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AIRCRAFT
Ту-22Б

FLIGHT MANUAL

Flight Operation

This Flight Manual has been elaborated on the basis of special instructions with due account of the experience of aircraft flight operation in military air units.

The Flight Manual defines the duties of each crew member as well as the sequence of their fulfilment in the process of aircraft preparation for flight, during flight and after flight. The Flight Manual contains the basic instructions to the aircraft crew on aircraft operation and flying technique.

The aircraft crew includes:

— the crew commander (the pilot);

— the crew navigator (the navigator);

— the operator.

Given below in the Flight Manual text are the indicated magnitudes of the airspeed, flight altitude and Mach number unless otherwise specified.

Important.

Check the insets for availability.

The book contains 402 pages and 7 insets:

Inset 1, between pages 80 – 81, secret;

Inset 2, between pages 84 – 85, secret;

Inset 3, between pages 84 – 85, secret;

Inset 4, between pages 90 – 91, secret;

Inset 5, between pages 166 – 167, secret;

Inset 6, between pages 334 – 335, secret;

Inset 7, between pages 334 – 335, secret.

1. BASIC DATA ON AIRCRAFT Ту-22Б

1.1. PURPOSE AND BASIC DATA

Aircraft Ту-22Б is a supersonic long-range bomber. The aircraft equipment makes it possible to use the aircraft both in the daytime and at night in VFR and IFR conditions.

When used as a bomber, the aircraft may be loaded with conventional bombs of up to 9000 kg and deliver bombing strikes from high, medium, low and extreme low altitudes in the daytime and at night.

For repulsion of the fighters' attack delivered into the rear hemisphere, the tail part of the aircraft accommodates gun Р-23 carrying an ammunition load of 500 cartridges.

The aircraft is provided with chaff dispensers of the КДС and АПП types intended for protection against the missile guidance systems.

Aircraft Ту-22Б is equipped with:

— two engines РД-7М2, each having 16,000-kgf thrust at takeoff power and 10,500-kgf thrust at maximum non-reheat power;

— roll and yaw damper Д2К-115;

— pitch damper ДТ-105А;

— stability automatic controller АУ-105А;

— stability automatic controller and pitch neutral setting system СПН-105А;

— feel simulator controller АДУ-105А;

— oxygen regulator КП-24М;

— critical angle-of-attack, sideslipping and g-load warning unit АУАСП-10Р;

— flight director system ПУТЬ-4;

— compass system КС-6А;

— astrotracker БЦ-63А;

— air data computer system ЦСВ-1М;

— autopilot АП-7МЦ;

— command radio set РСИУ-5В, communication radio set Р-836 ("Неон");

— radio receiver УС-8;

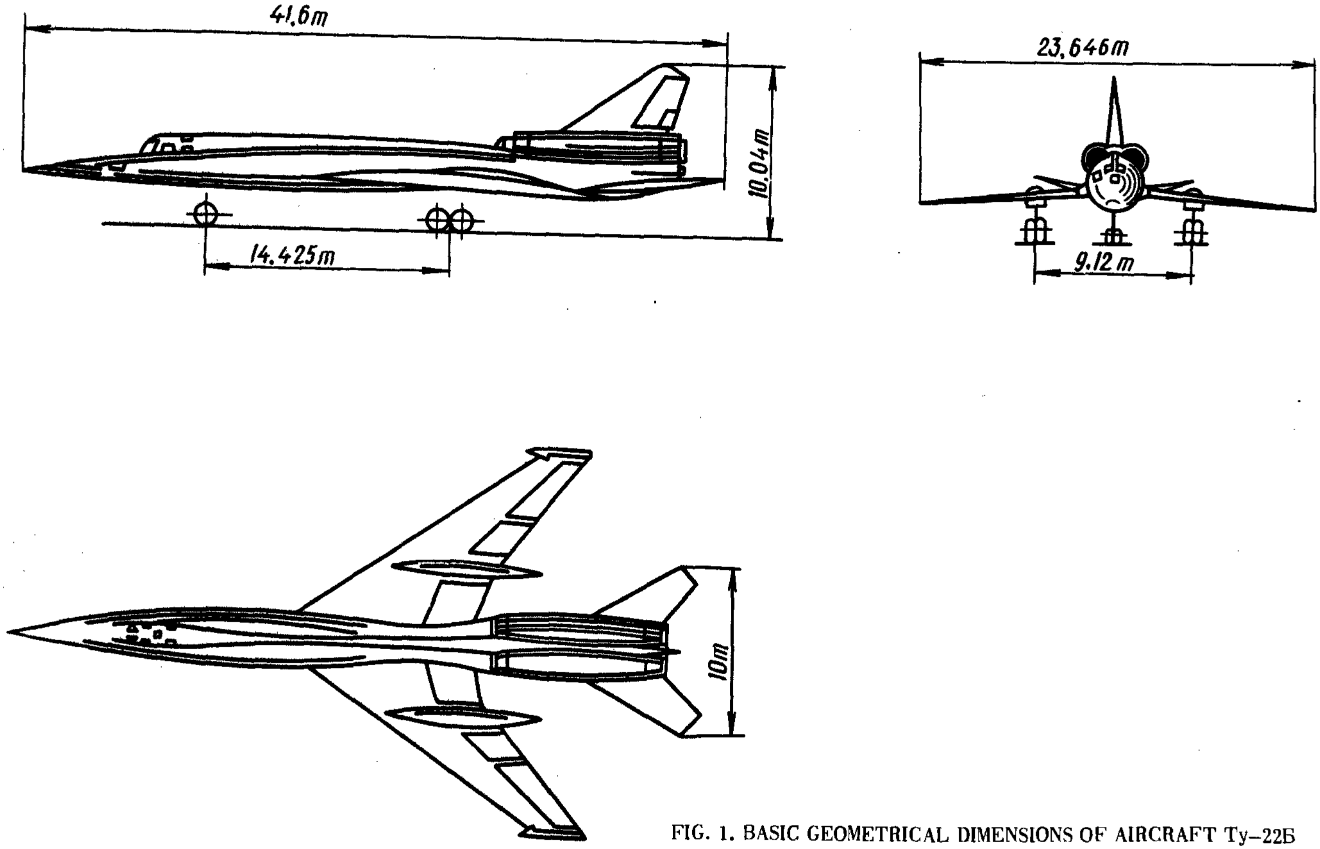

FIG. 1. BASIC GEOMETRICAL DIMENSIONS OF AIRCRAFT Ту–22Б

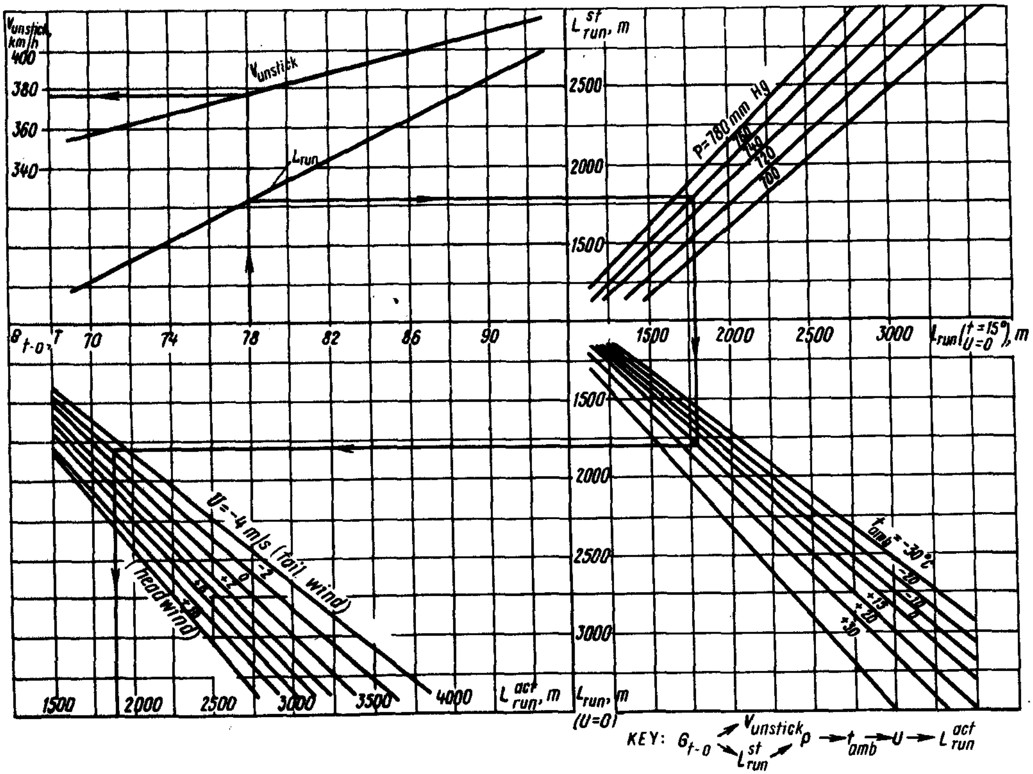

FIG. 2. NOMOGRAM USED FOR DETERMINING TAKEOFF RUN LENGTH AND UNSTICK SPEED OF AIRCRAFT Ty–22Б

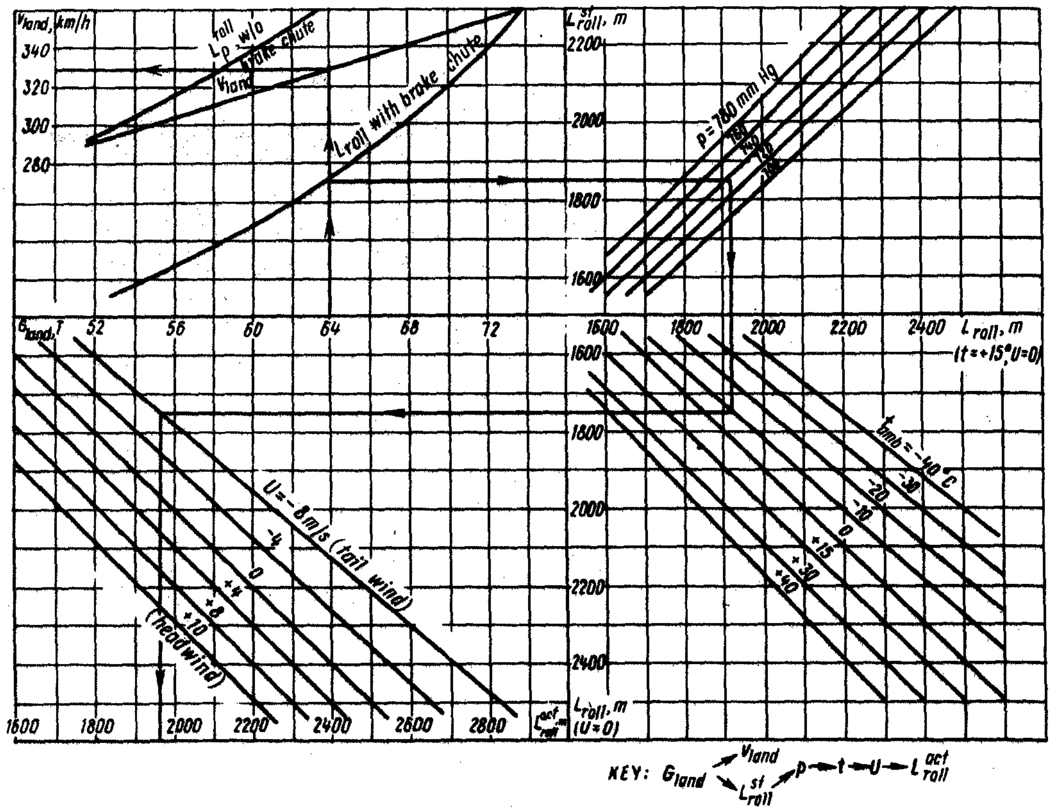

FIG. 3. NOMOGRAM USED FOR DETERMINING LANDING ROLL LENGTH AND LANDING SPEED OF AIRCRAFT Ту–22Б

— survival radio set P-850;
— short-range radio navigation and landing system РСБН-2С;
— Doppler ground speed and drift meter ДИСС-1;
— automatic direction finder АРК-11;
— low-altitude radio altimeter РВ-УМ;
— high-altitude radio altimeter РВ-25;
— instrument landing system СП-50 with runway localizer receiver КРП-Ф, glide path receiver ГРП-2, marker radio receiver МРП-56П and КАТЕТ receiver;
— interrogator-responder СРЗО-2;
— chaff dispensers КДС-16ГМ and АПП-22;
— radar illumination warning unit СПО-3;
— fire-control radar ПРС-3;
— radar bomb sight РАДОН;
— magnetic recorder МС-61;
— aerial photographic equipment incorporated in АФА-41/20 and АФА-42/100 aerial cameras;
— tail gun turret ДК-20;
— TV sight ТП-1А;
— optical bomb sight ОПБ-15;
— bombing equipment system.

The aircraft accommodates the following electric power sources:
— four DC generators ГС-18ТП;
— two storage batteries 12САМ-55;
— three inverters ПО-6000, inverter ПО-500 and two inverters ПТ-1000Ц;
— two AC generators СГС-30-8РС.

The basic overall dimensions of aircraft Ту-22Б are given in Fig. 1.

Operating conditions and takeoff/landing characteristics.

The aircraft should be used on airfields with concrete runway length of at least 3000 m.

The aircraft takeoff/landing characteristics versus the aircraft mass and atmospheric conditions are shown in Figs 2 and 3.

1.2. PECULIARITIES OF AIRCRAFT STABILITY AND CONTROLLABILITY

The aircraft possesses angle-of-attack and speed stability within the entire range of operating altitudes, airspeeds, weights and c. g. positions. However, in passing the transonic zone within the range of Mach numbers M = 0.95 — 1.05 the aircraft acquires slight speed instability.

When flying at Mach numbers M = 1.1, the aircraft reveals adverse roll control response, and at M = 1.4, an involuntary banking appears.

In these conditions, the involuntary banking is counteracted by deflection of flap-ailerons and rudder in the roll direction so that the aircraft could fly without sideslipping.

At certain flight regimes, the aircraft features minor lateral oscillations (approximately one oscillation for 2 s), with the slip indicator ball deflecting up to 1/4 ball diameter.

If lateral oscillations occur in flight, change the flight regime (airspeed or altitude) to stop the oscillations.

Increase of the angles of attack in excess of the permissible limits in flight (i. e., angles of attack at which the critical angle-of-attack warning unit starts operating) is accompanied by buffeting, involuntary banking, slight unintentional pitch-up and speed instability.

When performing a maneuver with g-load $n_y = 1.2 - 1.8$ at Mach numbers $M = 0.8 - 1.25$ at altitudes exceeding 12,000 m, accordingly, the aircraft buffeting appears. This is accompanied by operation of the feel simulator controller (АДУ) and critical angle-of-attack, sideslipping and g-load warning unit (АУАСП). Further increase of the g-load originates waggling, with bank angles reaching 10 to 15°. At subsonic airspeeds, with g-load (n_y) equalling 2.1, the aircraft displays a slight involuntary pitch-up tendency testifying to the onset of angle-of-attack instability.

Flying at low airspeeds is accompanied by more distinct response of the aircraft to variation of engine power setting. Therefore, when the aircraft falls into buffeting, increase of airspeed and decrease of angles of attack may be attained by forward application of the control wheel and by raising the engine power to the maximum non-reheat power setting.

Execution of flight at subsonic airspeeds in excess of 650 km/h reduces the amount of control wheel application per g-unit. To avoid increase of g-load above $n^{oper}_{y\,max}$ during maneuvering flights, it is recommended to fly the aircraft by small-amount ($\Delta X_b = 40 - 60$ mm) applications of the control wheel column.

At high airspeeds, when the aircraft attains g-loads close to $n^{oper}_{y\,max}$ (especially when executing banked turns at 45 to 50° angles), the extension rods of the pitch damper get locked and the longitudinal stability margin gets sharply decreased. Therefore, the aircraft should be flown in this case by smooth small-amount applications of the control wheel.

In certain flight conditions, the aircraft may start pitching.

In all cases of aircraft pitching, it is necessary to set the control wheel column to the trim position (in the initial flight conditions) and fix it in this position for 1 to 2 s. If, this done, the aircraft persists in varying the pitch angle, it is recommended to counteract the rate of pitch by smooth application of the control wheel column and level off the aircraft.

At airspeeds corresponding to the Mach numbers $M = 0.95 - 1.05$, the aircraft features speed instability; therefore, the above speed range is a transition one and maneuvers with $n_y > 1$ are prohibited at this flight regime.

At subsonic airspeed, the control wheel may inadvertently turn to the right through an angle of up to 10° when the aircraft is trimmed out because of the different degree of cooling of the fuselage skin and aileron longitudinal control rods running in the fuselage.

When the aircraft flies at supersonic airspeeds and high altitudes, more intensive heating of the fuselage skin, as compared with the aileron control rods, may result in a reverse phenomenon, i. e., with increase of airspeed in sustained level flight the control wheel returns to the neutral position and may further turn to the left through and angle of up to 6°.

In flight, the horizontal stabilizer deflection angle shown by the stabilizer position indicator may fail to correspond to position of the marks on the control wheel column as a result of the different degree of cooling of the fuselage skin and stabilizer control rods as well as due to elastic deformation of the control wheel column and control system linkage caused by the forces applied to the control wheel.

2. OPERATING LIMITATIONS

The aircraft maximum speed and Mach number limitations are given in Table 1, the minimum speed and Mach number limitations are presented in Fig. 4, and the other limitations, in Table 2.

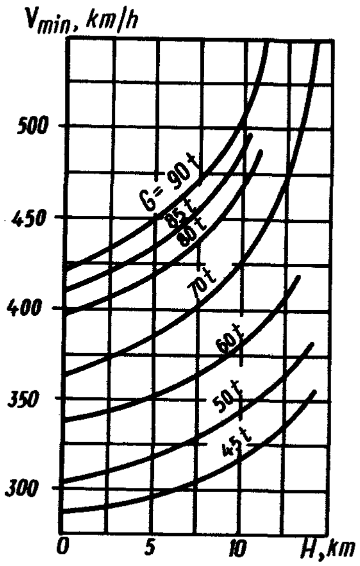

FIG. 4. MINIMUM PERMISSIBLE AIRSPEED VERSUS MASS OF AIRCRAFT Ty-22Б AND FLIGHT ALTITUDE

Table 1

Limitation object	Flight regime			Cause of limitation
	H, m	V, km/h	Mach number	
Flap-ailerons control	0—2600	960		Strength of flap-ailerons and rudder
	2600—6000		0.9	
	6000—8000	960		Mach buffeting
	8000—11,000	1060		
	Above 11,000		1.6	
Ailerons control	0—11,000	800		Aileron reversal
	Above 11,000		1.4	

Table 1, continued

Limitation object	Flight regime			Cause of limitation
	H, m	V, km/h	Mach number	
Change-over from flap-ailerons to ailerons and back	For all altitudes	600	0.9	
Aircraft control with feel simulator controller turned off (failure)	0—8000	750	—	Inadvertent entry into impermissible g-load may take place
Aircraft control with dry friction damper turned off (failure)	For all altitudes		0.9	At $M > 0.9$ rudder starts buffeting
Aircraft control with pitch damper and stability automatic controller turned off	For all altitudes	650	—	Inadvertent entry into impermissible g-load may take place

NOTE. The limitations are given for the aircraft flight configuration.

Table 2

No.	Limitation	Limitation value	Cause of limitation
	Aircraft		
1	Maximum takeoff mass, t	92	Airframe strength
2	Estimated landing mass, t	60	Landing gear strength
3	Maximum permissible landing mass, t NOTE. Number of aircraft landings, with landing mass varying from 60 to 65 t, should not exceed 3 % of total number of landings	65	Landing gear strength
4	Minimum permissible airspeed	Operation of angle-of-attack, sideslipping and g-load warning unit with respect to angle of attack	Aircraft approach to C_y close to $C_{y\ perm}$

Table 2, continued

No.	Limitation	Limitation value	Cause of limitation
5	Maximum permissible g-load	2	Airframe strength
6	Limit permissible g-load during aircraft recovery from tight spiral	2.5	Airframe strength
7	Maximum permissible airspeeds, km/h (Mach number):		Strength of flaps, LG doors and takeoff/landing lights
	— during extension and retraction of flaps and landing gear and during flight with flaps and landing gear extended;	500 ($M \leqslant 0.9$)	
	— with landing lights extended	450	
8	Maximum permissible speed during extension of brake chute, km/h	330	Strength of brake chute
9	Maximum permissible landing speed, km/h	330	Strength of wheels
	Maximum permissible speed at nose wheel lift-off moment, km/h	360	Strength of wheels
10	Permissible unstick speed, km/h	420	Strength of wheels
11	Maximum takeoff and landing crosswind component, m/s	12	Strength of wheels
	NOTES. When crosswind component exceeds 12 m/s but is less than 15 m/s, takeoff and landing are allowed in exceptional cases by decision of unit commander (flight control officer)		
12	Maximum tailwind component, m/s, for landing mass, t:		Strength of tyres
	— not higher than 60;	3	
	— 60 to 61;	2	
	— 61 to 63	1	
	Powerplant		
13	Time of continuous operation, min:		
	(a) in flight:		
	— at reheat power settings for time period equal to one engagement of afterburner and at engine RPM exceeding 96 % (total for all power settings);	120	Strength of turbine and engine afterburner
	including time of flying at altitudes of up to 5500 m (up to 8000 m at airspeeds exceeding 800 km/h) inclusive;	15	
	— at reheat power settings higher than those corresponding to cruise conditions;	30	

Table 2, continued

No.	Limitation	Limitation value	Cause of limitation
	— including time of flying at altitudes of up to 5500 m;	5	
	(b) on ground:		
	— at reheat power settings;	1	Strength of turbine and engine afterburner
	including time of flying with throttle lever set above 79 divisions on throttle lever position indicator;	40 s	
	— at non-reheat power settings with engine RPM exceeding 96 %;	15	
	— at idle power	15	
14	It is allowed to repeat accelerations to above power settings on expiration of specified time of engine continuous operation on ground and in flight:		
	— to reheat power settings and power settings corresponding to engine RPM above 96 % after engine speed below 96 %, min;	At least 3	
	— to idle power after running at power settings with both air bleed valves closed, min	At least 1	
15	It is allowed to perform repeated accelerations to reheat power settings within limits of engine specified continuous operation time, S	After 5 s	Time of afterburner manifold preparation for operation
16	Maximum engine RPM at sustained power settings, %	99.5 to 100.5	Strength of engine turbine
17	Maximum permissible turbine exhaust gas temperature, °C:		Strength of engine turbine
	— at non-reheat power settings for all altitudes and at reheat power settings for altitudes up to 11,000 m;	645	
	— at reheat power settings for altitudes of 11,000 m and higher;	675	
	— during engine starting:		
	on ground;	720	
	in flight	660	
18	Permissible oil pressure, kgf/cm^2:		Rejection of heat and lubrication of engine shafting components
	— at power settings with bleed valves closed;	3.8 to 5	
	— at power settings with bleed valves open;	3.0 to 5	
	— at idle power setting	At least 2	
19	Permissible oil temperature, °C	From —40 to +85	Rejection of heat and lubrication of engine shafting components

Table 2, continued

No.	Limitation	Limitation value	Cause of limitation
20	Maximum permissible reliable starting altitude, m	10,000	Reliable ignition of main combustion chamber
21	Maximum speed of aircraft flying with air intake lips not retracted, km/h (Mach number)	750 (No more than 0.9)	Strength of air intake lips
22	Permissible time of engine steady operation at $n_y = \pm 0.2$, s	7	Reliable supply of engines with fuel
23	Maximum speeds of aircraft flying at altitudes from 0 to 400 m at ambient temperature, km/h:		Strength of compressor first stage blades
	— exceeding +40 °C;	910	
	— from +45 to +55 °C;	910	
	— exceeding +55 °C	910	
	Survival and emergency escape systems		
24	Permissible altitudes of flying, m:		
	— in pressurized cabin for long time period, in non-pressurized cabin for short time period (up to 10 min) and during ejection;	*14,000*	Supply of crew members with oxygen
	— in non-pressurized cabin for long time period;	*7000 to 12,000*	Supply of crew members with oxygen
	— with access doors released, at airspeed of up to 400 km/h (with crash helmet light filter raised and oxygen mask loose)	*Up to 4000*	Effect of air stream on crew members
25	Access doors are released in straight flight at airspeed below 920 km/h at altitude up to, m	*14,000*	
26	Safe abandoning of aircraft is provided:		
	(a) at airspeeds, km/h, when using:		
	— crash helmet with lowered light filter and loose oxygen mask;	*Up to 900*	Effect of air stream on crew members
	— crash helmet with raised light filter;	*Up to 700*	Effect of air stream on crew members
	(b) at altitudes, m:		
	— in level flight;	$V \geqslant 350$	Time required for operation of ejection system and parachute
	— during descent;	$(350 + 10\ V_y)$	
	— during pitch-up.	$(350 - 5\ V_y)$	Time required for operation of ejection system and parachute

Table 2, continued

No.	Limitation	Limitation value	Cause of limitation
	NOTES: 1. Altitudes of safe ejection in descent and pitch-up conditions are given for operator who is the first to eject (interval between ejection of other crew members is 2 s). 2. Safe emergency ejection is possible only with landing gear retracted		
	Control system		
27	Permissible altitudes and airspeeds at which autopilot may be used:		
	(a) minimum altitude of flying with lateral control channel enabled, m:		Flight safety in case of autopilot failure
	— in daytime;	*200*	
	— at night;	*300*	
	(b) minimum altitude of flying with longitudinal control channel enabled in daytime and at night, m;	*2000*	
	(c) maximum altitude of flying with autopilot engaged, m;	*13,500*	
	(d) minimum speed of flying with autopilot engaged, km/h;	*550*	
	(e) maximum speed of flying with autopilot engaged, km/h.	*950* ($M \leqslant 1.4$)	
	WARNING. NEVER ENABLE AUTOPILOT LONGITUDINAL CONTROL CHANNEL WITHIN RANGE OF MACH NUMBERS M = 0.95—1.05 BECAUSE AT THIS SPEED AIRCRAFT ACQUIRES SPEED INSTABILITY		
28	Permissible angle of rudder deflection (before lighting-up of lamp and connection of flight spring-loaded feel mechanism) at airspeeds exceeding 500 km/h, deg., maximum	±7 (±5)	Strength of rudder
29	Maximum crosswind component in controlling flap-ailerons or ailerons and flap-ailerons at a time during landing, m/s	8	Lateral control sufficient feel load

3. EQUIPMENT AND INSTRUCTIONS FOR USE

3.1. POWERPLANT

The aircraft outfitted with two gas turbine engines РД-7М2 provided with an afterburner.

The engine has the following controls:

— the throttle control lever (РУД) which is used for controlling the engine at non-reheat and reheat power settings;

— the SHUTOFF (ОСТАНОВ) lever which serves for shutting off the engine.

The following instruments are used for checking engine operation:

— fuel control lever position indicator УПРТ-2 used for checking proper setting of engine power;

— two-pointer tachometer indicator ИТЭ-2 intended for checking engine rotor rotation speed in per cent of the maximum rotation speed;

— electromechanical three-pointer engine-gauge unit ЭМИ-3РТИ used for checking the fuel pressure downstream of the high-pressure pumps (at the fuel nozzle inlet) as well as the engine inlet oil pressure and temperature;

— afterburner fuel manifold induction-type pressure gauge ДИМ-80Т intended for checking fuel pressure in the afterburner manifold;

— exhaust gas temperature gauge 2ТВГ-366 used for determining the gas temperature in the engine jet nozzle.

All the instruments are mounted on the pilot's instrument board.

Engine starting is controlled from the engine starting control panel accommodated on the right-hand console in the pilot's cabin.

The engines may be started only with the engine instruments, fire-extinguishing system and aircraft electrical systems cut in.

The process of starting of both engines is automized. The starting time is controlled with the help of the automatic starting control panel which is cut in by depressing the START (ЗАПУСК) button located on the starting board providing successive starting of the engines in any sequence.

It is allowed to repeat engine starting only after the previous engine starting cycle has been completed and lamps used for checking operation of the automatic starting control panel have gone out. The engine starting circuitry provides for discontinuing the engine starting process at any moment of engine rotor spin-up. To do this, set the SHUTOFF lever to the SHUTOFF (ОСТАНОВ) position and depress the STOP (СТОП) button on the engine starting board.

If the engine rotor speed or turbine exhaust gas temperature rises above the limits permissible for the given power setting, decelerate the engine to lower power at which the above parameters will correspond to the specified standard. Powerplant operating limitations are given in Table 3. If the engine was running at reheat power settings, decelerate it to non-reheat power.

Change the engine power setting by smooth shifting of the throttle control lever.

If the specified time of engine continuous running at idle power has been completely used up, accelerate the engine to power at which the engine operates with the bleed valves closed. Let the engine run at this power setting for at least 1 min and again decelerate it to idle power.

When the aircraft gains speed or ambient air temperature rises, the engine rotor speed increases, reaching the maximum level at +15 °C stagnant air flow temperature. With further temperature increase, the rotor speed is maintained constant.

At low altitudes, variation of airspeed may result in operation of the compressor air bleed valves when the engines operate at low power settings, with the throttle control lever occupying one and the same position. When the air bleed valve position indicator lamps start flickering, decrease or increase the engine speed until the lamps stop flickering.

NOTE. When the compressor fifth-stage air bleed valves get closed, the indicator lamp of the compressor sixth-stage air bleed valve is allowed to come on for a short period of time.

To initiate the reheat power on the ground and in flight, turn on the afterburner of each engine separately by smoothly displacing the throttle control lever of the respective engine to a position corresponding to no less than 75 divisions on the fuel control lever position indicator.

Before turning on the afterburner, ensure operation of both booster pumps in each group of the service tanks (both green lamps of each group should be alive).

Check to see that the afterburners have been turned on by appearance of the reheat fuel pressure, by coming-on of the white REHEAT (ФОРСАЖ) light, by a kick, by increase of engine thrust and aircraft nosing-down.

WARNING. NEVER CUT IN THE FUEL EQUALIZER DURING TAKEOFF AND WHEN FLYING AT REHEAT POWER SETTINGS.

NOTES: 1. When accelerating the engine from the maximum non-reheat power to the reheat one, the engine thrust drops by 15 % for the period of fuel ignition in the afterburner. If the afterburner is turned on in the process of engine acceleration from low power, the engine thrust grows smoothly, without gaps. However, starting from the moment of beginning of jet nozzle flaps opening and till the instant of fuel ignition in the afterburner, the engine thrust remains below that characteristic of non-reheat power settings, when the engine runs with the jet nozzle flaps partially closed at the given rotor speed.

2. At high altitudes, the afterburner is turned on at low reheat fuel pressures, i.e., at pressures up to 3 kgf/cm^2.

In case of afterburner ignition failure or flame-out, maximum non-reheat power is set up automatically on expiration of 20 s.

The time of engine acceleration from idle power till the moment the fuel pressure in the reheat fuel manifold reaches 75 kgf/cm^2 should not exceed 32 s (at takeoff reheat power).

For repeated cutin of the afterburner, shift the throttle control lever to the position corresponding to maximum non-reheat power for time period of no less than 5 s and turn on the afterburner.

To switch off the afterburner, smoothly shift the throttle control lever to the position corresponding to no less than 68 divisions on the fuel control lever position indicator.

In case of reheat disengagement failure, switch off the afterburner by using the emergency switch. After emergency disengagement of the reheat, do not initiate it any further in this flight.

If the red lamp lights up on the pilot's instrument board (the HP-7 pump inlet fuel pressure is below 2.5 kgf/cm^2), decelerate the engine until the lamp fades out. Check operation of the fuel system by reference to the lamps on the fuel automatics control board. If the lamp remains alive after the engine has been decelerated but the engine operates normally (its parameters correspond to those specified for the given power setting), do not shut off the engine.

Before shutting off the engine on the ground, let it cool down by running idle for 3 min. To this end, shift the shutoff lever to the SHUT-OFF (ОСТАНОВ) position.

In emergency cases, shut off the engine on the ground and in flight without running it at idle power setting. To this end, energetically shift the throttle control lever to the IDLE (МАЛЫЙ ГАЗ) stop and the shutoff lever, to the SHUTOFF position in the following situations:

— if the engine is set on fire;

— in case of engine surge;

— when the engine starts buffeting;

— in case of sharp increase of the turbine exhaust gas temperature at sustained power or lighting-up of the gas overtemperature warning lamp;

— when the engine oil pressure drops below 1 kgf/cm^2;

— by the aircraft technician's command.

The duration of engine continuous running at rotor speed below 96 % at non-reheat power settings is not limited.

If one of the fuel control lever position indicators failed, select non-reheat power settings by reference to the ИТЭ tachometer indicator. In this case, the engine speed shown by the tachometer indicator should be equal to that of the other engine. In this case, select the reheat power settings by reference to the reheat fuel pressure which should be equal to that of the other engine.

NEVER accelerate a cold engine after its starting to high power settings without its preliminary warming up at power settings corresponding to divisions 27 to 29 and 50 to 52 on the fuel control lever position indicator for 1 and 2 min, accordingly.

After relighting the engine in flight, NEVER:

— accelerate the engine to the maximum rotor speed earlier than 1 min after depression of the START (ЗАПУСК) button;

— accelerate the engine to power settings higher than 52 divisions on the fuel control lever position indicator without its preliminary warming up at the power setting corresponding to divisions 50 to 52 on the indicator for 5 min if the engine was stopped in flight for 25 min and more.

Check initiation of the maximum high-altitude reheat power setting by observing the fuel pressure in the reheat fuel manifold, which increases the moment the jet nozzle flaps start opening to increase the jet nozzle passage area, as well as by the nature of aircraft acceleration.

In the process of aircraft acceleration and flying at the maximum speed, check uniformity of fuel consumption from the front and rear tank groups without letting the discrepancy in the fuel quantity gauge indications exceed 1500 kg (according to the summary consumption scale). When discrepancy in fuel quantity gauge indications reaches this level, shift the throttle control lever to a position corresponding to division 90 and lower of the fuel control lever position indicator and go on flying at reheat power setting to equalize the quantity of fuel consumed by the starboard and port engines by varying the degree of their augmentation.

Table 3

Power settings	Position of throttle control lever as shown by fuel control lever position indicator, div.	Engine rotor speed at $t_{amb} = +15$ °C, %	Maximum permissible turbine exhaust gas temperature, °C	Fuel pressure in primary manifold, kgf/cm^2	Fuel pressure in reheat fuel manifold, kgf/cm^2
Takeoff full reheat up to altitude of 5500 m	97—100	99.5—100.5	645	65	75
Full reheat at altitudes of 5500 m and higher (maximum high-altitude reheat for M>1.22, for engine РД-7М2)	97—100	99.5—100.5	675	65	75
Cruising reheat	82—84	99.5—100.5	645	65	40
Maximum non-reheat power	67—69	99.5—100.5	645	65	—
Nominal power	50—52	91—93	540	50	—
Idle power	0—2	40—43	410		

When the Mach number decreases below 1.2, with the throttle control lever invariably set against the full reheat stop, the maximum high-altitude reheat power gets automatically disengaged (the engines change over to the maximum reheat power) and automatically engaged as soon as the Mach number of flight surpasses 1.22.

3.2. FUEL SYSTEM

The usable capacity of the aircraft fuel system is:
— 60,000 ltr with tank No. 1;
— 55,500 ltr without tank No. 1.

Before starting the engines, refer to the fuel quantity gauge to check the quantity of fuel in the tank groups and the total quantity of fuel in the aircraft fuel system; compare the fuel quantity gauge indicator readings with those of the flowmeter.

After engine starting and in flight, check the remaining fuel load by observing the readings of the fuel quantity gauge and flowmeter. In this case, the fuel quantity gauge switch should remain in the SUM (СУММА) position throughout the entire flight period.

Table 4

Position of fuel quantity gauge selector switch	Aircraft with tank No. 1			
	Port engine		Starboard engine	
	Tank No.	Tank group No.	Tank No.	Tank group No.
I	8—19 (port)	I	8—19 (starboard)	I
II	3—4	II	5	II
III	2	III	6—7	IIIA+IIIБ
IV	1 (50 %)	IV	1 (50 %)	IV
Sum	8—19 (port) + (3—4) + +2+1 (50 %)	—	8—19 (starboard) + 5+ +6+7+1 (50 %)	—

Table 4, continued

Position of fuel quantity gauge selector switch	Aircraft without tank No. 1			
	Port engine		Starboard engine	
	Tank No.	Tank group No.	Tank No.	Tank group No.
I	8—19 (port)	I	8—19 (starboard)	I
II	3—4	II	5	II
III	2	III (port)	6	III (starboard)
IV	2	—	7	IVA
Sum	8—19 (port) + + (3—4) + 2 (— 1840 kg)	—	8—19 (starboard) + + 5 + 6 + 7 + 1840 kg from tank No. 2 (group IVБ)	

NOTES. 1. When the fuel quantity gauge switch is set to position III (on aircraft without tank No. 1), pointer 1 shows the actual quantity of fuel in tank No. 2.

2. With the fuel quantity gauge switch set to position IV (on aircraft without tank No. 1), pointer 1 duplicates the readings of fuel quantity in tank No. 2 and pointer 2 shows the actual quantity of fuel in tank No. 7.

3. Fuel of 1840 kg in quantity is consumed from tank No. 2 by the starboard engine. It is included into the fuel quantity indication sum of the starboard engine (pointer 2).

In flight, periodically check the amount of fuel remaining in the groups of tanks being emptied and the quantity of fuel in the groups from which fuel is not consumed. Compare the fuel quantity gauge readings taken with the records made in the flight schedule. The remaining fuel load should be one and the same for both engines and the summary quantity of fuel remaining in the aircraft fuel system (as indicated by the fuel quantity gauge) should coincide with the fuel remainder read by the flowmeter (within the permissible range).

NOTE. If the density of the fuel used is lower than that estimated for the flowmeter, the fuel remainder indicated by the flowmeter is always lower than the actual one and the value read off the fuel quantity gauge and by the end of the flight (at 4 to 5-h flight duration) this difference may amount to 3 to 4 t.

If the amount of fuel consumed from the front and rear groups of tanks is unequal (different fuel consumption by the engines, open or untight cross-feed cock, etc.), with the summary difference in the quantity gauge readings reaching 1500 to 2000 kg, cut in the fuel equalizer. After the fuel amount gets equal, cut out the fuel equalizer.

CAUTION. IF THE FUEL CONSUMPTION INDICATED BY THE FUEL QUANTITY GAUGE AND FLOWMETER OBVIOUSLY SURPASSES THE FUEL CONSUMPTION CORRESPONDING TO THE POWER SETTING OF THE GIVEN ENGINE, IT IS FORBIDDEN TO CUT IN THE FUEL EQUALIZER.

Allocation of the fuel tanks in the groups is given in Table 4.

Fuel sequence control is effected automatically, by setting the AUTO CTL — MAN (УПРАВЛ. АВТОМ. — РУЧН.) switch to the AUTO (АВТОМ.) position, with the automatic fuel controller cut in.

Check operation of the fuel system automatic control units by the amber fuel sequence caution lights and green booster pump operation indicator lights;

— complete fuelling of the aircraft is accompanied by illumination of the group II amber light, two green pump operation indicator lights for each group II and two green indicator lights for group III and two green indicator lights for group IIIБ (in groups III (port) and IVA on aircraft carrying no tank No. 1) whose pumps operate in the stand-by mode;

— emptying of the port engine group II tanks to a fuel remainder of 11,300 ltr and starboard engine group II tanks to a fuel remainder of 7760 ltr results in automatic engagement of the group I pumps of both engines and lighting-up of one amber light of group I and one green indicator light in each tank group I; if the fuel consumption is lower than the delivery of fuel from the wing tank groups, filling of the port engine group II tanks to a level of 11,300 ltr or starboard engine group II tanks to a level of 7760 ltr entails automatic discontinuance of fuel transfer from the wing tank groups and extinguishment of the amber caution light and green indicator light of tank group I; after fuel is used up from tank groups II to the required levels, the pumps of tank group I get again cut in;

— 8 min after each tank group I is emptied to a fuel remainder of 350 to 500 ltr (on aircraft with tank No. 1 and without tank No. 1) the group I pumps get disengaged and both green indicator lights fade out;

— as soon as 500 ltr of fuel remains in group II of the port engine, the pumps of this group get changed over from the main to the accelerated duty, and the pumps of group III, from the stand-by to the main duty; simultaneously, the pump of group IV comes to operate in the stand-by duty which is accompanied by lighting-up of the green indicator lights of tank group IV (on aircraft with tank No. 1) and amber caution light of tank group III (port tank group III on aircraft carrying no tank No. 1).

NOTE: If tank No. 2 is filled with less than 10,200 ltr of fuel, with 500 ltr of fuel remaining in the tanks of port engine group II, the pumps of this group get disengaged;

— when 600 ltr of fuel remains in the starboard engine group II tanks, the pumps of tank group IIIA (starboard engine tank group III on aircraft carrying no tank No. 1) come to operate in the main duty while the pumps of tank group II are changed over to operate in the accelerated duty, which is accompanied by lighting-up of two green indicator lights and one amber caution light of tank group IIIA (the light of the starboard group III tanks on aircraft carrying no tank No. 1);

— when 600 ltr of fuel remains in tank group IIIA, the pumps of tank groups IIIA and IIIБ (starboard tank group III and group IVA on aircraft carrying no tank No. 1) get changed over to operate in the accelerated and main duties, accordingly, and the pumps of tank group IV come to operate in the stand-by duty (on aircraft with tank No. 1), which is accompanied by lighting-up of the tank group IV green indicator lights and tank group IIIБ (IVA) amber caution light.

CAUTION. WHEN THERE REMAINS 500 TO 700 KG OF FUEL IN THE FUEL SYSTEM OF AIRCRAFT CARRYING TANK No. 1, AS INDICATED BY FUEL QUANTITY GAUGE POINTER 2, WITH FUEL QUANTITY GAUGE SWITCH SET TO THE THIRD POSITION, OPEN THE CROSS-FEED COCK.

NOTES: 1. The illuminating amber caution lights will not extinguish after disconnection of the emptied tank group pumps (the tank group I light may go out in the process of operation).

2. Failure of the indicator and caution lights to light up in the above sequence is indicative of automatic control units failure.

In case of failure of one of the engines, cut in the fuel equalizer to maintain the aircraft main c.g. position within 35±2 % MAC on aircraft with tank No. 1 and within 36±2 % MAC on aircraft without tank No. 1. This is accompanied by opening of the cross-feed cock and lighting-up of the white light indicating cut-in of the fuel equalizer.

When the fuel equalizer is cut in, the fuel quantity gauge gets cut out and its pointer gets zeroed.

Fuel consumption from the front or rear tank groups is indicated by illumination of the respective green indicator light labelled FRONT (ПЕРЕДНИЕ) or REAR (ЗАДНИЕ). If both green indicator lights are alive simultaneously, fuel is consumed from the front and rear tank groups at a time.

The fuel equalizer operates in parallel with the automatic fuel controller which maintains the assigned fuel sequence with the fuel equalizer cut in.

For checking the fuel remainder, the automatic fuel controller board is provided with a button which, when kept depressed, disconnects the fuel quantity gauge transmitters from the fuel equalizer unit and connects them to the measuring units. In this case, the engine will consume fuel from the front and rear tank groups at a time, i.e., both green indicator lights labelled FRONT (ПЕРЕДНИЕ) and REAR (ЗАДНИЕ) will be alive. If the fuel equalizer fails to operate, it gets automatically disconnected as soon as the aircraft c.g. position reaches 30±2 % MAC or 40±2 % MAC on aircraft with tank No. 1 and 31±2 % MAC or 41±

±2 % MAC on aircraft without tank No. 1. Automatic disconnection of the fuel equalizer is accompanied by extinguishment of the white light while two green indicator lights remain alive and the cross-feed cock is kept open.

To ensure manual control of fuel consumption from the tank groups, proceed as follows:

— set the switches used for manual control of the pumps of the tank group being emptied at the given moment to the upper position;

— set the AUTO CTL — MAN (УПРАВЛ. АВТОМ. — РУЧНОЕ) switch to the MAN (РУЧН.) position;

— make sure that the fuel automatic controller switch is set to the ON (ВКЛЮЧЕНО) position;

— turn on the switches used for manual control of the pumps of the successive tank groups as soon as the respective fuel sequence amber lights come to illuminate;

— turn off the switches used for manual control of the pumps of the preceding tank groups after their emptying, making reference to the fuel quantity gauge indications and to extinguishing or flickering of the pump operation green indicator lights.

In the process of manually-controlled emptying of the fuel tanks, check to see that fuel is uniformly consumed by the port and starboard engines. In so doing, periodically check the fuel remainder by reading the fuel quantity gauge summary scale.

During landing approach, the fuel remainder should be at least 5 t; fuel consumption from tank No. 1 is not recommended.

On aircraft with tank No. 1, the pilot's instrument board accommodates red warning lights labelled 30-MIN FUEL REMAINDER (ОСТАТОК ТОПЛИВА 30 МИН) or 6000-KG FUEL REMAINDER (ОСТАТОК ТОПЛИВА 6000 КГ) which light up when 1650 ltr of fuel remains in each of tanks Nos 2 and 7 and red warning lights labelled 15-MIN FUEL REMAINDER (ОСТАТОК ТОПЛИВА 15 МИН) or 2800-KG FUEL REMAINDER (ОСТАТОК 2800 КГ) which come on to indicate that 3550 ltr of fuel remains in tank No. 1.

On aircraft without tank No. 1 (beginning from Series 29), the pilot's instrument board accommodates a red warning light labelled 6000-KG FUEL REMAINDER (ОСТАТОК ТОПЛИВА 6000 КГ), which comes on when 6100 ltr of fuel remains in tank No. 2 and 1450 ltr of fuel, in tank No. 7, and a red warning light labelled 3000-KG REMAINDER (ОСТАТОК 3000 КГ) which comes on to indicate that 3800 ltr of fuel remains in tank No. 2.

3.3. INERT GAS SYSTEM

The inert gas system is used to prevent explosion of fuel tanks pierced by bullets, shells, shell fragments, missile warheads and splinters of demolished airframe.

The inert gas system should be cut in before flying for combat missions as well as in all cases when the aircraft may be attacked by the enemy.

Cut in the inert gas system before takeoff by setting the INERT GAS (НЕЙТРАЛЬНЫЙ ГАЗ) switch to the upper position. Cut out the system after shutoff of the engines.

If a combat flight is to be performed on a partially fuelled aircraft, ensure explosion proofness of the empty tanks by purging them with carbon dioxide supplied from ground sources through the fillers before flight.

3.4. CREW CABIN AIR CONDITIONING SYSTEM

The ventilation-type air conditioning system is intended for maintaining the assigned pressures and temperatures in the cabin. The system is controlled with the help of the following on/off and selector switches located on the lower part of the pilot's electric board arranged on the port side over the engine control panel:

— the PRESSURE RELEASE (СБРОС ДАВЛЕНИЯ) switch located on the pilot's engine control panel, used for emergency pressure release in the cabin;

— the LOW ALT VENTIL (ВЕНТИЛЯЦ. НА МАЛЫХ ВЫСОТАХ) switch used for cutting in atmospheric air ventilation of the cabin;

— the АРД LOW — NORM (АРД ПОНИЖ. — НОРМ.) switch used for changing over cabin automatic air pressure controller АРД-54 from the normal operating mode to the combat one;

— the PRESSURIZ PORT, STBD (НАДДУВ ЛЕВ., ПРАВ.) switches used for opening and closing the shut-off valves from the port and starboard engines;

— the РТВК AUTO — COLD — HOT (РТВК АВТОМАТ — ХОЛ. — ГОР.) switch used for automatic and manual control of the valve transferring air into the hot or cold line;

— the CROSS-FEED EVAPOR HOT — COLD (КОЛЬЦЕВ. ИСПАРИТ. ГОР. — ХОЛ.) switch used for controlling the cross-feed valve;

— the FAN (ВЕНТИЛЯТОР) switch.

Check operation of the cabin air conditioning system by using the following instruments located on the pilot's instrument board:

— the cabin ventilation air flowmeter indicator (УРВК);

— cabin altitude and differential pressure indicator УВПД-15;

— pressurized cabin air thermometer 2ТУЭ-111 located on the upper beam on the cabin port side between frames Nos 9 and 10.

Irrespective of the nature of the anticipated flight mission, cut in the cabin pressurization system after starting the engines and, before taxiing out from the parking site, pressure-seal the access doors.

The rate of air flow supplied into the cabin pressurization system should be as follows as read by the cabin ventilation air flowmeter indicator:

— from 1 to 10 units during taxiing (depending on the ambient air temperature);

— at least two units before takeoff and during descent;

— from 3 to 7 units in flight (depending on the position of the РТВК cabin air temperature controller switch).

The cabin air temperature preset by the cabin air temperature controller should be within 16 to 26 °C.

In all cases when the CROSS-FEED EVAPOR (КОЛЬЦЕВ. ИСПАРИТ.) switch is set to the HOT (ГОР.) position, the РТВК switch should also be set to the HOT position for no less than 25 s. When the РТВК switch is set to the COLD (ХОЛ.) or AUTO (АВТОМАТ) position, the CROSS-FEED EVAPOR switch should occupy only the COLD (ХОЛ.) position.

Cut-in of the turbocooler at excessive air flow rates (5 to 7 units according to the УРВК cabin ventilation air flowmeter indicator) causes increase of the general level of noises in the cabin. To reduce the level of the noises, decrease the supply of air from the engines, which will result in certain increase of air temperature in the cabin.

The time required to pass from the normal pressure in the cabin to the combat one varies from 22 to 25 s and the time of cabin depressurization with the help of the PRESSURE RELEASE (СБРОС ДАВЛЕНИЯ) switch, with the pressurization system cut in and access doors pressure-sealed, is 60 s.

To preclude possible oversaturation of the pressurized cabin air with oxygen, do not let the rate of air flow in the cabin to decrease below one unit as read by the cabin ventilation air flowmeter indicator (УРВК).

The time of reversal of the cabin air pressurization system electrically-controlled mechanisms is as follows:

— 60 to 90 s for the shut-off cocks (by using the PRESSURIZ (НАДДУВ) switches);

— 5 to 6 s for the atmospheric air inlet unit (by using the LOW ALT VENTIL (ВЕНТИЛЯЦ. НА МАЛЫХ ВЫСОТАХ) switch);

— 20 to 25 s for the selector valve (by using the РТВК cabin air temperature controller switch);

— 18 to 22 s for the shutters (by using the CROSS-FEED EVAPOR (КОЛЬЦЕВ. ИСПАРИТ.) switch).

3.5. PRESSURE-SEALING SYSTEM OF ENTRY HATCHES

The pressure-sealing system of the entry hatches is intended for pressure-sealing the cabins by inflating the rubber seals of the entry hatches with air at a pressure of 2.7 to 3.2 kgf/cm^2. The system is controlled by using the DOOR PRESSURE-SEAL (ГЕРМЕТИЗАЦ. ЛЮКОВ) cock which has two positions: OPEN (ОТКРЫТО) and

CLOSED (ЗАКРЫТО). The pressure in the system is checked by reference to pressure gauge МВ-10Ц. The cock and the pressure gauge are located on the oxygen equipment control panel at the operator's or pilot's station.

3.6. ANTI-ICING SYSTEM

The anti-icing system is used for protecting the aircraft against icing in flight.

The system provides for:

— heating of the engine guide vane assembly vanes, inlet diffuser streamlined struts, engine cone and air intakes as well as the air intake used for admitting air for cooling the engine accessories;

— heating of the cabin glass panels.

The engine anti-icing system is cut in by using the ENGINE ANTI-ICING (ПРОТИВООБЛЕДЕНЕНИЕ ДВИГАТЕЛЕЙ) cock located on the cabin starboard side at the pilot's working station.

The pilot's and navigator's glass panels heater is turned on by using the GLASS HEATING (ОБОГРЕВ СТЕКОЛ) switches located on the cabin starboard side at the pilot's and navigator's stations.

3.7. CREW OXYGEN EQUIPMENT AND SPECIAL OUTFIT

The crew oxygen equipment and special outfit are used to provide vital activities and working capacity of the crew in flight and in case of ejection.

Liquid oxygen is contained in two oxygen bottles СКГ-15В, 15 kg in capacity each.

The working station of each crew member is furnished with oxygen set КП-24М and parachute-packed emergency oxygen set КП-23.

Oxygen set КП-24 supplies the crew with oxygen in the following conditions:

— for a continuous period of time — when flight is performed in a pressurized cabin within the entire range of the aircraft employment altitudes and in a non-pressurized cabin at altitudes not exceeding 12,000 m;

— for a short period of time (up to 10 min) — during descent in a non-pressurized cabin from the maximum possible flight altitude to an altitude below 12,000 m;

— for a short period of time (up to 10 min) — during ejection at all permissible flight altitudes with automatic change-over to oxygen supply from parachute-packed emergency oxygen set КП-23.

Oxygen set КП-24 accommodates the following controls:

— the air diluter handle used to initiate the supply of pure oxygen or mixture of oxygen with air;

— the emergency oxygen supply lever used to initiate continuous supply of pure oxygen;

— the excessive oxygen pressure build-up flywheel used to initiate continuous supply of pure oxygen at the excessive pressure during ground checking of the oxygen set operation.

For checking operation of the oxygen system, provision is made for the following instruments:

— oxygen pressure gauge МК-18 used to check the oxygen pressure in aircraft liquid oxygen bottles СКГ-15М (with the operating pressure within 8 to 10 kgf/cm^2);

— oxygen-flow indicator ИК-24Н used to check the oxygen pressure at the inlet of oxygen set КП-24М (the pressure-measuring part of the indicator) and to supply oxygen for breathing (the indicating part of the indicator);

— oxygen-flow indicator УК-57-15М used to check the quantity of liquid oxygen in the oxygen bottles.

All flights should be performed with crash helmet ЗШ-3М (ЗШ-5, ЗШ-5А) and oxygen mask КМ-32 (КМ-34) put on.

Each crew member should use only the individual outfit set which is matched to size and fitted to the crew-member's body.

CAUTION. NEVER USE DEFECTIVE OUTFIT.

In flight, all crew members should periodically check oxygen supply by the oxygen demand regulator (by observing motion of the ИК-24 oxygen-flow indicator segments) and pressure in the system (against the indicator pressure gauge) which should be within 8 to 10 kgf/cm^2. Besides, the pilot should observe the readings of the liquid oxygen indicator to check the quantity of liquid oxygen in the oxygen bottles. If the total amount of liquid oxygen remaining in both oxygen bottles is below 6 kg or if pressure in the system is lower than 6 kgf/cm^2, the pilot should descend to the altitude of 4000 m.

If oxygen set КП-24М is unserviceable (lack of oxygen or high breathing resistance) or if you start feeling worse, immediately cut in the emergency oxygen supply, for which purpose set the emergency oxygen supply lever on oxygen set КП-24М to the OPEN (ОТКРЫТО) position.

In so doing, intensify the check of the liquid oxygen reserve since you have considerably increased its flow rate (the estimated rate of oxygen flow is about 2 kg/h for one crew member).

The unused remainder of liquid oxygen in each oxygen bottle is 3 kg.

The reserve of the gaseous oxygen contained in parachute-packed emergency oxygen set КП-23 is sufficient for 10 to 12-min breathing.

3.8. FIRE PROTECTION SYSTEM

The fire protection system is used to detect and extinguish fire in two engine compartments as well as in fuselage and wing fuel tanks (four compartments) and in one forward service compartment.

Fire is detected with the help of fire detection system ССП-2А and extinguished with the use of two shots of fire extinguishers. Carbon dioxide contained in the inert gas system bottles may be used as additional means of extinguishing fire as the third and fourth fire-extinguishing shots. The quantity of the extinguishant used in each shot is rated for suppression of fire in the entire compartment.

The fire protection system operation is controlled and checked with the help of the fire warning system board.

The fire warning system board accommodates:

— the SUPPLY (ПИТАНИЕ) switch used to make the system ready for detection and suppression of fire;

— seven red light-buttons indicating the compartment on fire; if required, the red light-buttons may be used for manual cut-in of the first-shot fire extinguishers;

— two BOTTLES READY (ГОТОВНОСТЬ БАЛЛОНОВ) lights of the first-shot and second-shot group fire extinguishers;

— the SECOND GROUP BOTTLES OPENING (ОТКРЫТИЕ БАЛЛОНОВ II ГР.) button for cutting in the second-shot fire extinguishers;

— two PORT, STBD BOTTLES (БАЛЛОНЫ ЛЕВЫЕ, ПРАВЫЕ) switches used for cutting in the fire-extinguishing inert gas system bottles (the third and fourth shots of the fire extinguishing system);

— the LAMP CHECK (ПРОВЕРКА ЛАМП) button used for checking serviceability of the light-buttons.

Illumination of the red light-button is accompanied by flickering of the ДСТ ON FIRE (ПОЖАР ДСТ) signal.

On aircraft Ту-22У, lighting-up of any red light-button is accompanied by illumination of the AIRCRAFT ON FIRE (ПОЖАР САМОЛЕТА) signal on the annunciator and flickering of the SEE ANNUNCIATOR (ВНИМАНИЕ, ТАБЛО) signal on the pilot's instrument board.

After the fire has been put out, the light-button and AIRCRAFT ON FIRE signal go on illuminating, the SEE ANNUNCIATOR (ДСТ ON FIRE) signal goes on flickering.

To check operation of the fire-extinguishing system, turn off and then again turn on the SUPPLY (ПИТАНИЕ) switch on the fire warning system board 25 to 30 s after the fire extinguishers start operating.

If the red light-button and annunciator signal come on after turning-on of the SUPPLY (ПИТАНИЕ) switch, this means that the fire has not been put out. If this is the case, successively enable the second-, third- and fourth-shot fire extinguishers. Turn on the SUPPLY switch before starting the engines and turn it off after the engine shutoff.

3.9. HYDRAULIC SYSTEM

The hydraulic system includes three independent systems.

Hydraulic system I is used for:

— main and emergency braking of the main landing gear wheels;

— retraction and extension of the landing gear;

— opening and closing of the cargo compartment doors;

— steering the nose wheels;

— supplying power to one channel of the aileron, rudder and horizontal stabilizer actuators;

— enabling the aileron and rudder control system feel mechanisms.

Hydraulic system II is intended for:

— supplying power to one channel of the aileron, rudder and horizontal stabilizer actuators;

— emergency extension of the landing gear;

— emergency closing of the cargo compartment doors;

— actuating the rudder dry-friction damper and, in case of hydraulic system I failure, for actuating the aileron dry-friction damper.

Hydraulic system III is used for:

— controlling the horizontal stabilizer actuator in case of failure of hydraulic system I or II (or both of them);

— emergency extension of the landing gear in case of simultaneous failure of both hydraulic systems.

To check the pressure in the hydraulic systems, refer to the pressure gauges located on the pilot's instrument board: on the left part — the pressure gauges labelled MAIN (ОСНОВНАЯ) and CONTROLS (РУЛЕЙ), on the right part — the pressure gauge labelled HYD SYST III (III-Я ГИДРОСИСТЕМА). The nominal working pressure in each hydraulic system is within 203 to 220 kgf/cm^2.

Check retraction and extension of the landing gear by coming-on of three green extended-position lights and three red retracted-position lights located on the pilot's instrument board.

Main braking of the main landing gear wheels is effected by depressing the pedals. Operation of the unbraking system is checked by reference to the indicator lamp located on the pilot's instrument board. This system is enabled by turning on the switch located on the pilot's port console.

The landing gear controls include:

— the LG (ШАССИ) switch, having the RETRACTION (УБОРКА), NEUTRAL (НЕЙТРАЛЬНО) and EXTENSION (ВЫПУСК) positions, used for retraction and extension of the landing gear. The switch is located on the landing gear control panel;

— the LG EMERG EXT (АВАР. ВЫПУСК ШАССИ) switch used only for extending the landing gear from hydraulic system III. The switch is located on the cabin port side under the red cap labelled OFF — ON (ВЫКЛ.— ВКЛ.);

— the DEPRESS BUTTON AND PULL UP (НАЖМИ КНОПКУ И ПОТЯНИ ВВЕРХ) lever used only for emergency extension of the landing gear from hydraulic system II. The lever is located on the control surface locking panel (at the bottom, on the port side).

The aileron, rudder and horizontal stabilizer hydraulic booster cut-out cocks labelled AIL (ЭЛ), RUD (РН) and STAB (СТ), accordingly, are located on the HYDRAULIC BOOSTERS (ГИДРОУСИЛИТЕЛИ) panel on the instrument board right side.

3.10. PNEUMATIC SYSTEM

The pneumatic system provides:

— controlling the fuel dumping from the fuselage and wing fuel tanks in flight;

— emergency jettisoning of the entry hatches and disengagement of the pedals and control column;

— controlling the engine nacelle and afterburner cooling ejectors;

— controlling the system used for pressure-sealing the crew entry hatches;

— controlling the engine and air intake anti-icing system;

— controlling the engine accessories air cooling valve;

— controlling the engine compressor air blow-off valves;

— pressurizing the units of the РАДОН, high-altitude altimeter, radar sight, Doppler ground speed and drift meter and command radio set systems with air;

— pressurizing the НЕОН unit;

— extending the turbopumps;

— opening the brake chute container doors;

— releasing the brake chute.

The compressed air is generated by air compressors АК-150 creating a working pressure of 150 kgf/cm^2.

The pressure in the bottles is checked by reference to the air pressure gauge installed on the oxygen control panel of the pilot's console.

For the case of engine failure or damage to the pipeline supplying air from compressor АК-150, the consuming systems are provided with bottles ensuring operation of the respective mechanisms.

3.11. AUTOPILOT

The autopilot provides:

— aircraft stabilization about the three axes;

— hold of the assigned barometric altitude with generation of light and audio signals indicating variation of the flight level;

— execution of coordinated turns, climbs and descents;

— lateral aiming of the aircraft at the target when used together with the bomb sighting systems.

The autopilot is coupled with the following systems:

— the air data computer system;

— the РАДОН radar bomb sight;

— the optical bomb sight (ОПБ);

— the compass system;

— the ПУТЬ flight director system;

— the astrotracker, limit bank attitude and comparison unit БСПК-1, critical angle-of-attack and g-load warning unit (АУАСП), feel simulator controller (АДУ).

The basic control, checking and indication components of the autopilot are:

(a) control panel ПУ-10 accommodating:

— the AP ON (ВКЛ. АП) button used for engaging the autopilot into aircraft control;

— the AP PREP — OFF (ПОДГ. АП — ОТКЛ.) switch for connecting and disconnecting the autopilot power supply in the synchronization mode;

— the AC ON (ВКЛ. КВ) light-button used to indicate altitude controller readiness for operation and its enabling to operate in the present barometric altitude hold mode;

— the LAT (ПОПЕР.) and LONG (ПРОД.) switches for separate enabling and disabling of the longitudinal and lateral channels control;

— the ROLL (КРЕН) selector for manual centering of the roll channel;

— the NAV CTL (УПР. ШТ.) light-button used to indicate the navigator's engagement in handling the autopilot and cut-off of control from the navigator;

— the P—N (Л—Ш) switch for changing over the autopilot control from the pilot to the navigator;

— the TURN (РАЗВОРОТ) and DESCENT—CLIMB (СПУСК—ПОДЪЕМ) knobs for controlling the aircraft within $\pm(35$ to $40)^\circ$ in roll and within $\pm(4$ to $6)^\circ$ in pitch;

— two three-position light indicators with the OFF (ОТКЛ.), PREP (ПОДГ.) and ON (ВКЛЮЧ.) lights used to indicate the operating modes of the autopilot longitudinal and lateral channels;

(b) navigator's control panel ПУШ-3 accommodating:

— the TURN (РАЗВОРОТ) and PITCH (ТАНГАЖ) knobs used to control the aircraft within $\pm(20$ to $30)^\circ$ in roll and within $\pm(4$ to $6)^\circ$ in pitch;

— the CTL ON (ВКЛ. УПРАВЛ.) button used to change over the aircraft autopilot control from the pilot to the navigator;

— the AP ON (АП ВКЛ.) light used to indicate engagement of the autopilot by the pilot;

— the CTL ON (УПР. ВКЛ.) light used to indicate the navigator's engagement in handling the autopilot;

(c) the control wheel accommodating the AP OFF (ОТКЛЮЧЕНИЕ АВТОПИЛОТА) button used for disengaging the autopilot.

To check autopilot serviceability, proceed as follows:

— before turning on the autopilot, set the TURN (РАЗВОРОТ), DESCENT — CLIMB (СПУСК — ПОДЪЕМ) and ROLL (КРЕН) knobs to the neutral position, place the P—N (Л—Ш) switch to the P (Л) position and turn on the LAT (ПОПЕР.) and LONG (ПРОД.) switches;

— listen to the navigator's report on the intermediate position of the TURN and PITCH knobs;

— turn on the AUTOPILOT (АВТОПИЛОТ) circuit breaker and the AUTOPILOT AND MVG (АВТОПИЛОТ И ЦГВ) switch on the pilot's starboard console;

— 5 min after turning-on of the AUTOPILOT circuit breaker, turn on the AP PREP (ПОДГ. АП) switch;

— make sure that the amber PREP (ПОДГ.) and white OFF (ОТКЛ.) lights illuminate on the light indicator and the AC ON (ВКЛ. КВ) light-button is dead.

NOTES: 1. The lateral stabilization light indicator fails to operate in the flickering mode and to illuminate the PREP (ПОДГ.) and OFF (ОТКЛ.) inscriptions if the TURN (РАЗВОРОТ) knobs on the pilot's and navigator's consoles are not in the neutral position or the P—N (Л—Ш) switch occupies the N (Ш) position.

2. The longitudinal stabilization light indicator fails to operate in the flickering mode and to illuminate the PREP (ПОДГ.) and OFF (ОТКЛ.) inscriptions if the DESCENT — CLIMB (СПУСК — ПОДЪЕМ) and PITCH (ТАНГАЖ) knobs are not set to the neutral position;

— observe the readings of the ПП flight director indicator to make sure that the master vertical gyro operates normally;

— compare the readings of the flight director indicator and gyro horizon with the visible horizon line; turn off the autopilot in case of discrepancy in the readings of the indicators or in case of their failure to comply with the actual parking angle;

— set the horizontal stabilizer to 4° according to the stabilizer position indicator, then shift the ailerons and rudder to the neutral position;

— depress the AP ON (ВКЛ. АП) button — the lateral and longitudinal stabilization light indicators should illuminate the ON (ВКЛ.) position, the AC ON (ВКЛ. КВ) light-button should come on and the AP ON (АП ВКЛ.) light should come to illuminate on the navigator's console.

NOTE. In case of slow movement of the control wheel in roll and that of the control column in pitch, eliminate their slow movement by turning the ROLL (КРЕН) and DESCENT — CLIMB (СПУСК — ПОДЪЕМ) knobs;

— apply forces to the control wheel, control column and pedals to make sure that the servo unit solenoid clutches have been engaged.

CAUTION. NEVER CUT IN THE ALTITUDE CONTROLLER IF THE GREEN "AC ON" ("ВКЛ. КВ.") LIGHT-BUTTON IS DEAD. IT IS FORBIDDEN TO USE THE TRIM TAB ACTUATORS WITH THE AUTOPILOT SERVO UNITS CUT IN;

— check the autopilot cutin interlocking system, with the roll and pitch selectors on the control panels deflected. To this end, turn off the AP PREP (ПОДГ. АП) switch on the pilot's console and shift the TURN (РАЗВОРОТ) knob from the neutral position; turn on the AP PREP switch — the OFF (ОТКЛ.) inscription should illuminate on the lateral (roll) stabilization light indicator; return the TURN knob to the neutral position and turn off the AP PREP switch; turn the DESCENT — CLIMB knob to either side from the index by no less than 10°; turn on the AP PREP switch — the OFF inscription should illuminate on the longitudinal (pitch) stabilization light indicator; return the DESCENT — CLIMB knob to the neutral position; as soon as the PREP (ПОДГ.) inscription comes to illuminate on the lateral (roll) and longitudinal (pitch) light indicators, depress the AP ON (ВКЛ. АП) button — the ON (ВКЛ.) inscription should light up on the light indicators;

— make sure that the control wheel and column have deflected in response to turning the TURN and DESCENT — CLIMB knobs from the neutral position; rightward turn of the TURN knob causes turning of the control wheel to the right while leftward turn of the same knob results in turning of the control wheel to the left.

Rotation of the DESCENT — CLIMB (СПУСК — ПОДЪЕМ) knob in the DESCENT (СПУСК) direction should cause forward deflection of the control column while rotation of the same knob in the CLIMB (ПОДЪЕМ) direction should result in backward deflection of the control column;

— check operation of the limit switches; to this end, manipulate the ailerons and horizontal stabilizer by using the TURN and DESCENT — CLIMB knobs until they are cut off by the limit switches; after this, return the ailerons to the neutral position by using the TURN knob; when the horizontal stabilizer limit switches open, the control column returns to the initial position, the AP CHANNEL OFF PITCH (КАНАЛ АП ОТКЛЮЧЕН ТАНГАЖ) red lamp lights up on the pilot's instrument board, the audio signalling system operates and the OFF (ОТКЛ.) inscription lights up on the longitudinal (pitch) stabilization light indicator; turn off and then again turn on the AP PREP (ПОДГ. АП) switch; after the PREP (ПОДГ.) inscription appears on the longitudinal (pitch) stabilization light indicator, instantaneously depress the AP ON (ВКЛ. АП) button — the longitudinal (pitch) stabilization light indicator should show the ON (ВКЛ.) inscription; check deflection of the horizontal stabilizer by reference to the stabilizer position indicator;

— check operation of the limit switches by using the controls available at the navigator's station; to this end, instantaneously depress the CTL ON

(ВКЛ. УПРАВЛ.) button — this will result in lighting-up of the NAV CTL (УПР. ШТ.) light-button and CTL ON (УПР. ВКЛ.) light; when performing this check, manipulate the TURN and PITCH knobs in the same way as in case of the pilot's control; change over to autopilot control from the pilot's station; to this end, depress the NAV CTL light-button which should extinguish; simultaneously, the CTL ON light will come out on the navigator's console;

— check serviceability of the autopilot fast disengagement button, for which purpose (with the hydraulic systems cut in), apply forces to the control wheel, control column and pedals; make sure that the servo unit solenoid clutches are engaged; without trimming out the controls, depress the autopilot fast disengagement button on the control wheel; this will result in extinguishment of the AC ON (ВКЛ. КВ) light-button on the pilot's console; the OFF (ОТКЛ.) inscription should come to illuminate on the light indicator and the AP ON (АП ВКЛ.) light should fade out on the navigator's console;

— turn off the switches labelled AP PREP (ПОДГ. АП), AUTOPILOT AND MVG (АВТОПИЛОТ И ЦГВ) and the circuit breaker labelled AUTOPILOT (АВТОПИЛОТ).

3.12. COMPASS SYSTEM

The compass system provides permanent determination and indication of the aircraft magnetic heading, turn angle as well as generation of magnetic or true bearings and radio station relative bearings. Besides, the directional system generates course signals into other systems.

The compass system may operate in the following modes:

— the magnetic slaving (MS) mode;

— the directional gyro (DG) mode;

— the celestial slaving (CS) mode.

The compass system is controlled from control panel ПУ-1 located on the right side of the navigator's electric power supply board.

The control panel accommodates:

— the MS — DG — CS (МК — ГПК — АК) switch for selecting the compass system operating mode;

— the NORTH — SOUTH (СЕВЕРН.— ЮЖН.) switch for introducing latitude updating;

— the MAIN — STBY (ОСН.— ЗАП.) switch for change-over of the magnetic slaving channels from the main channel to the stand-by one;

— the gyro additional azimuth drift compensation knob;

— the COURSE SELECTOR (ЗАДАТЧИК КУРСА) knob for selecting the assigned course in the DG (ГПК) mode;

— the SLAVING (СОГЛАСОВАНИЕ) button for speeding up the slaving rate.

To determine serviceability of the compass system, the navigator should proceed as follows:

(a) check for 28 and 36-V voltages;

(b) determine the compass system normal slaving rate, for which purpose the navigator should do the following:

— turn on the circuit breaker labelled KC-6A and switch labelled KC-6A SUPPLY (ПИТАНИЕ KC-6A) on the navigator's power supply board;

— set the mode-of-operation switch to the MS (MK) position and the channel selector, to the MAIN (OCH.) position; 3 to 5 min after turning-on of the KC-6A SUPPLY switch, depress the SLAVING button;

— using the conventional magnetic declination setting knob on slaving unit KM-4, introduce 12 to 15° slaving error into the system (as indicated by the inner scale and deviation marker) and start the stopwatch;

— determine the time of indicator scale turning through 10°; the slaving rate should be within 2 to 5 deg/min; use the same procedure to determine the slaving rate, with the setting knob of slaving unit KM-4 turned into the other direction;

(c) determine a higher slaving rate, using the following procedure:

— after slaving the compass system, turn the setting knob of slaving unit KM-4 to introduce a 170° slaving error into the system (as indicated by the inner scale and deviation marker);

— depress the fast slaving button and simultaneously start the stopwatch;

— check the time of the indicator scale (pointer) slaving, with the setting knob on slaving unit KM-4 turned through 170°; the slaving should take place at a rate of at least 8°/s; use a similar procedure to determine a higher slaving rate, with the setting knob of slaving unit KM-4 turned to the other side; repeat the check, with the channel selector set to the STBY (ЗАП.) position;

(d) check serviceability of the compass system in the directional gyro (ГПК) mode, with the channel selector set to the MAIN (OCH.) position. To this end, proceed as follows:

— set the mode selector to the DG (ГПК) position;

— turn the course selector clockwise through an angle of up to 60°; in this case, the scale of navigator's indicator УШ-1 and the pointer of combined course indicator HKП should slowly move in the course increase direction; with the course selector turned through an angle of at least 90°, the navigator's indicator scale and course indicator pointer should turn at a higher rate; repeat the check, moving the course selector counterclockwise — the navigator's indicator scale and course indicator pointer should move in the course decrease direction; when the course read by the navigator's indicator scale and course indicator is changed by turning the course selector, pointer "G" ("Г") of the gyro magnetic and celestial heading indicator (УГА) should remain motionless; repeat the checks with the channel selector set to the STBY (ЗАП.) position;

(e) check serviceability of the compass system in the CS (AK) mode with the channel selector set to the MAIN (OCH.) position; to this end, proceed as follows:

— cut in power supply of the astrotracker (ЗСО);
— set switches AC1 and AC2 to the ALIGNMENT (НАСТРОЙКА) position;
— place the mode-of-operation switch to the CS (AK) position and depress the compass system fast slaving button, then set the MAIN — STBY (ОСН.—ЗАП.) switch to the MAIN (ОСН.) position;
— put down the readings of great-circle course indicator (УОК), astrotracker, navigator's indicator (УШ) and heading indicator (УГА) (pointer "A");
— set the switch on the astrotracker control panel to position AC1 (AC2) and, using the SETTING (УСТАНОВКА) buttons, increase or decrease the course shown by the great-circle course indicator (УОК) by 30°; in this case, the compass system indicators should vary their readings by the same angle in the same direction; before reading the course off the navigator's indicator, depress the compass system fast slaving button; compare the great-circle course reading with the readings of the compass system indicators (permissible reading deviations are within ±1°).

NOTE. After checking operation of the compass system main channel, set the MAIN — STBY (ОСН.— ЗАП.) switch to the STBY (ЗАП.) position and check operation of the standby channel, using the above procedure;

(f) check serviceability of the navigator's indicator with the use of automatic direction finder АРК-11; to this end, proceed as follows:
— turn on the ADF (APK) circuit breaker on the pilot's circuit breaker board;
— set the mode-of-operation switch on the automatic direction finder control board to the COMP I (КОМП. I) position (to be done by the navigator);
— depress the loop manual rotation switch labelled LOOP LH — RH (Л — П РАМКА) leftward and rightward and ensure that the loop rotates in the required direction by observing the motion of the navigator's indicator pointer.

3.13. ASTROTRACKER (ЗСО)

The astrotracker (ЗСО) is used to:
— determine the aircraft position coordinates and its course at night by reference to the two heavenly bodies;
— determine the aircraft course in the daytime by reference to the Sun.
The astrotracker may operate in the following modes:
— alignment with the heavenly bodies;
— tracking of the heavenly bodies.
The astrotracker is controlled with the help of the computer whose face panel accommodates:
— the switch labelled STARS — SUN (ЗВЕЗДЫ — СОЛНЦЕ);

— multi-position scale selector wafer switch;

— switch labelled TRACKING — ALIGNMENT (СЛЕЖЕНИЕ — НАСТРОЙКА);

— switch labelled ILLUM (ПОДСВ.);

— switch labelled SLAVING FROM ABNE (automatic bomber navigation equipment) — INTO ABNE (КОРРЕКЦИЯ ОТ НБА — В НБА);

— the ON — OFF (ВКЛ.— ВЫКЛ.) switch;

— the buttons labelled COORDINATE SETTING (УСТАНОВКА КООРДИНАТ);

— scales Φ, L, S_{GM}, α_1, δ_1, α_2, δ_2, Y, X, φ, λ;

— the switch labelled OPERATION — ADJUSTMENT (РАБОТА — УСТАНОВКА);

— the switch labelled GCC — TC (ОК — ИК);

— the HEATING SOLVES (ПРОГРЕВ РЕШАЕТ) and A2 — A1 annunciators.

The astrotracker is coupled with:

— the compass system;

— the automatic bomber navigation equipment;

— the master vertical gyro.

To check serviceability of the astrotracker before a daytime flight, proceed as follows:

— set up the latitude and longitude of the aircraft parking site;

— introduce the latitude and longitude of the primary great circle pole;

— make sure that the X coordinate was tracked in agreement with the place of aircraft parking relative to the primary great circle within $\pm$(15 to 20 km).

To check proper coupling of the astrotracker with the automatic bomber navigation equipment, proceed as follows:

— set the switch labelled ADJUSTMENT — OPERATION (УСТАНОВКА — РАБОТА) to the ADJUSTMENT (УСТАНОВКА) position and introduce the magnitude of the Y coordinate corresponding to the aircraft parking site;

— set the ADJUSTMENT — OPERATION switch to the OPERATION (РАБОТА) position;

— set the aircraft X and Y coordinates on unit PH-17;

— set the switch labelled SLAVING FROM ABNE — INTO ABNE (КОРРЕКЦИЯ ОТ НБА — В НБА) into the FROM ABNE (ОТ НБА) position and make sure that the readings of the LATITUDE (ШИРОТА) and LONGITUDE (ДОЛГОТА) counters do not differ from the actual coordinates by more than 10 to 12°;

— introduce parameters S_{GM}, δ, $\alpha = 0$ and lock on the Sun.

For checking serviceability of the astrotracker and its coupling with the automatic bomber navigation equipment before a night-time flight, use the procedure specified for checking the astrotracker before performing flight in the daytime.

When using the astrotracker to determine the aircraft fix (the TO ABNE mode), introduce the S_{GM} δ_1, λ and δ_2 parameters of the heavenly bodies with azimuths differing from each other within 60 to 120°.

If there are no heavenly bodies with azimuths within the indicated limits, align both sextants to one and the same heavenly body, determining only the aircraft course.

To check remote coupling of the astrotracker with the compass system, proceed as follows:

— set the switch on the compass system panel to the CS (AK) position;

— set the switch labelled MAIN — STBY (ОСН. — ЗАП.) to the MAIN (ОСН.) position;

— set the wafer switch to position AC1 (AC2);

— using the COORDINATE SETTING (УСТАНОВКА КООРДИНАТ) buttons, set the zero great-circle course as read by the gyro-magnetic and celestial heading indicator (УГА) (pointer A) and great-circle course indicator (УОК);

— depress the fast slaving button;

— increase or decrease the great-circle course by 30° — the readings of the navigator's indicator and compass system should change by the same magnitude;

— set the MAIN — STBY switch to the STBY (ЗАП.) position and perform the same operations.

To check remote coupling of the astrotracker with the automatic bomber navigation equipment, proceed as follows:

— set the SLAVING FROM ABNE — INTO ABNE switch to the INTO ABNE position;

— using the wafer switch and COORDINATE SETTING buttons, set the following magnitudes on the navigation computer scales: $\Phi=0°$, $L = 90°+\lambda$; $S_{GM} = 0°$, $\varphi=0°$, $\lambda=\lambda_M$; $\alpha_1=0°$; $\delta_1=+50°$; $\lambda_2=+50°$; $\delta_2=0°$; after solution of the problem by the computer, the X scale should occupy the zero position; zero the Y scale (if its reading is other than zero) by using switch Y (which should be placed to the SETTING (УСТАНОВКА) position) and COORDINATE SETTING buttons so that scales φ, λ, X and Y should be free of hesitation;

— set the wafer switch to the AC1 (AC2) position;

— cut in the automatic bomber navigation equipment and set the following present position data (PPD) on its scales: $Y_{PPD} = 0$; $X_{PPD} = 0$; $\beta = 0°$;

— set the switch on astrotracker unit PH-20 to the ON (ВКЛ.) position;

— place the computer wafer switch to position "φ" and set up an "Y" magnitude close to 100 km by the COORDINATE SETTING buttons while varying the latitude;

— set the wafer switch to position "λ" and, using the COORDINATE SETTING buttons, set up an "X" magnitude close to 100 km;

— place the wafer switch to position AC1 (AC2), with the SLAVING FROM ABNE — INTO ABNE switch set to the INTO ABNE position; the readings of scales X_{PPD} and Y_{PPD} should correspond to the magnitudes set on the astrotracker computer accurate within ±10 km (check remote coupling of the astrotracker with the automatic bomber navigation equipment within the range of 0 to ±500 km).

NOTE. When the automatic bomber navigation equipment scales indicate Y and X magnitudes, see to it that the discrepancy in indications of the computers of the astrotracker and automatic bomber navigation equipment does not exceed 250 km;

— place the SLAVING FROM ABNE — INTO ABNE switch on the astrotracker computer to the FROM ABNE position;

— set the switch on astrotracker unit PH-20 to the OFF (ВЫКЛЮЧЕНО) position;

— set up the magnitudes on scales X_{PPD} and Y_{PPD} of the automatic bomber navigation equipment within the range of 0 to ±500 km; in this case, the readings of scales X and Y on the astrotracker computer should correspond to the X_{PPD} and Y_{PPD} magnitudes inserted into the automatic bomber navigation equipment computer within the accuracy of ±10 km;

— zero scales X_{PPD} and Y_{PPD} of the automatic bomber navigation equipment and disengage the latter.

3.14. AIR DATA COMPUTER SYSTEM (ЦСВ)

The air data computer system ensures measurement of the following parameters:

— true airspeed V;
— barometric height H;
— relative air density Δ;
— ambient air temperature T_{amb};
— the flight Mach number.

The parameters being measured (V, T_{amb}, M and H) are sent out to the navigator's altitude indicator (УВШ) and altitude indicator (УВ), airspeed indicator (УС), ambient temperature indicator (УТ) and Machmeter. The air data computer system generates signals (V, H, T_{amb}, Δ and M) and sends them out into other systems (optical bomb-sight, autopilot, automatic bomber navigation equipment, tail turret, short-range radio navigation and landing system, radio altimeter).

The face side of the navigator's altitude indicator accommodates P_0 and T_0 input knobs and a dial. The introduced temperature magnitude is read off scale C by referring to the fixed index, and the pressure (in mm Hg) is indicated by the counter. The pressure input range varies from 810 to 590 mm Hg.

CAUTION. NEVER SET PRESSURES EXCEEDING 810 AND LOWER THAN 590 MM Hg ON THE COUNTER SCALE.

To check serviceability of the air data computer system, proceed as follows:

— turn on inverter ПО-6000 No.2;

— turn on circuit breaker labelled ADCS (ЦСВ) at the navigator's station;

— turn on the ADCS (ЦСВ) switch on the navigator's electric power supply board;

— vary pressure P_0 and temperature T_0 on the navigator's altitude indicator scale to make sure that the air data computer system is serviceable by deflection of the pointers;

— set the pressure and temperature of the airfield of departure on the navigator's altitude indicator.

3.15. FLIGHT DIRECTOR SYSTEM

The flight director system is used for controlling the aircraft by reference to the command bars. It provides:

— execution of landing approach in IFR conditions with the use of СП-50 ILS equipment or KATET ILS system;

— en-route flying with the aid of the short-range navigation and landing system;

— indication of roll, pitch, heading, sideslip, assigned course (ψ_{ass}), radio station relative bearing, magnetic radio bearing, aircraft deviation from the assigned flight track in the horizontal and vertical planes, assigned flight track interception command and display of signals indicating serviceability of СП-50 ILS equipment and short-range navigation and landing system.

The flight director system may operate in the following modes:

— the landing mode (СП);

— the short-range navigation (СВОД) mode (flying on a trajectory preset by the short-range navigation and landing system or landing controlled by the KATET ILS system beacons).

The flight director system is controlled from control panel ПУ-30 accommodating:

— the switches СП and СВОД used for selecting the flight director system operating mode;

— the switch used for moving apart the command bars.

When controlled by the flight director system, the aircraft is piloted by reference to two instruments: flight director indicator ПП-1П (ПП) and combined course indicator НКП-4 (НКП).

The flight director indicator is used for handling the aircraft on its flight path. It is actually a combined indicator incorporating the remote-reading gyro horizon, command bars, indicator showing aircraft deviation from the assigned altitude or glide slope and sideslip indicator.

The combined course indicator displays the assigned course and present heading, the magnetic radio bearing, aircraft fix relative to the assigned flight track, radio station relative bearing and operation of the localizer and glide slope beacons.

Serviceability of the flight director system should be checked by the pilot and navigator by using the following procedure:

— give the "Turn on inverter ПТ-1000Ц" command to the operator;

— give the "Turn on compass system КС-6А" command to the navigator;

— turn on the circuit breaker labelled MVG (ЦГВ);

— depress the master vertical gyro fast slaving button on the flight director indicator;

— make sure that the roll and pitch indicators have been zeroed;

— turn on the circuit breaker and switch labelled ПУТЬ at the pilot's station;

— set the landing (СП) or short-range navigation (СВОД) mode on control panel ПУ-30;

— set the command bar control switch to the ON (ВКЛ.) position;

— set the DG (ГПК) mode on compass system control panel ПУ-1;

— set the assigned course equal to zero on the combined course indicator scale; while selecting different course magnitudes on the navigator's indicator, observe variation of the course readings on the combined course indicator, and motion of the command side deviation bar on the flight director indicator; the present heading indicator on the combined course indicator should follow the navigator's indicator readings accurate within $\pm 1.5°$; the command side deviation bar of the flight director indicator should deflect rightward at 30° heading and leftward at 330° heading (the check completed, set up the MS (МК) mode on control panel ПУ-1);

— cut in ILS equipment СП-50;

— using the centering knob on control board М-50, center the localizer deviation bar on the combined course indicator;

— cut out ILS equipment СП-50;

— select the assigned course (equal to that displayed on the combined course indicator), using the assigned course setting knob; at zero roll and pitch, make sure that the command bars are zeroed (occupy the neutral position).

On the runway before takeoff, check position of the combined course indicator deviation bar which should be set in the centre. With ILS equipment cut in and switch ПУ-30 occupying the position corresponding to the landing (СП) mode, the runway localizer receiver (КРП) warning flag should be closed.

3.16. DOPPLER GROUND SPEED AND DRIFT METER (ДИСС)

The radar Doppler ground speed and drift meter is used for automatic and autonomous determination and indicaton of the aircraft ground speed and drift angle as well as for inserting the speed and angle magnitudes into the automatic bomber navigation equipment computer within the entire range of airspeeds and flight altitudes, starting from the airspeed of 500 km/h and altitude of 200 m.

The Doppler meter is automatically changed over to operate in the MEMORY (ПАМЯТЬ) mode when the aircraft starts flying in conditions differing from level flight (with $\pm 5°$ roll and minus 2 to plus 10° pitch after coming-on of the ROLL PITCH (КРЕН ТАНГАЖ) light) or in case of generation of a jamming signal and weak signal after coming-on of the JAM (ПОМЕХА) and WEAK SIGNAL (СЛАБЫЙ СИГНАЛ) lights.

The control panel and indicator of the Doppler ground speed and drift meter are located on the navigator's instrument board.

The control panel accommodates:

— the IRRAD — DOPPLER ON — OFF (ИЗЛУЧ. — ВКЛ. — ВЫКЛ. ДИСС) switch for turning on power supply of the Doppler meter;

— the LAND — SEA (СУША — МОРЕ) switch used for correcting the ground speed (when flight is performed over the land, the switch should be set to the LAND (СУША) position and in case of flying over the sea, to the SEA (МОРЕ) position);

— the MAN CTL (РУЧН. ПРИВ.) switch for accomplishing manual control of the antenna;

— the NAVIG — BOMBING (НАВИГ. — БОМБОМЕТ.) switch for selection of the automatic bomber navigation equipment operating mode;

— the 115-V lamps labelled READY, PRESS (ГОТОВН., ДАВЛ.) for checking serviceability of the Doppler ground speed and drift meter.

To enable the Doppler ground speed and drift meter, proceed as follows:

— turn on the circuit breaker labelled WIND (ВЕТЕР) on the navigator's circuit breaker panel;

— turn on the ДИСС switch on the control panel;

— turn on the IRRAD (ИЗЛУЧЕНИЕ) switch on the control panel.

On expiration of 3 to 5 min, a green light labelled IRRAD will come to illuminate on indicator B-7 (which means that the meter is ready to operate).

If the drift angle channel is unserviceable (the indicator pointer occupies the right-hand or left-hand position for a continuous period of time), the navigator should check the drift angle by any means available, then he should set the drift angle equalling that measured by using the MAN CTL (РУЧН. ПРИВ.) switch.

3.17. INTERROGATOR-RESPONDER (СРЗО)

The interrogator-responder (СРЗО) is employed by the all-arms radar identification system. It is used for identifying the aircraft on which it is installed and the target detected by the radars with which it is coupled.

The interrogator-responder provides:

— generation of response signals when the aircraft is interrogated by ground-based, shipborne and aircraft interrogators;

— processing of the check identification signals;

— generation of interrogation signals, together with coupled radars (radar bomb sight РАДОН or fire control radar ПРС), for identification of targets detected by these radars;

— decoding of accepted response signals and sending-out of decoded response signals to the radars (radar bombsight РАДОН or fire control radar ПРС).

The interrogator-responder is controlled from the control panels(boards) located at the operator's and pilot's stations and provided with the following control, check and indication elements;

(a) on the control panel (unit 9A);

— the switches labelled SUPPLY — OFF (ПИТАНИЕ — ВЫКЛ.) for enabling (disabling) the interrogator-responder;

— the switch labelled INTERROG — OFF (ЗАПРОС — ВЫКЛ.) for enabling the interrogation mode;

— the switch labelled INTERROG — 3 — INTERROG — 2 (ЗАПРОС — 3 — ЗАПРОС — 2) for switching over the interrogations made by two- or three-pulse signals;

— the OUTPUT 1—2 (ВЫХОД 1—2) switch for changing the length of the interrogation pulse;

— the switch labelled КЛАПАН — OFF (КЛАПАН — ВЫКЛ.) for enabling (disabling) the КЛАПАН mode;

— the code selector;

— the DISTRESS (БЕДСТВИЕ) switch for enabling the distress signal;

— the P ON (Р ВКЛ.) switch for enabling the РАДОН (radar bombsight) mode;

— the BRIGHT (ЯРКОСТЬ) knob for regulating the brightness of the identification mark on the radar screen;

— the indicator light labelled CODE ON — TRANS (КОД ВКЛЮЧЕН — ПЕР.) for checking code selection in the transmitter;

— the indicator lamp labelled CODE ON — DECODER (КОД ВКЛЮЧЕН — ДШ) for checking code selection in the decoder;

— the indicator light labelled SUPPLY CHECK (КОНТРОЛЬ ПИТАНИЯ) for checking cut-in of the interrogator-responder;

— the RESPONSE INDIC (ИНДИК. ОТВЕТА) indicator light for ascertaining operation of the response channel;

— the P ON (ВКЛ. Р) indicator light which comes on to indicate that the interrogator-responder operates in coupling with the РАДОН radar;

(b) on the control board (unit 16A):

— the КЛАПАН — OFF (КЛАПАН — ВЫКЛ.) switch for enabling (disabling) the КЛАПАН mode;

— the INTERROG — OFF (ЗАПРОС — ВЫКЛ.) switch for enabling the interrogation mode;

(c) on the navigator's control board:

— the switch labelled IFF INTERROG OFF (ЗАПРОС СРЗО ВЫКЛ.) for enabling the interrogation mode;

(d) on unit ГБ3.604.002:
— the DESTRUCTION (ВЗРЫВ) button for destruction of the interrogator-responder code elements.

Interrogator-responder СРЗО-2 is cut in after engine starting. When the interrogator-responder operates in the interrogator mode, the operator should turn on the INTERROG (ЗАПРОС) switch for the time period required for identifying the target detected by the radar. If the radar screen displays asynchronous marks of the identification channel, turn on the КЛАПАН switch.

3.18. BOMBING EQUIPMENT

Aircraft Ту-22Б carries bombing equipment used for suspension of aerial bombs from cluster adapters КДЗ-22 and КД4-105А as well as for their transportation and precision bombing with the use of optical bombsight ОПБ-15, button КСБ-49 or night aerial cameras НАФА.

The bombing equipment system has three bomb release patterns:

(1) combat release of aerial bombs is effected by the navigator only in the ARMED mode with the use of sight ОПБ-15 or button КСБ-49 (bomb release with the help of the sight is accompanied by automatic opening of the bomb compartment doors; before releasing bombs with the help of button КСБ-49, open the bomb compartment doors by using the main or auxiliary bomb door control switches; after bombing the bomb compartment doors are closed by the navigator only from the main bomb door control system and by the pilot only from the auxiliary bomb door control system);

(2) emergency release of bombs is performed by the navigator or pilot in the ARMED or SAFE mode from the bomb emergency release panels;

(3) emergency release of bombs with the mains deenergized (from storage batteries), in the ARMED or SAFE mode is performed only by the pilot from the bomb emergency release panel, with the mains deenergized.

During emergency release of aerial bombs the bomb compartment doors are opened automatically.

The bombing equipment light indication system enables checking:

— suspension of aerial bombs from racks;
— position of bomb compartment doors;
— readiness of the electric circuits for bomb release;
— operation of the electric bomb release;
— preparation of the system for bomb release in the ARMED or SAFE mode.

NOTE. The normal variant of aircraft loading with aerial bombs, when used as a bomber, is 3 t; the overload variant is 9 t. The possible variants of aircraft loading with aerial bombs are given in Table 5.

Table 5

Type and calibre of aerial bombs, kg	Designation of racks	Number of racks, pc	Number of suspended aerial bombs, pc
ФАБ-3000М-54 (М-46)	КД4-105А	2	2
	КД4-105А	2	2
	КД4-105А	4	3
ФАБ-1500М-54	КД4-105А	2	4
	КД4-105А	4	6
ФАБ-500М-62 (М-62Т)	КД3-22	2	6
	КД3-22	4	12
ФАБ-500М-54 (М-46)	КД3-22	4	12
	КД3-22	4	18
РБК-250-275 АО-1СЧ	КД3-22	2	8
	КД3-22	4	16
ФАБ-250М-54 (М-46)	КД3-22	4	16
	КД3-22	4	24
ОФАБ-100	КД3-22	4	16
	КД3-22	4	24

3.19. BOMBING/NAVIGATION EQUIPMENT

3.19.1. General

The bombing/navigation equipment is used for detection of targets, precision level bombing, air navigation and detection of thunder clouds.

The system includes three interconnected parts: radar sight, automatic bomber navigation equipment (НБА) and optical bombsight (ОПБ).

3.19.2. Radar Sight

The radar sight is used for detecting radar-contrast targets and thunder clouds.

Control and checking elements. — The control panel (РН-21Д) accommodates the following controls:

— the SUPPLY (ПИТАНИЕ) switch for power supply to the equipment;

— the TRANSMITTER (ПЕРЕДАТЧИК) switch for turning on the transmitter;

— the ANTENNA (АНТЕННА) switch for selecting the antenna operating modes (circular, manual, sectoral);

— the ROTATION (ВРАЩЕНИЕ) switch for manual control of the antenna in azimuth;

— the switch labelled TILT MANUAL — AUTO (НАКЛОН РУЧНОЙ — АВТОМ.) for selecting the automatic or manual antenna tilting mode;

— the TILT (НАКЛОН) switch for manual tilt of the antenna;

— the RANGE (ДАЛЬНОСТЬ) switch for selection of the antenna scanning range and for output of voltages proportional to the scanning range into the equipment units;

— the mode-of-operation switch for selection of the equipment operating mode (search of the target, aiming with the help of the optical bombsight (ОПБ), target aim correction, aiming with the use of the НБА automatic bomber navigation equipment, offset correction);

— the ALTITUDE (ВЫСОТА) switch for manual or automatic input of altitude;

— the ALTITUDE (ВЫСОТА) handwheel for manual input of altitude;

— the AL (ЛП) switch for selection of the aiming line;

— the OFF-CENTERED SECTOR (СМЕЩ. СЕКТОР) switch for turning on the off-centered sector display;

— the MARKS (МЕТКИ) knobs, i. e., the knobs labelled SCALE (МАСШТ.), AZIMUTH (АЗИМУТ), MARKER (МАРКЕР), SIGHT (ВИЗИР) for adjusting the brightness of the above marks;

— knob "15—80" for smooth variation of the range;

— the HIGH (ВЫСОК.), PH12 COOLING (ПРОДУВ РН12), PH28 COOLING (ПРОДУВ РН28) for checking cut-in of the transmitter and cooling of the above units.

Indicator PH-6 is used for displaying the radar image of the terrain on the screen of the cathode-ray tube.

The indicator panel accommodates the following controls:

— the knobs labelled SIGHT MARK (МЕТКА ВИЗИР) and BEARING MARK (МЕТКА ПЕЛЕНГА) for manual shifting of the respective marks;

— the switch labelled A-SCAN-μA-SCAN (ПМ—МПМ) for selection of the scanning image;

— the knobs labelled FOCUS (ФОКУС) and BRIGHT (ЯРКОСТЬ) for focusing the scanning image and adjusting its brightness;

— the knobs labelled BACKGROUND (ФОН), DISCRIM (ВЫДЕЛЕНИЕ), GAIN (УСИЛ.), RECEPT (ПРИЕМ) for adjusting the brightness and contrast of the radar image;

— the switch labelled WS SUPPRESSION (ПОДАВЛЕНИЕ ВП) for suppression of signals reflected from the agitated water surface in the radar image;

— the knob labelled ILLUM (ПОДСВЕТ) for adjusting illumination of the azimuth scale;

— the SLAVING (КОРРЕКЦИЯ) switch for enabling the slaving mode or decoding aircraft fix;

— the button labelled SIGHTING KNOB INTERLOCK CONTACT (БЛОК. КОНТАКТ РУЧКИ ВИЗИРОВАНИЯ) used for slaving and decoding the aircraft fix.

The PH-24 switchover panel is used for switching over the transmitter radiation into the antenna or its dummy with the help of the DUMMY — ANTENNA (ЭКВИВАЛЕНТ — АНТЕННА) switch.

3.19.3. Automatic Bomber Navigation Equipment (НБА)

The automatic bomber navigation equipment complete with the radar sight (or independently) is used for air navigation and bombing of radar-invisible targets.

The automatic bomber navigation equipment is coupled with:

— the aircraft flight-control and navigation equipment;

— the Doppler ground speed and drift meter;

— the compass system;

— the air data computer system;

— the radio altimeter;

— the autopilot;

— the astrotracker.

Controls and check instruments. — The PH-20 panel is used for turning on/off the automatic bomber navigation equipment, for coordination of operation of units PH-8, PH-9 and PH-17 as well as for input of the course, true airspeed, ground speed and drift angle, generation of the aircraft bearing, shaping of the supply voltage for the integrating motors and normalization of the signal component to be sent out to the autopilot.

The control panel accommodates the following controls;

— the ON — ABNE — OFF (ВКЛ. — НБА — ВЫКЛ.) switch for supplying power to the automatic bomber navigation equipment;

— the MANUAL INPUT (РУЧНОЙ ВВОД) switch for selection of the navigation tracer modes;

— the AT — OFF (ЗСО — ВЫКЛ.) switch for enabling the automatic bomber navigation equipment slaving mode by reference to the astrotracker data;

— the AP — CTC (АП — РКР) switch for enabling the autopilot control from the automatic bomber navigation equipment when set to the AP (АП) position and for motor-actuated setting of the coordinates of a new waypoint and the aircraft present when set to the CTC (PKP) position (for slaving and decoding);

— the RECKONING — OFF (СЧИСЛЕНИЕ — ВЫКЛ.) switch for enabling the coordinates reckoning mode;

— the mode-of-operation selector switch having five positions: DECODING — SLAVING — NAVIGATION — WIND CHECK — MARK IDENTIFIED — UNIDENTIFIED (РАСШИФРОВКА — КОРРЕКЦИЯ — НАВИГАЦИЯ — ОПРЕДЕЛЕНИЕ ВЕТРА — ОРИЕНТИР ОПОЗНАННЫЙ — НЕОПОЗНАННЫЙ) for selection of the automatic bomber navigation equipment operating mode;

— the lights labelled START (НАЧАЛО), MEASUREMENT (ИЗМЕРЕНИЕ), END (КОНЕЦ) indicating the wind force determination mode;

— the AIMING (ПРИЦЕЛИВАНИЕ) light indicating operation of the automatic bomber navigation equipment in the aiming mode;

— light "W, α" indicating manual input of the ground speed and drift angle;

— four lights;

— the α^0 counter labelled DRIFT ANGLE (УГОЛ СНОСА) indicating the followed-up or manually introduced drift angle magnitude;

— the β^0 counter labelled GREAT-CIRCLE COURSE (НАПРАВЛЕНИЕ ГЛ. ОРТОДРОМИИ) indicating the manually introduced great-circle course;

— the U counter labelled WIND VELOCITY (СКОРОСТЬ ВЕТРА) indicating the followed-up or manually introduced wind velocity magnitude;

— the ε^0 counter labelled ACFT WIND ANGLE (БОРТОВОЙ УГОЛ ВЕТРА) indicating the followed-up or manually introduced aircraft wind angle;

— the W counter labelled GROUND SPEED (ПУТЕВАЯ СКОРОСТЬ) indicating the followed-up or manually introduced ground speed magnitude;

— the Θ counter for checking the target bearing;

— knobs labelled U, ε, W, α and β for manual input of the wind, ground speed and drift angle magnitudes.

Handling of equipment in flight. When handling the equipment in flight, meet the following requirements:

— cut in the transmitter not earlier than 5 min after turning on the automatic bomber navigation equipment;

– enable the µA-SCAN (МПМ) mode only after performing the turn and intercepting the run-in track;

— carry out automatic search in level flight in conditions corresponding to the aircraft pitch angle within 3.5 to 4°. When flying at other pitch angles, control the search manually.

To obtain the maximum terrain scanning range, proceed as follows:

— with the transmitter turned off, set the BACKGROUND (ФОН) knob on the PH-6 indicator to the extreme counterclockwise position and the DISCRIM (ВЫДЕЛЕНИЕ) knob, to the extreme clockwise position;

— rotate the GAIN (УСИЛЕНИЕ) knob clockwise from the extreme position until weak noise signals appear on the indicator screen;

— set the TILT (НАКЛОН) switch on unit PH-21Д to the AUTO (АВТОМ.) position and the RANGE (ДАЛЬНОСТЬ) switch, to position "180"; place the TRANSMITTER (ПЕРЕДАТЧИК) switch to the ON (ВКЛ.) position;

— manipulate the BACKGROUND knob to simultaneously obtain the maximum contrast of the terrain background noise signal and target signal on the screen, then rotate the DISCRIM knob to illuminate the target signals;

— place the RANGE switch to position "350" and additionally manipulate the BACKGROUND and DISCRIM knobs to obtain the best contrast of the terrain image.

If a trouble occurs in some channel, make sure that the remaining part of the equipment operates adequately and evaluate operation of the faulty channel for execution of the mission.

3.19.4. Optical Bombsight

The optical bombsight is used for solving problems of aiming at and bombing of movable and fixed targets in conditions of optical visibility as well as for setting up mine barriers and executing torpedo bombing with automatic introduction of the aiming data, the airspeed and target movement data being inserted manually and automatically.

The optical bombsight provides:

— execution of the aircraft lateral aiming;

— measurement of the wind velocity;

— automatic opening of the bomb doors;

— automatic release of the aerial bombs;

— bombing of optically- and radar-visible targets with the use of the radar;

— bombing of optically-and radar-invisible targets with the use of the radar and automatic bomber navigation equipment.

The optical bombsight is provided with automatic input of the barometric altitude, true airspeed supplied by the air data computer system and the aircraft heading supplied by the compass system.

The optical bombsight is coupled with the autopilot and automatic bomber navigation equipment.

The bombsight head accommodates the following controls:

— the CSM (МПС) switch used for turning on the constant-speed motor;

— the GYRO (ГИРО) switch used for cutting in the gyro stabilizer;

— the TURN (РАЗВ.) switch for furnishing the ΔK_{turn} signal to the autopilot;

— the AUTO SYNCHRO (А. СИНХР.) switch for cutting in the automatic synchronization mechanism;

— the AUTO SLAVE (А. КОРР.) switch for enabling the gyro stabilizer automatic slaving mode;

— th FAST SLAVE (БЫСТР. КОРР.) button for enabling the gyro stabilizer fast slaving mode;

— the VERT (ВЕРТИКАЛЬ) button for checking the position of the gyro stabilizer vertical reference datum;

— the VERT (ВЕРТИКАЛЬ) light indicating the position of the gyro stabilizer vertical reference datum;

— the WIND (ВЕТЕР) switch for introducing wind components (U_x, U_y) and relative bearing (RB) into the bombsight for determining the wind direction module;

— the B — T (Б — Т) switch for enabling the bombing mode;

— the longitudinal sighting knobs for setting the longitudinal sighting angle;

— the side sighting knob for setting the side sighting angle;

— the knobs used for introducing wind components U_x, U_y into the bombsight;

— the gyro caging lever for caging the gyro;

— the AUTO RELEASE (АВТОСБРОС) lever for cutting in power supply of the optical bombsight warning and release circuits;

— the sighting knob buttons for introducing the sighting angles into the sight from the constant-speed motor;

— the knob labelled φ_{aim} for manual setting of the aiming angle;

— the ship movement speed and direction input knob labelled V_{sh}, δV_{sh} for introducing the movable target (ship) movement speed and direction into the sight;

— the elongation knob.

The computer accommodates:

— the switch labelled H, V for turning on automatic input of altitude and airspeed;

— the switch labelled $\frac{T_A}{H}$, $\frac{T}{H}$ for enabling ballistic functions $\frac{T_A}{H}$ and $\frac{T}{H}$;

— the AIM-OFF (ВЫНОС) knob for input of the aiming-off vector;

— knobs labelled Θ_T, Θ_{TA} for setting up the assigned characteristic bomb fall time;

— the knob labelled ΔV for setting up aerodynamic correction to airspeed;

— the knob labelled BURST HEIGHT h (ВЫСОТА РАЗРЫВА h) for setting up the height of ammunition burst over the target;

— the knob labelled TARGET ELEVATION ΔH (ПРЕВЫШЕНИЕ ЦЕЛИ ΔH) for setting up the target elevation over the sea (aerodrome) level;

— the knob labelled V for setting up the airspeed;

— the knob labelled TRAIN — FORMATION (СЕРИЯ — СТРОЙ) for input of the train correction during train bombing and formation correction during formation bombing.

3.20. HIGH-ALTITUDE RADIO ALTIMETER

The high-altitude radio altimeter provides measurement of the absolute altitude of aircraft flight above any surface irrespective of the weather conditions. It sends out information to pointer altitude indicators УВ-25А, navigation and bombing system instruments and into the air data computer system. The altitude measurement range is within 500 to 25,000 m.

In the OPERATION (РАБОТА) mode, the radio altimeter sends out the altitude magnitude into the automatic bomber navigation equipment instruments, РАДОН radar bombsight instruments, air data computer system (ЦСВ), with the CORR INPUT — RESET (ВВОД КОРРЕКЦ. — СБРОС) switch set to the CORR INPUT (ВВОД КОРРЕКЦ.) position, and to altitude indicators УВ-25А. The CHECK (КОНТРОЛЬ) and CALIBRATION (КАЛИБРОВКА) modes are used for checking general serviceability of the radio altimeter.

The radio altimeter operating modes are controlled with the help of control board ЩУ-25А located in the navigator's cabin on the starboard console accommodating the following controls:

(a) the mode-of-operation switch having the following positions:

— the OFF (ВЫКЛ.) position for turning on the radio altimeter;

— the CALIBR (КАЛИБР.) position for enabling the radio altimeter check mode;

— the CHECK (КОНТРОЛЬ) position for checking the proper operation of the radio altimeter measuring circuit;

— the OPERATION (РАБОТА) position for switching over the radio altimeter for operation in the altitude measurement mode;

— the BARO (БАРО) position for switching over altitude indicator УВ-25А from tha radio altimeter to the ЦСВ air data computer system;

(b) the correction switch with the following positions:

— theCORR INPUT (ВВОД КОРРЕКЦИИ) position for introducing barometric altitude corrections into the ЦСВ air data computer system by reference to the radio altimeter data;

— the RESET (СБРОС) position for resetting the introduced correction;

(c) the MEMORY PASS (ПРОПУСК ПАМЯТЬ) button for checking proper operation of the radio altimeter measurement circuit in the CALIBRATION mode and for changing over the ЦСВ air data computer system to operate in the OPERATION (РАБОТА) mode with the correction introduced;

(d) indicator lights:

— the LOCK-ON (ЗАХВАТ) light used to indicate proper operation of the radio altimeter;

— the INPUT (ВВОД) light used to indicate computation of the introduced correction by the ЦСВ air data computer system in the process of altitude correction;

— the MEMORY (ПАМЯТЬ) light used to indicate operation of the ЦСВ air data computer system with the correction introduced;

(e) the BRIGHT (ЯРКОСТЬ) knob for adjusting the lamp brightness.

For cutting in the radio altimeter, turn on the PB-25 circuit breaker on the navigator's right-hand circuit breaker panel and set the mode-of-operation switch to the OPERATION (РАБОТА) position.

Normal operation of the radio altimeter is indicated by illumination of the LOCK-ON (ЗАХВАТ) light and functioning of the altitude indicators. If the LOCK-ON light is dead, check serviceability of the radio altimeter. To this end, proceed as follows:

— set the mode-of-operation switch to the CALIBR (КАЛИБР.) position;

— as soon as the LOCK-ON light comes on, depress the button labelled MEMORY PASS (ПРОПУСК ПАМЯТЬ); as a result, the pointer of altitude indicator УВ-25А should deflect to the "2000-m" mark after each depression of the button;

— set the mode-of-operation switch to the CHECK (КОНТРОЛЬ) position; in this case, the LOCK-ON light should come on and the altitude indicator should show the altitude put down on control board ЩУ-25А.

Introduce correction into the barometric altimeter in the OPERATION (РАБОТА) mode by setting the correction switch to the CORR INPUT (ВВОД. КОРРЕКЦ.) position, which is accompanied by coming-on of the INPUT (ВВОД) indicator light.

The correction is introduced during the time period required for the pointer of indicator УВ-25А to turn from the altitude indicator of the ЦСВ air data computer system but for no less than 1 min.

After introducing the correction, depress the button labelled MEMORY PASS, which will result in coming-on of the MEMORY (ПАМЯТЬ) light. To reset the correction introduced, shift the correction switch to the RESET (СБРОС) position; as a result, the INPUT (ВВОД) and MEMORY (ПАМЯТЬ) lights will fade out.

3.21. LOW-ALTITUDE RADIO ALTIMETER

The low-altitude radio altimeter provides measurement of the aircraft absolute flight altitude irrespective of the weather conditions and sending-out of information to pointer altitude indicator УВ-57 located on the pilot's instrument board. Besides, the low-altitude radio altimeter is used to generate the limit altitude light and audio warning signals.

The altitude measurement range is within 0 to 600 m. The limit altitude may be set against the marks corresponding to the altitudes of 50, 100, 150, 200, 250, 300 and 400 m with the help of the ПСВ-УМ altitude warning selector switch located on the pilot's instrument board. When the limit altitude zone is reached during descent, the red LIMIT ALTITUDE (ОПАСНАЯ ВЫСОТА) lamp lights up on the pilot's instrument board and the intercom audio signalling system starts operating. The РВ-УМ radio altimeter is enabled by using the switch on the pilot's left-hand electric board. For checking operation of the limit altitude warning system, set the ПСВ-УМ altitude warning selector switch to the "К" position and then to any other position, except for the OFF (ВЫКЛ.) one. This should be accompanied by coming-on of the LIMIT ALTITUDE (ОПАСНАЯ ВЫСОТА) red warning light and by operation of the intercom audio signalling system.

The radio altimeter is turned off after the flight is completed.

3.22. DEFENSIVE ARMAMENT SYSTEM

3.22.1. Purpose and Composition

The defensive armament sighting system is intended for detection, lock-on and tracking of the enemy's fighters launching an attack from the rear hemisphere and for conducting precision fire from gun Р-23 against them.

The defensive armament system includes:

— the fire-control radar;

— TV sight ТП-1А;

— tail gun turret ДК-20.

The tail gun turret is controlled from the control panel accommodating:

— the AUX (ВСПОМ.) switch for cutting in the gun auxiliary circuits;

— the "~" switch for initiating AC voltage supply to the system accessories;

— the DIAPHR (ДИАФРАГ.) switch for cutting in the TV sight camera diaphragm adjustment circuits;

— the TVS (ТП) switch for turning on the TV sight;

— the PUMP (НАСОС) switch for cutting in the drive pumps;

— the FIRE (ОГОНЬ) switch for preparing the firing circuit;

— the ATTACK — FWD (АТАКА — ПРЯМАЯ) switch for selecting the computer operating mode;

— the COMP (ВЫЧИСЛ.) switch for turning on the computer unit;

— the CG (ФКП) switch for turning on the aerial camera gun;

— the FIRE INTERLOCK (БЛ. СТР.) switch for turning off the firing circuits at high sight and gun displacement angles as well as in cases when the gun occupies the extreme positions;

— the GAS PROTECTION (ГАЗ. ЗАЩИТА) switch for turning on the gas protection system;

— the GAS PROTECTION light for indicating operation of the gas protection system;

— the LOCK-ON (ЗАХВАТ) light for indicating target lock-on by the fire-control radar.

3.22.2. Fire-Control Radar

The fire-control radar is used for:

— detecting the enemy's fighters from the side of the aircraft rear hemisphere;

— locking-on of the selected target, automatic tracking of the target and sending-out of the data required for solving the air gunnery problems into the computer.

The fire-control radar includes the following display, control and monitoring units.

Display unit 2ДК-4 intended for visual observation of targets, determination of their spatial position, display of antenna motion in the manual guidance mode and observation of the identification mark.

The front panel of the unit carries the following controls and indicator lights:

— the ILLUM (ПОДСВЕТ) knob for illuminating the display unit scale;

— the INDIC ON (ВКЛ. ИНДИК.) button for enabling the antenna indication mode;

— the FOCUS (ФОКУС) knob for focusing the image and marks displayed on the screen;

— the BRIGHT (ЯРКОСТЬ) knob for adjusting the required brightness of the image;

— the LOCK-ON (ЗАХВАТ) light for indicating the locked-on target mode;

— the FIRE (ОГОНЬ) light for indicating automatic fire;

— the HIGH OFF (ВЫКЛ. ВЫСОКОЕ) light for indicating the troubles in high-voltage circuits.

Control unit 2ДК-6 used for controlling the fire-control radar operating modes.

The front panel of the unit accommodates the following controls:

— the ZONE SHIFT (СМЕЩ. ЗОНЫ) switch for shifting the zone in azimuth;

— the FIRE AUTO — OFF (ОГОНЬ АВТОМАТ. — ВЫКЛ.) switch for turning on and preparing the firing circuits;

— the switch labelled INTERROG — LONG RANGE — OFF (ОПРОС — ПОВЫШЕН. ДАЛЬНОСТЬ — ВЫКЛ.) for enabling the detected target INTERROGATION (ОПРОС) mode;

— the AUDIO SIGNAL — OFF (ЗВУК. СИГНАЛ — ВЫКЛ.) switch for turning off the locked-on target indication system;

— the LONG — SHORT (ДАЛЬШЕ — БЛИЖЕ) switch for changeover to tracking the short-range or long-range target;

— the SHIFT AUTO — MAN (СМЕЩЕНИЕ АВТОМАТ. — РУЧНОЕ) switch for change-over of the manual or automatic scanning zone shift;

— the RE-TUNING (ПЕРЕСТРОЙКА) knob for re-tuning the irradiation frequency;

— the LOCK-ON RANGE (ДАЛЬН. ЗАХВ.) knob for setting the lock-on range mark to the required range;

— the MID FREQ (СРЕД. ЧАСТОТА) light for checking mid-frequency irradiation;

— the TRIGGER ZERO (НУЛЬ ГАШЕТКИ) light for indicating the trigger zero position;

— the TARGET RESET (СБРОС ЦЕЛИ) button for manual target reset.

Monitoring unit 2ДК-7 used for checking the radar serviceability.

The front panel of the unit accommodates the following controls:

— the RADAR — OFF (СТАНЦИЯ — ВЫКЛ.) switch for putting the radar into operation;

— the HIGH — OFF (ВЫСОКОЕ — ВЫКЛ.) switch for turning on high voltage;

— the OPTICS — LAYING — RADIO (ОПТИКА — НАВОДКА — РАДИО) switch for selecting the sighting system operating mode;

— the BALANCE — CHECK (БАЛАНС. — КОНТРОЛЬ) switch for checking the servo-amplifier balance;

— the switch labelled LAYING AUTO — MAN — CHECK (НАВЕДЕНИЕ АВТОМАТ — РУЧН. — КОНТРОЛЬ) for selecting the automatic or manual target guidance mode;

— the MGC — AGC (РРУ — АРУ) switch for selecting the manual or automatic gain of the receiver;

— the switch labelled MFC — AFC — AFC SELECT (РПЧ — АПЧ — ПОИСК АПЧ) for selection of manual or automatic frequency control;

— the switch labelled RE-TUNING — AUTO — MAN (ПЕРЕСТР. — АВТ. — РУЧН.) for re-tuning the irradiation frequency;

— the SC1 — SC2 (1ШК — 2ШК)' switch for switching over the circuits in the process of the fire-control radar serviceability check;

— a wafer switch for connecting the monitoring circuits;

— the FREQUENCY (ЧАСТОТА) knob for manual frequency control;

— the GAIN (УСИЛЕНИЕ) knob for varying the gain of the receiving channel in the MGC (РРУ) mode;

— the TILT I — TILT II (НАКЛОН I — НАКЛОН II) switch for checking the angle aided tilt tracking channel;

— the AZIMUTH I — AZIMUTH II (АЗИМУТ I — АЗИМУТ II) switch for checking the angle-aided azimuth tracking channel;

— the indicator for checking current and voltage magnitudes.

Unit 2ДК-24 intended for transmitting stabilized and rectified voltages into the radar units.

The unit accommodates the following controls arranged under the cover;

— the MA (ЭМУ) switch for turning on/off the electromagnetic amplifier;

— the AZIMUTH MOTOR (МОТОР АЗИМУТА) switch for turning on/off the antenna azimuth-drive motor;

— the TILT MOTOR (МОТОР НАКЛОНА) switch for turning off/on the antenna tilt-drive motor.

3.22.3. TV Sight

The TV sight is intended for rear-hemisphere sighting of targets and for remote control of the gun during manual tracking of the attacking target and for input of air gunnery data into the computer.

The TV sight includes the following monitoring and control units.

The TV sight kinescope unit intended for observation of targets.

The unit front panel accommodates the following controls:

— the N — P (Н — П) switch for selecting the negative or positive image;

— the BRIGHT (ЯРК.) knob for regulating the image brightness;
— the CONTR (КОНТР.) knob for regulating the image contrast;
— the FOCUS (ФОКУС) knob for focusing the image.

The TV sight control panel used for exercising remote control of the TV sight camera and gun.

The control panel accommodates the following controls:

— the DIAPHRAGM (ДИАФРАГМА) switch for manual or automatic selection of the diaphragm;
— the DIAPHRAGM knob for manual setting of the diaphragm;
— the SEARCH (ПОИСК) switch for turning on the automatic search mode;
— the SEARCH knob for manual search of the target;
— the RADIO RF (РАДИОДАЛЬН.) switch for enabling the mode providing input of target range into the computer from the radar sighting station range-finder;
— the RF (ДАЛЬНОМЕР) knob for follow-up of the target range for its input into the computer from the TV sight;
— the SPAN (БАЗА) knob for setting the span of the attacking target;
— the FIRE (ОГОНЬ) trigger for turning on the fire manual control circuits;
— the ACTIONS (ДЕЙСТВИЯ) lever for turning on the gun control circuits via the TV sight prism.

3.22.4. Tail Gun Turret

The tail gun turret is used for controlling one gun P-23, 23 mm in calibre, for feeding the gun with cartridges, for ejection of empty cartridge cases, links and unused cartridges (in case of misfire), for eliminating fire stoppages, etc. The gun and gunnery are remotely controlled from the TV sight or radar sighting station. The rate of fire is 2400 to 2600 rounds per minute. The gun ammunition set consists of cartridges with common incendiary shells.

The gun turret angles of fire are limited within ±30° in the horizontal plane (to the right and to the left) and within ±30° in the vertical plane (up and down). The ammunition set consisting of 500 cartridges is arranged in the cartridge box and in the ammunition feed chutes. The gun cartridge feed is continuous.

Fire stoppages are eliminated automatically. The gun makes it possible to conduct fire in bursts (short bursts — 15 to 20 shots, medium bursts — 20 to 30 shots and long bursts — 40 to 50 shots).

CAUTION. AFTER FIRING 250 CARTRIDGES FROM THE GUN IN ANY MODE, MAKE A 10 TO 15-MIN INTERVAL IN THE FIRE FOR COOLING THE GUN.

The gun turret control is changed over with the help of the switch labelled OPTICS — LAYING — RADIO (ОПТИКА — НАВОДКА — РАДИО).

3.23. SHORT-RANGE NAVIGATION AND LANDING SYSTEM

The short-range navigation and landing system (РСБН) is used for solving short-range navigation, interaircraft navigation and landing problems.

The short-range navigation and landing system enables:

— flying on any straight flight route;

— orbital flying;

— smooth bringing of the aircraft to the assigned flight track;

— breakthrough descent along the assigned trajectory;

— execution of landing approach; localizer- and glide slope-aided interception of the runway heading with indication of the distance to the runway approach end;

— continuous localization of the aircraft fix;

— determination of coordinates when abeam the ground beacon and aircraft identification.

The short-range navigation and landing system equipment is controlled and its operation is checked with the help of the navigator's control board and computer control unit located on the starboard of the navigator's station as well as with the help of the pilot's landing control board located on the engine control panel.

The navigator's control board accommodates:

— the CHANNELS (КАНАЛЫ) switches for selecting the assigned channel;

— the mode-of-operation switch for selecting the operating mode;

— the AZIMUTH (АЗИМУТ) and ORBIT (ОРБИТА) knobs for setting up the assigned azimuth and distance to the preset point on the azimuth line;

— the azimuth indicator for indication of the azimuth (relative to the true meridian of the beacon);

— the range counter for indication of the distance to the preset point on the azimuth line;

— the BREAKTHROUGH ON (ВКЛ. ПРОБИВАНИЯ ОБЛАЧНОСТИ) switch for enabling the BREAKTHROUGH mode;

— the LANDING (ПОСАДКА) light for indication of the short-range navigation and landing system operation in the LANDING (ПОСАДКА) mode;

— the AZ ZERO CHECK (КОНТРОЛЬ НУЛЯ А) and R ZERO CHECK (КОНТРОЛЬ НУЛЯ Д) knobs for adjusting the azimuth and range zeroes and for adjusting the length of the azimuth gate pulse.

The navigator's computer unit accommodates:

— the knob and indicator labelled TCA (ЗПУ) for setting the true course angle;

— the knob and indicator labelled TARGET ANGLE (УГОЛ ЦЕЛИ) for setting the assigned azimuth;

— the knob and counter labelled TARGET RANGE (РАССТОЯНИЕ ДО ЦЕЛИ) for setting the distance to the waypoint.

The pilot's landing control board accommodates:

— the LANDING (ПОСАДКА) switch for enabling the LANDING mode;

— the LANDING CHANNELS (КАНАЛЫ ПОСАДКИ) switch for selecting the assigned landing channel;

— the LANDING (ПОСАДКА) light used to indicate enabling of the LANDING mode.

The pilot's and navigator's instrument boards accommodate:

— pilot's direct-reading range and azimuth indicator ППДА-Л and navigator's direct-reading range and azimuth indicator ППДА-Ш used to indicate the present magnitudes of azimuth and distance to the ground-based short-range navigation and landing system beacon;

— the PASSAGE SIGNAL (СИГНАЛ ПРОЛЕТА) button;

— the ZONE APPROACH (ПОДЛЕТ К ЗОНЕ) and ZONE PASSAGE (ПРОЛЕТ ЗОНЫ) lights used to indicate approach to the zone and its passage.

The pilot's instrument board accommodates:

— the GLIDE SLOPE ON (РАДИОГЛИССАДА ВКЛЮЧЕНА) light used to indicate the enabling of the glide slope channel;

— the RANGE CHANNEL FAULTY (КАНАЛ ДАЛЬНОСТИ НЕИСПРАВЕН) light used to indicate failure of the range channel;

— the IDENTIFICATION (ОПОЗНАВАНИЕ) button for enabling the IDENTIFICATION mode.

The navigator's instrument board accommodates:

— the AZIMUTH SEARCH (ПОИСК АЗИМУТ) light for checking serviceability of the azimuth channel;

— the RANGE SEARCH (ПОИСК ДАЛЬН.) light for checking serviceability of the range-finding channel.

3.24. DC POWER SUPPLY SYSTEM

The DC power supply system including four parallelly-operating generators ГС-18ТП and two storage batteries 12САМ-55 used to provide DC power supply for all consumers in the normal operating mode and for feeding electrical power to the consumers used for completing the flight in the emergency operating mode.

The system provides the accomplishment of the following functions:

— operation of the generators in parallel with the storage batteries;

— connection of the ground power supply source to the aircraft mains accompanied by automatic disconnection of the storage batteries;

— change-over of the DC power supply system from the normal operating mode to the emergency one with the help of the switch labelled INSTR SUPPLY FROM BAT (ПИТАНИЕ ПРИБОРОВ ОТ АККУМ.) and common generators disconnection strip with de-energizing of the common DC mains; in this case, the first-category consumers are supplied from the pilot's instrument buses and from the storage battery double-feed buses;

— supply of electrical power to the fuel pumps of tanks Nos 2 and 7 directly from the generators when disconnecting them from the aircraft common mains.

The operator's instrument board accommodates the following controls:

— four generator switches located under the GENERATORS OFF (ВЫКЛЮЧЕНИЕ ГЕНЕРАТОРОВ) inscription plate and generator common disconnection strip;

— the storage battery emergency disconnection switch used for disconnecting the storage batteries from the aircraft common mains, with the mains de-energized by the generator common disconnection strip;

— the BATTERIES (АККУМУЛЯТОРЫ) switch for connecting the storage batteries to the aircraft mains;

— two switches labelled BAT CONNECTION TO RH AND LH BUS (ВКЛЮЧЕНИЕ АККУМ. НА АККУМ. ШИНУ ПРАВ. И ЛЕВ.) protected by red caps, used for parallel connection of the storage batteries to the bus.

NOTE. It is allowed to use the switches labelled RH AND LH BAT OFF (ОТКЛЮЧЕН. АККУМУЛЯТ. ПРАВ. И ЛЕВ.) in flight only if it is necessary to locate the faulty battery;

— the switch labelled INSTR SUPPLY FROM BAT (protected by a red cap) for changing over the pilot's instruments buses and double-supply buses for power supply from storage batteries;

— the switch labelled GND PWR TO MAINS (АЭРОДР. ПИТАН. НА СЕТЬ) for connecting the ground power supply source to the aircraft mains;

— four rheostats for regulating the generator voltage.

The load current of each generator is checked by a separate ammeter.

Loading of the storage batteries and ground power supply source is also checked by a separate ammeter.

The voltage of all power supply sources and the mains voltage are checked by a voltmeter with the help of the wafer switch labelled DC VOLTAGE (НАПРЯЖЕНИЕ ПОСТОЯН. ТОКА).

All the check instruments are located on the operator's instrument board.

In flight, all the generators should be turned on, their operation should be checked by reference to the readings of the ammeters and voltmeter.

The aircraft mains voltage should be within 28 to 28.5 V. It is necessary to exercise permanent check of the uniformity of load distribution between the parallelly-operating generators. If the difference between the maximum and minimum generator loading currents exceeds 60 A, adjust parallel operation of the generators.

Adjust parallel operation of the generators not earlier than 30 min after takeoff. In so doing, use the following procedure:

— apply a load to the generators which makes up at least 50 % of the nominal load (by cutting in all the consumers required for execution of the flight), the mean load per generator approximating 350 A. Turn on high-power consumers in succession so as to avoid dangerous overloading of one of the generators;

— using external resistors, increase voltage of the generators having a lower load and decrease the voltage of the generators having a higher load so that the load difference of separate generators should not exceed 60 A;

— set the voltmeter switch to the MAINS (СЕТЬ) position; if the mains voltage is not within 28 to 28.5 V, increase or decrease voltage of all generators to the required level by turning all external resistors through one and the same angle;

— turn off the consumers which are not required for continuation of the flight mission.

NOTE. If the loads are too low, some of the generators may get disconnected; for repeated connection of the generators to the mains, raise the load of the generators by turning on the consumers.

Increase of the mains voltage to 31 V and abrupt rise of the load applied to one of the generators testify to mains overloading. This may be accompanied by automatic cut-out of the overexcited generator from the mains. The operator should turn off the switch of the faulty generator.

NOTE. If the generator fails to operate as a result of overexcitation, its repeated connection to the mains in the given flight is impossible.

After the flight mission is completed, before shutting off the engines, disconnect the generators from the mains by using the following procedure:

— turn off all the consumers except for the stand-by fuel pumps, engine instruments and aircraft intercom system;

— retract the air intakes;

— turn off the storage batteries by using the switch labelled BATTERIES (the generators are inoperative);

— after shutting off the engines, turn off the generators;

— turn on the storage batteries and close the fuel emergency shut-off cocks;

— turn off the storage batteries.

Turning-on of the switch labelled INSTR SUPPLY FROM BAT (ПИТАНИЕ ПРИБОРОВ ОТ АККУМ.) enables power supply of the following consumers from storage batteries:

— the gyro horizon (АГД);

— the turn indicator (ЭУП);

— three-pointer motor-driven oil pressure gauges ЭМИ-3Р:

— fuel pressure gauges with static inverter СПО-4;
— the air blow-off valve indication system;
— fuel control lever position indicators УПРТ-2;
— the fuel emergency shut-off cocks;
— the cross-feed valve;
— the fire protection system;
— the fire extinguishing bottles;
— the magnetic recorder;
— the trim tab and trimming mechanism control circuits;
— the horizontal stabilizer electric actuator control circuits;
— the flap and horizontal stabilizer position indicators;
— the cabin air pressure emergency release circuits;
— the landing gear control circuits;
— the anti-skid unit;
— the brake chute deployment system;
— the landing gear indication system;
— the fuel pump operation indication system;
— the hydraulic amplifiers emergency cross-feed system;
— the cabin emergency illumination system and aircraft abandoning commands annunciator;
— command radio set (РСИУ) No. 1;
— the intercom system (СПУ);
— the Pitot-tube heating circuits;
— the engine starting control circuits;
— the interrogator-responder destruction circuits;
— the bomb emergency release circuits;
— the friction dampers control and indication circuits;
— the hydraulic system pressure gauges;
— automatic direction finder АРК-11.

The double-feed buses supply power to:
— the fuel pumps of tank No. 1;
— the fire-extinguishing system cocks;
— the electromagnet used for shutting off the generator cooling system in case of fire;
— the engine starting fuel pumps;
— the horizontal stabilizer electric actuator;
— the engine ignition system;
— the brake chute deployment and release actuators;
— inverter ПО-500;
— engine starting control unit АПД-38;
— the anti-skid unit;
— the OVERTEMPERATURE (ПРЕДЕЛЬНАЯ t°) warning system;
— the system used for controlling emergency extension of the landing gear from hydraulic system III;
— the automatic system used for switching over the pumps of tank No. 2 to the normal operating mode during fuel dumping;

— flight recording system МСРП-12;

— the electric mechanism used for change-over from the flap-ailerons to ailerons;

— recorder К3-63;

— the pitch damper;

— the stability automatic controller;

— the stability automatic controller and pitch neutral setting system.

3.25. 115-V 400-Hz SINGLE-PHASE ELECTRICAL POWER SUPPLY SYSTEM

The system including three inverters ПО-6000 (two main inverters and one stand-by inverter) and one emergency inverter ПО-500 is intended for supplying the consumers with one-phase voltage with automatic or manual connection of the stand-by inverter instead of any of the faulty main inverters.

The system has the following functions:

— connection of the ground power supply source to the mains via a plug connector with the aircraft inverters cut out;

— supply of electrical power to the emergency consumers from inverter ПО-500.

The system is controlled by:

— two switches labelled MAIN INV No. 1 — OFF — STAND-BY (РАБОЧИЙ № 1 — ВЫКЛ. — РЕЗЕРВНЫЙ) and MAIN INV No. 2 — OFF — STAND-BY (РАБОЧИЙ № 2 — ВЫКЛ. — РЕЗЕРВНЫЙ);

— three rheostats РС-4 used to regulate the voltage of the inverters;

— the switch labelled GND SUP (АЭРОДР. ПИТАН.) used to connect the ground electrical power supply source to the 115-V AC aircraft mains;

— the inverter switch labelled "ПО-500" used for manual connection of the inverter to the 115-V AC emergency bus.

All the system controls, except for the "ПО-500" inverter switch, are accommodated on the operator's instrument board. The "ПО-500" inverter switch is located on the pilot's left-hand electrical power supply board.

Operation of the system is monitored by two voltmeters and two lights indicating operation of the main inverters.

All the test and indication instruments and facilities are accommodated on the operator's instrument board.

CAUTION. NEVER TURN ON INVERTERS ПО-6000 WITH THE MAINS SUPPLIED FROM STORAGE BATTERIES.

In flight, inverters ПО-6000 Nos 1 and 2 should be turned on.

Before turning-on of the inverters, the inverter voltage should be within 115 to 116 V. If the voltage is below that indicated, raise it by using rheostats РС-4.

After cutting-in of the consumers, the mains voltage should be not below 114 V; if the voltage is below that indicated, raise it to 114—115 V by using rheostats.

The operator should periodically check voltage by reference to the voltmeters.

In case of failure of one of main inverters ПО-6000, the stand-by inverter gets automatically connected instead of that which failed. In this case, the light indicating operation of the failed main inverter should go out.

If both main inverters fail to operate, the stand-by inverter gets connected to the starboard mains instead of inverter ПО-6000 No. 2.

In case of failure of the main inverters, their switches should remain in positions Nos 1 and 2.

If the stand-by inverter fails to get connected to the aircraft mains, which is identified by the readings of the respective voltmeter and by the indicator light, turn on the stand-by inverter manually.

The port side mains (inverter No. 1) feeds the following consumers:

— radar illumination warning unit СПО-3;
— radio communication set receiver УС-8;
— the НЕОН radio communication set transmitter;
— IFF equipment;
— fuel flowmeters;
— the tail gun turret with the TV sight;
— the fire-control radar;
— the low-altitude radio altimeter.

The starboard mains (inverter No. 2) supplies electrical power to:

— the air data computer system;
— the astrotracker;
— the automatic direction finder;
— the radar bombsight;
— the Doppler ground speed and drift meter;
— the command radio sets;
— the optical sight;
— the fuel quantity gauge;
— the automatic blinker;
— the automatic fuel controller;
— the fuel equalizer;
— the high-altitude radio altimeter;
— the critical angle-of-attack, sideslip and g-load warning unit;
— the short-range navigation system;
— the landing system.

Stand-by inverter ПО-500 is turned on in flight manually in case of de-energizing of the DC mains. After turning on the inverter, the command radio set (РСИУ) and automatic direction finder АРК-11 get connected to it.

3.26. 36-V 400-Hz THREE-PHASE ELECTRICAL POWER SUPPLY SYSTEM

The system including two inverters ПТ-1000Ц (main and stand-by inverters) is intended for supplying the consumers with 36-V 400-Hz three-phase voltage with automatic or manual connection of the stand-by inverter instead of the faulty main inverter.

The system is controlled by the MAIN — OFF — STAND-BY (РАБОЧИЙ — ВЫКЛ. — РЕЗЕРВ) switch.

Operation of the system is checked by a voltmeter measuring the mains voltage and white light used to indicate operation of the stand-by inverter.

The system controls as well as check and indication instruments are located on the operator's instrument board.

In flight, the switch should occupy the MAIN (РАБОЧИЙ) position.

The mains voltage should be within 36 to 37 V.

In case of failure of the main inverter, the stand-by inverter gets automatically connected in place of the faulty main inverter, which is accompanied by coming-on of the white indicator light; the voltmeter pointer should read the mains voltage within 36 to 37 V.

If the stand-by inverter fails to be connected to the mains, turn it on manually. To this end, set the switch to the STAND-BY (РЕЗЕРВ) position.

The system is used to feed the following consumers:

— the autopilot;

— the flight-and-navigation system;

— the compass system, astrotracker, pitch damper (ДТ) and stability automatic controller (АУ);

— roll and yaw damper Д2К;

— the stability automatic controller and pitch neutral setting system, as well as feel simulator controller.

3.27. 200-V UNSTABLE-FREQUENCY THREE-PHASE ELECTRICAL POWER SUPPLY SYSTEM

The system incorporating two generators СГС-30-8РС is used:

— to supply 200-V 340 to 570-Hz three-phase electric current to consumers with automatic change-over of the load to serviceable mains;

— to connect the 200-V ground power source to the mains through the plug connector and to simultaneously disconnect the main generators.

The system is controlled by:

— two generator switches labelled GENERATORS NOS 1 AND 2 ON (ВКЛЮЧЕНИЕ ГЕНЕРАТОРОВ № 1 И 2);

— the switch labelled GND PWR TO MAINS (АЭРОДР. ПИТАН. НА СЕТЬ) with three positions: LH — OFF — RH (ЛЕВ. — ВЫКЛ. — ПРАВ.) providing connection of the ground power supply source either to the port side mains (generator No. 1) or to the starboard mains (generator No. 2);

— two external resistors labelled NOS 1 AND 2 VOLTAGE REGUL (РЕГУЛИРОВКА НАПРЯЖЕНИЯ № 1 И 2) used to regulate the voltage of the generators.

Operation of the system is checked by reference to two voltmeters measuring the voltage of the port side and starboard mains and two red lights labelled LIGHT ON — GEN INOPER (ЛАМПА ГОРИТ — ГЕН. НЕ РАБОТАЕТ) used to indicate cut-off of the generators from the mains.

All the system controls, check and indication instruments are located on the operator's instrument board.

In flight, the AC generators should be turned on.

The operator should check the mains voltage which should be within 204 to 208 V as indicated by the voltmeters.

All the consumers are supplied from generator No. 1 (connected into the port side mains) while generator No. 2 runs idle.

Cut-off (failure) of generator No. 1 is accompanied by coming-on of the generator failure warning red light.

The operator should set the switch of generator No. 1 to the OFF (ВЫКЛЮЧЕНО) position to switch over the consumers for power supply from generator No. 2. To starboard mains voltmeter should read voltage within 204 to 208 V and the port side voltmeter should indicate zero.

The system supplies electrical power to the crew cabin glass heating system.

3.28. PASSIVE JAMMING EQUIPMENT

Passive jamming is set up by dispensing the radar-jamming chaffs from chaff dispensers of the АПП and КДС types.

The group-protection chaff dispenser (АПП) is equipped with one two-cell and one five-cell bunkers. It provides chaff dispensing in boxes K-1, K-3 and K-4.

Chaff dispenser АПП-22 ensures manual dispensing of chaff packs by turning on the respective switches on the АПП chaff dispenser control panel or automatic dispensing of the chaff packs at eight fixed speeds with 0.1 to 2-s time intervals between the packs when chaffs are packed in boxes K-1 and K-3 and with 0.3 to 6-s time intervals between the packs for chaffs packed in boxes K-4 in the following modes:

— SUCCESSIVE dispensing, i.e., dispensing of chaffs cell by cell from each bunker;

— PARALLEL dispensing, i.e., simultaneous dispensing of the chaff packs from two cells of one bunker or from two cells of each bunker;

— dispensing of the chaff packs in series in the SUCCESSIVE or PARALLEL mode (140 to 200 boxes K-1 and K-3 or 50 to 70 boxes K-4 in one series from each cell).

The number of the chaff dispenser packs contained in one АПП group-protection chaff dispenser is sufficient for simultaneous continuous time setting-up of passive jamming to acquisition radars operating on SHF and VHF wavebands for 90 min and to radars employing UHF wavebands for 30 min at the first chaff-dispensing speed (interval 1).

The chaff dispensers are controlled from two panels accommodating the following controls:

— the MAINS (СЕТЬ) switch for turning on power supply;

— the INTERVAL (ИНТЕРВАЛ) switch for selecting the chaff packs dispensing time interval;

— the PARAL — SUCCESS (ПАРАЛ. — ПОСЛЕДОВ.) switch and switches labelled SERIES, AUTO (СЕРИЯ, АВТ.) for selecting the operating mode;

— the switches labelled CELLS 1, 2, 3, 4, 5 (ОТСЕКИ 1, 2, 3, 4, 5) for selecting the bunker cells;

— the START (ПУСК) and STOP (СТОП) buttons for starting and discontinuing the chaff-dispensing process;

— lights used to indicate loading of the bunker cells and chaff dispensing.

The individual-protection chaff dispenser (КДС) provides dispensing of chaffs in boxes K-1.

The chaff dispenser is controlled from the panel accommodating the following controls and checking elements:

— the SUPPLY (ПИТАНИЕ) switch for turning on power supply;

— the switches labelled SERIES — PROGR (СЕРИЯ — ПРОГР.), II — I — I + II and СПО-3 for selecting the operating mode;

— the switch labelled INTERVALS 0.3—1—3 (ИНТЕРВАЛЫ 0,3—1—3) for selecting the chaff packs dispensing time interval;

— the DISPENSING (СБРОС) button for initiating chaff dispensing;

— the PORTION — CONT (ПОРЦИЯ — НЕПР.) switches for selecting the operating mode and discontinuing chaff dispensing;

— lights used to indicate loading of the bunker cells and chaff dispensing.

Chaff packs may be dispensed from each cell separately or simultaneously from two cells of one or two holders in the following modes:

— the SERIES — CONT (СЕРИЯ — НЕПРЕРЫВНО) dispensing mode, i.e., continuous dispensing of the chaff packs until full emptying of the cells at box release time intervals equalling 0.3, 1 and 3 s;

— the PROGRAM — CONT (ПРОГРАММА — НЕПРЕРЫВНО) dispensing mode, i. e., dispensing of the chaff packs in boxes in series until full emptying of the cells for 2 s, making 0.3 or 1-s interval between boxes and 5-s interval between series;

— the PROGRAM — PORTION (ПРОГРАММА — ПОРЦИЯ) dispensing mode, i. e., dispensing of the chaff packs in boxes, 25 to 40 boxes in a portion, with automatic discontinuance of the dispensing process after dispensing each portion of boxes. The box portions are released in series in a way similar to that used in the PROGRAM — CONT mode;

— the SERIES — PORTION (СЕРИЯ — ПОРЦИЯ) dispensing mode, i. e., dispensing of the chaff packs in boxes, 90 to 140 boxes in a portion, with automatic discontinuance of the dispensing process after dispensing each portion of boxes with the 0.3, 1 and 3-s intervals between boxes;

The duration of continuous operation of each chaff dispenser until its full emptying, with the cells being emptied in succession, is as follows versus the time interval between each pack in the SERIES — CONT (СЕРИЯ — НЕПРЕРЫВНО) mode;

4 min for 0.3-s interval;

13 min for 1-s interval;

40 min for 3-s interval;

— in the PROGRAM — CONT (ПРОГРАММА — НЕПРЕРЫВНО) mode:

15 min for 0.3-s interval;

50 min for 1-s interval.

3.29. AUTOMATIC DIRECTION FINDER

The automatic direction finder ensures the accomplishment of the following missions:

— air navigation by reference to homing and broadcasting radio stations and beacons with visual or audial indication of the course;

— determination of the aircraft fix;

— landing planning and approach;

— determination of the drift angle and wind vector;

— monitoring of signals generated by radio stations operating on the waveband of automatic radio compass frequencies.

For controlling the automatic direction finder, the control panel accommodates:

— the WAVEBAND (ДИАПАЗОН) switch (with a retainer) for selecting the operating bands;

— the COARSE TUNING (НАСТРОЙКА ГРУБАЯ) knob (with a retainer) for coarse frequency tuning;

— the FINE TUNING (НАСТРОЙКА ПЛАВНАЯ) knob for fine frequency tuning;

— buttons used for fixed tuning of the automatic direction finder to nine frequencies;

— the S (П) button for smooth frequency tuning;

— the VOLUME CONTROL (РЕГ. ГРОМК.) button for manual control of the receiver volume;

— the switch labelled COMPASS-I — ANTENNA — LOOP — COMPASS II (КОМПАС-I — АНТЕННА — РАМКА — КОМПАС II) for selecting the automatic direction finder operating mode;

— the switch labelled WIDE — NARROW (ШИР. — УЗК.) for selecting the receiver bandwidth;

— the VOICE — CW (ТЛФ — ТЛГ) switch for selecting the automatic direction finder operating mode;

— the switch labelled LOOP LH — RH (Л — П РАМКА) for manual rotation of the relative bearing indicator pointer;

— the ILLUM (ПОДСВЕТ) knob for regulating the brightness of control panel scale illumination;

— the PANEL SWITCH (ПЕРЕКЛ. ПУЛЬТ.) button for switching over the control panels.

For checking serviceability of the automatic direction finder, proceed as follows:

— set the intercom mode-of-operation switch to position РК-1;

— place the mode-of-operation switch on the navigator's control panel to the ANTENNA (АНТЕННА) position and depress the panel switch-over button; make sure that the automatic direction finder is turned on by reference to cut-in of the scale illumination and deflection of the tuning indicator pointer;

— turn the VOLUME CONTROL (РЕГ. ГРОМК.) knob all the way clockwise (until noise is heard in the earphones).

Tune the fixed-frequency channels of automatic direction finder АРК-11 to the frequencies of the radio stations to be used in flight. To this end, proceed as follows:

— set the passband switch to the NARROW (УЗК.) position;

— place the VOICE — CW (ТЛФ — ТЛГ) switch to the position corresponding to the radio station operating mode;

— make sure that the retainers on the WAVEBAND and COARSE TUNING knobs are closed; depress the required button, which will result in operating of the tuning mechanism.

Set up the frequency of the first radio station selected. To this end, proceed as follows:

— unlock the WAVEBAND knob, set the nearest narrow waveband, corresponding to the first assigned frequency, against the triangular index and again fix the knob in position;

— make sure that the FINE TUNING knob is pulled all the way out; unlock the COARSE TUNING knob and align the required division of the scale with the sighting line;

— depress the FINE TUNING knob right home and, by turning the knob, make sure that the required division of the scale is aligned with the sighting line; with the automatic direction finder being tuned to the frequency of the operating radio station, the indicator pointer should be deflected to the right as far as possible;

— lock the COARSE TUNING knob;

— using a similar procedure (but with the use of other buttons), select the fixed frequencies of other radio stations to be used in flight;

— check proper tuning of the automatic direction finder by switching over the buttons and by following up the assigned tuning frequencies.

Check operation of the automatic direction finder in the COMPASS-I (КОМПАС-I) mode by reading the radio station relative bearing or true bearing as indicated by pointer No. 1 of navigator's indicator УШ-1 and by the combined course indicator (НКП); compare the readings taken with the estimated data. The difference between the instrument indications and estimated data should not exceed $\pm 2°$;

— check operation of the automatic direction finder in the COMPASS-II (КОМПАС-II) or LOOP (РАМКА) mode;

— check rotation of the loop by using the switch labelled LH — RH (ЛЕВО — ПРАВО);

— put down the fixed frequencies of the radio stations on the automatic direction finder control board inscription plate.

NOTE. When carrying out the checks, switch over the buttons or wavebands no more than three times a minute.

3.30. RADIO COMMUNICATION EQUIPMENT

3.30.1. НЕОН Communication Radio Set

The high-frequency НЕОН radio set with radio receiver УС-8 ensures long-range communication of the air crew with ground radio stations and with radio sets of other aircraft. The radio set operates in the CW (continuous-wave) and VOICE modes. The control boards of the НЕОН radio transmitter and radio receiver УС-8 are located at the operator's station.

The front panel of the НЕОН transmitter control board accommodates:

— the switch labelled SIMPL RECEPT — CW — VOICE (СИМПЛ. ПРМ — ТЛГ — ТЛФ) for selecting the operating mode;

— the multi-position switch labelled CHANNELS (КАНАЛЫ) for selecting the radio set operating channels;

— the MONITORING (САМОКОНТРОЛЬ) control knob for regulating the monitoring volume;

— the ON (ВКЛ.) indicator light for checking the transmitter readiness for operation; the light comes on when the mode-of-operation switch is set to the VOICE (ТЛФ) and CW (ТЛГ) positions, which corresponds to supply of high voltage to the transmitter;

— indicator light "Б" used to indicate decrease of power by 25 %;

— the CONTROL TAKE-OVER (ВЗЯТИЕ УПРАВЛЕНИЯ) button.

The front panel of the УС-8 receiver control board accommodates:

— the mode-of-operation switch for selecting the receiver operating mode;

— the waveband selector switch for switching over the wavebands;

— the TUNING (НАСТРОЙКА) knob for fine tuning of the receiver;

— the VC (РГ) and GC (РУ) knobs for controlling the volume and gain of the receiver;

— the TONE CONTROL (РЕГ. ТОНА) knob for controlling the tone of continuous-wave signals;

— the ILLUM (ПОДСВЕТ) knob for regulating the scale illumination;

— the NARROW — WIDE (УЗК. — ШИР.) switch for selection of the passband;

— the BOARD SWITCH-OVER (ПЕРЕКЛ. ПУЛЬТА) button for switching over the control boards (the button is not used on the given aircraft).

To check serviceability of the НЕОН radio transmitter and УС-80 radio receiver, proceed as follows:

— turn on the communication radio set RECEIVER (ПРИЕМН.) and TRANSMIT (ПЕРЕДАТ.) circuit breakers located on the operator's circuit breaker panel;

— turn on the НЕОН switch on the electric power supply board;

— set the mode-of-operation switch on the УС-8 receiver control board to the VOICE (ТЛФ) position;

— select the required channel of the НЕОН transmitter and tune radio receiver УС-8;

— make sure that monitoring signals are heard in the earphones;

— establish contact with the ground radio station.

Use a similar procedure to check operation of the radio set in the continuous-wave mode.

3.30.2. Command Radio Set РСИУ-5В

Radio set РСИУ-5В is used to establish radio communication between the aircraft or between the aircraft and ground-based radio station in the VOICE mode.

The control board of radio set No. 1 is located on the pilot's engine control panel and that of radio set No. 2 is mounted at the operator's station.

The РСИУ-5В radio set control board accommodates:

— the NOISE SUPPR (ПОДАВИТ. ШУМОВ) switch for turning on the noise suppressor;

— the POWER FULL — LOW (МОЩН. ПОЛН. — ПОНИЖ.) switch for varying the transmitter power;

— the RADIO — COMPASS (РАДИО — КОМПАС) switch for changing over the transmitter to operate in the RADIO (РАДИО) or COMPASS (КОМПАС) mode (the switch is vacant);

— the volume control labelled VOLUME (ГРОМК.) for regulating the communication volume;

— the CHANNEL (КАНАЛ) switch for switching over the transmitter channels;

— the selected channel indicator.

To check serviceability of radio sets РСИУ-5В, proceed as follows:

— turn on the circuit breakers labelled РСИУ-5В No. 1 (РСИУ-5В № 1) and РСИУ-5В No. 2 (РСИУ-5В № 2) on the pilot's circuit breaker panel;

— turn on the switches labelled РСИУ-5В No. 1 and РСИУ-5В No. 2 on the pilot's engine control panel;

— set the intercom system mode-of-operation switch to the VHF (УКР) position for radio set No. 1 or to the ARS (ДР) position for radio set No. 2;

— select the operating channel on the control board;

— establish contact with the ground radio station.

3.30.3. Aircraft Intercom System

The aircraft intercom system is used to provide voice communication between the aircraft crew members and to connect the headsets to the communication and command radio sets, to the automatic direction finder and РСБН short-range navigation and landing system.

The telephones and throat microphones are connected for establishing different kinds of internal and external radio communication through the interphone control box whose face side accommodates:

— the switch labelled MAINS 1 — 2 (СЕТЬ 1 — 2);

— the switch labelled INTERCOM — RADIO (СПУ — РАДИО) for monitoring signals in the internal or external communication system;

— the COMMON (ОБЩАЯ) and MONITOR (ПРОСЛ.) knobs for controlling the volume of the receiver output signal and for monitoring the intercom signals;

— the conference call button labelled CONF CALL (ЦВ) for connecting the intercom lines of all crew members to the aircraft intercom system;

— the switch used to select different types of radio communication; the switch has the following positions: VHF (УКР), MF (СР), CRS (КР), ADD R/SET (ДР), PK1, PK2.

The positions of the switch correspond to the following types of radio communication:

— VHF (УКР) — connection of radio set РСИУ No. 1 and radar illumination warning unit СПО-3;

— MF (CP) — connection of the HEOH and УС-8 radio sets;

— ADD R/SET (ДР) — connection of radio set РСИУ-5В No. 2 and radar illumination warning unit СПО-3;

— PK1 — connection of the APK automatic direction finder;

— PK2 — connection of short-range navigation and landing system РСБН-2.

The CRS (KP) position of the switch is not used on the aircraft.

To check serviceability of the intercom system, proceed as follows:

— turn on the INTERCOM (СПУ) switch on the pilot's left-hand power supply board;

— place the MAINS 1 — 2 (СЕТЬ 1 — 2) switch to any position;

— set the communication type selector switch to the VHF (УКР) position;

— establish radio contact with the crew members or with the ground-based (airfield) radio station.

3.30.4. Magnetic Recorder MC-61

The magnetic recorder (MR) is used for registration (recording) of all communications carried on by the crew members via the internal and external communication lines and monitored by the pilot through his interphone control box. The recorder may also be used only for recording the speech from the pilot's throat microphones.

The recorder is controlled from a special control board.

The face side of the control board accommodates:

— the ON — OFF (ВКЛ. — ВЫКЛ.) supply switch;

— the INTERCOM — THROAT MIC (СПУ — ЛАР) switch for recording the signals arriving from the output of the pilot's intercom system (the INTERCOM position) or from his throat microphones (the THROAT MIC position);

— the CONT OPER — AUTO TRIG (НЕПРЕРЫВНАЯ РАБОТА — АВТОПУСК) switch used for enabling the recorder for continuous recording of speech or for automatically triggering the recorder as the voice signal appears with the INTERCOM — THROAT MIC switch set to any position (when the signal disappears, the recording ceases);

— the recording check indicator light labelled RECORD (ЗАПИСЬ) which glows when the tape transport mechanism is switched on;

— the inscription illumination light and ILLUM (ПОДСВЕТ) control knob.

To check serviceability of the recorder, proceed as follows:

— set the ON — OFF (ВКЛ. — ВЫКЛ.) switch on the control board to the ON (ВКЛ.) position;

— place the CONT OPER — AUTO TRIG switch on the control board to the AUTO TRIG position;

— establish radio contact with the crew members (normal operation is indicated by coming-on of the RECORD light).

4. CHECKING AIRCRAFT READINESS FOR FLIGHT

4.1. AIRCRAFT PREPARATION FOR INSPECTION

1. On arrival at the parking site, the pilot should listen to the aircraft senior technician's report on the aircraft readiness for flight in compliance with the assigned flight mission, on elimination of troubles and faults revealed in the previous flight and during postflight inspection as well as on the aircraft takeoff mass and c.g. position, on its fuelling, filling with oil, air, hydraulic fluid, oxygen and cooling agent.

After listening to the aircraft senior technician's report, the pilot should check the condition and snug fit of the crew members' flying clothing (summer, winter or demi), as well as the completeness of the flying outfit (pressure helmet and oxygen mask) in compliance with the flight mission. On performing this check, the pilot should give a command to the crew members to start the aircraft inspection.

NOTES: 1. The crew members may also perform inspection of the aircraft and their working stations before the pilot's arrival at the parking site.

2. The crew members are <u>not allowed</u> to accept the aircraft if any maintenance operations are being carried out on it by the maintenance personnel.

3. Upon completion of the aircraft inspection by the crew, the pilot should look through the check list and sign it.

4.2. AIRCRAFT INSPECTION BY PILOT

2. The aircraft preflight inspection is carried out by the pilot by following the walk-around inspection route shown in Fig. 5.

When inspecting the landing gear nose leg, the pilot should make sure that:

— the landing gear nose leg uplock is open;

— the folding brace strut and brace device are free of damage;

— the landing gear wheel tyres are intact;

— there is no oil leakage from the nose strut seals;

— the nose wheel steering mechanism is free of damage and oil leakage;

— the landing gear doors occupy a proper position;
— the nose leg well doors are closed.

When inspecting the fuselage port side, check to see that:
— slip covers are removed from the Pitot-static tubes and plugs are taken off the static pressure vents;
— there is no oxygen leakage through the oxygen vents;
— the landing lights are intact and tightly fit the light body.

When inspecting the port wing, make certain that the turbopump of hydraulic system III is completely retracted and the aileron trim tabs are in the neutral position.

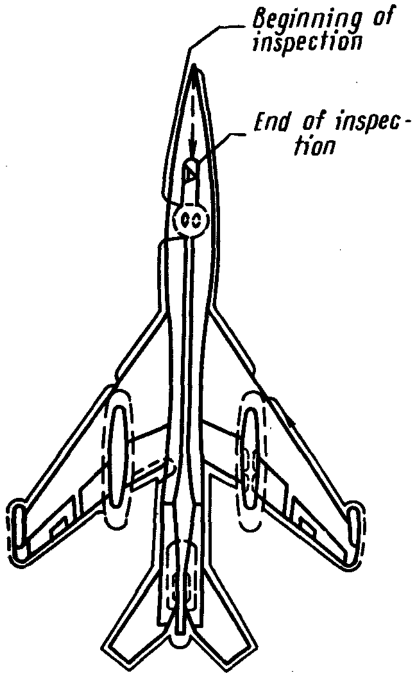

FIG. 5. AIRCRAFT WALK–AROUND INSPECTION ROUTE

When inspecting the port landing gear leg and nacelle, make sure that:
— chocks are placed under the wheels;
— the wheel tyres are not damaged;
— the anti-skid unit detectors and their electric wires are reliably secured;
— the air pressure in the expansion rod chamber of the engine air blow-off valve control system is at least 120 kgf/cm^2;
— the landing gear is free of mechanical damage;
— the landing gear leg uplock is open.

When examining the port engine nacelle, make sure that:
— the blanking cover is removed from the air intake;
— the covers of the cowlings and access doors are closed;

— the blanking covers are removed from the air blow-off ports of the air blow-off valve casing branch pipes, engine nacelle cooling branch pipe and the oil system drain hole;

— the blanking cover is removed from the intake branch pipe of the generator cooling system;

— the blanking cover is removed from the jet nozzle;

— the jet nozzle and the exhaust gas shield are free of damage.

When examining the tail fuselage, ascertain that:

— the brake chute container is mounted properly and its locks and doors are reliably closed;

— the rudder trim tab occupies the neutral position (to be ascertained by the indicator located on the rudder and trim tab trailing edges).

Thereupon, the pilot should examine the fuselage starboard side and starboard wing, using the reverse procedure.

In so doing, the pilot should make certain that:

— the single-point fuelling system filler cover is closed;

— the protective housing is removed from the ice detector;

— the blanking cap is taken off the evaporator tank drain pipeline;

— the atmospheric air intake used for feeding the cabin ventilation system at low altitudes is closed;

— the protective cap is removed from the angle-of-attack transmitter vane.

4.3. AIRCRAFT INSPECTION BY NAVIGATOR

3. When performing the aircraft inspection before flight, the navigator should make sure that:

— the radar antenna radome is intact and reliably closed;

— the cabin glass panels are intact and clean;

— the protective covers are removed from the automatically-integrated sextant caps;

— the aircraft is adequately outfitted with ammunition in compliance with the assigned flight mission;

— the aerial bombs are properly suspended;

— the fuzes are properly outfitted with delay mechanisms;

— the fuze arming devices or ball-type plugs of the fuze triggering devices are adequately connected to the fuzes and triggering device planks.

4.4. AIRCRAFT INSPECTION BY OPERATOR

4. When carrying out aircraft inspection before flight, the operator should make sure that:

— the aircraft radomes are clean and free of damage;

— the cover is removed from the gun which should be set to the travelling position;

— the ammunition belt and cartridge link ejection chute are properly installed;

— the ammunition set is available on the aircraft and the counter shows the quantity of cartridges in the belt;

— all access and side doors are properly fitted;

— the switches labelled DRIVE (ПРИВОД), TRAVELLING POSITION (ПОХОДНОЕ ПОЛОЖЕНИЕ) and FIRE (ОГОНЬ) on the switches and circuit breakers box on the contactor control box are turned on;

— the TV sight protective cap is removed (if it is removable);

— the chaff dispensers are loaded with chaffs;

— the HEOH transmitter is tuned to the required frequency and switched on to operate in the remote control mode.

4.5. INSPECTION AND PREPARATION OF EJECTION SEATS

5. When inspecting the ejection seats, each crew member should make sure that:

— the ground safety pins on the ejection seat right-hand ejection preparation handle, in the head of the telescopic firing mechanism, in the hatch door squib-actuated jettisoning mechanism and on the hatch door air valve are installed in their proper places and the ejection preparation handles are locked;

— the oxygen system hoses are free of damage, sharp bends and squeezing;

— the oxygen hose connector of oxygen set КП-23 is locked and the oxygen pressure is 150 kgf/cm^2.

After performing the above inspection, each crew member should proceed as follows:

— check the parachute for proper stowage in the seat pan.

CAUTION. NEVER PLACE PILLOWS, PARACHUTE BAGS AND OTHER ITEMS INTO THE SEAT PAN;

— connect the oxygen hose of oxygen set КП-23 to the hose secured to the seat;

— connect the КП-23 oxygen set engagement snap hook to the rip cord ring;

— connect the snap hook of the КАП-3 combined parachute release control unit line to the seat pan ring;

— report the accomplishment of aircraft and ejection seat external inspection to the crew commander;

— put on the headset, crash helmet and fasten the throat microphones.

4.6. TAKING SEATS AND RAISING THEM TO FLIGHT POSITION

6. Upon taking the ejection seat, each crew member should proceed as follows:

— put on and fasten the parachute harness;

— fit to size (with the technician's assistance), fasten and tighten up the seat belts;

— connect the snap hook of the HA3-7 survival kit line to the ring on the flight clothing (with the survival kit packed);

— couple the oxygen mask with the oxygen pressure regulator and secure the latter to the right-hand strap of the parachute harness by a latch;

— check proper stowage of the oxygen hose;

— connect the corrugated hose of the oxygen mask to the harness by a special strap;

— check serviceability of the shoulder harness reel mechanism.

The navigator should check the seat pan for easy travel and reliable fixation in the extreme rear position.

The pilot should make sure that the handle of the mechanism used for additional fixation of the seat in the flight position and located on the left side of the seat pan is set to the extreme upper position.

7. Before raising the seats to the operating position, the pilot gives a command to the aircraft technician to remove the ground safety pins and start seat raising.

In the process of seat raising, the operator should proceed as follows:

— open the cock used for supplying air into the radio equipment units;

— check proper setting of codes on the interrogator-responder control panel;

— turn on all the circuit breakers on the operator's panel;

— make sure that the seat occupies the extreme upper position by referring to lighting-up of the white light labelled SEAT IN UPPER POSITION (КРЕСЛО В ВЕРХНЕМ ПОЛОЖЕНИИ);

— check to see that the seat oxygen hose is coupled with the oxygen hose of the aircraft oxygen system;

— turn on the required electric power consumers by the command of the crew commander.

8. After raising the seat into the operating position, each crew member should couple the headset plug connector with the cord of the intercom control box, adjust the position of his seat in height (with the pilot's seat pan occupying a normal position, the lower edge of the seat stabilizing shields should be level with the pilot's eyes).

Besides, the pilot should proceed as follows:

— fix the seat by lowering the handle, used for additional fixation of the seat in the flight position, to the extreme lower position.

NOTE. Before lowering the seat and adjusting it in the required position, the pilot should open the restraint mechanism by placing its handle to the extreme upper position;

— check to see that all circuit breakers are cut in on the main circuit breaker board;

— adjust the pedals to the pilot's height.

4.7. CHECKING OF OXYGEN EQUIPMENT

9. After raising the seat to the flight position, each crew member should check:

— absence of oxygen hose bending and pinching;

— reliability of coupling of the seat oxygen set connector with the aircraft hose;

— opening of the oxygen cock and oxygen pressure in the system, which should be within 8 to 10 kgf/cm^2;

— the quantity of liquid oxygen in the liquid oxygen converters which should be within 25 to 30 kg.

CAUTION. THE FLIGHT IS PROHIBITED IF THE PRESSURE IN THE SYSTEM RISES ABOVE 11.5 KGF/CM^2 AS SHOWN BY THE OXYGEN INDICATOR.

NOTE. In the process of taxiing and takeoff the pressure in the system may rise to 11.5 kgf/cm^2;

— the position of the control knobs on oxygen set КП-24М:

the air diluter lever should occupy the "100 % O_2" position;

the emergency oxygen supply control lever should be set to the CLOSED (ЗАКРЫТО) position;

the pressure differential setting handwheel should be screwed all the way clockwise.

10. Each crew member should check operation of oxygen set КП-24М without excessive pressure and at an excessive pressure.

For checking operation of oxygen set КП-24М without excessive pressure, proceed as follows:

— check the oxygen set for pressure-tightness at rarefaction; to this end, close the oxygen valve, open the oxygen emergency supply cock and relieve oxygen pressure to zero (making reference to the oxygen indicator); close the oxygen emergency supply cock, put on the oxygen mask, close the holes in the excessive pressure regulator with your fingers and make an inhalation; if it is impossible to make an inhalation, oxygen set КП-24М is considered to be pressure-tight and the oxygen mask, adequately fitted to the face;

— open the oxygen valve and make sure that the oxygen pressure is within 8 to 10 kgf/cm^2, then make two or three inhalations and exhalations; with the oxygen set operating properly, breathing should be unobstructed, the oxygen indicator segments should get apart during the inhalation and come together during the exhalation;

— check operation of the oxygen emergency supply system; to this end, place the КП-24 oxygen set emergency supply control lever to the

OPEN (ОТКРЫТО) position and make sure that oxygen is supplied into the mask, then set the lever to the CLOSED (ЗАКРЫТО) position — oxygen supply into the mask must discontinue.

Each crew member should check operation of oxygen set КП-24 at an excessive pressure by using the following procedure:

— check to see that the air diluter lever is set to the "100 % O_2" position;

— close the holes in the pressure regulator body with the fingers and rotate the handwheel counterclockwise to build up 300-mm H_2O excessive pressure in the oxygen mask as read off pressure gauge M-1000;

— make two or three inhalations and exhalations; if during inhalation the pressure gauge pointer is deflected to the left and returns to the initial position during exhalation, the excessive pressure being relieved to zero when the holes in the pressure regulator body are opened, oxygen set КП-24 is considered to be serviceable;

— turn the excessive pressure setting handwheel all the way clockwise.

CAUTION. OXYGEN SET КП-24 IS CONSIDERED TO BE UNSERVICEABLE AND EXECUTION OF FLIGHT IS PROHIBITED IF THE EXCESSIVE PRESSURE IS AVAILABLE IN THE OXYGEN MASK, WITH THE HOLES IN THE PRESSURE REGULATOR BODY OPEN, OR IF IT IS IMPOSSIBLE TO BUILD UP THE EXCESSIVE PRESSURE (300 MM H_2O) IN THE MASK, WITH THE HOLES IN THE PRESSURE REGULATOR CASING CLOSED.

4.8. INSPECTION OF CABIN AND ITS PREPARATION FOR FLIGHT BY PILOT

11. When inspecting the cabin (Figs 6, 7 and 8), the pilot should proceed as follows:

— make sure that the cabin is free of foreign objects;

— check presence of tables of corrections to the airspeed indicator and barometric altimeter;

— turn on the aircraft intercom system;

— make sure that the nose-wheel steering mechanism is disengaged;

— check proper setting of the pedals to fit the pilot's height and reliability of pedal fixation in the neutral position before unlocking of the control surfaces.

CAUTION. IT IS FORBIDDEN TO ADJUST THE PEDALS IN FLIGHT;

— make sure that the crew members have taken seats at their working stations (the lights, showing that the navigator and operator have abandoned the aircraft, are dead);

— unlock the rudder and ailerons and check reliability of fixation of the control surface locking lever in the rear position;

— check position of the landing gear emergency extension valve lever as well as position and locking of the static and Pitot pressure selector valves;

SECRET
Inset 1
8/026254–T86

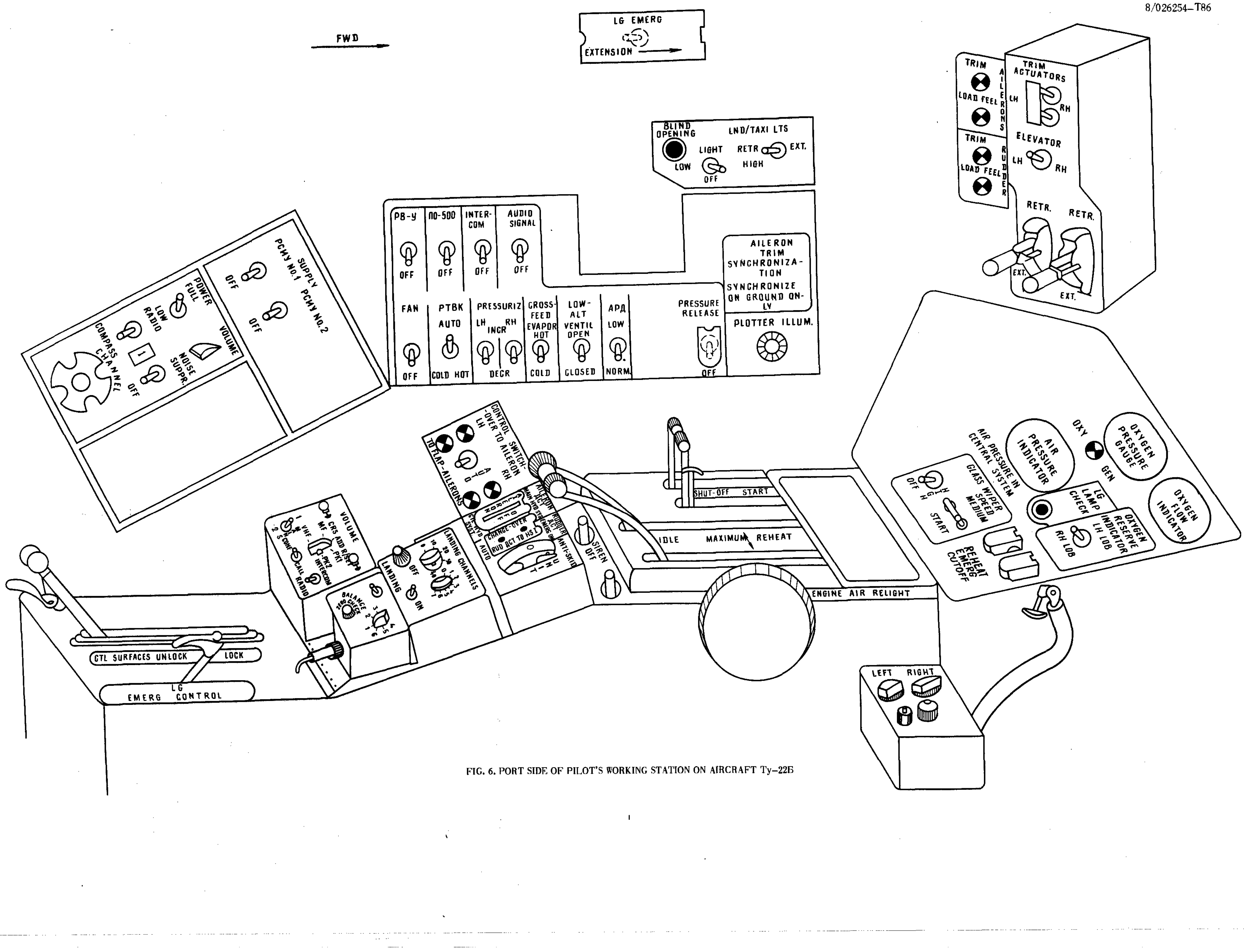

FIG. 6. PORT SIDE OF PILOT'S WORKING STATION ON AIRCRAFT Ту–22Б

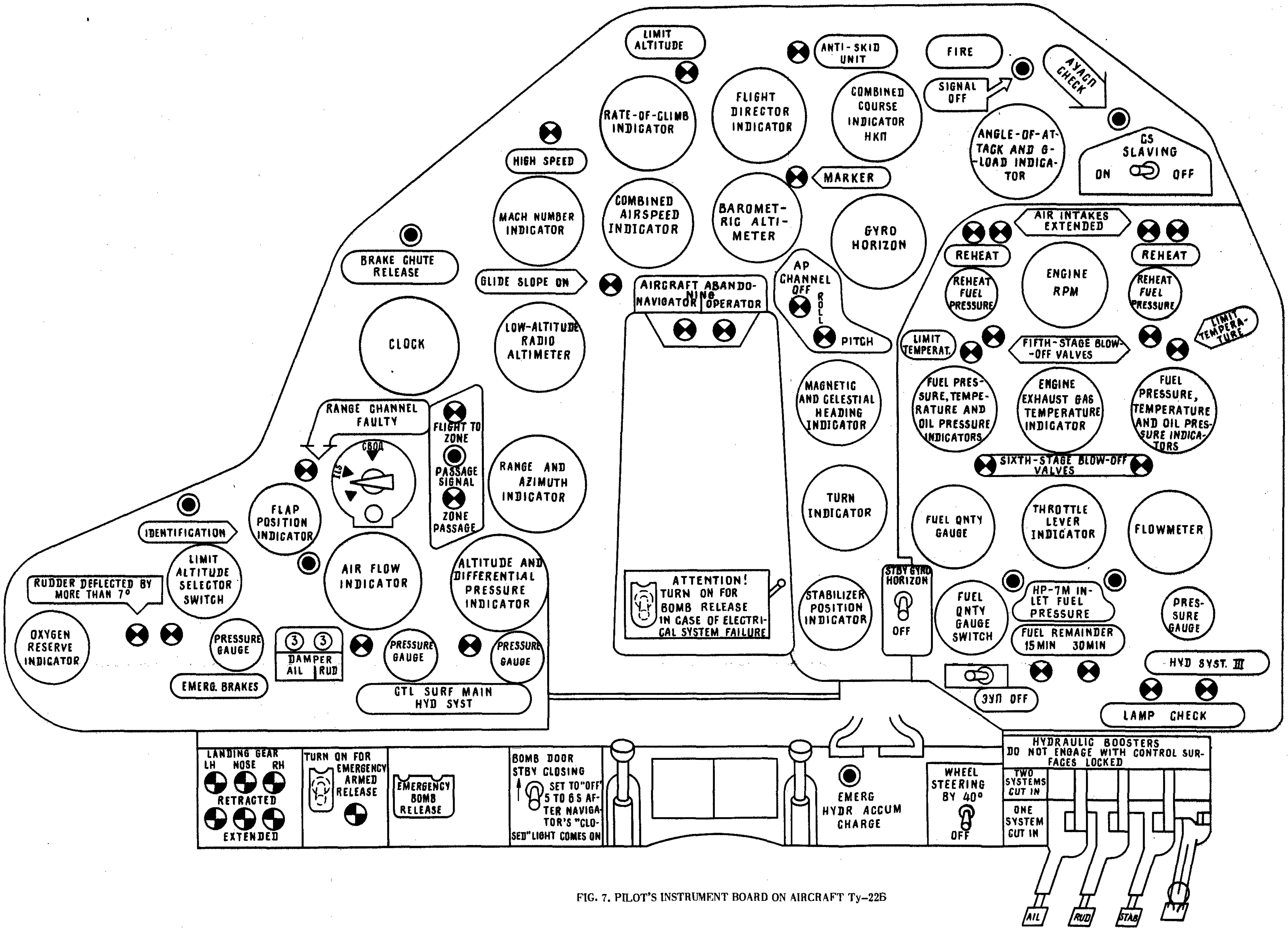

FIG. 7. PILOT'S INSTRUMENT BOARD ON AIRCRAFT Ty-22Б

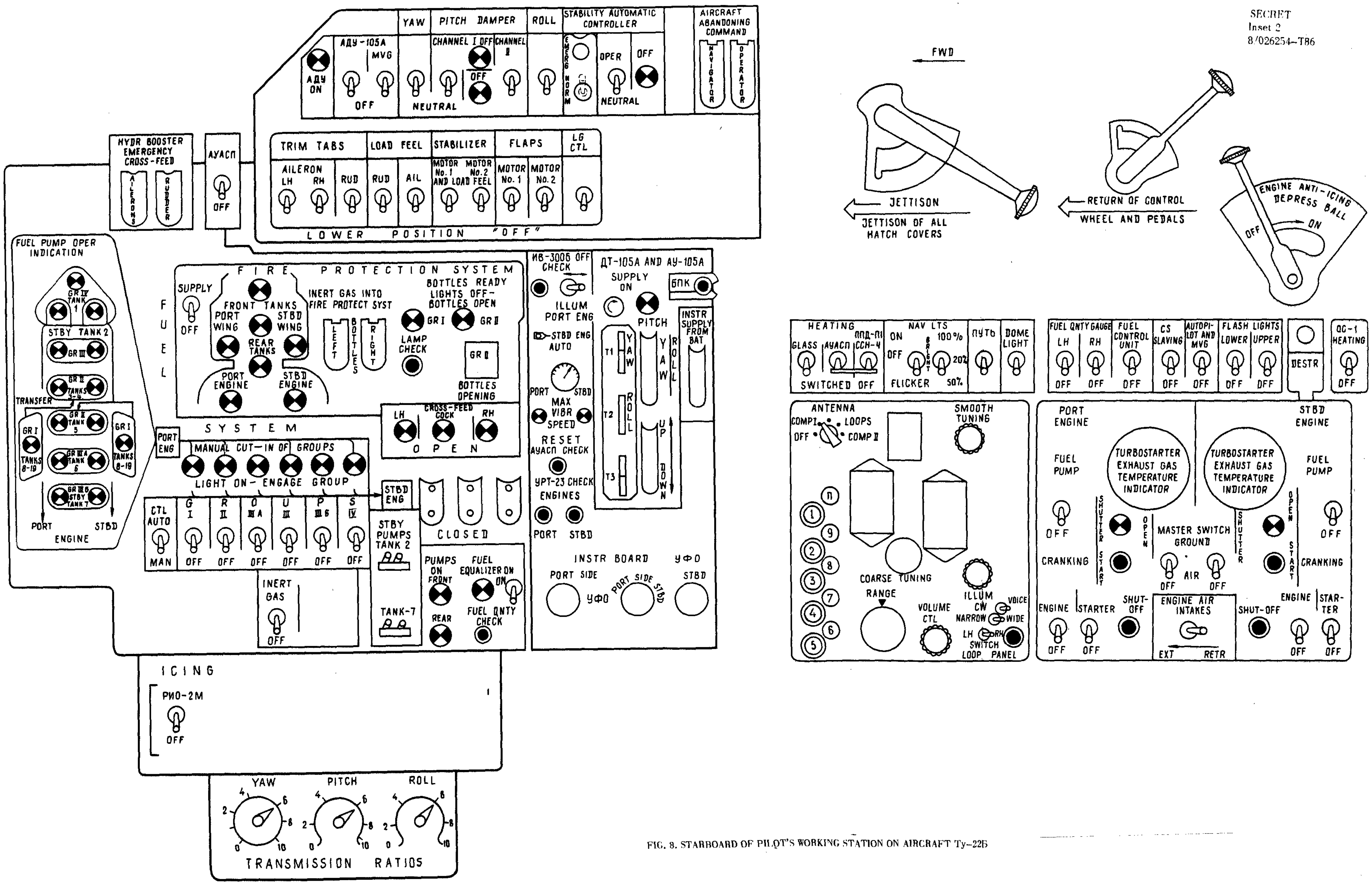

FIG. 8. STARBOARD OF PILOT'S WORKING STATION ON AIRCRAFT Ту-22Б

— cut in the circuit breakers on the additional board;

— turn on inverter ПО-500 and check radio set РСИУ No. 1 when powered from this inverter (with inverters ПО-6000 turned off);

— give a command to the operator to turn on inverters ПТ-1000Ц and ПО-6000 (if there is no power supply from the ground power source);

— make sure that the bomb release lever is secured by the safety pin and locked, with the mains deenergized, and that the switches labelled TURN ON FOR EMERGENCY ARMED RELEASE (ПРИ АВАРИЙНОМ СБРОСЕ НА ВЗРЫВ ВКЛЮЧИ) and EMERGENCY BOMB RELEASE (АВАРИЙНЫЙ СБРОС БОМБ) are capped, locked and sealed;

— turn on radio sets РСИУ Nos 1 and 2 and check the internal and external communication systems for proper operation;

— check the navigator's and operator's aircraft abandoning light indication system;

— turn on the magnetic recorder and set the AUTO TRIG — CONT OPER (АВТОПУСК — НЕПРЕРЫВНАЯ РАБОТА) switch on the control panel to the CONT OPER (НЕПРЕРЫВНАЯ РАБОТА) position. This should be accompanied by coming-on of the ILLUM (ПОДСВЕТ) and RECORD (ЗАПИСЬ) lights, which testifies to magnetic recorder readiness for operation; on completing the check, turn off the magnetic recorder and set the INTERCOM — THROAT MIC (СПУ — ЛАР) switch to the INTERCOM (СПУ) position;

— turn on the РВ — УМ radio altimeter and check it for proper operation;

— check to see that the pointers of all cabin instruments are set to the initial position and zero the altimeter pointers; make sure that the barometric pressure scale readings do not differ from the actual pressure at the airfield level by more than ±2 mm Hg, with due account of elevation (depression) of the aircraft parking site relative to the runway and ambient air temperature;

— with the navigator's assistance, check indication of the radio station relative bearing on course indicator НКП-4 during operation of automatic direction finder АРК-11.

CAUTION. TAKEOFF IS PROHIBITED IF THE READING DISCREPANCIES EXCEED ±2 MM HG;

— with the operator's assistance, check operation of the radar illumination warning unit (СПО); to this end, turn the STATION (СТАНЦИЯ) switch to the ON (ВКЛ.) position and the SOUND (ЗВУК) and SECTORS (СЕКТОРЫ) switches, to the ON (ВКЛЮЧЕНО) position; turn on transmitter Р-1 or ПРС fire control radar and depress the CHECK (ПРОВЕРКА) button on the radar illumination warning unit control panel; this is accompanied by operation of the audio and light indication system which should get cut out after release of the CHECK button;

— turn on the landing control system and select the airfield channel on the control board;

— make sure that the ANTI-SKID UNIT (АВТОМАТ ТОРМОЗОВ) switch is set to the ON (ВКЛЮЧЕН) position and locked, the aileron switch labelled ДСТ occupies the neutral position and the ДСТ RUD (ДСТ — РН) switch is placed to the AUTO (АВТОМАТ) position;

— check to see that the air conditioning system switches occupy the initial position; the switches should be set as follows: the РТВК switch — to the neutral position, the АРД switch, to the NORM (НОРМ.) position, the PRESSURE RELEASE (СБРОС ДАВЛЕНИЯ) switch, to the OFF (ВЫКЛ.) position and closed with a red cap;

— set the PRESSURIZ (НАДДУВ) switches (of the port and starboard engines) to the LESS (МЕНЬШЕ) position; release the switches after keeping them in this position for at least 90 s;

— set the LOW ALT VENTIL (ВЕНТИЛЯЦ. НА МАЛЫХ ВЫСОТАХ) switch to the CLOSED (ЗАКРЫТ) position and keep it in this position for 5 to 6 s; place the CROSS-FEED EVAPOR (КОЛЬЦЕВ. ИСПАРИТ.) switch to the COLD (ХОЛ.) or HOT (ГОР.) position, depending on the ambient air temperature;

— check operation of the engine shut-off lever latches and reliability of their fixation in the START (ЗАПУСК) position and then shift them to the SHUT-OFF (ОСТАНОВ) position;

— make sure that the engine control levers are smoothly shifted and reliably fixed in any position while the УПРТ fuel-control unit lever position indicator pointers follow the motion of the engine control levers;

— make sure that the caps of the afterburner emergency cut-out switches are provided with easily broken locking arrangement;

— make sure that the air pressure in the system is at least 120 kgf/cm^2;

— make sure that the glass wiper control switch is set to the OFF (ВЫКЛЮЧЕНО) position and the wiper speed selector switch, to the START (ПУСК) position;

— make sure that the pedal and control wheel column disengagement lever is locked;

— check to see that the switches used for retraction and extension of the landing gear and flaps occupy the neutral position; depress the LAMP CHECK (КОНТРОЛЬ ЛАМП) button to check serviceability of the landing gear retracted-position lights;

— make sure that the takeoff/landing lights control switch is set to the RETRACTED (УБРАНЫ) position;

— with the aircraft technician's assistance, check deflection of the rudder, ailerons and their trim tabs to full angles, then set the trim tabs to the neutral position by referring to lighting-up of the indicator lights on the trim tab control panel and the left aileron trim tab synchronization board;

— make sure that the emergency fuel dumping cocks are set to the OFF (ВЫКЛЮЧЕНО) position and locked;

— turn on the switch labelled STAND-BY GYRO HORIZON (РЕЗЕРВНЫЙ АГД); the time required for the gyro horizon to come to the working state does not exceed 1.5 min;

— set the ПП БСПК-1 switch to the upper position;

— depress the ROLL (КРЕН) button — the LIMIT RH ROLL (ПРЕДЕЛ. ПР. КРЕН) and VG FAILURE (ОТКАЗ ГВ) lights will come to illuminate on the annunciator; when the button is released, the lights should come out (the LIMIT LH ROLL (ПРЕДЕЛ. ЛЕВ. КРЕН) light may come on for a short period of time);

— depress the PITCH (ТАНГАЖ) button — the LIMIT LH ROLL (ПРЕДЕЛ. ЛЕВ. КРЕН) light will come to illuminate on the annunciator; when the button is released, the light should go out (the VG FAILURE (ОТКАЗ ГВ) light may come to illuminate for a short period of time);

— set the switch to the lower position and lock it by a safety guard;

— turn on the electric turn indicator switch and, on expiration of 2 or 3 min, depress the edge of the instrument board (trying to turn it around the vertical axis as far as the shock absorbers permit) to make sure that the ЭУП turn indicator pointer has deflected from its intermediate position;

— make sure that there are no air bubbles in the slip indicator damping fluid;

— turn on the MVG (ЦГВ) circuit breaker, depress the master vertical gyro fast slaving button located on the flight director indicator and make sure that the roll and pitch indicators on the indicator have assumed the zero positions;

— turn on the flight-and-navigation system and MVG (ЦГВ) switch of the АДУ feel simulator controller;

— set up the "СП" or "СВОД" mode on control panel ПУ-30 and the COMMAND BARS (КОМАНДНЫЕ СТРЕЛКИ) switch, to the ON (ВКЛЮЧЕНО) position;

— set the assigned zero course on combined course indicator НКП-4 and navigator's indicator УШ-1; in this case, the command bar of the combined course indicator should be located in the centre;

— with the navigator's assistance, check correspondence of the course indicator readings to those of the navigator's indicator; the present course indicator on the combined course indicator should follow the magnitudes preset by the navigator accurate within ±1.5°;

— by manipulating the course selector on control panel ПУ-1, set up the course of 30° and then 330°; in this case, the lateral-motion command bar on the flight director indicator should deflect to the left and then to the right;

— set the switch on control panel ПУ-30 to the "СП" position and check operation of the course zone indicators by deviation of the pointers and operation of the warning flags; check and adjust the course pointer electric zero by depressing and rotating the knob labelled BALANCE — ZERO CHECK (БАЛАНС — КОНТРОЛЬ НУЛЯ) on control panel М-50;

— check locking of the bottom and emergency hatch doors jettisoning lever in the initial position;

— check to see that the hatch door jettisoning master handle and the handle of the cock used for bleeding air from the pedal and control wheel actuating cylinder are set to the initial position and locked;

— check the brake chute release knob safety cap for easy opening and lock it;

— having ascertained that the control surfaces are unlocked, check the hydraulic booster engagement levers for easy travel and reliable fixation in all the three positions; this done, set the levers to the OFF position.

CAUTION. NEVER ENGAGE THE HYDRAULIC BOOSTERS WITH THE AIRCRAFT CONTROLS LOCKED;

— check the position of the engagement lever of hydraulic system III; the lever should be set to the OFF (ВЫКЛЮЧЕНО) position; the pressure in hydraulic system III should be at least 150 kgf/cm^2;

— make sure that the rudder and aileron hydraulic booster emergency cross-feed valve switches are turned off and closed by red caps;

— turn on the fire protection system;

— turn on the fuel quantity measuring automatic control units and check proper indications of the fuel quantity gauges and setting of the engine fuel flowmeter in compliance with the aircraft fuelling;

— turn on the fuel equalizer and, on expiration of 20 to 30 s, ascertain its normal operation and opening of the cross-feed valve by illumination of the indicator lights; the check over, turn off the fuel equalizer and make sure that the cross-feed valve has been closed by referring to extinction of the indicator light;

— successively turn on the fuel pump manual control switches (place the AUTO — MAN (АВТОМ. — РУЧН.) switch to the MAN (РУЧН.) position) and check their normal operation by lighting-up of the indicator lights;

— set the paired switches of the stand-by pumps of tanks Nos 2 and 7 on the fuel system electric board to the upper position; in this case, the booster pumps should not get engaged and their lights should not come on.

CAUTION. IF THE LIGHTS OF THE BOOSTER PUMPS OF TANKS NOS 2 AND 7 COME ON, GIVE A COMMAND TO THE AIRCRAFT TECHNICIAN TO SWITCH OVER THE PUMPS TO THE GENERATORS. DO NOT START THE ENGINES BEFORE PUMP SWITCHOVER;

— set the AUTO — MAN (АВТОМ. — РУЧН.) switch to the AUTO (АВТОМ.) position and ascertain normal operation of the fuel system automatic control units by referring to lighting-up of the indicator lights in compliance with the actual fuel load.

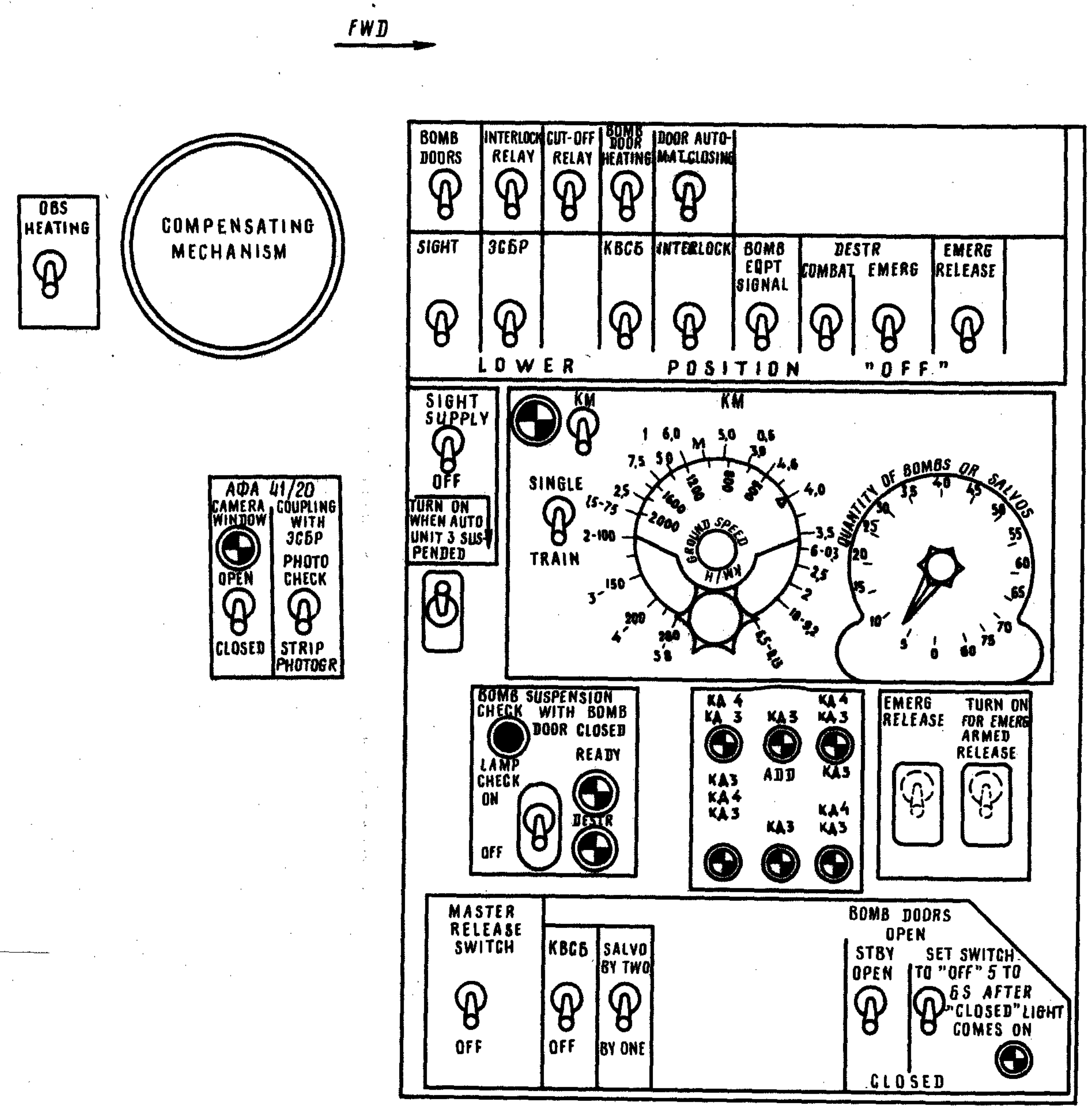

FIG. 9. PORT SIDE OF NAVIGATOR'S WORKING STATION ON AIRCRAFT Ту-22Б

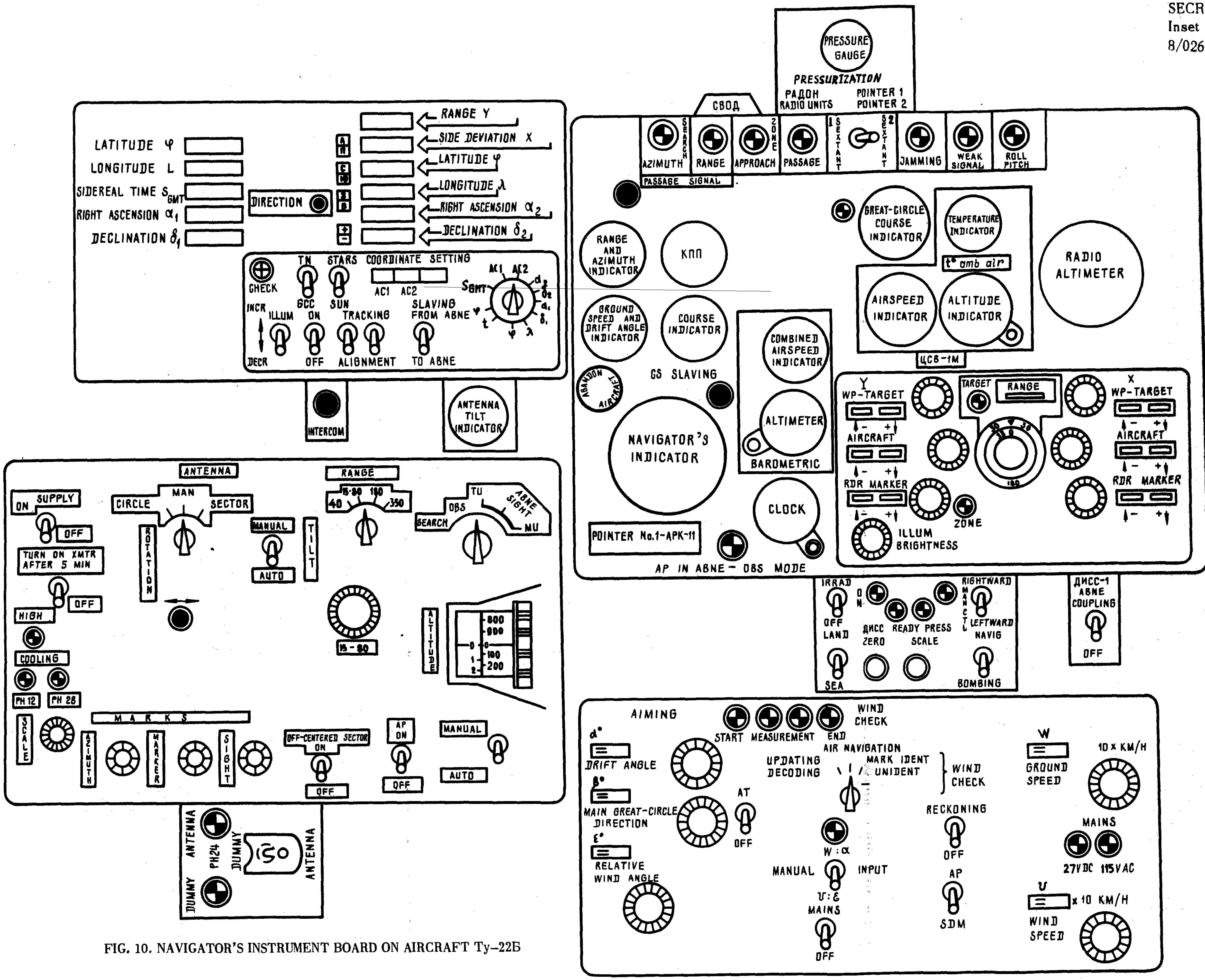

FIG. 10. NAVIGATOR'S INSTRUMENT BOARD ON AIRCRAFT Ty–22Б

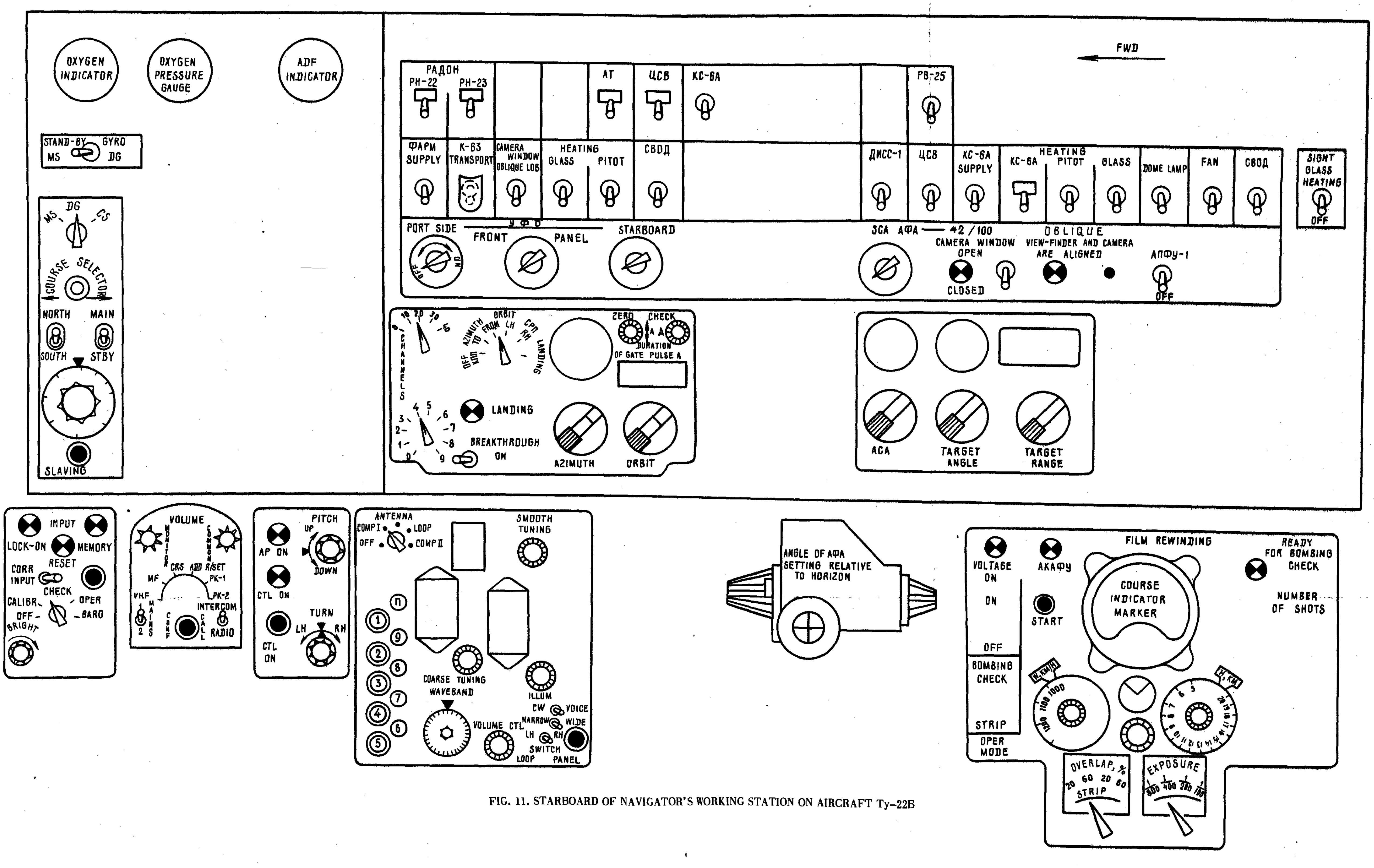

FIG. 11. STARBOARD OF NAVIGATOR'S WORKING STATION ON AIRCRAFT Ту–22Б

4.9. INSPECTION AND PREPARATION OF CABIN FOR FLIGHT BY NAVIGATOR

12. When inspecting the cabin and preparing it for flight (Figs 9, 10 and 11), the navigator should proceed as follows:

— give the cabin entrance hatch closing command;

— check locking of the lower and upper hatch door jettisoning handles;

— perform visual inspection of the cabin to make sure that it is free of foreign objects;

— check availability of all the equipment;

— ascertain that the bombing equipment controls, knobs and scales of the optical bombsight are set to the initial position;

— ensure that the casings of separate units and the glass panels are free of damage;

— check availability and fitness of compass deviation cards, quadrantal error curves as well as the КУС indicator and altimeter correction tables (Figs 12 and 13);

— turn on all the circuit breakers;

— connect the navigator's working table interlocking system;

— connect the headset to the intercom system and check its operation;

— with the pilot's and operator's assistance, check the internal and external communication systems and aircraft abandoning light indication system;

— check operation of the bombing equipment warning and indication system;

— make sure that inverters ПО-6000 and ПТ-1000Ц are turned on;

— turn on all the navigation equipment;

— set the barometric pressure and ambient temperature on the УВШ navigator's altitude indicator;

— check to see that the pointers of all cabin instruments are set to the initial position, zero the altimeter pointers; in this case, the readings of the barometric pressure scale should not differ from the actual airfield barometric pressure by more than ± 2 mm Hg, with due account of elevation (depression) of the aircraft parking site relative to the runway and of the ambient temperature.

CAUTION. TAKEOFF IS PROHIBITED IF THE DIFFERENCE IN INSTRUMENT READINGS EXCEEDS ± 2 MM HG;

— wind up the aircraft clock and set the exact time;

— check operation of the gyro horizon; to this end, depress the CAGE (АРРЕТИР.) button for at least 5 s and turn on switch АГБ-3. The time required for the gyro horizon to start running in the operating mode does not exceed 1.5 min.

13. With the pilot's assistance, check operation of the compass system. To this end, proceed as follows:

— set the STAND-BY GYRO (ЗАПАСН. ГА) switch to the MS (MK) position;

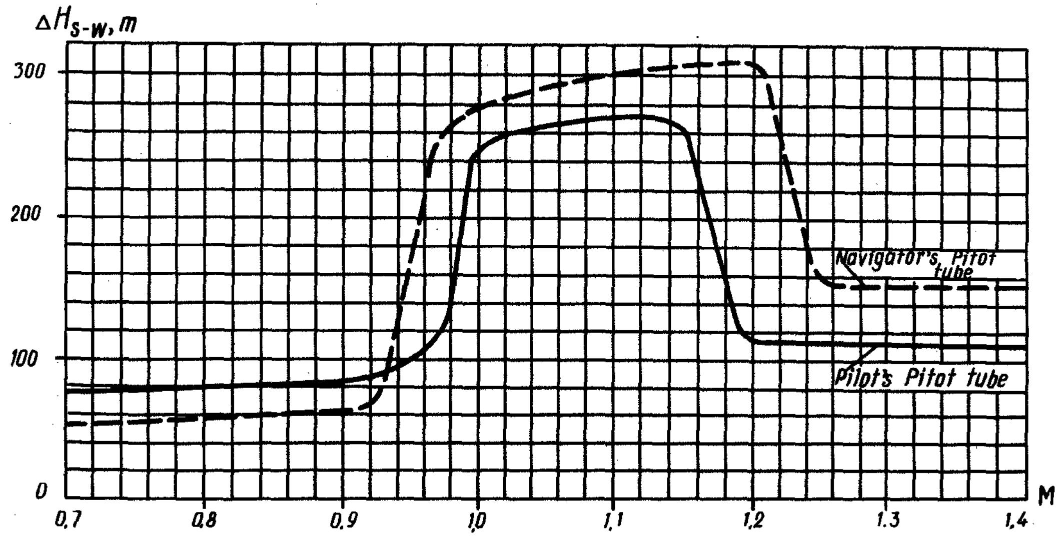

FIG. 12. AERODYNAMIC CORRECTIONS TO ALTIMETER INSTALLED ON AIRCRAFT Ty–22Б

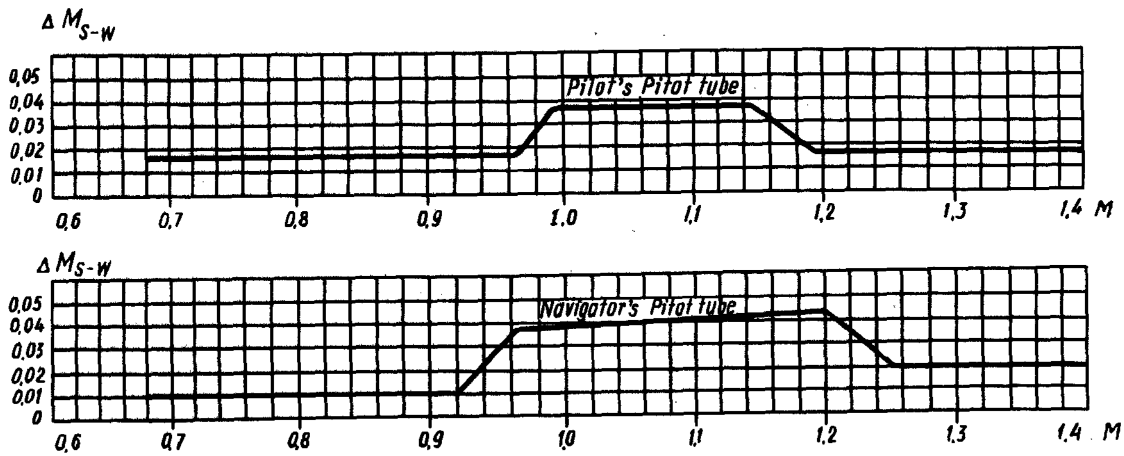

FIG. 13. AERODYNAMIC CORRECTIONS TO MACH NUMBER INDICATOR INSTALLED ON AIRCRAFT Ty-22Б

— set zero magnetic declination on the navigator's indicator and erection mechanism, make sure that the CS SLAVING (КС КОРРЕКЦИЯ) switch on the pilot's instrument board is set to the ON (ВКЛ.) position;

— place the mode-of-operation switch on the control panel to the MS (МК) position, the gyro unit switch, to the MAIN (ОСН.) position and the NORTH — SOUTH (СЕВЕР — ЮГ) switch, to the NORTH (СЕВЕР) position (if flight is to be performed in the northern hemisphere); using the LATITUDE (ШИРОТА) knob, set the local latitude;

— energize the compass system; 3 to 5 min later, depress the SLAVING (СОГЛАСОВАНИЕ) button and compare the gyromagnetic heading readings on the scales of the navigator's indicator (УШ), gyromagnetic and celestial heading indicator (УГА) with those on the scales of the pilot's combined course indicator (НКП) and gyromagnetic and celestial heading indicator, with the gyro unit switch set to the MAIN (ОСН.) and STAND-BY (ЗАП.) positions (the discrepancy in heading indications should not exceed ±1.5°);

— set the mode-of-operation switch to the DG (ГПК) position and compare the readings of gyro heading on the scales of the navigator's indicator and pilot's combined course indicator;

— check input of an optional gyro heading (with the COURSE SELECTOR (ЗАДАТЧИК КУРСА) knobs turned to the right, the magnitude of the gyro heading displayed by the navigator's indicator and pilot's combined course indicator should increase);

— set the mode-of-operation switch to the MS (МК) position; depress the SLAVING (СОГЛАСОВАНИЕ) button and make sure that the readings given by the compass system indicators and by magnetic compass КИ-13 correspond to the aircraft ground heading.

14. With the pilot's assistance, check operation of the АРК automatic direction finder. To this end, proceed as follows:

— set the intercom system mode-of-operation switch to the "РК-1" position, and the mode-of-operation switch on the automatic direction finder control board, to the ANTENNA (АНТЕННА) position and make sure that the automatic direction finder is switched on (by coming-on of the scale illumination lights and deflection of the tuning indicator pointer);

— check proper tuning of the channels to the radio station frequencies in compliance with the flight mission and make a respective record on the control board instruction plate;

— check to see that the АРК automatic direction finder can be smoothly tuned;

— tune to the frequency of the selected radio station, listen to the call-signs and, having turned the mode-of-operation switch to the COMPASS-I (КОМПАС I) position, check indications of the RADIO BEARING (РАДИОПЕЛЕНГ) pointer on the navigator's indicator and pilot's combined course indicator; the RADIO BEARING pointer must read the magnetic bearing of the selected radio station plotted on the chart (the discrepancy should not exceed ±2°);

— check operation of the automatic direction finder in the COMPASS-II (КОМПАС-II) mode (the magnitude of the bearing in this mode may differ from the actual bearing by 180°); with the automatic direction finder operating in the LOOP (PAMKA) mode, take audial bearings by using the LH — RH (Л — П) switch;

— check proper change-over of control from the navigator's control board to the pilot's control board and back.

15. With the pilot's assistance, check the short-range navigation and landing system. To this end, proceed as follows:

— turn on power supply of the short-range navigation and landing system;

— set the switch on the intercom system call box to the "PK-2" position;

— select the number of the channel of the radio beacon to be used;

— set any operating mode except for the LANDING one on the control board;

— 2 to 5 min after turning on the power supply, listen to the radio beacon call-signs. At the same time this should be accompanied by search and lock-on of the radio beacon; in this case, the lights labelled RANGE CHANNEL FAULTY (НЕИСПРАВЕН КАНАЛ ДАЛЬНОСТИ) and AZIMUTH CHANNEL FAULTY (НЕИСПРАВЕН КАНАЛ АЗИМУТА) should go out and the ППДА-Ш direct-reading range and azimuth indicator should read the radio beacon azimuth and range;

— calibrate pulse duration by using the AZIMUTH ZERO GATE PULSE (СТРОБ НУЛЯ АЗИМУТА) and RANGE ZERO (НУЛЬ ДАЛЬНОСТИ) knobs;

— compare the readings of the navigator's direct-reading range and azimuth indicator with those of the similar pilot's indicator.

16. Check the radio altimeter. To this end, proceed as follows:

— set the mode-of-operation switch to the CALIBR (КАЛИБР.) position;

— as soon as the LOCK-ON (ЗАХВАТ) light comes on, depress the MEMORY PASS (ПРОПУСК ПАМЯТЬ) button; in this case, the pointer of indicator УВ-25А should deflect to the "2000-m" mark after each depression of the button;

— place the mode-of-operation switch to the CHECK (КОНТРОЛЬ) position; in this case, the LOCK-ON (ЗАХВАТ) light should come on and the altitude indicator should read the altitude put down on control board ЩУ-25А.

17. Check the Doppler ground speed and drift meter. To this end, proceed as follows:

— turn on power supply of the Doppler ground speed and drift meter; this should result in coming-on of the MEMORY (ПАМЯТЬ), 115 V (115 B), PRESS (ДАВЛ.) lights and on expiration of 1.5 to 2 min, of the READY (ГОТОВН.) light;

— turn on the IRRAD (ИЗЛУЧ.) switch (the IRRAD light should come on), depress the switch labelled MAN CTL (РУЧН. ПРИВ.) to the RIGHTWARD (ВПРАВО) or LEFTWARD (ВЛЕВО) position and make sure that the drift angle has been changed respectively; in this case, the IRRAD (ИЗЛУЧ.) light should keep flickering;

— set the "α" knob on the control panel of the НБА automatic bomber navigation equipment to zero and make sure that the drift angle pointer on the ДИСС-1 meter is within ±10°.

Turn on the power supply of the astrotracker, automatic bomber navigation equipment and set the required data (in compliance with the flight mission) on the astrotracker and automatic bomber navigation equipment scales.

4.10. INSPECTION OF CABIN AND ITS PREPARATION FOR FLIGHT BY OPERATOR

18. When inspecting the cabin (Figs 14 and 15), the operator should proceed as follows:

— make sure that the cabin is free of foreign objects;

— check to see that the lower and emergency hatch door jettisoning handles are locked in the travelling position;

— with the pilot's and navigator's assistance, check the internal and external communication over the USW radio set and intercom system and lighting-up of the ABANDON AIRCRAFT (ПОКИНЬ САМОЛЕТ) inscription on the annunciator;

— ascertain that the shut-off valve of the entrance hatch door pressurization system is set to the CLOSED (ЗАКРЫТО) position;

— check the pressure gauge reading to make sure that the hatch door jettisoning system is filled with air; the pressure should be at least 120 kgf/cm^2;

— check to see that the ground power supply sources are connected to the aircraft mains and give a command for their cut-in;

— chech voltage of the storage batteries under load (the voltage should be at least 24 V);

— turn on the 27.5-V ground power supply;

— refer to the voltmeter to check voltage of the ground power supply sources and aircraft mains; to this end, successively set the voltmeter switch to the РАП-1, РАП-2 and A/C MAINS (БОРТСЕТЬ) position; in this case, the voltage should be within 27.5 to 28 V;

— make sure that the circuit breakers on the electric power supply board are turned on;

— successively turn on inverters ПО-6000, ПТ-1000 and check their voltage which should be 114 to 115 V and 34 to 38 V, respectively.

NOTES: 1. It is allowed to energize inverters ПО-6000 from the ground power source only if they are supplied from power units АПА-35-2 and АПА-50.

2. Illumination of white lights testifies to cut-in of the main inverters;

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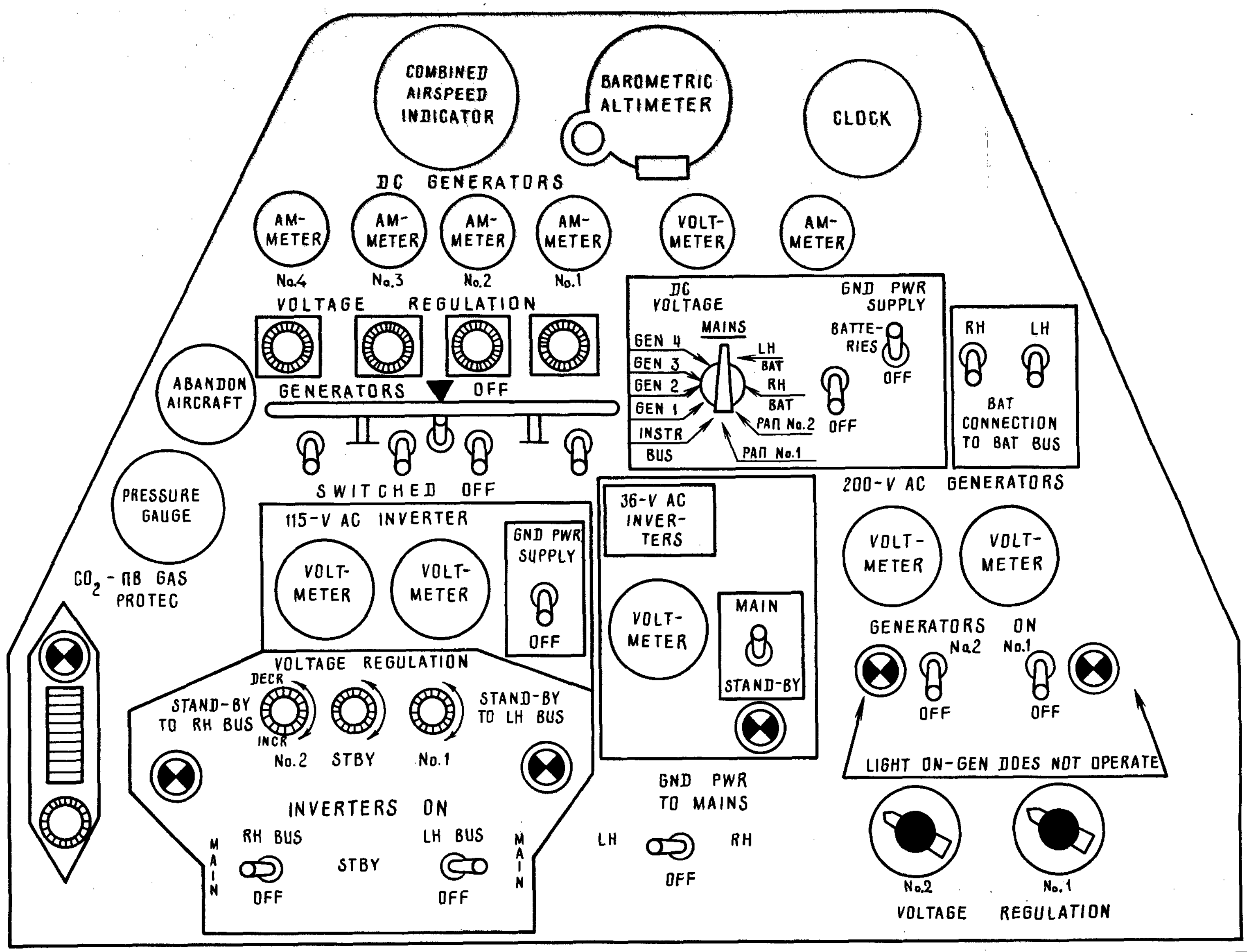
8/026254–T86



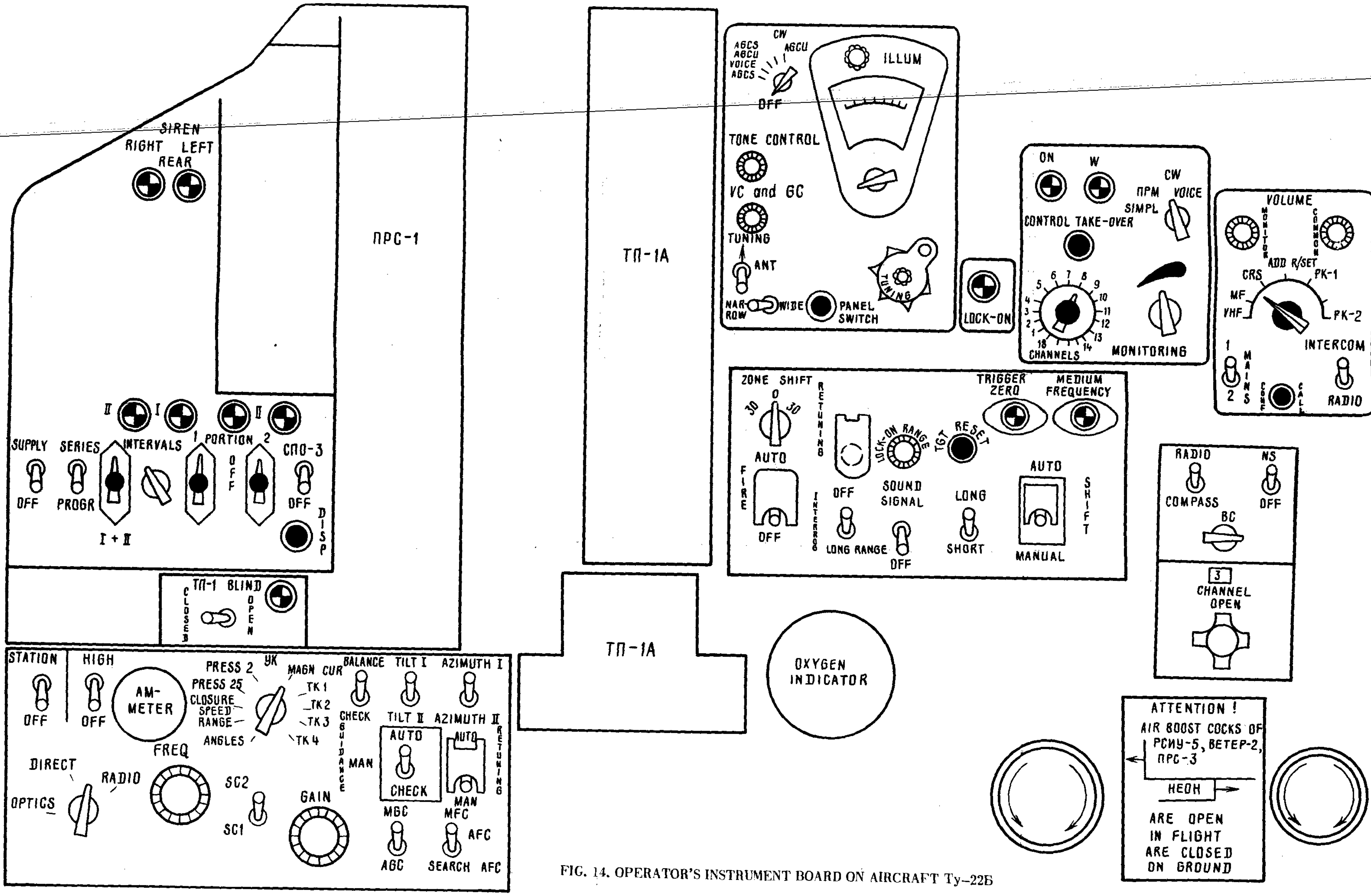
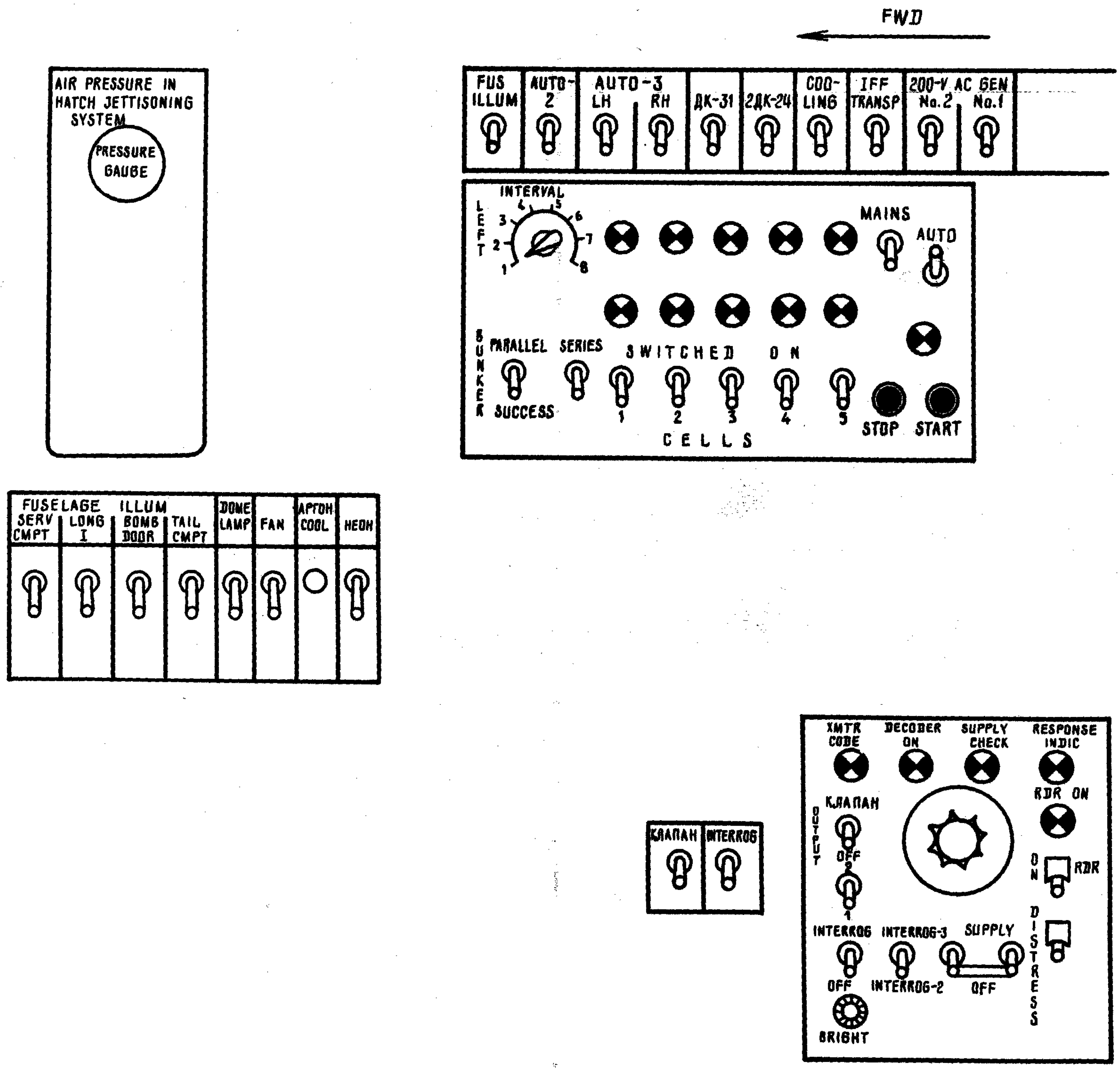
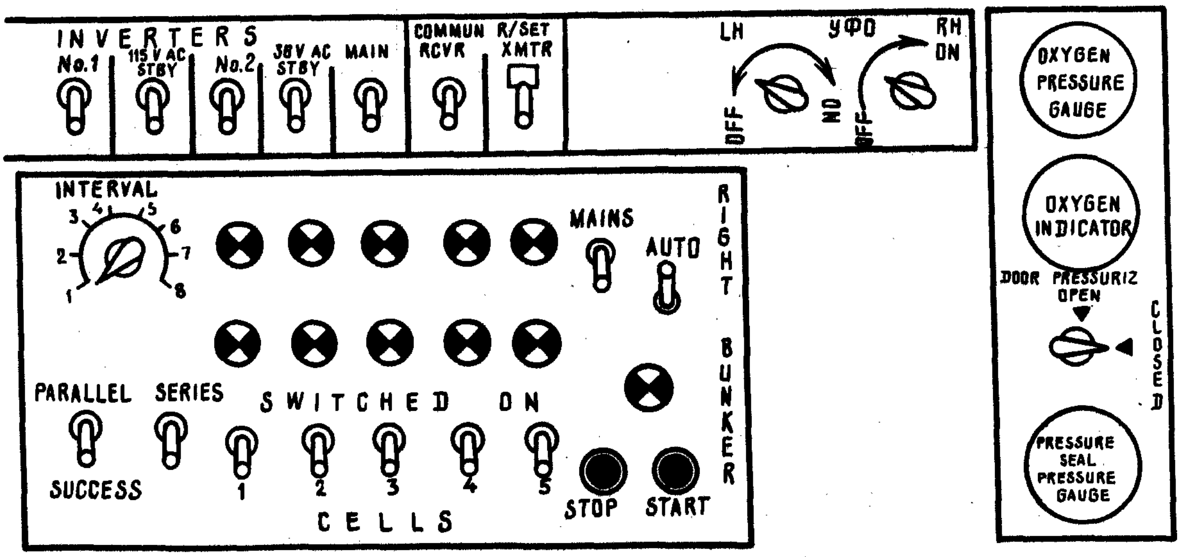


FIG. 14. OPERATOR'S INSTRUMENT BOARD ON AIRCRAFT Ty-22Б


FWD
AIR PRESSURE IN HATCH JETTISONING SYSTEM
PRESSURE GAUGE
FUS ILLUM
AUTO-2
AUTO-3
LH
RH
ДК-31
2ДК-24
COOLING
IFF TRANSP
200-V AC GEN
No.2
No.1
INTERVAL
LEFT
1 2 3 4 5 6 7 8
MAINS
AUTO
BUNKER
PARALLEL
SERIES
SUCCESS
SWITCHED ON
1 2 3 4 5
CELLS
STOP
START
FUSELAGE ILLUM
SERV CMPT
LONG I
BOMB DOOR
TAIL CMPT
DOME LAMP
FAN
АРГОН COOL
НЕОН
КЛАПАН
INTERROG
XMTR CODE
DECODER ON
SUPPLY CHECK
RESPONSE INDIC
RDR ON
OUTPUT
КЛАПАН
OFF
2
1
ON
RDR
DISTRESS
INTERROG
INTERROG-3
SUPPLY
OFF
INTERROG-2
OFF
BRIGHT



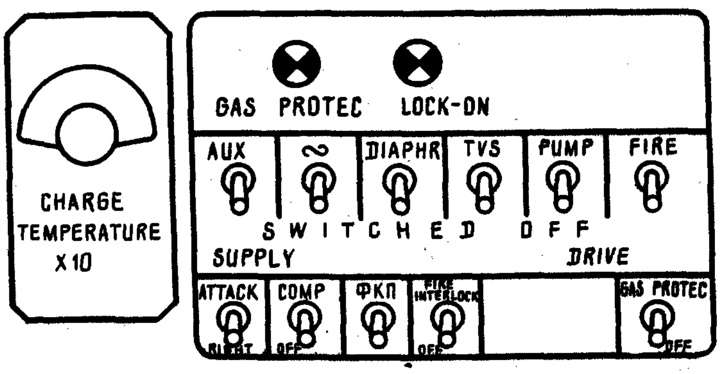


FIG. 15. STARBOARD OF OPERATOR'S WORKING STATION ON AIRCRAFT Ty–22Б

— turn on the НЕОН transmitter and УС-8 receiver;

— perform visual inspection of the control panels of the НЕОН transmitter, УС-8 receiver, fire-control radar and TV sight;

— make sure that the units of the radio and radar sets are reliably secured and cables are connected to them;

— check control of the НЕОН transmitter and УС-8 receiver from the remote control panels;

— check tuning of the РСИУ command radio stations;

— check to see that the gas protection system is filled with carbon dioxide (by reference to the pressure gauge readings);

— check to see that the gun barrel accumulated rounds correction is adequately set on unit ДТЗ; the correction should be set as follows:

at 0 to 1000 accumulated rounds — 0;

at 1000 to 1300 accumulated rounds — 10 m/s;

at 1300 to 1500 accumulated rounds — 20 m/s;

— using the charge temperature scale on unit ДТЗ, set the ambient temperature corresponding to the anticipated flight altitude;

— turn on the interrogator-responder and set the respective codes on its control panel.

4.11. STARTING OF ENGINES AND CHECKING OF SYSTEMS AND EQUIPMENT WITH ENGINES RUNNING

4.11.1. Preparation for Engine Starting

19. Before starting the engines, the pilot should turn on the magnetic recorder and dictate the date, time, his surname, the number of the flight mission and the aircraft board number, then he should turn off all the electric power consumers, leaving only inverter ПО-500, command radio set РСИУ, intercom system, magnetic recorder and engine instruments energized.

Using the intercom system, the pilot should inquire the crew members and the aircraft technician about their readiness for engine starting.

In response to the pilot's engine start readiness inquiry, the navigator should turn off all the electric power consumers (except for the light signalling and lighting systems at night) and report his readiness for starting the engines to the pilot; the operator should check the voltage of the aircraft mains under load, turn off all the electric power consumers (except for the light signalling and lighting systems at night) and report the normal voltage and his readiness for starting the engines to the pilot.

20. Upon receiving the reports from the crew members and aircraft technician on their readiness for engine starting, the pilot should request the flight control officer for permission to start the engines.

On obtaining the engine starting clearance, the pilot must do the following:

— apply the parking brakes;

— make sure that the pointers of the engine instruments are set to the initial positions;

— make sure that the lights indicating operation of the compressor air blow-off valves and the HP-7 pump inlet fuel pressure are alive;

— turn on the fire protection system; to this end, set the switch on the fire protection system control board to the SUPPLY (ПИТАНИЕ) position and check operation of the first-shot fire-extinguisher readiness indication system;

— check the position of the engine anti-icing system valve; if the ambient air temperature is +5 °C and lower, turn on the engine anti-icing system; to this end, turn the valve control handle to the ON (ВКЛЮЧЕНО) position;

— extend the air intake lips; to this end, place the ENGINE AIR INTAKES (ЗАБОРНИКИ ДВИГАТЕЛЕЙ) switch on the starting control panel to the EXTENDED (ВЫДВИНУТЫ) position; check the position of the air intake lips by coming-on of the amber caution lights on the pilot's instrument board and by the report of the ground aircraft observer;

— set the AUTO — MAN (АВТОМАТ — РУЧНОЕ) switch on the fuel system control board to the MAN (РУЧНОЕ) position;

— open the fuel shut-off cocks; to this end, place both FUEL SHUT-OFF COCKS (ПОЖАРНЫЕ КРАНЫ) switches on the fire protection system control board to the OPEN (ОТКРЫТО) position (check opening of the fuel shut-off cocks by coming-on of the green indicator lights on the control board);

— throw up the paired switches of the stand-by pumps of tanks Nos 2 and 7 on the fuel system electric control board;

— make sure that the throttle control lever is set against the IDLE (МАЛЫЙ ГАЗ) stop.

4.11.2. Starting and Run-Up of Engines

21. The engines may be started both from the ground electric power sources and from the aircraft storage batteries (internal starting).

To start the engines, use the following procedure:

— make sure that the CRANKING (ПРОКРУТКА) switches of the engine and starter are set to OFF (ВЫКЛЮЧЕНО);

— open the exhaust duct shutter of the turbostarter of the engine to be started; to this end, set the MASTER SWITCH (ГЛАВНЫЙ ВЫКЛЮЧАТЕЛЬ) toggle switch to the upper position; ascertain opening of the shutter by illumination of the SHUTTER OPEN (ЗАСЛОНКА ОТКРЫТА) white light;

— turn on the fuel pump of the engine to be started; to this end, shift the switch labelled FUEL PUMP (ТОПЛИВНЫЙ НАСОС) to the upper position (check to see that the pump has been engaged by coming-on of the green light indicating operation of the pump of tank No. 2).

NOTE. When starting the starboard engine on aircraft with tank No. 1, first open the cross-feed cock;

— open the fuel shut-off cock of the engine being started; to this end, set the fuel shut-off cock lever on the cabin left-hand panel to the START (ЗАПУСК) position and make sure that it has been retained by the latch;

— give the "Clear off engines" command to the aircraft technician over the intercom system;

— on obtaining the "Engines cleared" affirmative, depress the START (ЗАПУСК) button and release it on a lapse of 1 or 2 s; in this case, the white lamp, indicating the operation of the engine-starting control panel, will light up on the cabin port console and the turbostarter will start spinning.

NOTE. In case of emergency takeoff, it is allowed to perform simultaneous starting of both engines, keeping to the following time intervals between each depression of the engine START buttons:
- 3 to 5 s for starting the engines from the ground power source;
- 13 to 15 s for starting the engines from the aircraft storage batteries (depress the START button of the second engine at the end of increase of the first engine turbostarter temperature).

22. In the process of engine starting, check the following:

— the initial instantaneous rise of the turbostarter exhaust gas temperature, which should not exceed 900 °C (at a steady-state power setting, it should not exceed 760 °C);

— the engine exhaust gas overtemperature which should not be in excess of 660 °C.

CAUTION: DISCONTINUE ENGINE STARTING IF THE TURBOSTARTER AND ENGINE EXHAUST GAS OVERTEMPERATURE EXCEEDS THE ABOVE VALUES.

NOTES: 1. Engine starting may be accompanied by flickering of the exhaust gas overtemperature warning light.

2. Do not make further attempts of engine starting after two successive engine start failures;

— shut-down of the turbostarter at engine rotor speed of 20 to 21.5 % by referring to drop of the turbostarter exhaust gas temperature.

CAUTION: 1. DISCONTINUE THE ENGINE STARTING PROCESS IN CASE OF TURBOSTARTER DISENGAGEMENT FAILURE (AT ENGINE ROTOR SPEED BELOW 23 %).

2. IT IS ALLOWED TO REPEAT ENGINE STARTING ONLY AFTER THE ENGINE ROTOR HAS COME TO A COMPLETE STANDSTILL. TURBOSTARTER SHUT-DOWN IS NOT OBLIGATORY IN THIS CASE;

— extinguishment of the light indicating the fuel-regulating pump inlet fuel pressure (on the instrument board or annunciator);

— extinguishment of the light indicating operation of the engine starting control panel, which should take place no later than on expiration of 66 s;

— coming-on of the lights indicating operation of the stand-by pumps (one light for tank No. 2 and one light for tank No. 7); after the lights come on, set the FUEL PUMP (ТОПЛИВНЫЙ НАСОС) switch on the engine starting control panel to the OFF (ВЫКЛЮЧЕНО) position;

— the time of engine acceleration to a speed of 37 %, which should be within 70 to 120 s.

23. After the engine has accelerated to idle power, set the master starting switch to the OFF (ВЫКЛЮЧЕНО) position and make sure that the turbostarter exhaust duct shutter gets closed by fading-out of the shutter position indicator light.

Check engine operation at idle power (the readings of the engine instruments should be within the limits specified in Table 3).

Upon receiving the aircraft technician's report on normal operation of the engine, start the second engine and, after the latter accelerates to idle power, give the command to the operator to connect the generators to the aircraft mains, turn on the inverters, and disconnect the ground power supply (if the engine was started from the ground power source).

NOTES: 1. To check the proper operation of pumps of hydraulic systems I and II, start the engines in an alternate sequence.

2. After starting the engines, check pressure in both hydraulic systems and boost-charge the hydraulic accumulator of the emergency braking system.

3. Upon completion of starting of the second engine, the second indicator lamps are to light up to indicate normal operation of pumps in tanks Nos 2 and 7.

24. On listening to the operator's report on cut-in of the generators and inverters, the pilot should proceed as follows:

— give the "Turn off ground power supply" command to the aircraft technician;

— turn off inverter ПО-500;

— turn on the switches labelled ILS (СП), РВ—УМ, AUDIO SIGNAL (ЗВУКОВ. СИГНАЛ), ЭУП, АГД, CTL AUTO—MAN (УПРАВЛ. АВТОМ. — РУЧН.) by setting to AUTO (АВТОМ.), АУАСП, CS SLAVING (КОРРЕКЦИЯ КС), AUTOPILOT (АВТОПИЛОТ) and

MVG (ЦГВ), ПУТЬ, FUEL QUANTITY GAUGES (ТОПЛИВОМЕРЫ) and FUEL CONTROL UNIT (АВТОМАТ РАСХОДА ТОПЛИВА);

— at an ambient air temperature below zero, turn on the circuit breaker labelled OC-1 HEATING (ОБОГРЕВ ОС-1);

— make sure that the fuel system automatic control units operate properly by illumination of the fuel consumption amber lights and green lights indicating operation of the pumps in compliance with the fuelling variant;

— make sure that all the switches on the engine starting board are turned off and the ENGINE AIR INTAKES (ЗАБОРНИКИ ДВИГАТЕЛЕЙ) switch is set to the EXTENDED (ВЫДВИНУТЫ) position;

— close the engine starting board cover.

Table 6

Engine warm-up rating according to УПРТ indicator, divisions	Warm-up time, min	Maximum permissible RPM as read off ИТЭ tachometer indicator, %
28	1	—
51	2	94

NOTES: 1. It is allowed to accelerate the engine to the power setting corresponding to 28 divisions as read off the УПРТ indicator without running the engine at idle power.

2. If the light indicating the position of the compressor sixth-stage air blow-off valve starts flickering, change the position of the engine control lever until the light stops flickering.

3. Limit the engine speed at power setting corresponding to 51 divisions as read off the УПРТ indicator by decreasing the engine rating against this indicator.

25. Upon receiving the aircraft technician's report on disconnection of the ground electric power source and its removal from the aircraft, the pilot should proceed to warm-up and run-up of the engines in compliance with the recommendations given in Table 6 and Fig. 16.

When warming up the engine by running at power corresponding to 51 divisions as read off the УПРТ fuel control lever position indicator, check operation of the high-altitude equipment. To this end, proceed as follows:

— observe the readings of the УРВК cabin ventilation air flowmeter indicator to make sure that there is no air supply with the shut-off cocks closed;

— at high ambient temperatures, set the CROSS-FEED EVAPOR (КОЛЬЦЕВ. ИСПАРИТ.) and РТВК switches to the COLD (ХОЛ.) position, and at low temperatures, to the HOT (ГОР.) position; keep the switches in this position for 20 to 25 s, then place the РТВК switch to the neutral position;

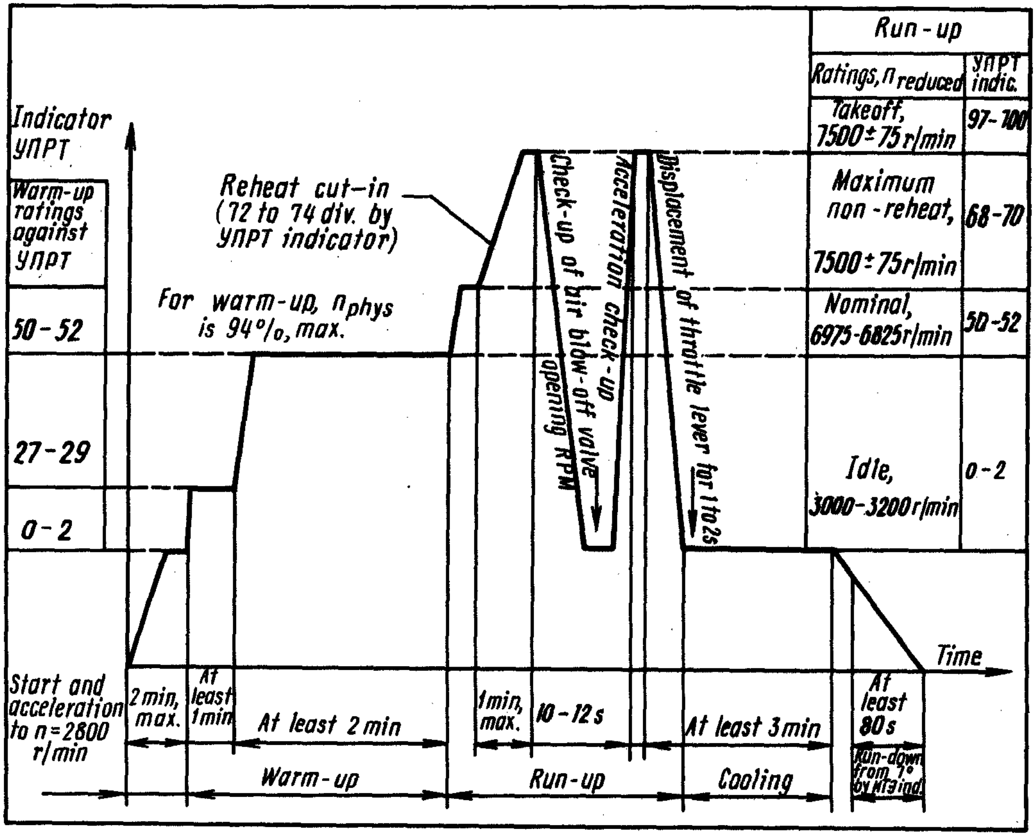


FIG. 16. WARM-UP AND RUN-UP CHART FOR ENGINES РД-7М2 (engines РД-7М2 with maximum RPM of 7400±75 r/min reduced by 100 r/min)

— check air supply into the cabin from each engine separately as well as by the PTBK cabin air temperature controller. The check over, set up the rate of air flow into the cabin within 1 to 2 units as shown by the УРВК cabin ventilation air flowmeter indicator.

In the process of engine acceleration to higher power settings, observe fading-out of lights on the instrument board to make sure that:

— the compressor sixth-stage air blow-off valve gets closed at the engine speed within 71.5 to 73.5 %.

CAUTION. IF THE COMPRESSOR SIXTH-STAGE AIR BLOW-OFF VALVE INDICATOR LIGHT FAILS TO EXTINGUISH, IT IS FORBIDDEN TO INCREASE THE ENGINE SPEED MORE THAN 75 %;

— the compressor fifth-stage air blow-off valve gets closed at the engine speed within 85.5 to 88 % at +15 °C ambient air temperature.

NOTE. If the ambient air temperature differs from the above-mentioned one, take into account the following: every 6 °C temperature decrease (increase) causes approximately 1 % decrease (increase) of the engine RPM at the engine speeds exceeding 68 % against the ИТЭ-2 indicator.

After the engine has been warmed up in accordance with the specified schedule, it is allowed to operate at all power settings. If the engine is shut down after warm-up running, it should be warmed up for 3 min when started again irrespective of duration of the period for which it was inoperative.

If the engine is run for at least 5 min with both compressor air blow-off valves closed after a three-minute warm-up period, it may be started and accelerated to any power setting at an acceleration rate, provided it has been kept at a standstill for not over 90 min.

26. During engine run-up, proceed as follows:

— check operation of the exhaust gas limit temperature warning system; to this end, depress the УРТ-23А CHECK (КОНТРОЛЬ УРТ-23А) button of the engine under trial and smoothly raise the engine power till the LIMIT t° (ПРЕДЕЛЬНАЯ t°) light comes on; after engine running at this power for 20 to 30 s, the exhaust gas temperature should be 470 to 510 °C (variation of the engine speed should not exceed 1 %, i. e., it should be within ±0.5 %);

— check engine vibration; the vibration indicator pointer should be located at the initial section of the scale (from zero to the mechanical index), the HIGH VIBRATION (ВИБРАЦИЯ ВЕЛИКА) indicator light should be dead;

— while smoothly retracting the throttle lever, check the engine speed at which the compressor air blow-off valves get open by reference to illumination of the indicator lights on the instrument board.

CAUTION: 1. IF THE LIGHT INDICATING OPENING OF THE COMPRESSOR FIFTH-STAGE AIR BLOW-OFF VALVE FAILS TO COME ON BEFORE THE ENGINE SPEED REACHES 82 %, DECELERATE THE ENGINE BY RETRACTING THE THROTTLE LEVER TO THE

"IDLE" STOP WHILE WATCHING THE EXHAUST GAS TEMPERATURE. SHUT OFF THE ENGINE IN CASE OF ABRUPT EXHAUST GAS TEMPERATURE RISE AND OTHER SURGE SYMPTOMS.

2. IF THE LIGHT INDICATING OPENING OF THE COMPRESSOR SIXTH-STAGE AIR BLOW-OFF VALVE FAILS TO COME ON AT THE ENGINE SPEED WITHIN 71.5 TO 73.5 %, SMOOTHLY THROTTLE DOWN THE ENGINE TO IDLE POWER AND, AFTER LETTING THE ENGINE RUN AT THIS POWER FOR 3 MIN, SHUT DOWN THE ENGINE;

— at a steady-state power setting, check the engine speed at the idle power, which should be within 40 to 43 %;

— with the engines operating properly, successively check acceleration of both engines from idle power to the maximum non-reheat power setting by smoothly shifting the throttle lever to the respective position for 1 to 2 s (without jerks). The time of engine acceleration should be within 17 to 20 s since the moment of the throttle lever motion initiation till the instant the engine gains the maximum speed. It is permissible to have 3 % short-time overspeeding of the engine and instantaneous increase of the exhaust gas temperature to 630 °C.

27. Shut off the engines after their three-minute cooling at idle power by shifting the engine shut-off lever to the SHUTOFF (ОСТАНОВ) position. Without waiting for the engine rotor to stop, turn off the booster pumps. After the engine rotor comes to a complete standstill, close the fuel emergency shut-off cocks.

28. Perform engine cranking to remove fuel remainder from the engine in case of starting failure. To crank the engine, proceed as follows:

— open the fuel emergency shut-off cock;

— open the cross-feed cock (when cranking the starboard engine on an aircraft with tank No. 1);

— check position of the throttle levers (the shut-off lever is set to the SHUT-OFF (ОСТАНОВ) position and the throttle lever, to the IDLE (МАЛЫЙ ГАЗ) position);

— set the ENGINE AIR INTAKES (ЗАБОРНИКИ ДВИГАТЕЛЕЙ) switch to the EXTENDED (ВЫДВИНУТЫ) position;

— set the master starting switch to the upper position;

— throw the FUEL PUMP (ТОПЛИВНЫЙ НАСОС) switch to the upper position;

— place the ENGINE CRANKING (ПРОКРУТКА ДВИГАТЕЛЯ) switch to the CRANKING (ПРОКРУТКА) position;

— make sure that the turbostarter exhaust duct shutter is open by illumination of the SHUTTER OPEN (ЗАСЛОНКА ОТКРЫТА) indicator light;

— depress and release the START (ЗАПУСК) button; this will result in coming-on of the engine starting automatic control panel indicator light;

— check shut-off of the turbostarter by drop of the turbostarter exhaust gas temperature;

— check the engine RPM which should be at least 11 % as shown by the ИТЭ indicator;

— after cranking the starboard engine, close the cross-feed cock.

CAUTION. IT IS ALLOWED TO PERFORM REPEATED CRANKING OF THE ENGINE ONLY AFTER THE ENGINE ROTOR COMES TO A COMPLETE STANDSTILL.

29. Perform turbostarter cranking to remove fuel remainder from the turbostarter in case of starting failure. To crank the turbostarter, proceed as follows:

— open the fuel emergency shut-off cock;

— set the AIR INTAKES EXTENDED (ЗАБОРНИКИ ВЫДВИНУТЫ) switch to the EXTENDED (ВЫДВИНУТЫ) position;

— set the master starting switch to the upper position;

— throw the FUEL PUMP (ТОПЛИВНЫЙ НАСОС) switch to the upper position;

— place the TURBOSTARTER CRANKING (ПРОКРУТКА ТУРБОСТАРТЕРА) switch to the CRANKING (ПРОКРУТКА) position;

— make sure that the turbostarter exhaust duct shutter is open by illumination of the SHUTTER OPEN (ЗАСЛОНКА ОТКРЫТА) indicator light;

— depress and release the START (ЗАПУСК) button (the electric motor gets cut out on expiration of 10 to 12 s and the automatic starting control panel gets disconnected on a lapse of 41 to 47 s after depression of the START button).

4.11.3. Checking Aileron and Flap-Aileron Control System

30. To carry out the check, proceed as follows:

(a) make sure that the rudder and aileron dry-friction damper lights are dead with the hydraulic boosters and FRICTION DAMPER (ДЕМПФЕР ТРЕНИЯ) circuit breaker turned off;

(b) make sure that the engine control panel switch labelled AILERONS — FLAP-AILERONS (ЭЛЕРОНЫ — ЭЛЕРОН-ЗАКРЫЛКИ) is set to the AILERONS (ЭЛЕРОНЫ) position and the AILERONS (ЭЛЕРОНЫ) white lights are alive;

(c) check engagement of the spring feel mechanism and trimming mechanism with hydraulic system II engaged; to this end, proceed as follows:

— set the aileron hydraulic booster control lever to the ONE SYSTEM CUT IN (ВКЛЮЧЕНА ОДНА СИСТЕМА) position and make sure that the trim tab neutral position indicator light has extinguished and the aileron feel mechanism neutral position indicator light has come on;

— fully deflect the ailerons several times and make sure that the feel mechanism is engaged by increase of the forces;

(d) check automatic switch-over of dry-friction damper supply to hydraulic system II; to this end, proceed as follows:

— set the dry-friction damper (DFD) aileron switch to the MAIN HYDRAULIC SYSTEM (ОСНОВНАЯ ГИДРОСИСТЕМА) position; this should result in coming-on of the green indicator light labelled AILERON DFD (ДСТ ЭЛЕРОНОВ);

— place the dry-friction damper switch to the neutral position, which should result in extinguishment of the indicator light;

(e) check engagement of the aileron control units, with hydraulic systems I and II cut in; to this end, proceed as follows:

— shift the aileron hydraulic booster control lever to the TWO SYSTEMS CUT IN (ВКЛЮЧЕНЫ ДВЕ СИСТЕМЫ) position; check deflection of the ailerons with two hydraulic systems cut in.

NOTE. When deflecting the ailerons, make sure that pressure in hydraulic systems I and II varies, thus testifying to normal operation of the hydraulic booster;

— check trimming-out of the aileron feel mechanism; the check over, set the mechanism to the neutral position by referring to lighting-up of the indicator lamp;

— turn on the aileron dry-friction damper from hydraulic system II; the forces arising on the control wheel after the dry-friction damper engagement should not increase;

— turn on the switch labelled AILERON HYDR BOOSTER EMERGENCY CROSS-FEED (АВАРИЙНОЕ КОЛЬЦЕВАНИЕ ГИДРОУСИЛИТЕЛЯ ЭЛЕРОНОВ) and check to see that the control wheel is capable of moving; the control wheel forces should increase to 100 kgf;

— cut out the aileron dry-friction dampers and, by shifting the control wheel to the right or to the left, make sure that the aileron dry-friction dampers have got disengaged; in this case, the control wheel forces will be reduced to the normal level; if the control wheel forces fail to decrease to the normal level, this is indicative of an unserviceable condition of the dry-friction dampers;

— place the aileron dry-friction damper switch to the MAIN HYDRAULIC SYSTEM (ОСНОВНАЯ ГИДРОСИСТЕМА) position and make sure that the dry-friction dampers have got engaged by coming-on of the DFD (ДСТ) indicator light and by the increase of the control wheel forces;

— turn off the switch labelled AILERON HYDR BOOSTER EMERGENCY CROSS-FEED (АВАРИЙНОЕ КОЛЬЦЕВАНИЕ ГИДРОУСИЛИТЕЛЯ ЭЛЕРОНОВ) and check deflection of the ailerons;

(f) check change-over of control to the flap-ailerons; to this end, proceed as follows:

— make sure that the flaps are completely retracted;

— set the ailerons to the neutral position;

— place the switch labelled AILERONS — FLAP-AILERONS (ЭЛЕРОНЫ — ЭЛЕРОН-ЗАКРЫЛКИ) to the FLAP-AILERONS (ЭЛЕРОН-ЗАКРЫЛКИ) position and start the stopwatch; this should result in fading-out of the AILERONS (ЭЛЕРОНЫ) white indicator lights and coming-on of the FLAPS blue indicator lights on expiration of 20 to 27 s;

— check operation of the flap-ailerons while deflecting the control wheel through full angles; the flap-ailerons should be deflected smoothly, without jerks and stoppages;

— set the aileron-flaps to the neutral position;

— place the switch labelled AILERONS — FLAP-AILERONS to the AILERONS position; this should result in extinguishment of blue indicator lights and coming-on of white indicator lights on a lapse of 20 to 27 s.

CAUTION. NEVER CHECK CONTROL OF FLAP-AILERONS BY DEFLECTING THE CONTROL WHEEL WITH THE HYDRAULIC BOOSTER DISENGAGED;

— make sure (by the aircraft technician's report) that deflection of the control wheel is accompanied by adequate deflection of the ailerons while flap-ailerons are motionless;

— set the switch labelled AILERONS — FLAP-AILERONS (ЭЛЕРОНЫ — ЭЛЕРОН-ЗАКРЫЛКИ) to the AUTO (АВТОМАТ) position (on aircraft with automatic change-over of control from the ailerons to flap-ailerons and back); this should be accompanied by illumination of the white indicator lights;

(g) make sure that the change-over switches of the rudder and aileron hydraulic booster emergency cross-feed cocks are turned off and closed by red caps, the switch of the aileron dry-friction dampers occupies the MAIN HYDRAULIC SYSTEM (ОСНОВНАЯ ГИДРОСИСТЕМА) position and the aileron dry-friction damper green indicator light is alive.

4.11.4. Checking Rudder Control

31. To carry out the check, proceed as follows:

— make sure that the landing gear nose wheel steering control is turned off;

— make sure that the switch labelled RUDDER DFD CHANGE-OVER TO HYDR SYST I (ПЕРЕКЛЮЧЕНИЕ ДСТ РН НА I ГС) is set to the AUTO (АВТОМАТ) position.

NOTE. With the rudder dry-friction damper control switch set to the AUTO (АВТОМАТ) position, the electrical system of the rudder dry-friction damper will be prepared for automatic engagement of the rudder dry-friction damper for hydraulic power supply from hydraulic system I which is cut in when pressure in hydraulic system II is reduced to 100 kgf/cm^2 and lower;

— set the rudder hydraulic booster control lever to the position labelled ONE SYSTEM CUT IN (ВКЛЮЧЕНА ОДНА СИСТЕМА) and make sure that the lights indicating the neutral position of the rudder feel mechanism and dry-friction damper have come on and that the trim-tab light and abnormal conditions annunciator labelled FIRE (ПОЖАР) and DFD (ДСТ) have extinguished;

— give the following command to the aircraft technician: "Depress the nose wheel uplock indication system limit switch";

— fully deflect the rudder several times; ascertain operation of the indication system annunciator labelled RUDDER DEFLECTED BY MORE THAN 7° (РН ОТКЛОНЕН БОЛЕЕ 7°) or RUDDER DEFLECTED BY MORE THAN 5° (РН ОТКЛОНЕН БОЛЕЕ 5°) and engagement of the flight artificial-feel mechanism (by increase of the pedal forces);

— give the "Release the limit switch" command to the aircraft technician;

— shift the rudder hydraulic booster control lever to the BOTH SYSTEMS CUT IN (ВКЛЮЧЕНЫ ОБЕ СИСТЕМЫ) position and check deflection of the rudder with both systems engaged.

NOTE. When deflecting the rudder, make sure that there is variation of pressure in the systems as indicated by pressure gauges of hydraulic systems I and II, which testifies to normal operation of the rudder hydraulic booster;

— check trimming-out of the rudder feel mechanism, then set it to the neutral position by referring to coming-on of the indicator light;

— turn on the switch labelled RUDDER HYDR BOOSTER EMERGENCY CROSS-FEED (АВАРИЙНОЕ КОЛЬЦЕВАНИЕ ГИДРОУСИЛИТЕЛЯ РН);

— check to see that the pedals can move in both directions; the pedal forces should rise to 125 kgf.

NOTE. The possibility of moving the pedals with slight effort, with the cross-feed cock turned on, testifies to an unserviceable condition of the dry-friction damper or rudder hydraulic booster cross-feed cock;

— shift the switch labelled RUDDER DFD CHANGE-OVER TO HYDR SYST I (ПЕРЕКЛЮЧЕНИЕ ДСТ РН НА I ГС) to the EMERG RUDDER DFD ON (ДСТ РН АВАР. ВКЛЮЧ.) position; as a result, the pedal forces should increase to 200 kgf, which testifies to operation of the rudder dry-friction damper from hydraulic systems II and I;

— change over the switch labelled RUDDER DFD CHANGE-OVER TO HYDR SYST I to the AUTO (АВТОМАТ) position and, by observing the decrease of pedal forces to 125 kgf, make sure that the rudder dry-friction damper has got connected to hydraulic system II.

NOTE. The 125 and 200-kgf forces are given for reference only. They are not subject to checking;

— turn off the switch labelled RUDDER HYDR BOOSTER EMERGENCY CROSS-FEED (АВАРИЙНОЕ КОЛЬЦЕВАНИЕ ГИДРОУСИЛИТЕЛЯ РН) and check deflection of the rudder.

4.11.5. Checking Horizontal Stabilizer Control

32. Check horizontal stabilizer control from the hydraulic systems, with both engines running at power settings not less than 30 divisions against the fuel control lever position indicator. When checking horizontal stabilizer control, mind that the stabilizer deflection rate is limited by the maximum operating rate of the stabilizer hydraulic booster (5 to 6 deg/s when operating from one hydraulic system and 10 to 12 deg/s when operating from two hydraulic systems); therefore, it is not allowed to sharply move the control wheel, applying excessive forces to it, especially when the control wheel is moved in the direction of the trimmed-out position since the increase of forces on the control wheel is of no avail in raising the said stabilizer deflection rates but leads only to increasing the hydraulic booster feedback load.

CAUTION. AT SUBZERO TEMPERATURES, PROCEED AS FOLLOWS:

- SET THE HORIZONTAL STABILIZER HYDRAULIC BOOSTER CONTROL VALVE LEVER TO THE "TWO SYSTEMS CUT IN" POSITION;
- USING THE TRIMMING MECHANISM, SET THE HORIZONTAL STABILIZER TO THE "MINUS 8°" POSITION AS SHOWN BY THE STABILIZER POSITION INDICATOR;
- WARM UP THE HORIZONTAL STABILIZER HYDRAULIC BOOSTER; TO THIS END, FOUR OR FIVE TIMES SMOOTHLY DEFLECT THE CONTROL WHEEL BACKWARD TO THE STABILIZER POSITION OF MINUS 11° AGAINST THE STABILIZER POSITION INDICATOR AND SMOOTHLY RETURN THE CONTROL WHEEL TO THE TRIMMED-OUT POSITION;
- SET THE CONTROL WHEEL TO THE ZERO POSITION AS SHOWN BY THE STABILIZER POSITION INDICATOR;
- SET THE HORIZONTAL STABILIZER HYDRAULIC BOOSTER CONTROL VALVE LEVER TO THE "OFF" POSITION.

33. To check horizontal stabilizer control, proceed as follows:

(a) check electric control of the stabilizer control electric actuator by doing the following:

— deflect the horizontal stabilizer from the zero trimmed-out position to the position corresponding to "minus 3°" of the stabilizer position indicator scale (the time of stabilizer motion does not exceed 5 s);

— check to see that horizontal stabilizer deflection corresponds to the stabilizer position indicator readings and aircraft technician's report.

NOTE. It is allowed to deflect the stabilizer on the ground by the stabilizer control electric actuator no more than three times through ±3° angles from any trimmed-out position;

(b) check horizontal stabilizer deflection when controlled from the hydraulic systems, for which purpose proceed as follows:

— set the hydraulic booster control valve lever to the ONE SYSTEM CUT IN (ВКЛЮЧЕНА ОДНА СИСТЕМА) position;

— check operation of the trimming system, to this end, using the trimming mechanism switch, deflect the horizontal stabilizer to the MINUS 10° (МИНУС 10°) position as shown by the stabilizer position indicator, then return it to zero and set to the MINUS 8° (МИНУС 8°) position;

— check the horizontal stabilizer deflection rate, with the stabilizer controlled by one hydraulic system; to this end, deflect the control wheel fully backward and return it to the trimmed-out position (the time of control wheel and stabilizer deflection to the trimmed-out position is 2 s);

— set the hydraulic booster control valve lever to the TWO SYSTEMS CUT IN (ВКЛЮЧЕНЫ ДВЕ СИСТЕМЫ) position;

— check the horizontal stabilizer deflection rate, with the stabilizer controlled by two hydraulic systems; to this end, smoothly deflect the control wheel fully backward and return it to the trimmed-out position (the time of control wheel and stabilizer deflection to the trimmed-out position is 1 s);

(c) check deflection of the horizontal stabilizers to the extreme positions and smoothness of system operation by reference to the stabilizer position indicator; to this end, proceed as follows:

— smoothly move the control wheel all the way backward; in so doing, see that the stabilizer is deflected to the extreme position (from minus 17° to minus 19° against the stabilizer position indicator);

— return the control wheel to the trimmed-out position;

— apply the control wheel all the way forward; in so doing, see that the stabilizer deflects to the extreme position (+1° against the stabilizer position indicator);

— by relieving the forces applied to the control wheel, provide its smooth return to the trimmed-out position (minus 8° as read off the stabilizer position indicator).

34. Check the neutral position of the extensible rods of the pitch damper and stability automatic controller. To this end, proceed as follows:

— enable both channels of the pitch damper (PD) and stability automatic controller (SAC); the PD (ДТ) red lights should go out and the SAC (АУ) light should go on illuminating;

— check to see that the БПО PITCH (ТАНГАЖ БПО) handle is set against the white mark;

— make sure that the switch labelled STABILITY AUTOMATIC CONTROLLER NORM — EMERG (АВТОМАТ УСТОЙЧИВОСТИ НОРМ. — АВАР.) is set to the NORM (НОРМ.) position and closed by a red cap;

— give the "Depress the limit switch" command to the aircraft technician; the depression of the nose leg uplock limit switch should result in extinguishment of the SAC (АУ) red warning light and coming-on of the СПН stability automatic controller and pitch neutral setting system green indicator light and nose leg uplock red warning light;

— apply the control wheel all the way backward; as a result, the horizontal stabilizer should deflect to the previously checked extreme position as shown by the stabilizer position indicator;

— return the control wheel to the trimmed-out position;

— apply the control wheel all the way forward from the trimmed-out position; as a result, the horizontal stabilizer should deflect to the extreme position (+1° against the stabilizer position indicator);

— by decreasing the control wheel force, ensure smooth return of the control wheel to the trimmed-out position.

CAUTION. TAKEOFF IS PROHIBITED IF THE EXTREME POSITIONS OF THE HORIZONTAL STABILIZER FAIL TO ALIGN WITH THE DISABLED AND ENABLED CHANNELS OF THE PITCH DAMPER AND STABILITY AUTOMATIC CONTROLLER (THE PITCH DAMPER AND STABILITY AUTOMATIC CONTROLLER ARE UNSERVICEABLE).

NOTE. It is allowed to turn on/off the first and second channels of the pitch damper and stability automatic controller only with the stabilizer control electric actuator circuit breaker labelled МУС turned on, stabilizer hydraulic booster engaged and hydraulic system pressure available.

35. Check pressure in the hydraulic systems, with the rudder, ailerons and hydraulic stabilizer simultaneously moved within the ± (5—6)° range from the trimmed-out position. To this end, make two or three simultaneous reversals of the rudder, ailerons and horizontal stabilizer within the above-indicated range of angles and determine pressure in the hydraulic systems. The pressure in each hydraulic system should drop but it should be no less than 150 kgf/cm^2. Set the horizontal stabilizer into the position corresponding to minus 4° against the stabilizer position indicator.

NOTES: 1. To check proper deflection of the control surfaces, the pilot should refer to the reports of the ground observer.
2. It is allowed to simultaneously check the ailerons and rudder from one and two hydraulic systems in turn.

4.11.6. Checking Feel Simulator Controller (АДУ), Control Wheel Travel Rate Limiter (ОС), Damper Д2К, Pitch Damper (ДТ), Stability Automatic Controller (АУ) and Stability Automatic Controller and Pitch Neutral Setting System (СПН)

36. To check the feel simulator controller (АДУ) and control wheel travel rate limiter (ОС), proceed as follows:

— turn on the АДУ switch; in this case, the green indicator light on the right-hand electric board should come on.

NOTE. The moment of feel simulator controller engagement may be marked by short-time (not in excess of 0.5 s) coming-on of the АУАСП light;

— apply the control wheel backward; shifting of the control wheel through 80 mm from the trimmed-out position is accompanied by engagement of the feel simulator controller spring, creating the additional forces across the control wheel, which causes the АУАСП indicator light to come on;

— release the control wheel and make sure that it freely moves in the forward direction; the АУАСП indicator light should fade out.

NOTE. If the moment of feel simulator controller cut-in is immediately followed by engagement of the feel simulator controller spring, check the angle of attack against the АУАСП indicator (the АУАСП indicator angle-of-attack transmitter vane may be set to any position during aircraft parking) and give a command to the ground observer to lower the vane;

— check engagement of the control wheel travel rate limiter; to this end, proceed as follows:

quickly shift the control wheel forward from the trimmed-out position and then backward until the feel simulator controller comes into action; the rise of the feel simulator forces is percepted in direct proportion to the control wheel travel rate;

return the control wheel to the trimmed-out position.

37. To check damper Д2К, proceed as follows:

— turn on the roll and yaw dampers;

— set the following transmission ratios on the БПО transmission ratio unit: 4 for the roll channel, 7 to 8 for the yaw channel or with respect to white marks;

— open the cap of the switch labelled ROLL, YAW — PITCH, SAC (КРЕН, КУРС — ТАНГАЖ, АУ) on the damper indicator panel (ПКД) and place the switch to the ROLL, YAW (КРЕН, КУРС) position;

— open the cap of the damper spring-return switch labelled UP — DOWN (ВВЕРХ — ВНИЗ) and press the switch upward; as a result, the rudder should deflect to the left, and the left-hand aileron, upward (which must be reported by the aircraft technician); concurrently, the indicator pointers should deflect upward to the reference mark;

— depress the damper UP — DOWN switch downward; this done, the rudder, ailerons and damper indicator pointers should deflect in the opposite direction (perform this check two or three times);

— release the spring-return switch; as a result, the rudder, ailerons and damper indicator pointers should return to the neutral position, which must be reported by the aircraft technician.

CAUTION. WHEN REVERSING THE "UP — DOWN" SWITCH ON THE DAMPER INDICATOR PANEL FROM ONE EXTREME POSITION TO THE OTHER ONE, KEEP THE SWITCH IN THE NEUTRAL POSITION FOR AT LEAST 3 S AND IN THE DEPRESSED POSITION, FOR NO LONGER THAN 5 S.

38. To check damper Д2К, pitch damper, stability automatic controller as well as of the stability automatic controller and pitch neutral setting system, proceed as follows:

— place the switch labelled ROLL, YAW — PITCH, SAC on the damper indicator panel to the PITCH, SAC position;

— depress the UP — DOWN damper spring-return switch to the UP (DOWN) position and take the readings of the stabilizer position indicator to make sure that the horizontal stabilizer has deflected by 1.6 to 2.2°; in this case, the T1, T2 and АУ stability automatic controller pointers of the damper indicators should go up (down) to the reference marks;

— release the UP — DOWN damper switch and observe the readings of the stabilizer position indicator to make sure that the horizontal stabilizer has returned to the MINUS 4° position and the T1, T2 and АУ stability automatic controller pointers of the damper indicators occupy the neutral position;

— open the cap of the stability automatic controller and pitch neutral setting system unit spring-return switch labelled UP — DOWN;

— simultaneously depress the damper switch labelled UP — DOWN and similarly labelled switch of the stability automatic controller and pitch neutral setting system unit to the UP position; as a result, all the three indicator pointers should deflect up to the reference marks, the pitch damper and stability automatic controller cut-out indicator lights should be dead; release the switches — the pointers of the damper indicator should return to the neutral position;

— simultaneously depress the damper switch labelled UP — DOWN and similarly labelled switch of the stability automatic controller and pitch neutral setting system unit to the DOWN (ВНИЗ) position; as a result, all the three indicator pointers should deflect down to the reference points, the pitch damper and stability automatic controller cut-out indicator lights should be dead; release the switches — the pointers of the damper indicator should return to the neutral position;

— simultaneously depress the damper switch labelled UP — DOWN to the UP position and similarly labelled switch of the stability automatic controller and pitch neutral setting system unit to the DOWN position; as a result, the pointers of the damper indicator should deflect upward and immediately return to the neutral position; the red warning lights of the pitch damper and stability automatic controller first and second channels should come on;

— release the spring-return switches, turn off and again turn on the switches of the first and second channels of the pitch damper and stability automatic controller; as a result, the red warning lights of the first and second channels of the pitch damper and stability automatic controller should fade out;

— simultaneously depress the damper switch labelled UP — DOWN to the DOWN position and similarly labelled switch of the stability automatic controller and pitch neutral setting system unit to the UP position; as a result, the pointers of the damper indicator should deflect down and immediately return to the neutral position; the red warning lights of the first and second channels of the pitch damper and stability automatic controller should come on;

— release the spring-return switches, turn off and again turn on the switches of the first and second channels of the pitch damper and stability automatic controller; as a result, the red warning lights of the first and second channels of the pitch damper and stability automatic controller should go out;

— once or twice alternately depress the damper switch labelled UP — DOWN to the UP and DOWN positions and ascertain sound operation of the pitch damper and stability automatic controller;

— give a command to the aircraft technician to remove the latch from the nose wheel uplock limit switch; as a result, the green lights labelled СПН and АДУ should fade out and the red warning light labelled АУ should come on to indicate disengagement of the artificial feel simulator (АДУ), stability automatic controller (АУ) as well as of the stability automatic controller and pitch neutral setting system (СПН);

— successively depress the damper switch labelled UP — DOWN to the UP and DOWN positions to make sure that the stability automatic controller (АУ) pointer of the damper indicator remains neutral while the T1 and T2 pointers deflect to the reference marks;

— release the damper switch labelled UP — DOWN and close the caps on the damper switches labelled UP — DOWN and similarly labelled switches of the stability automatic controller and pitch neutral setting unit;

— with reference to readings of the stabilizer position indicator, make sure that the horizontal stabilizer is set to the MINUS 4° (МИНУС 4°) position and the damper indicator pointers are neutral.

4.11.7. Checking of Equipment by Navigator

39. After engine starting, the navigator should proceed as follows:

— inquire the operator for availability of the 28-, 115-, 36- and 208-V voltages;

— turn on all the instruments and equipment required for execution of flight;

— close the bomb bay doors by the aircraft technician's command;

— check availability of bombs and serviceability of the bombing equipment signalling system;

— make sure that the bomb bay doors and camera bay doors are closed;

— turn on power supply of the astrotracker, introduce the star Greenwich mean time (t_{GMT}) into the computer and make sure that the introduced time magnitude is automatically set in by referring to the motion of scale S_{GMT}; check correctness of the initial data introduced into the computer;

— turn on the НБА automatic bomber navigation equipment and set the coordinates of the first waypoint on the scales of the waypoint counters, the departure airfield coordinates on the scales of the present coordinate counters and the coordinates of the first radar marker on the scales of the $X_{rdr\ mkr}$, $Y_{rdr\ mkr}$, counters;

— set airfield coordinate Y on the computer scale and turn on the switch labelled SLAVING FROM ABNE (КОРРЕКЦИЯ ОТ НБА);

— if the luminary bodies are visible, tune the astrotracker and turn on the TRACKING (СЛЕЖЕНИЕ) switch;

— make sure that the selector handles on the autopilot control panel are set to the middle position.

NOTE. If the selector handles on the autopilot control panel are deflected from the initial position, the autopilot will fail to be engaged;

— make sure that zero magnetic declination is set on the scales of the navigator's indicator (УШ) and slaving unit (КМ);

— set the mode-of-operation switch on the compass system control panel to the MS (МК) position and slave the main and stand-by gyro units; all the indicators, except for pointer "A" on the gyro-magnetic and celestial heading indicator, should read the magnetic heading of the parking site;

— enable the magnetic slaving of the stand-by gyro unit;

— set the compass system mode-of-operation switch to the DG (ГПК) position;

— select the great-circle course by using the astrotracker or COURSE SELECTOR (ЗАДАТЧИК КУРСА) knob.

4.11.8. Checking of Equipment by Operator

40. After engine starting, the operator should proceed as follows:

— check the voltage of each generator (the voltage should be within 28 to 28.5 V); if the voltage is higher or lower than that specified, adjust it; if the voltage is lower than 25 V, report the necessity of engine shut-down to the pilot;

— successively turn on all the generators and turn off the ground power supply source;

— connect the aircraft storage batteries to the aircraft mains;

— turn on inverters ПО-6000 Nos 1 and 2 and inverter ПТ-1000Ц and take the readings of the ammeters to check distribution of current between all the generators; when high current loads are applied, see to it that the generator load does not exceed 600 A;

— check the voltage of inverters ПО-6000 Nos 1 and 2 (the voltage should be within 114 to 115 V);

— use a voltmeter to check operation of stand-by inverter ПО-6000 when successively connected instead of main inverters ПО-6000 Nos 1 and 2;

— check voltage of main and stand-by inverters ПТ-1000Ц (the voltage should be within 34 to 38 V);

— turn on the AC generators; this done, the red warning lights should come on to extinguish within 6 s; this testifies to normal connection of the generator to the mains; the normal generator voltage should be within 204 to 208 V at the engine RPM of 40 to 42 % and higher;

— check voltage of all electric power sources by reference to the indicators and report operation of the electrical equipment to the pilot;

— make sure that the airing system supply valves of the НЕОН radio transmitter, ДИСС Doppler ground speed and drift meter, РСИУ radio set, РВ-25А radio altimeter and ПРС-3 fire-control radar are open;

— turn on power supply of the fire-control radar and TV sight, НЕОН radio transmitter, УС radio receiver and СПО radar illumination warning unit;

— establish a two-way communication with the flight control post in the keying mode (if it is stipulated by the flight plan);

— by referring to the pressure gauge readings, make sure that the hatch door jettisoning system is filled with air (the pressure should be at least 120 kgf/cm^2);

—turn on the СРЗО interrogator-responder and check proper setting of codes on the СРЗО interrogator-responder control panel.

5. FLIGHT PERFORMANCE

5.1. CREW OBSERVATION DUTIES

41. To prevent aircraft collision with obstacles on the ground and in flight, all crew members must observe the surrounding air (ground) space and timely and duly report the detected obstacles to the pilot. The observation should be conducted continuously since the moment of aircraft taxiing-out from the parking site. Distribution of the observation sectors for each crew member is given in Fig. 17.

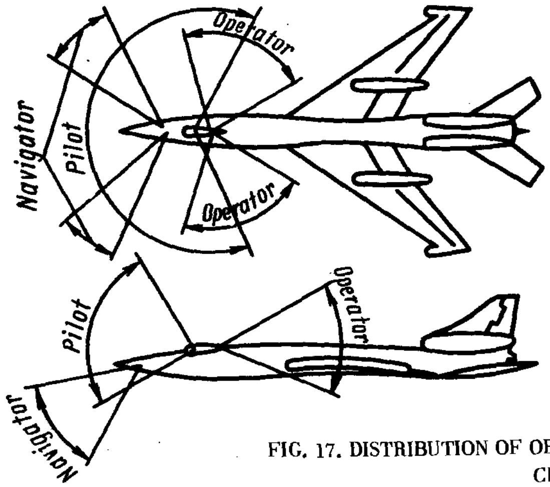


FIG. 17. DISTRIBUTION OF OBSERVATION SECTORS AMONG CREW MEMBERS

When observing the surrounding ground or air space, pay attention to the following:

— when taxiing-out from the aircraft parking site, keep an eye on the taxiing aircraft, passing-by trucks, different obstacles and ground personnel;

— when airborne, watch the aircraft joining the group and those flying in close proximity to your own aircraft, especially the aircraft flying at the same altitude on collision courses; the observation report should contain the sector in which an aircraft is detected as well as the aircraft type, altitude, flight direction and distance.

When flying in IFR conditions, the air crew members should carry out observation with the help of the РАДОН and ПРС radar stations, СРЗО interrogator-responder and the СПО radar illumination warning unit. The navigator and operator should report to the pilot a target appearing in the scanning zone, the distance to the target, the sector in which the target is detected as well as the target flight altitude and direction.

5.2. COMMAND RADIO COMMUNICATION AND INTERCOM PROCEDURES

42. In all flights within the airfield zone, beginning from the moment of engine starting, all crew members should maintain VHF radio communication, for which purpose:

— the communication switch on the pilot's interphone control box should be set to the VHF (УКР) or ADD R/SET (ДР) position while the INTERCOM — RADIO (СПУ — РАДИО) switch should occupy the RADIO (РАДИО) position;

— the navigator's and operator's communication switch should be placed to the VHF (УКР) or ADD R/SET (ДР) position while the INTERCOM — RADIO switch should occupy the INTERCOM position;

— the RADIO (РАДИО) and COMMON (ОБЩАЯ) volume controls on the interphone control boxes of all crew members should be set to the extreme right-hand position.

43. Two-way command radio communication with the flight control officer should be maintained by the pilot while the navigator and operator should operate in the receiving mode only.

To establish interphone communication with the crew members, the pilot should depress the INTERCOM (СПУ) button, and the navigator and operator, the CONFERENCE CALL (ЦИРКУЛЯРНЫЙ ВЫЗОВ) buttons.

The above-described communication procedure should be maintained during en-route flights when the aircraft is within the airfield zone and in formation flights.

After departing from the initial waypoint and obtaining the flight mission execution clearance from the flight control officer in an en-route flight, the operator (on the pilot's permission) should change over to HF radio communication in accordance with the flight mission and communications plan.

44. In emergency cases presenting a threat to the flight safety, all the crew members should change over to VHF radio communication (by setting the INTERCOM — RADIO (СПУ — РАДИО) switch to the RADIO position) and maintain communication with one another via the VHF radio set, which makes it possible to simultaneously monitor communications with the control tower and other air crews.

Concurrent operation of the НЕОН HF radio transmitter and РСИУ radio receiver on frequencies multiple to those of the HF radio transmitter, the HF transmitter operation may be monitored at the output of the VHF radio receiver, thus disturbing normal reception conditions.

5.3. PREPARATION FOR TAXIING-OUT AND AIRCRAFT TAXIING

45. Prior to taxiing out, the pilot should proceed as follows:

— listen to the reports of the crew members that the entrance doors are closed and make sure that his entrance door is closed, too;

— give the following command to the operator: "Pressurize cabin, turn on pressurization system" and obtain the command execution affirmative from him; on receiving the "Pressurize cabin" command, the operator should set the entrance door pressure-sealing lever to the OPEN (ОТКРЫТО) position and check to see that the pressure in the door rubber seals rises to 2.7—3.2 kgf/cm^2 within 22 to 25 s;

— make sure that the pressure in the main and booster hydraulic systems is normal (203 to 220 kgf/cm^2, with the pointers free of vibration) and that all the three hydraulic booster cut-in valves occupy the TWO SYSTEMS CUT IN (ВКЛЮЧЕНЫ ДВЕ СИСТЕМЫ) position;

— make certain that the emergency braking hydraulic system is under pressure; boost-charge the system, if required;

— check to see that the pitch angle of minus 5° is set on the flight director indicator and remote-reading gyro horizon;

— make sure that the АУАСП critical angle-of-attack and g-load warning unit is not caged by the built-in test button;

— by referring to illumination of the amber lights, make sure that the air intake lips are extended;

— check the quantity of fuel in the tanks by reference to the fuel quantity gauge and verify the readings of the flowmeter indicator;

— make certain that the AUTO — MAN (АВТОМ.— РУЧН.) switch is set to the AUTO (АВТОМ.) position and the fuel automatic control units operate properly;

— cut in the fuel equalizer (АЦ) and refine the aircraft c.g. position; if the white light and both green lights labelled FRONT PUMPS ENGAGED (ВКЛЮЧЕНЫ ПЕРЕДНИЕ) and REAR PUMPS ENGAGED (ВКЛЮЧЕНЫ ЗАДНИЕ) or the white light and one green light labelled REAR PUMPS ENGAGED come to illuminate on the fuel equalizer control board, taxiing is allowed; if the white light and one green light labelled FRONT PUMPS ENGAGED are alive, taxiing is PROHIBITED; on ascertaining the aircraft normal c.g. position, turn off the fuel equalizer;

— refer to extinguishment of the green indicator light to make sure that the cross-feed cock is closed;

— make sure that the switches of the feel simulator controller (АДУ) and master vertical gyro (ЦГВ) are turned on, and the АДУ controller green light is dead;

— make sure that the damper switches are turned on (the red lights are dead and the АУ stability automatic controller (SAC) light is alive), the switch labelled SAC NORMAL — EMERGENCY (АУ НОРМАЛЬНО — АВАРИЙНО) is set to the SAC NORMAL (АУ НОРМАЛЬНО) position and closed by a cap and the transmission ratio unit (БПО) is set to the transmission ratio by referring to the marks;

— check to see that the switch labelled SUPPLY OF INSTRUMENTS FROM BATTERIES (ПИТАНИЕ ПРИБОРОВ ОТ АККУМУЛЯТОРОВ) is turned off and capped;

— listen to the operator's report on cut-in of the СРЗО interrogator-responder and correct selection of the codes on the СРЗО interrogator-responder control panel;

— obtain the taxiing-out readiness report from the navigator and operator;

— give the following command to the navigator: "Follow pre-taxiing drill chart" and make sure that the aircraft and crew members are absolutely ready for taxiing;

— give the command: "Crew, put on your oxygen masks";

— obtain the taxiing-out clearance from the flight control officer and the respective signal from the aircraft senior technician; warn the crew members of the taxiing-out start by giving the "Crew, taxiing" command.

46. Having ascertained that there are no obstacles on the taxiway, release the parking brakes. As the aircraft starts rolling, turn on the nose wheel steering control mechanism switch and depress the button of the steering control mechanism to change it over for turning the nose wheels through 40°.

Steering of the nose wheels in taxiing is controlled by pedals, with the rudder hydraulic booster engaged. With the rudder hydraulic booster disengaged, the nose wheels may be steered but in this case it is necessary to smoothly apply the pedals as abrupt application of pedals may result in failure of the nose wheel steering mechanism.

As soon as the aircraft starts moving, set the throttle levers to the IDLE (МАЛЫЙ ГАЗ) position, then check operation of the nose wheel steering control mechanism by slight application of the pedals and functioning of the main brakes.

CAUTION. IF THE AIRCRAFT FAILS TO SLOW DOWN WHEN OPERATION OF THE MAIN WHEEL BRAKING SYSTEM IS CHECKED, USE THE EMERGENCY WHEEL BRAKING SYSTEM BY PULLING THE EMERGENCY BRAKE APPLICATION LEVERS ALL THE WAY BACKWARD. KEEPING THE LEVERS IN THIS POSITION, SHUT DOWN THE ENGINES.

47. To check serviceability of the ДТ pitch damper, decelerate the aircraft by applying the brakes at a taxiing speed of 15 to 20 km/h until the aircraft noses down. In so doing, keep the control wheel strictly motionless. If the pitch damper is serviceable, lowering of the aircraft nose should be accompanied by deflection of the stabilizer position indicator pointer through 1 to 1.6° down from the horizontal stabilizer trimmed-out position (depending on the intensity of brake application). For example, with the horizontal stabilizer trimmed out (set to minus 4°), the stabilizer position indicator will show minus 5 to 5.6°. The "T1" and "T2" pointers of the ПКД damper control panel indicator will move downward, and the АУ stability automatic controller pointer will remain neutral.

48. Perform taxiing, with the engine running at idle RPM. If the taxiway is covered with ice, turn the aircraft by slight deflection of pedals and by smooth application of brakes. In this case, the taxiing speed should not exceed 5 to 6 km/h.

NOTE. The taxiing speed is selected by the pilot, proceeding from the specific situation and from the necessity to provide safety of the airfield traffic.

CAUTION: 1. NEVER TURN THE AIRCRAFT WHEN ONE OF THE LANDING GEAR BOGIES IS MOTIONLESS.

2. IF THE AIRCRAFT IS BEING TAXIED AT IDLE POWER FOR MORE THAN 15 MIN, STOP TAXIING AND, WHILE HOLDING THE AIRCRAFT IN POSITION ON THE BRAKES, RUN THE AIRCRAFT ENGINES WITH THE COMPRESSOR BLOW-OFF VALVE CLOSED FOR 1 MIN, THEN PROCEED WITH TAXIING.

While taxiing, check operation of the anti-skid unit. Application of brakes at a taxiing speed of at least 30 km/h should be accompanied by flickering of the indicator light. Permanent glow of the indicator light testifies to failure of the anti-skid unit. If this is the case, turn off the anti-skid unit, smoothly decelerate the aircraft and report the matter to the flight control officer. Takeoff with a faulty anti-skid unit is PROHIBITED.

When on straight portions of the taxiway, check operation of the aircraft emergency braking system by slight deflection of the emergency braking levers; this done, boost-charge the emergency hydraulic accumulator (the pressure should be within 203 to 220 kgf/cm^2).

In taxiing at crosswind, the aircraft has a tendency to turn upwind. However, aircraft turning is easily counteracted by pedal application, with the nose wheel steering mechanism engaged to 40° operational range.

5.4. PREPARATION FOR TAKEOFF

49. When in the holding area, proceed as follows:

— stop the aircraft on the taxiway 30 to 50 m short of the runway edge;

— extend the wing flaps to 25°;

— using the trimming mechanism, set the horizontal stabilizer to the takeoff position corresponding to an angle of minus 8° as read off the stabilizer position indicator;

— make sure that the seat locking mechanism is set to the lower position. Give the command to pull up the oxygen masks and change over to oxygen supply from the aircraft oxygen system when flying at $H \geqslant 4000$ m and in case of variable flight profile;

— give a command to the navigator to follow the aircraft pre-takeoff drill chart;

— make sure that the channel selector on control panel M-50 in set to the channel number of the ILS equipment of the departure airfield and check to see that the localizer pointer is set to its electrical zero;

— make certain that the AILERONS — FLAP-AILERONS (ЭЛЕРОНЫ — ЭЛЕРОН-ЗАКРЫЛКИ) switch on the aileron control board occupies the AUTO (АВТОМАТ) position and the white indicator lights are alive;

— refer to illumination of the white indicator lights to make sure that the aileron and rudder artificial feel mechanisms are neutral;

— check the throttle levers for proper retention;

— check pressure in the hydraulic systems;

— turn on the windscreen wipers if required;

— check zero setting of the altimeters;

— make sure that the FSC (АДУ), MVG (ЦГВ) and damper switches are turned on, and that the SAC NORMAL — EMERGENCY (АУ НОРМАЛЬНО — АВАРИЙНО) switch is capped; in so doing, ascertain that the FSC ON (АДУ ВКЛЮЧЕН) green indicator light and СПН SUPPLY (ПИТАНИЕ СПН) green indicator light on the damper indicator panel as well as the PD (ДТ) red warning lights are dead, whereas the SAC OFF (АУ ОТКЛЮЧЕН) light is alive;

— turn on the Pitot tube and angle-of-attack transmitter heating systems but not earlier than 1 to 2 min before takeoff (irrespective of weather conditions);

— request the line-up clearance from the flight control officer and the technician responsible for aircraft inspection;

— when cleared, taxi to the line-up point; prior to braking the aircraft in the takeoff position, set the pedals to neutral, release the nose wheel 40° range steering button and make sure that the nose wheel steering mechanism has been switched over for turning the wheel through 5°.

50. When at the line-up point, proceed as follows:

— apply the parking brakes;

— give the command to the navigator to follow the aircraft pre-takeoff drill chart;

— set the takeoff heading on the НКП combined course indicator and make sure that the localizer bar is within the indicator centre;

— set the flight regime selector on control panel ПУ-30 to the СВОД position and enable the LANDING regime; the localizer bar should be within the НКП combined course indicator centre; then, disable the LANDING regime;

— check operation of the fuel automatic control units.

NOTE: When flying for combat missions, turn on the inert gas system;

— shift the throttle levers of both engines to the maximum non-reheat power position and, as soon as the engine RPM reach 85 %, reverse the ailerons from one extreme position to the other one, deflect the horizontal stabilizer by applying full forward and backward pressure to the control column, then return the stabilizer to the trimmed-out position; when deflecting the ailerons and stabilizer, watch restoration of pressure in the hydraulic systems and make sure that the feel simulator controller is not engaged;

— make sure that the aircraft is absolutely ready for takeoff and inform the crew members on the takeoff readiness in compliance with the pre-takeoff drill chart;

— restrain the shoulder harness;

— request the takeoff permission from the flight control officer.

51. The navigator should proceed as follows:

— check correspondence of readings of the compass system to the takeoff heading;

— retain the seat pan in the rear position and fasten the safety belts;

— read the respective pre-takeoff drill chart paragraphs by the pilot's command;

— check the scope of information received from the pilot by reference to the pre-takeoff drill chart.

NOTES: 1. When performing takeoffs from airfields located in areas where the compass system induction flux-gate transmitter features operation instability (or metal reinforcement of the runway jams to the magnetic field) and there is no possibility of magnetic slaving, set up the takeoff great-circle course manually, by using the course selector on control panel ПУ-1, after aligning the aircraft strictly with the runway centre line. The great-circle takeoff course should be set by reference to the navigator's indicator, with the switch set to the MAIN (OCH.) position.

2. When flight is performed in areas where induction flux-gate transmitter ИД-2 features operation instability, do not perform magnetic slaving of the main and stand-by gyro units.

The slaving switch of the stand-by gyro unit should occupy the DG (ГПК) position. Calculate the great-circle takeoff course to be set by the course selector by using the following formula:

$GCC_{t/o} = TH_{t/o} - \beta_{afld}$.

3. When it is possible to use the astrotracker, subject the compass system to celestial monitoring in the holding area.

5.5. TAKEOFF

5.5.1. Takeoff with Aircraft Mass within 80 Tons

52. Perform takeoff on the aircraft, up to 70 t in mass, at cruising reheat power, and on the aircraft, 70 t in mass and above, at full reheat power.

Select the required power setting by using the following procedure:

— set the maximum non-reheat power for both engines by simultaneous shifting of both throttle levers;

— check readings of the engine instruments;

— when shifting the throttle levers, make certain that their retention device is properly adjusted;

— bring one of the engines to a rating corresponding to 84 divisions on the УПРТ fuel-control unit lever position indicator and check afterburner enabling by reference to the pressure indicated by the reheat fuel pressure gauge (the fuel pressure should be at least 14 kgf/cm^2), coming-on of the REHEAT (ФОРСАЖ) indicator light, exhaust gas temperature and forward-directed jerk of the aircraft;

— set up the same power rating for the other engine;

— after igniting the afterburner of the second engine, simultaneously shift the throttle levers of both engines to set the required takeoff power for both engines; the fuel pressure indicated by the reheat fuel pressure gauges should be at least 20 kgf/cm^2 at cruising reheat power and no less than 40 kgf/cm^2 at full reheat power.

CAUTION: 1. IF THE REHEAT POWER SETTING OF ONE OF THE ENGINES FAILS TO BE SELECTED AFTER THE SECOND ATTEMPT, DISCONTINUE THE TAKEOFF AND CLEAR THE RUNWAY.

2. IF THE AIRCRAFT HELD BY THE PARKING BRAKES STARTS MOVING DURING ENGINE ACCELERATION TO REHEAT POWER, SHIFT THE THROTTLE LEVERS OF BOTH ENGINES TO THE "IDLE" POWER SETTING. NEVER PERFORM TAKEOFF UNTIL THE CAUSE OF TROUBLE IS DETECTED AND THE LANDING GEAR WHEEL TYRES ARE PROPERLY INSPECTED.

NOTES: 1. The pilot has to know the estimated takeoff run and airborne distances, the minimum decision speed (for the case of failure of one of the engines) as well as location of obstacles along the takeoff line and the direction for a safe turn in case of an aborted takeoff after overrunning the runway.

2. If the flaps have been extended by less than 23° or by more than 30°, the afterburner engagement is accompanied by sounding of the horn prohibiting the takeoff.

53. The pilot should inform the crew members about the takeoff by giving the "Taking off" command. Release the brakes by simultaneously relieving the effort applied to both brake control pedals so as to preclude aircraft running with partially braked wheels. During the takeoff run, hold the direction by gentle smooth application of pedals. The wheel brakes may be used for correcting the takeoff run direction only in case of absolute necessity only.

When performing the takeoff run, pay major attention to holding the direction, determining the moment of the nose-wheel lift-off initiation and to assuming the normal pitch angle (within 8 to 9°).

At a speed of 300 km/h, apply a full back pressure to the control column and keep it in this position until the aircraft starts nosing-up and the nose wheels clear the runway.

The aircraft unstick speed and nose-wheel lift-off initiation speed versus the aircraft takeoff mass in standard weather conditions are shown in Fig. 18.

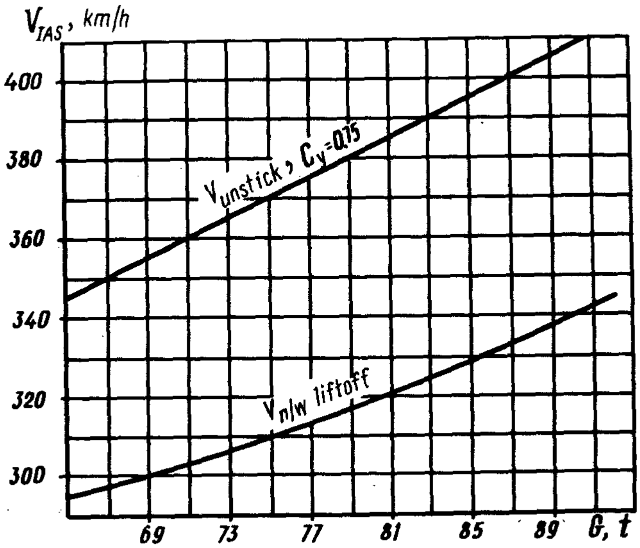


FIG. 18. UNSTICK AND NOSE-WHEEL LIFT–OFF SPEED VERSUS TAKEOFF MASS OF AIRCRAFT Ту-22Б

On defining the moment of nose wheel lifting, move the control column forward at a rate, depending on the pitch angle increase rate, to a position providing aircraft unsticking at a pitch angle of 8 to 9^0 (approximately to the trimmed-out position). The beginning of aircraft nosing-up and the moment of the nose-wheel lift-off initiation are determined by a change in the horizon position relative to the cabin glass panel and fuselage upper lines.

Decrease of the pitch angle during takeoff leads to increase of the takeoff run and aircraft unsticking speed.

54. During takeoff on the aircraft having the flight mass of 70 to 72 t the aircraft unsticking takes place in the process of build-up of the takeoff pitch angle which may be fixed only after aircraft unsticking (during aircraft acceleration in climbing flight); in case of a higher flight mass, the aircraft unsticks after build-up and fixation of the normal pitch angle (8 to 9°) by the pilot when the aircraft attains the required unsticking speed. The aircraft unsticking speed versus the aircraft takeoff mass is given in Table 7 (for standard conditions and unstick pitch angle of 8.5°) and in Fig. 18.

Table 7

G, t	70	75	80	85	90	92
$V_{unstick}$, km/h	360	370	385	395	405	410

NOTE. Proceeding from the strength of the landing gear nose wheels, the maximum permissible speed of the aircraft at the moment of nose-wheel lift-off should not exceed 360 km/h.

CAUTION. STOP INCREASING THE PITCH ANGLE IF THE CRITICAL ANGLE-OF-ATTACK AND G-LOAD WARNING UNIT OPERATES DURING TAKEOFF.

55. When airborne, brake the wheels at a height of 10 to 15 m and set the landing gear and flaps control switches in the retraction position.

The retraction of the nose leg is followed by automatic cut-in of the feel simulator controller (АДУ), stability automatic controller (АУ) as well as stability automatic controller and pitch neutral setting system (СПН). This is accompanied by coming-on of the FSC (АДУ) and СПН green indicator lights and by fading-out of the SAC (АУ) red warning light.

CAUTION. NEVER PULL BACK THE RETAINER LEVER WITH THE LANDING GEAR CONTROL SWITCH SET TO THE NEUTRAL POSITION.

Maintain the climb angle at such a level that the airspeed should not exceed 500 km/h until full retraction of the landing gear and flaps. Use the stabilizer trimming mechanism to counteract the control column pitch-up forces rising with airspeed increase as well as due to retraction of the landing gear and flaps and afterburner disengagement.

The aircraft takeoff run and unstick speed versus the weather conditions and aircraft takeoff mass are shown in Fig. 2.

5.5.2. Takeoff of Aircraft with Takeoff Mass Exceeding 80 Tons

56. When preparing the aircraft with the takeoff mass exceeding 80 t for flight, the pilot should determine the takeoff run and airborne distances from the nomogram given in Fig. 2 for the actual takeoff conditions and evaluate the possibility of takeoff, bearing in mind that the unstick speed is not to exceed 420 km/h.

Takeoff of the aircraft with a higher takeoff mass is characterized by increase of the time period between the beginning of aircraft nose lifting and the aircraft unsticking. Apply the control column all the way backward at an airspeed of 320 km/h.

Nose wheel lift-off takes place depending on the flight mass at airspeeds shown in the chart given in Fig. 18. After lifting off the nose wheels and assuming a 4 to 6° pitch-up angle, maintain this attitude by forward application of the control column. On attaining the speed which is 15 to 20 km/h lower than the estimated unstick speed, smoothly assume the takeoff angle by applying the control column backward. The aircraft unstick will take place at a speed estimated for the given flight mass.

After unsticking, the airborne aircraft is stable and well controllable.

CAUTION. IT IS PROHIBITED TO FURTHER INCREASE THE PITCH ANGLE DURING THE TAKEOFF RUN AND AFTER UNSTICKING IF THE CRITICAL ANGLE-OF-ATTACK AND G-LOAD WARNING UNIT OPERATES WHEN THE AIRCRAFT IS BEING BROUGHT TO THE TAKEOFF PITCH ANGLE ATTITUDE.

5.5.3. Navigator's Actions During Takeoff

57. During takeoff, the navigator should proceed as follows:
— start the clock mechanism;
— cut in dead reckoning of the НБА automatic bomber navigation equipment;
— put down the takeoff time and heading;
— report the attaining of speeds of 150, 200, 250, 300, 350 km/h, takeoff angle achieving speed, unstick speed and the speeds after every 50 km/h till the moment of full retraction of the landing gear and flaps to the pilot via the intercom;
— turn on the Pitot tube heater and, if required, the glass heater;
— turn on the Doppler ground speed and drift meter to operate in the illumination mode;
— turn on radio altimeter РВ-25 by setting the switch to the OPERATION (РАБОТА) position;
— turn on the radar to operate in the warm-up mode;
— make sure that the entire navigation equipment and radar operate properly.

5.5.4. Crosswind Takeoff

58. When performing the crosswind takeoff run, hold the direction by pedal application, without using the wheel brakes. If the effectiveness of the nose wheels and rudder is insufficient, use the wheel brakes.

Perform takeoff at a crosswind component of 6 to 7 m/s in the same way as in still air. Minor banking of the aircraft which may occur at the moment of unsticking should be counteracted by slight deflection of the ailerons.

To counteract aircraft banking in the direction of the applied pedal after aircraft unsticking during takeoff at a crosswind component of 8 to 9 m/s and above, turn the control wheel into the wind while pulling the control column backward.

The following approximate recommendations may be given as to the control wheel deflection, depending on pedal application: at a 12-m/s crosswind component, keep the aircraft from turning by applying the respective pedal and turn the control wheel by 25 to 30° in the opposite direction. This deflection of the control wheel corresponds to 4 to 5° of aileron deflection. The forces applied to the control wheel in this case will be within 12 to 13 kgf.

After the aircraft clears the runway, keep the aircraft from possible banking by using the ailerons. Thereupon, gently set the pedals to the neutral position with simultaneous respective deflection of the ailerons to balance the aircraft laterally. This done, set the landing gear and flap control switches to the retracted position.

In the process of climb acceleration, make a corrective upwind turn by the drift angle magnitude.

5.5.5. Peculiarities of Takeoff in Weather Minima

59. The flight technique and aircraft crew actions during takeoff in takeoff weather minima are the same as in normal takeoff.

However, takeoff calls for greater caution and high flying accuracy on the part of the pilot since the takeoff run, aircraft unsticking and its separation from the ground take place in conditions of limited visibility of the landmarks. Further climb to a safe flight altitude may be performed only by reference to instruments in unsteady flight conditions characterized by variation of the pitch angle and loads applied to the control wheel and column.

With the aircraft lined up on the runway, the pilot should once again make sure that the flight and navigation instruments and PB-УМ low-altitude radio altimeter are serviceable, set the 5° pitch angle on the scales of the ПП flight director indicator and gyro horizon, then make sure that the heaters of the Pitot tube, angle-of-attack transmitter, glass panels and engines are turned on.

During the takeoff run, pay particular attention to accurate holding of the direction, timely pulling of the control column and assuming the takeoff pitch angle. After unsticking, make sure that the wings are level and the aircraft climbs steadily.

Before entering clouds, fully pass to flying on instruments.

On retracting the landing gear and flaps, set up a 10-m/s climb speed and bring the engines to a lower rating on attaining the airspeed of 700 km/h.

To maintain the assigned airspeed, the control wheel and column must be moved smoothly and precisely.

Abrupt and excessive application of the control wheel and column may originate considerable g-loads; overspeeding is also possible in that case.

After breaking through the clouds or climbing to the assigned altitude, select the required power setting.

5.6. CLIMB

5.6.1. Climb During Circling Flight

60. On attaining the airspeed of 450 km/h, make sure that the landing gear and flaps get retracted, then turn off the afterburners of both engines in succession, set up an airspeed of 500 km/h and trim out the aircraft if required.

When climbing, check the aircraft attitude and operation of the engines by reference to the flight and navigation instruments.

Observe the aircraft behaviour at the beginning of climb to make sure that the roll, yaw and pitch dampers function properly.

With the stability automatic controller and dampers operating properly and transmission ratios set adequately, the aircraft is steady in flight and has no tendency to fluctuations in yaw, roll and pitch. However, if the flight is performed in disturbed atmosphere, especially at low airspeeds, the aircraft displays roll instability even with the dampers serviceable. Therefore, it is recommended to avoid overcontrolling the ailerons and rudder.

On reaching the altitude of 450 to 470 m, start decreasing the vertical climb speed, simultaneously decelerating the engines so as to avoid inscreasing the airspeed in excess of 500 km/h, and level off the aircraft at the circling flight pattern altitude.

Check retraction of the landing gear, flaps and air intake lips and inform the crew members accordingly. Set the landing gear and flaps control switches to the neutral position.

5.6.2. Climb in Flying to Maneuvering Area or for Combat Employment

61. Perform climb at maximum non-reheat or reheat power, depending on the flight mission.

The optimum climbing conditions for maximum non-reheat and reheat power settings are as follows:

— 780 to 800 km/h up to 6000 m;

— $M = 0.88$ to 0.9 from 6000 to 11,000 m;

— $M = 1.05$ above 11,000 m.

In flights which are not aimed at attaining the maximum flight range, climb to an altitude of 7000 m and higher at an airspeed of 700 km/h ($M = 0.9$).

After takeoff, retract the landing gear and flaps, without letting the airspeed exceed 500 km/h. On making sure that the landing gear, flaps and air intake lips have been retracted, set the landing gear and flaps control switches to the neutral position.

CAUTION: 1. IF THE AIR INTAKE LIPS FAIL TO RETRACT AUTOMATICALLY, TRY TO RETRACT THEM MANUALLY. TO THIS END, SET THE AIR INTAKE LIPS CONTROL SWITCH ON THE ENGINE STARTING CONTROL PANEL TO THE " RETRACTED" POSITION. IF THE AIR INTAKE LIPS REMAIN IN THE EXTENDED POSITION, IT IS ALLOWED TO FLY AT MACH NUMBER NOT EXCEEDING 0.9. IN SO DOING, DO NOT LET THE AIRSPEED EXCEED 750 KM/H. IF THE AIR INTAKE LIPS HAVE BEEN RETRACTED MANUALLY, AFTER EXTENDING THE LANDING GEAR SET THE SWITCH TO THE " EXTENDED" POSITION.

2. NEVER DEFLECT THE RUDDER BY MORE THAN 7° AT AIRSPEEDS EXCEEDING 500 KM/H.

Before entering the clouds, check to see that the Pitot tube heater and the engine anti-icing system are turned on. Proceed to flying only by reference to instruments at steady speed and pitch angle.

62. On attaining airspeed $V = 610$ km/h, the pilot should make sure that control has been automatically changed over from the ailerons to the flap-ailerons (the blue lights are alive and the white lights have extinguished).

NOTE. If the aircraft control system has failed to automatically change over to the flap-ailerons or if the aircraft is not equipped with the system used for automatic change-over of the aircraft control from the ailerons to the flap-ailerons, the pilot should select the flap-aileron control manually, for which purpose he should set the switch to the FLAP-AILERONS (ЭЛЕРОН-ЗАКРЫЛКИ) position.

It is allowed to pass from the aileron control to the flap-aileron control in straight flight at an altitude of at least 500 m, at an airspeed not exceeding 750 km/h and Mach number not over 0.9, with the autopilot disengaged and flaps retracted.

For changing over the control, proceed as follows:

— set the switch labelled AILERONS — FLAP-AILERONS (ЭЛЕРОНЫ — ЭЛЕРОН-ЗАКРЫЛКИ) to the FLAP-AILERONS (ЭЛЕРОН-ЗАКРЫЛКИ) position; as a result, the white lights should fade out and blue lights should come to illuminate on a lapse of 20 to 27 s.

On making sure that the aircraft control has been changed over to the flap-ailerons (which is indicated by illumination of the blue lights), it is allowed to pass to flying at any permissible airspeed.

CAUTION: 1. NEVER TURN OFF THE AILERON HYDRAULIC BOOSTER IF FLIGHT IS PERFORMED WITH THE FLAP-AILERONS ENGAGED.

2. IF A BANK HAPPENS TO OCCUR DURING CHANGE-OVER OF CONTROL FROM THE AILERONS TO THE FLAP-AILERONS AND BACK, COUNTERACT AIRCRAFT BANKING BY APPLYING THE CONTROL WHEEL IN THE RESPECTIVE DIRECTION WITHOUT WAITING FOR THE END OF CONTROL CHANGE-OVER.

62a. When flying at a 2000-m altitude, report pressurization of the cabin and operation of the high-altitude and oxygen equipment to the crew commander.

63. When in climb, check the cabin pressure differential by reference to the УВПД cabin altitude and differential pressure indicator (at altitudes exceeding 7000 m the pressure differential should be within 0.38 to 0.42 kgf/cm^2).

64. If climb is accomplished at an airspeed of 780 km/h at maximum non-reheat power, set up a vertical speed of 10 to 20 m/s after full retraction of the landing gear and flaps and, on attaining the airspeed of 700 km/h, turn off the afterburner; while making reference to the gyro horizon and checking the climb conditions by the rate-of-climb indicator, set up the pitch angle at which the aircraft will attain the airspeed of 780 km/h with slight acceleration.

When climbing at reheat power, accelerate the aircraft to the airspeed of 700 km/h by using the above procedure. On attaining the airspeed of 700 km/h, throttle down the engines to the cruising reheat power (or keep the engine power unchanged, depending on the flight mission) and start smoothly increasing the pitch angle to the required level, making reference to the readings of the gyro horizon and rate-of-climb indicator. In so doing, gradually increase the airspeed to 780 km/h.

When levelling off the aircraft at altitudes of up to 7000 m, turn off the afterburner 300 to 500 m short of the assigned altitude. Smoothly (with g-load $n_y = 0.5-0.6$), level off the aircraft and select the required power setting.

65. If climb is performed at an airspeed of 700 km/h, turn off (decrease the reheat rating) the afterburner and start increasing the climb angle at an airspeed of 650 km/h.

While maintaining the assigned climb airspeed, watch the increase of the Mach number. On attaining Mach number $M = 0.9$ (approximately at an altitude of 7000 m), make sure that the aileron and rudder dry-friction dampers are engaged by reference to illumination of the green indicator lights on the pilot's instrument board. Maintain this Mach number in further climb to the altitude of 11,000 m.

66. If an aircraft whose flight mass exceeds 80 t has to climb to an altitude above 11,000 m, level off the aircraft at an altitude of 11,000 m, accelerate the engines to the maximum reheat power (if they were running at cruising reheat rating), accelerate the aircraft to the airspeed corresponding to $M = 1.05$ and start further climb, maintaining the above Mach number and engine power.

CAUTION: 1. IF CLIMB IS PERFORMED AT REHEAT POWER SETTINGS, THE CREW MEMBERS SHOULD WELL KNOW THE AIRCRAFT CEILING CORRESPONDING TO THE GIVEN FLIGHT MASS, WITH THE ENGINES RUNNING AT MAXIMUM NON-REHEAT RATING. IF THE AIRCRAFT IS FOUND AT AN ALTITUDE EXCEEDING THIS CEILING, AND THE ENGINES HAVE BEEN DECELERATED TO THE MAXIMUM NON-REHEAT POWER SETTING, DESCEND TO THIS CEILING ALTITUDE OR BELOW.

2. IN FLYING TO THE MANEUVERING AREA AND BEFORE INTERCEPTION OF THE EN-ROUTE FLIGHT COURSE, READ THE ASSIGNED ALTITUDE AGAINST THE SCALE OF THE NAVIGATOR'S BAROMETRIC ALTIMETER. TO THIS END, WHEN FLYING AT THE TRANSITION ALTITUDE (AT LEAST 400 M), THE NAVIGATOR SHOULD SET THE MOVABLE SCALE OF THE ALTIMETER TO DIVISION "760".

3. THE PILOT SHOULD SET HIS BAROMETRIC ALTIMETER TO THE STANDARD PRESSURE (DIVISION "760") DURING EN-ROUTE FLIGHTS AFTER INTERCEPTION OF THE EN-ROUTE FLIGHT COURSE.

67. For using the ventilation system at altitudes of up to 2000 m, the pilot (operator) should set the switch labelled LOW ALT VENTIL (ВЕНТИЛЯЦИЯ НА МАЛЫХ ВЫСОТАХ) to the CLOSED (ЗАКРЫТО) position and keep it in this position for 5 to 6 s.

Set up air consumption in the cabin to be within 3 to 7 units as shown by the УРВК cabin air flow indicator.

On obtaining the required cabin temperature close to the preset by the PTBK pressurized cabin air temperature controller, place the CROSS-FEED EVAPOR (КОЛЬЦЕВ. ИСПАРИТ.) switch to the COLD (ХОЛ.) position and the PTBK switch, to the AUTO (АВТОМАТ) position. If the automatic temperature control fails to provide the required temperature in the cabin, change over to the manual temperature control.

5.7. DESCENT

68. Descend from high altitudes, with the engines throttled down and throttle levers set against the stops corresponding to idle power. In so doing, when flying at altitudes up to 6000 m, maintain the airspeed within the range from 500 km/h to the airspeed corresponding to $M = 0.9$. At an altitude below 6000 m, keep the descent airspeeds within 500 to 700 km/h. The maximum gliding range is attained at an airspeed of 550 km/h.

The vertical speed of descent to an altitude of 2000 m should not exceed 30 m/s (in case of emergency descent, it is allowed to have V_y not in excess of 100 m/s). At altitudes from 2000 to 1000 m the vertical descent speed should not exceed 10 m/s, and at altitudes below 1000 m it should not be over 5 m/s.

CAUTION: 1. SINCE THE SMALLER POINTER OF THE TWO-POINTER ALTIMETER IS PARTIALLY OVERLAPPED BY THE BACK END OF THE LARGER POINTER, ALTITUDE READING BECOMES DIFFICULT AT CERTAIN POSITIONS OF THESE POINTERS; IF THE PILOT IS INATTENTIVE, IT MAY EVEN LEAD TO A ±1000-M ERROR; THEREFORE, DURING DESCENT CAREFULLY CHECK THE ALTITUDE FROM 2000 M AND DOWN OVER THE TERRAIN RELIEF BY REFERRING TO THE TWO-POINTER ALTIMETER (ВД), RADIO ALTIMETER PB-25A AND NAVIGATOR'S ALTITUDE INDICATOR INCORPORATED IN THE AIRSPEED AND ALTITUDE DIRECTOR.

2. IN ALL FLIGHTS, WHEN DESCENDING FROM HIGH AND MEDIUM ALTITUDES, TURN ON THE PB-УM RADIO ALTIMETER AS SOON AS THE ABSOLUTE ALTITUDE OF 2000 M IS REACHED.

3. AT H = 2000 M AND BELOW, THE OXYGEN MASK SHOULD BE IN THE FASTENED POSITION.

Enter the clouds when flying straight on a fully trimmed-out aircraft. Before entering the clouds, cut in the engine anti-icing system and make sure that the switches of the heaters of the Pitot tube, angle-of-attack transmitter and glass panels are turned on.

When descending, the navigator should watch the altitude and, beginning from the altitude of 1800 m, report the altitude change to the pilot every 300 m as well as when approaching the circling flight altitude.

In case of bomb release failure on the bombing range, the navigator should make sure that bombs are suspended from the racks by depressing the button labelled BOMBS SUSPENDED (ПРОВЕРКА ПОДВЕСКИ БОМБ).

Bring the aircraft to the landing airfield and perform landing approach, following the directions of the flight control officer.

While on the transition level after obtaining the clearance for descent to the circling flight altitude from the flight control officer, all the crew members should set the airfield pressure on their altimeters and report the readings of their altimeters to the pilot.

5.8. LANDING APPROACH

5.8.1. General

69. The main methods of performing the landing approach in both VFR and IFR conditions are an extended rectangular-pattern approach and approach from the estimated line accomplished with the comprehensive use of radio/radar aids.

The extended rectangular-pattern approach is used for training the air crews in accomplishment of the takeoff, landing approach, approach estimation and landing with full-scale or partial employment of radio/radar aids in VFR and IFR conditions.

Fly the aircraft on the final leg in VFR and IFR conditions with the comprehensive use of airborne flight director indicators and ILS equipment. It is allowed to descend on the final leg in the clouds or under conditions of the limited visibility to the altitude which is not lower than that corresponding to the pilot's estimated weather minima or airfield weather minima if it is higher than that of the pilot.

If the aircraft fails to break through the clouds or the approach lights (red or white flickering lights) have not come in view on attaining the indicated altitude, the air crew should stop descending, go around, report the matter to the flight control officer and act according to his instructions.

5.8.2. Extended Rectangular-Pattern Approach with Employment of ILS Equipment, РСБН Short-Range Navigation and Landing System (КАТЕТ ILS System) and ПУТЬ-4 Flight Director System Instruments

A. Landing Approach by Referring to Command Bars

70. Proceeding from the runway heading, plan a maneuver for approaching the outer homing station on the landing course. To approach the outer homing station, use the altitude assigned by the flight control officer. The extended rectangular traffic pattern is shown in Fig. 19.

Before approaching the outer homing station, set the mode-of-operation switch on panel ПУ-30 to the ILS (СП) or СВОД position, depending on the radio/radar aids to be used for landing. Place the command bars switch to the ON (ВКЛЮЧЕНО) position. Using the course selector on the НКП combined course indicator, set the landing course.

When performing an ILS (СП) approach, set the number of the landing channel, corresponding to the given airfield, on control board М-50 and place the switch to the ON (ВКЛ.) position.

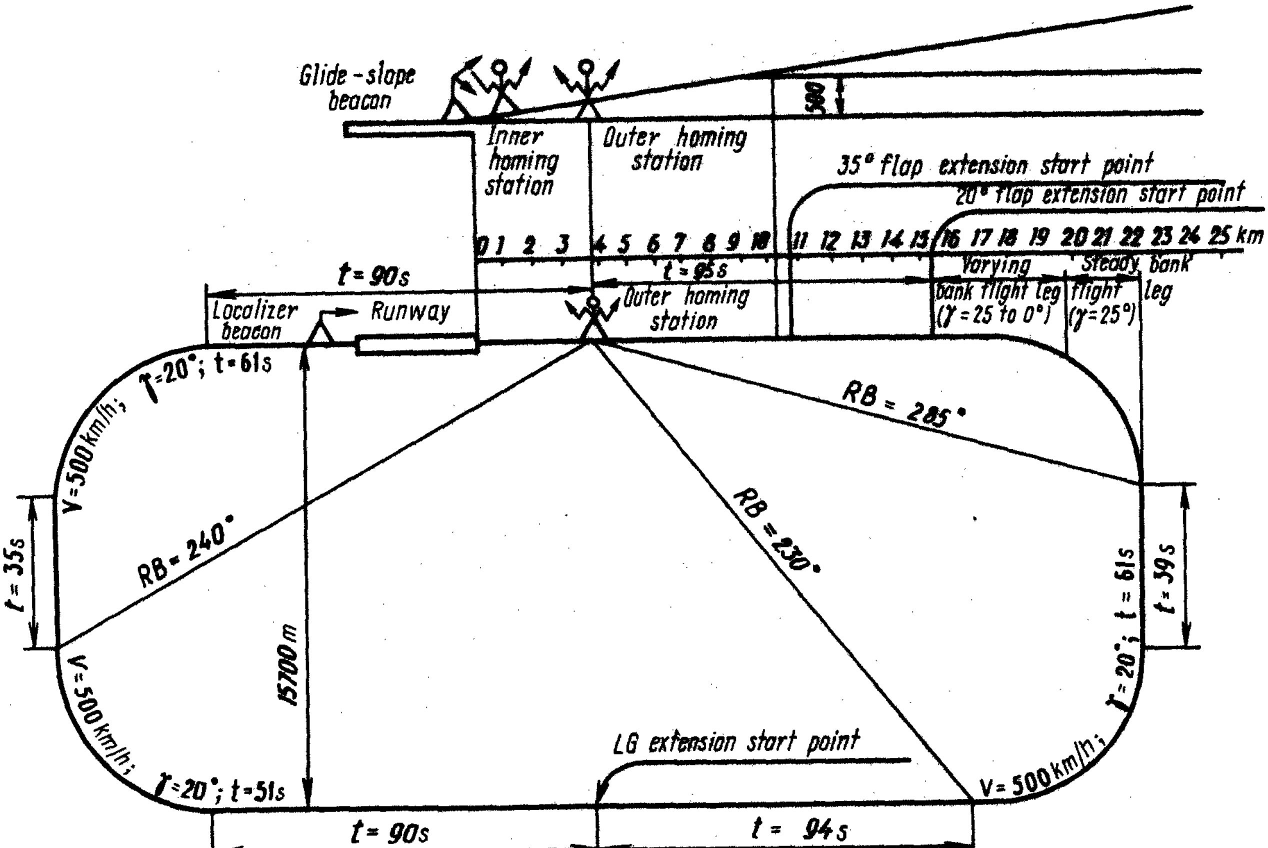


FIG. 19. EXTENDED RECTANGULAR TRAFFIC PATTERN TO BE FLOWN IN LANDING ($t_{pattern}$ = 12 min)

When performing approach by using the РСБН (КАТЕТ) short-range navigation and landing system, select the landing channel number, corresponding to the given airfield, on the РСБН system control board and turn on the LANDING (ПОСАДКА) switch.

71. Using the CHANNELS (КАНАЛЫ) switches on the РСБН system control panel, the navigator should select the РСБН system navigation channel No. corresponding to the landing airfield. This done, the navigator should make certain that the flight director indicator operates normally: the localizer zone position bar shows deviation from the runway centre line and, as the aircraft approaches the glide slope zone, the glide-slope position bar goes up. When the aircraft enters the glide slope zone, the glide-slope position bar moves towards the centre, and when the aircraft passes the glide slope zone, it goes down. The warning flags should be closed (black field). When passing the outer homing station, start the stopwatch.

72. The pilot should make sure that the combined course indicator (НКП) and flight director indicator (ПП) operate normally: the localizer zone position bar on the combined course indicator shows deviation from the runway centre line, and the vertical command bar of the flight director indicator shows the direction for the corrective turn. When the aircraft approaches the glide slope zone, the glide-slope position bar and the command horizontal bar of the flight director indicator go up and, as the aircraft enters the glide slope zone, the glide-slope position bar and the command horizontal bar of the flight director indicator move towards the centre and they move down when the glide slope zone is left behind. The warning flags are closed (black field).

Turn to Crosswind Leg

73. Perform the turn to crosswind leg 1.5 min after passing the outer homing station when flying on the landing course at the altitude assigned by the flight control officer and at an airspeed of 500 km/h with a bank angle of 20°.

If you are going to perform a circling flight, turn to crosswind leg after fully retracting the landing gear and flaps and disengaging the afterburner.

Turn to Downwind Leg

74. When the АРК automatic direction finder pointer shows a radio station relative bearing of 240° in case of the left-hand traffic pattern (120° for the right-hand traffic pattern), make a turn to downwind leg with a 20° bank angle to intercept the course reverse to the landing one with due account for the drift angle.

After turning on downwind leg, descend to the traffic pattern altitude of 500 to 700 m and maintain the airspeed of 500 km/h.

When abeam the outer homing station, extend the landing gear at an airspeed not exceeding 500 km/h (landing gear extension takes 12 to 15 s). When extending the landing gear, accelerate the engines without allowing the airspeed to drop below 480 km/h. After coming-on of the landing gear extended green indicator lights and restoration of pressure (as shown by the pressure gauge) in the main hydraulic system (within 20 s), set the landing gear control switch to the neutral position.

CAUTION: 1. WHEN SETTING THE LANDING GEAR CONTROL SWITCH TO THE NEUTRAL POSITION, NEVER PULL THE RETAINER LEVER BACKWARD. SHIFT THE LEVER TO THE NEUTRAL POSITION BY A SINGLE MOTION.

2. AFTER PLACING THE LANDING GEAR CONTROL SWITCH TO THE NEUTRAL POSITION, ONCE AGAIN CHECK ILLUMINATION OF THE LANDING GEAR EXTENDED GREEN INDICATOR LIGHTS, THEN INFORM THE CREW THAT THE LANDING GEAR IS EXTENDED.

75. After extending the landing gear, check to see that the aircraft control system is switched over from the flap-ailerons to the ailerons, the air intake lips are extended, the stability automatic controller, feel simulator controller and the stability automatic controller and pitch neutral setting system are cut out. When performing this check, make sure that:

— the AILERONS (ЭЛЕРОНЫ) white lights are alive;

— the anti-skid unit is cut in;

— the pressure in the hydraulic systems is normal;

— the AIR INTAKES EXTENDED (ВОЗДУХОЗАБОРНИКИ ВЫДВИНУТЫ) amber indicator lights are alive;

— the remaining fuel makes it possible to accomplish landing;

— the FSC (АДУ) green indicator light is dead;

— the SAC OFF (АУ ОТКЛ.) red warning light is alive;

— the SUPPLY (ПИТАНИЕ) green indicator light is dead; the circuit breakers on the auxiliary and main control boards are turned on.

NOTES: 1. If in flight the АУ stability automatic controller was switched over to to stand-by operating mode because of failure of the pitch damper, the stability automatic controller does not get disengaged during landing gear extension (the red light is dead), proceeding to operate as one pitch damper channel.

2. If the АДУ feel simulator controller fails to get disengaged automatically (the green light goes on illuminating), the pilot must cut it out manually.

3. If after landing gear extension the control system fails to automatically change over to the ailerons (the white lights are dead), the pilot should change over the control system to the aileron control manually, for which purpose he should set the AILERONS — FLAP-AILERONS (ЭЛЕРОНЫ — ЭЛЕРОН-ЗАКРЫЛКИ) switch to the AILERONS (ЭЛЕРОНЫ) position.

Turn to Base Leg

76. On attaining the radio station relative bearing RB = 230° ± DA in case of the left-hand traffic pattern (RB = 130° ± DA in the right-hand traffic pattern), make the turn to base leg with a bank angle of 20° at an airspeed of 500 km/h.

After making the turn to base leg (after closing of the localizer warning flag) during an ILS (СП) approach, depress the knob labelled BALANCE — ZERO CHECK (БАЛАНС — КОНТРОЛЬ НУЛЯ) on control panel M-50 and make sure that the vertical position bar of the НКП combined course indicator is accurately zeroed. If required, turn this knob, when still depressed, to zero the combined course indicator vertical position bar.

When on the base leg, verify the flight course. Turn on the LANDING (ПОСАДКА) switch of the РСБН system if landing approach is accomplished with the aid of KATET ILS equipment.

Turn to Final

77. As soon as the APK automatic direction finder relative bearing pointer indicates RB = 285° ± DA in case of the left-hand traffic pattern (RB = 75° ± DA in the right-hand traffic pattern), bank the aircraft at an airspeed of 500 km/h until the vertical command bar is settled in the centre of the ПП flight director indicator and keep the bar within the black circle limits by slight and smooth movements of the control wheel. Aircraft turning through 55 to 65° takes place at a permanent bank angle of 23 to 27° preset by computer B-4. Further flying of the aircraft until it gets into the localizer equisignal zone is performed by gradual decrease of the bank angle, which may be accompanied by three or four deflections of the vertical command bar. At the moments of sharp deflections of the command bar from the circle centre the pilot should react to the value of bar deflection but not to its speed.

The turn to final should be commenced at a distance of at least 22 km from the runway. If the distance is smaller, the flight and navigation system cannot provide normal interception of the landing line. The optimum runway distance at which the turn to final may be started is 22 to 28 km.

If the moment of commencement of the turn to final is determined correctly and the command bar remains in the black circle centre, the aircraft enters the localizer equisignal zone 14 to 16 km short of the runway approach end. While turning, watch the altitude and airspeed.

If the turn to final is started later, keeping of the vertical command bar within the ПП flight director indicator centre may result in interception of the localizer equisignal zone and approach to the runway centre line from the other side of the equisignal zone.

If the turn to final is commenced earlier than required, the aircraft flying with a bank angle of 23 to 27° will turn through 55 to 65° on its course. If the vertical command bar is further kept in the centre of the ПП flight director indicator scale, the aircraft will recover from the bank, approaching the runway centre line at an angle of 25 to 35° irrespective of the runway distance. When approaching the runway centre line, proceed keeping the command bar within the indicator scale centre; as a result, the aircraft will enter the localizer equisignal zone with the runway heading. In this case, the localizer zone position bar will displace to the indicator centre.

Check proper interception of the landing course by the aircraft by reference to the combined course indicator (deviation of the position bar as well as course and relative bearing readings).

After interception of the landing course, once again make sure that the localizer and glide-slope warning flags are closed and, while flying level at an airspeed of 500 km/h, extend the flaps to 20° at a distance of 18 km from the runway approach end.

78. At airfield traffic pattern altitude exceeding 700 m the aircraft enters the localizer and glide-slope equisignal zones almost at one and the same time. In this case, it is recommended to fly by reference to both command bars so as to prevent getting above the glide slope before intercepting the landing course. Extend the flaps to 20° during descent immediately after interception of the landing course.

Descent on Landing Course

79. When the glide-slope position bar approaches the first upper division of the indicator (at a distance of 10 to 14 km from the runway approach end, with the airfield traffic pattern altitude not exceeding 500 to 700 m), extend the flaps to 35° at an airspeed of 450 km/h and bring the aircraft into descent while keeping the horizontal command bar against zero.

While keeping the command bars within the black circle limits, trim out the aircraft, fly it by reference to the ПП flight director indicator and НКП combined course indicator. In so doing, watch the flight altitude and airspeed.

In the process of flaps extension and after their extension to 35° the airspeed should gradually decrease. During descent the aircraft is stable. Correct aircraft deviations from the assigned course by using the ailerons. The employment of the rudder brings in these cases the aircraft into swinging and impairs its controllability.

The loads imposed on the control column in response to variation of the airspeed and engine power should be removed by using the trimming mechanism.

80. When approaching the outer homing station, gradually decrease the airspeed so as to pass the outer homing station at an airspeed of

400 km/h and at an altitude of 250 m as shown by the two-pointer altimeter (200 m as read by the low-altitude radio altimeter).

After downward penetration through the clouds or after the approach lights come in view, take the final landing decision and proceed flying on instruments, checking the flight direction visually.

If the landing approach and its planning do not provide normal landing of the aircraft on the ranway, go around from the altitude of at least 120 m as indicated by the two-pointer altimeter (80 m as shown by the low-altitude radio altimeter) and repeat the landing approach.

81. When performing descent to the inner homing station, pay major attention to holding the aircraft in the localizer and glide slope zones and to maintaining the assigned airspeed and flight altitude. Fly by reference to the command bars until reaching the altitude of at least 100 m as indicated by the two-pointer altimeter (60 m as shown by the low-altitude radio altimeter). Thereupon, pass to visual flying while checking the airspeed, altitude and descent glide slope by instruments.

Pass the inner homing station at an airspeed of 370 to 380 km/h and at an altitude of 100 m as shown by the two-pointer altimeter (60 m as indicated by the low-altitude radio altimeter).

NOTE. Here and further in the text, the readings of the two-pointer altimeter and low-altitude radio altimeter are given without making allowance for their instrumental and methodical errors for the glide slope of 2.7° as well as for location of the outer and inner homing stations on one level with the runway and at a distance of 4 and 1 km from the runway threshold, accordingly.

After the beginning of the flare-out procedure, perform piloting only visually by reference to the earth surface or landing lights.

82. The navigator should keep a constant eye on proper accomplishment of the maneuver by the pilot during the landing approach or its planning. In case of deviations from the assigned parameters, he should immediately report the situation to the pilot.

NOTE. When the aircraft flies with the landing gear and flaps extended at an airspeed of up to 500 km/h, the position error corrections do not exceed $\Delta V = 15$ km/h for airspeed and $\Delta H = 40$ m for altitude.

B. Landing Approach by Referring to Position Bars (with command bars separated)

83. Landing approach by referring to position bars (with the command bars separated) is accomplished with the use of localizer and glide slope beacons. For performing the crosswind and downwind turns as well as for carrying out the turn to base leg and descent on the landing course, use the above procedure.

To accomplish the turn to final and intercept the landing course, with the command bars separated, proceed as follows.

On attaining the radio station relative bearing of RB = 285°±DA in case of the left-hand airfield traffic pattern (RB = 75°±DA in the right-hand airfield traffic pattern), start accomplishing the turn to final with a bank angle of 25° at an airspeed of 500 km/h. The required bank angle involved in the turn is determined by comparing the variation of the aircraft course with the change in the relative bearing, and after the localizer position bar changes its position on the scale of the HKП combined course indicator, by correlating the angle to which the localizer position bar is displaced with the aircraft remaining correction turn to intercept the landing course.

With the aircraft approaching the centre of the localizer equisignal zone, the localizer position bar of the combined course indicator will approach the indicator scale centre. If the aircraft is adequately in line with the runway, the assigned course pointer should settle against the stationary index on the indicator casing (at no drift angle) while the localizer position bar should settle against zero (within the black circle limits).

On aligning the aircraft with the runway axis, once again make sure that the localizer and glide slope warning flags are closed and extend the flaps to 20° at an airspeed of 500 km/h in level flight.

NOTES: 1. If in the process of turning to final 20 to 25° is left to intercept the landing course and the position bar does not yet change its position (which is likely as a result of an early start of the turn to final), roll the aircraft out of the turn and fly on the intercepted course till the moment the localizer position bar changes its position. After this occurs, make a corrective turn to the landing course by correlating the localizer position bar displacement with the aircraft remaining correction turn to intercept the landing course.

2. If in the process of execution of the turn to final more than 20 to 25° is left to intercept the landing course, and the localizer position bar has already changed its position (which is likely as a result of a late start of the turn to final), it is allowed to increase the bank angle to 30° to align the aircraft with the runway line.

5.8.3. Landing Approach from Estimated Line with Comprehensive Use of Radio/Radar Aids

84. To execute the landing approach from the estimated line, the navigator should calculate the distance from the descent start estimited line to the landing airfield and flight course and report the calculated data to the pilot.

When approaching this estimated line, the pilot should request the clearance for landing from the estimated line from the flight control officer; on obtaining the descent start line interception clearance, report this to the flight control officer and start descending.

The vertical and forward descent speeds should be determined proceeding from the condition of intercepting the estimated line at an airspeed of 600 km/h and altitudes of 900, 1200 and 1500 m (depending on the en-route flight level before the beginning of the descent).

Intercept the estimated line with the use of the APK automatic direction finder, PCБH short-range navigation and landing system and РАДОН radar bombsight.

At a distance of 20 km before reaching the estimated line, the navigator specifies the flight course after passing the estimated line, the relative bearing of the outer homing station as well as the range and azimuth of the initial moment of turning to the landing course.

85. When reaching the estimated line, the pilot should make a corrective turn to the course by the navigator's command, throttle down the engines and bring the aircraft into descent, simultaneously decreasing the forward speed to 500 km/h.

On attaining the 500-m altitude, level off the aircraft and extend the landing gear 1 to 2 min before starting the turn to the landing course at an airspeed not exceeding 500 km/h. Turn to the landing course by the navigator's command while flying at an altitude of 500 m and airspeed of 500 km/h.

When turning to the landing course, follow the indications of the ПП flight director indicator command bars and localizer and glide slope position bars.

After placing the aircraft on the landing course, extend the flaps to 20° at a distance of 18 to 20 km from the runway and at an airspeed of 500 km/h.

Perform further interception of the glide slope, full extension of the flaps and landing approach planning by using the procedure specified for the extended rectangular landing pattern approach.

5.8.4. Extended Rectangular Landing Pattern Approach with Employment of PCБH System

86. For planning the extended rectangular landing pattern approach with employment of the PCБH short-range navigation and landing system, it is necessary to determine the slant ranges and azimuths of the points corresponding to the beginning of the crosswind and downwind turns as well as that of the turn to base leg and turn to final at the respective airspeed and bank angle for each airfield.

The pilot should process as follows:

— when cleared for airfield approach, fly to the airfield;

— make the crosswind and downwind turns as well as the turn to base leg, turn to final when the readings of the direct-reading range and azimuth indicator become equal to the estimated values;

— after starting the turn to final, select the assigned landing approach channel and turn on the LANDING (ПОСАДКА) switch;

— enter the glide slope and localizer zones and maintain airspeeds by using the procedure specified for the extended rectangular landing pattern ILS approach.

5.8.5. Landing Approach with Employment of РАДОН Radar Bombsight

87. The radar bombsight makes it possible to bring the aircraft to the landing approach course if there are specific radar markers in the airfield area. For this purpose, the navigator should have the chart showing the location of the radar markers and indicating their slant ranges relative to the points corresponding to the beginning of the crosswind and downwind turns as well as of the turns to base leg and final. Besides, the relative bearings of these points with respect to the radar marker should be plotted on the chart.

By determining the aircraft fix relative to the radar markers in the airfield area, the navigator gives the turn point approach course. The navigator gives the turn start command, proceeding from the marker range and relative bearing to this marker.

After performing the turn to final, perform further landing approach visually by reference to the landmarks.

Presence of a radar marker within the runway axis considerably facilitates landing approach with the aid of the radar bombsight which may be performed at a lower cloud base level. Execution of this approach is allowed only for the crews based at the given airfield and who have the charts for landing approach by reference to the radar markers.

5.9. LANDING

5.9.1. Landing with Aircraft Mass of up to 60 Tons

88. On passing the inner homing station, verify the landing estimation and start smoothly reducing the engine RPM so as to have the airspeed within 360 to 370 km/h by the flare-out start moment.

It is not recommended to increase the engine RPM for verifying the landing estimation after passing the inner homing station as this complicates the landing process. Do not use the trimming mechanism to perform the pull-up.

When maintaining the required glide path of descent, the flare-out start point should be projected at a distance of 300 to 500 m from the runway approach end. Taking into account the actual aircraft landing mass, once again make sure before flare-out that the airspeed is within 360 to 370 km/h. Increase of the airspeed in excess of the specified one prolongs the landing distance. IT IS PROHIBITED to decrease the airspeed below 360 km/h.

Start the flare-out at a height of 10 to 15 m, gradually decreasing the engine RPM to idle power.

When the engines are throttled down, the aircraft acquires a tendency to increasing the pitch angle, which may result in high-level flare-out. Therefore, it is necessary to counteract the aircraft pitch increase tendency. Stop the flare-out at a height of 1 to 1.5 m. Do not use the trimming mechanism during the flare-out when throttling down the engines.

Hold off the aircraft over the ground with a gradual descent so as to touch down on the main wheels.

CAUTION. DO NOT FURTHER INCREASE THE PITCH ANGLE IF THE CRITICAL ANGLE-OF-ATTACK AND G-LOAD WARNING UNIT OPERATES WHILE LANDING.

NOTE. In the first introductory flights, the pilot usually has an impression that the touchdown is accomplished from a somewhat higher altitude. Such an impression is contributed to a considerable length of the fuselage. This should be taken into account; otherwise, the aircraft will touch the ground at speeds higher than that specified for the touchdown.

Perform landing at a pitch angle of 8 to 9°, which corresponds to landing airspeeds of 310 to 300 km/h with the aircraft mass equalling 56 t and 320 to 310 km/h if the landing mass is 60 t.

89. The operator should proceed as follows:

— turn on the TV sight;

— zero the ocular prism by using the indicators; during the landing roll, keep an eye on deployment of the brake chutes, their inflation and release, which should be immediately reported to the pilot.

90. Upon touchdown on the main wheels, counteract possible bouncing of the aircraft by small forward movement of the control column. Lower the aircraft nose until the nose wheels touch the runway and deploy the brake chutes at an airspeed not exceeding 330 km/h.

If the aircraft clears the ground after touchdown, cease further separation of the aircraft from the ground by adequate application of the control column; when the aircraft goes down, apply backward pressure to the control column, precluding a rough touchdown; in so doing, take care not to increase the pitch angle above the normal value and touch the aircraft tail bumper against the ground.

If the aircraft clears the ground at an airspeed of 290 km/h and lower, the pilot should cease aircraft separation from the ground by coordinated motions of the control column and land the aircraft without pulling the control column.

CAUTION. IT IS PROHIBITED TO REDUCE THE TOUCHDOWN SPEED BELOW 290 KM/H.

At the touchdown moment, avoid application of the brake control pedals since touchdown with braked wheels will result in destruction of the LG wheels.

Apply the brakes simultaneously with depressing the brake chute deployment button. On making sure that the brake chutes have deployed normally by the intensity of aircraft deceleration or by obtaining the respective report from the flight control tower, decrease the intensity of wheel braking. At the runway end, brake the wheels to provide normal speed of aircraft taxiing to the taxiway.

Perform landing on a 2500-m long runway, using the landing speeds recommended in Item 88 and making precise landing estimation with respect to the runway approach end.

After touching the runway by the main wheels, deploy the brake chutes and, as the aircraft lowers its nose, apply backward pressure to the control column, thus precluding a rough touching of the runway by the wheels. After the aircraft lowers its nose, start braking the wheels, using the main braking system.

91. In case of failure of the brake chute system (deployment failure of the brake chutes), brake the wheels during the landing roll by using the main braking system. If the aircraft overruns the runway, use the emergency brakes and, if there is a danger of collision with an obstacle, shut down the engines and de-energize the aircraft.

NOTE. Shut-down of the engines during the landing roll causes sharp pressure drop in the main hydraulic system and failure of the main brakes.

The landing roll length versus the weather conditions and landing mass is given in Fig. 3.

92. It is allowed to use emergency braking in the following cases:

— failure of the main braking system;

— brake chute deployment failure with simultaneous failure of the main braking system;

— overrunning the runway;

— danger of collision with an obstacle.

Brake the wheels, using the emergency braking system, by smooth pulling of the emergency braking levers with a gradual increase of the forces in response to diminishing of the landing roll speed. Emergency braking of the wheels on the soil may originate strong jolts of the aircraft as a result of wheel digging into the soil. If this is the case, decrease the intensity of wheel braking.

93. Hold the direction during the landing roll by applying the pedals in the required direction. At the end of the landing roll, retract the flaps and engage the nose LG wheel steering mechanism for turning through an angle of 40°. To this end, depress the button on the control wheel, with the flaps fully extended or in the process of their extension, and keep the button in the sunk position throughout the entire period required for execution of a smaller-radius turn.

CAUTION: 1. IF THE NOSE WHEEL STEERING MECHANISM IS ENGAGED FOR THE 40° OPERATING RANGE, PEDAL APPLICATION AT SPEEDS EXCEEDING 40 TO 50 KM/H SHOULD BE SHORT AND SMOOTH. CUT IN THE NOSE WHEEL STEERING MECHANISM FOR THE 40° RANGE WITH THE PEDALS NEUTRAL. INOBSERVANCE OF THIS REQUIREMENT MAY CAUSE DAMAGE TO THE WHEEL STEERING MECHANISM.

2. ON COMPLETING THE LANDING ROLL, TURN OFF THE HEATERS OF THE PITOT TUBE AND ANGLE-OF-ATTACK TRANSMITTER. DO IT NOT LATER THAT 1 TO 2 MIN AFTER LANDING.

Taxi in to the taxiway at a speed of 20 to 30 km/h, then drop the brake chutes when on a straight roll. It is also allowed to drop the brake chutes on the runway if removal of the brake chutes does not interfere with takeoff or landing of other aircraft and in case of crosswind landing.

5.9.2. Landing with Aircraft Mass of 61 to 65 Tons

94. Landing with aircraft mass of 61 to 65 t is allowed only in exceptional cases on well-prepared airfields in good visibility conditions.

When performing landing approach, maintain the flight speed in descent within 410 to 420 km/h when flying over the outer homing station, within 390 to 400 km/h when flying over the inner homing station and within 370 to 380 km/h before flare-out, depending on the actual landing mass. Perform the aircraft touchdown at the beginning of the runway at a speed of 320 to 330 km/h at the pitch angle being the same as for landing of the aircraft having a 60-t mass. For extending the brake chutes and further actions, the pilot should use the procedure specified for landing of an aircraft 60 t in mass.

WARNING. <u>NEVER</u> INCREASE THE LANDING SPEED ABOVE 330 KM/H.

5.9.3. Landing with Aircraft Mass Exceeding 65 Tons

95. It is allowed to land the aircraft with the 65 to 75-t mass in the emergency cases with a greater caution on the part of the pilot, in good visibility conditions, at no tail wind as well as in cases when all the possibilities of reducing the landing mass are exhausted or cannot be used.

Landing with the mass exceeding 75 t is allowed in cases when it is impossible to abandon the aircraft.

96. When langing the aircraft whose mass exceeds 65 t, observe the following requirements:

— after turning to final, maintain the airspeeds given in Table 8 versus the aircraft mass (the data given in the table are rated for standard conditions);

Table 8

Aircraft mass, t	Airspeed, km/h				Landing roll, m
	flying over outer homing station	flying over inner homing station	flare-out start	landing	
70	440	420	400	330—340	2200—2350
75	450	430	410	340—350	2350—2500
80	470	450	430	360—370	2550—2700
85	490	460	440	370—380	2700—2850

— in the process of landing, avoid the high flare-out, banking and touchdown at a high vertical speed.

CAUTION. LANDING OF THE AIRCRAFT WITH THE MASS EXCEEDING 65 TONS MAY RESULT IN DESTRUCTION OF THE LANDING GEAR WHEELS HAVING THE 330-KM/H LANDING SPEED LIMITATION;

— after deploying the brake chutes at a speed not exceeding 330 km/h, start braking the wheels.

Further, the pilot should use the procedure similar to that involved in landing of the aircraft having a normal landing mass.

5.9.4. Crosswind Landing

97. Counteract drift in the course of landing approach only by varying the aircraft heading. Maintain the flare-out start and touchdown speed at a 5-m/s and higher crosswind component to be 10 km/h higher than in case of a usual landing. Land the aircraft without banking on both bogies of the main landing gear. Immediately after touchdown, apply the pedal to counteract drift so that the aircraft axis should be parallel to the runway centre line.

CAUTION. PREMATURE DECREASE OF THE DRIFT ANGLE DURING FLARE-OUT MAY RESULT IN OFF-RUNWAY LANDING.

After the aircraft touches the runway, lower the landing gear nose leg, deploy the brake chutes and hold the direction by applying the pedals. The effectiveness of rudder application and nose wheel steering is sufficient for maintaining the landing roll direction without applying the brakes. If required, use the wheel brakes for maintaining the landing roll direction.

At the end of the landing roll, should the aircraft show a tendency to turn into the wind under the action of the brake chutes, the latter should be dropped.

5.10. GO-AROUND

98. A safe go-around of an aircraft, having a flight mass of up to 65 t, with the landing gear extended and flaps down to 35° is provided from an altitude of at least 120 m as indicated by the two-pointer altimeter (80 m as referring to the low-altitude radio altimeter). On taking the go-around decision, the pilot has to do the following:

— shift the throttle levers of the engines to the maximum non-reheat power setting while maintaining the descent angle;

— give the "Going around" warning command to the crew;

— set the landing gear and flap control switches to the retraction position;

— report the decision taken to the flight control officer;

— while increasing the airspeed to 450 to 500 km/h, decrease the vertical speed of descent to zero and bring the aircraft into climb;

— climb to the circling flight altitude, reduce the engine power to the required rating, trim out the aircraft and repeat the landing approach.

The altitude loss during go-around does not exceed 30 m.

5.11. TAXIING-IN AND SHUTDOWN OF ENGINES

99. Before taxiing to the parking site, the pilot should make certain that there is normal pressure in the hydraulic systems and that the brakes and nose wheel steering mechanism operate properly.

CAUTION: 1. IF THE NOSE WHEEL STEERING MECHANISM AND MAIN BRAKES DO NOT OPERATE PROPERLY, STOP TAXIING AND SHUT DOWN THE ENGINES ON OBTAINING THE RESPECTIVE CLEARANCE FROM THE FLIGHT CONTROL OFFICER.

2. NEVER TAXI TO THE GROUP PARKING SITE WITH NON-RELEASED OR STUCK BOMBS.

It is allowed to taxi to the parking site when the parking site and taxiways make it possible to perform a safe taxiing-in maneuver. If the parking sites are arranged closely to one another or if the taxiway and parking sites are covered with ice or snow, tow the aircraft to the parking site, using a towing tractor.

After taxiing-in to the parking site, shift the throttle levers of both engines to the IDLE stop, then turn off the nose wheel steering mechanism, engage the parking brakes, make sure that the horizontal stabilizer is trimmed out to the zero position, retract the air intake lips and give the following command to the crew: "Cut out pressurization, depressurize cabin, close oxygen valve, turn off electric power consumers and generators". The pilot himself should turn off the hydraulic boosters and all electric power consumers except for the intercom (navigation lights in the dark time of the day), booster pumps of tanks Nos 2 and 7, fuel fire shut-off cocks and fire protection system.

100. On obtaining the above command from the pilot, the operator should proceed as follows:

— set the PRESSURIZ (НАДДУВ) switch to the LESS (МЕНЬШЕ) position and keep it in this position till full cessation of air supply into the cabin (to be checked by reference to the УРВК cabin air flow indicator);

— place the CROSS-FEED EVAPOR (КОЛЬЦЕВ. ИСПАРИТ.) switch to the COLD (ХОЛ.) position;

— set the hatch doors pressure-sealing cock to the CLOSED (ЗАКРЫТО) position; in so doing, make sure that the pressure in the hoses indicated by the MB pressure gauge should drop to zero for 5 to 7 s;

— turn off all the electric power consumers, generators and storage batteries.

101. On obtaining the command execution report from the crew members, the crew commander should shut down the engines. After making sure by the aircraft technician's report that the chocks are placed under the wheels, release the parking brakes.

Shut down the engines after cooling them down for 3 min at idle power by shifting the engine shut-down cock to the SHUT-OFF (ОСТАНОВ) position. If taxiing to the parking site at idle power lasts more than 3 min, it is allowed to shut down the engines immediately after taxiing-in to the parking site.

Without waiting for the engine rotor to stop, cut out the booster pumps as well as the fire protection and anti-icing systems; close the fuel fire shut-off cocks after the engine rotor comes to a complete standstill.

Open the window and warn the ground maintenance crew of the fact that there is no air pressure in the access door pressure seals.

5.12. USE OF AUTOPILOT IN FLIGHT

102. Before taxiing out from the parking site, the pilot should make sure that the AP PREP (ПОДГ. АП) switch on the autopilot control panel is turned off and the annunciators are set to the OFF (ОТКЛ.) position.

Turn on the autopilot under steady-speed flight conditions and in straight flight within the airspeed range of 550 to 950 km/h but at an airspeed not exceeding that corresponding to $M < 1.4$ at altitudes over 2000 m.

WARNING. NEVER ENABLE THE AUTOPILOT LONGITUDINAL CHANNEL AT MACH NUMBERS FROM 0.95 TO 1.05.

NOTES: 1. When flying in the clouds, it is allowed to turn on the autopilot in conditions of non-disturbed atmosphere.

2. Switch on the autopilot only in steady flight conditions. When turning on the autopilot in climb or descent before levelling off, disable the autopilot longitudinal channel and enable it again in level flight after aircraft retrimming.

3. During autopilot-controlled flight, with the autopilot pitch channel enabled, do not let airspeed vary by more than ± 100 km/h.

103. To turn on the autopilot in level flight, in climb and descent, proceed as follows:

— make sure that the TURN, DESCENT — CLIMB (РАЗВОРОТ, СПУСК — ПОДЪЕМ) and ROLL (КРЕН) knobs on the control panel are set to the intermediate position, the P — N (Л — Ш) switch is placed to the P (Л) position and the switches labelled LAT (ПОПЕР.) and LONG (ПРОД.) are turned on (it is allowed to enable the autopilot channels separately);

— trim out the aircraft after climbing to the assigned altitude at which the autopilot is to be turned on;

— set the AP PREP (ПОДГ. АП) switch on the autopilot control panel to the ON (ВКЛ.) position (this will result in automatic centering of the yaw, roll and pitch channels); the longitudinal and lateral stabilization annunciators should start operating in the flickering mode on a lapse of approximately 10 s, periodically illuminating the PREP (ПОДГ.) and OFF (ОТКЛ.) inscriptions;

— depress the AP ON (ВКЛ. АП) button on the control panel to switch on the autopilot servo units; the lateral and longitudinal stabilization annunciators should display the ON (ВКЛ.) inscriptions;

— after turning on the autopilot, the pilot should make sure that the first channel of the pitch damper is enabled by reference to the T1 pointer of the damper indicator and indicator light (the light is dead) and that the second channel of the pitch damper and the stability automatic controller are disabled by reference to the T2 and SAC (АУ) pointers of the damper indicator and indicator lights of the second channel of the pitch damper and stability automatic controller (the lights are alive).

104. If aircraft banking does not exceed 5°, counteract it by operating the ROLL (КРЕН) knob on the control panel. Do not use this knob any further when flying with the autopilot turned on until it becomes necessary to switch over the autopilot channel.

Before repeated enabling of the autopilot or its roll channel after their cut out, set the ROLL knob to the neutral position.

105. If 0.5 to 1 min after autopilot enabling the aircraft starts descending or climbing, turn off the longitudinal stabilization switch labelled LONG (ПРОД.), trim out the aircraft repeatedly and again turn on the LONG (ПРОД.) switch.

About 10 s later, the longitudinal stabilization annunciator starts operating in the flickering mode, periodically illuminating the PREP (ПОДГ.) and OFF (ОТКЛ.) inscriptions. After the annunciator starts flickering, depress the AP ON (ВКЛ. АП) button (the longitudinal stabilization annunciator will illuminate the ON (ВКЛ.) inscription while the AC ON (ВКЛ. КВ) light-button will be alive).

Illumination of the green AC ON light-button on the pilot's autopilot control panel testifies to the altitude controller (AC) readiness for being switched on. To turn on the altitude controller, depress the AC ON light-button; as a result, the AC ON light-button should fade out, which is indicative of cutting-in of the altitude controller electromagnetic clutch.

CAUTION: 1. NEVER TURN ON THE ALTITUDE CONTROLLER IF THE "AC ON" GREEN LIGHT-BUTTON IS DEAD.

2. NEVER USE THE TRIMMING MECHANISMS WITH THE AUTOPILOT TURNED ON.

106. If aircraft deviation from the course is observed within 3 to 4 min since the moment of autopilot engagement, this means that the autopilot was enabled under conditions of aircraft sideslipping. If this is the case, turn off the lateral stabilization switch labelled LAT (ПОПЕР.)

on the autopilot control panel, retrim the aircraft and again turn on the LAT (ПОПЕР.) switch. In about 10 s, the lateral stabilization annunciator starts operating in the flickering mode, periodically illuminating the PREP (ПОДГ.) and OFF (ОТКЛ.) inscriptions. As soon as the annunciator starts flickering, depress the AP ON (ВКЛ. АП) button.

107. The roll and yaw channels will fail to get enabled if the aircraft bank angle exceeds ±(7.5 to 8.5°). The lateral stabilization annunciator will show the OFF (ОТКЛ.) inscription.

The pitch angle will fail to get enabled if the aircraft pitch angle exceeds 8.5 to 10.5° in the pitch-up direction and minus 1 to minus 0.5° in the dive direction. In this case, the longitudinal stabilization annunciator will illuminate the OFF inscription.

108. To vary the flight altitude, use the DESCENT — CLIMB (СПУСК — ПОДЪЕМ) knob located on the pilot's control panel or the PITCH (ТАНГАЖ) knob located on the navigator's control panel.

When these knobs are turned, the altitude controller gets automatically disengaged. Rotation of the DESCENT — CLIMB knob results in coming-on of the green indicator light-button labelled AC ON (ВКЛ. КВ).

Turning of the DESCENT — CLIMB knob to the stop and rotation of the PITCH knob on the navigator's control panel change the pitch angle within ±5°.

WARNING. AUGMENTED CLIMB FROM H = 2000 m TO H = 10,000 m, WITH THE "DESCENT — CLIMB" KNOB TURNED ALL THE WAY BACK, MAY ENTAIL INCREASE OF AIRSPEED TO M = 0.95 AND HIGHER. IF THIS HAPPENS, TO PROVIDE THE ASSIGNED CLIMB SPEED, DISABLE THE AUTOPILOT LONGITUDINAL CHANNEL, SET THE "DESCENT — CLIMB" KNOB TO THE NEUTRAL POSITION, TRIM OUT THE AIRCRAFT IN THE ASSIGNED CLIMB CONDITIONS AND AGAIN ENABLE THE AUTOPILOT LONGITUDINAL CHANNEL.

To vary the flight altitude from the pilot's (navigator's) control panel, level off the aircraft by setting the DESCENT — CLIMB (PITCH) knob to the neutral position. If the altitude goes on varying, disable the longitudinal channel, trim out the aircraft in level flight and again enable the longitudinal channel.

109. Turn on the altitude controller by another depression of the AC ON (ВКЛ. КВ) light-button after setting the DESCENT — CLIMB (СПУСК — ПОДЪЕМ) knob to the neutral position or by placing the PITCH knob on the navigator's control panel to the neutral position if the latter was used for varying the altitude.

To avoid abrupt pitch changes in case of autopilot disengagement after performing climb or descent by using the DESCENT — CLIMB knob, set the speed used before the beginning of attitude change.

To change the flight regime after climb or descent, turn off the AP PREP (ПОДГ. АП) switch on the pilot's control panel, change the flight regime, trim out the aircraft by using the spring feel mechanisms, turn on the AP PREP switch and, when the lateral and longitudinal stabilization annunciators start operating in the flickering mode, periodically illuminating the PREP and OFF inscriptions, depress the AP ON button and AC ON light-button when flying level. IT IS NOT ALLOWED to turn on the altitude controller during climb or descent.

110. The pilot makes a coordinated turn by using the TURN (РАЗВОРОТ) knob on the pilot's control panel while the navigator performs the same operation (when assuming aircraft control) by using the TURN knob on the navigator's control panel or OBS (ОПБ) knobs.

Clockwise and counterclockwise rotation of the TURN knob on the pilot's control panel up to the second stop builds up an aircraft bank angle of 35 to 40° while clockwise and counterclockwise rotation of the identical knob on the navigator's control panel to the second stop sets up a bank angle of 20 to 30°.

To recover the aircraft from the turn into the straight-and-level flight attitude, return the TURN knob to the neutral fixed position. Simultaneous rotation of the TURN and DESCENT — CLIMB knobs on the pilot's and navigator's control panels enables to perform ascending and descending spirals.

111. To pass autopilot control from the optical bombsight or automatic bomber navigation equipment to the navigator, shift the P — N (Л — Ш) switch on the control panel to the N (Ш) position.

For performing spirals, the navigator should depress the CTL ON (ВКЛ. УПРАВЛЕНИЯ) knob on navigator's control panel ПУШ-3С. This will result in coming-on of the CTL ON (УПР. ВКЛ.) light on the navigator's control panel and NAV CTL (УПР. ШТ.) light-button on control panel ПУ-10.

112. The autopilot servo units get normally cut out by using the AP PREP (ПОДГ. АП) switch on the pilot's control panel.

In emergency cases, the autopilot (servo units) should be cut out by depressing the fast cut-out button (КБО) on the pilot's control wheel.

If required, lateral stabilization (the roll and yaw channels) and longitudinal stabilization (pitch channel) may be cut out separately by the respective switches on the pilot's control panel. To prepare the autopilot for repeated enabling after its cut-out by the fast cut-out button, turn off and again turn on the AP PREP switch on the pilot's control panel.

113. For repeated cut-in of the longitudinal or lateral stabilization, turn off the respective stabilization switch on the pilot's control panel. Trim out the aircraft, if required, and turn on the disabled stabilization switch.

About 10 s later, the annunciator will start operating in the flickering mode, periodically illuminating the PREP (ПОДГ.) and OFF (ОТКЛ.) inscriptions. As soon as the annunciator comes to illuminate, depress the AP ON (ВКЛ. АП) button. The annunciator should display the ON (ВКЛ.) inscription. If the longitudinal stabilization was cut out, additionally turn on the altitude controller by depressing the AC ON (ВКЛ. КВ) light-button.

The position of the AP PREP switch and depression of the fast cut-out button have no effect on operation of the master vertical gyro and gyro horizon of the ПП flight director indicator.

On attaining the airspeed corresponding to M = 0.95, cut out the autopilot longitudinal stabilization. To this end, turn off the longitudinal stabilization switch labelled LONG (ПРОД.) on the pilot's control panel, having previously made sure that the aileron and rudder dry-friction damper switches are turned on.

The longitudinal stabilization annunciator should display the OFF (ОТКЛ.) inscription.

As soon as the aircraft reaches an airspeed corresponding to M = 1.05, trim out the aircraft and cut in the autopilot longitudinal stabilization.

114. If one of the engines fails, turn off the AP PREP switch on the pilot's control panel, change the flight regime in compliance with Items 376, 377, then trim out the aircraft and cut in the autopilot.

115. When cutting out the autopilot, the pilot should make sure that:

— the second channel of the pitch damper has got enabled as indicated by the T2 pointer of the damper indicator (ПКД) and extinguishment of the indicator light;

— the stability automatic controller has got cut in as referenced by extinguishment of the indicator light;

— the first channel of the pitch damper operates as shown by the T1 pointer of the damper indicator and indicator light (the light is dead);

— damper Д2К has got engaged as evident from aircraft behaviour.

116. To ensure flight safety, the autopilot is provided with:

— automatic cut-out of the lateral stabilization mode (roll and yaw channels) in case the aircraft bank angle exceeds 10 to 20°. In this case, the red light labelled AP ROLL CHANNEL OFF (КАНАЛ КРЕНА АП ОТКЛЮЧЕН) lights up on the pilot's instrument board and buzzing of the marker receiver is switched on;

— automatic disabling of the autopilot roll and yaw control channels if the aircraft bank angle exceeds 42 to 50°. This is accompanied by coming-on of the red light labelled AP ROLL CHANNEL OFF on the pilot's instrument board and buzzing of the marker receiver;

— signalling system indicating the change of the flight level by ± (70 to 110) m in the ALTITUDE STABILIZATION mode at $H \geqslant 2000$ m (the "ΔH" light comes on to illuminate in the flickering mode on the pilot's annunciator);

— automatic disabling of the pitch channel in case of the change of the flight level by ± (100 to 160) m, which is accompanied by coming-on of the AP PITCH CHANNEL OFF (КАНАЛ ТАНГАЖА АП ОТКЛЮЧЕН) light on the pilot's instrument board; concurrently, the marker receiver starts buzzing, and the longitudinal stabilization annunciator on the pilot's control panel illuminates the OFF (ОТКЛ.) inscription;

— automatic disabling of the pitch channel as soon as the limit permissible angle of attack or g-load is attained, which is indicated by coming-on of the AP PITCH CHANNEL OFF light.

Coming-on of the light is accompanied by buzzing of the marker receiver and illumination of the OFF (ОТКЛ.) inscription on the longitudinal stabilization annunciator;

— the pitch channel has two УКВ limit switches (one limit switch for subsonic speeds and the other for supersonic speeds) which cut out this channel in case of autopilot defects causing involuntary deflection of the horizontal stabilizer through angles corresponding to the maximum permissible g-loads. Cut-out of the channel is indicated by coming-on of the AP PITCH CHANNEL OFF red light located on the pilot's instrument board. Coming-on of the light is accompanied by switch-on of the marker receiver buzzer and illumination of the OFF (ОТКЛ.) inscription on the longitudinal stabilization annunciator located on the pilot's control panel.

CAUTION: 1. IF THE AUTOPILOT ROLL CHANNEL GETS AUTOMATICALLY CUT OUT, IT IS FORBIDDEN TO USE THIS CHANNEL REPEATEDLY IN THIS FLIGHT.

2. AUTOMATIC CUT-OUT OF THE AUTOPILOT PITCH CHANNEL MAY BE CAUSED BY 100-KM/H AIRSPEED CHANGE OR BY VARIATION OF AIRCRAFT TRIM. IF THIS IS THE CASE, PERFORM LONGITUDINAL TRIMMING OF THE AIRCRAFT AND AGAIN ENABLE THE AUTOPILOT LONGITUDINAL CHANNEL. IF THE PITCH CHANNEL GETS AUTOMATICALLY CUT OUT FOR THE SECOND TIME, IT IS FORBIDDEN TO USE THE DISABLED CHANNEL FURTHER IN THIS FLIGHT.

5.13. SUBSONIC FLIGHTS

117. At high airspeeds, the aircraft controlled by the ailerons or flap-ailerons has reliable lateral control within the entire range of airspeeds up to the limit speeds.

It is allowed to perform turns and 360° turns with a bank angle of up to 45°.

Flying at high subsonic airspeeds (exceeding 650 km/h) requires the lower amount of the control column movement and efforts applied per unit of g-load. Therefore, in the above conditions the amount of the control column movement should not exceed 40 to 60 mm from the trimmed-out position. In this case, the g-load will not surpass the limits permissible in service. The stability automatic controller ensures a certain angle-of-attack stability margin after the pitch damper extensible rods come to the stop, which is especially important for execution of 360° turns with the maximum bank angles.

CAUTION. WHEN THE AIRCRAFT FLYING AT HIGH AIRSPEEDS DEVELOPS G-LOADS CLOSE TO THE MAXIMUM PERMISSIBLE VALUES, THE PITCH DAMPER EXTENSIBLE RODS MOVE OUT TO THE STOP AND THE AIRCRAFT ANGLE-OF-ATTACK LONGITUDINAL STABI-

LITY MARGIN DIMINISHES. THEREFORE, AT G-LOADS CLOSE TO THE MAXIMUM PERMISSIBLE VALUES THE AIRCRAFT SHOULD BE FLOWN CAREFULLY, BY SMOOTH MOTIONS, AVOIDING EXCESSIVE INCREASE OF G-LOAD.

118. In flight, check the aircraft angle-of-attack and g-load by reference to the УАП indicator, taking care to avoid increase of the angle of attack and g-load to the critical value ($n_y > 2$).

At all flight regimes, pilot the aircraft by smooth motions of the control column, counteracting the forces by using the trimming mechanism. In so doing, avoid the artificial feel mechanism functioning within the steep section of its operational curve where the aircraft pitch control is much more complicated because of low increment of forces required for varying the g-load.

119. Presence of the feel simulator controller in the aircraft longitudinal control system does not limit the creation of the permissible operational g-load in all flight conditions (in both the vertical maneuver and 360° turn). Build-up of the maximum operational g-load is accompanied by actuation of the feel simulator controller, which is percepted by the pilot by abrupt increase of forces on the control column (the moment the feel simulator controller actuates, the red light comes to illuminate on the УАП indicator).

If application of the control column before actuation of the feel simulator controller results in build-up of g-load which is lower than that required for execution of the maneuver, the pilot may move back the control column to create the required g-load at the expense of an additional compression of the АДУ controller spring.

In so doing, he should check increase of the vertical g-load and angle of attack by reference to the УАП indicator.

Keep it in mind that due to certain inertia of the aircraft variation of the g-load lags behind the control column travel. Therefore, energetic backward movement of the control column may result in actuation of the feel simulator controller at a small g-load value (n_y = 1.1 to 1.2). In this case, the g-load reaches steady magnitude n_y = 1.7 to 2.2 on a lapse of 1 to 1.5 s after actuation of the feel simulator controller.

120. Control column speed limiter OC-1 interferes with abrupt displacement of the control column.

NOTE. Execution of the maneuver with the g-load and the airspeed loss to 610 km/h after actuation of the feel simulator controller is accompanied by change-over of the feel simulator controller, which will result in additional backward travel of the control column and increment of the g-load by 0.2 to 0.3 g.

121. If the pilot unintentionally overswings the aircraft in the longitudinal plane, it is necessary to move the control column to the trimmed-out position (or to the intermediate position between notches corresponding to −1 to −2.5° if aircraft overswinging took place at control column forces trimmed out in other than level flight) and fix the aircraft in this position for 1 or 2 s. If after this the aircraft goes on varying the pitch angle, decrease

the pitch angular rate by smooth and small (not in excess of 40 mm) movements of the control column in the direction opposite to that of aircraft movement and then level off the aircraft by a smooth movement of the control column.

122. At altitudes of up to 8000 m, perform 360° steep turns with a bank angle of up to 45° at airspeeds not below 600 km/h, and 360° shallow turns with a bank angle of up to 30°, at an airspeed of at least 550 km/h. When flying at an altitude of 10,000 m, perform 360° turns with a bank angle of 15 to 20° at an airspeed corresponding to $M=0.88-0.9$.

Enter the 360° turn and recover from it at all airspeeds by coordinated deflections of the ailerons and rudder. With an increase of the flight altitude, build up g-load in the turns and 360° turns more carefully, checking the angles of attack by reference to the УАП indicator since the column over control results in aircraft buffeting.

When executing 360° steep turns, preclude the aircraft nose going down. If this takes place, decrease the bank angle, stop descending and bring the bank angle to the assigned value.

Check proper execution of the 360° turns by reference to the gyro horizon, speed indicator, rate-of-climb indicator, altimeter, turn and sideslip indicator.

Accomplish a spiral with a bank angle of 30° at an airspeed of 550 to 600 km/h.

5.14. SUPERSONIC FLIGHTS

123. Before reaching the Mach number exceeding 0.9, make sure that the aileron and rudder dry-friction dampers are engaged and the aileron and rudder dry-friction damper green indicator lights are alive.

Accelerate both engines to the maximum reheat power in succession and start accelerating the aircraft to the assigned Mach number at an altitude of at least 11,000 m.

Flying at Mach numbers of 0.95 to 1.05 is characterized by speed instability (minor pull forces appear on the column) which interferes with aircraft piloting. Therefore, this airspeed range is considered to be transient; it is not recommended to perform turns at this airspeed.

The transition to supersonic airspeeds involves neither buffeting nor vibration.

At supersonic airspeeds the aircraft is stable and well controllable. Turns and 360° turns with a bank angle of up to 50° can be performed easily. During their execution, the aircraft reveals no tendency to diving or pitching-up.

NOTES: 1. At supersonic airspeeds the stability automatic controller is turned off. During transition from the supersonic airspeed to the subsonic one the stability automatic controller gets automatically engaged into operation.

2. At Mach numbers exceeding 1.1, a certain tendency appears to reverse banking in response to rudder deflection; therefore, it is not recommended to deflect the rudder during execution of the turns.

During en-route flights, it is recommended to perform turns with a bank angle of up to 45—50° to decrease the turning radii, with the engines operating at maximum reheat ratings.

124. If the aircraft is to climb at reheat power and the subsequent level flight leg is to be flown at supersonic speeds and then at subsonic speeds, before turning off the afterburner the crew must make sure that the actual flight altitude does not exceed the ceiling specified for the given aircraft flight mass and maximum non-reheat power setting. If in this case the filght altitude exceeds the aircraft ceiling, maintain the airspeed corresponding to the Mach number not below 0.9, with the engines running at reheat rating. If the flight altitude exceeds the aircraft ceiling, descend to this ceiling or below it while maintaining the airspeed corresponding to the Mach number not below 0.9, assume the flight level in compliance with the requirements and report the situation to the flight control officer.

125. To return from supersonic airspeeds to subsonic ones, throttle down the engines in succession to the maximum non-reheat power setting and, if required, to the desirable power setting on expiration of 3 to 5 s.

It is recommended to return from supersonic airspeeds to subsonic ones (within the airspeed instability range) in straight flight without g-loads since the increase of push forces (during aircraft deceleration) within the range of Mach numbers from 0.95 to 1.05 may be accompanied by spontaneous rise of g-loads. The push forces arising on the control column may be easily counteracted by the trimming mechanism.

It is expedient to throttle down the engines from reheat power setting to non-reheat one by smoothly shifting the throttle control levers to lower setting for 5 to 7 s. If required, it is allowed to shift the throttle control levers to the idle power stop from any reheat power setting stop for 1.5 to 2 s.

5.15. HIGH-ALTITUDE FLIGHTS AND FLIGHTS PERFORMED AT ALTITUDES CLOSE TO SERVICE CEILING

126. With the engines running at full reheat rating, the service ceilings largely depend on the Mach number or airspeed (Fig. 20).

At Mach numbers below 1, the service ceiling is limited by $C_{y\ perm}$ (buffeting onset); therefore, it cannot be recommended for flights. Besides, at M = 0.95 — 1.05, the aircraft acquires longitudinal speed instability ("Mach tuck") interfering with aircraft piloting.

The maximum magnitude of the service ceiling corresponds to the true airspeed of 1060 km/h (M = 1). In these conditions, the aircraft flies at angles of attack close to the maximum permissible ones. With the airspeed (Mach number) increasing, the service ceiling magnitude goes down.

127. The service ceilings versus the airspeed (Mach number), with the engines running at full reheat rating (95 and 100 divisions against the fuel-control unit lever position indicator), at normal aircraft flight mass (G = 69 t) are given in Table 9.

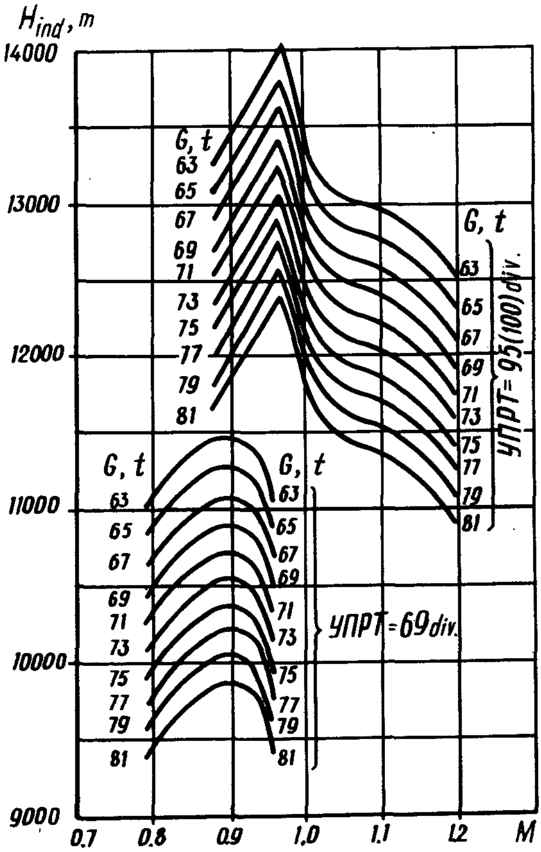


FIG. 20. SERVICE CEILING OF AIRCRAFT Ty–22Б VERSUS MACH NUMBER OF FLIGHT

Table 9

Service ceiling, m	Mach number of flight	V_{TAS}, km/h	V_{IAS}, km/h
13,500	1.0	1065	515
12,700	1.1	1168	614
12,300	1.2	1275	700
11,550	1.3	1382	810

128. The aircraft service ceiling at the takeoff mass of 85 t with subsequent continuous climb at the optimum airspeed is as follows:

— 12,200 m with the engines running at full reheat rating corresponding to 100 divisions against the fuel-control unit lever position indicator;

— 10,000 m with the engines running at maximum non-reheat rating corresponding to 69 divisions against the fuel-control unit lever position indicator.

With the engines running at power setting corresponding to less than 100 divisions against the fuel-control unit lever position indicator as well as in case of single-engine flights the range of airspeeds and the aircraft service ceiling get considerably reduced.

129. The maximum magnitudes of the service ceilings versus the engine power setting for two-engine or single-engine flights at normal flight mass (G = 69 t) are given in Table 10.

130. The aircraft service ceiling is independent of the ambient air temperature at Mach numbers below 1.2. The aircraft ceiling versus the aircraft flight mass may be determined from the chart (see Fig. 20).

Table 10

Power setting	Service ceiling, m	Mach number	V_{TAS}, km/h	V_{IAS} km/h
Minimum reheat power of both engines corresponding to 74 divisions against fuel-control unit lever position indicator	12,800	0.98	1043	529
Maximum non-reheat power of both engines corresponding to 69 divisions against fuel-control unit lever position indicator	10,500	0.98	988	567
Maximum reheat power of one engine corresponding to 100 divisions against fuel-control unit lever position indicator, with the other engine turned off	9400	0.85	925	583
Minimum reheat power of one engine corresponding to 74 divisions against fuel-control unit lever position indicator, with the other engine turned off	7100	0.77	865	615
Maximum non-reheat power of one engine corresponding to 69 divisions against fuel-control unit lever position indicator, with the other engine turned off	3100	0.57	674	577

Variation of the service ceiling versus the aircraft mass may be approximately found by the formula:

$$\Delta H_{ceil} = 100 \Delta G,$$

where ΔH_{ceil} is variation of aircraft service ceiling, m;
ΔG is variation of aircraft mass, t.

Thus, an increase of the aircraft mass by 1 t results in a decrease of the service ceiling by about 100 m.

131. With the engines running at the maximum reheat power at Mach

numbers below 0.97, the service ceiling magnitude is limited by the moment of buffeting onset. For this reason, when flying at the service ceiling with Mach numbers below 1.05 the level flight only is allowed. NEVER perform any evolutions at $M = 1$.

Aircraft flying at high altitudes and at altitudes close to the service ceiling calls for accurate and well coordinated movements of the control surfaces because of a low air density and decrease of the damping moments.

132. High-altitude subsonic flights are performed at medium speeds ($C_{y\ l.f.}$ being rather high) and relatively high Mach numbers ($M = 0.9$). Therefore, the permissible available g-load margin is low ($n_{y\ perm} = \frac{C_{y\ buf}}{C_{y\ l.f.}}$), which restricts aircraft maneuverability. This should especially be taken into account in bumpy air conditions.

To preclude possible build-up of impermissible g-loads and stalls, avoid aircraft falling into buffeting, taking all measures possible to leave the turbulent air zone.

133. For flying at altitudes exceeding 11,000 m, with the aircraft having heavy flight mass, use only supersonic airspeeds to preclude getting into the unsteady speed zone or aircraft buffeting.

CAUTION. BUILD-UP OF G-LOAD $n_y = 1.2 - 1.8$ AT ALTITUDES EXCEEDING 12,000 M WITHIN THE MACH NUMBER RANGE OF 0.8 TO 1.25 IS ACCOMPANIED BY AIRCRAFT BUFFETING, ACTUATION OF THE FEEL SIMULATOR CONTROLLER AND OPERATION OF THE CRITICAL ANGLE-OF-ATTACK AND G-LOAD WARNING UNIT. FURTHER RISE OF THE G-LOAD ORIGINATES AIRCRAFT WAGGLING WITH THE BANK ANGLES REACHING 15°. AT G-LOAD OF 2.1 AND HIGHER AT SUBSONIC AIRSPEEDS, A NEGLIGIBLE UPDRIFT IS OBSERVED.

The aircraft having a high flight mass may also be flown at subsonic speeds ($M = 0.9$) with the engine afterburner turned on.

NOTE. Perform augmented flight at the altitude which is 500 m below that maximum permissible for flying at reheat power, with $M = 0.9$.

134. The maximum altitude of flight, up to the service ceiling, is attained at airspeeds corresponding to Mach numbers $M = 0.9 - 0.95$, with the engines running at maximum reheat rating. At these altitudes, flight will be accomplished at C_y equal to the buffeting C_y magnitude ($C_{y\ buf}$) at no updrift and g-load margin. Therefore, to ensure safety of flight at altitudes close to the service ceiling, the maximum permissible flight altitude ($H_{max\ perm}$) has been established for flying at reheat rating with $M = 0.9$. This altitude is 500 m lower than that limited with regard to $C_{y\ buf}$. When flying at these altitudes, mind that the maximum thrust, angle-of-attack and updrift margins are inconsiderable. The maximum altitude with respect to the airspeed corresponding to $M = 0.9$ (H_{oper} for $C_{y\ buf}$ minus 500 m) is given in Fig. 21 for updrift $W_{eff} = 2 - 3$ m/s and vertical g-load n_y 1.05.

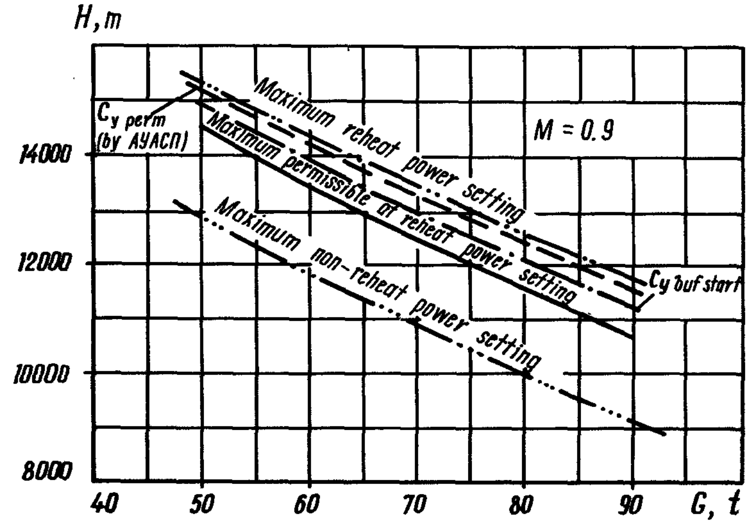


FIG. 21. FLIGHT ALTITUDE OF AIRCRAFT Ty–22Б VERSUS AIRCRAFT MASS

Perform flights close to these altitudes if there is no bumpiness. In this case, all maneuvers should be executed with the g-load not exceeding 1.05 and the bank angle not above 15°; abrupt deflection of the controls, especially horizontal stabilizers, is impermissible. Flying at these altitudes may be accomplished only at reheat power settings.

5.16. FLIGHTS AT MINIMUM PERMISSIBLE AIRSPEEDS

135. NEVER let the airspeed decrease below the minimum permissible value when flying in any flight conditions (see Fig. 4). In case of involuntary approach to the minimum permissible airspeeds, be alert not to increase the g-load to $n_y > 1$ in order to preclude low-speed buffeting (to this end, avoid abrupt movements of the control column).

The aircraft is well controllable at the minimum permissible airspeeds, with due consideration on the part of the pilot.

136. When the aircraft starts falling into buffeting conditions, immediately increase the airspeed by forward application of the control column and by accelerating the engines to the maximum non-reheat power setting. The aircraft enters the lower angles of attack without considerable delay and starts gaining speed.

CAUTION. IF THE AIRCRAFT FALLS INTO A STALL, THE CREW MEMBERS SHOULD IMMEDIATELY ABANDON THE AIRCRAFT.

If the aircraft is pulled into buffeting, inadvertent pitch-up or banking at airspeeds which are close to the minimum permissible one, increase the airspeed.

At low airspeeds, the aircraft is much more responsive to variation of the engine power setting.

137. Do not make turns at minimum permissible airspeeds. In case of dire necessity, it is allowed to make turns with bank angles not exceeding 15° after increasing the airspeed by at least 50 km/h above the minimum permissible value.

CAUTION: 1. NEVER PROCEED DECREASING THE AIRSPEED (INCREASING THE ANGLE OF ATTACK) WHEN THE CRITICAL ANGLE-OF-ATTACK AND G-LOAD WARNING UNIT OPERATES WITH THE AIRCRAFT FLYING AT AIRSPEEDS CLOSE TO THE MINIMUM PERMISSIBLE ONES.

2. IF THE CRITICAL ANGLE-OF ATTACK AND G-LOAD WARNING UNIT OPERATES IN FLIGHT TO INDICATE THE CRITICAL G-LOAD, FURTHER INCREASE OF THE G-LOAD PROHIBITED.

3. WHEN THE CRITICAL ANGLE-OF-ATTACK AND G-LOAD WARNING UNIT OPERATES, THE PILOT SHOULD DECREASE THE ANGLE OF ATTACK OR G-LOAD BY SMOOTHLY PUSHING THE CONTROL COLUMN FORWARD OR BY DECREASING THE BANK ANGLE. PROCEED WITH THE COMBAT MISSION ONLY AFTER MAKING SURE THAT THE FLIGHT REGIME HAS BEEN SELECTED CORRECTLY.

5.17. LOW AND EXTREME-LOW ALTITUDE FLIGHTS

5.17.1. Operating Instructions

138. It is allowed to carry out low and extreme-low altitude flights in the day-time and at night in the following weather conditions:

— cloud amount — up to 10;
— lower cloud base height — 100 m above the assigned flight altitude;
— horizontal visibility — at least 4 km.

It is allowed to descend to the extreme low altitudes in the day-time and at night in the following weather conditions:

— cloud amount — up to 10;
— lower cloud base height — at least 400 m;
— horizontal visibility — at least 4 km.

139. For ground-level subzero ambient temperatures, the minimum permissible flight altitudes versus the speed of flying over flat or moderate terrain and water surface in the day-time and at night in VFR conditions are given in Table 11. The altitude magnitudes specified in Table 11 should be increased by 100 m if flight is performed in the day-time and at night in IFR conditions over the surface with a monotonous snow cover and over a smooth water surface as well as in the day-time in VFR conditions over the surface having no conspicuous landmarks.

Table 11

Airspeed, km/h	Minimum permissible altitudes, m	
	in the day-time	at night
550—750	150	250
750—800	200	300
800—950	300	350
500—550	300	350

140. It is allowed to perform the folowing flights at above-zero ground-level ambient temperatures:

— long-time flight at low and extreme-low altitudes at temperatures not above +15 °C and an airspeed not exceeding 650 km/h as well as at altituds ranging from 1000 to 5000 m at an airspeed not in excees of 750 km/h;

— en-route flights at altitudes from 200 to 2000 m in the day-time and at altitudes from 300 to 2000 m at night at an airspeed of 600 to 750 km/h, with the autopilot lateral channel enabled only; when executing such flights, control the aircraft pitch angle manually;

— short-time flight (not exceeding 20 min) within the entire range of airspeeds indicated in Table 11 at up to 3000-m altitudes at temperatures of not over +25 °C and at altitudes in excess of 3000 m at a temperature of +25 °C and higher. It is allowed to carry out low and extreme-low altitude flights at above-zero ground-level temperatures only with the pressurized cabin air conditioning system turned on.

141. In conditions of good visibility of the water surface or terrain in the day-time and at night as well as at horizontal visibility of at least 6 km, it is allowed to decrease the flight altitudes indicated in Table 11 for a short time period (not over 20 min) at certain flight route legs:

— by 50 m at altitudes of 250 m and lower;

— by 100 m at altitudes of 300 m and higher.

The minimum permissible altitude of flying through a bumpy-air zone is 250 m. When performing flight in these conditions, maintain airspeed within 630 to 650 km/h.

142. In all cases when the pilot loses his notion of the flight altitude as well as when the aircraft gets into the zone with more complicated weather conditions as compared with those specified in Item 138, it is necessary to increase the absolute altitude of flying over a flat terrain up to 400 m, over 2000 to 1000-m high mountains up to 600 m and over more than 2000-m high mountains, up to 1000 m.

143. Low-altitude flights are performed in the following conditions:

— flyby-trajectory flights — in the day-time in VFR conditions, over a flat or moderate terrain at altitudes indicated in Table 11;

— stepwise-trajectory (variable-profile) flights — in the day-time and at night over broken country having no prominent and often-repeated variations of terrain relief as well as in the day-time and at night in IFR conditions, irrespective of the terrain relief, at a safe altitude estimated in compliance with the requirements of Item 147;

— horizontal-trajectory flights — in all cases of flying over broken country with prominent and often-repeated variations of the terrain relief at a safe altitude estimated in compliance with the requirements of Item 147.

144. The coverage zone of the РСИУ communication radio set, РСБН and СРЗО systems is limited by the direct visibility range, equalling 45 to 85 km at 100 to 600-m altitudes.

When flight is performed over a broken country, the image displayed on the screen of the РАДОН radar bombsight indicator has a considerable distortion, which interferes with location, identification and selection of the required radar marker. If flight is carried out over industrial areas, it is practically impossible to use the РАДОН radar bombsight because of its low-level resolving power.

At altitudes below 200 m, the ДИСС Doppler ground speed and drift meter starts operating in the MEMORY mode or generates ground speed and drift angle data into the automatic bomber navigation equipment with a considerable error; therefore, it is necessary to cut out the Doppler ground speed and drift meter at these altitudes.

When performing low-altitude flights over magnetic anomaly areas, use the compass system in the DG (ГПК) mode, with the flight course correction made only by reference to the astrotracker (provided its operation is stable).

In flying through bumpy air, drift of the compass system gyros makes up 3 to 6° for one hour and the flux-gate detector operates unsteadily, and course correction with the help of the astrotracker in IFR conditions is impossible, course correction should be done by manual setting of the estimated great-circle course.

145. Visual orientation and target search in low-altitude flights are performed by the pilot while the navigator informs the pilot of the distance to the landmark (target).

5.17.2. Preparation for Flight

146. Depending on the nature of the terrain relief, time of the day and weather conditions, select the flight trajectory (flyby, stepwise or horizontal). Single out the obstacles to be flown by in the daytime in VFR conditions by using the "zoom — descent" vertical maneuver.

When performing flight along a stepwise trajectory, change speed at least 30 to 40 km before approaching the obstacle and not earlier than 40 to 50 km after passing the obstacle.

147. When the flight leg minimum pressure reduced to the sea level is set on the barometric altimeter, estimate the safe flight altitude by using the formula:

$$H_{\text{ind safe reduced}} = H_{\text{abs safe}} + H_{\text{ter}} + \Delta H_{\text{obst}} - \Delta H_{t} - \Delta H_{\text{cor}},$$

where $H_{abs\ safe}$ — assigned absolute safe altitude of flight (to be picked up from Table 11 with due account of the condition of the earth and water surfaces, time of the day and weather conditions);

H_{ter} — height of the topmost point of the terrain relief above the sea level, m;

ΔH_{obst} — height of artificial ground obstacles, m;

ΔH_t — barometric altimeter temperature correction calculated with the help of computer slide НЛ-10, m;

ΔH_{cor} — instrument correction, m.

148. Estimate the parameters of the "zoom — descent" vertical maneuver for flying over separate obstacles in the day-time under VFR conditions:

(a) elevation of the obstacle (H_{elev}) above the assigned flight altitude, by using the formula:

$$H_{elev} = H_{obst} - H_{ass},$$

where H_{obst} — height of the obstacle above the terrain (to be determined by reference to the map), m;

H_{ass} — assigned flight altitude, m;

(b) minimum safe elevation of the obstacle flyby altitude (H_{safe}) above the assigned altitude, by using the formula:

$$H_{safe} = H_{obst} + H_{safe\ still},$$

where $H_{safe\ still}$ — minimum safe altitude of flying over the obstacle in still air, m (at V = 550 — 650 km/h, $H_{safe\ still}$ = 50 m and at V = 750 — — 850 km/h, $H_{safe\ still}$ = 80 m);

(c) the g-load magnitude and increment of the pitch angle, by using the chart given in Fig. 22.

For example, at H_{safe} = 220 m and V = 700 km/h, normal zoom entry g-load n_y should be at least 1.7; this g-load magnitude should be maintained by the pilot till initial pitch angle $\Delta\Theta$ is changed by 7°;

(d) the optimum maneuver start distance, by using the formula:

$$L_{opt} = L_{min} + 800\ \text{m},$$

where L_{min} — the minimum distance to the obstacle at the maneuver start moment (to be determined by reference to the chart given in Fig. 23 for selected maneuver parameters $\Delta\Theta$, n_y and assigned airspeed), m;

800 m — increment of the minimum distance to the obstacle with due account of the pilot's error in determining the maneuver start moment;

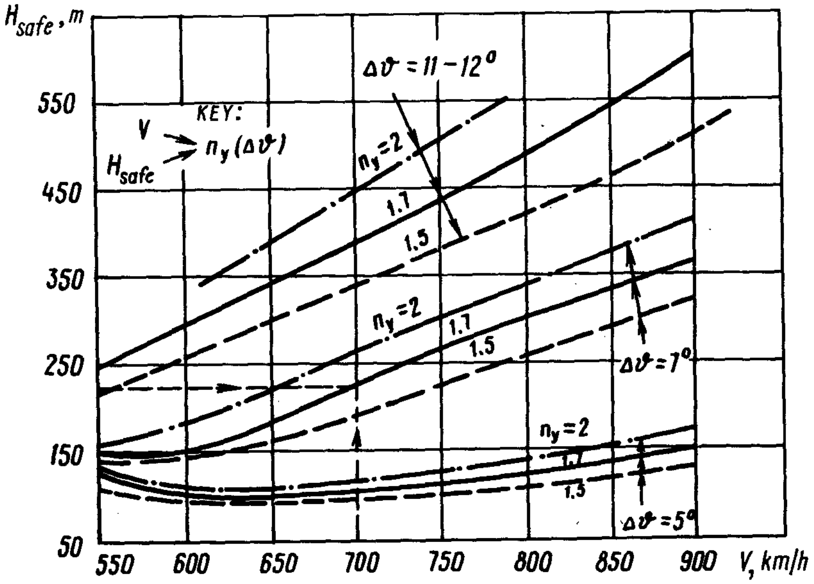


FIG. 22. OBSTACLE FLY–AROUND MANEUVER PARAMETERS VERSUS MINIMUM SAFE ELEVATION OF FLY–AROUND ALTITUDE ABOVE OBSTACLE AND AIR–SPEED (with $\alpha_{\text{throttle lever}}$ = const)

(e) the minimum distance between two single ground obstacles at which flyover of each of the obstacles is allowed with aircraft bringing to the assigned altitude, by using the formula:

$$L_{obst} = L_{b.o} + 800 \text{ m} ,$$

where $L_{b.o}$ — the distance between the obstacles (to be determined by reference to the chart given in Fig. 24 for selected maneuver parameters $\Delta\Theta$, n_y and assigned airspeed), m;

800 m — tolerance for possible pilot's error in visually determining the distance to the next obstacle.

If the actual distance between two single obstacles is shorter than the estimated minimum distance between them, do not fly over each separate obstacle; in this case, perform flight at altitudes which are higher than the most high obstacle by at least 150 m in conditions of still atmosphere and by no less than 250 m when flight is accomplished in bumpy air.

149. Fuel consumptions per kilometre on zooming flight legs ($n_{y\,entry}$ = = 1.5 — 2.0; $n_{y\,rec}$ = 0.5 — 0.4; $\alpha_{\text{throttle lever}}$ = const) and during execution of turns with 20 to 40° bank angles at low altitudes within the

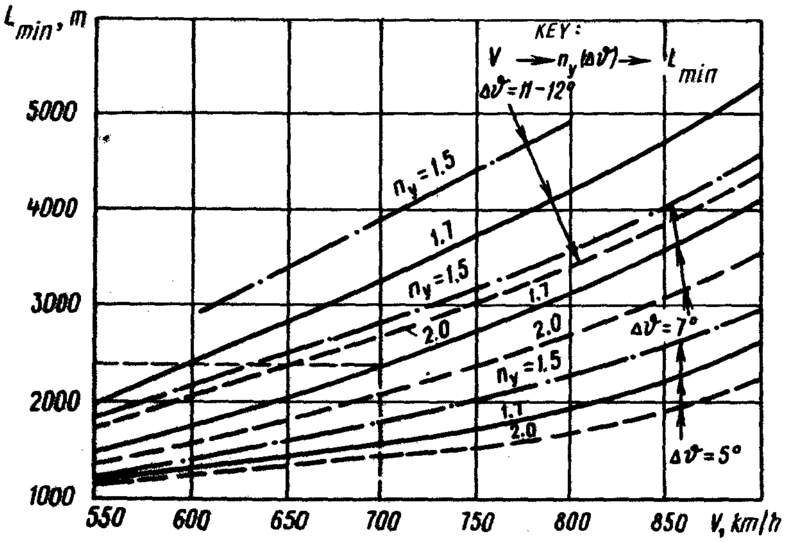


FIG. 23. MINIMUM SAFE MANEUVER START DISTANCE VERSUS AIRSPEED AND MANEUVER PARAMETERS INVOLVED IN FLYING AROUND OBSTACLE

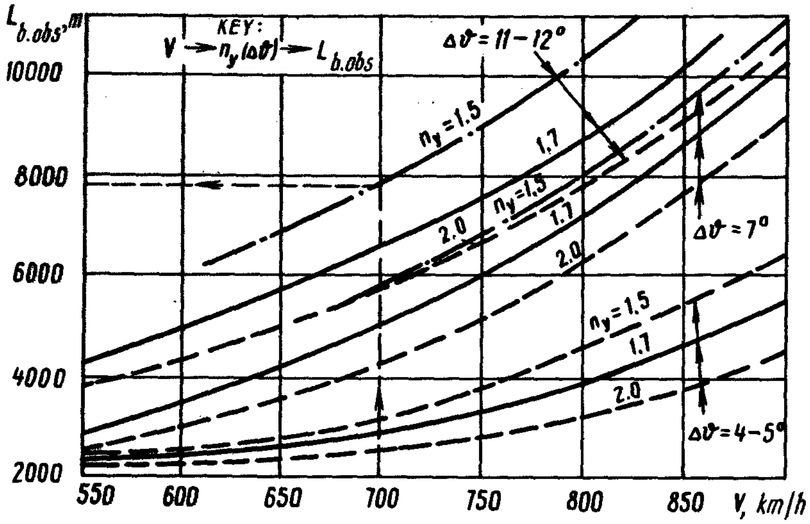


FIG. 24. MINIMUM DISTANCES BETWEEN OBSTACLES VERSUS AIRSPEED AND MANEUVER PARAMETERS INVOLVED IN FLYING AROUND OBSTACLE

airspeed range of 550 to 950 km/h are increased by 10 % as compared with fuel consumption per kilometre in steady level flight performed at the same airspeeds.

150. Fuel consumption (W_{acc}), distance covered (L_{acc}) and time (τ_{acc}) of flying at low altitudes during acceleration of the aircraft having different flight masses (G_{fl}) and at different ambient temperatures (t), with the engines running at maximum non-reheat power setting, are given in Table 12.

Fuel consumption (W_{dec}), distance covered (L_{dec}) and flight time (τ_{dec}) during aircraft deceleration (with the engine running idle) are given in Table 13.

Table 12

Acceleration range, km/h	W_{acc}, kg				L_{acc}, km				τ_{acc}, min			
	At ambient temperature, °C											
	0 and below	+10	+20	+30	0 and below	+10	+20	+30	0 and below	+10	+20	+30
						G_{fl} = 65 t						
650 – 750	105	125	165	255	4.0	4.5	6.0	9.5	0.35	0.40	0.55	0.80
650 – 850	205	245	330	515	7.5	9.0	12.0	19.0	0.65	0.75	1.0	1.60
650 – 950	310	370	490	770	11.5	13.5	18.5	28.5	0.95	1.15	1.5	2.35
						G_{fl} = 75 t						
650 – 750	120	145	190	295	4.5	5.0	7.0	11.0	0.35	0.45	0.60	0.90
650 – 850	235	285	380	590	8.5	10.0	13.5	21.5	0.75	0.90	1.15	1.80
650 – 950	355	425	570	885	12.5	15.5	20.5	32.0	1.10	1.35	1.75	2.75
						G_{fl} = 85 t						
650 – 750	145	175	235	365	5.5	7.0	9.0	14.5	0.45	0.55	0.70	1.10
650 – 850	290	350	465	725	11.5	13.5	18.5	28.5	0.85	1.05	1.35	2.15
650 – 950	435	520	695	1085	17.0	20.5	27.0	42.5	1.30	1.55	2.10	2.25

NOTE. When accelerating the aircraft from an airspeed which is lower (higher) than 650 km/h, increase (decrease) fuel consumption by 51, 59 and 72 kg, time by 0.16, 0.18, 0.21 min and the distance covered by 1.9, 2.1, 2.8 km for each 50 km/h of airspeed variation for the aircraft flight masses of 65, 75 and 85 t, respectively.

Table 13

Deceleration range, km/h	W_{dec}, kg	L_{dec}, km	τ_{dec}, min
850—700	30	7.5	0.7
850—600	45	12.5	1.2
850—500	65	17.5	1.7

NOTE. When decelerating the aircraft from an airspeed which is higher (lower) than 850 km/h, increase (decrease) fuel consumption by 9 kg, time by 0.25 min and distance covered by 2.5 km for each 50-km/h variation of airspeed.

5.17.3. Peculiarities of Aircraft Piloting

151. The main method of aircraft piloting at low altitudes over the land in the daytime is visual flight with the flight regime check by reference to instruments. If flight is accomplished over the water surface or at night, it is recommended to fly on instruments with visual reference.

When flying at an altitude of at least 2000 m, turn on the autopilot and check its serviceability.

After checking autopilot serviceability, turn off the LONG (ПРОД.) switch on the control panel and proceed executing the flight mission with the autopilot lateral channel enabled. When flying at the assigned altitude of 200 to 2000 m in the daytime and 300 to 2000 m at night, disable the autopilot lateral channel by using the AP PREP (ПОДГ. АП) or LAT (ПОПЕР.) switch on the control panel and in emergency cases, by using the fast cut-out button on the pilot's control wheel.

152. To prepare the autopilot for repeated cut-in after its cut-out by the fast cut-out button, it is sufficient to turn off and again turn on the AP PREP (ПОДГ. АП) switch. Perform repeated enabling of the autopilot lateral channel at altitudes exceeding 200 m in the daytime and 300 m at night. To this end, turn on the LAT (ПОПЕР.) and AP PREP (ПОДГ. АП) switches. In about 10 s, the lateral stabilization light indicator will start operating in the flickering mode, periodically illuminating the OFF (ОТКЛ.) and PREP (ПОДГ.) inscriptions. Thereupon, depress the AP ON (ВКЛ. АП) button (the lateral stabilization light indicator will illuminate the ON (ВКЛ.) inscription).

CAUTION. NEVER FLY AT AN ALTITUDE BELOW 2000 M WITH THE AUTOPILOT LONGITUDINAL CHANNEL ENABLED.

153. Before descending to the assigned altitude in en-route flight, set the altitude warning selector switch on the ПСВ-УМ control panel (from the РВ-УМ radio altimeter set) to the nearest altitude value which is lower than the assigned flight altitude.

During descent, the navigator should watch the altitude by the high-altitude radio altimeter and, when flying at altitudes from 1800 to 500 m (when descending from high and medium altitudes), he should report the absolute altitude to the pilot after every 300 m. When the aircraft approaches the safe flight altitude ($H_{ind\ safe\ reduced}$), the navigator should also report it to the pilot.

154. Assume the assigned altitude of flying over a flat terrain or smooth water surface by reference to the readings of the РВ-УМ radio altimeter, checking the altitude by the barometric altimeter and visually. Maintain the assigned altitude visually and by reference to the two-pointer altimeter and rate-of-climb indicator, periodically checking the absolute altitude against the РВ-УМ radio altimeter.

To assume the assigned altitude of flying over the broken country, populated points, forest as well as over the sea at sea disturbance exceeding the force of four, on descending to the 500-m absolute altitude determined by radio altimeter PB-25, note the barometric altimeter readings, compare them with the altitude estimated before flight and proceed descending to the assigned altitude, making reference to the two-pointer altimeter readings with due account of the difference between the actual altimeter reading and estimated altitude. In so doing, check altitude variation by reference to the PB-УМ radio altimeter and visually.

On reaching the assigned flight level, trim out the aircraft with respect to all the three axes.

To reduce the fatigue and to ease down the flight altitude hold, increase the flight altitude by 50 to 100 m and, after flying at this altitude for 3 to 5 min, assume the assigned altitude.

CAUTION. ACCURATE HOLDING OF ALTITUDE IS IMPEDED BY POSITIVE OR NEGATIVE FORCES ARISING ACROSS THE CONTROL COLUMN. IT IS NOT ALLOWED TO LEAVE PULLING FORCES ON THE CONTROL COLUMN.

155. Periodically (in case of airspeed variation or aircraft mass change by 3 to 4 t) set the zero pitch angle on the АГД-1 remote-reading gyro horizon indicator to fly over single obstacles in steady level flight in the daytime under VFR conditions.

Maintain the assigned flight altitude by smooth and small movements of the control column. It is recommended to control the column by both hands.

156. To set up the assigned airspeed during variation of the flight conditions, be accurate in selecting the engine power setting which will keep the assigned airspeed at a constant level in further flight. This is attained by minor shifting of the engine control levers (as compared with their initial position).

NOTES: 1. At low altitudes, the aircraft engines have a considerable thrust margin; therefore, increase of engine rating to the maximum non-reheat power setting leads to energetic acceleration of the aircraft and, in case of slackening of the pilot's attention, the aircraft may easily surpass the established limitation airspeed.

2. Variation of engine power changes longitudinal trim of the aircraft and calls for extra attention on the part of the pilot to timely counteract the arising pitch-up or diving moments and to maintain the assigned flight altitude.

3. To hold the assigned airspeed within the airspeed range of 800 to 950 km/h, the engines may accelerate to transient power settings corresponding to operation of the engine fifth-stage compressor air blow-off valves. In this case, select the following operating conditions for the engines to prevent air bleeding from the air blow-off valve control system: one engine should operate with both air blow-off valves closed, and the other, with one or both air blow-off valves open. To keep the aircraft c.g. position within the operational limits in this case, periodically cut in the fuel equalizer or shift the throttle control levers to another position to preclude fuel unbalance between the forward and rear groups of tanks above 1500 to 2000 kg.

157. Perform turns as follows:

— with a bank angle not exceeding 20° at altitudes of 200 m and lower and with a bank angle not in excess of 30° at altitudes of 200 to 400 m in the daytime under VFR conditions;

— with a bank angle not exceeding 25° in the daytime under IFR conditions and at night;

— with a bank angle not in excess of 20° in the daytime and at night by using the coordinated turn lever, with the autopilot lateral channel enabled.

In exceptional cases, it is allowed to make turns with a bank angle of up to 40° (with the autopilot lateral channel disabled) when flights are performed in the daytime under VFR conditions at altitudes exceeding those specified in Table 11 by more than 100 m.

CAUTION. NEVER PERFORM DESCENDING TURNS. IF THE AIRCRAFT CLIMBS WHEN MAKING A TURN, ASSUME THE ASSIGNED ALTITUDE IN STRAIGHT FLIGHT AFTER COMPLETING THE TURN.

158. When approaching a single obstacle to the estimated optimum maneuver start distance (to be determined visually by the pilot) in the daytime under VFR conditions, proceed as follows:

— bring the aircraft into a zoom with a selected g-load before the aircraft acquires the required pitch angle increment as referenced by remote-reading gyro horizon АГД-1 (see Fig. 22);

— when approaching the assigned obstacle fly-over altitude, level off the aircraft with n_y=0.5—0.4; if the selected n_y magnitude exceeds the g-load at which the feel simulator controller starts operating at the given airspeed, proceed smoothly bringing the control column backward while overcoming the additional force of the feel simulator controller spring engaged. In so doing, monitor the g-load by reference to the АУАСП critical angle-of-attack and g-load warning unit and do not let the g-load exceed n_y=2; when zooming, avoid decreasing the airspeed below 500 km/h; to this end, increase the engine power setting if required;

— fly level till passing the obstacle;

— after passing the obstacle, bring the aircraft into descent with V_y=5 m/s (with n_y=0.5—0.4);

— when approaching the assigned altitude, level off the aircraft.

CAUTION. IT IS ALLOWED TO FLY AROUND SINGLE OBSTACLES ONLY IN THE DAYTIME UNDER VFR CONDITIONS.

When passing to flight altitudes exceeding 2000 m, with the autopilot lateral channel enabled, turn on the autopilot longitudinal channel on a straight flight leg at a steady airspeed. To enable the autopilot longitudinal channel, proceed as follows:

— trim out the aircraft;

— turn on the LONG (ПРОД.) switch on the control panel.

On expiration of about 10 s, the longitudinal stabilization light indicator will start operating in the flickering mode, periodically illuminating the OFF (ОТКЛ.) and PREP (ПОДГ.) inscriptions. After this, depress the AP ON (ВКЛ. АП) button (the longitudinal stabilization light indicator will illuminate the ON (ВКЛ.) inscription).

5.17.4. Actions of Crew Members in Case of Failure of Aircraft Systems and Equipment

159. In case of failure of one pitch damper channel (or failure of the stability automatic controller), increase the flight altitudes by at least 50 m as compared with those indicated in Table 11. In so doing, see to it that airspeeds do not exceed 750 km/h.

160. If two pitch damper channels (or one channel of the pitch damper and stability automatic controller) fail to operate, the minimum flight altitude should be at least 500 m and the airspeed should not exceed 650 km/h. In case of inadvertent aircraft banking at a low altitude (which is indicated by illumination of the LIMIT LH ROLL (ПРЕДЕЛ. ЛЕВ. КРЕН) or LIMIT RH ROLL (ПРЕДЕЛ. ПРАВ. КРЕН) lights on annunciator ТС-2) when flight is accomplished with the autopilot lateral channel enabled, the pilot should cut out the autopilot by using the fast cut-out button and level off the aircraft. It is not allowed to enable the autopilot lateral channel in further flight.

161. In case of failure of the РВ-УМ low-altitude radio altimeter the flight altitude should be maintained at the level which is not below the estimated safe alitude of flight for the barometric altimeter (see Item 147).

162. In the event of failure of other aircraft systems and equipment, it is necessary to climb through an altitude of at least 1000 m, determine the nature and cause of the failure, report the situation to the departure airfield flight control post and act in compliance with the recommendations laid down in Section 8.

Before abandoning the aircraft at flight altitudes below 350 m, the pilot should give the "Get ready for ejection" command and bring the aircraft into climb with $n_y = 1.8–2.2$.

The other actions of the crew to be taken during ejection are laid down in Section 8 of this Manual.

5.18. LONG-RANGE FLIGHTS

163. The maximum range of aircraft flight is achieved during cruising-climb flights at non-reheat power settings at M=0.88 with the aircraft reduced mass equalling 270 t (at an altitude which is 600 to 900 m lower than the aircraft ceiling at the maximum non-reheat power setting). The reduced aircraft mass is determined by the formula:

$$G_{reduced} = G\frac{P_0}{P_H}.$$

To obtain the maximum flight range in climb, execute the cruising-climb flight at the maximum non-reheat power setting with the aircraft flying at the airspeed specified in Item 61.

If the aircraft has to climb to the assigned altitude within the minimum time according to the flight mission, perform climb at the maximum reheat power setting, maintaining the same airspeed as that involved in climb at the maximum non-reheat power setting. In this case, fuel consumption does not practically change while the distance covered by the aircraft during the climb will be reduced by about 100 to 150 km.

164. To carry out a maximum-range cruising-climb flight, proceed as follows. After climbing to the cruising-climb flight start altitude determined for $G_{reduced}=270$ t versus the aircraft mass, bring the aircraft into a maximum-range cruising-climb flight with $M=0.88$. In this case, the initial airspeed should be as follows:

— 650 km/h for the 8500-m altitude;
— 640 km/h for the 8750-m altitude;
— 630 km/h for the 9000-m altitude;
— 620 km/h for the 9250-m altitude;
— 610 km/h for the 9500-m altitude.

The initial flight altitude and its variation throughout the cruising-climb flight period with $G_{reduced}=270$ t versus the aircraft mass is determined by reference to the nomogram given in Fig. 25.

The Mach number equalling 0.88, obtained after setting up the initial airspeed at the respective altitude is kept constant throughout the entire flight period. In this case, the aircraft will maintain a constant climb attitude as a result of decrease of its mass as fuel is burnt out. The aircraft flying on the optimum profile (performs a cruising-climb flight) at the non-reheat power setting should gain about 600 m of altitude per flight hour.

Handling of the aircraft performing a cruising-climb flight does not practically differ from the flight performed at a constant altitude. The flight may be accomplished with the autopilot turned on, with a periodic correction of the flight altitude.

165. The long-range flight may also be performed at a supersonic airspeed, with the engines running at reheat rating. The flight range, however, gets abruptly cut down three-fold in this case. In this situation the higher the airspeed, the lower the flight range.

To obtain the supersonic maximum flight range, climb to the altitude of up to 8000 m at the maximum non-reheat power setting, accomplishing further climb and acceleration to the cruising Mach number of flight at full reheat.

If the Mach number, attained in the process of aircraft acceleration after shifting of the throttle control levers to the cruising reheat position, is diminished, increase the engine power above the cruising reheat one while maintaining the constant flight altitude and Mach number. As fuel gets used up, decelerate the engines so as to preclude aircraft overspeeding.

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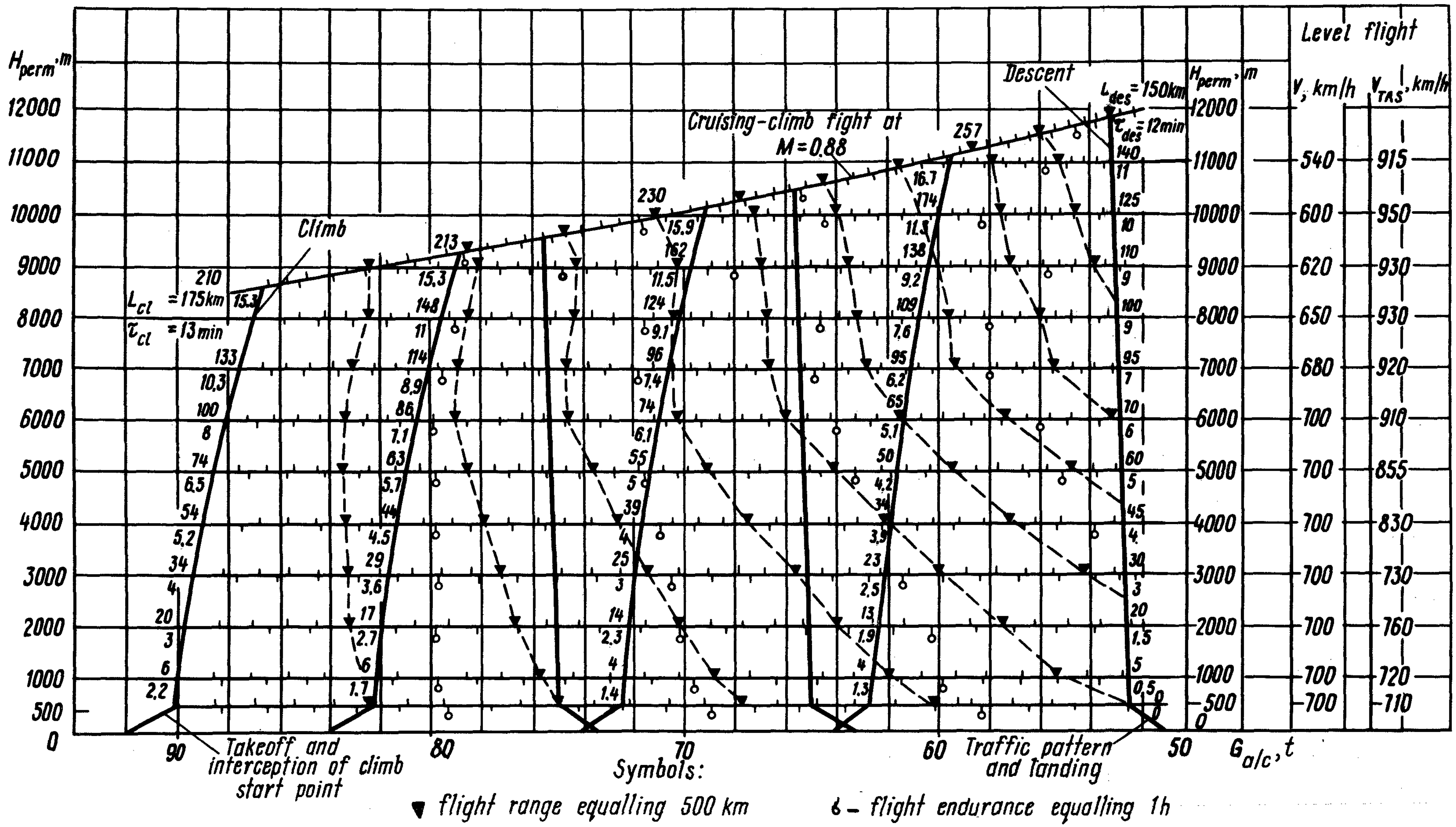

FIG. 25. NOMOGRAM USED FOR DETERMINING RANGE AND ENDURANCE OF FLIGHT PERFORMED ON AIRCRAFT Ту–22Б IN MAXIMUM–RANGE LEVEL–FLIGHT AND CRUISING–CLIMB CONDITIONS (climb is accomplished at maximum non-reheat power setting at airspeed of 780 to 800 km/h up to 6000–m altitude and Mach number of 0.88 to 0.90 on leg of climb from 6000 m to 11,000 m; descent is performed with engines running at idle power setting (O division against УПРТ indicator) at 550–km/h airspeed)

After selecting the cruising power, perform flight at a constant Mach number.

When flying at the supersonic airspeed ($M = 1.15—1.25$), make turns at full reheat with a bank angle of 50 to 45°. In this case, fuel consumption makes up 1200 to 1500 kg accordingly.

166. Descend to the circling flight altitude at an airspeed of 550 km/h with the throttle control levers set to zero against the fuel-control unit lever position indicator.

Fuel consumption in a circling flight accomplished before landing with the landing gear down for 11 min equals 1500 kg. If the circling flight period is more or less than 11 min, fuel consumption should be increased or decreased accordingly, in proportion with the duration of the circling flight period.

The unusable fuel remainder is 450 kg. It is included into the mass of an empty aircraft; therefore, it should be neglected during range estimation.

The mass of an empty aircraft should be taken from the aircraft Service Log.

Determine the guarantee (air navigation) fuel reserve (provided for the cases of inaccurate holding of the flight route, change of weather, etc.) in each special case separately, proceeding from the flight execution conditions. This fuel reserve usually approximates 10 % for subsonic flights and 15 % for supersonic flights.

167. The range and endurance of flight at the assigned fuel load (or the fuel mass required for the assigned flight range) during a cruising-climb flight and maximum-range level flight as well as climb and descent characteristics may be determined by the nomogram given in Fig. 25. The same characteristics for other different flight conditions and profiles as well as aircraft climb and acceleration characteristics at full reheat versus the ambient temperature and aircraft mass at the beginning of the acceleration process are determined in compliance with the Flight Range and Endurance Calculation Instructions.

5.19. IFR FLIGHTS

5.19.1. Flights in Clouds

168. Aircraft piloting in clouds does not differ from aircraft handling in usual conditions and calls for greater caution on the part of the pilot and smooth application of the control column in the longitudinal direction.

It should be taken into account that minor variations of the pitch angle may bring about considerable changes of the flight altitude and airspeed. Therefore, aircraft deviations should be corrected by double motions of the control column.

Pass from the climbing attitude into level flight by reference to the gyro horizon and rate-of-climb indicator, concurrently varying the engine power versus the level flight execution speed; change over the level-flight attitude for climb after selecting the engine power setting required for climb; when passing from level flight to descent, make reference to the gyro horizon and rate-of-climb indicator, simultaneously throttling down the engines to the power required to provide descent at the assigned airspeed.

When flying in clouds at altitudes of up to 10,000 m, make turns with a bank angle not exceeding 30°, and at altitudes higher than 10,000 m, with a bank angle not in excess of 20°.

To keep the assigned airspeed in the process of execution of a 360° turn or common turn, slightly increase the engine power before entering the maneuver.

169. Before entering the clouds, compare the readings of the gyro horizons with the actual aircraft position relative to the natural horizon, then turn on the engine anti-icing system and glass heater, check cutting-in of the Pitot tube and angle-of-attack transmitter heating system and pass to flying on instruments only.

When landing the aircraft in the rain or snowfall, the pilot should turn on the glass wipers after recovering from the turn to final. Set up a medium or high operating speed for the glass wipers, depending on the precipitation intensity.

With airspeed decrease, the effectiveness of the glass wipers operation goes up. When the glass wipers operate in the rain of an average intensity, visibility through the windshield is sufficient for performing a normal landing. During flare-out, the airspeed decreases and visibility through the windshield gets better. In case of a wet snow or rain, when there is a possibility of icing, turn on the glass heater.

5.19.2. Peculiarities of Engine Operation During Flights in Clouds

170. When the aircraft flies in cumulonimbus clouds at non-reheat power, an electric discharge may occur between the cloud and aircraft even at no thunderstorm, which in some cases, especially at low altitudes, may cause engine surge.

The electric discharge manifests itself in the form of a bright flash accompanied by aircraft shuddering. If this occurs, concentrate your attention on the engine instruments. If either of the engines reveals RPM drop, exhaust gas temperature rise or other surge symptoms, immediately shut down the engine by shifting the engine shut-off lever to the SHUT-OFF (OCTAHOB) position. Thereupon, evaluate the possibility of engine starting and start the engine in compliance with Items 393 through 396 of this Manual.

171. If the engine normally operates at idle power setting after its starting, set up power corresponding to no more than 45 divisions against the fuel-control unit lever position indicator. Discontinue the flight mission and proceed to the landing airfield. NEVER accelerate the engine to power

which is higher than that corresponding to 45 divisions as read off the fuel-control unit lever position indicator. If the windmilling speed is below 17 %, do not start the engine; perform a one-engine landing and make a respective entry in the check list.

5.19.3. Flight in High-Intensity Cumulus and Thunderstorm Clouds

172. Flight in high-intensity cumulus and thunderstorm clouds is dangerous because of a heavy bumpiness (sometimes leading to origination of g-loads considerably exceeding permissible g-loads), possibility of intensive aircraft icing and engine failure when the aircraft gets into a haily zone as well as because of possible discharge of lightning through the aircraft.

CAUTION. INTENTIONAL ENTRY INTO HIGH-INTENSITY CUMULUS AND THUNDERSTORM CLOUDS IS PROHIBITED.

Detect thunderstorm zones with the help of the aircraft radar which should be used for regular search of thunderstorm cells.

If thunderstorm cells are encountered on the flight route, they are displayed on the radar screen in the form of light spots with a shade. The thunderstorm cell detection range the longer, the higher the flight altitude and the more developed the thunderstorm cloud. If the thunderstorm cells are arranged in the form of an extended chain, this is indicative of an atmospheric front.

If there are thunderstorm cell marks on the radar indicator screen, fly around thunderstorm zones at a distance of 20 to 30 km, varying the aircraft course so as to avoid approaching the thunderstorm cloud to a distance closer than 10 km.

173. To successfully break through the thunderstorm zones, proceed as follows:

— before the flight, thoroughly study the weather situation, refine the flight route leg supposed to be attacked by thunderstorms, determine the type of the thunderstorm and its intensity if possible;

— intercept the atmospheric fronts at an angle of 90°.

174. It is allowed to penetrate through the thunderstorm zones above the clouds at an altitude of at least 1000 m above the top boundary of the clouds.

It is allowed to break through the frontal clouds with separate thunderstorm cells in the place where the distance between the thunderstorm cells is at least 25 km. If it is impossible to avoid getting into the dangerous thunderstorm zone by using the above methods, discontinue the flight mission, report the situation to the flight control post and perform landing on the home or nearest alternate airfield. If necessary, thunderstorm may be avoided by reheat climbing at a subsonic or supersonic airspeed. After evading from the thunderstorm, the crew should recalculate the flight range, making account for the actual fuel remainder.

When flying around the thunderstorm cell, the crew members should proceed as follows:

— turn off the radio equipment;
— turn on the glass heater;
— turn on the cabin illumination and aircraft anti-icing systems;
— set up the airspeed specified in Item 180;
— maintain the level flight.

5.19.4. Flights in Icing Conditions

175. When analyzing the weather situation before the takeoff, the crew should find out the flight legs and altitude at which the aircraft may get icy.

CAUTION. IT IS FORBIDDEN TO TAKE OFF IF THE AIRCRAFT SURFACES ARE COVERED WITH ICE, SNOW OR CONSIDERABLE LAYER OF HOAR-FROST.

176. Prior to starting the engines, cut in the engine anti-icing system and the glass heaters. With the aircraft being on the prestart line, turn on the Pitot tube and angle-of-attack transmitter heating systems.

In the process of engine run-up, taxiing, takeoff and flight at air temperature of +5 °C and below, it is allowed to use the engines only with the anti-icing system cut in, which should be accomplished before engine starting. It is allowed to use the anti-icing system at all power settings.

177. It is allowed to fly in icing conditions at true airspeeds exceeding 650 km/h. It is not recommended to fly in the icing zone for more than 15 min at true airspeeds below 650 km/h.

When performing flights in which the aircraft may get covered with ice, check cut-in of the engine anti-icing system, pilot's and navigator's glass heaters and heating systems of the Pitot tube and angle-of-attack transmitter before entering the icing zone (clouds).

In case of precipitations, turn on the glass wipers, setting up the wiper movement speed providing an adequate visibility through the cabin glass panels.

178. Determine the onset of aircraft icing in flight by appearance of an ice deposit on the glass wipers and other protruding components of the aircraft structure and by coming-on of the РИО radioisotope ice detector (RID) indicator light. Turn on the RID (РИО) switch before the flight and turn it off after taxiing in to the parking site. If the RID light comes on in flight or ice appears on the aircraft structure components, once again make sure that the engine anti-icing system, the pilot's and navigator's glass heaters and heating systems of the Pitot tube and angle-of-attack transmitter are cut in.

When going around in icing conditions, retract the landing gear and flaps, increase the airspeed up to 600—650 km/h and proceed flying at this airspeed before approaching the outer homing station beam, then decrease the airspeed up to 500 km/h, extend the landing gear and carry out a normal landing approach. The ice goes off the aircraft surfaces during accomplishment of evolutions or during increase of the airspeed up to 600—650 km/h.

5.19.5. Flights in Bumpy Air

179. If the crew is aware of bumpy air zones on the flight route, the crew must take measures to avoid getting into these zones.

On getting into a heavy bumpiness zone in the process of climb, the pilot takes a decision to proceed with the climb or to abort it, depending on the flight mission, flight mass and bumpiness zone altitude.

180. The airspeeds recommended for flying in bumpy air are as follows: 630 to 650 km/h at altitudes of up to 7000 m and $M=0.9$ at altitudes exceeding 7000 m.

If aircraft control is impossible because of heavy bumps, change the flight altitude, keeping to the recommended airspeeds. If the flight was performed at an altitude close to the cruising-climb flight altitude, decrease the altitude of flight by 1000 to 2000 m.

181. If the aircraft got into bumpy air at a low airspeed, immediately reduce the angle of attack, bring the aircraft into descent and then into level flight, increasing the airspeed to the value recommended in Item 180.

182. If the aircraft got into bumpy air at a supersonic airspeed, first change the flight altitude to recover from the bumpy air zone and, if air bumpiness persists, smoothly retract the throttle control levers to the idle power setting from any reheat power setting and decrease the airspeed to the recommended one.

CAUTION. DESCEND AT A SUPERSONIC AIRSPEED TO THE ALTITUDE OF 11,000 M. IF IT IS NECESSARY TO PROCEED WITH THE DESCENT, FIRST PASS TO A SUBSONIC FLIGHT SPEED AND THEN GO ON DESCENDING.

Intercept a new course the moment the bumpiness becomes less intensive by a successive coordinated corrective turning of the aircraft at a bank angle not exceeding 5 to 10°. In so doing, avoid applying back pressure to the control column.

When maintaining the assigned flight regime, the pilot should manipulate the control surfaces only to prevent considerable deviations from the assigned regime without eliminating minor jerks.

When flying in bumpy air, avoid frequent retrimming of the aircraft and abrupt applications of the control column (especially backward).

If the vertical gust is active for a long period of time (over 3 s), which is accompanied by aircraft pitch-up or diving, counteract the control column forces by short-time pulses of the trimming mechanism to relieve the control column forces.

183. The main instrument used for checking the actual spatial position of the aircraft in bumpy air is the gyro horizon. The auxiliary instruments used in this case are the turn-and-slip indicator and airspeed indicator.

Fly the aircraft by reference to the gyro horizon, maintaining the assigned average airspeed. Accurate holding of the assigned flight altitude is not obligatory in this case.

If aircraft banking is advancing under the action of strong and uneven air motion, the pilot has to counteract it without delay by using the ailerons and rudder.

When handling the aircraft in bumpy air, the pilot should attentively watch the autopilot operation (by observing the motion of the control levers) and spatial attitude of the aircraft, intervening into aircraft control immediately whenever required.

CAUTION: 1. NEVER TURN ON THE AUTOPILOT AND USE IT TO CONTROL THE AIRCRAFT IN HEAVY BUMPINESS.

2. AFTER RECOVERY FROM THE BUMPINESS ZONE, THE NAVIGATOR SHOULD DEPRESS THE "BOMBS SUSPENDED" ("ПРОВЕРКА ПОДВЕСКИ БОМБ") BUTTON TO MAKE SURE THAT BOMBS ARE SUSPENDED FROM THE RACKS.

Deviation of the normal g-load from the initial value as indicated by the critical angle-of-attack and g-load warning unit versus the bumpiness intensity is given in Table 14.

Table 14

Bumpiness intensity	Deviation of n_y from initial g-load value indicated by critical angle-of-attack and g-load warning unit
Minor	Below 0.05
Weak	0.05—0.1
Moderate	0.1—0.15
Moderately heavy	0.2—0.3
Heavy	Above 0.3

5.20. NIGHT FLIGHTS

184. When preparing for night flying, perform the following operations in addition to those carried out in the daytime during aircraft inspection:

— when performing external inspection of the aircraft, check serviceability of the landing lights, position lights, formation lights and flashing lights;

— after raising the seats into the working position, turn on the cabin internal illumination lights, adjust the required light intensity and make sure that all the instruments and control panels are well illuminated at the crew members' working stations;

— check serviceability of the dome light and the lamp used for illumination of the flight papers;

— turn on the position and flashing lights and check their operation;

— extend the landing lights and check them for proper functioning when switched over to the LOW (МАЛЫЙ) and HIGH (БОЛЬШОЙ) positions (shifting to HIGH for a short period of time only); the light beam should be directed along the aircraft axis. The best illuminated spot should be located at a distance of no more than 10 m from the aircraft, which will correspond to 40—50 m at the aircraft takeoff/landing angles; the check over, turn off the landing lights;

— dim all indicator lights and open the blinds of the systems abnormal condition warning lights;

— check cleanliness of the cabin glass panels.

185. To start and run up the engines, use the procedure specified for engine starting and run-up in the daytime.

As soon as the engines accelerate to idle power, extend the landing lights and shift them to the low beam.

On receiving the taxi-out clearance from the flight control officer, give the "Remove chocks" command to the aircraft technician.

On obtaining the "Chocks removed, intercom disconnected" report from the aircraft technician over the intercom, blink the landing lights. On receiving the taxiing-out signal from the senior technician, inform the crew about taxiing out over the intercom. Set the landing lights to the high beam position and start taxiing. After taxiing out from the parking site to the taxiway, change over the landing lights to the low beam position (for better visual scanning of the terrain in the process of taxiing, it is allowed to select the high beam position for a short period of time).

Before the takeoff, check illumination of the instruments, then set the landing lights to the high beam position and switch on the glass heaters. If the high beam of the lights creates a light screen, which impedes aircraft piloting, perform takeoff with the lights switched over to the low beam.

CAUTION: 1. IT IS NOT ALLOWED TO PERFORM TAKEOFF AT NIGHT ON AN AIRCRAFT WITHOUT THE LANDING LIGHTS LOW OR HIGH BEAM TURNED ON.

2. IN SNOW, RAIN, DUST OR HAZE, PERFORM TAKEOFF WITH LANDING LIGHTS SET TO THE LOW BEAM POSITION; IF THE LOW BEAM CREATES A LIGHT SCREEN, TAKEOFF IS PROHIBITED.

186. When performing takeoff at night, use the takeoff procedure specified for daytime flying. During the takeoff run, hold the direction by reference to relative displacement of the runway landing lights.

On clearing the ground, fly the aircraft by reference to the runway lights, gyro horizon, airspeed indicator and rate-of-climb indicator; before passing the runway threshold lights, pass to flying on instruments alone.

After unsticking and setting the landing gear and flap switches to the retraction position, retract the landing lights.

To perform a circling flight at night, use the flight route and airspeeds specified for the daytime circling flights. Fly by reference to instruments; it is not recommended to use the natural horizon.

187. Carry out landing approach in the same way as in the daytime, avoiding delay in the turn to final. Accomplish the turn to final on the traffic pattern altitude. When making the turn, watch the flight altitude and airspeed. Check proper alignment with the runway centre line visually or by reference to the combined course indicator localizer bar.

While on the descent path after turning to final, the pilot should be especially careful in holding the assigned airspeeds and altitudes of flying over the outer and inner homing stations.

After passing the outer homing station at an altitude of 150 to 200 m, extend the landing lights and switch them over to the high beam position.

CAUTION: 1. NEVER USE THE LANDING LIGHTS DURING SNOWFALL, RAIN AS WELL AS IN CASE OF DUST OR HAZE.

2. WHEN PERFORMING LANDING APPROACH IN IFR CONDITIONS, NEVER DISTRACT YOUR ATTENTION FROM INSTRUMENT FLYING IN ORDER TO SEARCH THE RUNWAY APPROACH LIGHTS, RUNWAY THRESHOULD OR RUNWAY LIGHTS. IN THESE CASES, IT IS ALLOWED TO PASS TO VISUAL FLYING ONLY AFTER WELL VISIBLE RUNWAY LIGHTS COME IN VIEW.

Flare out when only in the beam of the airfield searchlights, executing the flare-out procedure in the same way as in the daytime. After taxiing off to the taxiway, switch over the landing lights to the low beam.

NOTE. If the landing lights have failed to be extended completely, clear the runway, stop taxiing, retract the landing lights and extend them again.

When on the landing roll, hold the direction by reference to relative displacement of the runway lights. Extend the brake chutes and brake the aircraft in the landing roll by using the procedure specified for daytime landing.

It is possible to perform landing on the runway which is not illuminated by the airfield searchlights, with the aircraft landing lights turned on, but it requires great experience in night flying and landings on non-lit runways in a trainer aircraft on the part of the pilot. In this case, special attention should be given to accurate determination of the point at which the aircraft should start the flare-out at the assigned gliding speed and to keeping the normal holding-off profile of the aircraft over the runway.

When performing the prolonged flights at all altitudes, avoid sweating or freezing of the pilot's cabin glass panels.

5.21. FORMATION FLIGHTS

5.21.1. Daytime Formation Flights

188. The aircraft may fly in close or loose formations.

A close formation is such an arrangement of aircraft in flight in which the intervals and distances between them do not exceed two aircraft spans and lengths.

A loose formation is an arrangement of flying aircraft in which the intervals and distances between them exceed two aircraft spans and lengths but are sufficient to keep all the aircraft in the formation within the field of vision.

5.21.2. Taxiing

189. Two-way contact with the flight control officer is established by the section leader. The wingman pilots must operate in the reception mode only.

The engines should be started by the section leader's command. On obtaining the taxiing-out readiness reports from the wingmen, the section leader should request the taxiing-out clearance from the flight control officer and, on obtaining the clearance, he should give the taxi-out command to the wingmen.

The first to taxi out in the section (pair) is the section leader, and then, the wingmen in succession, at a distance of at least 100 m from one another. The same taxiing-out sequence should be observed by the other sections (pairs).

In the process of taxiing-out, the navigator and operator will carry out observation in the specified sectors.

190. On free sections of the taxiway, the taxiing speed should not exceed 20 km/h. During turns and close to obstacles or if the taxiway is covered with ice, the taxiing speed should not exceed 5 km/h.

When in the holding area, the aircraft should be arranged along the runway centre line, at a distance of 50 to 100 m from its approach end. When arranged in pair for solo takeoff, the aircraft may occupy their positions on the runway in an echelon or line-abreast formation. In this case, the distance between the aircraft should be sufficient to provide an absolute safety against aircraft collision in the process of their taxiing-out and takeoff.

For takeoff in pair, the echelon formation should be arranged into the wind.

5.21.3. Takeoff

191. The time intervals to be maintained between takeoffs are established by the commander assigning the flight mission.

Should the aircraft get into the wake of the preceding aircraft which has just got airborne, keep the aircraft against banking by short and energetic applications of the controls and leave the wake, crabbing upwind.

When in climb after takeoff, the wingman pilot should watch the preceding aircraft, being ready for performing a maneuver to approach and join the section leader.

5.21.4. Join-Up and Formation Flight of Section (Pair)

192. After takeoff, the leader sets up an airspeed of 600 km/h and strictly maintains the assigned flight regime during join-up of the section. If it is necessary to change the flight regime, the leader has to inform the wingmen of this necessity.

If the leader and other aircraft fly within the visual contact in case of the section join-up at medium and high altitudes, the first wingman flying on the join-up leg sets up a step-down vertical separation of 200 m, and the other wingman, a step-down vertical separation of 400 m relative to the leader at an interval of at least 200 m to the left or to the right from him (depending on the wingman's place in the formation).

When breaking upward through the clouds and when flying at night, all the aircrews in the formation (or the leader only), report their altitude every 500 to 1000 m in climb to the assigned join-up altitude.

If after the takeoff the aircrews proceed flying out of visual touch with one another, the wingmen fly in the direction of the joint-up area in a vertical separation of 300 m between the aircraft, before they can see the leader and other aircraft.

When approaching the leader and joining him, the crew commander (the pilot) should keep it in mind that the aircraft has a considerable sluggishness which, when neglected, may result in his overtaking the leader.

When the wingman approaches the leader, his speed should not exceed that of the leader by:

— more than 100 to 150 km/h at a distance of 5000 m between the aircraft;

— more than 70 to 100 km/h at a distance of 2000 m between the aircraft;

— more than 30 to 50 km/h at a distance of 1000 m between the aircraft.

193. Before joining the preceding aircraft, the wingmen flying in a close formation should assume the following initial position:

— 100 to 200-m distance and interval;

— 30 to 50-m step-down (step-up) vertical separation.

Assume the initial position and join up the preceding aircraft only in straight-and-level flight or climb.

When flying in a loose formation, the wingmen should not assume the initial position before joining the preceding aircraft.

194. To join the leader (preceding aircraft), proceed as follows:

— request the join-up clearance from the leader; on obtaining the join-up clearance, inform your crew that you are going to join the formation from the left (from the right);

— select the required power setting so as to smoothly bring the aircraft to the assigned distance and step-down (step-up) vertical separation at an increased interval; the speed of closure with the leader (preceding aircraft) should not exceed 20 km/h;

— equalize the speed with that of the leader (preceding aircraft) and, while flying with a bank angle of 3 to 5°, smoothly shorten the interval to the assigned one in several stages;

— report your joining the formation to the leader.

It is not allowed to join the formation:

— when making turns;

— at no two-way radio contact;

— at poor visual contact with the leader.

When flying in a V-formation, the right-hand wingman should dress on the left-hand one.

195. The wingmen keep their place in the formation by varying the engine power and by manipulating the controls while banking the aircraft by no more than 3 to 5°. To change the distance, smoothly vary the position of the throttle control levers, responding to variation of the distance in due time. The engine RPM should not vary by more than 3 to 5 % as shown by the tachometer indicator. Failure to notice the increase in distance in due time calls for a necessity of a great variation of the RPM, which complicates aircraft piloting and raises the rate of fuel consumption. The crew commander should select the engine power setting precluding engine running at powers corresponding to operation of the air blow-off valves.

To perform climb, the team leader gives out the climb command, selects the required power setting and smoothly brings the aircraft into climb, maintaining the airspeed of at least 600 km/h.

To perform descent, the leader gives the descent command to the wingmen, smoothly selects the assigned vertical speed of descent and decreases the engine power setting to rating corresponding to 15 to 20 divisions as read off the УПРТ indicator while maintaining the assigned airspeed.

196. If the V-formation faces the danger of getting into the clouds or if visibility is impared, which makes formation flying impossible, the team leader should give the "Prepare for break-up" command to the wingmen. On getting the "Break-up" executive command, the aircraft flying in the formation break up by using the following procedure:

(a) when flying at medium and high altitudes:

— the leader maintains the assigned course, altitude and airspeed;

— the left-hand wingman turns away to the left through 15°, descends by 300 m and flies on the new course for 2 min, after which he makes a corrective turn to the previous course;

— the right-hand wingman turns away to the right through 15°, then he gains 300 m of altitude and flies on the new course for 2 min, after which he makes a corrective turn to the previous course;

(b) when flying at low and extreme low altitudes:

— the leader brings his aircraft into climb without changing the course and airspeed and assumes an altitude safe for instrument flying (400, 600 and 1000 m, depending on the terrain relief);

— the left-hand wingman turns away to the left through 15° and climbs to an altitude which is 600 m higher than the leader's flight altitude, flies on the new course for 2 min and makes a corrective turn to the previous course;

— the right-hand wingman turns away to the right through 15° and climbs to an altitude which is 300 m higher than the leader's flight altitude, flies on the new course for 2 min and makes a corrective turn to the previous course.

During break-up, the aircrews do not change airspeed.

197. Before making a turn, the section leader should prepare the section (pair) for the turn. To this end, he should give a preparatory command to the wingmen, stating "Get ready to turn left (right) through .... degrees" and on a lapse of 4 to 5 s, he should issue the "Turn" executive command. When accomplishing the turn, the outer wingman gains an altitude with respect to the leader and speeds up the engines. The inner wingman loses an altitude and decelerates the engines. When flight is performed at low altitudes, make turns at one and the same altitude. When making the turn, the section leader should keep his bank angle constant, not exceeding 20° at medium altitudes and 10 to 15° at high altitudes. 4 to 5 s before rolling the aircraft out of the turn, the section leader should give a command to the wingmen, stating "Get ready to roll out of turn" and, when approaching the assigned course, he should issue the "Roll out" executive command.

198. To regroup the pair of aircraft from one echelon formation into another, following the leader's executive command, the wingman commander decelerates the engines by 5 to 7 divisions against the УПРТ indicator; while keeping to the set up interval, the wingman commander increases the distance to 100—150 m and assumes a 50-m step-down vertical separation relative to the leader, then he equalizes the airspeed, smoothly changes the aircraft position for the left-hand (right-hand) echelon to a higher interval with a bank angle of up to 3°, smoothly reduces the distance and simultaneously decreases the step-down vertical separation to the assigned level, then he takes up the assigned interval.

In the process of regrouping, the crews of both aircraft keep a constant eye on each other. After the regrouping is completed, the wingman reports the assumption of his place in the formation to the leader.

199. To regroup the section from the V-formation into the echelon formation, the wingman who is going to change his place in the formation, without varying the interval, follows the leader's executive command to

increase the distance to 100—500 m and the step-down vertical separation to 50 m relative to the other wingman whom he will join to form the echelon formation. On increasing the distance, he should equalize the airspeed and smoothly bring the aircraft into the right-hand (left-hand) echelon to an increased interval with a bank angle of up to 3°; at the same time, he must decrease the distance and step-down vertical separation relative to the preceding aircraft to the assigned value and establish the assigned interval.

The regrouping completed, the wingman reports the assumption of his new place in the formation to the leader.

200. The procedure used for breaking up the formation before landing is determined in different weather conditions by the flight mission and by the instructions of the flight control officer.

When approaching the airfield, the leader requests the approach level, landing conditions and formation break-up clearance from the flight control officer.

On obtaining the approach echelon and section (pair) break-up clearance, the leader gives a command to the wingmen to act of their own accord.

On obtaining the above command (during leftward break-up of the formation), the left-hand wingman breaks away from the formation by making a left-hand turn to the assigned course, after which he starts descending. On expiration of the estimated break-up period, beginning from the moment the left-hand wingman starts turning to the assigned course, the leader starts turning to the assigned course and brings the aircraft into descent; following the leader, the right-hand wingman performs his maneuver by using the same procedure.

During descent, all the crews report their flight altitude after every 1000 m. The succeeding sections break up for landing by using the same sequence. The crews hold the flight regime during descent in compliance with the requirements of the given Manual.

5.21.5. Getting into Wake of Preceding Aircraft

201. Flying aircraft Ty-22 forms two high-power wing-tip vortexes, 2 to 3 m in diameter. The power of the vortex wake is kept up at a distance of up to 7000 to 8000 m from the aircraft and 25 to 40 m below it. Further away, the vortex wake gets gradually washed out.

When the aircraft gets into the wake of the preceding aircraft, at a distance of 8000 m, the crew may percept intensive impacts on the aircraft structure (similar to those experienced during flight in heavy bumpiness conditions at high indicated airspeeds), and the aircraft is energetically pushed out of the wake; in this case, inadvertent banking of the aircraft may reach 50° with the altitude loss of about 50 m.

In some cases after aircraft pushing out of the vortex wake, an untimely intervenience of the pilot into aircraft control may result in unintentional pulling of the aircraft into a tight spiral.

When the aircraft gets into the vortex wake of the preceding aircraft at a distance of 10,000 to 12,000 m from it, aircraft flight is similar to that performed in heavy bumpiness conditions.

In all cases when the aircraft gets into the vortex wake at a distance of up to 10,000 m from the preceding aircraft, the pilot should proceed as follows:

— while keeping the aircraft from heavy banking by energetic applications of the control wheel, recover from the vortex wake effective zone; application of the control column in the pitch direction should be smooth;

— after the action of the vortex wake becomes non-effective, smoothly level off the aircraft and check operation of the engines;

— if the aircraft gets into a tight spiral, act in accordance with the recommendations laid down in Items 424 and 425.

5.21.6. Forced Peel-Off from Formation

202. In case of forced peel-off from the formation, the crew commander should report the cause of peel-off to the team leader. To peel off the formation, proceed as follows:

— lag behind the group or smoothly go outward with climb to a safe altitude when flying at low altitudes;

— descend on a straight leg or turn away outward when flying at medium and high altitudes.

In all other cases, act in compliance with the instructions of the section leader, ensuring flight safety.

6. AIR NAVIGATION

6.1. GENERAL

203. En-route air navigation is performed by following the order envisaged by the navigator's flight plan.

Any variation of the flight route and profile caused by sudden changes in weather or unexpected opposition of the enemy must be well considered and estimated.

Hasty departure from the navigator's flight plan will complicate the flight; it may even lead to flight mission execution failure.

During an en-route flight, the crew commander should do the following:

— guide the crew activities in compliance with the flight plan;

— accurately hold the assigned flight regime;

— avoid arbitrary changes in the flight regime without informing the navigator.

During an en-route flight, the navigator should do the following:

— provide air navigation with the use of the air navigation equipment in strict accordance with the navigator's flight plan;

— check proper keeping of the flight regime in compliance with the engineering-and-navigational schedule;

— keep the required aircraft documents in flight.

6.2. APPROACH TO INITIAL WAYPOINT

204. In all cases, the initial waypoint should be approached by using the pattern worked out in the process of preparation for flight. The pattern should be elaborated with due account of peculiarities of the basing area and possibility of employment of the ground and airborne radio aids and it should provide reliable approach to the initial waypoint.

The initial waypoint may be represented by the takeoff airfield or a landmark located at some distance from this airfield.

205. When bringing the aircraft to the initial waypoint, the navigator should do the following:

— check approach to the initial waypoint by reference to the heading, time as well as to the data supplied by the РСБН short-range navigation and landing system, АРК automatic direction finder and РАДОН radar bombsight;

— the moment the aircraft passes the initial waypoint, determine the precise fix of the aircraft, mark this fix on the map, verify the aircraft coordinates by reference to the automatic bomber navigation equipment indicator counters, put down the time of passing the initial waypoint in the aircraft Log Book and inform the crew about it;

— report the turn start to the crew commander as follows: "21.00, initial waypoint, turning right (left) to intercept course...";

— on passing the initial waypoint, check interception of the required direction by comparing the readings of the course indicators with the position of the УДЦ indicator pointer on the automatic bomber navigation equipment indicator.

6.3. INTERCEPTION OF ASSIGNED COURSE LINE AND AIR NAVIGATION IN FLYING TOWARDS TARGET

206. Interception of the assigned course line starting from the initial waypoint or intermediate waypoints is carried out by using the methods specified by the navigator's flight plan with a comprehensive use of all air navigation facilities.

When intercepting the assigned course line, the navigator should proceed as follows:

— check proper interception of the course;

— slave the compass system and refine the course with due account of the drift angle;

— with the ДИСС Doppler ground speed and drift meter operating, put down the drift angle as well as the ground speed (W) and wind (δ and U) parameters, supplied from automatic bomber navigation equipment unit PH-20, in the aircraft Log Book;

— with the ДИСС Doppler ground speed and drift meter being inoperative, check the direction and speed of the wind with the use of the РАДОН radar bombsight or ОПБ optical bombsight (in case of earth visibility) and insert these data into the НБА automatic bomber navigation equipment (set them on unit PH-20) or determine them with the help of the НБА equipment;

— determine the time of approaching the reference landmark and report it to the crew commander.

207. Duplicate the assigned course line interception by:

— comparing the actual course angle with the assigned course angle;

— determining the relative bearing of the radio beacon located at the initial or intermediate waypoint;

— radar scanning of the terrain.

6.4. COMPASS SYSTEM SLAVING

208. The compass system should usually be slaved with the help of the astrotracker. If the heavenly bodies are not visible and both sextants of the astrotracker fail to operate, the compass system may be slaved with the use of the magnetic sensors.

To slave the compass system with the help of the astrotracker, proceed as follows:

— set the TH — GCC (ИК — ОК) switch on the astrotracker to a position complying with the course reading system;

— set the wafer switch to the AC-1 or AC-2 position (corresponding to the sextant whose operation is more reliable);

— make sure that the given sextant has locked on the beam (by reference to the "pulse burst" on indicator ИЭ-1);

— set the compass system mode-of-operation switch to the CS (AK) position;

— depress the slaving button;

— the slaving operation completed, release the slaving button;

— switch over the compass system to operate in the DG (ГПК) mode.

When flight is performed in the daytime and at night before both the sextants lock on heavenly bodies, the SLAVING (КОРРЕКЦИЯ) switch on the astrotracker should occupy the FROM ABNE (ОТ НБА) position. In this case, the astrotracker computer will keep computing the φ, λ, X and Y coordinates furnished by the НБА automatic bomber navigation equipment.

When flights are performed at night and both sextants lock on heavenly bodies, the SLAVING switch should be set to the TO ABNE (В НБА) position. In this case, the φ, λ, X and Y coordinates will be computed by the astrotracker computer proper.

209. To perform slaving of the compass system from the magnetic sensor, proceed as follows:

— disable the magnetic slaving of the stand-by gyro unit;

— set the triangular index on the external scale of slaving unit KM-4 to the position corresponding to the primary great-circle magnetic heading in the given point;

— shift the compass system mode-of-operation switch on control panel ПУ-1 to the MS (MK) position;

— depress the slaving button;

— the compass system slaving completed, release the slaving button;

— switch over the compass system to operate in the DG (directional gyro) mode;

— set zero declination on slaving unit KM-4;

— enable the magnetic slaving of the stand-by gyro unit.

210. The main mode of the compass system operation is the DG (directional gyro) mode. When the compass system operates in this mode, the magnetic slaving of the stand-by gyro unit should be turned on. In this case, the navigator's indicator, the flight director indicator and combined course indicator show the great-circle course while the G (Г) pointers of pilot's and navigator's gyromagnetic and celestial heading indicators УГА-1У read the present magnetic heading. The great-circle course indicator (УОК) and pointers C (A) of pilot's and navigator's indicators УГА-1У show the present magnetic heading or great-circle course, depend-

ing on the position of the GCC — TH (OK — ИK) switch on the astro-tracker computer.

In zones where the magnetic compass shows unsteady operation, the magnetic slaving of the stand-by gyro unit should be turned off. In this case, the stand-by gyro unit will operate in the DG (directional gyro) mode.

6.5. AIR NAVIGATION ON ASSIGNED COURSE LINE WITH USE OF SHORT-RANGE NAVIGATION AND LANDING SYSTEM

211. The assigned course line may be hold with the help of the PCБH short-range navigation and landing system when performing flight in the PCБH system coverage zone in the OUTBOUND AZIMUTH (АЗИМУТ ОТ), INBOUND AZIMUTH (АЗИМУТ НА), ORBIT (ОРБИТА) and COMPUTER (СРП) modes.

When holding the assigned course line with the help of the PCБH system, the pilot should switch over the ПУТЬ system to operate in the СВОД mode.

212. To fly on the assigned azimuth line (only in the beacon inbound or outbound direction), proceed as follows:

— manipulate the AZIMUTH (АЗИМУТ) knob on the control board to select the assigned true azimuth relative to the beacon which will be used for controlling the flight;

— set the mode-of-operation switch on the control board to the INBOUND AZIMUTH (АЗИМУТ НА) position (for flying towards the beacon) or OUTBOUND AZIMUTH (АЗИМУТ ОТ) position (for flying from the beacon);

— give a command to the pilot to set the course equalling the assigned course line on the combined course indicator;

— bring the aircraft to the assigned azimuth line, using the position bars of the combined course indicator and the position bars of the pilot's and navigator's flight director indicators;

— on hitting the assigned azimuth line, take your heading with due account of the drift angle. Proceed flying by keeping the command bar of the ПП flight director indicator within the centre of the scale circle. Check accurate holding of the assigned azimuth line by reference to the position bars on the combined course indicator (НКП) and flight director indicator (КПП) and navigator's direct-reading range and azimuth indicator (ППДА-Ш).

Manipulate the ORBIT (ОРБИТА) knob on the control board to define the moment of passing the assigned point on the azimuth line and the distance from this point to the beacon used for controlling the flight. When the aircraft is 12 to 16 km short of this point, the ZONE APPROACH (ПОДЛЕТ К ЗОНЕ) light starts flickering while the moment this point is passed is marked by coming-on of the ZONE PASSAGE (ПРОЛЕТ ЗОНЫ) light.

213. To fly on the assigned orbit, proceed as follows:

— using the ORBIT (ОРБИТА) knob on the control board, select the assigned orbit radius;

— set the mode-of-operation switch on the control board to the LH ORBIT (ОРБИТА ЛЕВ.) or RH ORBIT (ОРБИТА ПРАВ.) position (depending on the direction of flight);

— determine the moment of starting the turn to intercept the assigned orbit by comparing the selected orbit radius with the present range shown by the navigator's direct-reading range and azimuth indicator (with due consideration of the turn radius) and report the turn start moment to the pilot;

— the pilot should perform an orbit flight while keeping the combined course indicator position bar within the scale circle centre and monitoring the flight by reference to the range shown by the pilot's direct-reading range and azimuth indicator (the range should remain constant and be equal to the selected orbit radius);

— the navigator should monitor the orbit flight by reference to the vertical position bar of the flight director indicator (КПП) and by the range scale of the navigator's direct-reading range and azimuth indicator.

To determine the moment of passing the point on the assigned orbit, select the true azimuth of this point by rotating the AZIMUTH (АЗИМУТ) knob on the control board. When 12 to 16 km short of this point, the ZONE APPROACH (ПОДЛЕТ К ЗОНЕ) light will start flickering and the moment of passing of this point will be marked by coming-on of the ZONE PASSAGE (ПРОЛЕТ ЗОНЫ) light.

214. For flying on the assigned course line, which does not pass through the radio beacon, use is made of the РСБН system computer. To perform flight in the COMPUTER (СРП) mode, proceed as follows:

— select any point on the assigned course line or on its continuation (the most accurate air navigation may be obtained when the straight line connecting this point to the radio beacon is square with the assigned course line);

— determine the true azimuth of this point, starting from the beacon meridian, and insert it into the computer unit by using the TARGET ANGLE (УГОЛ ЦЕЛИ) knob on the computer unit;

— determine the distance from this point to the radio beacon and insert it into the computer unit by using the TARGET RANGE (РАССТОЯНИЕ ДО ЦЕЛИ) knob.

— determine the true track angle of the assigned course line relative to the radio beacon meridian and insert it into the СРП computer unit by using the assigned track angle setting knob;

— set the mode-of-operation switch on the control board to the COMPUTER (СРП) position;

— intercept the assigned course line, using the flight director indicators (ПП, КПП) and combined course indicator (НКП);

— fly on the assigned course line, keeping the command bar of the ПП flight director indicator within the centre of the scale circle. In so doing, make reference to the position bars of the НКП combined course indicator and КПП flight director indicator (which should also be in the scale centre). To determine the moment of passing the point located on the assigned course line, use the AZIMUTH (АЗИМУТ) and ORBIT (ОРБИТА) knobs to set the true azimuth of this point and its distance from the radio beacon, accordingly. At a distance of 12 to 16 km short of this point, the ZONE APPROACH (ПОДЛЕТ К ЗОНЕ) light starts flickering while the moment of passing this point is marked by coming-on of the ZONE PASSAGE (ПРОЛЕТ ЗОНЫ) light.

6.6. AUTOMATED AIR NAVIGATION DURING EN-ROUTE FLIGHT

215. Automated air navigation is provided by the automatic bomber navigation equipment included into the РАДОН radar bombsight.

The principle of automated air navigation lies in the fact that the automatic bomber navigation equipment computes the present angle of the corrective turn to the next waypoint (target), generates a control signal proportional to the corrective turn angle and sends out this signal into the autopilot.

Before taxiing out from the parking site, the navigator must turn on all the required flight navigation and bombing equipment and carry out orientation of the compass system relative to the main great-circle course.

216. To perform automated flight, proceed as follows:

(a) make the following settings on the indicator of the automatic bomber navigation equipment;

— the coordinates of the first waypoint on the WP — TARGET (ППМ — ЦЕЛЬ) counters;

— the runway approach end coordinates on the AIRCRAFT (САМОЛЕТ) counters;

— the coordinates of the first radar marker on the RDR MARKER (Р/Л ОРИЕНТИР) counters for correction;

(b) make the following settings on the control panel of the automatic bomber navigation equipment:

— the mode-of-operation switch, to the NAVIGATION (НАВИГАЦИЯ) position;

— the MANUAL INPUT (РУЧНОЙ ВВОД) switch, to position "U, ε°" and manually set the wind force on counters U and ε°;

— the AP — SDM (АП — РКР) switch, to the SDM (РКР) position;

— the RECKONING (СЧИСЛЕНИЕ) switch, to the OFF (ВЫКЛ.) position;

— the main great-circle course.

217. Before the takeoff, the navigator should proceed as follows:

— when in the holding area, check correspondence of the compass system readings to the takeoff (runway) heading and, after making sure that the aircraft is positioned along the runway centre line, manipulate the course selector knob, if required, to refine setting of the takeoff heading angle ($HA_{t/o} = MH_{t/o} - MTA_{MGCC}$);

— check the $MH_{t/o}$ readings by reference to indicator KM-4;

— when the aircraft starts moving, start the stopwatch to indicate the ground run time and turn on the RECKONING (СЧИСЛЕНИЕ) switch.

Before approaching the initial waypoint, the navigator should proceed as follows:

— verify the aircraft present fix by reference to the data of the РСБН system or by using another more accurate means at hand;

— make sure that the coordinates of the first waypoint are properly set on the WP — TARGET (ППМ — ЦЕЛЬ) counters;

— evaluate proper indication of the УДЦ indicator reading and distance remaining to the waypoint on the automatic bomber navigation equipment indicator.

218. At the moment of initial waypoint approach, the navigator should proceed as follows:

— make the "Takeover control" report to the crew commander and, on obtaining the respective clearance, set the AP — SDM (АП — РКР) switch to the AP (АП) position, which will be accompanied by coming-on of the AP IN ABNE — OBS MODE (АП В РЕЖИМЕ НБА — ОПБ) light (the aircraft will start automatically turning in the direction of the first waypoint);

— after the aircraft recovers from the turn, check proper holding of the flight direction by the aircraft.

219. In flight, the crew should monitor the accuracy of flying on the assigned flight route and approaching the waypoints and target as regards the place and time. Check the aircraft fix and, if it is impossible, separately check to see whether the aircraft holds the required distance and direction.

Determine the aircraft fix as follows:

— by reading the aircraft position off the scales of the AIRCRAFT (САМОЛЕТ) counters of the automatic bomber navigation equipment indicator;

— by reference to the РСБН system azimuth and distance magnitudes;

— by means of the РАДОН radar bombsight;

— by indications of the УДЦ indicator pointer and RANGE (ДАЛЬНОСТЬ) counter of the automatic bomber navigation equipment indicator;

— by reference to the aircraft position indicated by the astrotracker counters;

— by intersection of the aircraft position lines obtained with the help of angle-measuring radio aids;

— by visual orientation.

220. For accurate determining of the aircraft fix with the help of the

automatic bomber navigation equipment, periodically update the present position of the aircraft by reference to the radar markers.

To perform updating by reference to the radar marker, proceed as follows:

— set the coordinates of the radar marker to be used for updating the aircraft present position on the RDR MARKER (Р/Л ОРИЕНТИР) counters of the automatic bomber navigation equipment indicator;

— detect and identify the marker, whose coordinates are set on the RDR MARKER counters, on the indicator screen;

— report the control transfer to the crew commander and set the AP — SDM (АП — РКР) switch to the SDM (РКР) position;

— select the MARKER UPDATING (КОРРЕКЦИЯ ПО ОРИЕНТИРУ) mode on unit PH-21 or UPDATING (КОРРЕКЦИЯ) mode on unit PH-20;

— turn on the UPDATING switch on indicator PH-6;

— rotate the aircraft relative bearing and sighting mark handwheels to align the crosshairs with the updating point, using the A-SCAN (ПМ) scanning mode (in the sector or biased sector) and verify the alignment by using the μA-SCAN (МПМ) scanning mode;

— turn off the UPDATING switch on control unit PH-6 and select the SEARCH mode on control unit PH-21 or NAVIGATION mode on control unit PH-20;

— evaluate the correctness of the updated aircraft position on the AIRCRAFT (САМОЛЕТ) counters and proper indication of the angle of corrective turning to the next waypoint and distance left to this waypoint;

— on obtaining the control takeover clearance, set the AP — SDM (АП — РКР) switch to the AP (АП) position, which will entail automatic corrective turning of the aircraft.

221. Update the aircraft present position by reference to the astrotracker data only during long-time flying over the terrain having no landmarks or over the water surface when it is impossible to perform updating of the aircraft present position by other more accurate methods.

To update the aircraft present position by reference to the astrotracker, proceed as follows:

— by switching over electronic indicator ИЭ-1 to the first and second sextants, make sure that both sextants follow the heavenly bodies;

— make certain that the UPDATING switch of the computer is set to the TO ABNE (В НБА) position;

— place the AT — OFF (ЗСО — ВЫКЛ.) switch on unit PH-20 to the AT (ЗСО) position and the mode-of-operation switch, to the UPDATING position;

— the updating completed, which may be determined by extinguishment of the orange light on the indicator of unit PH-6, select the NAVIGATION (НАВИГАЦИЯ) mode on unit PH-20.

222. Check proper holding of the track in direction by:

— watching proper holding of the assigned course;
— watching variation of the drift angle;
— reading the indications of the УДЦ indicator pointer;
— reference to the position lines parallel to the assigned course line;
— side deviation of the aircraft at the check reference point;
— reference to the vertical position bar of flight director indicator КПП-М2.

Check proper holding of the track in range by:

— the readings of the RANGE (ДАЛЬНОСТЬ) counter on the automatic bomber navigation equipment indicator;
— dead reckoning;
— reference to the aircraft position lines which are normal to the assigned course line.

223. Correct the track by evaluating the checkup results, on the basis of detected deviation of the aircraft in range and direction. Correct the track only in cases when the deviation magnitude surpasses possible errors involved in the checkup method.

224. When correcting the track, the navigator should do the following:

— report the aircraft deviation to the crew commander;
— select the means of correction of the track in direction and range and make the required calculations;
— report the calculation results and maneuver start line (time) to the crew commander.

The accuracy of air navigation depends on the accuracy of aircraft heading indication by the compass system; therefore, the navigator should periodically compare the readings of the course followed with the actual heading and slave the compass system if indications of the aircraft heading differ by 2° and more from the astrotracker readings or by 3° and more with the readings of the G (Г) pointer.

Slave the course followed not rarer than every 40 to 50 min of flight. It is advisable to make the first slaving of the course in the level flight 2 to 3 min after departing from the initial waypoint and climbing to the assigned altitude.

Approach the point of turning to the target or combat run start point by using the procedure specified for approaching the next waypoint.

225. Aircraft entry into the target area and its approach to the target may be performed:

— by automated air navigation;
— with the help of the РАДОН radar bombsight by reference to the radar image of the terrain or by the radar marker;
— visually, by reference to the conspicuous landmarks in the target area.

To verify the present position of the aircraft on the target detection line, perform updating of the aircraft present position by reference to the target in the TARGET UPDATING (КЦ) mode (on unit PH-21).

226. To approach the waypoint and automatically turn to the next flight route leg, proceed as follows:

— when approaching the waypoint to a distance of 50 km (to be determined by reference to the RANGE (ДАЛЬНОСТЬ) counter of the automatic bomber navigation equipment indicator and unit PH-6), start the stopwatch and estimate the time of flight to the waypoint;

— read the course indicators and take the readings of the УДЦ indicator pointer to make sure that you hold the required direction towards the waypoint;

— report the control transfer to the crew commander and set the AP — SDM (АП — PKP) switch to the SDM (PKP) position;

— set the coordinates of the next waypoint on the WP — TARGET (ППМ — ЦЕЛЬ) counters;

— evaluate proper indication of new parameters on the УДЦ indicator and range;

— the moment the stopwatch reads the waypoint estimated passage time (with the aircraft position referenced by the AIRCRAFT counters) report the turn start to the crew commander and set the AP — SDM switch to the AP position; as a result, the aircraft will automatically turn to the course of flying to the next waypoint;

— on rolling the aircraft out of the turn, make sure that you hold the proper direction of flight by reference to the readings of the course indicators and УДЦ indicator pointer irrespective of the position of the AP — SDM switch on unit PH-20.

At the moment of bomb release, the autopilot gets automatically disconnected from the optical bombsight and gets engaged into course stabilization from the compass system.

If bombs are not released (during photography, for example), to avoid sharp turns, turn off the TURN (PA3B.) switch and pass over the aircraft control to the crew commander after aligning the sighting and aiming angle indexes.

In all cases, orientation on the combat run is carried out by reference to the radar image on the PH-6 unit indicator screen, as well as to the readings of the RANGE (ДАЛЬНОСТЬ) counter, pointers of the УДЦ indicator and AIRCRAFT (САМОЛЕТ) counters on the automatic bomber navigation equipment indicator.

6.7. AIR NAVIGATION WHEN FLYING FROM TARGET

227. On the target outbound course, air navigation is accomplished in compliance with the navigator's flight plan by following the rules involved in flying on the target inbound course. Flying from the target includes the following main stages:

— approach to the return waypoint;

— execution of flight from the return waypoint to the terminal waypoint;

— approach to the terminal waypoint and landing airfield;
— aircraft landing.

To intercept the assigned return course line, monitor proper holding of the course and correct it, use the methods specified for flight on the target inbound course.

228. For automated air navigation on the route of return flight to the terminal waypoint, use the methods involved in flying in the direction of the target.

Approach the landing airfield:
— by flying in the direction of the homing radio station;
— with the use of the РСБН system;
— by reference to the conspicuous radar markers displayed on the screen of the РАДОН radar bombsight;
— with the use of the automatic bomber navigation equipment;
— with the help of the radio direction finders;
— visually.

229. When flying on the return flight route, the crew may be ready for landing on an alternate airfield. To perform approach to the alternate airfield, the crew should proceed as follows:
— specify the route of flying to the alternate airfield;
— determine the possibility of approach to the given airfield by the actual fuel remainder;
— estimate the data for approaching the alternate airfield and pick up technical aids for checking proper holding of the flight course, depending on the navigation situation afforded;
— when approaching the point of turning to the alternate airfield; set the alternate airfield coordinates on the WP — TARGET (ППМ — ЦЕЛЬ) counters and fly by reference to indications of the УДЦ indicator pointer, concurrently using all other means permissible in the given navigation situation.

Aircraft descent for execution of the landing approach may be started from the assigned line or from the airfield traffic area. Descent above the landing airfield may be performed by using the extended rectangular approach traffic pattern or an approach pattern estimated for the given airfield.

Landing approach and its planning are accomplished with the use of the airfield radio aids. After returning from the flight route, landing approach may be executed by using an extended rectangular approach traffic pattern or from the estimated line.

If landing approach is to be performed in the process of returning from the flight route, the method of airfield approach from the estimated line is the main approach method to be used.

230. In performing the landing approach from the estimated line (Fig. 26), accomplish descent by using the "Cloud break-through" mode of the РСБН system. To this end, proceed as follows:
— when flying on the INBOUND AZIMUTH (АЗИМУТ НА) course

(in the direction of the beacon) or in the COMPUTER (СРП) mode (in the direction of the turn to final start point), the navigator should enable the CLOUD BREAKTHROUGH mode at a distance of 250 km from the runway threshold, having reported the matter to the crew commander;

— check serviceability of the given mode by operation of the glide-slope warning flags on the flight director indicator and combined course indicator and by upward deviation of the bars;

— the moment the horizontal position bar is settled within the indicator scale centre, start descending to the altitude of 1000 m while keeping the vertical command bar on the КПП flight director indicator within the instrument scale centre (making reference to the НКП combined course indicator); the navigator should check descent by reference to the position bar of the КПП flight director indicator, altitude and distance to the ground beacon as displayed by the СВОД system flight director indicator, which should correspond to the data presented in Table 15.

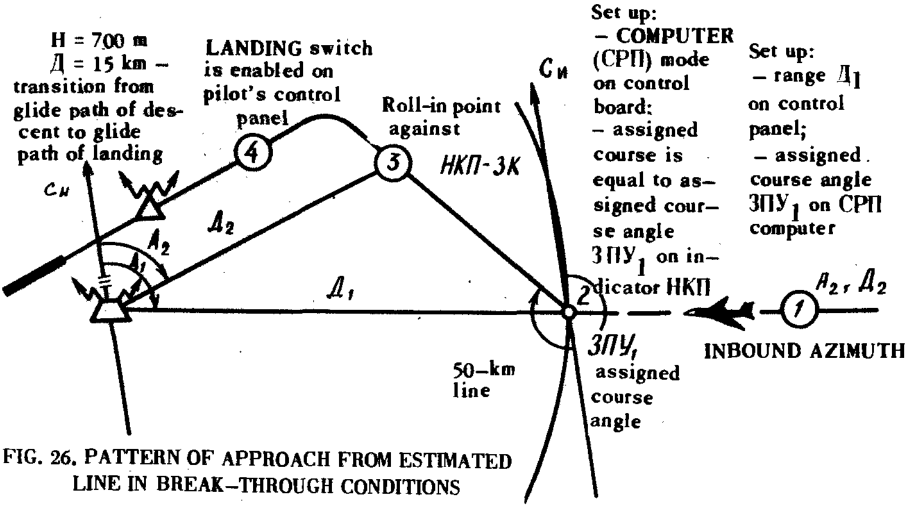

FIG. 26. PATTERN OF APPROACH FROM ESTIMATED LINE IN BREAK-THROUGH CONDITIONS

Table 15

Range shown by ППДА direct-reading range and azimuth indicator, km	Flight altitude, m
200	12,000
190	11,000
180	10,000
150	9000
135	8000
120	7000
105	6000
90	5000
70	4000
55	3000
35	2000
20	1000

231. When preparing for flight, determine the azimuth and range of the landing course roll-in point; if landing approach is accomplished from the estimated line with the РСБН system used in the COMPUTER (СРП) mode (Fig. 27), determine the assigned track angle magnitude (for setting it on the СРП computer control unit).

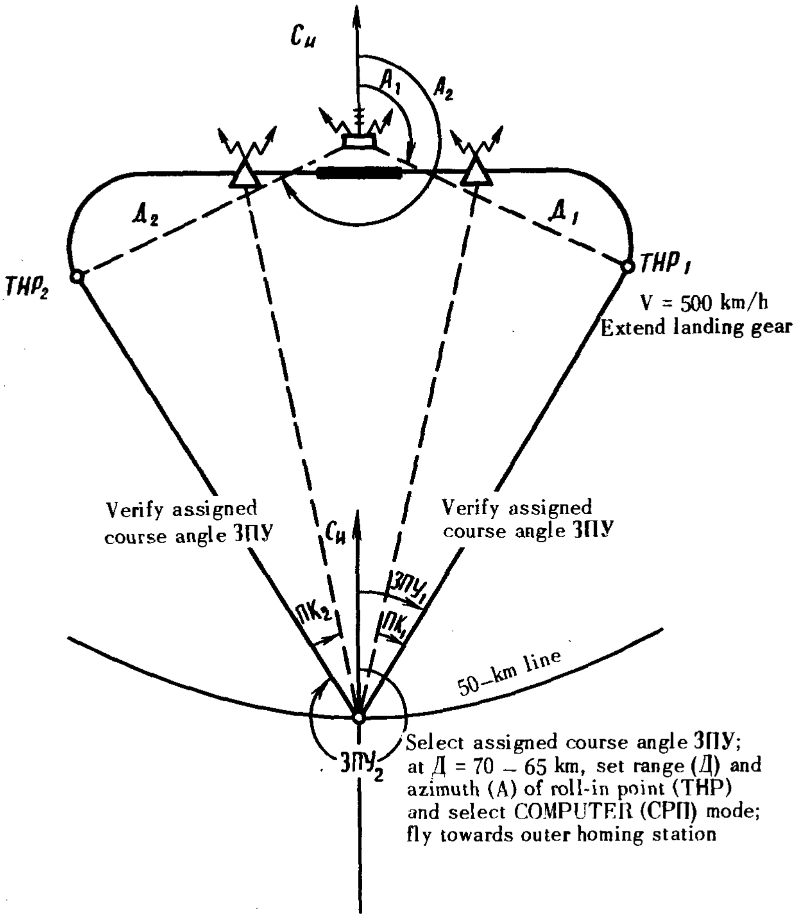

FIG. 27. PATTERN OF APPROACH FROM ESTIMATED LINE IN "COMPUTER" MODE

In this case, the crew operating procedure is as follows:

— the crew commander should set the СВОД mode on control unit ПУ-30 and start the command bars;

— make a corrective turn to the landing airfield outer homing station;

— 15 to 20 km before reaching the 50-km line, the navigator should set the azimuth and range of the landing course roll-in point on the СРП computer control unit and on the РСБН system control board, then enable the COMPUTER (СРП) mode;

— determine the course of flying to the landing course roll-in point with the help of the navigation computer and set it as the assigned track angle on the СРП computer control unit;

— the crew commander should set the assigned course pointer on the combined course indicator to the landing course magnitude;

— at the moment of interception of the 50-km line, start turning to the course of flying in the direction of the landing course roll-in point; monitor holding of the assigned course line when flying to the assigned point by reference to the ПП flight director indicator command bars and vertical position bars of the НКП combined course indicator and КПП flight director indicator; if in flying to the landing course roll-in point the vertical position bars of the НКП combined course indicator and КПП flight director indicator are left aside, the navigator should rotate the assigned track angle setting knob on the СРП computer control unit to set the vertical position bars within the indicator scale centre and read the new magnitude of the assigned true track angle off the assigned track angle scale, take the drift angle into account and report the new magnitude of the assigned point approach course to the crew commander;

— the crew commander should make a corrective turn to intercept a new course and accurately approach the assigned point while keeping the vertical position bar of the НКП combined course indicator within the indicator scale centre;

— 1 or 2 min before starting the turn to the landing course, extend the landing gear when flying at an airspeed not exceeding 500 km/h;

— make the turn to the landing course the moment the direct-reading azimuth and range indicator shows the azimuth and range of the landing course roll-in point (which is identified by coming-on of the ZONE PASSAGE (ПРОЛЕТ ЗОНЫ) light);

— at the turn start moment, the crew commander should turn on the LANDING (ПОСАДКА) switch on the pilot's control board; if landing is accomplished with the use of ILS equipment, set the ILS (СП) mode on control panel ПУ-30.

232. When performing the landing approach from the estimated line by using the РСБН system in the INBOUND AZIMUTH (АЗИМУТ НА) and COMPUTER (СРП) modes (Fig. 28), refer to the map to read the azimuth to be followed for flying to the 50-km line as well as the azimuth and range of the landing course roll-in point and assigned track angle for flying to the given point.

In this case, the crew operating procedure is as follows:

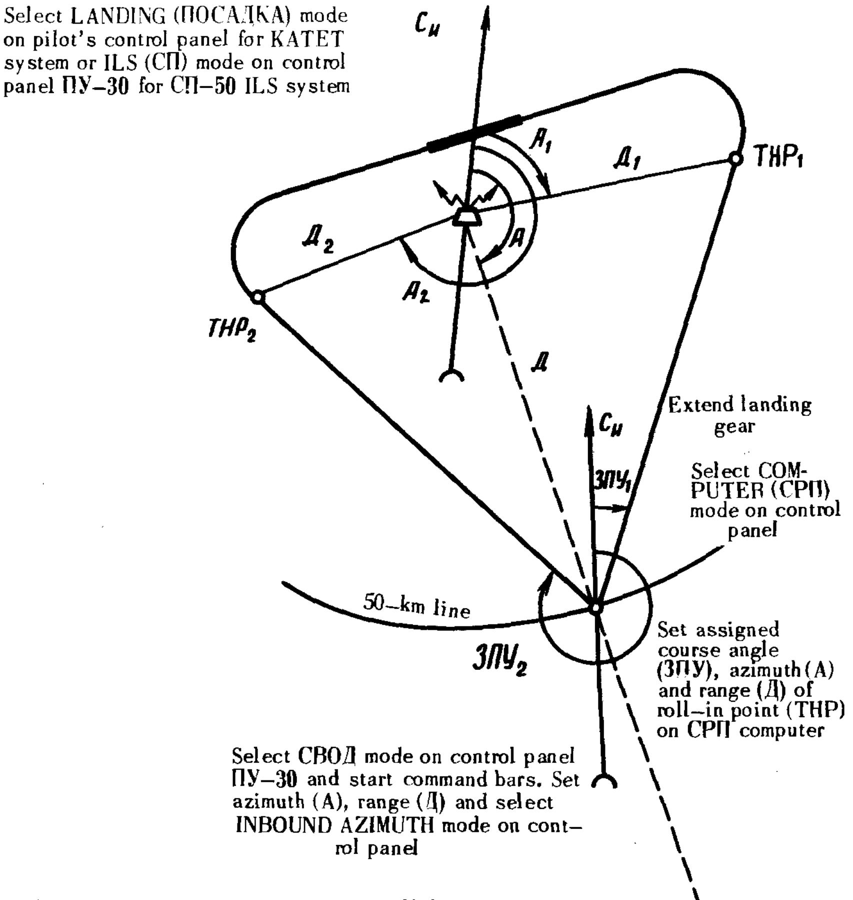

FIG. 28. PATTERN OF APPROACH FROM ESTIMATED LINE IN "INBOUND AZIMUTH" AND "COMPUTER" MODES

— on passing the last waypoint, set the СВОД mode on control panel ПУ-30 and start the command bars;

— the navigator should set the azimuth equal to the true track angle of the desired course in the beacon direction and 50-km range on the РСБН system control board; place the mode-of-operation switch to the INBOUND AZIMUTH (АЗИМУТ НА) position; fly on the assigned azimuth line while keeping the vertical position bar of the combined course indicator and vertical command bar of the ПП flight director indicator within the indicator scale centre;

— set the assigned track angle, azimuth (target angle) and range (distance to the target) of the landing course roll-in point on the СРП computer control unit;

— the moment the aircraft approaches the 50-km line, make a turn to the course of flying to the landing course roll-in point;

— during the turn, the navigator should set the COMPUTER (СРП) mode on the РСБН system control board.

For further flying on the approach course, the crew should use the procedure specified for landing approach with employment of the РСБН system in the COMPUTER (СРП) mode.

233. When making landing approach by using an extended approach traffic pattern, with the РСБН system operating in the COMPUTER (СРП) mode (Fig. 29), proceed as follows:

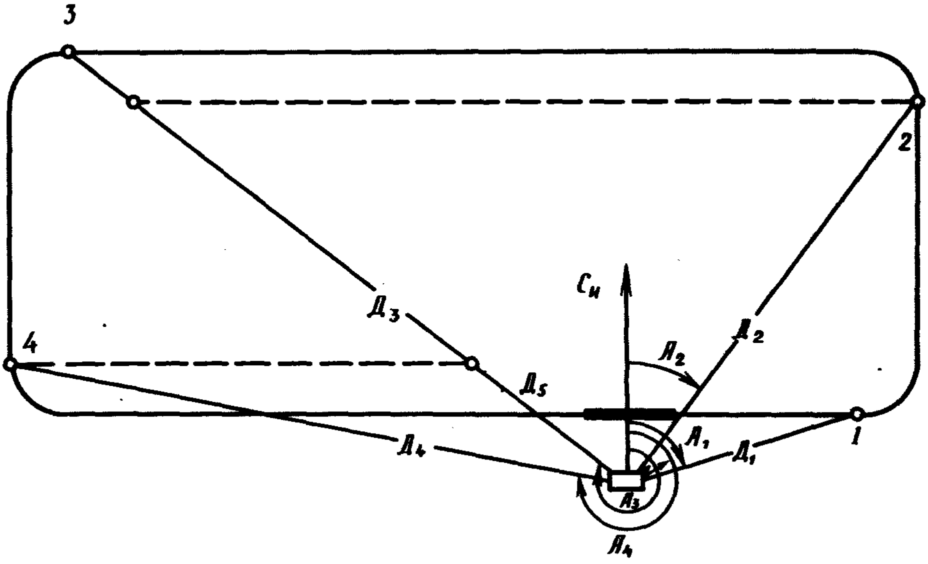

FIG. 29. EXTENDED RECTANGULAR PATTERN РСБН–CONTROLLED APPROACH IN "COMPUTER" MODE

— in the process of flight preparation, draw up a table and fill it in with the azimuths and ranges of the points corresponding to the beginning of the crosswind and downwind turns as well as of the turns to base leg and final;

— when approaching the outer homing station, the crew commander should set the assigned course pointer on the НКП combined course indicator to the landing course magnitude, set the СВОД mode on control panel ПУ-30 and start the command bars;

— the navigator should set the azimuth and the range to the base leg turning start point on the control board, then he should set the assigned course angle equal to the true landing course ±180°, azimuth (target angle) of the base leg turn start point and the range of the downwind turn start point on the СРП computer control unit;

— when making the crosswind leg turn, check the turn accomplishment in time, azimuth and range;

— make the downwind turn the moment the vertical position bar of the НКП combined course indicator is settled within the indicator scale centre. In so doing, check the moment of starting the downwind turn by checking the time, the radio station relative bearing, azimuth and range of the downwind leg turn start point;

— after the aircraft starts turning, the navigator should set the range to the base leg turn start point on the СРП computer control unit;

— intercept the desired course line from the downwind leg turn to the crosswind leg turn and fly on this course by using the command bar of the ПП flight director indicator and position bars of the НКП combined course indicator and КПП flight director indicator, by keeping them within the indicator scale centre;

— make the turn to base leg after the ППДА direct-reading azimuth and range indicator reads the azimuth and range corresponding to the tabulated magnitudes for the base leg turn start point; in so doing, check the base leg turn start moment by referring to time, radio station relative bearing and coming-on of the ZONE PASSAGE (ПРОЛЕТ ЗОНЫ) indicator light; in the process of turning to base leg, the navigator should set the range ($Д_5$) of the turn to final start point on the СРП computer control unit;

— make the turn to final at the moment when the vertical position bar of the НКП combined course indicator (КПП flight director indicator) settles within the indicator scale centre, checking the turn start moment by referring to the relative bearing of the radio station as well as azimuth and range.

If the КАТЕТ ILS system is used for landing approach, the crew commander should set the LANDING — OFF (ПОСАДКА — ВЫКЛ.) switch on the pilot's control board to the LANDING (ПОСАДКА) position the moment the aircraft starts turning to final. This will result in coming-on of the LANDING (ПОСАДКА) lights on the РСБН system control board and on the pilot's control board and of the AZIMUTH CHANNEL UNSERVICEABLE (НЕИСПРАВЕН КАНАЛ АЗИМУТА) indicator light, on the navigator's instrument board. The direct-reading range and azimuth indicator will show the touch-down point range.

If the ILS system is used for landing approach, after the beginning of the turn to final the crew commander should shift the mode-of-operation switch on control panel ПУ-30 from the СВОД to the ILS (СП) position.

The crew commander should check proper accomplishment of the turn by comparing the readings of the assigned course pointer and radio station relative bearing pointer on the НКП combined course indicator.

When there remains 20° and less before turning to the landing course, these pointers should be aligned. 30° before intercepting the landing course with the use of ILS equipment or 20° before hitting the landing course with the help of the КАТЕТ ILS system, the vertical position bar on the НКП combined course indicator (КПП flight director indicator) will deflect from the initial position.

234. If the crew has no preliminary estimations of the azimuths and ranges of the turn start points, in performing landing approach to an alternate airfield by using an extended rectangular approach traffic pattern with the help of the ILS (СП) or КАТЕТ equipment and РСБН system operating in the COMPUTER (СРП) mode (Figs 30 and 31), proceed as follows:

— when approaching the outer homing station, the crew commander should set the assigned course pointer on the НКП combined course indicator to the landing course position, turn on the СВОД mode on control panel ПУ-30 and start the command pointers; select the КАТЕТ or ILS ground equipment operating channel on the pilot's control board;

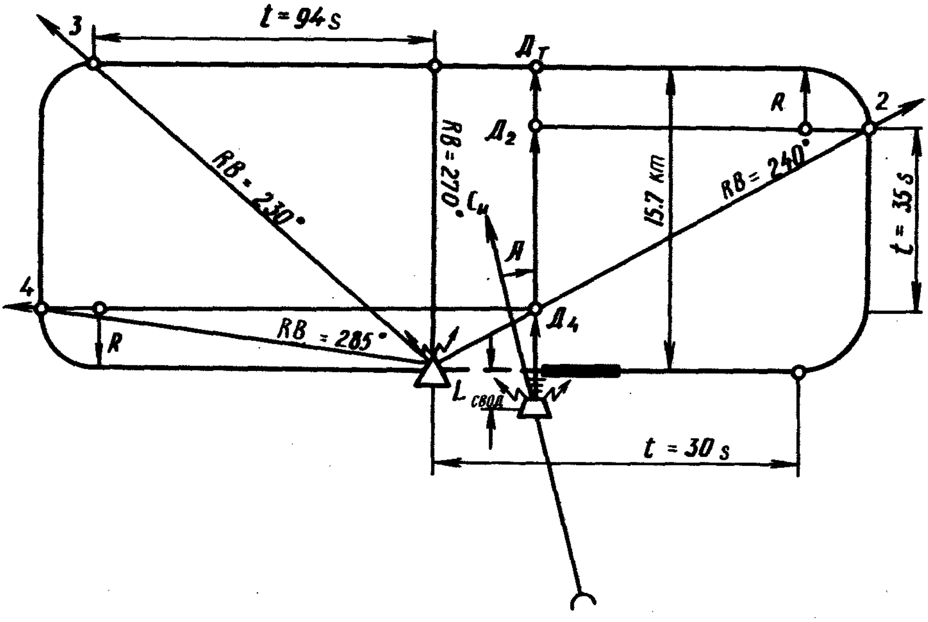

FIG. 30. ILS– AND РСБН–CONTROLLED APPROACH PATTERN IN "COMPUTER" MODE

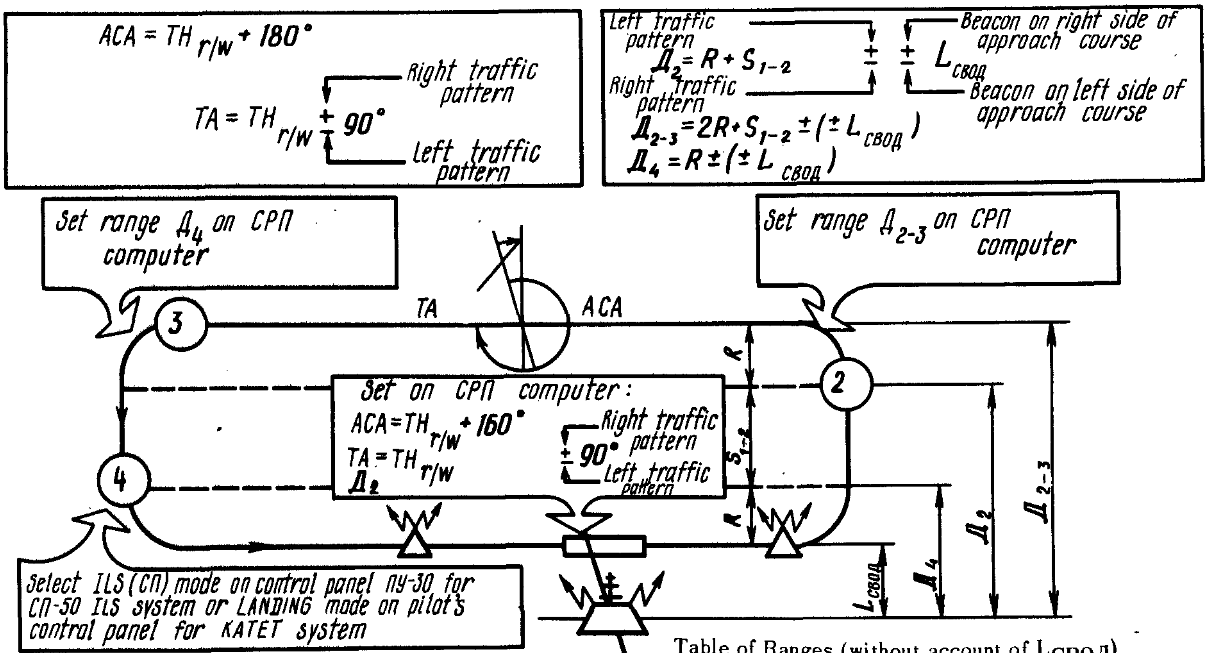

Table of Ranges (without account of $L_{СВОД}$)

$Д_2$	$Д_{2-3}$	$Д_4$										
		Drift angle when flying from downwind leg turn to base leg turn										
		Drift to runway						Drift from runway				
		5°	4°	3°	2°	1°	0°	1°	2°	3°	4°	5°
10.3	15.7	6.15	6.00	5.85	5.7	5.55	5.4	5.25	5.1	4.95	4.8	4.65

$+L_{свод}$

FIG. 31. FORMULAS AND TABLE USED FOR ESTIMATION OF EXTENDED RECTANGULAR PATTERN OF РСБН–CONTROLLED APPROACH IN "COMPUTER" MODE (for any airfield)

— the navigator should select the required channel on the РСБН system control board and set the mode-of-operation switch to the COMPUTER (СРП) position; on the СРП computer control unit, he should set assigned course angle $ACA = TH_{r/w} \pm 180°$, target angle $TA = TH_{r/w} + 90°$ for the right-hand traffic pattern and target angle $TA = TH_{r/w} - 90°$ for the left-hand traffic pattern; target range $Д_2 = (15.7\ km \pm L_{СВОД}) - R$,

where $L_{СВОД}$ is the distance from the РСБН system ground beacon to the runway centre line;
R is the radius of the turn;

— when making the turn to crosswind leg, check the turn moment by reference to time, azimuth and range;

— determine the moment of starting the turn to downwind leg by setting of the vertical position bar of the НКП combined course indicator (КПП flight director indicator) within the indicator scale centre, checking this moment by reference to time and radio station relative bearing (Rad. Sta. RB) which should equal 240° (120°);

— after starting the turn, the navigator should set up target range $Д_{tgt} = 15.7\ km \pm L_{СВОД}$;

— fly from the downwind leg turn to the base leg turn while keeping the vertical position bar of the НКП combined course indicator (КПП flight director indicator) within the indicator scale centre;

— on passing the outer homing station beam, start the stopwatch and start turning to base leg at radio station relative bearing Rad. Sta. RB = 230° (130°) ± DA; when making the turn, the navigator should set target range $Д_4 = R \pm L_{СВОД}$ on the counter with due account of the drift angle ($L_{DA} = 150 \cdot DA°$, m);

— start turning to final the moment the vertical position bar of the НКП combined course indicator (КПП flight director indicator) is settled within the indicator scale centre, checking the moment of the turn by reference to the radio station relative bearing [Rad. Sta. RB = 285° (75°) ± 1/2DA]; the distance to the final turn start point should be at least 22 km from the runway threshold;

— the navigator should check proper execution of the turn to final and proper holding of the assigned altitudes and airspeeds; in case of any deviations from the assigned parameters, report the situation to the crew commander;

— at the moment of passing the outer homing station, switch over the automatic direction finder to the inner homing station and make the following report to the crew commander: "Outer, altitude..., airspeed...";

— when flying on the final approach leg from the outer homing station to touchdown, monitor proper holding of airspeed and altitude;

— the moment the aircraft passes the inner homing station, the navigator should make the following report to the crew commander: "Inner, altitude..., airspeed... ".

6.8. FLIGHT IN COMBAT FORMATION (SECTION)

6.8.1. Takeoff and Join-Up of Combat Formation (Section)

235. Takeoff is performed by solo aircraft at assigned time intervals. If all the aircraft of the formation get airborne from one and the same airfield, join-up of the formation is accomplished on the flight route by airspeed variation, and in the airfield traffic pattern, by course variation.

The most acceptable way for joining up the combat formations of air subunits is en-route pursuit flight.

When the formation aircraft perform takeoff from several airfields, join-up is carried out by the "rendezvous" method.

The combat formation join-up methods and patterns are elaborated for different takeoff directions for the given basing airfield in advance.

6.8.2. Air Navigation During Flight in Close Combat Formation

236. The peculiarities of air navigation in a close combat formation are as follows:

— the necessity of strict holding of aircraft position in the formation;

— the necessity of strict account of aircraft (section) maneuverability during variation of the flight regime;

— restricted possibilities of maneuvering for an accurate approach to the target (estimated line) within the assigned time period.

During flight in a close combat formation, air navigation is carried out by all crew members in compliance with the common air navigation rules and navigator's plan elaborated for the given flight.

The section leader should:

— be always aware of the aircraft position in the combat formation and check the actions of the wingmen crews;

— strictly hold the assigned flight regime;

— inform the combat formation crews on flight regime variations in due time, avoiding sharp changes in airspeed, direction and altitude of flight;

— pass over the estimated data for execution of the combat mission to the combat formation crews;

— keep a constant eye on the air and meteorological situation.

237. The section navigator (the navigator of the combat formation leader) should do the following:

— accomplish air navigation in compliance with the general air navigation rules specified for a solo aircraft in compliance with the navigator's plan;

— keep an eye on proper holding of the flight regime;

— watch the appearance of thick cumulus and thunderstorm clouds and make timely reports on the cloud situation to the section leader;

— report the data taken into account on separate flight legs and their variations to the section leader to be further passed over to the wingmen crews;

— determine the flight navigation elements and pass over the data taken into account for execution of the combat mission to the wingmen crews.

238. The wingman commander should do the following:

— keep his place in the combat formation;

— watch the leader and other aircraft of the combat formation;

— execute all the leader's commands in due time;

— report his position in response to the section leader's request;

— pass over the data accepted by the leader to his crew in due time.

239. The wingman navigator should do the following:

— be engaged in overall monitoring of the flight in compliance with the general air navigation rules specified for a solo aircraft and with the navigator's plan;

— determine the flight navigation elements and report his data on the leader's request;

— determine the initial data for execution of the flight mission;

— be ready at any moment to perform flight as the formation (section) leader or individually as a solo aircraft.

6.8.3. Holding Position in Combat Formation

240. The basic conditions for proper holding of one's position in the combat formation are strict holding of the assigned flight route and flight regimes by all the crews.

Aircraft position in the combat formation may be checked by using the following methods:

— the visual method (when the preceding aircraft is visible);

— when the aircraft passes the reference lines specified at certain distances to one and the same radar marker located ahead;

— by noting the time of passing the check reference points;

— by the distance left to one and the same radar marker located ahead;

— by observing the indicator screen;

— by determining the distance to the aircraft with the help of the CP3O interrogator-responder;

— with the aid of the ПРС fire-control radar.

241. When checking your position in the combat formation by reference to the РАДОН radar bombsight indicator screen, set up the 15 to 80-km scanning range scale and observe the marks of the adjacent aircraft within the "altitude spot".

If the distance to the adjacent aircraft exceeds the flight altitude, turn on the INTERROG (ЗАПРОС) switch on the interrogator-responder auxiliary board for a short period of time. As a result, the range rings should appear on the indicator screen of the РАДОН radar bombsight.

When checking adequate holding of the aircraft position in the combat formation by the time of passing the check reference points, the leader informs the other aircraft on the actual time of passing these reference points, and the wingmen crews determine their position relative to the leader as the difference between the time of passing one and the same reference point by the leader and wingman and by comparing the actual time distance with the assigned one.

When checking his position in the combat formation by the distance left to the next waypoint (check reference point), the leader counts off the distance left and the wingmen determine their position relative to the leader by a linear distance equalling the difference of the distances from the leader and wingmen to the waypoint (check reference point).

6.8.4. Extension of Combat Formation

242. The aircraft should be extended in combat formations to time distances providing execution of landing at the estimated line before reaching the approach maneuver roll-in line.

The assigned-line extension maneuver should be performed by following a pattern specified by the navigator's flight plan.

In separate cases, extension of the formation may be accomplished over the landing airfield by following the estimated pattern.

6.9. PECULIARITIES OF AIR NAVIGATION IN DIFFERENT CONDITIONS

6.9.1. Air Navigation at Extreme Low Altitudes

243. Flights executed at extreme low altitudes have the following peculiarities:

— air navigation is carried out in these conditions mainly with the help of aircraft navigation facilities and by visual orientation;

— the landmark visual detection range and identification time are considerably reduced;

— the range of landmark detection with the help of airborne radars is reduced;

— higher circumspection is required on the part of the crew;

— decreased VHF communication range and possibilities of employment of ground-based radio aids;

— higher errors of the flight directors.

244. If the extreme-low-altitude flight leg begins from the takeoff

airfield, the crew should proceed as follows:

— after performing takeoff and climbing to the circling flight altitude specified for the given airfield, level off the aircraft;

— following the command issued by the crew commander, all the crew members should set the flight route minimum pressure reduced to the sea level on the barometric altimeters and compare the altimeter readings;

— on obtaining the respective clearance from the flight control officer, bring the aircraft into descent to the assigned altitude at a vertical speed not exceeding 3 m/s.

245. When descending to the extreme low altitude when flying en-route, the crew should proceed as follows:

— slave the compass system;

— update the aircraft position on the automatic bomber navigation equipment indicator;

— perform accurate interception of the let-down line;

— before starting the descent, the navigator should report the aircraft position, the descent mode and the estimated altitude of flying at the extreme low altitude, as referenced by the two-pointer altimeter.

246. When flying at extreme low altitudes, pay special attention to holding the assigned flight regime. Inasmuch as the check landmarks are detected from small distances and the. time reserve for their identification is insufficient, even small deviations from the assigned course line may result in complete failure to locate the landmarks.

Considerable deviations from the assigned course line may stem from untimely start of the turn and pilot's errors in the amount of the bank angle.

Perform air navigation at extreme low altitudes in a complex, using aircraft air navigation means along with other navigation facilities (PCБH system, direction finders, broadcasting radio stations, homing radio stations, etc.) accessible for the given air situation at each flight route leg.

6.9.2. Air Navigation in Chaff Clouds

247. One of the effective means of opposing the acquisition and guidance radars is the combat formation flight under the cover of the chaff clouds.

The jamming aircraft crew should proceed as follows:

— drop chaffs in the assigned area, strictly keeping to the assigned chaff dropping time and mode;

— avoid arbitrary variation of the course when dropping chaffs;

— give a timely information on any changes in the course with a view to maintaining the assigned course line to the combat formation crews.

248. For entering the chaff clouds, the crew navigator should proceed as follows:

— 30 to 40 km before entering the chaff dropping zone, select the 15 to 80-km scanning range, set the ANTENNA — TILT (АНТЕННА — НАКЛОН) switch to the MAN (РУЧН.) position, set up the antenna tilt angle within 1 to 2° and turn on the ФАРМ camera attachement;

— detect the chaff cloud and enter it; to this end, using Table 16, determine the chaff cloud approach angle and turn linear lead (for $V=1000$ km/h, $\beta=20°$);

Table 16

Turn angle, deg.	10	20	30	40	50	60
Turn linear lead, km	0.4	1.5	3.2	5.7	8.6	12

— start turning at the moment of approach to the chaff cloud to a distance equal to the turn linear lead;

— correct the bank angle during the turn so that the chaff cloud image passes through the screen centre and has the shape of a straight line by the end of the turn;

— set the precise sighting mark to a distance of 3 to 5 km and pass to µA-scanning;

— make corrective turns to aligh the image of the chaff cloud with the aircraft zero relative bearing line.

6.9.3. Peculiarities of Using Air Navigation Facilities in Different Navigation Situations

249. Oversea flights may be performed in coast line visual visibility and zero visibility conditions.

Oversea flights in coast line visual visibility conditions or in conditions of coast line display on the РАДОН radar bombsight indicator screen do not practically differ from overland flights.

Air navigation over the open sea (ocean) is accomplished mainly with the use of radio and astrotracking aids, the drift angle being periodically checked by an isobaric method.

250. Before flying over the open sea (ocean), the navigator should proceed as follows:

— slave the compass system;

— update the aircraft position;

— place the LAND — SEA (СУША — МОРЕ) switch on the ДИСС Doppler ground speed and drift meter to the SEA (МОРЕ) position.

251. When flying over the open sea (ocean), the navigator has to do the following:

— carry out air navigation by the comprehensive use of all air navigation facilities;

— at least twice an hour, check the drift angle by using an isobaric method and compare the magnitude of this angle with the readings of the Doppler ground speed and drift meter;

— at least twice an hour, determine the aircraft fix with the help of long-range radio navigation aids.

252. When flying in Arctic conditions, the navigator should remember that the readings of the magnetic sensors are unstable; therefore, hold the flight direction in this case only in the DG (ГПК) mode, checking the course by reference to the astrotracker.

253. When flying over a terrain free of landmarks and over the mountains, the navigator should proceed as follows:

— carry out air navigation with the comprehensive use of all air navigation facilities;

— at least twice an hour, determine the aircraft fix with the help of the long-range radio navigation aids with no mountain masses on their inbound course;

— take into account instability of readings of the Doppler ground speed and drift meter when flying over mountains;

— during orientation, take into account the main direction of the mountain ridges.

7. COMBAT EMPLOYMENT

7.1. PHOTORECONNAISSANCE

7.1.1. Air Photography Estimations

254. Air photography estimations are made by the navigator during preparation for flight. The estimated data are entered into the aircraft navigator's Log Book, and the data required for air photography are marked on the target map.

The estimations made preparatory to vertical (strip or area) air photography should define:

— the way of approaching the object to be photographed and the method used to execute the mission;

— the possibility of taking photographs at the assigned altitude and airspeed;

— the size of the area to be photographed;

— the course used to approach the object to be photographed;

— the flight altitude and airspeed;

— the photography scale;

— the number of flight routes;

— the lateral overlap between the flight routes;

— the longitudinal overlap between the photographic pictures;

— the required number of photographic pictures and loading of one aerial camera per flight;

— the photography time interval;

— the estimated angles of aiming point ("marker") sighting, corresponding to the beginning and end of photography;

— the duration of the air photography;

— the amount and direction of aiming point offset (if the optical sight offset mechanism is to be used);

— the linear interval to be maintained between the aircraft in the formation during area formation photography.

When made preparatory to oblique air photography, the estimations should determine:

— the way of approaching the object to be photographed and the method of executing the mission;

— the possibility of taking photographs at the assigned flight altitude, airspeed and centre line range;

— the length of the area to be photographed;

— the course to be used for approaching the object to be photographed;

— the flight altitude and airspeed;

— the АФА camera tilt angle;

— the slant range of the object to be photographed along the centre line (to be set on the altitude scale of the АФА camera control unit);

— the scale of photography along the centre line;

— longitudinal overlap between the photographs along the centre line;

— the photography time interval (during oblique photography by vertical aerial cameras);

— the required number of photographs;

— the duration of the photography;

— the foreground and background ranges and photography depth.

For radar photography, the preliminary estimations specify the photography time interval, the number of photographs and ФАРМ camera attachment loading per flight.

The aerial camera basic data are given in Table 17.

7.1.2. Peculiarities of Map Preparation

255. Used as target maps for aerial photography are maps with 1:500000, 1:200000 and 1:100000 scales. The target map should point out the main landmarks providing reliable approach to the reconnaissance object, indicate the assigned run-in track, the boundaries of the onset and termination of the vertical (oblique) photography (the width of the brackets should equal the overall lateral lock-on of the terrain according to the map scale), the photography altitude and airspeed, the assigned conventional track angle, the required number of photographs and the protography time interval.

Besides, the following elements are plotted on the map, depending on the accepted mission execution method.

For vertical photography:

— the estimated target sighting angles corresponding to the beginning and end of photography;

— the duration of photography;

— the amount and direction of the aiming point offset (when the optical sight offset mechanism is used);

— the target great-circle coordinates and correction points.

The following data are plotted and inscribed on the map for strip (area) air photography:

— the assigned run-in track for each photography run;

— the entry landmarks (for each run) singled out on the course line at the photography onset boundary distance providing accurate

Table 17

АФА Camera Performance

Type of АФА camera	F, cm	Lens angular field	Type of installation	Size of photographic picture, cm	Lateral lock-on at number of strips: 1	2	4	Film length, m	Maximum number of shots	Lock-on in length of one strip, 20 % / 60 %	Minimum interval, s	АФА camera operating range: actual, H, m / W, km/h	theoretical, H, m / W, km/h
41/20	20	48°30′	Fixed, at angle of 3° backward	18x18	0.9H			60 120	270 540	120H / 60H	2	Up to 20,000 / 300—1500	Not specified
42/100	100	17°	Movable, from 6±2.5° to 40±2.5°	30x30				60	185	45НД / 22.5НД	2	5000—20,000 / 400—2400	100НД—5000 / 500—700
ФАРМ	3.5	—	Fixed	24.4 mm				12.5	450		0.75		

interception of the photography flight route;

— the landmarks corresponding to the onset and termination of the photography (marked on the course line or in its immediate proximity) on the photography onset and termination boundaries;

— auxiliary conspicuous landmarks to the right and left of the course line;

— the linear interval between the aircraft in the formation for formation area photography.

For oblique air photography:

— the foreground and background boundaries;

— the photography centre line (marked by a dash line);

— the АФА camera tilt angle relative to the horizon;

— the slant range along the centre line to be set on the АФА camera control unit;

— the photography time interval.

Used as the target map for radarscope photography is the flight chart on which the photography onset and termination boundaries and time interval are marked by conventional symbols.

7.1.3. Inspection and Check of Photographic Equipment by Navigator

256. Before checking the operation of the photographic equipment, perform visual inspection of the photo cameras and photographic equipment units. In the scope of inspection, make sure that:

— the protective covers of the lens are removed;

— the surfaces of the lens and protective glass of the camera windows are not fouled;

— the exposure and photography modes are selected properly.

After inspecting the camera equipment, test it when energized in the presence of a camera equipment technician (mechanic).

257. For checking operation of oblique photo camera АФА-42/100, proceed as follows:

— turn on the circuit breaker labelled CAMERA WINDOW — OBLIQUE (ФОТОЛЮК — ПЕРСП.);

— open the camera window by setting the CAMERA WINDOW switch on the panel to the OPEN (ОТКРЫТ) position; as a result, the green light should come on;

— turn on the АПФУ unit 115-V AC power supply switch labelled "АПФУ-1";

— set the camera by manipulating the view-finder to the assigned tilt angle; after camera adjustment, the light labelled CAMERA AND VIEW-FINDER ADJUSTED (ФОТОАППАРАТ И ВИДОИСКАТЕЛЬ СОГЛАСОВАНЫ) should come on (check camera tilt at two to three view-finder tilt angles);

— make the following settings on the control unit of camera

АФА-42/100: select the ground speed, slant range, exposure and diaphragm (in compliance with the flight mission); place the mode-of-operation switch to the STRIP I (I МАРШРУТ) position and common switch labelled АФА, to the ON (ВКЛЮЧ.) position — this will result in coming-on of the VOLTAGE ON (ТОК ВКЛЮЧЕН) indicator light; by turning the ADJUSTMENT (НАСТРОЙКА) knob, set the compensation speed indicator pointer to the zero position; depress the START (ПУСК) button and perform accurate adjustment by using the ADJUSTMENT (НАСТРОЙКА) knob;

— after depressing the START button, watch operation of the АФА camera; sound operation of the photo camera will be indicated by the TRANSPORT (ПЕРЕМОТКА) light flickering during film transportation and by the counter showing the number of the photographic pictures taken;

— on making two or three shots, shift the VOLTAGE ON (ТОК ВКЛЮЧЕН) switch on the control unit to the OFF (ВЫКЛ.) position;

— close the camera window and turn off the power supply of the АПФУ unit.

258. To check operation of vertical air photography camera АФА-41/20, proceed as follows:

— turn on the АФА-41/20 camera window doors control circuit breaker on the photographic equipment control board;

— switch on the АФА-41/20 camera control unit power supply circuit breaker on the photographic equipment control board;

— open the camera window by setting the CAMERA WINDOW (ФОТОЛЮК) switch on the photographic equipment control board to the OPEN (ОТКР.) position, which should result in coming-on of the green light;

— set the COMMON (ОБЩ.) switch on the АФА-41/20 camera control unit to the ON (ВКЛ.) position (this should result in coming-on of the VOLTAGE ON (ТОК ВКЛЮЧЕН) light), manipulate the INTERVAL (ИНТЕРВАЛ) knob to select the assigned interval, shift the STRIP PHOTOGRAPHY (МАРШРУТНАЯ СЪЕМКА) switch to the START (ПУСК) position and watch operation of the АФА camera; sound operation of the camera will be indicated by illumination of the TRANSPORT (ПЕРЕМОТКА) light and by the counter which reads the number of photographic pictures taken;

— on making two or three shots, cut out the camera; to this end, turn off the STRIP PHOTOGRAPHY and COMMON switches on the АФА-41/20 camera control unit;

— close the camera window.

7.1.4. Air Photography

259. To carry out air photography by using oblique aerial camera АФА-42/100, proceed as follows:

— turn on switch АПФУ-1, open the camera window and set the camera to the assigned tilt angle;

— set the strip switch on the АФА camera control unit to the STRIP I (I МАРШРУТ) position and the CHECK BOMBING — STRIP (КОНТР. БОМБОМ. — МАРШРУТ) switch, to the STRIP (МАРШРУТ) position and check setting of the ground speed, slant range (flight altitude) and assigned exposure;

— turn on the COMMON (ОБЩ.) switch and set the compensation speed indicator pointer to the zero position;

— when approaching the object to be photographed, depress the START button on the camera control unit and perform fine adjustment by using the ADJUSTMENT (НАСТРОЙКА) knob;

— check operation of the aerial camera by flickering of the TRANSPORT (ПЕРЕМОТКА) lights and increase of the photographic picture counter readings;

— the photography completed, turn off the common switch and the АПФУ unit power supply and close the camera window.

260. To perform photography by using vertical aerial camera АФА-41/20, proceed as follows:

— open the camera window, turn on the common switch and set up the interval between the shots and exposure in compliance with the photography mission;

— when approaching the object of photography, set the strip photography switch to the START (ПУСК) position and check operation of the АФА camera by flickering of the TRANSPORT (ПЕРЕМОТКА) light and by increase of the photographic picture counter readings;

— the photography completed, turn off the common switch and close the camera window.

NOTE. Turn on the PROTECTIVE GLASS HEATING (ОБОГРЕВ ЗАЩИТНЫХ СТЕКОЛ) switch when passing over from a subzero temperature zone into an above-zero one.

7.2. BOMBING

7.2.1. Preparation for Bombing Flight

261. Prior to executing a bombing flight, prepare a 1:500000 or larger scale map of the target area.

When studying the map and determining the target search methods, use the photo boards and photographs obtained in the process of visual and radar reconnaissance of the target for selecting the offset points.

When plotting the bombing flight route, determine the acceleration start point for bombing at $M>1$. Plot the route of flying to the target on the target area map and mark conspicuous landmarks providing location of the target (offset points) visually or with the help of the radar. Study the flight route and target area (offset points) when preparing the maps and plotting the flight route.

262. The crew should study the target area and target proper (offset points) by reference to plans, photo boards and photo diagrams of visual and radar reconnaissance under supervision of the specialists and chiefs of respective services and also by using information obtained by crews who performed flight to the target.

By studying the target area (offset points), the crew should obtain the knowledge of:

— the air defence system of the target area, its nature and sizes;

— the target range and the nature of target visibility attained with the help of the optical and radar bombsights from different altitudes and directions;

— the system of landmarks, providing reliable interception of the target (offset points), and its definition;

— presence of dummy targets and offset points;

— target elevation relative to the offset points;

— the coordinates of the offset points, the radar marker of the acceleration start point and intermediate waypoints.

Proceeding from the assigned bombing data (H, V Θ), pick out the $\frac{T}{H}$, $\frac{T_A}{H}$ magnitudes from the ballistic tables and compute the still air angle.

263. When preparing for range bombing, the crew should study and know:

— the procedure of bombing in compliance with the flight mission;

— the target situation (assigned targets);

— location of visible landmarks, radar markers, landmarks located on the target roll-in leg, the target and the procedure of using these landmarks and radar markers for approaching the target;

— elevation (depression) of the target and altitude verification ranges;

— indications of the radio aids (РСБН system, automatic radio direction finder, airfield marker beacon or broadcasting radio station) used for checking the assigned lines;

— the employment of instrument check methods to preclude unassigned target bombing;

— the procedure used for establishing radio contact with the bombing range;

— the safety measures and conditions in which bombing is PROHIBITED.

264. The crew commander should:

— know the crew operating procedure on the bombing run;

— have data on the time of flying from the bombing clearance line to the moment of bomb doors opening and bomb release;

— have data on indications of the radio aids at the assigned lines.

265. The crew navigator should:

— plan the flight route leg at which the initial data should be set on the sight and bombing armament controls;

— elaborate the procedure used for intercepting the bombing run start point as well as for finding and identifying the assigned target;

— have a prepared bombing range board, tables used for instrument aiming check and all other tables and charts required.

7.2.2. Check of Optical Bombsight

266. Check coupling of the optical bombsight with the compass system. To this end, proceed as follows:

— turn on the SIGHT SUPPLY (ПИТАНИЕ ПРИЦЕЛА) switch on the navigator's bombing equipment control board;

— check illumination of the sight scales;

— turn on the GYRO (ГИРО) switch on the optical bombsight;

— cut in the compass system;

— make sure that the WIND (ВЕТЕР) switch on the optical bombsight is set to the "U_x, U_y, K" position;

— select the 0, 5, 10, 15, 20, 45, 90, 180, 225, 270, 315, 340, 350 and 355° headings on the navigator's course indicator; the optical bombsight course scale should read the same magnitudes accurate within +1.5°.

267. Check operation of the elongation mechanism. To this end, proceed as follows:

— set the elongation mechanism knob to the "backward" position and, while looking through the eyepiece, make sure that the sighting prism is additionally turned, which should be accompanied by coming-on of the ELONG (УДЛИНЕН.) light located on the eyepice portion of the sight;

— set the elongation mechanism knob to the initial ("forward") position;

— check the elongation mechanism knob for reliable fixation in the "backward" and "forward" positions.

268. Check precession of the free gyro and operation of the automatic slaving system. To this end, proceed as follows:

— 10 min after turning on the GYRO (ГИРО) switch, uncage the gyro and turn off the AUTO SLAVE (A. КОРР.) switch;

— at sighting angles close to zero, align the sight crosshairs with any landmark by using the sighting knobs and start the stopwatch;

— on a lapse of 2 min, determine the amount of crosshairs displacement which should not exceed 1.5°;

— turn on the AUTO SLAVE switch — the optical bombsight crosshairs should get slowly displaced;

— depress the FAST SLAVE (БЫСТР. КОРР.) button — the crosshairs displacement should be energetic; after the gyro stabilizer erection, the crosshairs should stop displacing;

— align the crosshairs with some conspicuous point on the ground, cage the gyro and then uncage it, depress the FAST SLAVE button — the bombsight crosshairs should move in the direction of the selected point and stop in the area of this point;

— check indication of the gyro stabilizer vertical reference datum by depressing the VG (ВЕРТИКАЛЬ) button; with the gyro caged, the VG light should be alive; uncage the gyro and 1 or 2 min later make sure that the light has extinguished;

— the checks completed, cage the gyro stabilizer and turn off the GYRO (ГИРО) switch.

269. Check accuracy of the bombsight computer operation and the time of sighting beam motion in the longitudinal and lateral directions, making reference to the data of the table located on the top cover of the sight casing, for conditions close to bombing.

270. Check operation of the wind measuring mechanism by using an autosynchronous method for the longitudinal and lateral directions taken separately. To this end, proceed as follows:

(a) set the 15,000-m altitude and 1200-km/h airspeed on the computer;

(b) when checking operation of the mechanism in the longitudinal direction, proceed as follows:

— set the following magnitudes on the sight: $U_x = U_y = 0$; $\text{tg}\,\mu_o = 0$; $\varphi_s = 75°$; $V_{sh} = 0$;

— depress the sighting knob button and turn on the CSM (МПС) switch;

— when the sighting angle index is aligned with magnitude $\varphi_s = 69°$, turn on the AUTO SYNCHRO (А. СИНХР.) switch and start the stopwatch;

— on a lapse of 1 min, set up $U_x = 200$ km/h;

— the moment the longitudinal sighting index is aligned with magnitude $\varphi_s = 0°$, stop the stopwatch, then turn off the CSM and AUTO SYNCHRO switches and pull out the sighting knob buttons; the time indicated by the stopwatch should be within 95 to 106 s;

(c) when checking operation of the mechanism in the lateral direction, proceed as follows:

— set the following magnitudes on the sight: $U_x = 0$; $U_y = 100$ km/h; $\text{tg}\,\mu_o = 1.6$; $\varphi_s = 0$; $V_{sh} = 0$;

— depress the sighting knob buttons, then start the CSM switch and stopwatch;

— the moment scale index $\text{tg}\,\mu_o$ gets aligned with magnitude $\text{tg}\,\mu_o = 1$ stop the stopwatch, turn off the CSM and AUTO SYNCHRO switches and pull out the sighting knob buttons; the time indicated by the stopwatch should be within 82 to 97 s.

7.2.3. Check of Radar Bombsight

271. Turn on the sight power supply. To this end, proceed as follows:

— turn on switches PH-22 and PH-28 on the navigator's control board;

— set the SUPPLY (ПИТАНИЕ) switch on control panel PH-21Д and MAINS (СЕТЬ) switch on control panel PH-20A to the ON (ВКЛ.) position. This will result in coming-on of the PH-28 BLOWING (ПРОДУВ PH-28) light on control panel PH-21Д.

272. When checking the antenna azimuth control modes, proceed as follows:

— check the antenna manual control system. To this end, depress the momentary switch to the right and then to the left; the sweep line should rotate clockwise and counterclockwise at a speed of 8 to 12 r/min;

— check circular rotation of the antenna. To this end, set the antenna mode-of-operation switch to the CIRCULAR (КРУГОВ.) position; the sweep line should rotate clockwise at a speed of 16 to 24 r/min;

— check sector swinging of the antenna. To this end, set the antenna mode-of-operation switch to the SECTOR (СЕКТОР) position; the sweep line should swing at a rate of 25 to 55 swings per minute; using the AZIMUTH MARKS (МЕТКИ АЗИМУТ) knob, adjust the brightness of the relative bearing line which should serve as the sector-sweep axis; rotate the knob of the BEARING MARK (МЕТКА ПЕЛЕНГА) knob to check turning of the sector-sweep axis from 0 to 360°;

— set the antenna mode-of-operation switch to the MAN (РУЧН.) position — the sweep line should stop rotating;

— set the switch labelled OFF-CENTERED SECTOR (СМЕЩ. СЕКТОР) to the ON (ВКЛ.) position — the off-centered sector should appear on the indicator screen; rotate the BEARING MARK knob to check turning of the sector-sweep axis;

— check automatic engagement of the sector. To this end, set the mode-of-operation switch of the sights to the OBS (ОПБ) position; the off-centered sector should appear on the indicator screen; rotate the "tg μ_o" knob on the optical bombsight to check turning of the sector-sweep axis.

273. Check the antenna reflector tilt mechanism. To this end, place the TILT (НАКЛОН) switch on unit PH-21Д to the MAN (РУЧН.) position; using the UP — DOWN (ВВЕРХ — ВНИЗ) switch, tilt the antenna and make sure that the antenna is tilted by reference to indicator И-3.

Set an 8.36-km altitude on unit PH-21Д, place the TILT switch to the AUTO (АВТ.) position and make sure that the readings of indicator И-3 are within 5.5 to 6.5 divisions.

Place the A-SCAN — μA-SCAN (ПМ — МПМ) switch on unit PH-6 to the μA-SCAN (МПМ) position; using the SIGHT MARK (МЕТКА ВИЗИР.) knob, set the sighting mark range equal to 20 km. In this case, the readings of indicator И-3 should be within 11 to 13 divisions.

274. When checking the μA-SCAN, place the mode-of-operation switch to the SEARCH (ПОИСК) position and set the accurate sighting mark to the 10-km range.

Shift the A-SCAN — μA-SCAN switch to the μA-SCAN position, which should result in appearance of a rectangular sweep image.

Manipulate the AZIMUTH MARKS (МЕТКИ АЗИМУТ) and SIGHT MARK (МЕТКА ВИЗИР.) knobs to adjust the brightness of the electronic crosshairs. Place the antenna mode-of-operation switch to the SECTOR (СЕКТОР) position and depress the operating button of the PH-6 unit indicator. This should result in appearance of a 50 to 68° sector on the screen.

275. Check display of the sighting mark and control of the accurate sighting mark. To this end, proceed as follows:

— manipulate the SIGHT MARK (МЕТКА ВИЗИР.) knob on control panel PH-21Д to adjust the brightness of the sighting mark;

— select the scanning range of 180 km (15 to 80) and make sure that rotation of the SIGHT MARK knob on the PH-6 indicator is accompanied by movement of the sighting mark on the indicator screen.

276. Check presence and proper shaping of the aiming line. To this end, proceed as follows:

— make sure that the mode-of-operation switch on control panel PH-21Д is set to the SEARCH (ПОИСК) position and the ANTENNA — ROTATION (АНТЕННА — ВРАЩЕНИЕ) switch is placed to the CIRCULAR (КРУГОВОЕ) position;

— set the AL (ЛП) switch on control panel PH-21Д to the ON (ВКЛ.) position;

— check to see that the A-SCAN — μA-SCAN switch on the indicator of unit PH-6 is placed to the A-SCAN position;

— rotate the AZIMUTH (АЗИМУТ) knob on the PH-6 indicator to align the azimuth scale zero with the fixed index;

— manipulate the lateral sighting knob on the optical bombsight to set magnitude tg $\mu_o=0$ on the tg μ_0 scale; while varying the φ_s magnitude throughout the entire scale range, make sure that the aiming line is aligned with the fixed index (azimuth scale zero) on the PH-6 indicator;

— set the tg $\mu_0=\pm 0.4$ magnitude and $\varphi_s=78$, 45 and 30° sighting angle magnitudes (by using the longitudinal sighting knob) on the optical bombsight;

— check the aiming line sweep angle; the aiming line should get swept by the ± 5, ± 22 and $\pm 35°$ angles (1°10′ tolerance).

277. Check proper operation of the sight in the optical bombsight mode. To this end, proceed as follows:

(a) set the 180-km scanning range on control panel PH-21Д;

(b) set the accurate sighting mark to the 20-km range in the SEARCH (ПОИСК) mode;

(s) on the optical bombsight computer:

— turn on the switch labelled $\frac{T}{H}$, $\frac{T_A}{H}$;

— make sure that the switch labelled "H, V" is turned off;

— select the altitude of 10,000 m by using the "ΔH" knob and the airspeed of 1200 km/h, by using the "V" knob;

(d) on the optical bombsight:

— pull out the longitudinal and lateral sighting buttons;

— set magnitude tg $\mu_0 = 0$;

— set magnitudes $U_x = 0$ and $U_y = 0$ by using the wind knobs;

— set magnitude $\varphi_s = 60°$ by manipulating the longitudinel sighting knob;

(e) set the mode-of-operation switch on control panel PH-21Д to the OBS (ОПБ) position and make sure that the accurate sighting mark is set within 100 to 110 km;

(f) using the position lever on optical bombsight ОПБ-15, set the accurate sighting mark to the 160-km range;

(g) using the "U_x" knob, vary the U_x magnitudes and make sure that the computer ground speed scale reads $V \pm U_x$ ($1200 \pm U_x$); the check completed, set $U_x = 0$;

(h) using the position lever on the optical bombsight, set the accurate sighting mark to the range of 70 km and, by observing variation of the number of scale marks on the screen of indicator PH-6, make sure that the sight has started operating in the 15 to 80-km scanning range mode;

(i) set the A-SCAN — μA-SCAN (ПМ — МПМ) switch on indicator PH-6 to the μA-SCAN (МПМ) position; start the stopwatch the moment one of the 10-km scale marks gets aligned with the accurate sighting mark; the stopwatch should read the 30 ± 0.5-s time;

(j) check adequate change-over of the sight to operate in the main synchronization mode. To this end, proceed as follows:

— press the sighting knob buttons;

— using the position lever, decrease the range of the accurate sighting mark to the range of transition to the main synchronization mode; the moment the optical range (20 km) coincides with the radar range, the accurate sighting mark gets aligned with the 10-km scale mark (μA-SCAN (МПМ)) and the green light comes to illuminate on indicator PH-6;

— ensure automatic engagement of the constant-speed motor — the index of the sighting angles (φ_s) will start moving over the scale;

— pull out the sighting knob buttons;

— increase the tg μ_0 magnitude to make sure that the slant range of the accurate sighting mark increases (the 10-km scale marks move down the screen); the check completed, set magnitude tg $\mu_0 = 0$;

(k) set the sighting angle (φ_s) close to zero and make sure that the accurate sighting mark is aligned with the 10-km scale mark (with a ± 250-m tolerance).

278. Check the quality of the radar image and adequate operation

of the antenna mirror inclination control unit. To this end, proceed as follows:

— place the A-SCAN — μA-SCAN switch on indicator PH-6 to the A-SCAN (ПМ) position, the mode-of-operation switch on control panel PH-21Д to the SEARCH (ПОИСК) position and the scanning range, within 15 to 80 km;

— set the ANTENNA — DUMMY (АНТЕННА — ЭКВИВАЛЕНТ) switch on control panel PH-24 to the ANTENNA (АНТЕННА) position;

— place the XMTR (ПЕРЕДАТЧИК) switch to the ON (ВКЛ.) position and make sure that the indicator lights labelled HIGH (ВЫСОКОЕ) and PH-12 COOLING (ПРОДУВ PH-12) are alive.

CAUTION. CUT IN THE TRANSMITTER NOT EARLIER THAN 5 MIN AFTER TURNING ON POWER SUPPLY. AT TEMPERATURE BELOW 10 °C, CUT IN THE TRANSMITTER AFTER 15-MIN WARM-UP OF THE EQUIPMENT;

— set the ALTITUDE (ВЫСОТА) switch on control panel PH-21Д to the MANUAL (РУЧНАЯ) position and manipulate the ALTITUDE knob to set the altitude within 100 to 200 m;

— make sure that the TILT (НАКЛОН) switch occupies the AUTO (АВТОМ.) position;

— rotate the BCKGND NOISE (ФОН) and DISCRIM (ВЫДЕЛЕНИЕ) knobs to obtain the radar image of the terrain;

— set the TILT (НАКЛОН) switch to the MANUAL (РУЧНОЙ) position and tilt the antenna downwards until the radar image is vanished, then again shift the switch to the AUTO position which should result in restoration of the radar image;

— check the quality of the radar image in the μA-SCAN mode; to this end, align the relative bearing line and the accurate sighting mark with one of the clutter signals on the screen in the A-SCAN mode, then change over into the μA-SCAN mode and make sure that the screen displays the selected radar marker close to the crosshairs;

— cut out the transmitter.

279. Check the compass system slaving and wind determination circuits. To this end, proceed as follows:

(a) change over the compass system to operate in the DG (ГПК) mode and select the zero heading as read off the scale of navigator's indicator УШ-1;

(b) on control panel PH-21Д, set the mode-of-operation switch to the ROUND SEARCH (ПОИСК, КРУГОВОЕ) position, the altitude within 100 to 200 m and the scanning range, within 15 to 80 km;

(c) place the RECKONING (СЧИСЛЕНИЕ) switch on control panel PH-20A to the OFF (ВЫКЛ.) position;

(d) set the $X_{r.m}$ and $Y_{r.m}$ coordinates equal to zero on indicator PH-17;

(e) on control panel PH-20A:

— set the mode-of-operation switch to the WIND CHECK — MARK IDENTIFIED (ОПРЕДЕЛЕНИЕ ВЕТРА — ОРИЕНТИР ОПОЗНАН) position;

— set up main great-circle course track angle $\beta=0$ and make sure that the great-circle course displayed by indicator PH-17 equals zero;

(f) on indicator PH-6:

— set the relative bearing line to 45°;

— turn on the SLAVING (КОРРЕКЦИЯ) switch;

— set the accurate sighting mark to the 70-km range;

(g) on making the above settings, turn off the SLAVING switch on indicator PH-6, then turn on the stopwatch and make sure that aircraft coordinates $X_{a/c}=Y_{a/c}=49.5\pm1.75$ km are indicated on the counters of unit PH-17; 2 min after turning off of the SLAVING switch on indicator PH-6, turn it on again, set the accurate sighting mark to 60 km; 3 min later again turn off the SLAVING switch and make sure that $X_{a/c}=Y_{a/c}=42.4\pm1.75$ km, wind course angle $\varepsilon=45\pm20°$ and wind speed $U=200\pm40$ km/h (on control panel PH-20A); the check completed, set the mode-of-operation switch on control panel PH-20A to the NAVIGATION (НАВИГАЦИЯ) position.

280. Check the "marker" shaping circuit. To this end, proceed as follows:

— set $X_{WP}=0$, $Y_{WP}=0$, $X_{a/c}=0$ and $Y_{a/c}=-70$ km on the automatic bomber navigation equipment indicator (PH-17);

— set a 12,000-m altitude on control panel PH-21Д and place the mode-of-operation switch to the ABNE (НБА) position;

— read the counter scale to make sure that the slant range of the "marker" is within 71 ± 1.5 km and the "marker" relative bearing equals $0\pm3°$;

— set $Y_{a/c}=-9$ km on indicator PH-17;

— change over the radar sight into the main synchronization mode, set the sighting angle and tg μ_0 equal to zero on the optical bombsight; manipulate the "ΔH" knob on the computer to align the accurate sighting mark with the "marker" (first in the A-SCAN and then in the μA-SCAN mode) and make sure that at the moment of alignment the altitude read off the computer is within 15 ± 1 km and the relative bearing equals $0\pm2°$.

281. Check the accuracy of "marker" shaping. To this end, make the following settings:

— set the zero heading on the compass system;

— set $\beta=0$ on control panel PH-20A;

— set the 8000-m altitude on control panel PH-21Д;

— set $Y_{a/c}=-4.6$ and $X_{a/c}=0$ on indicator PH-17;

— set the 8000-m altitude on the optical bombsight computer;

— set $\varphi_s=30°$ and $\alpha_{aim}=0$ on the optical bombsight.

Change over to the μA-SCAN mode; the "marker" should be aligned with the electronic crosshairs (with an accuracy of ±1.5 km).

Make a similar check for the 10,000 and 12,000-m altitudes, using Table 18.

Table 18

$H_{PH\text{-}21} = H_{OBS}$, m	$Y_{a/c}$, km	φ_s, deg.
8000	— 2.90	20
8000	— 4.60	30
10,000	— 8.40	40
10,000	—12.05	50
12,000	—20.09	60
12,000	—33.20	70
14,000	—52.00	75
16,000	—59.50	75
18,000	—67.00	75

NOTE. The Table is specified for the following conditions:
— the "marker" should be aligned with the electronic crosshairs;
— the heading should equal zero, $\beta = 0$, $X_{a/c} = 0$, $\alpha_{aim} = 0$.

282. Check operation of the polar coordinate circuit and reckoning circuit. To this end, proceed as follows:

(a) set 45° heading on navigator's indicator УШ-1;

(b) make the following settings on automatic bomber navigation equipment control panel PH-20A:

— place the MANUAL INPUT (РУЧНОЙ ВВОД) switch to the "W_α" position;

— manually set $W = 1200$ km/h and $\alpha = 0$;

(c) make the following settings on indicator PH-17:

— set $X_t = Y_t = +200$ km on the scales of the WP—TARGET (ППМ—ЦЕЛЬ) counters;

— set $X_{a/c} = Y_{a/c} = 0$ on the AIRCRAFT (САМОЛЕТ) counters and make sure that the moving taget indicator pointer reads $0 \pm 3°$ and the RANGE (ДАЛЬНОСТЬ) counter indicates the distance to the target equalling 280 ± 27 km;

— set $X_t = X_t = +100$ km on the scales of the WP — TARGET (ППМ — ЦЕЛЬ) counters and make sure that the moving target indicator pointer shows $0 \pm 3°$ and the RANGE (ДАЛЬНОСТЬ) counter reads 141 ± 8.5 km;

— introduce the drift angle magnitude into control panel PH-20A and make sure that the moving target indicator pointer turns in the direction opposite to that of the drift, through the same number of degrees; the check over, set the zero drift angle;

(d) turn on the RECKONING (СЧИСЛЕНИЕ) switch and start the stopwatch; 3 min later, turn off the RECKONING switch and make sure that the AIRCRAFT (САМОЛЕТ) counters indicate magnitudes $X_{a/c} = Y_{a/c} = 42.4 \pm 2.8$ km.

283. Turn off the radar bombsight. To this end, proceed as follows:

— place the ANTENNA — ROTATION (АНТЕННА — ВРАЩЕНИЕ) switch to the MANUAL (РУЧНОЙ) position and, by depressing the RIGHTWARD — LEFTWARD (ВПРАВО — ВЛЕВО) switch, turn the sweep line (antenna) through a relative bearing indicated in the table attached to indicator PH-6;

— turn off the MAINS (СЕТЬ) switch on control panel PH-20A and SUPPLY (ПИТАНИЕ) switch on control panel PH-21Д;

— set the sight controls to the initial position.

7.2.4. Check of Bomb Release Circuits

284. Check proper opening and closing of the bomb doors by using the main and stand-by control systems.(if the bomb doors were opened with the help of the stand-by control system, close them, using the stand-by closing switch located on the pilot's forward electric power supply board).

285. Check serviceability of the bomb electric interlocking and indication system. To this end, proceed as follows:

— arm all actuators on the racks being loaded (with the shackles removed from the racks);

— turn on the switches labelled MASTER RELEASE SWITCH (ГЛАВНЫЙ ВЫКЛЮЧАТЕЛЬ СБРАСЫВАНИЯ) and BRVSB (КВСБ) on the bombing equipment control board;

— set an arbitrary interval and train on the ЭСБР electrical bomb release;

— using bomb release button КСБ-49, check the bomb train set on the ЭСБР electrical bomb release — none of the rack actuators should operate, with the interlocking control boxes serviceable, and the bomb suspension indicator lights should be dead;

— fit shackles on the racks;

— place inserts H-116 into the carrying hook openings, and insert rings, into the ARMED — SAFE (ВЗРЫВ — НЕВЗРЫВ) levers;

— close the bomb doors;

— depress the button used for checking suspension of aerial bombs from the racks; this should result in coming-on of the lights corresponding to the loaded racks on the bombing equipment control board.

286. Check the circuits used for combat release of bombs with the help of the optical bombsight. To this end, proceed as follows:

— turn on the switch labelled MASTER RELEASE SWITCH (ГЛАВНЫЙ ВЫКЛЮЧАТЕЛЬ СБРАСЫВАНИЯ) on the bombing equipment control board;

— set the switch on the ЭСБР electrical bomb release to the TRAIN (СЕРИЯ) position and the SALVO (ЗАЛП) switch, to the BY ONE (ПО-1) position;

— place the knob of the electric bomb release counter to the position corresponding to the number of the bombs suspended;

— turn on the SIGHT SUPPLY (ПИТАНИЕ ПРИЦЕЛА) switch;

— manipulate the longitudinal sighting knob to set the sighting angle on the optical bombsight, which is 10 to 15° higher than the aiming angle, and turn on the CSM (МПС) switch;

— arm the AUTO RELEASE (АВТОСБРОС) lever on the optical bombsight and turn on the BRVSB (КВСБ) switch on the bombing equipment control board;

— issue the "Clear the doors" command;

— on receiving the door clearance affirmative, countersink the longitudinal and lateral sighting knob buttons; 4 to 8 s before the bomb release moment the bomb doors will get automatically opened and the moment the aiming and sighting angles get aligned, the quantity of release units set on the ЭСБР electrical bomb release will come to operate to release aerial bombs; the shackles will open and the inserts will be set to ARMED;

— pull out the sighting knob buttons and turn off the CSM (МПС) switch on the optical bombsight.

287. Check operation of the emergency bomb release circuits in the SAFE mode. To this end, proceed as follows:

— arm all bomb shackle release units on the bomb racks;

— place inserts into the shackles;

— place the rings of inserts H-116 into the ARMED — SAFE (ВЗРЫВ — НЕВЗРЫВ) levers;

— close the bomb doors;

— issue the "Clear the doors" command and, on receiving the door clearance affirmative, turn on the EMERGENCY BOMB RELEASE (АВАРИЙНОЕ СБРАСЫВАНИЕ) switch — the bomb doors will open and the inserts will be set to SAFE.

288. Check operation of the emergency bomb release circuits in the ARMED mode. To this end, proceed as follows:

— arm all the shackle release units on the bomb racks;

— place inserts into the shackles;

— place the insert rings into the ARMED — SAFE levers, issue the "Clear the doors" command and, on receiving the door clearance affirmative, close the bomb doors;

— turn on the switch labelled TURN ON FOR EMERGENCY ARMED RELEASE (ПРИ АВАРИЙНОМ СБРОСЕ НА ВЗРЫВ ВКЛЮЧИ);

— turn on the EMERGENCY BOMB RELEASE switch; this will result in opening of the bomb doors and setting of the inserts to ARMED.

NOTE. The same procedure is used for checking the bomb emergency release circuits by the pilot.

289. Check operation of the combat and emergency bomb release circuits in the ARMED and SAFE modes, with the ПУ-22 system switch set to the SQUIB (ПИРО) and MECH (МЕХ.) positions, from the navigator's and pilot's stations and functioning of the emergency bomb release circuit, with the mains de-energized, from the pilot's station.

When checking operation of the bomb combat release circuit, with the ПУ-22 system switch set to the SQUIB (ПИРО) position, the tester lamp should come on the moment the contact ball passes through the spring-loaded contact of the plank. When the emergency bomb release circuit is checked in the ARMED mode, with the ПУ-22 system switch set to the SQUIB position, the tester lamp should also come on while during the check in the SAFE mode the lamp should be dead.

Use the same procedure for checking integrity of the fuze mechanical arming circuit, with the switch set to the MECH position.

When the bomb release circuits are checked in the ARMED mode, the plank slider should not be countersunk and the tester ball should not come out of the plank.

When the check is carried out in the SAFE mode, the tester ball should freely come out of the plank.

290. Cut out the cabin equipment and set the controls to the initial position in compliance with Table 19.

Table 19

Initial Positions of Navigation and Bombing System Controls

Controls	Position
In pilot's cabin	
On control board:	
— the BOMB DOOR STBY CLOSING switch	Turned off
— the EMERGENCY BOMB RELEASE (АВАРИЙНЫЙ СБРОС БОМБ) switch	Turned off
— the switch labelled TURN ON FOR EMERGENCY ARMED RELEASE (ПРИ АВАРИЙНОМ СБРОСЕ НА ВЗРЫВ ВКЛЮЧИ)	Turned off, capped and sealed
On the bomb release control panel, with the mains de-energized:	
— the ARMED (ВЗРЫВ) switch	Turned off and sealed
— the bomb release lever in case of electrical system failure	Turned off and secured by safety pin

Table 19, continued

Controls	Position
In navigator's cabin	
On bombing equipment control panel:	
— the circuit breakers	Turned on
— the switch labelled BOMB DOORS OPEN — CLOSED (СТВОРКИ Б/ЛЮКА — ОТКРЫТЫ — ЗАКРЫТЫ)	Set to neutral
— the switch labelled BOMB DOORS — STBY OPEN	OFF (ВЫКЛ.)
— the switch labelled MASTER RELEASE SWITCH (ГЛАВНЫЙ ВЫКЛЮЧАТЕЛЬ СБРАСЫВАНИЯ)	OFF (ВЫКЛ.)
— the BRVSB (КВСБ) switch	OFF (ВЫКЛ.)
— the SALVO (ЗАЛП) switch	In compliance with flight mission
— the switch labelled SIGHT SUPPLY (ПИТАНИЕ ПРИЦЕЛА)	OFF (ОТКЛ.)
— the switch labelled INDICATOR LAMP CHECK (ПРОВЕРКА СИГНАЛЬНЫХ ЛАМП)	OFF (ВЫКЛ.)
— the switch labelled TURN ON DURING AUTO-3 SUSPENSION (ВКЛЮЧИ ПРИ ПОДВЕСКЕ АВТОМАТ-3)	In compliance with flight mission
On optical bombsight:	
— the switches labelled CSM (МПС), GYRO (ГИРО) and AUTO SYNCHRO TURN (РАЗВ. А. СИНХР.)	OFF (ОТКЛ.)
— the AUTO SLAVE (А. КОРР.) switch	OFF (ОТКЛ.)
— the WIND (ВЕТЕР) switch	U_x, U_y, K
— the B — T (Б — Т) switch	B (Б)
— the longitudinal sighting knob	$\varphi = 78°$
— the elongation mechanism knob	Fixed in FORWARD (ОТ СЕБЯ) position
— the lateral sighting knob	$\text{tg}\ \mu_0 = 0$
— the wind knobs	$U_x = 0$, $U_y = 0$
— the gyro caging lever	CAGE

Table 19, continued

Controls	Position
— the AUTO RELEASE (АВТОСБРОС) lever	Released
— the sighting knob buttons	Pulled out
— the φ_{aim} angle manual setting knobs	Pulled out and fixed
— the knobs labelled V_{sh} ($V_к$) and δV_{sh} (δ $V_к$) for setting ship motion speed and direction	0
On optical bombsight computer:	
— the switch labelled "H, V"	OFF (ОТКЛ.)
— the switch labelled "$\frac{T_A}{H}$, $\frac{T}{H}$"	OFF (ОТКЛ.)
— the AIM-OFF (ВЫНОС (B)) knob	0
— the knob labelled "θ_T, θ_A" used for setting bomb characteristic fall time	In compliance with flight mission
— the "ΔV" knob	0
— the knob labelled BURST HEIGHT (h) (ВЫСОТА РАЗРЫВА (h))	0
— the knob labelled TARGET ELEVATION ΔH (ПРЕВЫШЕНИЕ ЦЕЛИ (ΔH)) knob	0
— the TRAIN — FORMATION (СЕРИЯ — СТРОЙ) knob	0
On control panel PH-21Д:	
— the SUPPLY (ПИТАНИЕ) switch	OFF (ВЫКЛ.)
— the TRANSMIT (ПЕРЕДАТЧИК) switch	OFF (ВЫКЛ.)
— the RANGE (ДАЛЬНОСТЬ) knob	"180"
— the mode-of-operation switch	SEARCH (ПОИСК)
— the AL (ЛП) switch	OFF (ВЫКЛ.)
— the TILT (НАКЛОН) switch	MAN (РУЧН.)
— the ROTATION (ВРАЩЕНИЕ) switch	MAN (РУЧН.)
— the OFF-CENTERED SECTOR (СМЕЩ. СЕКТОР) switch	OFF (ВЫКЛ.)

Controls	Position
— the ALTITUDE (ВЫСОТА) switch	MAN (РУЧН.)
— the MARKS 15—80 (МЕТКИ 15—80) knobs	Extreme LH position
On indicator PH-6:	
— the switch labelled A-SCAN — μA-SCAN (ПМ — МПМ)	A-SCAN (ПМ)
— the BRIGHT (ЯРКОСТЬ) knob	Extreme LH position
— the DISCRIM (ВЫДЕЛЕНИЕ) knob	Extreme LH position
— the BACKGROUND NOISE (ФОН) knob	Extreme LH position
— the GAIN (УСИЛЕНИЕ) knob	Extreme LH position
— the UPDATING (КОРРЕКЦИЯ) switch	OFF (ВЫКЛ.)
— the WS SUPPRESSION (ПОДАВЛЕНИЕ ВП) switch	OFF (ВЫКЛ.)
— the ILLUM (ПОДСВЕТ) knob	Extreme LH position
On automatic bomber navigation equipment control panel PH-20:	
— the MAINS (СЕТЬ) switch	OFF (ВЫКЛ.)
— the mode-of-operation switch	NAVIGATION (НАВИГАЦИЯ)
— the AT (ЗСО) switch	OFF (ВЫКЛ.)
— the RECKONING (СЧИСЛЕНИЕ) switch	OFF (ВЫКЛ.)
— the switch labelled MANUAL INPUT W, α — U, ε° (РУЧНОЙ ВВОД W, α — U, ε°)	U, ε°
— the switch labelled AP—SDM (АП — РКР)	SDM (РКР)
— the knob labelled MAIN GREAT-CIRCLE COURSE (НАПРАВЛЕНИЕ ГЛ. ОРТОДРОМИЙ)	"0°" by scale
On switchover panel PH-24:	
— the ANTENNA — DUMMY (АНТЕННА — ЭКВИВАЛЕНТ) switch	ANTENNA (АНТЕННА)

7.2.5. Inspection of Bombing Equipment

291. Before climbing into the cabin, the navigator should check to see that:

— the radar radome is intact;

— the sight and cabin glass panels are clean;

— the interlocking switch on the aircraft port side is turned off;

— the aircraft is loaded with aerial bombs in compliance with the flight mission and the fuzes are properly prepared;

— the fuzes are set to the adequate delay time;

— the balls of the fuze charging cords or mechanical locking balls are properly installed in the plank of the ПУ-22 system; in performing this check, examine the balls from top to bottom, in compliance with the bomb suspension order;

— the rings of the fuze arming rods are inserted into the ARMED — SAFE (ВЗРЫВ — НЕВЗРЫВ) mechanisms of the bomb rack shackles (in case of fuzes aimed with the help of the fuze arming control).

292. On climbing into the cabin, the navigator should proceed as follows:

— set the navigation and bombing system controls to the initial position (See Table 19);

— turn on all the circuit breakers on the navigator's bombing equipment control board;

— check the position of the switch labelled TURN ON DURING AUTO-3 SUSPENSION (ВКЛЮЧИ ПРИ ПОДВЕСКЕ АВТОМАТ-3) which should be turned off with the chaff dispenser removed;

— check serviceability of the lamps, using a rotary switch.

293. After starting the engine and connecting 27-V, 115-V and 208-V power supply sources to the aircraft mains, proceed as follows:

— check the bomb suspension indication system;

— set:

characteristic bomb fall time Θ;

the aerodynamic correction for the assigned bombing conditions;

the burst height;

target elevation above the sea level;

correction for train and formation in per cent of altitude;

aim-off value $B=0$;

wind components $U_x=0$ and $U_y=0$;

sighting angle $\varphi_s=78°$;

lateral sighting angle tg $\mu_0=0$;

the elongation mechanism knob, to the FORWARD (ОТ СЕБЯ) position;

— check computation of course by the optical bombsight by reference to the navigator's indicator;

— turn off the SIGHT SUPPLY (ПИТАНИЕ ПРИЦЕЛА) switch.

7.3. OPTICAL BOMBING

7.3.1. Preparation of Sight and Bombing Equipment

294. Before intercepting the initial target approach point (ITAP), the crew commander should:

— strictly hold the assigned flight regime, check the aircraft position by the available means and request the navigator to refine the time of intercepting the point of turn on the target (initial target approach point) and the time of approaching the target;

— check setting of the bombing equipment controls to the initial position by listening to the navigator's reports.

295. The crew navigator should proceed as follows:

(1) on the bombing equipment control board:

— make sure that all the circuit breakers are turned on;

— make certain that the SIGHT SUPPLY (ПИТАНИЕ ПРИЦЕЛА) switch is turned on.

NOTE. The optical bombsight power supply should be turned on not later than 30 min before dropping bombs;

— ascertain that the emergency bomb release switches labelled EMERG RELEASE (АВАРИЙН. СБРАСЫВ.) and ARMED — SAFE (ВЗРЫВ — НЕВЗРЫВ) are turned off (the red safety caps are lowered and locked);

— make sure that the switches labelled MASTER RELEASE SWITCH (ГЛАВНЫЙ ВЫКЛЮЧАТЕЛЬ СБРАСЫВАНИЯ), BRVSB (КВСБ) and STBY OPEN (ЗАПАС. ОТКРЫТ.) are turned off and the switches labelled SALVO (ЗАЛП) and LOAD VARIANT (ТИП ЗАГРУЗКИ) are set in compliance with the flight mission;

— prepare the electrical bomb release (ЭСБР) in compliance with the flight mission;

(2) on the optical bombsight computer:

— make sure that the "H, V" and "$\frac{T}{H}$, $\frac{T_A}{H}$" switches are turned on;

— rotate the "h" knob to set the assigned bomb burst height (in case of ground burst, set h=0);

— check proper computation of the absolute flight altitude generated by the central airspeed and altitude director; if required, refine the airspeed and alitude magnitudes by rotating the "ΔH" knob or update the airspeed and altitude director readings by referring to readings of the radio altimeter;

— check proper computation of the true airspeed generated by the airspeed and altitude director and, if required, refine the airspeed by rotating the "ΔV" knob;

— check adequate setting of the assigned correction for the train or formation in % of H;

— check proper setting of the range, offset aiming point offset direction (in case of precision aiming, set B=0);

— check proper setting of the characteristic bomb fall time (Θ_T and $\Theta_{T.A}$);

(3) check aircraft control from the optical bombsight; to this end, manipulate the lateral sighting knob to align the α_s index with the α_{aim} index; request the crew commander for the control take-over clearance and, on obtaining this clearance, sink the φ_s and tg μ_o buttons; turn on the STAB (СТАБ.) and TURN (РАЗВ.) switches — the light labelled AP IN ABNE — OBS MODE (АП В РЕЖИМЕ НБА — ОПБ) should come on; using the α_s lateral sighting knob, shift the α_s index to the left (right) from the α_{aim} index and make sure that the aircraft makes a left-hand (right-hand) turn, accordingly; after checking operation of the autopilot, pass aircraft control to the crew commander, having turned off the TURN (РАЗВ.) switch);

(4) on the optical bombsight:

— manipulate the "U_x" knob to set ground speed on the computer ground speed scale; using the "U_y" knob, set the α_{aim} index on the α_{aim} scale to the drift angle;

— set longitudinal sighting angle $\varphi_s=78°$;

— set the α_s index to the bombing run assigned drift angle (at no wind data, set $\alpha_{aim}=\alpha_s=0$);

— make sure that the longitudinal and lateral sighting knob buttons are pulled out;

— make sure that the aiming angle manual setting knob is pulled out and fixed in position;

— when dropping bombs from an altitude exceeding 2000 m, make sure that the elongation mechanism knob on the optical bombsight is set to the FORWARD (ОТ СЕБЯ) position and reliably fixed in this position.

CAUTION. FAILURE TO FOLLOW THE ABOVE REQUIREMENT, WITH THE SIGHT OPERATING IN THE AUTOMATIC MODE, MAY RESULT IN OFF-TARGET (OFF-RANGE) RELEASE OF BOMBS;

— make sure that the B — T (Б — Т) switch occupies the "B" ("Б") position;

— make sure that the STAB (СТАБ.), CSM (МПС) and AUTO SINCHRO (А. СИНХР.) switches are turned off, the switches labelled AUTO SLAVE (А. КОРР.) and GYRO (ГИРО) are turned on and the WIND (ВЕТЕР) switch is set to the "U_x, U_y, K" position;

— check proper sending-out of heading information from the compass system into the optical bombsight by reference to the vector tracer course scale;

— in case of offset aiming point bombing, set up the δ_s aim-off direction and ship speed V_{sh} = 100 km/h (for precision bombing, set up δ_s = 0 and V_{sh} = 0);

(5) prepare aerial camera АФА-41/20 to carry out photographic check

(by comprehensive use of all air navigation means, bring the aircraft to the target roll-in point and make the following report: "Time two-one-double zero, combat course ... degrees, target approach time");

(6) when checking the bombing equipment and setting the required bombing data on them, report your actions to the crew commander.

7.3.2. Bombing with Aiming at Target

296. When performing bombing with aiming at a target, the crew commander should proceed as follows:

— bring the aircraft to the run-in track preset by the navigator;

— assist the navigator in search of the target;

— watch the autopilot operation;

— strictly hold the assigned flight regime;

— pass aircraft control to the navigator in due time and watch the aircraft position after control transfer (after the navigator turns on the TURN (РАЗВ.) switch;

— check operation of the crew navigator when on the run-in track.

297. The crew navigator should proceed as follows:

— turn on aerial camera АФА-41/20;

— while flying level, uncage the gyro and check the vertical gyro; to this end, depress the VG (ВЕРТИКАЛЬ) button and make sure that the VERTICAL (ВЕРТИКАЛЬ) light is dead.

NOTE. If the VG light is alive with the VG button depressed, cage and again uncage the gyro and depress the buttons labelled VG and FAST SLAVE (Б. КОРР.). Release these buttons 10 to 15 s after extinguishment of the VG light;

— find the target in the sight field of vision, reliably identify it and make a report: "Target is seen" to the crew commander;

— turn on the switch labelled MASTER RELEASE SWITCH (ГЛАВНЫЙ ВЫКЛЮЧАТЕЛЬ СБРАСЫВАНИЯ);

— make sure that the EBR (ЭСБР) and DESTR (ВЗРЫВ) lights are alive;

— turn the longitudinal and lateral sighting knobs to align the target with the sight crosshairs, sink the sighting knob buttons and turn on the CSM (МПС) switch;

— report take-over of the control to the crew commander and, on obtaining the control take-over clearance, cut in the TURN (РАЗВ.) switch; as a result, the light labelled AP IN ABNE — OBS MODE (АП — В РЕЖИМЕ НБА — ОПБ) will come to illuminate and the aircraft will start turning if the α_s index is deviated from the α_{aim} index;

— take aim in range and direction, using the longitudinal and lateral sighting knobs as well as the wind vector longitudinal and lateral component knobs;

— at sighting angle φ_s = 55 to 60°, trigger the automatic release lever (this will result in coming-on of the red AUTO RELEASE (АВТОСБРОС) light on the optical bombsight) and make the "Atomatic release triggered" report.

CAUTION. IF AFTER TRIGGERING THE AUTOMATIC RELEASE LEVER A DECISION WAS TAKEN NOT TO DROP THE BOMBS, THE NAVIGATOR SHOULD IMMEDIATELY DEPRESS THE AUTOMATIC RELEASE LEVER BUTTON TO RELEASE THE LEVER, AFTER WHICH HE SHOULD TURN OFF THE BOMBING EQUIPMENT CONTROLS;

— follow the motion of the sighting angle index and mutual position of the α_s and α_{aim} indexes;

— proceed taking aim in range and direction;

— after taking the bomb release decision 5 to 10° before dropping the bombs, turn on the BRVSB (КВСБ) switch and make sure that the READY (ГОТОВ) light has come to illuminate on the bombing equipment control board and make the following report to the crew commander: "Selectors ON, READY light illuminates";

— 4 to 8 s before the bomb release moment, check opening of the bomb doors by reference to illumination of the green light labelled DOORS (ЛЮКИ) on the optical bombsight and lights labelled BOMB DOORS OPEN (СТВОРКИ БОМБОЛЮКА ОТКРЫТЫ) on the bombing equipment control board; the moment the indexes of the φ_s longitudinal sighting angle and φ_{aim} aiming angle get aligned, check bomb release by extinguishment of the lights on the optical bombsight, return of the automatic release lever to the initial position and fading out of lights indicating suspension of bombs (with the bomb racks fully unloaded) on the armament control board;

— on releasing the bombs, make the following report to the crew commander: "Bombs released, time ...";

— turn off the switches labelled BRVSB (КВСБ) and MASTER RELEASE SWITCH (ГЛАВНЫЙ ВЫКЛЮЧАТЕЛЬ СБРАСЫВАНИЯ), cage the gyro, close the bomb doors and turn off the switches labelled TURN (РАЗВ.), CSM (МПС), GYRO (ГИРО);

— pull out the sighting buttons;

— enter the time (T), drift angle (УС), heading, altitude (H), ground speed (W) and aiming angle (φ_{aim}) into the Flight Log Book;

— check suspension of bombs, with the bomb doors closed;

— cut out aerial camera АФА-41/20 and close the camera window.

CAUTION. IF NO +27-V "RELEASE" SIGNAL CALLING FOR AUTOPILOT DISENGAGEMENT ARRIVED FROM THE OPTICAL BOMBSIGHT WITH THE "TURN" SWITCH ENABLED ON THE RUN-IN TRACK (THIS MAY HAPPEN IN CASE OF SYNCHRONIZATION WITHOUT BOMB RELEASE OR ON A DRY RUN), IMMEDIATELY CUT OUT THE "TURN" ("РАЗВ.") SWITCH AND PASS AIRCRAFT CONTROL TO THE CREW COMMANDER. IF OTHERWISE, AT SIGHTING ANGLES φ_s CLOSE TO ZERO, AND ESPECIALLY AT $\varphi_s = 0$, THE α_s INDEX WILL SHARPLY DEFLECT FROM THE α_{aim} INDEX, WHICH WILL CAUSE ABRUPT TURNING OF THE AIRCRAFT.

NOTE. For higher reliability of target detection and identification in all cases of optical bombing, perform the instrument check of the aircraft position relative to the target or other conspicuous landmarks, using the radar bombsight and РСБН system.

7.3.3. Offset Bombing

298. Before intercepting the run-in track during offset bombing, the crew navigator should proceed as follows:

— verify correct setting of the offset (aim-off) range on the computer scale;

— verify proper setting of the target aim-off direction to the offset point ($\delta_{aim\text{-}off}$) on the optical bombsight vector tracer scale;

— check proper setting of airspeed on the optical bombsight vector tracer scale — the airspeed should equal 100 km/h;

— check adequate insertion of aircraft heading from the compass system into the optical bombsight by reference to the vector tracer course scale;

— perform offset aiming, following the procedure specified in Items 296 and 297.

NOTE. The $\delta_{aim\text{-}off}$ direction is measured by an angle formed by the positive direction of the main great-circle course (grid meridian direction) and the target — offset point vector direction.

7.3.4. Bombing from Altitudes of 500 to 2000 m

299. When bombing is carried out from altitudes below 2000 m, the crew commander should proceed as follows:

— on intercepting the descent termination line, bring the aircraft into the horizontal level-flight attitude;

— strictly hold the assigned flight regime;

— intercept the run-in track assigned by the navigator;

— assist the navigator in search of the target;

— obtain the run-in track drift angle from the navigator and, after detecting the target, make a corrective turn in the target direction, with due account of the drift angle;

— check operation of the navigator on the run-in track.

300. The crew navigator should proceed as follows:

— check to see that the optical bombsight is energized before intercepting the initial target approach point;

— calculate the absolute altitude (H_{abs}), true airspeed (V_{TAS}), grid course (УК), time of intercepting the initial target approach point and time of target approach and report the calculated data to the crew commander;

— set the armament controls to the initial position, prepare the electrical bomb release in compliance with the flight mission and make sure that the optical bombsight switches labelled GYRO (ГИРО), AUTO SLAVE (А. КОРР.) are turned on whereas the CSM (МПС) and TURN (РАЗВ.) switches are turned off; set $U_x = 0$ and sighting angle $\varphi_s = 78°$; make sure that the aiming angle manual setting buttons and the buttons of the longitudinal and lateral sighting knobs are pulled out; check setting of the Θ_T and $\Theta_{T.A}$ parameters on the computer in compliance with the bombs suspended; cancel the H and V parameters; set H = 2000 m; turn on the switch labelled "$\frac{T}{H}$, $\frac{T_A}{H}$"; insert the zero correction for train and formation, set up aim-off B = 0;

— provide interception of the initial target approach point and approach to the assigned target by comprehensive use of all air navigation facilities;

— determine the ground speed and drift angle when on the run-in track;

— using the "U_y" knob, set the α_{aim} index to the drift angle;

— using the measured actual ground speed and absolute flight altitude, pick up the magnitudes of the aiming angle and theoretical ground speed from the table;

— manipulate the airspeed setting knob on the computer to set the theoretical ground speed on the ground speed scale;

— turn off the switch labelled "$\frac{T}{H}$, $\frac{T_A}{H}$" and rotate the "$\frac{T_A}{H}$" knob to set the tabulated aiming angle on the optical bombsight; manipulate the "$\frac{T}{H}$" knob to set the $\frac{T}{H}$ magnitude equal to $\frac{T_A}{H}$;

— align α_s with α_{aim} by using the lateral sighting knob;

— at a target range of 30 to 35 km, verify the ground speed and absolute altitude and compare the aiming angle with that specified in the table;

— turn on the АФА-41/20 camera;

— uncage the gyro, check the vertical gyro and sink the buttons;

— turn on the switch labelled MASTER RELEASE SWITCH (ГЛАВНЫЙ ВЫКЛЮЧАТЕЛЬ СБРАСЫВАНИЯ);

— check illumination of the EBR (ЭСБР) and DESTR (ВЗРЫВ) lights;

— locate and precisely identify the target through the sight optics, and make a report; "Target is seen" to the crew commander;

— on obtaining the bombing clearance, turn on the BRVSB (КВСБ) switches and make the following report: "Selectors ON, the READY light illuminates";

— turn on the CSM (МПС) switch; using the longitudinal sighting knob and making a corrective turn (to be done by the pilot), align the sight crosshairs with the target;

— trigger the automatic release lever and make the "Automatic release triggered" report;

— keep the target aligned with the sight crosshairs by using the "φ_s" knob and by making corrective turns;

— check opening of the bomb doors and the bomb release moment;

— on releasing the bombs, make the following report to the crew commander: "Bombs released, time...";

— turn off the switches labelled BRVSB (КВСБ) and MASTER RELEASE SWITCH (ГЛАВНЫЙ ВЫКЛЮЧАТЕЛЬ СБРАСЫВАНИЯ), close the bomb doors, cage the gyro and turn off the CSM (МПС) switch;

— check availability of bombs with the bomb doors closed;

— put down the bomb release time, absolute altitude (H_{abs}), true airspeed (V_{TAS}), ground speed (W), drift angle (УС) and aiming angle;

— turn off the АФА-41/20 camera and close the camera window.

NOTES: 1. When the given aiming method is used, synchronous movement of the target and crosshairs is possible only provided $H_{abs} \geqslant W_x$, where H_{abs} is expressed in "m" and W_x, in "km/h".

2. The theoretical ground speed is computed by the following formula:

$$W_{theor} = \frac{H_{act}}{H_{abs}} \cdot W_x.$$

3. The aiming angle as a function of H_{abs}, Θ and W is computed by the following formula:

$$\mathrm{tg}\ \varphi_{aim} = \frac{W_T - \Delta}{H} + \frac{L - \Gamma}{2H}.$$

7.3.5. Minimum-Altitude Bombing

301. Bombing from altitudes below 500 m is performed with the sighting angle extender turned on, without using the sight automatic control units. For carrying out minimum-altitude bombing, the crew navigator should proceed as follows:

(1) before intercepting the initial target approach point:

— check to see that the optical bombsight power supply is turned on;

— estimate the absolute altitude (H_{abs}), true airspeed (V_{TAS}), grid course (УК), time of intercepting the initial target approach point, the time of approaching the target and report the estimated data to the crew commander;

— set the bombing equipment controls to the initial position and prepare the electrical bomb release in compliance with the flight mission;

— make sure that the "H, V" and "$\frac{T}{H}$, $\frac{T_A}{H}$" switches are turned off on the computer and that aim-off B = 0, ΔL % = 0;

— turn on the GYRO (ГИРО) switch on the optical bombsight and make sure that the CSM (МПС) and TURN (РАЗВ.) switches are turned off;

— enable the elongation mode and check to see that the ELONG (УДЛИНЕН.) lamp lights up on the optical bombsight;

— manually turn the "φ_{aim}" knob, using additional numbering of the φ_s scale, indicated in brackets, to set the φ_{aim} magnitude picked out from the aiming data table, making reference to the absolute altitude (H_{abs}), airspeed (V), characteristic bomb fall time (Θ) and computed magnitude W_x;

— turn the "φ_s" knob, using additional numbering of the φ_s scale, indicated in brackets, to set the φ_s sighting angle which is 6 to 8° higher than the φ_{aim} aiming angle;

— manipulate the "U_y" knob to set α_{aim} = DA;

— check to see that the longitudinal and lateral sighting buttons are pulled out;

— provide interception of the initial target approach point by the aircraft by using all the available air navigation means;

(2) on the bombing run:

— when at a 30 to 35-km target range, verify the ground speed, drift angle and absolute altitude of flight, then check proper setting of the φ_s, φ_{aim} and α_{aim} angles on the optical bombsight;

— turn on the switch labelled MASTER RELEASE SWITCH (ГЛАВНЫЙ ВЫКЛЮЧАТЕЛЬ СБРАСЫВАНИЯ) and make the following report to the crew commander: "Master release switch ON, electric bomb release and DESTRUCTION lights illuminate";

— if there is a radar-contrast landmark in the assigned target area, intercept the visible target by using the radar bombsight, while keeping the radar marker on the indicator screen in a position conforming to the position of the visible target on the sight crosshairs;

— on reaching the target range, corresponding to the set-up sighting angle, turn on the BRVSR (КВСБ) switches and make the following report: "Selectors ON, the READY light illuminates";

— open the bomb doors, using the BOMB DOORS (СТВОРКИ Б/ЛЮКА) switch; check to see that the doors have been opened by reference to illumination of the respective lights and make the "Bomb doors open" report;

— at a target range corresponding to the set-up sighting angle, locate the target through the sight optics; using the "tg φ_s" knob, superimpose the cross line of the sight crosshairs on the target, determine the target approach corrective turn angle (by reference to the marks on the cross line of the sight crosshairs), make a report: "Target is seen" to the crew commander and perform lateral aiming;

— set $\varphi_s = \varphi_{aim}$ and get ready for dropping bombs by using the bomb release button;

— as soon as the target comes into alignment with the cross line of the sight crosshairs, depress the bomb release button to release the bombs and make the following report: "Bombs released, time...";

— turn off the switches labelled BRVSB (КВСБ) and MASTER RELEASE SWITCH (ГЛАВНЫЙ ВЫКЛЮЧАТЕЛЬ СБРАСЫВАНИЯ), close the bomb doors, cage the gyro, disable the ELONGATION mode and make the following report: "Selectors and master bomb release switch OFF, bomb doors closed, gyro caged, elongation OFF";

— put down the absolute altitude (H_{abs}), true airspeed (V_{TAS}), ground speed (W), drift angle (УС), aiming angle φ_{aim} and bomb release time.

7.4. "РАДОН" RADAR BOMBING

7.4.1. Preparation of Sights and Bombing Equipment

302. Before intercepting the initial target approach point, the crew commander should proceed as follows:

— strictly hold the assigned flight regime, check the aircraft fix by the available means, request the navigator to verify the time of intercepting the point of turn on the target (initial target approach point) and the time of approaching the target;

— make certain that the bombing equipment controls are set to the initial position by listening to the crew navigator's reports.

303. The navigator should proceed as follows:

(1) determine a systematic error of the accurate sighting mark. To this end, proceed as follows:

— set $\varphi_s \approx 5°$ on the optical bombsight, then pull out the lateral and longitudinal sighting knob buttons;

— enable the OBS (ОПБ) mode on unit РН-21Д and switch on the μA-SCAN (МПМ) sweep image on indicator РН-6;

— change over into the main synchronization mode;

— set $\varphi_s = 0$ and tg $\mu_0 = 0$;

— tilt the antenna and rotate the knobs labelled BACKGROUND NOISE (ФОН) and DISCRIM (ВЫДЕЛЕНИЕ) knobs to obtain contrast visibility of the altitude spot boundary;

— manipulate the "ΔH" knob on the radar bombsight to bring the altitude spot boundary to the accurate sighting mark;

— read the altitude off the radar sight and compare it with the altitude indicated by the radio altimeter. Put down the altitude difference into the Flight Log Book.

NOTES: 1. The systematic error of the accurate sighting mark ($\Delta HД_{a.s.m}$) equals the difference in altitudes read off the optical bombsight computer and radio altimeter, i. e., $\Delta HД_{a.s.m} = H_{comp} - H_{r.a}$.

2. If $\Delta HД_{a.s.m}$ does not exceed 200 to 250 m, it is fully compensated for by variation of the altitude on the optical bombsight computer, i. e. $\Delta HД_{a.s.m} = \Delta H$.

3. If $\Delta HД_{a.s.m} > 200$ to 250 m, only part of the error is compensated for. When flight is performed at altitudes of up to 5000 m, $\Delta HД_{a.s.m} = 3/4\Delta H$; at flight altitude $H > 5000$ m, $\Delta HД_{a.s.m} = 0.8\Delta H$.

4. To compensate for the systematic error of the accurate sighting mark, set the altitude to be found by using the formula given below on the optical bombsight computer:

$$H_{comp} = H_{r.a} + \Delta HД_{a.s.m};$$

(2) prepare the optical bombsight and bombing equipment, using the procedure laid down in Items 294 and 295;

(3) check proper setting of the target and radar marker coordinates on unit РН-17;

(4) perform updating of aircraft coordinates by reference to the radar marker;

(5) enable the SEARCH mode on unit РН-21Д, set up the scanning range of 180 km and set the aiming line;

(6) at the moment of initial target approach point interception, report the target approach corrective turn (to the estimated course against the УДЦ indicator), bombing run course and the time of approaching the target to the crew commander.

7.4.2. Bombing with Aiming Directly at Target

304. When carrying out РАДОН radar bombing, the crew commander should proceed as follows:

— intercept the run-in track assigned by the navigator;

— watch operation of the autopilot;

— strictly hold the assigned flight regime;

— watch aircaft position after passing the control to the navigator;

— check the navigator's operation on the bombing run and take measures to preclude off-target (off-range) and out-of-mission dropping of bombs;

— check opening (closing) of the bomb doors and turning on/off of bombing equipment controls by listening to the navigator's reports;

— following the navigator's command, make a maneuver to intercept the next flight leg.

305. The crew navigator should proceed as follows:

— find the target image on the screen of indicator РН-6 by reference to the mutual position of the radar markers and target, reliably identify the target and make a report: "Target is seen" to the crew commander;

— report corrective turning of the aircraft to the target to the crew commander as follows: "... degrees to right (left)" (to align the aiming line with the target);

— turn on the ФАРМ aerial camera attachment;

— while flying level, uncage the gyro of the optical bombsight and check the vertical gyro;

— at a target range of at least 160 km, turn on the OBS (ОПБ) mode on unit РН-21Д;

— using the POSITION (ПОЛОЖЕНИЕ) lever and lateral sighting knob, align the electronic crosshairs with the target image on the screen;

— inform the aircraft commander that you are going to take over the aircraft control and, on obtaining the control take-over clearance, cut in the TURN (РАЗВ.) switch; this will result in coming-on of the light labelled AP IN ABNE — OBS MODE (АП В РЕЖИМЕ НБА — ОПБ) and the aircraft will start turning in the α_s index direction if the α_s and α_{aim} indexes are separated;

— switch on the μA-SCAN sweep on indicator PH-6 and verify alignment of the crosshairs with the target;

— sink the longitudinal and lateral sighting knob buttons on the optical bombsight and uncage the gyro;

— when on the approach line, turn on the switch labelled MASTER RELEASE SWITCH (ГЛАВНЫЙ ВЫКЛЮЧАТЕЛЬ СБРАСЫВАНИЯ) and make the following report: "Master release switch ON, electric bomb release and DESTRUCTION lights illuminate";

— if the target blip is inconsiderably misaligned from the electronic crosshairs, hold it in place by using the POSITION (ПОЛОЖЕНИЕ) lever and lateral sighting knob;

— if the target blip is considerably misaligned from the electronic crosshairs, which testifies to improper insertion of the wind vector into the optical bombsight, perform preliminary synchronization and aiming in direction by using the wind vector longitudinal and lateral component knobs;

— periodically switch on the A-SCAN sweep and make sure that aiming is carried out at the assigned target;

— after change-over into the main synchronization mode (which is indicated by coming-on of the green light on indicator PH-6, cut-in of the constant-speed motor and cessation of accurate sighting mark control from the POSITION lever), turn the longitudinal and lateral sighting knobs to refine alignment of the target blip with the electronic crosshairs and proceed aiming in range and direction;

— check proper insertion of the altitude and airspeed into the radar bombsight;

— at sighting angle φ_s = 55 to 60°, trigger the automatic release lever, which will result in coming-on of the AUTO RELEASE (АВТОСБРОС) red warning light on the optical bombsight, and make the "Automatic release triggered" report;

— periodically check the mutual position of the α_s and α_{aim} indexes and shifting of the φ_s index;

— compare the computed aiming angle with the tabulated one;

— on taking a final bomb-release decision, 5 to 10° before dropping the bombs, turn on the BRVSB (КВСБ) switch, make sure that the READY (ГОТОВ) light has come on to illuminate on the bombing equipment control board and make the following report to the crew commander: "Selectors ON, the READY light illuminates";

— 4 to 8 s before dropping the bombs, check opening of the bomb doors (which is identified by coming-on of the DOORS (ЛЮКИ) light on the optical bombsight, BOMB DOORS OPEN (СТВОРКИ БОМБОЛЮКА ОТКРЫТЫ) light on the bombing equipment control board and the red light on indicator PH-6);

— the moment of alignment of the φ_s and φ_{aim} indexes is accompanied by bomb release which will be marked by extinguishment of the AUTO RELEASE and DOORS lights and the red light on indicator PH-6 as well as by return of the automatic release lever to the initial position;

— on releasing the bombs, make the following report to the crew commander: "Bombs released, time ...";

— turn off the switches labelled BRVSB and MASTER RELEASE SWITCH, close the bomb doors, cage the gyro and turn off the switches labelled TURN (РАЗВ.) and GYRO (ГИРО);

— put down the T_{rel}, drift angle, φ_{aim}, W and H magnitudes;

— enable the SEARCH mode;

— check availability of bombs with the bomb doors closed;

— turn off the ФАРМ camera attachment.

CAUTION. IF A DECISION WAS TAKEN NOT TO RELEASE THE BOMBS AFTER TRIGGERING THE AUTOMATIC RELEASE, THE NAVIGATOR SHOULD IMMEDIATELY DISENGAGE THE AUTOMATIC RELEASE AND BOMBING EQUIPMENT CONTROLS.

7.4.3. Offset Bombing

306. When performing offset bombing, the navigator should proceed as follows:

— check proper setting of the aim-off range on the computer scale;

— check proper setting of aim-off direction $\delta_{aim\text{-}off}$ (i. e., the direction from the target to the offset point) on the optical bombsight;

— check proper setting of the airspeed on the optical bombsight vector tracer; this airspeed should equal 100 km/h;

— check proper introduction of the aircraft heading into the optical bombsight computer from the compass system, using the vector tracer scale;

— on intercepting the run-in track, locate and identify the offset point image on the PH-6 indicator screen;

— prepare the bombing equipment for offset bombing in compliance with the requirements of Items 294, 295 and 302 through 305.

7.4.4. Bombing from Altitudes Below 2000 m

307. When carrying out bombing from altitudes below 2000 m, the crew commander should proceed as follows:

— on approaching the descent termination line, bring the aircraft into a straight-and-level flight attitude;

— strictly hold the assigned flight regime;

— carry out visual orientation and render assistance to the navigator in accurate intercepting of the initial target approach point and approaching of the target;

— intercept the run-in track assigned by the navigator;

— assist the navigator in locating the target;

— obtain the run-in track drift angle from the navigator and, on locating the target, monitor the target approach flight with due accout of the drift angle;

— when performing lateral aiming, check accomplishment of the corrective turns;

— check the navigator's operation on the run-in track.

308. The crew navigator should proceed as follows:

(1) before takeoff, verify the adjustment of the range zero, reducing the error to minimum;

(2) before intercepting the point of turn on the target (initial target approach point), make the following settings:

(a) on the computer:

— place the switches labelled "H, V" and "$\frac{T}{H}$, $\frac{T_A}{H}$" to the OFF (ВЫКЛЮЧЕНО) position;

— using the TARGET ELEVATION (ПРЕВЫШЕНИЕ ЦЕЛИ) (ΔH) knob, set theoretical altitude $H_{theor} = 2000$ m;

— manipulate the AIM-OFF (ВЫНОС (B)) knob to set up $B = 0$;

— use the "ΔV" knob to set the true airspeed;

— using the knobs labelled "$\frac{T_A}{H}$", "$\frac{T}{H}$" and TRAIN — FORMATION (СЕРИЯ — СТРОЙ), set the $\frac{T_A}{H}$, $\frac{T}{H}$ and ΔL % magnitudes selected from the aiming data table for the assigned bombing altitude and airspeed.

NOTE. The aiming data tables are estimated for true airspeeds (for every 100 km/h) and types of aerial bombs employed within the following ranges:

$$H = 200 \text{ to } 500 \text{ m};\ H = 600 \text{ to } 1000 \text{ m};$$

$$W = V_{TAS} \pm 60 \text{ km/h}.$$

The aiming angles given in the table are estimated by the following formula:

$$\operatorname{tg} \varphi_{aim} = \operatorname{tg} \varphi_{trans} - \frac{\sqrt{НД_{trans}^2 - H^2} - A}{H_{theor}}.$$

Besides, the following parameters are put down into the table: ΔL %, $\frac{T_A}{H}$, $\frac{T}{H}$, φ_{trans} and $НД_{trans}$.

The magnitude of the $\frac{T_A}{H}$ parameter should be estimated by the formula:

$$\frac{T_A}{H} = \frac{\operatorname{tg} \varphi_{av.\,aim}}{V},$$

where $\varphi_{av.\,aim} = \frac{\varphi_{max.\,aim} + \varphi_{min.\,aim}}{2}$;

$\varphi_{aim\ min}$ and $\varphi_{aim\ max}$ are the minimum and maximum aiming angles picked out from the respective tabulated altitude range.

The magnitude of the $\frac{T}{H}$ parameter should be estimated by the formula:

$$\frac{T}{H} = \frac{T_A}{H} + \frac{\Delta_{av}}{VH_{theor}},$$

where Δ_{av} is the bomb trail for the average bombing altitude specified in the given table.

The ΔL % correction should be estimated by the following formula:

$$\Delta L\,\% = (\text{tg}\,\varphi_{aim} - \text{tg}\,\varphi_{theor})\ 100,$$

where $\text{tg}\,\varphi_{theor} = \frac{T_A}{H}V + \frac{T}{H}U_x$;

(b) on the optical bombsight:

— place the CSM (МПС) and TURN (РАЗВ.) switches to the OFF (ВЫКЛЮЧЕНО) position;

— set the GYRO (ГИРО) switch to the ON (ВКЛЮЧЕНО) position;

— using the "φ_s" knob, set $\varphi_{trans} = 52°$ for $H \leq 500$ m or $\varphi_{trans} = 60°$ for $H > 500$ m;

— using the "U_x" knob, set $U_x = U_{x\,est}$;

— set the V, H_{theor}, $\frac{T}{H}$, $\frac{T_A}{H}$, ΔL %, U_x parameters; in this case, the φ_{theor} parameter is automatically computed as equalling the magnitude specified in the table;

— manipulate the "tg μ_0" knob to set $\alpha_s = \alpha_{aim.\,est}$;

— using the "U_y" knob, set $U_y = 0$ ($\alpha_{aim} = 0$);

— pull out the longitudinal and lateral sighting knob buttons;

(3) when on the bombing run, the navigator should proceed as follows:

— at a 30 to 40-km target range, set the required number of bombs in a train on the electric bomb release, place the TRAIN — SINGLE (СЕРИЯ — ОДИНОЧНО) switch to the TRAIN (СЕРИЯ) position, turn on the switch labelled MASTER RELEASE SWITCH (ГЛАВНЫЙ ВЫКЛЮЧАТЕЛЬ СБРАСЫВАНИЯ) and ФАРМ camera attachment, then make the following report: "Master release switch ON, electric bomb release and destruction lights illuminate, ФАРМ camera attachment ON";

— verify setting of α_{aim} to the measured or estimated drift angle magnitude;

— using the "U_x" knob, verify setting of the measured or estimated W_x magnitude (according to the computer ground speed scale);

— check the φ_{trans}, ΔL % and φ_{theor} theoretical aiming angle computation magnitudes;

— on detecting the target, change over to the optical bombsight mode; using the position lever, superimpose the sighting mark on the target and make a report: "Target is seen" to the crew commander;

— superimpose the aiming line on the target by using the lateral sighting knob and sink the buttons;

— using the α_{aim} and α_s indexes, determine the direction of the corrective turn, take over the aircraft control on obtaining the respective clearance from the crew commander and make the "White illuminates" report;

— accomplish lateral aiming in a synchronous way;

— perform range aiming in a synchronous way (using the position lever and "U_x" knob);

— using measured (as a result of synchronization) ground speed W and absolute bombing altitude (H_{abs}), verify the ΔL % magnitude;

— verify setting of the φ_{trans} angle;

— at the initial range of 4 to 6 km, accurately align the sighting mark with the target, trigger the automatic release lever and make the "Automatic release triggered" report;

— starting from the moment of transition into the main synchronization mode, stop aiming, turn on the BRVSB (КВСБ) switch and make the following report: "Selectors ON, the READY light illuminates";

— check to see that the bomb doors are open;

— the moment the φ_s and φ_{aim} indexes come into alignment, check bomb release and make the following report: "Bombs released, time...";

— turn off the switches labelled BRVSB (КВСБ) and MASTER RELEASE SWITCH (ГЛАВНЫЙ ВЫКЛЮЧАТЕЛЬ СБРАСЫВАНИЯ), close the bomb doors and make the following report: "Selectors and master release switch OFF, bomb doors closed";

— put down the H_{abs}, V_{TAS}, W, drift angle, φ_{aim} parameters and the bomb release time;

— turn off the ФАРМ camera attachment.

CAUTION: 1. CARRY OUT AIMING WITH THE GYRO CAGED.

2. NEVER CARRY OUT AIMING AFTER TRANSITION TO THE MAIN SYNCHRONIZATION MODE.

7.4.5. Radar Marker Bombing with Employment of Automatic Bomber Navigation Equipment

309. When performing radar marker bombing with employment of the automatic bomber navigation equipment, the crew commander should proceed as follows:

— accurately intercept the run-in track;

— watch operation of the autopilot;

— strictly hold the assigned flight regime;

— watch the aircraft position after passing the aircraft control to the navigator;

— check operation of the navigator when on the bombing run and take measures to preclude dropping the bombs at an unassigned target.

310. The crew navigator should proceed as follows:

(1) before interception of the initial target approach point:

— prepare the optical bombsight and bombing equipment by using the procedure specified for bombing with aiming at a target; in so doing, take special care to see that the aim-off range (B) should equal zero;

— check to see that the altitude has been properly introduced into the РАДОН radar bombsight computer in case of the manual input mode;

— slave the aircraft heading;

— read ground speed W and drift angle off the scale of the Doppler ground speed and drift meter and introduce them into the optical bombsight computer;

— if required, pass to air navigation by using the peculiar great-circle co-ordinate system when the great-circle course coincides with the assigned run-in track;

— update the aircraft position by using the radar marker whose co-ordinates in the selected co-ordinate system are set on the counters of unit PH-17;

— make sure that $\beta_0=0$ (β_{ind}) on unit PH-20A;

— make certain that the aircraft heading is adequately displayed on the PH-17 unit;

— check to see that the target and radar marker co-ordinates are properly set on the PH-17 unit;

— the moment the aircraft intercepts the initial target approach point, make its corrective turn in the target direction by setting the AP — SDM (АП — РКР) switch on unit PH-20A to the AP (АП) position or by making a corrective turn manually, by reference to the УДЦ moving target indicator pointer;

(2) when on the bombing run:

— turn on the ФАРМ camera attachment;

— uncage the gyro and check the vertical gyro;

— turn on the switch labelled MASTER RELEASE SWITCH (ГЛАВНЫЙ ВЫКЛЮЧАТЕЛЬ СБРАСЫВАНИЯ);

— check illumination of the EBR (ЭСБР) and DESTR (ВЗРЫВ) lights;

— on unit PH-21Д, turn on the SECTOR (СЕКТОР) switch and place the mode-of-operation switch to the ABNE (НБА) position;

— verify proper indication of the ground speed and drift angle on unit PH-20A in response to signals sent out from the Doppler ground speed and drift meter;

— locate the "marker" on the screen of indicator PH-6; using the position lever, align the accurate sighting mark with it and, using the lateral sighting knob, align the aiming line with the displayed marker;

— check proper shaping of the "marker" signal by the mutual position of radar markers in the target and "marker" area;

— turn on the μA-SCAN sweep;

— verify the alignment of the crosshairs with the "marker" and pull out the buttons of the optical bombsight sighting knobs;

— take over aircraft control by turning on the TURN (РАЗВ.) switch on the optical bombsight;

— periodically perform radar updating of the aircraft present position, after which use the POSITION (ПОЛОЖЕНИЕ) lever and optical bombsight lateral sighting knob to align the electronic crosshairs with the "marker" first in the A-SCAN (ПМ) and then μA-SCAN (МПМ) mode;

— the last updating of the aircraft present position should be completed at a target range providing for execution of the corrective turn, cut-in of the bombing equipment units and opening of the bomb doors;

— trigger the automatic release lever and make the "Automatic release triggered" report;

— keep the crosshairs on the "marker", using the optical bombsight longitudinal and lateral sighting knobs;

— 5 to 10° before the bomb release moment, turn on the BRVSB (КВСБ) switch and make the following report to the crew commander: "Selectors ON, the READY light illuminates";

— watch the mutual position of the α_s and α_{aim} indexes and displacement of the sighting angle index;

— check opening of the bomb doors;

— at the moment of bomb release, make the following report: "Bombs released, time...".

For further handling of the bombing equipment, use the procedure specified for bombing with aiming at a target.

NOTE. During corrective turns, the radar marker is displaced on the screen in the turn direction. When the aircraft is recovered from the roll, the image is restored.

7.4.6. Bombing in Active Radar Jamming Conditions

311. When bombing is performed in radar sight active jamming conditions, the crew navigator should proceed as follows:

— turn off the transmitter and pass to "marker" sighting in the ABNE mode, using the procedure laid down in Items 309 and 310;

— turn on the transmitter for a short period of time only for updating the aircraft present position by reference to the radar markers which can be seen on the screen of indicator РН-6.

For handling the bombing equipment, use the procedure specified for bombing under conditions without active jamming.

7.4.7. Supersonic Bombing

312. For carrying out supersonic bombing, use the procedure laid down in Items 302 through 305.

When on the bombing run, take into account the following additional peculiarities:

— refine the altitude by reference to the radio altimeter and uncage the gyro after transition to supersonic flight conditions;

— the time of bombing run flying is too short;

— great aiming angles restrict the possibilities of sighting in the main synchronization mode.

7.4.8. Bombing in Climb

313. РАДОН radar bombsight aiming in climb may be accomplished by the vector or synchronous method provided the required corrections corresponding to the selected aiming method are introduced into the sight.

During bomb release, the crew commander should proceed as follows:

— bring the aircraft to the run-in track preset by the navigator;

— on listening to the navigator's "Get ready for climb" report, increase the engine RPM in compliance with the flight mission;

— on listening to the navigator's "Climb" report, bring the aircraft into climb at a constant airspeed of 780 km/h; at this airspeed proceed climbing to the altitude of 6000 m; starting from the altitude of 6000 m, climb to the altitude of 11,000 m at Mach number $M=0.88$—0.9; on passing the altitude of 11,000 m, set Mach number $M=1.05$;

— on listening to the navigator's "Constant-speed climb" report, maintain the pre-estimated vertical climb speed at a constant level and make the "Constant-speed climb" report to the navigator;

— watch the autopilot operation;

— check the navigator's operation on the combat run and take measures to preclude off-target (off-range) bomb release.

314. The crew navigator should proceed as follows:

(1) before intercepting the initial target approach point:

— prepare the bombing equipment, using the procedure specified for level bombing (see Items 302 and 303);

— at $H>2000$ m, determine the accurate sighting mark systematic error;

— verify the climb start line by reference to the wind vector longitudinal component;

— using the TRAIN — FORMATION (СЕРИЯ — СТРОЙ) knob, set the ΔП % correction, corresponding to the synchronous aiming method, on the optical bombsight computer;

— by the comprehensive use of the air navigation means, bring the aircraft to the initial target approach point and make the following report to the crew commander "Combat course...";

(2) when on the bombing run:

— 3 to 5 km before reaching the climb start line, make the "Get ready for climb" report to the crew commander;

— uncage the gyro and check the vertical gyro;

— turn on the switch labelled MASTER RELEASE SWITCH (ГЛАВНЫЙ ВЫКЛЮЧАТЕЛЬ СБРАСЫВАНИЯ) and check to see that the EBR (ЭСБР) and DESTR (ВЗРЫВ) lights are alive;

— the moment the aircraft approaches the climb start line, make the "Climb" report to the crew commander;

— making reference to the mutual position of the radar markers on the screen of indicator PH-6, locate the target, reliably identify it and make the "Target is seen" report to the crew commander;

— make a corrective turn in the target direction;

— at H=3000 m, verify the altitude as indicated by the radio altimeter, using the "ΔH" knob on the computer;

— perform aiming in range by using a synchronous method and aiming in direction by matching the required drift angle (for this purpose, use the longitudinal and lateral sighting knobs as well as the U_x and U_y knobs); manipulate the bombing equipment controls by using the procedure specified for level bombing (Items 304 and 305);

— after transition to the main synchronization mode (which is indicated by coming-on of the green indicator light on indicator PH-6 and by cut-in of the constant-speed motor), make the "Constant-speed climb" report to the crew commander; proceed aiming in range by using a synchronous method;

— verify the altitude by referring to the radio altimeter readings with due account of the accurate sighting mark systematic error; to this end, use the "ΔH" knob on the computer;

— check proper computation of speed, sent out from the airspeed and altitude director, by the computer;

— at a sighting angle of 55 to 60°, trigger the automatic release lever and make the "Automatic release triggered" report to the crew commander;

— watch the position of the α_s and α_{aim} indexes;

— proceed taking aim as far as the bomb release moment;

— 5 to 10° before dropping the bombs, refine the altitude as indicated by the computer, turn on the BRVSB (КВСБ) switch and make the following report: "Selectors ON, the READY light illuminates";

— 4 to 8 s before dropping to bombs, check to see that the bomb doors are open;

— check bomb release at $\varphi_s = \varphi_{aim}$;

— after releasing the bombs, make the following report: "Bombs released, time...";

— turn off the switches labelled BRVSB and MASTER RELEASE SWITCH, close the bomb doors, cage the gyro and turn off the switches labelled TURN (РАЗВ.) and GYRO (ГИРО).

NOTE. When taking aim by the vector method, introduce a correction, accounting for variation of the bomb fall trajectory with bombs released in climb conditions, into the optical bombsight computer. Before transition to the main synchronization mode, keep the target aligned with the crosshairs by using the POSITION (ПОЛОЖЕНИЕ) lever and the lateral sighting knob. After transition to the main synchronization mode, use the longitudinal and lateral sighting knobs. In all other respects, the crew activities are similar to those laid down in Item 313.

CAUTION. WHEN TAKING AIM IN RANGE, TRANSITION FROM ONE AIMING METHOD TO ANOTHER WITHOUT ALTERING THE TRAIN OR FORMATION CORRECTION IS STRICTLY PROHIBITED.

7.5. SPECIAL CASES DURING OPTICAL OR RADAR BOMBING

7.5.1. Complicated Radar Objects Bombing

315. When carrying out complicated radar objects bombing, the navigator should proceed as follows:

— study location of the target in the complicated radar object by the photographic pictures of the object taken in the A-SCAN (ПМ) and μA-SCAN (МПМ) modes at different ranges and different approach directions;

— if the target located in the complicated radar object in observed as a single clutter on the screen of indicator PH-6, take its aim by using a common procedure;

— if the target cannot be discriminated from the overall radar image of the object, perform offset or "marker" bombing.

7.5.2. Release of Retarded Items

316. When taking aim for bomb release, take into account the horizontal (S) and vertical (h_{ISP}) offsets of the point of bomb burst relative to the target.

In the process of bomb release, aim may be taken by using the following methods.

A. By using the radar-visible auxiliary aiming point (AAP). In so doing, to determine the aiming data, take into account the horizontal and vertical offsets of the illumination start point (ISP) relative to the offset aiming point. To account for the vertical offset of the illumination start point, introduce conventional characteristic bomb fall time Θ' and bomb burst height equal to the illumination start altitude into the computer. The altitude should be calculated by the formula:

$$h = \Delta H_t + h_{ISP} — \Delta H_{AAP},$$

where ΔH_t and ΔH_{AAP} is elevation of the target and auxiliary aiming point relative to the sea level;

h_{ISP} is the altitude of the illumination start point relative to the target.

To take into account the horizontal offset of the illumination start point, introduce magnitude S (by the auxiliary aiming point aim-off scale) and the direction of the illumination start point summary offset relative to the target (by vector tracer scale δ_s) into the optical bombsight computer. Estimate these magnitudes by graph plotting or with the use of the drift meter by reference to the known magnitudes of the auxiliary aiming point aim-off vector and direction of the auxiliary aiming point relative to the target (δ_s) as well as to the magnitudes of the illumination start point offset ($S_n = \frac{ut_{illum}}{2}$) and its direction ($\delta_U$) relative to the target ($\delta_U = \delta + 180°$ where σ is the wind direction).

B. Aiming at a visually visible or radar-visible target. To determine the aiming data, take into account the horizontal and vertical offsets of the point.

To account for the vertical offset of the illumination start point, insert conventional characteristic bomb fall time Θ' and bomb burst height equal to the illumination start altitude ($h = h_{ISP}$) into the optical bombsight computer.

The horizontal offset is taken into account by introducing the magnitude and direction of the illumination start point offset relative to the target into the optical bombsight computer. The offset magnitude is set on the computer auxiliary aiming point aim-off scale, and the offset direction, on vector tracer scale δ_s.

C. By reference to the "marker", with the use of the automatic bomber navigation equipment. The vertical offset is taken into account by introducing the conventional characteristic bomb fall time (Θ') and bomb burst height equal to the illumination start altitude ($h = h_{ISP}$) into the optical bombsight computer. The horizontal offset should be accounted for by introducing the offset aiming point coordinates into the automatic bomber navigation equipment.

317. For bombing equipment handling and navigator's aiming procedure, refer to Items 298 and 306 through 310.

7.5.3. Bombing with Autonomous Employment of РАДОН Bombsight Radar Portion

318. Bombing with autonomous employment of the РАДОН bombsight radar portion may be performed in exceptional cases only (in case of failure of the optical bombsight).

When performing bombing with autonomous employment of the РАДОН bombsight radar portion, the crew navigator should proceed as follows:

(1) before intercepting the initial target approach point:

— prepare the bombing equipment;

— determine the wind velocity and compute the ground speed and drift angle on the bombing run;

— enable the SEARCH mode on unit РН-21Д;

— determine slant release range $НД_{rel}$ for the assigned bombing altitude by referring to the ground speed and set its magnitude on the scale of indicator РН-6 by rotating the accurate sighting mark knob;

— turn the relative bearing line through the bombing run estimated drift angle;

— the moment the aircraft intercepts the initial target approach point, report aircraft turning to the combat course to the crew commander;

(2) when on the bombing run:

— locate and identify the target by its radar image on the screen of indicator РН-6 and make a report to the crew commander that it is necessary to make a corrective turn in the target direction so that the relative bearing line should divide the target image in half;

— turn on the switch labelled MASTER RELEASE SWITCH (ГЛАВНЫЙ ВЫКЛЮЧАТЕЛЬ СБРАСЫВАНИЯ);

— check coming-on of the EBR (ЭСБР) and DESTR (ВЗРЫВ) lights;

— refine the magnitudes of the ground speed and drift angle by reference to the Doppler ground speed and drift meter data or determine these magnitudes by any other means and verify the slant release range ($НД_{rel}$);

— turn on the OFF-CENTERED SECTOR (СМЕЩ. СЕКТОР) switch on control panel РН-21Д;

— make corrective turns to keep the target image on the relative bearing line;

— open the bomb doors at target horizontal range $ГД = L + A$ (where "L" is the distance from the target to the bombing range boundary on the side of the initial target approach point and "A" is the bomb release range under actual bombing conditions); when the target approaches the accurate sighting mark to a distance of 3 to 5 km, turn on the BRVSB (КВСБ) switch, make sure that the READY (ГОТОВ) light is alive and get ready for bomb release from button КСБ-49;

— the moment the target image approaches the accurate sighting mark, depress button КСБ-49 to release bombs;

— make the "Bombs released, time..." report to the crew commander;

— after releasing the bombs, turn off the switches labelled BRVSB (КВСБ) and MASTER RELEASE SWITCH (ГЛАВНЫЙ ВЫКЛЮЧАТЕЛЬ СБРАСЫВАНИЯ), close the bomb doors and set the bombing equipment controls to the initial position;

— put down the following parameters into the Flight Log Book: T_{rel}, DA (drift angle), W (ground speed), $НД_{rel}$ (slant release range), H_{abs} and V_{TAS}.

7.5.4. Bombing in Case of Failure of Airspeed and Altitude Director

319. In case of ЦСВ director failure, the crew navigator should proceed as follows:

— turn off the "H, V" switch on the optical bombsight computer and manually select the absolute altitude and true airspeed specified for the bombing run;

— report the bombing run altitude and airspeed to the crew commander;

— watch accurate holding of the assigned flight regime;

— proceed taking aim and releasing bombs by using the procedure specified for the operating ЦСВ airspeed and altitude director, precluding only the altitude and airspeed maneuver.

7.5.5. Bombing in Case of Optical Bombsight Computer Failure

320. In case of optical bombsight computer failure, it is allowed to perform bombing only in cases of dire necessity, since such bombing cannot provide high accuracy of target hitting.

If the optical bombsight computer fails to operate, the navigator should proceed as follows:

— when dropping bombs on a radar-contrast target, pass to aiming with autonomous employment of the РАДОН bombsight radar portion;

— when bombing a target having no radar contrast and if there is no possibility to release bombs by the leader's signal, manually set up the aiming angle picked out from the table and take aim, following the procedure specified for a common aiming sight; in so doing, set tg $\mu_0 = 0$ and take into account angle $\mu_{r.r.}$ (actual bomb release range) by reference to the sight field of vision cross line.

7.5.6. Bombing with Autopilot Switched Off

321. With the autopilot switched off, bombing is performed by using the procedure specified for the operating autopilot, the difference lying in the fact that corrective turns are accomplished by the crew commander by following the navigator's commands. The amount and direction of the corrective turn are determined by the navigator, proceeding from the difference in indications of the α_s and α_{aim} indexes. The corrective turn is performed in the direction of the α_s index.

7.5.7. Actions of Crew in Case of Failure of Bomb Release Control Circuits, Hang-Up of Bomb or Its Dropping on Bomb Doors

322. In case of failure of the bomb release control circuits (bombs fail to be released from the optical bombsight, bomb release button КСБ-49, in emergency cases from the navigator's and crew commander's

stations and from the storage battery), the crew navigator should proceed as follows:

— report failure of the bomb release control circuits and bomb release failure to the crew commander;

— turn off all the bomb release control switches labelled AUTO RELEASE (АВТОСБРОС), BRVSB (КВСБ), MASTER RELEASE SWITCH (ГЛАВНЫЙ ВЫКЛЮЧАТЕЛЬ СБРАСЫВАНИЯ) and emergency jettisoning switches;

— close the bomb doors;

— make sure that bombs are suspended from the racks by reference to the indicator lights;

— turn off all the bombing equipment circuit breakers;

— before making the landing approach, ensure suspension of bombs from the racks by illumination of the respective indicator lights.

323. The crew commander should proceed as follows:

— report the bomb release failure caused by failure of the bomb release control circuits to the flight control post;

— fly the aircraft without making abrupt evolutions;

— land the aircraft with minimum g-loads;

— taxi in to a special parking apron.

After taxiing to the parking apron, the navigator should make sure that bombs are suspended from the racks by illumination of the indicator lights; do not open the bomb doors.

7.6. TACTICAL BOMBING OF REAL OBJECTS

7.6.1. Preparation for Tactical Bombing

324. For training in taking aim at real objects, as a rule, the crew has to perform tactical bombing of real objects in each combat flight.

Preparation for tactical bombing flights and preparation of bombsights should be carried out by using the procedure and scope specified for range bombing.

CAUTION. WHEN PERFORMING TACTICAL BOMBING, MIND THE FOLLOWING:

— NEVER TURN ON THE SWITCHES LABELLED "MASTER RELEASE SWITCH" AND "BRVSB" ("КВСБ"), TRIGGER THE AUTO RELEASE LEVER OR OPEN THE BOMB DOORS;

— TURN OFF THE "TURN" SWITCH IN DUE TIME.

The results of tactical bombing may be checked with the help of the РСБН system as well as by vertical aerial photography of the terrain or by photography of the radar image on the screen of РАДОН radar bombsight indicator РН-6.

7.6.2. РСБН-Checked Tactical Bombing

325. The РСБН short-range navigation and landing system may be used to determine the aircraft range and azimuth relative to the ground beacon within the beacon coverage radius with a sufficient degree of accuracy, which makes it possible to use this range and azimuth for checking the accuracy of target tactical bombing.

To perform РСБН-checked tactical bombing, proceed as follows:

— estimate the accurate target coordinates (azimuth and range) relative to the ground beacon;

— estimate the plotting boards for processing the tactical bombing results;

— have a camera attachment for taking photographic pictures of the navigator's direct-reading range and azimuth indicator.

326. When performing РСБН-checked tactical bombing, the crew navigator should proceed as follows:

— turn on the РСБН system, monitor the call signs of the ground beacon and prepare the camera attachment for operation;

— bring the aircraft to the initial target approach point by using all the air navigation means;

— detect the target by the mutual position of radar- or visually-located landmarks;

— take aim at the assigned target by using the procedure specified for conventional bombing;

— after the sighting angle index comes into alignment with the aiming angle index, cease executing the lateral aiming, turn off the TURN (РАЗВ.) switch and strictly hold the flight direction;

— the moment the sighting angle index gets zeroed, check operation of the camera attachment;

— further on, the navigator proceeds in the same way as during conventional bombing;

— put down the aircraft heading, absolute altitude (H_{abs}), true airspeed (V_{TAS}), sighting angle, drift angle, bomb release time and trail distance into the Flight Log Book.

7.6.3. Camera-Checked Tactical Bombing

327. When performing camera-checked tactical bombing, the crew navigator should proceed as follows:

— prepare the optical and РАДОН radar bombsights for operation and take aim by using the procedure specified for conventional bombing;

— prepare the АФА camera for vertical single-strip photography with 20 % overlap;

— the moment the sighting angle index comes into alignment with the aiming angle index, depress the START (ПУСК) button on the АФА camera control unit and start the stopwatch;

— turn off the АФА camera on a lapse of time equalling T_A;

— put down the time, aircraft heading, drift angle (DA), ground speed (W), absolute altitude (H_{abs}) and time interval T_A into the Flight Log Book.

7.6.4. ФАРМ Camera Attachment-Checked Tactical Bombing

328. When performing the ФАРМ camera attachment-checked tactical bombing, the crew navigator should proceed as follows:

— prepare the optical bombsight and РАДОН radar bombsight for operation and take aim in the same way as during conventional bombing;

— take photographic pictures with the use of the ФАРМ camera attachment in the AUTO (АВТОМАТ) mode after every 20 revolutions of the antenna;

— after carrying out simulated bombing, put down time interval (T), aircraft heading, drift angle (DA), absolute altitude (H_{abs}), true airspeed (V_{TAS}) and aiming angle φ_{aim} into the Flight Log Book.

The results of tactical bombing are checked by reference to the position of the target image on the photographs as well as by determining the actual flight elements on the bombing run.

7.7. PECULIARITIES OF LOW- AND EXTREME-LOW ALTITUDE TOSS BOMBING WITH USE OF "РАДОН" RADAR BOMBSIGHT

329. When performing toss bombing with the use of the РАДОН radar bombsight, the crew commander should proceed as follows:

— intercept the combat course assigned by the navigator;

— zero the gyro horizon scale;

— on listening to the navigator's "Climb" report, build up g-load $n_y = 1.5$ for 1.5 to 2 s and keep this g-load constant till the bomb release moment;

— when performing the maneuver, avoid making sharp backward motions by the control column to avoid surpassing the permissible g-loads;

— avoid aircraft banking during pitch-up;

— do not change the engine power setting selected before pitch-up till levelling-off the aircraft;

— on listening to the navigator's "Release" ("Simulated release") report, change over the aircraft from the pitch-up attitude into level flight with g-load $n_y=0.4$—0.5.

If attaining of the 19 to 20° pitch-up attitude by the aircraft is not followed by the navigator's "Release" report, prohibit bombing and level off the aircraft.

330. The crew navigator should proceed as follows:

— determine (at $H \geqslant 2000$ m) the systematic error of the accurate sighting mark;

— turn off the switches labelled "V, H", "$\frac{T}{H}$, $\frac{T_A}{H}$" and select $H=2000+(\pm\Delta H_{SRC})$; V_{ass} and $U_x=0$;

— determine W_x, H_{abs} and pick out the magnitudes of the $\varphi_{s\ theor}$ and $\varphi_{aim\ theor}$ angles from the table;

— set up the theoretical sighting angle by rotating the longitudinal sighting knob, and the theoretical aiming angle, by manipulating the "$\frac{T_A}{H}$" knob;

— sink the button of the longitudinal sighting knob;

— set the α_{aim} index to the drift angle magnitude and align it with the α_s index;

— locate the target blip on the screen of indicator PH-6 and make the "Target is seen" report to the crew commander;

— change over to operate in the optical bombsight mode, then, using the POSITION (ПОЛОЖЕНИЕ) lever, align the accurate sighting mark with the target blip and report execution of a corrective turn in the target direction to the crew commander as follows: "... degrees to right (left)" (to align the aiming line with the target);

— change over to the μA-SCAN (МПМ) mode;

— turn on the switch labelled MASTER RELEASE SWITCH (ГЛАВНЫЙ ВЫКЛЮЧАТЕЛЬ СБРАСЫВАНИЯ);

— check illumination of the EBR (ЭСБР) and DESTR (ВЗРЫВ) lights;

— keep the target blip aligned with the crosshairs by using the position lever and by making aircraft corrective turns (to be done by the crew commander);

— 2 km before transition to the main synchronization mode, make the "Attention" report to the crew commander;

— at the moment of transition to the main synchronization mode (which is checked by reference to illumination of the green CAUTION (ПРЕДУПРЕЖДЕНИЕ) light in indicator PH-6)., make the "Climb" report to the crew commander;

— trigger the automatic release lever and make the "Automatic release triggered" report;

— turn on the BRVSB (КВСБ) switch, make sure that the READY (ГОТОВ) lamp lights up on the bombing equipment control board and make the following report: "Selectors ON, the READY light illuminates";

— check opening of the bomb door (the bomb door will open 3 to 7 s after transition to the main synchronization mode);

— at the moment of operation of the automatic release lever, make the following report: "Bombs released, time ..." (the first bomb will be released 10.8 to 11 s after transition to the main synchronization mode);

— turn off the BRVSB (КВСБ) switch and the switch labelled MASTER RELEASE SWITCH, then close the bomb doors;

— put down the bomb release time (T_{rel}), drift angle (DA), theoretical sighting angle ($\varphi_{s\ theor}$), theoretical aiming angle ($\varphi_{aim\ theor}$), ground speed (W_x) and absolute altitude (H_{abs}) into the Flight Log Book.

NOTES: 1. The theoretical still air sighting angle, corresponding to the initial moment of aircraft entry into pitch-up, during РАДОН radar bombsight bombing is estimated by the formula:

$$\cos \varphi_{s\ theor} = \frac{H_{theor}}{A_{pitch\text{-}up} + X_{pitch\text{-}up}},$$

where H_{theor} is the theoretical altitude to be set on the computer (H_{theor} = 2000 m);
$A_{pitch\text{-}up}$ is the actual toss bombing rangé picked out from the ballistic tables proceeding from the following condition: the pitch-up angle is 15° for the assigned absolute bomb release altitude and assigned true bombing airspeed;
$X_{pitch\text{-}up}$ is the horizontal distance covered by the aircraft during pitch-up.

2. The corrections for the wind to still air sighting angles $\varphi_{s\ theor}$ should be determined by the following formulas:

$$\Delta\varphi_s^0 = U_x K_s;$$

$$K_s = \frac{(T + t_{pitch\text{-}up})\, H_{theor}}{A_{total}^2 \sqrt{1 - \left(\frac{H_{theor}}{A_{total}}\right)^2}} 57.3,$$

where T is the bomb fall time;
$t_{pitch\text{-}up}$ is the pitch-up time;
H_{theor} is the theoretical altitude equalling 2000 m;

$$A_{total} = A_{pitch\text{-}up} + X_{pitch\text{-}up}.$$

3. The still air (theoretical) aiming angle should be computed by the following formula:

$$\operatorname{tg} \varphi_{aim\ theor} = \operatorname{tg} \varphi_{s\ theor} - \frac{\gamma t_{pitch\text{-}up}}{H_{theor}}.$$

4. The corrections for the wind to still air aiming angles should be calculated by the following formulas:

$$\Delta\varphi_{aim}^0 = U_x K_{aim};$$

$$K_{aim} = \frac{K_s}{\cos^2\varphi_{s\ theor}\,(1 + \operatorname{tg}^2\varphi_{aim\ theor})}.$$

5. In the process of the bombing equipment preflight preparation the crew navigator should additionally check computation of the pitch-up time ($t_{pitch-up}$) by the optical bombsight by following the procedure given below:

(a) set H=2000 m and V=750 km/h on the optical bombsight computer;

(b) set the U_x, U_y and tg μ_0 parameters equal to zero;

(c) using the $\frac{T_A}{H}$ knob, set $\varphi_{aim\ theor}$ picked out from the table by reference to the data set on the computer;

(d) manipulate the longitudinal sighting knob to set the $\varphi_{s\ theor}$ sighting angle selected for the same conditions as the $\varphi_{aim\ theor}$ aiming angle;

(e) switch on the constant-speed motor;

(f) switch on the longitudinal sighting knob button and simultaneously start the stopwatch;

(g) stop the stopwatch the moment the sighting and aiming angle indexes come into alignment. The stopwatch should read 11 s.

7.8. EMERGENCY RELEASE OF BOMBS

331. Emergency release of bombs is performed in a specially assigned area by a decision of the crew commander. Bombs may be released in the ARMED or SAFE mode from the pilot's or navigator's station.

332. When releasing the bombs in the ARMED mode, the navigator should proceed as follows:

— turn on the switch labelled TURN ON FOR EMERGENCY ARMED RELEASE (ПРИ АВАРИЙНОМ СБРОСЕ НА ВЗРЫВ ВКЛЮЧИ);

— place the ARMED — SAFE (ВЗРЫВ — НЕВЗРЫВ) switch on the navigator's electric bomb release board to the ARMED (ВЗРЫВ) position; this will result in coming-on of the ARMED (ВЗРЫВ) indicator light;

— turn on the EMERGENCY BOMB RELEASE (АВАРИЙНЫЙ СБРОС) switch on the navigator's electric bomb release board; this will result in opening of the bomb doors, coming-on of the OPEN (ОТКР.) indicator light and bomb dropping; carry out the check by reference to illumination of the indicator lights;

— close the bomb doors.

NOTE. When the navigator prepares the bomb release circuits in the ARMED mode, the crew commander, if required, may perform emergency release of bombs in the SAFE mode by using the EMERGENCY BOMB RELEASE switch.

333. When releasing the bombs in the ARMED mode, the pilot should proceed as follows:

— place the ARMED — SAFE switch on the pilot's front electric board to the ARMED position — the ARMED light will come to illuminate;

— turn on the EMERGENCY BOMB RELEASE switch on the pilot's front electric board; this will result in opening of the bomb doors, coming-on of the OPEN (ОТКР.) indicator light and release of bombs.

334. When releasing the bombs in the SAFE mode, the pilot should proceed as follows:

— turn on the EMERGENCY BOMB RELEASE switch — the bomb doors will open, the OPEN indicator light will come on and bombs will be released;

— close the bomb doors.

335. Emergency release of bombs with the use of a storage battery (from the superemergency circuit) in the ARMED or SAFE mode is accomplished from the pilot's station.

When releasing the bombs in the ARMED mode, the pilot should proceed as follows:

— set the ARMED — SAFE switch on the bomb emergency release panel to the ARMED position;

— turn the battery-supplied release knob on the pilot's bomb emergency release control panel;

— close the bomb doors.

When releasing the bombs in the SAFE mode, the pilot should proceed as follows:

— turn the battery-supplied release knob on the pilot's bomb emergency release control panel;

— close the bomb doors.

7.9. FLIGHT PERFORMED WITH EMPLOYMENT OF DEFENSIVE ARMAMENT

7.9.1. Chaff Dispenser КДС-16ГМ

336. When checking chaff dispenser КДС-16ГМ, proceed as follows:

— make sure that the chaff container cells are loaded with chaffs of the required type (by visual inspection and by reference to the cellulose bars on the control panel);

— turn on the AUTO-2 (АВТОМАТ-2) circuit breaker;

— place the КДС chaff dispenser switch on the control panel to position "I";

— set the СПО-3 — OFF (СПО-3 — ВЫКЛ.) switch to the OFF (ВЫКЛ.) position;

— check chaff dispensing in the SERIES — CONT (СЕРИЯ — НЕПРЕРЫВНО) mode; to this end, place the SERIES — PROGR (СЕРИЯ — ПРОГР.) switch to the SERIES (СЕРИЯ) position and the PORTION — CONT (ПОРЦИЯ — НЕПР.) switches of the first and second cells, to the CONT (НЕПР.) position; set up the chaff dispensing interval to be equal to 1 s;

— turn on the SUPPLY (ПИТАНИЕ) switch on the control panel; this should result in coming-on of the white lights indicating presence of chaffs in the cells;

— depress the DISP (СБРОС) button — the white lights of the cells should start flickering, indicating the release of chaff packs in the assigned mode;

— cut out the cells by placing the PORTION — CONT switch to the OFF (ВЫКЛ.) position;

— check dispensing of chaffs in the PROGRAM — CONT (ПРОГРАММА — НЕПРЕРЫВНО) mode; to this end, place the SERIES — PROGR (СЕРИЯ — ПРОГР.) switch to the PROGR (ПРОГР.) position, cut in the cells and depress the DISP (СБРОС) button;

— cut out the cells.

337. Use a similar procedure to check dispensing of chaffs from the second chaff dispenser and from two chaff dispensers at a time with the КДС switch set to positions "II" and "I+II".

CAUTION: 1. IT IS NOT RECOMMENDED TO DISCONTINUE CHAFF DISPENSING BY TURNING OFF THE "SUPPLY" SWITCH.

2. WHEN CARRYING OUT THE CHECK, PLACE A SPECIAL BAG FOR COLLECTING CHAFF PACKS UNDER THE CHAFF DISPENCER OUTLET FUNNELS.

3. THE DURATION OF CHAFF DISPENSING DURING EACH CUT-IN OF THE DISPENSER SHOULD NOT EXCEED 3 S.

338. To prepare the chaff dispenser for dispensing the chaffs in the assigned mode in flight, the operator should proceed as follows:

— set the SERIES — PROGR (СЕРИЯ — ПРОГР.), PORTION — OFF — CONT (ПОРЦИЯ — ВЫКЛ. — НЕПР.), КДС — I — II + II switches and time interval switch on the control panel to the positions corresponding to the assigned chaff dispensing mode;

— turn on the SUPPLY (ПИТАНИЕ) switch. For dispensing the chaffs, depress the DISP (СБРОС) button. For automatic dispensing of the chaffs, turn on the СПО-3 switch on the control panel.

339. The duration of dispensing the chaffs from chaff dispenser КДС-16ГМ (in minutes) is given in Table 20.

Table 20

Chaff dispenser operating mode	Operating time of chaff dispenser КДС-16ГМ (in min) at intervals of chaff dispensing, s					
	from one cell			from four cells		
	0.3	1	3	0.3	1	3
SERIES — CONT	2	6.5	20	8	26	80
SERIES — PORTION	2	6.5	20	8	26	80
PROGRAM — CONT	7.5	25	—	30	100	—
PROGRAM — PORTION	7.5	25	—	30	100	—

340. The chaff dispenser operates in the automatic mode in response to a signal arriving from the СПО-3 radar illumination warning unit, which triggers the automatic chaff dispensing circuit when the fighter radar sight starts operating in the autotracking mode.

To stop chaff dispensing, place the PORTION — OFF — CONT (ПОРЦИЯ — ВЫКЛ. — НЕПР.) switch to the OFF (ВЫКЛ.) position.

7.9.2. Chaff Dispenser АПП-22

341. When checking chaff dispenser АПП-22, the operator should make sure that the chaff bunkers are loaded with chaffs of the required type (to be ascertained by visual inspection and by reference to the inscription plates on the control panels) and check the chaff dispenser for proper operation when dispensing the chaffs in the SUCCESSIVE and PARALLEL modes. To this end, proceed as follows:

— make sure that the AUTO-3 (АВТОМАТ-3) circuit breakers on the circuit breaker panel are turned on;

— turn on the MAINS (СЕТЬ) switch on the port chaff bunker control panel; this should result in coming-on of the green lights indicating presence of chaffs in the respective cells;

— set the SUCCESS — PARALLEL (ПОСЛЕДОВ. — ПАРАЛ.) switch to the SUCCESS (ПОСЛЕДОВ.) position;

— successively setting the cell switches to the ON (ВКЛЮЧЕНО) position and depressing the START (ПУСК) button, dispense the chaffs at the first, second, fourth, sixth and eight intervals, accordingly; this should be accompanied by flickering of the green light in the right-hand lower corner of the control panel;

— place the SUCCESS — PARALLEL (ПОСЛЕДОВ. — ПАРАЛ.) switch to the PARALLEL (ПАРАЛ.) position and check simultaneous operation of two cells in any combination at the third and fifth chaff dispensing intervals for 3 s.

342. Using a similar procedure, check operation of the starboard (two-cell) chaff bunker, dispensing the chaffs for 5 to 6 s with switchover of intervals.

Discontinue chaff dispensing by using the STOP (СТОП) button.

NOTES: 1. When checking chaff dispenser АПП-22, place a special bag for gathering the chaffs under the chaff dispenser outlet funnels.

2. The duration of chaff dispensing from each chaff bunker does not exceed 10 s.

343. When preparing the chaff dispenser for dispensing the chaffs in flight in the assigned mode, the operator should turn on the MAINS (СЕТЬ) switch and depress the START (ПУСК) button.

The chaff dispensing procedure and frequency are checked by reference to flickering of the green chaff dispensing indicator light. The main characteristics of chaff dispenser АПП-22 are given in Table 21.

Table 21

Bunker variant	Cell type	Type of chaffs / number of boxes (box type)	Frequency range covered, cm	Interval number 1: t, s / T, min	2: t, s / T, min	3: t, s / T, min	4: t, s / T, min	5: t, s / T, min	6: t, s / T, min	7: t, s / T, min	8: t, s / T, min
Two-cell	First cell — wide	ДОФ and ДОС / 874 (АПП-К3)	14.5—60	2 / 29	1 / 14.5	0.8 / 11.6	0.5 / 7.6	0.4 / 5.8	0.25 / 3.6	0.2 / 2.9	0.1 / 1.4
	Second cell — narrow	ДОС and ДОФ / 920 (АПП-К1)	0.8—14	2 / 30.6	1 / 15.3	0.8 / 12.3	0.5 / 7.6	0.4 / 6.1	0.25 / 3.8	0.2 / 3.0	0.1 / 1.5
		ДПФ (ДПС) / 322 (АПП-К4)	60—1000	6 / 32	3 / 16	2.4 / 12.8	1.5 / 8	1.2 / 6.4	0.75 / 4	0.6 / 3.2	0.3 / 1.6
Five-cell		ДОС and ДОФ / 4600 (ЭАПП-К1)	0.8—14	2 / 30.6	1 / 15.3	0.8 / 12.3	0.5 / 7.6	0.4 / 6.1	0.25 / 3.8	0.2 / 3.0	0.1 / 1.5
		ДПФ (ДПС) / 1610 (АПП-К4)	60—1000	6 / 32	3 / 16	2.4 / 12.8	1.5 / 8	1.2 / 6.4	0.75 / 4	0.6 / 3.2	0.3 / 1.6

NOTE. "t" is the box release interval in seconds;
"T" is the time of cell emptying, in minutes.

To discontinue chaff dispensing, depress the STOP (СТОП) button (in the SERIES mode, chaff dispensing is discontinued after dispensing a complete series of chaffs).

Chaffs may be dispensed in any of the eight modes in succession or in parallel as well as in series. When chaffs are dispensed in succession, they are successively ejected from each cell and from each chaff bunker in the order of enabling the respective switches on the control panel; when chaffs are dispensed in parallel, they are released from no more than five cells: from two two-cell chaff bunkers and three five-cell bunkers whose switches are enabled on the control panel.

It is allowed to vary the chaff dispensing interval, the operating mode and to connect and disconnect the cells without stopping the chaff dispenser.

NOTE. It is allowed to dispense the UHF and SHF chaffs from the АПП-22 chaff dispensers at the flight altitude below 10,000 m and at $M<0.9$.

344. During chaff dispenser operation, keep an eye on the chaff dispensing indicator. If the green chaff dispensing indicator light has stopped flickering with the chaff dispenser turned on, this testifies to a delay in chaff dispensing. If this is the case, locate and cut out the faulty cell.

Presence of chaffs in the cell is indicated by illumination of the green light located above the switch of the respective cell. When the cell is emptied to two thirds of its capacity, the red light of this cell starts glowing on the control panel.

After full emptying of the cell, both lights go out on the control panel.

7.9.3. Radar Illumination Warning Unit СПО-3

345. To check operation of radar illumination warning unit (station) СПО-3, proceed as follows:

— turn on the switches of all the four channels as well as the switches labelled STATION (СТАНЦИЯ) and VOLUME (ЗВУК) on the control panel;

— with the РАДОН radar bombsight or ПРС fire-control radar operating in the illumination mode, depress the CHECK (ПРОВЕРКА) button.

If all the channels are serviceable, the depression of the button causes operation of the audio signalling system and coming-on of all indicator lights.

After checking operation of the radar illumination warning unit, set the switches to the OFF (ОТКЛ.) position.

When in flight, turn on the STATION and VOLUME switches and channel switches on the control panel.

Control the operation of radar illumination warning unit СПО-3 by enabling and disabling the required channels and audio signalling system, depending on the aircraft position in the combat formation. Keep an eye on the rear hemisphere indicator lights labelled REAR RIGHT (СПРАВА СЗАДИ) and REAR LEFT (СЛЕВА СЗАДИ).

7.9.4. Tail Turret

346. After climbing into the cabin, the operator should check operation of the fire-control radar. To do this, he should proceed as follows:

(1) prepare the fire-control radar for switching-on and make sure that:

— the AUTO FIRE (АВТООГОНЬ) switch is turned off and sealed;

— the RETUNING (ПЕРЕСТРОЙКА) button and RETUNING switch on unit 2ДК-7 are sealed;

— the operating and auxiliary fuses of unit 2ДК-24 are serviceable;

— the ILLUM (ПОДСВЕТ) and FOCUS (ФОКУС) knobs on unit 2ДК-4 are set to the intermediate position, and the BRIGHT (ЯРКОСТЬ) knob, to the extreme left-hand position;

— the ZONE SHIFT (СМЕЩЕНИЕ ЗОНЫ) switch on unit 2ДК-6 is set to zero, the LOCK-ON RANGE (ДАЛЬН. ЗАХВ.) knob occupies the extreme left-hand position, the FIRE (ОГОНЬ) switch is set to OFF and sealed, the INTERROG (ОПРОС) switch is placed to the intermediate position, the AUDIO SIGNAL (ЗВУК. СИГНАЛ) switch is set to the OFF position and the SHIFT (СМЕЩЕНИЕ) switch, to the MANUAL (РУЧНОЕ) position;

— the STATION — OFF (СТАНЦИЯ — ВЫКЛ.) and HIGH — OFF (ВЫСОКОЕ — ВЫКЛ.) switches on unit 2ДК-7 are set to OFF while the switch labelled SC 1 — SC 2 (1ШК — 2ШК) occupies the SC 1 (1ШК) position, the radar wafer switch is set to the PLUS 27 V (ПЛЮС 27 В) position, the BALANCE — CHECK (БАЛАНС — КОНТРОЛЬ) switch is placed to the CHECK (КОНТРОЛЬ) position, the DIRECTION (НАВЕДЕНИЕ) switch to the MAN (РУЧН.) position, the RETUNE (ПЕРЕСТР.) switch to the MAN (РУЧН.) position, mode-of-operation switch labelled OPTICS — DIRECT — RADIO (ОПТИКА — НАВОД. — РАДИО) to the RADIO (РАДИО) position, the FREQ (ЧАСТОТА) knob occupies the extreme left-hand position and the GAIN (УСИЛЕНИЕ) knob the extreme left-hand position, the MGC — AGC (РРУ — АРУ) switch is set to the AGC (АРУ) position and the AFT — AFC (АРЧ — АПЧ) switch, to the intermediate (AFC) position;

— the switches labelled AMPLIDYNE (ЭМУ), AZIMUTH MOTOR (МОТОР АЗИМУТА), TILT MOTOR (МОТОР НАКЛОНА) switches are set to OFF, and the REFLECTOR (РЕФЛЕКТОР) switch, to ON.

CAUTION. TO CONCEAL THE OPERATING FREQUENCY RANGE OF THE TRANSMITTER, USE THE MAGNETRON FIXED INTERMEDIATE FREQUENCY WHEN HANDLING HIGH VOLTAGE. IN THIS CASE, THE RED "MID FREQ" LIGHT ON UNIT 2ДК-6 SHOULD BE DEAD;

(2) carry out preliminary cut-in of the fire-control radar; to this end, proceed as follows:

— make sure that inverter ПО-6000 and the fire-control radar cooling and supply circuit breakers are turned on;

— place the STATION — OFF switch on unit 2ДК-7 to the STATION position and check serviceability of the radar by using the built-in test system; to this end, set the wafer switch on unit 2ДК-7 to the SC 1 (1ШК) position;

— check radar voltages and compare them with the data specified in the table provided on unit 2ДК-7;

— check deflection of the reflector. To this end, place the wafer switch to the REFL OFF (ОТКЛ. РЕФЛ.) position. In this case, the indicator pointer should periodically deflect within 0 to 250 divisions; the period of pointer hesitations should approximate 3 s;

— depress the trigger lever on the TV sight fire-control panel; as a result, the indicator pointer should stop within the range of 0 to 20 divisions;

— using the BRIGHT (ЯРКОСТЬ) and FOCUS (ФОКУС) knobs, adjust the sharpness of the image on the indicator screen; while rotating the LOCK-ON RANGE (ДАЛЬН. ЗАХВ.) knob on unit 2ДК-6, make sure that the target blip is displaced within the 2000 to 6500-m range;

— check the receiver gain;

— set the MGC — AGC (РРУ — АРУ) switch to the MGC (РРУ) position; while slowly rotating the GAIN (УСИЛЕНИЕ) knob clockwise, watch the appearance of clutter on the indicator screen, which is usually accompanied by coming-on of the LOCK-ON (ЗАХВАТ) and FIRE (ОГОНЬ) lights on the indicator; set the MGC — AGC switch to the AGC position — the clutter should fade out and the LOCK-ON and FIRE lights should extinguish;

(3) check operation of the manual and automatic direction channels, to this end, proceed as follows:

— set the DIRECTION (НАВЕДЕНИЕ) switch on unit 2ДК-7 to the MAN (РУЧН.) position;

— check off-centering of the scanning zone by successively placing the ZONE SHIFT (СМЕЩ. ЗОНЫ) switch on unit 2ДК-6 to the "minus

30°" and "plus 30°" positions, the antenna should move to the left and to the right; check shifting of the zone by the indicator scale, with the INDIC ON (ВКЛ. ИНДИК.) button on unit 2ДК-4 depressed;

— place the SHIFT (СМЕЩЕНИЕ) switch to the AUTO (АВТОМАТ) position and check automatic shifting of the scanning zone; depress the INDIC ON button on unit 2ДК-4 and refer to the indicator screen scale graduated in degrees to make sure that the antenna is shifted through $\pm(11$ to $29)°$ in azimuth;

— set the SHIFT switch to the MAN (РУЧНОЕ) position and check manual direction of the antenna by turning the TV sight fire-control panel to the right and to the left and then upward and downward; the antenna should move respectively; check antenna movement by reference to the indicator scale;

— check automatic direction of the antenna by depressing the antenna direction switch on unit 2ДК-7 to the CHECK (КОНТРОЛЬ) position and the AZIMUTH I — AZIMUTH II (АЗИМУТ I — АЗИМУТ II) or TILT I — TILT II (НАКЛОН I — НАКЛОН II) switch to one of the positions for one second; in this case, the antenna head should hesitate or be set within the range of 14 to 32° in tilt or 18 to 52° in azimuth;

(4) check the angular tracking channel. To this end, proceed as follows:

— place the SC 1 — SC 2 (1ШК — 2ШК) switch on unit 2ДК-7 to the SC 2 (2ШК) position;

— set the indicator wafer switch to the ANGULAR (УГЛОВ.) position;

— shift the MGC — AGC (РРУ — АРУ) switch to the MGC (РРУ) position;

— turn the GAIN (УСИЛЕНИЕ) knob to the extreme left-hand position;

— place the BALANCE — CHECK (БАЛАНС — КОНТРОЛЬ) switch to the BALANCE (БАЛАНС) position;

— depress the AZIMUTH I — AZIMUTH II switches to both positions in succession; the difference in readings of the 2ДК-7 unit indicator should not exceed 30 divisions; perform a similar check by successively depressing the TILT I — TILT II switch to both positions;

— set the BALANCE — CHECK switch to the CHECK position; check the difference in indicator readings by successive depression of the AZIMUTH I — TILT I and AZIMUTH II — TILT II switches; the difference in the indicator readings should not exceed 35 divisions;

— place the BALANCE — CHECK switch to the BALANCE position, depress the AZIMUTH II switch and memorize the indicator readings; shifting of the BALANCE — CHECK switch to the CHECK position should bring about increase of the indicator readings by 50 to 70 divisions; perform a similar check by depressing the TILT II switch;

(5) check operation of the range-finder channel. To this end, proceed as follows:

— place the wafer switch on unit 2ДК-7 to the RANGE (ДАЛЬН.) position, then depress the AZIMUTH I — AZIMUTH II and TILT I — TILT II switches; this should result in appearance of two check pulse marks on the indicator screen at a range of 300 to 900 m and 800 to 1600 m; the moment the check pulse gets locked on in range, the locked-on target blip on the indicator screen is divided into three arcs; the readings of the 2ДК-7 unit indicator should be within 20 to 50 divisions for the first check pulse and within 70 to 130 divisions for the second check pulse; the LOCK-ON (ЗАХВАТ) and FIRE (ОГОНЬ) lights on unit 2ДК-4 should be alive; for locking-on the second check pulse in range, depress the LONG — SHORT (ДАЛЬШЕ — БЛИЖЕ) switch on unit 2ДК-6 to the LONG (ДАЛЬШЕ) position;

— set the wafer switch on unit 2ДК-7 to the CLOSURE SPEED (СКОР. СБЛ.) position; depress the LONG switch — the indicator pointer should deflect by 70 to 130 divisions and return to zero;

— turn on the switches labelled AMPLIDYNE (ЭМУ), AZIMUTH MOTOR (МОТОР АЗИМУТА) and TILT MOTOR (МОТОР НАКЛОНА) switches on unit 2ДК-24 and close the unit cover;

— successively shift the wafer switch to the PRESS 25 (ДАВЛЕН. 25) and PRESS 2 (ДАВЛЕН. 2) positions; the indicator pointer should read 160 to 280 divisions;

— set the wafer switch to the MAGNET CURRENT (ТОК МАГНЕТ.) position and the HIGH — OFF (ВЫСОКОЕ — ВЫКЛ.) switch on unit 2ДК-7, to the HIGH (ВЫСОКОЕ) position; the indicator pointer should read in this case 180 to 280 divisions;

— place the AGC — MGC (АРУ — РРУ) switch to the AGC (АРУ) position;

(6) check operation of the automatic frequency control. To this end, proceed as follows:

— successively set the wafer switch to the "TK-1", "TK-2", "TK-3", "TK-4" positions and depress one of the AZIMUTH I — AZIMUTH II or TILT I — TILT II switches; the indicator readings should be within 20 to 240 divisions of the scale without hesitations of the pointer;

(7) check presence of the ground target blips on the indicator and their lock-on.

The check completed, set the HIGH — OFF (ВЫСОКОЕ — ВЫКЛ.) and STATION — OFF (СТАНЦИЯ — ВЫКЛ.) switches to the OFF (ВЫКЛ.) position and return all the control knobs and switches to the initial position.

347. Check operation of the TV sight.

1. Perform external inspection and preparation of the sight by using the following procedure:

— check smooth rotation of the fire control panel in azimuth and the control knobs in elevation; when released, the control knobs and control panel should automatically return to the zero position;

— check prompt operation (by click) of the FIRE (ОГОНЬ) firing triggers, actuating lever, RF (РАДИОДАЛЬН.) switch as well as of the switches labelled SEARCH (ПОИСК) and DIAPHRAGM (ДИАФРАГМА) (if any) and check smooth travel of the INTERCOM (СПУ) and AUTO (АВТОМАТ) buttons; make sure that the FIRE firing triggers are not jammed in the countersunk position;

— check rotation of the knobs labelled DIAPHRAGM, SEARCH, RF and SPAN (БАЗА) on the TV sight control panel; the rotation should be smooth, without seizure; check prompt operation (by click) of these switches when set to the extreme left-hand position on the TV sights having no separately located switches labelled SEARCH and DIAPHRAGM (by rotating the SEARCH and DIAPHRAGM potentiometer knobs counterclockwise);

— check rotation of the knobs of potentiometers labelled BRIGHT (ЯРК.), FOCUS (ФОКУС), CONTR (КОНТР.) and ILLUM (ПОДСВЕТ); the rotation should be smooth, without seizure; on sights provided with the N — P (Н — П) switch, check reliability of switch operation;

— set the switches and potentiometer knobs to the initial position in compliance with Table 22.

Table 22

Controls	Initial position
	On control panel of TV sight ТП-1
DIAPHRAGM (ДИАФРАГМА) switch (if available)	AUTO (АВТОМАТ)
SEARCH (ПОИСК) switch (if available)	Turned off
DIAPHRAGM knob	Extreme left-hand position (turned leftward to click)
SEARCH knob	Extreme left-hand position (turned leftward to click)
RF switch	Turned off
SPAN knob	Intermediate position
RF knob	Intermediate position
	On unit of ТП-1 TV sight kinescope
N — P switch	P (П)
BRIGHT (ЯРК.) knob	Extreme left-hand position
CONTR (КОНТР.) knob	Extreme left-hand position
FOCUS (ФОКУС) knob	Intermediate position
	On unit 2ДК-7
STATION (СТАНЦИЯ) switch	OFF (ВЫКЛ.)
HIGH (ВЫСОКОЕ) switch	OFF (ВЫКЛ.)
OPTICS — DIRECT — RA-	RADIO (РАДИО)

Table 22, continued

Controls	Initial position
DIO (ОПТИКА—НАВОД.—РАДИО) switch	
BALANCE — CHECK (БАЛАНС — КОНТРОЛЬ) switch	CHECK (КОНТРОЛЬ)
DIRECTION (НАВЕДЕНИЕ) switch	AUTO (АВТОМАТ)
MGC — AGC (РРУ — АРУ) switch	AGC (АРУ)
MGC — AFC — AFC SEARCH (РРУ — АПЧ — ПОИСК АПЧ) switch	AFC (АПЧ)
RETUNING (ПЕРЕСТР.) switch	Set to lower position and locked
SC 1 — SC 2 (1ШК — 2ШК) switch	SC 1 (1ШК)
Wafer switch	"+27 V" ("+27 В")
FREQ (ЧАСТОТА) knob	Intermediate position
GAIN (УСИЛЕНИЕ) knob	Extreme left-hand position
On unit 2ДК-6	
ZONE SHIFT (СМЕЩ. ЗОНЫ) switch	"0"
FIRE (ОГОНЬ) switch	OFF (ВЫКЛ.)
INTERROG OFF — LONG RANGE (ОПРОС ВЫКЛ. — ПОВЫШ. ДАЛЬН.) switch	OFF
AUDIO SIGNAL (ЗВУК. СИГНАЛ) switch	OFF
SHIFT (СМЕЩЕНИЕ) switch	MAN (РУЧНОЕ)
RETUNING (ПЕРЕСТРОЙКА) knob	Capped and locked
On tail turret control panel	
AUX (ВСПОМ.) switch	OFF
DIAPHRAGM switch	OFF
"~" switch	OFF
TVS (ТП) switch	OFF
PUMP (НАСОС) switch	OFF
FIRE (ОГОНЬ) switch	OFF
ATTACK (АТАКА) switch	Any position
EXTENSION (ВЫПУСК) switch	OFF
CG (ФКП) switch	OFF
FIRE INTERLOCK (БЛ. СТР.) switch	OFF
GAS PROTEC (ГАЗ. ЗАЩИТА) switch	OFF

2. On completing the external inspection, check the TV sight under voltage.

CAUTION. DO NOT LET THE TV SIGHT CAMERA PRISM BE DIRECTED AGAINST THE SUN OR SOME OTHER BRIGHT SOURCE OF LIGHT AND STRICTLY KEEP TO THE TV SIGHT ENABLING AND DISABLING PROCEDURE TO PRECLUDE BURNING-THROUGH OF THE VIDICON. IF THE SUN OR SOME OTHER BRIGHT LIGHT SOURCE LIES WITHIN THE SIGHT FIELD OF VISION, TURN THE PRISM AWAY FROM THE LIGHT SOURCE BEFORE OPENING THE BLIND.

To check the TV sight under voltage, proceed as follows:

— make sure that the DIAPHRAGM knob on the TV sight control panel is set to position "100" and on the TV sights accommodating the TVS camera blinds the DIAPHRAGM switch is placed to the MAN (РУЧН.) position;

— turn on the switches labelled "~", TVS (ТП) and AUX (ВСПОМ.) on the tail turret control panel; 5 min later and at subzero temperatures on expiration of 15 min turn on the DIAPHRAGM switch and manipulate the BRIGHT (ЯРК.) knob to set the required illumination brightness on the kinescope screen;

— rotate the FOCUS (ФОКУС) knob to obtain a sharp image of the central pip and range-finding ring;

— turn on the circuit breaker labelled FUS ILLUM — TVS BLIND (ОСВЕЩЕНИЕ ФЮЗЕЛЯЖА — ШТОРКА ТП); place the TVS BLIND switch on the operator's electric power supply board to the OPEN (ОТКР.) position; this should result in opening of the blind and coming-on of the green light located near the switch;

— place the DIAPHRAGM switch on the TV sight control panel to the AUTO (АВТОМАТ) position;

— turn the TV sight control panel (with the actuating lever depressed) to direct the sighting beam to some remote object on the terrain;

— check smooth control of brightness, contrast and focussing of the image by using the BRIGHT, CONTR and FOCUS knobs; check illumination of indicator scales by turning the ILLUM BRIGHTNESS knob; use the CONTR and BRIGHT knobs to select the required contrast and brightness of the image;

— set the DIAPHRAGM switch to the MAN position, and the DIAPHRAGM knob, to position "100"; as a result, the diaphragm should get closed (to be ascertained by diminishing of the image contrast and vanishing of the image on the kinescope screen); shift the DIAPHRAGM knob to position "2" — the diaphragm should open (image will appear on the kinescope screen);

— place the DIAPHRAGM switch to the AUTO position; while rotating the TV sight control panel, direct the prism to ground objects having different illumination degrees; if the automatic diaphragm-setting circuit operates properly, the quality of the image of these objects should not change (the image should be full-pattern and sufficiently sharp);

— turn on the SEARCH (ПОИСК) switches; by setting the SEARCH knob to different positions, make sure that the prism (image) displacement speed varies; check the scanning angles by reference to the indicators; they should lie within ±40° in the horizontal plane and within ±4° in the vertical plane;

— turn off the SEARCH switch, depress the actuating lever; successively turn the TV sight control panel to the right and to the left and the control panel knobs, upward and downward, to make sure that the prism position indicator pointers move in the same directions, and the displayed image, in the opposite directions; in this case, any change in the control panel (knobs) turning angle should be accompanied by variation of the prism (image) displacement speed; after the control panel (knobs) stops rotating, the prism (image) keeps displacing in the same direction at a constant speed proportional to the control panel turning angle;

— turn on the RF (РАДИОДАЛЬН.) switch; when the RF and SPAN (БАЗА) knobs are turned, the diameter of the range-finding ring on the kinescope screen should not change;

— turn off the RF switch; by rotating the SPAN and RF knobs, make sure that the diameter of the range-finding ring diminishes with the range increase and becomes larger with the range decrease; when the span is prolonged, the ring diameter should increase, becoming shorter with span decrease;

— change over the position of the N — P (Н — П) switch to make sure that the image on the kinescope screen varies accordingly (from negative to positive and vice versa);

— check operation of the ФКП camera gun.

CAUTION. DURING THE CAMERA GUN CHECKUP THE "FIRE" SWITCH ON THE TAIL TURRET CONTROL PANEL SHOULD BE TURNED OFF;

— turn on the CG (ФКП) switch on the tail turret control panel;

— depress the actuating lever and FIRE (ОГОНЬ) firing trigger; this should be accompanied by camera gun motor specific operating noise and flickering of the CG (ФКП) indicator light if the camera gun magazine is loaded with film;

— turn off the CG (ФКП) switch.

348. Check coupling of the ПРС fire-control radar with the TV sight. To this end, proceed as follows:

— perform preliminary cut-in of the ПРС fire-control radar;

— make sure that the "~" and TVS (ТП) switches on the tail turret control panel are turned on;

— place the OPTICS — DIRECT — RADIO (ОПТИКА — НАВОД. — РАДИО) switch to the DIRECT (НАВОД.) position;

— using the control panel, zero the TV sight head by reference to the indicators and, without changing the control panel position, depress the actuating lever — the antenna head should be set to zero with a ±9° error as shown by the indicators on unit 2ДК-4;

— when the TV sight fire-control panel is turned to the right and to the left, upward and downward, the antenna should follow the TV sight prism.

349. Check adequate control and operation of the tail turret.

CAUTION: 1. BEFORE STARTING THE CHECK, THE OPERATOR SHOULD MAKE SURE THAT THERE ARE NO CARTRIDGES IN ANY OF THE FOUR CARTRIDGE CHAMBERS (TO BE ASCERTAINED BY TURNING THE CARTRIDGE CHAMBER UNIT).

2. MAKE SURE THAT THE TURRET CONTROL BOX IS FITTED WITH BLANKING CAP No. 1.

3. THE SWITCHES LABELLED "DRIVE ON — OFF" ("ПРИВОД ВКЛ. — ВЫКЛ.»), "FIRE — OFF" ("ОГОНЬ - ВЫКЛ.") AND "TRAVELLING POSITION ON — OFF" ("ПОХОДНОЕ ПОЛОЖЕНИЕ ВКЛ. — ВЫКЛ.") ON THE SWITCH BOX ARE SET TO THE "ON" ("ВКЛ."), "FIRE" ("ОГОНЬ") AND "ON" ("ВКЛ.") POSITIONS, ACCORDINGLY.

4. THE CIRCUIT BREAKERS LABELLED "LIMIT SWITCH — OFF" ("КОНЦЕВ. - ВЫКЛ."), "GAS PROTECT HEAT - OFF" ("ОБОГРЕВЫ ГАЗ. ЗАЩ. - ВЫКЛ."), "HYD SYS HEAT - OFF" ("ОБОГРЕВЫ ГИДРОСИС. — ВЫКЛ."), "ДП ON — OFF" ("ДП ВКЛ. — ВЫКЛ.") AND "МП-2500 ON — OFF" ON THE CONTACTOR BOX (BEFORE BRAKE CHUTE STOWAGE) ARE SET TO THE "LIMIT SWITCH" (КОНЦЕВ.), "GAS PROTEC" ("ГАЗ. ЗАЩ."), "HYD SYS" ("ГИДРОСИС."), "ДП — ON" ("ДП ВКЛ.") AND "МП-2500 ON" ("МП-2500 ВКЛ.") POSITIONS, ACCORDINGLY.

5. WHEN CARRYING OUT THE CHECK, IT IS FORBIDDEN TO DEPRESS THE FIRING TRIGGER. DEPRESS THE FIRING TRIGGER ONLY WHEN CHECKING THE GAS PROTECTION SYSTEM AND CAMERA GUN, STRICTLY FOLLOWING THE PROCEDURE SPECIFIED BELOW.

6. PERFORM CHECKS IN COMPLIANCE WITH ITEMS 1 THROUGH 5 TOGETHER WITH AIRCRAFT ARMAMENT SPECIALISTS.

1. Check tail turret control from the TV sight, with the computer unit switched off. To do this, proceed as follows:

— place the switch labelled OPTICS — DIRECT — RADIO (ОПТИКА — НАВОД. — РАДИО) to the OPTICS (ОПТИКА) position;

— turn on the TV sight;

— turn on the FIRE INTERLOCK (БЛ. СТР.) and PUMP (НАСОС) switches on the tail turret control panel; depress the PUMP button on the control panels provided with the button and light labelled PUMP; as a result, the PUMP light should come on;

— check to see that the gun follows the motion of the control panel and TV sight prism in the horizontal and vertical planes at different prism motion speeds (at different control panel turn angles); when carrying out the check, make reference to the indicators, displacement of the terrain image on the TV sight screen and report of the aircraft armament specialist;

— check operation of the tail turret limit stops;

— check the fire interlocking circuits; to this end, turn the prism and the turret through 20 to 25° in the horizontal plane, making reference to the indicators, and release the actuating lever; the turret will assume the travelling position and the TV sight prism will remain in its place;

— turn the TV sight control panel to the zero position and depress the actuating lever — the LOCK-ON (ЗАХВАТ) light should start glowing on the turret control panel; the light will go out the moment the turret gets into alignment with the TV sight prism; perform a similar check, with the prism and turret turned in the vertical plane;

— check readiness of the system for firing; to this end, turn on the FIRE (ОГОНЬ) switch on the turret control panel, depress the actuating lever on the TV sight control panel and, without depressing the FIRE firing triggers, depress the light-button on the СЧП rounds counter; coming-on of the light indicates readiness of the system for firing (in this case, the turret should be set in the operating zone);

— turn off the FIRE switch.

2. Check turret control from the TV sight, with the computer unit turned on. To this end, proceed as follows:

— turn on the COMP (ВЫЧИСЛ.) switch on the turret control panel and set up the range equalling 1500 m by using the range knob on the TV sight control panel;

— turn the turret and TV sight prism through an angle of 20 to 25° and stop the prism by setting the TV sight control panel to the zero position; after prism stopping, the turret, which has ceased its motion, should displace through some angle in the backward direction, which testifies to sound operation of the computer; carry out a similar check in the vertical plane;

— using the range and span knobs, vary the range and span from the minimum to maximum magnitudes to watch the deflection of the turret; at a turret angle of 150° and zero elevation, the increase in range will entail leftward and upward displacement of the turret; with the range decreased, the turret will displace rightward and downward;

— turn off the COMP (ВЫЧИСЛ.) switch on the turret control panel.

3. Check functioning of the gas protection system and operation of the belt feed motor. In performing the check, proceed as follows:

— make sure that the AUX (ВСПОМ.), "∼", TVS (ТП), PUMP (НАСОС) switches are turned on and the PUMP (НАСОС) button (if available) is depressed on the turret control panel (the PUMP light is alive);

— make sure that the gas protection bottle heater is turned off and the belt feed mechanism (if the cartridge belt is available in the feed chute) is unlocked and hinged up;

— turn on the FIRE switch on the turret control panel;

— depress the actuating lever and FIRE firing trigger (the time of depression of the firing trigger should not exceed 0.5 s); in this case, carbon dioxide should be fed into the turret; after release of the firing trigger, the supply of carbon dioxide into the turret should discontinue; make sure that the depression of the FIRE firing trigger is accompanied by operation of the ammunition belt feed motor;

— turn off the FIRE (ОГОНЬ) switch.

4. Check heating of the bottles and the carbon dioxide pressure in the gas protection system. To this end, turn on the GAS PROTEC (ГАЗ. ЗАЩИТА) switch on the turret control panel; coming-on of the GAS PROTEC light on the turret control panel shows that the pressure of carbon dioxide in the gas protection bottles is below 50^{+20}_{-10} atm. and the bottle heating system is turned on. As soon as the gas pressure in the bottles reaches 55 to 65 atm., the heaters get automatically disconnected and the GAS PROTEC light goes out within no more than 10 min at an ambient temperature higher than minus 40 °C and within no more than 20 min at a temperature below minus 40 °C. The carbon dioxide pressure as indicated by the ЭДМУ pressure gauge should be at least 40 kgf/cm^2 at the light extinguishment moment.

350. De-energize the ПРС fire-control radar and TV sight; to this end, proceed as follows:

— place the DIAPHRAGM knob on the TV sight control panel to position "100" and on sights, accommodating the DIAPHRAGM switch, first set this switch to the MAN (РУЧН.) position;

— turn off the "~" and TVS (ТП) switches on the turret control panel; the diaphragm should get closed; wait for 1 to 2 min after diaphragm closing and only then turn off the AUX (ВСПОМ.) and DIAPHRAGM switches on the turret control panel;

— set the TVS BLIND (ШТОРКА ТП) switch on the operator's electric power supply board to the CLOSED (ЗАКРЫТО) position — the TV sight camera blind should become closed and the light indicating its opening should extinguish; this done, turn off the circuit breaker labelled FUS ILLUM — TVS BLIND (ОСВЕЩЕНИЕ ФЮЗЕЛЯЖА — ШТОРК. ТП);

— place the STATION (СТАНЦИЯ) switch to the OFF (ВЫКЛ.) position;

— set all the controls to the initial position.

351. After performing takeoff and reporting the readiness to the crew commander, switch on the TV sight and tail turret; to this end, turn on the AUX, GAS PROTEC, "~", TVS, PUMP and FIRE INTERLOCK switches on the turret control panel, and on expiration of 5 min, the DIAPHRAGM switch, then open the TV sight camera blind.

CAUTION: 1. FOR HEATING THE SYSTEM AT SUBZERO AMBIENT TEMPERATURE, TURN ON THE "AUX" SWITCH IMMEDIATELY AFTER ENGINE STARTING.

2. TURN ON THE "GAS PROTEC" SWITCH ONLY IF THE GAS PROTECTION SYSTEM BOTTLES ARE FILLED WITH CARBON DIOXIDE (CO_2). AFTER CESSATION OF FIRE OR IN CASE OF FIRE STOPPAGE, TURN OFF THE "GAS PROTEC" SWITCH.

352. Set the switch labelled OPTICS — DIRECT — RADIO (ОПТИКА — НАВОД. — РАДИО) on unit 2ДК-7 to the OPTICS (ОПТИКА) position, depress the actuating lever on the TV sight control panel and, while rotating the TV sight control panel rightward and leftward and control panel knobs upward and downward, ensure displacement of the sighting prism by reference to the pointer indicators.

Turn on the SEARCH (ПОИСК) switch and turn the SEARCH knob clockwise. Using the pointer indicators, make sure that the TV sight prism moves at different speeds, depending on the position of the SEARCH knob.

Check control of the tail turret from the TV sight.

CAUTION. WHEN CHECKING THE TAIL TURRET CONTROL, DO NOT TURN ON THE "FIRE" SWITCH.

353. Turn on the PUMP switch, depress the actuating lever and shift the TV sight in the horizontal plane to the extreme position; as a result, the green LOCK-ON light should start glowing on the turret control panel, thus testifying to presence of a mismatch angle between the locked turret and the TV sight prism which is turned through a greater angle as compared with the turret. Slowly move the TV sight prism in the backward direction and check to see that the LOCK-ON light goes out within some period of time (the turret gets aligned with the prism). Perform a similar check by moving the prism in the other direction and in the vertical plane.

NOTE. When the OPTICS — DIRECT — RADIO switch on unit 2ДК-7 is set to the OPTICS position, coming-on of the LOCK-ON light indicates serviceability of the fire interlock circuits.

354. Carry out preliminary enabling of the ПРС fire-control radar. To this end, turn on the STATION (СТАНЦИЯ) switch on unit 2ДК-7 and place the HIGH (ВЫСОКОЕ) switch to the OFF (ОТКЛ.) position. After letting the fire-control radar warm up for 10 to 15 min, check:

— presence of voltage across six indicator lights on unit 2ДК-24;

— presence of supply voltage and its magnitude by reference to the first scale of the wafer switch on unit 2ДК-7;

— deflection of the reflector;

— presence of test pulses and operation of the angular tracking channel by setting the SC 1 — SC 2 (1ШК — 2ШК) switch on unit 2ДК-7 to the SC 2 (2ШК) position, and the wafer switch, to the ANGULAR (УГЛОВ.) position (operation of the angular tracking channel is determined by outburst of the antenna mark towards the screen periphery with the AZIMUTH I — AZIMUTH II (АЗИМУТ I — АЗИМУТ II) or TILT I — TILT II (НАКЛОН I — НАКЛОН II) switch on unit 2ДК-4 shifted to any side and the INDIC ON (ВКЛ. ИНДИК.) button depressed);

— pressure in the units; after making sure that the MID FREQ (СРЕДНЯЯ ЧАСТОТА) light is dead, enable the fire-control radar to operate at full power (turn on the HIGH (ВЫСОКОЕ) switch on unit 2ДК-7) and check the magnetron and crystal currents.

355. Depending on the nature of the executed combat mission, keep the artillery armament system cut in completely or partially with the RADIO mode enabled.

When entering the enemy fighters effective area, enable the artillery armament, the fire-control radar and the TV sight to operate at full power.

356. During solo flights, it is advisable to resort to the automatic direction of the antenna to the target; to this end, proceed as follows:

— place the DIRECTION (НАВЕДЕНИЕ) switch on unit 2ДК-7 to the AUTO (АВТОМ.) position;

— using the LOCK-ON RANGE (ДАЛЬН. ЗАХВ.) knob on unit 2ДК-6, set the lock-on range limit mark to a range which is shorter than the lock-on range of the signals returned from the ground.

357. When flying in combat formations and in a complicated air situation, perform the manual direction of the antenna to the target; to this end, proceed as follows:

— place the DIRECTION (НАВЕДЕНИЕ) switch on unit 2ДК-7 to the MAN (РУЧН.) position;

— set the lock-on range limit mark to the range which is shorter than the range of the ground clutter;

— place the ZONE SHIFT (СМЕЩ. ЗОНЫ) switch on unit 2ДК-6 to the "0", "—30°" or "+30°" position, depending on the scanning sector assigned to the crew in the combat formation.

358. When a target blip appears on the fire-control radar screen, determine the state identity of the target; to this end, turn on the INTERROG (ЗАПРОС) switch on interrogator-responder unit 16A and set the SCAN (ОПРОС) switch on unit 2ДК-6 to the ON (ВКЛЮЧ.) position.

Employment of the artillery armament in the antenna automatic direction mode is accompanied by lock-on of the target by the fire-control radar at a range of 4 km. The period from the onset of the automatic direction till lock-on of the target is characterized by monitoring of an audio signal via the intercom.

Target lock-on is identified by reference to the annunciator on unit 2ДК-4, by coming-on of the LOCK-ON (ЗАХВАТ) light and by displaying the lock-on mark on the fire-control radar indicator screen.

To lock on the target in the antenna manual direction mode, move the fire-control radar antenna in the target direction towards the centre of the zone in which the target is detected, using the TV sight control panel. This done, depress the AUTO (АВТОМАТ) button. After target lock-on, set the TV sight control panel to the zero position.

359. If the fire-control radar fails to operate or cannot be used because of heavy clutter, use the TV sight in the daytime in good visual aiming and firing conditions. To this end, proceed as follows:

— place the OPTICS — DIRECT — RADIO (ОПТИКА — НАВОД. — РАДИО) switch on unit 2ДК-7 to the OPTICS (ОПТИКА) position;

— set the ATTACK — STRAIGHT (АТАКА — ПРЯМАЯ) switch on the turret control panel to the position corresponding to the nature of the fighter attack, turn on the FIRE (ОГОНЬ) switch on the same panel;

— select the size of the detected target by using the SPAN (БАЗА) knob;

— depress the actuating lever and direct the central pip of the sight to the target; using the RF (ДАЛЬНОМЕР) knob, smoothly frame the target and keep tracking it by the sight central pip.

When using the OPTICS — RANGE-FINDER mode, turn on the RF (РАДИОДАЛЬН.) switch on the TV sight control panel and keep tracking the target only with the help of the sight central pip. In this case, the target range is introduced from the fire-control radar.

When the target approaches the fire opening range, commence fire (the effective firing range is 2 km and less). Conduct fire in 0.2 to 0.4-s short bursts or bursts 1 to 1.2 s in duration with 15 to 20-min intervals for cooling the gun after every 125 rounds.

NOTE. It is allowed to use 250 cartridges without gun cooling within a short time period. Further reliable operation of the gun is not guaranteed in this case.

360. In the process of firing, watch pressure in the gas protection system.

CAUTION. IF CARBON DIOXIDE IS USED UP TO A LEVEL AT WHICH THE PRESSURE AGAINST PRESSURE GAUGE ЭДМУ-80 DOES NOT RISE TO 40 KGF/CM^2 AFTER THE LAST BURST AND THE "GAS" ("ГАЗ") LIGHT KEEPS ILLUMINATING ON THE TURRET CONTROL PANEL, FIRING IS PROHIBITED.

8. FLIGHT EMERGENCY PROCEDURES

8.1. GENERAL

361. On locating any failure of the aircraft equipment, each crew member should calmly check to see whether some error could be made in its handling in flight.

If the crew member has found the failure of the equipment, he should immediately report the matter and his actions to the pilot.

The pilot informs the crew of the failure and decision taken and makes the respective report to the flight control officer or formation leader (in case of formation flights). Further on, he acts, depending on the situation afforded, taking into consideration the instructions of the flight control officer or formation leader.

In any emergency situation in which the crew may need help, it is necessary to cut in the identification system "Distress" signal.

8.2. FIRE ON BOARD AIRCRAFT

8.2.1. Fire During Takeoff

362. If fire is located at a speed which does not provide aircraft stopping within the limits of the airfield stopway, proceed with the takeoff; if this happens at a lower speed, abort the takeoff. To this end, proceed as follows:

— set the throttle control levers of both engines to the IDLE (МАЛЫЙ ГАЗ) stop;

— apply the control column all the way forward;

— fully depress the brake pedals;

— deploy the brake chutes at a speed not exceeding 330 km/h;

— before overrunning the runway, apply the emergency brakes at the end of the runway and order the crew to jettison the emergency exit hatches;

— in case of an unavoidable collision with an obstacle or if aircraft stopping within the stopway limits cannot be provided, shut down the engines, close the fuel emergency shut-off cocks and give the "De-energize aircraft" command to the operator.

363. If fire was detected after liftoff of the nose wheel, proceed with the takeoff and further on act in compliance with the instructions of the present Manual.

8.2.2. Fire in Crew Cabin

364. ***Symptoms:***

— appearance of flame;
— appearance of smoke;
— appearance of burning fumes.

365. ***Actions:*** all crew members should tighten their oxygen masks.

The pilot should proceed as follows:
— give the "Eliminate fire" command;
— bring the aircraft to the altitude of 4000 m;
— discontinue the flight mission;
— check operation of the engines and make sure that there is no fire in the engine compartments;
— set up an airspeed of 600 to 650 km/h in level flight at an altitude of 4000 m;
— depressurize the cabin;
— turn on the switch labelled INSTR SUPPLY FROM BAT (ПИТАНИЕ ПРИБОРОВ ОТ АККУМУЛЯТОРОВ).

The operator should proceed as follows:
— turn off inverters ПО-6000 Nos 1 and 2 and ПТ-1000Ц;
— turn off the DC generators, using the common switch bar;
— turn off the AC generators.

The pilot should cut in inverter ПО-500 (by turning on the switch labelled INSTR SUPPLY FROM BAT or switch "ПО-500") and turn off all the electrical power consumers fed from the main electrical system.

The navigator and operator should locate the place of fire and fire source, put out the fire and, if necessary, help the pilot to extinguish fire at his working station.

366. After putting out fire, the crew should proceed as follows:
— turn on all the DC generators and refer to the indicator readings to ascertain their normal operation;
— turn off the switch labelled INSTR SUPPLY FROM BAT;
— successively turn on the electrical power consumers required for flying to the nearest airfield on the friendly territory and landing the aircraft; when turning on the electrical power consumers, attentively watch the fire outbreak area;
— if fire appears repeatedly, turn off the electrical power consumer, which is the actual fire source, and put out fire.

367. If there is no possibility of extinguishing fire, the pilot takes a decision to land the aircraft at the nearest airfield on the friendly territory or to abandon it.

8.2.3. Fire in Engine Compartments

368. ***Symptoms***:

— flickering of the DFD ON FIRE (ПОЖАР ДСТ) indicator light (flickering of the SEE ANNUNCIATOR (ВНИМАНИЕ ТАБЛО) indicator light and coming-on of the AIRCRAFT ON FIRE (ПОЖАР САМОЛЕТА) annunciator);
— coming-on of the red light-button of the respective engine on the fire warning system board.

Fire may be accompanied by deviation in readings of the engine instruments and appearance of smoke in the cabin through the pressurization system.

369. ***Actions***:

— shut down the engine whose compartment is on fire;
— close the fuel emergency shut-off cock of this engine;
— close the cock of cabin pressurization from the engine on fire;
— ascertain operation of the first-shot fire extinguishers by extinguishment of the white light labelled GR 1 BOTTLES READY (ГОТОВНОСТЬ БАЛЛОНОВ 1 ГР.);
— make sure that the fire is being extinguished; to this end, 25 to 30 s after operation of the first-shot fire extinguishers, turn off and again turn on the SUPPLY (ПИТАНИЕ) switch of the fire warning system board.

If the DFD ON FIRE indicator light (the SEE ANNUNCIATOR indicator light and AIRCRAFT ON FIRE annunciator) does not flicker and the red light-button has failed to come on, this indicates that fire has been put out; in this case, discontinue the flight mission and proceed to the nearest landing airfield on the friendly territory.

CAUTION. NEVER RELIGHT THE ENGINE WHICH WAS ON FIRE.

370. If the fire has not been put out, proceed as follows:
— cut in the second-shot fire extinguishers by depressing the buttons labelled SECOND GROUP BOTTLES OPENING (ОТКРЫТИЕ БАЛЛОНОВ 2 ГР.);
— successively connect the port and starboard bottles of the inert gas system to the fire protection system;
— make sure that fire is put out after operation of the inert gas system bottles.

If fire persists, the pilot takes a decision to abandon the aircraft or perform landing.

371. If fire is detected without operation of the fire warning system (on receiving the respective information from the ground, from the adjacent aircraft, etc.), the pilot must depress the light-buttons of the compartment in which fire is detected. This results in operation

of the first-shot fire extinguishers if they have not been already used. Further on, act by following the procedure given above.

8.2.4. Fire in Fuel Tank Compartments and in Service Compartment

372. ***Symptoms***:

— flickering of the DFD ON FIRE (ПОЖАР ДСТ) indicator light (flickering of the SEE ANNUNCIATOR (ВНИМАНИЕ ТАБЛО) indicator light and coming-on of the AIRCRAFT ON FIRE (ПОЖАР САМОЛЕТА) annunciator);

— coming-on of the red light-button of the respective compartment on the fire warning system board.

373. ***Actions***:

— make sure that the first-shot fire extinguishers operated by reference to extinguishment of the white indicator light labelled GR 1 BOTTLES READY (ГОТОВНОСТЬ БАЛЛОНОВ 1 ГР.);

— make sure that there is no fire (if it has been put out), discontinue the flight mission and proceed to the nearest airfield for landing.

If fire has failed to be extinguished, act in compliance with the recommendations laid down in the sub-section entitled "Fire in Engine Compartments".

8.3. FAILURE OF ONE ENGINE DURING TAKEOFF

374. ***Symptoms***:

— decrease of aircraft acceleration;

— aircraft tendency to turning and increasing the pitch angle and, after unsticking, to banking in the direction of the failed engine;

— drop of engine RPM and turbine exhaust gas temperature.

375. ***Actions***:

(a) if engine failure occurred at a speed equal to or higher than the minimum speed required for safe continuation of the takeoff (Fig. 32) and aircraft stopping within the stopway limits cannot be provided on the given airfield, proceed with the takeoff; in other cases, abort the takeoff, following the recommendations laid down in Item 362.

CAUTION: 1. IT IS NOT RECOMMENDED TO PERFORM PULSE BRAKING AND SHUT DOWN THE OPERATING ENGINE TILL THE END OF THE LANDING ROLL TO PRECLUDE PRESSURE DROP IN THE HYDRAULIC SYSTEM IN THE PROCESS OF THE LANDING ROLL.

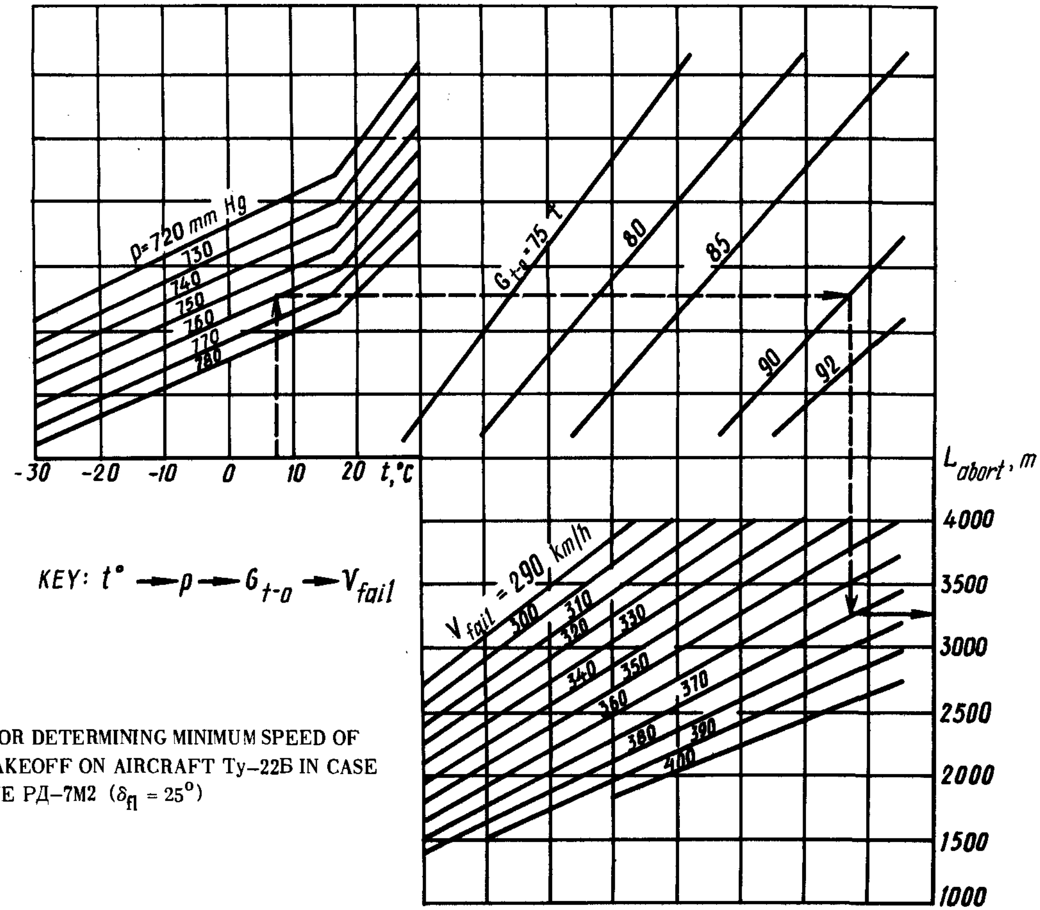

FIG. 32. NOMOGRAM USED FOR DETERMINING MINIMUM SPEED OF SAFE CONTINUATION OF TAKEOFF ON AIRCRAFT Ty-22Б IN CASE OF FAILURE OF ENGINE РД-7М2 ($\delta_{fl} = 25^{\circ}$)

2. DURING TAKEOFF ABORTION ON AN AIRCRAFT HAVING A HIGH MASS AT SPEEDS CLOSE TO THE MINIMUM ONES REQUIRED FOR SAFE CONTINUATION OF THE TAKEOFF, THE LANDING ROLL LENGTH MAY EXCEED THAT OF THE RUNWAY (SEE FIG. 33). THE PILOT SHOULD KNOW THE SAFE TURN-AWAY DIRECTION FOR THE CASE OF OVERRUNNING THE STOPWAY;

(b) to proceed with the takeoff, the pilot should act as follows:

— while keeping the aircraft from turning by pedals, decrease the pitch angle;

— shift the throttle control levers of both engines to the full reheat position;

— after unsticking, create 1 to 2° bank in the direction of the operating engine (the ball of the turn indicator will deflect through 1/2 to 1/4 its diameter in the direction of the running engine) and decrease the pitch angle;

— while gradually climbing, accelerate the aircraft to an airspeed which is 10 to 15 km/h higher than the unsticking speed;

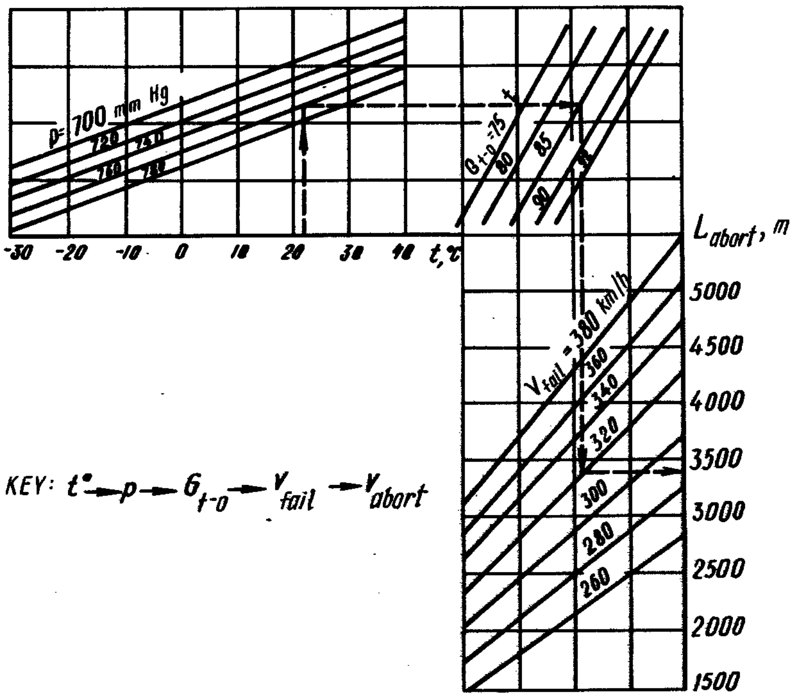

FIG. 33. NOMOGRAM USED FOR DETERMINING ABORTED TAKEOFF DISTANCE FOR AIRCRAFT Ty–22Б IN CASE OF FAILURE OF ONE ENGINE (δ_{fl} = 25°)

— at a height of 20 to 30 m, brake the wheels and retract the landing gear (for 40 to 50 s); when retracting the landing gear, do not let the airspeed go down;

— after retracting the landing gear, at an altitude of at least 50 m accelerate the aircraft to a speed which is 35 to 40 km/h higher than the unsticking speed, then retract the flaps and set the throttle control lever of the failed engine to the IDLE stop, and the engine shut-off lever, to the SHUT-OFF (OCTAHOB) stop;

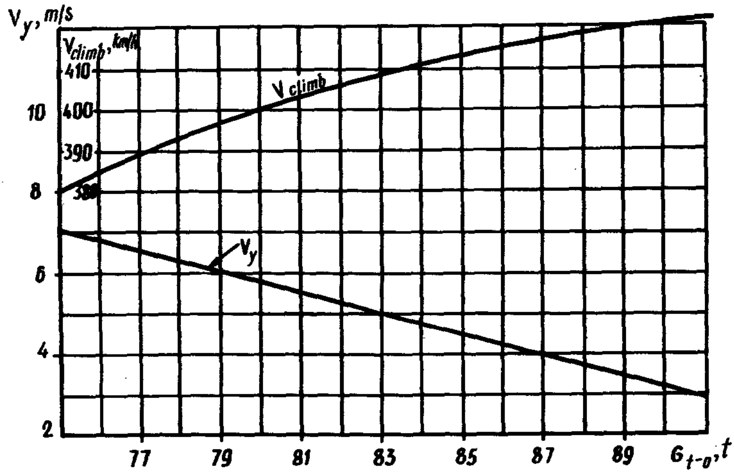

FIG. 34. VARIATION OF OPTIMUM CLIMB AIRSPEED AND MAXIMUM VERTICAL SPEEDS OF AIRCRAFT Ty–22Б VERSUS AIRCRAFT TAKEOFF MASS DURING ONE–ENGINE CLIMB, WITH ENGINE РД-7М2 RUNNING AT MAXIMUM REHEAT RATING IN STANDARD CONDITIONS ($\delta_{fl} = 25°$, landing gear extended)

— order the operator to turn off the DC and AC generators of the failed engine;

— to prevent pressure drop in the hydraulic system, avoid sharp and excessive motions of all control surfaces at a time;

— at an altitude of 300 to 500 m, on attaining an airspeed of 500 km/h, select the maximum non-reheat power for the running engine;

— cut in the fuel equalizer;

— dump the fuel and perform landing.

NOTES: 1. In case of failure of one engine, the maximum speeds of control surfaces reversal are diminished in half.

2. When the DC generators of the failed engine are turned off, the load of the remaining operating generators may exceed the maximum permissible value (each generator is rated for a continuous-acting load of 600 A).

3. The takeoff with one engine failed at a speed, equalling that of unsticking or surpassing it, is possible for practically all takeoff masses.
4. The most favourable near-ground vertical speeds may be obtained on the aircraft with the landing gear down and flaps deflected by 25° at a bank angle of 1 to 2° and sideslipping in the direction of the operating engine.

Fig. 34 illustrates variation of the most favourable climb speed and vertical speeds versus the takeoff mass of the aircraft with one engine running.

8.4. FAILURE OF ENGINE IN FLIGHT

376. Symptoms:

— aircraft deceleration;

— spontaneous increase of the pitch angle, turning and banking tendency;

— drop of engine speed and exhaust gas temperature;

— change in the sound accompanying engine operation;

— coming-on of the ENGINE FAILURE (НЕИСПРАВНОСТЬ ДВИГАТЕЛЯ) or LIMIT TEMPER t° (ПРЕДЕЛЬНАЯ t°) light.

377. Actions:

— counteract increase of the pitch angle as well as the aircraft turning and banking tendency;

— set up an airspeed of 500 to 550 km/h and bring the aircraft into descent if the aircraft was flown on one engine above the service ceiling;

— order the operator to turn off the generators of the failed engine;

— shut down the failed engine;

— turn on the fuel equalizer;

— evaluate the engine condition and relight it after making sure that the engine is free of buffeting, the oil pressure is at least 1 kgf/cm^2 and windmilling speed is stable.

NOTES: 1. If the cause of engine failure is not clear to the pilot, select the engine power setting not exceeding 45 divisions against the engine fuel-control unit lever position indicator.

2. If engine shut-down was caused by fuel shortage (failure of the fuel consumption automatic control units or booster pumps), select rating not exceeding the maximum non-reheat rating with fuel consumption controlled manually.

378. If the ENGINE FAILURE (LIMIT TEMPER t°) light comes on, check the turbine exhaust gas temperature and immediately shift the throttle control lever to the IDLE stop; if the light goes on illuminating (flickering) or if it has extinguished but the idle speed exhaust gas temperature exceeds 540 °C, shut down the engine. If the light is dead and

the exhaust gas temperature is below 540 °C, smoothly shift the throttle control lever to increase the engine power setting; should in this case the light come on (start flickering), shut down the engine.

CAUTION. NEVER SHIFT THE THROTTLE CONTROL LEVER TO THE INITIAL POWER SETTING TO DETERMINE THE TURBINE EXHAUST GAS TEMPERATURE IF GAS TEMPERATURE WAS NOT NOTED DURING COMING-ON (FLICKERING) OF THE "ENGINE FAILURE" ("LIMIT TEMPER t°") LIGHT.

379. If engine relight was failed or if it is impossible to relight the engine, close the fuel emergency shut-off cock, discontinue execution of the flight mission and proceed to the nearest airfield for landing.

380. Periodically check fuel remainder for each engine against the total fuel quantity gauge scale by depressing the MEASUREMENT (ИЗМЕРЕНИЕ) button. The operator should check loading of the remaining operating DC generators. If the generator load exceeds 600 A per generator, report the situation to the pilot and turn off the part of the consumers following the pilot's command.

8.5. ONE-ENGINE LANDING APPROACH

381. When performing one-engine landing approach, after turning to final set up an airspeed of 480 to 500 km/h and extend the landing gear. If the landing approach is executed from the estimated line, extend the landing gear 20 to 25 km short of the runway.

NOTES: 1. Circling level flying with the landing gear extended at an airspeed of 480 to 500 km/h, with the aircraft flight mass of up to 57,000 kg, is provided at engine power corresponding to 48 to 50 divisions against the fuel control unit lever position indicator.

2. The landing gear extension time, with only one engine running, is increased two-fold, which may be accompanied by drop of pressure in the system and short-time coming-on of the indicator light.

382. At a distance of 12 to 13 km from the runway threshold, let the flaps 20° down, trim out the aircraft and start descending so as to pass the outer homing station at an altitude of 250 m as indicated by the barometric altimeter (200 m according to the low-altitude radio altimeter) and at an airspeed of 400 km/h; the inner homing station should be passed at an altitude of 100 m as indicated by the barometric altimeter (60 m according to the low-altitude radio altimeter) and at an airspeed of 380 km/h.

CAUTION: 1. EXTEND THE FLAPS THROUGH 35° ONLY AFTER TAKING THE FINAL LANDING DECISION SINCE ONE-ENGINE GO-AROUND WITH THE FLAPS EXTENDED THROUGH 35° CANNOT BE PROVIDED. ONE-ENGINE LANDING APPROACH MAY BE PERFORMED ONLY WITH THE FLAPS EXTENDED THROUGH 20°.

2. WHEN DESCENDING ON THE RUNWAY HEADING, DO NOT LET THE AIRSPEED DECREASE BELOW THAT RECOMMENDED, AVOIDING UNNECESSARY MOTIONS OF THE OPERATING ENGINE THROTTLE CONTROL LEVER. WHEN CHANGING THE POWER SETTING (FOR VERIFYING THE LANDING ESTIMATION), COUNTERACT THE ARISING AIRCRAFT BANKING BY USING THE AILERONS.

8.6. ONE-ENGINE GO-AROUND

383. One-engine go-around may be allowed in exceptional cases only. The go-around decision must be taken at an altitude of at least 250 m as indicated by the barometric altimeter (at least 200 m according to the low-altitude radio altimeter).

384. When going around with the landing gear and flaps extended through 20°, the pilot should proceed as follows:

— accelerate the engine to the maximum non-reheat power setting while keeping the descent angle constant;

— retract the landing gear and flaps;

— make the "go-around" report to the crew;

— as soon as the airspeed increases to 500 km/h, bring the aircraft into climb;

— climb to the circling flight altitude, decelerate the engine to the required power setting, trim out the aircraft and repeat landing approach.

NOTES: 1. Altitude loss in the process of landing gear and flap retraction approximates 80 m.

2. Enabling of reheat power settings on a running engine is not recommended because of thrust decrease before the moment of afterburner relighting.

8.7. EMERGENCY FUEL DUMPING

385. Perform emergency fuel dumping in the following cases:

— failure of one engine;

— sharp decrease of the fuel level in the tank group from which fuel is not being consumed at the given moment (fuel is dumped from the opposite tank group to equalize the aircraft c. g. position);

— failure of both booster pumps in tank groups from which fuel cannot be consumed;

— de-energizing of the main electrical power system.

CAUTION: 1. <u>NEVER</u> DUMP FUEL IN FLIGHT WHEN THE AIRCRAFT IS ON FIRE AND AFTER THE FIRE IS PUT OUT.

2. IT IS NOT RECOMMENDED TO DUMP FUEL IN CASE OF AC GENERATOR FAILURE.

386. Perform fuel dumping, with the landing gear and flaps retracted, at an airspeed of up to 700 km/h in level flight, during turns executed with a bank angle of up to 20° as well as during climb or descent at a vertical speed of up to 10 m/s.

387. Emergency fuel dumping is not automated on aircraft through series 43 inclusive. In this case, for fuel dumping proceed as follows:

— switch over the engine to non-reheat power settings;

— turn off power supply of the autopilot (autopilot and master vertical gyro), navigation lights and compass system slaving from the master vertical gyro;

— order the navigator and operator to turn off all the electrical equipment arranged in the tail compartment (the navigator disconnects the РСБН system, and the operator, the TV sight, fire-control radar, roll damper, interrogator-responder and НЕОН radio transmitter);

— set the manual control switch of the pumps of tank No. 2 (group III on aircraft with tank No. 1 and port group III on aircraft without tank No. 1) to the upper position and check to see whether all the other manual control switches are placed to the OFF (ВЫКЛЮЧЕНО) position;

— open the cross-feed cock and make sure that it is open by illumination of the green indicator light;

— make sure that the switches of the stand-by pumps of tanks Nos 2 and 7 are set to the upper position;

— place the AUTO — MAN (АВТОМ. — РУЧН.) switch to the MAN (РУЧН.) position;

— set both cocks used for fuel dumping from the fuselage and wing tanks to the ON (ВКЛЮЧЕНО) position;

— by listening to the operator's report, make sure that fuel is dumped from tanks Nos 3—4 and 5 (group II on all aircraft) and from tank No. 6 (group IIIA on aircraft with tank No. 1 and starboard group III on aircraft without tank No. 1);

— the fuel dumping completed, set both fuel dumping cocks to the OFF (ВЫКЛЮЧЕНО) position;

— perform landing.

CAUTION: 1. ON AIRCRAFT WITH TANK No. 1, IN THE PROCESS OF FUEL DUMPING IN FLIGHT IN SOME CASES (AT INITIAL FUEL LOADING OF TANK No. 2 EQUALLING 10,000 KG), THE AIRCRAFT C.G. POSITION MAY CHANGE TO 23 % MAC. TO BRING THE AIRCRAFT C.G. POSITION TO THE PERMISSIBLE RANGE, CONSUME FUEL FROM TANK No. 2 (GROUP III) WITH THE PUMPS CONTROLLED MANUALLY. CUT IN THE PUMPS OF TANK No. 7 (GROUP IIIБ) MANUALLY ONLY AFTER EQUALIZING THE QUANTITY OF FUEL FOR EACH ENGINE.

2. ON AIRCRAFT WITHOUT TANK No. 1, IN THE PROCESS OF FUEL DUMPING IN FLIGHT THE AIRCRAFT C.G. POSITION WILL ACCOUNT FOR 37 TO 38 % MAC AND IN SOME CASES IT MAY SHIFT TO 40 % MAC (AT FUEL REMAINDER IN TANK No. 2 BELOW 7500 KG). TO KEEP THE AIRCRAFT C.G. POSITION WITHIN THE PERMISSIBLE LIMITS, MANUALLY ENGA-

GE THE PUMPS OF TANK No. 7 (GROUP IVA) AFTER FUEL DUMPING, WITH THE PUMPS OF TANK No. 2 (PORT GROUP III) CONTROLLED MANUALLY.

NOTE: To facilitate emergency fuel dumping, an instruction plate with a brief list of actions to be taken for enabling the emergency fuel dumping is provided in the pilot's cabin between the emergency fuel dumping cocks.

388. To proceed flying, act as follows:

— on aircraft with tank No. 1, after emptying of tank No. 2 (group III) to feed both engines, with the pumps being controlled manually, equalize the quantity of fuel in the tank groups of the port and starboard engines; in so doing, do not let the readings of the first and second fuel quantity gauge pointers differ more than 1000 kg when the switch is set to the TOTAL (СУММА) position; on equalizing the quantity of fuel, manually engage the pumps of tank No. 7 (group IIIБ) and manually engage the pumps of tank No. 1 when the quantity of fuel in each of tanks Nos 2 and 7 reaches 1000 kg;

— on aircraft having no tank No. 1, manually engage the pumps of tank No. 7 (group IVA) and the pumps of tank No. 2 (group IVБ), with the pumps of tank No. 2 (port group III) controlled manually.

389. Emergency fuel dumping on aircraft beginning from series 44 is automated. For emergency dumping of fuel, proceed as follows:

— set both emergency fuel dumping cocks to the ON (ВКЛЮЧЕНО) position; this results in automatic opening of the cross-feed cock (coming-on of the green light), cut-out of the automatic fuel controller, change-over of the pumps of tank No. 2 to operate in the nominal duty while the pumps of tank No. 7 keep operating in the stand-by duty as a result of which fuel is being consumed from tank No. 2;

— after dumping fuel, set both cocks or one of them to the OFF (ВЫКЛЮЧЕНО) position; this will entail automatic cut-in of the automatic fuel controller which keeps the pumps of tank No. 2 operating in the nominal duty and changes over the pumps of tank No. 7 also to operate in the nominal duty, closing the cross-feed cock (the green indicator light goes out).

CAUTION: 1. NEVER PERFORM EMERGENCY FUEL DUMPING WITH THE ENGINES (ENGINE) RUNNING AT REHEAT POWER.

2. IT IS ALLOWED TO CUT IN EMERGENCY FUEL DUMPING THROUGH ONE OF THE COCKS ON AIRCRAFT OF ALL MODIFICATIONS IN EXCEPTIONAL CASES ONLY TO PROVIDE NORMAL C.G. POSITION OF THE AIRCRAFT IN CASE OF ITS SUDDEN CHANGE (I.E., IN CASE OF FUEL TANK PUNCTURE).

3. WHEN DUMPING FUEL AS A RESULT OF FAILURE OF ONE OF THE ENGINES, SET THE CROSS-FEED COCK MANUAL CONTROL SWITCH TO THE "OPEN" POSITION AND, AFTER RETURNING THE DUMPING COCKS TO THE "OFF" POSITION, MAKE SURE THAT THE COCK OPEN-POSITION GREEN INDICATOR LIGHT IS ALIVE. PASS TO MANUAL CONTROL OF THE PUMPS.

NOTES: 1. Dumping of 24,000 kg of fuel takes 18 min.

2. After fuel dumping, the aircraft mass equals 60 to 65 t.

3. Fuel is dumped from port tank group II (tanks Nos 3—4) through the wing cells of the first groups (tanks Nos 8 through 19) of both wing panels. If there was no or little fuel in the tanks of the first groups by the moment of fuel dumping, keep it in mind that in the process of fuel dumping the quantity of fuel in these tanks may increase to 2500 kg (in each tank). By the end of fuel dumping, these tanks will be completely emptied.

4. When dumping fuel in flight, do not use the readings of the fuel flowmeter since it reads the fuel remainder without accounting for the amount of fuel dumped.

8.8. FAILURE OF BOTH ENGINES IN FLIGHT

390. Symptoms:

— aircraft deceleration;
— drop of engine speed and turbine exhaust gas temperature;
— change of sound of the engines.

391. Actions:

— retard the throttle control levers of both engines to the IDLE (МАЛЫЙ ГАЗ) position, and the engine shut-off lever, to the SHUT-OFF (ОСТАНОВ) position;
— bring the aircraft into descent;
— change over to stabilizer control from hydraulic system III;
— cut out the DC and AC generators and start feeding the instruments from the storage batteries;
— turn on inverter ПО-500;
— make sure that the engines are windmilling;
— engage the fuel pump of the engine being started by using the controls located on the engine starting control board;
— open the cross-feed cock (when cranking the engine on aircraft with tank No. 1);
— start the engine.

After starting one of the engines, proceed as follows:

— engage the fuel pump on the electric starting control board (in case of coming-on of by one indicator light of stand-by pumps of tanks Nos 2 and 7);
— close the cross-feed cock (on aircraft with tank No. 1);
— accelerate the engine to the power setting required for carrying out the flight, stop descending, order the operator to cut in the generators of the starboard (port) engine, place the aileron DFD (ДСТ) switch to the neutral position, then to the MAIN HYD SYST (ОСНОВНАЯ ГИДРОСИСТЕМА) position and proceed to starting the other engine.

392. On receiving the starboard (port) engine generator cut-in command, the operator should proceed as follows:

— set the generator and battery bus emergency switch common bar to the ON (ВКЛЮЧЕНО) position;

— turn on the switches of the generators of the engine started and make sure that the generators operate normally;

— il the DC generators operate normally, shift the switch labelled INSTR SUPPLY FROM BAT (ПИТАНИЕ ПРИБОРОВ ОТ АККУМУЛЯТОРОВ) to the lower position;

— turn on inverters ПО-6000 Nos 1 and 2 and inverter ПТ-1000Ц;

CAUTION: 1. WHEN BOTH ENGINES ARE WINDMILLING, ALL CONTROL SURFACES ARE STILL CONTROLLABLE BUT CONTROL SURFACE REVERSAL SPEEDS ARE LIMITED.

2. IF STARTING OF ONE ENGINE IS FAILED, IMMEDIATELY START THE OTHER ENGINE. BEFORE REPEATING THE ATTEMPT OF STARTING OF ONE AND THE SAME ENGINE, PURGE THIS ENGINE AT THE WINDMILLING SPEED FOR 2 MIN.

3. IF STARTING OF BOTH ENGINES AT AN ALTITUDE OF UP TO 4000 M IS FAILED OR FLAMEOUT OF THE ENGINES TAKES PLACE AT AN ALTITUDE BELOW 4000 M, THE CREW MEMBERS HAVE TO ABANDON THE AIRCRAFT.

8.9. ENGINE RELIGHT IN FLIGHT

393. Relight the engine in flight in the following cases:

— after spontaneous shut-down of the engine;

— during the test flight to check the in-flight air relight system;

— for training purposes.

CAUTION. IN CASE OF ENGINE SHUT-DOWN BECAUSE OF BUFFETING OR FIRE OUTBREAK, THE REPEATED ENGINE RELIGHT IS PROHIBITED.

394. It is recommended to use the following airspeeds for engine relight:

— 500 to 530 km/h at altitudes of 8000 to 10,000 m;

— 500 to 650 km/h at altitudes below 8000 m.

395. To relight the engine, proceed as follows:

— make sure that the engine is free of buffeting;

— make sure that the windmilling speed is within 17 to 24 %;

— make certain that the oil pressure is 1 kgf/cm^2;

— check operation of the booster pumps of the engine being started (by illumination of the green indicator lights);

— make sure that the air blow-off valves are open (by illumination of the blue lights);

— check the position of the levers (the throttle control lever should be set to the IDLE stop and the engine shut-off lever, to the SHUT-OFF (ОСТАНОВ) position);

— purge the engine for 2 min;

— depress and, on a lapse of 1 or 2 s, release the AIR RELIGHT (ЗАПУСК В ВОЗДУХЕ) button; this should result in coming-on of the white light indicating operation of the engine automatic starting control panel;

— shift the engine shut-off lever to the START (ЗАПУСК) position, after which the engine should automatically accelerate to the altitude idle speed. The maximum exhaust gas overtemperature should not exceed 660 °C.

NOTES: 1. At altitudes of 10,000 to 7000 m, the engine altitude idle RPM should be within 67 to 68 %. Decrease of altitude below 7000 m entails 1.5 to 2 % diminishing of the engine altitude idle speed for each 1000 m of altitude loss.

2. NEVER shift the throttle control lever higher than the idle stop before the engine accelerates to the speed corresponding to the altitude idle speed;

— after the engine accelerates to the altitude idle speed, order the operator to cut in the generators of this engine;

— not earlier than 1 min after depression of the start button, accelerate the engine to the power setting required for carrying out the flight and check the engine parameters;

— cut out the fuel equalizer.

CAUTION: 1. IF THE ENGINE OPERATED AT THE WINDMILLING SPEED FOR MORE THAN 25 MIN, AFTER STARTING THE ENGINE SET UP RATING CORRESPONDING TO 50 TO 52 DIVISIONS AGAINST THE FUEL-CONTROL UNIT LEVER POSITION INDICATOR AND LET THE ENGINE RUN AT THIS RATING FOR AT LEAST 5 MIN, AFTER WHICH IT IS ALLOWED TO ACCELERATE THE ENGINE TO ANY RATING.

2. IF THE CAUSE OF SPONTANEOUS SHUT-DOWN OF THE ENGINE IS NOT CLEAR TO THE PILOT, AFTER RELIGHTING THE ENGINE IN FLIGHT IT IS FORBIDDEN TO USE POWER SETTINGS WHICH ARE HIGHER THAN 45 DIVISIONS AGAINST THE FUEL-CONTROL UNIT LEVER POSITION INDICATOR.

396. If engine relight is failed, shift the engine shut-off lever to the SHUT-OFF (ОСТАНОВ) position and purge the engine at the windmilling speed for 2 min, then repeat the relight procedure. After two high-altitude engine relight attempts, it is recommended to decrease the flight altitude by 1000 to 2000 m and perform the next engine relight attempt. After three successive air relight attempts with a 2-min interval, perform the next starting attempt after making a 10-min interval for cooling the engine starting system electrical units.

If the requirements on the engine starting system units cooling time are not met, make the appropriate record in the check list after flight.

397. If the engine automatic starting control panel white indicator light fails to come on after depression of the start button or fades out after the start button is released, depress the start button and keep it depressed throughout the entire engine relight process but for no more than 60 s.

8.10. ENGINE SURGE

398. Symptoms:

— appearance of one or several pops;
— abrupt increase of turbine exhaust gas temperature;
— engine speed drop.

NOTE. At low power settings and high altitudes the pops may be negligible. Engine surge at high altitudes of flight usually leads to spontaneous shut-down of the engine. At low altitudes the engine shut-down does not occur, but showing unsteady operation. Shifting of the throttle control lever to the IDLE stop does not eliminate unsteady operation of the engine.

399. Actions:

— refer to the exhaust gas temperature indicator or coming-on of the ENGINE FAILURE (НЕИСПРАВНОСТЬ ДВИГАТЕЛЯ) or LIMIT TEMPER t° (ПРЕДЕЛЬНАЯ t°) indicator light to locate the engine under surge;

— immediately shut down the engine;

— accelerate the other engine to the power setting required for carrying out the flight;

— assess the engine condition (by the windmilling speed and oil pressure which should be at least 1 kgf/cm^2);

— after making sure that the engine parameters are within the specified limits, blow out the engine for no less than 2 min and perform its relight;

— after relighting the engine, let it run at idle power for at least 3 min and, on ensuring normal operation of the engine, slowly accelerate it to the power setting which corresponds to no more than 45 divisions against the УПРТ indicator.

CAUTION. IF ENGINE SURGE PERSISTS, SHUT DOWN THE ENGINE AND MAKE NO FURTHER ATTEMPTS TO RELIGHT IT.

8.11. FAILURE OF COMPRESSOR AUTOMATIC CONTROL UNITS

400. Symptoms:

— engine surge at low power settings with the compressor air blow-off valves closed;

— increase of turbine exhaust gas temperature beyond the permissible limit and unsteady running of the engine at high power settings, with the compressor air blow-off valves open.

401. Actions:

— if the fifth-stage compressor air blow-off valve indicator light fails to come on with the engine throttled down to power corresponding to less than 35 divisions against the УПРТ indicator (the light is dead because of the air blow-off valve is closed), do not decelerate the engine to power below 35 divisions against the УПРТ indicator; in this case, it is allowed to use all ratings higher than 35 divisions against the УПРТ indicator;

— if it is necessary to decrease thrust, shut down the engine by retarding the throttle control lever to the IDLE stop for no more than 1 s and by shifting the engine shut-off lever to the SHUT-OFF (ОСТАНОВ) position without letting the engine run at idle power;

— if engine throttling-down to decreased ratings (the engine RPM is below 70 %) is not accompanied by coming-on of the sixth-stage compressor blow-off valve indicator light, it is allowed to use power settings corresponding to the engine speed exceeding 71.5 %; during the aircraft landing, taxiing and engine shut-down, throttle down the engine by using a procedure specified for normal operation of the compressor automatic control units;

— if the air blow-off valve indicator lights come on at power settings which are higher than those corresponding to closing of the compressor air blow-off valves, NEVER use the power settings at which the УПРТ indicator readings exceed 54 divisions.

402. To change power settings corresponding to less than 54 divisions against the УПРТ indicator, smoothly displace the throttle control lever, paying special attention to the turbine exhaust gas temperature.

403. It is not recommended to use power settings with the sixth-stage compressor blow-off valves open within the range of the engine speed exceeding 75 % for a continuous period of time.

8.12. ENGINE BUFFETING

404. Symptoms:

— high vibration of the aircraft;

— illumination of the HIGH VIBRATION (ВИБРАЦИЯ ВЕЛИКА) warning light;

— the pointer of the vibration speed indicator is beyond the mechanical index.

405. Actions:

— check the readings of the engine instruments;

— in case of variation or drop of the engine speed and oil pressure as well as in the event of exhaust gas and oil temperature rise, decelerate the engine to a lower power setting down to the IDLE one; if this fails to stop buffeting or to bring the readings of the instruments within the specified limits, immediately shut down the engine;

— with the instruments having normal readings, decelerate both engines in turn and locate the faulty engine by observing the change in the intensity of buffeting, then decelerate this engine to a lower rating and, if buffeting persists, shut down the engine without delay;

— close the fuel emergency shut-off cock of the shut-down engine and do not perform its further relight.

8.13. AFTERBURNER LIGHT-UP FAILURE

406. Symptoms:

— no reheat fuel pressure;

— the REHEAT (ФОРСАЖ) light fails to come on or it goes dead on expiration of 24 s after reheat light-up;

— more than 50 °C decrease of the turbine exhaust gas temperature;

— no aircraft acceleration.

407. Actions:

— repeatedly cut in the afterburner; do not perform takeoff if the afterburner fails to ignite before the takeoff;

— if the afterburner fails to light up in flight, retard the throttle control lever to a position corresponding to less than 68 divisions against the УПРТ indicator; let the engine run at this power setting for at least 5 s and repeat afterburner light-up. If the afterburner fails to be ignited in this case, perform subsequent attempts at lower (by 1000 to 2000 m) altitudes. If the afterburner failed to be ignited in descending to the altitude of 6000 m, cease the afterburner light-up attempts.

8.14. AFTERBURNER CUT-OFF FAILURE

408. Symptoms:

— reheat fuel pressure is available (in excess of 14 kgf/cm^2);

— illumination of the REHEAT (ФОРСАЖ) light;

— the turbine exhaust gas temperature corresponds to reheat power settings.

409. Actions:

— set the throttle control lever to a position corresponding to less than 70 divisions against the УПРТ indicator;

— turn off the afterburner by using the reheat emergency cut-off switch.

CAUTION. NEVER TURN OFF THE AFTERBURNER BY USING THE REHEAT EMERGENCY CUT-OFF SWITCH FROM POWER SETTINGS CORRESPONDING TO MORE THAN 75 DIVISIONS OF THE FUEL CONTROL LEVER POSITION INDICATOR.

8.15. SPONTANEOUS AFTERBURNER CUT-OFF

410. Symptoms:

— extinguishment of the REHEAT indicator light;
— reheat fuel pressure drop;
— automatic change-over of the engine to the maximum non-reheat power setting;
— drop of the engine thrust.

411. Actions:

— shift the throttle control lever of this engine to the position corresponding to less than 68 divisions against the УПРТ indicator;
— bring the aircraft into descent, without letting the flight Mach number decrease below 0.9;
— turn off the afterburner of the other engine;
— cut in the afterburners of both engines in turn at an altitude below 13,000 m. If the afterburner fails to light up, descend to an altitude at which flight can be performed at non-reheat power settings.

8.16. FAILURE OF AUTOMATIC FUEL CONTROL UNITS

412. Symptoms:

— coming-on of the amber light, indicating emptying of the next tank group, is not accompanied by illumination of the respective green lights;
— the amber fuel consumption sequence lights became dead;
— the amber light, indicating the sequence of emptying the next tank group, did not come on when there remained 200 to 400 kg of fuel in the service tank group;
— fuel is consumed from the stand-by groups (tanks Nos 2 and 7) when there is fuel in the previous groups of tanks.

413. Actions:

A. If the amber lights come on in the assigned sequence and the respective green lights fail to come on, proceed as follows:
— disengage the reheat;
— cut in the port and starboard engine tank group booster pumps whose amber lights are alive and check operation of the pumps by illumination of the green lights;
— place the AUTO — MAN (АВТОМ.— РУЧН.) switch to the MAN (РУЧН.) position;
— set the fuel quantity gauge switch to a position corresponding to the tank group being emptied;

— disengage the booster pumps of the emptied tank groups after the extinguishment or flickering of the green lights.

NOTE. Disengage the booster pumps of the second tank groups (tanks Nos 3—4 and 5) after fading-out of the lights indicating operation of the pumps, of tanks Nos 3—4.

B. If the amber lights of the emptied tank group have extinguished and the amber lights of the tank group from which fuel is to be consumed have failed to come on or if fuel is being consumed from the stand-by groups of tanks Nos 2 and 7, proceed as follows:

— disengage the engine reheat rating;

— engage the booster pumps of tanks Nos 3—4 and 5;

— place the AUTO — MAN switch to the MAN position;

— engage the pumps of port and starboard tanks Nos 8 through 19 to operate for fuel transfer into tanks Nos 3—4 and 5; disengage the pumps, taking care to preclude rise of the fuel quantity in tanks Nos 3—4 in excess of 9000 kg and in tank No. 5, above 6000 kg;

— disengage the pumps of port and starboard tanks Nos 8 through 19 after fading-out of the green indicator lights of these pumps.

C. After performing the operations laid down in Items A or B, proceed as follows:

(a) on aircraft with tank No. 1:

— engage the pumps of tank No. 6 at 500 to 700-kg fuel remainder in tank No. 5 as indicated by pointer "2", with the fuel quantity gauge switch set to the second position;

— engage the pumps of tank No. 2 at 500 to 700-kg fuel remainder in tanks Nos 3—4 as indicated by pointer "1", with the fuel quantity gauge switch set to the second position;

— disengage the pumps of tanks Nos 3—4 and 5 after fading-out or flickering of the green pump operation indicating lights of tanks Nos 3—4;

— engage the pumps of tank No. 7 at a fuel remainder of 5000 kg as indicated by pointer "2", with the fuel quantity gauge switch set to the third position;

— disengage the pumps of tank No. 6 after fading-out or flickering of the green indicator lights of these pumps;

— engage the pumps of tank No. 1 and open the cross-feed cock at a fuel remainder of 500 to 700 kg as indicated by pointer "2", with the fuel quantity gauge switch set to the third position; this will result in illumination of the green indicator lights of tanks Nos 2, 7 and 1; fuel is consumed first from tanks Nos 2 and 7 and then from tank No. 1;

(b) on aircraft without tank No. 1:

— engage the pumps of tank No. 6 at a fuel remainder of 500 to 700 kg in tank No. 5 as indicated by pointer "2", with the fuel quantity gauge switch set to the second position;

— engage the pumps of tank No. 2 (port tank group III) at a fuel remainder of 500 to 700 kg in tanks Nos 3—4 as indicated by pointer "1", with the fuel quantity gauge switch set to the second position;

— disengage the pumps of tanks Nos 3—4 and 5 after extinguishment or flickering of the green indicator lights of the pumps of tanks Nos 3—4;

— engage the pumps of tank No. 7 at a fuel remainder of 500 to 700 kg in tank No. 6 as indicated by pointer "2", with the fuel quantity gauge switch set to the third position;

— disengage the pumps of tank No. 6 after extinguishment or flickering of the green indicator lights of these pumps;

— engage the pumps of tank No. 2 (tank group IVБ) at a fuel remainder of 500 to 700 kg as indicated by pointer "2", with the fuel quantity gauge switch set to the fourth position; this will result in illumination of four indicator lights of the pumps of tank No. 2 and two green indicator lights of the pumps of tank No. 7.

CAUTION. DURING MANUALLY-CONTROLLED FUEL CONSUMPTION, CHECK TO SEE THAT FUEL IS UNIFORMLY CONSUMED BY THE PORT AND STARBOARD ENGINES. IN SO DOING, PERIODICALLY CHECK THE FUEL REMAINDER BY THE SUMMARY SCALE OF THE FUEL QUANTITY GAUGE.

8.17. FAILURE OF TANK BOOSTER PUMPS

414. Symptoms:

— extinguishment of one or several indicator lights in the service and stand-by groups of tanks;

— illumination failure of the green indicator lights of the next tank group to be emptied, with the amber light of this group alive.

415. Actions:

A. If one green light of the tank group being emptied has extinguished, proceed as follows:

— turn off the afterburner at an altitude of less than 10,000 m;

— at an altitude exceeding 10,000 m, proceed flying at reheat ratings, checking absence of fuel supply from the stand-by tank groups.

CAUTION. OPERATION OF ENGINES РД-7М2 AT MAXIMUM ALTITUDE REHEAT RATING IS NOT ALLOWED IN THESE CONDITIONS.

B. If both green lights of the tank group from which fuel is consumed have extinguished, proceed as follows:

(1) turn off the afterburner;

(2) observe the readings of the fuel quantity gauge to make sure that no fuel is consumed from the stand-by tank groups; if fuel is consumed from these tanks, perform flight with the fuel consumption automatic control system turned on;

(3) on finding out that fuel is being consumed from the stand-by tank group, pass to manual control of fuel consumption; to this end, proceed as follows:

(a) in case of failure of the pumps of tank groups I and II:
— dump the fuel in the emergency way;
— equalize the fuel remainder for each engine;
— proceed to the nearest airfield for landing;
(b) in case of failure of the pumps of tanks Nos 3—4 in the process of fuel consumption from tank No. 6, proceed as follows:
— engage the pumps of tanks Nos 2 and 6;
— place the AUTO — MAN (АВТОМ.— РУЧН.) switch to the MAN (РУЧН.) position;
— engage the pumps of tank No. 7 and disengage the pumps of tank No. 6 after extinguishment or flickering of the green indicator lights of tank No. 6;
— dump fuel in the emergency way from tanks Nos 3—4 by turning on the cocks labelled WG TNK DUMP (СЛИВ КРЫЛЬЕВЫХ);
— after dumping fuel, place the cock to the OFF (ВЫКЛЮЧЕНО) position and equalize the fuel remainder for each engine;
(c) if the pumps of tank No. 2 fail to operate during fuel consumption from tanks Nos 3—4, consume fuel, with the fuel consumption automatic control system turned on, till the moment the amber light indicating the beginning of fuel consumption from tank No. 2 comes on;
(d) after coming-on of the amber light or in case of failure of the pumps of tank No. 2 during fuel consumption, proceed as follows:
— open the cross-feed cock;
— engage the pumps of tank No. 6;
— engage the pumps of tank No. 1 on aircraft provided with tank No. 1 and the pumps of tank No. 2 on aircraft having no tank No. 1;
— place the AUTO — MAN (АВТОМ.— РУЧН.) switch to the MAN (РУЧН.) position;
— proceed to the nearest alternate airfield;
(e) in case of failure of the pumps of tank No. 6 in the process of fuel consumption from tanks Nos 3—4, proceed as follows:
— open the cross-feed cock;
— engage the pumps of tanks Nos 3—4;
— set the AUTO — MAN switch to the MAN position;
— engage the pumps of tank No. 2 and disengage the pumps of tanks Nos 3—4 after extinguishment or flickering of the green indicator lights of the pumps of tanks Nos 3—4;
— after tanks Nos 3—4 are emptied or if the pumps of tank No. 6 fail to operate during fuel consumption from tank No. 2, dump the fuel in the emergency way by turning on the cock labelled FUS TK DUMP (СЛИВ ФЮЗЕЛЯЖНЫХ);
— equalize the fuel remainder for each engine;
— proceed to the nearest alternate airfield;
(f) if the pumps of tank No. 7 fail to operate during fuel consumption from any other tank, proceed as follows:
— consume fuel, with the fuel consumption automatic control system cut in, until at least 1000 kg of fuel is left in tank No. 6;

— land on the nearest airfield;

(g) in case of failure of the pumps of tank No. 7 being emptied, proceed as follows:

— open the cross-feed cock;

— consume fuel, with the fuel consumption automatic control system cut in;

— proceed to the nearest airfield.

CAUTION: 1. WITH TANK NO. 7 FILLED TO CAPACITY AND 8000 KG OF FUEL REMAINING IN TANK No. 2, THE C. G. POSITION OF THE AIRCRAFT CARRYING NO TANK No. 1 WILL APPROXIMATE 34 TO 36 % MAC.

2. WITH TANK No. 7 FILLED TO CAPACITY AND 5000 KG OF FUEL REMAINING IN TANK No. 2, THE C. G. POSITION OF THE AIRCRAFT CARRYING NO TANK No. 1 MAY REACH 40 TO 41 % MAC.

416. In all cases of pumps failure, the crew has to recalculate the flight range, taking into consideration the unusable fuel, and choose the landing airfield versus the recalculation result.

8.18. FLIGHT WITH FUEL EQUALIZER CUT IN

417. Cut in the fuel equalizer in flight in the following cases:

— in case of failure of one of the engines;

— in case of the pitch damper failure;

— for equalizing the fuel load of both engines.

418. To cut in the fuel equalizer, proceed as follows:

— open the cover of the fuel equalizer control board;

— place the fuel equalizer switch to the ON (ВКЛЮЧЕНО) position; this results in coming-on of the white light labelled FUEL EQUALIZER ON (АВТОМАТ РАБОТАЕТ) and two green lights labelled REAR PUMPS ENGAGED (ВКЛЮЧЕНЫ ЗАДНИЕ) and FRONT PUMPS ENGAGED (ВКЛЮЧЕНЫ ПЕРЕДНИЕ) (within 15 to 20 s, one of the green lights may go off, depending on the aircraft c.g. position);

— check the fuel remainder by observing the readings of the fuel quantity gauge TOTAL (СУММА) scale; to this end, depress the FUEL QNTY CHECK (ИЗМЕРЕНИЕ ТОПЛИВА) button;

— when there remains 7000 kg of fuel in the aircraft fuel system, cut out the fuel equalizer and pass to manual control of fuel consumption.

CAUTION: 1. DO NOT ENGAGE THE REHEAT RATING WITH THE FUEL EQUALIZER CUT IN.

2. DO NOT CUT IN THE FUEL EQUALIZER WHEN THERE REMAINS LESS THAN 7 TONS OF FUEL IN THE AIRCRAFT FUEL SYSTEM.

419. If the fuel equalizer has failed to be cut in (the white light labelled FUEL EQUALIZER ON is dead), check the quantity of fuel in the aircraft fuel system by observing the readings of the port and starboard engines fuel quantity gauges; if required, equalize the quantity of fuel per engine (on aircraft with tank No. 1, the quantity of fuel for the port engine should be more by 1500 to 2000 kg); to this end, proceed as follows:

— set the fuel equalizer switch to the lower position;

— open the cross-feed cock;

— set the pump manual control switches of the tanks under consumption to the ON (ВКЛЮЧЕНО) position;

— place the AUTO — MAN (АВТОМ.— РУЧН.) switch to the MAN (РУЧН.) position;

— while controlling the pumps manually, equalize the quantity of fuel per engine, making reference to the fuel quantity gauge.

NOTE. To shift the aircraft c.g. position backward, turn on the switch of the pumps of tank No. 2, with the switch of the pumps of tanks Nos 3—4 and 5 cut in; in this case, fuel will be consumed from tanks Nos 3—4; to displace the aircraft c.g. position forward, engage the pumps of tank No. 6 — fuel will be consumed from tank No. 5. Provide the equal quantity of fuel to the port and starboard engines, making reference to the fuel quantity gauge. If tank No. 5 has been emptied by the fuel equalizer cut-in moment, empty tanks Nos 3—4 or tank No. 2 to shift the aircraft c.g. position backward; to this end, disengage the pumps of tank No. 6, with the pumps of this tank engaged; to displace the aircraft c.g. position forward, empty tank No. 6 by engaging the pumps of tank No. 7, with the pumps of tank No. 6 turned on.

After equalizing the quantity of fuel supplied to each engine, proceed as follows:

— place the AUTO — MAN switch to the AUTO position;

— set the pump manual control switches to the OFF (ВЫКЛЮЧЕНО) position;

— cut in the fuel equalizer.

If the fuel equalizer has failed to be cut in, consume fuel by controlling the pumps manually, with the cross-feed cock open.

8.19. FAILURE OF AILERON (RUDDER) HYDRAULIC BOOSTER

420. Symptom: seizure or locking of the control wheel (pedals).

421. Actions:

— decrease the airspeed to 600 km/h (Mach number not exceeding 0.9);

— pass from flap-aileron control to aileron control;

— disengage the aileron (rudder) dry-friction dampers;

— pass to booster-free control; in this case, an inadvertent deflection of the control wheel (pedals) may occur;

— engage the hydraulic booster emergency cross-feed system;
— discontinue execution of the flight mission and proceed to the landing airfield.

NOTES: 1. Disengagement of the aileron (rudder) hydraulic booster is accompanied by fading-out of the aileron (rudder) dry-friction damper green indicator light and flickering of the indicator lights in the annunciator.

2. Transition to booster-free control entails disengagement of the roll (yaw) damper.

422. To pass over to booster-free control for training purposes, proceed as follows:
— at an altitude of 5000 m, set up an airspeed of 500 km/h, pass from the flap-aileron control to aileron control, trim out the aircraft and disengage the rudder hydraulic booster, with the pedals neutral;
— make sure that the hydraulic booster has disengaged by increase of forces across the pedals, with the pedals slightly deflected;
— if required, trim out the aircraft by using the rudder trim tab;
— engage the rudder hydraulic booster;
— disengage the aileron dry-friction damper;
— disengage the aileron hydraulic booster and make sure that it has been disengaged by increase of forces across the control wheel;
— if required, trim out the aircraft by using the aileron trim tabs;
— perform slight corrective turns to both sides with an up to 10° bank angle, after which engage the aileron hydraulic booster when flying level;
— engage the aileron dry-friction damper.

CAUTION: 1. WHEN FLYING WITH THE HYDRAULIC BOOSTER DISENGAGED, NEVER LET THE ROLL EXCEED 15° AND AIRSPEED, 600 KM/H.

2. WHEN THE AIRCRAFT STARTS BANKING HEAVILY, ENGAGE THE HYDRAULIC BOOSTERS. NEVER REPEAT DISENGAGEMENT OF THE HYDRAULIC BOOSTERS IN THE GIVEN FLIGHT.

8.20. INADVERTENT FALLING OF AIRCRAFT INTO TIGHT SPIRAL

423. Inadvertent falling of the aircraft into a tight spiral may be caused by a piloting error. Aileron-controlled recovery from the tight spiral is possible but it takes much more time than the recovery controlled by flap-ailerons.

424. When the aircraft accidentally falls into a tight spiral (at a 55 to 65° bank angle, 70 to 80-m/s descent speed, 800 to 850-km/h airspeed and 4000 to 9000-m altitudes), the pilot should proceed as follows:
— retard the throttle control levers to the IDLE (МАЛЫЙ ГАЗ) position;

— set the ailerons to neutral;

— deflect the rudder in the direction opposite to that of the spiral till the light labelled RUDDER DEFLECTED BY MORE THAN 7° (РН ОТКЛОНЕН БОЛЕЕ 7°) comes on; keep the rudder in this position until the aircraft recovers from the bank;

— while smoothly applying the control column backward and simultaneously depressing the pedal, create g-load $n_y = 1.8—2.2$.

The aircraft will start smoothly decreasing the descent angle, airspeed and bank angle.

425. On attaining the airspeed of 800 km/h, deflect the ailerons to speed up aircraft recovery from the bank, then decrease the g-load and level off the aircraft.

Recovery from a tight spiral at altitudes exceeding 6000 m and airspeeds of 800 to 850 km/h is characterized by transition through the aircraft instability zone with regard to $M = 0.95—1.05$. This phenomenon is revealed by the aircraft tendency to involuntary increase of the g-load which is counteracted by slight forward application of the control column.

Altitude loss involved in aircraft recovery from the tight spiral at altitudes of 9000 to 4000 m ranges from 2000 to 700 m, the recovery time averaging 15 to 20 s.

CAUTION. IF THE AIRCRAFT IS OUT OF CONTROL OR CANNOT BE RECOVERED FROM A TIGHT SPIRAL, THE PILOT SHOULD TAKE AN EJECTION DECISION AND ESTIMATE THE MINIMUM ALTITUDE FOR ABANDONING THE AIRCRAFT BY ALL THE CREW MEMBERS, WITH DUE ACCOUNT OF THE VERTICAL SPEED OF DESCENT IN ACCORDANCE WITH TABLE 2, ITEM 26.

8.21. AIRCRAFT PITCHING

426. If the aircraft has fallen into longitudinal overswinging for some reason (failure of the pitch damper, stability automatic controller, vertical air gust, piloting errors, etc.), the pilot should proceed as follows to avoid aircraft overswinging and build up of impermissible g-loads:

— if the aircraft starts suddenly pitching up, which is accompanied by increase of an angular velocity and g-load, smoothly move the control column forward beyond the trimmed-out position (through approximately minus 1° as shown by the stabilizer position indicator) and fix it in this position till the moment the pitch angle and g-load stop increasing, then smoothly level off the aircraft;

— when the aircraft starts unexpectedly and energetically diving, smoothly apply the control column backward (to a position of approximating minus 2.5° according to the stabilizer position indicator) and fix it in this position till the moment the pitch angle and g-load stop decreasing, then smoothly level off the aircraft.

If the aircraft starts pitching as a result of erroneous or abrupt applications of the control column aimed at preventing the pitch-up or diving, the pilot should return the control column to the position corresponding to the level-flight attitude (between the control column horizontal tube marks corresponding to the minus 1° and minus 2.5° readings of the stabilizer position indicator) and fix the control column in this position for 1 or 2 s. Aircraft pitching should cease. After the aircraft pitching ceases, smoothly level off the aircraft.

8.22. OSCILLATIONS OF CONTROL WHEEL AND PEDALS IN FLIGHT

427. If the control wheel starts oscillating in flight, the pilot should proceed as follows:

— decrease the airspeed to 600 km/h or to $M \leqslant 0.9$;

— level off the aircraft;

— make sure that the dry-friction dampers are engaged by reference to the indicator lights;

— change over aircraft control from the flap-ailerons to ailerons.

If the above measures do not stop the control wheel oscillations, disengage the roll damper.

If the control wheel proceeds oscillating, which interferes with aircraft piloting, decrease the airspeed to 550 km/h and disconnect the main hydraulic system from the hydraulic booster by shifting the hydraulic booster switch-on knob to the intermediate position.

If the control wheel oscillations persist, pass to controlling the ailerons manually (see Item 422).

428. If the pedals start oscillating in flight, the pilot should proceed as follows:

— decrease the airspeed to 600 km/h or to Mach number $M \leqslant 0.9$;

— make sure that the dry-friction dampers are engaged by reference to the indicator lights;

— disengage the yaw damper.

If the pedals go on oscillating with the above measures taken, which interferes with aircraft piloting, disconnect the hydraulic booster from the main hydraulic system. To this end, place the hydraulic booster switch-on knob to the intermediate position.

If pedal oscillations persist, proceed to booster-free rudder control (see Item 422).

429. If the pilot is forced to pass to booster-free aileron or rudder control, discontinue the flight mission, report the situation to the flight control officer and proceed to the landing airfield.

8.23. FAILURE OF FLAP-AILERON CHANGE-OVER MECHANISM

430. Symptom: automatic or manual change-over from aileron control to flap-aileron control is not accompanied by extinguishment of the white indicator lights and coming-on of the blue lights; during change-over of aircraft control from the flap-ailerons to the ailerons the white lights have extinguished and the blue lights have failed to come on (or vice versa) within 27 s.

431. Actions: set the switch to the initial position (make sure that aircraft control is reversed by reference to the indicator lights) and proceed executing the flight mission without surpassing the airspeed indicated for the flight controlled by the ailerons (flap-ailerons). If setting of the switch to the initial position is not accompanied by illumination of the white and blue lights (the aileron and flap-aileron control takes place at a time), proceed executing the flight mission.

432. Symptom: automatic or manual change-over from aileron control to flap-aileron control or vice versa is accompanied by illumination of one white and one blue light (partial change-over of control).

433. Actions: set the switch to the AILERONS (ЭЛЕРОНЫ) or FLAP-AILERONS (ЭЛЕРОН-ЗАКРЫЛКИ) position. After the second white light (blue light) comes on, proceed executing the flight mission by using the aileron (flap-ailerons) control. If setting of the switch to the initial position does not result in coming-on of the second white (blue) light (the aileron is deflected on one of the wing panels and the flap-aileron on the other), proceed executing the flight mission, avoiding increase of airspeed above 600 km/h ($M<0.9$).

CAUTION. WITH THE AIRCRAFT SIMULTANEOUSLY CONTROLLED BY THE AILERONS AND FLAP-AILERONS OR BY THE FLAP-AILERONS ONLY, PERFORM LANDING WITH THE FLAPS EXTENDED BY 20°, WITH THE AIRSPEED RANGING FROM 330 TO 340 KM/H AT THE AIRCRAFT LANDING MASS OF UP TO 60 TONS.

8.24. FAILURE OF TRIMMING MECHANISM IN LONGITUDINAL CONTROL SYSTEM

434. Symptoms:

— variation of forces across the control column in steady-state flight conditions; drift of the control column, when relieved, and entry of the aircraft into diving or pitch-up (which may be accompanied by coming-on of the АУАСП indicator light and change of the g-load);

— the control column fails to be trimmed out by using the trimming mechanism.

435. Actions:

— level off the aircraft by smooth application of the control column;

— cut out the feel simulator controller.

NOTE. If the trimming mechanism fails to operate when set to the intermediate position, perform prolonged flight at an airspeed calling for application of the minimum force to the control column;

— discontinue execution of the flight mission;

— while applying great forces to the control column, pass to controlling the aircraft from the stabilizer control mechanism (perform change-over at M=0.8 to 0.85 and altitudes exceeding 9000 m and at airspeeds ranging from 550 to 580 km/h and altitudes below 9000 m);

— at an altitude of at least 1000 m, pass to hydraulic booster control, decrease the airspeed to 480—500 km/h, extend the landing gear and flaps by 20° and again pass to aircraft control from the stabilizer control mechanism;

— start turning to base leg and to final at a distance providing an entry into the glide slope of descent in level-flight conditions;

— at a distance of 18 to 20 km from the runway threshold, pass to hydraulic booster control, carrying out further descent and landing with the hydraulic booster engaged;

— with pushing forces applied to the control column, extend the flaps by 35° when on the final approach leg.

CAUTION: 1. IF PULLING FORCES ARE APPLIED TO THE CONTROL COLUMN, LAND THE AIRCRAFT WITH THE FLAPS EXTENDED BY 20°.

2. IF THE AIRCRAFT STARTS PITCHING, ENGAGE THE HYDRAULIC BOOSTER, SET UP THE REQUIRED FLIGHT REGIME AND AGAIN PASS TO HORIZONTAL STABILIZER CONTROL FROM THE STABILIZER CONTROL MECHANISM.

3. WHEN ENGAGING THE HYDRAULIC BOOSTER, HOLD THE CONTROL WHEEL SINCE AFTER ENGAGEMENT OF THE HYDRAULIC BOOSTER IT WILL SHIFT AT A HIGH RATE TO A POSITION CORRESPONDING TO THE MOMENT OF TRIMMING MECHANISM FAILURE.

8.25. AIRCRAFT PILOTING WITH HORIZONTAL STABILIZER CONTROLLED BY STABILIZER CONTROL MECHANISM

436. Change over to the horizontal stabilizer control from the stabilizer control mechanism in the following cases:

— in case of longitudinal control trimming mechanism failure;

— in case of failure of the horizontal stabilizer hydraulic booster;

— in case of failure of three hydraulic systems.

437. To change over to horizontal stabilizer control from the stabilizer control mechanism, proceed as follows:

— fix the control column in the position corresponding to the assigned flight regime and shift the stabilizer hydraulic booster valve handle to the HYDR BOOSTER OFF (ГИДРОУСИЛИТЕЛЬ ВЫКЛЮЧЕН) position; this entails automatic disengagement of the pitch damper and stability automatic controller; the reversal speed of the horizontal stabilizer, when controlled by the stabilizer control mechanism, is 0.7°/s;

— select the airspeed corresponding to Mach number M=0.8—0.85 at an altitude exceeding 9000 m and airspeed of 550 to 580 km/h at an altitude below 9000 m;

— make turns with a bank angle of up to 20°;

— when climbing or descending, maintain an airspeed of 550 to 580 km/h.

NOTES: 1. When changing over the stabilizer control to the control from the stabilizer control mechanism, the hydraulic system III cut-in valve handle should occupy the lower position.

2. If possible, change over to stabilizer control from the stabilizer control mechanism in level flight.

3. Control the stabilizer by short (0.3 to 0.5-s) double pulses of the switch labelled STABILIZER CONTROL (УПРАВЛЕНИЕ СТАБИЛИЗАТОРОМ). Change the engine power settings by smooth displacement of the throttle control levers.

8.26. FAILURE OF ROLL AND YAW DAMPERS

438. Symptoms:

— control wheel jerks in the aileron control direction and kicks across the pedals;

— low-amplitude and low-frequency sustained roll and yaw oscillations;

— failure of the aircraft behaviour to correspond to the positions of the pedals and control wheel with respect to the ailerons (considerable sideslipping of the aircraft with the pedals neutral, absence of aircraft banking with the control wheel applied in the roll direction);

— inadvertent banking of the aircraft.

439. ***Actions***:

— while maintaining the level-flight attitude, disengage the yaw and roll dampers;

— engage the dampers in turn to locate the faulty channel and disengage it;

— pilot the aircraft with the roll or yaw damper disengaged at high altitudes and subsonic airspeeds by using the ailerons with the rudder neutral to prevent aircraft overswinging.

CAUTION: 1. TO PRECLUDE AIRCRAFT OVERSWINGING DURING LANDING APPROACH (ESPECIALLY IN BUMPY AIR CONDITIONS), AVOID ABRUPT DEFLECTIONS OF THE AILERONS AND RUDDER.

2. THE AMOUNT OF DEFLECTION OF THE CONTROL SURFACES MAY BECOME LOWER WHEN THE SERVO UNIT ACTUATING ROD IS JAMMED IN ANY POSITION BUT NEUTRAL.

8.27. FAILURE OF PITCH DAMPER AND STABILITY AUTOMATIC CONTROLLER

440. ***Symptoms:***

— coming-on of the red warning light of the failed pitch damper channel;

— inadvertent tendency of the aircraft to changing the pitch angle, angle-of-attack and g-load;

— pitch angle variation in level flight;

— ease-off of longitudinal control and aircraft tendency to overswinging (in case of failure of two damper channels).

441. ***Actions:***

— avoiding abrupt applications of the control column, level off the aircraft;

— successively disable the channels of the pitch damper and stability automatic controller to locate and disable the unserviceable channel (channels);

— in case of onset of inadvertent pitch oscillations, fix the control column in the trimmed-out position and decrease the airspeed by throttling down the engines;

— place the stability automatic controller switch labelled NORMAL — EMERG (НОРМАЛЬНО — АВАРИЙНО) to the EMERG (АВАРИЙНО) position and make sure that it has been changed over by deflection of the stability automatic controller and pitch damper pointers on the ПКД control panel.

NOTE: After operation of the stability automatic controller and pitch neutral setting system, the aircraft returns to the initial g-load with an inadvertent slight nose-down.

CAUTION:
1. IF ONE PITCH DAMPER CHANNEL OR STABILITY AUTOMATIC CONTROLLER FAILS TO OPERATE, PERFORM FLIGHT AT AN AIRSPEED NOT EXCEEDING 750 KM/H. IN CASE OF FAILURE OF TWO PITCH DAMPER CHANNELS, EXECUTE FLIGHT AT AN AIRSPEED OF NOT OVER 650 KM/H.
2. PASS MACH NUMBER M=0.95—1.05 IN LEVEL FLIGHT.
3. IF ONE PITCH DAMPER CHANNEL OR STABILITY AUTOMATIC CONTROLLER FAILS TO OPERATE DURING THE TAKEOFF RUN, WHICH IS ACCOMPANIED BY SERVO UNIT ACTUATING ROD DRIFT IN THE DIVE DIRECTION, INCREASE THE AIRSPEED AT WHICH THE NOSE LEG IS LIFTED BY 20 KM/H.
4. DURING FLARE-OUT BEFORE LANDING, RETARD THE THROTTLE CONTROL LEVERS SMOOTHLY SO AS TO PREVENT AIRCRAFT BALLOONING; AT THE MOMENT OF TOUCH-DOWN, FIX THE CONTROL COLUMN IN POSITION, TAKING CARE TO PRECLUDE AIRCRAFT UNSTICKING FROM THE RUNWAY. IF

UNSTICKING TAKES PLACE, MIND THAT BACKWARD APPLICATION OF THE CONTROL COLUMN AT THE MOMENT OF REPEATED TOUCH-DOWN IS NOT ALLOWED.

5. LANDING WITH AIRCRAFT C.G. POSITION WITHIN 38 TO 40 % MAC IS ALLOWED IN CASE OF THE PITCH DAMPER OR STABILITY AUTOMATIC CONTROLLER FAILURE IN AN EMERGENCY SITUATION ONLY. A DECISION TO PERFORM SUCH LANDING IS TAKEN BY THE FLIGHT CONTROL OFFICER ONLY. LANDING WITH THE AIRCRAFT C.G. POSITION EXCEEDING 40 % MAC IS PROHIBITED.

442. During landing approach, the aircraft c.g. position may be roughly checked by the trim position of the horizontal stabilizer in compliance with Table 23 (with the landing gear extended, $\delta_{flaps}=35°$).

Table 23

C.g. position, % MAC	Trim position of horizontal stabilizer according to stabilizer position indicator, deg.			
	V=500 km/h		V=400 km/h	
	$G_f=55$ t	$G_f=60$ t	$G_f=55$ t	$G_f=60$ t
30	−4.6	−5.2	−8.3	−8.9
40	−3.1	−3.6	−5.8	−6.3

8.28. FAILURE OF FEEL SIMULATOR CONTROLLER

443. ***Symptoms:***

— coming-on of the АУАСП critical angle-of-attack and g-load warning unit red warning light in flight conditions in which this light should not illuminate;

— increase of forces in response to backward application of the control column in any flight conditions as well as operation of the feel simulator controller at angles of attack which are considerably lower than the critical angle of attack against the АУАСП unit;

— decrease or absence of load with the control column applied forward and then backward;

— when the trimming mechanism switch is pressed backward, the control column first remains motionless and only on a lapse of 1 to 2 s it starts moving backward at a low speed, which may be taken by mistake as a trimming mechanism failure.

444. ***Actions:***

— cut out the feel simulator controller; this may cause variation of forces across the control column;

— perform flight at an airspeed not exceeding 750 km/h;

— handle the aircraft by moving the control column more smoothly, so as to avoid surpassing the angle-of-attack and g-load limitations;

— if the feel simulator controller has failed to be cut out, trim out the load by using the trimming mechanism and proceed with flight mission execution.

NOTES: 1. The forces may be trimmed out if the horizontal stabilizer deflection angle does not exceed 6°.

2. With the landing gear down and flaps extended by 35°; the pulling forces may reach 50 kgf in the process of landing.

3. It is allowed to perform landing with the flaps extended by 20°.

8.29. FAILURE OF AUTOPILOT OR PITCH DAMPER FIRST CHANNEL WITH AIRCRAFT CONTROLLED BY AUTOPILOT

445. ***Symptoms:***

— roll, pitch and yaw oscillations of the control surfaces and aircraft induced with a constant or increasing amplitude;

— variation of the aircraft roll, pitch and yaw;

— operation of the audio and light indication systems.

446. ***Actions:***

— disengage the autopilot by using the fast cut-out button;

— level off the aircraft;

— make sure that the roll and yaw dampers as well as the second channel of the pitch damper and stability automatic controller are engaged (by the aircraft behaviour and movement of the "T2" and "АУ" pointers on the ПКД damper indicator panel as well as by extinguishment of the "ДТ" and "АУ" (channel II) red warning lights);

— successively enable the autopilot channels to locate the faulty channel and disable the latter;

— proceed executing the flight mission while controlling the aircraft manually with respect to the autopilot failed channel.

NOTES: 1. The autopilot longitudinal channel is automatically disconnected by the limit switches with the horizontal stabilizer deflected through angles corresponding to their operation, with the flight level changed by ±(100 to 160) m in the STABILIZATION mode at altitudes exceeding 2000 m or in response to signals transmitted by the АУАСП critical angle-of-attack and g-load warning unit arriving on attaining the limit angle-of-attack or g-load value, which is accompanied by operation of the audio and light signalling systems.

2. The autopilot lateral channel is automatically disengaged by the autopilot interlocking circuits as soon as the 10 to 20° bank angle is attained with the autopilot operating in the STABILIZATION mode and 42 to 50° in the CONTROL mode, which is accompanied by operation of the audio and light signalling systems.

447. Failure of the master vertical gyro system gyro unit yields automatic disengagement of the autopilot lateral channel by the interlocking circuits on attaining the 10 to 20° bank angle with the autopilot operating in the STABILIZATION mode and 42 to 50°, in the CONTROL mode.

Altitude change by ±(70 to 110) m is accompanied by flickering of the "ΔH" light on the annunciator; in this case, the pilot should bring the aircraft to the assigned flight altitude by using the DESCENT — CLIMB (СПУСК — ПОДЪЕМ) knob and again cut in the altitude controller.

448. In case of failure of one of the gyro horizons (АГД or АГБ-3), when the mismatch angle reaches 4.5 to 9.5°, the VG FAILURE (ОТКАЗ ГВ) annunciator comes to illuminate. The pilot should locate the gyro unit which has failed by comparing the readings of three gyro horizons and ЭУП electric turn indicator.

449. If the АГД gyro horizon fails to operate, the pilot must turn off the STBY HORIZON (РЕЗЕРВНЫЙ АГ) switch on the instrument board and start flying by reference to the ПП flight director indicator and duplicating instruments.

450. In case of failure of the АГБ-3 gyro horizon, the navigator should turn off the "АГБ-3" switch on the navigator's auxiliary board.

CAUTION: 1. IF PITCH DAMPER CHANNEL I FAILS TO OPERATE ON AIRCRAFT FURNISHED WITH THE СПН STABILITY AUTOMATIC CONTROLLER AND PITCH NEUTRAL SETTING SYSTEM AND THE AIRCRAFT FLYING AT A SUBSONIC SPEED (500 TO 800 KM/H) IS CONTROLLED BY THE AUTOPILOT, AS SOON AS ANGULAR SPEED $\omega_z > 1 \pm 0{,}2°/S$ IS ATTAINED, THE AUTOPILOT GETS DISENGAGED EARLIER THAN THE STABILITY AUTOMATIC CONTROLLER AND PITCH NEUTRAL SETTING SYSTEM COMES TO OPERATE; THEREFORE, INSTANTANEOUS RISE OF G-LOAD MAY IN THIS CASE COME TO $\Delta n_y < 0.4—0.6$.

2. AFTER DISENGAGEMENT OF UNSERVICEABLE PITCH CHANNEL I, SWITCH OVER THE STABILITY AUTOMATIC CONTROLLER TO OPERATE IN THE "EMERG" MODE.

8.30. FAILURE OF ONE HYDRAULIC SYSTEM

451. ***Symptoms:***

— drop of pressure below 100 kgf/cm² in the main or booster hydraulic system;

— flickering of the abnormal conditions annunciator and coming-on of the red warning light.

452. ***Actions:***

— extend the ATH turbopumps; to this end, shift the lever used for engaging hydraulic system III from the lower position to the intermediate one; the 210-kgf/cm^2 operating pressure is set up in hydraulic system III within 1 to 2 s;

— on expiration of 2 s, engage hydraulic system III; to this end, shift the lever used for engaging hydraulic system III to the upper position;

— if the flight was performed at a supersonic airspeed, pass to a subsonic airspeed and proceed executing the flight at Mach numbers not exceeding 0.9;

— transfer control from the flap-ailerons to the ailerons.

NOTES: 1. In case of failure of the main hydraulic system, the dry-friction damper of the ailerons gets automatically connected to the booster system. The dry-friction damper indicator light continues glowing. If the light is dead, place the aileron dry-friction damper switch to the CTL SURF HYD SYST (ГИДРОСИСТЕМА РУЛЕЙ) position.

2. If the booster hydraulic system fails, the rudder dry-friction damper gets automatically connected to the main hydraulic system. The dry-friction damper indicator light goes on illuminating. If the light is dead, set the RUDDER DFD (ДСТ РН) switch to the EMERG (АВАРИЙНО) position.

453. In case of failure of the main hydraulic system, perform emergency extension of the landing gear by using the booster hydraulic system. To this end, proceed as follows:

— with the main hydraulic system landing gear extension control lever neutral, place the landing gear emergency extension lever to the position corresponding to landing gear extension and leave it in this position;

— make sure that the LG DOWN (ШАССИ ВЫПУЩЕНО) green indicator lights have come to illuminate.

454. Perform landing with the flaps extended by 20°. Deflect the flaps when descending after turn to final.

If the main hydraulic system fails to operate, after touch-down extend the brake chutes, shut down one of the engines and decelerate the aircraft by using the emergency brake levers. When carrying out the landing roll and taxiing off the runway in this case, use the emergency braking system to hold the proper direction since the nose wheel steering mechanism is inoperative in this situation. On clearing the runway, stop the aircraft by using the wheel emergency braking system and shut down the engine.

8.31. SIMULTANEOUS FAILURE OF TWO HYDRAULIC SYSTEMS

455. ***Symptoms:***

— pressure drop below 100 kgf/cm^2 in the main and booster hydraulic systems;

— flickering of the abnormal conditions annunciator and coming-on of two red hydraulic system failure lights.

456. ***Actions:***

— pass from flap-aileron control to aileron control;

— set up airspeed not exceeding 600 km/h (Mach number not over 0.8);

— cut in hydraulic system III (the emergency hydraulic system);

— after coming-on of the AILERONS (ЭЛЕРОНЫ) white lights, change over to booster-free control of the ailerons and rudder;

— engage the hydraulic booster chamber emergency cross-feed system;

— discontinue the flight mission and proceed to the landing airfield.

457. In the landing airfield area, carry out emergency extension of the landing gear from hydraulic system III when flying level at an altitude of at least 500 m and airspeed within 470 to 500 km/h. To this end, proceed as follows:

— make sure that the landing gear main hydraulic system control valve switch is neutral;

— make sure that the landing gear emergency extension booster hydraulic system control lever is set to the OFF (ВЫКЛЮЧЕНО) position;

— place the switch of the control valve used for extension of the landing gear from hydraulic system III to a position corresponding to landing gear extension (the landing gear extension time is 17 s);

— perform landing with the flaps extended by 20°;

— maintain the approach gliding speed equal to at least 380 km/h.

CAUTION. AVOID EXTRA APPLICATIONS OF THE CONTROL COLUMN DURING LANDING APPROACH, ESPECIALLY AT THE MOMENT OF LANDING GEAR EXTENSION SINCE THE HORIZONTAL STABILIZER REVERSAL SPEED HAS DIMINISHED.

458. Land the aircraft with a 5 to 7° landing angle. In so doing, maintain the touch-down speed within 320 to 340 km/h. The pilot's actions after touch-down are similar to those involved in case of failure of one hydraulic system.

8.32. FAILURE OF MAIN OR BOOSTER HYDRAULIC SYSTEM AND HYDRAULIC SYSTEM III

459. ***Symptoms:***

— pressure drop below 100 kgf/cm^2 in the hydraulic systems which failed to operate;

— flickering of the abnormal conditions annunciator and coming-on of two red warning lights indicating failure of the respective hydraulic systems.

460. ***Actions:***

— change over aircraft control from flap-ailerons to ailerons when flying level at an airspeed not exceeding 600 km/h ($M \leqslant 0.9$);

— pass to manual control of the ailerons and rudder at an airspeed not exceeding 600 km/h (place the control levers of the respective hydraulic boosters to the extreme lower position and turn on the hydraulic booster chamber emergency cross-feed system);

— when the main hydraulic system is inoperative, perform emergency extension of the landing gear by using the booster hydraulic system.

CAUTION. WHEN PERFORMING LANDING APPROACH, ESPECIALLY AT THE LANDING GEAR EXTENSION MOMENT, AVOID EXTRA APPLICATIONS OF THE CONTROL COLUMN AS THE HORIZONTAL STABILIZER REVERSAL SPEED HAS DECREASED.

Upon touch-down, act in the same way as in case of failure of one hydraulic system.

8.33. CABIN DEPRESSURIZATION

461. ***Symptoms:***

— physical perception of the change in pressure differential (pain in the ears);

— abrupt increase of the "cabin" altitude and decrease of pressure differential as read by the УВПД cabin altitude and differential pressure indicator.

462. ***Actions:***

— make sure that air is supplied into the cabin from the engines;

— make sure that the oxygen equipment is serviceable;

— descend to the altitude of 7000 m and proceed flying at this altitude; if the fuel load cannot provide for execution of flight at the given altitude, return to the landing airfield; if the fuel load is insufficient for reaching the airfield at the altitude of 7000 m, perform flight at a higher altitude which should not exceed 12,000 m, taking into account the fact that the crew is allowed to endure this altitude for as short time as possible; should any of the crew members feel a so-called "altitude" pain, make certain that the air diluter knob on oxygen set КП-24 is set to the "100 % O_2" position;

— the crew members should intensify supervision over operation of the oxygen equipment, carry out mutual check of the physical state of each other; every 5 minutes report your physical state and operation of the oxygen equipment to the pilot; if any of the crew members is feeling bad, descend to the altitude of 4000 m;

— the pilot should periodically check the oxygen remainder.

8.34. DISCONTINUANCE OF AIR SUPPLY INTO CABIN FROM ENGINES

463. ***Symptom:*** drop of air consumption as registered by the УРВК cabin air flow indicator.

464. Actions:

— descend to the altitude of 7000 m;
— turn on the low-altitude cabin ventilation system;
— make sure that the cabin glazing electric heaters are turned on;
— discontinue execution of the flight mission and further on act in the same way as during depressurization of the cabin.

8.35. FAILURE OF AUTOMATIC CABIN AIR PRESSURE REGULATOR АРД-54

465. ***Symptoms:***

— increase in pressure differential in excess of 0.43 kgf/cm^2 as read by the УВПД cabin altitude and differential pressure indicator;
— physiological éffect on the crew members at an abrupt increase of the pressure differential.

466. ***Actions:***

— set the АРД automatic cabin air pressure regulator to the DECR (ПОНИЖ.) position; if in this case the pressure surpasses 0.43 kgf/cm^2, disengage the pressurization system, descend to the altitude of 7000 m and order the crew members to get ready for cabin depressurization;
— on obtaining the readiness report from the crew members, carry out emergency release of pressure by placing the PRESSURE RELEASE (СБРОС ДАВЛЕНИЯ) switch to the ON (ВКЛЮЧЕНО) position;
— cut in the low-altitude cabin ventilation system;
— discontinue execution of the flight mission (if the available fuel load cannot provide for accomplishment of the flight mission at the altitude of 7000 m) and further on act in the same way as during cabin depressurization;
— maintain the required temperature in the cabin by a periodic short-time opening of the cabin pressurization system air delivery shut-off valves.

8.36. FAILURE OF РТВК CABIN AIR TEMPERATURE REGULATOR

467. ***Symptom:*** abrupt increase or decrease of the cabin temperature irrespective of the flight conditions and flight regime.

468. ***Actions:***

— pass to manual control by placing the CROSS-FEED EVAPOR (КОЛЬЦЕВ. ИСПАРИТ.) and РТВК switches to the COLD (ХОЛ.) position if it is hot in the cabin or to the HOT (ГОР.) position if it is cold;

— if the high temperature in the cabin persists, turn off the cabin pressurization system (keep the PRESSURIZ (НАДДУВ) switch in the DECR (МЕНЬШЕ) position for at least 90 s);

— the crew members should make sure that the air diluter knob on oxygen set КП-24 is set to the "100 % O_2" position;

— make sure that the glass heaters are turned on;

— descend to the 7000-m altitude;

— depressurize the cabin, having ordered the crew to get ready for depressurization;

— discontinue the flight mission and further act in the same way as in case of cabin depressurization;

— if a necessity arises to maintain the cabin temperature at a certain level, turn on air supply from the engines for a short period of time by using the PRESSURIZ switches.

8.37. FAILURE OF OXYGEN EQUIPMENT

469. ***Symptoms:***

— discontinuance of oxygen supply into the mask (the oxygen indicator segments are closed, failing to respond to inhalation and exhalation at a "cabin" altitude exceeding 2000 m);

— abrupt drop of oxygen pressure (below 6 kgf/cm^2);

— cabin depressurization at altitudes exceeding 11,000 m does not result in build-up of an excessive pressure in the oxygen mask.

470. ***Actions:***

— turn on oxygen supply from parachute-packed oxygen set КП-23;

— descend to the 4000-m altitude at the maximum vertical speed possible.

NOTE. If the oxygen pressure in the oxygen system rises above 11.5 kgf/cm^2, all the crew members should turn on the emergency oxygen supply system by placing the handle on emergency oxygen set КП-24М to the OPEN (ОТКРЫТО) position. Descend to the altitude below 7000 m, depressurize the cabin and turn on the low-altitude ventilation system.

8.38. FAILURE OF RADIO SET

471. *Operator's actions:*

(a) in case of failure of the communication radio set transmitter, maintain radio contact with the ground via VHF command radio set РСИУ No. 2, using radio stations of alternate airfields and radio sets of airborne aircraft;

(b) if radio set РСИУ No. 1 fails to operate, use radio set РСИУ No. 2 to maintain radio contact.

NOTE. In this situation, the flight mission discontinuance decision is to be taken by the pilot;

(c) if the HF and VHF radio sets Nos 1 and 2 fail to operate, switch on the "Distress" signal.

NOTE. The pilot should land the aircraft on the nearest airfield, using the automatic direction finder for monitoring radio signals and watching the signal flares.

8.39. INTERCOM FAILURE

472. ***Actions:*** For intercommunication, use VHF radio sets Nos 1 or 2 by placing the switches on the interphone control boxes to the RADIO (РАДИО), VHF (УКР) or ADD R/SET (ДР) positions.

NOTE. Intercommunications should be carried on within the limits established by the pilot since these communications will go on the air.

8.40. FAILURE OF GENERATOR СГС-30-8РС

473. ***Symptoms:***

— no voltage across the voltmeter;
— illumination of the red warning light labelled LIGHT ON — GEN INOPER (ЛАМПА ГОРИТ — ГЕНЕРАТОР НЕ РАБОТАЕТ).

474. ***Actions:***

— the operator should cut out the failed generator;
— go on executing the flight mission;
— if both generators fail to operate, cut them out, then cut in again and check for proper operation; if serviceability of the generators has not restored, cut out the generators, discontinue execution of the flight mission and proceed to the landing airfield.

8.41. FLIGHT AND LANDING WITH AIRCRAFT MAINS DE-ENERGIZED

475. ***Symptoms:***

— simultaneous failure (cut-out) of a great number of consumers (all consumers connected to the main bus);
— off-scaling of ammeters and abrupt drop of voltage;
— failure of four generators.

476. *Operator's actions:*

— shift the capped switch labelled INSTR SUPPLY FROM BAT (ПИТАНИЕ ПРИБОРОВ ОТ АККУМУЛЯТОРОВ) to the upper position.

CAUTION. THE INSTRUMENTS ARE SUPPLIED FROM THE STORAGE BATTERIES FOR 40 TO 45 MIN OF FLIGHT;

— report the failure to the crew commander;
— set the generator common switch bar to the OFF (lower) position;
— cut out inverters ПО-6000 Nos 1 and 2 and inverter ПТ-1000;
— discontinue the flight mission and proceed to the landing airfield.

NOTE. It is recommended to reduce the time of using radio set РСИУ No. 1 in the TRANSMIT (ПЕРЕДАЧА) mode.

Fuel will be consumed only from tanks Nos 2 and 7; it is allowed to consume fuel manually from tank No. 1 (on aircraft where it is installed) by engaging the pumps of tank No. 1 on the engine starting control board. Fuel in the other tanks should be dumped in the emergency way. Consume the remaining fuel according to the rate of fuel consumption per hour, having determined, if possible, the amount of fuel remaining in tanks Nos 1, 2 and 7 before de-energizing the main aircraft mains.

477. Use the following fuel consumption sequence:

(a) on aircraft with tank No. 1:

— select the maximum non-reheat power for the port engine and reduced power, with the compressor air blow-off valves open, for the starboard engine;

— set up an airspeed of 580 to 600 km/h and proceed flying with descent if the given altitude cannot be maintained at the selected airspeed;

— dump the fuel in the emergency way;

— select similar power settings for both engines after 30 min of flight, including the time of emergency fuel dumping;

— engage the pumps of tank No. 1, using the FUEL PUMP (ТОПЛИВНЫЙ НАСОС) switches located on the engine starting control board;

— proceed to the nearest airfield for landing;

(b) on aircraft having no tank No. 1:

— set up an airspeed of 580 to 600 km/h at similar power settings of both engines;

— dump the fuel in the emergency way;

— engage the pumps of tank No. 2 by using the FUEL PUMP (ТОПЛИВНЫЙ НАСОС) switch on the engine starting control board;

— follow to the nearest landing airfield.

478. In flight performed at a subsonic airspeed, with the landing gear and flaps retracted and with the pitch damper and stability automatic controller disengaged, the aircraft c.g. position should not exceed 38 % MAC. When piloting the aircraft, avoid long-radius and sharp applications of the control column as this may lead to aircraft overswinging in pitch and to approaching high angles of attack. Control the aircraft by applying double and short-radius motions to the control column.

479. Land the aircraft with the flaps retracted, acting in accordance with the recommendations of Items 492 through 494.

Extension of the landing gear improves pitch control since the aircraft c.g. position is displaced by 1 to 1.5 % forward. The aft c.g.

limit of the aircraft landing with the main aircraft mains de-energized is 37 % MAC (the pitch damper being inoperative).

480. The aircraft c.g. position may be checked by the trim position of the horizontal stabilizer given in Table 24 (the landing gear is extended, the flaps are retracted, G=59 t).

Table 24

Aircraft c.g. position, % MAC	Trim position of horizontal stabilizer against stabilizer position indicator, deg.		
	V=500 km/h	V=400 km/h	V=350 km/h
34	−4.8	−5.7	−6.3
39	−3.7	−4.1	−4.4

8.42. FAILURE OF COMPASS SYSTEM

8.42.1. Failure of Master Directional Gyro

481. ***Symptoms:***

— fast growth of the difference in indications of the heading on the УШ navigator's indicator and УГА gyro-magnetic and celestial heading indicator (the GM (Г) pointer);

— continuous variation of the heading on the navigator's indicator;

— the heading read by the navigator's indicator differs from the true (magnetic) heading by a magnitude incommensurable with the azimuth corrections;

— the master directional gyro fails to be controlled from course selector control panel ПУ-1.

482. ***Actions:***

— when flying straight, depress the SLAVING (СОГЛАСОВАНИЕ) button;

— place the MAIN — STBY (ОСН. — ЗАП.) switch on the control panel to the STBY (ЗАП.) position;

— without releasing the SLAVING button, set the stand-by directional gyro to operate in the mode of magnetic slaving or celestial slaving relative to the main great-circle course;

— the slaving operation completed, release the button and select the DG (ГПК) mode.

8.42.2. Failure of Magnetic Slaving

483. ***Symptoms:***

— the readings of the GM pointer do not change during aircraft turns or rotation of the pointer in straight flight;

— the magnetic heading differs from the true heading (great-circle course, grid heading) by a quantity which is incommensurable with the azimuth corrections.

484. Action: perform flight in the DG (ГПК) mode, using the astro-tracker for updating the aircraft heading (celestial slaving mode).

8.42.3. Total Failure of Compass System

485. Symptom: readings of all the instruments remain unchanged.

486. Action: fly on the celestial heading, making reference to aircraft magnetic compass КИ-13. Make turns with a bank angle not exceeding 10°.

CAUTION. USE THE MAGNETIC COMPASS READINGS ONLY WITH THE POWER SUPPLY OF THE AUTOMATIC BOMBER NAVIGATION EQUIPMENT AND RADAR TURNED OFF.

8.43. FAILURE OF STATIC AND DYNAMIC PRESSURE SYSTEMS

487. Symptoms: improper readings of the speed indicators, altimeters, rate-of-climb indicator, Mach number indicator, altitude and airspeed indicators of the airspeed and altitude director, which are determined by the airspeed failure to correspond to the power setting of the engines or by discrepancy in readings of the pilot's instruments and those of the other crew members.

488. Actions:

— compare the readings of similar-type instruments installed on the instrument boards of other crew members; compare the readings of the barometric altimeters with those of the radio altimeters; the readings are considered to be correct if they are identical for two instruments connected to different Pitot tubes or static vents;

— if the static or dynamic pressure system fails to operate in the pilot's cabin, change over the instruments to the static and dynamic systems of the navigator's cabin by placing the system cocks to the EMERGENCY (АВАРИЙНО) position.

The readings of the instruments should get restored within 15 to 20 s since the moment of the above change-over of instruments supply.

NOTE. In certain cases, the readings of the instruments may be restored after aircraft descent to the altitude with above-zero ambient temperature.

8.44. LANDING OF AIRCRAFT WITH FORWARD C.G. LIMIT

489. If landing is performed on the aircraft with the forward c.g. limit, the trim position of the control column, with the landing gear and flaps extended at an airspeed of 400 km/h will correspond to the horizontal

stabilizer position from minus 9 to minus 11° against the stabilizer position indicator. The amount of control column application and the forces required for maintaining the assigned glide slope and before landing rise to some extent.

8.45. FLYING AND LANDING OF AIRCRAFT WITH AFT C.G. LIMIT

490. Failure of the fuel system automatics and the fuel quantity gauge may create the aft c.g. limit (42 to 44 % MAC) which may be determined by the pilot by reference to the change in the trim position of the horizontal stabilizer. In this case, the trim position of the control column will be 0.5 to 1° lower against the stabilizer position indicator as compared with the normal c.g. position, and it will range from minus 4 to minus 6° versus the airspeed and flight altitude, with the landing gear and flaps extended by 35° at an airspeed of 400 km/h.

If the c.g. position exceeds 42 % MAC, the aircraft reveals airspeed instability; therefore, it should be flown by slight and smooth double applications of the control column so as to preclude origination of impermissible g-loads.

After extension of the landing gear, aircraft piloting is improved to some extent (the aircraft c.g. position is displaced by 1 to 1.5 % MAC forward).

Land the aircraft with the flaps extended by 35°. Extend the flaps by pulses, with subsequent retrimming of the aircraft. During pullup, avoid considerable variation of the engine power setting. Decelerate the engines to idle power in several steps, retrimming the aircraft after each motion of the throttle control levers. Before throttling down the engines, maintain an airspeed of 400 km/h when flying on the approach glide slope.

491. After throttling down the engine, during the flare-out, keep deflecting the control column smoothly backward by its coordinated applications till the touch-down moment. Land the aircraft at an increased speed (320 to 330 km/h at G=56.5 t). At the instant of touch-down, push the control column all the way forward.

If the aircraft bounces after touch-down, keep the control column in the extreme forward position.

Upon touch-down, extend the brake chutes. In the first half of the landing roll (while the aircraft is running at a speed of down to 150 km/h), hold the direction by using the rudder; further on, do it by braking the respective LG bogie till the aircraft comes to a complete standstill. Do not taxi after clearing the runway.

8.46. LANDING APPROACH AND LANDING WITH FLAPS RETRACTED OR INCOMPLETELY EXTENDED

492. It is allowed to perform landing with the flaps retracted or incompletely extended if the aircraft landing mass does not exceed 60 t.

After aligning the aircraft with the runway centre line (with the flaps retracted), diminish the airspeed so as to have the airspeed not below 430 km/h by the moment of approaching the outer homing station. Pass the outer homing station at an altitude of 210 m as indicated by the barometric altimeter (160 m as shown by the radio altimeter). While descending, take care to remove the horizontal stabilizer control forces from the control column.

On passing the outer homing station, set up the vertical speed of descent equalling 5 to 6 m/s so as to pass the inner homing station at an altitude of 90 m as indicated by the barometric altimeter (40 m as shown by the radio altimeter) and at an airspeed of 420 km/h. On passing the inner homing station, make sure that your estimations are correct.

493. Start flaring out at a distance of 500 m from the runway threshold while flying at an airspeed of 400 km/h. In so doing, smoothly throttle down the engines to idle power. Hold off with gradual descent for the aircraft to softly touch the runway by the main wheels. If after touch-down the aircraft wheels clear the runway, push the control column forward to discontinue aircraft separation from the ground and smoothly land the aircraft while proceeding with the further descent. The aircraft touches the ground at an airspeed of 340 to 350 km/h with a 9 to 10° landing angle.

Upon touch-down, lower the nose wheel, start braking the wheels and deploy the brake chutes at a speed not exceeding 330 km/h.

494. If the flaps have failed to extend completely, decrease the gliding and flare-out start speeds as follows as compared with those involved in landing with the flaps retracted:

— by 10 km/h with the flaps extended by 10°;
— by 20 km/h with the flaps extended by 20°.

8.47. FAILURE OF LANDING GEAR EXTENSION SYSTEM

495. Symptom: the landing gear extension indicator lights failed to come on in the process of landing gear extension.

496. Actions:

— check pressure in the main hydraulic system;
— check the position of the landing gear control switch;
— make sure that the circuit breaker labelled LG CTL (УПРАВЛ. ШАССИ) is cut in on the pilot's auxiliary board;
— depress the button labelled LG LAMP CHECK (ПРОВЕРКА ЛАМП ШАССИ) to check serviceability of the landing gear light indication system lamps;
— retard the throttle control lever of one of the engines to check the landing gear extension audio signalling system for proper operation; if the system fails to operate (with the landing gear extended position indi-

cator lamp faulty), land the aircraft by using a common landing procedure; if the audio signalling system operates, decrease the airspeed to 470—480 km/h, then retract and again extend the landing gear. If the landing gear extension failure persists, fly over the runway at a height of 100 to 150 m to check the landing gear position visually.

497. If the audio signalling system operates (also with the tail bumper skid failing to extend for the nose wheel), place the landing gear main extension/retraction switch to the neutral position, and the valve used for extending the landing gear from the booster hydraulic system, to the position corresponding to landing gear extension.

CAUTION. THE LANDING GEAR EMERGENCY EXTENSION VALVE HANDLE SHOULD OCCUPY THE POSITION CORRESPONDING TO LANDING GEAR EXTENSION THROUGHOUT THE ENTIRE PERIOD OF AIRCRAFT TAXIING AND TAXIING IN FOR PARKING.

498. In case of simultaneous failure of the main and booster hydraulic systems, carry out emergency extension of the landing gear from hydraulic system III.

For landing, use the procedure laid down in the sub-section entitled "Landing with Nose (Main) Leg Unextended (Partially Extended)".

8.48. LANDING WITH NOSE (MAIN) LEG UNEXTENDED (PARTIALLY EXTENDED)

499. Symptom: the nose (main) leg extended position indicator light did not come on during landing gear extension.

500. Actions:

— obtain the landing clearance from the flight control officer;

— release bombs;

— cut in the inert gas system;

— consume fuel to a remainder of 4 to 6 t; to this end, select idle rating for the starboard engine and accelerate the port engine to the power setting required for execution of the flight and empty tank No. 2 to a fuel remainder which is 1 t lower than the fuel level in the starboard engine groups; in so doing, check the amount of the remaining fuel by the fuel quantity gauge TOTAL (СУММА) scale, then select similar power settings for both the engines;

— the navigator should take a place in the passage between the pilot's and operator's seats.

NOTE. If the nose leg becomes folded at the instant of touch-down, the navigator should unfasten the safety belts and pull himself up by the handgrip bar mounted on the emergency exit hatch cover;

— the pilot and operator should tighten up and lock the seat belts;

— before turning to final, turn on the switch labelled INSTR SUPPLY FROM BAT (ПИТАНИЕ ПРИБОРОВ ОТ АККУМУЛЯТОРОВ).

NOTE. When the switch labelled INSTR SUPPLY FROM BAT is turned on, the generators go on operating to supply electric power to the main aircraft mains;

— the pilot should turn on inverter ПО-500;

— perform landing approach, extension of the flaps and touch-down by using the procedure specified for a normal flight;

— when executing flare-out and hold-off, make a slight bank in the direction of the extended landing gear leg.

501. After touch-down with the nose LG leg unextended (incompletely extended), proceed as follows:

— apply the braking facilities and shut down the engines;

— smoothly lower the nose fuselage to the horizon without letting it touch the runway; this done, turn the aircraft away onto the soil;

— cut out the control column and pedals by using the emergency cut-out lever;

— jettison the emergency exit hatch cover after touch-down (to be done by the operator);

— directly before the aircraft nose fuselage touches the soil, give the "De-energize aircraft" command to the operator;

— after the aircraft comes to a complete standstill, the crew should leave the aircraft.

502. After touch-down with the main LG leg unextended (partially extended), proceed as follows:

— lower the aircraft onto the nose leg and jettison the emergency exit hatch covers while keeping the aircraft from banking in the direction of the leg which has failed to extend;

— shut down the engines;

— before the aircraft drops its wing, use the emergency braking system to brake the wheels of the extended leg and give the "De-energize aircraft" command to the operator;

— after the aircraft comes to a complete standstill, the crew should leave the aircraft.

8.49. BELLY LANDING

503. Land the aircraft with the landing gear retracted on a soft-soil runway in case of failure to extend the landing gear from the three hydraulic systems and if one of the crew members cannot leave the aircraft.

504. Actions:

— release bombs;

— cut in the inert gas system;

— consume fuel to a fuel remainder of 4 to 6 t;

— while consuming fuel, perform several landing approach cycles preparatory to landing on a soft-soil runway with a view to practising the landing procedure and refining the estimations;

— perform landing with the flaps 35° down;

— the crew members should tighten up and lock the seat belts;

— the pilot should unlock the emergency exit hatch sliding window, the operator and navigator should jettison the emergency exit hatch covers;

— during hold-off, close the fuel emergency shut-off cocks of the engines;

— perform landing with the aircraft flying closer to the ground at a speed of 330 to 340 km/h.

NOTES: 1. After the aircraft touches the soil with the fuselage, the operator should de-energize the aircraft.

2. When leaving the aircraft through the emergency exit hatches, use the rope ladder provided in the cabin.

8.50. DITCHING

505. Ditch the aircraft on water with the landing gear and flaps retracted and with the bombs released. The ditching will not result in aircraft turning upside down and in submerging into the water. The surface gliding length during ditching is within 1000 to 1500 m.

506. Perform ditching:

— into the wind at a smooth water surface;

— along the wave run-up crest irrespective of the wind direction in case of wave roll-on (swelling) if the wind strength does not exceed 8 to 10 m/s;

— into the wind, onto the ascending slope of the wave at a wind strength exceeding 10 m/s as well as in case of any wind-induced waves without wave roll-on.

Land the aircraft on water closer to the coast line or to the friendly ships (boats).

507. Actions to be taken during ditching approach:

— turn on the interrogator-responder to operate in the DISTRESS (БЕДСТВИЕ) mode;

— dump the fuel in the emergency way;

— perform descent at an airspeed of 400 km/h, the vertical descent speed ranging from 4 to 6 m/s;

— when descending, trim out the aircraft so as to remove the pitch load off the control column;

— start flare-out at a distance of 500 m from the selected ditching point while flying at an airspeed of 400 km/h, smoothly decreasing the engine thrust in the process of the flare-out procedure;

— perform ditching at an airspeed of 380 km/h at a landing angle not exceeding 6 to 7°;

— close the fuel emergency shut-off cocks of the engines at the hold-off altitude and de-energize the aircraft after touch-down.

508. When the aircraft approaches the water and in the process of ditching, keep the aircraft against banking. Upon ditching, debark the rescue facilities and abandon the aircraft through the emergency exit hatches.

8.51. AIRCRAFT ABANDONING IN EMERGENCY

509. The aircraft abandoning decision is taken by the crew commander. The crew members eject by his command, strictly keeping to the following ejection sequence: the operator, the navigator and then the pilot.

510. To provide for more favourable ejection conditions, if time permits, the pilot should do the following:

— level off the aircraft and decrease the airspeed to 500 km/h;

— climb to the altitude of 1000 to 2000 m or descend to the 3000-m altitude;

— tighten up and lock the shoulder harness;

— depressurize the cabin.

511. Pilot's actions:

— give the "Get ready for ejection" command to the operator and navigator and, on obtaining the readiness affirmative, jettison the emergency exit hatch covers by using the jettison master control valve.

NOTE. Flying at airspeeds exceeding 700 km/h with all emergency exit hatch covers jettisoned or at airspeeds exceeding 500 km/h with one operator's emergency exit hatch cover jettisoned impedes transmission of the ejection commands via the intercom because of noise in the cabin;

— give the "Abandon aircraft" command to the operator and cut in the ABANDON AIRCRAFT (ПОКИНЬ САМОЛЕТ) light indicator;

— within 1 to 2 s since the moment of the operator's ejection (after the red light comes on), give the "Abandon aircraft" command to the navigator and turn on the ABANDON AIRCRAFT light indicator;

— deflect the seat preparation handles (or one of them) backward and then forward;

— lower the crash helmet light filter;

— after making sure that the operator and navigator have ejected, assume the ejection posture and, directly before ejection, place your feet on the seat footrests, press the footguard interlocking pedals by your heels (press your arms against the armrests, feet against the footrests; press the body and head against the seat back and the headrest, clench your jaws and close your eyes);

— press the ejection levers (or one of the levers) with the fingers (the ejection will take place).

512. Actions to be taken by the operator and navigator (or trainee pilot) by the "Get ready for ejection" pilot's command:

— turn on the distress signal (to be done by the operator only);

— move the seat pan to the extreme rear position and lock it in this position;

— place the feet on the seat footrests and press the footguard interlocking pedals by the heels;

— make the "Ready" report to the pilot.

513. Actions to be taken by the operator and navigator (or trainee pilot) by the "Abandon aircraft" command:

— deflect the seat preparation handles (or one of them) backward and then forward;

— lower the crash helmet light filter;

— assume the ejection posture (press the arms against the armrests, feet against the footrests, back and head against the seat back and headrest, clench the jaws and close the eyes);

— press the ejection levers (or one of the levers) with the fingers (the ejection will take place).

514. When abandoning the aircraft without the preparatory command, quickly fulfil the above operations without reporting the state of readiness to the pilot and without retracting the seat pan to the rear position and locking it in this position. These operations are carried out automatically due to operation of the seat preparation handles.

In exceptional cases, in case of a clearly pronounced life hazard and failure of communication with the pilot, the operator and navigator will be authorized to abandon the aircraft without waiting for the pilot's command.

515. If there is no time reserve, the pilot omits the "Get ready for ejection" preliminary command, directly giving out the "Abandon aircraft" executive command first to the operator and then to the navigator with simultaneous jettisoning of the emergency exit hatch covers with the help of the jettison master control valve and successive turning on of the ABANDON AIRCRAFT (ПОКИНЬ САМОЛЕТ) light indicators.

516. If the emergency exit hatch covers fail to be jettisoned (by means of the master control valve or seat preparation handle), perform autonomous jettisoning of the cover with the help of the mechanically-operated jettisoning handle by shifting the detent forward and pulling the handle. In this situation, the pilot should pull the handle located to the left of the control column to disconnect and throw off the control column and pedals.

517. After disconnection of the control column and pedals, the pilot may restore aircraft control if required. To this end, he should proceed as follows:

— relieve pressure in the cylinder by turning the valve (located on the starboard) to the left;

— pull the control column until it comes into engagement;
— slacken the shoulder straps by using the D-rings;
— release the feet by pressing the foot grip release levers with hands;
— pull the stirrups of the left and then right pedals by the feet to bring the pedals into engagement.

518. To ensure a trouble-free and timely separation of the crew member from the seat and deployment of the parachute, each crew member should proceed as follows:
— release the harness lock by pulling the ring;
— energetically push the seat away with hands and feet;
— pull the parachute manual deployment ring, keeping to the recommended delay intervals.

CAUTION. PREMATURE MANUAL DEPLOYMENT OF THE PARACHUTE IS PROHIBITED IN ALL CASES OF EJECTION (INCLUDING CASES OF INTENSIVE ROTATION OF AN EJECTED CREW MEMBER). STRICTLY KEEP TO THE DELAY INTERVALS INVOLVED IN THE PARACHUTE DEPLOYMENT PROCEDURE.

519. When being ejected over mountainous terrain, closely watch the altitude. If required, duplicate operation of the respective automatic systems used for separation of the crew member from the seat and parachute deployment (release the harness lock, push off the seat and pull the parachute manual deployment ring) in due time (at an altitude of at least 500 m above the terrain relief).

Having made sure that the parachute have been normally deployed, trim the harness main sling under your thighs. If required, take off the oxygen mask (at an altitude of not more than 4000 m) and release the survival kit at an altitude of 300 to 500 m. If ejection is performed at a low altitude, it is allowed to land without survival kit release.

CAUTION. NEVER RELEASE THE SURVIVAL KIT WHEN LANDING IN WOODED COUNTRY.

520. When at a height of 100 to 150 m before touch-down, proceed as follows:
— turn downwind;
— join the legs with the knees and footsteps put together, then bend the legs in the knees and, depending on the wind strength, bring the joined legs forward;
— keep the footsteps parallel to the ground till the moment of touch-down and touch the ground by the entire surface of the footsteps.

521. When landing in a heavy wind or on an even terrain, get rid of the parachute canopy after touching the ground by feet.

522. When being ejected over the water surface and there is height (time) reserve, proceed as follows:

— make sure that the parachute have been normally deployed and determine the direction towards the land;

— raise the crash helmet light filter and take off the oxygen mask (at an altitude not exceeding 4000 m);

— pull out the red handle on the pressure regulator and uncouple the oxygen hose;

— at an altitude of 300 to 500 m, release the survival kit and life raft; the survival kit will hang on a 15-m line and the life raft inflation bottle will get automatically actuated; if the life raft fails to be inflated, sharply pull the survival kit line upward;

— trim the harness main sling under the thighs;

— while gripping the right shoulder strap by the left hand, open the main harness lock by the right hand and take the leg straps out of the D-rings;

— pull the starting head of the life jacket bottle by the right hand to inflate the latter.

CAUTION. NEVER ACTUATE THE LIFE JACKET GAS INFLATION SYSTEM WITH THE MAIN PARACHUTE HARNESS LOCK CLOSED;

— being supported by the harness, join your hands and lower them;

— at a height of 7 to 10 m, separate the hands and transfer them in turn to the parachute harness risers;

— at the moment of touching the water, straighten your legs and body, unclasp the fingers of your hands and get rid of the harness.

523. Upon splash-down, proceed as follows:

— inflate the life jacket floats by pulling the gas inflation plugs;

— turn downwind (assume a position with your back turned to the wave front);

— tear apart the calibrated seam of the survival kit line by separating the orange end from the main line, then use the life raft and survival kit.

524. If there is no height (time) reserve and splash-down is accomplished with the parachute harness and hoses connected and with the survival kit unreleased, proceed as follows:

— on coming to the water surface, raise the crash helmet light filter and take off the oxygen mask.

CAUTION: 1. PRIOR TO TAKING OFF THE OXYGEN MASK, KEEP YOUR BREATH TO PRECLUDE SUCKING OF WATER THROUGH THE OXYGEN HOSE.

2. IF YOU ARE DRAGGED OVER THE WATER SURFACE BY THE PARACHUTE CANOPY, CUT OFF ONE OF THE PARACHUTE HARNESS RISERS BY USING A KNIFE;

— inflate the life jacket floats by pulling the gas inflation plugs;

— open the lock of the harness main sling;

— energetically pull the starting head of the life jacket bottle by the right hand to inflate the jacket;

— turn downwind (assume a position with your back turned to the wave front) and inflate the jacket additionally if required;

— pull out the red handle of pressure regulator РД-24 and disconnect the oxygen hose;

— release the survival kit and life raft;

— pull up the life raft by the line and actuate the life raft inflation bottle by sharp motion of the line;

— tear apart the calibrated seam of the survival kit line by separating the orange end, coupled with the parachute pack, from the main line;

— separate the hose of the parachute-packed oxygen set from the pressure regulator by pulling out the regulator pin with the help of the red handle;

— take the leg straps of the harness out of the D-rings, get rid of the harness and then use the life raft and survival kit.

NOTE. When flying in a special life jacket, get rid of the harness by proceeding as follows:

(1) throw the right-hand shoulder strap of the harness over your back;

(2) pull the left-hand float of the life jacket together with the hand under the left-hand shoulder strap and get rid of the parachute harness;

— tear apart the calibrated seam of the survival kit line by separating the orange end from the main line, then use the life raft and survival kit;

— embark the life raft from the narrow (stern) end, having first sunk it under your body; in so doing, take care to avoid rupturing of the life raft by the metal parts of the outfit.

CAUTION. WHILE CLIMBING INTO THE HELICOPTER WHEN RESCUED FROM THE WATER, NEVER TOUCH THE RESCUE CABLE TILL THE MOMENT IT TOUCHES THE WATER TO PRECLUDE DISCHARGE OF STATIC ELECTRICITY ACCUMULATED ON THE HELICOPTER.

NOTE. For sending out distress signals marking your position, use the signalling means available in the survival kit. Recommendations on employment of the survival kit are laid down in special instructions attached to each survival kit set.

525. When being ejected from a low altitude over the water surface, perform the operations to be executed before splash-down after it. In this case, manually open the carbon dioxide bottle to inflate the life raft.

NOTE. The actions to be taken by the crew members when abandoning the aircraft in emergency are laid down for the case of using parachute С-3-3И (Series II) with survival kit НАЗ-7 enclosed into the parachute pack.

When flying with life raft МЛАС-1 and life jacket, inflate the jacket before splash-down and embark the life raft after splash-down.

526. Actions to be taken by the crew for emergency escape on the ground:

— jettison the door of the entrance hatch (if the aircraft landing gear is lowered) or of the emergency exit hatch;

— pull out the red handle on the pressure regulator and uncouple the oxygen hose;

— disconnect the snap hook of the survival kit line from the suit;

— release the lock of the seat belts and the parachute harness lock;

— abandon the aircraft (the navigator should escape through the entrance or emergency exit hatch, the operator, through the emergency exit hatch, and the pilot, through the entrance hatch or sliding window, using the rope ladder, if possible).

9. PECULIARITIES OF FLIGHT OPERATION OF AIRCRAFT Ty-22У

9.1. MAIN DATA AND OPERATIONAL LIMITATIONS

527. The Ty-22У trainer is used for training the bomber aviation pilots in piloting technique who have studied the tactical characteristics and specifications of aircraft Ty-22 in the full scope and have undergone the preliminary training on flight simulator KTC-22. Besides, the Ty-22У trainer is used for checking the piloting technique of the pilots.

The air crew of aircraft Ty-22У includes:

— the crew commander (instructor);
— the assistant crew commander (pilot);
— the navigator.

9.2. BASIC FLIGHT PERFORMANCE

528. The basic flight performance concerning the range and endurance of long-range flights as well as the cruising-climb flight radii are shown in Figs 35 and 36.

9.3. AIRCRAFT MASS AND C.G. POSITION

529. The mass of an empty aircraft having no tank No. 1 equals 45,500 kg, the c.g. position of the empty aircraft (with the landing gear extended) making up 45.7 % MAC.

The mass of the empty aircraft carrying tank No. 1 is equal to 43,580 kg, the c.g. position of the empty aircraft (with the landing gear extended) making up 50.7 % MAC.

9.4. DESIGN PECULIARITIES OF AIRCRAFT Ty-22У AS COMPARED WITH AIRCRAFT Ty-22Б

530. The Ty-22У trainer has the following design peculiarities as compared with aircraft Ty-22Б.

1. The aircraft has a pressurized cabin with dual control of the aircraft, engines, fuel system, deployment and jettisoning of the brake chutes, wheel emergency braking system, cabin depressurization system.

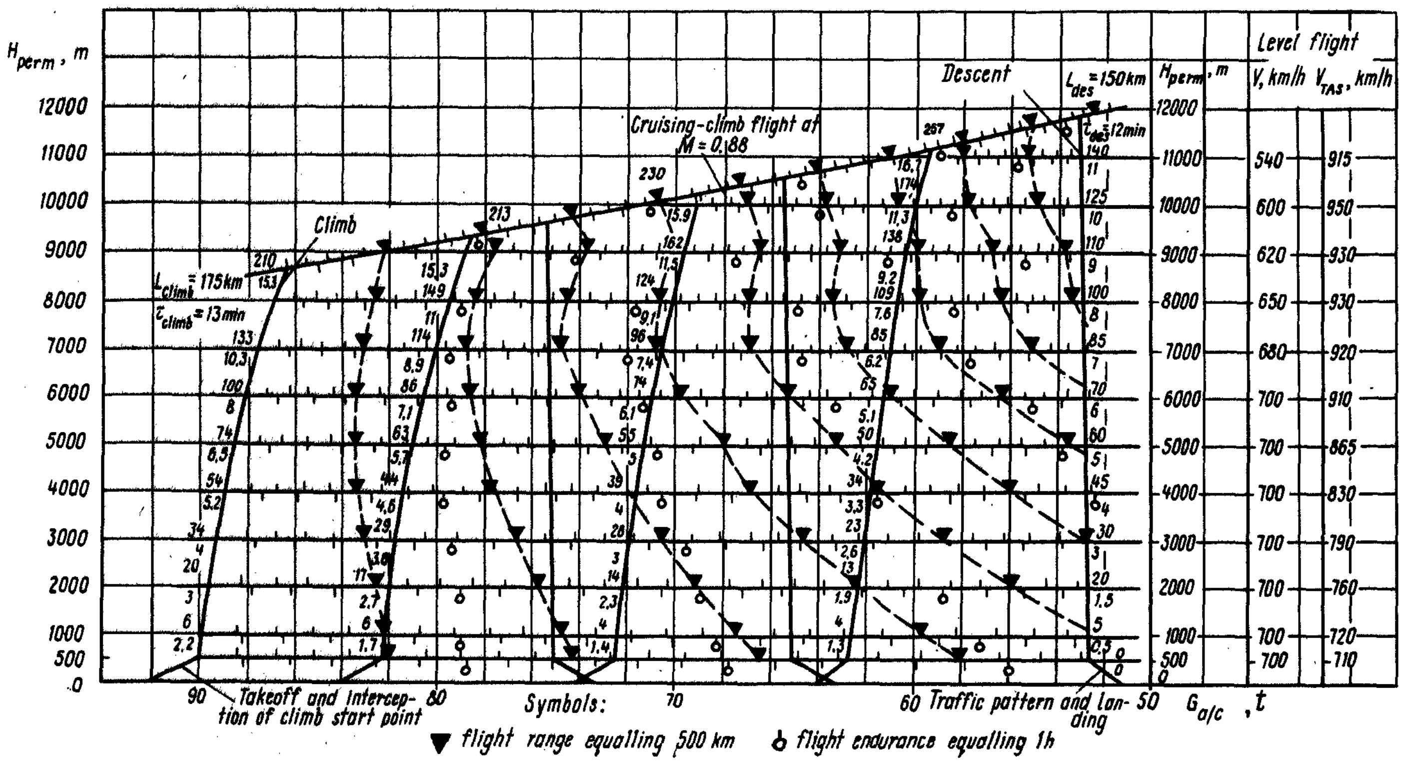

FIG. 35. NOMOGRAM USED FOR DETERMINING RANGE AND ENDURANCE OF FLIGHT PERFORMED ON AIRCRAFT Ту–22У IN MAXIMUM–RANGE LEVEL–FLIGHT AND CRUISING–CLIMB CONDITIONS (climb is accomplished at maximum non-reheat rating at airspeeds of 780 to 800 km/h up to 6000-m altitude and Mach number of 0.88 to 0.9 on leg of climb from 6000 m to 11,000 m; descent is performed with engines running at idle rating (O division against УПРТ indicator) at 550-km/h airspeed)

The aircraft is also provided with an additional canopy providing the field of view for the instructor.

2. The navigator's station accommodates the following additional equipment:

— an electric board used for controlling and checking the electric power sources;

— the HEOH radio transmitter control panel;

— the УС radio receiver control panel;

— the CP3O interrogator-responder control panel;

— the РАДОН radar bombsight and HEOH transmitter pressurization cocks.

3. The pilot's working station is additionally provided with the light indication system showing transfer of the aircraft systems control and change-over of instruments from the instructor to the pilot. The indicator lights closed by the green and amber light filters are located near the respective switches and instruments.

The pilot checks these lights together with the instructor when inspecting the cabin and preparing it for flight.

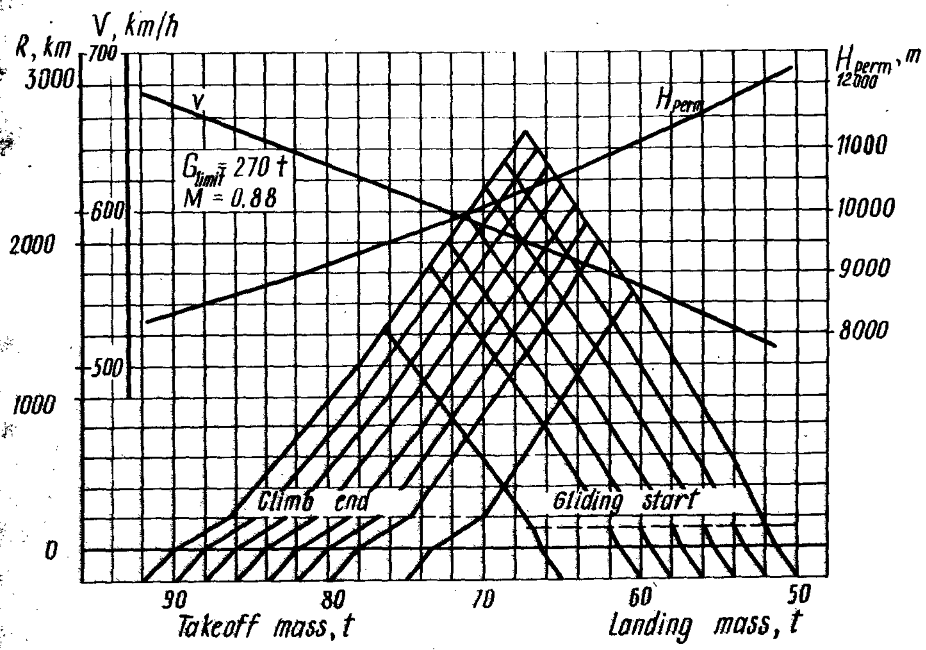

FIG. 36. NOMOGRAM USED FOR DETERMINING FLIGHT RADIUS, ALTITUDE AND AIRSPEED OF CRUISING–CLIMB FLIGHT ON AIRCRAFT Ту–22У IN OPTIMUM–RANGE SUBSONIC CONDITIONS

4. The instructor's working station is arranged instead of the operator's station (Figs 37 through 39). The position of the instructor in the cabin and the canopy structure provide good observation without distortions in the forward hemisphere and the possibility to check the pitch angle during takeoff and landing. The instructor's working station is equipped similarly to the pilot's working station but it has a smaller number of instruments and the arrangement of the instruments is different due to the cabin layout conditions.

Layout of the equipment in the instructor's cabin enables training of the pilots in flying on instruments with employment of the existing landing systems and independent control of the aircraft in the process of taxiing, takeoff and flying at all operational airspeeds and altitudes of flight as well as when performing the landing.

The following instruments and controls provided in the pilot's cabin are not available at the instructor's working station:

— the aileron and rudder hydraulic booster control handle;

— the landing gear emergency extension handle;

— the parking brake engagement handle;

— the switches of the ДТ dry-friction damper, АУ stability automatic controller, double-channel damper Д2К and damper test panel;

— the dry-friction damper switches;

— the life raft and survival kit release handles;

— the engine shut-off levers;

— the engine ground starting board;

— the РТД-4 fuel flowmeter indicator;

— the УТД remote-reading fuel quantity gauge indicator with switch ПГ-5 (on aircraft Ту-22У beginning from aircraft No. 4302, the instructor's working station accommodates the УТД indicator with switch ПГ-5 and the FUEL QNTY GAUGE SWITCH-OVER TO INSTRUCTOR (ПЕРЕКЛЮЧЕНИЕ ТОПЛИВОМЕРА НА ИНСТРУКТОРА) button);

— the engine anti-icing system control cock;

— the LIMIT TEMPER t° (ПРЕДЕЛЬНАЯ t°) warning lights;

— the emergency fuel dumping cocks;

— the autopilot control panel (the instructor's working station accommodates only the autopilot emergency cut-out button located on the control column);

— the compass system slaving switch;

— gyro-magnetic and celestial heading indicator УГА-IV incorporated in the compass system set;

— the ЭУП electric turn indicator;

— g-load indicator АМ-10;

— the УК oxygen reserve indicator;

— thermometer 2ТУЭ;

— the УРВК cabin air flow indicator;

— the control boards of magnetic recorder МС, ILS equipment СП, radar illumination warning unit СПО-3 and automatic direction finder АРК;

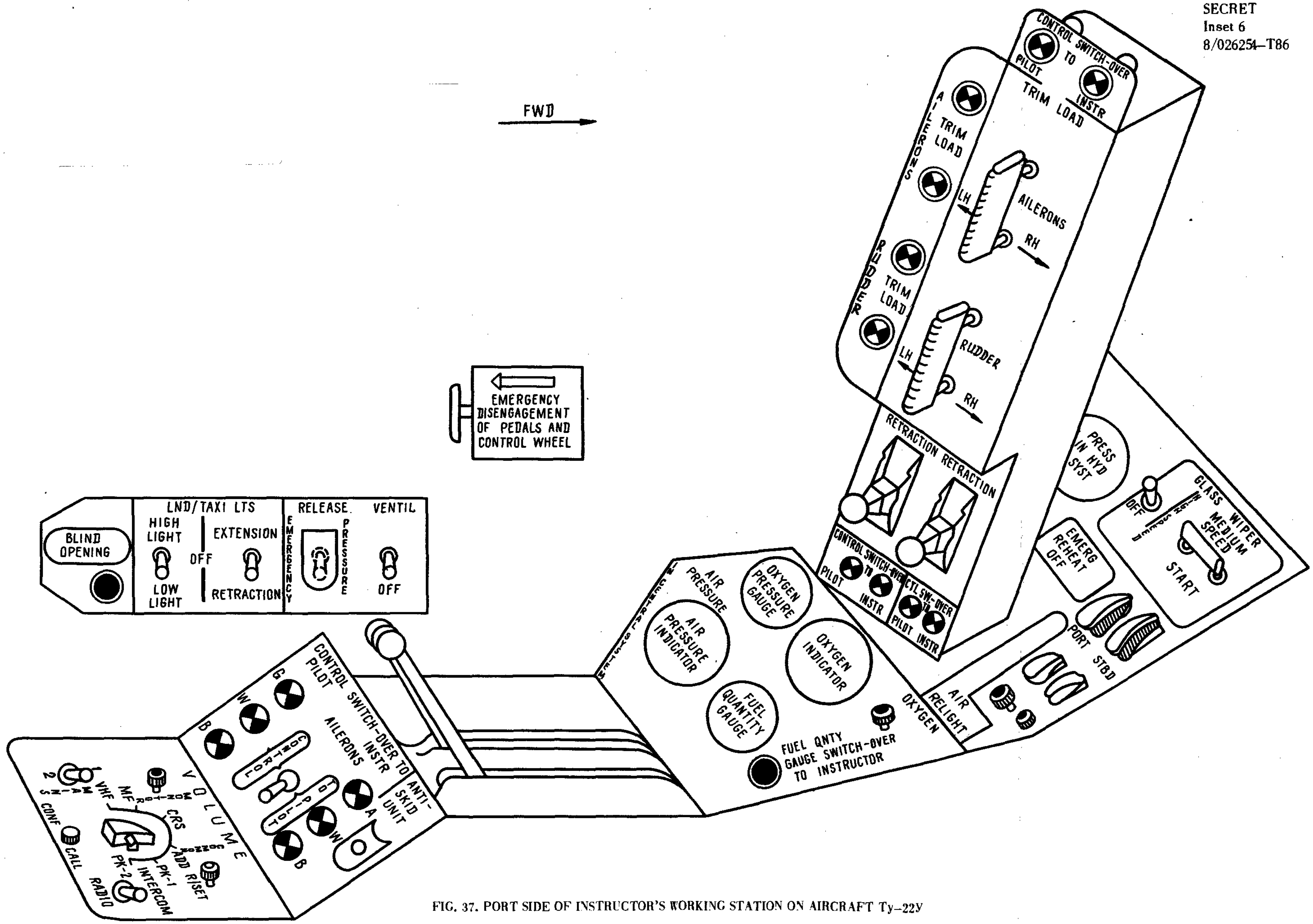

FIG. 37. PORT SIDE OF INSTRUCTOR'S WORKING STATION ON AIRCRAFT Ty–22V

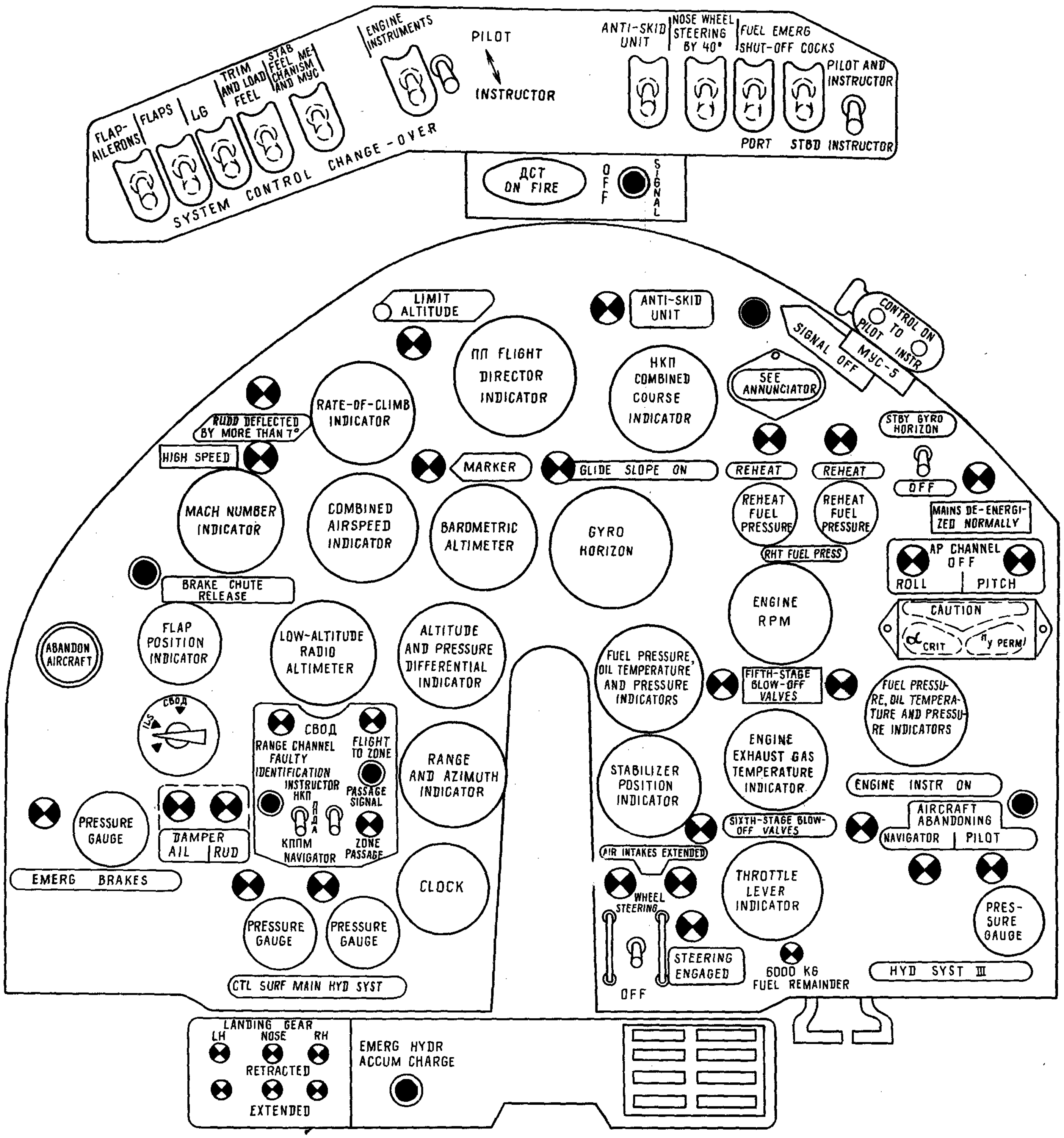

FIG. 38. INSTRUCTOR'S INSTRUMENT BOARD ON AIRCRAFT Ty-22У

SECRET
Inset 7
8/026254–T86

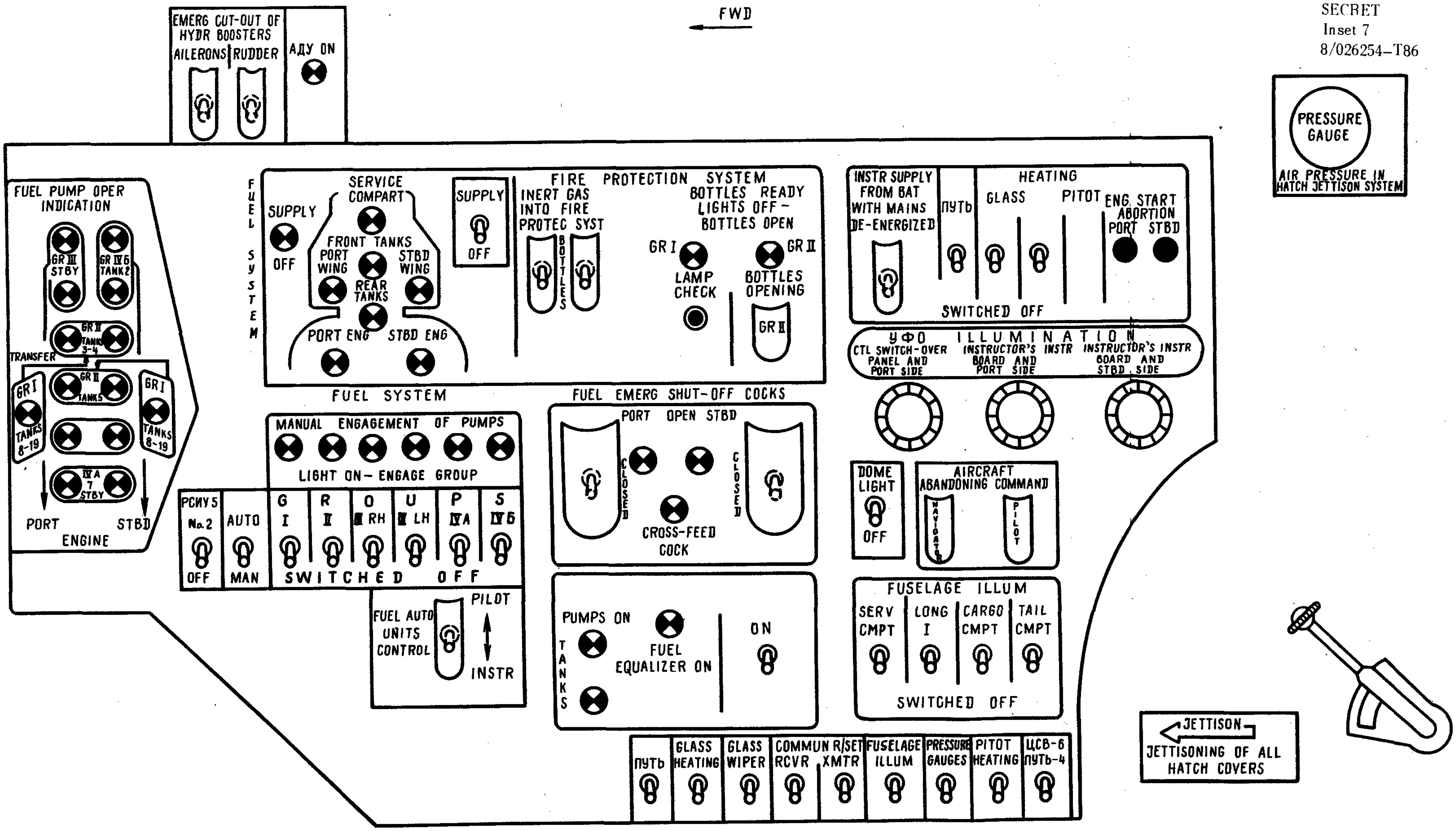

FIG. 39. STARBOARD OF INSTRUCTOR'S WORKING STATION ON AIRCRAFT Ty–22У

— altitude warning selector switch ПСВ-5 incorporated in the set of the РВ-УМ low-altitude radio altimeter.

The instructor should take into account the peculiarities of equipment arrangement at his working station since the absence of the above controls and instruments at his working station does not enable the instructor to perform some operations on controlling the aircraft systems and equipment from the instructor's working station without the pilot's intervenience.

For training the pilot and correcting his mistakes as well as for periodic checking of engine operation by reference to instruments, the instructor's working place is provided with a control panel used for switching over the systems control (the instructor's control panel).

The control switch-over panel accommodates the following switches:

— FLAP-AILERONS (ЭЛЕРОН-ЗАКРЫЛКИ);

— WING FLAPS (ЩИТКИ-ЗАКРЫЛКИ);

— LG (ШАССИ);

— TRIM AND LOAD FEEL (ТРИММЕР И ЗАГРУЖ. МЕХАНИЗМ);

— STAB FEEL MECHANISM AND МУС (ЗАГРУЖ. СТАБИЛ. И МУС);

— ENGINE INSTRUMENTS (ПРИБОРЫ ДВИГАТЕЛЯ);

— ANTI-SKID UNIT (АВТОМАТ ТОРМОЗОВ);

— NOSE WHEEL 40° STEERING (РАЗВОРОТ ПЕРЕДНЕЙ СТОЙКИ НА 40°);

— FUEL EMERGENCY SHUT-OFF COCKS (ПОЖАРНЫЕ КРАНЫ).

Setting of the above switches to the PILOT (ЛЕТЧИК) position provides control of the mechanisms from the pilot's station. In this case, the actuating switches located at the instructor's working station are the command switches (the instructor may intervene into aircraft control, if required), and the pilot may control the respective mechanisms only with the actuating switches in the instructor's cabin occupying the neutral position. When the switches are set to the INSTRUCTOR (ИНСТРУКТОР) position, the mechanisms may be controlled only from the instructor's working station while the actuating switches located at the pilot's working station are cut off.

9.5. OPERATING INSTRUCTIONS

9.5.1. Landing Gear

531. Extension/retraction of the landing gear and nose wheel steering may be controlled from the pilot's and instructor's working stations with the systems control transfer switches on the instructor's control panel and the actuating switches set to the respective position.

9.5.2. Landing Gear Extension/Retraction Control System

532. The landing gear is extended and retracted by the pilot with the help of the switch located on the trim tabs control board. In this case, the landing gear control switch located on the instructor's trim tabs control panel occupies the neutral position, and the landing gear control switch arranged on the systems control transfer panel is set to the PILOT (ЛЕТЧИК) position.

Extension or retraction of the landing gear is accomplished by the instructor by placing the switch to the EXTENDED (ВЫПУЩЕНО) or RETRACTED (УБРАНО) position.

If the landing gear control switch is set to the INSTRUCTOR (ИНСТРУКТОР) position, the landing gear extension and retraction are controlled only from the instructor's working station. The control transfer is indicated by the lights located on the pilot's and instructor's trim tabs control panels.

9.5.3. Nose Wheel Steering Control System

533. The nose wheel is turned through $\pm 7°$ ($\pm 5°$) from the pilot's and instructor's working stations with the WHEEL STEERING (РАЗВОРОТ КОЛЕСА) switch on the pilot's or navigator's control panel turned on, without depressing any buttons and irrespective of the position of other wheel steering control switches.

The nose wheel steering through $\pm 40°$ is accomplished:

— by the instructor, irrespective of the position of the switch on the systems control transfer panel and NOSE WHEEL-TO-FLAP INTERLOCK (БЛОКИРОВКА СО ЩИТКАМИ) switch on the pilot's instrument board: with the flaps retracted, after short-time depression of the button, and with the flaps extended, with the button depressed;

— by the pilot, only by setting the switch on the systems control transfer panel to the PILOT AND INSTRUCTOR (ЛЕТЧИК И ИНСТРУКТОР) position: with the flaps retracted, after short-time depression of the button, irrespective of the position of the NOSE WHEEL-TO-FLAP INTERLOCK switch; with the flaps extended, with the button depressed and only when setting the NOSE WHEEL-TO-FLAP INTERLOCK switch to the OFF (ВЫКЛ.) position.

9.5.4. Landing Gear Wheel Brake Automatic Release Control System

534. The landing gear wheel brake automatic release system is cut in by the pilot with the help of the switch located on the left-hand panel. In this case, the anti-skid unit control transfer switch on the

systems control transfer panel should be set to the PILOT AND INSTRUCTOR (ЛЕТЧИК И ИНСТРУКТОР) position.

The landing gear wheel brake automatic release system is cut in by the instructor with the help of the switch located on the engine control panel.

Operation of the landing gear wheel brake automatic release system is checked by reference to the indicator lights located on the pilot's and instructor's instrument boards.

9.5.5. Aircraft and Engine Control

Aircraft Control

535. Aircraft Ту-22У has dual control — it may be controlled both from the pilot's and instructor's working stations.

By using the switch located on his control column, the instructor may at any moment intervene into the horizontal stabilizer control with the help of the stabilizer control mechanism and fully disable stabilizer control by means of the stabilizer control mechanism from the pilot's working station by shifting the SCM (МУС) switch located on the systems control transfer panel to the INSTR (ИНСТР.) position.

The glareshields of the pilot's and instructor's instrument boards accommodate annunciators showing transfer of the stabilizer control mechanism for control from the pilot's or instructor's working station.

The position of the horizontal stabilizer is checked by the УПС stabilizer position indicators located on the pilot's and instructor's instrument boards.

To simulate the action of the aerodynamic load on the control column being deflected, the stabilizer control system incorporates a spring-loaded feel mechanism permanently included into the control system.

The stabilizer load feel mechanism may be controlled by the pilot only with stabilizer load feel mechanism switch В-45 (on the systems control transfer panel) set to the PILOT (ЛЕТЧИК) position.

The right side of the instructor's working station accommodates a control panel with two hydraulic valve control handles. The handle located closer to the cabin side is used for engagement and disengagement of hydraulic system III.

The other handle controls the stabilizer actuator control valve. The flap control system of aircraft Ту-22У differs from a similar system of aircraft Ту-22Б by an electrically-operated remote control from the instructor's working station.

The flaps are controlled from the pilot's and instructor's working stations with the help of switches (on the pilot's and instructor's trim tab control panels). By using his flap control switch, the instructor may at any moment intervene into the pilot's actions and even fully take over the flap control by placing the switch on the systems control transfer panel to the INSTRUCTOR (ИНСТРУКТОР) position.

The pilot's and instructor's trim tab control panels accommodate the annunciators showing the transfer of flap control.

Deployment and jettisoning of the brake chutes may be controlled from the pilot's and instructor's working stations.

Engine Control

536. Variation of the engine power settings is accomplished on aircraft Ту-22У synchronously from the pilot's and instructor's working stations.

The engine shut-off levers are provided only at the pilot's working station. Displacement of the throttle control levers at the instructor's working station causes turning of the throttle control lever rollers on the pilot's control panel and motion of the engine main cable control system.

The instructor's throttle control levers have no friction retention device and maximum rating transient stops. The throttle control levers are locked at the assigned power setting stops by using the retention device on the pilot's control panel. The forces required for displacing the throttle control levers are somewhat higher at the instructor's working station than those at the pilot's station.

9.5.6. Pneumatic System

537. The pneumatic system of aircraft Ту-22У additionally includes:

— two pressure gauges МВ-250: one pressure gauge for checking the pressure in the aircraft emergency escape control system, and the other, for checking pressure in the main compressed air services (accommodated at the instructor's working station);

— the hatch covers centralized jettisoning lever located at the instructor's working station;

— the cylinders used for disengagement of the instructor's control column and pedals.

9.5.7. High-Altitude and Oxygen Equipment

538. The high-altitude equipment of aircraft Ту-22У differs from similar equipment of aircraft Ту-22Б as follows:

— provision is made for dual control of emergency pressure release from the instructor's and pilot's working stations (the EMERG PRESSURE RELEASE (АВАРИЙН. СБРОС ДАВЛЕНИЯ) switch is located on the left-hand electric power supply panel at the instructor's working station);

— aircraft Ту-22У accommodates cabin altitude and differential pressure indicator УВПД-15 (at the instructor's working station).

The schematic diagram of the oxygen system and arrangement of the oxygen equipment at the navigator's and pilot's working stations are not changed.

In the instructor's cabin, the oxygen set and oxygen valve КВ-5 are installed on the engine control panel.

The oxygen feed system instruments (oxygen indicator ИК, oxygen indicator pressure gauge, oxygen differential pressure gauge М-1000 and the OXYGEN (КИСЛОРОД) amber caution light) are located on the oxygen board.

9.5.8. Fire Protection System

539. The right-hand panel of the instructor's working station accommodates the fire warning and extinguishment control panel. The fire extinguishment system controls located on the instructor's control panel duplicate the control of this equipment from the pilot's control panel which has no differences from that provided on aircraft Ту-22Б.

For putting out fire in the instructor's cabin, provision is made for portable fire extinguisher ОУ, charged with carbon dioxide, located on the starboard side.

9.5.9. Emergency Escape System

540. The emergency escape system of aircraft Ту-22У includes the instructor's ejection system instead of the operator's ejection system. The ejection procedure used by the instructor is similar to that used by the pilot and navigator.

Centralized jettisoning of the exit hatch covers is performed from the instructor's working station.

The pilot's and navigator's working stations are provided with the aircraft abandoning command annunciators.

9.5.10. Fuel Flow Automatic Control System

541. To provide checking serviceability of the system, the instructor's cabin accommodates the FUEL AUTO CTL (УПРАВЛЕН. ТОПЛИВНОЙ АВТОМАТ.) switch with the PILOT (ЛЕТЧ.) and INSTR (ИНСТР.) positions.

Concurrently with the system check performed by the pilot, the instructor makes sure that the pumps cut-in indication system operates properly and the fuel sequence is adequate by reference to the instruments located on the instructor's control panel.

After the pilot completes the systems check, the enabled controls and switches should be kept cut in.

For checking operation of the fuel flow automatic control system from his working station, the instructor should proceed as follows:

— place the switch labelled FUEL AUTO CTL (УПРАВЛЕН. ТОПЛИВНОЙ АВТОМАТ.) to the INSTR (ИНСТР.) position;

— set the AUTO — MAN (АВТОМ. — РУЧН.) switch to the AUTO (АВТОМ.) position;

— make sure that the fuel flow automatic control system operates properly by coming-on of the amber and green lights (in compliance with the aircraft fuelling variant).

9.5.11. Ground Fuel Pump Manual Control System

542. The system is checked from the pilot's working station with the FUEL AUTO CTL switch in the instructor's cabin set to the PILOT (ЛЕТЧ.) position.

After the pilot completes the system check, the enabled controls and switches should be kept cut in.

To check operation of the fuel pump manual control system from his working station, the instructor should proceed as follows:

— set the FUEL AUTO CTL switch to the INSTR position;

— place the AUTO — MAN (АВТОМ. — РУЧН.) switch to the MAN (РУЧН.) position;

— by successively turning on the filled tank group pump manual control switches, make sure that all the pumps operate by illumination of the green lights;

— turn off all the pump manual control switches and make sure that all the pumps have been cut out by extinguishment of the green indicator lights;

— place the FUEL AUTO CTL switch to the PILOT position.

9.5.12. Engine Instruments

543. The engine instrument indicators are installed on the pilot's and instructor's instrument boards.

Change-over of the indicators of pressure gauges ДИМ-80Т, pressure gauge ЭМИ-3 and thermometer 2ТВГ from the pilot's to the instructor's control and vice versa is accomplished by using the ENGINE INSTRUMENTS (ПРИБОРЫ ДВИГАТЕЛЯ) switch located on the instructor's control transfer panel.

Setting of the ENGINE INSTRUMENTS switch to the PILOT position enables the engine operation check by reference to the pilot's instruments while its setting to the INSTR position corresponds to engine operation check by reference to the instructor's instruments. In this case, two amber lights labelled SWITCHED OVER TO INSTRUCTOR (ВКЛЮЧЕНО НА ИНСТРУКТОРА) start glowing on the pilot's instrument board.

For carrying out short-time checking of engine operation by reference to the above instruments, the instructor's instrument board is provided with a button labelled ENGINE INSTR ON (ВКЛ. ПРИБОРОВ КОНТР. ДВИГАТЕЛЕЙ).

9.5.13. Engine Starting System

544. The instructor may perform the following engine starting operations from his cabin:

— in-flight air relight of the engines (with the pilot's assistance);

— monitoring of operation of the engine starting automatic control panel;

— abortion of engine starting;

— emergency disengagement of the afterburner.

The port and starboard engines may be started in flight with the help of the AIR RELIGHT (ЗАПУСК ДВИГАТЕЛЕЙ В ВОЗДУХЕ) buttons mounted on the instructor's oxygen panel. For checking operation of the engine automatic starting control panel, the instructor's oxygen panel is also provided with a white indicator light. The button and light are connected in parallel with similar equipment arranged in the pilot's cabin.

To provide abortion of engine starting, the instructor's right panel accommodates the ENG START ABORTION (ПРЕКРАЩЕНИЕ ЗАПУСК.) switch connected in series with a similar switch accommodated in the pilot's cabin. In cases of emergency, the afterburners of the port and starboard engines are disengaged with the help of two switches labelled EMERG REHEAT OFF (АВАРИЙНОЕ ОТКЛЮЧЕНИЕ ФОРСАЖА) which are mounted on the instructor's oxygen panel. The switches are connected in parallel with identical switches in the pilot's cabin.

9.5.14. Engine Air Intake Lip Control System

545. The instructor's cabin accommodates only the lip extended-position duplicating indicator lights connected in parallel with similar indicator lights in the pilot's cabin. The lights are located on the instructor's instrument board.

9.5.15. Fuel Booster Pump Control and Check System

546. To duplicate control of the fuel booster pumps and check their operation, the instructor's working station accommodates:

— the pump manual control circuit breakers;

— the MAN — AUTO (РУЧНОЕ — АВТОМАТ) switch for change-over of the pump control modes;

— the FUEL AUTO CTL (УПРАВЛЕН. ТОПЛИВНОЙ АВТОМАТ.) switch with the PILOT (ЛЕТЧ.) and INSTR (ИНСТР.) positions;

— the fuel sequence amber indicator lights;

— the booster pump operation green indicator lights;

— the fuel equalizer operation white indicator lights;

— two green indicator lights showing operation of the front and rear tank group pumps during operation of the fuel equalizer;

— the emergency fuel reserve red warning lights;

— the fuel equalizer switch.

Automatic and manual fuel consumption is controlled from the pilot's working station if the FUEL AUTO CTL switch in the instructor's cabin is set to the PILOT (ЛЕТЧ.) position. When the switch is set to the INSTR position, fuel consumption is controlled only from the instructor's working station.

The above equipment (except for the fuel remainder indicator lights) is arranged on the instructor's right-hand panel. Its arrangement on the panel is similar to that in the pilot's cabin. The emergency fuel remainder indicator lights are located on the instructor's instrument board and on the annunciator. All the above indicator lights are connected in parallel with those installed in the pilot's cabin.

The fuel equalizer and the cross-feed cock are controlled from the instructor's and pilot's working stations as follows: cut-in of the fuel equalizer and opening of the cross-feed cock are performed by the pilot and instructor irrespective of each other; the fuel equalizer is cut out and cross-feed cock is closed only after turning-off of both switches.

9.5.16. Fuel Emergency Shut-Off Cocks

547. For controlling the fuel emergency shut-off cocks of the port and starboard engines and for checking the position of these cocks, the instructor's working station accommodates:

— two switches labelled FUEL EMERGENCY SHUT-OFF COCKS (ПОЖАРНЫЕ КРАНЫ) used for controlling the fuel emergency shut-off cocks;

— two cock opening green indicator lights;

— two switches labelled FUEL EMERGENCY SHUT-OFF COCKS used for switching over the cocks control to the instructor and pilot (or to the instructor only); the switches are located on the control switch-over panel.

The control duplicating circuit is arranged so that, with switches set to the PILOT AND INSTR (ЛЕТЧ. И ИНСТР.) position, the respective fuel emergency shut-off cock may be closed by both the pilot and instructor independently of each other while cock opening may be accomplished only by setting the executive switches at the pilot's and instructor's working stations to the OPEN (ОТКРЫТО) position.

If the switch is set to the INSTR (ИНСТР.) position, the fuel emergency shut-off cocks may be closed and opened only by the instructor.

9.5.17. Flight and Navigation Instruments

548. For feeding dynamic and static pressures to the pressure-operated and barometric instruments (speed indicators, altimeters, ram pressure warning units, altitude controllers, ЦСВ-1М airspeed and altitude director sensor unit, rate-of-climb indicator, etc.), aircraft Ту-22У has eight separate manifolds supplied from four ППД Pitot tubes and four static vents.

The Pitot tubes are located on the skin outer side (two Pitot tubes on the aircraft starboard and two, on the port side).

For connecting the pilot's barometric instruments (in case of damage to one of the manifolds) to the navigator's Pitot and static pressure system, the port side of the pilot's working station accommodates two low-pressure cocks.

If the static line is damaged, the instructor's barometric instruments may be connected to the static pressure system of ram pressure warning unit ОСН-4; for this purpose, the port side of the instructor's working station accommodates a low-pressure cock.

The flight and navigation instruments are connected to the battery-supply buses and to the two-line buses which are normally connected to the aircraft mains; if the aircraft mains is de-energized, the navigator or instructor may switch over the instruments electric power supply system to the storage batteries.

9.5.18. ПУТЬ System

549. When aircraft Ту-22У is controlled with the help of the ПУТЬ system, it should be piloted by reference to two flight director indicators ПП-1 and two НКП combined course indicators.

For checking the ПУТЬ system from the instructor's cabin, it is necessary to additionally turn on the ПУТЬ circuit breaker on the instructor's circuit breakers panel and ПУТЬ switch on the instructor's right-hand panel.

The ПУТЬ system operating mode may be enabled from pilot's or instructor's control panel ПУ-30, depending on the position ("ПУТЬ" TO PILOT (ПУТЬ НА ЛЕТЧ.) or "ПУТЬ" TO INSTR (ПУТЬ НА ИНСТР.)) of the switch located on the instructor's systems control switchover panel.

If the switch is placed to the "ПУТЬ" TO INSTR position, the operating mode of the ПУТЬ flight and navigation system is enabled from instructor's control panel ПУ-30. In this case, the switch located on pilot's control panel ПУ-30 may occupy any position and the MODE FROM INSTRUCTOR (РЕЖИМ ОТ ИНСТРУКТОРА) indicator lamp should light up on the pilot's instrument board.

If the switch is set to the "ПУТЬ" TO PILOT position, the operating mode of the ПУТЬ system is enabled from pilot's control panel ПУ-30 while the mode-of-operation switch on instructor's control panel ПУ-30 may occupy any position.

9.5.19. Compass System

550. For disabling the ГА-1 stand-by gyro unit magnetic slaving (with the MAIN — STBY (ОСН. — ЗАП.) switch on control panel ПУ-1 set to the MAIN (ОСН.) position), the STBY, DG — MS (ЗАПАСНОЙ, ГПК — МК) switch is additionally provided near the panel.

9.5.20. Electric Power Sources and Aircraft Mains

551. All the controls and check instruments of the electric power sources are located on the special electric board arranged on the port side of the navigator's cabin.

In addition to the switch located at the navigator's working station, the DC electric power source control system incorporates a switch labelled INSTR SUPPLY FROM BAT WITH MAINS DE-ENERGIZED (ПИТАНИЕ ПРИБОРОВ ОТ АККУМУЛ. ПРИ ОБЕСТОЧ. СЕТИ) located on the instructor's right-hand panel. Besides, the instructor's instrument board accommodates the storage battery cut-in indicator light which comes on to illuminate when the aircraft mains supply buses get de-energized.

The instruments and systems provided in the instructor's cabin are supplied from the instructor's circuit breakers panel located on the cabin starboard. The circuit breakers panel is electrically coupled with the port side bus, except for two circuit breakers labelled HYD SYS PRES GAUGE (МАНОМЕТР ГИДРОСИСТЕМЫ) and PITOT HEATING (ОБОГРЕВ ППД) which are connected to the bus used for instruments supply from the storage batteries with the aircraft mains de-energized.

552. When handling the electrical equipment, the navigator should observe the following requirements.

1. All the DC generators should be turned on. The generator is allowed to be turned off in flight only in case of its failure, which must be reported to the instructor by the navigator.

Operation of the generators should be checked by reference to the ammeters and voltmeter. Parallel operation of the generators should be adjusted at least 30 to 40 min after the takeoff.

2. In flight, both AC generators СГС-30-8РС should be turned on. Their operation should be checked by reference to the voltmeter and red

lights. Coming-on of either light indicates generator cut-out from the aircraft mains. In this case, follow the directions of Items 473 and 474.

3. Check operation of inverters ПО-6000 by reference to the voltmeter and white indicator lights.

If inverter ПО-6000 No. 1 or 2 fails to operate, its indicator light will go out and the stand-by inverter will get automatically cut in instead of the failed inverter. In this case, the voltmeter of the failed inverter gets connected to the stand-by inverter.

In case of simultaneous failure of both main inverters ПО-6000 the stand-by inverter gets automatically cut in instead of main inverter ПО-6000 No. 2 that failed to operate.

4. Check operation of inverters ПТ-1000 by reference to the voltmeter and white light. If the light is dead, the main inverter operates; illumination of the light corresponds to operation of the stand-by inverter.

5. In case of fire on board the aircraft, as well as in case of a short circuit in the aircraft electrical system or failure of four generators, de-energize the aircraft mains and change over to electric power supply from the storage batteries. If this is the case, follow the instructions of Items 475 through 480.

6. In the event of failure or spontaneous shut-down of one of the engines, the navigator should request more accurate information from the pilot (instructor) which of the engines is inoperative and disconnect the generators of the inoperative engine from the aircraft mains by setting the switches of the generators of this engine to the lower (OFF) position.

9.5.21. Instructor's Cabin Glass and Pitot Tube Heating System

553. The instructor's cabin glass heating system is turned on by using the GLASS HEATING (ОБОГРЕВ СТЕКОЛ) switch located on the instructor's right-hand panel.

The heating system of the instructor's cabin instrument Pitot tube is enabled by using the PITOT HEATING (ОБОГРЕВ ППД) switch (located on the instructor's panel).

9.5.22. Landing/Taxi Lights

554. The lights are controlled from the pilot's and instructor's cabins. To this end, the instructor's engine control panel accommodates two switches used for controlling the landing/taxi light extension/retraction and beam switch-over.

When the instructor's switches are set to the neutral position, the landing/taxi lights are controlled from the pilot. The instructor may at any moment intervene into the pilot's actions.

9.5.23. Radio Communication Equipment

HF Communication Radio Set (НЕОН transmitter with УС-8 receiver)

555. As distinguished from aircraft Ту-22Б, aircraft Ту-22У has a different arrangement of the НЕОН transmitter remote control panel and УС-8 receiver control board, which are installed on the navigator's cabin port side.

In flight, the navigator selects the required channel on the НЕОН transmitter control panel and tunes the УС-8 receiver to the assigned frequency by the instructor's or pilot's command. When carrying on radio communication, the navigator maintains a steady reception by tuning the frequency of receiver УС-8.

Handling of Sealed Radio Equipment Pressurization Cocks

556. Open the pressurization cocks of the РАДОН and НЕОН units before taxiing out, by rotating the cock opening handwheels all the way counterclockwise. In flight, watch the pressure in the units of the РАДОН radar bombsight, ДИСС Doppler ground speed and drift meter, radio altimeter and РСИУ communication radio set to be pressure-sealed by observing the readings of the two-pointer pressure gauge.

Pointer "1" indicates pressure in the РАДОН units pressurization system, and pointer "2", in the pressurization system of the units of the ДИСС Doppler meter, РВ radio altimeter and РСИУ radio set (the pressure should be within 690 to 780 mm Hg). If the pressure rises above that indicated, close the РАДОН units pressurization cock. As soon as the pressure drops to 690—700 mm Hg, open this cock again.

If pointer "1" shows pressure below 690 mm Hg, turn off the РАДОН radar bombsight. In case of pressure drop below 690 mm Hg as indicated by pointer "2", turn off the ДИСС Doppler meter, РВ radio altimeter and give a command to the pilot and instructor to change over the РСИУ radio set to operate at a lower power.

Upon landing, close the РАДОН and НЕОН units pressurization cocks by turning the pressurization cock handwheels all the way clockwise.

Procedure Used for Establishing Intercommunication by Crew Members

557. For establishing intercommunication, the instructor should depress the INTERCOM (СПУ) button located on the control wheel (with the INTERCOM — RADIO (СПУ — РАДИО) switch on the interphone control box occupying any position) or place the INTERCOM — RADIO switch to the INTERCOM position and use any of the INTERCOM or R/SET (РАЦИЯ) buttons on the control wheel, or depress the CONF CALL (ЦВ) button on the interphone control box (with the INTERCOM — RADIO toggle switch occupying any position).

For carrying on external communication, the instructor should place the INTERCOM — RADIO switch to the RADIO position and depress the R/SET button on the control wheel, having preliminarily set the mode-of-operation switch on the interphone control box to a position corresponding to the required radio station (the INTERCOM buttons on the pilot's and instructor's control wheels are substituted by the CONF CALL (ЦВ) buttons.

Table 25

Crew member	Radio facility				
	РСИУ radio set		Communication radio set	АРК-11	РСБН
	No. 1	No. 2			
Instructor	+	+ +	+	+	+
Pilot	+ +	+	+	+ +	+ +
Navigator	+	+	+ +	+ +	+ +

NOTES: 1. The "+ +" sign indicates that the crew member controls the respective radio facility and operates in the transmission mode while the "+" sign stands for operation in the transmission mode only.

2. The pilot controls the РСБН short-range navigation and landing system only in the LANDING mode.

The possibilities of controlling the radio facilities and using them in the transmission mode by the crew members are shown in Table 25.

To enable the intercom system, the pilot should turn on the INTERCOM (СПУ) circuit breaker on the circuit breakers board and INTERCOM switch on the engine control panel.

9.5.24. Radio Navigation Equipment

РСБН Short-Range Navigation and Landing System

558. The РСБН short-range navigation and landing system set carried by aircraft Ту-22У additionally accommodates:

— the red light labelled RANGE CHANNEL FAULTY (КАНАЛ ДАЛЬНОСТИ НЕИСПРАВЕН);

— the green light labelled ZONE APPROACH (ПОДЛЕТ К ЗОНЕ);

— the red light labelled ZONE PASSAGE (ПРОЛЕТ ЗОНЫ);

— the white light labelled GLIDE SLOPE ON (РАДИОГЛИССАДА ВКЛЮЧЕНА);

— the white light labelled КППМ ON (КППМ ВКЛЮЧЕН);

— the switch labelled NAVIGATOR'S КППМ-2 — INSTRUCTOR'S НКП-4 (КППМ-2 ШТУРМАНА — НКП-4 ИНСТРУКТОРА);

— the PASSAGE SIGNAL (СИГНАЛ ПРОЛЕТА) button;

— the IDENTIFICATION (ОПОЗНАВАНИЕ) button;

— the ППДА NAVIGATOR — INSTRUCTOR (ППДА ШТУРМАН — ИНСТРУКТОР) switch;

— direct-reading range and azimuth indicator ППДА-П installed on the instructor's instrument board. The ППДА-П indicator may be connected to the output of the azimuth and range measuring units as well as to the РСБН system computer only instead of navigator's indicator ППДА-Ш. Change-over of indicator ППДА-Ш to the instructor is indicated in the navigator's cabin by coming-on of the amber light labelled ППДА — TO INSTRUCTOR (ППДА НА ИНСТРУКТОРА) located on the instrument board.

To check serviceability of the ППДА-П indicator, the instructor should proceed as follows:

— make sure that the РСБН system is enabled and that lock-on in azimuth and range has taken place;

— place the ППДА NAVIGATOR — INSTRUCTOR (ППДА ШТУРМАН — ИНСТРУКТОР) switch to the INSTRUCTOR (ИНСТРУКТОР) position;

— compare the РСБН-2 ground beacon azimuth and range readings of the instructor's ППДА indicator with similar readings of the navigator's ППДА-Ш indicator.

РВ-УМ Low-Altitude Radio Altimeter

559. The РВ-УМ radio altimeter set includes second indicator УВ-57 and second LIMIT ALTITUDE (ОПАСНАЯ ВЫСОТА) light, which are installed on the instructor's instrument board and operate in conjunction with indicator УВ-57М and LIMIT ALTITUDE (ОПАСНАЯ ВЫСОТА) light located on the pilot's instrument board.

When checking serviceability of the radio altimeter and limit altitude warning circuit, the instructor should proceed as follows:

— compare the readings of indicator УВ-57 with those of pilot's indicator УВ-57;

— make sure that the LIMIT ALTITUDE lights concurrently come on to illuminate on the instructor's and pilot's instrument boards.

9.5.25. Radar Equipment

СРЗО Aircraft Interrogator-Responder

560. The СРЗО aircraft interrogator-responder is controlled from the control panel and from the radio set control switch-over board located on the navigator's cabin starboard.

When using the interrogator-responder in flight, the navigator should proceed as follows:

— watch sound operation of the interrogator-responder by reference to illumination of the lights located on the control board;

— switch over the codes on the interrogator-responder control panel in due time;

— turn on the INTERROG (ЗАПРОС) switch for a short period of time to identify the detected target (aircraft, ship);

— turn on the КЛАПАН switch if the radar screen is cluttered with a large number of asynchronous identification marks interfering with the target identification;

— turn on the DISTRESS (БЕДСТВИЕ) switch by the instructor's (pilot's) command.

9.6. CHECKING OF AIRCRAFT READINESS FOR FLIGHT

9.6.1. Aircraft Inspection

561. When inspecting the aircraft and preparing the cabins for flight, follow the recommendations laid down in Section 4 of the present Flight Manual.

When examining the working station and preparing it for flight, the pilot should remember that the electric power sources are controlled from the navigator's cabin (therefore, the ПТ-1000 and ПО-6000 inverter cut-in commands should be given to the navigator) and the NOSE WHEEL-TO-FLAP INTERLOCK (БЛОКИРОВКА СО ЩИТКАМИ) switch should be set to the OFF (ВЫКЛ.) position.

562. The pilot together with the instructor should additionally check the serviceability of the control transfer system by following the procedure given below:

— with the actuating control switches of the flaps, landing gear, trim tabs and load feel mechanisms, horizontal stabilizer load feel mechanism and stabilizer control mechanism, anti-skid unit and nose-wheel steering mechanism occupying the neutral position, set the switches on the systems control transfer panel in the instructor's cabin to the PILOT (ЛЕТЧ.) position, which should result in illumination of the control transfer green indicator lights at the pilot's working station, and the amber indicator lights, at the instructor's working station;

— place the switches on the systems control transfer panel to the INSTR (ИНСТР.) position; this will result in extinguishment of the green indicator lights and coming-on of the amber lights at the pilot's working station as well as extinguishment of the amber lights and coming-on of the green control transfer indicator lights at the instructor's working station.

When inspecting his working station and preparing it for flight, the pilot should report his actions and the readings of the check instruments to the instructor.

563. When inspecting the working station (Figs 37 through 39) and preparing it for flight, the instructor should proceed as follows:

— adjust the foot control pedals to size and check reliable fixation of the pedals;

— turn on the circuit breaker on the right-hand panel;

— check to see that the switches are reliably shifted by the common switch bars located on the systems control transfer panel and place the switches to the PILOT (ЛЕТЧИК) position (the FUEL EMERGENCY SHUT-OFF COCKS (ПОЖАРНЫЕ КРАНЫ) switches, to the PILOT AND INSTRUCTOR (ЛЕТЧИК И ИНСТРУКТОР) position);

— check to see that all the pointers are set to the initial position and set the airfield pressure on the barometric altimeter;

— connect the headset to the interphone control box;

— by extinguishment of the lights, make sure that the navigator's and pilot's seats are set to the extreme upper position;

— request the pilot about the position of the landing gear emergency extension lever, static and dynamic pressure change-over switches, high-altitude equipment control switches and engine anti-icing system control cock.

NOTE. The above-mentioned controls located in the pilot's cabin should occupy the positions indicated in Item 11;

— give the following commands to the pilot: "Cut in circuit breakers on auxiliary board" and "Unlock ailerons and rudder";

— give the "Cut in inverters ПТ-1000Ц and ПО-6000" command to the navigator (in absence of the 36-V and 115-V 400-Hz AC ground power supply source);

— give the "Cut in РСИУ No. 1 and 2 and РВ-УМ radio altimeter" command to the pilot;

— check operation of the interphone and external communication systems as well as illumination of commands calling for emergency escape of the navigator and pilot from the aircraft;

— check operation of РВ-УМ radio altimeter indicator УВ-57;

— give a command to the pilot to cut in the localizer and glide-slope beacon receivers;

— set the ANTI-SKID UNIT (АВТОМАТ ТОРМОЗОВ) switches to the ON (ВКЛЮЧЕН.) position;

— check opening of the oxygen valve and oxygen pressure in the system;

— check the oxygen system for proper serviceability at rarefaction without pressure differential and with pressure differential; check operation of the oxygen emergency feed system;

— make sure that the throttle control lever moves without seizure and gets reliably fixed in any position; if required, give a command to the pilot to alter the degree of throttle control lever retention;

— make sure that the pointers of the УПРТ fuel-control unit lever position indicator follow the motion of the throttle control levers;

— make certain that the afterburner emergency disengagement lever caps are provided with pieces of quick-disconnect locking wire;

— make sure that the compressed air system is pressurized (the pressure in the system should be at least 120 kgf/cm^2);

— make sure that the glass wiper control switch occupies the OFF (ВЫКЛЮЧЕНО) position and the wiper speed switch is set to START (ПУСК);

— make sure that the pedal disengagement lever and control wheel buttons are locked;

— check to see that the rudder and aileron trim tabs occupy the neutral position by reference to the lights on the trim tab control panel and synchronization board;

— make sure that the landing gear and flap retraction/extension switches are neutral;

— give a command to the pilot to check serviceability of the landing gear lights; by following this command, the pilot depresses the LG LAMP CHECK (ПРОВЕРКА ЛАМП ШАССИ) button to make sure that the landing gear position red and green lights are alive;

— make sure that the taxi/landing light control switch is set to the RETRACTED (УБРАНЫ) position;

— with the assistance of the aircraft technician, check proper deflection of the rudder, ailerons and their trim tabs to full angles; the check completed, set the trim tabs to the neutral position, making reference to the indicator lights, and request the ground signalman of the trim tabs position;

— using the electrically-operated stabilizer control mechanism, check deflection of the horizontal stabilizer by reference to the stabilizer position indicator; the check completed, return the horizontal stabilizer to the initial position.

NOTE: On the ground, it is allowed to deflect the horizontal stabilizer by using the stabilizer control mechanism not more than three times through angles not exceeding $\pm 3°$;

— turn on the STBY GYRO HORIZON (РЕЗЕРВН. АГ) switch; the time required for the gyro horizon to come to the working state is not over 1.5 min;

— turn on the ПУТЬ switch;

— give a command to the navigator to vary the aircraft headings in the DG (directional gyro) mode; in this case, the present heading indicator on the НКП combined course indicator should follow the magnitudes preset by the navigator accurate within $\pm$ (1—1.5)°;

— set the ILS (СП) or СВОД mode on control panel ПУ-30; by following the instructor's command, the navigator sets new (higher or lower) heading magnitudes by turning the knob on control panel РУ-1 and the pilot makes sure that the command bars deflect to the right or to the left;

— check the position and locking of the exit hatch cover common and individual jettisoning handles;

— check the safety cap of the brake chute deployment button for smooth opening; close the cap;

— check the stabilizer hydraulic booster control lever for smooth travel and reliable fixation and set it to the extreme rear position;

— check to see that the lever used for engagement of hydraulic system III is set to OFF; the pressure in hydraulic system III should be at least 150 kgf/cm^2;

— check correspondence of aircraft fuelling to the flight mission; to this end, depress the button labelled FUEL QNTY GAUGE SWITCHOVER TO INSTRUCTOR (ПЕРЕКЛЮЧЕНИЕ ТОПЛИВОМЕРА НА ИНСТРУКТОРА) and request the pilot of the quantity of fuel indicated by the fuel quantity gauge or give a command to the pilot to check the fuel quantity in the tanks if the fuel quantity gauge is not installed in the instructor's cabin;

— place the FUEL AUTO CTL (УПРАВЛЕН. ТОПЛИВНОЙ АВТОМАТ.) switch to the INSTR (ИНСТР.) position, and the AUTO — MAN (АВТОМ. — РУЧН.) switch, to the MAN (РУЧН.) position;

— successively turn on the fuel pump manual control system switches and observe illumination of the green lights to ensure serviceability of all the fuel booster pumps;

— place the AUTO — MAN (АВТОМ. — РУЧН.) switch to the AUTO (АВТОМ.) position and watch coming-on of the lights in compliance with the fuel sequence to make sure that the fuel automatic control system is serviceable;

— set the FUEL AUTO CTL switch to the PILOT (ЛЕТЧИК) position;

— cut in the fuel equalizer and within 20 to 30 s observe illumination of the lights to make sure that the fuel equalizer is serviceable; the check completed, cut out the fuel equalizer;

— set the ANTI-SKID UNIT switch to the ON position, the ПУТЬ switch also to the ON position, the NOSE WHEEL STEERING (РАЗВОРОТ ПЕРЕДНЕЙ НОГИ) switch to the OFF (ВЫКЛЮЧЕН) position and the FUEL EMERGENCY SHUT-OFF COCKS (ПОЖАРНЫЕ КРАНЫ) switch, to the OPEN (ОТКРЫТО) position;

— fix the switches labelled FUEL EMERGENCY SHUT-OFF COCKS in the open position by using the hinge caps;

— make sure that the LG (ШАССИ) and FLAPS (ЗАКРЫЛКИ) switches are neutral.

564. After taking the ejection seat, the navigator should proceed as follows:

— perform visual inspection of the НЕОН transmitter and УС-8 receiver;

— make sure that the aircraft electric power supply system is connected to the 27-V DC and 115-V 400-Hz AC ground power sources;

— enable the HF communication radio set and check its operation;

— cut in the intercom by turning on the INTERCOM (СПУ) circuit breaker on the pilot's circuit breaker board and the INTERCOM switch;

— set the INTERCOM — RADIO (СПУ — РАДИО) switch on the interphone control box to the RADIO (РАДИО) position, and the mode-of-operation switch knob, to the MF (СР) position;

— turn on the circuit breaker labelled COMMUN R/SET XMTR — RCVR (СВЯЗНАЯ РАЦИЯ ПЕРЕДАТЧИК — ПРИЕМНИК) on the instructor's circuit breaker panel;

— turn on the HEOH switch on the navigator's control board;

— cut in receiver УС-8; to this end, set the mode-of-operation switch on the navigator's receiver remote control board to the VOICE WITH AGC (ТЛФ С АРУ) position;

— select the required channel on the HEOH transmitter control board and tune the УС-8 receiver to the assigned frequency;

— check presence of sidetone monitoring;

— establish contact with the ground radio station and obtain its affirmative on normal operation of the radio set;

— check operation of the radio set in the CW mode;

— cut out the radio set.

To check operation of the СРЗО interrogator-responder on the ground, proceed as follows:

— turn on the IFF TRANSPONDER (СРЗО) circuit breaker on the power supply circuit breaker board located on the navigator's cabin port side;

— turn on the SUPPLY (ПИТАНИЕ) toggle switch on the control panel;

— check proper selection of codes on the СРЗО interrogator-responder control panel;

— check normal operation of the interrogator-responder by observing illumination of the indicator lights; normal operation of the interrogator-responder may be identified by illumination of indicator lights labelled CODE ENABLED XMTR DECODER (КОД ВКЛЮЧЕН. ПЕР. ДШ) and SUPPLY CHECK (КОНТРОЛЬ ПИТАНИЯ); in case of irradiation, the RESPONSE INDIC (ИНДИК. ОТВЕТА) neon light should illuminate in the flickering mode;

— turn off the СРЗО interrogator-responder.

When inspecting the cabin and preparing it for flight, the navigator should proceed as follows:

— check for voltage of the aircraft storage batteries with the battery switches turned on;

— refer to the voltmeter to check for voltage of the ground power supply sources and aircraft electrical system; to this end, successively set the voltmeter switch to the РАП and AC MAINS (БОРТСЕТЬ) positions;

— turn on all the circuit breakers on the left-hand electric power supply board;

— turn on inverters ПТ-1000, ПО-6000 by following the pilot's or instructor's command and check their voltage which should be within 34 to 38 V and 112.5 to 117.5 V, accordingly.

CAUTION. WHEN THE AIRCRAFT ELECTRICAL SYSTEM IS SUPPLIED FROM THE GROUND POWER SOURCE, IT IS ALLOWED TO TURN ON INVERTERS ПО-6000 ONLY IF THE GROUND ELECTRIC POWER UNIT HAS AN EQUAL OR HIGHER POWER.

9.6.2. Preparation of Engines for Starting

565. Start the engines from the pilot's cabin. When starting the engines, follow the directions of Items 19 through 29.

Before starting the engines, request the engine start readiness affirmative from the aircraft navigator and technician over the intercom.

When preparing the engines for starting, the crew members should proceed as follows:

(a) navigator:

— check for the aircraft mains voltage (it should be 24 to 28 V);

— turn off all the electric power consumers (at night, the light indicators and cabin illumination should remain switched on);

— make the following report to the pilot: "Voltage normal, ready to start engines";

(b) pilot:

— make sure that the parking brake is applied;

— on obtaining the engine start readiness report from the navigator and ground signalman, report the engine start readiness to the instructor and request the engine start clearance from the flight control officer by following the instructor's command; on obtaining the engine start clearance, start the engines in compliance with the recommendations of Section 4 of the present Flight Manual;

(c) instructor:

— check to see that the fuel emergency shut-off cocks are open;

— cut in the fire protection system; in this case, the indicator lights should be dead and the light indicating readiness of the first-shot fire extinguishers should come on;

— check the position of the fuel system automatic control unit switches.

9.6.3. Engine Starting, Warm-Up and Run-Up

566. In the process of engine starting, warm-up and run-up, the instructor should proceed as follows:

— check to see that the pilot's actions are correct (by listening to his reports);

— watch the engine power settings by observing the readings of the УПРТ fuel-control unit lever position indicator, ИТЭ tachometer indicator, indicator lights showing the position of the compressor sixth- and fifth-stage blow-off valves as well as by illumination of the REHEAT (ФОРСАЖ) lights;

— set (if required) the ENGINE INSTRUMENTS (ПРИБОРЫ ДВИГАТЕЛЯ) switch on the control transfer panel to the INSTRUCTOR (ИНСТРУКТОР) position or depress the button labelled ENGINE INSTR ON (ВКЛЮЧЕНИЕ ПРИБОРОВ КОНТРОЛЯ ДВИГАТЕЛЕЙ) on the instrument board to check the engine operation parameters by reference to engine-gauge indicator УИЗ, temperature gauge 2ТВГ and indicator УИП-80;

— check proper keeping to the time of engine acceleration to the idle speed;

— if required, discontinue the engine starting by depressing the buttons labelled LH (RH) ENG START ABORTION (ПРЕКРАЩЕНИЕ ЗАПУСКА ЛЕВОГО (ПРАВОГО) ДВИГАТЕЛЯ).

567. During engine starting, the navigator should proceed as follows:

— on reporting the engine start readiness to the pilot, watch the voltmeter readings;

— by following the pilot's command, check the voltage of both generators (the pilot orders the navigator to check the generators after engine acceleration to RPM of 37 %); if the voltage across one of the generators is below 25 V, report the necessity of engine shut-down to the pilot to reveal the cause of voltage drop; make a similar check when starting the other engine;

— after starting the other engine, check for voltage across all the generators by successive shifting of the voltmeter switch to the GEN 1 (1 ГЕН.), GEN 2 (2 ГЕН.), GEN 3 (3 ГЕН.) and GEN 4 (4 ГЕН.) positions;

— connect the generators to the aircraft electrical system, cut out the РАП external power connector and check for generator voltage (which should be within 28 to 28.5 V); if the voltage surpasses these limits, adjust the voltage;

— turn on inverters ПО-6000 Nos 1 and 2 and ПТ-1000, check uniformity of load distribution between all the generators by the ammeter readings (the generator load should not exceed 200 A with the engines running on the ground and 600 A in flight);

— check for voltage across inverters ПО-6000 (it should be within 112.5 to 117.5 V); normal operation of the inverters is indicated by illumination of the white lights;

— check the voltage (by referring to the voltmeter) and operation of stand-by inverter ПО-6000 when cut in instead of main inverter ПО-6000 No. 1 or 2;

— check for voltage across main and stand-by inverters ПТ-1000 (it should be within 35.5 to 36.5 V);

— cut in AC generators СГС-30-8; this should result in coming-on of red indicator lights; extinguishment of the lights on expiration of 6 s testifies to normal energizing of the generators (their voltage should be within 207.5 to 208.5 V);

— connect the aircraft storage batteries to the aircraft electrical system;

— report normal operation of the electric power sources to the pilot, after which turn on the required consumers.

568. The instructor should set the STBY GYRO HORIZON (РЕЗЕРВ. АГ) and ПУТЬ switches to the ON (ВКЛЮЧЕНО) position.

9.6.4. Checking of Controls and Equipment with Engines Running

569. Check the controls from the pilot's cabin in compliance with the requirements of Items 30 through 38.

When checking the aircraft control system, the pilot reports his actions, instrument readings and operation of the indication system to the instructor.

When the instructor checks the aircraft control system from his cabin, the pilot, following the instructor's commands, makes the required manipulations of the controls which are not available in the instructor's cabin.

The stabilizer control as well as operation of pitch dampers ДТ, stability automatic controller АУ, double-channel damper Д2К, feel simulator controller АДУ and other control systems are checked by the pilot before flight from his working station in compliance with the requirements of Items 30 through 38.

570. From his working station the instructor checks the extreme positions of the stabilizer with two hydraulic systems cut in (after performing a full scope of checks from the pilot's cabin).

CAUTION. IT IS FORBIDDEN TO CHECK THE AIRCRAFT CONTROL SYSTEM FROM THE PILOT'S AND INSTRUCTOR'S CABINS AT ONE AND THE SAME TIME.

9.6.5. Preparation of Equipment and Its Checking by Navigator

571. When preparing and checking the equipment, the navigator should follow the requirements of Items 39 and 40 (within the scope of duties assigned to the navigator and operator).

9.7. FLIGHT PERFORMANCE

9.7.1. General

572. When flying on aircraft Ту-22У, follow the requirements of Section 5 of the present Flight Manual, taking into account the peculiarities of equipment arrangement in the pilot's and instructor's cabins.

9.7.2. Crew's Observation Duties and Communication Procedures

573. For the crew's observation duties, follow the requirements of Item 41. The instructor should perform observation of the forward hemisphere, duplicating the pilot's observation duties, and the navigator, the bottom hemisphere.

When performing flights in the airfield area, all the crew members should maintain VHF radio communication. For this purpose, the radio aids selector switch on the pilot's and instructor's interphone control boxes should be set to the VHF (УКР) position, and the INTERCOM — RADIO (СПУ — РАДИО) switch, to the RADIO (РАДИО) position; the RADIO and COMMON (ОБЩАЯ) volume controls on the interphone control boxes of all the crew members should be set to the extreme right-hand position.

Two-way radio command communication with the flight control officer should be maintained by the pilot while the navigator and instructor should operate in the reception mode.

To establish the intercommunication contact with the crew, the pilot and instructor should depress the INTERCOM (СПУ) button, and the navigator, the CONF CALL (ЦИРКУЛЯРНЫЙ ВЫЗОВ) button.

9.7.3. Engine Shut-Down and Relight in Flight

574. In case of the engine shut-down and relight in flight, the crew should follow the directions of Items 393 through 396. To shut down the engine by the instructor's command, the pilot should proceed as follows:

— inform the crew of which engine he is going to shut down;

— be ready to counteract aircraft bank, pitch and yaw instability;

— reduce the engine RPM to idle rating and let the engine run at this rating for 1 to 2 min;

— shift the shut-off lever of the port (starboard) engine to the SHUT-OFF (ОСТАНОВ) position and report your actions to the instructor;

— give the following command to the navigator: "Cut out port (starboard) engine generators".

575. When starting the engine, the instructor should proceed as follows:

— give the following command to the pilot: "Get ready to start port (starboard) engine", on this command, the pilot should check the engine operating parameters as laid down in Item 395 and report his readiness to start the port (starboard) engine to the instructor;

— make sure that the throttle control lever of the engine being started is set to the IDLE (МАЛЫЙ ГАЗ) position, and the shutoff lever, to the SHUT-OFF (ОСТАНОВ) position (on pilot's report);

— on obtaining the engine start readiness report from the pilot, depress the button labelled PORT (STBD) ENGINE AIR RELIGHT (ЗАПУСК ЛЕВОГО (ПРАВОГО) ДВИГАТЕЛЯ В ВОЗДУХЕ) for 1 to 2 s and make sure that the engine starting control units start operating (to be ascertained by coming-on of the white indicator light); if the light have failed to come on, keep the button depressed throughout the entire engine starting procedure but for no more than 60 s;

— after the engine starting control units have come to operate, give the following command to the pilot: "Shift the shut-off lever of the port (starboard) engine to the ENG START (ЗАПУСК) position"; on this command, the pilot shifts the shut-off lever of the engine being started to the ENG START (ЗАПУСК) position and makes the following report to the instructor "The shut-off lever of the port (starboard) engine is set to the ENG START (ЗАПУСК) position", checking engine acceleration to the altitude idle speed by referring to increase of RPM and exhaust gas temperature; if the exhaust gas temperature exceeds 660°, discontinue the engine starting; to this end, he should shift the engine shut-off lever to the SHUT-OFF (ОСТАНОВ) position and make a report to the instructor that engine starting have been aborted because of high exhaust gas temperature;

— after the engine has accelerated to the altitude idle speed, give the following command to the navigator: "Cut in generators of port (starboard) engine";

— select the engine rating required for executing the flight and check the engine operation parameters.

9.7.4. Taxiing and Shut-Down of Engines

576. Prior to starting taxiing, in the process of taxiing, when taxiing to the parking site and shutting down the engine, the pilot should act in compliance with Items 45 through 48 and 99 through 101. Besides, prior to starting the taxiing, the pilot should make sure that the NOSE WHEEL-TO-FLAP INTERLOCK (БЛОКИРОВКА СО ЩИТКАМИ) switch is set to the OFF (ВЫКЛ.) position.

577. The peculiarities involved in taxiing out from the parking site by the instructor lie in the following:

— prior to starting the taxiing, the instructor gives the "Follow pre-taxiing drill chart" command to the navigator (the navigator's questions are answered by the pilot who makes the respective checks in his cabin while the instructor carries out general supervision and checks the position of the controls and instrument readings in his cabin);

— on obtaining the taxiing clearance from the flight control officer, the instructor gives the following command: "Crew, taxiing out. Pilot, release parking brake". Further taxiing is carried out in compliance with Items 45 through 48.

The peculiarities involved in taxiing in to the parking site by the instructor and the engine shut-down lie in the following:

— after taxiing in to the parking site, disengage the nose wheel steering mechanism and give the following command to the pilot: "Apply parking brakes, cut out cabin pressurization (ventilation) system";

— on making sure that the horizontal stabilizer have been trimmed to zero, order the crew to cut out the electric power consumers and hydraulic boosters;

— on listening to the reports of the crew members that the electric power consumers and hydraulic boosters have been cut out, give the "Cut out generators" command to the navigator and "Shut down engines" command to the pilot; following the "Cut out generators" command, the navigator shifts the generator switch common bar to the lower position;

— without waiting for the engine rotors to stop, give the following command to the pilot: "Cut out pumps, depressurize cabin and close fuel emergency shut-off cocks"; on listening to this command, the pilot should set the AUTO — MAN (АВТОМ. — РУЧН.) switches to the MAN (РУЧН.) position and relieve pressure in the pressurization hoses while checking to see that the pressure indicated by the pressure gauge drops to zero; after the rotors come to a complete standstill, he should place the switches of the fuel emergency shut-off cocks to the CLOSED (ЗАКРЫТО) position and report his actions to the instructor.

578. After the engines are shut down, the pilot should give the "Cut out batteries" command to the navigator; on listening to this command, the navigator should shift the battery switches to the OFF (ВЫКЛЮЧЕНО) position.

NOTE. If taxiing in to the parking site is performed by the pilot, he should follow the directions of Item 99.

9.7.5. Preparation for Takeoff and Execution of Takeoff by Instructor

579. In addition to performing the operations laid down in Items 49 and 50, the instructor should proceed as follows:

— before stopping the aircraft in the holding position, set the flap control switch to the EXTENSION (ВЫПУСК) position and make sure that the nose wheel steering mechanism have passed over from great angles to small ones;

— when on the holding line, make sure that the switches on the systems control transfer panel are set to the PILOT (ЛЕТЧИК) or PILOT AND INSTRUCTOR (ЛЕТЧИК И ИНСТРУКТОР) position;

— cut in the Pitot tube heating system (not earlier than 1 to 2 min before the takeoff);

— in case of precepitation, turn on the glass wiper and select the required speed for the wiper brush;

— after stopping the aircraft at lineup, give the following command to the pilot: "Apply parking brake, adjust throttle control lever retention";

— on aircraft with flap-ailerons, check to see that the FLAP-AILERONS — AILERONS (ЭЛЕРОН-ЗАКРЫЛКИ — ЭЛЕРОНЫ) switch is set to the AILERONS (ЭЛЕРОНЫ) position (which is indicated by illumination of the white lights);

— on obtaining the takeoff clearance, accelerate the engines to the takeoff power (when shifting the throttle control levers, check them for retention to preclude moving-off of the levers during the takeoff);

— depress the brake pedals and give the "Release parking brake" command to the pilot.

The procedure used for performing the takeoff from the instructor's cabin is similar to that involved in executing the takeoff from the pilot's cabin.

The instructor cannot see the nose fuselage from his cabin but it does not impair the accuracy of maintaining the pitch angle by reference to the position of the canopy frame relative to the natural horizon.

9.7.6. Landing

580. Before the landing approach, determine the amount of the remaining fuel and its distribution among the tank groups or request the fuel load from the pilot if the fuel quantity gauge is not installed in the instructor's cabin.

If required, select different power settings to consume the required amount of fuel from the tanks to maintain the required aircraft c.g. position.

When on the prelanding glide path, give the "Release throttle control lever retention device" command to the pilot.

The procedure used for executing landing from the instructor's cabin does not differ from that involved in performing landing from the pilot's cabin. A higher location of the instructor's cabin causes no errors in determining the distance to the ground in the process of landing.

9.7.7. Night-Time Flying

581. When preparing for a night-time flight, follow the procedure laid down in Item 184; besides, make the following checks in the instructor's cabin:

— reliability of controlling the taxi/landing lights extension and retraction;

— switch-over to the high and low beams;

— operation of all УФО ultra-violet lighting lamps and their rheostats as well as of the КЛСРК cabin white-light fittings and domes;

— the direction of the beam light and the intensity of light given by the УФО lamps; in so doing, diminish the mat screen on the glass surface with the instrument readings well illuminated (the screening effect arising from illumination of the cabin windshields by the УФО ultra-violet lighting lamps considerably impairs visibility through them and complicates the piloting technique during the takeoff).

After the instructor-controlled takeoff, pass to flying on instruments immediately after the aircraft clears the ground.

The flight papers may be read in flight only with the white cabin lights turned on. When turning on the white cabin lights, give the "Intensify air circumspection" command to the crew.

9.8. FLIGHT EMERGENCY PROCEDURES

9.8.1. General

582. When emergency situations occur in flight, the crew of aircraft Ту-22У should follow the regulations laid down in Section 8. Besides, the instructor should do the following:

— in case of unsteady operation and surge of the engines, set the ENGINE INSTRUMENTS (ПРИБОРЫ ДВИГАТЕЛЕЙ) switch to the INSTRUCTOR (ИНСТРУКТОР) position immediately on listening to the pilot's report and act in compliance with the nature of the failure; if it is necessary to shut down the engine, give the engine shut-down command to the pilot;

— in case of failure of the fuel automatic control system and fuel booster pumps, immediately set the FUEL AUTO CTL (УПРАВЛЕН. ТОПЛИВНОЙ АВТОМАТ.) switch to the INSTRUCTOR position and act by following the procedure indicated in Items 410 through 413; in so doing, mind the following: the cross-feed cock is controlled by the pilot by following the commands given by the instructor who requests the fuel level in the tanks and fuel distribution between the tanks from the pilot if the fuel quantity gauge is not installed in the instructor's cabin;

— if it becomes necessary to dump fuel in the emergency way in flight, give the following command to the pilot: "Dump fuel from tanks Nos ...." (tank Nos should be mentioned).

9.8.2. Abandoning of Aircraft in Emergency

583. When abandoning aircraft Ту-22У in emergency, follow the general regulations laid down in Items 509 through 526, taking into account the following peculiarities:

— the aircraft may be abandoned by the crew members during execution of introductory and check-out flights only by the instructor's command in the following succession: pilot, navigator, instructor;

— in ferry flights (with the radio operator occupying the instructor's place), only the pilot gives the aircraft abandoning command to the crew; in this case, the crew members abandon the aircraft in the following succession: radio operator, navigator, pilot.

If it is necessary to leave the aircraft on the ground, the instructor should jettison the entrance hatch cover (if the aircraft is supported by the landing gear) or the emergency exit sliding window (left or right).

To facilitate opening of the right-hand sliding window, it is necessary to deflect the hydraulic booster emergency cut-out panel downward and shift the control column return valve handle to the CLOSED (ЗАКРЫТО) position.

APPENDICES

Appendix 1

AIRCRAFT TEST FLIGHT

1. General

1. The aircraft test flight is performed with a view to evaluating the aircraft flight performance as well as checking the engines, aircraft units and systems, aviation and radio/radar equipment, and armament for proper operation.

2. For performing a test flight, the most experienced first-grade pilots occupying a position of no lower than the air detachment commander are appointed by the order of the air unit commander.

3. When preparing for the test flight and when performing this flight, act in compliance with the flight regulations, flight operating instructions of the aircraft, engine and equipment as well as by following the directions of the respective authorities.

4. It is allowed to perform the test flights in the following weather conditions:

— cloud amount — 10, cloud base height — at least 500 m;

— horizontal near-ground visibility — at least 5 km;

— the operational altitudes free of clouds and bumpy air; horizontal visibility — at least 6 km.

5. When the test flight is performed after replacement of the pitch damper, stability automatic controller, feel simulator controller and stability automatic controller and pitch neutral setting system as well as after introduction of certain alterations, performing scheduled maintenance operations involving the removal of the above equipment, the aircraft takeoff, with the pitch damper and stability automatic controller operating in the NORMAL (НОРМАЛЬНО) mode may be allowed only after checking serviceability of the pitch damper and stability automatic controller in the EMERGENCY (АВАРИЙНО) mode by performing special taxiing.

6. After each test flight, the aircraft should be inspected in the scope of postflight inspection by a commission appointed by the air squadron deputy commander for the air engineering service.

7. After the test flight, the air squadron deputy commander for the air engineering service should carry out a postflight critique with the air crew and respective specialists of the air engineering service.

8. The test flight results should be entered into the flight record sheet; the respective entry should be made in the aircraft Log Book (in the "Aircraft Condition Checkup" Section).

9. The air unit deputy commander for the air engineering service will take a decision as to the necessity of a repeated test flight.

10. After performing the test flight, the aircraft is cleared to fly other missions by the air unit deputy commander for the air engineering service.

Test flights are performed:

— after aircraft acceptance from the Manufacturing plant or from other air unit;

— after carrying out preventive maintenance;

— after performing 100- and 200-h scheduled maintenance;

— after prolonged (for more than a month) parking;

— after replacement of the engines (engine);

— after modification to the control system, replacement of hydraulic boosters, rate gyros ДУС, relay and amplifier unit РУБ and servo unit РАУ of any of the channels of pitch damper ДТ and stability automatic controller АУ, rate gyros ДУС and unit БПН of the СПН stability automatic controller and pitch neutral setting system as well as limiter clutch МОП and limiting box КОП of the АДУ feel simulator controller and autopilot; in other cases, by the order of the air unit senior officers (occupying a position of no lower than air unit deputy commander for the air engineering service).

2. Test Flight Program

Test flight procedure	During aircraft acceptance	After preventive maintenance	After interval in flights exceeding one month	After 100-h scheduled maintenance	After 200-h scheduled maintenance	After replacement of engines (engine)	After modification to control system, replacement of servo units and ДУС, РУБ and РАУ units of any pitch damper ДТ, stability automatic controller АУ and rate gyros, БПН unit of СПН stability automatic controller and pitch neutral setting system as well as МОП and КОП units of АДУ feel simulator controller, autopilot, hydraulic units of hydraulic system III	Remarks
Preparation for Taxiing and Taxiing								
1. Check the interphone and radio communication systems for proper operation	+	+	+	+	+	+	+	
2. Start and run up the engines (check to see that the readings of the engine instruments comply with requirements of this Flight Manual)	+	+	+	+	+	+	+	
3. Check the operating parameters of all the aircraft systems with the engines running	+	+	+	+	+	+	+	
4. Check the fuel amount in the tanks by reference to the fuel quantity gauges (make sure that the flowmeter indicator readings correspond to the fuel amount in the tanks; check serviceability of the tank group fuel consumption indication system)	+	+	+	+	+	+	+	
5. Taxi out from the parking site	+	+	+	+	+	+	+	

Continued

Test flight procedure	During aircraft acceptance	After preventive maintenance	After interval in flights exceeding one month	After 100-h scheduled maintenance	After 200-h scheduled maintenance	After replacement of engines (engine)	After modification to control system, replacement of servo units and ДУС, РУБ and РАУ units of any pitch damper ДТ, stability automatic controller АУ and rate gyros, БПН unit of СПН stability automatic controller and pitch neutral setting system as well as МОП and КОП units of АДУ feel simulator controller, autopilot, hydraulic units of hydraulic system III	Remarks
6. Check operation of the nose wheel steering system in the process of taxiing with the wing flaps retracted and extended	+	+	+	+	+	+	+	
7. Check operation of the main and emergency brakes as weel as proper operation of the pitch damper and stability automatic controller	+	+	+	+	+	+	+	
8. Taxi out to the runway	+	+	+	+	+	+	+	
9. Perform special taxiing to determine proper operation of the pitch damper and stability automatic controller	+	+	+	+	+	+	+	
Takeoff Run								
1. Perform full-scope preparation for takeoff, turn on the afterburner, set the throttle control levers to 95 divisions as read by the УПРТ indicator, release the parking brake and start the takeoff run		+	+		+			
2. Check proper holding of direction by the aircraft during its motion along the runway		+	+		+			

Continued

Test flight procedure	During aircraft acceptance	After preventive maintenance	After interval in flights exceeding one month	After 100-h scheduled maintenance	After 200-h scheduled maintenance	After replacement of engines (engine)	After modification to control system, replacement of servo units and ДУС, РУБ and РАУ units of any pitch damper ДТ, stability automatic controller АУ and rate gyros, БПН unit of СПН stability automatic controller and pitch neutral setting system as well as МОП and КОП units of АДУ feel simulator controller, autopilot, hydraulic units of hydraulic system III	Remarks
3. At a speed of 120 to 150 km/h, stop the takeoff run, set the throttle control levers to the IDLE (МАЛЫЙ ГАЗ) position, extend the brake chute and start braking the aircraft		+	+		+			
4. In the course of brake application, check the effectiveness of the brakes and anti-skid units (by flickering of the light)		+	+		+			
5. At a speed of 50 to 60 km/h, check operation of the emergency brake (till the aircraft comes to a complete standstill)		+	+		+			
6. On completing the run, taxi to the aircraft inspection site and shut down the engines to carry out the operations in compliance with Maintenance Schedule No. 16 (the "Preparation for Repeated Flight with Engines Shut Down" Section)		+	+		+			

Continued

Test flight procedure	During aircraft acceptance	After preventive maintenance	After interval in flights exceeding one month	After 100-h scheduled maintenance	After 200-h scheduled maintenance	After replacement of engines (engine)	After modification to control system, replacement of servo units and ДУС, РУБ and РАУ units of any pitch damper ДТ, stability automatic controller АУ *and rate* gyros, БПН *unit* of СПН stability automatic controller and pitch neutral setting system as well as МОП and КОП units of АДУ feel simulator controller, autopilot, hydraulic units of hydraulic system III	Remarks
Execution of Flight Prepare for flight and carry out flight in strict compliance with the Flight Manual. When performing the test flight, check serviceability of all the aircraft systems and aircraft equipment. CAUTION. *WHEN PERFORMING* THE TEST FLIGHT AFTER REPLACEMENT OF THE PITCH DAMPER, STABILITY AUTOMATIC CONTROLLER, FEEL SIMULATOR CONTROLLER AND STABILITY AUTOMATIC CONTROLLER AND PITCH NEUTRAL SETTING SYSTEM OR THEIR UNITS, ACCOMPLISH TAKEOFF WITH THE PITCH DAMPER AND STABILITY AUTOMATIC CONTROLLER TURNED ON AFTER CHECKING THEIR SERVICEABILI-								

Continued

Test flight procedure	During aircraft acceptance	After preventive maintenance	After interval in flights exceeding one month	After 100-h scheduled maintenance	After 200-h scheduled maintenance	After replacement of engines (engine)	After modification to control system, replacement of servo units and ДУС, РУБ and РАУ units of any pitch damper ДТ, stability automatic controller АУ and rate gyros, БПН unit of СПН stability automatic controller and pitch neutral setting system as well as МОП and КОП units of АДУ feel simulator controller, autopilot, hydraulic units of hydraulic system III	Remarks
TY IN THE PROCESS OF SPECIAL TAXIING. IN SO DOING, THE LIMIT C.G. POSITIONS OF THE AIRCRAFT DURING TAKEOFF SHOULD BE WITHIN 36 TO 37 % MAC (WITH THE LANDING GEAR EXTENDED)								
1. Perform takeoff and check:								
— proper holding of direction by the aircraft moving along the runway	+	+	+	+	+	+	+	
— the unstick speed (by the navigator's report)	+	+	+	+	+	+	+	
— the aircraft behaviour in the process of unsticking and climbing	+	+	+	+	+	+	+	
2. When flying an extended rectangular traffic pattern at an altitude of 1000 to 1500 m in a level flight, check the normal operation of:								
— the engines	+	+	+	+	+	+	+	
— the aircraft systems	+	+	+	+	+	+	+	
— the flight and navigation instruments	+	+	+	+	+	+	+	

Continued

Test flight procedure	During aircraft acceptance	After preventive maintenance	After interval in flights exceeding one month	After 100-h scheduled maintenance	After 200-h scheduled maintenance	After replacement of engines (engine)	After modification to control system, replacement of servo units and ДУС, РУБ and РАУ units of any pitch damper ДТ, stability automatic controller АУ and rate gyros, БПН unit of СПН stability automatic controller and pitch neutral setting system as well as МОП and КОП units of АДУ feel simulator controller, autopilot, hydraulic units of hydraulic system III	Remarks
— the aviation and radio equipment	+	+	+	+	+	+	+	
Determine the time of landing gear extension and retraction	+	+	+	+	+	+	+	
Determine the time of flap extension and retraction		+			+			
NOTE. Extend and retract the landing gear and flaps by using the following procedure: — set up the airspeed of 500 km/h and extend the landing gear — reduce the airspeed to 470 km/h and set the flap control switch to the extension position; as the flaps are being extended, decrease the airspeed to 420—430 km/h — retract the flaps, then retract the landing gear when flying at an airspeed of 470 to 500 km/h								
3. When flying level at an altitude of 5000 to 6000 m, check:								

Continued

Test flight procedure	During aircraft acceptance	After preventive maintenance	After interval in flights exceeding one month	After 100-h scheduled maintenance	After 200-h scheduled maintenance	After replacement of engines (engine)	After modification to control system, replacement of servo units and ДУС, РУБ and РАУ units of any pitch damper ДТ, stability automatic controller АУ and rate gyros, БПН unit of СПН stability automatic controller and pitch neutral setting system as well as МОП and КОП units of АДУ feel simulator controller, autopilot, hydraulic units of hydraulic system III	Remarks
— emergency pressure release from the cabin and operation of the altitude warning unit	+	+	+	+	+			
— aircraft stability and controllability within the range of airspeeds from 500 km/h to the limitation airspeed (when changing the flight regime and during execution of turns)	+	+	+	+	+		+	
— aircraft control by the autopilot in straight-and-level flight, during execution of coordinated turns, climb and descent (the check is carried out from the pilot's and navigator's cabins)	+	+	+	+	+		+	
— operation of the automatic fuel consumption control and metering equipment	+	+	+	+	+	+		
— operation of the oxygen equipment	+	+	+	+	+			
— operation of barometric instruments with the static pressure line changed over to the emergency line	+	+	+	+	+			

Continued

Test flight procedure	During aircraft acceptance	After preventive maintenance	After interval in flights exceeding one month	After 100-h scheduled maintenance	After 200-h scheduled maintenance	After replacement of engines (engine)	After modification to control system, replacement of servo units and ДУС, РУБ and РАУ units of any pitch damper ДТ, stability automatic controller АУ and rate gyros, БПН unit of СПН stability automatic controller and pitch neutral setting system as well as МОП and КОП units of АДУ feel simulator controller, autopilot, hydraulic units of hydraulic system III	Remarks
— operation of the electrical equipment and glass heaters	+	+	+	+	+	+		
— operation of the following equipment: РАДОН radar bombsight, ДИСС meter, РВ radio altimeter, АРК *automatic* direction finder, РСБН system, СРЗО interrogator-responder, СПО-3 radar illumination warning unit, ПУТЬ flight director system, etc.	+	+	+	+	+			
— the aircraft behaviour and operation of the engines with one of the engines throttled down (check the engines in succession)	+	+	+	+	+	+		
— operation of the landing gear retracted position audio signalling system	+	+	+	+	+			
— opening and closing of the bomb doors	+	+	+	+	+			
— operation of the photographic equipment	+	+	+	+	+			
— operation of the roll, pitch and yaw dampers and stability automatic controller	+	+	+	+	+	+	+	

Continued

Test flight procedure	During aircraft acceptance	After preventive maintenance	After interval in flights exceeding one month	After 100-h scheduled maintenance	After 200-h scheduled maintenance	After replacement of engines (engine)	After modification to control system, replacement of servo units and ДУС, РУБ and РАУ units of any pitch damper ДТ, stability automatic controller АУ and rate gyros, БПН unit of СПН stability automatic controller and pitch neutral setting system as well as МОП and КОП units of АДУ feel simulator controller, autopilot, hydraulic units of hydraulic system III	Remarks
— at an airspeed of 500 km/h, perform aerodynamic balancing of the aircraft by using the procedure laid down in Appendix 5 of the present Manual	+	+			+			
CAUTION: NEVER DISTURB THE SEQUENCE OF TRANSITION TO BOOSTER-FREE CONTROL DURING AERODYNAMIC BALANCING								
— the engine operating parameters (including the reheat power settings) and their compliance with the requirements of this Manual		+		+	+	+		
— synchronous setting of the throttle control levers	+	+		+	+	+		
— engine acceleration and operating stability at transient power settings (to be checked for each engine separately)						+		
— operation of the cabin pressurization system	+	+	+	+	+	+		

Continued

Test flight procedure	During aircraft acceptance	After preventive maintenance	After interval in flights exceeding one month	After 100-h scheduled maintenance	After 200-h scheduled maintenance	After replacement of engines (engine)	After modification to control system, replacement of servo units and ДУС, РУБ and РАУ units of any pitch damper ДТ, stability automatic controller АУ and rate gyros, БПН unit of СПН stability automatic controller and pitch neutral setting system as well as МОП and КОП units of АДУ feel simulator controller, autopilot, hydraulic units of hydraulic system III	Remarks
4. At an altitude of 8000 to 9000 m, check:								
— the engine operating parameters (including the reheat power settings) and their correspondence to the requirements of this Manual						+		
— synchronous setting of the throttle control levers						+		
— engine acceleration and stability of operation at transient power settings (check engine acceleration for each engine separately)						+		
— operation of the generators						+		
— operation of the cabin pressurization system	+	+	+	+	+	+		
5. When climbing, check:								
— operation of the autopilot	+	+	+	+	+		+	
— operation of the high-altitude radio altimeter	+	+	+	+	+			
— stability of operation of the automatic fuel consumption control equipment	+	+	+	+	+	+		

Continued

Test flight procedure	During aircraft acceptance	After preventive maintenance	After interval in flights exceeding one month	After 100-h scheduled maintenance	After 200-h scheduled maintenance	After replacement of engines (engine)	After modification to control system, replacement of servo units and ДУС, РУБ and РАУ units of any pitch damper ДТ, stability automatic controller АУ and rate gyros, БПН unit of СПН stability automatic controller and pitch neutral setting system as well as МОП and КОП units of АДУ feel simulator controller, autopilot, hydraulic units of hydraulic system III	Remarks
6. At an altitude of 11,000 m, check:								
— cut-in of the afterburner						+		
— the engine operating parameters up to the maximum permissible flight Mach number						+		
— synchronous setting of the throttle control levers						+		
— engine acceleration and stability of operation at transient power settings (to be checked for each engine separately)						+		
— operation of all the aircraft systems				+	+	+	+	
— operation of the aviation equipment						+		
7. At an altitude of 13,000 m, check light-up of the afterburner								
8. Descend to the altitude of 10,000 m and check the air relight of the engines (engine), strictly keeping to the procedure laid down in the "Engine Relight in Flight" Sub-Section		+				+		

Continued

Test flight procedure	During aircraft acceptance	After preventive maintenance	After interval in flights exceeding one month	After 100-h scheduled maintenance	After 200-h scheduled maintenance	After replacement of engines (engine)	After modification to control system, replacement of servo units and ДУС, РУБ and РАУ units of any pitch damper ДТ, stability automatic controller АУ and rate gyros, БПН unit of СПН stability automatic controller and pitch neutral setting system as well as МОП and КОП units of АДУ feel simulator controller, autopilot, hydraulic units of hydraulic system III	Remarks
9. While flying level at an altitude of 10,000 to 11,000 m:								
— check operation of the electrical equipment	+	+	+	+	+			
— check the aircraft stability and controllability at subsonic speed	+	+			+		+	
— check operation of the 3CO astrotracker, ПУТЬ system, PB radio altimeter, VHF and HF radio sets and other equipment	+	+	+	+	+			
— check operation of the barometric instruments with the static pressure line changed over to the emergency line	+	+	+	+	+			
— check operation of the roll, pitch and yaw dampers and automatic stability controller				+	+		+	
— check operation of the feel simulator controller				+	+		+	
— evaluate aircraft stability and controllability with the rudder and aileron hydraulic boosters and dry-friction dampers	+	+			+		+	

Continued

Test flight procedure	During aircraft acceptance	After preventive maintenance	After interval in flights exceeding one month	After 100-h scheduled maintenance	After 200-h scheduled maintenance	After replacement of engines (engine)	After modification to control system, replacement of servo units and ДУС, РУБ and РАУ units of any pitch damper ДТ, stability automatic controller АУ and rate gyros, БПН unit of СПН stability automatic controller and pitch neutral setting system as well as МОП and КОП units of АДУ feel simulator controller, autopilot, hydraulic units of hydraulic system III	Remarks
turned off. If the aircraft aerodynamic balancing is not sufficient, balance the aircraft by using the procedure laid down in Appendix 5 of this Manual CAUTION. NEVER DISTURB THE SEQUENCE OF TRANSITION TO BOOSTER-FREE CONTROL DURING AERODYNAMIC BALANCING								
— turn on the aileron and rudder hydraulic boosters and dry-friction dampers	+	+	+	+	+			
— check operation of the high-altitude equipment and TPTBK cabin air temperature regulator; check transition to the combat rating (pressure differential 0.2 kgf/cm^2)	+	+	+	+	+			
— check aircraft control by the autopilot in straight flight, execution of coordinated turns from the pilot's control panel and from the navigator's emergency control panel	+	+	+	+	+			

Continued

Test flight procedure	During aircraft acceptance	After preventive maintenance	After interval in flights exceeding one month	After 100-h scheduled maintenance	After 200-h scheduled maintenance	After replacement of engines (engine)	After modification to control system, replacement of servo units and ДУС, РУБ and РАУ units of any pitch damper ДТ, stability automatic controller АУ and rate gyros, БПН unit of СПН stability automatic controller and pitch neutral setting system as well as МОП and КОП units of АДУ feel simulator controller, autopilot, hydraulic units of hydraulic system III	Remarks
— check optical bombsight coupling with the autopilot	+	+	+	+	+			
— check serviceability of the bombing equipment	+	+	+	+	+			
— check operation of the photographic equipment	+	+	+	+	+			
— check operation of tail turret ДК-20 when controlled from the TV sight and fire-control radar	+	+	+	+	+			
10. After the crew has completed the checks, turn off the autopilot at an altitude of 11,000 m, accelerate the aircraft to the maximum permissible flight Mach number and check:								
— aircraft stability and controllability		+			+		+	
— *the amount of control* wheel deflection (with respect to the ailerons) from the neutral position to keep the aircraft from banking		+			+		+	

Continued

Test flight procedure	During aircraft acceptance	After preventive maintenance	After interval in flights exceeding one month	After 100-h scheduled maintenance	After 200-h scheduled maintenance	After replacement of engines (engine)	After modification to control system, replacement of servo units and ДУС, РУБ and РАУ units of any pitch damper ДТ, stability automatic controller АУ and rate gyros, БПН unit of СПН stability automatic controller and pitch neutral setting system as well as МОП and КОП units of АДУ feel simulator controller, autopilot, hydraulic units of hydraulic system III	Remarks
— forces required for maintaining the straight-and-level flight		+			+		+	
NOTE. The control wheel deflection (for moving the ailerons) from the neutral position should be below 30°, the forces applied not exceeding 5 kgf								
11. At an airspeed corresponding to M = 1.15, check:								
— aircraft control by the autopilot	+	+		+	+		+	
— the engine operating parameters	+	+		+	+		+	
— opening and closing of the bomb doors	+	+		+	+		+	
— operation of the АДУ feel simulator controller				+	+		+	
CAUTION. NEVER TURN ON THE AUTOPILOT OR FLY WITH THE PITCH CHANNEL ENGAGED AT AIRSPEEDS CORRESPONDING TO M = 0.95—1.05								

Continued

Test flight procedure	During aircraft acceptance	After preventive maintenance	After interval in flights exceeding one month	After 100-h scheduled maintenance	After 200-h scheduled maintenance	After replacement of engines (engine)	After modification to control system, replacement of servo units and ДУС, РУБ and РАУ units of any pitch damper ДТ, stability automatic controller АУ and rate gyros, БПН unit of СПН stability automatic controller and pitch neutral setting system as well as МОП and КОП units of АДУ feel simulator controller, autopilot, hydraulic units of hydraulic system III	Remarks
12. During descent, check:								
— the aircraft stability and controllability	+	+	+	+	+		+	
— the engine operating parameters	+	+	+	+	+	+	+	
— the high-altitude equipment	+	+	+	+	+	+		
13. In level flight at an altitude of 5000 to 6000 m, check:								
— operation of hydraulic system III		+			+		+	
— operation of the АДУ feel simulator controller				+	+		+	
NOTE. The procedure used for checking hydraulic system III is laid down in Appendix 2 of this Manual								
14. During descent and landing approach, check:								
— the aircraft stability and controllability	+	+	+	+	+	+	+	
— operation of the aircraft radio aids used in landing	+	+	+	+	+	+	+	
— extension of the landing gear and flaps	+	+	+	+	+	+	+	

Continued

Test flight procedure	During aircraft acceptance	After preventive maintenance	After interval in flights exceeding one month	After 100-h scheduled maintenance	After 200-h scheduled maintenance	After replacement of engines (engine)	After modification to control system, replacement of servo units and ДУС, РУБ and РАУ units of any pitch damper ДТ, stability automatic controller АУ and rate gyros, БПН unit of СПН stability automatic controller and pitch neutral setting system as well as МОП and КОП units of АДУ feel simulator controller, autopilot, hydraulic units of hydraulic system III	Remarks
— operation of the РВ-УМ low-altitude radio altimeter	+	+	+	+	+	+	+	
NOTE. At an altitude of 2000 m, turn off the autopilot								
15. Land the aircraft. In so doing, proceed as follows:								
— determine the landing speed (by the navigator's report)	+	+	+	+	+	+	+	
— check operation of the brake chute deployment and jettisoning systems	+	+	+	+	+	+	+	
— check operation of the wheel brakes and anti-skid unit	+	+	+	+	+	+	+	
— check operation of the nose wheel steering control	+	+	+	+	+	+	+	
NOTES: 1. The test flight order should contain the test flight program items to be checked. 2. Aircraft preparation for taxiing and test takeoff run just as for the test flight is accomplished in the full scope in compliance with the relevant instructions and standing regulations. The test flight preparation record sheet should be filled in as required								

IN-FLIGHT CHECK OF HYDRAULIC SYSTEM III

To check operation of hydraulic system III in flight, use the following procedure:

— when flying level at an altitude of 5000 to 6000 m and airspeed of 500 km/h, extend the ATH-15 turbopump; to this end, shift the hydraulic system III actuation lever from the extreme lower position to the intermediate position;

— on a lapse of 2 to 3 s, having made sure that the pressure in hydraulic system III equals 210 kgf/cm^2, change over stabilizer control to hydraulic system II, for which purpose place the hydraulic booster engagement lever to the ONE SYSTEM CUT IN (ВКЛЮЧ. ОДНУ СИСТЕМ.) position;

— make sure that hydraulic system I has been disengaged (by reference to the pressure gauge) and the stabilizer is normally controlled with pressure supplied from hydraulic system II only (to be ascertained by the aircraft behaviour);

— cut in hydraulic system III; to this end, place the system actuation lever to the extreme upper position;

— fly for 2 to 3 min at an airspeed of 500 to 600 km/h, shift the control wheel column several times till attaining g-loads $n_y = 1.2$ and $n_y = 0.8$; in so doing, observe the pressure gauge readings to make sure that hydraulic system III operates normally and the pressure in the system does not drop below 180 kgf/cm^2;

— in level flight, disconnect hydraulic system III from the stabilizer control system, for which purpose set the actuation lever to the intermediate position;

— shift the hydraulic booster engagement lever to the TWO SYSTEMS CUT IN (ВКЛЮЧ. ДВЕ СИСТ.) position and make sure that the stabilizer control system has been connected to hydraulic system I;

— pass to stabilizer control from hydraulic system III only; to this end, while flying level, set the system actuation lever to the extreme upper position, and the stabilizer hydraulic booster engagement lever, to the OFF (ВЫКЛЮЧЕНО) position.

NOTE. If some abnormalities occur in stabilizer control after disengagement of hydraulic systems I and II and engagement of hydraulic system III, immediately disengage hydraulic system III (shift the hydraulic system III actuation lever to the intermediate position) and engage hydraulic systems I and II;

— perform flight with the stabilizer controlled only by hydraulic system III for 1 to 2 min;

— when flying at an airspeed of 500 to 600 km/h, move the control wheel column several times until attaining g-loads $n_y = 1.2$ and $n_y = 0.8$;

in so doing, observe the readings of the pressure gauge to make sure that hydraulic system III operates normally and the pressure in the hydraulic system does not drop below 170 kgf/cm^2;

— set the stabilizer hydraulic booster engagement lever to the TWO SYSTEMS CUT IN (ВКЛЮЧ. ДВЕ СИСТ.) position; this done, disengage hydraulic system III by placing its actuation lever to the intermediate position;

— observe the pressure gauge readings to make sure that hydraulic systems I and II have been engaged and hydraulic system III has been disengaged.

Perform landing approach with the stabilizer controlled from hydraulic systems I and II.

When checking hydraulic system III in flight, note the pressure in the system with the aircraft controlled:

(a) from hydraulic systems II and III;

(b) from hydraulic system III only.

CHECK OF PITCH DAMPER AND STABILITY AUTOMATIC CONTROLLER DURING AIRCRAFT TAXIING AND TEST FLIGHT

The directions laid down in this Appendix are applicable in case of replacement of rate gyro ДУС, relay-and-amplifier unit РУБ and servo unit РАУ installed in any channel of the pitch damper and stability automatic controller as well as the ДУС rate gyro and БПН unit of the СПН stability automatic controller and pitch neutral setting system, and modification of the systems and performing the scheduled maintenance involving replacement of the above units.

Check of Stability Automatic Controller Pitch Damper for Proper Operation During Special Taxiing

Check adequate operation of the stability automatic controller pitch damper in the EMERGENCY mode during aircraft taxiing at a speed of 15 to 20 km/h with the stabilizer trimmed out to the minus 8° position according to the stabilizer position indicator.

1. Determine the amount of stabilizer deflection with the pitch damper and stability automatic controller disabled. To this end, proceed as follows:

— disable the first and second channels of the pitch damper and stability automatic controller;

— energetically apply the brakes two or three times; in so doing; check the amount of stabilizer deflection by observing the readings of the stabilizer position indicator, which should be within ±0.5° relative to the trimmed position.

2. Check the first channel of the pitch damper for proper operation. To this end, proceed as follows:

— enable the first channel of the pitch damper;

— energetically apply the brakes two or three times; in so doing, check the first channel of the pitch damper for proper operation by reference to the stabilizer position indicator.

If the channel operates properly, the moment the aircraft nose goes down the stabilizer should deflect from the trimmed position by 0.8 to 1.2° in the pitch-up direction (the stabilizer position indicator pointer will move from the minus 8° position to the minus 8.8 to 9.2° position); at the moment of aircraft nosing-up, the stabilizer should deflect by 0.8 to 1.2° in the diving direction (the stabilizer position indicator pointer will move from the minus 8° position to the minus 7.2 to 6.8° position).

3. Check the second channel of the pitch damper for proper operation. To this end, proceed as follows: disable the first channel and enable the

second channel of the pitch damper, then check operation of the second channel in compliance with Item 2 (i.e., by using a procedure similar to that used for checking the first channel of the pitch damper).

4. Check adequate operation of the stability automatic controller. To this end, proceed as follows:

— disable the first and second channels of the pitch damper;

— set the OPER — NEUTR (РАБОТА — НЕЙТР.) switch to the OPER (РАБОТА) position;

— place the NORM — EMERG (НОРМ. — АВАР.) switch to the EMERG (АВАР.) position and check adequate operation of the stability automatic controller in compliance with Item 2;

— set the NORM — EMERG switch to the NORM position.

5. Check the first and second channels of the pitch damper for proper simultaneous operation. To this end, proceed as follows:

— place the OPER — NEUTR switch to the NEUTR position;

— disable the first and second channels of the pitch damper;

— energetically apply the brakes three or four times; in so doing, check the first and second channels of the pitch damper for proper simultaneous operation by reference to the stabilizer position indicator.

If both channels operate in a proper way, lowering of the aircraft nose in the process of braking should be accompanied by stabilizer deflection by 1.6 to 2.4° from the trimmed position in the pitch-up direction (the stabilizer position indicator pointer will move from minus 8° to minus 9.6 to 10.4°). At the moment of aircraft nosing-up, the stabilizer should deflect by 1.6 to 2.4° in the diving direction (the stabilizer position indicator pointer will move from minus 8° to minus 6.4 to 5.6°).

6. If the amounts of stabilizer deflection, as referenced by the stabilizer position indicator, are below the lower deflection limit or if the direction of stabilizer deflection is other than stated in Items 2, 3, 4, and 5, this testifies to malfunctioning of the pitch damper or stability automatic controller.

If in the process of special taxiing the pitch damper and stability automatic controller were found to operate properly in the EMERGENCY mode, the aircraft is cleared for the test flight.

Test Flight Performed after Replacement of Pitch Damper and Stability Automatic Controller

If only one of the pitch damper channels or only stability automatic controller was subjected to modification, replacement or removal of their units, this channel or the stability automatic controller will be subjected to checking for normal operation in the course of the test flight.

Perform takeoff and climb for executing the test flight with the pitch damper and stability automatic controller operating in the NORMAL (НОРМАЛЬНО) mode.

1. When flying level at an altitude of 5000 to 6000 m and an airspeed of 600 km/h, trim out the aircraft and disable the first and second channels of the pitch damper and stability automatic controller. Turn on the load feel mechanism on aircraft which are not equipped with the feel simulator controller and control column speed limiter (OC) before disabling the pitch damper.

2. Deflect the stabilizer to build up g-loads $n_y=0.8$ and $n_y=1.2$. Evaluate the control column travel and aircraft behaviour.

3. In level flight, enable the first channel of the pitch damper without turning on the load feel mechanism on aircraft which are not equipped with the feel simulator controller and control column speed limiter.

CAUTION: 1. IF AN ABNORMAL REACTION (BUFFETING OR OTHER ABNORMALITIES) IN THE AIRCRAFT BEHAVIOUR OCCURS IN LEVEL FLIGHT AFTER ENABLING OF ONE OF THE PITCH DAMPER CHANNELS OR STABILITY AUTOMATIC CONTROLLER WHEN MANIPULATING THE CONTROL COLUMN, DISABLE THIS CHANNEL OR STABILITY AUTOMATIC CONTROLLER WITHOUT DELAY. FAILURE OF THE PITCH DAMPER CHANNEL OR STABILITY AUTOMATIC CONTROLLER MAY ALSO MANIFEST ITSELF IN OPERATION OF THE СПН STABILITY AUTOMATIC CONTROLLER AND PITCH NEUTRAL SETTING SYSTEM IN RESPONSE TO THIS CHANNEL. REPEATED ENABLING OF THE FAULTY CHANNEL OF THE PITCH DAMPER OR STABILITY AUTOMATIC CONTROLLER IN THE GIVEN FLIGHT IS PROHIBITED. IN THIS CASE THE FLIGHT MISSION SHOULD BE DISCONTINUED.

2. THE PILOT SHOULD BE EXTREMELY ATTENTIVE IN RETURNING TO THE AIRFIELD AND PERFORMING LANDING. APPLICATIONS OF THE CONTROL WHEEL COLUMN SHOULD BE SMOOTH AND SCARCE.

4. Deflect the stabilizer to build up g-loads $n_y=0.8$ and $n_y=1.2$. Watch the aircraft behaviour and deflection of pointer "T1" of the ПКД damper control panel indicator to make sure that the first channel of the damper operates properly.

5. Disable the first channel of the pitch damper and enable the second channel. Check serviceability of the second channel by using the procedure specified for checking the first channel.

6. Disable the second channel and enable the stability automatic controller. Open the NORM — EMERG (НОРМ. — АВАР.) switch cap and set the switch to the EMERG (АВАР.) position. Check operation of the stability automatic controller in the EMERGENCY mode by using the procedure specified for checking one pitch damper channel.

7. Place the NORM — EMERG switch to the NORM position and cap it.

8. Enable the first and second channels of the pitch damper. Turn on the load feel mechanism on aircraft which are not equipped with the АДУ feel simulator controller and OC control column speed limiter. When flying at an airspeed of 600 to 650 km/h, deflect the stabilizer to build up g-loads $n_y=0.8$ and $n_y=1.2$. Watch the aircraft behaviour and amount of control column application as well as identical deflection of pointers

"T1" and "T2" of the ПКД damper control panel indicator to make sure that both channels are serviceable and evaluate operation of the pitch damper.

9. When flying at an altitude of 6000 m and an airspeed of 700 to 750 km/h, make a 90 to 120° turn with a 45 to 50° bank angle. When turning, pay attention to the readings of the ПКД indicator pointers labelled "T1", "T2" and "SAC" ("АУ"). The "SAC" ("АУ") pointer should start departing from the neutral position when pointers "T1" and "T2" have already covered half of their travel range.

10. Without turning off the pitch damper and stability automatic controller, climb to the 10,000-m altitude at an airspeed corresponding to $M=0.9$; estimate operation of the pitch damper by minor deflections of the stabilizer.

11. Turn on the afterburner, climb to the 11,000-m altitude and set up an airspeed corresponding to $M=1.15$—1.2. The moment the aircraft passes $M=1$ should be marked by coming-on of the SAC (АУ) light indicating disabling of the stability automatic controller.

12. Make minor deflections of the stabilizer, estimate the aircraft behaviour and determine the amount of stabilizer deflection required for building up g-loads $n_y=0.8$ and $n_y=1.2$.

Pay attention to deflection of the "T1", "T2" and "SAC" ("АУ") pointers on the ПКД panel (the "SAC" ("АУ") pointer should occupy the neutral position).

13. The pitch damper and stability automatic controller check completed, turn off the afterburner and start descending.

14. If both channels of the pitch damper and stability automatic controller operate properly, perform the entire flight, including the landing, with the pitch damper and stability automatic controller turned on.

CAUTION. ON AIRCRAFT EQUIPPED WITH THE СПН STABILITY AUTOMATIC CONTROLLER AND PITCH NEUTRAL SETTING SYSTEM, CHECK OPERATION OF THE СПН SYSTEM IN THE COURSE OF THE ENTIRE FLIGHT BY ILLUMINATION OF THE "SUPPLY" ("ПИТАНИЕ") LIGHT LOCATED ON THE ПКД DAMPER CONTROL PANEL. IF THE LIGHT GOES OUT OR THE RED LIGHT INDICATING DISABLING OF THE PITCH DAMPER FIRST OR SECOND CHANNEL OR STABILITY AUTOMATIC CONTROLLER COMES ON, DISCONTINUE THE FLIGHT MISSION.

AIRCRAFT TEST FLIGHT AFTER REPLACEMENT OF FEEL SIMULATOR CONTROLLER

The directions given in this Appendix are also applicable in case of replacement of the МОП-2 and КОП-2 units incorporated in the АДУ feel simulator controller system as well as in cases of modification of the system and performing the scheduled maintenance operations with replacement of the feel simulator controller.

1. Perform the takeoff with the aircraft mass ranging from 70 to 75 t and the aircraft c.g. position of 36 to 37 % MAC, with the feel simulator controller turned on. The FSC ON (АДУ ВКЛЮЧЕН) light should come on during takeoff after landing gear retraction.

CAUTION. IF IN THE PROCESS OF LANDING GEAR RETRACTION THE FEEL SIMULATOR CONTROLLER OPERATES AT G-LOAD $n_y=1$ (WHICH IS INDICATED BY COMING-ON OF THE "АУАСП" LIGHT) AND THE PILOT CONTINUES TO FEEL EXCESSIVE FORCES ON THE CONTROL COLUMN AT MINOR BACKWARD DEFLECTIONS OF THE CONTROL COLUMN, TURN OFF THE FEEL SIMULATOR CONTROLLER AND DISCONTINUE THE FLIGHT MISSION.

2. When flying level at an altitude of 11,000 m and an airspeed corresponding to $M=1.2$ to 1.25, perform the following checks:

(a) check operation of the feel simulator controller by limit switch position $\Delta X=80$ mm; to this end, proceed as follows:

— when flying straight, apply the control column backward until the feel simulator controller operates (which is evidenced by an abrupt increase of the forces on the control column) and is accompanied by illumination of the АУАСП indicator light; the steady g-load built up during backward application of the control column should not exceed 1.7—1.8;

— level off the aircraft.

CAUTION: 1. IF THE FEEL SIMULATOR CONTROLLER FAILS TO OPERATE AT G-LOAD $n_y=1.8$ TO 2 (THE SPRING IS NOT CONNECTED), MOVE THE CONTROL COLUMN FORWARD, SMOOTHLY LEVEL OFF THE AIRCRAFT AND DISCONTINUE THE FLIGHT MISSION.

2. IN ALL CASES WHEN BUILDING UP THE G-LOAD BY STABILIZER DEFLECTION, CHECK THE G-LOAD BY REFERENCE TO THE АУАСП CRITICAL ANGLE-OF-ATTACK AND G-LOAD WARNING UNIT;

(b) check operation of the feel simulator controller by reference to limit switch position $\Delta X=110$ mm; to this end, when making a turn with a 45 to 50° bank angle, apply the control column backward until the feel simulator controller operates (which is evidenced by an abrupt increase of the forces on the control column and is accompanied by illumination of the АУАСП indicator light); the steady g-load built up during backward application of the control column should not exceed 1.7—1.8;

— bring the aircraft into a straight-and-level flight attitude.

CAUTION. IF THE FEEL SIMULATOR CONTROLLER FAILS TO OPERATE AT G-LOAD $n_y = 2 - 2.2$, LEVEL OFF THE AIRCRAFT AND DISCONTINUE THE FLIGHT MISSION.

3. When flying level at an altitude of 11,000 m, pass to a subsonic airspeed corresponding to $M = 0.9$; check operation of the feel simulator controller with respect to the angle of attack; to this end, decelerate the aircraft to the airspeed corresponding to cut-in of the feel simulator controller. The moment the aircraft reaches the airspeed at which the α_{pres} indicator stops by 0.5 divisions short of reaching the α_{crit} red sector on the АУАСП warning unit should be accompanied by coming-on of the АУАСП warning unit light and operation of the feel simulator controller.

Perform aircraft deceleration at the engine power setting corresponding to 20 to 25 divisions read by the УПРТ indicator. During deceleration, remove the forces from the control column by using the trimming mechanism. After operation of the feel simulator controller, smoothly bring the aircraft into descent and level it off on attaining the airspeed of 500 to 550 km/h.

CAUTION: 1. DURING DECELERATION, THE PILOT SHOULD NOT DECREASE THE AIRSPEED BELOW THE MINIMUM PERMISSIBLE OPERATING VALUE SPECIFIED FOR THE GIVEN FLIGHT MASS IN THE FLIGHT MANUAL.

2. IF THE FEEL SIMULATOR CONTROLLER FAILS TO CUT IN ON ATTAINING THE MINIMUM AIRSPEED, FURTHER DECREASE OF THE AIRSPEED IS PROHIBITED.

4. When flying at an altitude of 4000 to 6000 m an airspeed of 700 to 750 km/h, check operation of the feel simulator controller by the $\Delta X = 40$ mm limit switch position. To this end, proceed as follows:

— using the trimming mechanism switch, create the g-load of 0.7 to 0.8, then apply the control column backward until the feel simulator controller operates (which is evidenced by an abrupt increase of the control column forces); the steady g-load set up during backward application of the control column should not exceed 1.3 to 1.5;

— level off the aircraft.

CAUTION. IF THE FEEL SIMULATOR CONTROLLER FAILS TO OPERATE AT $n_y = 1.5 - 1.6$, APPLY THE CONTROL COLUMN FORWARD, LEVEL OFF THE AIRCRAFT AND DISCONTINUE THE FLIGHT MISSION.

5. When flying at an altitude of 4000 to 6000 m an airspeed of 700 to 750 km/h, check operation of the feel simulator controller by the $n_{y\ pres}$ signal. To this end, proceed as follows:

— using the trimming mechanism switch, build up the g-load of 1.2 to 1.3 and bring the aircraft into descent, overcoming the backward pressure of the control column;

— on attaining vertical speed $V_y = 15 - 20$ m/s, smoothly apply the control column backward until the feel simulator controller operates at g-load $n_y = 1.8$ to 2 (which is evidenced by an abrupt increase of the control column forces);

— level off the aircraft and trim out the forces to zero.

CAUTION. IF THE FEEL SIMULATOR CONTROLLER FAILS TO OPERATE AT G-LOAD $n_y = 1.8$ to 2, APPLY THE CONTROL COLUMN FORWARD, LEVEL OFF THE AIRCRAFT AND DISCONTINUE THE FLIGHT MISSION.

6. Execute the landing approach. During landing gear extension the green feel simulator controller light should go out. If landing gear extension is not accompanied by coming-on of the light, turn off the feel simulator controller.

NOTES: 1. On aircraft Ty-22У, coming-on of the light on the АУАСП indicator in the pilot's cabin during actuation of the feel simulator controller should be accompanied by illumination of the SEE ANNUNCIATOR (ВНИМАНИЕ), "$n_{y\ perm}$" and "α_{crit}" light indicators on the instructor's instrument board. If required, the instructor requests the $n_{y\ pres}$ magnitude from the pilot.

2. When executing the flight, the pilot should inform (over the intercom) the crew of the airspeeds and g-loads, corresponding to operation of the feel simulator controller, and the navigator should put down these data into the Flight Log to be further transferred into the test flight record sheet.

AERODYNAMIC BALANCING OF AIRCRAFT IN FLIGHT

Aircraft Balancing at Altitude of 5000 to 6000 m

1. Trim out the aircraft in level flight at an airspeed of 500 km/h relative to all the three axes.
2. Change the aircraft control from the flap-ailerons to the ailerons.
3. Cut out the dry-friction dampers of the ailerons and rudder.
4. With the pedals being in neutral, disengage the rudder hydraulic booster, yaw damper and turn on the rudder hydraulic booster emergency cross-feed cock.
5. Wait for 1 min and make sure that the hydraulic booster is disengaged by increase of the pedal forces and by coming-on of the rudder trim tab white indicator light.
6. If required, trim out the aircraft by using the rudder trim tab.
7. Make 20° coordinated turns to both sides with a bank angle of up to 15°.
8. Engage the hydraulic booster, turn on the yaw damper and turn off the rudder hydraulic booster emergency cross-feed cock.
9. Refer to decrease of the pedal forces and coming-on of the load feel simulator indicator light to make sure that the hydraulic booster is engaged.
10. Disengage the aileron hydraulic booster and the roll damper and turn on the aileron hydraulic booster emergency cross-feed cock.
11. Wait for 1 min and, by referring to increase of the control wheel forces and coming-on of the white aileron trim tab light, make sure that the hydraulic booster is disengaged.
12. If required, balance the aircraft, using the aileron trim tabs.
13. Make 20° coordinated turns to both sides with a bank angle of up to 15°.
14. Bring the aircraft into a straight flight and check aircraft balancing simultaneously with respect to two axes; to this end, disengage the rudder hydraulic booster while keeping the pedals neutral.
15. Fly straight for 2 min and make sure that the aircraft behaviour is normal. If required, balance the aircraft, using the trim tabs.
16. Make 20° turns to both sides with a bank angle of 15°. In so doing, do not let airspeed exceed 550 km/h.
17. Estimate the pedal and control wheel forces while making evolutions, without using the switches on the trim tab control panel.
18. When flying straight, engage the aileron and rudder hydraulic boosters, turn off the aileron emergency cross-feed cock, turn on the aileron and rudder dry-friction dampers and make sure that they are engaged by illumination of the green indicator light.

CAUTION: 1. SHOULD EXCESSIVE FORCES ARISE ACROSS THE CONTROL LEVERS, ENGAGE THE HYDRAULIC BOOSTERS WITHOUT DELAY AND STOP FURTHER BALANGING OF THE AIRCRAFT.

2. NEVER DISTURB THE SEQUENCE OF CHANGE-OVER TO BOOSTER-FREE CONTROL OF THE RUDDER AND AILERONS.

Aircraft Balancing at Altitude of 10,000 to 11,000 m

When flying level at an airspeed corresponding to $M=0.82$ to 0.84, check the aircraft balancing with respect to the rudder and ailerons by using the sequence specified for the 5000 to 6000-m altitude and, if required, perform additional balancing of the aircraft. Do not alter the selected positions of the rudder and aileron trim till appropriate operations are accomplished on the ground.

CAUTION: 1. THE 10,000 TO 11,000-M ALTITUDE IS THE MAIN ALTITUDE FOR AIRCRAFT BALANCING.

2. PERFORM AIRCRAFT BALANCING AT A FLIGHT MASS NOT EXCEEDING 70 TONS.

3. SLIGHT JERKING OF THE PEDALS, WHICH DOES NOT INTERFERE WITH AIRCRAFT HANDLING, MAY OCCUR AT AN INDICATED AIRSPEED CORRESPONDING TO $M=0.82$—0.84, WITH THE PΠ-23A BOOSTER DISENGAGED.

DETERMINING C.G. POSITION OF AIRCRAFT Ty-22

To determine the c.g. position of aircraft Ty-22 in flight, proceeding from the known mass and c.g. position of the loaded aircraft (in %MAC), measure the quantity of fuel as indicated by the fuel quantity gauge, find out the aircraft flight mass, measure the quantity of fuel in tank groups, and then, using the chart given in Fig. 1, find the variation of the aircraft c.g. position versus the quantity of fuel in the tank groups and aircraft flight mass. Thereupon, determine the ΔX_f sum total in % MAC and sum it up with the c.g. position of the loaded aircraft to determine the c.g. position of the aircraft in flight.

Example. Find the c.g. position of aircraft Ty-22, proceeding from the following data: the c.g. position of the loaded aircraft is 41.5 % MAC, the fuel remainder is 10,000 kg, the aircraft flight mass is 59,000 kg, the amount of fuel in the tanks is as follows: tank No. 6 — empty, tank No. 7 — 3400 kg, tank No. 2 — 6600 kg.

Solution. 1. Using the chart given in Fig. 1, determine variation of the aircraft c.g. position versus the quantity of fuel in the tank groups and aircraft flight mass: tank No. 2 — $\Delta\overline{X}_{f1}=14$ % MAC, tank No. 7 — $\Delta\overline{X}_{f2}=7.1$ % MAC.

2. Find sum $\Delta\overline{X}_f$:$\Sigma\Delta\overline{X}_f=-14+7.1=-6.9$ % MAC.

3. Determine the aircraft c.g. position by using the following formula: $\Delta\overline{X}_f=\overline{X}_{f\,l.\,a/c}+\Sigma\Delta\overline{X}_f=41.5-6.9=34.6$ % MAC.

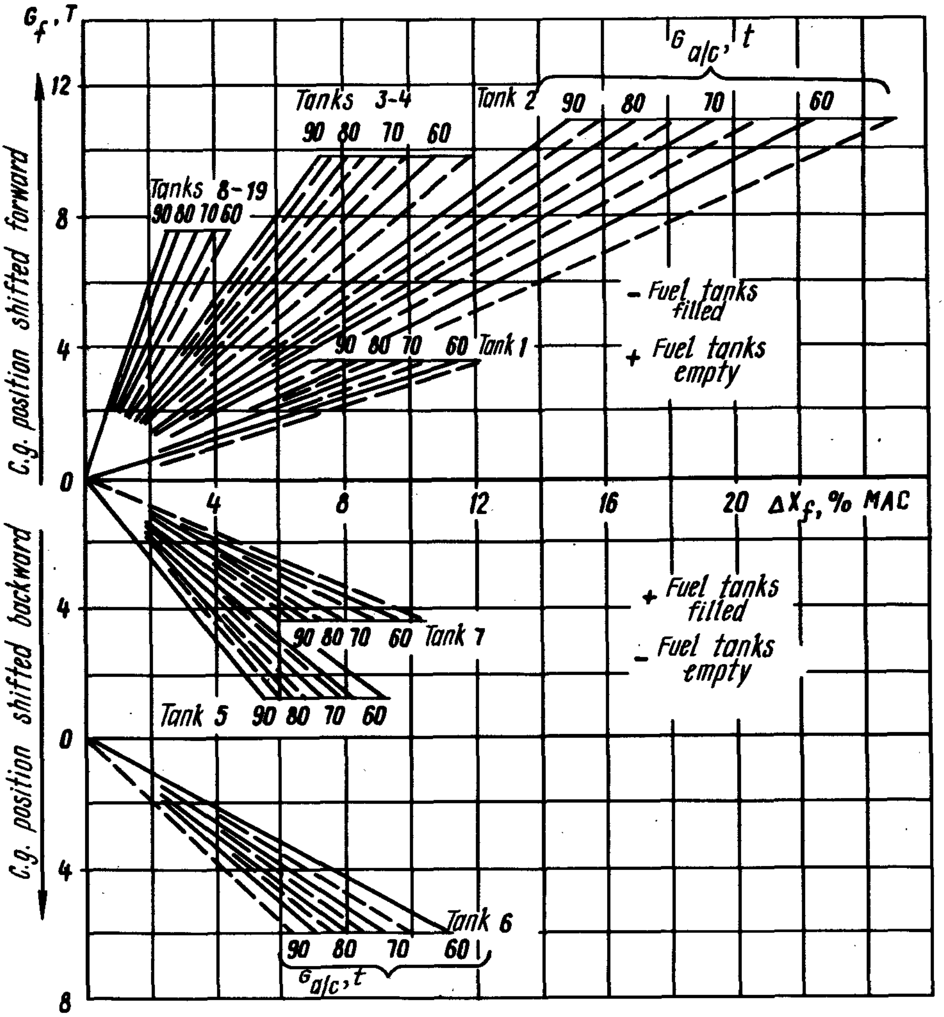

FIG. 1. CHART USED FOR DETERMINING EFFECT OF FUEL AMOUNT IN TANK GROUPS ON AIRCRAFT C.G. POSITION AT DIFFERENT FLIGHT MASSES

DETERMINING INDICATED FLIGHT ALTITUDE AND TRUE AIRSPEED

To determine indicated flight altitude H_{ind}, the barometric flight altitude (H_p) being assigned with due account of the en-route obstacles, proceed as follows.

By referring to assigned values of H_{ind} or M_{ind} and H_p, determine aerodynamic correction ΔH_a by using the chart given in Fig. 12 of this Manual. Calculate the H_{ind} indicated altitude to be maintained by the pilot so as to fly at the assigned barometric altitude (H_p). In calculating the H_{ind} indicated altitude, refer to the H_p value with due account of the instrumental (ΔH_{instr}) and aerodynamic (ΔH_a) corrections to be taken with the appropriate signs.

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