire is secured by means of two insulators made of ebonite or organic glass. Near the receivers, the wire is separated from the feed-in of automatic radio compass APK-5 No.2 by means of an organic glass strip.

Radio compass APK-5 No.1 receives D.C. from the navigator's circuit breaker panel via circuit breaker ABC-2 and 115  $\pm 3$  V, 400 c.p.s. A.C. from the navigator's fuzible link panel via fuzible link CH-5. Every control panel has its own protection means for the automatic radio compass APK-5.



25X1



25X1

These are: 2 A fusible link for A.C. supply and 5 A fusible link for D.C.

Automatic Radio Compass AFK-5 No.2

- The set of automatic radio compass No.2 (Fig.77) includes:
- (1) receiver;
  - (2) inboard loop;
  - (3) control panel;
  - (4) pilot's course indicator;
  - (5) silica gel cell;
  - (6) blister surface antenna.

The navigator takes the readings of radio compass No.2 by two-pointer course indicator VEB-1. All components of automatic radio compass No.2 (except for the loop), are mounted in the front pressurized cabin (Fig.71).

The principle of operation of the radio compass and the design of its units are similar to those of compass No.1.

Receiver of automatic radio compass No.2 is located on the support behind the pilot's seat between frames Nos 9 and 10 so that it stands under receiver of compass No.1. Receiver of compass No.2 is locked in the same manner as the receiver of compass No.1.

Loop antenna is located in the lower portion of the fuselage between frames 12 and 13.

Pilot's course indicator is located on the co-pilot's instrument panel.

Antenna 3 (Fig.77) of automatic radio compass No.2 is glued up to the inner surface of the radar-operator's blister.

Antenna feed-in made of 1.3 sq.mm wire NBM is connected to the antenna block and laid upon ebonite base insulators.

The outer circuit being unprotected, the D.C. supply is delivered to the automatic radio compass from the navigator's circuit breaker panel, and the A.C. supply of 115 V, 400 c.p.s. from the navigator's fusible link panel.

2. RADIO ALTIMETERS EB-2 AND EB-17M

Low-altitude radio altimeter EB-2 and high altitude radio altimeter EB-17M are provided for determining the true altitude of flight. Both radio altimeters employ the principle of time variation as the radio waves travel from the aircraft to the earth and back to the aircraft. The radio altimeters differ in the type of wave radiation, the EB-2 emitting continuous waves and the EB-17M sending out pulses. For the layout of the instruments and components of the radio altimeters refer to Fig.78.

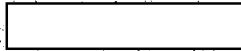
Low-Altitude Radio Altimeter EB-2

Low-altitude radio altimeter EB-2 is intended for determining the true altitude of flight.

The functioning of the altimeter does not depend upon the weather conditions, cover of ground, and speed of flight.

Performance Data

Altitude range .....	0 to 1200 m.
first range .....	0 to 120 m.
second range .....	100 to 1200 m.
Altitude indication lag for aircraft Ty-16 .....	12.5 m.
Altitude measurement precision over:	
first range .....	$\pm 2$ m. $\pm 5\%$ of the altitude measured
Transmitter mean frequency .....	$F_m = 444 \pm 2$ Mc.p.s.
Frequency wobbling band:	
in first range .....	$37 \pm 4$ Mc.p.s.
in second range .....	4 Mc.p.s.
Modulation frequency .....	$124 \pm 3$ Mc.p.s.
Power emitted .....	not less than 0.15 W



25X1

25X1

25X1

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Power consumed ..... not exceeding 70 W

Sensitivity:

first range ..... not less than 80 db  
(46 conventional units)

second range ..... not less than 70 db  
(36 conventional units)

The set of EB-2 (Fig.78) includes:

- (1) transceiver;
- (2) supply dynamotor of EB-2;
- (3) indicator HFB-46
- (4) audio frequency filter Q34-1B.

The PB-9 and PB-17M altimeters have common antennas included in the set of the EB-17M.

Principle of Operation

Low-altitude radio altimeter EB-2 operates on the principle of reflecting from the ground the radio waves emitted by the altimeters transmitter as R.F. oscillations modulated in frequency. The reflected pulse gets as far as the receiver input where the direct pulse of the transmitter is taken. The reflected pulse comes with a time lag, so the frequency of the reflected pulse differs from the frequency of the direct one at a given moment.

The difference of these frequencies measured by the altimeter and converted into D.C. is supplied to the altimeter indicator graduated in metres.

Altimeter Units

The shock mount of the transceiver is installed on the equipment support at the bottom part of frame No.22.

Dynamotor PV-11A with the filter box is located on the upper rack of the support above the transceiver of radio altimeter EB-2. It is provided for supplying high voltage

D.C. to the tube plates. The dynamotor is a two-pole one-armature converter.

The dynamotor base is provided with four rubber shock absorbers.

The radio-altimeter EB-2 is fed from the D.C. bus through circuit breaker A3C-5 mounted on the pilot's circuit breaker panel. Audio frequency Q34-1B is located above the transceiver of radio altimeter EB-2 next to the dynamotor PV-11A. It serves for suppressing the noises generated by the cable supplying power from the aircraft mains to the socket.

The R.F. wiring running from the antenna switch AN-1 to the transceiver is secured with the aid of rubber-padded clamps fitted to the support by bushings. The feed cable running to the dynamotor is shielded and attached to the support with the aid of the clamps with bonding padding. The feed cable of the dynamotor running from the aircraft mains is connected through audio frequency filter Q34-1B to the socket of radio altimeter EB-2 installed on frame No.22.

High Altitude Radio Altimeter EB-17M

Radio altimeter EB-17M is intended for measuring the true altitude of the aircraft above the ground within 100 to 17000 metres irrespective of the weather and visibility conditions.

- The set of the EB-17M (Fig.78) consists of the following:
- (1) transceiver;
  - (2) indicator;
  - (3) two antennas (receiving and transmitting);
  - (4) antenna switch AN-1.

Performance Data

The altitude is measured employing the pulse method, the accuracy of readings on scale being 10 m.

S-E-C-R-E-T

25X1

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The accuracy of scanning dial of "X1" scale equals  $\pm 15$  m.  $\pm 0.25\%$  of the altitude measured; and of the dial having "X10" scales,  $150$  m.  $\pm 0.25\%$  of the altitude measured. The carrier frequency of the transmitter is  $440 \pm 1$  m.c.s.

The average power of the transmitter of the dial of "X1" scale is not less than  $0.2$  W, the duration of the pulse radiation amounting to approximately  $0.5 \mu$  sec. The indicator scale is graduated within  $0$  to  $1000$  metres.

#### Principle of Operation

The operation of the radio altimeter is based on the pulse principle: the radio altimeter transmitter emits R.F. pulses which propagate toward the earth to be reflected and returned back to the airplane where they are taken by the receiving antenna. The reflected pulses amplified by the receiver are sent to the indicator. Besides the reflected pulses, the receiver input takes up the direct (main) pulses which are directed to the indicator from the receiver output. The indicator measures the time lapsed between the moment of the pulse radiation and the moment of its return which is proportionate to the altitude of flight. The readings are taken off the leading edges (left side) of the direct and reflected pulses obtained on the indicator scale graduated in metres.

The display tube scale is graduated from  $80$  m. to  $17000$  m.

The indicator screen displays circular scan with two marks (pulses), one keeping to zero while the other depending on the altitude travels to indicate the altitude.

The indicator of radio altimeter PB-17M is mounted on the left console of the navigator between frames 4 and 5.

The transceiver of radio altimeter PB-17M is located on the support under the transceiver of radio altimeter PB-2 next to frame 22. The shock mount of the transceiver is attached to the second rack of the panel support.

The receiving and transmitting antennas are nothing more than a symmetric oscillator. The antennas are arranged under the airframe on the access doors as though forming continuation of each other, the receiving antenna being set between frames 23 and 24, and the transmitting antenna, next to frame 30.

The antennas are intended for both altimeters. The switch AN-1 mounted on the lower side of the panel support rack under the transceiver of radio altimeter PB-17M is intended for changing the receiving and transmitting antennas over from one radio altimeter to the other. The switch AN-1 functions automatically, i.e. the antennas get disconnected from the radio altimeter PB-17M upon engagement of the radio altimeter PB-2, though the circuit of the PB-17M remains energized if the current has been applied to it before. If the pilot switches off radio altimeter PB-2, switch AN-1 again connects the antennas to radio altimeter PB-17M. The switch AN-1 is controlled through relay PH-2 set in the fuel gauge distribution box by means of switch installed in the left lower angle of the indicator PB-2 located on the pilot's instrument panel.

Power supply to the radio altimeter PB-17M is taken from the  $115 \pm 3$  V,  $400$  c.p.s. A.C. busbar through fusible link CN-5 on the navigator's fusible link panel and through fusible link CN-2 on indicator front panel.

The antenna switch AN-1 is fed with current from the pilot's circuit breaker panel through circuit breaker A3C-2.

The R.F. cables from the receiving antenna up to the antenna switch are passed along the pipe under the plating of the second fuel tank access door made of vitrified textolite (access door for the antenna and the pipe being required for replacement of the R.F. cables) and along the bottom part of frame 22 where it is secured by means of rubber-padded clamps; from the transmitting antenna at frame No.30, the R.F. cable runs over to the port side, runs along stringer 15 to reach frame 22; passing along stringer 15 bottom the cable comes to switch AN-1.

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25X1

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Radio frequency cable running from the transceiver to the indicator is laid along the bottom piece of frame 22 up to stringer 4 and farther along the stringer as far as the scaled gland on the bottom piece of frame No.12 (next to stringer 7).

Beginning with frame 12, the cable is laid together with the bunched conductors of the electric system along the port side up to the indicator of altimeter PB-17H.

### 3. INSTRUMENT LANDING SYSTEM CR-50

The radio equipment of the instrument landing system carried aboard the aircraft is intended for determining the distance to the D.M.E. transponder-beacon, for navigating the airplane in the hold zone along circular orbits, determining the true distance to the landing point, borders of the airfield, and for blind landing of the aircraft. The equipment of the instrument landing aids is divided in three autonomous parts: distance measuring (D.M.E.) equipment CA-1, marker receiver set, and "blind landing" instruments.

Depending on the problems confronting the crew, all the equipment or only certain units of the system may be employed. Diagram of instrument landing equipment CR-50 carried aboard the airplane is shown in Fig.75.

#### Distance Measuring Equipment CA-1

The aircraft distance measuring equipment serves for:

- (a) determining the distance to the air-field of landing or to any other airfield provided with D.M.E. transponder of the PA-1 type;
- (b) navigating the airplane along the circular orbits around the landing airfield;
- (c) indicating the distance to the landing point on the landing run.

Besides, the distance measuring equipment facilitates and assures the calculation of the speed of approach to the airfield, calculation of the time needed to approach to the airfield, and so on.

The D.M.E. (Fig.79) includes:

- (1) receiver;
- (2) transmitter;
- (3) indicator HPD-50
- (4) control panel;
- (5) receiving and transmitting antennas.

The CA-1 mounted in the aircraft is characterized by the following performance data:

#### 1. Two modes of operation:

- (a) measuring of the distance or indication of the distance from the aircraft to the airfield with D.M.E. transponder CA-1;
- (b) orbiting, i.e. indication of circular orbits to be flown around the airfield equipped with PA-1.

2. The D.M.E. CA-1 shows the range to the circumference with the D.M.E. transponder PA-1 located in its centre (the circumference running through the beginning of the runway).

The coverage of the distance measuring equipment CA-1 (i.e. the maximum range to the airfield that might be measured by the equipment) depends upon the altitude of flight. At an altitude of 5000-m. the coverage is 150-km.; the altitude getting lower, the coverage decreases. At an altitude of 1000 m. it is equal to 80 - 90 km.

Measurement ranges:

- first range: 0 to 30 km.;
- second range: 10 to 150 km.; the ranges are marked on appropriate scales of indicator HPD-50.

#### 3. Accuracy of measurements:

- (a) when operating within the first range the error is not over 600 m.  $\pm 2\%$  of the distance measured;
- (b) when operating within the second range the error does not exceed 3000  $\pm 2\%$  of the distance measured under normal weather conditions.

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4. With the aid of distance measuring equipment the aircraft can be directed around the airfield along six orbits (9, 11, 13, 15, 17 and 19 km. from zero circumference) until the airfield is ready to receive the airplane. The airplane is in this instance navigated with the aid of pointer-type zero indicator.

The precision of the orbit indication is at least  $\pm 250$  m. under normal weather conditions and at least  $\pm 450$  m. under adverse weather conditions.

5. The distance measuring equipment employs three channels of communication (by coding the paired pulses).

6. Any of the simultaneously functioning D.M.E. transponders PA-1 can be chosen by means of the COMMUNICATION CHANNELS (КАНАЛЫ ССЗ) knob.

The call signals of the D.M.E. transponders are indicated by a neon lamp that lights up simultaneously with the signals being sent (Morse code).

7. Operating frequencies: 845 Mc.p.s. (35.5 cm.) for the transmitter, and 895 M/cs (33.4 cm.) for the receiver.

8. Power consumed from the aircraft mains is not more than 720 W.

The distance measuring equipment is operated by the pilot having indicator ИРА-50 and control panel within his reach. The receiver of the distance measuring equipment is installed on the starboard side in the compartment accommodating colour flare bombs. The equipment receiving antenna is located ahead of the colour flare bomb compartment. The transmitter and transmitting antenna of the distance measuring equipment are installed in the rear compartment 04.

The measurement of distance from the aircraft to the airfield D.M.E. transponder is based upon measuring the time of the pulse signals passing from the aircraft to the airfield D.M.E. transponder and back.

The transmitter of the aircraft distance measuring equipment emits paired pulses following at 100 c.p.s. frequency (time shift between pulses being 10000 microseconds).

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These interrogation paired pulses are received by the antenna of the D.M.E. transponder receiver. The decoder located in the receiver of the D.M.E. transponder is intended to decode the pulses (to pass the paired pulses only of the channel the decoder is tuned to) and convert them into single pulses. The single pulses modulate the transmitter of the D.M.E. transponder which radiates the response pulses through the transmitting antenna.

The response pulses of the D.M.E. transponder are taken by the receiving antenna of the D.M.E. CA-1, amplified in the receiver at intermediate and low frequencies, and directed to the input of the selector and measuring circuits of the distance measuring equipment. The starting pulse of the aircraft distance measuring equipment coming to the input of the selector circuits and the response pulses of D.M.E. transponder PA-1 are separated by a time delay. The distance to the D.M.E. transponder is determined by this time delay.

The airfield D.M.E. transponder responds to many (up to 45) aircraft D.M.E. systems, and the input of its receiver takes the response pulses of all systems CA-1. For selecting the required response pulses, the receiver of distance measuring equipment CA-1 is provided with time selector whose pulses unlock the receiver shortly before the response pulses come. As the aircraft approaches the airfield, the time to unlock the receiver is automatically changed. The transmitting frequency (845 M/c.s.) differs from the receiving frequency (895 M/c.s.) so that the transmission does not interfere with the reception.

The measuring circuit of the aircraft D.M.E. generates voltages proportionate to the delay and puts into action the range indicator (a D.C. instrument graduated in kilometres).

The orbit flying is ensured by special tuning of the D.M.E. measuring circuit.

The deviation of the pointer of indicator ИРА-50 depends on the direction of flight along the circumference (orbit)

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and the direction of the airplane deviation from the orbit:

- if during left circle flying the pointer of instrument ИРА-50 shows to the left of the centre of the orbit scale triangle mark, the orbit lies on the left and the aircraft should be turned also to the left, and vice versa;

- if during right circle the pointer of instrument ИРА-50 shows to the left of the centre of the orbit scale triangle mark, orbit lies to the right and the aircraft should be turned also to the right, and vice versa.

All controls of the D.M.E. are concentrated on the control panel (Figs 71, 79) and on the range indicator mounted on the pilot's instrument panel.

The transmitter of aircraft D.M.E. is combined with the supply unit. It serves for creating the R.F. paired pulses of interrogation emitted by the transmitting antenna.

The transmitter is installed in the rear compartment on the rack between frames Nos 57 and 58 so that its base is at the level of stringer No.10.

The shock mount with four shock absorbers serves for securing the transmitter to the rack by means of six screws, 5-mm dia. and a nut.

The transmitter is easy to remove: its body is attached to the shock mount with the aid of two hinge-joint screws with a shaped non-falling nut. The front panel of the transmitter carries three plug connectors (one of them being R.F. for the transmitting antenna) marked TRANSMITTING ANTENNA (АНТЕННА ПЕРДАТЧИКА), SUPPLY (ПИТАНИЕ), and RECEIVER (ПРИЕМНИК). On the front panel, between the plug connectors the axle of potentiometer is projecting for the purpose of the voltage (115 V, 400 o.p.s.). Besides, there are two fusible links and two handles on the panel (the handles serve for removing and installing the transmitter).

The exterior appearance of the D.M.E. receiver is similar to the D.M.E. transmitter.

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The receiver of the aircraft D.M.E. serves for reception and amplification of pulses sent out by the airfield D.M.E. transponder and for creating the voltage proportionate to the transponder.

The receiver is mounted on the starboard side, on the rack between frames 51 and 52 (the base standing at the level of stringer No.13).

The receiver is attached to the bracket by means of eight bolts, 5-mm dia., and anchor nuts.

On the front panel of the receiver there are three receptacles: TRANSMITTER (ПЕРДАТЧИК), CONTROL PANEL (УПРАВЛ.) and RECEIVER ANTENNA (АНТЕННА ПРИЕМНИКА).

The remote control panel is mounted on the port side on the common board with panel M-50 of ILS control between frames 6 and 7 (Fig.71). It serves for operating the D.M.E.; its knob marked D.M.E. (Д.М.Е.) is intended for changing over the channels, and the knob marked ORBITS (ОБЪЕЗД) for selecting one of six orbits. The aircraft D.M.E. is switched on from this panel.

The quick-release panel is attached to the base by means of latches. The panel base is connected to the board with the aid of four screws, 5-mm dia.

Range indicator ИРА-50 is a pointer-type electromagnetic instrument for measuring distance. It mounts knobs for changing the modes of operation and selection of the specific distance band. The indicator is located on the pilot's instrument panel.

The transmitting and receiving antennas of the D.M.E. are identically made half-wave shortened vertical rods.

The transmitting antenna is intended for radiating the interrogation pulses and is located in the lower portion of the airframe along the aircraft axis between frames 56 and 57. The antenna is reached through special access doors.

The receiving antenna is used for receiving the response pulses sent by the D.M.E. transponder. It is installed



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in line with the transmitting antenna between frames 49 and 50 (along the aircraft axis).

Power supply. The D.C. is supplied to the distribution box of the D.M.E. (mounted in the rear compartment) between frames 58 and 59) from the left circuit breaker panel of the navigator through circuit breaker A3C-2, and the 115 V A.C. is taken to the D.M.E. distribution box from the navigator's fusible link panel through fusible link CH-5.

Wiring. The R.F. cables from the receiving and transmitting antennas to the receiver and transmitter are fixed to the stringers with the aid of latch (transmitter cable), to the bottom part of frame No.49 (receiver cable) with the aid of screws and self-locking nut, and along the line of electric cables between frames 49 and 51, by means of clamps.

#### Marker Receiver MPM-48H

The marker receiver MPM-48H (Fig.75) is intended for receiving the pulses of the airfield marker transmitters (radio beacons MPM-48).

The marker receiver employs a signalling bell and warning lamps to determine the moment when the airplane flies over the marker radio beacon MPM-48 while doing the landing approach and gliding.

The set of marker receiver MPM-48H (Fig.80) includes:

- (1) marker receiver;
- (2) inboard antenna;
- (3) signalling bell;
- (4) warning lamps.

The noise-protected radio set MPM-48H employs the circuit of direct amplification and has 75 Mc/s. fixed frequency.

The sensitivity of the MPM-48H receiver keeps within 1.8 to 4 mV with a modulation percentage of 30%, modulation frequency 3000 c.p.s., and a current across the relay coil of 0.8 mA.

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The current to operate the marker receiver relay does not exceed 0.6 mA  $\pm 10\%$ , and the relay drop-out current is not less than 0.4 mA  $\pm 10\%$ . The relay operates reliably by a current of not lower than 0.8 mA.

The plate circuits are fed with 220 V power from receivers of automatic radio compasses ARK-5 Nos 1 and 2.

A reliable indication of the marker radio beacon installed on the airfield is provided for altitudes up to 2000 m.

Except for the bell and the warning lamps, the equipment is located in the rear compartment 0-4.

The receiver has no control of its own and is engaged for operation when automatic radio compasses Nos 1 and 2 are energized.

Marker radio beacon MPM-48 intended for marking the fixed points on the ground during the landing approach and gliding emits modulated and manipulated R.F. oscillations in a vertical direction.

Manipulator of the radio beacon MPM-48 performs one of the two manipulations:

- six dots per second;
- two dashes per second.

Besides, the radio beacon transmitter can be engaged for continuous radiation.

The wave length is 4 m. (75 Mc/s.). The frequency is stabilized by quartz crystals.

The receiver MPM-48H converts the radio beacon pulses received by the antenna into pulses of 0.4 to 3.0 Kc/s. frequency and rectifies them. The relay operates upon the reception of D.C. pulses to engage the warning lamps and the bell according to the code of the marker transmitter. The warning lamps and the bell are fed from the SUPPLY (CONTINUED) plug of the receiver MPM-48H.

Marker receiver 14 (Fig.81) is mounted on a bracket on the port side between frames Nos 63 and 64. The shock absorbing plate with four shock absorbers is held to the duralumin bracket.

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Inboard antenna 13 is located near the receiver between frames Nos 64 and 63 along the axis of stringer No.17.

The antenna stands on four rubber shock absorbers secured to a welded bracket which is located on stringers Nos 18 and 16. The longitudinal and transverse oscillations of the antenna body are limited by stops. The antenna is bonded with eight bonding jumpers.

The R.F. co-axial cable running from the antenna to the receiver is passed along frame 63 and is attached to the stringers.

Course Receiver KPH-2 and Glide Path Receiver FPH-2

Course Receiver KPH-2

The course receiver (phase version) is a part of the aircraft ILS intended for the reception of the airfield course beacon pulses so that the pilot might see the centre line of the runway.

The set of the course receiver (Fig.32) includes:

- (1) receiver KPH-2 with dynamotor Y-18-1;
- (2) control panel (common with glide path receiver);
- (3) indicator HCH-48 (two items common with glide path receiver);
- (4) antenna;
- (5) ILS distribution box (common with glide path receiver).

The KPH-2 is an ultrashort-wave receiver operating on six fixed frequencies of 108.3, 108.7, 109.1, 109.5, 109.9 and 110.3 Mc.p.s.

The receiver heterodyne is stabilized by crystals.

The sensitivity of the receiver is not less than 20  $\mu$ V. Intermediate frequency 6.9 Mc/s.

The transmission band over the intermediate frequency at the level of 0.5 from the resonant value is 150 Mc/s.

Weakening of the symmetric pulse not less than 100-fold.

Operating range of the course receiver KPH-2 not less than 70 km. at an altitude of H = 1000 metres.

Total consumption of current from 28 V main: not in excess of 3 A.

The receiver is operated by the pilot.

The KPH-2 is an ultrashort-wave superheterodyne receiver. The receiving antenna takes up the radiation of the airfield phase course beacon having a false spectrum with two components: directional radiation and nondirectional circular radiation.

In a horizontal plane the directional radiation of the beacon forms two areas (lobes) whose border line shows the direction of the landing course.

The directional radiation consists of ultradiosfrequency pulses (side bands) modulated by 60 c.p.s. low frequency voltage in amplitude.

The modulating voltage of the two lobes are antiphased. The non-directional circular radiation of the beacon is a pulse of the same superasonic frequency modulated in frequency by auxiliary subcarrier frequency of 10 Mc/s.

The subcarrier is, in turn, modulated in frequency by 60 cycles with 1 Mc.p.s. frequency deviation.

The phase of 60 c.p.s. modulating voltage of the circular radiation is the same irrespective of the attitude of the airplane in space, and therefore it is termed as the radiation of constant phase.

The directional radiation whose phase changes its sign as the airplane changes from one lobe to the other is termed as the radiation of variable phase.

When the airplane is precisely on course, the receiving antenna of the KPH-2 takes the radiation of constant phase only. In this instance, the vertical pointer of indicator HCH-48 belonging to the KPH-2 stands in the middle (zero) position.

As the airplane deviates from the course line to the right or to the left, the receiving antenna will take the radiation of the variable phase, too.

Depending upon the side the airplane deviates to, the 60 c.p.s. modulating voltages of the two radiations will have

either the same or opposite phases. Comparing the phases of these voltages in a special phase zoning device causes the deviation of the course indicator pointer to respective side.

The pointer deviates to the side of the course line (during the landing approach) and shows where the aircraft bias to be turned to make a correction. If the airplane is well off the runway, the deviation of the pointer shows the position of the airplane relative to the runway.

The receiving device is equipped with a distress signaling system: if the signals are lost or when the receiver is damaged, the opening of the indicator yields a white flag instead of a black one which means that the landing system will not be used.

Receiver KPH-φ is remotely controlled. The housing of the receiver consists of a chassis and two covers. All units of the receiver are mounted on the chassis. The front panel has sockets marked ANTENNA (АНТЕННА) and CONTROL (КОНТРОЛЬ) and the handle for removing and installing the set. KPH-φ receiver 26 (Fig.61) is placed in non-pressurized portion of the fuselage between frames Nos 64 and 65 along the port-side so that its base stands as high as stringer No.7. The shock mount on which the receiver is installed with the aid of four shock absorbers is rigidly attached to the rack, the shock absorbers (without the base) being secured directly to the rack by means of four bolts each. The rack is fixed to the frames with six bolts and rests on two brace struts.

The control panel is intended for remote control of the radio sets KPH-φ and IPI-2. It is attached to the panel next to frame No.6 (port side) together with the panel of the CA-1.

Six positions of the selector on the control panel correspond to the following fixed waves of the radio sets:

Position of selector	Fixed wave of radio set KPH-φ	Fixed wave of radio set IPI-2
1	1	
2	2	1
3	3	
4	4	2
5	5	
6	6	3

The indicators HCH-48 are intended for indicating the course and glide slope. U-shaped antennas of the radio set KPH-φ (symmetric oscillator) with tuning element made as a shorted circuit is designed for receiving the signals of the airfield course radio beacon. The antenna is mounted in the upper portion of the fin, with the base of the fairlead resting on a special plate. It is protected with a fairing made of vitrified textolite (Fig.69).

The antenna connects to the radio set by a length of two-wire R.F. cable passed along the forward spar of the fin, and in the rear compartment 3-4, along the stringers next to frames Nos 64 and 65 up to the peg marked ANTENNA (АНТЕННА) on the radio set whose front panel faces the stern.

The instrument landing junction box serves for electrical connection of the instrument landing system components and for power supply from the aircraft mains. The box is located on the floor, between frames Nos 5 and 6 with the aid of four screws, 4-mm dia., without shock mounts (Fig.71). The cover of the box can be easily removed.

Except the R.F. cable running to the antenna, all cables are passed along the electric wiring of the aircraft.

Glide-Path Radio Set IPI-2 (Receiver)

The glide-path receiver IPI-2 is intended for reception of the signals sent out by the glide-path radio beacon showing gliding trajectory of the airplane while it is landing.

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The set of the receiver TPN-2 (Fig.81) includes:

- (1) receiver TPN-2 with dynamotor Y-18-1;
- (2) antenna;
- (3) two indicators NCH-48, control panel and instrument landing system distribution box which are common for the KPN-4 facility (See KPN-4 above).

The TPN-2 is a superheterodyne ultrashort-wave receiver operating on three fixed frequencies of 332.6, 333.8 and 335 megacycles per second. Change-over from one frequency to another is accomplished by control from the panel by engaging appropriate quartz crystal.

The sensitivity of the receiver is not lower than 300  $\mu$ V with two indicators NCH-48H, and not lower than 250  $\mu$ V with one indicator NCH-48H.

Operating range at an altitude of 1000 m. is not less than 25 km.

Total current consumed by the receiver (from the aircraft mains) does not exceed 3 A.

The antenna of the glide-path receiver takes up the horizontally polarized waves of the glide-path radio beacon. In this event depending upon the position of the airplane relative to the equisignal zone, signal modulated by 150 or 90 c.p.s. frequency dominates in the antenna. The pulse received by the antenna is converted by the receiver to generate two frequencies modulated by 150 and 90 cycles per second which are rectified and produce opposite currents applied to the glide-path indicator.

While the airplane precisely follows the glide-path line (gliding trajectory), i.e. flies over the equisignal zone, the horizontal pointer of the indicator keeps to zero. When the airplane departs upward from the glide-path line, the indicator pointer comes downward, and when the airplane departs downward, the pointer comes upward. In all events, the pointer indicates the equisignal zone.

The receiving unit is provided with an emergency warning system employing a white flag (blinker) in indicator NCH-48.

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The TPN-2 is installed in the front pressurized cabin. The receiver TPN-2 is controlled by the pilot from the instrument landing system panel. The indications of the receiver can be seen by both the pilot and co-pilot whose instrument panels carry indicators NCH-48.

Receiver TPN-2 employs the superheterodyne circuit with nine tubes and quartz-crystal stabilization of frequency.

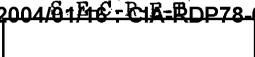
The receiver is located in the pilots' compartment on the floor, port side, next to frame No.6, near the instrument landing system panel. Receiver TPN-2 is mounted in special tub (Fig.71). The tub with two horizontally set dowels on the rear wall moves along two shaped members riveted to the floor. The dowels enter two holes made to receive them, the front portion of the tub being fixed together with the shock mount.

The antenna of glide-path receiver TPN-2 is intended for reception of the horizontally polarized radiation of the glide-path beacon and is presented by two horizontal oscillators. It is made of brass foil and glued up to the inner side of the navigator's glass panel (Fig.71). The antenna is not provided with tuning devices, its size being selected with a view to pass three fixed frequencies of the receiver. The antenna is connected to the receiver by means of a two-wire R.F. cable. The peg is taken off the cable and the two conductors are fitted to the connector screws. The cable is attached to the left side by means of metal clamps with rubber padding.

The protection is accomplished by circuit breaker A3C-10 (common for receiver KPN-4) and fusible link CH-10 in wire PL-7 (See power supply of receiver KPN-4).

220-V dynamotor Y-18-1 receiving the current from the aircraft mains feeds power to the plates of the receiver tubes.

Except the R.F. cables, the wiring is laid along the path of the electric cables and secured by means of common clips.



Section 3

RADAR EQUIPMENT OF THE AIRCRAFT

The aircraft has the following radar equipment:

- (1) aircraft transponder;
- (2) radar gunsight NPC-1;
- (3) radar bombsight PBL-4.
- (4) tail warning radar "SIREN-2".

Arrangement of the radar equipment in the aircraft is shown in Fig.83.

1. AIRCRAFT TRANSPONDER

The aircraft transponder of the autonomous identification system operating in a range of metre band is intended for receiving interrogation signals and for automatically sending a coded reply signals of the same frequencies. The transponder allows the interrogator to determine the following:

- whether the interrogated plane is friend or foe;
- the range to the plane.

In flight the transponder operates automatically.

It functions within a frequency range of from 160 to 170 Mc. The tuning frequency of the transponder is continuously changed. The frequency change is achieved by wobbling of a shorted turn at constant speed (variable-inductance circuit) in the circuit common for the receiving and transmitting tubes. One "wobbling" cycle takes 0.6 to 0.68 sec. During this period the transponder is consecutively tuned to the frequencies covering a band of 160 to 170 Mc. receiving the interrogator signals and sending its own signals at approximately the same frequency.

The transponder sends coded pulses in response. Every code includes a combination of narrow and wide pulses and intervals. The variation of the pulses in the code combination is controlled with the aid of the cam contactor. The trans-

ponder employs the Morse code where the narrow pulses correspond to points, and the wide pulses, to dashes. The transponder has four one-letter codes. In the coding system each letter consists of up to four pulses each and as it is necessary to separate one letter from another, the code transmission time is divided into five equal parts within 0.6 to 0.68 sec. each corresponding to five cycles of wobbling. The fifth "wobbling" cycle invariably produces interval. The time of code transmission amounts to 3.2 ± 0.2 sec. The desired code is selected by resetting the code selector on the code panel.

If the aircraft suffers distress, the pilot may send SOS signals. For this purpose the DISTRESS (DICTORIE) switch on the code panel should be turned to ON. The distress signals last much longer than the dots and dashes, so they greatly differ from all other codes. The distress signal consists of the wide pulses only lasting for equal periods of time and has no intervals.

In case it becomes necessary to prevent the aircraft and the transponder from being captured by the enemy, the latter must be destroyed. This is done with the aid of the destructor actuated by the destructor button installed on the pilot's left console, or automatically, with the aid of the inertia contactor operating upon impact.

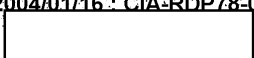
The set of the transponder installed in the aircraft

(Fig.84) includes the following:

- transceiver;
- transmit-receive antenna;
- code panel with connecting cable;
- destructor button;
- inertia contactor;
- R.F. antenna cable.

Transponder Performance Data

Interrogator-responder range ..... 35 km.  
 Code used ..... Morse



25X1

25X1

Number of codes ..... four, and signal of distress  
 Time of code transmission ..... 3.2  $\pm$  0.2 sec.  
 The transceiver frequency periodically changes within a range of 14 Mc. covering a band of 160 to 170 Mc.  
 Power of the transmitter pulses ..... not less than 4.5  
 Period of frequency wobbling ..... 0.6 to 0.68 sec.  
 Period of responding pulse:  
   narrow ..... 8 to 12  $\mu$ sec.  
   wide ..... 20 to 30  $\mu$ sec.  
 Signal of distress ..... 50 to 70  $\mu$ sec.  
 Transponder antenna has a circular radiation pattern in a horizontal plane. Wave polarization is vertical.  
 Power consumed by transponder from the aircraft mains ..... not exceeding 155 w.

Location of Transponder Units in Aircraft

The equipment (but antenna) of the transponder is located along the port side portion of the front pressurized cabin (See Fig.83).

Transceiver 19 is installed in the lower part of the navigator-operator's panel support between frames Nos 10 and 11. The transceiver base plate is bolted to the platform on the cabin floor. The body of the transceiver is mounted on the attachment base plate and secured to it in the front lower portion of the unit with the aid of union nuts.

The transmit-receive antenna is placed in the lower part of the fuselage, between frames Nos 26 and 27. The antenna base is attached to the easily removable plate which, in its turn, is fixed to the fuselage skin with the aid of bolts. For checking the R.F. cable for reliable connection to the

antenna its attachment base is removed and the antenna is lowered with one hand is lowered.

Code panel 8 is mounted on a special panel located on the side between frames Nos 7 and 8 within easy reach of the navigator. Located on the same board next to the code panel is a selector button marked DESTRUCT, with the indicating lamp (Fig.85); fixed under the button is the transponder power selector switch.

Inertia contactor 16 (Fig.83) is mounted on a rigid board fixed on the profiles of the navigator-operator's port side panel support next to the transceiver of the transponder.

For delivering the current to the DESTRUCTOR (DESTRUCT) unit of the transponder a bunched conductor with a two-pin plug is provided. Prior to the flight the two-pin plug should be inserted into the DESTRUCTOR (DESTRUCT) receptacle on the transceiver.

All units of the transponder are connected to one another to the power supply sources by means of bunched conductors of wires, type ENBA, (coloured blue). The code panel is connected to the transceiver and the aircraft mains through a plug connector which is attached to the special angle bracket fixed on the horizontal rib of the code panel mounting board. These bunched conductors are placed in the common sheath of conductors of the electrical equipment running along the port side of the front pressurized cabin and are secured to the aircraft main structure with the aid of common brackets. The R.F. cable running from the transceiver to the antenna is laid along the fuselage port side (Ø2 and Ø3) and attached to the fuselage stringers. A special seal is provided in the web of the pressurized floor of frame No.12 where the R.F. cable running to the antenna passes through the web.

The R.F. cables are connected to the transceiver with the aid of R.F. angle connectors with a view to decreasing the bending radius of the cables in question.

The transponder is fed from the 26 V aircraft mains through a two-circuit bus bar of the co-pilot's panel circuit

25X1

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breaker via circuit breaker A3C-5. This circuit is provided with switch E-45 installed on the code panel (port side) within the pilot's reach. The feed circuit is also provided with filter V-14A to reduce radio interference of the aircraft mains.

The destructor circuit is fed from the storage battery bus bar in the storage battery junction box located next to frame No.17.

#### Designation and Functioning of Transponder Units

Transceiver is intended to receive non-coded interrogator signals and to automatically send coded signals in response. The transceiver includes the transceiver proper and the supply unit.

The transceiver has the following five channels:

- (1) transmit-receive channel;
- (2) sensitivity automatic stabilization channel;
- (3) carrier-blocking channel;
- (4) coding control channel;
- (5) response indication channel.

CODE PANEL serves for changing the codes and for governing the transponder operation.

Antenna is a flat shortened dipole of streamline shape with a tuning element.

Destructor button is designed for destroying the transponder and for checking the destructor circuits. Indicating lamp is installed together with the button, on the same base.

The button is pressed to destroy the coding equipment of the transceiver. The indicating lamp shows the condition of the destructor circuit.

**WARNING:** The plug should never be inserted into the detonator receptacle while the indicating lamp is on, as in this event the transponder will be destroyed!

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The indicating lamp lights upon pressing the destructor button or upon the operation of the inertia contactor. In the above case the plug receives the voltage from the storage battery junction box bus bar.

Inertia contactor serves to automatically close the detonator circuit when the airplane suffers distress over the enemy area. The inertia contactor consists of a pendulum, pendulum lever, springs and two contacts. Normally the pendulum keeps the lever in the armed position and the contactor contacts are open. When the airplane impacts the ground with an acceleration of 10 G, the inertia contactor contacts close, the current to the plug is supplied from the storage battery junction box bus bar and the indicating lamp lights up.

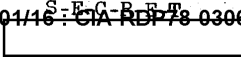
#### 2. RADAR GUNSIGHT HPC-1 (UNIT AP17)

Radar gunsight HPC-1 ensures, irrespective of the visibility conditions, automatic search, lock-on and tracking of the target and automatic delivery of the data to the HBE-53 computer; the data are required for aimed firing from the tail gun mount against the attacking plane within a zone of  $\pm 35^\circ$  in azimuth and at angle of sight from the side of the rear hemisphere.

The sight transmitter generates powerful pulses of R.F. energy which the waveguide carries to the antenna radiator to emit into space.

The antenna angular travel in azimuth and its tilt are governed by means of antenna rotator actuated by the controlling voltage which is generated by the automatic search mechanism.

The antenna is scanning to search the space within the desired limits. The target appearing within the zone of search reflects the energy that radiates it. The sight antenna receives part of the radiated energy, and the antenna receiver converts the R.F. pulses first into an intermediate frequency of 10 Mc. and then into video pulses of the target which are sent to:



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- (1) the indicator for obtaining the target marking;
- (2) the protector that guards the sight against non-synchronous pulse interference produced by radars operating in 3-cm. range.

The protector output directs the video pulses of the target to the range computing mechanism where they are selected according to the distance and sent to the angle tracking mechanism.

The target having been detected, the searching mechanism is automatically disconnected and the sight changes over to tracking the target.

During the target tracking the antenna of the sight is automatically directed towards the target. The antenna revolution is governed by the angle tracking mechanism which generates controlling voltages proportionate to the angle of the target departure from the equisignal direction of the antenna.

The controlling voltages are supplied to the antenna rotator. The sight antenna rotates to decrease the difference between the mismatching angle and the direction towards the target.

Apart from the autonomous employment of the sight the sight antenna may be scanned to the target with the aid of the optical sighting station controlled by the operator-gunner who uses the optical sight. The sight antenna having been scanned to the target, the radar sight looks on the target then automatically gets disconnected from the optical sight and switches over (as in the case of the autonomous employment) to automatically tracking the target.

When tracking the target, the radar sight transmits to the computer the data of target bearing, angular velocity and the range to the target.

Main Performance Data of the Sight

During an automatic tracking of the target the sight ensures the following:

target locking-on range while scanning .....	3-5 km.
Maximum zone of search in azimuth and elevation .....	$\pm 35^\circ$
Scanning time of search zone .....	not exceeding 16 $\pm$ 3 sec.
Possible change of the value and angular position of the search zone .....	within $\pm 20$ to $\pm 35^\circ$ of the area scanned
Automatic tracking of the detected target with errors not exceeding 70 m. of range and 14 min. of arc of angular coordinates with a range to target .....	from 800 to 1500 m.
Resolution in range .....	not less than 200 m.
Resolution in angle .....	not less than $8^\circ$
Minimum coverage .....	not exceeding 250 m.
Operating frequency generated by the magnetron .....	9370 $\pm$ 30 Mc.
Error of the main radio pulse .....	not less than 40 kW
Duration of main pulse .....	0.5 $\pm$ 0.05 $\mu$ sec.
Main pulse repetition rate .....	1920 to 2080 c.p.s.
Intermediate frequency .....	30 Mc.
Weight of the sight .....	170 kg

Designation of Units of Radar Sight HPC-1

The radar gunsight includes twenty one units with cables. 1. Unit AP17-1 (antenna) is intended to perform the following:

- (a) radiating radio pulses of the transmitter and receiving the radio pulses reflected from the target;



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- (b) obtaining equisignal direction in space;
  - (c) searching and tracking the target in the zone of scan;
  - (d) transmitting angular coordinates of the target to the indicator, gyro instrument and computer synchronously;
  - (e) supplying the sweep voltage to the indicator and the angular tracking unit.
2. Receive-transmit unit PM1-2 is designed to perform the following:
- (a) generating powerful radio pulses;
  - (b) switching over for transmission and reception;
  - (c) converting the pulses reflected from the target and received by the antenna into intermediate frequency pulses and preamplifying them;
  - (d) supplying the starting pulse for actuating the circuit of the automatic frequency governor, reception keying circuit, and forming the controlling pulses in the receiver-indicator unit.
3. Receiver-indicator unit AP17-3A serves for the following:
- (a) amplifying and converting the pulses reflected from the target;
  - (b) synchronizing the functioning of the sight units;
  - (c) changing the sight over to the firing control mode of operation.
4. Indicator AP17-4A with the control panel:
- (a) indicates the targets coming within the field of vision of the sight and determines the distance to them;
  - (b) indicates the lock-on and tracking of the target;
  - (c) indicates the antenna tilt while the sight is engaged for searching and tracking of the target;
  - (d) performs the aiming control of the sight.
5. Junction boxes AP17-5 and AP17-6 are provided for interconnection of the sight units.
6. Control panel AP17-7A:

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- (a) governs the main supply voltages of the sight, magnetron current, currents of the first and second crystal detectors, computing the range to the target, antenna revolution speed, control range and the pressure of the air in the TRANSMITTER - ANTENNA (TRF RAYTRON - ANT UNIT) waveguide system;
  - (b) switches the sight over for the control mode of operation with a view of determining whether the sight is serviceable.
7. Gang box AP17-8E is designed to perform a connection between sight NPC-1, computer and the tail sighting station.
8. Amplidyne AP17-9A ensure amplification of the controlling voltage of the angle tracking unit and transmission of the amplified voltage to the antenna motors.
9. Angle tracking unit AP17-10A:
- (a) extracts the error signal;
  - (b) compares the error signal with the reference voltage and sends D.C. pulses for rotating the antenna;
  - (c) changes the sight over for target tracking mode of operation;
  - (d) performs angle tracking of the target.
10. Range and search control unit AP17-11A:
- (a) determines the range to the target as expressed through the D.C. voltages;
  - (b) performs automatic range tracking of the target;
  - (c) controls the antenna rotation in the automatic scanning mode of operation.
11. Supply unit AP17-12A:
- (a) converts 115 V, 400 c.p.s. alternating current into rectified voltages of +300 V, +230 V, +150 V (1), +150 V (2), -150 V;
  - (b) regulates voltages of +300 V, +150 V (2), -150 V.
12. Unit AP17-13A serves to connect the sight to the A.C. and D.C. centralized mains of the aircraft.
13. Search control panel AP17-14A serves for governing antenna revolutions in the automatic scanning mode of operation.

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14. Firing button AP17-16 is provided for connecting the turret control circuit to the remote control system.

15. Remote control panel AP-17A is intended to switch over the gun-sight modes of operation:

(a) autonomous functioning of the radar gunsight when set at RADAR (РАДМО);

(b) aiming of the antenna at the target with the aid of the optical gunsight when set at AIMING (НАВЕДКА);

(c) governing of cannon directly by optical sight when set at OPTICAL (ОПТИКА).

16. Gyro instrument AP17-19Д serves for determining the target angular velocity (in a horizontal and vertical planes).

17. Servo unit AP17-20Д is provided to control the azimuth and tilt motors of the gyro instrument.

18. Range transmitting unit AP17-21Д supplies voltages of the range to the ПДС-53 computer.

19. Set of cables AP17-15 for connecting the sight units.

Location and Installation of Radar Gunsight NPC-1  
in Aircraft

The sight units are located in the rear pressurized cabin and outside of the pressurized spaces of cabins 06 and 04 (Fig.86).

Antenna AP17-1 is mounted on the outer surface of the pressurized cabin horizontal plate so that the reflector and the antenna radiator face the aircraft tail and the centre line of the unit runs parallel to the aircraft axis (the mark on the antenna base brought against the mark on the plate), its tilting angle amounting to minus  $34 \pm 3$ . The antenna base is attached to the special assemblies of the airframe with the aid of three bolts; the antenna is tilted by means of levelling washers, 0.1 to 0.15 mm thick.

Transceiver PH1-2 is bolted (Fig.87) to two profiles of plate 06 and connected to the AP17-1 unit by means of waveguide AP17-25. The waveguide is equipped with a clamp and a supporting holder that are set with a view to obviate the bending stresses arising as the transceiver mount reacts to shocks.

Gyro instrument AP17-19Д (Fig.87) is mounted next to transceiver PH1-2, between frames Nos 72-75. Its base is secured to two sections on the horizontal plate so that the mark made on the unit and the hinged base is aligned with the mark on the horizontal plate.

Units AP17-16, AP17-7Д, AP17-8E, AP17-14Д and AP17-17Д are located on the starboard of the rear pressurized cabin, between frames Nos 73-75.

Unit AP17-4Д is installed in the rear pressurized cabin on a special plate hinged to the armoured plate of frame No.75, starboard. Due to the hinged device the unit can be brought to the operating and to the stowed positions. Besides, the unit body together with the attachment frame can travel to the right relative to the gyro instrument, which enables the operator to bring the unit screen opposite his eyes.

Units AP17-5, AP17-6, AP17-21 and AP17-13Д are mounted on the port side of plate 04, between frames Nos 60 and 62a. These units are secured to the brackets on the cabin airframe.

Unit AP17-12 (Fig.88) is installed on a special support on the port side section of plate 04 next to frame No.62a.

Units AP17-20, AP17-11, AP17-3Д, AP17-10 are arranged on the brackets of the support installed on the port side of plate 04 along the axis of frame No.61 (Fig.89).

Note: This support is provided to carry unit AP17-22 and special spare holders of the delay line. Mounted on the support is also cooling fan ДБ-3 of the unit for cooling the sight on the ground.

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Amplidyne unit AP17-9D is mounted under the support carrying the units; it is placed on bracket connected to the stringers of the aircraft airframe.

Mounted near the support is a special vertical post intended to protect the units arranged on the support against blows and jerks that might affect the units when the cannon ammunition is loaded.

From the outside units AP17-1, P11-2 and AP17-19D are protected with special metal cowls having removable panels giving access to the units. The operating section of the AP17-1 antenna (its reflector) is protected with easily removable cowl made of dielectric.

Two fans DB-3 are installed above the P11-2 unit for cooling it when sight MPC-1 is operated on the ground. The fan is engaged when the tail bumper is extended and is disengaged when the tail bumper is retracted.

All units of sight MPC-1 are interconnected and connected to computer HBE-53 and to power supplies with the aid of shielded, high tension and high frequency cables and wires ENBN painted blue. The plug connectors of every cable are engraved to indicate cable and unit numbers for connection. Such cables pass through the web of frame No.69 and the ceiling of cabin #6 via sealed two-receptacle connectors. The plug connector numbers are written in red enamel close to the connectors on the frame web and cabin ceiling.

The cables are attached to the airframe, plates and supports with the aid of clamps with shaped rubber pieces and bonding strip.

The cables running to units AP17-19D and AP17-4D are made long enough to ensure transfer of the units without disconnecting them as may be required for operation.

The portion of the shielded cable near unit AP17-4D is protected with a piece of canvas wound about it so as to protect the cable against fraying when the unit is shifted.

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For suppressing the interference the jacket of every unit has a special terminal labelled GROUND (ЗЕМЛЯ) connected to the aircraft main structure by means of a bonding jumper.

#### Power Supply of the Sight

Radar gunsight MPC-1 is fed from 28 V aircraft D.C. mains, or 115 V, 400 c.p.s. A.C. mains. The 28 V supply is delivered by two special cables and units AP17-13D and AP17-9D to the following circuits of the sight:

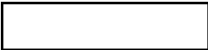
- (1) excitation windings of the azimuth and antenna tilting motors;
- (2) antenna radiator rotating motor;
- (3) fans of unit P11-2;
- (4) heating elements of unit AP17-19A;
- (5) amplidyne motors of unit AP17-9D;
- (6) a large number of relays of various units of the radar gunsight.

115 V, 400 c.p.s. current is supplied through unit AP17-5 to junction box AP17-5 whence it is delivered to the units of the radar gunsight provided with rectifiers.

Unit AP17-9D is fed from the 28 V circuit breaker panel bus bar of the rear pressurized cabin through circuit breaker CB-40. Unit AP17-13D receives power from plug connector No.31 fed from the 28 V circuit breaker panel bus bar of rear pressurized cabin via circuit breaker A3C-20, and from A.C., 115 V, 400 c.p.s. bus bar through plug connector No.43 of the Navigator-operator's fuse panel via fuse CII-15.

#### Cann. Operation of Radar Gunsight MPC-1, Computer HBE-35 and Armament System

The cannon mounts are governed with the aid of the remote control celsyn drive through two channels (coarse and precise).



The coarse selsyns are connected to the antenna shafts by means of gear train having gear ratio of 1:1, and the precise selsyns, by means of the gear train having gear ratio of 31:1.

Radar sight HBE-53 is connected to the OMC unit through gang box AP17-8E. Sight OMC is connected to radar sight NPC-1 when the selector on the AP17-17A unit is brought to LAYING (HABCO/KKA). The circuits of the radar gunsight are connected to the circuits of the HBE-53 computer in the laying and the target lock-on modes of operation, unless the selector on the AP17-17A unit is set at OPTICAL (OJTKKA).

Air Supply System of Radar Gunsight NPC-1

To compensate the air leakage and to maintain normal atmospheric pressure inside transmit-receive unit PNI-2 and waveguide AP17-25 when the aircraft is flying at altitudes not less than 3000 m. mounted in the plane are duralumin pipes and rubberized hoses for delivering compressed air (1.1<sup>+0.1</sup><sub>-0.2</sub> kg/sq.cm.) to the valve-fitted connection of unit AP18-2 from the seventh stage of the engine compressors via the pressure reducer (unit 436).

The air supply system of the NPC-1 radar gunsight is controlled by means of the valve labelled ARGON SUPPLY (HOJ-KAKKA APTOHA) and installed next to frame No.73. The gunner should open the valve every 30 min. of operation.

The air pressure in the units is controlled with the aid of the indicator on unit AP17-7A using the selector of the unit.

3. RADAR BOMSIGHT PEN-4

Radar bombsight PEN-4 is designed for searching and detecting the ground and surface targets irrespective of the optical visibility conditions for solving the navigation tasks with the aid of radar recognized terrainmarks and for precision bombing of ground and surface targets (stationary

and moving) with an automatic bomb release at altitudes of from 3000 m. to 15000 m.

The bombsight equipment is fully synchronized with optical sight OMB-11p, and its sighting plane is stabilized by the optical sight vertical gyro the bank angles do not exceed 10°.

Radar bombsight PEN-4 consists of 16 units shown in Fig.90 and described below.

Radar Bombsight Performance Data

Operating range:

- when detecting and identifying large objects ..... 140 to 180 km.
- when sighting ..... 70 km.
- when operating with the target identification beacon .....

to be determined by direct visibility at maximum flight altitude

Sighting method ..... synchronous, employing mechanisms of optical sight OMB-11p

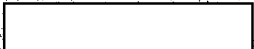
Bomb release method ..... automatic, through the contact system of optical sight and electrical bomb release system

Bombing altitudes when using optical sight OMB-11p ..... 3000 to 15,000 m.

Bombing speed range ..... 300 to 1250 km/hr  
the sight may operate on two fixed waves switched over as required

Searching in azimuth:  
circular scanning ..... through 360°  
sector scanning (50°) ..... within front zone (±65° as from the path of flight)

Frequency band ..... 9310 to 9430 Mc.





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Pulse power ..... 90 kW as minimum  
 Duration and recurrence of pulses ..... 0.45 usec. and  
 1250 c.p.s. for  
 ranges of 10, 20, 10  
 to 70 km.; 1 usec.  
 and 535 c.p.s. for  
 ranges of 100 and  
 200 km.

Antenna angular velocity in azimuth  
 plane:  
 during continuous rotation ..... 20 r.p.m.  
 while scanning ..... 12 r.p.m.  
 Frequency of antenna wobbling during  
 sector scanning ..... 45 per min.  
 Angles of antenna tilt ..... from +5° to -25°  
 Power consumed from aircraft mains (28 V) 3 kW

Principle of Operation of Radar Bombsight

The operation of the PNE-4 radar bombsight is based on employing radio waves reflected from the objects that stand in their way.

The radar antenna periodically emits powerful transient pulses. The pulses reflected from the surface of the ground are taken by the same antenna to be sent to the indicating devices after appropriate amplification. The screen of the cathode-ray tube indicator yields the radar-presented image of the locality the aircraft is flying over.

The radar and fixed antenna are engaged to sweep a narrow strip of the ground, but when the antenna is rotated by the motors a circular area of large radius is consecutively swept. 1-cm. waves propagate following a rectilinear pattern, therefore the distance to the target (slant range) can be determined by the time needed for the pulses radiated to reach the object and come back to the emitter. The direction towards the reflecting object is determined by the azimuth position of the antenna at the moment the reflected pulse has come back

The radar equipment employs the indicators with radial-circular scan and B-scan.

The operator can choose one of the five scales ("10", "20", "100" - "700", "1000" and "2000" km., depending on the distance to the target).

The indicator is provided with luminous circles (range marks).

Course line. The rotation of the sweep trace on the indicator is synchronized with the rotation of the antenna. When the antenna is rotated, the moment the antenna bearing coincides with the aircraft fore-and-aft axis may be marked on the screen with a bright radial line (course line). The azimuth angle between the course line and the direction to the target is determined by means of the course line on the screen, rotary light filter (with the marks made on it) and rotary scale (graduated in degrees from 0° to 360°).

Sector scanning. The operator may use the sector scanning mode of operation besides the circular scanning whenever it may be required to study a certain site on the area searched. In this event the antenna (and the sweep line on the indicator screen synchronized with it) start wobbling within the limits of the sector. The sector display is mainly used when the aircraft is on the bombing run.

Navigation. Special radar maps (or ordinary maps) should be used for decoding the image produced on the indicator screen.

Apart from homing on an object or on a pulse radio beacon the radar bombsight PNE-4 enables the operator to solve a number of navigation problems, the principal ones being the determination of the aircraft coordinates and of the flight true airspeed and drift.

Bombing. The radar sight solves the problems of precision bombing employing the navigator's equipment used in conjunction with optical sight OMB-11p. The searching and target determination are usually accomplished by the navigator-operator who uses his own indicator; the lateral aiming and



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aiming in range are done with the aid of the navigator's indicator. The navigator's indicator P8 is a sighting arrangement of radar bombsight PEN-4.

Units PEN-4 installed within the navigator's easy reach and convenience ensure two modes of sight operation (searching and homing).

When employing the optical sight operating in conjunction with radar bombsight PEN-4, the sighting may be done both with the aid of the telescopic arrangement of optical sight ONE-11p and the navigator's indicator screen.

The bombing problems are solved by means of the computing mechanisms of optical sight ONE-11p.

The bomb ballistic data, corrections for the train and aircraft formation are introduced into the mechanism of sight ONE-11p. The bombs are released automatically.

The operation of the radar bomb sight is best understood by reference to the service manual of "RADAR BOMBSIGHT PEN-4.

#### Location and Installation of Radar Bombsight PEN-4

The units of the radar sight are installed in the front pressurized cabin and also outside of it at the bottom of the fuselage.

Depending on the control employed, the units of the radar bombsight are mounted within the reach of the navigator-operator and the navigator (See Fig.83).

The units forming the set of the radar bombsight (except the P1 antenna, transceiver P2, modulator P12, junction boxes, control panels and indicators) are provided with shock-mounted mounting frames which are bolted to the aircraft main structure when the units are installed in the aircraft. The body of the unit is inserted into the mounting frame along two guides and secured to the frame with two shaped union nuts fitted in the lower front portion of the unit. Every unit has a terminal marked GROUND (ЗЕМЛЯ) connected to the airframe or the control panel support with the aid of a bonding jumper.

Antenna (unit P1) 14 together with the attachment plywood board carrying the mechanisms and the reflector of the unit is arranged in the lower portion of the pressurized cabin in a space between frames Nos 5 and 8. Mounted on the webs of frames Nos 6 and 7 are two L-shaped sections to which the attachment board of the antenna is secured with six bolts. The attachment board of the antenna has a notch (marking the position of the antenna axis) that must coincide with the aircraft longitudinal axis.

The portion of the antenna projecting outside (reflector) is protected with a cowling made of dielectric which is secured to the fuselage skin. To protect the crystals of the P2 unit from the antenna radiated pulses while scanning the rear sphere of the aircraft, a reflecting duralumin plate is mounted slantwise on the vertical web of frame No.8.

Transceiver 15 (unit P2) is installed in the front pressurized cabin, under the pilots' seats, between frames Nos 8 and 9 (Fig.91). The unit is installed on two L-shaped bars and secured to them with four bolts.

Unit P2 is connected to unit P1 by a waveguide passing through the web of frame No.8 via sealing gasket.

Modulator 17 (unit P12) is located (See Fig.83) in the front pressurized cabin, between frames Nos 9 and 10, starboard (Fig.85). The shock absorbers of the unit are locked to four brackets cast of magnesium alloy and mounted on the web of frame No.9 and the shaped members of the operator's panel support. The unit shock absorbers are secured with the aid of four 10-mm bolts.

Junction boxes 2, 10, 7 (Fig.83), or else units P15, P14, P13, are issued by the Manufacturer with the set of cables to be connected to the radar bombsight units to ensure connection between radar bombsight PEN-4 and the aircraft mains, antenna OAPM-1 and optical sight ONE-11p. Junction box P15 is placed on the bottom piece of frame No.12, port side portion viewing forward, and secured to the angles on the stringer

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Bottom pieces with four bolts. Junction box F13 is fixed to the web of frame No.9, port side portion, and is bolted to the angles on the frame web. Junction box F14 is mounted on the port, between frames Nos 4 and 5 (under the navigator's table); it is fixed to two brackets connected to the fuselage stringers.

Control panel 3 (unit P6) is installed on the port side portion of the front pressurized cabin, between frames Nos 10 and 11 above the units placed on the operator's panel support (Fig.92). Unit P6 is mounted between two brackets on a special plywood plate and is hinged so that it may swivel (Fig.93). When the unit is engaged in operation the front panel faces the operator and is locked with the aid of a special stop.

When the stop is retracted the panel swivels so that its front face stands against the cabin boardside thereby providing access to the units mounted on the panel support of the operator.

Indicator 1 (unit P5) of the operator (Figs 83 and 92) is arranged on the port side wall of the cabin next to frame No.12. The unit is secured with the aid of a slide that moves along the guiding rail towards the cabin side from the operator, or towards the operator. A screw is provided on the right side for locking the unit. Unit P5 is tilted relative to a vertical plane by means of a screw fitted on the front portion of the unit attachment fixture.

The screen of additional indicator P5 is photographed with the aid of special camera CA-PJ-1 (Fig.94) which is done with a view to controlling the functioning of radar bomb sight PBN-4. This requires that unit P5 should be attached to the camera in question. The screen of the unit is placed parallel to the camera objective.

Unit P5 is attached together with the attachment fixture of camera CA-PJ-1. The whole mount is arranged between the right panel support of the operator and the bottom piece of frame No.12.

Units P2, P4, F11, F1C are installed on the shaped members and racks of the operator's left panel support. Units F11, P4 and P3 are mounted one after another on the upper rack of the left panel support. Unit P10 is installed on the rack under the units.

Synchronizer 13 (unit P7; see Fig.83) is placed under the control bridge of the pilot next to frame No.5 as viewed from the side of the navigator's cabin. The mounting frame of the unit is secured to the two plates which in turn are bolted to the bracket on the floor of the cabin under the control bridge.

Navigator's control panel 12 (unit P9) is mounted on the port side of the pressurized cabin, between frames Nos 3 and 4 under the navigator's table). The base of the control panel is attached to the bracket that is connected to the stringers of the fuselage (Fig.95). During operation unit P9 may be pulled out nosewise (Fig.96).

Indicator 11 (unit P8; see Fig.83) is installed in the front upper portion of the pressurized cabin on the left of the aircraft fore-and-aft axis.

The mounting base of the unit is secured to a carriage which slides along a guiding rail together with the unit. It is fixed to the side portion of the carriage with the aid of a screw. Its position may be changed relative to a vertical plane and azimuth (Fig.97). To obviate striking of the P8 unit (in the drawn-out position) against sight OMB-11p which may be caused by vibrations of the aircraft, the unit is attached to the guiding rail with the aid of a shock-absorbing hose.

#### Arrangement of Radar Bomb Sight Cables in Aircraft

The radar sight cables are secured to the frames and side members of the control panel supports installed on the port side of the cabin with the aid of special clips.

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The cables running to units P8, P9, P6, P3, P4, P11, P7 provide for their free movement. The cables that are shifted during operation of the units are protected with canvas covers.

#### Power Supply of Radar Bombsight

Radar bombsight PBN-4 receives power from 28 V D.C. aircraft mains and from 115 V, 400 c.p.s. A.C. mains. The feeding is accomplished through junction box (unit P15). The box is connected to the aircraft mains by means of cable No.18 via two relays K25A of the feed circuits for A.C. and D.C. in the relay box of radar bombsight PBN-4, on the left panel support of the operator. The feed circuits passing through A.C. relay K25A are protected by fuse CH-15A installed in the fuse junction box of the operator; the D.C. feed circuit is protected by circuit-breaker A3C-20A installed on the circuit-breaker panel of the operator.

#### Units of Radar Bombsight

Antenna equipment (unit P1) is intended for directed radiation of R.F. pulses and for reception of the reflected pulses. The antenna equipment consists of R.F. portion and the gear for azimuth rotation and tilting and of the equipment for transmitting the azimuth and tilt data.

The waveguide system of the antenna is designed for transmitting the R.F. energy from the transmit-receive unit to the antenna, and vice versa.

Transceiver (unit P2) is used:

- (a) for generating powerful short pulses of radio frequency and for transmitting them to the antenna;
- (b) for superheterodyne reception and preamplification of the reflected pulses taken by the antenna;

(c) for converting the R.F. pulses of the magnetron oscillator into the R.F. pulses controlling the system of automatic frequency control.

Range unit P3 is intended for pulse shaping, for starting the modulator and the sweep circuit in the operator's synchronizer, for sweep delay and for stage delay of the range stop. Besides, the range unit produces the range marker for precision bombing and two-, ten-, and twenty-kilometre scale marks.

Operator's synchronizer (unit P4) is designed for amplification of the I.F. pulses (converted into video pulses and then amplified) for obtaining the sweeps on the operator's indicator, camera CA-PA-1 and the navigator's indicator (when engaged for scanning) for automatic frequency control duties.

Operator's indicator and camera CA-PA-1 (units P5/1 and P5/2) are intended for observing the radar presentation of the landscape, range markers, sighting markers, scale marks, course line, and the IFF equipment pulses yielded by their screens.

Operator's control panel (unit P6) is designed for turning the equipment and controlling its functioning, i.e. connecting and disconnecting power supply, connecting and disconnecting the transmitter, controlling the antenna, selection of the modes of operation, tuning of the receiver, adjustment of the brightness of the markers and the like.

Navigator's synchronizer (unit P7) is intended for shaping and shaping the sighting marker, for synchronous lighting, for shaping and amplifying the video pulses sent to the control electrode of the indicator tube, for generating the voltage of sweep in the navigator's indicator. The synchronizer is connected to indicator P8, navigator's control panel P9 and bombsight ONE-11p via junction box P14.

Navigator's indicator (unit P8) is a combined instrument intended for searching and homing duties.



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When engaged for the searching mode of operation, it is intended for showing on its screen the radar presentation of the locality, range markers, sighting markers, and the pulses sent by the identification equipment.

When engaged for the homing duties, the indicator is used as a sighting equipment of radar bombsight PBN-4 serving for the navigator for performing all operations concerned with lateral aiming and aiming in range accomplished with the aid of observing the display on the indicator screen.

Navigator's panel (unit P9) accommodates all calibration adjustable potentiometers and vital controls of the navigation equipment.

High-voltage rectifier (unit P10) is designed to feed the cathode-ray tubes of indicators P5/1, P5/2 and P8 (+400 V). The rectification circuit employs a half-cycle rectifier.

Rectifier (unit P11) is provided to feed the units of the sight with stabilized voltages of +300 and -300 V and with non-stabilized voltage of +400 V.

Plus 300 V stabilized voltage is supplied to local oscillators and the anode circuits in unit P2, anode circuits of tubes of units P3, P4, P7, P5/1, P5/2, the circuits for adjustment the focusing and brightness of indicator P8, the potentiometers of control panels P6 and P9. Minus 300 V voltage is supplied to the bias circuit of unit P7, the heterodyne tubes of unit P2, and the operator's synchronizing automatic frequency control. The sweep amplifier in synchronizer P4 consumes a non-stabilized voltage of +400 V.

Modulator (unit P12) is intended for shaping the high-voltage pulses modulating the transmitter magnetron generators and for shaping the pulses starting the navigator's synchronizer and the IFF equipment.

#### Air Supply System to Radar Bombsight PBN-4

Regular operation of receive-transmit unit P2, antenna waveguide and modulating unit P12 at flight altitudes of

3000 m. and higher requires that the leakage of air from these units should be made up so that the pressure equal to that on the ground is maintained. For this purpose air is drawn from the seventh stage of the compressor of engine when it is compressed to 6 kg/sq.cm. and is delivered to the valve-equipped connection of modulator P12 from the one-way union of the distributor (the union is common with the system of radar sight NPC-1 via the pressure reducer unit 436) where the pressure of the air is reduced down to 1.1±0.1 kg/sq.cm.; the air is delivered to the modulator connection by means of tubing equipped with air strainers, traps and dehumidifiers.

The air supply is controlled by the navigator-operator with the aid of valve marked AIR SUPPLY (ПОДКАЧКА) and installed within his easy reach.

The air supply system operation is checked by watching the indicator installed on the control panel: when the indicator shows a pressure drop, the valve should be opened, and when the pressure jumps up to the normal value the valve should be closed.

Dehumidifier (Fig.99) is installed under unit P12.

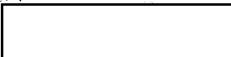
In some aircraft the air is supplied to the sight by an automatic pump engaged as soon as the air pressure drops. The functioning of the air supply system is checked by the warning lamp marked PUMP ENGAGED (ПОМПА ВКЛЮЧЕНА); the lamp is installed on control panel P6.

#### 4. TAIL WARNING RADAR "SIRENA-2"

The tail warning radar is intended to warn the members of the crew that the aircraft is being radiated by the radar emitting unit or radar sight of enemy aircraft flying near it.

To be referred to as D.M.E. (distance measuring equipment).

S-E-C-R-E-T



The warning is effected aurally, through the aircraft intercommunication system or the monitoring circuit of radio set PCNV-3M.

The sound signal tone changes indicate whether the radiating aircraft is approaching or retiring.

Performance Data of the Tail Warning Radar

1. Operating range ..... from 3.15 to 3.45 cm.
2. Sensitivity of the radar within the operating range at the pulse duration of 0.5  $\mu$ sec. and a frequency of 1000 c.p.s. .... not less than  $0.13A10^{-5}$  W
3. Angle of aspect in a vertical and horizontal planes of the rear hemisphere ..... 50 to 80°
4. Power supply ..... 28 V aircraft mains
5. Power consumed ..... 50 W
6. Weight of the radar set less cables ..... 6 kg

Principle of Operation

The tail warning radar is a crystal receiver with a pulse amplifier and audio signal stages. The pulse taken by the antenna via the R.F. connector is sent out to the germanium rectifier and then to the pulse amplifier. From the last stage of the amplifier the pulse passes to the integrator. The pulses generate a pulsating voltage at the output of the integrating circuit whose amplitude is proportionate to the power of the signal received, the ripple frequency equals the pulsed frequency.

The voltage from the integrator output reaches the audio signal channel.

The audio signal channel consists of a multivibrator and audio frequency amplifier.

The multivibrator does not generate pulses when there is no grid voltage of the control tube.

It starts oscillating upon application of pulses exceeding  $0.43 \cdot 10^{-5}$  W to the control tube grid.

The change of the pulse power brings about the change of the multivibrator oscillating frequency.

Upon reception of the pulse the input frequency of the main multivibrator is an intermittent sequence of pulses whose recurrence frequency is a function of the power of the pulses received, the interruption frequency being a function of the circuit components of the modulating multivibrator.

The voltage from the main multivibrator input is amplified in the audio amplifier and is delivered to the control panel from the main multivibrator output via the amplifier connector.

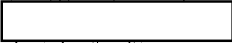
The tail warning radar set includes a gang unit intended to prevent the inadvertent operation of the radar that might be caused by functioning of radar bombsight PBU-4 and radar NPC-1 bombsight.

The gang unit receives the pulse sent out for starting the tail warning radar. After having been converted the pulse is sent out to the integrator of the main unit, thus obviating the oscillation of the main multivibrator and hence the appearance of the audio pulses at the output of the amplifier-indicator unit caused by the signals delivered to its input synchronously with the delivery of the pulses to the input of unit No.4.

From the control panel the frequency audible signals are sent out to the intercommunication system of the aircraft through the divider and to radio set PCNV-3M through the regulator.

Description and Installation

The antenna is a section of the waveguide whose power is transferred with the aid of the loop; it is made integral



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with the crystal receiver head, the connection being accomplished by means of a rigid coaxial section.

The antenna and the amplifier-and-indicator unit are mounted on the port side stabilizer.

The amplifier-and-indicator unit is coated with varnish for protection against moisture.

The control panel is a box with a warning lamp arranged on its side wall indicating the engagement of the station. The side wall of the box also mounts two toggle switches. One of the toggle switches serves for engaging the gang units, and the other, for connecting the audible signal system.

The gang unit is made as a box with a partition on its base for mounting tubes. The wiring and the inner portion of the unit are coated with moisture-proof varnish.

The unit for gang operation with radar bombsight PEI-4 is installed on the starboard, next to unit P12, and the unit for gang operation with the radar gunsight, in the tail portion of the aircraft, next to unit AP17-12A.

Section 4

REDUCTION OF INTERFERENCE  
LEVEL ON THE AIRCRAFT

1. REDUCTION OF INTERFERENCE LEVEL CAUSED  
BY STATIC ELECTRICITY

To eliminate the causes of the dangerous discharges of static electricity, efforts should be made to obtain electric integrity of the aircraft and smooth (sparkless) outlet of the static electricity into the atmosphere. The former is achieved by employing bonding fixtures, and the latter, by static electricity dischargers.

Besides, the aircraft is provided with the following:

(a) automatic charge removers which connect the aircraft structure to the ground as the aircraft touches the runway. In the process of operation, the charge removers should be

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properly maintained, because the aircraft remains charged after returning from the flight if they are out of order, as the rubber tires insulate the aircraft from the ground;

(b) special grounding wires, one of which is thrown from the aircraft before extending the ladder and the other is used to earth the aircraft for parking. The first wire is in special bag of the navigator-radar-operator on frame No.12, and the other (in a similar bag) is in the well of the nose landing gear.

WARNING: It is prohibited to extend the ladder from the aircraft, to touch the latter and to leave it until the first grounding wire has been thrown out.

Bonding of the aircraft is effected:

(a) by directly connecting the separate metal components of the aircraft structure with the aid of bolts, or rivets when manufacturing the aircraft, provided these components do not move relative to each other in the process of operation;

(b) by connecting the components to each other with the aid of bonding strips, provided the latter are made movable.

The bonding strips are made of tin-plated copper braiding of three types (16x10, 110x16 and 116x24) having various lengths. The length is determined by the minimum distance between the points to be connected taking into account the possibility of their travel relative to each other.

The identification marks (spots, strips and dots) made on the bolts and terminals of the bonding strips in red paint serve for checking the quality of the bonding equipment in the process of operation. These marks indicate the contacts which in the process of operation must undergo the inspection.

The components of the aircraft structure are mainly bonded with the aid of rivet joints which does not require installation of any additional equipment. Ten per cent of the rivets are not anodized with a view to ensure a reliable electrical connection of the rivet joints holding the skin

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to the stringers, spars, frames and ribs, connecting the spar bands and rib bands to their webs, and the like. Such rivets are not used in the rivet joints of smaller brackets, stiffeners, control panels, boxes, and the like.

Butt and attachment bolt connections are used for bonding the components of the airframe.

Bonding of the elements of control (rigid members) is effected by connecting them to the airframe with the aid of the bonding strips.

Bonding of the elements of control (cables) is effected by metal sheave blocks installed in addition to the textolite ones and by contacting the cable terminals to the elements of control and the controlled units.

Bonding of the movable units (rudders and elevators, ailerons, trim tabs, bomb bay and engine nacelle doors, and the like) with the aid of strips arranged next to pivots or hinges (Fig.100).

Unbonded are hinged doors and covers whose area is less than 0.2 sq.m. and also doors and covers (irrespective of the area) secured with the aid of bolts or catches.

#### Bonding of the Tanks

The bonding of the fuel and oil tanks as well as of the tanks for hydraulic fluid is effected in the following way:

(a) in rubber tanks the bonding strips connect the metal filler necks to the aircraft structure (Fig.100a). If metal rings are fitted inside the tank, they are connected to each other and to the tank filler neck with the aid of jumpers;

(b) metal tanks have welded lugs which are connected to the aircraft structure by bonding strips.

#### Bonding of Pipes of Fuel-Oil-Air and Other Systems

The metal pipes of the above systems are bonded in the following manner:

- (a) with the aid of metal gaskets placed in the pipe attachment blocks (Fig.100a);
- (b) with the aid of clamps and jumpers;
- (c) with the aid of bonding bands placed in the rubberized pipe connections.

Unbonded are certain sections of the piping up to 0.5 m. long connected by means of rubberized hose and pipes used as pieces in the aircraft structure.

#### Bonding of Equipment Units

The units of the radio and radar equipment, instruments and electronic equipment, instrument panels, boards, distribution boxes, and panel supports are bonded in the following way:

- (a) either by contacting these items directly to the aircraft structure or to panel supports with the aid of the bolts;
- (b) or by using the bonding strips fitted between the units to be bonded (Fig.100a).

Unbonded are switches, selectors, rheostats, indicating lamps and other smaller items of the control and change-over systems installed on metal panels and on the aircraft structure.

#### Electrostatic Dischargers

The electrostatic dischargers are provided for ensuring sparkless discharge of the static electricity accumulated on the aircraft structure into the atmosphere.

The discharger is a duralumin tube, 12x10-mm dia., whose one end is secured to a steel adapter and the other end is cone-shaped and has an opening. Fitted inside the tube is a cotton wick showing some 30 mm from the tube; the free end of the wick is split. The wick is impregnated with a mixture of kerosene (80%) and water (20%) so that its damp end consists of a great number of pointed ends gives away the static electricity.

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25X1

[Redacted]

25X1

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The steel adaptor is screwed into the seat which is rigidly secured to the aircraft structure.

2. INTERFERENCE CAUSED BY ELECTRICAL AND RADIO EQUIPMENT AND METHODS OF INTERFERENCE SUPPRESSION

To suppress the interference caused by the electric and radio facilities do the following:

- (a) try to localize the interference where it is generated;
- (b) protect the receiving equipment from the interference that has penetrated the common circuits.

This is usually done by screening the interference sources and by installing de-coupling capacitors and filters.

Screening is a method of applying metal shielding to all units and wires handling the interference voltage, or units and wires where the interference voltage is induced with a view to removing the capacitive, inductive and electromagnetic effect on the receiving facilities of the radio sets.

The screens of the wires must be properly connected to the aircraft structure. The wires on the aircraft are screened by means of tinned copper shielding slipped over them and connected at its ends to the aircraft structure through the plug connectors (Fig.101).

The screens of the bunched conductors and the wires are connected to the aircraft structure with the aid of clamps having bonding padding. The transient resistance of the clamps between its lugs and the aircraft structure must not exceed 600 microohms.

If the bunch carries only several shielded wires, they must be arranged over the surface of the bunch.

When disconnecting the screened wires, be sure to finish the portions of the screen as it is shown in Fig.101 (see references 12 and 18). As a rule, the screened wires in the aircraft are disconnected as shown in assembly 12.

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De-coupling capacitors. The coupling capacitors are intended for use against the interference with the view of localizing the latter where it appears. The capacitors are installed directly by the electric mechanisms producing the interference and are connected to the plus wires feeding the mechanisms. The body of every capacitor is connected to the aircraft structure.

The de-coupling capacitor is actually an infinite D.C. resistor which freely passes the A.C. of the interference over to the aircraft structure but keeps it off the plus circuit.

Radio filters. The radio filters mounted aboard the aircraft are intended for localizing the radio interference where it is produced (protective filters) as well as for suppressing the interference that has penetrated the radio facilities through the aircraft mains (suppression filters).

The filters comprise D.C. chokes and capacitors intended to handle the current of the specific frequencies only.

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25X1

S-E-C-R-E-T  
25X1

[Redacted]

Controller RH (5) for camera HAA-3c/50 are concentrated on navigator's starboard console between frames Nos 2 and 3. Camera controller RH of camera CA-PT-1 (2) is located for the operator's main control panel.

Chapter 3

PHOTOGRAPHIC EQUIPMENT

Photographic equipment of the aircraft includes:

1. AQA-33 type cameras marked AQA-33/100M, AQA-33/75M, AQA-33/50M for vertical and oblique photography done in day-time;
2. Camera HAA-3c/50 for night time survey;
3. Camera CA-PT-1 for photographing the screen image of radar bombsight PEN-4.

Note: The Manufacturer does not provide the aircraft with cameras AQA-33 and HAA-3c/50.

The location of the photographic equipment carried aboard the aircraft is shown in Fig.102.

Mount unit for day and night photography cameras is arranged in the fuselage between frames Nos 20 and 22. Automatic tilting mount ARAV-156-H for cameras AQA-33 is placed on the upper or lower row of sleeves arranged on the shaped sections of the fuselage beams. In the case of camera AQA-33/100 the tilting mount is placed on the upper sleeves, and, in the case of camera AQA-33/75M or AQA-33/50M, on the lower sleeves.

When it is imperative to install aerial cameras 4 in the aircraft for the night survey, tilting mount ARAV-156-H is removed from the lower row of sleeves and the tilting mount for camera HAA-3a/50 is installed instead.

Camera CA-PT-1 (1) is arranged in the nose pressurized cabin between frames Nos 11 and 12.

Board 7 for controls of the camera hatch and tilting mount ARAV-156-H, camera controller RH<sub>2</sub> (6) and camera

1. AERIAL CAMERAS, TYPE AQA-33M

Aerial camera AQA-33M is intended for vertical and oblique photography of the strips, areas and separate objects on ground and field photographic reconnaissance, for aerial photographic survey and for photographic control of the bombing results.

Camera AQA-33M may be used at various altitudes depending on the scale of surveying.

Table 13 deals with minimum altitudes of the aircraft employment depending on the flight velocity, with the image resolution not exceeding 0.1 mm at various exposures.

Aerial camera AQA-33M is automatically controlled from camera controller installed apart from the camera.

All mechanisms of the aerial camera are actuated and the film is taken into the camera for flattening the film by means of the drive and pressure unit mounted in the common housing.

Data Common to AQA-33M - Type Cameras

- ..... 30x30 cm.
- Number of frames in film magazine ..... 190 - 195
- Length of film loaded into film magazine. 32x6000 cm.
- Duration of photography cycle:
- at t° = +15 - 25°C ..... not exceeding 2 sec.
- at t° = -60°C ..... not exceeding 2.5 sec.
- Power required at t° = +15 - 25°C
- with electric heaters off ..... up to 13.5 A

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Current consumed at  $t^{\circ} = -60^{\circ}\text{C}$  with  
 electric heaters on ..... up to 16 A  
 Camera controller intervals ..... 2 to 60 sec.  
 Voltage required ..... 26 V  $\pm 10\%$   
 Camera normal operation is ensured under the following  
 conditions:  
 Vibration ..... from 10 to 80 c.p.s.  
 Ambient air temperature ..... from  $+50$  to  $-60^{\circ}\text{C}$   
 Relative humidity ..... up to 98%  
 Altitude above sea level ..... up to 12,000 m.

Camera A.A-33M set carried aboard the aircraft includes:  
 film magazine with two spools and film, camera with the  
 objective unit, camera controller, drive and pressure unit,  
 cardan shaft, flexible cable, electric cables, light filters,  
 clock and automatic tilting mount AKAQV-156-H.

The weight of the set:

- camera A.A-33/50M ..... 105 kg
- camera A.A-33/75M ..... 110 kg
- camera A.A-33/100M ..... 120 kg

Minimum Altitude of Survey

Flight speed, km/hr	Exposure of camera														
	A.A-33/50M					A.A-33/75M					A.A-33/100M				
	1/75 sec.	1/150 sec.	1/300 sec.	1/75 sec.	1/150 sec.	1/300 sec.	1/75 sec.	1/150 sec.	1/300 sec.	1/75 sec.	1/125 sec.	1/200 sec.			
1	2	3	4	5	6	7	8	9	10						
	Altitude in metres:														
250	4620	2500	1100	6900	3470	1740	9250	5680	3470						
300	5550	2750	1375	9330	4160	2360	11100	6800	4170						
350	6480	3250	1625	9720	4860	2420	13000	7950	4860						
400	7400	3700	1850	11100	5550	2780	14800	9090	5550						
450	8330	4150	2080	12500	6250	3120	16660	10230	6250						
500	9250	4625	2300	13880	6940	3470	18500	11360	6850						
550	10180	5090	2550	15280	7640	3820	20370	12500	7640						
600	11100	5550	2775	16660	8330	4160	22220	13640	8330						
650	12030	6000	3000	18050	9030	4500	24070	14770	9030						
700	12950	6500	3250	19440	9720	4880	25950	15900	9720						
750		6900	3460		10400	5520		10500							
800		7400	3700		11100	5550		11100							
850		7850	3900		11800	5900		11800							
900		8330	4170		12500	6250		12500							
950		8780	4400		13100	6600		13200							
1000		9200	4650		13900	6950		13900							

Main Performance Data of Type A.A-33M Camera

Description	A.A-33/50M	A.A-33/75M	A.A-33/100M
Objective type .....	"Industar-52"	"Telemar-2"	"Telemar-7"
Objective focal length, cm. ....	50	75	100
Objective relative aperture	1:5	1:6.3	1:7
Angle of coverage along picture side	34°	23°	17°
Type of shutter	louvres	louvres	louvres
Exposure range, sec. ....	1/75; 1/150; 1/300	1/75; 1/150; 1/300	1/75; 1/125; 1/200
Shutter efficiency .....	Not less than 40%	Not less than 40%	Not less than 40%
Light filters	KC-18 CC-14 KC-14	KC-18 CC-14 KC-14	KC-18 CC-14 KC-14

Apart from this the camera set includes:

- (a) special tools;
- (b) fixtures;
- (c) spare parts for electric motors;
- (d) electric lamps.

Components of Serial Cameras A.A-33M

Chamber 1 (Fig.103) is a cast rectangular body whose upper portion is called easel. On both sides of the easel are arranged latches 6 which secure the film magazine to the

chamber. The right wall carries camera actuator 7, socket 13 for connecting the electric cord, seat 8 with a lamp holder to illuminate the counter, counter knob 9 intended to set the counter at zero.

The left wall of the body accommodates the following: a nozzle to connect the hose delivering air inside the camera for flattening the film, seat for the clock, and seats for the holders receiving the clock and level illuminating lamps.

Journals on the front and rear walls of the chamber attach the latter to the camera tilting mount. Besides the journals, the rear wall of the chamber is provided with a sliding level for bringing the focal plane of the camera to a horizontal position. The level division runs into 60 min.

The recording instruments (level, clock and digits of the exposure counter) are illuminated by electric lamps and photographed on the film via the recording objectives.

Objective portion 10 is rigidly attached to the lower base of the chamber.

Objective portion includes the housing, objective lens, shutter, protective covers and mechanism transmitting the magazine speed gear motion to the shutter. The protective covers safeguard the objective lens and prevent the film from being lightstruck through the shutter lamels if they are not adjusted close to each other.

Secured on the body of the objective portion is disc with knob 12 arranged rightward for changing the exposure setting. At the bottom the objective portion is protected with cover 11.

Cameras A.A-33M are furnished with appropriate objective lenses (See Table). The objective lens surfaces are coated. The filter speed should be taken into account when the light filters are made use of.

The louvre-type shutter with the electric heaters is set inside the objective housing between the lenses. The film magazine mechanism is arranged inside the body and comprises the following units:



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- (a) actuator;
- (b) measuring mechanism;
- (c) flattening mechanism;
- (d) cut-off mechanism;
- (e) friction;
- (f) meter;
- (g) film rewinding indicator.

Actuator serves for transmitting the motion of the drive mechanism to the film magazine.

Measuring mechanism carries the motion of the actuator to the measuring roller and serves for rewinding a constant portion of film equalling the length of the picture plus intermediate area.

Flattening mechanism presses the film to the camera easel and flattens it by the flow of air at the moment of exposure.

Cut-off mechanism is intended to disengage the film magazine mechanism from the camera actuator, with the gates being closed, so as to prevent damage to the latter.

Friction serves for slipping the take-up spool as its diameter is changed while the film is being rewound and for ensuring the tight winding.

Metre indicates the amount of non-exposed film on the supply spool in metres.

Film rewinding indicator shows that the camera and film transport mechanism function properly. The film magazine is provided with mechanical and electrical indicators. The mechanical indicator is a disc whose sectors are painted white and black. The electrical indicator makes and breaks the appropriate contacts to send the current impulses to the lamp of camera controller KIV.

Camera controller KIV2 of the universal type is intended for remote control of the camera. It allows to:

- (a) automatically keep the time interval between the exposures within 2 to 60 sec.;
- (b) make single exposures;

- (c) automatically control the bombing results;
- (d) govern the camera operation by flickering of the indicating lamp;
- (e) engage the air camera for continuous operation;
- (f) determine the number of exposures made;
- (g) engage and disengage the camera controller electric heaters.

The camera controller (Fig. 104) is shaped as a rectangular box with mechanism KIV2 mounted inside it. All controls and indicating devices are located on the front panel. Fixed in the centre of the panel is setting dial 7 with white scale 4 made throughout its circumference. Scale divisions from 2 to 60 sec. correspond to time intervals between the exposures. Division value of the scale amounts to 1 sec.

Marked between the divisions of 2 and 60 sec. is the infinity symbol ( $\infty$ ) for non-automatic operation controlled by the SINGLE EXPOSURE (ОДНОКРАТНОЕ СЪЕМКА) button.

Made on the cover is yellow scale 8 whose divisions correspond to the bombing altitudes. The value of every division of the scale is equal to 0.5 km.

Arranged under setting dial 7 are three buttons; central button 16 serving to start the instrument, right button 15 to stop the instrument, and left button 18 to make single exposures. To the right and left of the buttons two groups of selectors and switches are located. The camera controller is changed over to BOMBING CONTROL (ОДНОКРАТНОЕ СЪЕМКА) or survey with intervals (ИНТЕРВАЛ) with the aid of selector 13. Switch 12 is engaged only if the camera must operate continuously, i.e. with the intervals between the exposures equalling the camera operation cycle.

Switch 2 is intended to turn the camera controller electric heater ON and OFF.

Selector 1 and indicating lamp 5 are not used in set with camera automatic tilting mount АА.У-156-Н (the indicating lamp must be taken out of the lamp holder and the selector left in the ON position).

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Indicating lamp 6 lights after the instrument is energized, i.e. after pressing starting button 16 or when setting the dial at infinity ( $\infty$ ).

Indicating lamp 9 flickers in case of normal rewinding of the film. Besides, when selector 13 is brought to BOMBING CONTROL (КОНТРОЛЬ БОМЕОМ ТАЙМА), the lamp light indicates that the camera controller mechanism has assumed its original position and is ready for automatic bombing control.

Located to the right of setting dial 7 is exposure counter 11 (division value of the drum amounts to 5 exposures). All in all the counter shows 400 exposures. The digital drum is set at zero by rotating disc 10 in the direction indicated by the arrow.

Changeable fuse link BN-20 is placed under cover 3.

Twelve-pin plug 14 of the camera controller is mounted on the lower wall. Set next to it is two-pin plug 17 with the two-core cord of the electric bomb release connected to it. The current impulse from the electric bomb release is supplied through this cable.

The controller is secured to the aircraft main structure with the aid of a part having a dove-tail shape. The rear wall of the camera controller is provided with a recess receiving the dove-tail.

The camera controller comprises the following main units:

- (a) actuator;
- (2) central mechanism for closing the starting contact;
- (3) exposure counter;
- (4) electric heater;
- (5) valve, choke and capacitor (for reducing the radio noise).

All mechanisms of the aerial camera are set in motion and the air is delivered to the chamber portion by means of drive and pressure unit 2 (Fig.103).

Two electric motors MA-4CA are mounted inside the sleeves screwed to the body of the unit.

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The camera drive electric motor operates upon receiving the current pulse sent by the camera controller in preset time intervals. Its operation lasts not more than two seconds ensuring complete operation cycle of the camera.

The electric motor of the air blower is engaged in operation simultaneously with starting of the camera controller functioning upon pressing the START (ИЗК) button. It functions as long as the air survey is performed.

Heaters. When camera A9A-33M operates under subzero temperatures within a range of  $-15^{\circ}\text{C}$  to  $-60^{\circ}\text{C}$ , the electric heater of camera controller KHV2 should be switched on through switch 2 (Fig.104). Electric heaters of the clock and shutter are switched automatically through the thermoregulator when the temperature keeps within  $+3^{\circ}\text{C}$  to  $+13^{\circ}\text{C}$ .

#### Tilting Mount AKAW-156-H

Tilting mount AKAW-156-H (Fig.103) is intended for mounting aerial camera A9A-33M in the aircraft and for reducing the vibration.

The camera mount unit is located in the central part of the fuselage between frames Nos 20 and 22 where two rows of seat sleeves 15 are set on the profiles of the landing gear beams to install the tilting mount with the aid of spring-loaded shock absorbers. The tilting mount is made up of three frames hinged together.

Frame 20 is fixed rigidly; four spring-loaded shock absorbers and setting screws are provided in its corners for levelling the tilting mount.

Note: When the tilting mount is used for aerial camera A9A-33/100M, spring-loaded shock absorbers 16 marked (on the cover) F = 1000 mm are installed; for aerial cameras A9A-33/75M or A9A-33/50M use shock absorbers marked F = 750 mm.

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Electric mechanism MY-2 (19) is fixed to the frame starboard portion. Its rated voltage is 26 V  $\pm 10\%$ , rated torque equals 100 kg-cm. and rated current consumed under rated load is 8.5 A.

The output shaft of the electric mechanism carries bevel gear wheel 18 engaged with gear 57 on the axle of cam shaft 56.

The cam shaft is provided with seven cams 49, 50, 51, 52, 53, 54, 55 with seven microswitches BK-1-140 arranged against the cams on the frame panel. Cam 55 serves for blocking the bombing control mode of operation. Cams 54, 53, 52, 51, 50 are used for fixing frame 27 in  $0^\circ$ ,  $15^\circ$ ,  $10^\circ$ ,  $20^\circ$  and  $25^\circ$  positions. Cam 49 engages the tilting mount for reverse run after setting it at  $0^\circ$ .

Besides, the shaft is furnished with two spur gears 48 meshed with toothed quadrants 40 fixed to middle frame 27.

When electric mechanism 19 starts operating, gear wheels 48 rotate to shift quadrants 40 thereby turning frame 27 together with inner frame 29 and aerial camera around semi-axles 21. The aerial camera will be tilted only backwards through angles  $0^\circ$ ,  $10^\circ$ ,  $15^\circ$ ,  $20^\circ$ ,  $25^\circ$  and stop in any of the above positions depending on the desired angle at which the angle-of-tilt selector on the tilting mount control panel is set.

At this setting the camera performs one-strip oblique survey (except when set at  $0^\circ$ ). This mode of the tilting mount operation is called BOMBING CONTROL. It engages cameras AQA-33/100M, AQA-33/75M and AQA-33/50M.

Frame 29 serves for attaching the aerial camera and for performing the two-strip photography.

The journals of cameras AQA-33M are set in the sockets where hinged covers 24 lock them. In its turn the cover is secured with the aid of hinged clamp 25 with stop 26. Besides, the journals are additionally secured with locking screw 22 with a view to obviating the possible play.

Provided in the front part of the frame is locking screw 41 with a spherical washer securing the bracket of the aerial

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camera journal. The rear wall of the frame has bracket-plate 23 for mounting the drive and pressure unit.

Socket 30 is provided for connecting the power source to the camera controller when checking the tilting mount functioning on the test-stand or on the ground. Button 31 sends pulses to relay PH-2 when starting the inner frame to move from the extreme positions and when checking the tilting mount functioning in the AERIAL RECONNAISSANCE (PASBEZKA) mode of operation with the aerial camera removed.

Located on the left side (looking forward) of the lower portion of frame 29 is split box 43 accommodating the following:

- (1) relay PH-2 for starting the frame to move from the extreme positions;
- (2) relay MP-2 of the reverse movement;
- (3) relay K25A of the angle-of-tilt mechanism;
- (4) relay K24A of the tilting mount mechanism;
- (5) split receptacle.

Located above the box is electric mechanism MY-2 (28) which serves for turning frame 29 with the aerial camera around semi-axes 42 to the port or starboard side. In this instance the aerial camera performs two-strip oblique photography in the extreme positions. This mode of the tilting mount functioning is called AERIAL RECONNAISSANCE (PASBEZKA).

The output shaft of electric mechanism 28 carries spur gear wheel 28 which is engaged with gear wheel 39 fitted onto cam shaft 32. Microswitch BK-1-140 is set on panel 33 against cams 34. Microswitch 35 disconnects the electric mechanism when frame 29 assumes its extreme positions. Microswitch 36 operates when the tilting mount comes to the zero position; it cuts off the current supply via relay PH-2 and simultaneously cuts in the indicating lamp on the photographic equipment panel. Microswitch 37 is used for blocking the RECONNAISSANCE mode of operation.

The inner frame is tilted in the AERIAL RECONNAISSANCE mode of operation with the aid of link mechanism comprising ball-crank 47, slider 46 and dovetail 44. This mechanism is

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also used for changing the frame tilting angle from 6°30' to 8°30' or vice versa, which is done by resetting slider 46 relative to dovetail 44 and fixing it for the desired operation modes with the aid of screw 45.

The proper setting of the air camera is checked in the BOMBING CONTROL and AERIAL RECONNAISSANCE modes of operation with the aid of level brought to its sides.

**Note:** The frame is departed from the vertical through 6°30' when placing air camera A2A-33/100M on the tilting mount, and through 8°30' when placing camera A2A-33/75M. Air camera A2A-33/50M is not used in the AERIAL RECONNAISSANCE mode of operation, as the edges of the camera hatch cut the field of vision of the camera when the latter is tilted to the board side.

The tilting mount is governed from the photographic equipment control panel (Fig.105) arranged on the navigator's starboard console.

Switch 3 (Fig.105) controls opening and closing of the camera hatch doors. When the camera hatch doors are open, the green indicating lamp lights up.

If the camera window doors are closed, the camera and tilting mount do not function.

#### Functioning of Camera Mount Unit

Survey with preset intervals. Setting dial 7 of the camera controller (Fig.104) should be brought to the preset interval (5 - 7 sec.), and selector 13 to position INTERVAL (INTERVAL). Starting button 18 is pressed to apply voltage to the camera controller electric motor, aerial camera and drive-and-pressure unit. The air blower starts delivering the compressed air to the camera and at the moments of exposure the film will be pressed to the platen of the film magazine.

The camera controller sends current pulses to the electric motor actuator of the camera. The motion of the aerial camera is transmitted to the film magazine with the aid of the actuator head, and the film starts immediately rewinding (beginning of the camera operation cycle), the platen comes down to the camera case, the pressure of the air in the camera goes up to press the film to the platen. Simultaneously the shutter in the camera objective lens gets wound and the objective cover gets opened.

As the shutter operates, the contacts in the chamber engaging the recording instrument lamps (clock, level and counter) whose indications are recorded on the film get closed.

After functioning of the shutter the contact-pulse mechanism of the chamber gets closed to send pulses to tilting mount ANKAV, and if the latter is set at AERIAL RECONNAISSANCE (PARABEZNA), electric mechanism 28 (Fig.103) will operate and the camera will come from one extreme position to the other. At the same time the film magazine platen comes up to set the film free so that the take-up spool will draw the film from the supply spool.

As the film is being rewound, the mechanical and electrical indicators in the film magazine operate. The mechanical indicator operates upon rotation of the indication drum arranged on the semi-axle of the supply spool, the electrical indicator showing the film rewinding by short flickers of lamp 9 (Fig.104) of the camera controller marked REWINDING (PEREKOTKA).

The camera operation cycle comes to its end when the platen in the film magazine has assumed its uppermost position and the indicator on the driving axle of the film magazine has come against FREE (SVOBODNO). In this position the gate may be closed and the film magazine removed.

Single exposures and continuous operation. For making single exposures setting dial 7 (Fig.104) should be brought to infinity ( $\infty$ ), after which indicating lamp 6

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marked CURRENT ON (ТОК ВКЛЮЧЕН) lights to show that the system is energized.

Single exposure requires that SINGLE EXPOSURE (ОТРАЗОЖЕНА ЧИСТОТ) button 18 should be pressed. In this instance the camera makes one exposure and stops. The operation cycle is repeated upon pressing the button again.

The camera is changed over for continuous operation with the aid of switch 12 of the camera controller. The setting dial must be brought to infinity ( $\infty$ ), and selector 13, to INTERVAL (ИНТЕРВАЛ).

Photographic control of bombing results. For the automatic control of the bombing results the electric bomb release cord should be connected to the camera controller and the bomb release button.

The yellow triangular index of setting dial 7 (Fig.104) should be brought against the desired altitude on yellow altitude scale 8. Selector 13 should be set at BOMBING CONTROL (КОНТРОЛЬ БОМБОСТАВАННЯ). Directly before releasing the bombs the camera controller should be out in by pressing START (ПВСК) button 16 which is followed by lighting of red indicating lamp 6 labelled CURRENT ON (ТОК ВКЛЮЧЕН) and green indicating lamp 9 labelled READY FOR BOMBING CONTROL (ГОТОВ К КОНТРОЛЮ БОМБОСТАВАННЯ). The camera controller motor starts operating. Lamp 9 goes out as the bomb release button is pressed (0.2 to 0.3 sec. long). In a period of time depending upon the preset altitude, i.e. 10 sec. before the burst of the bomb, the camera electric motor starts operating and functions continuously as long as 25 sec.; lamp 9 flickers to indicate that the film is being rewound properly. In 25 sec. lamp 9 stops flickering and lights again to show that the system has assumed its original position READY FOR BOMBING CONTROL (ГОТОВ К КОНТРОЛЮ БОМБОСТАВАННЯ).

During 25 sec. of continuous operation camera A1A-33M makes 11 - 13 exposures; 5 or 6 of them made before the burst of the bomb and 6 or 7 exposures after.

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During the next survey approach the photography is done in the same sequence.

#### Camera Hatch

Made in the fuselage skin between frames Nos 20 and 22 is camera hatch (Fig.106) sizing 450x560 mm with remote control from the navigator's panel of photographic equipment (Fig.105).

Electric mechanism VP-7M (1) actuates doors 17 (Fig.106) to draw inside the fuselage along guides 14 and 16 with the aid of linkage.

Electric mechanism VP-7M operates to impart motion to driving shaft 2 on the opposite end of which driving pulley 12 with steel bands 13 looped over it is mounted to transmit rotation to the pulley of the driven shaft. Turnbuckles 11 connect bell-cranks 10 to the camera hatch doors. Driving shaft 2 carries four cams 4 and two protective limiters 9 which safeguard box 3 with the microswitches against damage.

Microswitch 5 serves for disengaging electric mechanism VP-7M when the camera hatch doors are open and for applying voltage to the indicating lamp on the photographic equipment panel labelled CAMERA HATCH OPEN (ОКОН ОТКРЫТ). Microswitch 6 disconnects the electric mechanism feed when the camera hatch is open. Microswitch 7 is intended to interlock the controller of camera A1A-3c/50, and microswitch 8 is intended to interlock the controller of camera A1A-33M.

#### 2. AERIAL CAMERA A1A-3c/50

Aerial camera A1A-3c/50 (Fig.107) is intended for night photography. It can be used for single exposures and short-strip survey. The aerial camera is an automatic device remotely governed from the camera controller. The exposure is done automatically by the flare of photoflash bomb. The camera mechanism is actuated by electric motor MA-40M.

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## Main Data of Camera HA.A-3c/50

Objective ..... Industar-52  
 Objective lens focal length ..... 50 cm.  
 Objective lens relative aperture ..... 1:5  
 Camera field-of-vision angle:  
 along picture longer side of 24 cm. . 27°  
 along picture shorter side of 18 cm. 20°  
 along diagonal ..... 34°  
 Picture size ..... 18x24 cm.  
 Number of pictures ..... 150  
 Type of shutter ..... louvres  
 Exposure in seconds ..... 1/25, 1/50, 1/100  
 Shutter efficiency:  
 for 1/25-sec. exposure ..... not less than 50%  
 for 1/100-sec. exposure ..... not less than 45%  
 Shutter lag ..... not more than 1/60 sec.  
 Current consumed, at 26 V and t°  
 within +10 to +30°C ..... not more than 12 A  
 Current consumed, at 26 V and  
 t° = -60°C ..... not more than 13.5 A  
 Time of operation cycle at 26 V in  
 the mains and t° = +10°C to +30°C .. not more than 3 sec.  
 Camera, film magazine, camera control-  
 lor and converter function at an  
 ambient air temperature of ..... +50°C to -60°C  
 Automatic release operates at an  
 ambient temperature ..... +35°C to -60°C  
 Shutter operates under illumination  
 intensity of automatic release  
 photocell ..... 2 to 15 lux  
 Operating voltage of camera HA.A-3c/50 26 V ±10%  
 Camera mount unit ensures survey at  
 angles ..... from 0° to 25° with  
 intervals of 2°30'

The flight set of camera HA.A-3c/50 includes: film  
 magazine with two spools and film, chamber with the cone,  
 objective shutter and electric motor MA-40A, camera controller,  
 automatic release AC, converter PV-45A, camera mount unit and  
 electric cards.

The weight of the flight set runs to 46 kg.

In addition to the above the delivery camera set includes:  
 (a) special tools; (b) various fixtures; (c) spare parts for  
 electric motor, automatic release and converter.

Aerial camera is located in the fuselage between frames  
 20 and 22.

When camera HA.A-3c/50 is employed, tilting mount AKAFV-156-H  
 could be removed and the appropriate tilting mount installed  
 in the lower row of sleeves instead.

## Description of Components of Camera HA.A-3c/50

Film magazine 3 (Fig.108) is an autonomous part of the  
 aerial camera intended for arranging, rewinding, measuring the  
 aerial film and for protecting it against light-striking. The  
 film magazine accommodates 37-m. length of film, 19 cm. wide.

The film magazine consists of a case and mechanism. The  
 upper surface of the case bears arrow 5 showing the position  
 of the camera relative to the aircraft attitude. Celluloid  
 plate 4 is secured to the upper surface of the case, too, for  
 locking entries.

Gate 6 in the base of the film magazine case protects  
 the film against being light-struck when the film magazine is  
 moved from the chamber portion.

The film magazine mechanism comprises three main units:  
 (1) rewinding mechanism;  
 (2) measuring mechanism which serves for measuring  
 required amount of film equalling the length of frame plus  
 immediate area;  
 (3) mechanism flattening the film at the moment of  
 exposure.

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Chamber portion 2 of aerial camera is a cast rectangular body with objective-lens-bearing housing attached to its lower portion, and flattening glass plate with the latch in the upper portion for securing the film magazine to the chamber. The rear wall of the chamber has a hole with a threaded plug which receives the crank for testing the camera operation. The chamber portion accommodates mechanism consisting of (a) dynamic brake relay meant for speedily braking the electric motor axle and all the mechanism of the chamber portion after discontinuing the power supply to the electric motor; (b) transmission mechanism intended for imparting the motion to the shutter, film magazine and counter; the latter serves for recording three-digit number of the picture.

Cone 17 is intended for securing the objective housing with the shutter. Three brackets 14 are attached to the cone for setting the aerial camera in the camera mount unit.

Shade 6 with the protective cover is put on the cone with the view of safeguarding the shutter and objective against damage and of limiting the side rays of light. Exposure setting knob 15 is secured on the outer surface of the cone shade.

A louvre-type shutter is mounted between the objective lenses. The shutter mechanism comprises the actuator, the operating gear consisting of lamels and pinions, exposure setting mechanism and releaser mechanism.

Automatic releaser 18 is provided for sending the current pulses to the shutter electromagnet when the photo-flash bomb explodes.

Photocell 11F-1 is cesium, gas-filled. Amplifier tube 616C is intended to amplify the photoflux whose intensity is too weak. After that the amplified current is directed to the shutter electromagnet which in turn ensures operation of the shutter.

Converter PV-45A (1) is designed for converting the low voltage across the aircraft mains to high voltage necessary for the operation of the amplifier tube and photocell.

Camera controller (Fig.108) serves for remote governing camera MA-A-3c/50.

Housing 7 accommodates common switch 1, indicating lamp 2 labelled REWINDING (HPC. BCTKA), indicating lamp 3 labelled CURRENT ON (TON. BKJH. EH), indicating lamp 4 labelled ILLUMINATION (HOC. BCTKA), starting button 5 labelled CHECK-UP (HPC. BPKA), heater switch 6 and connector plug 8. Common switch consists of two switches having one common handle.

When the operation is over, the common switch should be set to OFF (BPKA. LHO). One of the switches disconnects the light photography circuit, the other switch cuts in the camera electric motor circuit so that the camera should complete half of its cycle before the film magazine platen has assumed its uppermost position.

When common switch 1 is "ON" the aerial camera electric circuit is closed and the camera is prepared for operation. Indicating lamp 3 labelled CURRENT ON (TON. BKJH. EH) lights up.

As the film is being rewound in the process of the camera operation, REWINDING (HPC. BCTKA) indicating lamp 2 flickers. CHECK-UP (HPC. BPKA) button 5 serves for checking the aerial camera operation.

Heater switch 6 serves for engaging the shutter heater into operation.

Mount Unit for Camera MA-A-3c/50

The mount unit serves for setting the aerial camera at angles of 0°, 2.5°, 5°, 7.5°, 10°, 12.5°, 15°, 17.5°, 20°, 22.5° and 25° relative to a vertical plane opposite to the flight direction and for reducing the effect of the aircraft vibrations on the quality of the pictures.

Mounted on the outer frame of the mount unit (Fig.107) are four spring-loaded absorbers 11 intended for arranging the camera mount unit in the sleeves attached to the aircraft main structure. Inner frame 9 is connected to outer frame 12 with the aid of semi-axles 13.

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The tilt of the inner frame is fixed with the aid of spring-loaded catch 8 which enters the hole of sector 7 located on the outer frame.

The camera is turned and set at required angle before the flight depending on the mission assigned to the aircraft.

Inner frame 9 has four lugs. Two of them are slotted to receive the bolts of the aerial camera brackets with the aid of which the aerial camera is secured to the mount unit.

The automatic releaser is secured to the suspension bracket with the aid of the dovetail; converter PV-45A is installed on special platform of the outer frame. All members of the aerial camera are connected by means of electric cords equipped with plugs and sockets.

#### Functioning of Air Camera HASA-3c/50

After setting common switch 1 (See Fig.108) into ON (ВКЛЮЧЕНО) position the indicating lamp marked CURRENT ON (ТОК ВКЛЮЧЕН) lights on the camera controller showing that the voltage is supplied to the filament of the amplifier tube in automatic releaser and converter PV-45A is engaged into operation. At the same time the aerial camera electric motor receives power and starts rotating, thereby imparting motion to the mechanisms of the film magazine, shutter and counter. The measuring rollers of the film magazine rewind half the picture and get disengaged.

While the film is being rewind, the REWINDING (ПЕРЕМОТКА) indicating lamp on the camera controller flickers. The film having been rewound, the film magazine platen lowers down on the glass plate of the chamber portion of the shutter and the successive digit designating the picture springs in the counter.

As soon as it happens the electric motor and all mechanisms of the camera chamber portion, film magazine and shutter stop immediately. In this position the aerial camera is ready for operation.

The operation cycle of the aerial camera is performed as follows:

- (1) exposure (beginning of the cycle);
- (2) rising of the film magazine platen;
- (3) beginning of the film rewinding process;
- (4) termination of the film rewinding process;
- (5) closest pressure of the platen;
- (6) breaking of the interlocking contacts (termination of the cycle).

When the photocell is illuminated by the flare of the photoflash bomb, its circuit induces current which is then amplified by the amplifier tube and sent to the shutter releaser electromagnet. The armature of the releaser electromagnet draws itself to the core actuating the camera shutter to operate. The film is being exposed and the counter digits are photographed on the film. Then the camera electric motor is engaged in operation rising the platen, rewinding the film and lowering the platen. All this done, the motor comes to standstill.

#### Installation of Camera HASA-3c/50

The aerial camera is installed in the fuselage between frames Nos 20 and 22 on the lower row of cast sleeves provided with the profiles of the landing gear fore-and-aft booms placed 210 mm below the upper row of sleeves. The mount unit is secured to the sleeves by means of union nuts 10, and the aerial camera is placed on the inner frame and fixed with the nuts fitted on the camera.

Automatic releaser A.C. is secured to suspension socket 20 by means of dovetail, the automatic releaser lensular aperture facing the camera hatch hole. The dovetail is used for attaching converter PV-45A on the platform of the camera mount unit outer frame. Camera controller RH is mounted on the navigator's panel by means of a dovetail, too. In this instance the platform for the dovetail used for



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mounting camera controller KHV2 is removed and a dovetail for the controller of camera HA9A-3c/50 is fixed in its place.

3. AERIAL CAMERA OA-PM-1

Camera OA-PM-1 is automatic and remotely controlled. It is designed for photographing the image of the cathode-ray tube screen of radar bombsight PSH-4 while performing sector and circular scanning.

Main Data

Operating voltage of camera .....	26 V $\pm$ 10%
Type of objective .....	Uran-10
Objective lens focal length .....	10 cm.
Objective relative aperture .....	1:2.5
Diaphragm .....	iris
Picture size and shape .....	circular, 13-cm. dia.
Film dimensions:	
width .....	19 cm.
length .....	2850 cm.
Number of pictures taken without reloading	
film magazine .....	200
Operation cycle .....	in every 2, 5, 10, 20 revolutions of antenna or sector scans
Current consumed:	
with heater OFF .....	5.3 A
with heater ON .....	15.6 A
Temperature range of operation .....	from +50°C to -60°C
Relative humidity .....	up to 98%

The flight set of camera OA-PM-1 includes the chamber with conc. objective and silica gel cell, film magazine with two spools and film (two lengths), camera controller, electric cards, casing, camera mount unit, sight, clock. The flight weight of the set amounts to 30 kg.

Units of Camera OA-PM-1

Chamber 13 (Fig.109) serves as a connecting link between the conc and the film magazine.

Located in the upper portion of the body is the focal plane of the camera which is a rectangular window glazed with flattening glass. Film magazine 14 is attached to the upper part of the chamber.

Silica gel cells are provided in the rear part of the chamber portion. In the left part of the chamber body, located under the cover, is the change speed mechanism whose motion is imparted to the film rewinding mechanism, exposure counter, distributing roller governing the lifting of the platen and closing the contacts.

Knob 17 serves for checking the manual operation of the camera which functions exactly as it does when driven by the electric motor.

Arranged on the left part of the chamber are eight-pin plug 24 and potentiometer knob 23 intended for changing the illumination intensity of the recording instruments as required by sensitivity of the film employed for survey.

Electric motor MA-40A, plug and socket connector, dynamic make relay of the electric motor armature, clock and exposure counter which are projected on the film with the aid of special objective are placed on the front wall of the body under cover 12.

Two spiral heaters of the chamber and the heater of the film mechanism in the box are accommodated inside the chamber body. The electric heaters are cut in by means of the thermo-

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regulator when the temperature inside the chamber is  $8 \pm 5^{\circ}\text{C}$ .  
Cone. One end of the cone is secured to the chamber portion. The other end of the cone is attached to the jacket with indicator 1 of radar bombsight PEN-4 secured to it by means of clamp 2.

The jacket is provided with sight 27 which enables the operator to observe the indicator screen during the survey. The right part of the sight is made "blind" so that the observation is carried out by one eye only. The jacket is provided with outer casing which is turned to align the oval ports of the inner jacket and outer casing through which the indicator screen is accessible for cleaning and the shutter can be opened manually for focusing the camera. The focusing is accomplished with the aid of rings 5 turned in a vertical plane over the threaded portion of the cone body.

The shutter accommodated above the camera objective is opened by means of special electromagnet. When the camera is being focused, the shutter is opened by hand with the aid of special lever. The manual shutter opening mechanism is accommodated outside the objective, the lever being accessible through the oval ports in the jacket. The diaphragm setting lever is arranged there, too. When the shutter is fully open, the appropriate contact gets closed to make the circuit of the camera controller indicating lamp 5 (Fig.110) marked SHUTTER (SABOP), after which the lamp lights up and keeps on while the shutter is open.

Film magazine is intended for rewinding, measuring, flattening the film when it is being exposed, and for protecting it against being light-stricken.

Film magazine 14 (Fig.109) is made up of the base to which side pieces are attached for mounting the rewinding mechanism and the cover. The left side wall of the film magazine carries the output end of driving shaft of the film rewinding mechanism and disc 15 of the mechanical indicator; placed under jacket 16 are the four-pin plug connecting the film magazine electric circuit with the chamber and the push-

rod actuating the platen raising lever. The right side wall mounts movable semi-axes of the spools, the meter of the non-exposed film and the film magazine carrying belt being arranged in the centre of the side wall. The film magazine mechanism mounted inside the film magazine comprises the following main parts:

- (a) rewinding mechanism;
- (b) flattening mechanism of the film magazine which serves for flattening the film;
- (c) friction mechanism arranged on the take-up spool and intended for slipping the supply spool;
- (d) film rewinding indicator which shows that the camera and rewinding mechanism function properly; the film magazine is provided with electrical and mechanical indicators;
- (e) meter showing the amount of the non-exposed film left; the meter scale is marked in metres.

The inner part of the film magazine carries two box-shaped electric heaters; besides, the electric heaters are fixed in the metering and guiding rollers.

The inner surface of the film magazine is lined with sheet cork for reducing the heat loss.

#### Camera Controller

Camera controller (Fig.110) serves for remote control of camera CA-PM-1 operating in conjunction with radar bombsight PEN-4.

The camera controller allows to:

- (a) engage and disengage the aerial camera;
- (b) take pictures at desired frequency (every 2, 5, 10 and 20 revolutions of the antenna);
- (c) carry out survey under sector and circular scanning modes of operation;
- (d) perform single exposures;
- (e) govern the functioning of the camera by the indicator lamps;

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(f) show the number of the exposures made.

Arranged in the right part is exposure counter drum 8 with a division value of five exposures. The digital drum is illuminated from the inside. It is set at zero by means of disc 7.

Three indicating lamps are set above it. Red indicating lamp 6 lights when the common switch is brought to the ON (ВКЛЮЧЕНО) position. The green indicating lamp shows that the film magazine functions properly; it flickers when the film is being rewound in the film magazine. Yellow indicating lamp 5 lights up brightly when the shutter is open all the way out. When packet-type switch 14 is changed over to SINGLE EXPOSURE (ОДИНОВЧЕВЫЙ), lamp 5 periodically goes out and lights up at half glow. To get a good picture press the button when lamp 5 has gone out.

In the left part there is a plate for making entries. The lower portion of the camera controller is provided with four sockets. Socket 12 marked "MAINS 26 V" (СЕТЬ 26 В) supplies power to the whole camera controller; socket 13 for an eight-pin plug marked CAMERA (КАМЕРА) receives the electric cord connecting the camera controller with the camera; four-pin plug 15 marked RADAR (РАДОНОСКАТОР) supplies pulses from the antenna circular scanning mechanism of radar bombsight PBN-4 and pulses from the sector scanning antenna relay. Plug 16 is not used here. The rear wall of the camera controller is furnished with a dovetail for attaching the camera controller to the aircraft main structure.

The principal mechanism of the camera controller is a camloaded relay which is an electro-magnet device converting the current pulses coming from the antenna unit of radar bombsight PBN-4 into mechanical travel of the cams closing the contacts that send the pulses to the shutter and electric motor of the camera.

To make the operation of the camera controller units more reliable, the camera is provided with an electric heater which is cut in automatically by means of the thermoregulator

at an ambient temperature of  $+8^{\circ}\text{C}$   $\pm 5^{\circ}\text{C}$  and cut out when the temperature comes to  $+25^{\circ}\text{C}$   $\pm 5^{\circ}\text{C}$ .

#### Camera Mount Unit

The camera mount unit (Fig.109) is used for carrying the aerial camera and the indicator of radar bombsight PBN-4. The mount unit comprises the lower fixed frame which in turn is made up of two brackets 8 and 11. One end of the lower frame is secured to the profile of the operator's console holder by means of the support, and the other end, to the operator's central panel holder.

Sleeves 20 of the fixed portion of the camera mount unit receive movable frame consisting of two posts 22, guiding pipes 28 and base 9 with spring-loaded shock absorbers 18 on which the aerial camera is mounted.

Shock absorbers 18 are held to sleeves 20 by union nuts 19. To reduce the vibration of the camera mount unit during the take-off and landing, the frame together with the camera mounted on it is braced with the aid of three spiral springs 4. The indicator of radar bombsight PBN-4 is attached to the movable jacket by its upper part and to the pipe of post 28 with the aid of bracket 29. The camera mount unit is removed and installed together with the camera but without the film magazine. To avoid breaking of the shock-absorber springs during the aircraft landing, the bottoms of sleeves 20 are lined with felt pads.

The camera and camera controller are connected by means of a number of length of electric cord. Besides, special cords connect the camera controller with the aircraft mains and the antenna equipment of radar bombsight PBN-4. The plug of the first (power) cord is connected to the socket of the camera controller, the other end of it provided with a plug, too, is connected to the aircraft mains and engraved MAINS (СЕТЬ).

The thicker pin should be connected to the plus. If this condition is not observed, the electrolytic capacitor unit will fail.

The other electric cord - the one of the radar - serves for connecting the camera controller with the antenna equipment. One end of this cord is connected to the plug marked RADAR (РАДМОНОКАТОР) on the camera controller, and the other, split end, to the antenna microswitch for the circular scanning mode of operation and to the reversing relay of the antenna operating for sector scanning. The third cord connects the camera to the camera controller.

Mount Unit of Camera QA-PJ-1

The mount unit for camera QA-PJ-1 is installed in the fuselage between frames Nos 11 and 12 and secured to the operator's starboard console holder and to the operator's panel holder arranged on frame No.12.

For removing the mount unit take out four locking pins 6 (Fig.109) and withdraw the whole mount unit together with the camera. The camera controller is mounted on a special beam whose lower portion is secured to the holder of the operator's main panel.

4. ELECTRICAL SYSTEM OF PHOTOGRAPHIC EQUIPMENT

The electrical system of the photographic equipment performs the following duties:

- (1) it governs the functioning of the camera hatch doors;
- (2) it changes the tilting camera mount middle frame over to the angles of 0, 10°, 15°, 20° or 25° in the direction opposite the flight in the BOMBING CONTROL mode of operation;
- (3) it sets the tilting mount inner frame at angles of 6°30' or 8°30' (depending on the camera mounted) right and

left of the aircraft axis in the AERIAL RECONNAISSANCE mode of operation;

- (4) it supplies power to aerial cameras AQA-33M, HAQA-3c/50 and QA-PJ-1.

Camera Hatch Door Control

The camera hatch doors are brought to the required position with the aid of selector 3. For this purpose one of contacts 27 or 28 is energized to supply power to electric mechanism YP-7M which governs the functioning of the camera hatch doors. When the doors come to their extreme positions, microswitches 14 and 15 function to break the feed circuits of the contactors.

When the doors are in the open position, the microswitch not only de-energizes the appropriate contactor but also feeds the following:

- (1) lamp 2 indicating the open position of the camera hatch doors;
- (2) selector 4 marked BOMBING CONTROL (КОНТРОЛЬ БОМБОКРАШЕНИЯ) - AERIAL RECONNAISSANCE (РАЗВЕДКА), thus interlocking the tilting mount not to be operated when the camera hatch doors are closed.

Electric mechanism YP-7M is D.C. two-pole, series-wound, reversible electric motor 40 intended to impart rotation to the output shaft through the worm gear and two-stage planetary reducing gear 39. Electromagnetic clutch 41 provided in the electric motor is mounted with a view to reducing the run-out of the output shaft and for engaging the electric motor shaft with the reducing gear.

Performance Data of Electric Mechanism YP-7M

Rated operating voltage .....	24 V
Rated shaft torque .....	1.77 kg/cm.
Rated current .....	7.9 A

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Intermittent mode of operation ..... 1 min. of operation under rated load and 10 min. of interval within a scope of 3 cycles. The above can be repeated after complete cooling down

When the camera hatch doors are open, limit switches 12 and 13 connected to the cables of the bunch between the camera and the camera controller operate, too. Those switches are intended to start the functioning of aerial cameras ATA-33N and HAA-3c/50 only when the camera hatch doors are open all the way out as they break the feed of the aerial camera chamber electric motors.

Functioning in the BOMBING CONTROL Mode of Operation

Selector 4 should be brought to the desired position whenever necessity comes to prepare the system for BOMBING CONTROL mode of operation. If in this instance the inner frame of the camera tilting mount is out of the zero position, the voltage should be first applied to contactor 18 of electric mechanism MYQ-2 (29) by means of switch 22; the electric mechanism sets the inner frame to the zero position.

Only in this position of the inner frame will the power supplied by selector 4 via pressed down switch 22 reach button 7 and relay 8 which govern the functioning of electric mechanism MYQ-2 (37) of the camera tilting mount middle frame.

The middle frame may be set at a certain angle in two cases, i.e. when the frame setting requires that a greater tilting angle should be changed over to a smaller one, or vice versa.

In the first case (i.e. when a greater tilting angle is changed over to a smaller one), selector 9 should be brought

to indicate the required angle, and then button 7 pressed. As a result, relay PH-2 (8) functions so that its contacts interlock button 7 thus ensuring automatic operation of the circuit. The power is supplied via contacts of button 7 and the contacts of relay 8 to selector 9 whence it is directed to the winding of contactor 10 by means of the appropriate limit switch (31, 32, 33, 34, 35).

Contactor 10 gets engaged to make the supply circuit of mechanism MYQ-2 (37) which inclines the tilting mount through the appropriate angle. When the tilting mount reaches the angle, special cam provided on the shaft and geared with the electric mechanism will press the appropriate limit switch set for the desired angle.

As a result:

(1) the supply circuit of contactor 10 and the electric mechanism is de-energized, i.e. the middle frame of the tilting mount stops;

(2) the circuit of indicating lamp 6 is closed.

Relay PH-2 (8) will be energized till selector 9 is switched to another angle or till selector 4 is brought to NORMAL RECONNAISSANCE (РАЗВЕДКА).

In the second case (i.e. when the tilting angle is increased) the middle frame of the tilting mount should be first raised to zero position. For this purpose selector 9 should be brought to zero and button 7 pressed. As a result, the system functions as described above and the middle frame of the tilting mount assumes the zero position. Then selector 9 is brought to the required angle and then button 7 pressed. It involves engagement of contactor 10 which supplies power to electric mechanism MYQ-2 (37). The latter raises the frame 1° above the zero position, which will press limit switch 23. This switch delivers voltage to the winding of relay MP-2 (36) which operates to reverse electric mechanism MYQ-2 (37), its contacts closing its own supply circuit. Electric mechanism 37 lowers the middle frame to the required angle. At the same time special cam provided on the shaft and

geared with the electric mechanism presses the respective limit switch (31, 32, 33, 34, 35) set for the required angle.

As a result:

- 1. Supply circuit of contactor 10 gets broken thus de-energizing the electric mechanism, i.e. the frame comes to standstill.
- 2. Relay 36 gets de-energized.
- 3. The circuit of indicating lamp 6 gets closed.

Note: After contactor 10 has been de-energized, relay 36 retains current for a while as its winding is fed with the back e.m.f. provided by the electric motor of mechanism MVQ-2 (37) rotated due to inertia.

This phenomenon is liable to disengage the toothed sectors of the middle frame from the toothed wheels of the shaft. Limit switch 45 is provided to obviate such a trouble. This switch is preset for 26.5° angle and connected to the minus circuit of relay 36.

In case the middle frame has tilted through more than 25°, switch 45 is pressed, thus breaking the minus circuit of relay 36. This de-energizes relay 36 and breaks the supply circuit of electric mechanism MVQ-2 (37) engaged in increasing the frame tilting angles; at the same time the supply circuit gets closed to engage the mechanism in decreasing the tilting angles. Therefore, the mechanism brings the frame to the required angle and stops.

Electric mechanism MVQ-2 is D.C., two-pole, reversible, series-wound electric motor 43.

Main Data of Electric Mechanism MVQ-2

Operating voltage range ..... from 24.3 to 29.7 V  
 Shaft torque:  
 rated ..... 100 kg/cm.  
 maximum ..... 120 kg/cm.

Current consumed:

at rated shaft torque ..... not exceeding 8.5 A  
 at maximum shaft torque ..... not exceeding 10 A

Intermittent mode of operation:

for one-side rotation ..... 1.5-sec. operation period  
 and 1-sec. interval  
 (200 engagements)

for two-side rotation:

right ..... 30-sec. operation period  
 and 3-sec. interval  
 left ..... 30-sec. operation period  
 (10 cycles)

The electric mechanism may be engaged in the same operation mode after a one-hour lapse of time.

System Engaged in AERIAL RECONNAISSANCE Mode of Operation

Preparation of the whole system for AERIAL RECONNAISSANCE mode of operation requires that the selector 4 should be brought to the respective position. If the middle frame of the tilting mount is not in the zero position, the current from selector 4 will pass to contactor 10 of electric mechanism 37 through the normally closed contacts of limit switch 30. Electric mechanism 37 is energized to raise the middle frame to the zero position. The frame comes to the zero position thereby pressing limit switch 30 so that the current from selector 4 will reach contactor 18 through the normally open contacts of switch 30. As a result, electric mechanism MVQ-2 (29) starts operating to bring the inner frame to a tilted position and then gets disconnected as special cam provided on the shaft and geared with electric mechanism MVQ-2 (29) presses limit switch 19. The inner frames will be left in this position until aerial camera AOA-33M makes an exposure.

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While making an exposure the aerial camera sends a pulse reaching relay 21 through cable K-14. Relay 21 operates to close the supply circuit of contactor 18 and its own supply circuit via the normally closed contacts of limit switch 20.

Electric mechanism WQ-2 (29) starts operating to bring the inner frame from one extreme position to the other. When the frame passes by the zero position, limit switch 20 operates to make the circuit of indicating lamp 5 and to break the supply circuit of relay 21. But contactor 18 remains engaged, as its winding is fed through the parallel-connected circuit via limit switch 19 and electric mechanism 29 goes on driving the inner frame to the other extreme position. Once the frame has reached the extreme position, limit switch 19 operates to break the current supply of contactor 18. The electric mechanism stops the frame and holds it in the position until the camera sends another pulse.

Electric mechanism 29 operates in one direction all the time, the frame being brought from one extreme tilted position to the other by means of a crank mechanism.

Button 16 may be employed for sending an artificial pulse to relay 21 thereby providing a check-up of the circuit operation for aerial reconnaissance without engaging the aerial camera.

#### Power Supply

Controllers of aerial cameras AFA-33M and HANA-3c/50 are supplied with current through socket 48K (11) installed on the navigator's starboard console. If the serviceability of these cameras must be checked without using the aircraft connecting cable bunch between the camera and camera controller, power may be supplied to the appropriate camera controllers through socket 48K (17) fixed directly on the camera tilting mount. The controller of camera A-T-1 is connected to the aircraft mains with the aid of socket 48K (24) installed on the main panel of the navigator-operator.

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#### Installation of Electric System Units

Units of the electric system are arranged in the aircraft in the following places:

1. On the navigator's starboard console - camera hatch door control 3, BOMBING CONTROL (КОМПОНА БОРБОМБЕТАННЯ) - AERIAL RECONNAISSANCE (ПАЗНАС) selector 4, tilting angle selector 9, button 7, relay 8, indicating lamps of the camera hatch doors open position and functioning of the camera controller for bombing control and aerial reconnaissance.
2. On the tilting mount - electric mechanism WQ-2 (29 and 37), limit switches in the camera controller governing circuits engaged for bombing control and aerial reconnaissance (19, 20, 22, 30, 31, 32, 33, 34, 35, 23), contactors 10 and 18 and relays 21 and 36 controlling electric mechanism WQ-2.
3. In the photographic equipment junction box installed in frame No. 22 - contactors 27 and 28 controlling electric mechanism YP-7M and fuses HII-10.
4. At the camera hatch door - electric mechanism YP-7M (26), limit switches 14 and 15 in control circuits of electric mechanism YP-7M and limit switches 12 and 13 interlocking the camera control circuit.

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APPENDIXMODIFICATIONS INCORPORATED  
AFTER THE BOOK HAS BEEN PUBLISHEDElectrical Equipment

1. To avoid premature consumption of gasoline from the fifth group of the tanks, the system of engagement of the fifth group tanks has been modified. The pumps in question automatically come into operation for the standby duty only when the pumps of the fourth group of tanks are changed over from the standby to the normal duty.
2. For ensuring the installation of the set of electric fuel quantity gauge C9TC-60M (instead of the C9TC-60 set) some aircraft have additional portion of electric cables laid from the fuel quantity gauge amplifier to the indicators so that the C9TC-60M set should be installed in the aircraft without incorporating modifications into the aircraft circuit.
3. The drag parachute extension system of some aircraft employs additional interlock for obviating spontaneous disconnecting of the drag parachute in its container before the RELEASE (OSNIVCK) button has been pressed.
4. To improve the attachment of the tail unit de-icer system engagement mechanism (MKA-3A), the bolts of the mechanism attachment of steel 30X1CA are substituted for those of steel 10.
5. The power circuit of the heaters in the front and the rear pressurized cabins of some aircraft incorporate additional contactors, type KM-200, with a view to obviate overheating of the cabin heating sections due to burning of the contacts of the relay K-50 located in the electric heater (unit 1C7).

6. To obviate accidental disengagement of the generators ICP-18000, the generator panels of the operator are provided with special protectors for generator switches.

7. Spring-loaded lock is installed on the left engine control panel for locking the landing flap control selector in the neutral position.

8. To provide control over the voltage of the aircraft storage battery and the ground power source, two additional positions "AKX" and "PAH" are introduced for the generator panel voltmeter selector.

9. To obtain a reliable contact between the terminal of the minus wires and the aircraft structure and to obviate the overflow of the check paint, the terminals of the minus wires, cross section 5.15-mm and over, are secured in the following manner: a coating of anti-corrosion putty is applied to the surfaces of the terminals contacting the aircraft structure, the terminal is secured with the aid of a screw, and then the transient resistance is measured and the check paint is applied.

10. The fuel transfer pump electric motor MB-650 is replaced with standard motor, type MB-650A, having a resistor in the circuit for ensuring the starting with the afterburner ON. As a result, the distribution boxes of pumps 461 have no resistors NO-10-5 for engaging the pumps with electric motor MB-650 for augmented duty.

Besides, the electric motor MB-650 has a compound excitation for ensuring the engagement of the pumps directly for augmented duty.

11. To promote the reliable functioning of the fuel pumps, the circuits of the pumps of the third group of the tanks employ fusible cut-outs MH-50 instead of cut-outs MH-75, and wires c.s. 8.8 mm instead of wires, c.s. 5.15 mm.

12. The feed circuit of the power supply sources is changed as the Manufacturer has substituted the modified relay RPP-600A for the relay RPP-600. Relays RPP-600A and RPP-600 are interchangeable.



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13. For promoting the operational properties, the storage half-batteries, type 12CAN-55, 55 amp-hr capacity, is fitted instead of storage half-battery, type 12CAN-53, 53 amp-hr capacity.

Besides, half-batteries 12CAN-55 have longer guaranteed service life (1 year instead of 6 months) and may also be stored longer.

The negative wire attachment bolt of the new-type storage battery has larger diameter (10 mm instead of 8 mm).

14. The white light filter of the indicating lamp is replaced with a blue one with a view to improving the visibility of the tilting mount *AKAN* when employed for the aerial reconnaissance duties in the daytime.

15. The dome light *HCN-45* is installed in the upper portion of hatch over frame No.13 and not on the port side of frame No.20 for ensuring the illumination of the L.C. nose wheel brace lock.

16. For ensuring greater safety of the pilots' ejection, the hinged bracket of lamps *APV-OL* and *KICPK* on the overhead electric panel of the pilots is modified so that it can move only in sympathy with, and against, flight.

17. To obviate burning of the receptacle contacts of the ground power source when it is being engaged, with the ground supply switch ON and for obviating the possibility of the ground supply contactor engagement before the storage battery relay disconnects the aircraft mains, interlocking of the contact through the relay *PH-2* is introduced.

18. The Manufacturer no longer produces the relays *PH-1*, so the ground power receptacle is interlocked with the aid of the relay *TVE-210* located in the storage battery distribution box.

19. The *APV-OL-50* equipment is installed in the aircraft instead of equipment *APV-OL-45* with a view to improve the illumination conditions provided for the pilots and for the navigator.

20. Parachute ejection gun feed line circuit breakers are connected to the double-supply busbar but not to a normal busbar.

21. For controlling over the functioning of the hydraulic system, a white indicator lamp is connected to the hydraulic feed circuit. The lamp is mounted on the central instrument panel of the pilots.

22. For improving the reliability of functioning of the third group of fuel tanks, the pumps with motors *MB-650* are removed and pumps with motors *MB-650A* are installed instead.

23. For ensuring the engine starting in the air with the master switch disconnected, the connection diagram of the circuit breakers *A3C-20* and midair starting buttons are modified.

24. For obviating the damage that might be inflicted to the limit switch rods of the drag parachute release indication system, switches *BK2-14CB-1* are fitted instead of switches *B2-141B*.

25. Ultraviolet lighting lamp is fitted next to the second frame, port side, for providing better illumination of the rails of unit Index "225".

26. For ensuring the functioning of the fire equipment situated by the power supplied from the storage battery, with the shut-off and cross-feed valve circuit breaker line being energized, the fire warning system and the carbon dioxide cylinder control system are fed from the triple-supply busbar instead of the double-supply busbar.

27. For ensuring greater duration of the pulse sent out to the serial camera, wire *BB5* running from the electric release is replaced with wire *BIB* running from the eight *B-IP*.

28. For obviating an untimely consumption of the fuel from the fifth group of tanks, the connection diagram of the pumps of the fifth group of tanks is modified. The pumps in question get automatically engaged into the operation for

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standby duty only when the pumps of the fourth group are switched over from standby duty to normal duty.

29. In some aircraft modified fuel quantity gauge C3TC-60X has been installed instead of fuel quantity gauge C3TC-60K.

#### Radio Equipment

1. Noise filter P-12 is fitted between units T12 and F13 in the section of cable No.12 for suppressing the noises appearing during the operation of the radar bombsight PBN-4.

2. An open antenna (like a folded-dipole antenna) and the static electricity reflectors are additionally installed on the port side for ensuring a stable operation of the radio compass APK-5, No.2.

3. Filter AP17-30 is fitted between units AP-18 and AP17-5 in the gap of cable No.9 for reducing the interference produced by the NPC-I and affecting receiver YC-9.

4. For protecting the NPC-I station from the pulse interference of the fighters equipped with jamming stations and the distance measuring equipment as well as from the interferences caused by the equipment carried aboard the aircraft and operating at frequencies close to that of the NPC-I, noise protection unit AP17-22 and box AP1723 with modified units AP17-86 and AP17-86 are installed. Unit AP17-22 is fitted with five interconnected filters, which are superconic delay lines mounted in the assembled guides and located on the panel support and on the wall of the case ejection chute.

Stations NPC-I are completely removed from the aircraft and replaced with stations NPC-I having units No.22, 23 and AP17-8E (having special designation code) intended for operation with the sight NC-48 of earlier make. In some aircraft, unit AP17-22, box AP17-23 and modified units AP17-3A and AP17-8E are installed.

Note: Station NPC-I is intended for operation in conjunction with sight NC-53.

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5. Loop antenna is shifted to the upper portion of the frame and installed between frames No.14 and 15 for obviating the interference caused by the metal parts of the nose wheel and affecting the functioning of the receiver of automatic radio compass APK-5 No.2.

6. A special visor is installed over the unit AP17-12 located in the tail compartment for protecting the unit against moisture.

7. Non-adjustable brackets are taken off and special adjustable brackets are installed in the aircraft to ease the levelling of unit AP17-1.

8. Special quick-acting unit locking mechanisms are installed for ease in changing units P5 or P6 from the operating to the stowed position, and vice versa.

9. For ensuring the monitoring when receiver YC-9 is operating in the "AP4" position, quick-operating relay closing the receiver antenna to the aircraft structure when the telegraph key is being used is installed on some aircraft.

10. Because of the breakage of the textolite end-pieces of the folded-dipole antennas of the command set and to the folded-dipole antenna of the automatic radio compass APK-5, end-pieces are provided in some aircraft and the antenna ends are finished as hemispheres. In some aircraft, the end-pieces are cut off flush with the insulators.

11. For reliable operation, a circular breaker is fitted in the dynamotor instead of fusible outcuts.

12. For ensuring easy communication between the operating stations engaged in tuning of units AP-17 and other stations to the ground, intercom system receptacle is fitted in the tail compartment under the rack where unit AP17-12 is installed and special cables are provided for operations to be done in the compartment.

13. The code signal panel of the transponder is set slanted with a view to improve the observation.

14. For photographing the range scale of unit AP17-21, unit in question in some aircraft is provided with a camera gun, type HAY-457.

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15. For reducing the effect of the radio set PC.V-3K on the KPMO, the antennas of the radio set in some aircraft are arranged in such a way that the front antenna (as viewed backward) connects to receiver No.2 and the rear antenna, to transmitter and receiver No.1.

16. Filter B40-2 is introduced into the circuit of the PB-2 transmitting antenna for obviating the effect of radio altimeter PB-2 on the distance measuring equipment CD-I.

17. For controlling over the functioning of the transponder, a telephone outlet is fitted on the additional panel of the intercom system CHV-10 of the pilot.

18. In some aircraft the connections are changed over in the following way:

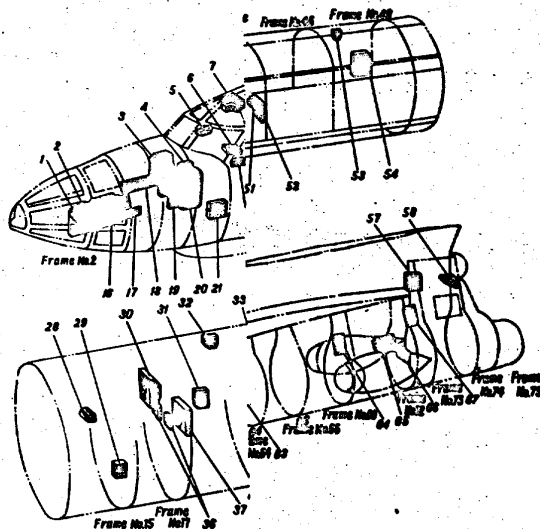
- AFK-5 No.1 - to the folded-dipole antenna;
- AFK-5 No.2 - to the blister antenna.

19. The static-electricity dischargers on the stabilizer of some aircraft are installed without the threaded adapters to prevent their breakage.

20. For improving the strength, the end-pieces of the stabilizer and fin static-electricity dischargers are modified.

21. Two static-electricity dischargers are installed on the wing tip cowl and the fin and three dischargers on the stabilizer for ensuring reliable discharge of static electricity of the aircraft structure.

The formula of the static-electricity discharger liquid is changed (80% of glycerine and 20% of ethyl alcohol instead of 80% of glycerine and 20% of water).



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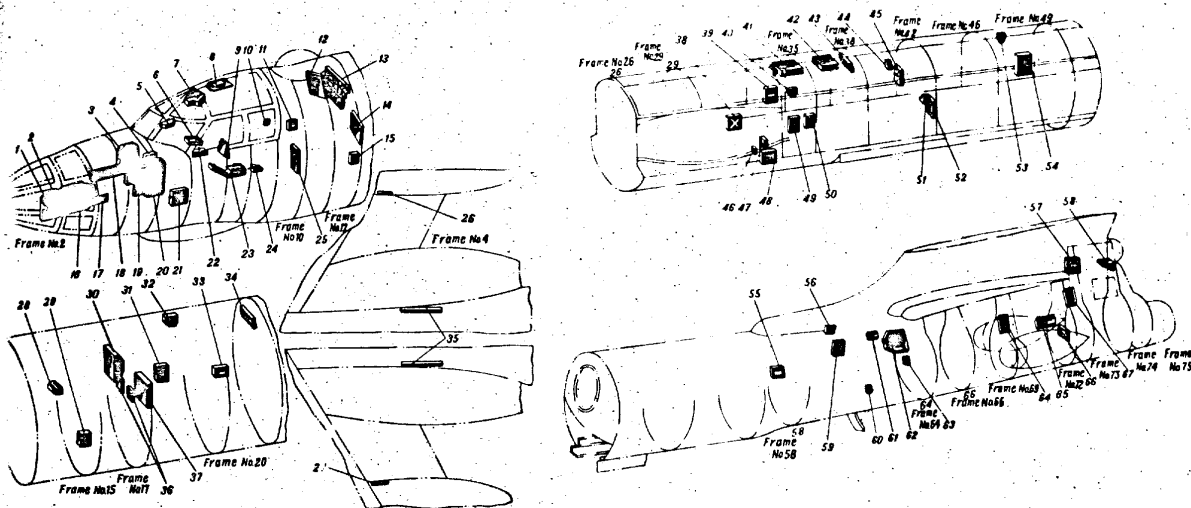


FIG. 1. SCHEMATIC LAYOUT DIAGRAM OF ELECTRIC EQUIPMENT CONTROL PANELS, BOARDS AND JUNCTION BOXES

- 1 - bomb bay door control board and navigator's camera control board; 2 - navigator's interphone control board; 3 - co-pilot's circuit-breaker control panel; 4 - glass panel heater junction box; 5 - co-pilot's trim tab control station; 6 - PYO-45 ultra-violet illumination thermostat control board of co-pilot; 7 - fuel control supply board; 8 - overhead electric control board of pilot; 9 - co-pilot's fuelling control board; 10 - trim tab synchronization control station; 11 - operating ITO-4500 inverter junction box; 12 - right junction box; 13 - radar operator's generator control panel; 14 - left junction box; 15 - stand-by ITO-4500 inverter junction box; 16 - bomb release electric control board; 17 - bottom bomb release electric control board on navigator's left-hand console; 18 - navigator's upper electric control board; 19 - navigator's left circuit-breaker control panel; 20 - pilot's circuit-breaker control panel; 21 - front cabin dual power supply junction box; 22 - pilot's trim tab control station; 23 - pilot's electric control board; 24 - bomb release control station for bomb release, with the mains de-energized; 25 - front cabin sound signalling system junction box; 26 - right hand junction box of landing gear and fuel pump relay; 27 - left-hand junction box of landing gear and fuel pump relay; 28 - hydraulic pump junction box; 29 - external supply junction box; 30 - storage battery junction box; 31 - upper cannon mount fuse junction box; 32 - power junction box; 33 - camera equipment junction box; 34 - fuel quantity gauge junction box; 35 - left-hand and right-hand distribution panels; 36 - junction box of operating and standby inverters; 37 - dual power supply junction box; 38 - fuel pump junction box; 39 - emergency bomb release box; 40 - power junction box; 41 - landing flap junction box; 42 - bomb release system junction box; 43 - igniter junction box; 44 - emergency circuit junction box; 45 - dual power supply junction box; 46 - bomb bay interlocking limit switch mechanism; 47 - bomb bay limit switch junction box; 48 - fuel pump junction box; 49 - junction box of emergency bomb release, with the mains de-energized; 50 - additional pump junction box; 51 - emergency circuit junction box; 52 - dual power supply junction box; 53 - power junction box; 54 - fuel pump junction box, rear; 55 - range-finder power supply junction box; 56 - power junction box; 57 - rear cabin sound signalling system junction box; 58 - gunner's electric control board; 59 - blister mount fuse junction box; 60 - switch box and extension lamp receptacle; 61 - power junction box; 62 - tail unit de-icer junction box; 63 - auto-pilot heater circuit breaker box; 64 - tail cannon mount fuse junction box; 65 - rear cabin circuit-breaker control board; 66 - radio operator's electric control board; 67 - rear pressurized cabin junction box.

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S-E-C-R-E-T

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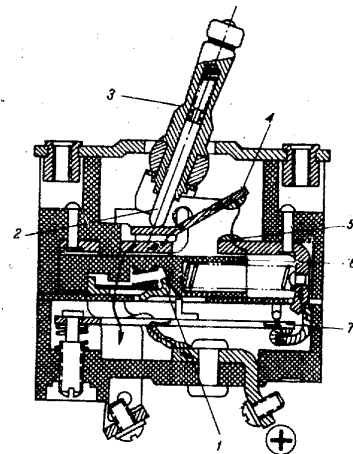


FIG. 2. AUTOMATIC CIRCUIT-BREAKER

- 1 - pawl; 2 - pin; 3 - lever; 4 - moving contact; 5 - fixed contact;
- 6 - block; 7 - bimetallic strip.

Note: The bold-line arrows in the diagram show the direction of current in the current-carrying elements of the circuit breaker.

S-E-C-R-E-T

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S-E-C-R-E-T

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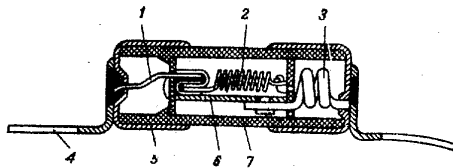


FIG. 3. DELAYED-ACTION FUSE LINK, TYPE HP  
 1 - fuse wire; 2 - spring; 3 - heating element; 4 - tip; 5 - cap; 6 - current-carrying element; 7 - fibretube.

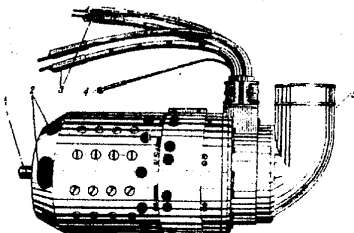


FIG. 4. GENERATOR, TYPE PCP-18000  
 1 - spline shank of rotor torsion shaft; 2 - cooling vena; 3 - power wires; 4 - shunt winding wire; 5 - air intake sleeve.

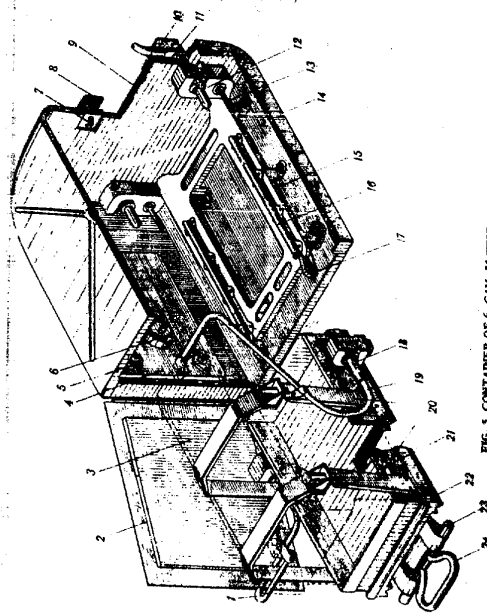


FIG. 5. CONTAINER OF 6-CAM-55 STORAGE BATTERY  
 1 - plate wire; 2 - container cover; 3 - battery, type 6-CAM-55; 4 - heating element; 5 - heating strip contact body; 6 - contact plate, type 7778; 7 - heating element fastener bolt; 8 - plate; 9 - thermal insulation (ATYU); 10 - plate; 11 - contact plate; 12 - contact plate; 13 - contact plate; 14 - contact plate; 15 - contact plate; 16 - plate; 17 - plate; 18 - contact plate; 19 - contact plate; 20 - contact plate; 21 - contact plate; 22 - contact plate; 23 - plate; 24 - lock pin.

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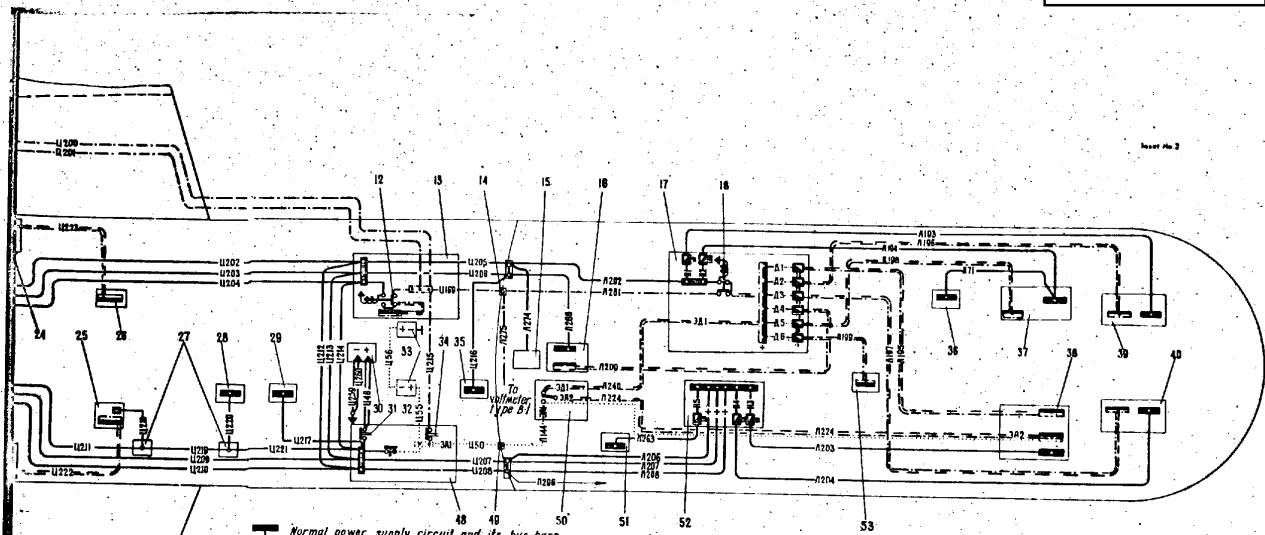


FIG. 7. CONNECTION DIAGRAM OF D.C. CIRCUIT SYSTEM

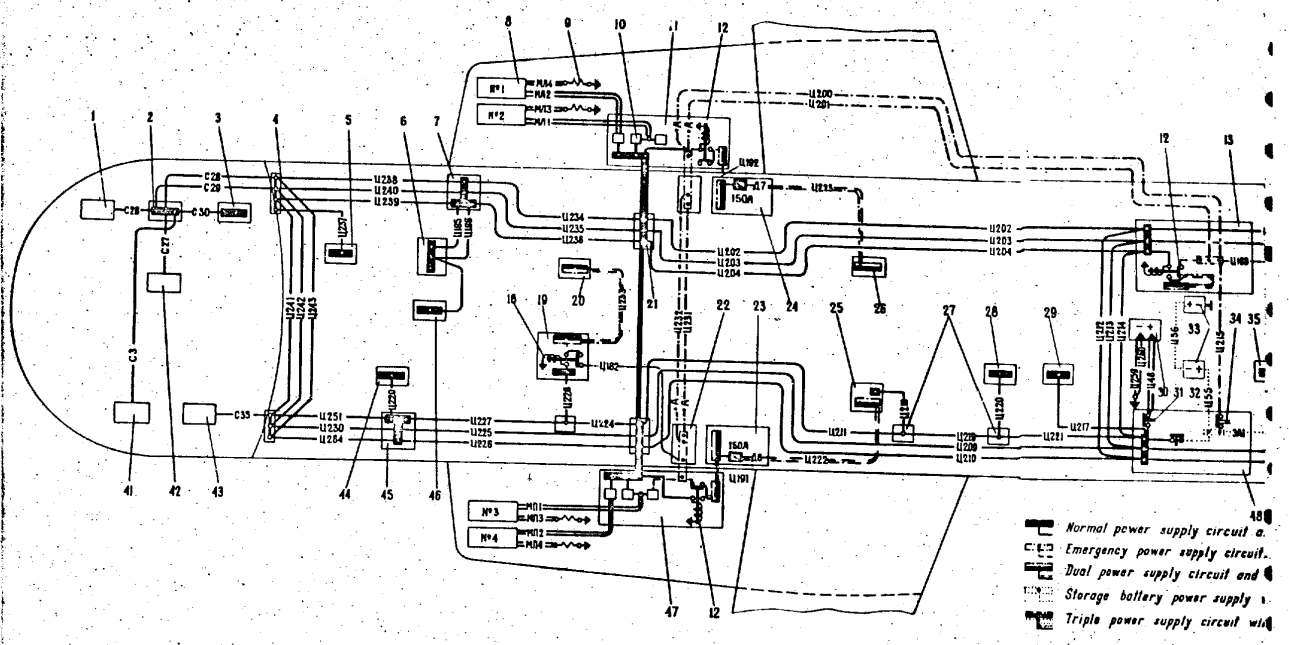
1 - tail station control box; 2 - power junction box of rear cabin; 3 - rear cabin circuit-breaker control panel; 4 - power lead from normal power supply circuit; 5 - tail cannon mount power supply junction box; 6 - tail unit de-icers junction box; 7 - power junction box; 8 - generator, type T-CP-18000; 9 - ballast resistor, type HC-10000; 10 - differential undercurrent relay, type ZMP-600; 11 - distribution panel, left; 12 - change-over contactor, type KII-400.I; 13 - dual power supply junction box at frame No. 17; 14 - power lead from emergency power supply circuit; 15 - top station control box; 16 - radar operator's circuit breaker control panel; 17 - dual supply junction box at frame No. 6; 18 - change-over contactor, type KII-300.I; 19 - fuel pump junction box of emergency power supply circuit; 20 - flare bomb emergency release junction box; 21 - power junction box of normal power supply circuit; 22 - power junction box of emergency control box; 23 - dual power supply junction box, right; 24 - dual power supply junction box, left; 25 - fuel pump junction box, right; 26 - fuel pump junction box, left; 27 - power junction box; 28 - upper cannon mount power supply junction box; 29 - camera equipment junction box; 30 - ground supply plug connector, type IIIA-400.IK; 31 - ground supply connection contactor, type K-400.I; 32 - contactor, type K-300.I, for connecting storage battery to normal power supply circuit; 33 - storage battery, type 12-CAM-55; 34 - contactor, type K-300.I, for connecting storage battery to emergency power supply circuit; 35 - hydraulic pump junction box; 36 - pilot's instrument panel; 37 - pilot's circuit breaker control panel; 38 - copilot's circuit breaker control panel; 39 - navigator's circuit breaker control panel, left; 40 - navigator's circuit breaker control panel, right; 41 - ICTI-53 box; 42 - contactor of round; 43 - blaster station control box; 44 - lower cannon mount power supply box; 45 - power junction box; 46 - autopilot heater circuit breaker box; 47 - distribution box, right; 48 - storage battery junction box; 49 - power lead from emergency supply circuit; 50 - generator panel; 51 - fuelling control board; 52 - glass panel heater (defroster) junction box; 53 - fuel delivery control board.

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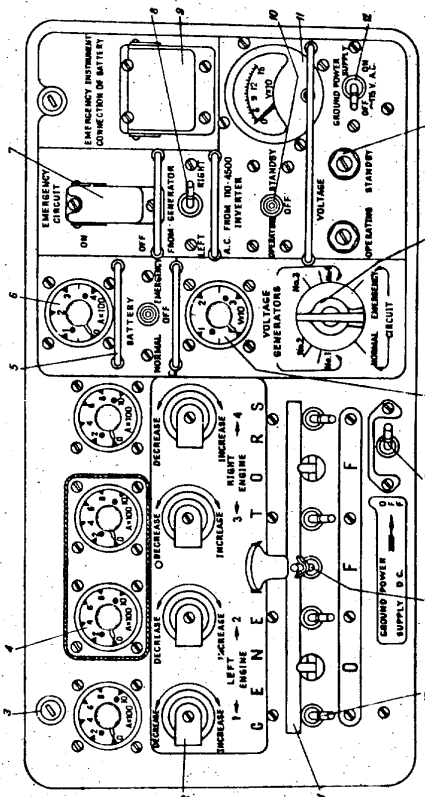
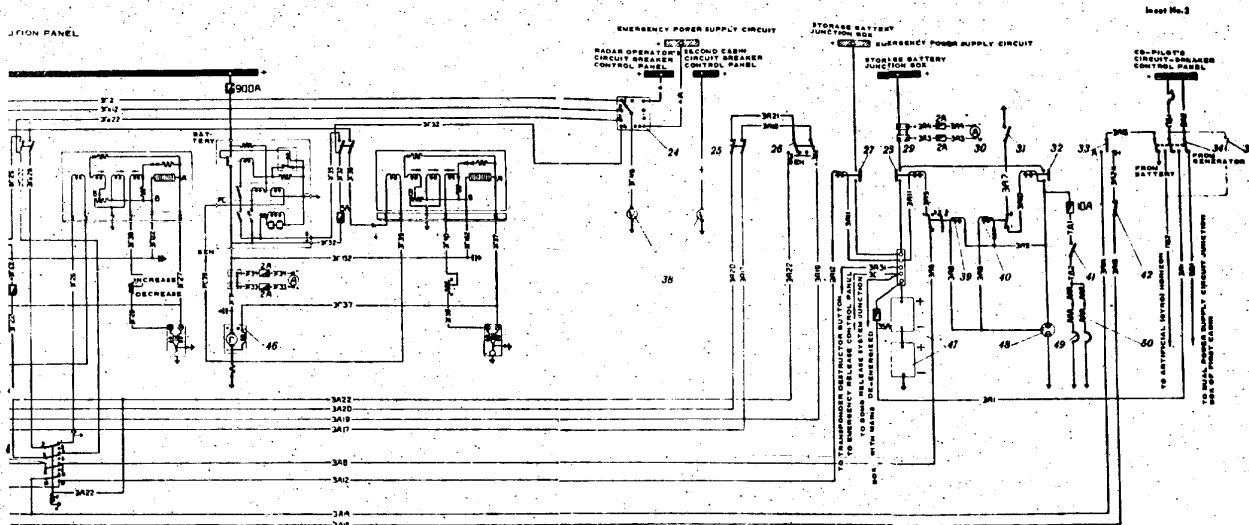


FIG. 8. GENERATOR CONTROL PANEL.

1 - master switch for simultaneous operation generator switches; 2 - extension resistor, type BC-20; 3 - panel attachment screw; 4 - meter, type A-3; 5 - safety clamp; 6 - meter, type A-1; 7 - protecting cover of switch, type 2B-45; 8 - change-over switch, type 2D11-45; 9 - cover of switches, type 2D11-45 and 2D11-45; 10 - change-over switch, type 2D11-45; 11 - meter, type 2B-45; 12 - switch, type B-45; 13 - adjusting resistor, type PC-40; 14 - normal range switch, type 2B-45; 15 - meter, type 2B-45; 16 - switch, type B-45; for disconnection of average battery blocking from normal power supply circuit; 17 - generator switch, type 2B-45.



WIRING DIAGRAM OF D.C. SUPPLY SOURCES

bus of ammeter, type PTP-2A; automatic corrector; 19 - emergency power supply; type 2B-45, power supply to normal power; 32 - connector, type N-4001, for connecting ground power supply source to normal supply circuit; 33 - storage battery change-over switch, type (III) 45; 34 - switches, types (III) 45 and (III) 45, of triple power supply bus bar; 35 - standby ground switch, type D-45; 36 - ammeter, type A-3; 37 - extension resistance, type BC-20; 38 - voltmeter, type B-1; 39 - blocking relay, type (II) 2; 40 - polarized relay, type (III) A; 41 - switch, type B-45, of battery container heater; 42 - switch, type B-45, disconnecting storage battery from normal power supply circuit; 43 - stability transformer, type TC-B1; 44 - generator No. 2; 45 - generator No. 3; 46 - generator No. 4; 47 - storage battery, type 12-CAM-55; 48 - ground power supply plug connector; 49 - thermal switch, type 777B, of storage battery container heater; 50 - storage battery container heater element; 51 - connection diagram of generator, type (CP) 18000; 52 - main pole; 53 - commutating pole; 54 - blocking relay, type (II) 6, for generator No. 2; 55 - blocking relay, type (II) 6, for generator No. 3.

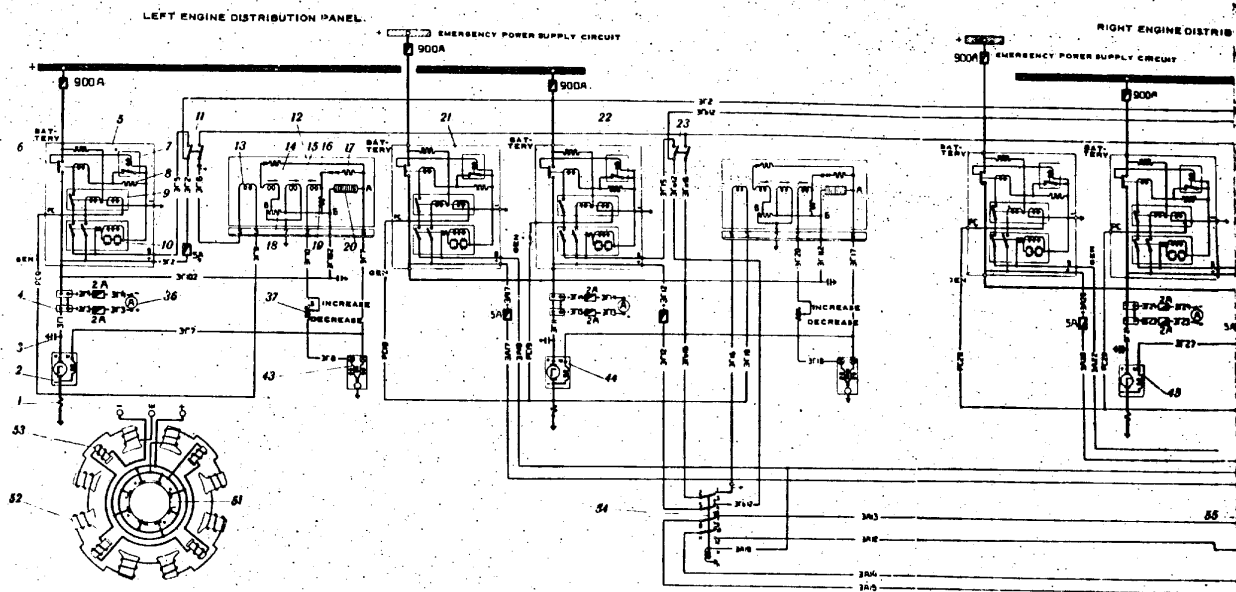


FIG. 9. CIRCUIT

1 - ballast resistor, type BC-18000; 2 - generator, type CCP-18000, No. 1; 3 - capacitor, type KBN-31; 4 - type A-3; 5 - differential undercurrent relay, type ZMP-600, for connecting generator No. 1 to normal power supply circuit; 6 - contactor; 7 - auxiliary relay, type PJ-5B; 8 - limiting resistor; 9 - command relay; 10 - polarized relay; 11 - switch, type 2B-45, of generator No. 1; 12 - carbon regulator, type PVT-62; 13 - parallel winding; 14 - temperature compensation winding; 15 - temperature compensation winding; 16 - working winding; 17 - stabilizing resistor; 18 - trimmer; 19 - carbon pile; 20 - carbon pile; 21 - relay, type ZMP-600, for connecting generator No. 2 to emergency circuit; 22 - relay, type ZMP-600, for connecting generator No. 2 to normal power supply circuit; 23 - switch; 24 - voltmeter selector switch, type 1B-45; 25 - emergency circuit switch, type 2B-45; 26 - change-over switch, type 2PPI-45, "from generator"; 27 - contactor, type K-500D, for connecting storage battery to emergency circuit; 29 - shunt of ammeter A-1; 30 - ammeter, type A-1; 31 - ground power supply switch, type B-4

S-E-C-R-E-T

25X1

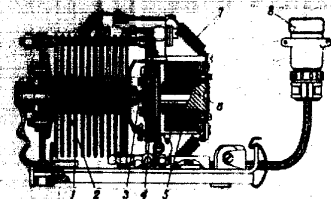


FIG. 10. CARBON REGULATOR, TYPE PVT-82  
1 - ribbed case; 2 - carbon pile; 3 - armature of electromagnet;  
4 - plate springs; 5 - windings of electromagnet; 6 - core of  
electromagnet; 7 - shunt springs; 8 - plug connector.

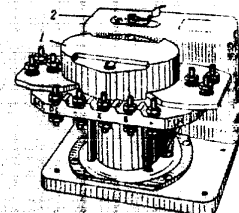
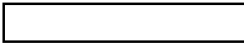


FIG. 11. DIFFERENTIAL RELAY, TYPE DMP-600  
1 - contact; 2 - case of command relay, relay  
PMP-2A and relay PZ-85, and resistors, type CH.

S-E-C-R-E-T

G-E-C-R-B-1



25X1



25X1

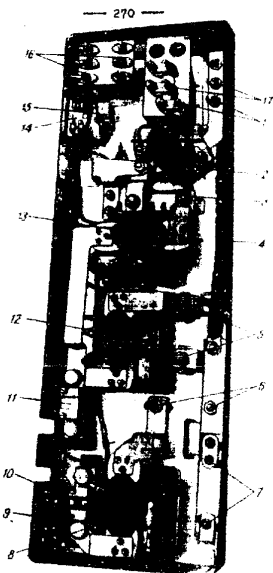


FIG. 12. DISTRIBUTION PANEL, LEFT  
 1 - location of fuse, type HPI-15, to protect fuel pump of tank 19; 2 - change-over contactor, type KII-400A; 3 - location of fuse, type TII-900, to protect generator No. 2 connected to emergency power supply circuit; 4 - terminal block; 5 - location of fuse, type TII-900, to protect generator No. 2 connected to normal power supply circuit; 6 - location of fuse, type TII-900, for generator No. 1 protection; 7 - location of delayed-action fuse, type HPI-200, for starter protection; 8 - relay, type ДП-600, for generator No. 1; 9 - location of fuse, type TII-2, to protect ammeter of generator No. 1; 10 - shunt of A-3 ammeter of generator No. 1; 11 - shunt of A-3 ammeter of generator No. 2; 12 - ДП-600 relay of generator No. 2 (normal); 13 - ДП-600 relay of generator No. 2 (emergency); 14 - location of fuses, type CT-2, to protect ammeter of generator No. 2; 15 - blocking relay, type HPI-2, for blow-off hand control; 16 - location of fuses, type KII-3, to protect ДП-600 relays of generators Nos 1 and 2; 17 - location of fuses, type HPI-30, to protect fuel pumps of tanks 10 and 15.

G-E-C-R-B-T

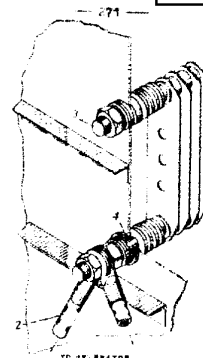
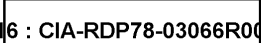


FIG. 13. INSTALLATION OF BALLAST RESISTOR, TYPE BC-18000

- 1 - ballast resistor, type BC-18000; 2 - generator minus wires; 3 - minus bolt; 4 - insulating washers.

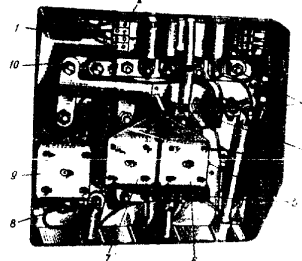


FIG. 14. STORAGE BATTERY JUNCTION BOX

- 1 - polarized relay, type IPI-A; 2 - terminal block; 3 - location of fuse, type TII-400, to protect working inverter, type PQ-400; 4 - blocking relay, type HPI-2; 5 - location of fuse, type HPI-25, to protect instrument power supply circuit under de-energize / mains conditions; 6 - contactor, type K-300A, for connecting storage battery to emergency power supply circuit; 7 - contactor, type K-300A, for connecting storage battery to normal power supply circuit; 8 - location of fuse, type CT-10, to protect storage battery heater circuit; 9 - contactor, type K-400A, for ground power supply source connection; 10 - shunt of ammeter, type A-1.

25X1

S-E-C-R-E-T

25X1

25X1

272

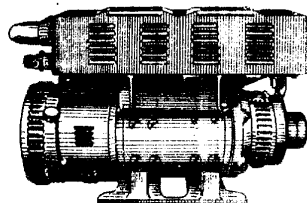


FIG. 15. INVERTER, TYPE IO-4800

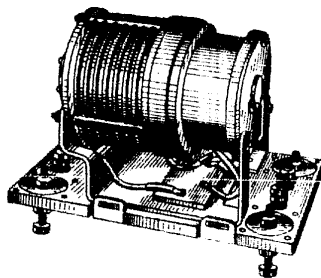


FIG. 16. CARBON REGULATOR, TYPE P-215

273

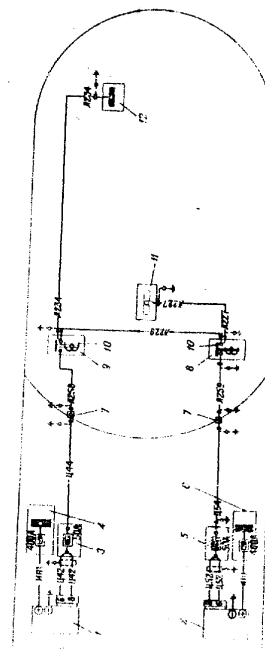


FIG. 17. A.C. POWER DISTRIBUTION DIAGRAM  
1 - standby inverter, type IO-4800; 2 - standby inverter (switching box); 3 - dual power supply circuit (switching box at same box); 4 - storage battery junction box; 5 - A.C. power junction box; 6 - relay box of operating IO-4800 inverter on left-hand shaft of standby inverter; 7 - A.C. power inverter on left-hand shaft of main system; 8 - relay box of operating IO-4800 inverter on right-hand shaft of standby inverter; 9 - relay box of operating IO-4800 inverter on right-hand shaft of main system; 10 - connector, type K-90; 11 - A.C. line panel of inverter; 12 - A.C. line panel of inverter.

S-E-C-R-E-T

25X1

25X1

25X1

— 274 —

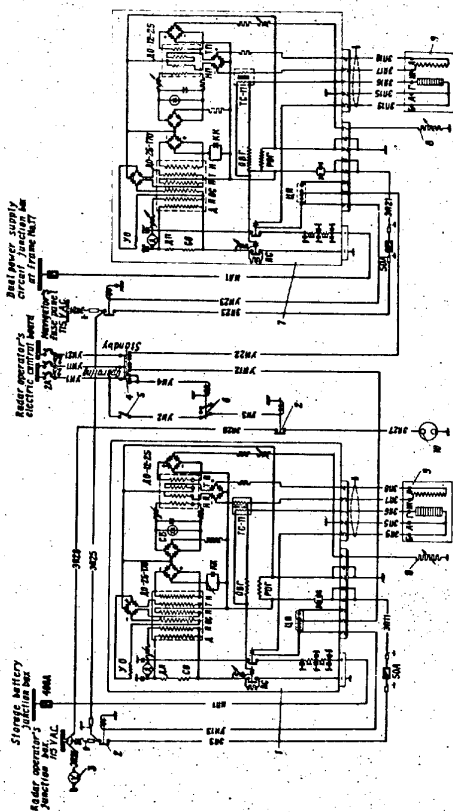


FIG. 11. CIRCUIT DIAGRAM OF A.C. SWITCHES  
 1 - stowage battery junction box  
 2 - radio power supply  
 3 - AC switch  
 4 - 100 microfarad capacitor  
 5 - 250 ohm resistor  
 6 - 250 ohm resistor  
 7 - 250 ohm resistor  
 8 - 100 microfarad capacitor  
 9 - 250 ohm resistor  
 10 - 250 ohm resistor  
 11 - 250 ohm resistor  
 12 - 100 microfarad capacitor  
 13 - 250 ohm resistor  
 14 - 250 ohm resistor  
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 16 - 100 microfarad capacitor  
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 19 - 250 ohm resistor  
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 22 - 250 ohm resistor  
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 24 - 100 microfarad capacitor  
 25 - 250 ohm resistor  
 26 - 250 ohm resistor  
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 91 - 250 ohm resistor  
 92 - 100 microfarad capacitor  
 93 - 250 ohm resistor  
 94 - 250 ohm resistor  
 95 - 250 ohm resistor  
 96 - 100 microfarad capacitor  
 97 - 250 ohm resistor  
 98 - 250 ohm resistor  
 99 - 250 ohm resistor  
 100 - 100 microfarad capacitor

— 275 —

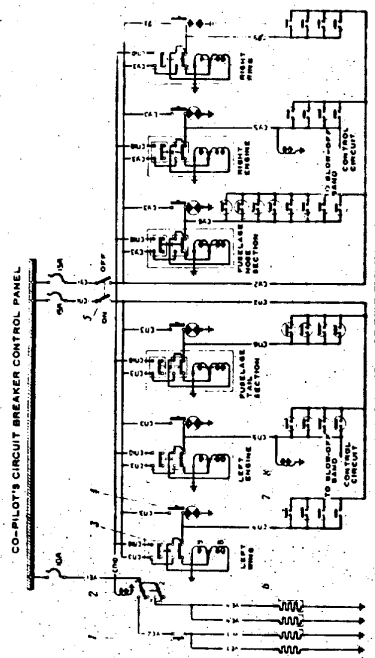


FIG. 12. WIRING DIAGRAM OF FIRE-FIGHTING SYSTEM  
 1 - spare CO<sub>2</sub> bottle switching solenoid, type SF2-2 - blocking solenoid, type FT-2; 2 - fire switch; 3 - lamp solenoid; 4 - lamp solenoid; 5 - switch, type SF-2; 6 - hammer; 7 - solenoid switching unit; 8 - differential pressure control valve.

25X1



S-E-C-R-E-T

25X1

25X1

276

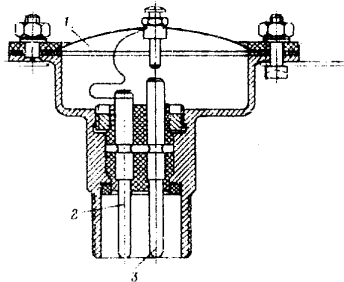


FIG. 20. OVERHEAT WARNING UNIT, TYPE 119  
1 - metallic diaphragm; 2 - side contact; 3 - central contact.

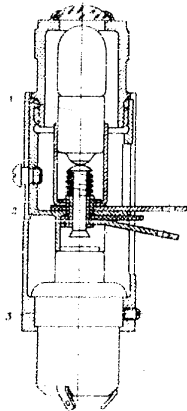


FIG. 21. LAMP BUTTON  
1 - signalling lamp, type CM-31;  
2 - signalling lamp holder; 3 - button, type 204K.

277

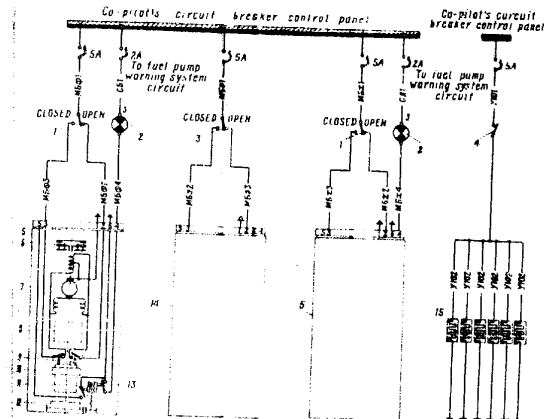


FIG. 22. WIRING DIAGRAM OF FUEL SHUT-OFF AND CROSS-FEED VALVE CONTROL SYSTEM AND OF INERT GAS CONTROL SYSTEM

1 - change-over switch, type III-45, for fuel shut-off valve control; 2 - signal (warning) light, type CHII-51, indicating that fuel shut-off valve is open; 3 - change-over switch, type III-45, for cross-feed valve control;  
4 - switch, type B-45, to actuate inert gas bottles; 5 - electric actuator, type MSK-2, of fuel shut-off valve;  
6 - electromagnetic brake clutch; 7 - electric motor; 8 - first three steps of planetary gear reduction unit;  
9 - limit switches for electric motor extreme position control; 10 - fourth step of gear reduction unit;  
11 - ratchet clutch; 12 - fifth step of gear reduction unit; 13 - limit switches for valve extreme position control; 14 - electric actuator, type MSK-2, of cross-feed valve; 15 - discharge boom.

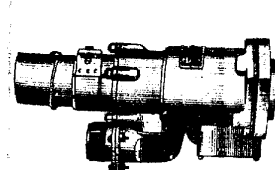


FIG. 23. ELECTRIC ACTUATOR, TYPE MSK-2

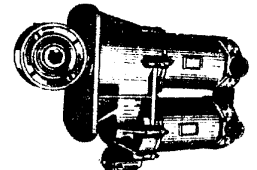


FIG. 24. ELECTRIC ACTUATOR, TYPE MSK-3

S-E-C-R-E-T

S-N-C-R-R-T

25X1

25X1

279

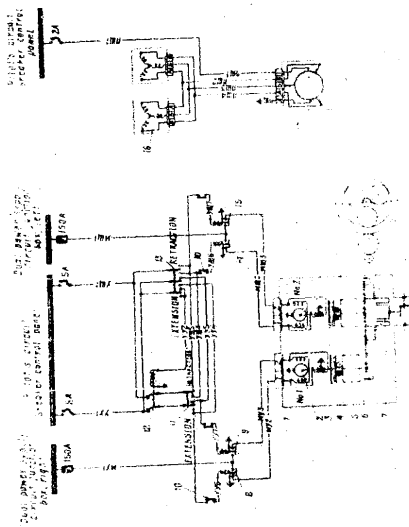


FIG. 25. CIRCUIT DIAGRAM OF LANDING FLAP SYSTEM

1 - electric actuator, type 3111; 2 - manual electric changeover switch (reversing and locking); 3 - electric actuator, type 3111; 4 - ball key; 5 - reduction unit, No. 30; 6 - friction clutch; 7 - friction clutch; 8 - contact, type K-250; 9 - contact, type K-250; 10 - contact, type K-250; 11 - contact, type K-250; 12 - contact, type K-250; 13 - changeover switch, type 2111-20; 14 - changeover switch, type 2111-20; 15 - changeover switch, type 2111-20; 16 - flap extension (electric motor No. 2); 17 - flap retraction (electric motor No. 1); 18 - flap position transmitter, type 2311-4.

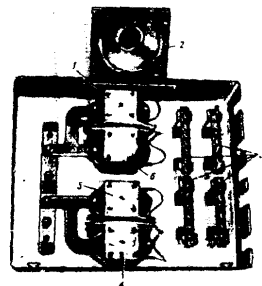


FIG. 26. LANDING FLAP SYSTEM JUNCTION BOX

1 - contactor, type K-250, for flap retraction (electric motor No. 1); 2 - dome, type IIC 45; 3 - terminal blocks; 4 - contactor, type K-250, for flap extension (electric motor No. 2); 5 - contactor, type K-250, for flap retraction (electric motor No. 2); 6 - contactor, type K-250, for flap extension (electric motor No. 1).



FIG. 27. ELECTRIC ACTUATOR, TYPE 3111-100A-00

S-N-C-R-R-T

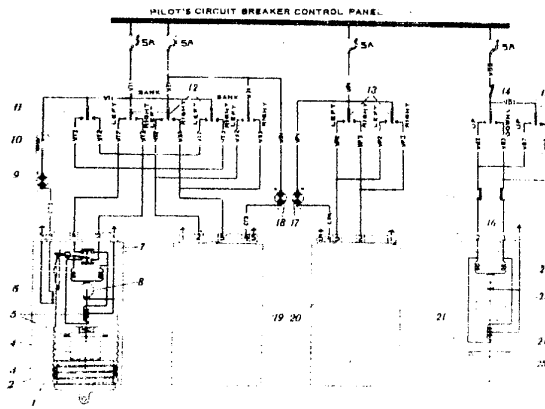
25X1

H-C-R-E-T

25X1

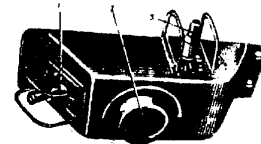
25X1

280

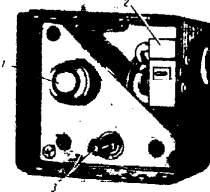


**FIG. 28. CIRCUIT DIAGRAM OF TRIM TAB CONTROL SYSTEM**  
 1 - electric actuator, type MI-100A-80, for left aileron trim tab control; 2 - end nut of ball-type helical pair; 3 - screw of ball-type helical pair; 4 - reduction unit; 5 - electromagnetic brake clutch; 6 - actuating screw around position synchronization contact; 7 - limit switches; 8 - electric motor; 9 - signal (warning) light, type CIII-51, indicating neutral position of left aileron trim tab; 10 - limit switch, type KB-6-1, for warning light blocking; 11 - change-over switch, type III-45, for left aileron trim tab electric actuator control; 12 - push-type change-over switches, type ZIII-20, for aileron trim tab electric actuator control; 13 - change-over switches, type III-45, for rudder trim tab electric actuator control; 14 - switch, type B-41, for emergency disengagement of rudder electric actuator control system; 15 - change-over switch, type III-45M, for elevator trim tab control; 16 - limit switches, type BK2-141B, of electric actuator YT-11; 17 - signal (warning) light, type CIII-51, indicating neutral position of rudder trim tab; 18 - signal (warning) light, type CIII-51, indicating neutral position of right aileron trim tab; 19 - electric actuator, type MI-100A-80, of right aileron trim tab; 20 - electric actuator, type MI-100A-35, of rudder trim tab; 21 - electric actuator, type YT-11, of elevator trim tab; 22 - first reduction unit (external gearing); 23 - electromagnetic engaging clutch; 24 - second reduction unit (planetary).

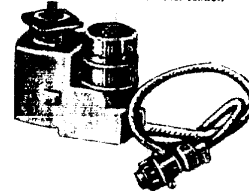
281



**FIG. 29. PILOT'S TRIM TAB CONTROL STATION**  
 1 - change-over switch, type III-45M, for rudder trim tab electric actuator control; 2 - button, type 5K, for drag chute release; 3 - change-over switch, type III-29, for left aileron trim tab electric actuator control.



**FIG. 30. AILERON TRIM TAB SYNCHRONIZATION STATION**  
 1 - signal light, type CIII-51, indicating neutral position of left aileron trim tab; 2 - limit switch, type KB-6-1; 3 - change-over switch, type III-45M, for left aileron trim tab electric actuator control.



**FIG. 31. GENERAL VIEW OF ELECTRIC ACTUATOR, TYPE YT-11**

H-C-R-E-T

S-E-C-R-E-T

25X1

25X1

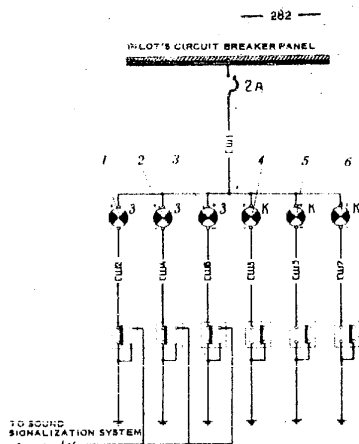


FIG. 32. CIRCUIT DIAGRAM OF L.G. LEG POSITION AND TAIL SKID CONTROL SYSTEMS  
 1 - signal light, type CIII-51, green, indicating extension of L.G. left leg; 2 - signal light, type CIII-51, green, indicating extension of nosewheel leg; 3 - signal light, type CIII-51, green, indicating extension of L.G. right leg; 4 - signal light, type CIII-51, red, indicating retraction of L.G. left leg; 5 - signal light, type CIII-51, red, indicating retraction of nosewheel leg; 6 - signal light, type CIII-51, red, indicating retraction of L.G. right leg; 7 - signal light, type CIII-51, green, indicating retraction of tail skid; 8 - limit switches, type BK-44; 9 - electric actuator, type NH-150, for tail skid control; 10 - limit switches; 11 - electric motor; 12 - electromagnetic brake clutch; 13 - three-step planetary gear reduction unit; 14 - screw of ball-type helical pair; 15 - rod nut of ball-type helical pair.

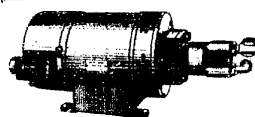


FIG. 33. GENERAL VIEW OF HYDRAULIC PUMP, TYPE 1BU-25

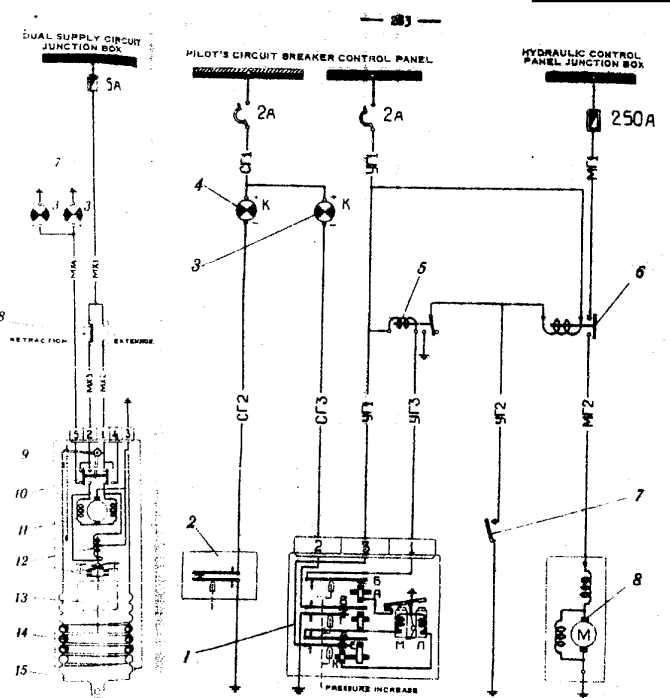


FIG. 34. CIRCUIT DIAGRAM OF HYDRAULIC PUMP CONTROL SYSTEM  
 1 - pressure selector, type ПДН3-150; A and B - contacts closing at pressure of 30 kg/cm<sup>2</sup>; B and Г - contacts opening at pressure of 100 kg/cm<sup>2</sup>; Д and Е - contacts opening at pressure of 100 kg/cm<sup>2</sup>; Ж and К - contacts closing at pressure of 150 kg/cm<sup>2</sup>; Л and М - coils of blocking relay; 2 - pressure drop warning unit, type ЦНД-130; 3 - signal light, type CIII-51, red, indicating pressure drop in normal hydraulic system; 4 - signal light, type CIII-51, red, indicating pressure drop in emergency hydraulic system; 5 - blocking relay, type ВП-3, for hydraulic pump control; 6 - contact, type К-400Д; 7 - switch, type ВП-450, for manual engagement of hydraulic pump; 8 - hydraulic pump, type 1BU-25.

S-E-C-R-E-T

S-E-C-R-E-T

25X1

25X1

284

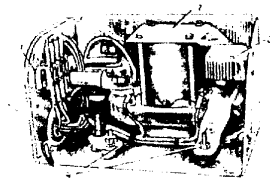


FIG. 35. HYDRAULIC CONTROL PANEL JUNCTION BOX

1 - terminal box; 2 - coil spring, type B-4014, for hydraulic pump engagement; 3 - blocking relay, type 111-21, for hydraulic pump control; 4 - location of delayed action fuse, type IIII-210.

285

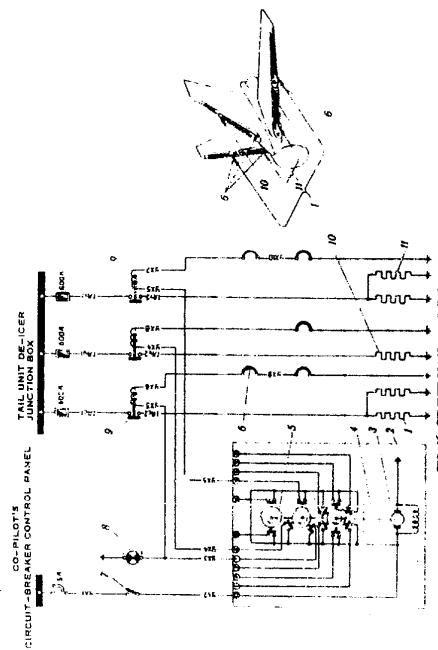


FIG. 36. CIRCUIT DIAGRAM OF TAIL UNIT DE-ICER SYSTEM

1 - external sections (body) of stabilizer de-icer system; 2 - electric armature, type 182A-2A; 3 - electric motor; 4 - fuse; 5 - primary gear reduction unit; 6 - contact assembly; 7 - thermal switch, type 777-B; 8 - switch, type B-45; 9 - signal light, type 131E-11, with white light filter; 10 - connector, type B-600; 11 - de-icer section (boom); 12 - internal de-icer section of stabilizer.

S-E-C-R-E-T

25X1

S-E-C-R-E-T

25X1

25X1

236

237

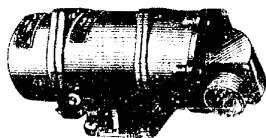


FIG. 37. GENERAL VIEW OF ELECTRIC ACTUATOR. UZPE-MKA-1A

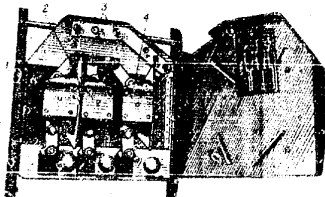


FIG. 38. TAIL UNIT DE-ICER SYSTEM JUNCTION BOX

1 - contact, type K-800B, of external de-icer section of stabilizer; 2 - contact, type K-800B, of fin de-icer section; 3 - bolts for attaching fuses, type 113-800; 4 - contact, type K-600 for internal de-icer section of stabilizer.

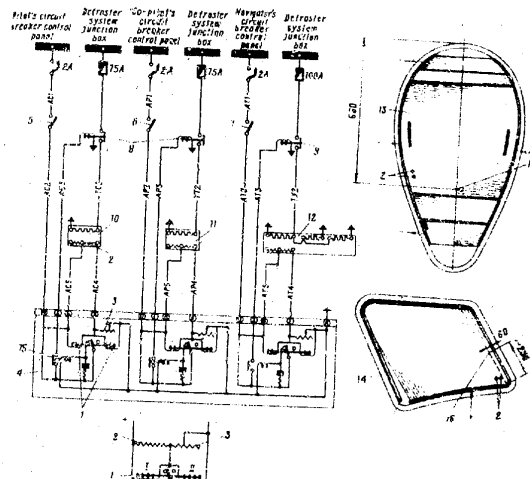


FIG. 39. CIRCUIT DIAGRAM OF DEFROSTER (GLASS PANEL HEATING) SYSTEM

1 - polarized differential relay, type PI; 4 - thermostat; 3 - control rheostat; 4 - automatic defroster control unit, type AOC-81M; 5 - switch, type B-45, of pilot's defroster; 6 - switch, type B-45, of co-pilot's defroster; 7 - switch, type B-45, of navigator's defroster; 8 - contact, type K-50B; 9 - contact, type K-100B; 10 - pilot's glass panel; 11 - co-pilot's glass panel; 12 - navigator's glass panel; 13 - layout of heater elements on navigator's glass panel; 14 - layout of heater element in pilot's glass panel; 15 - relay, type 113-46; 16 - glass temperature measurement point.

S-E-C-R-E-T

25X1

S-E-C-R-E-T

[Redacted]

25X1

[Redacted]

25X1

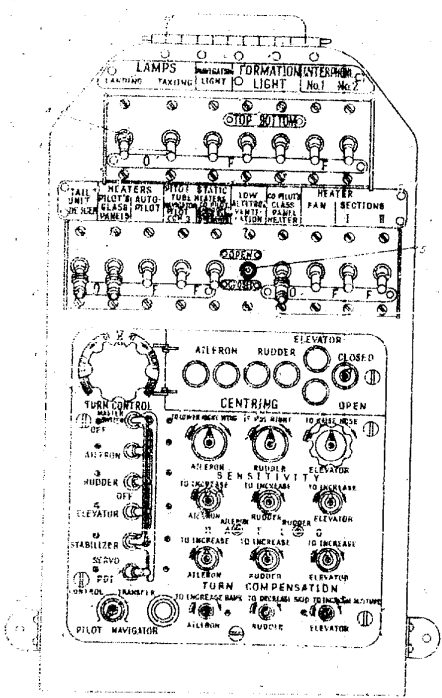


FIG. 43. UPPER (OVERHEAD) ELECTRIC CONTROL BOARD OF PILOTS  
 1 - extension; 2 - switch, type B-45; 3 - change-over switch, type 21R-45; 4 - change-over switch, type 21R-45; 5 - change-over switch, type 21R-45.

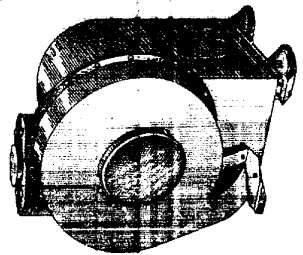


FIG. 44. GENERAL VIEW OF ELECTRIC HEATER, UNDER TOP

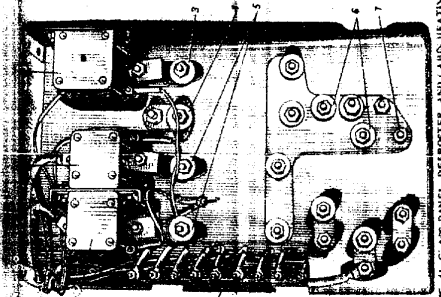


FIG. 41. GLASS PANEL DEFROSTER AND MAIN HEATING SYSTEM JUNCTION BOX  
 1 - connector, type 10-1001, for navigation glass panel heater; 2 - connector, type 10-1001, for navigator's glass panel heater; 3 - location of fuse, type 10-1159, for navigator's glass panel heater; 4 - location of fuse, type 10-1159, for pilot's glass panel heater; 5 - location of fuse, type 10-1159, for pilot's glass panel heater; 6 - location of fuse, type 10-1159, for pilot's glass panel heater; 7 - location of group protection fuse, type 10-1159; 8 - connector, type 10-1159, for pilot's glass panel heater.

S-E-C-R-E-T

[Redacted]

25X1

25X1

— 290 —

— 291 —

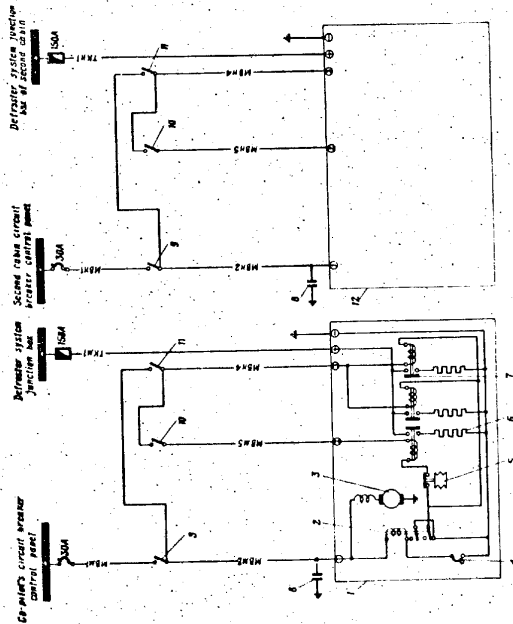


FIG. 43. CIRCUIT DIAGRAM OF CABIN HEATERS  
 1 - heater (index 107) of fuselage section; 2 - blocking relay, type P1L-2; 3 - ventilator electromagnetic; 4 - thermal switch; 5 - heater (index 107) of fuselage section; 6 - blocking relay, type P1L-2; 7 - capacitor, type K-50A; 8 - capacitor, type K-50A; 9 - capacitor, type K-50A; 10 - thermal change-over switch; 11 - first section switch; 12 - heater (index 107) of fuselage section.

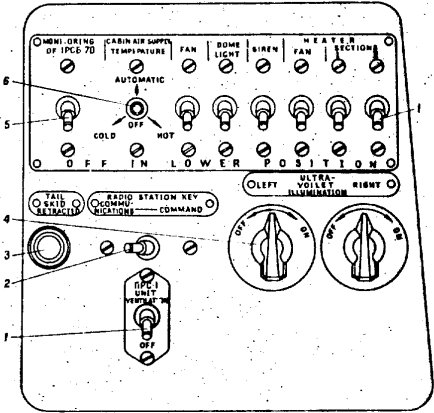


FIG. 44. RADIO OPERATOR'S ELECTRIC CONTROL BOARD  
 1 - switch, type B-45; 2 - change-over switch, type P1L-45; 3 - signal light, type P1L-51, with green filter; 4 - rheostat for ultra-violet illumination control, type P190-45; 5 - change-over switch, type P1L-45; 6 - change-over switch, type P1L-45.

25X1



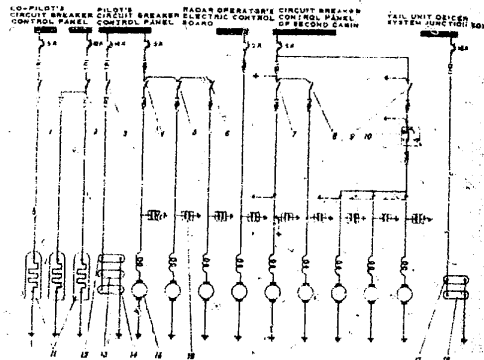


FIG. 45. CIRCUIT DIAGRAM OF INSTRUMENT FANNING AND HEATING SYSTEMS

1 - switch, type B-45, of heaters of TI-156 pitot tube of pilot, navigator and CCH-3 velocity head warning unit; 2 - switch, type B-45, of heaters of pitot tube of copilot, radio operator, radar operator, and of heaters of instruments, types IRI-90B (air position indicator) and OIE-11p (alt); 3 - switch, type B-45, of AJ-4-2M autopilot heaters; 4 - switch, type B-45, of navigator's fan; 5 - switch, type B-45, of pilot's fan; 6 - switch, type B-45, of copilot's fan; 7 - switch, type B-45, of radio-gunner's fan; 8 - switch, type B-45, of gunner's fan; 9 - switch, type B-45, of fans along the rails of radar station IIPC-1; 10 - limit switch, type 2K-44, of fans along the units of radar station IIPC-1; 11 - electric heating element of pitot tube TI-156; 12 - socket of autopilot directional stabilizer heater; 13 - socket of autopilot vertical gyro heater; 14 - socket of autopilot aileron servo unit heater; 15 - fan, type DB-3; 16 - capacitor, type KEM-31; 17 - socket of autopilot elevator servo unit heater; 18 - socket of autopilot rudder servo unit heater.



FIG. 46. GENERAL VIEW OF THERMOSTAT, TYPE PTBX-45

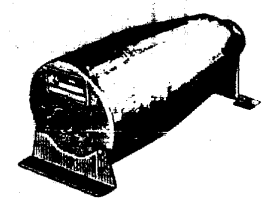


FIG. 47. GENERAL VIEW OF ELECTRIC ACTUATOR, TYPE MPT-1

S-E-C-R-E-T

25X1

25X1

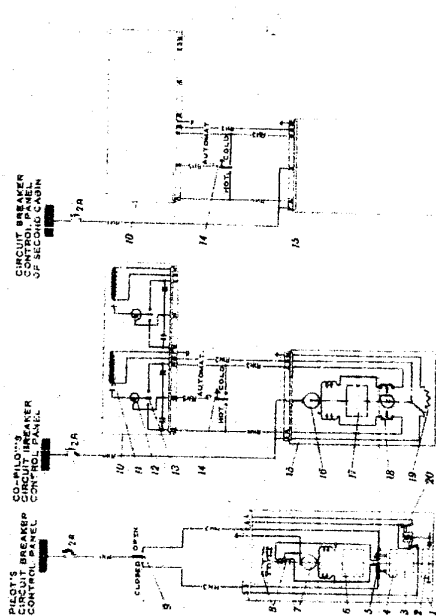


FIG. 48. CIRCUIT DIAGRAM OF ALTITUDE EQUIPMENT

1 - electric actuator, type V.C.H.-1, for low altitude ventilation; 2 - fifth step of planetary gear reduction unit; 3 - friction clutch; 4 - fourth step of planetary gear reduction unit; 5 - limit switches; 6 - first three steps of planetary gear reduction unit; 7 - second step of planetary gear reduction unit; 8 - limit switches; 9 - first three steps of planetary gear reduction unit; 10 - low altitude ventilation in cabin; 11 - cabin the warning (chronograph); 12 - PTM; 13 - 111; 14 - 111; 15 - 111; 16 - 111; 17 - 111; 18 - 111; 19 - 111; 20 - 111.

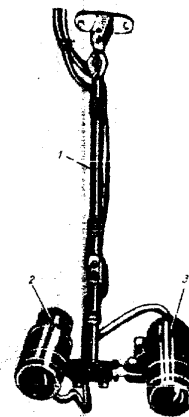


FIG. 49. HINGED BRACKET OF ULTRAVIOLET ILLUMINATION LAMPS  
1 - hinged bracket; 2 - ultraviolet illumination lamp, type APV400L 45; 3 - cabin lamp, type KJCTK 45.

S-E-C-R-E-T

25X1

S-E-C-R-E-T

25X1

25X1

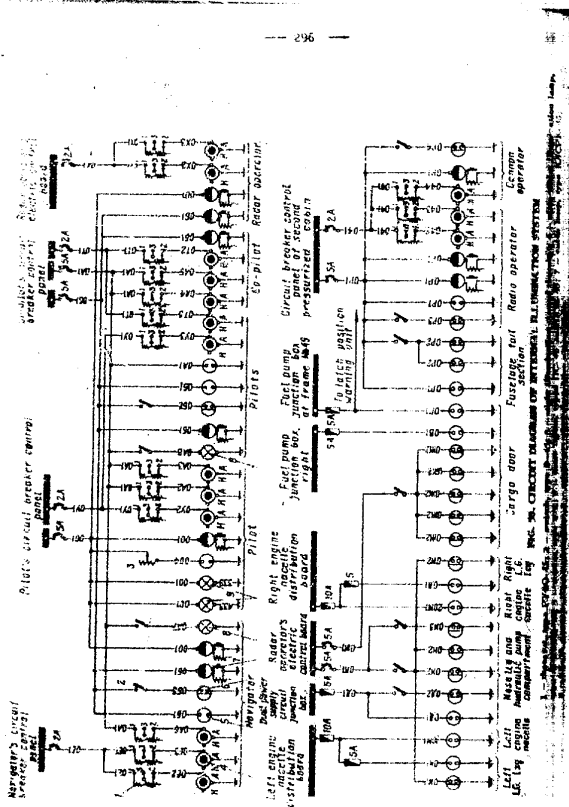


FIG. 51. GENERAL VIEW OF LANDING LAMP, TYPE J8C3-45

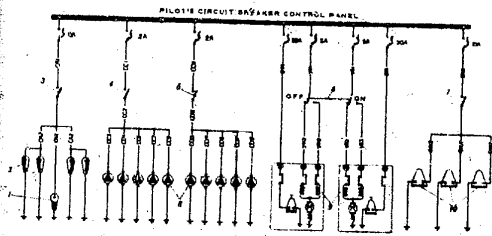


FIG. 52. CIRCUIT DIAGRAM OF EXTERIOR LIGHTING SYSTEM  
1 - tail navigation light, type XC-39; 2 - wing navigation light, type BAHO-45; 3 - switch, type B-45, of navigation lights; 4 - switch, type B-45, of top formation lights; 5 - switch, type B-45 of bottom formation lights; 6 - switch, type 2H11-45, of landing lamps; 7 - switch, type B-45, of tailing lamps; 8 - formation light, type HCCO-45; 9 - landing lamp, type J8C3-45; 10 - tailing lamp, type 0P-100.

S-E-C-R-E-T

25X1

25X1

25X1

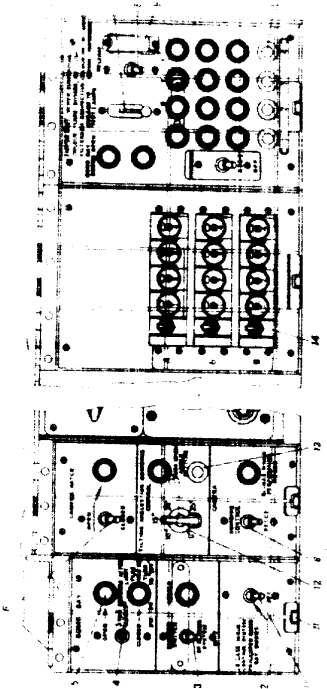


FIG. 13. NAVIGATOR'S BRIGHTNESS CONTROL.

switch, type 100, 100A, 100B, 100C, 100D, 100E, 100F, 100G, 100H, 100I, 100J, 100K, 100L, 100M, 100N, 100O, 100P, 100Q, 100R, 100S, 100T, 100U, 100V, 100W, 100X, 100Y, 100Z, 100AA, 100AB, 100AC, 100AD, 100AE, 100AF, 100AG, 100AH, 100AI, 100AJ, 100AK, 100AL, 100AM, 100AN, 100AO, 100AP, 100AQ, 100AR, 100AS, 100AT, 100AU, 100AV, 100AW, 100AX, 100AY, 100AZ, 100BA, 100BB, 100BC, 100BD, 100BE, 100BF, 100BG, 100BH, 100BI, 100BJ, 100BK, 100BL, 100BM, 100BN, 100BO, 100BP, 100BQ, 100BR, 100BS, 100BT, 100BU, 100BV, 100BW, 100BX, 100BY, 100BZ, 100CA, 100CB, 100CC, 100CD, 100CE, 100CF, 100CG, 100CH, 100CI, 100CJ, 100CK, 100CL, 100CM, 100CN, 100CO, 100CP, 100CQ, 100CR, 100CS, 100CT, 100CU, 100CV, 100CW, 100CX, 100CY, 100CZ, 100DA, 100DB, 100DC, 100DD, 100DE, 100DF, 100DG, 100DH, 100DI, 100DJ, 100DK, 100DL, 100DM, 100DN, 100DO, 100DP, 100DQ, 100DR, 100DS, 100DT, 100DU, 100DV, 100DW, 100DX, 100DY, 100DZ, 100EA, 100EB, 100EC, 100ED, 100EE, 100EF, 100EG, 100EH, 100EI, 100EJ, 100EK, 100EL, 100EM, 100EN, 100EO, 100EP, 100EQ, 100ER, 100ES, 100ET, 100EU, 100EV, 100EW, 100EX, 100EY, 100EZ, 100FA, 100FB, 100FC, 100FD, 100FE, 100FF, 100FG, 100FH, 100FI, 100FJ, 100FK, 100FL, 100FM, 100FN, 100FO, 100FP, 100FQ, 100FR, 100FS, 100FT, 100FU, 100FV, 100FW, 100FX, 100FY, 100FZ, 100GA, 100GB, 100GC, 100GD, 100GE, 100GF, 100GG, 100GH, 100GI, 100GJ, 100GK, 100GL, 100GM, 100GN, 100GO, 100GP, 100GQ, 100GR, 100GS, 100GT, 100GU, 100GV, 100GW, 100GX, 100GY, 100GZ, 100HA, 100HB, 100HC, 100HD, 100HE, 100HF, 100HG, 100HH, 100HI, 100HJ, 100HK, 100HL, 100HM, 100HN, 100HO, 100HP, 100HQ, 100HR, 100HS, 100HT, 100HU, 100HV, 100HW, 100HX, 100HY, 100HZ, 100IA, 100IB, 100IC, 100ID, 100IE, 100IF, 100IG, 100IH, 100II, 100IJ, 100IK, 100IL, 100IM, 100IN, 100IO, 100IP, 100IQ, 100IR, 100IS, 100IT, 100IU, 100IV, 100IW, 100IX, 100IY, 100IZ, 100JA, 100JB, 100JC, 100JD, 100JE, 100JF, 100JG, 100JH, 100JI, 100JJ, 100JK, 100JL, 100JM, 100JN, 100JO, 100JP, 100JQ, 100JR, 100JS, 100JT, 100JU, 100JV, 100JW, 100JX, 100JY, 100JZ, 100KA, 100KB, 100KC, 100KD, 100KE, 100KF, 100KG, 100KH, 100KI, 100KJ, 100KL, 100KM, 100KN, 100KO, 100KP, 100KQ, 100KR, 100KS, 100KT, 100KU, 100KV, 100KW, 100KX, 100KY, 100KZ, 100LA, 100LB, 100LC, 100LD, 100LE, 100LF, 100LG, 100LH, 100LI, 100LJ, 100LK, 100LL, 100LM, 100LN, 100LO, 100LP, 100LQ, 100LR, 100LS, 100LT, 100LU, 100LV, 100LW, 100LX, 100LY, 100LZ, 100MA, 100MB, 100MC, 100MD, 100ME, 100MF, 100MG, 100MH, 100MI, 100MJ, 100MK, 100ML, 100MM, 100MN, 100MO, 100MP, 100MQ, 100MR, 100MS, 100MT, 100MU, 100MV, 100MW, 100MX, 100MY, 100MZ, 100NA, 100NB, 100NC, 100ND, 100NE, 100NF, 100NG, 100NH, 100NI, 100NJ, 100NK, 100NL, 100NM, 100NO, 100NP, 100NQ, 100NR, 100NS, 100NT, 100NU, 100NV, 100NW, 100NX, 100NY, 100NZ, 100OA, 100OB, 100OC, 100OD, 100OE, 100OF, 100OG, 100OH, 100OI, 100OJ, 100OK, 100OL, 100OM, 100ON, 100OO, 100OP, 100OQ, 100OR, 100OS, 100OT, 100OU, 100OV, 100OW, 100OX, 100OY, 100OZ, 100PA, 100PB, 100PC, 100PD, 100PE, 100PF, 100PG, 100PH, 100PI, 100PJ, 100PK, 100PL, 100PM, 100PN, 100PO, 100PP, 100PQ, 100PR, 100PS, 100PT, 100PU, 100PV, 100PW, 100PX, 100PY, 100PZ, 100QA, 100QB, 100QC, 100QD, 100QE, 100QF, 100QG, 100QH, 100QI, 100QJ, 100QK, 100QL, 100QM, 100QN, 100QO, 100QP, 100QQ, 100QR, 100QS, 100QT, 100QU, 100QV, 100QW, 100QX, 100QY, 100QZ, 100RA, 100RB, 100RC, 100RD, 100RE, 100RF, 100RG, 100RH, 100RI, 100RJ, 100RK, 100RL, 100RM, 100RN, 100RO, 100RP, 100RQ, 100RR, 100RS, 100RT, 100RU, 100RV, 100RW, 100RX, 100RY, 100RZ, 100SA, 100SB, 100SC, 100SD, 100SE, 100SF, 100SG, 100SH, 100SI, 100SJ, 100SK, 100SL, 100SM, 100SN, 100SO, 100SP, 100SQ, 100SR, 100SS, 100ST, 100SU, 100SV, 100SW, 100SX, 100SY, 100SZ, 100TA, 100TB, 100TC, 100TD, 100TE, 100TF, 100TG, 100TH, 100TI, 100TJ, 100TK, 100TL, 100TM, 100TN, 100TO, 100TP, 100TQ, 100TR, 100TS, 100TT, 100TU, 100TV, 100TW, 100TX, 100TY, 100TZ, 100UA, 100UB, 100UC, 100UD, 100UE, 100UF, 100UG, 100UH, 100UI, 100UJ, 100UK, 100UL, 100UM, 100UN, 100UO, 100UP, 100UQ, 100UR, 100US, 100UT, 100UU, 100UV, 100UW, 100UX, 100UY, 100UZ, 100VA, 100VB, 100VC, 100VD, 100VE, 100VF, 100VG, 100VH, 100VI, 100VJ, 100VK, 100VL, 100VM, 100VN, 100VO, 100VP, 100VQ, 100VR, 100VS, 100VT, 100VU, 100VV, 100VW, 100VX, 100VY, 100VZ, 100WA, 100WB, 100WC, 100WD, 100WE, 100WF, 100WG, 100WH, 100WI, 100WJ, 100WK, 100WL, 100WM, 100WN, 100WO, 100WP, 100WQ, 100WR, 100WS, 100WT, 100WU, 100WV, 100WW, 100WX, 100WY, 100WZ, 100XA, 100XB, 100XC, 100XD, 100XE, 100XF, 100XG, 100XH, 100XI, 100XJ, 100XK, 100XL, 100XM, 100XN, 100XO, 100XP, 100XQ, 100XR, 100XS, 100XT, 100XU, 100XV, 100XW, 100XX, 100XY, 100XZ, 100YA, 100YB, 100YC, 100YD, 100YE, 100YF, 100YG, 100YH, 100YI, 100YJ, 100YK, 100YL, 100YM, 100YN, 100YO, 100YP, 100YQ, 100YR, 100YS, 100YT, 100YU, 100YV, 100YW, 100YX, 100YY, 100YZ, 100ZA, 100ZB, 100ZC, 100ZD, 100ZE, 100ZF, 100ZG, 100ZH, 100ZI, 100ZJ, 100ZK, 100ZL, 100ZM, 100ZN, 100ZO, 100ZP, 100ZQ, 100ZR, 100ZS, 100ZT, 100ZU, 100ZV, 100ZW, 100ZX, 100ZY, 100ZZ.



FIG. 14. CIRCUIT DIAGRAM OF SIGNAL FLARE SYSTEM.

1 - signal flare control relay, 2 - switch, 3 - button, 4 - signal flare terminal.

U-R-C-R-T

25X1

25X1



FIG. 55. SOUND SIGNALING SYSTEM RELAY BOX, FRONT PANEL (SEE FIG. 54)

1 - resistor, type K3-1A-M; 2 - alarm relay, type P11-2; 3 - relay, type P11-2, to break intermission signaling; 4 - terminal block; 5 - buzzer relay, type P11-2, for intermission signaling of cabin pressure drop.

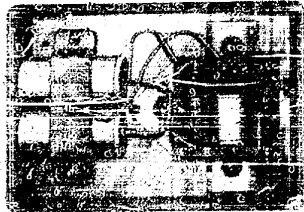


FIG. 56. SOUND SIGNALING SYSTEM RELAY BOX, REAR PANEL (SEE FIG. 54)

1 - capacitor, type K3-1A-M; 2 - buzzer relay, type P11-2, for intermission signaling of cabin pressure drop.

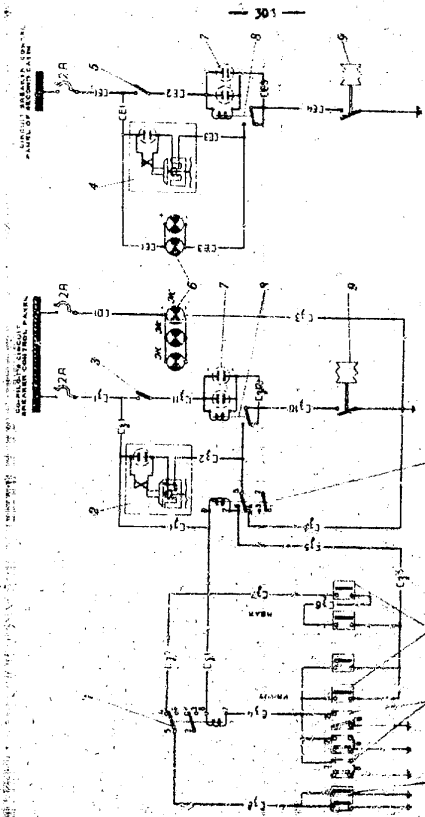


FIG. 57. CIRCUIT DIAGRAM OF SOUND AND LIGHT SIGNALING SYSTEMS  
1 - alarm relay, type P11-2; 2 - alarm relay, type P11-2; 3 - relay, type P11-2, to break intermission signaling; 4 - terminal block; 5 - buzzer relay, type P11-2, for intermission signaling of cabin pressure drop; 6 - buzzer relay, type P11-2, for intermission signaling of cabin pressure drop; 7 - capacitor, type K3-1A-M; 8 - buzzer relay, type P11-2, for intermission signaling of cabin pressure drop; 9 - cabin altitude warning unit, type RC-46-10; 10 - light switch mechanism, type MB-2; 11 - light switch, type MB-44; 12 - light switch, type MB-44; 13 - light switch, type MB-44.

U-R-C-R-T

25X1

H-E-C-R-E-T

25X1

25X1

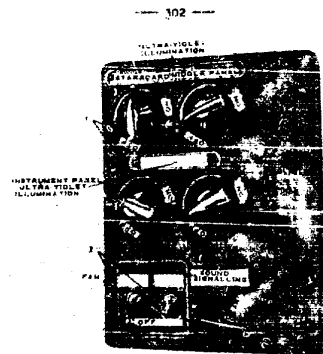


FIG. 58. CO-PILOT'S RHEGOSTAT CONTROL BOARD

1 - ultra-violet illumination rheostat, type PY90-51; 2 - switches, type B-45.

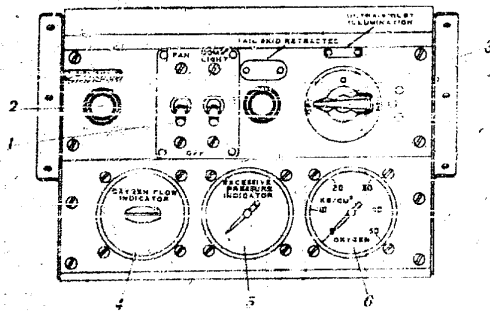


FIG. 59. GUNNER'S ELECTRIC CONTROL BOARD

1 - switch, type B-45; 2 - signal light, type C111-51; 3 - ultra-violet illumination control rheostat, type PY90-51; 4 - oxygen flow indicator; 5 - pressure pressure indicator; 6 - oxygen pressure gauge.

H-E-C-R-E-T

25X1

FIG. 56. AIRCRAFT ANTENNAS LAYOUT DIAGRAM

1 - non-inductive antenna of radio set PCIV-58; 2 - receiving antenna of receiver No. 2 of the radio set PCIV-58; 3 - antenna of receiver BPT-9; 4 - antenna of radio flight (RF) 1; 5 - wire antenna of radio communication station 1-PCV-70; 6 - lateral antenna BPT-68; 7 - connecting antenna CA-1; 8 - receiving antenna UJ-1; 9 - antenna of radio set PCIV-58; 10 - antenna of radio set PCIV-58; 11 - antenna of radio set PCIV-58; 12 - ultrasonic receiving antenna; 13 - antenna No. 3 of automatic radio compass APR-5; 14 - antenna of radio set BPT-9; 15 - antenna No. 2 of automatic radio compass APR-5; 16 - antenna No. 1 of automatic radio compass APR-5; 17 - antenna No. 2 of automatic radio compass APR-5; 18 - antenna No. 1 of automatic radio compass APR-5.

25X1

25X1

304

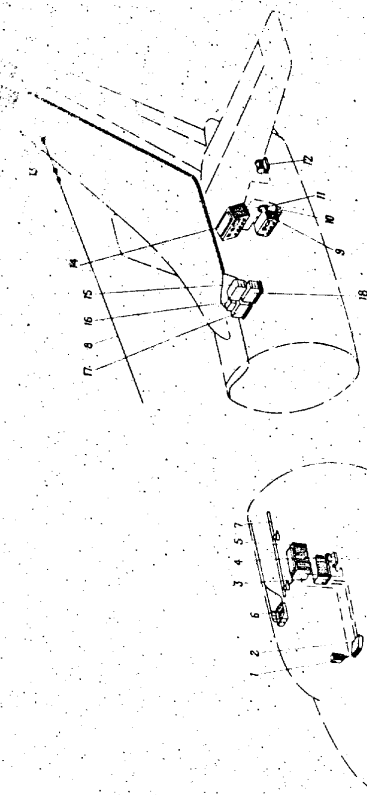


FIG. 61. ARRANGEMENT DIAGRAM OF COMMUNICATION RADIO SETS  
 1 - remote control panel of command set 1-PCB-70M; 2 - control panel of command set YC-9; 3 - dynamotor Y-600 of the transmitter of command set 1-PCB-70M; 4 - control panel of the PCB-7M command set; 5 - transmitter of command set 1-PCB-70M; 6 - control panel of the PCB-7M command set; 7 - receiver YC-9 of communication set 1-PCB-70M; 8 - wire antenna of communication set 1-PCB-70M; 9 - radio operator's electric board monitoring and telegraph key switches; 10 - telegraph key panel of the communication set; 11 - radio operator's electric board monitoring and telegraph key switches; 12 - dynamotor of communication set PCB-7M; 13 - tail outboard antenna of communication set PCB-7M; 14 - microphone of communication set PCB-7M; 15 - receiver No. 2 of communication set PCB-7M; 16 - microphone of communication set PCB-7M; 17 - PCB-7M transmitter; 18 - receiver No. 1 of PCB-7M command set.

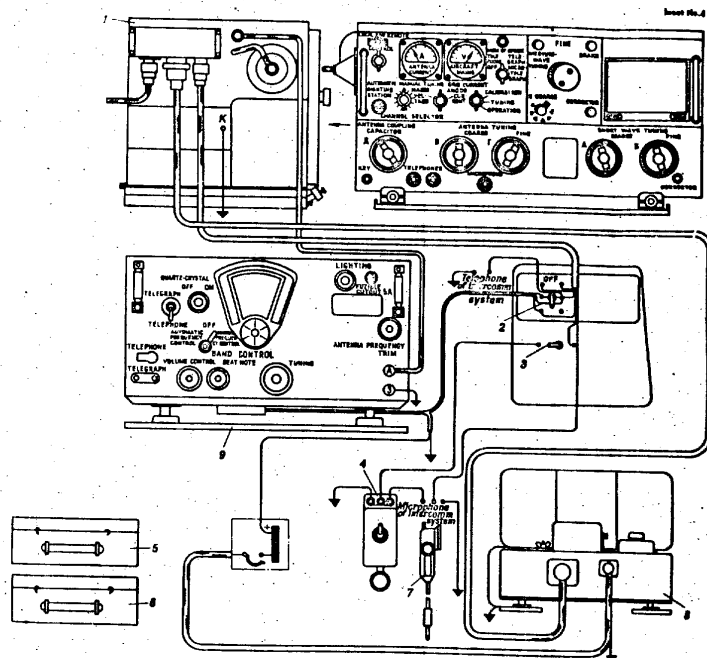


FIG. 62. DIAGRAM OF COMMUNICATION SET 1-PCB-70  
 1 - transmitter of set 1-PCB-70; 2 - self-monitoring switch; 3 - telegraph key switch; 4 - telegraph key panel;  
 5 - box containing spare tubes for the transmitter; 6 - box containing spare tubes for the receiver; 7 - microphones;  
 8 - dynamotor Y-600; 9 - receiver YC-9.

25X1

— 305 —

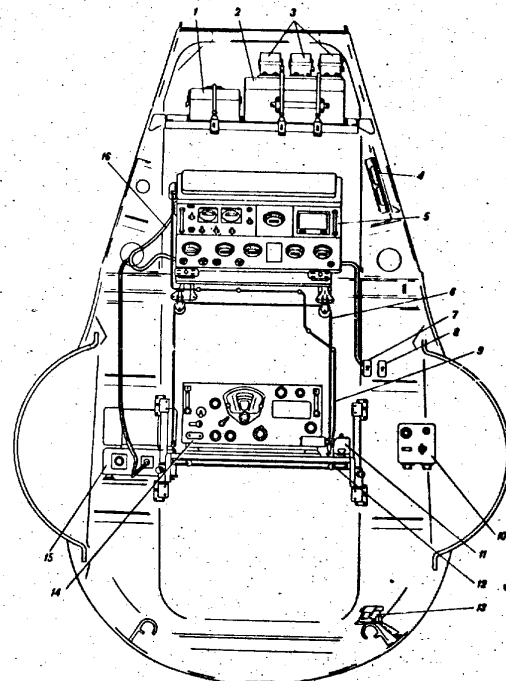


FIG. 63. ARRANGEMENT DIAGRAM OF COMMUNICATION SET 1-PCB-70M  
1 - box with spare tubes for receiver YC-8; 2 - box with spare tubes for transmitter of set 1-PCB-70;  
3 - boxes with crystals for set PC31Y-3M; 4 - split boxes of intercom system CIY-10 of the radio  
operator; 5 - communication transmitter of set 1-PCB-70; 6 - shock-absorbing cradles of the radio  
operator's table; 7 - monitoring switch; 8 - telegraph key switch (for command set transmitter  
1-PCB-70M); 9 - antenna fair-lead of receiver YC-8; 10 - radio operator's CIY-10 interphone set;  
11 - telegraph key panel; 12 - radio operator's table; 13 - foot switch of the radio operator's intercom  
set; 14 - receiver YC-8; 15 - dynamotor 3-600 (installed next to frame No. 75); 16 - antenna fair-  
lead of transmitter of set 1-PCB-70.



S-E-C-R-E-T  
25X1

25X1

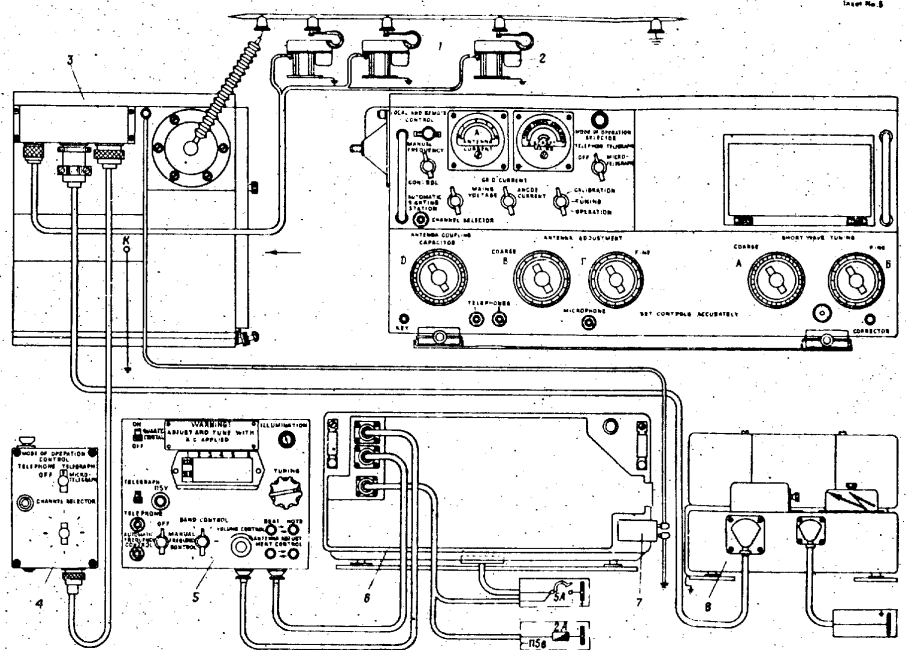


FIG. 64. DIAGRAM OF COMMAND RADIO SET 1-PCB-70M  
1 - folded-dipole antenna; 2 - relay PC; 3 - transmitter 1-PCB-70M; 4 - transmitter remote control panel; 5 - remote control panel of receiver YC-91; 6 - receiver YC-91; 7 - antenna filter A9Y-91; 8 - dynamotor 3-600.

S-E-C-R-E-T  
25X1

25X1

25X1

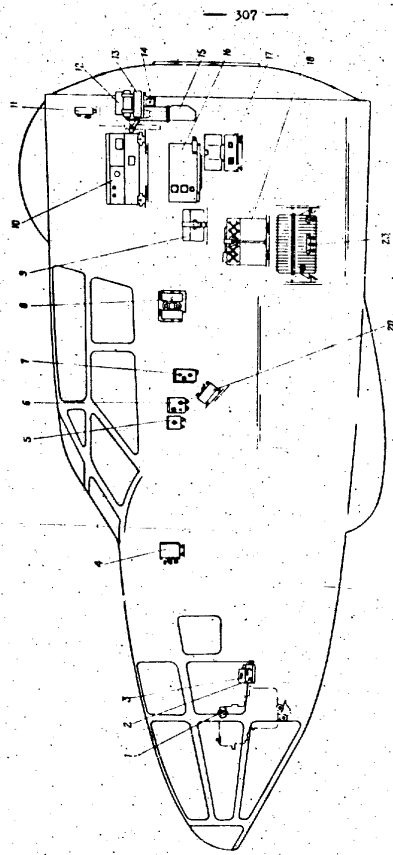


FIG. 65. ARRANGEMENT OF RADIO EQUIPMENT IN FRONT CABIN (STARBOARD)

1 - intercom system; 2 - intercom system; 3 - intercom system; 4 - intercom system; 5 - intercom system; 6 - intercom system; 7 - intercom system; 8 - intercom system; 9 - intercom system; 10 - intercom system; 11 - intercom system; 12 - intercom system; 13 - intercom system; 14 - intercom system; 15 - intercom system; 16 - intercom system; 17 - intercom system; 18 - intercom system; 19 - intercom system; 20 - intercom system; 21 - intercom system; 22 - intercom system; 23 - intercom system.

25X1

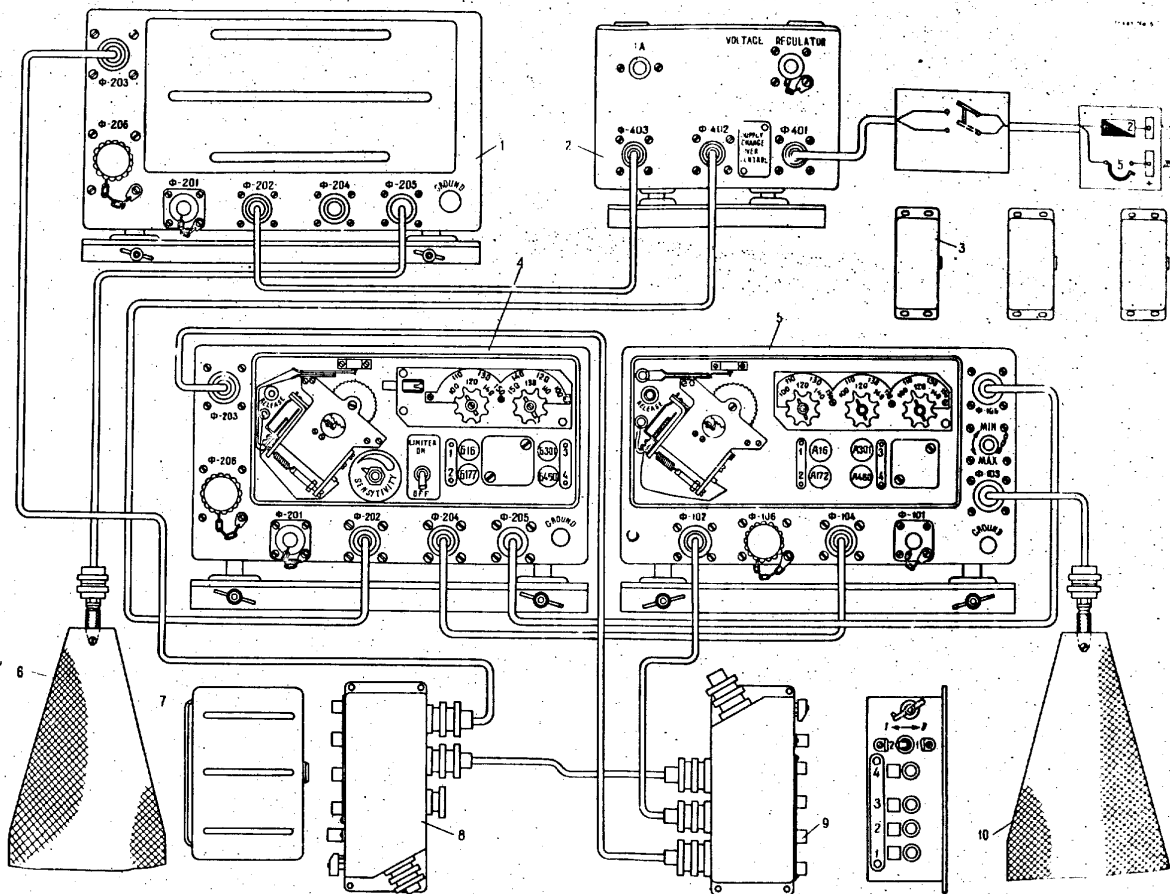


FIG. 67. DIAGRAM OF COMMAND SET PCMV-3M

1 - receiver No. 2 of command set PCMV-3M; 2 - selenium rectifier; 3 - for crystals; 4 - receiver No. 1 of set PCMV-3M; 5 - transmitter of PCMV-3M; 6 - receiving antenna of receiver No. 2; 7 - unit "51" for tuning the set; 8 - control panel of receiver No. 2 and transmitter; 10 - receive-transmit antenna of receiver No. 1 and transmitter.

25X1

25X1

— 308 —

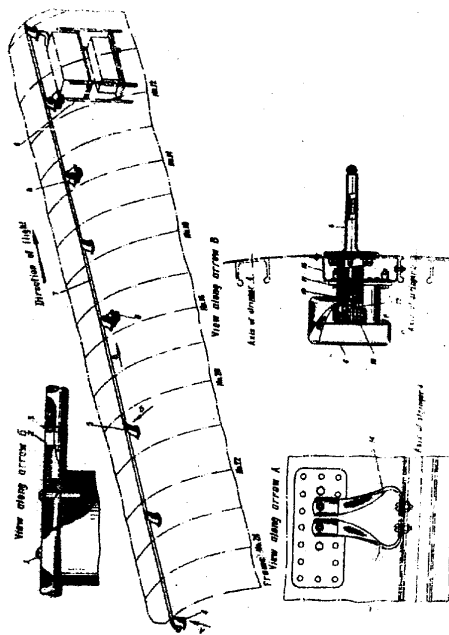


FIG. 66. FOLDABLE ANTENNA OF COMMAND SET, I-PCS-70M  
 1 - antenna tube to antenna base mounting; 2 - nut; 3 - silver socket/washer; 4 - metal support; 5 - base rubber cone; 6 - antenna tube; 7 - mounting rubber cone; 8 - mounting support; 9 - transmitter I-PCS-70M; 10 - mounting rubber cone; 11 - mounting support; 12 - mounting support; 13 - nut.

S-E-C-R-E-T

25X1

S-E-C-R-E-T  
25X1

25X1

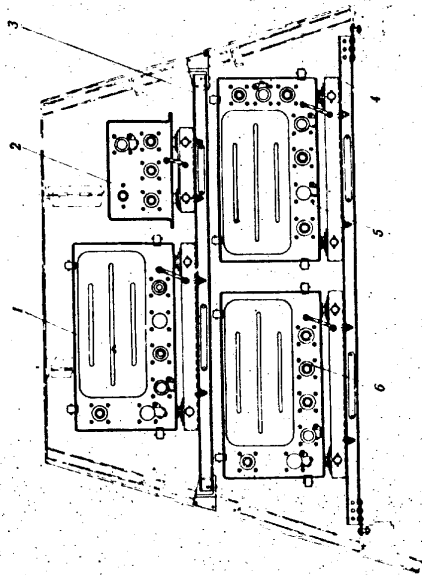


FIG. 68. ARRANGEMENT DIAGRAM OF RADIO SET PC317. 31  
1 - receiver No. 2; 2 - vacuum rectifier; 3 - upper rack carrying units of set PC317. 31; 4 - lower rack;  
5 - transmitter; 6 - receiver No. 1.

S-E-C-R-E-T

25X1

S-E-C-R-E-T

25X1

25X1

310

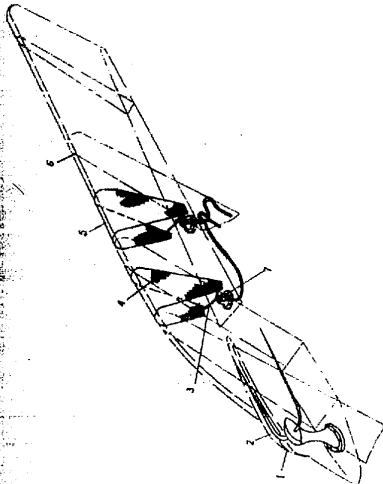


FIG. 19. ARRANGEMENT DIAGRAM OF FN ANTENNA  
1 - vertical lead; 2 - antenna of cone receiver; 3 - grid antenna loading; 4 - receiving antenna; 5 - receiving antenna of detector; 6 - 7 of table set (P. 107-108); 8 - for antenna; 9 - for antenna.

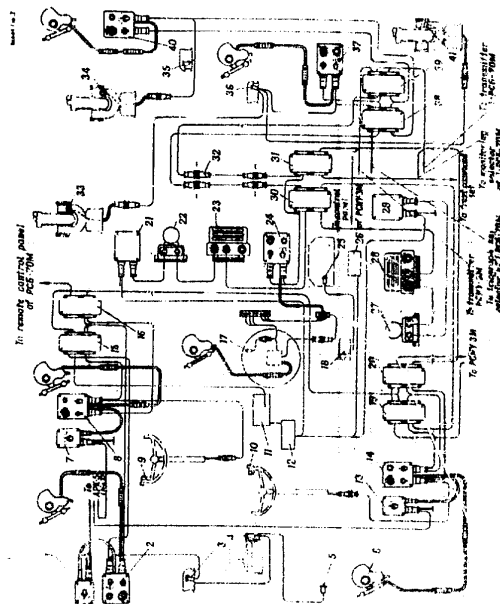


FIG. 20. DIAGRAM OF SWITCHING SYSTEM  
1 - antenna's additional part; 2 - antenna's receiver; 3 - antenna's lead; 4 - antenna's lead; 5 - antenna's lead; 6 - antenna's lead; 7 - antenna's lead; 8 - antenna's lead; 9 - antenna's lead; 10 - antenna's lead; 11 - antenna's lead; 12 - antenna's lead; 13 - antenna's lead; 14 - antenna's lead; 15 - antenna's lead; 16 - antenna's lead; 17 - antenna's lead; 18 - antenna's lead; 19 - antenna's lead; 20 - antenna's lead; 21 - antenna's lead; 22 - antenna's lead; 23 - antenna's lead; 24 - antenna's lead; 25 - antenna's lead; 26 - antenna's lead; 27 - antenna's lead; 28 - antenna's lead; 29 - antenna's lead; 30 - antenna's lead; 31 - antenna's lead; 32 - antenna's lead; 33 - antenna's lead; 34 - antenna's lead; 35 - antenna's lead; 36 - antenna's lead; 37 - antenna's lead.

S-E-C-R-E-T

25X1

25X1

25X1

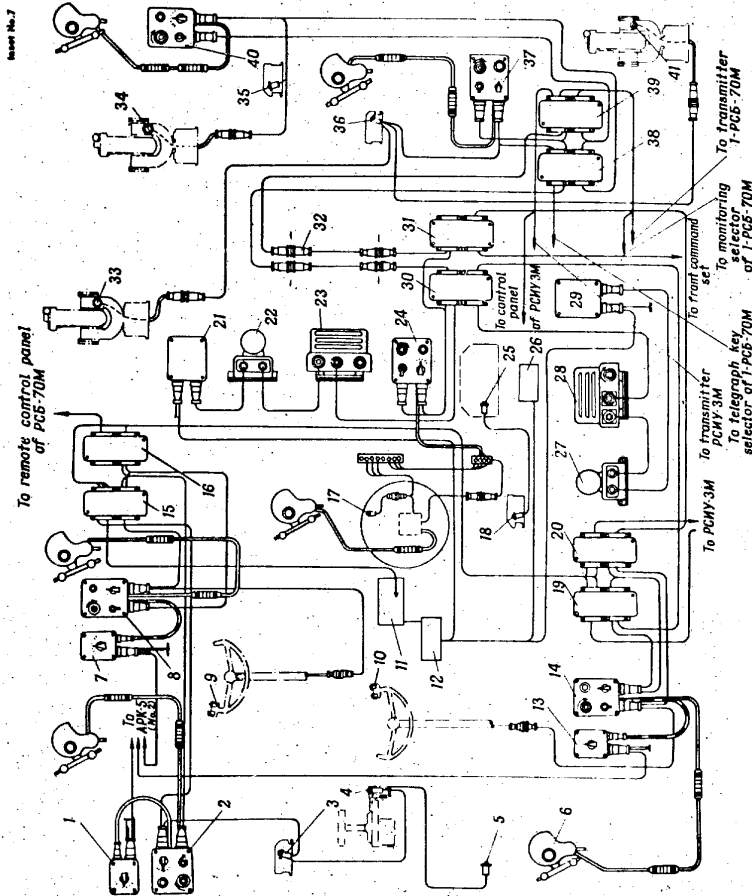


FIG. 70. DIAGRAM OF INTERCOM SYSTEM CIIV-10

1 - navigator's additional panel of intercom system; 2 - navigator's intercom set; 3 - navigator's foot button switch; 4 - button on AI-1-5-2V course stabilizer; 5 - button on navigator's control panel; 6 - head set with three microphones and connecting cables; 7 - pilot's additional panel; 8 - copilot's intercom set; 9 - CIIV (INTERCOM SYSTEM) and PAIWH (RADIO SETS) buttons on the copilot's control wheel; 10 - CIIV (INTERCOM SYSTEM) and PAIWH (RADIO SETS) buttons on pilot's control wheel; 11 - circuit breaker panel of copilot; 12 - pilot's overhead upper electric panel; 13 - pilot's additional panel; 14 - pilot's intercom set; 15, 19, 30, 36 - aircraft intercom junction box; 16, 20, 31, 39 - outside communication junction box; 17 - intercom system button on radar operator's sighting station; 18 - operator's foot button switch of intercom system; 21 - aircraft main filter of intercom system No. 2; 22 - dynamometer No. 2 of intercom system; 23 - amplifier No. 2 of intercom system; 24 - operator's intercom set; 25 - button on operator's instrument panel; 26 - operator's electric panel; 27 - dynamometer No. 1 of intercom system; 28 - amplifier No. 1 of intercom system; 29 - aircraft main filter No. 2 of intercom system; 32 - aircraft plug connectors; 33 - button of operator's sighting station (starboard blister); 34 - button on gunner's alt sighting station; 35 - gunner's foot button switch; 36 - radio operator's foot button switch; 37 - radio operator's intercom set; 40 - gunner's intercom set; 41 - intercom system button on radio operator's port sighting station.

25X1

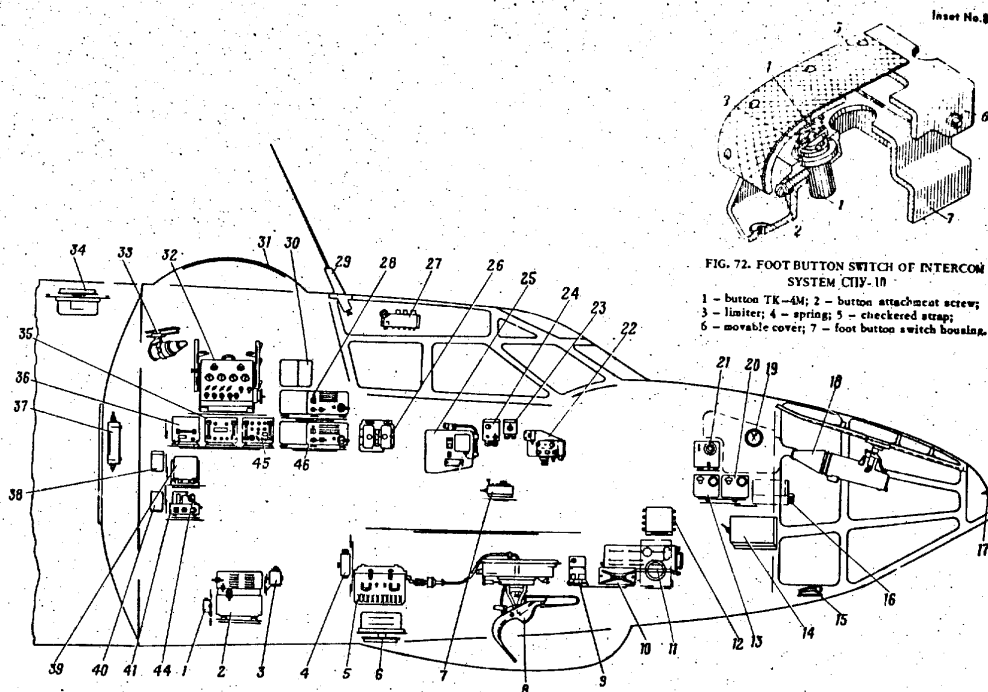


FIG. 72. FOOT BUTTON SWITCH OF INTERCOM SYSTEM CIY-10

- 1 - button TK-4M; 2 - button attachment screw;
- 3 - limiter; 4 - spring; 5 - checkered strap;
- 6 - movable cover; 7 - foot button switch housing.

FIG. 71. DIAGRAM OF RADIO EQUIPMENT LOCATED IN NOSE CABIN (PORT SIDE)

- 1 - filter  $\Phi$ 14-A of transponder set; 2 - transponder; 3 - transponder inertia switch; 4 - junction box P13 (radar bombsight PBI-4); 5 - transmitter receiver P2 (unit PBI-4); 6 - loop antenna of automatic radio compass APK-5 No. 2; 7 - pilot's control panel of automatic radio compass APK-5 No. 1; 8 - antenna P1 (PIE-4 bombsight); 9 - receiver  $\Gamma$ PI-2; 10 - ILS junction box; 11 - bombardier's synchronizer P7 (radar bombsight PBI-4); 12 - junction box P14 (radar bombsight PBI-4); 13 - automatic radio compass No. 2 control panel; 14 - bombardier's control panel P9 (radar bombsight PBI-4); 15 - intercom system foot button; 16 - intercom system button; 17 - slide-path receiver antenna; 18 - bombardier's indicator P8; 19 - two-pointer course indicator VIII-1; 20 - automatic radio compass No. 1 control panel; 21 - indicator of radio altimeter PB-17M; 22 - control panels of CL-1 and KPII- $\Phi$ ,  $\Gamma$ PI-2; 23 - pilot's additional panel of intercom system; 24 - pilot's intercom set; 25 - panel with code board, destructor button and transponder switch; 26 - intercom system distribution box; 27 - control panels of radio set PCMY-3M; 28 - receiver of automatic radio compass PK-5 No. 1; 29 - rod antenna of automatic radio compass No. 1; 30 - relay box of automatic radio compass No. 1; 31 - antenna of automatic radio compass No. 2; 32 - operator's control panel P6 of radar bombsight PBI-4; 33 - operator's indicator P5/1; 34 - loop antenna of automatic radio compass No. 2; 35 - operator's synchronizer P4; 36 - regulated rectifier; 37 - junction box P15; 38 - filter of intercom system No. 2; 39 - high voltage rectifier; 40 - filter of intercom system No. 1; 41 - amplifier of intercom system No. 1; 42 - dynamotor of intercom system No. 1; 43 - range unit P3 (radar bombsight PBI-4); 44 - receiver of automatic radio compass No. 2.



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25X1

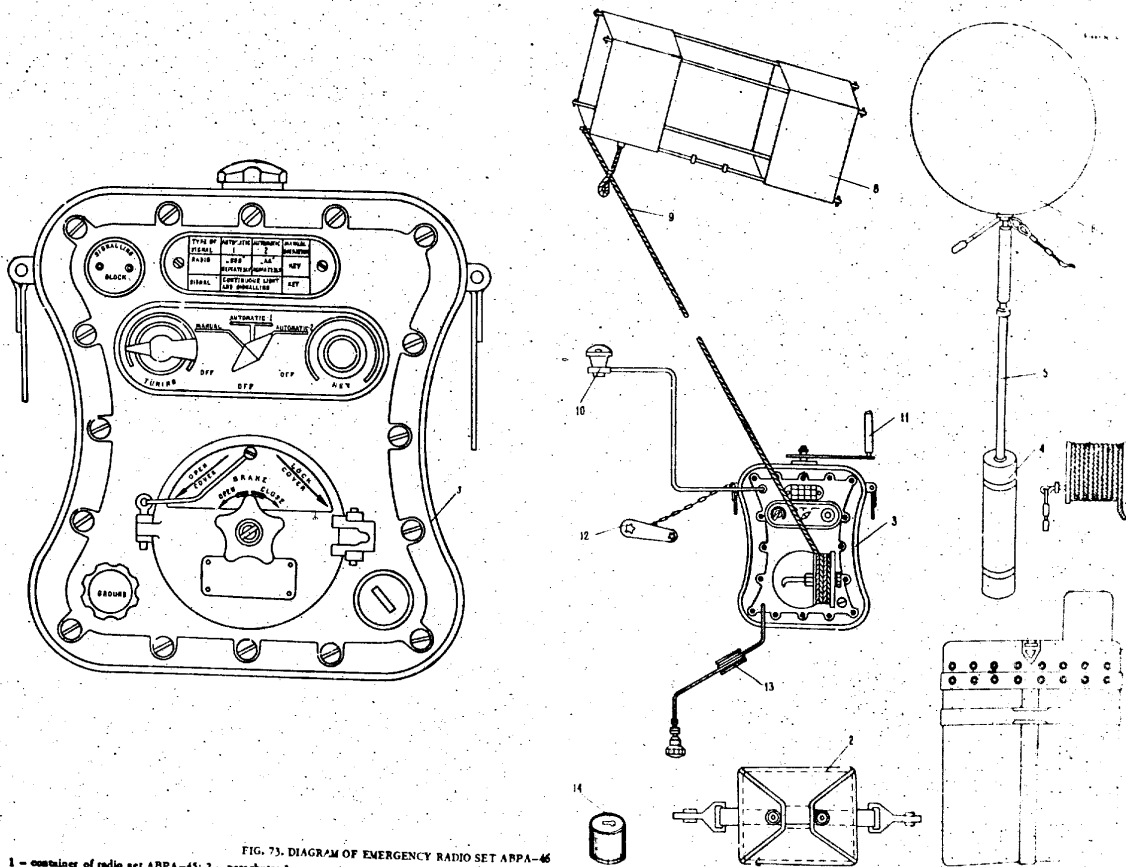


FIG. 73. DIAGRAM OF EMERGENCY RADIO SET ABPA-45  
 1 - container of radio set ABPA-45; 2 - parachute; 3 - transmitter; 4 - hydrogen generator; 5 - baloon filling pipe; 6 - baloon for lifting the antenna; 7 - spare coil with antenna; 8 - box kite; 9 - antenna; 10 - signaling lamp; 11 - crutch to rotate the generator; 12 - wrench for nutscrewing plugs; 13 - grounding wire (counterweight); 14 - can with a spare baloon.

SECRET

25X1

25X1

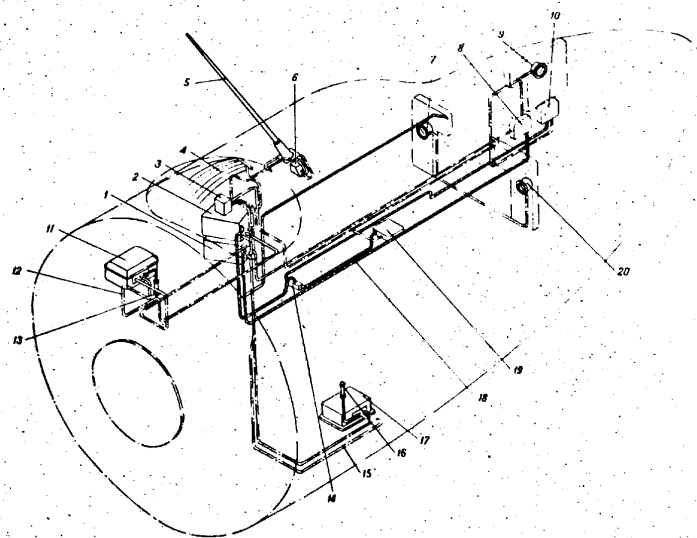


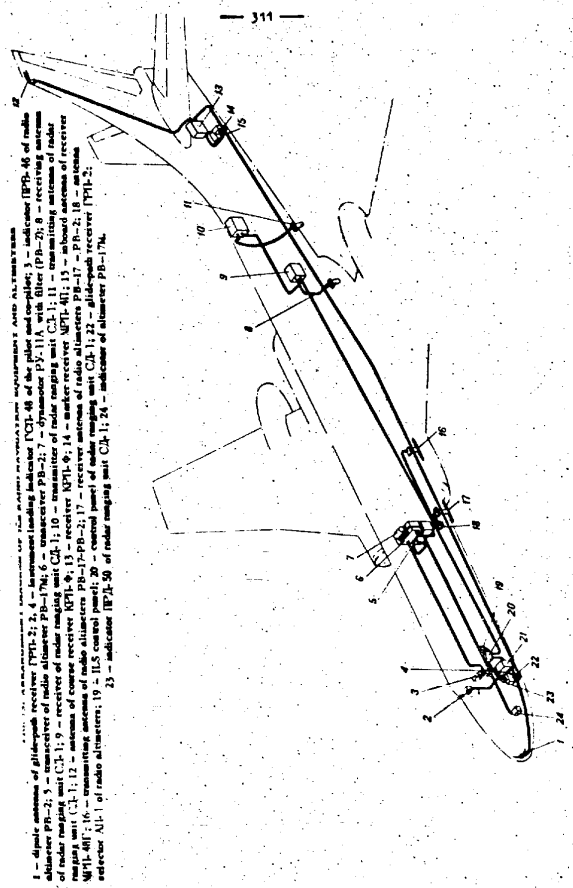
FIG. 74. ARRANGEMENT DIAGRAM OF RADIO NAVIGATION FACILITIES (AUTOMATIC RADIO COMPASSES NOS 1 AND 2)

1 - receiver of automatic radio compass APK-5 No. 2; 2 - receiver of automatic radio compass No. 1; 3 - box of APK-5 No. 1; 4 - blister antenna of APK-5 No. 2; 5 - rod antenna of APK-5 No. 1; 6 - rod antenna switch-over distribution box; 7 - indicator BCYII-1 of pilot's automatic radio compass No. 1; 8 - control panel of radio compass No. 2; 9 - navigator's two-pointer indicator VIII-E-1 of automatic radio compass Nos 1 and 2; 10 - control panel of automatic radio compass No. 1; 11 - inboard loop antenna of automatic radio compass No. 1; 12 - connecting cables of automatic radio compass No. 1; 13 - silica gel cell of automatic radio compass No. 1; 14 - flexible shaft receiver-piece of automatic radio compass No. 1; 15 - connecting cables of automatic radio compass No. 2; 16 - silica gel cell of automatic radio compass No. 2; 17 - inboard loop antenna of automatic radio compass No. 2; 18 - flexible shafts to operate the receivers of the automatic radio compass APK-5; 19 - pilot's control panel of automatic radio compass APK-5 No. 1; 20 - indicator BCYII-1 of co-pilot's automatic radio compass APK-5 No. 2.

S-E-C-R-E-T

25X1

S-E-C-R-E-T



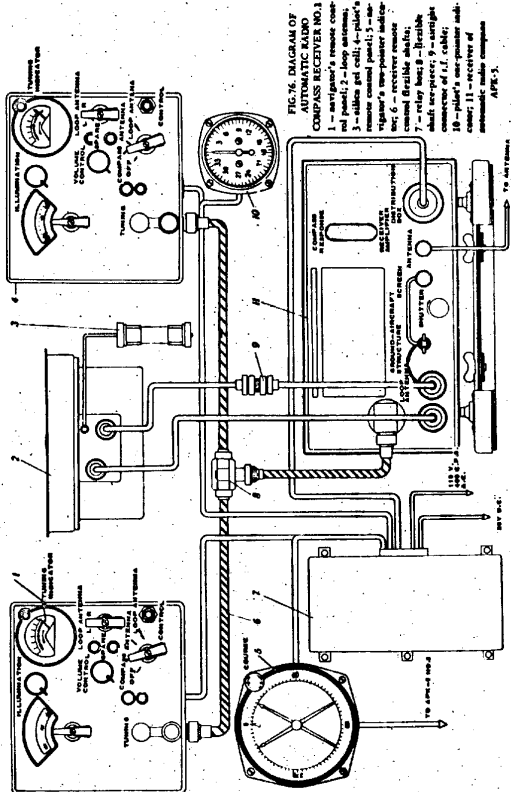
S-E-C-R-E-T

S-E-C-R-E-T

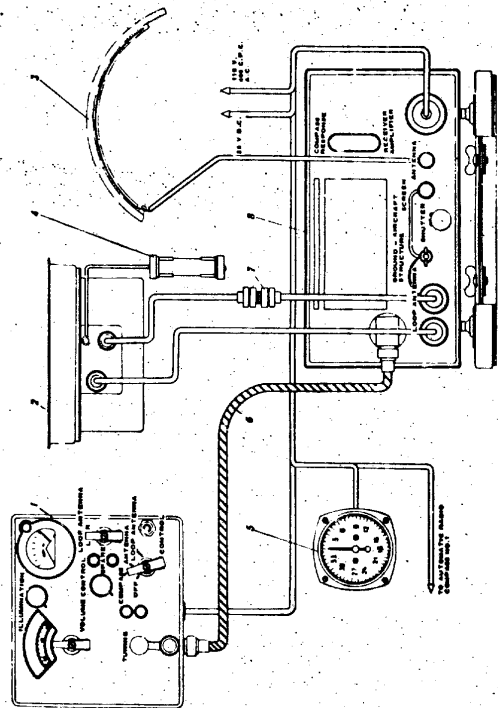
25X1

25X1

— 312 —



— 313 —



S-E-C-R-E-T

25X1

SECRET

25X1

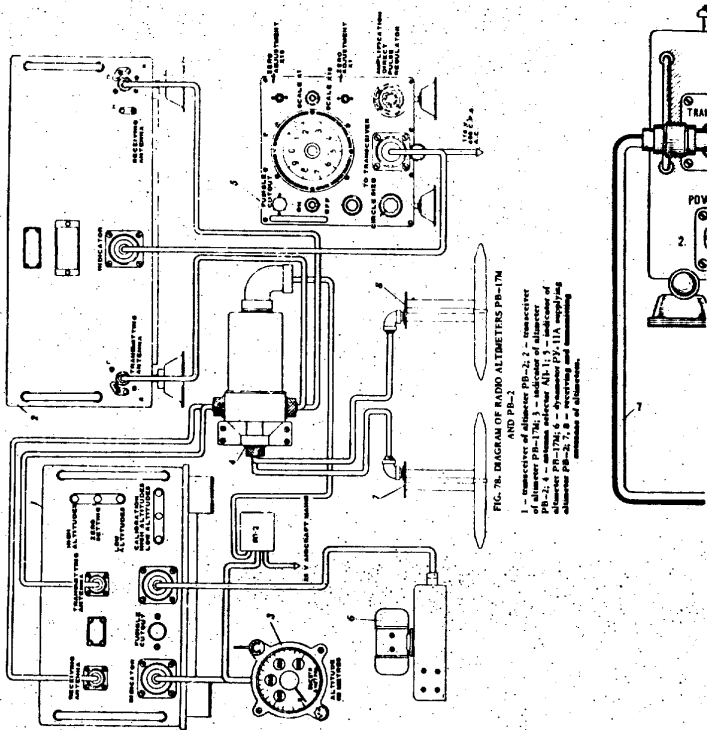


FIG. 7b. DIAGRAM OF RADIO ALTIMETERS PB-17M  
 1 - transmitter of altimeter PB-17M; 2 - receiver of altimeter PB-17M; 3 - indicator of altimeter PB-17M; 4 - receiver of altimeter PB-17M; 5 - transmitter of altimeter PB-17M; 6 - receiver of altimeter PB-17M; 7, 8 - receiving and transmitting antennas of altimeters.

SECRET

S-E-C-R-E-T

25X1

25X1

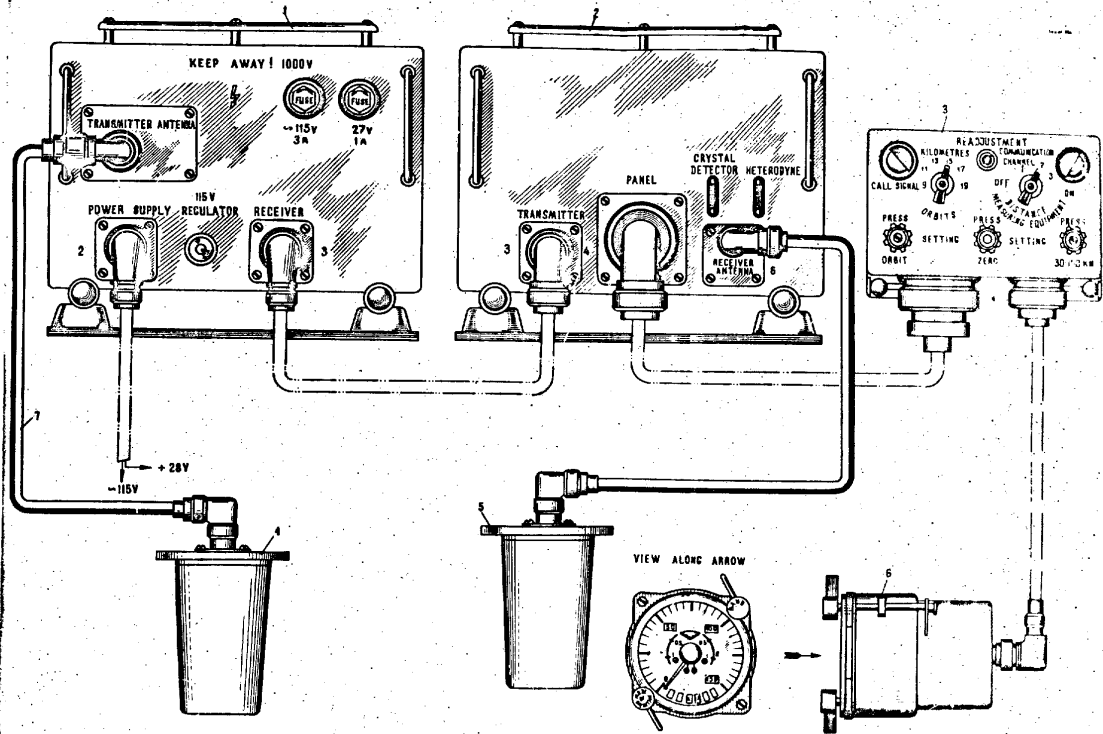


FIG. 79. DIAGRAM OF RADAR RANGING UNIT CA-1  
1 - transmitter; 2 - receiver; 3 - control panel; 4 - transmitting antenna; 5 - receiving antenna; 6 - radar ranging unit indicator; 7 - r.f. antenna cable.

S-E-C-R-E-T

25X1

25X1

25X1

25X1

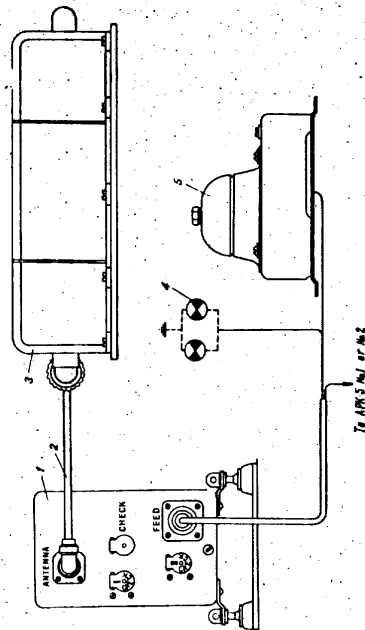


FIG. 8A. DIAGRAM OF MARKED RECEIVER  
 1 - receiver; 2 - r.f. cable; 3 - cabinet; 4 - tracking lamp; 5 - heli.

25X1

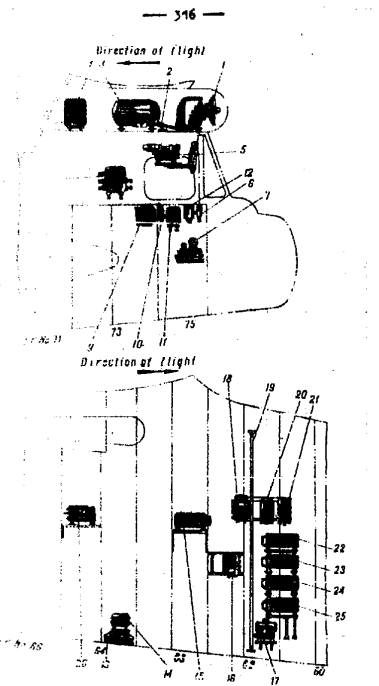


FIG. 81. RADIO AND RADAR EQUIPMENT LOCATED IN TAIL PORTION OF AIRFRAME AND REAR CABIN

1 - antenna AP17-1 of radar gun sight (RCS-1); 2 - waveguide AP17-25; 3 - transmitter AP18-2; 4 - gyro unit AP17-10A; 5 - indicator AP17-4D; 6 - mode-of-operation selector panel AP17-11D; 7 - dynamometer Y-600; 8 - coupling box AP17-8E; 9 - intercom set of rear gunner; 10 - trigger AP17-16; 11 - control panel AP17-7A; 12 - search control panel AP17-14D; 13 - inboard antenna of marker receiver (MTR-48H); 14 - receiver (MTR-48H); 15 - supply unit AP17-14D of sight (RCS-1); 16 - junction box AP17-5; 17 - amplifier unit AP17-8A; 18 - junction box AP17-6; 19 - guard post of support for units AP17; 20 - range transmission unit (MTR-21); 21 - supply box AP17-15A; 22 - servo amplifier unit; 23 - range unit (MTR-11D); 24 - receiver and indicator unit AP17-3D; 25 - angular tracking unit (MTR-10D); 26 - course receiver (MTR-9).

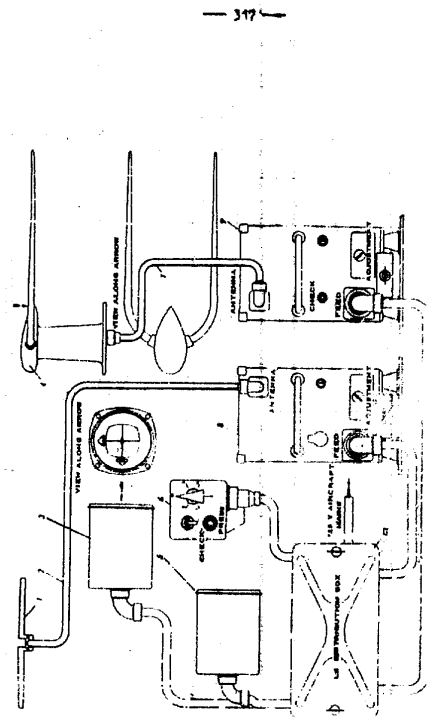


FIG. 82. ILS EQUIPMENT DIAGRAM  
1 - ILS receiver (MTR-48H); 2 - ILS cable; 3 - ILS antenna; 4 - ILS antenna; 5 - ILS antenna; 6 - control panel; 7 - ILS receiver (MTR-48H); 8 - ILS distribution box.



S-E-C-R-E-T

25X1

25X1

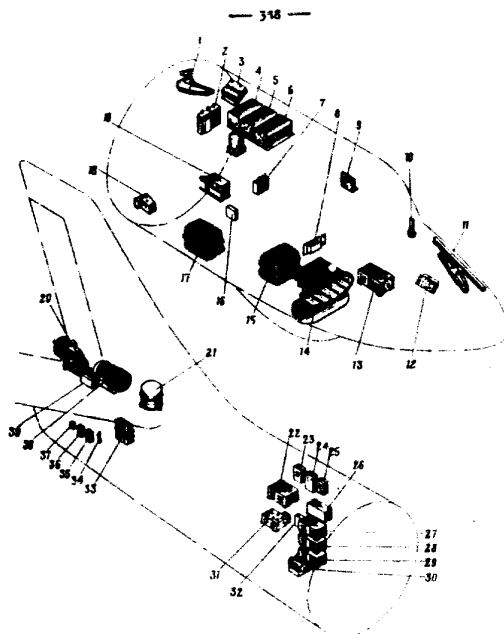


FIG. 83. LAYOUT OF RADAR EQUIPMENT IN AIRCRAFT

1 - indicator P-5/1 of navigator-operator's radar bombight (PHI-4); 2 - feeding box P15 of radar bombight (PHI-4); 3 - control panel P6 of operator's radar bombight (PHI-4); 4 - regulated rectifier P11; 5 - range unit P3; 6 - operator's synchronizer P4; 7 - junction box P12; 8 - control panel of null warning radar "SHREN-2"; 9 - interrogation code panel and destructer button; 10 - junction box P14; 11 - navigator-bombardier's indicator P8; 12 - navigator-bombardier's control panel P9; 13 - navigator-bombardier's synchronizer P7; 14 - antenna P1 of radar bombight (PHI-4); 15 - wave-cutter P2; 16 - inertia connector to clear destructer circuit; 17 - modulator P12; 18 - gang unit of radar bombight and null warning radar; 19 - transponder P2; 20 - antenna AP17-1 of radar gun-sight (RGC-1); 21 - gyro indicator AP17-11D; 22 - supply unit AP17-12D; 23 - junction box AP17-6; 24 - range transmitting unit AP17-21D; 25 - feed box AP17-13D; 26 - range unit AP17-11D; 27 - angle tracking unit AP17-10D; 28 - receiver indicator unit AP17-3D; 29 - servo amplifier unit AP17-20D; 30 - amplifier AP17-8D; 31 - junction box AP17; 32 - gang unit for gun-sight (RGC-1) and null warning radar; 33 - gang box for antenna AP17 and computer (PHI-5); 34 - range button AP17-16; 35 - control panel AP17-7D; 36 - area control panel AP17-8D; 37 - remote control panel AP17-17D; 38 - transceiver AP-18-2; 39 - indicator AP17-14D; 40 - high-voltage rectifier P15.

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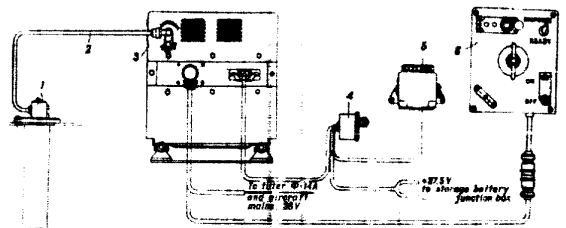


FIG. 84. TRANSPONDER ARRANGEMENT DIAGRAM

1 - transponder transmit-receive antenna; 2 - r.f. antenna cable; 3 - transponder; 4 - destructer button; 5 - inertia connector; 6 - code panel with cable and plug connector.

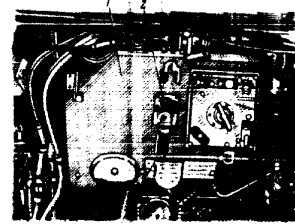
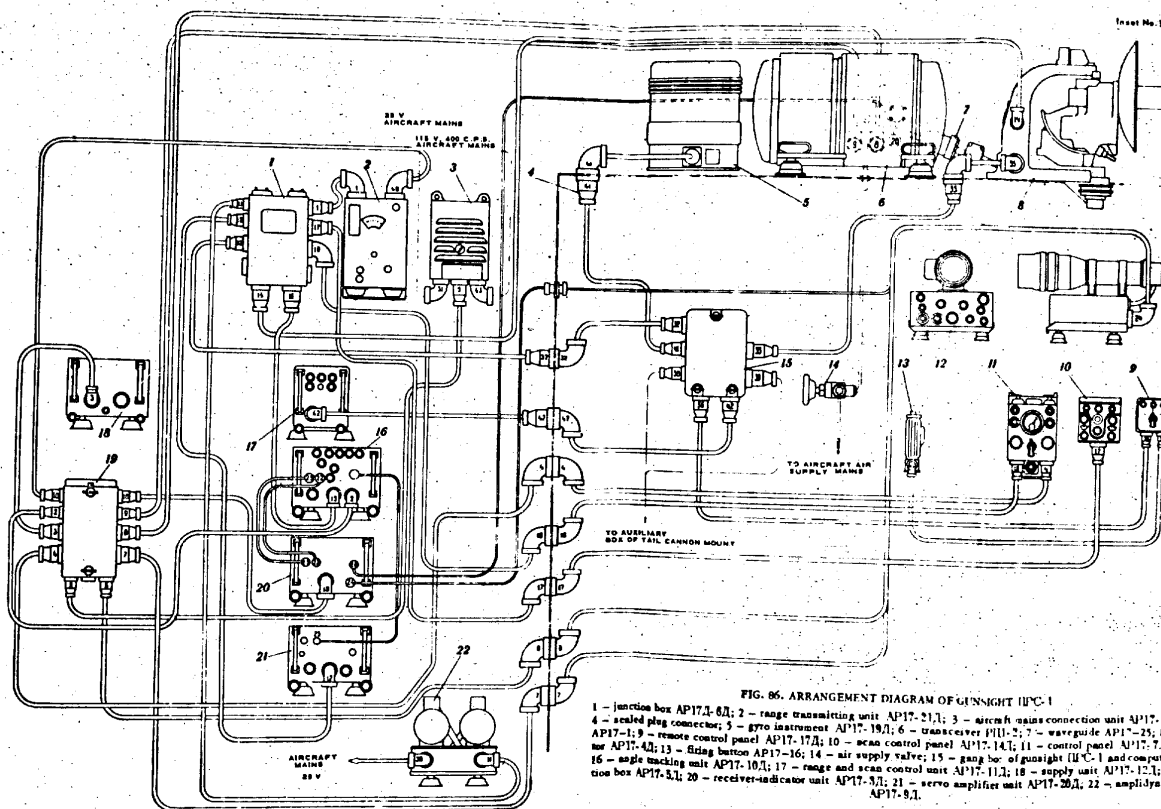


FIG. 85. TRANSPONDER UNITS INSTALLED WITHIN REACH OF THE PILOT

1 - transponder unit board; 2 - transponder destructer button with indicating lamp; 3 - transponder feed switch; 4 - transponder code panel.

S-E-C-R-E-T

25X1



S-E-C-R-E-T

25X1

25X1

[Redacted]



FIG. 87. UNITS AP-17 INSTALLED ON HORIZONTAL PLATE OF THE REAR PRESSURIZED CANOPY.  
1 - gyro instrument AD17-10L; 2 - transceiver AP18-2;  
3 - antenna AP17-1.

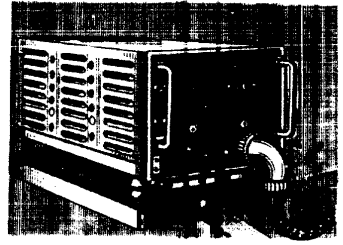


FIG. 88. UNIT AP17-12 INSTALLED ON FUSELAGE STARBOARD NEXT TO FRAME No. 53

25X1 S-E-C-R-E-T

S-E-C-R-E-T

25X1

25X1

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FIG. 09. SUPPORT WITH UNITS AP17  
INSTALLED IN NON-PRESSURIZED PORTION  
OF FUSELAGE NEXT TO FRAME No. 61

25X1

S-E-C-R-E-T

25X1

25X1

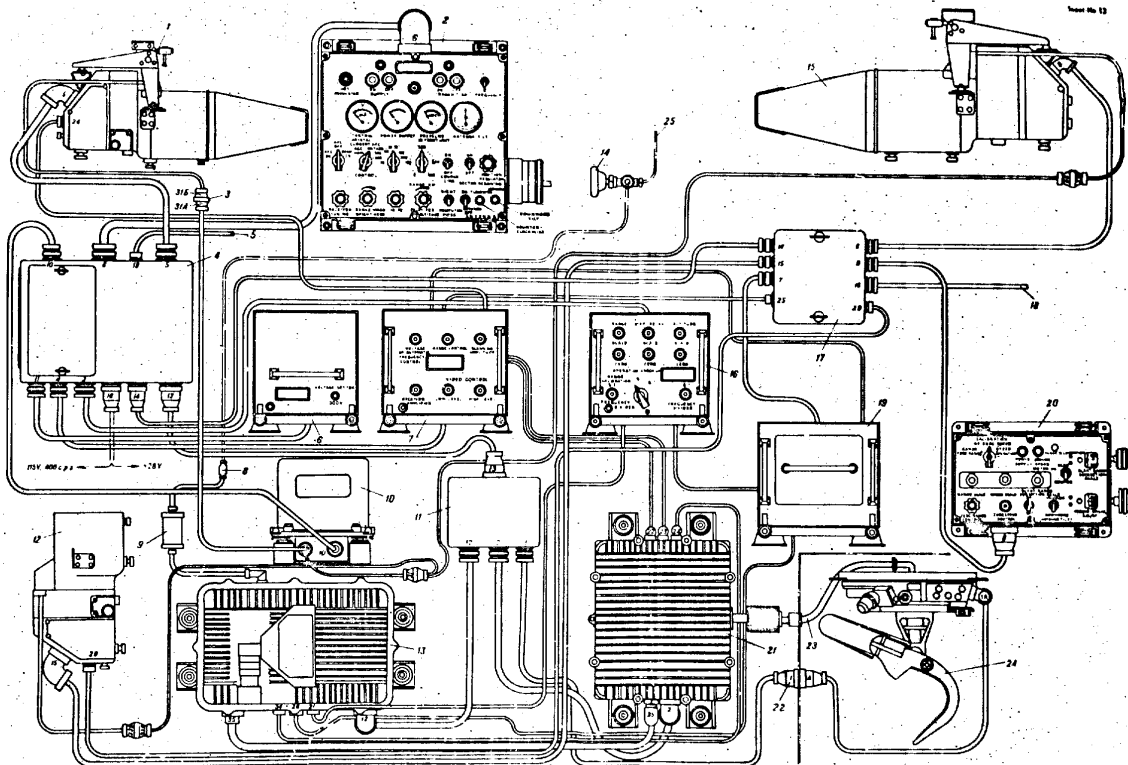


FIG. 90. ARRANGEMENT DIAGRAM OF RADAR BOMBSIGHT PEI-4

- 1 - navigator-operator's indicator P5/1; 2 - navigator-indicator's control panel P6; 3 - high voltage plug connector; 4 - junction feed box P13; 5 - cable No. 19 to control panel of camera 9A-P-1; 6 - regulated rectifier P11; 7 - range unit P3; 8 - adapter connecting dehumidifier to aircraft air mains; 9 - dehumidifier in the system of air supply to bombsight PEI-4; 10 - high voltage rectifier P10; 11 - junction box P13; 12 - indicator P5/2 for camera 9A-P-1; 13 - modulator P12; 14 - valve of air supply to radar sight PEI-4; 15 - navigator-bombardier's indicator P8; 16 - navigator-operator's synchronizer P4; 17 - junction box P14; 18 - cable No. 16 for altitude unit OIL-111; 19 - navigator-bombardier's synchronizer P7; 20 - navigator-bombardier's control panel P9; 21 - transceiver P2; 22 - sealed plug connector; 23 - waveguide; 24 - antenna P1; 25 - tube connecting air supply valve to the aircraft air system.

25X1 S-E-C-R-E-T

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S-E-C-R-E-T

25X1

25X1

323

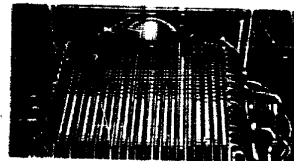


FIG. 91. INSTALLATION OF TRANSCIVER OF RADAR BOMBSIGHT PHL-4 (UNIT P2)

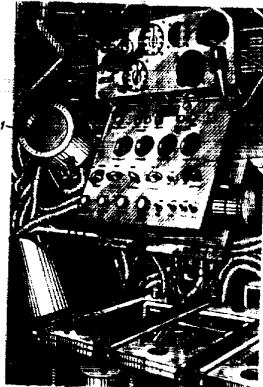


FIG. 92. INSTALLATION OF CONTROL PANEL OF RADAR BOMBSIGHT PHL-4 (UNIT P6) AND INDICATOR (UNIT P5/1)  
1 - unit P5/1; 2 - unit P6 in operating position.

25X1 S-E-C-R-E-T

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25X1

S-E-C-R-E-T

25X1

324

325

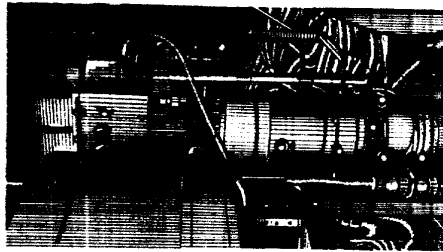


FIG. 94. INSTALLATION OF CAMERA P4-P5-1 AND UNIT P5/2

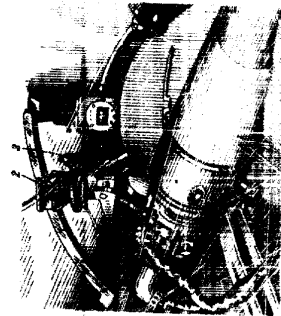


FIG. 95. CAMERA P4-P5-1 IN OPERATING POSITION. THE CAMERA IS MOUNTED ON A TRIPOD AND IS OPERATING AT A RANGE OF 1000 YARDS. THE CAMERA IS OPERATING AT A RANGE OF 1000 YARDS. THE CAMERA IS OPERATING AT A RANGE OF 1000 YARDS.

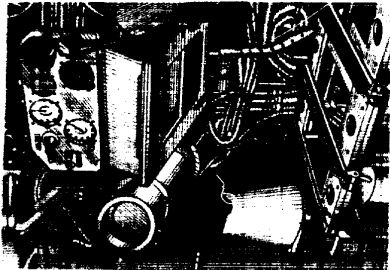


FIG. 96. INSTALLATION OF CONTROL PANEL OF RADAR BOMBIGHT (EEL-4) (UNIT P6) WITHIN OPERATOR'S REACH IN OPERATING POSITION

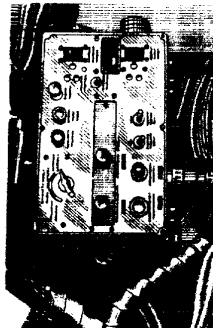


FIG. 97. UNIT P9 IN TRAVELLING POSITION

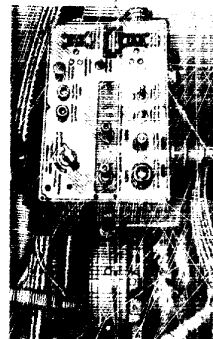


FIG. 98. UNIT P9 IN OPERATING POSITION. THE UNIT IS MOUNTED ON A TRIPOD AND IS OPERATING AT A RANGE OF 1000 YARDS. THE UNIT IS OPERATING AT A RANGE OF 1000 YARDS.

25X1 S-E-C-R-E-T

C-I-A-R-R-T

25X1

25X1

326

25X1

327

25X1

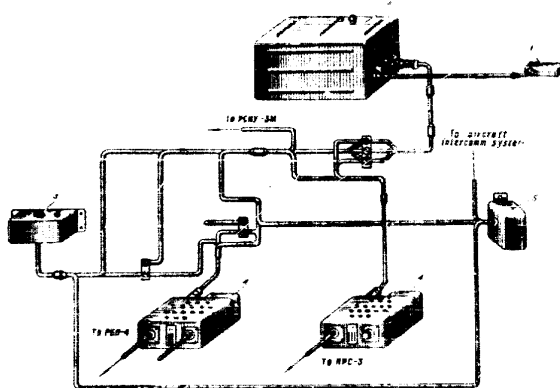


FIG. 98. WIRING DIAGRAM OF TAIL WARNING RADAR "SMPEHA-2"

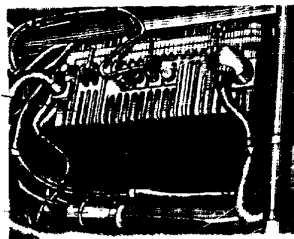


FIG. 99. MODULATOR OF RADAR SIGHT P1M-4 UNIT (1) 2) - dehumidifier cell

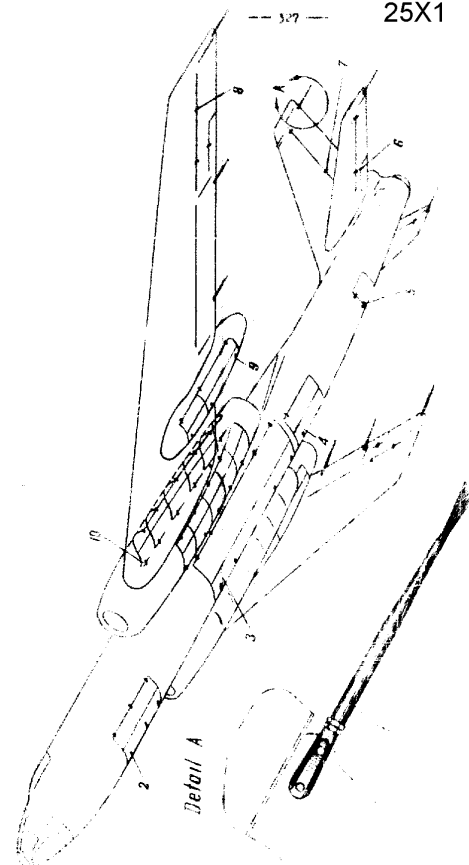


FIG. 100. ARRANGEMENT OF MOVABLE UNITS AND ARRANGEMENT OF ELECTROSTATIC DISCHARGERS. 1 - location of main I.G. wall doors; 2 - location of main I.G. wall doors; 3 - location of main I.G. wall doors; 4 - location of main I.G. wall doors; 5 - location of main I.G. wall doors; 6 - location of main I.G. wall doors; 7 - location of main I.G. wall doors; 8 - location of main I.G. wall doors; 9 - location of main I.G. wall doors; 10 - location of main I.G. wall doors.

C-I-A-R-R-T

25X1



S-E-C-R-E-T

[Redacted]

25X1

[Redacted]

25X1

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— 329 —

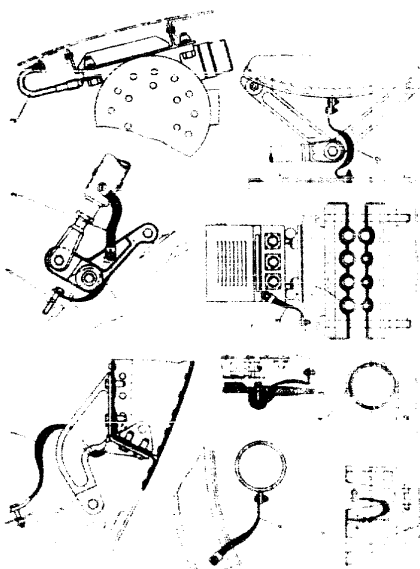


FIG. 99. GROUP 1 CERTAIN ASSEMBLIES AND FACILITIES  
 1 - bonding of screen wires; 2 - bonding of wires to control cable; 3 - bonding of single wire;  
 4 - plug connector; 5 - screen sleeve; 6 - plastic sleeve; 7 - bonding of two wires;  
 8 - bonding of two wires to a plug connector; 9 - bonding of two wires to a plug connector with  
 a plug with one plug; 10 - bonding of screen and leads; 11 - bonding of the screen.

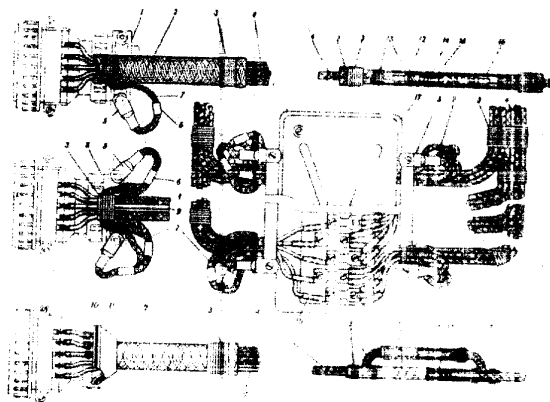


FIG. 101. SCREENING OF BUNCHED CONDUCTORS AND CHANGE-OVER FACILITIES  
 1 - termination of screened bunched conductor in the plug connector; 2 - braiding; 3 - "hooky"  
 thread; 4 - screened wires; 5 - terminal; 6 - connecting pipe; 7 - braiding of the screened wires on  
 bunched conductor; 8 - termination for a plug connector and a coupling of bunched conductor made up  
 of screened and non-screened wires; 9 - non-screened wire; 10 - termination of screened bunched  
 conductor for a plug connector and a union; 11 - brass holder; 12, 13 - termination of screened  
 wires in individual connector; 14 - thread; 15 - vinyl chloride plastic sleeve; 16 - individual connector;  
 17 - vinyl chloride plastic sleeve with the designation of wire; 18 - termination of screened wires  
 in intercom system split box; 19 - termination of screen when connecting the screened wire to the  
 individual connector.

S-E-C-R-E-T

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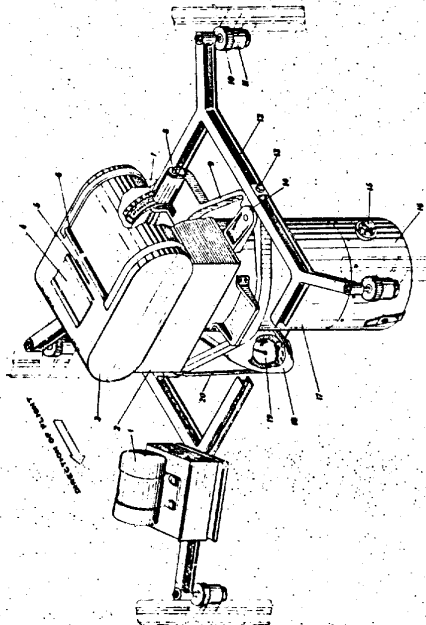


FIG. 107. MOUNT UNIT OF CAMERA HAΦA-3c/50  
 1 - converter; 2 - chamber portion; 3 - film magazine; 4 - collimated plate; 5 - pointer; 6 - gear; 7 - quadrant; 8 - shutter; 9 - film frame; 10 - magazine; 11 - block absorber; 12 - meter frame; 13 - lens; 14 - shutter; 15 - shutter release; 16 - photocell; 17 - shutter; 18 - shutter release; 19 - photocell; 20 - suspension bracket.

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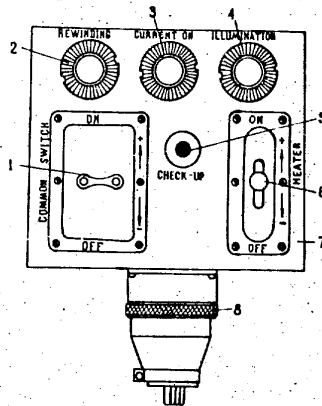


FIG. 108. CONTROLLER OF CAMERA HAΦA-3c/50  
 1 - common switch; 2 - REWINDING (PHEHOTOYKA) indicating lamp; 3 - CURRENT ON (TOK BK/IMPEH) indicating lamp; 4 - ILLUMINATION (IIOJCHET) indicating lamp; 5 - CHECK-UP (TPOBEPKA) button; 6 - heater; 7 - camera controller body; 8 - connector.

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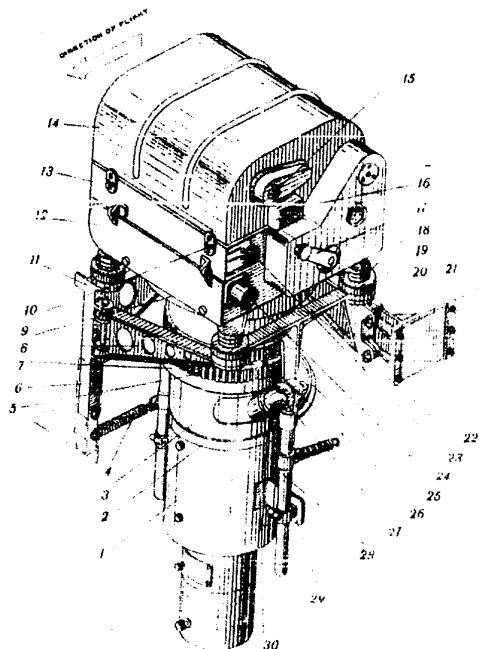


FIG. 100. MOUNT UNIT FOR CAMERA GA-P3-1  
 1 - indicator of radar bomb height (MHI); 2 - antenna ring; 3 - jacket; 4 - spring; 5 - focusing ring; 6 - locking pin; 7 - cone portion; 8 - bracket; 9 - base; 10 - lug; 11 - bracket; 12 - chamber cover; 13 - chamber piston; 14 - film magazine; 15 - film rewinding mechanical indicator; 16 - actuator handle; 17 - shock mount; 18 - narrow nut; 19 - base sleeve; 20 - bracket; 21 - post; 22 - potentiometer knob; 23 - alpha-beta plug; 24 - half lug; 25 - guiding pin; 26 - sight; 27 - post pipe; 28 - indicator attachment bracket; 29 - shock absorber linkage.

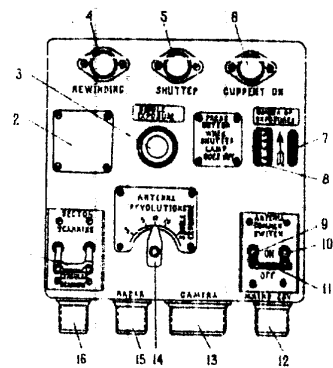


FIG. 110. CONTROLLER OF CAMERA GA-P3-1  
 1 - gang switch; 2 - plate; 3 - single exposure button; 4 - film rewinding indicator lamp; 5 - SHUTTER OFF indicator lamp; 6 - common switch; 7 - disc; 8 - exposure counter drum; 9 - common switch; 10 - antenna switch; 11 - magnet; 12 - MAINS 26 V (CFT) 20 B03171 socket; 13 - CAMERA (GA-MEPA) socket; 14 - jack-type switch; 15 - FIDAR (GA-UP) (GA-RDP) plug; 16 - spare plug.

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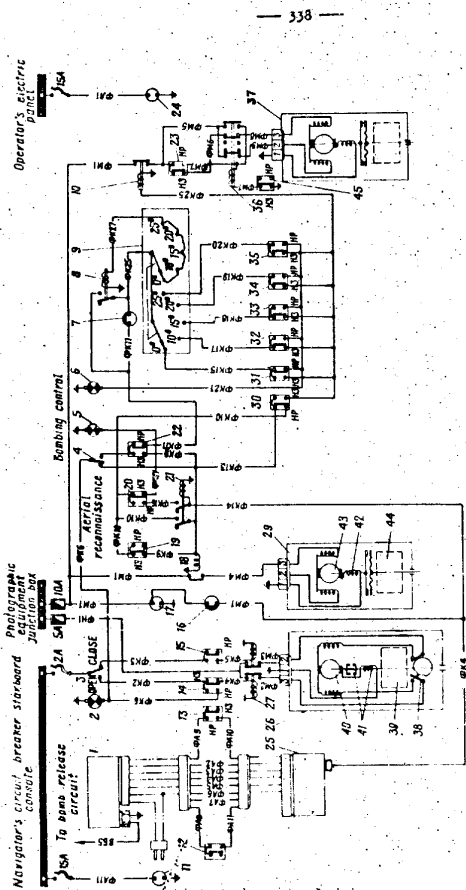


FIG. 111. CIRCUIT DIAGRAM OF PHOTOGRAPHIC EQUIPMENT

1 - camera controller; 2 - CAMERA HATCH OPEN indicating lamp; C31L-51; 3 - camera batch door control switch (31L-45); 4 - BOMBING CONTROL (RHTV) (31L-45); 5 - AERIAL RECONNAISSANCE (PARBE) (31L-45) selector (31L-45); 6 - indicating lamp (C31L-51) marked FLICKERS DURING AERIAL RECONNAISSANCE (PARBE) (31L-45); 7 - selector (31L-45); 8, 21 - interlocking relay (31L-2); 9 - selector (31L-45); 10, 18, 27, 28 - contactor K-25A; 11, 17, 24 - socket BR; 12, 13 - camera interlocking limit switches (31L-45); 14 - limit switches (31L-45) of camera batch control circuit interlocking; 15 - interlocking relay (31L-2); 16 - button SK; 17 - interlocking relay (31L-2); 18 - interlocking relay (31L-2); 19 - interlocking relay (31L-2); 20 - interlocking relay (31L-2); 22 - interlocking relay (31L-2); 23 - camera interlocking limit switches (31L-45); 24 - socket BR; 25, 30, 31, 32, 33, 34, 35 - interlocking relay (31L-2); 26 - interlocking relay (31L-2); 27 - interlocking relay (31L-2); 28 - interlocking relay (31L-2); 29 - interlocking relay (31L-2); 30 - interlocking relay (31L-2); 31 - interlocking relay (31L-2); 32 - interlocking relay (31L-2); 33 - interlocking relay (31L-2); 34 - interlocking relay (31L-2); 35 - interlocking relay (31L-2); 36 - interlocking relay (31L-2); 37 - interlocking relay (31L-2); 38 - cam with limit switches; 39 - planetary reducing gear; 40, 41 - electric motor; 42 - interlocking relay (31L-2); 43 - interlocking relay (31L-2); 44 - planetary reducing gear; 45 - limit switch.

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