Yak-50

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1. GENERAL

1.1. INTRODUCTION

YAK-50 is a single-seat aerobatic aircraft, intended for training aerobatic pilots and participation in championships. The aircraft can execute figures of simple and complex aerobatics. High power-to-weight ratio in combination with good controllability allows easy execution of both: normal and inverted aerobatic manoeuvres without altitude loss. Figure radiuses of direct and inverted flight practically do not differ. YAK-50 aircraft is a single-engine monoplane with a low-set cantilever wing, equipped with a tricycle landing gear. Aircraft is powered with M-14P air-cooled 360 h.p. engine with V530T-D35 variable pitch propeller. Simplicity of design, high strength and reliability makes flights by aircraft quite safe. The YAK-50 aircraft is equipped with modern flight control and navigation instruments and VHF radio station for communication with ground stations and other aircrafts.

1.2. AIRCRAFT PERFORMANCE

1.2.1. Dimensions And Areas
Fig. 1. General Arrangement
### 1.2.2. Weight And Balance Data

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2. MAINFRAME

2.1. FUSELAGE

Fuselage of YAK-50 aircraft is an all-metal monocoque with reinforced skin. It consists of two parts: forward and tail, rigidly docked on a bulkhead 12.

The transversal framework of a fuselage mainframe consists of nineteen bulkheads and supplementary bulkhead 0, which is used as firewall and for engine attachment. This bulkhead represents a dead duraluminium web, reinforced along its contour and in fittings attachment areas using profiles. Fittings for engine mounting frame, oil tank support assemblies and cowlings mounting brackets are mounted on a forward surface of firewall.

The longitudinal framework of fuselage mainframe consists of 14 bulbous stringers, uniformly distributed on the perimeter.

Stringers 3 and 6 of fuselage forward part are reinforced. Stringer 3 in the area between bulkheads 6 and 10 makes the under-canopy frame and is used for attachment of canopy rails. Cockpit floor is secured to stringer 6.

Cockpit floor, made of duraluminium sheets, reinforced with longitudinal profiles, stretches between bulkheads 5 and 8. In places, where pedals and control stick are installed, cut-outs are made, partially closed with covers. Covers are fastened to a floor using screws with anchor nuts.

Wing is attached to a fuselage is made on bulkheads 3, 5 and 8. For this purpose forward and back joints are mounted on bulkheads 3 and 8. In places of their installation bulkheads are reinforced with fittings and transversal webs.
Medium wing-to-fuselage attachment unit is mounted on bulkhead 5. Unit is fastened to a transverse beam of two-tee cross-section. Beam is comprised of four extruded profiles and a web, reinforced with angles. On the butt-ends in joints installation areas joints, beam is strengthened with fittings. All joints are bolted. Bulkheads 9 and 10 carry pilot’s seat mounting brackets.

The tail unit is mounted on a tail part of a fuselage: vertical- to bulkheads 16 and 19, horizontal- to bulkheads 16 and 18.

Fuselage skin is made of duraluminium sheets. The forward part of a skin consists of eight 0.8 mm panels, fastened to mainframe using rivets and by means of spot welding.

Tail skin consists of six parts: the upper sewing-up, upper and side lateral panels. Upper 0.8 mm panel is fastened to mainframe between bulkheads 12 and 16 by means of spot welding and countersunk rivets. Two 0.6 mm side panels are fastened to mainframe between bulkheads 12 and 15 by means of spot welding. Two 1.5 mm side panels are located between bulkheads 15 and 19, are chemically milled to thickness of 1.2, 1 and 0.8 mm. They fastened to mainframe using countersunk rivets. The upper skin between bulkheads 16 and 19 has a thickness of 2 mms and is chemically milled up to width of 1.5 and 1.2 mm. It is fastened to mainframe using button-head rivets.

In the bottom between bulkheads 1 and 3 fuselage has an access hole for access to fuel tank and engine control system aggregates.

An access hole for access to electric equipment is located between bulkheads 11 and 12 on the left side of a fuselage.

Caps of both access holes are attached using hinge and retained in closed position by easy-to-open locks.

Fuel tank filler access hole is located on a fuselage left side near a bulkhead 3. A hinged cap closes access hole. In closed position cap is retained with a single lock.

A hole for access to aircraft control system is located on the left of a fuselage tail between bulkheads 17 and 18. Removable cap of this access hole is secured using screws.

The wing-to-fuselage attachment is covered with fairings, made of 0.8 mm duralumin. Fairings are fastened to fuselage and wing using screws and anchor nuts. In the bottom fairing has a cut-out.

In the bottom of fuselage between bulkheads 4 and 5 there is an access hole for fuel drain from a sump. Access hole is covered with a cap that is attached using hinge and retained in closed position by easy-to-open lock.

The bottom left fairing has an access hole for draining atmospheric condensation water out of pitot-static lines. Its design and attachment is similar to fuel drain access hole.

2.2. WING

Aircraft wing is a single-spar structure with stressed skin and consists of two cantilevers. Each of them is supplied with slotted aileron. Three joints dock the wing to a fuselage. Joints of each wing are mounted on forward web, spar and on a trailing web. The appropriate joints of a fuselage are mounted on bulkheads 3, 5 and 8.

Main landing gear legs are attached to wing root sections. For undercarriage wheels accommodation in retracted position the lower skin of each wing has a cut-out, reinforced with duraluminium webs.

2.2.1. Wing Mainframe

Wing framework consists of longitudinal and transversal elements. Longitudinal framework consists of spar, leading and trailing webs, undercarriage beam, aileron web and set of stringers.

Wing spar represents a duraluminium riveted non-uniform beam. It consists of a web, reinforced with angles, and two booms. Wing-to-fuselage attachment joints are bolted to the spar root section. Aircraft mooring bracket is mounted on the spar between ribs 9 and 10. The forward web, located between ribs 1 and 3, represents a riveted beam, consisting of web and two extrusions.
The trailing web is located between ribs 1 and 4 and consists of a duraluminium web put between stringers. Forward and back webs have fittings bolted to them for wing attachment to fuselage. The undercarriage beam consists of two parts located between ribs 2 and 3 (first) and 4, 5 (second). Each part represents a riveted U-beam. Main landing gear leg mounting bracket is located between both parts of a beam. It consists of two formed aluminium alloy AK6 brackets, secured together using bolts with nuts thus comprising a box. Brackets are bolted to beams and riveted to ribs 3 and 4.

Wing ribs are split. They are made of duralumin and consist of nose and tail parts. Each wing has three aileron attachment points: root, medium and tip. Aileron root attachment bracket is riveted to a rear rib 7 tail, meanwhile medium and tip brackets- to webs of ribs 9 and 13. The aileron root attachment point is a welded bracket, consisting of a steel angle and a hollow bush. Pin, screwed in this bush, is used for aileron attachment. The medium and tip aileron attachment brackets are formed of duraluminium alloy and have double-row ball bearings press-fitted for bolts, securing an aileron. Nose part of port wing rib 12 has a bracket for pitot-static probe mounting.

2.2.2. Skin

Wing skin consists of top and bottom panels, made duraluminium sheets having different thickness. Lower skin has access doors for landing gear and ailerons control system brackets maintenance. Wing tip is made of fibreglass and is attached to a rib 14 using screws and anchor nuts.

2.2.3. Ailerons

Wing is equipped with slotted overhang balanced ailerons. Aileron framework consists of a tubular duraluminium spar, eight ribs and a tail stringer. Ribs are fastened to a spar using angles. The aileron nose section is covered with duraluminium sheet. Aileron in a whole is covered with fabric. Aileron is attached to a wing on three joints. Two of them are brackets, formed of AK6 [aluminium alloy], riveted to an aileron spar aileron: first– near the rib 3, second – near the rib 7. The third joint is riveted to a spar near the rib 1 and represents a bracket, formed of duraluminium alloy with the ball bearing, press-fitted in a hole. Aileron actuating pushrod is riveted to a spar near the rib 3. Balance weights are installed in the nose section over entire span of an aileron. Trim tab is attached to a trailing edge of an aileron near the rib 4.

2.3. TAIL UNIT

Aircraft tail unit has tapered shape and consists of horizontal and vertical tail. Vertical tail consists of fin and aerodynamically balanced rudder. Horizontal tail consists of one-piece stabilizer and two halves of elevator. The port half is supplied with a trim tab.

2.3.1. Fin

Fin framework consists of forward and back spars and set of ribs. Spars have U-shape and are made of D16AM-L1.2 sheet material. Fin-to-fuselage attachment fittings are bolted to a front spar. Rear spar carries three rudder attachment brackets. All brackets are formed of AK6 and contain press-fitted ball bearings. Fin ribs are made of duralumin. The lower rib 2a has a longitudinal cut-out for elevator balance weight. Two jaws are attached between ribs 2a and 3, which limit lateral movements of a balance weight. Fin skin is made of sheet duralumin. Frontal fairing, made of from sheet duralumin, is riveted to a front spar. Fuselage fairing, made of sheet glass fibre, is attached in front of the fin. It is secured to fin and fuselage skins using bolts and rivets.
Fig. 4. Tail unit
2.3.2. Rudder

Rudder framework consists of tubular duraluminium spar, five ribs and a hoop. Fairings, made of sheet duralumin, are riveted to noses of ribs. Tip, made of D16T L0.5, is fastened to a hoop and rib 5 using anchor nuts.
Spar carries three rudder attachment brackets. Upper and the medium brackets are mounted near ribs 5 and 3 respectively. Brackets are formed of aluminium alloy AK6 with press-fitted steel pins.
Brackets are riveted to a spar and noses of ribs.
The lower bracket, mounted near rib 1, is also formed of aluminium alloy AK6. It is manufactured in the form of control surface actuating lever with a tube. Tube is mounted and riveted to a spar. Steel threaded pin is fastened to the bottom of the lever. It is used for the installation of a nut, securing control surface.
Compensating plate, jutting out of the rudder contour, is attached to its back hoop.
Whole rudder is covered with fabric.

2.3.3. Tail Unit

The framework of the tail unit consists of forward and back spars, ribs and stringers.
The front spar of U-shape consists of two parts. Port and starboard parts are joined on a symmetry axis by means of a butt box with plates. Front spar web near ribs 1 carries the bolted brackets of forward tailplane-to-fuselage attachment fittings.
Rear spar is continuous, U-shaped. Between ribs 1 spar is reinforced with a box with plates. Rear tailplane-to-fuselage attachment fittings are bolted and riveted to its forward web, between ribs 1. This bracket at the same time is an elevator attachment point. Fittings are formed of aluminium alloy AK6.
Elevator attachment brackets are bolted and riveted to the rear spar web between ribs 3 and 5. Brackets are made of D16T L7 with press-fitted ball bearings. Corresponding elevator pins enter the holes in ball bearings on elevator attachment.
Tail unit skin is made of duraluminium. It consists of a nose part, two upper and two lower 0.6 mm sheets.
The removable fibreglass tail unit tip is secured to the tail unit using screws and anchor nuts.

2.3.4. Elevator

The split elevator is made of two halves. Framework of each half consists of tubular spar, trailing profile and five ribs. Duraluminium two-piece fairing is riveted to noses of ribs and the fibreglass tip is glued to a rib 5.
Elevator medium attachment point is common for both halves of control surface. It is mounted onto a spar and is fastened to it by means of two flanges. Unit represents the lever, to which balance weight and elevator control system cable are attached. Middle part of the lever has an eye with the press-fitted ball bearing, used for its connection to a bracket of the tail unit.
Each elevator half has hinge units near ribs 3 and 5. Hinge units are formed of aluminium alloy AK6 and have steel pins pressed inside. Hinge units are fastened to a spar and rib webs.
Elevator is covered with fabric. The port half is supplied with a trim tab, which is located between ribs 1 and 3 and is fastened to a control surface structure by means of piano hinge.
The trim tab is made of foam plastics and is glued over both sides with fibreglass. Trim tab actuating pushrod is attached to a bracket, riveted to trim tab underside.

3. COCKPIT

3.1. CANOPY

Cockpit canopy is of a streamlined shape. It consists of a visor, sliding and tail parts and is located between bulkheads 7 and 11. Visor frame consists of edging and plates.
Edging is fastened fuselage skin using rivets. Back (in respect to flight direction) part of a visor is edged with a synthetic skin bundle of black colour, which seals the slot between visor and sliding part.
Canopy sliding part front piece is made as a frame, side and trailing pieces are made of edgings.
Frame is made of steel tube, bent according to canopy contour. Handle and canopy lock are attached to this tube bottom each side. The sliding part moves on four bearings along two rails, secured to fuselage.
Bearings are mounted on side edgings using flanges and studs with nuts. Cables are secured to studs, mounted on flanges behind trailing bearings.

In closed position sliding part of canopy could be locked. The lock consists of casing with a pin, lever, and arm spring, fixed on a pin using a nut. Cable, which passes inside a frame tube, ends with a globule and is fastened to arm. The lock lever is rigidly connected to a pin and is hinged on a frame bracket. The lever has the second shoulder protruding through a slot in sliding part edging.

![Diagram of cockpit canopy](image)

**Fig. 5. Cockpit canopy**

1- visor; 2- sliding part; 3- trailing fixed canopy part; 4- guiding rail; 5- bungee chords; 6- visor edging; 7- leather strip; 8- sliding part edging; 9- glass; 10- tail part edging; 11- lock lever; 12- cable; 13- arm; 14- lock casing; 15- pin; 16- bearing; 17- flange; 18- ventilation

When canopy is closed pin enters a socket on a fuselage. To unlock the canopy one should pull a globule, thus lifting the lever, which will drive a pin out of the socket. The released sliding part acted by bungee chord will move back along the rails until its stop. Bungee chords are mounted on both sides of canopy. One end of each bungee chord is attached to a bracket, mounted on a bulkhead 16. The second end behind a bulkhead 12 is attached to a cable secured to sliding part of a canopy. Trailing end of each side rail has a pulley for guiding a cable. To open the canopy on the ground one should push the second shoulder of the lock lever, protruding outside. The lever will turn and drive a pin out of the fuselage socket thus opening the canopy. The framework of a canopy rear part consists of edgings, fastened to fuselage skin. In the front canopy rear part is covered with black velvet. Canopy glasses are made of organic glass, fastened to a frame and edgings using screws with nuts and washers.
3.2. SEAT

Pilot's seat is mounted at 16° angle between bulkheads 8 and 10. It can be adjusted by pilot's height.

Fig. 6. Pilot's seat

1- bracket; 2- bushing; 3- pin; 4- bracket; 5- casing; 6- spring; 7- cable; 8- seat height adjustment lever; 9-bracket; 10- waist strap; 11- buckle; 12- rigid back; 13- back soft cushion; 14- bolt; 15- shoulder strap; 16-bracket; 17- bracket; 18- profile; 19- shock absorber; 20- bracket; 21- seat pan.
Total amount of vertical adjustment is 65 mm.
The seat pan is secured to a bulkhead 9, seat back- to a bulkhead 10.
Seat framework consists of a duraluminium pan and back riveted together and with two longitudinal profiles of \( \mathcal{L} \) cross-section. Seat-to-bulkhead 10 mounting bracket is riveted to the top of seat back; shock absorber bracket is riveted to the bottom. Its second end is attached to a bulkhead 10.
Seat-to-bulkhead 9 mounting brackets and safety belts attachment brackets are riveted to a pan.
Seat-to-bulkhead 9 mounting bracket is formed of aluminium alloy AK6. In the bottom of a bracket the pin with a spring and pulley is located. Cable is attached to a pin; the second end of this cable is attached to a handle, mounted on a front side of a seat pan. When handle is pulled pin becomes flush with a bracket.
When seat is being installed into an aircraft pin enters a hole in a bracket mounted on bulkhead 9. This bracket has a shape of rail and has three holes for seat vertical adjustment.
A soft cushion, made of foamed plastics and covered with synthetic fabric, is fastened with belts to a rigid back of a seat framework. Pilot’s seat is equipped with safety harness, consisting of shoulder, waist straps and a middle strap. Waist strap is fastened to a seat pan, shoulder strap- to bulkhead 10 and middle strap- to bulkhead 8. The free ends of belts have buckles to be locked in a central lock, fastened to the starboard waist belt.

4. LANDING GEAR

Aircraft has a tricycle tail-wheel landing gear.
Two main legs are located in wings and are retractable in flight into a wing (backward in respect to flight direction).
The non-retractable tail wheel is mounted in a tail part of a fuselage.
Main landing gear legs are of a telescopic type with overhanging wheels attachment and liquid-gas shock-absorption. Braking wheels K141/T141 of size 500x150 are mounted on main legs. They are supplied with low-pressure tyres. Main landing gear legs are compressed air actuated using jacks. In retracted position landing gear legs are retained with locks, in extended position they are fixed with stops and hooks mounted on a shock absorber tusk.
Retracted and extended landing gear legs position is signalled with red and green warning lights.

4.1. BASIC SPECIFICATIONS

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Fig. 7. Landing gear

1- braking wheel K141/T141; 2- nutcracker; 3- main leg shock absorber; 4- main leg jack; 5- retracted position lock; 6- cable; 7- tail wheel shock absorber; 8- tail skid.

- Full travel of shock absorber rod, mm: 180
- Working fluid: AMG-10 oil, GOST 16794-53
- Shock absorber working gas: technical nitrogen, 2-nd grade, GOST 9293-59
- Oil quantity in shock absorber, cm³: 410
- Initial pressure of nitrogen in a shock absorber, kg/cm²: 10±0.5

200x80 tail wheel is castoring. At elevator deflection upwards in range from 15° to 25° tail wheel is fixed in neutral position. It is equipped with gas shock-absorption.

\(^1\) acronym for State standard (here and further- translator's notes)
4.2. MAIN LANDING GEAR LEGS

Main landing gear legs with braking wheels K141/T141 are located in a wing root section between ribs 3 and 4. Both legs are similar in design. Each leg consists of a shock absorber with a wheel, jack and lock. Shock absorber is hinged in brackets mounted on a wing primary structure. Jack rod is attached to a shock absorber hook and jack cylinder eyes- to undercarriage retracted position lock actuation mechanism. Bellcrank is mounted on a wing rib 4. In extended position main leg is fixed by means of hooks, retainer and a bracket, which all together comprise an extended position lock.

Fig. 8. Landing gear main leg

1- nutcracker; 2- shock absorber; 3- jack; 4- retracted position lock; 5, 6- brackets; 7- adjustment screw; 8- micro switch; 9- shock absorber tusk; 10- fixing device; 11- shock absorber hook; 12- adjustable rod; 13- bellcrank; 14- bracket; 15- micro switch; 16- adjustment screw; 17- lock hook; 18- latch; 19- lever
Hooks with their gaps grip the ledge of a bracket, and shock absorber tusk stops lay on the heads of bolts securing bracket to wing ribs. Thus rod of the retainer pushes hooks to a bracket, removing the backlash and safeguards the lock from being unlocked spontaneously.

In retracted position the leg is retained with the retracted position lock.

4.2.1. Shock Absorber

Shock absorber is of liquid-gas type, unicameral, consists of a sleeve, rod, piston with the inhibition valve on a return course, mobile bearing, fixed bearing and axle with a wheel.

Shock absorber barrel is welded of 30ChGSA2 steel. For shock absorber attachment to aircraft the tusk with eyes is welded to a top of a barrel. Retainer barrel is welded to a tusk. In a top of a tusk there are eyes for hooks.

In a middle of a barrel there is a socket for charging point. In the bottom of the barrel there are eyes for attaching nutcracker and a pin, which retains the undercarriage leg in the retracted position lock.

In the barrel bottom a fixed axle-box is mounted, on which shock absorber rod rests.

In order to pressurize barrel working chamber sealing rings, made of V-14 rubber, are installed on charging point and axle-box.

To protect mobile seal against mud nut with a gland and bush with an obturator are mounted from an exterior of a fixed axle-box.

Shock absorber rod is manufactured of 30ChGSA steel. Axle-box is mounted on its top, piston with a return stroke inhibition valve is located in its middle part, and the lower part carries a stub axle for braking wheel mounting.

Stub axle has eyes for a nutcracker lower link attachment.

Shock absorber functions as follows. At direct stroke (shock absorber compression) the energy of impact is absorbed by nitrogen being compressed. At this moment return stroke inhibition valve, made as a floating ring, lowers under the pressure in upper chamber, thus opening holes in the piston allowing liquid to freely pass from upper chamber to the lower one. At return stroke the inhibition valve overlaps holes in the piston and working fluid passes from an annular upper space through small throttling holes on the valve that provides smooth rod extension and cushions the kickback.

4.2.2. Jack

Jack is a cylinder with a movable rod inside. On the one cylinder side a nut with a union and eyes for cylinder attachment to a bellcrank on rib 4 are screwed on. Other the other side cylinder has a nut with an emergency valve.

4.2.3. Retracted Position Lock

The retracted position lock consists of two jaws, joined together with bolts, hook, and latch with a spring and lever.

The lever is mounted from jaw outside and has a ledge for one shoulder of the latch to rest on it. On the other shoulder of the latch carries the adjustment screw.

Using a pushrod the retracted position lock is connected to a bellcrank, mounted on a bracket. The second shoulder of a bellcrank is attached to a jack cylinder. The bellcrank has a cut-out to accept a stop fixed on a bracket.

Undercarriage actuation is performed as follows.

On retraction jack is supplied with compressed air through the union. Under air pressure the jack rod extends and overcomes the strength of a retainer spring thus rejecting hooks mounted on a tusk of a shock absorber. When hooks and bracket disengage, the extended position warning indicator bellcrank turns under spring action and adjustment screw presses a limit switch rod: extended position green warning light goes out. The hooks and a bracket disengage, hook ledges start pushing a shock absorber tusk and displace it. Leg starts retracting.

Before hooks and bracket disengage, the jack deflects the retracted position lock bellcrank against its stop. Bellcrank by means of pushrod disengages lever ledge and lock latch.

\[2\text{ high-tensile alloyed steel}\]
During retraction shock absorber pin approaches to retracted position lock jaw, presses it and turns until the hook is locked with the latch. In this moment the adjustment screw on the latch presses a rod of a limit switch and the red warning light of landing gear retracted position comes on. During undercarriage extension compressed air is supplied to other chamber of a jack to retract the rod. As leg is locked in the retracted position lock, rod can not move. Therefore jack cylinder starts moving, deflects a bellcrank of the retracted position lock against the stop. The bellcrank turns the lever, which engages with the latch and turns it. Latch and hook disengage. The hook turns under leg weight and jack force. The lock opens and leg extends until hooks on shock absorber tusk lean against each other. After lock opening leg retracted position red warning light goes out. After hooks of a tusk have gone against each other leg extended position green warning light comes on.

4.2.4. Wheel K141/T141

Braking wheel K141/T141 with pneumatic expander tube brakes and low pressure tyres are mounted on stud axles of undercarriage main leg. Brake casing is secured to shock absorber axle flange using six bolts. Chamber brakes are operated from a cockpit by means of compressed air.

4.3. TAIL WHEEL

The tail wheel is located under a fuselage between bulkheads 17 and 19. It consists of a skid, shock absorber and stop unit. The shock absorber is hinged in a bracket mounted on a bulkhead 19. The skid, consisting of rack and fork, is hinged in a bracket, mounted between bulkheads 17 and 18. The rack of a skid is fastened to a shock absorber rod. Wheel is mounted in a fork using an axle and a nut. Tail wheel is castoring. It means that fork has a capability to rotate in bronze bushes in respect to skid
Fig. 9. Tail wheel

1- wheel; 2- skid; 3- fixing device; 4- bracket; 5- cable; 6- bracket; 7- shock absorber
To lock tail wheel in neutral position during taxiing and landing run the stop unit is designed. It is mounted in a leg socket and consists of casing, closed with a nut, with retainer and spring inside. Cable is attached to the stop unit by means of a globule. Other end of this cable by means of a link is attached to elevator control lever. The cable is closed with a Bowden shell, fixed on a fuselage main frame. When elevator is deflected upwards in a range of 15-25° the cable does not stretch, that's why the stop unit under spring action lowers and enters the socket of a flange fixed on a skid fork, i.e. the wheel is fixed in a neutral position. At all other elevator positions cable stretches and drives the retainer from a socket of a flange. Wheel gains an opportunity to rotate around the skid axis. Tail wheel is equipped with pneumatic shock absorber. It is designed as a cylinder with two caps, screwed on its ends, and the rod inside. One end of the rod protrudes cap and finishes with a fork for connection with a skid rack. The rod travel is limited with stops, consisting of a set of rubber and metal rings, located inside the cylinder. Inner bore of a shock absorber is pressurized using rubber rings of circular cross-section. One of caps has a charging point for shock absorber charging with nitrogen. Nitrogen charging pressure is 14±0.5 kg/cm². Other cap has an eye for shock absorber attachment to a bracket on bulkhead 19.

5. AIRCRAFT CONTROL SYSTEM

Aircraft control system consists of elevator control, ailerons control, rudder control and elevator trim tab control. To actuate elevator, ailerons and rudder control stick and pedals are installed in pilot's cockpit. Elevator trim tab control system is manual and is performed using a wheel mounted in a cockpit.

5.1. ELEVATOR CONTROL

Elevator is actuated by means of a control stick, mounted in front of pilot's seat. At control stick full travel 16°30' forward and aft from neutral position elevator deflects ±25°. Elevator maximum deflection angles are limited with stops, mounted on a horizontal shaft bracket. Elevator control system is of mixed type: push-pull rod control up to a bulkhead 10 and cable- behind bulkhead 10. At control stick deflection the motion through a pushrod, attached to control stick, is transmitted on two-lever bellcrank, mounted near bulkhead 10. To both levers of bellcrank cables are connected using turnbuckles. Other ends of cables have forks, attached to elevator control quadrant.

5.2. AILERONS CONTROL

Ailerons are operated by means of control stick and rigid control system, consisting of push-pull rods and bellcranks. Deflecting a control stick to the right or to the left by 14°30' ailerons deflect upwards by 22° and downwards by 16°. Ailerons maximum deflection angles are limited by stops, mounted on a fuselage beam. Control stick movement turns a bellcrank, hard-mounted on horizontal shaft. This movement is further transferred through a set of rods and bellcranks in a wing to ailerons actuating bellcranks.
Fig. 10. Elevator and ailerons control

1, 2- pushrods; 3- shaft; 4- control stick; 5- PU-7 valve control lever; 6- bellcrank; 7- bracket; 8- cable; 9- elevator control quadrant with counterweight; 10- turnbuckle; 11- cover; 12- pushrod; 13- bellcrank; 14- bellcrank; 15- pivot; 16- bracket with stops; 17- bellcrank; 18- bracket with stops
5.3. CONTROL STICK MOUNTING

The aircraft control stick is mounted in a pilot's cockpit in front of bulkhead 8 and is hinged on the horizontal shaft under a cockpit floor between bulkheads 5 and 8. The shaft is made of a tube with hard-mounted two-lever aileron control bellcrank on one end, and control stick mounting bracket on the other. The shaft ends with axles, by means of which it is mounted in support bearings, mounted on bulkheads 5 and 8. The front support has self-aligning bearing. Control stick ultimate longitudinal deflections are limited by adjustable stops, mounted on a control stick shaft bracket. Control stick lateral deflections (i.e. ailerons) are limited by adjustable stops, mounted on a fuselage beam. The stops are mounted in a bracket, which is fastened to the lower cap strip of a beam using bolts with nuts. Control stick is made of a bent tube, which has a handle on its top and a pivot in the bottom for attachment to horizontal shaft. On the upper back of the handle a bracket is mounted using bolts. This bracket carries a lever with a cable link for PU-7 wheel brake system valve actuation. In a control stick installation area a cockpit floor cut-out is made, protected with a nylon cover. Protective cover by means of an edging, riveted to it, is fastened to a floor using screws with anchor nuts. The top of a protective cover is tied up to a control stick using chord.

5.4. ELEVATOR TRIM TAB CONTROL

Trim tab is attached to the port half of elevator, which is designed to reduce loads acting a control stick. Trim tab is actuated by means of control wheel, mounted in a cockpit on the port side. A control circuit is of mixed type: flexible in a fuselage and rigid in elevator. On the port side of pilot’s cockpit between bulkheads 7 and 8 a bracket is mounted, which carries a drum with a wheel. Two cables are attached to a drum. Via guiding pulleys, mounted near bulkheads 10 and 11, cables stretch to guiding pulleys, mounted on bulkhead 18. Pulleys located near bulkheads 10 and 11, are fixed in holder blocks, secured to brackets mounted on the same bulkheads. Rear spar of the horizontal tail has a bracket that carries pulleys with limiters. Holder block and limiter do not allow cables to slip from pulleys. From pulleys on bulkhead 18 cable run passes on a drum, mounted on elevator spar. Other ends of cables are attached to this drum. Drum has a thread inside for a worm. Worm is attached to one end of a pushrod that goes along elevator spar up to two-lever bellcrank, mounted on elevator spar behind rib 2. The second lever of a bellcrank is attached to a pushrod that goes along rib 2. The second end of this pushrod is attached to trim tab actuation bracket. Trim tab deflects up or down by 10°. Ultimate trim tab deflections are limited by stops, mounted on a drum bracket. When drum rotates the worm moves in the appropriate direction until it leans against stop. Trim tab position indicator is mounted on the port side of a cockpit near bulkhead 9. It is made in a form of stencil with a record “TRIM TAB; CLIMB-NEUTRAL-DIVE” and a small red cylinder, put on the upper cable and moving along the stencil.
Fig. 11. Control stick

1- handle grip; 2- PU-7 valve control lever; 3- cable; 4- tube; 5- cover; 6- pivot; 7- shaft; 8- bellcrank; 9- forward support; 10- stop; 11- stops; 12- bracket; 13- aft support
5.5. RUDDER CONTROL

Rudder is actuated by means of toe pedals using cables. Full pedal travel makes rudder to deflect at ±27°. From pedals cable run goes through guiding pulleys, mounted on bulkhead 10, to a rudder horn. Cables are attached using bolts with nuts, turnbuckles and forks. Cable tension adjustment is made using turnbuckles located behind frame 10.

5.6. PEDAL MOUNTING

Pedals are mounted on a pilot’s cockpit floor near bulkhead 6. Parallelogram pedals can be adjusted according to pilot’s height. Adjustment range is 100 mm. Pedals are mounted on a basis, attached to a cockpit floor. Basis contains bearings, in which axle is installed. Bellcrank and pedals adjustment mechanism are mounted on this axle.
Fig. 12. Rudder control

1- rocker arm; 2- footrest; 3- casing; 4- plate; 5- footrest tube; 6- turnbuckles; 7- bracket with pulley; 8- cable; 9- bracket; 10- bellcrank
Fig. 13. Pedal unit.

1- nut; 2- plate; 3, 4- rods; 5- bellcrank; 6- stop; 7- rocker arm; 8- footrest tube; 9- turnbuckle with a fork; 10- footrest; 11- knob; 12- cable; 13- casing; 14- worm

Cable run is connected to a bellcrank using turnbuckles. Additionally brackets are bolted to a bellcrank, which carry adjustable stops, limiting pedals travel. Stop heads have rubber inserts for damping impacts. The pedals adjustment mechanism consists of casing with a worm and a nut inside. Worm has a handle on its end. Pushrods are connected to a nut. Other ends of these rods are attached to a rocker arm hinged on adjustment mechanism casing. A rocker arm by means of footrest tubes is connected with rods. Other ends of these rods are hinged on the second axle of pedal basis. Pedals are adjusted according to pilot's height by rotating the worm using its handle. When worm is rotating nut moves forward or back, thus actuating the rods, which deflect a rocker arm. At rocker arm deflection pedals, which are connected to it, displace forward by 40 mm or back by 60 mm. Pedal step represents a bracket with a fluted surface. Leg fixing belts are fastened to side webs of a bracket. Bracket internal web carries two eyes for step attachment to a pedal tube.
6. AIR SYSTEM

Aircraft air system aircraft provides engine start-up, undercarriage retraction and extension, and undercarriage wheels braking.

Air system consists of two independent systems: main and emergency, connected with common charging line.

Each system is fed with compressed air out of individual onboard bottles:
- main system – out of six-litre spherical bottle Sh375Ja-6-75³,
- emergency system - out of three-litre spherical bottle Sh375Ja-3-60⁴.

Bottles charging with dry compressed air (dew point temperature should not exceed -45°C) is executed through a common charging point 3509S505 using a ground bottle. Charging air pressure in both systems is 50 kG/cm². In flight engine-mounted AK-50M2 compressor is additionally charging bottles.

The charging point is located on the port side of a fuselage near bulkhead 11.

Air pressure in main and emergency systems could be monitored using two-pointer manometer 2М-80, mounted on an instrument panel.

Main and emergency system bottles are mounted on a firewall.

Charging and additional charging lines consist of a charging point, compressor, filter 31VF3A⁶, gravity filter FT⁷, non-return valves Sh25Ja⁸, and pressure relief valve.

Pressure relief valve has a calibrated spring, which opens the valve, when pressure in a system exceeds 50±5 kG/cm².

Air system lines are made of rigid tubes and flexible hoses.

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³ Russian designation Ш375Я-6-75
⁴ Russian designation Ш375Я-3-60
⁵ Russian designation 5309C50
⁶ Russian designation 31ВФ3А
⁷ Russian designation ФТ
⁸ Russian designation Ш25Я
Fig. 14. Air system diagram

1- braking wheel K141/T141; 2- flexible hose; 3- EK-69 electric air valve; 4- undercarriage jack; 5-Sh220Ja-2-4 emergency valve; 6- 625300M undercarriage cock; 7- 652200A undercarriage emergency extension cock; 8- U139 (PU-7) reducing valve; 9- U135 (PU-8) differential valve; 10- FT gravity filter; 11-AK-50M2 compressor; 12- emergency system air bottle; 13- pressure relief valve; 14- non-return valve; 15- 31VF2 filter; 16- 2M-80 two-pointer manometer; 17- outlet valve; 18- 652200A main cock; 19- main system air bottle; 20- 3509S-50 charging point
6.1. MAIN SYSTEM

Main air system consists of 652200A main cock, 625300M landing gear cock, electro pneumatic valve EK-69⁹, pressure-reducing valve (U139) PU-7¹⁰, and differential valve (U135) PU-8¹¹. When electro pneumatic valve is switched on compressed air comes into air distributor for engine start-up. On undercarriage extension or retraction compressed air through 625300M landing gear cock, mounted on instrument panel, goes to undercarriage jacks. For wheel brakes actuation compressed air through PU-7 valve, which reduces air pressure from 50 kG/cm² down to 8 kG/cm², and through PU-8 differential valve acts wheel brakes. The reducing valve is actuated using lever on aircraft control stick. PU-7 valve is mounted on a trailing web of bulkhead 8 under a cockpit floor. PU-8 differential valve is actuated using pedals and provides individual main wheels braking. The differential valve is fastened to a web of a bulkhead 5.

6.2. EMERGENCY AIR SYSTEM

Air from emergency system bottle is used on a main air system malfunction. Emergency air system consists of 652200A undercarriage emergency extension cock, 652300 air bleeding valve and Sh220Ja-2-4¹² emergency valves. For undercarriage emergency extension it is necessary to put landing gear cock in a neutral position, then to open emergency undercarriage extension cock. In this case compressed air from emergency system bottle through emergency valves, mounted on undercarriage retraction jacks, comes into jack extension cavity that makes undercarriage to extend. Simultaneously compressed air comes to reducing valve that enables wheels braking using emergency air system. 652300 air bleeding valve eliminates a possibility of back pressure in landing gear retraction jacks during their operation from a main system if a closed 652200A emergency air cock is not pressure-tight. When undercarriage emergency extension cock is open (pressure exceeds 5 kG/cm²) the air bleeding valve closes an exit to atmosphere. Air bleeding valve is located in aircraft fuselage and is fastened to a web of bulkhead 6 using clamp.

7. POWER PLANT

YAK-50 aircraft power plant consists of M-14P engine with V530T-D35¹³ propeller, mounting frame, exhaust manifold, engine and its units’ controls, engine cooling, start-up, fuel and oil systems.

7.1. GENERAL

M-14P is four-stroke petrol air-cooling nine-cylinder single-row radial carburettor aircraft engine. Engine has the reduction gearbox, which decreases the propeller shaft R.P.M., and centrifugal supercharger with a single-speed mechanical drive. Engine is cooled by air coming through cooling gills, mounted in a frontal part of a cowling. Even cooling of cylinders is provided by means of air deflectors, mounted on each cylinder. Engine parts are lubricated by spraying oil under pressure. To start engine compressed air is used. Magnetos and ignition harness of the engine are shielded. To maintain different systems an engine following units are installed: V530T-D35 propeller, speed R-2¹⁴ governor, AK-14P¹⁵ carburettor.

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⁹ Russian designation ЭК-69  
¹⁰ Russian designations (У-139) ПУ-7  
¹¹ Russian designations (У-135) ПУ-8  
¹² Russian designation Ш220Я-2-4  
¹³ Russian designation В530Т-Д35  
¹⁴ Russian designation П-2  
¹⁵ Russian designation АК-14П
Two magnetos of M-9F, 702ML fuel pump, 702ML fuel pump, AK-50T series 3 air compressor, GSR-3000M series 4 generator, MN-14A oil pump, compressed air valve-type distributor and r.p.m. generator DTE-1.

Each cylinder head is equipped with two sparkle plugs and one firing air valve.

By means of mounting frame engine is secured to aircraft fuselage firewall.

| Engine dry weight, kG                  | 214±2%          |
| Engine overall dimensions, mm:         |                 |
| diameter (as measured on covers of valve boxes) | 985±3          |
| length                                 | 924±3          |

**Propeller V530T-D35 specifications**

| Diameter, m                              | 2.4             |
| Number of blades                         | 2               |
| Minimum angle of blade incidence on R=100 mm | 10°             |
| Maximum angle of blade incidence on R=100 mm | 28°30'          |
| Propeller weight, kg                     | 39              |

### 7.2. ENGINE MOUNTING FRAME

The engine-mounting frame is fastened to four brackets on a firewall and carries an engine, secured to a ring using eight studs through rubber anti-vibration mountings.

The engine-mounting frame consists of a ring and four braces (two top and two bottom), made of chromansil tubes.

Eight eyes for braces attachment and eight welded boxes for rubber anti-vibration mountings and engine attachment studs are welded to a ring.

Tubes of braces are welded together in pairs with frame-to-firewall attachment forks.

To attach braces to ring forks are welded to opposite tube ends.

Braces are secured to a frame ring and frame is attached to brackets on a firewall using chromansil bolts with nuts.

Engine ring and upper brace have points for bonding attachment.

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16 Russian designation 702МЛ
17 Russian designation ГСР-3000М
18 Russian designation МН-14А
19 Russian designation ДТЭ-1
Fig. 15. Engine mounting frame

1- top braces; 2- ring; 3- rubber anti-vibration mountings; 4- bottom brace; 5- bracket; 6- firewall; 7- bracket; 8- nut; 9- stud; 10- washer; 11- anti-vibration inserts; 12- bushing; 13- nut; 14- box
7.3. ENGINE COOLING SYSTEM

7.3.1. Cowling

Engine is covered with a streamlined removable cowling. It consists of top and bottom covers, joined together with coupling locks. Surface of top cowling panel is blended with fuselage contour. The remaining part of cowling projects out of the fuselage, thus comprising a slot between its trailing edge and a fuselage surface for cooling air output. Top cover has an inspection hole giving access to oil tank. Bottom cowling has the reinforced cut-outs for exhaust manifold pipes. The cowlings are formed of duraluminium skin, reinforced with longitudinal and transversal profiles and plates. Longitudinal profiles are installed along a break in the cowling. In the plane of symmetry bottom cowling has a fairing with a window, covering carburettor air intake filter. In a frontal part cowling skin is riveted to two semi rings, manufactured of a duraluminium tube. Cowling trailing edge is reinforced using a bulbous angle. Cowlings are secured in three points using three pairs of pins in leading, medium and trailing areas. For cowling attachment to firewall top cowling trailing lateral profile has two eyebolts, to which rods with damping device are fastened; bottom cowling trailing lateral profile has two brackets with damping device. Damping device consists of a socket, holder block, anti-vibration insert and a bush. Cowling is attached using stud with the spring retainer, which secures a bracket on a firewall to the damping device. Bottom attachments are adjustable by height.
Fig. 16. Cowling

1- pin; 2- longitudinal profile; 3- semi-ring; 4- top cowling; 5- pin; 6- profile; 7- profile; 8- access hole; 9- damping device; 10- bottom cowling; 11- coupling lock; 12- anti-vibration device; 13- dust filter fairing; 14- eye bolt; 15- link; 16- lever; 17- cover; 18- stop; 19- bracket; 20- pin
7.3.2. Carburettor Air Intake

Carburettor bottom flange has an air intake unit for heated air supply into carburettor. Air intake unit consists of a box, dust filter, air intake funnel and shutter. The box is welded. Side webs of a box have bosses, welded to them, with press-fitted bushes. An axle with a shutter actuation bellcrank, secured to its one end, is installed into the bushes. Other end of an axle terminates by a pin. Welded air intake funnel is hinged on the upper flange of a box. Air intake funnel supplies into carburettor box a warm air, heated when passing through cylinder fins. Bottom flange of a box has a hinged shutter regulating cold air supply into a box. The shutter is manufactured of D16AM-L0.8 aluminium alloy and has a shape of a bucket. For rigidity shutter ends are reinforced with spot-welded edgings. Additionally shutter lateral webs are fastened together with an axle. Plates with oval cut-outs are riveted to lateral webs of a shutter. The arm of a shutter control bellcrank enters a slot of one plate. Box axle pin enters the second slot. This pin limits the deflection of a shutter. Shutter is actuated using handle, mounted on an instrument panel in a cockpit. To the bottom of the box an air filter is riveted. Air filter is made of gauze and is covered with a shutter. Air intake unit is fastened to carburettor flange using bolts with anchor nuts. Gauze is mounted between carburettor flange and air intake box.

7.3.3. Gills

Cowling inlet opening is covered with controlled gills that regulate the amount of air, passing through the engine. Gills consist of the internal fixed disc, mobile ring, doors and external fixed ring. The internal fixed disc is fastened to engine flange in four points. External fixed ring is secured to engine cylinder studs using eleven tubular braces. The mobile ring is mounted on the fixed disc and has three bosses with machined grooves, in which ball bearings, fixed using eccentric bolts, enter. Such a design allows to eliminate backlashes and to provide mobile ring and fixed disc concentricity. When mobile ring turns, ball bearings roll along the rail, riveted to the fixed disc. One of the mobile ring bosses carries the bracket, to which the gills actuation pushrod is attached. Gills doors are manufactured of sheet duralumin. On their butt-ends doors have inserts riveted in. Inserts have holes for axles, made of steel spokes, fixed by one end on external fixed ring, by other end on a steel ring which is riveted to a flange of the internal fixed disc. Steel arms are riveted to doors, which enter inside the mobile ring. Arms have longitudinal slots for bolts, fixed on a mobile ring. When ring turns, bolts turn arms and doors of gills. The amount of mobile ring turn and, therefore, doors deflection angle is limited with a stop, mounted on fixed disc. To eliminate backlash doors are two by two interconnected with springs. Gills are actuated by means of semi hard rods. Gills actuation lever is located on the starboard console. To improve cooling of upper, the most shaded engine cylinders, the guiding visor is riveted to gills outer ring top.
Fig. 17. Cooling gills

1- quick-release shutter; 2- window bolt; 3- gasket; 4- visor; 5- tubular brace; 6- shutter; 7- bellcrank; 8-spoke; 9- outer ring; 10- spring; 11- washers; 12- control rod attachment bracket; 13- ball bearing; 14-movable ring; 15- stop; 16- inner fixed disc; 17- guide
7.3.4. Exhaust Manifold

The exhaust manifold is used to collect the exhaust gas from engine cylinders and to extract it to a fire safe area. It consists of two parts, which are not joined to each other. The right manifold part integrates five engine cylinders, the left- four engine cylinders.

Each part of a manifold consists of several sections, manufactured of titanium sheets and joined together using clamps with pressure-seal gaskets. Section joints are reinforced with bushes, welded to them. Manifold is secured to the engine by means of nipples, welded to section branch pipes, using nuts and elastic sealing rings.

7.3.5. Compressor Ventilation

A branch pipe, ending with a funnel, is mounted to cool a compressor. The nipple consists of two parts: tube and branch pipe with a funnel, joined together using clamp. The pipe flange is fastened to engine deflector using screws. Deflector has a hole of a diameter to allow the tube through. The branch pipe is fastened to one of the engine mount frame braces using clamp.

7.4. ENGINE CONTROL

Engine control system consists of throttle butterfly, propeller pitch, fuel cut-off valve, carburettor heating, cooling gills and oil cooler output channel flap drives.

Throttle butterfly, propeller pitch, fuel cut-off valve, cooling gills and oil cooler output channel flap are actuated by means of levers, mounted on the port console.

Fuel cut-off valve and carburettor heating are actuated with handles, mounted in the bottom of instrument panel.

Engine control system drives include rods of a semi hard type. They are made of steel cable, inserted into a copper guiding tube. Rods are connected to levers of engine control system and aggregates using ball joints and forks.

7.5. FUEL SYSTEM

Fuel system accommodates onboard the necessary amount of fuel and feeds the engine on its all power settings and at all permissible changes of aircraft attitude.

B91/115 fuel is used as a fuel for M-14P engine.

Fuel in aircraft is located in one tank of 55 litres capacity. Tank has a negative acceleration compartment for fuel feeding during inverted flight.

From the tank gravity-acted fuel flows through a non-return valve, fuel cut-off valve and fuel filter to 702ML fuel pump and then to a compensatory reservoir. From a compensatory reservoir fuel through a fine filter 8Д2.966.064 comes to carburettor and to P1B fuel pressure sensor.

20 Russian designation 8Д2.966.064  
21 Russian designation П1Б
Fig. 18. Engine control

1- gills control rod; 2- propeller pitch control rod; 3- throttle control rod; 4- carburettor heating control rod; 5- fuel cut-off valve control rod; 6- oil cooler flap control rod; 7- carburettor heating control lever; 8- fuel cut-off lever; 9- oil cooler control lever; 10- gills control lever; 11- stopper; 12- propeller pitch control lever; 13- throttle quadrant lever
Pressure of fuel coming to carburettor is monitored by means of three-pointer electrical indicator EMI-3K. The same instrument measures oil pressure and temperature. Instrument consists of UKZ-1 indicator, P1B fuel pressure sensor, P15B oil pressure sensor and P-1 oil temperature sensor. Indicator is mounted on instrument panel, and fuel pressure sensor is installed on a firewall.

To supply engine cylinders and to fill the main fuel manifold before engine start-up primer 740400 is used, which handle is installed on the instrument panel.

When handle is pulled, primer cavity is filled with fuel via the pipeline, connected to a tee, mounted before a non-return valve.

For oil dilution purpose fuel is supplied by means of 772 electromagnetic valve, mounted on a firewall and supplied with fuel through a flexible hose, joined with the output union of a fuel pump. Oil dilution push button is installed on an instrument panel of a pilot's cockpit.

To by-pass fuel excess and maintain necessary fuel pressure before carburettor the compensatory reservoir is connected to the main tank by the line with a bore narrowed using two chokes.

The amount of fuel in a tank is monitored using two level-warning indicators DSMK8A-5 and DSMK8A-7, mounted on a tank. Warning system functions by lighting green and red lamps, mounted on instrument panel in a pilot's cockpit. Green lamp light corresponds to fuel amount of 45 litres, red lamp warns about the emergency remainder of 12 litres.

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22 Russian designation ЭМИ-ЗК
23 Russian designation УКЗ-1
24 Russian designation ДСМК8А-5 and ДСМК8А respectively
7.6. BRIEF INFORMATION ON AGGREGATES

7.6.1. Main Fuel Tank

Main fuel tank has a capacity of 55 litres and is mounted on bulkheads 3 and 4 in a fuselage nose section, to the left of aircraft plane of symmetry. Bulkheads 3 and 4 have a shape of saddle. Fuel tank is fastened by means of metal coupling ribbons. The saddle under a tank is covered with felt to preserve tank surface from rubbing. Tank is welded of a drum, two end plates and negative acceleration compartment. Latter is separated from fuel tank internal cavity with web, which has a nipple for filling a compartment with fuel and a ball non-return valve. It is used to venting a compartment during filling and fuel usage and prevents fuel from leaking at negative accelerations. Threaded union is welded into compartment web for flexible input hose attachment. For drain valve installation a union is welded into the bottom of negative acceleration compartment. The other end plate of a tank has two threaded unions, welded to it: one for connection with venting manifold, other for manifold of fuel return from a compensatory reservoir. In a top of tank drum a fuel level warning indicator attachment flange and an elbow for connection with tank filler are welded. A flange for the second level warning indicator installation is welded in a bottom of a drum. Warning indicators are attached to flanges using studs and nuts. Fuel filler is mounted on a top of a fuselage between bulkheads 2 and 3 and is secured using six studs with nuts to a pan of the hatch. Filler is a cylinder with an elbow, welded to its bottom part, for connection with the fuel tank, and a flange on top for filter and filler cap installation. Fuselage has a hatch in its skin to access fuel filler. Hatch edging has a pan, riveted to it, for draining fuel, spilled during fuelling. A pipe, attached to a union on pan web, discharges accumulated fuel overboard of a fuselage.

7.6.2. Compensatory Reservoir

Compensatory reservoir is of spherical shape. Its casing is welded of two hemispheres, which have unions for system pipes attachment. Reservoir is mounted in a pan using coupling ribbons. The pan riveted to firewall front face.

7.6.3. Fuel Filter

Fuel filter consists of casing with filtering element inside, cover and crosspiece. Casing has two unions for connection with system pipes. Filtering element consists of two gauzes: outside, wrapped in a form of cylinder, soldered to a ring and reinforced with three vertical racks, and internal, which is wrapped conically. In the bottom both gauzes are soldered to a pan. It has the helicoidal spring, soldered to its outer side. Filtering element is secured to filter cover using a screw. At filter cover installation the spring firmly presses filtering element to a casing. In a closed position a crosspiece attached to a casing using hinged bolts retains cover. One bolt has a wing nut, screwed on it, which permits easy and fast opening of a filter cover. In the bottom cover has a fuel drain union, closed with a plug. Fuel filter is mounted on a firewall and is fastened using bolts with bushes going through casing eyes.

7.6.4. Drain Valve

Drain valve is intended for fuel drain from a fuel tank and is mounted on a tank tee. Drain valve consists of a casing with two unions and a socket with a shaped nut screwed inside. Valve stem passes through a nut internal bore, valve-head plate is pressed by a spring against landing surface of one of the unions. The outside end of a rod has a handle. Rod has a press-fitted pin, which fixes the valve in open and closed position. In the latter case pin enters into nut slots.
7.7. OIL SYSTEM

7.7.1. General

Aircraft oil system is intended for lubrication and cooling engine parts. Oil MK-22 or MS-20 (GOST 1013-49) could be applied for M-14P engine. It is allowed to mix the above-mentioned oils in any proportion. Aircraft oil system consists of oil pump, 18-liters tank, filter, venting tank, 2281-2-0 oil cooler, oil lines, sensors and indicator of oil pressure and temperature. Oil dilution system is connected to oil system through 772 oil dilution valve.

Oil system has a forced circulation using a two-stage gear pump mounted on a crankcase rear cover. In general oil lines are made of flexible hoses. The minority of oil lines is rigid.

When engine is running oil on its own accord flows by hose from a tank to filter and been filtered comes to oil pump input. Then the pressure stage of a pump submits oil under pressure to engine. In the engine oil passes through channels, gaps between mating parts and directional lubrication injectors. Then oil flows off into engine sump and from there through filter it is picked up by evacuating stage of a pump, which takes oil through cooler back to oil tank. Through delivering tube oil flows on a tray, where air is separated from oil (foam elimination).

Fig. 20. Oil system diagram

1- oil tank; 2- air intake; 3- filler union; 4- oil intake; 5- 600400A oil drain cock; 6- flexible hose; 7- venting tank; 8- gravity filter; 9- 2281-2-0 oil cooler; 10- ID-1.5 manometer
Inner spaces of oil tank and engine are connected with atmosphere through two upper vents (forward and back), mounted on engine crankcase, interconnected by a common pipe with the upper cavity of an oil tank. Oil tank upper cavity is connected with atmosphere through air intake and venting tank. In order to make oil system function uninterruptedly at any aircraft attitudes oil and air intakes in oil tank are made swinging.

For oil draining system has drain points in a tank, oil-cooler and a filter. Pressure and temperature of oil, incoming to engine, could be monitored using EMI-3K25 electrical indicator. Oil pressure sensor P15B26 is mounted on a firewall. Input oil temperature sensor P-127 is mounted before oil pump pressure stage.

For oil cooling system includes an air-oleo cooler with an adjustable cross-section area of output air channel. For system operation under low temperature conditions it has an oil dilution with fuel feature. It makes engine preparation for starting and starting easier and faster.

Oil dilution system consists of a 772 valve, pipelines and a dilution valve push-button.

7.7.2. Brief Information On Aggregates

7.7.2.1. Oil Tank

Oil tank is welded of light aluminium alloy. It consists of a drum, two end plates, oil quantity gauge pocket and filler.
Following unions are welded to drum end plates of a tank: drain valve union, inlet line union, vent manifold union and oil quantity gauge union.
Oil tank filler consists of a web and flange for filler cap attachment.
The oval flange with studs is welded to one of a drum side webs. Flange hole is used for oil intake device mounting and is closed with a cover, secured using studs with nuts.
Inside a tank the supports for input device axle installation are welded to both end plates. In a top of oil tank a tray for incoming oil is riveted to a drum and one of the end plates. The same end plate has a union, welded to it, for an inlet line with a branch pipe, that feeds oil on a tray.
Total oil tank capacity is 18 litres; maximum quantity of filled oil is 16 litres (for ferry flight), for aerobatics-10 litres, minimum amount of oil is 8 litres.
In order to make oil system function uninterruptedly at any aircraft attitudes oil and air intake device is made swinging. It consists of a cylindrical basis with a weight, welded to it. One more nipple is welded to the opposite (in respect to a weight) side of air intake basis.
Input device is mounted on a common casing using nuts. Central cylindrical part of casing is divided into two cavities with an inner dividing web. Casing is mounted on an axle, fixed in tank supports.
The axle inside is hollow and is divided into two parts using internal dead web. From each side of a web axle has two holes, drilled perpendicularly to each other, that connect each part of an axle with a corresponding cavity of input device casing.
Return pipe is attached to an axle on the part of oil intake. Manifold that connects oil tank with a venting tank is attached on the part of air intake.
Oil quantity gauge is made of a rule, which has a cover with a head attached to its one end. Cover could be screwed into the union of oil quantity gauge pocket. Rule has a number of 2 mm diameter holes and one 4 mm hole. Digits are marked above them. The distance between digits of holes by volume is equal to one litre of oil. The 4 mm hole corresponds to operational level of oil.
Oil could be drained from a tank using 600400А push-type drain valve.
Oil tank is mounted on a front face of firewall in a top left side in the support assemblies, covered with felt, and secured using duraluminium ribbons with turnbuckles.

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25 Russian designation ЭМИ-3К
26 Russian designation П15Б
27 Russian designation П-1
27 Russian designation АМуМ-Л1.2
7.7.2.2. Oil Cooler Fairing

Oil cooler is mounted between firewall and bulkhead 1 and is fastened to a firewall on four brackets. Oil cooler is closed with a removable fairing, manufactured of AMcM-L1.2 [aluminium] alloy. The fairing is fastened to fuselage stringers 7 using screws with anchor nuts. Fairing outlet is closed with a controlled door that adjusts the size of oil cooler channel outlet. Door control is manual. Door has an eye riveted for actuating pushrod attachment. The control system is made of semi hard rods. Oil cooler door control lever is mounted in a cockpit on the port console.

7.7.2.3. Filter

Filter consists of casing, cover with a drain plug, cover securing crosspiece, support ring, sleeve, spring and filtering element. Filtering element is mounted on a cover and its upper ring rests on a sleeve. Spring is located between the upper butt-end of a sleeve and casing. Casing has two threaded holes: side hole for oil input and upper one for filtered oil output. Filter design enables easy removal of filtering element for inspection or washdown without oil drain from oil tank. At cover with a filtering element removal the sleeve under spring pressure lowers down to a support ring and closes casing inlet opening. Fuel filter is mounted on a firewall and is fastened using bolts with bushes going through casing eyes.

28 Russian designation АМуМ-Л1.2
8. EQUIPMENT

8.1. COCKPIT EQUIPMENT

The instrument panel consists of four panels: port, middle, starboard and bottom. Side panels are rigidly attached to a fuselage main frame using screws with anchor nuts. The lower panel is rigidly fastened to a transverse beam using screws with anchor nuts. The middle quick-release panel is mounted on four anti-vibration inserts. To remove the panel it is necessary to unscrew two upper nuts and to take out two lower studs with the stop unit.

The port panel instrument panel contains:
- engine start button;
- magneto switch PM-1;
- air pressure gauge 2M-80K;
- landing gear cock 625300;
- landing gear warning lights;
- lamps check push button KNR;
- fuel cut-off valve control handle.

The starboard instrument panel contains:
- primer;
- oil dilution valve push-button;
- handle of undercarriage emergency extension cock;
- gills control handle;
- carburettor heating control handle.

The lower instrument panel contains:
- battery switch;
- alternator switch;
- Circuit breakers IGNITION, LANDING GEAR WARNING, INSTRUMENTS, RADIO, HORIZON, PITOT, CLOCK.

The middle instrument panel contains:
- speed indicator a US-450K;
- gyro horizon AGI-1K;
- altimeter VD-10K;
- clock ACS-1K;
- accelerometer AM-10K;
- three-pointer indicator EMI-3K;
- pressure-vacuum gauge MV-16K;
- ALTERNATOR FAILURE warning light;
- Voltammeter VA-2K;
- mixture temperature indicator TUE-48K;
- cylinders temperature indicator TCT-13K;
- R.P.M. indicator ITE-1;
- Warning light FUEL REMAINDER 55+1.5-0.5 litres,
- Warning light FUEL REMAINDER 10 litres.

On instrument panel frame above the middle panel the compass KI-13K is mounted.

Engine control panel is mounted on the port side of a cockpit between bulkheads 7 and 8. It is fastened to a fuselage main frame using screws with anchor nuts.

The port console contains:
- gills control lever;
- oil cooler door control lever;
- throttle quadrant lever;
- propeller pitch control lever.

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29 Russian designation KHP
8.2. FLIGHT CONTROL AND NAVIGATION EQUIPMENT

The set of navigation equipment contains: KI-13K magnetic compass, AGI-1K gyro horizon, VD-10K altimeter, US-450K speed indicator, ACS-1K clock, AM-10K accelerometer.

KI-13K magnetic liquid-damped compass is used for aircraft magnetic course indication. The principle of compass operation is based on magnetic field of compass permanent magnets and Earth magnetic field horizontal component interaction.

**Brief specifications**

<table>
<thead>
<tr>
<th>Instrument error</th>
<th>±1°</th>
</tr>
</thead>
<tbody>
<tr>
<td>Works at aircraft banks</td>
<td>up to 17°</td>
</tr>
<tr>
<td>Deviation, not more</td>
<td>±2.5°</td>
</tr>
</tbody>
</table>

AGI-1K gyro horizon is used for determination of aircraft attitude in respect to a plane of celestial horizon as well as for determination of existence and direction of sideslip. A principle of gyro horizon operation is gyroscopic with electrically actuated rotor. The gyro horizon represents a combination of two devices installed in one casing: a gyro horizon and slip indicator. Gyro horizon is powered with a three-phase 36V AC, 400 Hz. Consumed current doesn’t exceed 0.6A.

**Brief specifications**

| Reading accuracy in level flight | 1° |
| Reading error: | |
| after turn with a bank deeper than 15° | less than 3° |
| after performing aerobatics | less than 5° |
| Operating temperature | from +50°C to -60°C |

Two-pointer altimeter VD-10K is used for determination of relative flight altitude, i.e. flight altitude relative to take-off point. Principle of altimeter operation is based on aneroid capsule’s sag dependence upon barometric pressure change with flight altitude. Altitude readout is made using two arrows of different length and one scale. The small arrow indicates kilometres, and the large one- tens and hundreds of meters.

**Brief specifications**

| Operating temperature | from +50°C to -60°C |
| Range of measurements | from 0 to 10 km |
| Admissible errors at the altitude (standard temperature): | |
| 500 m | ±20 m |
| 5000 m | ±60 m |
| 10000 m | ±90 m |

US-450K speed indicator is used for aircraft indicated airspeed indicating. The principle of speed indicator operation is based on airflow dynamic pressure measurement by means of manometric capsule.

**Brief specifications**

| Range of measurements | from 50 to 450 km/h |
| Admissible reading error at standard temperature | up to ±6 km/h |

The aircraft chronometer-watch ACS-1K is used for current time and flight time indication.

The clock consists of three mechanisms:
Usual clock for daytime determination in hours and minutes;
mechanism for a flight time marking in hours and minutes;
stop watch for short periods of time measuring and readout in minutes, seconds and fractions of a second.

On its face clock has three scales.
AM-10K accelerometer is used for current load factor indication, and fixing of maximum accelerations, which act in a direction, perpendicular to a wing plane. The principle of accelerometer operation is based on the action of inertial forces on the instrument sensor (axle with weights mounted on a shaft), thus causing a shaft to turn around the axle. Shaft turn through drive links is transferred to instrument’s pointer. Pointer turn angle is proportional to aircraft acceleration.

Brief specifications

<table>
<thead>
<tr>
<th>Effective range of measurements</th>
<th>from –5g to +10g</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reading error during dynamic test at standard temperature in range:</td>
<td>±0.5 g</td>
</tr>
<tr>
<td>from +2 to +10 g</td>
<td>±0.5 g</td>
</tr>
<tr>
<td>from -2 to -5 g</td>
<td>±0.5 g</td>
</tr>
</tbody>
</table>

PITOT SYSTEM

PVD-6M pitot-static tube is installed on an aircraft to feed diaphragm-aneroid instruments. Static chamber of pitot-static tube is connected to US-450K airspeed indicator and VD-10K altimeter. Total pressure chamber is connected to US-450K airspeed indicator. System pipelines are made of rigid tubes. static system line is painted in white, total pressure line- in black.

8.3. ELECTRICAL POWER SYSTEM

GSR-3000M engine-mounted alternator is the main 28.5V DC power source of the aircraft. Alternator circuit includes RK-1500R controller box and power line filter SF-3000R, mounted on firewall back surface. Stand-by DC power source is the storage battery "Varley", mounted on a fuselage port side between bulkheads 11 and 12. For AGI-1K gyro horizon energizing with three-phase 36V 400 Hz AC is performed by PAG-1F converter, mounted on the right side of a fuselage near bulkhead 12. Commutation of electrical signals and circuits protection implements different contactors and relays mounted on electrical power panel. Electrical power panel is mounted on the port side of a fuselage between frames 10 and 11. For consumers’ energizing during their checkout and debugging in airfield conditions aircraft is equipped with a ground power connector SRAP-500K. It is mounted on the port side of a fuselage near bulkhead 10. Green warning light is installed near connector. Light comes on when aircraft is powered using ground electric power source. Network voltage could be monitored using VA-2K voltammeter, mounted on a middle shock-mounted instrument panel.

8.4. RADIO COMMUNICATION EQUIPMENT

Aircraft is equipped with the VHF sending-receiving command radio station "Ziablīk”30 (R-867), permitting to conduct a two-way radio communication with ground stations and airplanes on air.

30 "Chaffinch"
Fig. 21. DC power panel electrical wiring diagram

E1  Alternator         GSR-3000M
E2  Controller box    RK-1500R
E3  Network filter    SF-3000R
E4  Battery           "Varley"
E5  Connector         ShR28P2NG7
E6  Contactor          TKD-501DT
E7  Contactor          TKD-501DK
E10 Relay             TKE-52PDT
E11 Relay             TKE-22PDT
E12 Diode             DG7
E13 Fuse              SP-2
E14 Voltmeter         VA-2
E15 Ammeter shunt     ShA-240
E16 Fuse              IP-20
E17 Battery switch    VG-15
E18 Connector         ShRAP-500K
E19 Alternator switch VG-15
E42 Fuse              SP-2
C10 Relay             TKE-24PDT
C44 ALTERNATOR FAILURE warning light SM39 red
C46 GROUND POWER SUPPLY warning light SM39 green
RADIO STATION "ZIABLIK"

The VHF sending-receiving station "Ziablifk" (P-867) is intended for communication with ground stations and airplanes on air.

Crystal frequency control provides a capability to communicate without search and tuning. The radio station allows to sample of any communication channel (out of 360) within the limits of effective frequency range without additional set-up. The selection of a demanded channel is made using two handles located on radio station forward panel.

While operating the radio station the aviation headset AG-2 is used. It is acceptable to operate using the aviation headset containing TA-56M high-ohmic earphones and LA-5 throat microphones.

Radio station set consists of:
transceiver;
power supply unit;
antenna;
connection cables.

Radio station has a whip antenna mounted on fuselage top near bulkhead 14.

Transceiver and power supply unit are installed on a pilot's cockpit starboard near bulkhead 10.

Radio station is controlled using the transceiver forward panel. It has two channel selection knobs, volume control knob and a squelch switch.

Operating the radio station includes following operations:
turning radio station power ON and OFF;
radio station switching from reception mode to transmission mode and back.

When aircraft network is energized, the radio station "Ziablifk" is actuated using RADIO circuit breaker, installed on the lower instrument panel, and a NETWORK switch on radio station front panel.

Clicking of the RADIO push-button, mounted on a throttle control lever, makes transceiver reception/transmission changeover.

The radio station is designed to operate under following conditions:
ambient temperature from -40°C to +50°C;
maximum relative humidity 98% at ambient temperature of +40°C.

Main specifications

<table>
<thead>
<tr>
<th>Range of operational frequencies</th>
<th>118-135.95 MHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of communication waves</td>
<td>360</td>
</tr>
<tr>
<td>Transition time from one wave to another</td>
<td>less than 1 sec</td>
</tr>
<tr>
<td>Transition time from reception to transmission and back</td>
<td>less than 0.5 sec</td>
</tr>
<tr>
<td>Receiver sensitivity at modulation frequency of 1000 Hz, modulation factor 30%, voltage on two pairs of high-ohmic telephones 15V and signal-to-noise ratio on output equal to 3</td>
<td>not worse than 3 μV</td>
</tr>
</tbody>
</table>