# МІНІСТЕРСТВО ОСВІТИ І НАУКИ УКРАЇНИ

## НАЦІОНАЛЬНИЙ АВІАЦІЙНИЙ УНІВЕРСИТЕТ

**АЕРОКОСМІЧНИЙ ФАКУЛЬТЕТ**

**КАФЕДРА ПІДТРИМАННЯ ЛЬОТНОЇ ПРИДАТНОСТІ ПОВІТРЯНИХ СУДЕН**

**ДОПУСТИТИ ДО ЗАХИСТУ**
Завідувач кафедри
к.т.н., доцент
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«_____»________________2021 р.

# КВАЛІФІКАЦІЙНА РОБОТА (ПОЯСНЮВАЛЬНА ЗАПИСКА)

ВИПУСКНИКА ОСВІТНЬОГО СТУПЕНЯ «МАГІСТР»

ЗА ОСВІТНЬО-ПРОФЕСІЙНОЮ ПРОГРАМОЮ
«ТЕХНІЧНЕ ОБСЛУГОВУВАННЯ ТА РЕМОНТ ПОВІТРЯНИХ СУДЕН І АВІАДВИГУНІВ»

**Тема: «Методологічні основи забезпечення ефективності технічного обслуговування вертольоту злітною масою 8-16 тон»**


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**Нормоконтролер:** ____________/______________


**Київ 2021**

# MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE

## NATIONAL AVIATION UNIVERSITY

**AIRSPACE FACULTY**

**AIRCRAFT AIRWORTHINESS RETAINING DEPARTMENT**

**ADMIT TO DEFENCE**
Head of the Department
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___________ O.V. Popov
«____» __________ 2021

# MASTER DEGREE THESIS
# (EXPLANOTARY NOTE)

GRADUATE OF EDUCATIONAL DEGREE "MASTER"

FOR EDUCATIONAL AND PROFESSIONAL PROGRAMS "MAINTENANCE

AND REPAIR OF AIRCRAFT AND AIRCRAFT ENGINES"

**Topic: «Methodological bases of maintaining the efficiency of helicopter maintenance with takeoff weight of 8-16 tons»**

**Fulfilled by:** ____________ **Pyshun O.B.**

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**Kyiv 2021**

**NATIONAL AVIATION UNIVERSITY**

Airspace Faculty
Aircraft Continuing Airworthiness Department
Educational Degree "Master"
Speciality 272 "Aviation Transport"
Educational and professional programs "Maintenance and repair of aircraft and aircraft engines"

**APPROVED BY**
The Head of the department
Ph.D., associate professor
___________ O.V. Popov
“_____”__________2021

**Graduation Project Assignment**

Pyshun Oleg

1. Topic: "**Methodological bases of maintaining the efficiency of helicopter maintenance with takeoff weight of 8-16 tons** " approved by the Rector’s order of "11" October 2021 № 2196

2. Period of accomplishing of the Graduation Project since October 25, 2021 until December 31, 2021.

3. Initial data for the project: unit failures research of middle helicopters. Statistical data from National Transportation Safety Board,

4. The content of the explanatory note: introduction about activity and principle usage of sme systems of helicopters, listed general analysis of helicopter malfunctions and, pointed the project part of hydraulic control systems, list of precautions during work on helicopter, listed table of dangerous emissions during work on helicopter, general conclusions are explained.

5. The list of mandatory graphic materials: take-off and landing devices, schemes of pneumatic system, fuselage schemes. Illustrated material is completed with the help of Microsoft Office.

6. Time and Work Schedule

| # | Stages of Graduation Project Completion | Stage Completion Dates | Remarks |
|---|---|---|---|
| 1 | Task receiving, selection of material | 25.10.21– 31.10.21 | Done |
| 2 | Analytical part, detailed analysis of factors influencing on aircraft operational reliability, serviceability | 02.11.21-09.11.21 | Done |
| 3 | Project part | 12.11.21-18.11.21 | |
| 4 | Scientific part | 19.11.21-24.11.21 | |
| 5 | Labor precautions | 25.11.21-26.11.21 | |
| 6 | Ecology | 27.11.21-28.11.21 | |
| 7 | Arrangement of explanatory note | 29.11.21-06.12.21 | |
| 8 | Preparing for project defend | 13.12.21-20.12.21 | |

7. Advisers on individual sections of the project:

| Section | Adviser | Date, Signature | |
|---|---|---|---|
| | | Assignment Delivered | Assignment Accepted |
| Labor precaution | Ph.D., associate professor Kovalenko V.V. | | |
| Environmental protection | Ph.D., associate professor Sayenko T. V. | | |

8. Assignment issue date "_____"____________ 2021.

Degree work supervisor: __________________ Rugain O.V.

(signature)

Assignment is accepted for fulfillment __________________ Pyshun O. B.

(signature)

# ABSTRACT

The explanatory note to the qualification work "**Methodological bases of maintaining the efficiency of helicopter maintenance with takeoff weight of 8-16 tons** "

113 pages, 37 figures, 9 tables.

The qualification project is the construction of various resources, such as reliability, intercalation in relation to Mi-8 helicopters operating in Ukraine.

The aim of the study is to promote proposals coordinated to increase the utility and practicality of the chassis, fuselage and parts of the pneumatic system.

The purpose of the thesis is to promote proposals coordinated along the course and rearrangement of viability and the inviolable quality of service for aircraft systems and parts of the following.

The method of investigation is the analysis of the study of failures, which definitely helps to find out the principles of accidents and accidents, some analytical disadvantages of the project and measurable information studies to provide answers to recognized questions.

The main principle of this thesis is to ensure that the output will affect the experience of modern aviation. The method of providing the effect will describe the principle of proposals for the efficiency of servicing the fuselage, take-off and landing devices, pneumatic system and control system.

It is recommended to use diploma working materials in the educational process and practical activities of development laboratory specialists.

Keywords**: HYDRAULIC SYSTEM UNITS, LANDING GEAR, FUSELAGE, BRAKING SYSTEM, FAILURES, TECHNICAL OPERATION, MAINTENANCE, EFFCIENCY.**

# Content

## LIST OF ACRONYMS AND TERMS

AC – Aircraft;

LG – Landing Gear;

MLG – Main Landing gear;

NLG – Nose Landing gear;

CPF – Cenral Part of Fuselage;

TB – Tail Boom

EB – End Boom

NPF – Nose Part of Fuselage

TR – Tail Rotor

MR – Main Rotor

HS – Hydraulic System

APU – Auxiliary Power Unit

WF – Working Fluid

Failure – an event when the malfunction of an object operational condition takes place.

# INTRODUCTION

The formation of aviation is associated with an increase in the importance of flight safety and the effectiveness of the use of flight equipment. In order for passengers and flight crew to feel calm during the flight, safety always comes first. Flight safety is very important, because in every case of the use of AC, people's lives are involved. Safety should be the most important priority for any airline in all aspects of its operation. Violations of AC safety are associated not only with one plane crash and loss of life, but also with hostility and errors during maintenance, repair and operation, which also lead to injuries and death of personnel. Various incidents and accidents constitute statistics. As a rule, such cases make a great contribution to investigations. At the end of these investigations, we receive various types of tests.

The advantages of helicopters associated with the specifics of their flight, including vertical take-off and landing, determine the cost of their operation higher than in the case of AC. The reason for this state of affairs lies in the fact that many elements of their design are exposed to variable force and direction. As a result, if negligence or errors are made during inspections, overhauls or maintenance during the current operation of helicopters, damage to one of the main elements (for example, the rotor blade) may result. In summary, the helicopter maintenance system is key to ensuring that this type of AC is properly operational.

The objectives and tasks of maintenance are directly related to the design of the AC. The design affects the ease of maintenance of this type of AC. The concept of maintenance is the performance of tasks and actions necessary to ensure the continuity of airworthiness of the AC, including one-time or comprehensive inspection, control, replacement, elimination of a defect and making changes or performing repairs. During the maintenance stage of the AC, repairability, also called technicality of maintenance. It is an adaptation of the design to perform the necessary maintenance. Despite this fact, it is primarily of interest to maintenance authorities, it must be taken into account by users, and it has a significant impact on both costs and actual working hours. The most suitable indicator of repairability is the frequency and amount of maintenance. This factor completely affects both the cost and the real time of work. Thus, the lower the frequency and the volume of maintenance work performed, the longer the time for efficient use of the helicopter for transport and flight training tasks. During maintenance of helicopters, there are many different types of maintenance and checks.

For my work, I decided to stop at the Mi-8 helicopter. I chose this helicopter due to the successful combination of operational and cost characteristics of the helicopter MI-8 and its modifications have been in demand in the global helicopter market for many years. According to trading organizations, currently more than 2,500 helicopters of the MI-8 family and their modifications have been sold to private airlines and state organizations (police, fire guards, the army, etc.) in many countries of the world. In terms of the number of Mi-8 helicopters built (more than 13,000) and their development, the Mi-17 helicopters produced in more than 30 major modifications significantly exceed all foreign helicopters of this class, while more than 3,000 Mi-8 helicopters of various modifications were delivered abroad.

Widely used in more than 50 countries of the world for many civilian and military tasks. Mi-8 helicopters, as a rule, have a dual purpose, as indicated in the type certificate.

# PART 1 THE URGENCY OF ENSURING THE MAINTENANCE EFFICIENCY OF THE HELICOPTER WITH A TAKEOFF WEIGHT OF 8-16 TONS

## 1. 1 General assessment of domestic helicopters operational reliability

The Mi-8 multipurpose helicopter created at the Mil design bureau, the prototype of which made its first flight in 1960, is morally and physically obsolete. The main reasons that led to a decrease in the range of its application and productivity were insufficient efficiency and power of TB2-117 engines, imperfect aviation and radio-electronic equipment.

In the second half of the 70s, the Mil Design Bureau created the Mi-17 helicopter with TB3-117 engines, which was a further development of the Mi-8T helicopter and was widely exported to foreign countries. Later, Mi-8MT / MTV helicopters with TB3-117BM engines were created on its basis. In parallel, a special version of the Mi-8MT helicopter was created for military aviation. In 1973, the Mi-14 amphibious helicopter made its first flight, capable of taking off and landing on water and ground surfaces, which differs from the Mi-8MT helicopter in the design of the lower fuselage, made in the form of a boat, the presence of an additional tail float, two NLG and two retractable MLG, installation of special equipment.

The Mi-8MT/MTV helicopter, along with the maximum continuity of the design of the Mi-8T helicopter, has a number of significant differences.

These include:

reducing the mass of the fuselage structure due to the manufacture of the skin mainly from alloy D16AM with a smaller sheet thickness with the simultaneous installation of reinforcing annular linings along the reinforced frames of the CPF(CPF), TB (TB), end girder, as well as additional reinforcement by struts of frame Number 7 ; location on the right side panel of the CPF between frames Number 3 and 4 of the emergency hatch; changes in the parking compression of shock absorbers and AC tires due to an increase in the maximum take-off weight of the helicopter to 13,000 kg and a change in the range of permissible operational balance of the helicopter; installation of the УП-25/2 pressure reducing valve into the air system instead of the ПУ-7; cardinal revision of the power plant (use of more powerful and econumbermical main engines TB3-117BM with electronic controllers and an APUАИ-9В, which provides air starting of the main engines and backup power supply of the helicopter; revision of the rear spherical support and front belt of engine mounting; placement of an effective dust protection device with air and electric thermal anti-icing system; provision of forced air cooling of alternators, hydraulic pumps, air compressor, oil coolers; revision of the end compartment and the left side flap of the main gearbox compartment, hoods in accordance with the installation of the АИ-9В engine and the second generator; changes in the low-pressure fuel system, which provides fuel for ТВ3-117ВМ, АИ-9В engines, heater КО-50; implementation of the engine oil system with separate pumping of oil from the engine to the oil cooler, from the top drive box , the central drive, the first support and, when the oil unit bypass valve is triggered, into the oil tank; providing fire protection for the compartments of the main engines, heater, main gearbox and АИ-9В (the system has two fire extinguishers with pyroheads with a capacity of 4 liters each); the use of the main gearbox ВР-14 on the helicopter, which matches the rotational speed of the free turbines of the engines (15,000 rpm) and the rotor (192 rpm) at the numberminal operating mode for efficient use of the engine power; installation on the girder (left in the direction of flight) of a pulling type TR (clockwise direction of rotation, if you look at the EB) with modified blades, which in general made it possible to expand the range of directional control of the helicopter and obtain the maximum thrust of TR - 8700 N ( 870 kgf); introduction into the helicopter control system in addition to the control circuit for reconfiguring the main rotor speed, and in the directional control - of the СПУУ-52 movable stop system, which provides automatic limitation of the TR step to 80% of its maximum value at low temperatures and high ambient pressure during avoidance of overloading of the tail transmission of the helicopter; replacing the dispenser with a throttle in the line for supplying the WF to the hydraulic seal in the helicopter's HS. The above design solutions have made it possible to significantly improve the flight and mass characteristics, and to increase the helicopter flight performance.

Mi-8MT / MTV is designed for passenger and cargo transportation, as well as for special aviation operations in hard-to-reach areas. The helicopter (Figure 1) is designed according to a single-rotor scheme with a five-bladed MR and three-bladed TR. The helicopter is equipped with two ТВ3-117 turboshaft engines with a takeoff power of 2000 - 2500 hp. with. each (depending on the modification), which ensures the possibility of flight and landing in the event of a failure of one of the engines and the transition of the operating engine to an emergency mode with a capacity of 2200 - 2800 hp. with.

The helicopter is operated in the following options:

- transport (without additional fuel tanks), providing for the carriage of goods weighing up to 4000 kg or 24 passengers;

- sanitary, providing transportation of 12 bedridden patients and an accompanying medical worker;

- with an external sling designed for the transportation of bulky goods outside the cargo compartment weighing up to 3000 kg;

- ferry (with two additional tanks), providing the maximum flight range.

The helicopter is equipped with an electric winch, which allows lifting (lowering) loads weighing up to 150 kg with the help of an onboard boom, as well as, if there is a chain hoist, pulling loads weighing up to 3000 kg into the cargo compartment.

For the transportation of bulky cargo in the cargo compartment (for example, rotor blades) and for training parachute jumps through the cargo hatch on a helicopter, a half-open position or removal of the cargo compartment doors is provided.

In addition to the main options for using the helicopter, when installing additional equipment, it is able to solve problems:

- on the conduct of electronic warfare;
- to carry out chemical and engineering exploration;
- fire correction;
- aerial photography;
- rescuing people from hard-to-reach areas;
- - extinguishing fires.

Helicopter length:

- without MR and TR - 18.3 m
- with rotating MR and TR - 25.244m

Helicopter height:

- without TR 4.73m

- with a rotating TR 5,654m

Distance from the ground to the bottom point of the fuselage (clearance) - 0.445 m

Stabilizer area, 2 m2

The parking angle of the helicopter 3 ° 42 '

Cargo compartment dimensions,:

- length without cargo doors 5.34 m
- length with cargo doors 7.82 m
- width on the floor 2.06m
- maximum width 2.25m
- height 1.8m
- the distance between the load-bearing floor beams is 1.52 m
- emergency hatch 0.7m x1m
- track of loading ramps 1.5 ± 0.2 m

Passenger compartment dimensions:

- length 6,36 m
- width (on the floor) 2.05m
- height 1.7m
- seat pitch 0.74m
- the width of the passage between the seats 0.3m
- wardrobe (width x height x depth) 0.93m x 1.78m x 0.7m
- sliding door (width x height) 0.82m x 1.4m
- opening for the rear entrance door in the passenger version (width x height) 0.785m x 1.285m
- escape hatches in the passenger version of 0.46mx0.7m

Crew compartment size, 2.15m x 2.05m x 1.7m

Blisters 0.75m x 0.75m

Distance from the end of the blade to the TB in the parking lot, m 0.45

The angle of inclination of the main rotor axis forward 4 ° 30 '

Chassis track, 4.5m

Chassis base, 4,258m

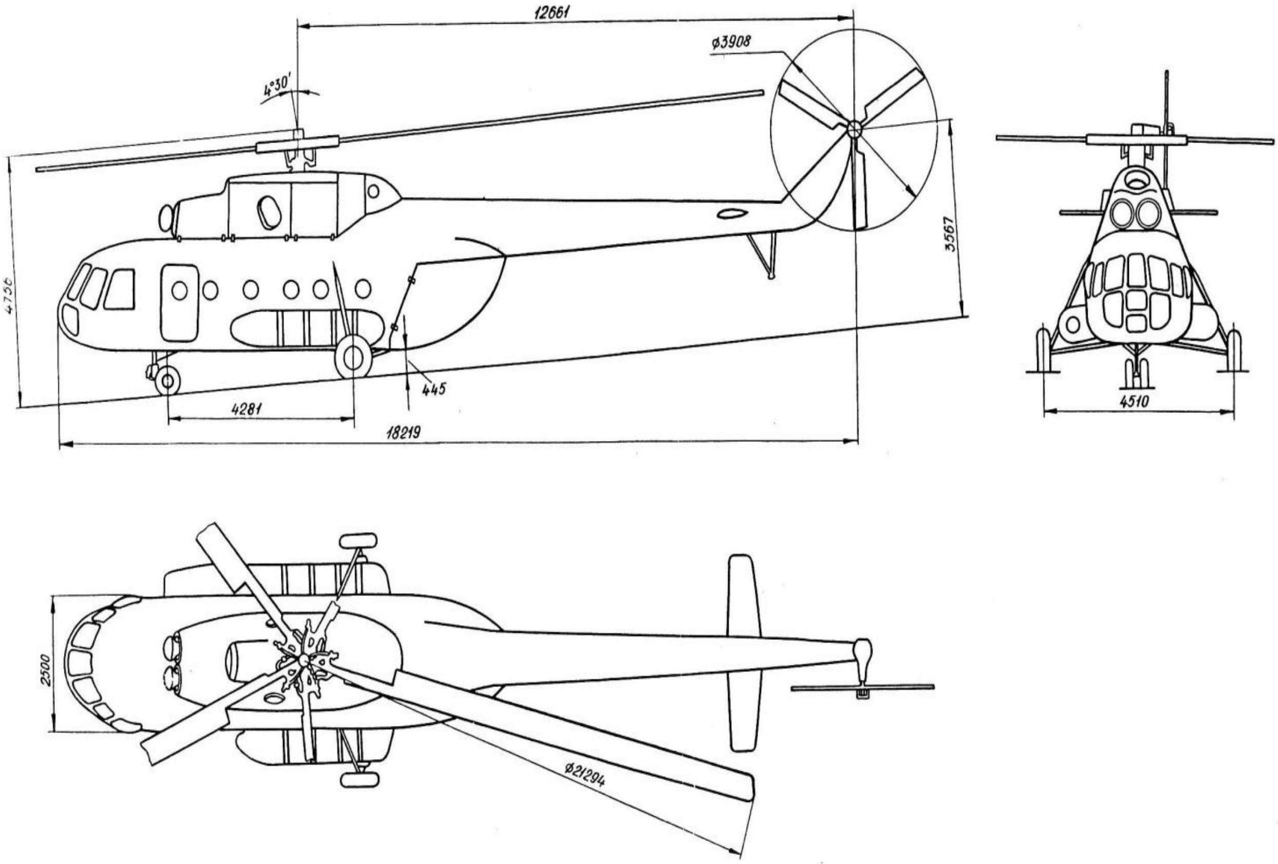


Figure 1 – The main dimensions of the helicopter Mi-8

Composition of the machine:

The Mi-8 helicopter consists of the following assemblies, devices and systems (Figure 2):

- fuselage
- stabilizer
- cowls
- takeoff and landing gear
- MR and TR
- power unit and fan unit
- powertrain
- Helicopter control system and autopilot
- HS

- pneumatic system
- de-icing system
- cabin heating and ventilation system
- external load suspension devices and airborne boom
- electrical, radio and apparatus equipment.

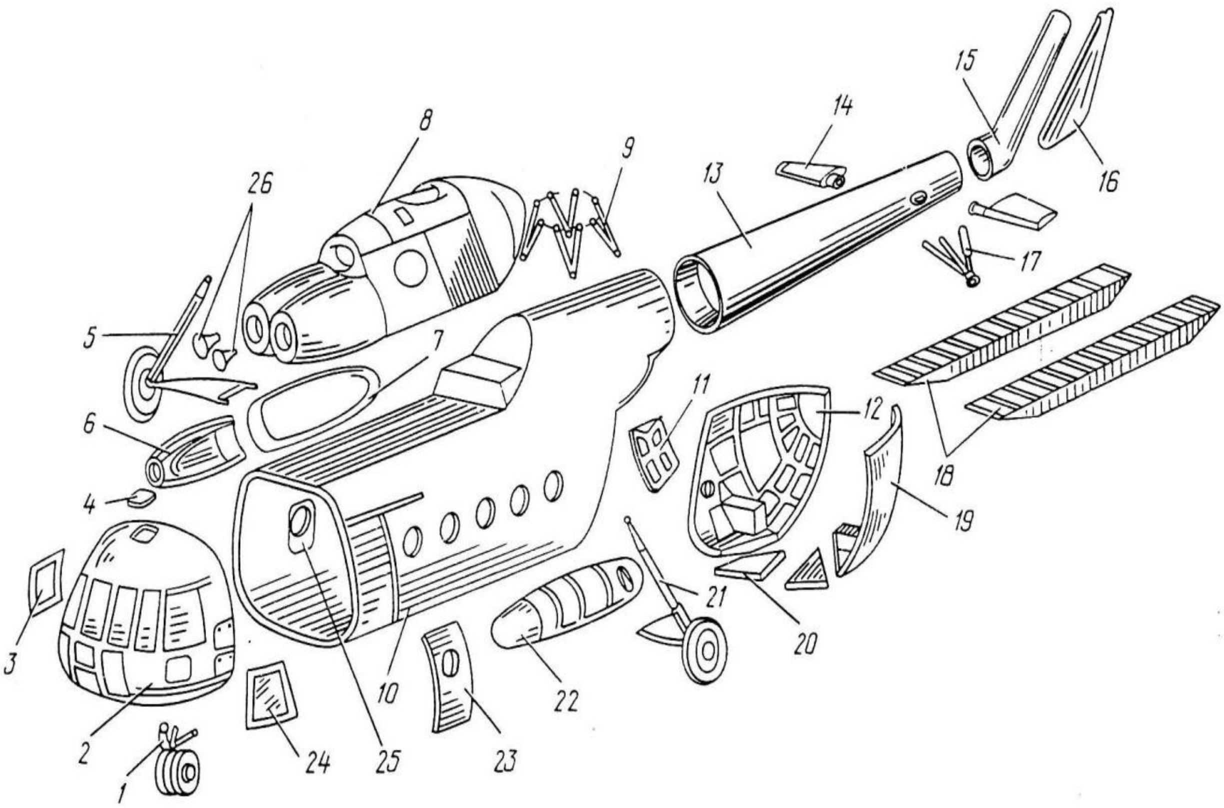


Figure 2 – Layout of the helicopter:

1. Front leg of the chassis; 2. The nose of the fuselage; 3, 24. Sliding blisters; 4. Cover of the hatch of the exit to the engines; 5, 21. MLG legs; 6. Heater hood KO-50; 7, 22. Suspended fuel tanks; 8. Hoods; 9. Gear frame; 10. The central part of the fuselage; 11. Hatch cover in the right cargo door; 12, 19. Cargo doors; 13. Tail boom; 14. Stabilizer; 15. End beam; 16. Fairing; 17. Tail support; 18. Ladders; 20. Sash guard; 23. Sliding door; 25. Emergency hatch-window; 26. Fairing of the dustproof device

## 1.2 Investigation of failures and malfunctions

According to the official data received by the State Aviation Safety Supervision Service of Ukraine, for 2005, for the 1st half of the year and the 3rd quarter of 2006, data on failures, malfunctions and numbern-compliance with technical requirements as a the result of the operation of Mi-8 helicopters, flying a total of 14,091 hours. Information on element failure is provided in Tables 1, 2 and 3.

Table 1 Information on failures of Mi-8 helicopter systems in 2005

| Code | Name of the system | Total | In-flight | Components that failed |
|---|---|---|---|---|
| 022 | Automatic flight control equipment | 4 | 1 | control panel АП-34 |
| 023 | Communication equipment | 8 | 0 | Орлан-85СТ; Ядро-1А |
| 024 | Power supply system | 8 | 0 | ВУ-6А; ПО-750; СНП-1; ПСГ-15М; ДВ-3 |
| 025 | Household and rescue equipment | 1 | 0 | Water pump |
| 026 | Fire-fighting equipment | 5 | 0 | ССП-ФК-БИ |
| 027 | Control system | 1 | 0 | |
| 028 | Fuel system | 7 | 1 | Fuel tank; float valve tank |
| 029 | HS | 4 | 0 | КАУ-30Б; РА-60 |
| 030 | POS | 3 | 1 | 1919Т; break heating wiring |
| 031 | Devices | 2 | 1 | Temperature sensor |
| 032 | Chassis | 8 | 0 | Shock-resistant; backlash in braces |
| 033 | Lighting and light alarm | 9 | 0 | МСЛ-3; РЕС-10; ЛФЛ-27-450-5 |

| Code | Name of the system | Total | In-flight | Components that failed |
|---|---|---|---|---|
| 034 | Aerobatic navigation equipment | 9 | 2 | 458МКС; ВБЕ-СВС; УС-450 |
| 036 | Pneumatic system | 4 | 0 | АД-50; 4830А; leaky brakes |
| 049 | Auxiliary power plant | 6 | 0 | КП-9В; СТГ-3; start coil |
| 051 | Glider | 2 | 0 | Roughness of the RV cable |
| 052 | Doors, hatches, creations | 4 | 0 | Backlash in knumberts |
| 053 | Fuselage | 2 | 0 | Corrosion of elements |
| 054 | Engine gondolas, pylons | 3 | 0 | |
| 055 | Plumage | 2 | 0 | |
| 056 | Lantern, windows | 2 | 1 | Cabin lantern |
| 065 | Screws | 20 | 0 | Cardan shaft bearing of til rotor; ЦО3-ВНГ; hydraulic damper of main rotor; blade damage; cracks |
| 071 | Propulsion | 2 | 0 | 1919Т; break heating wiring |
| 072 | Engine | 8 | 0 | К-40; ЕРД-3ВМ; chip filter |
| 073 | Engine fuel system | 6 | 2 | ИР-40ВА; НР-3ВМ |
| 074 | Ignition system | 1 | 0 | |
| 075 | Air sampling system | 1 | 0 | |
| 076 | Engine control system | 1 | 0 | |
| 077 | Engine control | 2 | 0 | 2УТ-6К; hinged connector ПК-6 |

| Code | Name of the system devices | Total | In-flight | Components that failed |
|---|---|---|---|---|
| 078 | Exhaust system | 2 | 0 | Numberzzle 8MT-6810-219 |
| 079 | Oil system | 9 | 0 | BMP |
| 080 | Launch system | 3 | 1 | СВ-78БА |
| 084 | Transmission | 2 | 1 | Д1М |
| 110 | Radio equipment | 20 | 9 | КУРС-МП; РЛС; ДИСС-15; А-037; RDR-2000; ДИСС-013; АРК-9; РВ-5м |
| 113 | Recognition, numbertification and active response equipment | 6 | 2 | ICAO encoder; КТ-76С; КТ-70; СО-79 |
| 142 | On-board means of control and registration of flight data | 8 | 1 | САРПП-12ДМ; МС-61; МЛП-14-3; ТКБ-54ТД |
| 171 | Others | 3 | 0 | |
| | Together | 188 | 23 | |

Table 2 Information on failures of Mi-8 helicopter systems for the 1st half of 2006

| Code | Name of the system | Total | In-flight | Components that failed |
|---|---|---|---|---|
| 022 | Automatic flight control equipment | 1 | 0 | ВК-53РЩ |
| 023 | Communication equipment | 14 | 3 | ПДУ-36; ЯДРО-1А; Р-863; Баклан-20; МС-61; ГСШ-А-18; Р-855А1; Б-1ЯрП-1А |
| 024 | Power supply system | 2 | 1 | КВР-3-2 |
| 026 | Fire-fighting | 5 | 0 | ДПС; ССП-ФК-БИ |

| Code | Name of the system | Total | In-flight | Components that failed |
|---|---|---|---|---|
| | equipment | | | |
| 027 | Control system | 1 | 1 | РА-60Б |
| 028 | Fuel system | 3 | 0 | ЄЦН-91Б; СКЕС-2027Б |
| 029 | HS | 6 | 1 | ГА-77В; hydraulic hose; МСТ-25А |
| 030 | anti-icing system | 3 | 1 | РІО-3; Temperature sensor of a fairing of the dust protection device; 1919Т |
| 031 | Devices | 3 | 0 | ВД-10К; АЧС; Д-1 |
| 032 | Chassis | 5 | 0 | КТ97/3; К2116 |
| 033 | Lighting and light alarm | 3 | 0 | СМ-28; МСЛ-3 |
| 034 | Aerobatic navigation equipment | 4 | 2 | АС-1; АГБ-3К |
| 036 | Pneumatic system | 5 | 0 | АД-50; brake hose; АК-50Т1; УП25/2 |
| 049 | Auxiliary power plant | 3 | 0 | КП-9; АІ-9В; НР-9В |
| 052 | Doors, hatches, creations | 2 | 0 | cargo lock lock |
| 053 | Fuselage | 3 | 0 | |
| 055 | Plumage | 1 | 0 | |
| 061 | Air screws | 2 | 0 | LNV number 5 |
| 065 | Screws | 5 | 0 | Corrosion; violation of paint and varnish coating; ВНГ |
| 072 | Engine | 2 | 2 | РО-40М; Thrust 1 |
| 073 | Engine fuel system | 2 | 2 | circuit breaker НР-40ВА |
| 075 | Air sampling system | 1 | 0 | |
| 076 | Engine control system | 1 | 1 | synchronization system |
| 077 | Engine control devices | 3 | 0 | БЭ-9Е; 2УЄ-6Б |
| 079 | Oil system | 4 | 0 | ВМР-2281Б; oil hose leaks |
| 080 | Launch system | 2 | 0 | Pipeline damage; СКНА-22-2А |
| 084 | Transmission | 2 | 1 | ВР-14 |
| 110 | Radio equipment | 9 | 8 | ДИСС-15; А-037-1В; KNS-81; ВЧ; RN-63; |

| Code | Name of the system | Total | In-flight | Components that failed |
|---|---|---|---|---|
| | | | | КТ-76 |
| 113 | Recognition, numbertification and active response equipment | 2 | 1 | КТ-70; КТ-76С |
| 142 | On-board means of control and registration of flight data | 4 | 0 | МС-61Б; БПСИ-4; БУР-1-2Ж; П-503 |
| | Together | 102 | 22 | |

Table 3 Information on failures of Mi-8 systems for the 3rd quarter of 2006

| Code | Name of the system | Total | In-flight | Components that failed |
|---|---|---|---|---|
| 023 | Communication equipment | 1 | 1 | ЯДРО-1А |
| 024 | Power supply system | 3 | 2 | КВР-3-2; КВР-1; ГС-18МО |
| 026 | Fire-fighting equipment | 1 | 0 | ССП-ФК2 |
| 027 | Control system | 1 | 1 | КАУ-30Б |
| 028 | Fuel system | 2 | 0 | СКЕС-2027Б; 463Б |
| 031 | Devices | 1 | 0 | РВ-3 |
| 032 | Chassis | 3 | 0 | КТ-97-22; 4Ж-2791-000ПС |
| 033 | Lighting and light alarm | 3 | 0 | МСЛ-3; ПРФ-4М |
| 034 | Aerobatic navigation equipment | 1 | 0 | ДИСС-15 |
| 036 | Pneumatic system | 4 | 0 | АД-50; hose 4824А-У6-270 |
| 049 | Auxiliary power plant | 1 | 0 | AI-9B |

| Code | Name of the system | Total | In-flight | Components that failed |
|---|---|---|---|---|
| 051 | Glider | 1 | 0 | Stabilizer |
| 065 | Screws | 7 | 0 | |
| 073 | Engine fuel system | 1 | 1 | НР-3ВМ |
| 075 | Air sampling system | 1 | 0 | ПЗУ |
| 077 | Engine control devices | 2 | 0 | 2УЕ-6Б; П-1 |
| 079 | Oil system | 2 | 2 | 2128Б; oil hose 230 |
| 084 | Transmission | 1 | 0 | ВР-14 |
| 110 | Radio equipment | 3 | 0 | ВЧ; СД-75; RDR-2000 |
| 113 | Recognition, numbertification and active response equipment | 1 | 0 | КТ-76С |
| 142 | On-board means of control and registration of flight data | 2 | 1 | САРПП-12; П-503 |
| | Together | 42 | 8 | |

**Conclusions to the part 1**

By examining statistics, we have determined that during the period of 21 months, the operators of this type of AC detected and provided information on 332 faults of which - 53 in the air. Of these, 16 are critical for flight safety.

Regarding failures by type of equipment, for 6 months of 2006 we have the following figures:

- Failures / malfunctions of electronic equipment - 24.51%
- Failures / malfunctions of electrical equipment - 4.90%
- Failures / malfunctions of the glider and its systems - 30.39%
- Failures / malfunctions of the engine / APU and their systems - 20.59%
- Failures / malfunctions of instrument equipment - 19.61%

For the third quarter of 2006, the percentage of failures by type of equipment has the following indicators:

- Failures / malfunctions of electronic equipment - 11.90%
- Failures / malfunctions of electrical equipment - 14.29%
- Failures / malfunctions of the glider and its systems - 28.57%
- Failures / malfunctions of the engine / APU and their systems - 28.57%
- Failures / malfunctions of instrument equipment - 16.67%

It should be numberted that a number of helicopter operators provide incomplete reports, do numbert fill in fault cards, provide irregular and untimely reports.

The results of the analysis show that there are various conditions or reasons for the failure of units and systems of helicopters, and, therefore, a more thorough assessment, verification and continued readiness to ensure a high level of safety and the correct choice of ways to improve these systems, as well as technologies for their maintenance, are required. Therefore, in the next part of the qualification work will be considered methods and techniques of maintaining the efficiency of helicopter maintenance with takeoff weight of 8-16 tons.

# PART 2 STRUCTURAL ENHACEMENT AND MODIFICATION OF SOME HELICOPTER SYSTEMS

This part of the qualification work addresses improvement of design and modification of certain helicopter systems to increase the efficiency of helicopter maintenance with a takeoff weight of 8-16 tons

## 2.1 Glider

The fuselage is designed to accommodate the crew, equipment, payload, as well as the interconnection of the main components of the helicopter. The power circuit of the fuselage is semi-monocoque. The fuselage, which has three structural connectors, includes the nose, the CPF, the TB and EB, which significantly improves manufacturability during the production, operation and repair of the fuselage.

The fuselage, consisting of a power set of reinforced, normal frames, longitudinal beams, stringers and smooth working skin, is assembled from separate panels. The cladding of the panels is connected to the frame by the glue-welded method, and at the joints of the panels to each other - overlapping with the help of multi-row riveted seams. the nose of the fuselage with its frame number 5H is joined with the number 1 of the CPF, which by frame number 23 is joined with the frame number 1 of the TB, connected by its frame number 17 with the number 1 of the EB. All these connections are made with bolts.

The fuselage design specifically provides for doors, hatches, blisters for emergency escape from the helicopter. (Figure 3). Two sliding blisters of the NPF, a sliding door, a hatch-window, a hatch cover on the right cargo door of the CPF have emergency release mechanisms.

The main materials of construction are sheet clad duralumin D16AT (D16AM, D16A), hardened duralumin V95 and magnesium alloys ML5, ML5D. In addition, in the design of many units, stampings from aluminum alloys AK6, AK8, castings from steel and non-ferrous alloys, as well as extruded profiles are used. Individual units and parts are made of alloy steels 30HGSA, 30HGSNA.

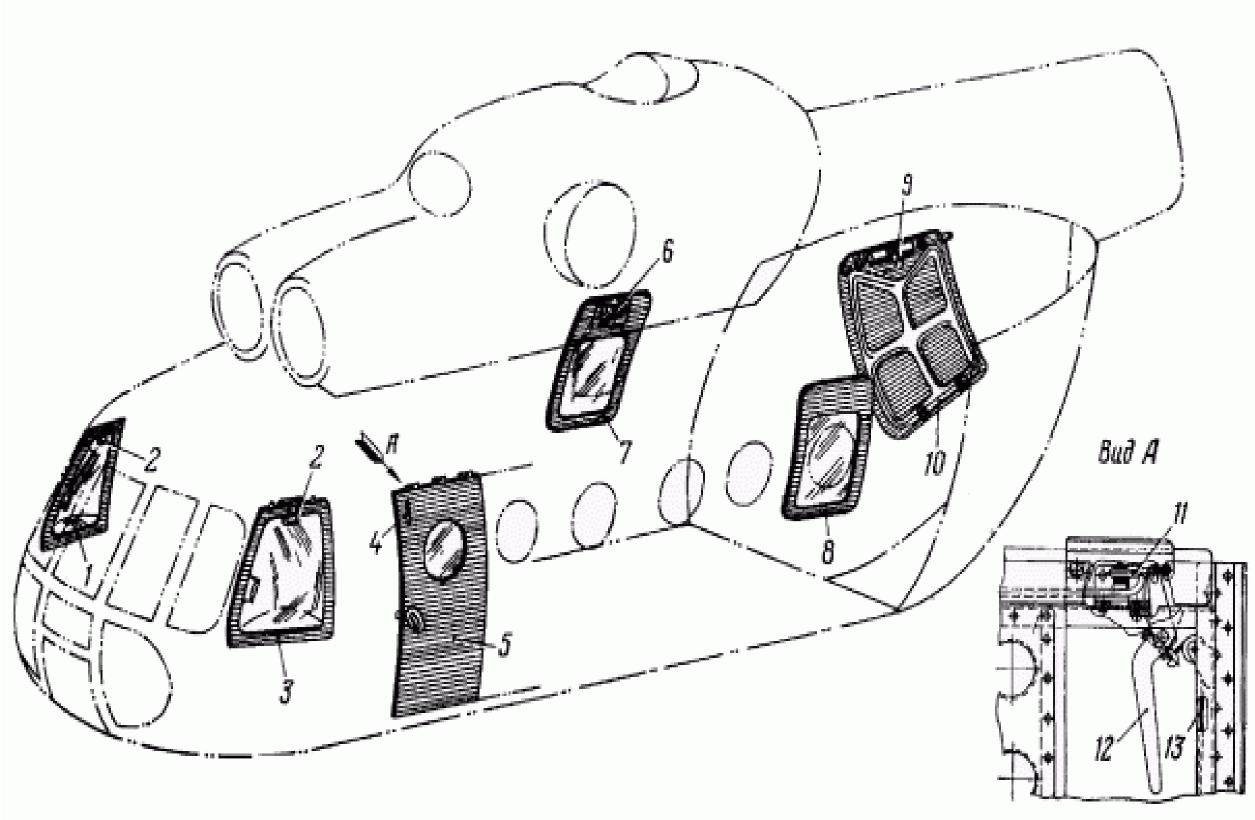


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Figure 3 – Layout of blisters, doors, hatches for leaving the helicopter in emergency situations

1. Right blister; 2, 6, 9. handles for emergency dumping; 3. left blister;

4. outside handle for emergency door reset; 5. left sliding door;

7, 8. escape hatch covers (on passenger helicopter);

10. emergency hatch cover in the right cargo flap (on transport helicopter);

11. locking pin; 12. internal handle for emergency door release;

13. rope to the middle door lock pin.

### 2.1.1 Nose section of fuselage

The NPF is a separate compartment with a length of 2,150 mm and is designed to accommodate the crew, command controls, instrumentation and create unified aerodynamic contours of the fuselage.

The power circuit of the NPF is semi-monocoque. The transverse set of the NPF consists of five frames 1H ... 5H. Frames number 1H ... 3H have lower and upper beams and incomplete sidewalls, which are closed on the glazing frame. Frame number 5H is a docking frame, it has a wall, reinforced with horizontal and vertical corner profiles, which separates the crew cabin from the cargo compartment. An opening is made along the axis of symmetry in frame number 5H for the entrance door. The door, made of sheet duralumin, is hinged on the right and has a lock with a two-way handle, two latch locks, an optical micro-eye and a soft backrest of the folding seat (Figure 5). To the front surface of the wall of the frame number 5H, stacks are attached for mounting equipment.

The main technological panels of the NPF are: floor and ceiling panels, left and right side panels with sliding blisters, a canopy with glazing, and a docking frame number 5H (Figure 4).

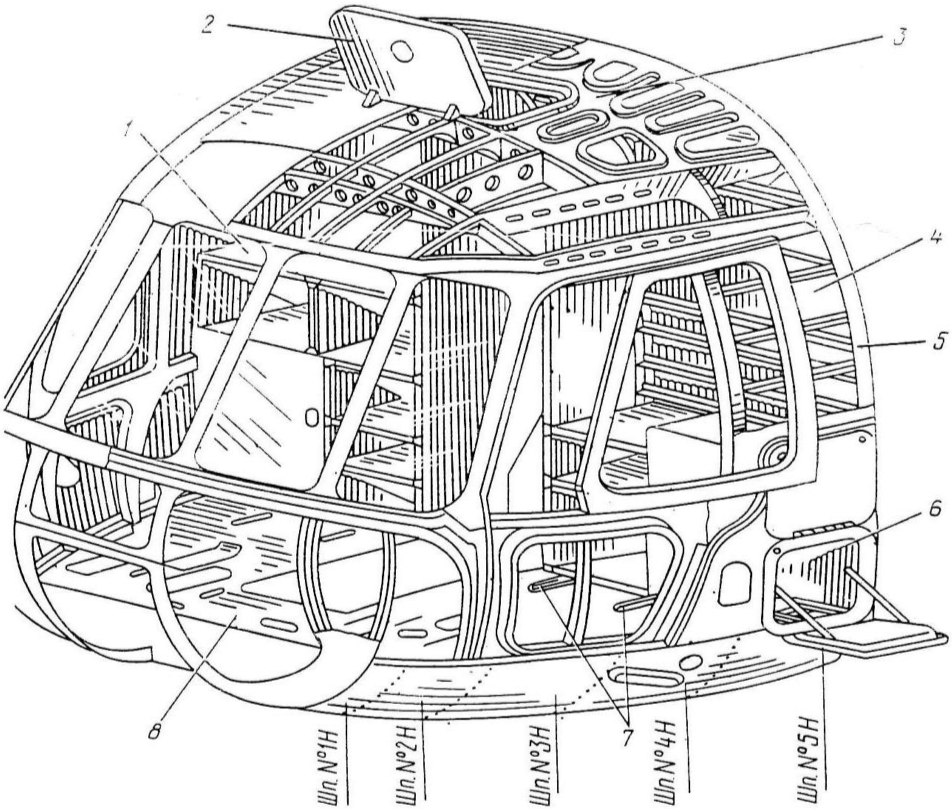



Figure 4 – Fuselage nose:

1. whatnot for radio-electronic equipment; 2. hatch cover for the exit to the power plant (see Figure 6); 3. stamped stiffness; 4. wall of frame number 5H; 5. sliding blister (see Figure 7); 6. a niche for a storage battery; 7. brackets for fastening the pilot's seat; 8. floor panel;

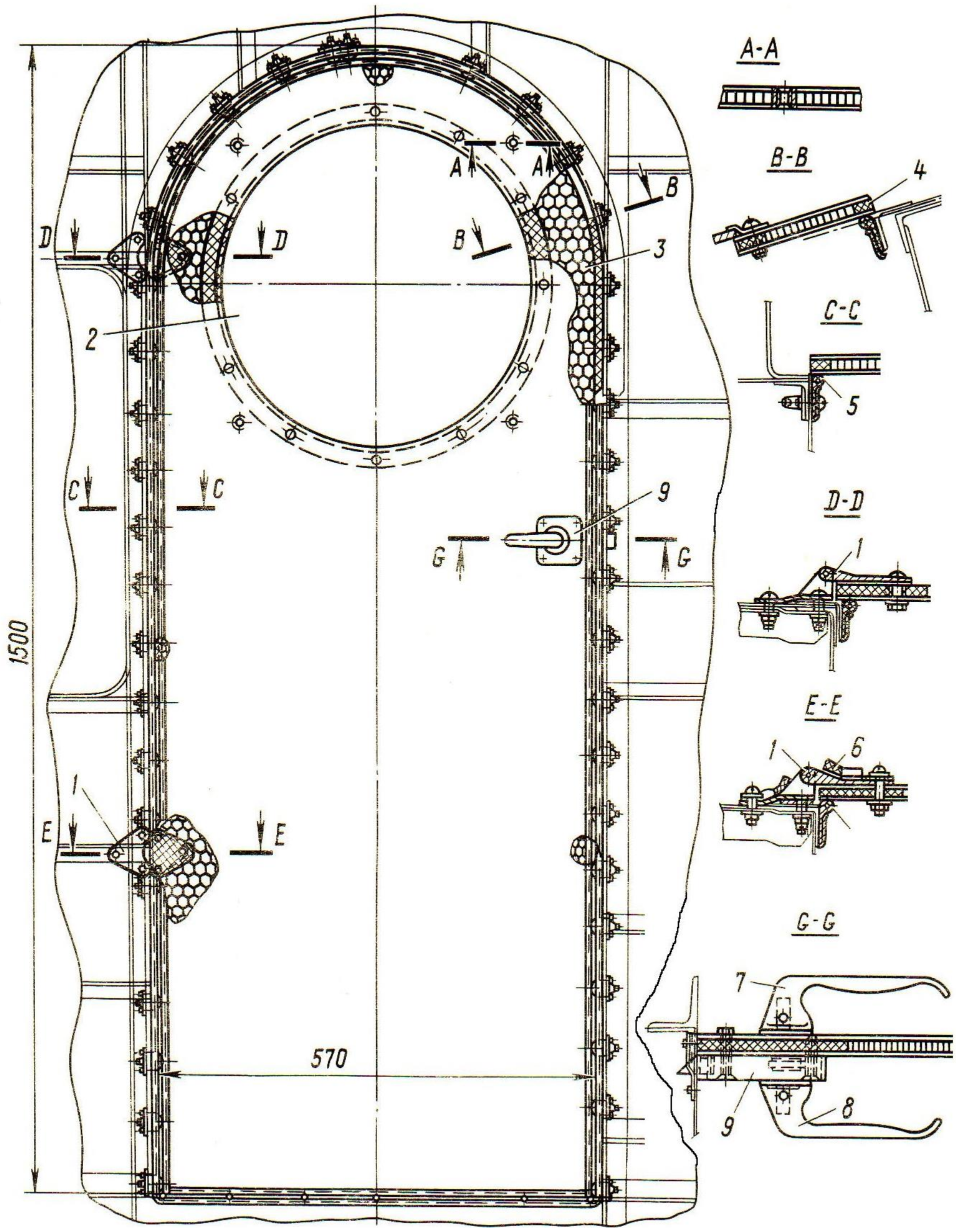



Figure 5 – The door to the cockpit:

1. Door hinges; 2. Window;

3. Honeycomb filler; 4. Textolite frame; 5. Sealing rubber profile;

6. Metallization; 7. Inner handle;

8. Outside handle; 9. Castle

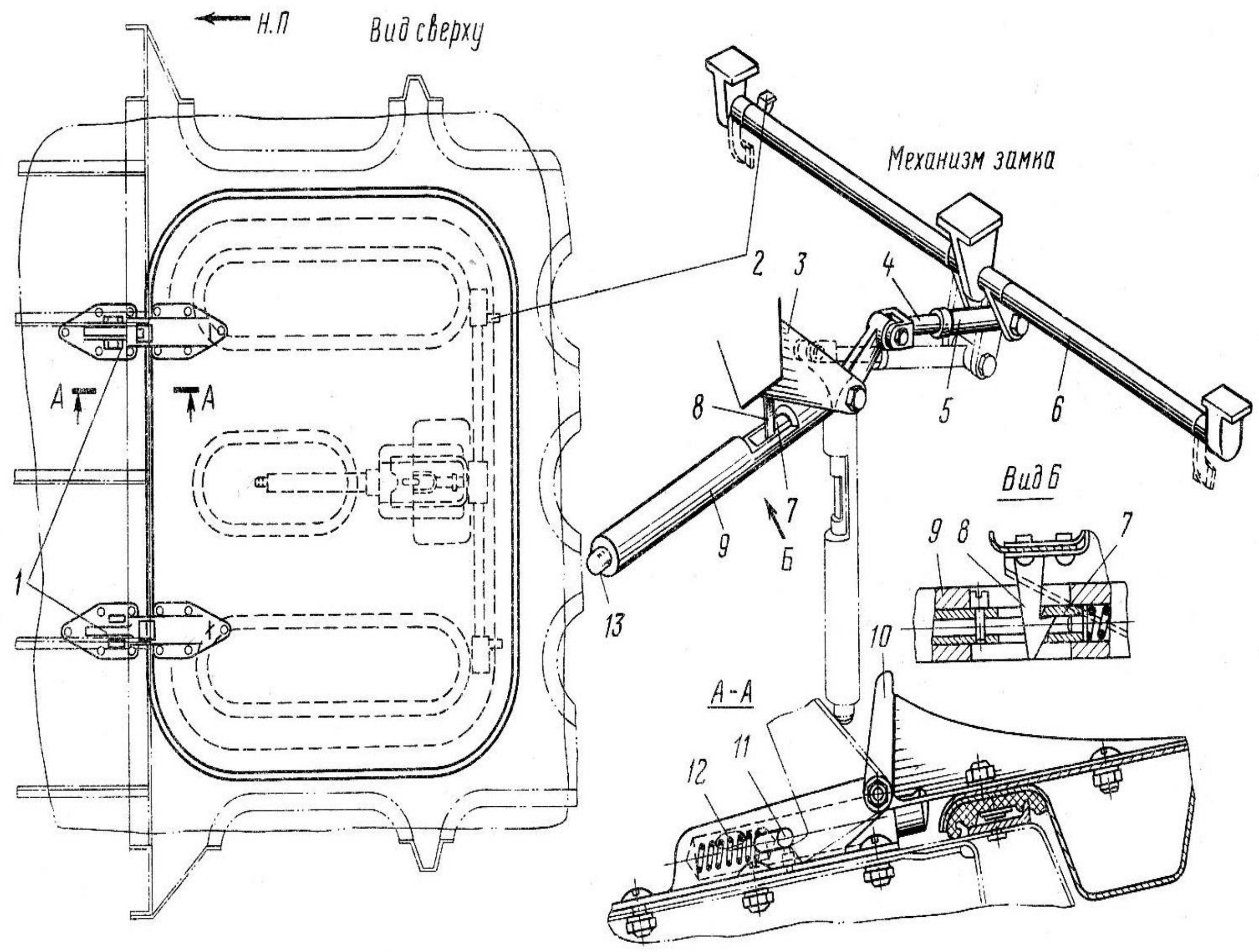



Figure 6 – Hatch to the outlet to the power unit:

1. Loops; 2. Emphasis; 3. Bracket; 4. Fork; 5. Adjusting clutch; 6. Shaft; 7. Latch; 8. Hook; 9. Handle; 10. Rib; 11. Pin of the retainer; 12. Spring 13. Button.

The sealing of the hatch in the closed position is ensured by rubber gaskets, which are pressed with a special profile attached to the hatch around the perimeter. If the hatch tightness is broken, its restoration is carried out by the adjusting clutch of the lock control rod.

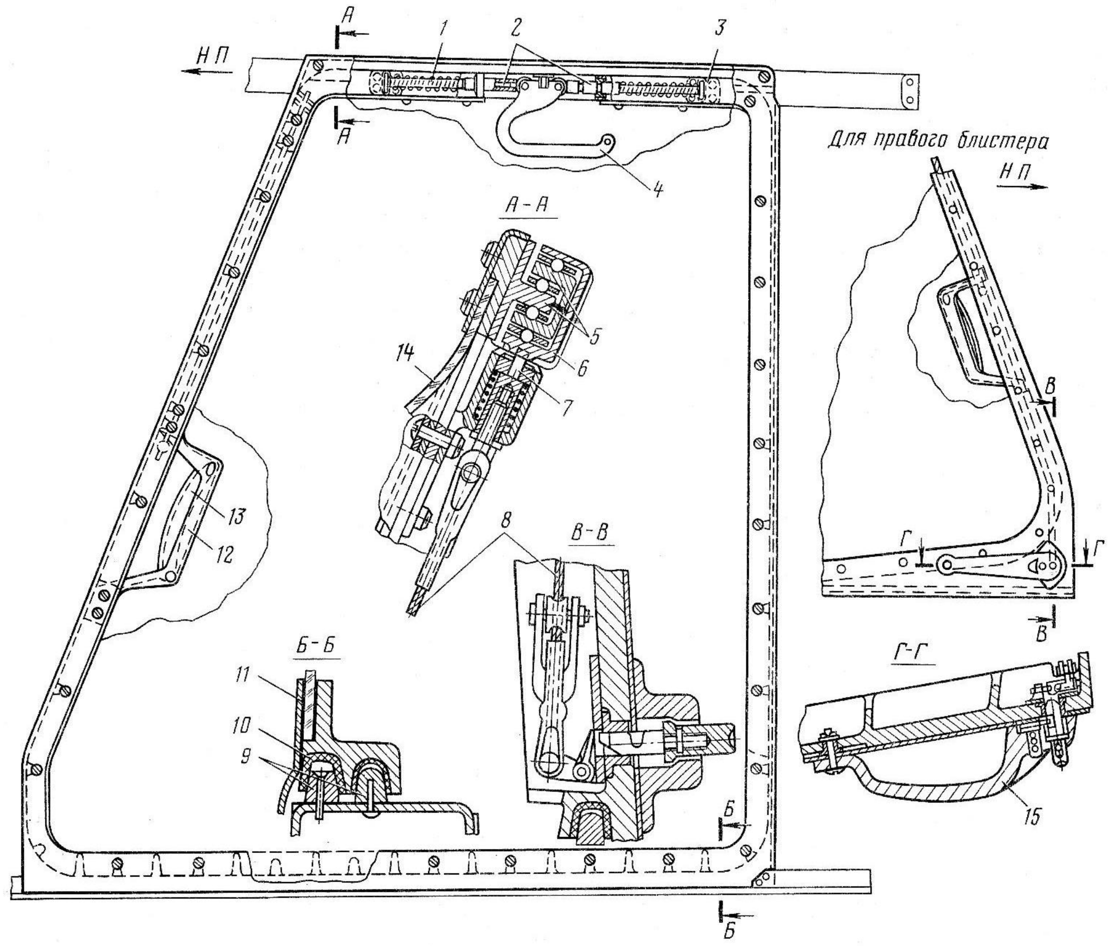



Figure 7 – Sliding blister:

1. Spring;

2. Locking pins;

3. Bracket; 4. Emergency release handle;

5. Internal guide profiles;

6. Outside guide profile;

7. Pin of the lock; 8. Rope; 9. Bottom guides profiles; 10. Felt pad; 11. Facing; 12. Handle; 13. Lever; 14. Organic glass; 15. Outer handle.

### 2.1.2 Cenral Part of Fuselage

The CPF is designed to accommodate passengers and cargo, as well as additional fuel tanks.

The CPF is a compartment with a length of 8740 mm. The load-bearing frame of the compartment includes 23 frames.

A cargo compartment is located between frames number. 1 and 13 of the central part, and between frames number. 13 and 21 there is a rear compartment with cargo doors.

Above the cargo compartment are located:

- between frames 2 and 7 – TB3-117 engines;
- between frames number 7 and 10 - main gearbox BP-14;
- between frames number 10 and 13 - a container for a supply fuel tank;
- between frames number 12 and 13 - APUАИ-9В.

Behind the frame number 10 there is a superstructure that smoothly merges into the TB. The cargo hatch of the rear of the cargo compartment is closed by two flaps, which are suspended from the inclined frame and form the rear bypass of the fuselage. The power frame consists of 23 frames, stringers, diaphragms and sheathing.

Technological connection of the bow and central parts of the fuselage and operational connection of the central part and TB are made along the docking frames number 1 and 23.

Technologically, the CPF is assembled from separate panels - floor, ceiling and side panels, rear compartment.

At the bottom of the docking frame number 1 there are:

- attachment point for the shock absorber strut of the front chassis leg;
- two welded steel brackets with spherical sockets for jack supports.

The design of the reinforced frame number 7 includes a number of connecting fittings:

- two upper and two front steel assemblies for fastening struts of special farms;

- two front brackets for attaching outboard fuel tanks;
- two sockets for fixing the main gearbox frame;
- two brackets for attaching external suspension cables;
- two attachment points for the hood frame number 1K.

Reinforced frame number 10 on the outside also has connecting fittings:

- two sockets for fixing the main gearbox frame;
- two steel attachment points for the shock-absorbing struts of the MLG legs;
- two attachment points for the rear struts of special farms;
- two rear brackets for attaching outboard fuel tanks;
- two brackets for attaching the external suspension cables.

On the outside of the reinforced frame number 13 there are:

- two attachment points for the main landing gear struts;
- four hinge hinges for cargo doors;
- two brackets for fixing АИ-9В;

In addition, normal frames have fittings:

- frame number 2 - two attachment points for the struts of the front leg of the chassis;
- frame number 2A - ceiling panel four brackets for the front engine mount;
- frame number 6 - attachment point for fan struts and frame number 1K;
- frame number 8 - four middle brackets for attaching external fuel tanks;
- frame number 11 - two attachment points for the semi-axles of the main landing gear legs;
- in the upper parts of frames number 12, 16 and 20 - fittings for the transmission tail shaft supports;
- on frames 12 and 13 - nodes for the AI-9V mounting brackets;
- between frames 2 and 5 - six attachment points for the KO-50 kerosene heater.

Inside the cargo compartment on the frames are made:

- unit for fastening the chain hoist used when the winch pulls loads into the cargo compartment (installed along the axis of symmetry of the floor);
- between frames 1 and 2 - a bracket for installing an LPG-150 winch;

- between frames number 5 and 10 - cradles for additional fuel tanks;
- on frames 2, 3, 4, 7, 8, 10, 11 and 13 - twenty-nine mooring points. (See Attachment A for a scheme)

To ensure the approaches and convenience of servicing the units and systems of the helicopter, hatches are made in the fuselage skin and in the floor. The hatches in the floor and outer skin of the cockpit are designed for assembling the units, approaching the control system units, the shock-absorbing strut of the front chassis leg, as well as access to the frame number. 5H docking bolts, the heating and ventilation pipes of the cabin.

The hatches, with the elements of the helicopter systems, access to which is most important during operation, are made mainly in the side panels. In the floor of the cargo compartment there are hatches that provide access to fuel taps and pipelines, radio compass antennas, etc. All hatches are closed with covers.

The sealing of the hatches located to the floor line is ensured by a rubber gasket glued around the perimeter to the lid. Hatches located above the floor line are not sealed.

To open the spring-loaded screw lock, turn the screw with a screwdriver or a metal plate. In the lower part of the screw there is a spiral slot into which a spring is inserted, riveted by its end to the skin.

The double-lever lock is opened by pressing on the plate. In this case, the lever rises up, and the latch is disengaged.

To open the lock with a handle from the outside, turn the screw with a screwdriver and remove the cover. From the inside, the lock is opened by turning the handle: the levers are disengaged and the cover is removed.

The hatch cover, secured with anchor nuts, is opened with a screwdriver. In this case, the screws are unscrewed, the cover is released. (A scheme of the location of the hatches is located in Attachment B)

### 2.1.3 Tail Boom

The TB is designed to move the TR out of the rotor rotation zone in order to create the necessary shoulder for the TR thrust force in order to compensate for the reactive moment.

The TB has the shape of a truncated cone with a length of 5440 mm. Technologically, it consists of three panels - two side and one bottom, which are overlapped with rivets.

Cutouts are made in the TB skin:

- between frames 13 and 14 on both sides - for the passage of the stabilizer spar;
- from above between frames number 1 and 2 and frames number 14 and 15 - hatches with covers for inspection and lubrication of the splined couplings of the transmission tail shaft;
- between frames 3 and 4 - under the МСЛ-3 flashing beacon;
- between frames number 11 and 12 - under the heading system sensor;
- from above between frames number 7 and 8, 15 and 16 - under the front lights.

At the bottom of the TB, between frames 2 and 6, a radome for the antenna of the ДИСС-15 equipment is installed. The upper part of the fairing is riveted from duralumin profiles and cladding, and is attached to the beam with screws. The lower part is made of radio-transparent material, fixed to the upper part on a cleaning rod and locked with two hinged locks and three plates with screws. The receiving and transmitting antennas of the PB-3 radio altimeter are also installed below.

In addition, the TB contains:

- on both sides on the frame number 13, knots for the bolts of the stabilizer adjusting brackets;
- on frame number 14 - brackets for mounting the stabilizer;
- on frame number 15 - attachment points for the tail support struts;
- on the frame number 17 at the bottom - the TB shock absorber attachment point.

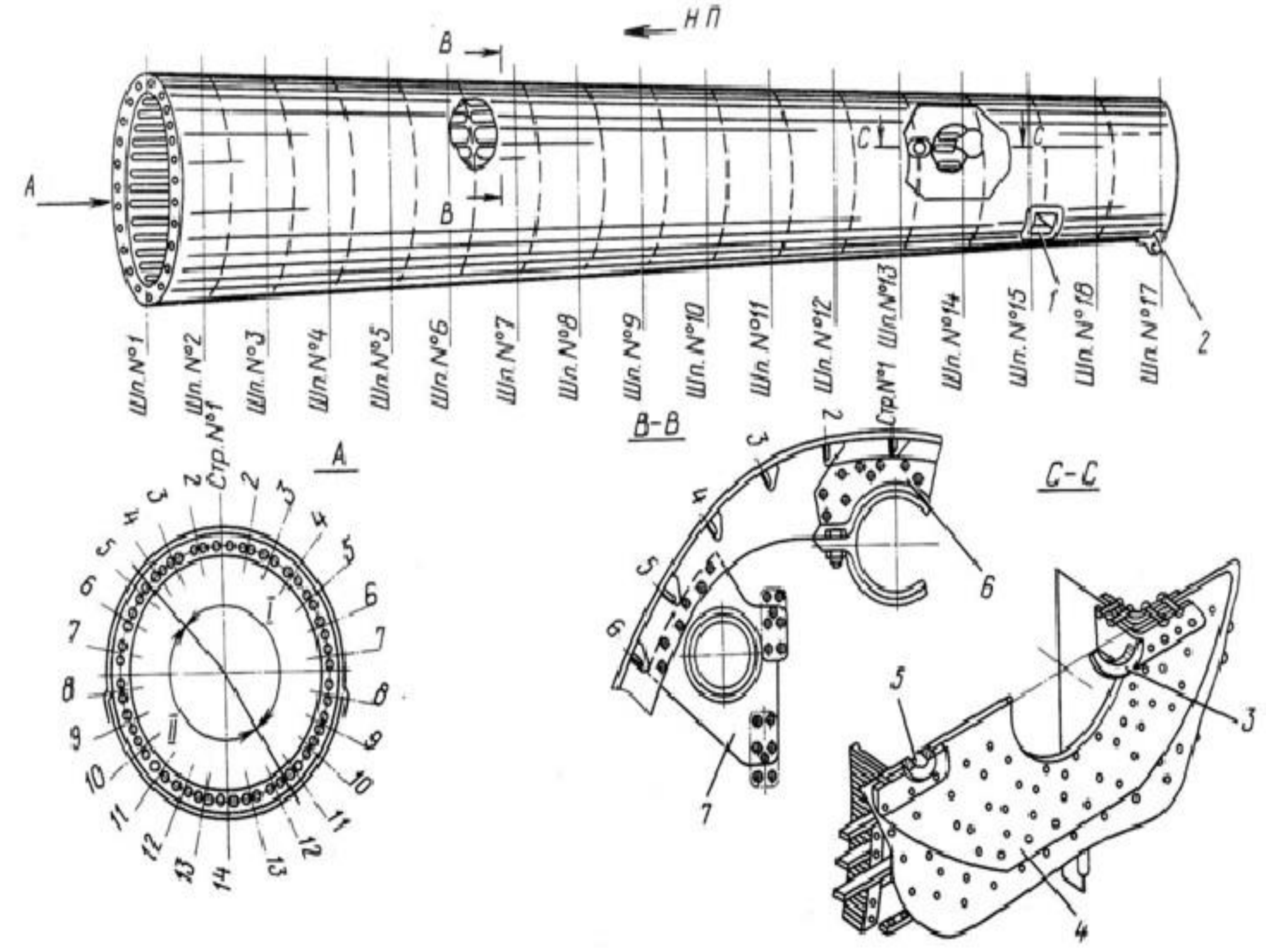


Figure 8 – Tail Boom:

1. attachment of the tail support struts;
2. attachment of the shock absorber of the tail support;
3. Bracket for fixing the stabilizer;
4. Cover
5. Hole for the shackle bolt for adjusting the stabilizer;
6. Fitting for transmission tail shaft support;
7. Bracket for fastening the guide pads of the control cables.

I. Bolt area with a diameter of 12 mm;

I I. Area of bolts with a diameter of 10 mm

The EB is designed to move the axis of rotation of the TR into the plane of rotation of the main rotor in order to ensure the balance of the moments of forces relative to the longitudinal axis of the helicopter.

The end girder of the riveted structure consists of a keel girder and a fairing. At frame number 2, the beam axis has an upward bend at an angle of 43º 10´ with respect to the TB axis.

The EB consists of a load-bearing set and a working sheathing.

EB sheathing is made of D16AT material of variable thickness:

- Between frames 1 and 3, reinforced plating with a thickness of 3.0 mm is installed;
- Between frames 3 and 8, sheathing with a thickness of 0.8 mm is installed;
- Between frames 8 and 9 - 1.0 mm sheathing.

There are two hatches in the bending part of the beam - an upper and a lower one. The upper hatch is intended for filling the intermediate gearbox with oil, and the lower one for inspecting the spline connection. The hatches are closed with covers, in which there are gill slits for air intake for cooling the intermediate gear. During operation, both hatches are used to install a device when measuring the angle of fracture between the tail and end shafts of the transmission.

The fairing forms the rear contour of the EB and is a fixed rudder that improves the directional stability of the helicopter. The fairing is made of two parts - lower (removable) and upper (non-removable).

In the lower part of the fairing there is a hatch, in the lid of which gill slits are made for the outlet of air cooling the intermediate gear. In addition, hatches for mounting the antennas of the product 6201 are made on both sides.

A tail light is installed at the rear along the axis of symmetry.

The detachable part of the fairing is attached to the chords of the EB spar with screws with self-locking screws, and the non-detachable part is riveted using buttstrips.

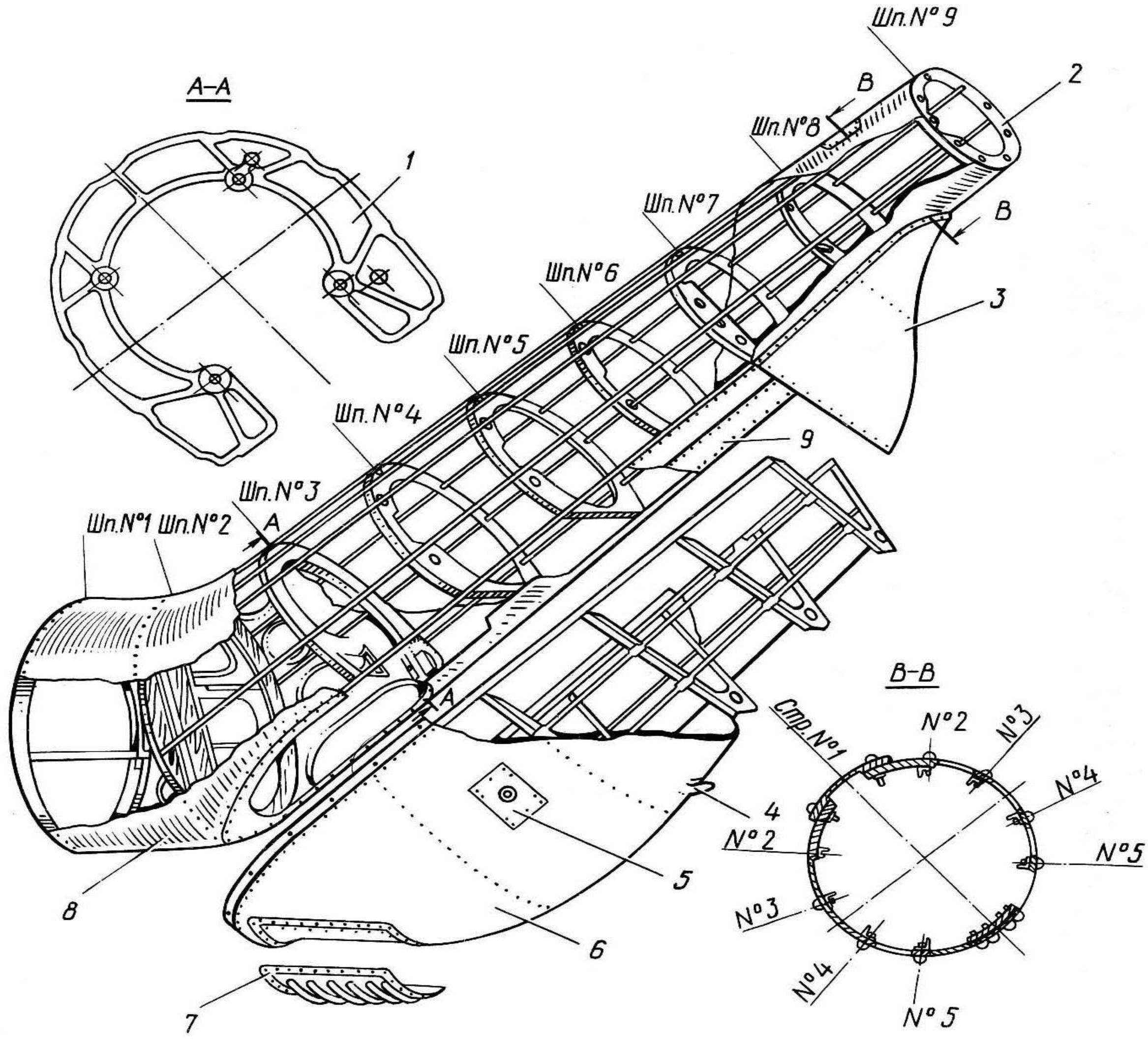



Figure 9 – End Boom:

1. Frame number 3 with intermediate gear attachment points;

2. Frame number 9 with a tail gear mounting flange;

3. The upper (non-removable) part of the fairing; 4. Tail light;

5. Antenna of radar identification; 6. Removable fairing part;

7. Cover with gills; 8. EB; 9. Spar.

#### 2.1.4 Stabilizer

The stabilizer is designed to improve the longitudinal stability and controllability of the helicopter.

The stabilizer is installed on the TB between frames 13 and 14 and is uncontrollable (its setting angle can only be changed when the helicopter is parked on the ground).

The stabilizer has a symmetrical NACA-0012 profile and consists of two halves - right and left, interconnected inside the TB.

Both halves of the stabilizer are similar in design. Each of them is riveted and includes:

- spar;
- seven ribs;
- tail stringer;
- diaphragm;
- frontal skin;
- linen sheathing;
- removable end fairing;
- unit for installing the stabilizer.

Beam type stabilizer spar.

Structurally consists of:

- upper belt;
- lower belt;
- wall.

On the toe of rib number 1 of each half of the stabilizer there is a riveted bracket with an earring, with the help of which the installation angle of the stabilizer is changed. On the toes of ribs number 7 there are riveted ears for attaching the cable antenna of the Karat-M24 radio station. A balancing weight weighing 0.2 kg is riveted to the front part of rib number 7, closed by a removable end fairing made of fiberglass.

The stabilizer setting angle can be changed in the range from $-9^{\circ}$ to $+9^{\circ}$ (according to the bulletin number 061.2.0.1770.4 dated June 4, 1992, it is set at $-3^{\circ}$ angle). Changing the angle is done on the ground using an adjusting bracket and shackle. Possible angles of the stabilizer are applied with red enamel on the trim of the TB from both sides, and on the adjusting shackle - red risk**.**

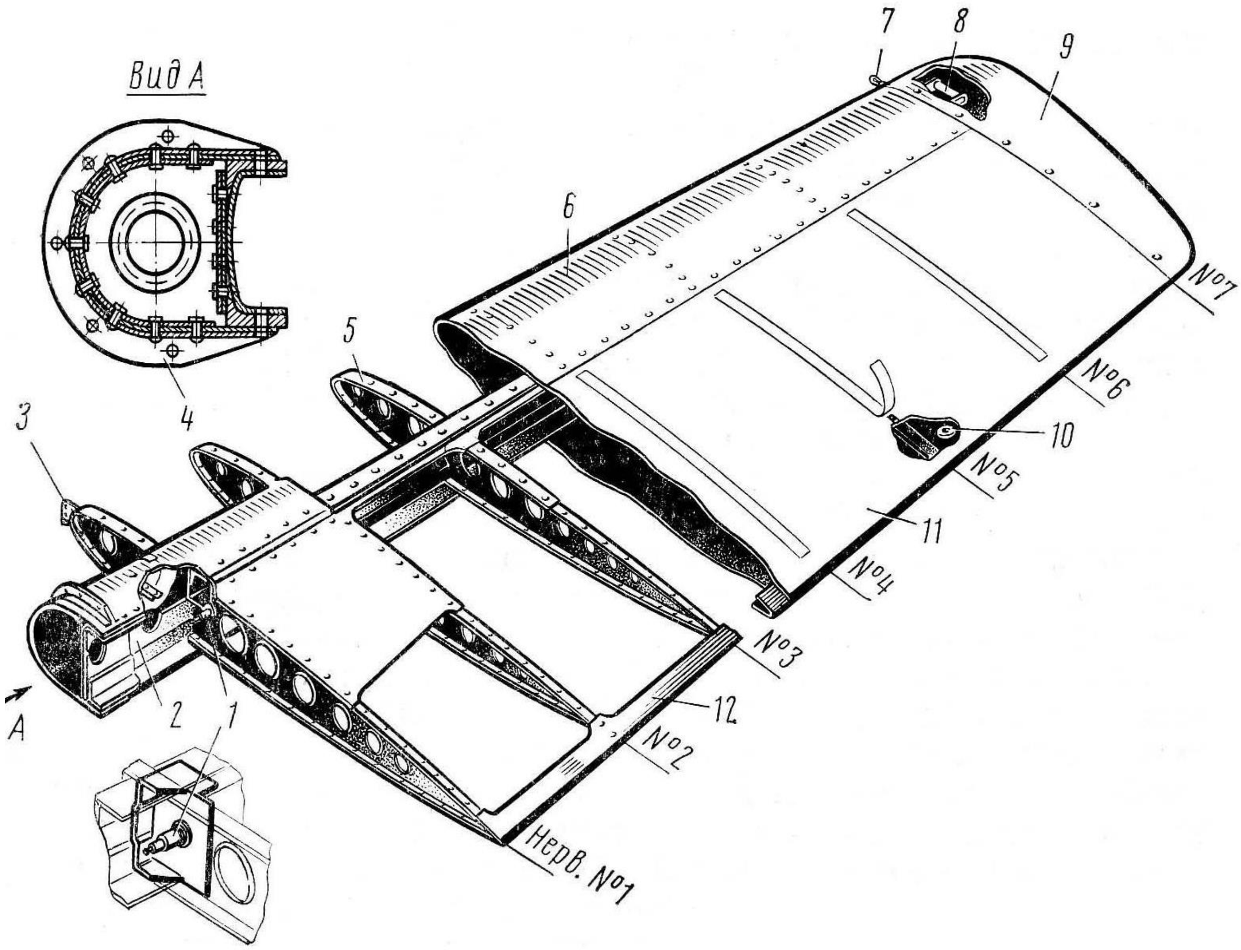



Figure 10 – Stabilizer

1. Axle of the stabilizer hinge; 2. Spar; 3. Adjusting bracket; 4. Docking flange;
5. Rib; 6. Duralumin cladding; 7. Antenna mount; 8. Balancing weight;
9. End fairing; 10. Drainage hole; 11. Linen sheathing; 12. Tail stringer.

### 2.1.5 Airframe Maintenance

In flight, the glider of a helicopter is exposed to concentrated forces, twisting and bending moments transmitted from the main and TR, landing gear, empennage, as well as to the action of alternating periodic loads, the main sources of which are the MR and TR.

The thrust and lift force on the helicopter, as well as the rotor torque are generated and transmitted to the fuselage through the main gearbox housing, therefore, the load level of the main gearbox frame and attachments to the fuselage is very high. The TR thrust constantly loads the fuselage with a bending moment in the horizontal plane and a twisting moment relative to the TB axis.

Determination of the serviceability of structural members, on which fatigue cracks can arise and develop as a result of concentrated and distributed variable loads, is an important element of the helicopter's technical operation. The most dangerous in this sense are sections of the structure - connectors, mates, docking planes and nodes, i.e. places in which the stress flow is structurally organized with increased concentration.

In operation, there were cases of fatigue failure of the bolts attaching the TB to the fuselage and the end boom to the TB, which required reinforcement of the bolts and an increase in their number at the joints of the beams. An effective way to timely identify a faulty bolt is a thorough visual inspection of the bolt, its locking and seating in the threaded socket. When performing routine maintenance, an in-depth inspection of the airframe elements is carried out, a calibrated tightening of the nuts of the bolts of fastening parts of the fuselage is checked.

The need for this is due to the fact that when one of the bolts is destroyed, the acting load is redistributed to the remaining bolts and the process of their destruction is accelerated, threatening the opening of the joint. If the joint bolts have sufficient bearing capacity and the stress concentration in the joint is excessive, fatigue cracks will form on the joint flanges. Such cases have occurred in the joints of the tail and end booms.

Fatigue cracks can appear on the skin and frames. The centers of origin of these cracks are located, as a rule, at the hatches, at the edges of the cutouts in the walls of the frames, at the holes for bolts, pins, etc. If cracks are found on the outer surface of the skin, it is necessary to inspect the internal power set (cracks and destruction of frames and stringers are possible).

The fuselages of helicopters are characterized by the occurrence of cracks and deformations not only in units and parts loaded in flight, but also as a result of the operation of equipment (maintenance, loading and unloading operations). This primarily applies to hoods, doors, cargo hatch flaps, ladders, cargo compartment floor. In operation, cracks are often detected in the brackets for attaching the hoods, door hinge assemblies.

The operational reliability of the fuselage is determined not only by the magnitude and duration of the loads acting on it in flight, but also by the operating conditions, climatic features of the basing area. The fuselage is adversely affected by the sun's rays, dust, dirt, moisture, precipitation, which cause corrosion of metal parts, destruction of protective coatings and glazing.

Corrosion resistance of aluminum alloys is lower than that of pure metal components. A significant decrease in corrosion resistance is observed in industrial and coastal areas due to the presence of chlorine ions and sulfur compounds in the air.

Constructive reasons contributing to corrosive damage to AC:

- crevices and gaps in which moisture can accumulate;
- areas inaccessible for observation and repair;
- insufficient tightness of butt joints;
- irrational arrangement of drainage holes.

Operational reasons:

- sharp temperature changes,
- mechanical damage,
- destruction of paintwork,
- insufficient amount (absence) of lubrication on the moving elements,
- contact with the structure of corrosive liquids (electrolyte).

Riveted and glued-welded joints, ensuring a strong connection of parts and assemblies of the frame (power set) and cladding into a single whole, require special attention in operation. For example, breaking one rivet at the engine inlet and getting it into the compressor will damage the engine.

Table 4 Possible malfunctions of the airframe and ways to eliminate them

| Malfunction. | Possible reasons for the appearance. | Troubleshooting method. |
|---|---|---|
| **Fuselage** | | |
| 1. Corrosion of the skin. | Damage to paintwork. | 1. Wash damaged areas with warm water; |
| 2. Loosening of rivets. | Vibration. | 2. Clean with sandpaper number. 6 ... number. 8; |
| 3. Holes, cracks, dents. | Mechanical damage. | 3. Wipe with a clean cloth with B-70 gasoline and wipe dry; |
| 4. Scratches, cracking, timber lagging. | Mechanical damage or exposure to direct sunlight. | 4. Prime and paint the treated areas. |
| 5. Loosen the self-locking screws. | Vibration. | 1. Drill out loose rivets from the side of the mortgage head; |
| **Stabilizer** | | |
| 1. Punctures and breaks in linen sheathing. | Mechanical damage. | 3. Drill a larger hole; |
| 2. Water in the inner cavity. | Blockage of drain holes. | 4. Install the rivet one size larger (0.5mm). |
| 3. Crack in the side member flange. | Fatigue crack. | Holes and cracks are repaired by patching the damaged areas. Before placing the patch, the ends of the cracks are drilled with a Ø 2mm drill, the damaged area is tinted. The patch must completely cover the damaged area and have the thickness of the base material. In case of minor dents, it is allowed to straighten the skin on the corresponding blank with a wooden mallet. |
| 4. Backlash in the hinge of the stabilizer halves. | Axle or bearing worn. | 1. Remove dirt with a napkin dipped in pure B-70 gasoline; |

| Malfunction. | Possible reasons for the appearance. | Troubleshooting method. |
|---|---|---|
| 5. Loosen the screws securing the stabilizer. | Loosen screws. | 2. To clean the surface with sandpaper number. 6 ... 8 so as to organize a smooth transition of the painted surface to the bare area (while not allowing the anode film of the cladding metal to be disturbed); |
| | **Glazing**. | |
| 1. Scratches and minor cracking. | Mechanical damage. | 4. Cover with primer, dry; |
| 2. Cracks less than 100 mm long. | Mechanical damage. | 5. Paint over with appropriate color enamel. |
| 3. Cracks over 100 mm. | Mechanical damage. | 1. Tighten with a screwdriver; |
| 4. Turbidity, silvering (a network of small cracks) in the pilot's field of view. | Mechanical damage or exposure to direct sunlight. | 2. Check the tightness of adjacent screws. |
| 5. Cracks or corrosion on magnesium profiles. | Damage to paintwork. | Stabilizer |
| 6. Cracks in the pressure linings. | Mechanical damage. | In case of punctures and breaks longer than 50 mm, replace the stabilizer. |
| 7. Cracking of the visible part of the rubber seal. | Exposure to direct sunlight. | In the event of a malfunction less than 50 mm in size, repair it. |

## 2.2 Take-off and landing devices

The take-off and landing devices are designed to absorb shock loads arising from the landing and movement of the helicopter on the ground, as well as to exclude the impact of the TR on the ground.

Takeoff and landing devices include:

- chassis,
- tail support.

The helicopter chassis is wheeled, tricycle with a front lever self-orienting support and main truss legs of a pyramidal type, not retracted in flight. The presence of the front wheel simplifies landing, allows more use of the brakes to reduce the after-landing run, excludes the possibility of the helicopter capsizing on the bow, which is especially important for a safe landing in poor visibility conditions. In addition, such a chassis layout provides good directional stability during take-off and run. All supports are equipped with liquid-gas shock absorbers. On the right and left shock-absorbing struts of the main supports, there are mechanisms for activating the hydraulic thrust bearing of the longitudinal control and the MC-61 tape recorder.

### 2.2.1 Main Landing gear

The MLG is a pyramidal truss type and includes:

- two shock absorbers;
- two brake wheels KT-97/3.

The design of the right and left struts, symmetrically located on both sides of the fuselage, is the same.

#### Cushion strut

The shock-absorbing strut is designed to absorb and dissipate the impact energy when landing and taxiing a helicopter on an uneven surface, as well as to damp lateral vibrations of the "ground resonance" type. The elements of the rack are made of high-alloy steel 30HGSA and heat-treated.

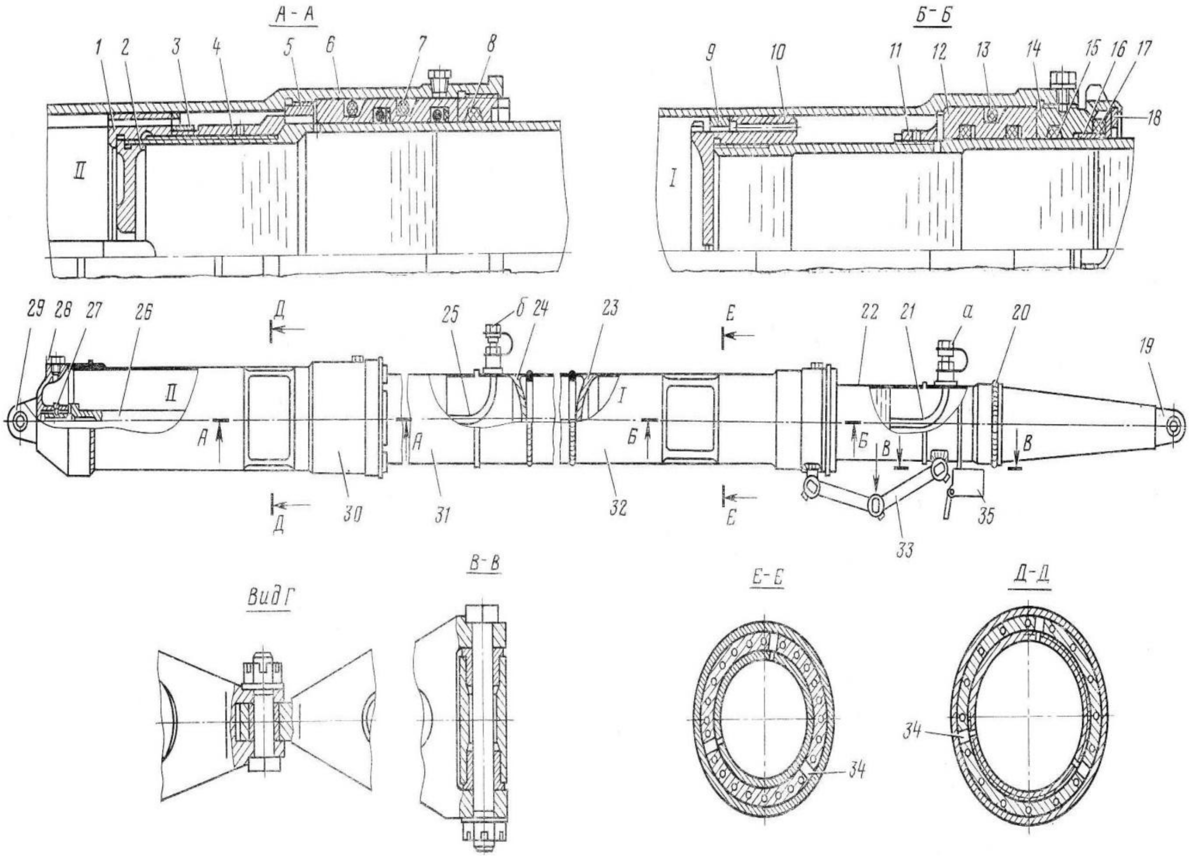



Figure 11 – Shock absorber

I. Low pressure chamber; I I. High pressure chamber; 1, 10. Movable axle box;
2. Diffuser; 3, 9. Floating brake valve; 4. Thrust sleeve; 5, 8, 11, 14. Nut;
6, 30. High pressure chamber cylinder; 7, 12. Fixed axle box; 13. O-ring; 15. Oil seal;
16. Buffer sleeve; 17. Shock-absorbing rubber ring; 18. Retaining ring;
19. Ear of attaching the shock absorber to the fuselage; 20. Bottom; 21, 25. Liquid level tube; 22. Stem of the low pressure chamber; 23, 24. Adapters; 26. Shaped needle; 27, 34. Locking screw; 28. Liquid drain connection; 29. Fork tip; 31. Rod-cylinder (rod of the high-pressure chamber);
32. Rod-cylinder (low pressure chamber cylinder); 33. Slot-hinge;
35. Mechanism for activating the hydraulic seal; a, b - charging valves.

**Brake wheel KT-97/3**

The brake wheel KT-97/3 is used to provide parking, taxiing, takeoff and landing of the helicopter. The wheels of the main landing gear are 865 * 280 mm with pneumatic shoe brakes. Structurally, the KT-97/3 wheel includes:

- pneumatics,
- drum,
- braking device.

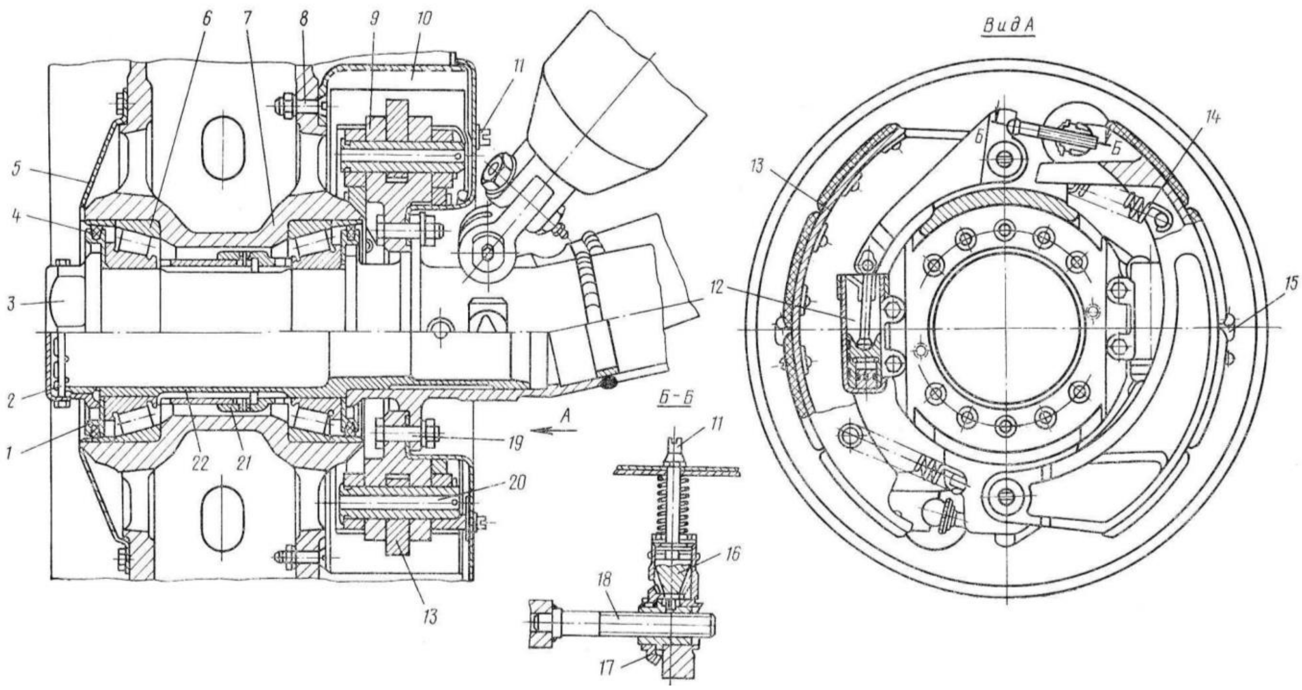



Figure 12 – Brake wheel KT 97/3:

1. Cover; 2. Locking bolt; 3. Wheel nut; 4. Felt ring; 5. Shield; 6. Taper roller bearing; 7. Drum wheel; 8. Countersunk head bolt; 9. Brake body; 10. Brake shirt; 11. Adjustment roller; 12. Air cylinder; 13. Brake shoe; 14. Recoil spring;
15. Hatch for measuring the gap; 16, 17. Bevel gears; 18. Adjusting screw; 19. Bolt of fastening of a brake; 20. Anchor roller; 21. Spacer sleeve; 22. Wheel axle.

### Wheel brake

The wheel brake is used to fix the helicopter in the parking lot and to reduce the forward speed of the helicopter when taxiing.

Brake type: pneumatic shoe. A brake jacket is mounted in the wheel housing, the brake housing is bolted to the axle shaft flange.

Fixed on the body:

- two air cylinders;
- two expanding levers;
- two brake pads;
- two return springs;
- adjusting screws with rollers.

When the left or right pilot presses the brake trigger located on the left handle of the cyclic step, the pressurized air from the air cylinders flows through the UP-O3 reducing accelerator into the air cylinders of the wheel brakes.

By air pressure, the pistons with rods move and turn the expander levers, which, through the adjusting screws and nuts, press the pads against the brake drum.

When the trigger is released, the air from the cylinders is vented through the UP-O3 into the atmosphere, and the springs return the pads to their original position.

### 2.2.2 NLG support

The NLG support is designed to absorb shock loads arising during takeoff and landing of the helicopter, as well as to provide parking, taxiing and towing of the helicopter on the ground.

Type: beam, lever with castor wheels.

Self-orienting wheels are used to maneuver the helicopter when it moves on the ground. After take-off, they are automatically installed in the flight line, which ensures the subsequent execution of a landing with a run.

Structurally, the front support consists of:

- lever amortization rack;
- forked brace;
- two non-brake wheels K-2-116.

The shock-absorbing strut is designed to absorb and dissipate the impact energy during helicopter landing and taxiing on uneven surfaces. All main parts and wheel axle are made of 30HGSA chromium-steel steel. The forked brace of the welded tubular structure is made of steel 30HGSA. Structurally, it consists of two pipes and a forked tip.

The K-2-116 wheel is designed to provide parking and movement of the helicopter on the ground, as well as to absorb part of the impact energy during landing. On the front support there are two non-brake wheels measuring 595 * 185 mm. The air pressure in the tire pneumatics is 4.5 + 0.5 kgf / cm². The wheel includes pneumatics and a drum.

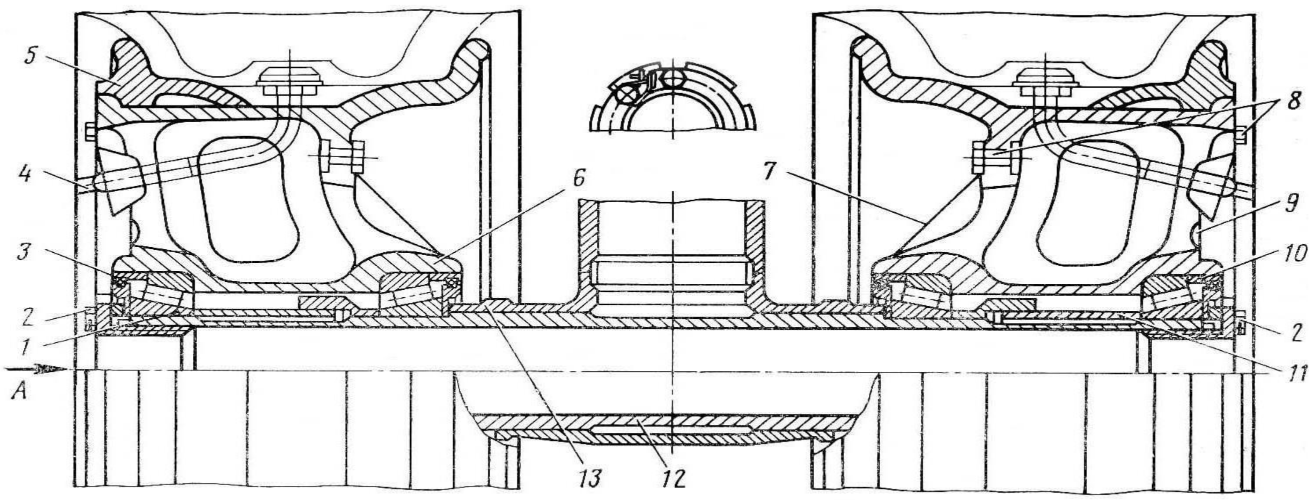



Figure 13 – Wheel K-2-116

1. Tapered roller bearing; 2. Wheel nut; 3. Cover; 4. Valve; 5.Removable flange. 6. Drum; 7, 9. Shields; 8. Bolts; 10. Felt ring; 11. Spacer sleeve; 12. Wheel axle; 13. Thrust ring.

### 2.2.3 Tail support

The tail support is designed to prevent the TR blades from hitting the ground when the helicopter lands with large pitch angles.

Tail support of the truss-pyramidal scheme, its design includes:

- amortization rack,
- two tubular duralumin struts;
- steel fork knot;
- stamped duralumin heel.

To exclude the transmission of possible vibrations of the tail support in flight to the TB, the support elements are attached to it by means of dampers.

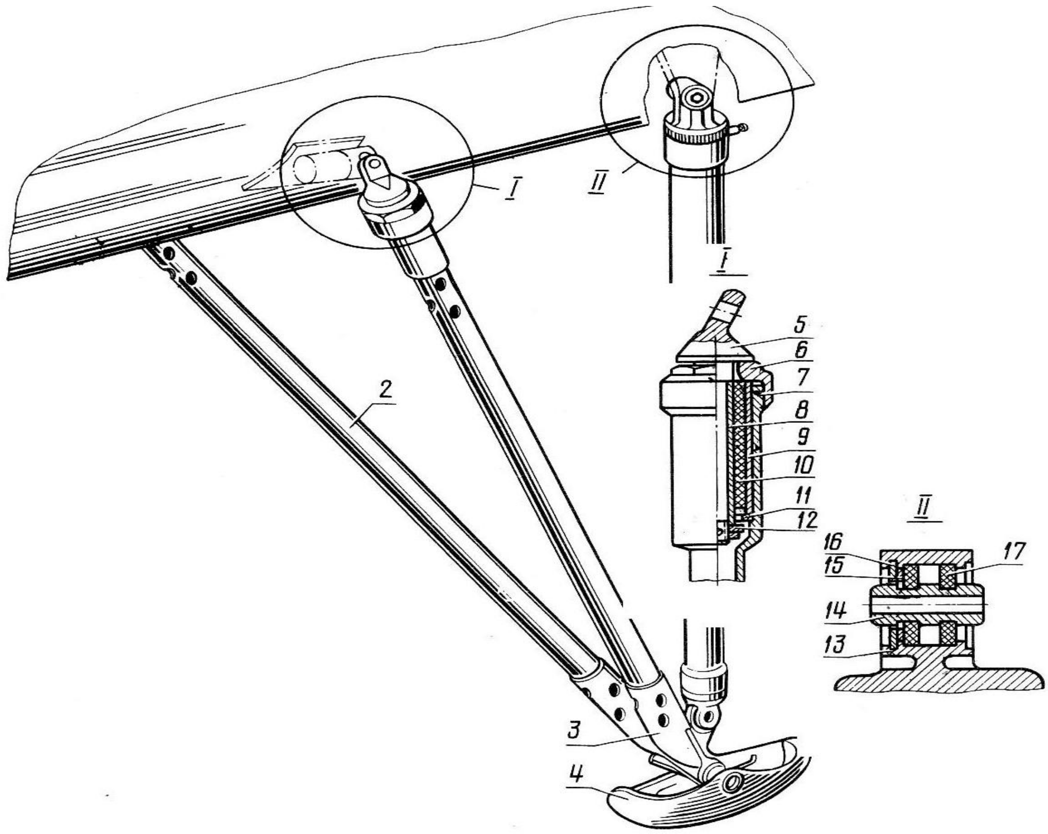



Figure 14 – Tail support:

1. Amortization rack; 2. Brace; 3. Fork knot; 4. Heel; 5. Ear; 6, 12. Nut; 7. Case; 8. Inner clip; 9. Outer clip; 10. Rubber bushing; 11. Ring; 13. Stand head; 14. Sleeve; 15. Retaining ring; 16. Washer; 17. Rubber ring.

### 2.2.4 Maintenance of takeoff and landing devices

Ensuring reliable operation of takeoff and landing devices is achieved by regular monitoring of their technical condition and the implementation of preventive measures. During the inspections, the following are checked:

- correct charging of suspension struts and wheel pneumatics;
- clearances in the wheel brakes and the performance of the braking system.
- fault detection of shock absorbers and struts in order to detect cracks, nicks, scratches, corrosion, loosening of fastening parts;
- determination of the technical condition of wheels and braking devices;
- checking the charging of shock absorbers and pneumatic devices of the wheels and their recharging if necessary;
- lubrication of bearings and pivot joints; replacement of wheels.

Special attention is paid to monitoring the condition of tires. Delamination, swelling of treads, wear up to the first solid cord is not allowed. When parked for a long time, the chassis wheels are covered with covers. On the pneumatic devices of the wheels of the chassis, there should be no delamination and swelling, cuts and punctures of tires, wear of the tread, loosening of the cord with exposure of the wire ring. Tires with a grid of cracks on the tread surface, scratches and shallow cuts without damage to the cord, cuts on the side surface no longer than 30 mm in length are allowed for operation. After the warranty life (the number of takeoffs and landings) has been developed, further operation of the tires is allowed until the tread is completely erased.

To ensure proper operation of the shock absorbers, it is especially important to ensure that they are properly filled with liquid and gas. Under operating conditions, if necessary, the liquid in the shock absorbers is replaced or additionally poured, and also charged with gas. The control of the correct charging is carried out for the shock absorbers of the main struts and the tail support by the exit of their rods, and for the shock absorber of the front leg - by the compression of the rod according to the indicator. A check of the liquid level is performed in the event of a mismatch in the output of the stem during normal nitrogen charging or with the crew's remarks.

Once every four years, the condition of the WF is monitored and, if necessary, the AMG-10 oil in the shock absorbers is replaced.

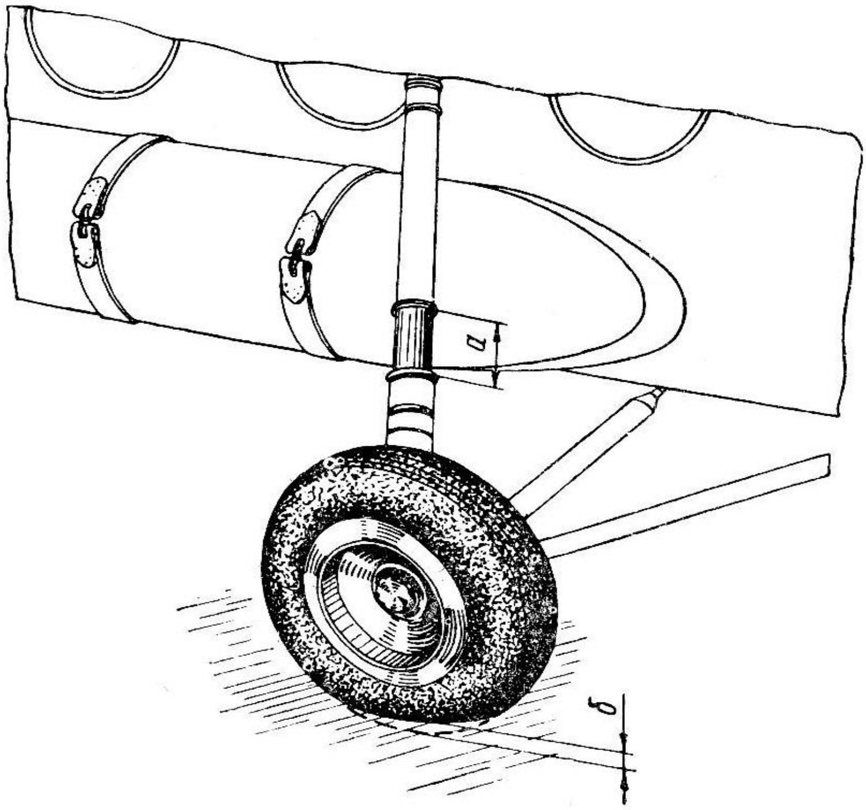



Figure 15 – Checking stem exit and pneumatic crimp:

a - outlet of the high-pressure chamber stem; b - compression pneumatics.

The following are not allowed in operation:

- cracks in welded seams and take-off and landing devices nodes;
- nicks, risks or scratches on the seams;
- violation of paintwork, corrosion on amortization;
- oil leakage and nitrogen bleeding;
- loosening of the tightening of the nuts of the bolts, violation of the locking;
- cracks, risks, nicks on the wheel drums.

Main operational parameters

Air pressure in the tires of the wheels:

- front support 4.5 + 5kgf / cm²;
- main support 5.5 + 5 kgf / cm².

Compression of pneumatics - unloaded helicopter (and with a takeoff weight of 12,000 kg):

- front support 30 ± 10 (45 ± 10) mm;
- main support 45 ± 10 (70 ± 10) mm.

Working bodies used in shock absorbers:

AMG-10 oil; nitrogen.

Amount of fluid in shock absorbers:

- high pressure chamber 2400 cm3;
- low pressure chamber 1100 cm3;
- front support 2080 cm3;
- tail support 300 cm3.

Initial nitrogen pressure in shock absorbers:

- high pressure chamber 60 + 1 kgf / cm2;
- low pressure chamber 26 + 1 kgf / cm2;
- front support 32 + 1 kgf / cm2;
- tail support 27 + 1 kgf / cm2.

Full stroke:

- high pressure chamber 240 mm;
- low pressure chamber 120 mm;
- front support 165mm;
- tail support 200mm.

High pressure chamber stem outlet

in the parking lot - an unloaded helicopter (and with a takeoff weight of 12,000 kg):

240 (100 ± 20) mm;

Compression of the amortization rod of the front support according to the sign in the parking lot:

unloaded helicopter (and with a takeoff weight of 12,000 kg):

65 + 10 (130 + 10) mm.

Table 5 Possible malfunctions of takeoff and landing devices

| Malfunction. | Possible reasons for the appearance. | Troubleshooting method. |
|---|---|---|
| 1. Cracks in welded seams, attachment points of support elements. | Consequences of a rough landing, helicopter towing on uneven ground. | Replace cracked parts. |
| 2. Scratches, nicks, risks on the cylinders of the suspension struts. | Mechanical damage. | Scratches, nicks, risks with a depth of less than 0.1 mm are removed: it is necessary to clean the damaged area with sandpaper number. 10, remove the cleaning products and restore the paintwork. |
| 3. Leakage of nitrogen or leakage of AMG-10 oil from under the charging connection or through the charging valves. | Charge valve too loose, seal or charge valve worn. | Tighten the charging valve, replace the gasket, replace the charging valve. |
| 4. Scratches, nicks, scratches, traces of corrosion on the surface of the shock absorber rod. | Mechanical damage. | Replace the shock absorber strut. |
| 5. Leakage of AMG-10 oil along the stocks of the amortstocks. | Insufficient tightening of the sealing nuts, drying out of the seals and O-rings, wear of the | Replace the shock absorber strut. |

| | | |
|---|---|---|
| | O-ring seals, mechanical damage. | |
| 6. Backlash connecting the horn of the swing arm with the lever. | Looseness or loosening of the connecting pin nut, breakage, bending of the lugs of the lock washer. | Replace washers, tighten and lock nuts. |
| 7. Delamination or swelling of tire protectors. | Manufacturing disadvantage. | Replace tire. |
| 8. Cuts and punctures on the tire. | Mechanical damage. | If cuts and punctures are less than 30 mm long and deep to the cord, the tire is allowed to operate;<br>if the length is more than 30 mm - replace the tire. |
| 9. Tread wear until the first continuous ply of ply appears. | Long-term operation. | Replace tire.. |
| 10. Leakage of air from the pneumatic chamber through the spool. | Destruction (drying out) of the spool seal. | Replace the spool. |
| 11. Reducing the clearance between the brake pads and the brake drum jacket. | Loss of spring elasticity. | Replace the spring, adjust the gap (0.3 - 0.4 mm). |
| 12. Seizure of brake pads in an intermediate position. | Wear of air cylinder parts, loss of spring performance. | Replace defective parts. |

### 2.2.5 Improving service efficiency and improving safety

To ensure more effective and safe maintenance, it is necessary to replace AMG-10 oil with an analogue of FH-51, since AMG at temperatures above 90 ÷ 100 ° C begins to intensively oxidize with the release of resinous substances, the oil is poisonous, causes destruction of seals from leather and ordinary rubber, with prolonged contact, it irritates the skin, causes dermatitis, and due to the appearance of a large number of counterfeits on the aviation fuels and lubricants market.

Signs of AMG-10 falsification:

- AMG-10, which have expired (the shelf life of AMG-10 in the average climatic zone with proper routine storage is 10 years, and in the southern regions 5 years, according to GOST 6794-75). In fact, sellers offer an illiquid product under the wording “AMG-10 oil”. There is also a situation when the product is within the limits of use according to the expiration date, but the oil indicators do not correspond to the manufacturer's passport data in accordance with GOST 6794-75. The main indicators that usually do not meet the standards are the freezing temperature (it is usually higher, i.e. it thickens earlier when negative temperatures occur in degrees Celsius), acid number, and the content of mechanical impurities.
- The fact that the oil is initially produced with underestimated indicators or some indicators are generally absent when standardizing AMG-10 oil. This suggests that the manufacturer initially moves away from the principles of GOST 6794-75 and offers an oil that is actually not AMG-10.

The main reason for this situation is the high price of AMG-10 , as well as a shortage that periodically arises due to irregular serial production.

Change the range of oil change in shock-absorbing struts from 4 to 2 years, since the systems of more modern AC, the service life of AMG-10 and its analogues is sharply reduced and can be no more than 100-200 hours.

## 2.3 Pneumatic system

The pneumatic (air) system of the helicopter is designed for braking the wheels of the main landing gear and recharging the wheel chambers from the onboard cylinders in off-airfield conditions using a special device.

Compressed air with a pressure of 4000 ... 5000 + 400 kPa (40 ... 50 + 4 kgf / cm2) is in two cylinders with a total capacity of 10 liters. The inner cavities of the two struts of the main landing gear legs are used as cylinders (Figure 25).

During the flight of the helicopter, the pneumatic system is recharged from the air compressor installed on the main gearbox.

Charging the pneumatic system with compressed air in the parking lot is carried out through the onboard charging valve from the ground cylinder.

The pneumatic system of the helicopter includes the following units (Figure 27): two air reservoirs; air compressor AK-50T; settling filter 5565-10; two check valves 636100M; air filter 723900-4AT; air filter 723900-6AT; automatic pressure machine AD-50; pressure reducing valve UP25 / 2; reduction accelerator UPO3 / 2M; onboard charging valve 3509C50; charging valve 800600A; two pressure gauges; pipelines (Figure 26).

To control the operation of the pneumatic system, the helicopter is equipped with two pressure gauges NTM-100 (MVU-100), MA-60K. Both pressure gauges are located on the left side panel of the pilots' electrical panel.

The HTM-100 pressure gauge is designed to control the air pressure in the cylinders of the helicopter pneumatic system, which should be within 4000 ... 5000 kPa (40 ... 50 kgf / cm2). The MA-60K manometer is designed to control the air pressure in the brake line, which depends on the amount of movement of the brake control lever when pressed and should be no more than 3300 + 300 kPa (33 + 3) kgf / cm2).

**Air compressor AK-50T1**

Air compressor AK-50T1 is designed to recharge the pneumatic system of the helicopter with compressed air during the flight. Compressor - piston type, two-stage, single-cylinder.

The compressor provides filling of the onboard cylinders with air up to a pressure of 5000 + 400 kPa [50 + 4 kgf / cm2] in a period of no more than 25 minutes. The AK-50T1 air compressor is driven from the main gearbox. The compressor is attached to the main gearbox flange with studs.

When the pressure in the system reaches 50 + 4 kgf / $cm^2$, the pressure switch switches the compressor to idle mode. At the same time, the development of its overhaul life of 750 hours continues. In the event that consumers consume the air supply and its pressure drops to 40 kgf / $cm^2$, the automatic pressure switch switches the AK-50T1 to operating mode and the pressure in the system is restored.

- Air compressor consists of:
- cylinder;
- crankcase;
- piston with rings;
- connecting rod;
- crankshaft;
- felt filter;
- suction valve;
- bypass valve;
- discharge valve.

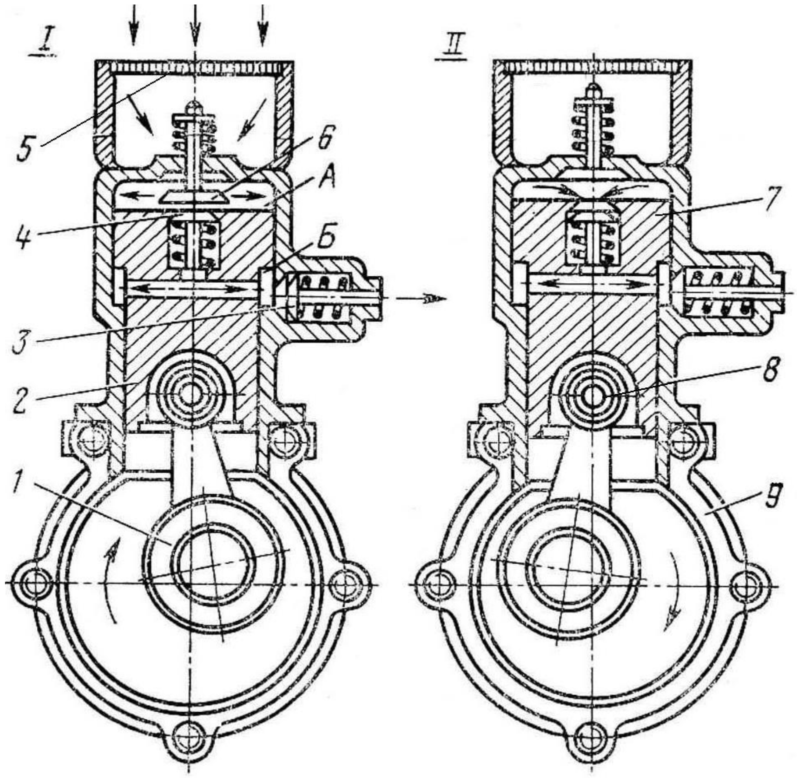



Figure 16 – Scheme of the compressor AK-50T1:
1. Crankshaft with eccentric; 2. Piston; 3. Discharge valve;
4. Bypass valve; 5. Felt filter; 6. Suction valve; 7. Cylinder;
8. Connecting rod; 9. Carter. I. Suction and discharge; II. Precompression

**5565-10 sump filter**

The 5565-10 sump filter is designed to clean the air from oil and moisture coming from the compressor to the helicopter pneumatic system and is attached to the supply tank container with a clamp. There is a tap on the filter to drain condensate overboard the helicopter.

Consists:

- body with air inlet and outlet fittings;
- reflective glass;
- a drain cock with a self-locking flywheel.

Flanges are made on the body, with which the filter is attached to the wall of the supply fuel tank on the left along the flight. The inlet and outlet nipples are screwed into the body at different heights (the outlet nipple is installed above), a baffle cup is screwed in from above.

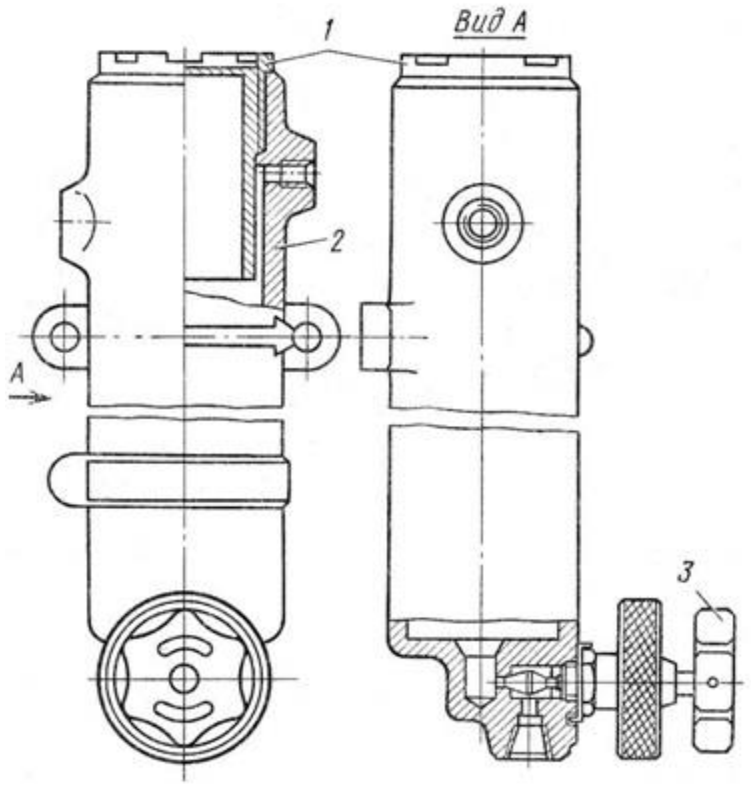



Figure 17 – Filter Sump 5565-10:

1.Reflective glass; 2. Case; 3. Drain cock handwheel.

**Check valve 636100M**

The check valve 636100M is designed to allow air to pass in one specified direction and to shut off the line in case of a reverse air flow. Check valves are installed on the pneumatic panel. The working pressure of the valve is up to 150 kgf / cm², the opening pressure is no more than 1 kgf / cm².

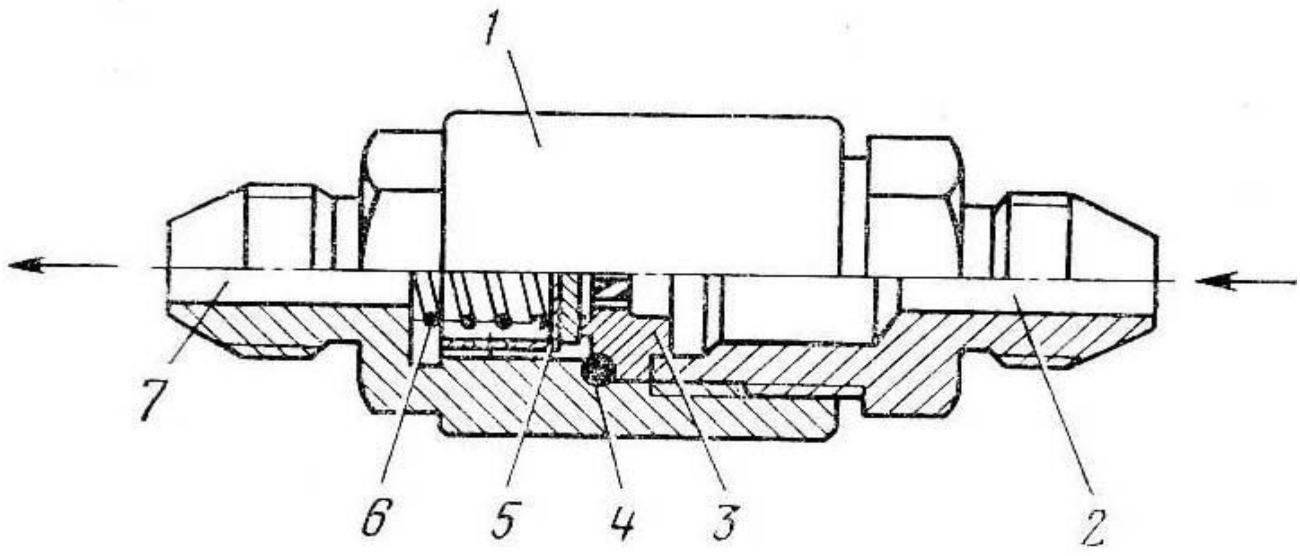



Figure 18 – Check valve. 636100M

1. Case; 2, 7. Fittings; 3. Saddle; 4. O-ring;

5. Cap with rubber washer; 6. Spring.

**Air filters 723900-4AT and 723900-6AT**

Air filters 723900-4AT and 723900-6AT are designed to clean the air from mechanical impurities and are installed in high-pressure lines. Provides a filtration purity of 10 ... 100 microns. 723900-4AT, installed in the onboard cylinders charging line after the onboard charging valve, 723900-6AT, located in the consumer circuit. The filters are structurally made in a similar way and differ in the diameters of the fittings - 4 mm for the 723900-4AT filter and 6 mm for the 723900-6AT filter for connecting the pipelines of the system. The filter element is formed by a set of felt discs and brass mesh discs. The presence of brass meshes is necessary to protect the system from getting particles of felt discs into it. The thrust washers located on both sides of the filter bag are perforated discs. During operation, air enters the housing fitting, passes through the holes in the thrust washer, filter elements, is cleaned of mechanical impurities and enters the system.

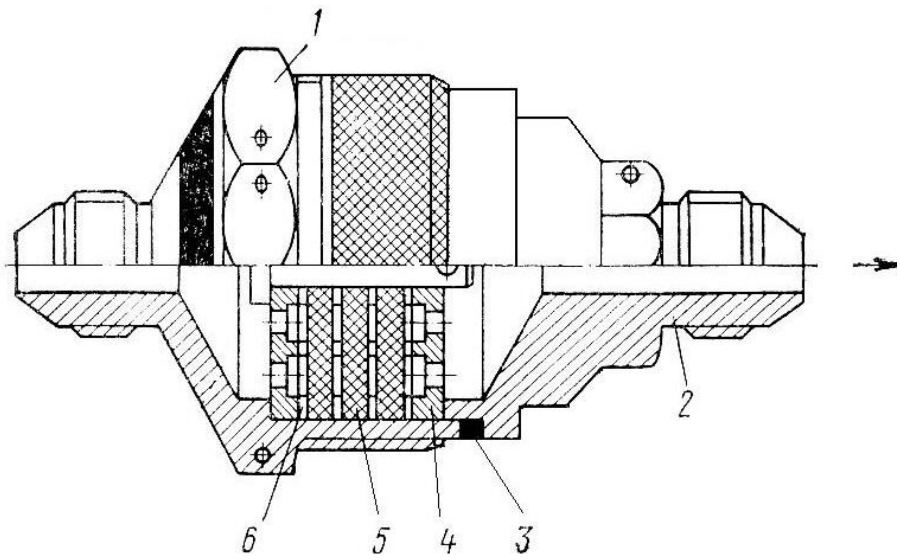



Figure 19 – Air filter

1. Body with inlet fitting; 2. Nut with outlet fitting; 3. O-ring; 4. Thrust washer; 5. Felt disc; 6. Brass mesh disc.

**Automatic pressure switch AD-50**

Automatic pressure switch AD-50 is designed to automatically switch the AK-50T1 compressor from operating mode to idle and vice versa. Switching the compressor from operating mode to idle occurs at an air pressure in the cylinders of 5000 + 400 kPa [(50 + 4) kgf / cm2], and from idle to operating mode - at an air pressure in the cylinders of at least 4000 kPa (40 kgf / cm2).  The pressure switch is installed on the pneumatic panel.

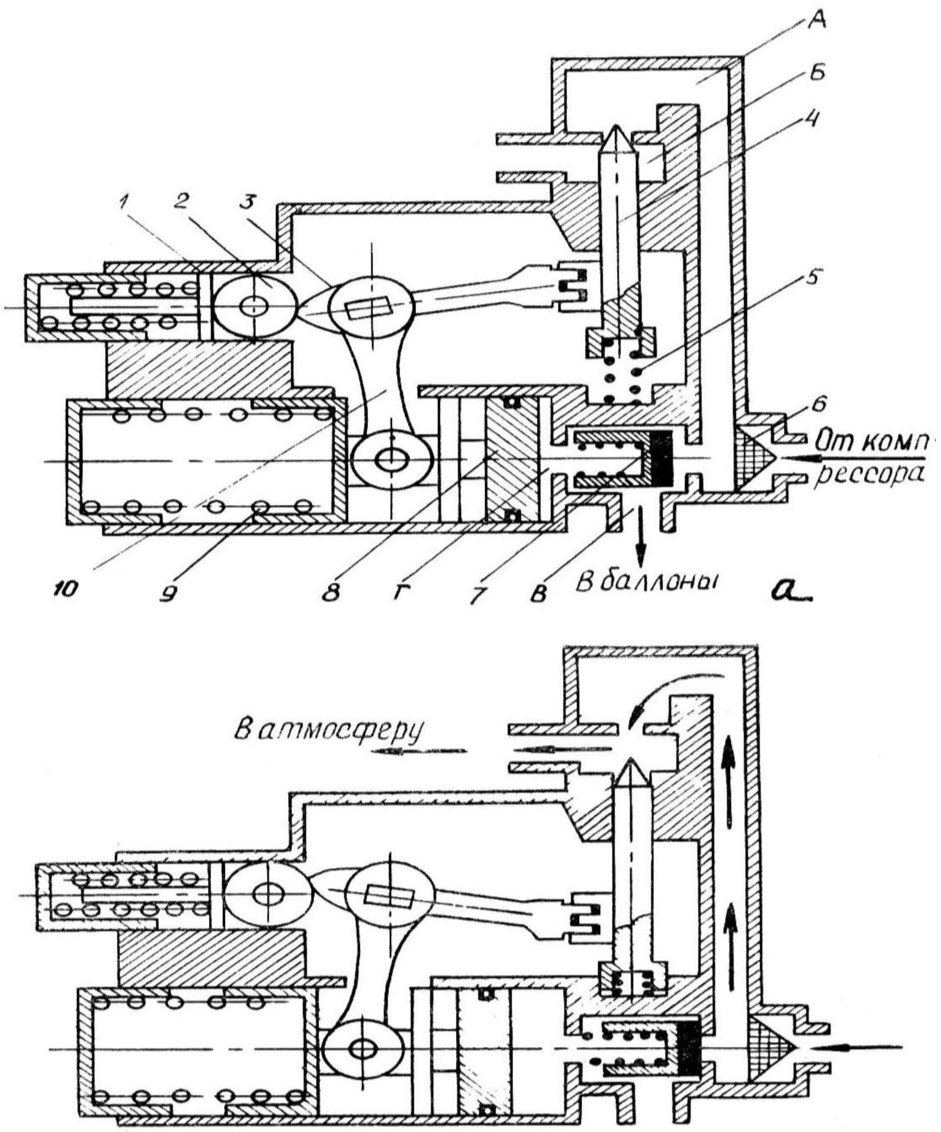



Figure 20 – Automatic pressure switch AD-50:

1. Lock with spring; 2. Locking roller; 3. Cam; 4. Locking needle; 5, 9. Springs; 6. Mesh filter; 7. Check valve; 8. Piston; 10. Crank arm

**Reducing valve UP25 / 2**

The UP25 / 2 pressure reducing valve is designed for pneumatic control of the wheel brakes of the main landing gear legs and provides:

- turning on the brakes by supplying them with reduced pressure;
- increasing or decreasing the braking efficiency by changing the value of the reduced pressure;

The pressure reducing valve is installed under the cockpit floor between frames number. 3H and 4H and is attached to the floor longitudinal beam on a bracket. On the same bracket there is a lever for pressing the pusher of the UP25 / 2 reducing valve, connected by a cable wiring with the brake control lever located on the left handle of the helicopter's longitudinal-lateral control. To fix the brake control lever in the braked position, a lock is provided on the control handle.

The cable routing is enclosed in a Bowden sheath and is attached to the clamp control knob. The UP-25/2 reducing valve is a variable pressure reducer, in which the outlet pressure is determined by compression of its reduction spring.

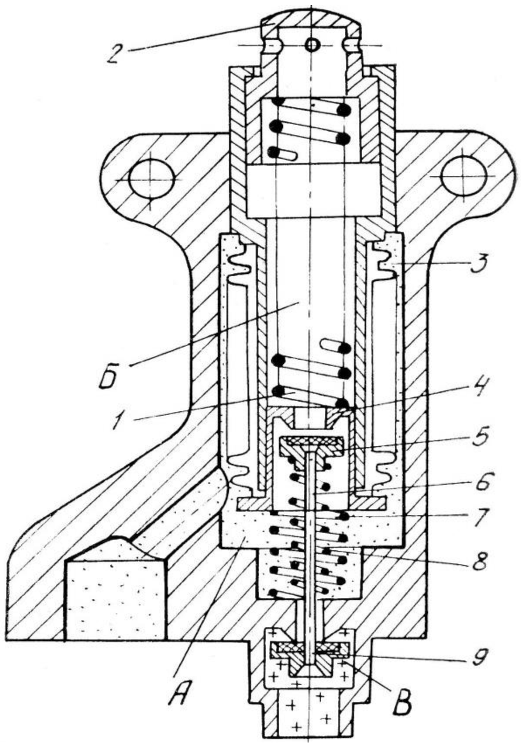



Figure 21 – UP-25/2 pressure reducing valve:

1. Reduction spring; 2. Pusher; 3. Bellows; 4. Piston; 5. Release valve; 6. Pusher; 7, 8. Springs; 9. Intake valve

**Reduction accelerator UPO3 / 2M**

The reduction accelerator UPO3 / 2M is designed to accelerate the supply of compressed air to the brakes of the wheels of the main landing gear legs, as well as to release air from the brakes into the atmosphere when the wheels are released. The reducing accelerator operates from the control pressure supplied from the UP25 / 2 reducing valve and creates a pressure in the brake line equal to 3300 + 300 kPa [(33 + 3) kgf / cm2]. The reduction booster is installed under the cockpit floor and is attached to the frame number. 3H by pins**.**

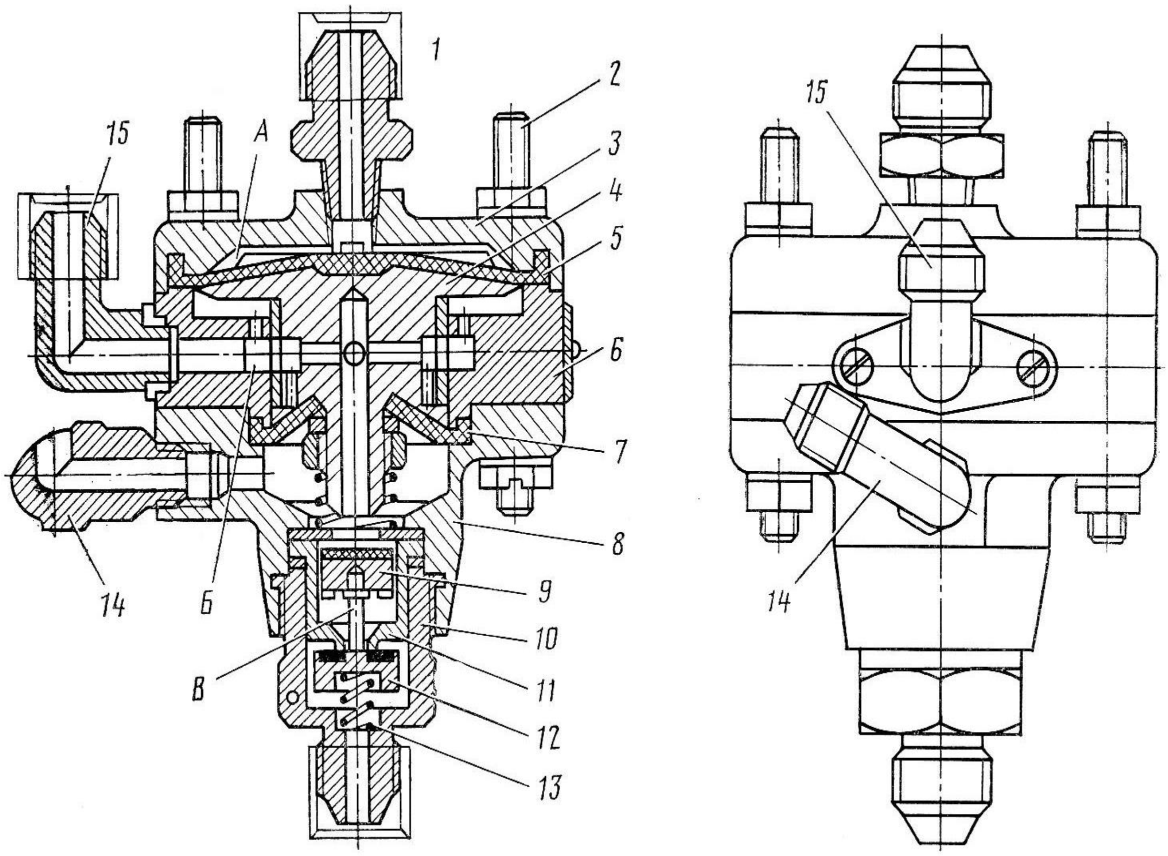



Figure 22 – Reduction accelerator UP-03 / 2M

1. Nipple for connecting the pipeline from the UP-25/2 valve; 2. Hairpin; 3. Cover; 4. Piston; 5, 7. Membranes; 6. Ring; 8. Case; 9. Release valve; 10. Nipple for connecting the pipeline from the power supply circuit; 11. Guide; 12. Intake valve; 13. Spring; 14. Fitting of the air supply line to the wheel brakes; 15. Connection for bleeding air into the atmosphere.

**Onboard charging valve 3509C50**

The onboard charging valve 3509C50 is designed to charge the onboard cylinders with compressed air from ground cylinders or special air compressors.

The onboard charging valve is installed in a hatch on the left side of the fuselage between frames number. 12 and 13 and is closed with a lid with a lock.

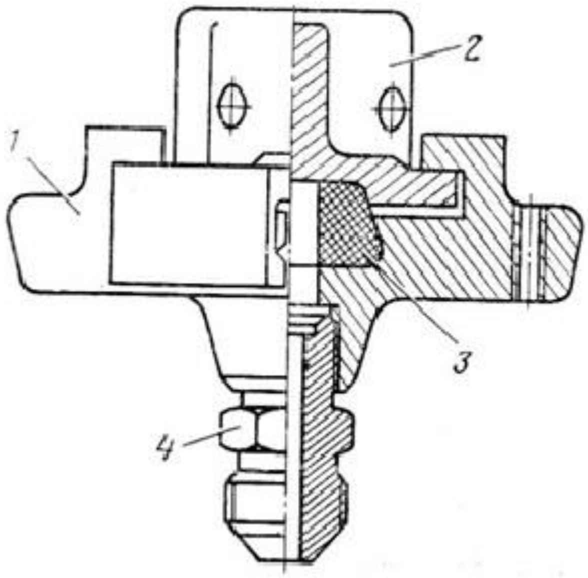



Figure 23 – On-board charging nipple:

1. Case; 2. Cover; 3. Rubber ring 4. Fitting.

**Charging valve 800600A**

The 800600A charging valve is designed to recharge chambers, wheels and shock-absorbing struts in off-aerodrome conditions and is mounted in the air supply tee of the left strut of the main chassis. When a special device is screwed on, the valve, compressing the spring, moves and compressed air enters the gap formed between the body and the rubber seal.

**Pneumatic panel**

For the convenience of assembling the units and checking the tightness of the connections, as well as reducing the number of pipelines, some of the units of the pneumatic system are mounted on a separate panel. The pneumatic panel is installed on the left side of the cargo compartment of the fuselage between frames number. 11 and 12.

The following units of the helicopter pneumatic system are installed on the pneumatic panel (Figure 24): air filter 723900-4AT; elbow, check valve 636100M; tee; automatic pressure machine AD-50.

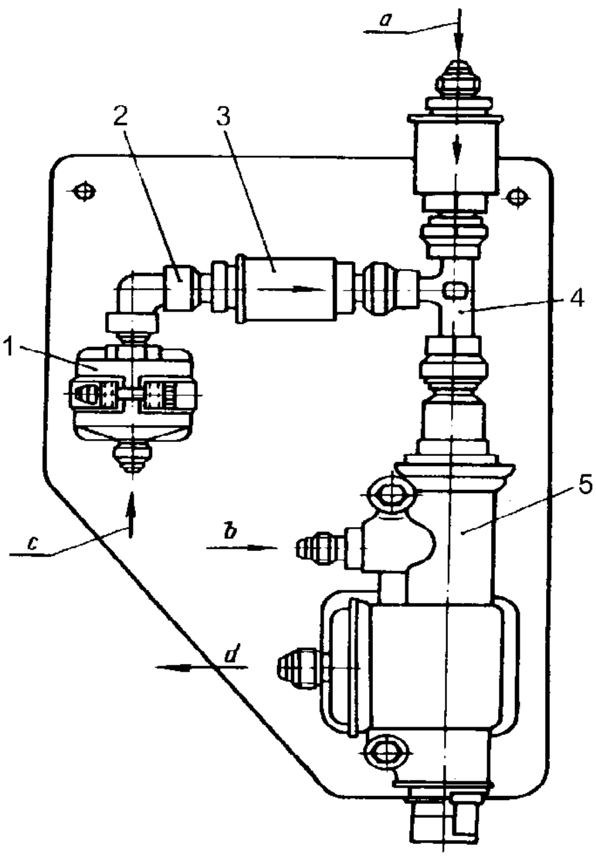



Figure 24 – Pneumatic panel

1. Air filter 723900-4AT 2. Elbow 3. Check valve 636100M

4. Tee 5. Automatic pressure switch AD-50

(a - from the compressor; b - from the cylinder; c - from the onboard charging connection; d - into the atmosphere

**Piping and hoses**

In the lines for charging the system and supplying air to the wheel brakes (at the section of the braces), the pipelines are made of steel tubes 12X18NT10T, the rest are duralumin from Amg2M.

All pipelines are tested for strength under pressure of 100 kgf / cm² and for tightness under pressure of 75 kgf / cm².

The pipelines are painted black with EP-140 enamel. The main landing gear is connected to the cylinders and wheels with flexible hoses.

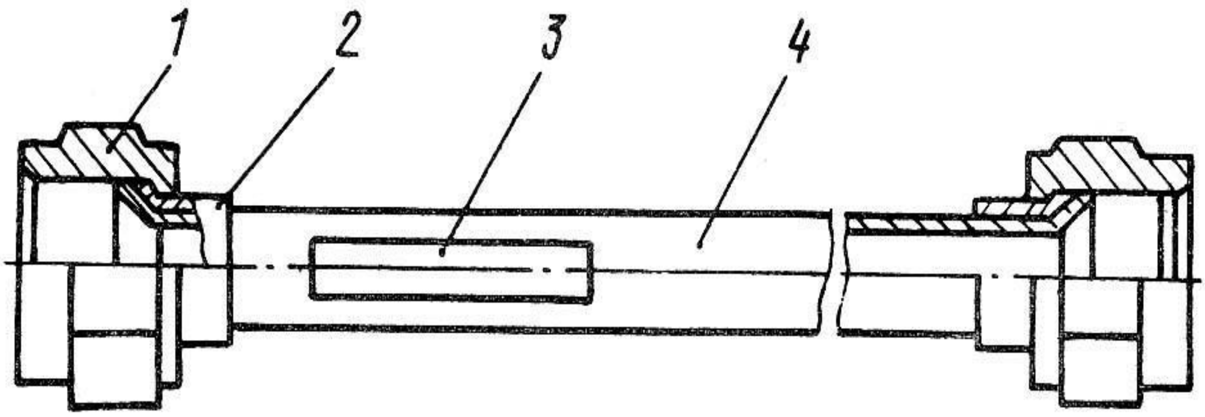



Figure 25 – Typical pipeline:

1. Union nut; 2. Nipple; 3. Tag; 4. Tube

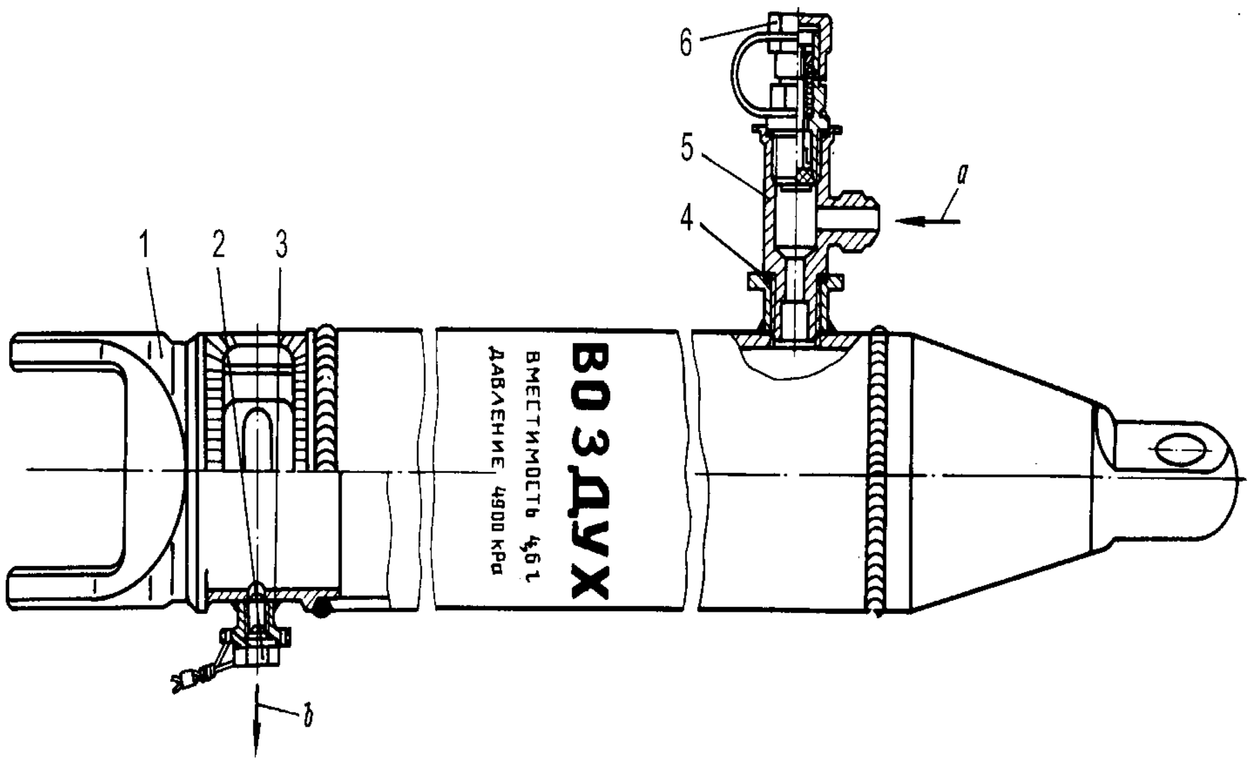



Figure 26 – Pneumatic system reservoir

1. Brace.

2. Plug.

3. Condensate drain connection.

4. Connection for supplying compressed air to the cylinder

5. Tee.

6. Valve for off-aerodrome recharging of wheel chambers

(a - compressed air supply; b - condensate drain).

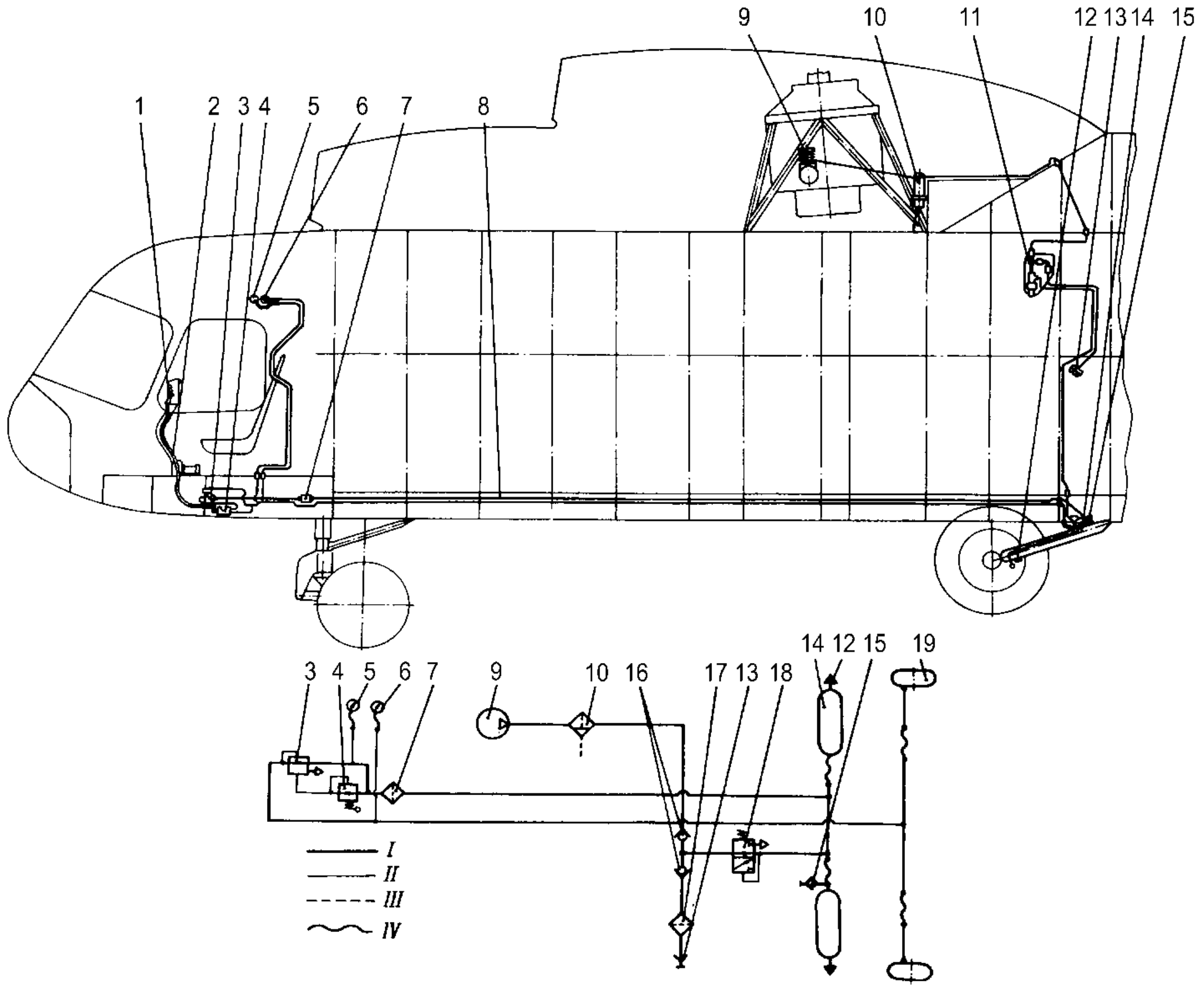



Figure 27 – Pneumatic system diagram

1. Brake control lever; 2. Rope wiring for control of the UP25 / 2 pressure reducing valve; 3. Reduction accelerator UPO3 / 2M; 4. Reducing valve UP25 / 2; 5. Air pressure gauge MA-60K; 6. Air pressure gauge NTM-100 (MVU-100); 7. Air filter 723900-6AT; 8. Pipelines; 9. Air compressor AK-50T1; 10. Filter-settler;

11. Pneumatic panel; 12. Nipple for draining condensate from the cylinder ;

13. Onboard charging valve 3509C50; 14. Air bottle; 15. Charging valve 800600A;

16. Check valve 636100M; 17. Air filter 723900-4AT;

18. Automatic pressure device AD-50; 19. Chassis wheel;

I. Pipelines for charging cylinders and brake lines. II. Control line pipelines;

III. Drainage piping. IV. Flexible hoses.

### 2.3.1 Basic rules for the operation of the pneumatic system

The operation of the pneumatic system in flight consists in monitoring its serviceability using control devices - pressure gauges NTM-100 "Air" and MA-60K "Brake".

The pressure in the onboard cylinders is automatically maintained within 40 ÷ 50 + 4 kgf / cm² and is determined by the "Air" manometer. If the pressure exceeds 50 + 4 kgf / cm², for example, in the event of a failure of the AD-50 pressure machine, it is necessary to maintain it within the set range by pressing the wheel brake control lever.

The pressure in the wheel brakes is controlled by the "Brake" pressure gauge, the normal pressure range is 0 ÷ 36 kgf / cm².

When you press the brake lever, there should be no:

- noise of the outgoing air;
- pressure drop in the brake circuit.

After releasing the lever, the pressure should drop to zero.

When carrying out inspections, flight equipment should pay special attention to:

- on the external condition of the units and pipelines of the pneumatic system: there should be no mechanical damage, corrosion, violation of the paintwork of the units;
- it is not allowed to touch the pipelines with each other and with the structural elements of the helicopter: the gap between the pipelines and the fixed elements of the structure must be at least 3 mm, and between the pipelines and the moving elements - at least 5 mm.

The tightness of the system is periodically checked, which is done using soap foam, and in winter conditions - with AMG-10 oil. The tightness of pipelines is ensured by the same taper of the mating elements. If the connection is leaking, the pipe nuts must be tightened. However, do not overtighten the connections as this could damage the threads or the flared portion of the pipeline. Etching of air at the joints is allowed no more than 50 bubbles per minute.

It is not allowed to get fuel and lubricants on rubber hoses, as this can lead to their cracking.

During the transition to another period of operation, condensate is drained from the onboard cylinders. Before carrying out any repair and installation work, it is necessary to bleed the air pressure from the pneumatic system.

Table 6. Possible malfunctions of the pneumatic system and ways to eliminate them.

| Malfunction | Possible reasons for the appearance. | Troubleshooting method. |
|---|---|---|
| 1. Etching of air in the joints of pipelines and units. | Union nut not tightened sufficiently. | Tighten the pipe union nut and lock it. |
| | Breakage of the thread of the pipeline or union nut. | Replace piping or union nut. |
| | Destruction of the flared end of the pipeline. | Replace the pipeline. |
| 2. Corrosion on pipelines. | Mechanical damage. | Sand with no. 6 abrasive paper and restore paintwork.<br>If the depth of corrosion is more than 0.2 mm, replace the pipeline. |
| 3. Violation of paintwork. | Mechanical damage. | Wipe the damaged area with a napkin soaked in B-70, cover with AK-070 primer and two layers of EP-140 black enamel. |
| 4. Faces, cracks, flattening of pipelines. | Mechanical damage. | Replace the pipeline. |
| 5. Cracked outer layer of the hose. | Ingestion of fuels and lubricants, long-term operation. | Replace hose. |
| 6. Air etching through the hose termination in the handpiece. | Loose nut tightening. | Tighten the union nut. |
| 7. The pressure drop in the braking circuit | Air poisoning due to damage to elements | Check for leaks by ear or with soapy water and eliminate. |

| Malfunction | Possible reasons for the appearance. | Troubleshooting method. |
| --- | --- | --- |
| when the brake lever is pressed. | or leaks in their connections. | |
| | Malfunction of the braking circuit units. | Determine the fault and replace the unit. |
| 8. When the drain cock of the sediment filter is open, condensate does not drain and air does not come out. | Clogged sump filter. | Remove the filter and rinse it with clean B-70 gasoline, blow it with compressed air and reinstall it.<br>In winter, warm up the filter from the ground heater. |

### 2.3.2 Improving the pneumatic system

To improve the pneumatic system, it is necessary to change the position of the AK-50 compressor and its drive. In the current state, the compressor, driven by the main gearbox, operates throughout the entire flight, which (as indicated in 2.3) affects its overhaul life.

## Conclusions to Part 2

Based on the above, it can be concluded that the above systems and parts of the helicopter were designed taking into account many operational factors, respectively, the field for their modernization or change is extremely small. However, some minor changes may increase the safety of workers or extend the overhaul life of elements of systems or parts.

# PART 3 JUSTIFICATION AND DETAILED STUDY OF POSSIBILITIES OF IMPROVEMENT OF THE LISTED SYSTEMS AND PARTS

## 3.1 Pneumatic system upgrade to extend compressor overhaul time.

Let's start with the pneumatic system. The "sick place" of the pneumatic system is a compressor which (as specified in 2.3.1) is operated for the entire time from the moment of engine start. To increase the life of the compressor, remove it from the reduction gear box and install it in the reduction compartment on the wall of frame number 10 above the cargo cockpit. Maintain the pressure in the aircraft cylinders within the limits of 40 50 + 4 kgf/cm $^2$ and determine by the "Air" pressure gauge. To put into operation, use a three-phase electric motor with 36 volts of DC with a capacity of 2.2 hp. In case of consumption of air reserve by consumers and its pressure drop to 40 kgf/cm $^2$, use a manual switch in the crew cockpit to turn on the drive motor. When the pressure in the system is equal to 50 + 4 kgf/cm $^2$ by the pressure gauge, turn off the compressor drive.

This change in the system will also require a change in the design of the gearboxes VR-8 and VR-14. Namely, it will be necessary to remove the connector for the compressor drive. The above changes fully correspond to the existing documents for servicing this type of helicopter.

## 3.2 Improvement of fuselage defectation

With regard to the fuselage, the greatest danger is the fatigue destruction of the bolt joints of the joint of the main parts of the airframe, which can lead to their disconnection with subsequent destruction of the entire structure, which can lead to human casualties. The inaccessibility of these bolted connections makes it difficult to control them by optical non-destructive testing methods due to the unreasonably high total labor intensity of the work. To detect cracks in threaded joints, nondestructive testing methods are used: magnetic powder, ultrasonic, electromagnetic and penetrating substances. However, each of them has its own specific disadvantages, one of which is the impossibility of quantifying the detection of defects. Ultrasonic method of NDT is considered to be promising in order to solve the given task of bolted connection testing. Since it has a number of advantages over the rest, such as the ability to control bolts in the assembly, the relative simplicity of implementation, the compactness of the devices, and small economic costs.

### 3.3 Method of improving reliability of aircraft hydraulic control systems

A significant increase in effort in the control system is observed when maneuvering a helicopter compared to the level of these forces in steady-state horizontal flight, especially when performing maneuvering at a high initial speed, since due to the curvature of the flight path, the blades fall into their own vortex trace. Powerful vortex bundles, coming from the ends of the previous blades in rotation or the same blades in the previous revolution; action on blades causes bursts of aerodynamic load and hinged moments. And hinge moments twisting the blades relative to the longitudinal axis, and are known to be a source of force in the helicopter control system. Thus, the disruption of flow from the blades of the MR propellers when flying at high altitude at high speed, as well as with vigorous maneuvering, leads to a significant increase in instantaneous forces on the actuating rods of the hydraulic amplifiers of the control system, which poses a threat to the safety of helicopter flights due to the possible "subsidence" of the hydraulic amplifiers and "driving" of the control levers. For this reason, the flight manual limits the maximum horizontal flight speeds of the helicopter at high altitudes, pitch and roll angles during maneuvering.

Elements of the intake part of the control system (automatic skewing, push-pull rods, bell-cranks, brackets, fasteners of hydraulic amplifiers) loaded with significant variable forces have a limited life.

The control system of modern helicopters is inextricably connected with the hydraulic system, the efficiency and reliability of which are particularly high, since the failure of the hydraulic system for the Mi-8 helicopter, as a rule, entails a complete loss of control.

High operational reliability of hydraulic systems of modern helicopters is provided by the following main factors:

- unlike aircraft on helicopters, hydraulic pumps are installed not on engines, but on the main reduction gear box and in case of engines failure they operate with normall supply at MR self-rotation mode;

- installation of hydraulic amplifiers on the rigid housing of the main reduction gear eliminates the possibility of self-oscillations of control in the area behind hydraulic amplifiers, which occur usually due to insufficient rigidity and due to deformations of the supports of hydraulic amplifiers;

- specially designed hydraulic amplifiers have increased dynamic strength for perception of alternating sign loads from hinge moments of blades.

Ensuring flight safety at Helicopter flight operations shall take into account:

At supercritical flight modes, at significant exceeding of permissible values of maximum speed, normal G-load, pitch and roll angles, forces from hinge moments of MR blades can exceed available forces of TR guides. This leads to the "subsidence" of hydraulic amplifiers, the "driving" of the control stick, the spontaneous deviation of the skew machine, that is, it creates a dangerous situation.

Available design forces of hydraulic amplifiers are determined at zero speed of rod and nominal pressure in hydraulic system, and at vigorous maneuvering of helicopter, when pilot works intensively simultaneously with all controls, liquid pressure in hydraulic system and accordingly available power of hydraulic amplifiers drop markedly. This leads to a decrease in the pilot's set speed of movement of the controls and can also complicate the piloting of the helicopter.

If the force developed by the hydraulic booster is less than the force from the hinged moments on the controls of the corresponding system, tightening begins, and then jerks begin, when the pressure drops completely, turning into driving the control handle or moving the step-gas lever up. If there is no discharge pressure and in the backup system, that is, complete failure of the hydraulic system, hydraulic amplifiers operate as rigid rods, so the forces from the hinge moments of the blades are transmitted to the controls. Control of the Mi-8 helicopter in this case, even with the coordinated actions of the left and right pilots, is extremely difficult. In this regard, it is important to conclude that the main reason for the breakdown of hydraulic amplifiers is the destructive load from vibration under adverse circumstances in flight, the main malfunctions in this case are the crack of the rod and the tab of the rod at both the KAU-30B and the RA-60B.

For this, it is important to conduct training more often and bring to the flight crew restrictions on the flight manual of the helicopter, since the occurrence of limit loads is mainly the reason for the flight crew error.

To prevent breakage of the rod, it can be done to strengthen the rod, that is, to increase the wall thickness, which will lead to greater strength of the rod, that is, as revealed from the operation data, that after 1,500 hours of using hydraulic amplifiers, the probability of breakage of the rod is approximately 2%, from which it follows that the thickness of the rod wall should be increased by 2%. The only disadvantage in using this method will be an increase in the weight of the hydraulic booster, which is not a significant disadvantage in solving this problem.

### 3.4 Method of hydraulic system operating fluid cleanliness control

One of the most important conditions for ensuring stable failure-free operation of hydraulic system units is keeping the WF clean at the required level.

Contaminants enter the system in various ways:

1) With WFs. The new WF contains a number of contamination particles, the number of which increases during storage and transportation, especially in case of violation of the rules for performing these actions.

2) Atmospheric pollution. Dust and water can enter the hydraulic system through drainage channels, as well as in case of violations of the rules closed filling of operating fluid into hydraulic system.

3) Contamination during maintenance and repair. Due to constant use and heavy operating conditions of units and assemblies (high pressures, temperatures and loads), hydraulic systems are constantly in need of maintenance and repair. During these operations, the hydraulic system units and assemblies interact with the "contaminated" environment. In addition, if a component of the system (e.g. a pipeline) is replaced, some contaminants may be present on its surface.

4) Wear of system parts. During operation there is continuous wear of surfaces of hydraulic system units (pumps, spool pairs). As a result, contaminants are generated in the hydraulic system.

To date, many methods have been developed to combat pollution, but it is currently not possible to achieve absolute purity of the WF. Even before the operation of the WF (during spilling, transportation and filling), it contains a small amount of mechanical impurities, which continuously grows during operation. Thus, we can conclude that the concentration of contaminants in the WF is valuable diagnostic information that allows us to conclude not only about its condition, but also about condition of the mechanical units of the system.

For example, spectral analysis based on oil sampling and analysis of particles of contaminants contained in the oil system of aircraft and gas turbines is used to assess the technical condition of the units, from the results of which it is possible to determine their nature. Knowing about the materials from which a particular unit of the system is made, based on information about the nature of pollution, it is possible to conclude which unit is subject to intense wear and tear. This technique works well for oil systems due to the fact that contaminants in oil are mainly metallic in nature (wear products of friction pairs, bearings) for which spectrum lines are clearly defined. Contaminants in hydraulic systems are often non-metallic or even organic substances for which it is very difficult to conduct spectral analysis, which means that it is not advisable to use such a technique to quickly assess the purity of the WF and the state of the hydraulic system units.

To implement proactive maintenance of the hydraulic system, a method is required that allows you to quickly and reliably assess the state of a particular unit. As an example, consider a hydraulic actuator, which is one of the most important units of the aircraft hydraulic system, which is extremely sensitive to the purity of the WF.

Hydraulic drive is used as an actuator on an aircraft where load control requires great effort, smoothness of movement and speed. Any hydraulic drive can be represented in the form of an input and an actuating link. The main element of the input link is a spool pair, which provides the supply of WF to the actuating link, in accordance with the pilot's control action on the steering wheel. The spool pair due to micron gaps between the spool and the sleeve is most affected by mechanical impurities and, according to statistics, is the most failing element of the hydraulic drive. Based on this, it can be said that the state of the spool pair largely determines the state of the entire unit.

Consider the effect of contamination particles on the operation of the spool pair of a typical hydraulic actuator. One of the main parameters of the spool pair that determines its quality is friction during movement and when the spool is straying from place. The issue of dependence of friction force in spool pairs on various factors is considered in detail in the work. If the pair is not cylindrical and if there is an initial eccentricity of the spool and sleeve axes, a radial unbalanced force appears, which tends to move the spool to the sleeve, thereby causing unacceptable increase of friction forces in the pair and, as a result, jamming of the slide valve in the sleeve.

Unbalanced radial force value is calculated by formula:

$$f_{рад} = \frac{\pi \mathrm{lrh}\Delta\rho}{2\mathrm{e}} \left(1 - \frac{2s+h}{\sqrt{(2s+h)^2 - 4e^2}}\right)$$

где:

$f_{рад}$ – unbalanced radial force;

l - length of slide valve belt;

r - slide valve radius;

Δp - pressure drop on the slide valve belt;

e - eccentricity;

h - taper;

s - value of clearance between slide valve and sleeve on the side of cone base.

Taper h in the spool pair is formed due to deformation of the surfaces of the spool pair by particles of contaminants falling into the gap between them. These particles circulate together with the WF through the hydraulic system and inevitably fall into the gaps between the parts of the spool pairs. In addition, it must be borne in mind that the surface of any solid body is wavy. Rubbing surfaces of slide valve and sleeve are made with purity within 8-11 classes, for which height of irregularities reaches values of 3.2-0.4 mcm, respectively, according to GOST 2789-59.

The materials are brittle rather than ductile in order to prevent fouling particles from entering the surface. When a spool pair of particles of commensurate size and greater hardness enters the gap, additional chips are formed. Other, less solid particles lead to elastic deformation of the parts of the pair. Larger particles will collapse against the sharp leading edge of the spool by more than small and have a similar effect, or plastically deform it, thereby plugging the gap. Thus, the mechanism violations of the cylindrical properties of the slide valve and sleeve surfaces consists in the effect on them of particles of contaminants of various sizes and hardness.

In addition, the amount of unbalanced radial force is significantly influenced by the eccentric location of the spool in the sleeve, which appears during the assembly of the pair due to the small dimensions of the spool and sleeve and the micron gaps between them.

Based on the above, consider the mechanism of development of spool pair jamming (Fig. 28).

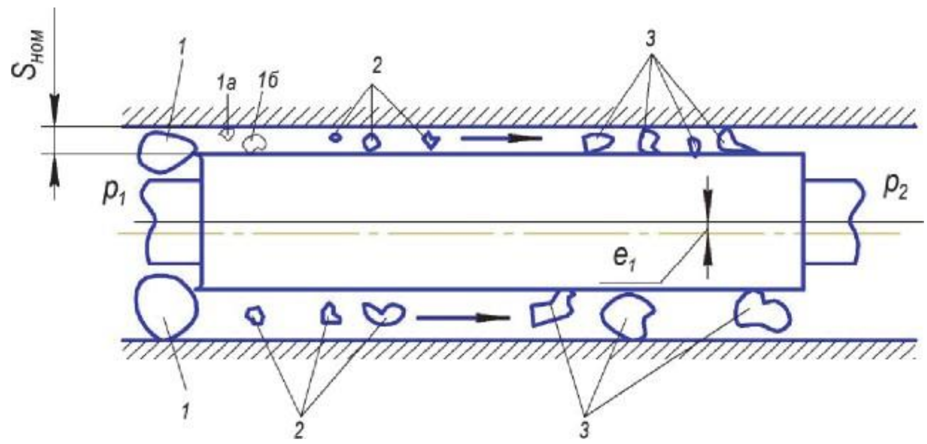



Figure 28 - First stage of spool pair jamming development

During assembly, the slide valve is installed in the sleeve with some nominal clearance $S_{ном}$ and eccentricity $e_1$ . Differential pressure $\Delta p = p_2 - p_1$acts on the slide valve. Contaminant particles of various sizes were present in the WF. During operation, the coarse particles 1 were split into smaller edges (1a and 1b), increasing the concentration of hazardous particles. The particles 2, which are smaller than the gap, passed unhindered; however, when contacting the surfaces of the parts, the pairs deformed them. The bulk of the particles 3, the size of which is commensurate with the gap, passing between the spool and the sleeve, contributed to the intense wear of their surfaces. Thus, over time, there was a violation of the cylinders of the surfaces of the slide valve and the sleeve, which was expressed in the fact that the slide valve acquired a taper h (Figure 29).

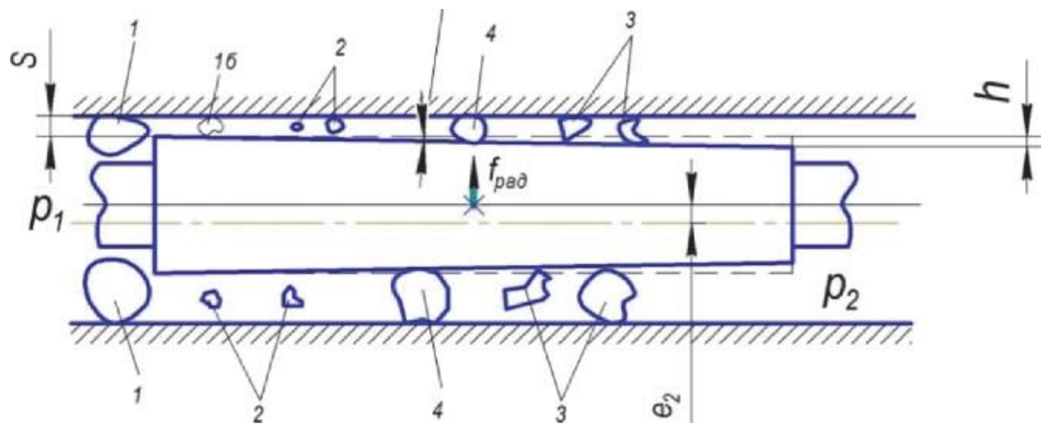



Figure 29 - Second stage of spool pair jamming development

Because of this, an unbalanced radial force arose that shifts the slide valve to the sleeve, thereby increasing the eccentricity between their axes and reducing the gap between them. Due to the sufficiently high surface hardness of the parts of the pair, the process of removing material from the surface has a low intensity, due to which some particles 4, falling into the gap, got stuck between the spool and the sleeve. In the third stage (Figure 30), the number of particles 4 stuck in the gap increased, accordingly, the phenomenon of the gap filling along the entire length of the belt occurred. At the same time, the friction forces in the pair increased and at a certain minimum permissible value of the gap exceeded the force required to move the slide valve, which led to its jamming in the sleeve.

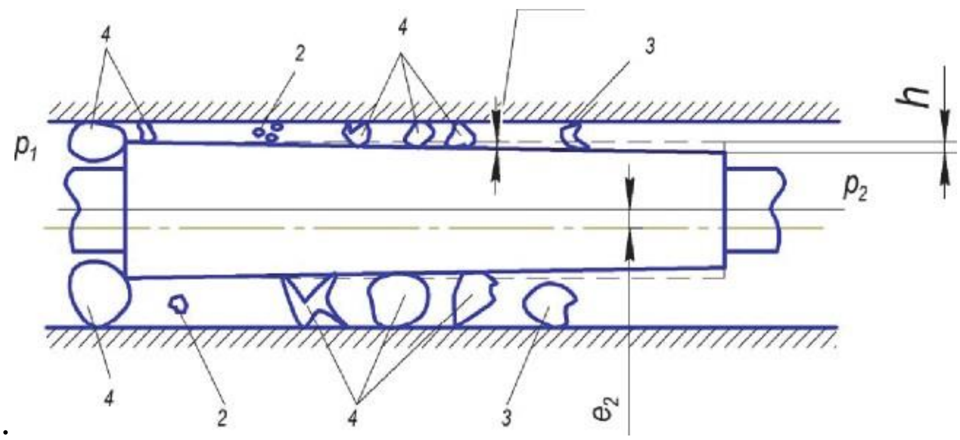



Figure 30 - Third stage of spool pair jamming development

Further, as an example, the minimum allowable clearance for the spool pair of the manual control of the hydraulic drive KAU-30B used in the control channels of the Mi-8 helicopter was calculated. Initial data for calculation are taken on the basis of disassembly of the specified unit during repair at one of aircraft repair plants:

e = 0.000006 m - eccentricity;

h = 0.000017 m - conicity of surfaces of spool-type couple;

s_nom= 0.00001 m - nominal clearance;

l =2 . 0.006m - length of the slide valve belt (in the slide pair of the hydraulic drive, a slide valve with two belts KAU-30B used);

r = 0.005m - spool radius.

The operating pressure in the hydraulic system of the Mi-8 helicopter during its regular operation is maintained in the range of 4.5-6.5 MPa. Based on this, we calculate the value of radial force and friction force in the pair at pressure drop in the pair (pressure drop on the slide valve shoulder) from minimum $\Delta p_{min}$= 4,5 MPa to maximum $\Delta p_{max}$ = 6,5 MPa.

Friction force of $F_{mp}$ which is calculated by a formula will counteract the movement of the valve core: $F_{mp} = f_{рад} \times \mu \times \cos a$ where μ – coefficient of friction, which, taking into account the viscosity and pressure of the liquid, is taken as μ= 0.34, and the angle a is the angle between the surface of the slide valve and the sleeve, formed due to the appearance of the spool cone (its size can be neglected due to extreme smallness). As can be seen from the formula, it depends on the amount of unbalanced radial force $f_{рад}$ - the force pressing the slide valve to the sleeve. Results of friction force variation calculation depending on the clearance in the spool pair using the formula are given in the table and in Figure 4.

Table 7. Results of calculation of friction force change depending on the gap in the pair

| Clearance, micron | Friction force, H | | | | Clearance, micron | Friction force, H | | | |
|---|---|---|---|---|---|---|---|---|---|
| s | $f_{min}$ | $F^{тр}_{min}$ | $f_{min}$ | $F^{тр}_{max}$ | s | $f_{min}$ | $F^{тр}_{min}$ | $f_{min}$ | $F^{тр}_{max}$ |
| 10 | 68,63 | 25,33 | 99,13 | 55,71 | 4,5 | 152,83 | 51,96 | 220,75 | 75,05 |
| 9,5 | 72,86 | 24,77 | 105,24 | 35,78 | 4 | 168,05 | 57,13 | 242,71 | 82,52 |
| 9 | 77,50 | 26,55 | 111,94 | 38,06 | 5,5 | 185,80 | 65,17 | 268,38 | 91,25 |
| 8,5 | 82,61 | 28,09 | 119,52 | 40,57 | 3 | 206,81 | 70,31 | 298,72 | 101,57 |

| Clearance, micron | Friction force, H | | | | Clearance, micron | Friction force, H | | | |
|---|---|---|---|---|---|---|---|---|---|
| 8 | 88,27 | 30,01 | 127,49 | 43,35 | 2,5 | 231,94 | 78,86 | 335,03 | 113,91 |
| 7,5 | 94,S5 | 32,15 | 136,57 | 46,43 | 2,5 | 243,42 | 82,76 | 351,61 | 120,55 |
| 7 | 101,55 | 34,S5 | 146,69 | 49,87 | 2 | 262,48 | 89,24 | 379,14 | 128,91 |
| 6,5 | 109,40 | 57,20 | 158,03 | 53,73 | 1,5 | 300,26 | 102,09 | 433,71 | 147,46 |
| 6 | 118,2S | 40,20 | 170,80 | 58,07 | 1 | 348,07 | 121,54 | 502,77 | 170,94 |
| 5,5 | 128,27 | 45,61 | 185,28 | 62,99 | 0,5 | 410,35 | 159,51 | 592,70 | 201,52 |
| 5 | 139,70 | 47,50 | 201,78 | 68,61 | | | | | |

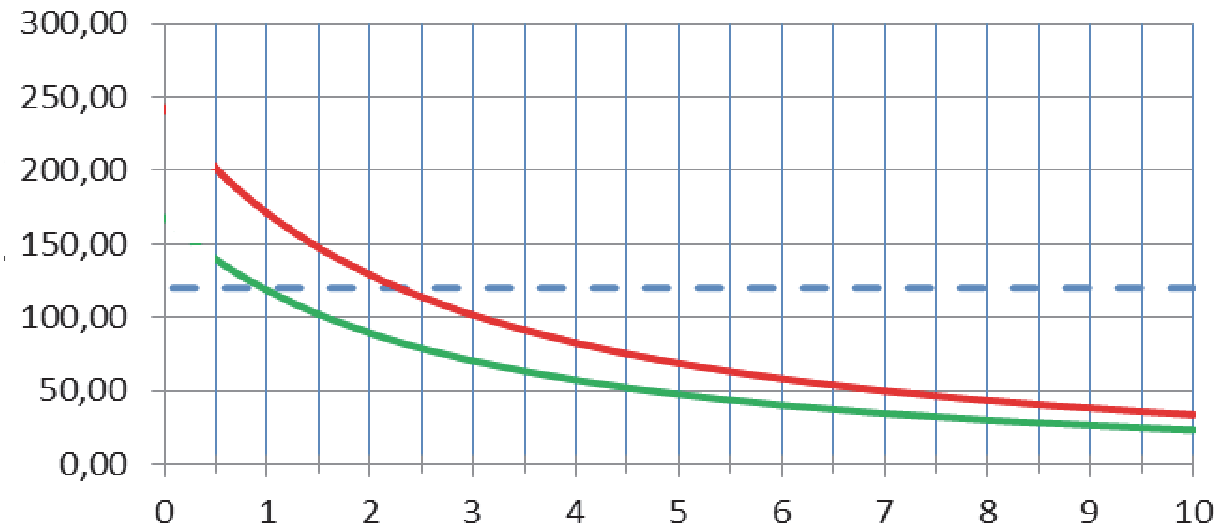



Figure 31 – Graph of friction force value versus gap

Red indicates the friction force in the pair at a pressure of 6.5 MPa; green indicates the friction force in the pair at a pressure of 4.5 MPa; dashed line indicates maximum force for slide valve stray. The dotted line corresponds to the maximum force equal to 120 N (12 kgf), which must be spent by the pilot to stray the slide valve

It can be seen that at the gap value from 2.3 mcm and less at high pressure, as well as at the gap value from 1 mcm and less at low pressure in the pair, the friction force exceeds the straying axial force by value and the spool pair is jammed. Accordingly, the minimum gap in this pair, at which its operability is maintained, should be more than 2.3 μm. Thus, for any spool pair, knowing its geometric parameters, it is possible to calculate minimum permissible clearance at which its operability is maintained. By comparing the actual clearance between the spool and the sleeve with the minimum permissible, it is possible to determine the technical condition of both the spool pair and the hydraulic drive as a whole.

Based on the above, it is possible to introduce a method that allows determining the technical state of the hydraulic drive by evaluating the clearance between the slide valve and the sleeve by measuring the average travel time of the actuating rod. It is advisable to use it at the stage of periodic maintenance and repair tests. A different approach is required to promptly assess the technical condition of the hydraulic actuator.

The idea is that in case of disturbances in the operation of the unit, when WF passes through it, there will be a significant difference between the concentration of contamination particles at its inlet and outlet. Therefore, the control of the purity of the WF in the immediate vicinity of the hydraulic drive will allow to give a conclusion about its current state. To implement this method, a means is needed that performs built-in control of the purity of the WF at two points.

Of the variety of modern devices, the most suitable is the in-line PHOTON-965.2 liquid contamination analyzer, designed to measure the counting concentration of mechanical impurities in liquid flows by size groups in accordance with GOST 17216-2001. FOTON-965.2 provides communication with an external computer and remote control. Figure 5 is a diagram illustrating the process of assessing the technical condition of the hydraulic actuator (spool pair).

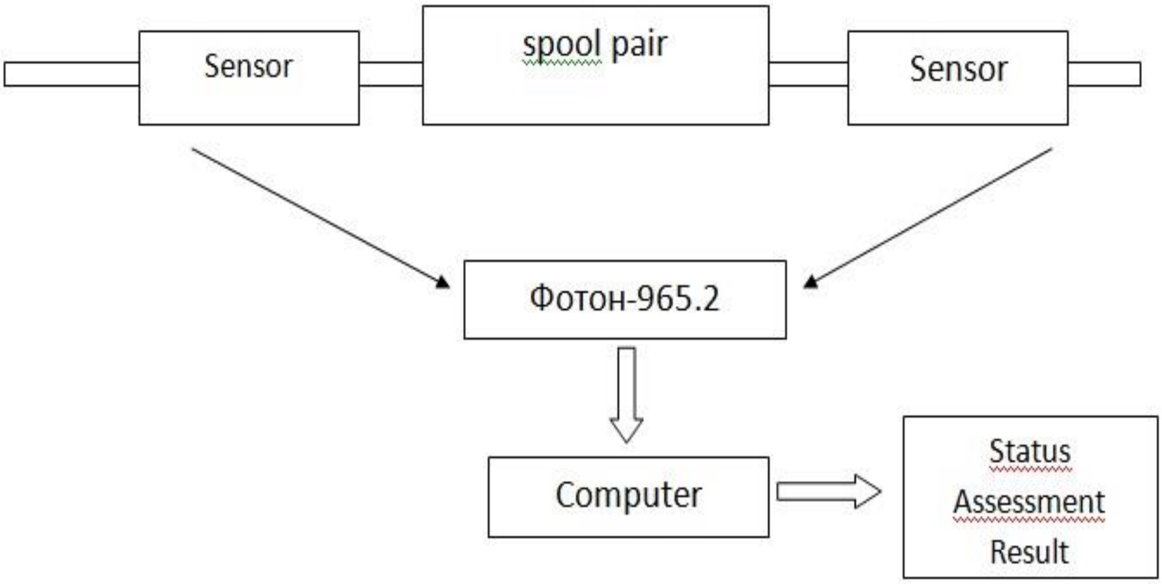



Figure 32 - Hydraulic Drive (Spool Pair) Status Assessment Diagram

Built-in sensors of photoelectric type are well suited to perform built-in control of WF purity, since the disturbance effects created by the aircraft (noise, vibration, electromagnetic radiation) do not affect its accuracy and objectivity. And the photoelectric method itself allows you to detect contamination particles from various materials (including non-magnetic ones) in a wide dimensional range. The sensors are located at the inlet and outlet of the hydraulic drive and record the number of particles, transmitting information to the fouling analyzer PHOTON - 965.2. The device sends data to the computer where the information is processed and converted. Then a decision is made on the technical condition of the hydraulic drive (spool pair).

## Conclusions to Part 3

After talking with representatives of some operators of this technique, I came to the conclusion that some maintenance elements require changes.

I consider the modification of the fuselage itself impractical because its design, with proper maintenance, is quite capable of maintaining sufficient reliability during long-term operation. To improve service, one of the methods of non-destructive testing of bolted joints of the fuselage process joints must be introduced. The most suitable method for this purpose is ultrasonic inspection. In terms of chassis modification, it is necessary to slightly change the maintenance schedule and replace the obsolete working fluid in ammortization racks. These actions will improve the effectiveness of ammortisers and protect the health of personnel.

As for improving the control and control systems for the cleanliness of hydraulic fluid, these methods of improving the above parts and systems will increase the reliability of the booster control system, which accordingly will allow the crew not to lose control over the equipment even in case of an emergency.

The improvement of the pneumatic system consists in changing the position of the Ak-50 compressor. In its current form, it performs work throughout the flight - from the moment the engines are promoted to the moment the main rotor stops, which inevitably affects the resource of this unit. Its overhaul resource is 750 hours. To reduce the expiration rate of this time, it is necessary to change the position of the compressor, namely: remove it from the main reduction gear box and install number 10 on the wall of the frame, and use a three-phase electric motor at 36/208 volts with a power of 2.3 horsepower to drive.

# Part 4 LABOUR PRECAUTIONS

## 4.1 Hazardous and harmful factors during aircraft operation and maintenance

At present, the problem of occupational safety and protection in enterprises is becoming more acute. The purpose of this work is to help protect employees from hazardous and harmful industrial factors, to eliminate accidents, including accidents and diseases at work. Since the air transport mechanic operates in an unfavorable environment, there are many factors. By the nature of the action, current and harmful production factors, according to the Державні санітарні норми та правила від 30.05.2014. divided into the following groups:

1) physical;

2) chemical;

3) biological;

4) psychophysiological.

Since the most common group is physical, the following reasoning and theories will concern only its units.

Physical factors of production are divided into the following:

1) moving machines and mechanisms; moving parts of production equipment; moving products, forms, materials; collapsing structures; decaying rocks;

2) increased content of dust and gases in the air of the working zone;

3) increase or decrease of temperature of instruments, materials;

4) increased noise level at the workplace;

5) increased voltage in the electrical circuit, the closure of which can occur through the human body;

6) increased level of static electricity;

And current power is more dependent on meteorological conditions and production conditions.

## 4.2 Technical and organizational measures for decreasing of dangerous and harmful factors influence level

The first problem is working with machines and moving parts. In this regard, employers must do everything possible to prevent access to dangerous moving parts of cars in order to protect the safety and well-being of employees. According to НПАОП 0.00-1.71-13

When working next to or on them the following set of rules and behaviors must be created:

1) Immediately report problems with machine protection to your manager.
2) Do not use unauthorized or damaged protection.
3) Don’t remove or try to damage the machine's protective devices.
4) Do not create new hazards, such as getting objects into moving parts or creating a new clamp/fastener point.
5) Never leave cars unattended when parts move. Remember that parts can still move after the machine has been turned off. Remove protection only when the machine is locked and marked.
6) If possible, lubricate the machine parts without removing the protection; otherwise, turn off the machine and lock it before lubrication.
7) Use the equipment only when the protection is in place and properly configured.
8) 10) Make sure that all safety measures are checked including: fences, insulators, locking mechanisms, emergency switches, etc.
9) Do not wear loose clothes, jewelry or long hair around cars - this increases the risk of getting into the car.
10) Make sure that the machine used corresponds to the task and is well maintained.
11) Train the personnel enough to be able to use the machines correctly according to the manufacturer's instructions.

12) Wear appropriate personal protective equipment before operating the machine, i.e. safety glasses, gloves, protective boots.

**Dust**. Dust can arrive practically from any source, including production and working materials; the paints and varnishes used on walls and furniture. Dust in air can cause or aggravate problems of the upper airways. It can also cause serious short-term or long-term diseases, such as skin rashes, autoimmune problems and cancer if dust contains heavy metals, chemicals or a mold.

Follow security guidelines on labels for any emitting dust materials with which you work.

1) Carry protective equipment if it is necessary in your working situation. For example, if you work in construction or with materials which produce dust, you wear goggles or glasses with side boards or the enveloping frames for protection of eyes. Put on a pylefiltratsionny mask to protect bosoms, a mouth and lungs.
2) Store the materials emitting dust in tight containers in storerooms and cases, but not in working areas with racks.
3) Remove dust by means of a vacuum, brooms, damp and dry vacuum cleaners or hoses. Carefully wipe hands, nails and a face before work and before leaving home to secure themselves against hit or inhalation of dust.

**Difference between temperatures** in maintenance timecouncils:

1) means of protection, including personal protection equipment of eyes, faces, the head and extremities, protective clothes, respiratory devices, protective boards and barriers have to be provided.
2) All pipes for steam and hot water within 7 feet from a floor or the working platform or within 15 inches measured horizontally from ladders, ramps or motionless ladders have to be covered with insulating material or are protected so that to prevent contact with them

3) Avoid overpopulation on working sites. Don't fill capacity to the brim to avoid a perekipaniye. Never leave hot surfaces or lubricant unguarded.

**Noise.** The noise, the bigger damage is louder it can cause and in certain cases can lead to continuous loss of hearing. Production noise standards are defined in ДСН 3.3.6.037-99

Further steps and councils for work in such conditions:

1) Decrease in noise level directly reduces risk of loss of hearing for your employees. It is necessary to consider the possibility of use of the alternative equipment or the safe systems of work.

2) Ear protection in the noisy environment usually has to be considered only like a temporary measure. It is necessary to work on decrease in noise level of influence up to one level lower than values. Protection has to be used as a last resort when the risk after taking measures to decrease in noise level remains.

3) To carry out inspections of hearing for the new employees working at noisy workplaces. It will allow to collect information on a condition of the basic line of health and hearing. It will help to reveal potential risk of loss of hearing throughout all labor life of employees.

**Electricity.** It is one of the most significant rules. Knowing several simple councils, you can save someone's life.

1) Always avoid water during the work with electricity. Never touch and don't try to repair any electric equipment or electrical circuits wet hands.
2) Always use the corresponding isolated rubber gloves and points in operating time with any electrical circuit.
3) Never try to remount the equipment which is energized. Always check that it is cut off power, by means of a tester.
4) Never use the equipment with worn-out cords, the damaged isolation or sockets.
5) If you work on any socket in your house, then always disconnect network.

6) In operating time always use the isolated tools.

7) Never use an aluminum or steel ladder if you work with any intake at height.

Moreover, electricity is the component necessary for implementation of requirements during the work on the aircraft. Therefore let's calculate quantity of grounding rods for protection against static electricity.

Standards of the standard 7237:2011 System of Standards of Safety. Electric safety. General requirements and nomenclature of types of protection.

Define quantity of grounding rods and length of the grounding chain grid at the onboard stand for protection against static electricity.

Normalized circuit resistance - RH ≤ 100 Ом

Separate grounder is the steel rod of diameter $d := 38$ mm,

length $l := 2.5 \cdot 10^3$ mm,

location depth $H := 2.5 \cdot 10^3$ mm,

soil – humus with specific resistance $\rho := 2 \cdot 10^5$ Ohm·mm.

Distance between rods $a := 2.5 \cdot 10^3$ mm (ratio a/l = 1).

All rods are connected by steel band with section $b := 40$ $c := 4$ mm by means of welding.

Table 8 – Classification of material resistance

| Soil | Specific resistance $\rho \cdot 10^2$ Ohm·m | Soil | Specific resistance $\rho \cdot 10^2$ Ohm·m |
|---|---|---|---|
| soil | 7 (4 – 10) | clay | 0.4 (0.08 – 0.7) |
| clay sand | 3 (1.5 – 4) | peat | 0.2 (0.05 – 0.3) |
| humus | 2 (0.096 – 5.3) | river water | 0.5 (0.1 – 0.8) |
| loamy soil | 1 (0.4 – 1.5) | sea water | 0.01 (0.002 – 0.01) |

In Table 8 the specific resistance values are given fore soil humidity 10–20%. Values in parenthesis shows variation limits depending on humidity.

The resistance of separate steel rod grounder can be defined by the formula:

$$Rrod := 0.366 \cdot \frac{\rho}{l} \cdot \left( \log\left(\frac{2 \cdot l}{d}\right) + \frac{1}{2} \cdot \log\left(\frac{4 \cdot H + l}{4 \cdot H - l}\right) \right)$$

$Rrod = 65.298$ Ohm

Assume the number of grounding rods $n := 3$. The length of connecting band will be:

$$l_1 := n \cdot a$$

$$l_1 = 7.5 \times 10^3 \quad \text{(mm)}$$

Band location depth $Hband := 1.25 \cdot 10^3$ mm

Table 9 – Coefficients of connecting band

| Number of rods (angles) in a circuit | ηrod ηangle | ηband |
|---|---|---|
| For a/l = 1 | | |
| 3 | 0.75 | 0.50 |
| 4 | 0.65 | 0.45 |
| 6 | 0.60 | 0.40 |
| 10 | 0.55 | 0.35 |
| 20 | 0.50 | 0.25 |
| 40 | 0.40 | 0.20 |

The resistance of circuit ground grid will be:

$$Rfull := \frac{Rrod \cdot Rband}{Rrod \cdot \eta band + n \cdot Rband \cdot \eta rod}$$

$Rfull = 20.105$ Ohm

The resistance of current spreading in the soil from steel band:

$$Rband := 0.366 \cdot \frac{\rho}{l_1} \cdot \log\left[\frac{2 \cdot (l_1)^2}{b \cdot Hband}\right]$$

$$Rband = 32.717 \quad \text{Ohm}$$

Coefficients $\eta rod := 0.75$ $\eta band := 0.5$ chosen from Tab 0.2

Single rod (ηrod) or angle (ηangle) grounder.

And connecting band (ηband) utilization coefficients.

Obtained value of circuit ground grid resistance is less than standardized ($R_H \leq 100$ Ohm), so we can accept number of grounding rods equal to 3 and length of connecting band 7.5 m.

### 4.2 Explosion and fire safety at aircraft maintenance working area

Fire-fighting safety and explosion safety shall be ensured in accordance with the Code of Civil Protection of Ukraine against 02.10.12. When designing the aircraft, non-combustible and hard burning materials were selected. The fire hazard of substances and materials is described in DSTU 8829:2019.

Organizational and technical measures shall include:

1) organization of the fire service (in the appropriate order) of the appropriate type (professional, volunteer, etc.), forces and equipment.

2) Certification of substances, materials, products, processes and objects in the field of fire safety.

3) Public participation in the fire safety station.

4) Training of workers, employees, students and police of fire safety of the population.

5) Development and implementation of fire safety standards and rules, instructions on substances and materials of fire hazard, observance of fire regime and actions of people in case of fire.

6) Development of measures for the actions of the administration, workers, employees and the population in case of fire and evacuation of people.

7) Manufacture and use of mixing means to ensure fire safety.

8) In general, fire and explosion safety requirements consist of requirements for fire protection systems as well as explosion protection.

Dangerous and harmful factors arising as a result of the explosion on people, prevention, preservation of material property is achieved by:

1) establishing the minimum required quantities of explosives used in the production process;
2) arrangement of hazardous areas or production using banks and bunkers or their placement in protective booths;
3) use of equipment designed for explosion pressure;
4) using emergency pressure relief units (safety membranes and valves);
5) use of high-efficiency shut-off and check valves;
6) use of active explosion suppression systems.

Organizational and technical measures related to explosion prevention contain:

1) development of a system of visual aids and training materials, regulations and norms for carrying out technological processes, rules of behavior of explosive substances and materials;
2) organization of research, instruction and admission of personnel engaged in explosive production processes;
3) monitoring and supervision of compliance with the following norms of the technological regime and accident prevention rules.

### 4.3 Labor protection requirements during work

According to НПАОП 0.00-1.71-13.

When working on an aircraft, the employee must:

1. All necessary circuits must be isolated during maintenance. Obtain permission before supplying power to the aircraft.

2. Make sure that the circuit breakers associated with the weather radar (if installed) are open, safe and marked.
3. Do not touch stroboscopes for at least 5 minutes after operation. The stroboscope will be hot.
4. Although the system or component is powered off, there is danger due to capacitor discharge voltages. Do not work with components or circuits without satisfactory grounding.
5. Workpieces, clamps and accessories shall be securely and securely fixed on the table or foundation slab
6. Make sure that there is no equipment above or below the aircraft, which can cause damage.
7. Make sure that the operating platform is correctly grounded during operations on the aircraft.
8. Install appropriate warning signs to prevent harm to other persons.
9. Make sure that the appropriate flight control and safety locks of the landing device are in the correct position.
10. Before approaching the landing tyre, allow the wheels and wheels to cool.
11. Put "Do not smoke" warning signs around the security zone.
12. Make sure that the supply of clean air to the work area is sufficient for safe operation
13. In case of jamming of tool, breakage of drill rod, container or other tool, turn off the machine;
14. Before stopping the work, be sure to remove the tool from the workpiece.

Before performing the maintenance procedure, the aircraft must be in the following configuration:

1) aircraft on the ground, rests on the landing gear.

2) Engine is OFF.

3) flaps are removed and locks are locked.

4) Doors of passenger and flight compartments are closed.

6) Parking brake applied.

7) The aircraft power system is de-energized.

8) All controls are in normal, automatic or off position.

The employee shall not:

a) use cartridges and devices with protruding locking screws and bolts;

b) hold and correct the drilled part with hands;

c) drill thin plates, strips, etc. without fixing them in special devices;

d) attach the part, accessory or tool to the machine;

e) slow down the spindle rotation manually;

f) use local lighting with voltage above 42 V;

g) tighten nuts, bolts and other connecting parts during machine operation;

h) cool the instrument with rags and ends;

i) use the bed to lay any objects and tools. Machining the part on the machine table;

j) take and supply through the machine any items during the operation of the machine;

k) use gaskets between the sponges of the wrench and the edges of the nuts;

l) use a tool with worn out conical shanks;

m) work on the machine in mittens or gloves, as well as bandaged fingers without rubber fingertips;

n) installing the part on the machine with the crane to be between the part and the machine;

o) operate on the machine during its operation, and let others do it;

p) tilt the head close to the spindle and cutting tool;

q) leave keys, accessories and other tools on the workcell.

## 4.4 Safety requirements during working at height

As you know, the height of Mi-8 is 5.34 meters, so working at height is a common procedure. Working at height means that a person works in a place that requires the necessary precautions to prevent his fall, which leads to serious injuries. High-altitude injuries are one of the most striking causes of serious work-related injuries and fatalities. Falling down stairs, scaffolding and climbing debris can lead to serious injuries, even when the height is perceived as not dangerous. Employers should provide all necessary measures to reduce the risk of their employees falling from a height, using proactive hazard recognition to continuously assess the site.

Therefore, the following requirements must be met:

1) do as much work as possible while you are on earth.
2) Ensure that employees can safely move to and from the area where they work at altitude.
3) Make sure that the equipment you use for your work is reliable, stable and suitable enough to perform the work. Check and maintain it regularly.
4) Be careful when you work near a brittle surface.
5) prepare for emergency evacuation and rescue.
6) Always wear a proven safety belt and non-slippery boots.

**Conclusion to part 4**

Based on the analysis of all hazardous aspects and processes, this part was carried out during the maintenance of the helicopter. It is very important that maintenance personnel follow all safety steps that contribute to a new high level of safety during maintenance.

The whole process of qualification work was carried out strictly in accordance with all labor precautions, warnings and rules.

# Part 5 ENVIRONMENTAL PROTECTION

## General introduction

Airports with their means and services are one of the main parts of the infrastructure necessary for the regular operation of aircraft. Airports make a significant contribution to the local economy and employment. However, along with the socio-economic benefits they bring, the environmental costs and consequences appear to be integral to the operation of airports.

As the demand for passenger and cargo travel grows, the flight industry is expected to move forward, leading to increased incentives and drivers for the construction of new airports or the expansion of existing airports, which will increase the importance and complexity of environmental and sustainable development challenges. Some of the key challenges to environmental protection and sustainable development associated with airports affect emissions, noise, land use at airports and energy consumption. The challenge facing not only airport authorities, but also all those involved in aviation in general, is to find a balanced approach to maximizing the capacity of airports and the opportunities and potentials for future growth, on the one hand, and minimizing the attendant negative consequences, on the other.

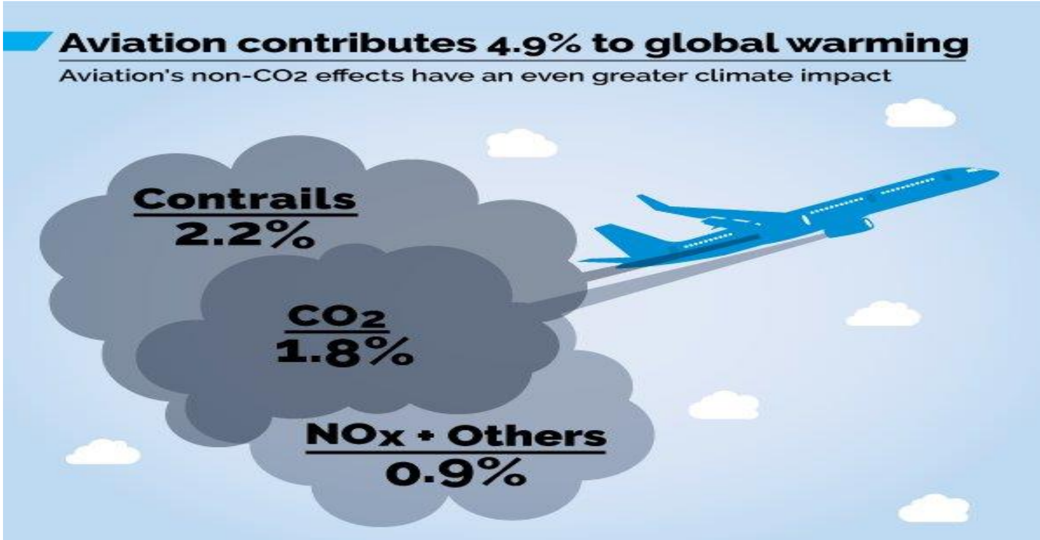



Figure 33 – Aircraft emission impact

Anthropogenic adverse effects on the Earth's climate are one of the most important environmental problems faced by the aviation industry. Emissions from aircraft at both ground and altitude can cause numerous adverse effects on air quality, climate and the ozone layer. Gases and particles emitted by aircraft engines can cause harmful effects at various stages of technical service.

At the ground level, where airports are involved, one of the negative results of aircraft emissions is the deterioration of air quality, which can directly affect human health and environmental pollution.

According to environmental reports and estimates, emissions of particulate matter, NOx, HC, SOx and CO from aircraft engines can affect air quality, health and well-being. Aviation-related emissions at the ground level and in the vicinity of airports are not limited to aircraft emissions; Ground support equipment is presented by other participants. This means that air pollution from airport surface services as well as airport surface access systems should be considered part of the environmental burden of airports.

All airports, regardless of scale or location, are regulated to some extent by local, state, tribal or federal environmental requirements. Many environmental regulations applicable to noise, water and air quality have been working for years - airport heads are accustomed to their compliance requirements. but the anticipated progress in the volume of air travel has increased the importance and complexity of certain environmental management issues. In addition, several new requirements are expected to lead to potentially significant changes in airport operations (in terms of procedural changes and potential infrastructure investments).

## 5.1 Overview of Airport Environmental Issues

Maintenance is projected to increase significantly over the next 15 years. As a result, airport development and expansion plans are likely to become increasingly important. A potential challenge to the completion of these projects is public concern about the environmental impact on airports. The operation of airports includes a number of activities affecting the environment, including:

1) aircraft operation.

2) Operation of airport and passenger vehicles, airport ground maintenance equipment

3) cleaning and maintenance of aircraft, ground maintenance equipments and vehicles.

4) anti-icing and anti-icing aircraft and airfields.

5) Fuelling and storage of fuel on aircraft and vehicles.

6) Operation and maintenance of airport facilities.

The environmental impact of these activities may increase as the airport expands. In some cases, before a country or local agency allows the airport to move forward with the expansion project, airport management must agree to some plans to mitigate the impact on the environment. Community concern about environmental impacts has led to delays or cancellations of projects.

So, for all this end it is necessary to assume that the main problems are emissions, waste of water after work, waste of fuel, lubricant and different liquids after work, diverse utilization (parts of components, components, small garbage). Let's talk about them.

### 5.1.1 Emissions after maintenance

The key sources of noise and atmospheric emissions during flights are aircraft engines with hard maintenance, periodic maintenance and taxiing, as well as auxiliary power plants (APU) during ground operation of aircraft and launch of their engines. The total amount of emissions of CO2 by aircraft is about 2% of the global volume of emissions of greenhouse gases It is expected that the number of emissions of CO2 by aircraft will grow approximately for 3-4% a year. Other sources of atmospheric emissions include the discharge of unused aviation fuel in emergency situations. Aircraft emit gases and particles that change the atmospheric concentration of greenhouse gases, increase the formation of condensation lines and can exacerbate cirrus clouds, which contributes to climate change. Moreover, it is estimated that aircraft account for about 3.5 per cent of the total radiation exposure (climate change rate) to all human activities, and this percentage, which excludes the effects of likely changes in cirrus clouds, is projected to increase.

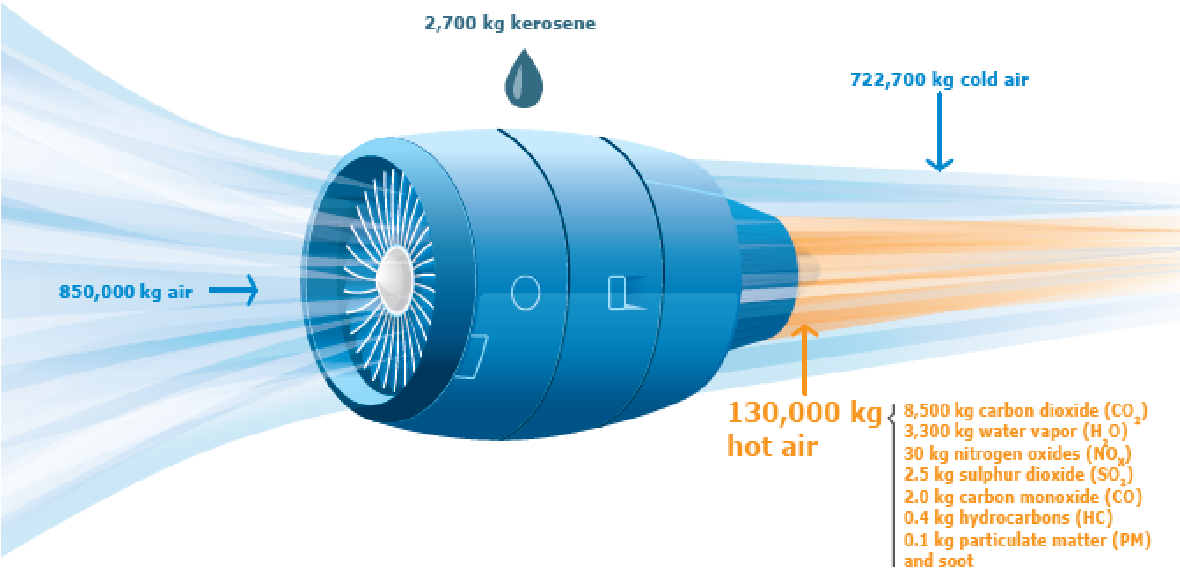



Figure 34 – Emissions of nowadays engine of passenger aircraft

In addition, during APU maintenance, engines are manufactured in accordance with manufacturers' procedures, which means that at least 2 people must be at the specified distance, which is detrimental to their health.

Figure 5. 2 shows the amount of fresh air used compared to the amount of exhaust. It should be borne in mind that this is a modern engine from medium-range aircraft. Just imagine how these numbers increase by 5 times for large aircraft. This highlights the passive effects of pollution.

### 5.1.2 Waste water emission

Hazardous substances can be released into the water from production shops, metalworking shops, as well as from aircraft flushing and technical flushing. toxic metals, petroleum products (e.g. oil, white alcohol and fuel), complexing agents and surfactants, heavy metals (e.g. compounds of cyanides and hexavalent chromium) and organic solvents may be among the main types of contaminants. Cadmium may also be present because it is still often used for surface treatment of selected aircraft parts (e.g. chassis, wings).

One of the most dangerous is cleaning the plane. Aircraft cleaning and other degreasing operations are typically performed prior to performing a variety of activities, such as surface preparation or coating or supplies for cleaning equipment or parts. This cleaning operation can lead to the origin of a wide range of air pollution as well as waste, which must be minimized and properly treated. When selecting a cleaning process, attention should be paid to the extent to which the most hazardous chemicals can be eliminated, for example:

- aromatic hydrocarbons (xylene).
- Methyl ethyl ketone (MEK).
- individual chlorinated solvents (such as chloroethylene, methylene chloride).

### 5.1.3 Combustible lubricants emission

Hazardous or likely hazardous wastes generated during major repairs and routine repairs of aircraft may include waste oil, oil emulsions and unused fuel; organic solvents and glycols; sludge containing metal hydroxides; lead batteries; nickel-cadmium and nickel-metal hydride batteries; surface treatment solutions used (after degreasing, etching, passivation, electrolyte coating and chemical coating) containing cyanides, hexavalent chromium and cadmium; a solid and semi-solid cyanide precipitate; residues of paint and water from nozzles; and mercury fluorescent lamps and fluorescent lamps. During maintenance, fuel and oil refilling and reflux are performed. This means that a lot of particles can be poured out, which greatly affect the environment. Let's discuss the painting as an example of pollution. Coating processes can release a wide range of hazardous pollutants due to the solvents used and the variety of specific chemicals. They result in the generation of wastes which must be properly disposed of by suitable acceptable means.

In general, the total amount of waste generated, including paint left in containers, paint no longer in use, surplus, fabric, etc., can be significantly reduced by the use of more environmentally friendly alternatives as well as related practices.

Figure 35– An example of stripping process

Until now, cleaning often required the use of highly aggressive and toxic chemicals, such as, for example, methylene chloride and phenol. Chromium is also removed through residues and waste. The application and removal of paint leads to the formation of hazardous wastes consisting of various residues, materials, solid sludge of paint, as well as to the masking of the tapes with residual paint, rags, paper towels, which must be eliminated through a controlled permitted circuit.

### 5.2 Recommended measures

The implementation of these requirements is a prerequisite for the normal operation of airlines, certification and licensing of airports, air carriers and other air transport facilities subject to mandatory certification, inventory of emissions and their sources. Measures for starting of engines and power units. The results of the calculations should include calculation tables with data at node points on the ground and contours of equal concentrations in two-dimensional space and clearly show air pollution in residential and other protected areas.

1) provide forms of maintenance in which motor and APU races are performed.
2) Calculate the periodicity of execution of maintenance forms and their number during the reporting calendar period.
3) Provide a place for the execution of motor races relative to the production and technical terrain of the base and the nearest settlements or other protected territories.
4) Use block diagram of devices reflecting exhaust gases.
5) Calculate statistics on the recurrence of synoptic conditions (wind direction and speed, temperatures, pressure and relative humidity) during the year and months.

**Water waste measures:**

a) separating highly toxic waste streams, preferably containing cyanide, hexavalent chromium, cadmium and other toxic metals.
b) Accounting of the amount of waste water discharged.
c) Maintenance of information on discharged materials.
d) introduction of wastewater treatment technologies.
e) Separated or shared wastewater shall be treated in advance prior to discharge into local sewage systems, including using coagulation, flocculation, sedimentation and other suitable industrial wastewater treatment techniques.

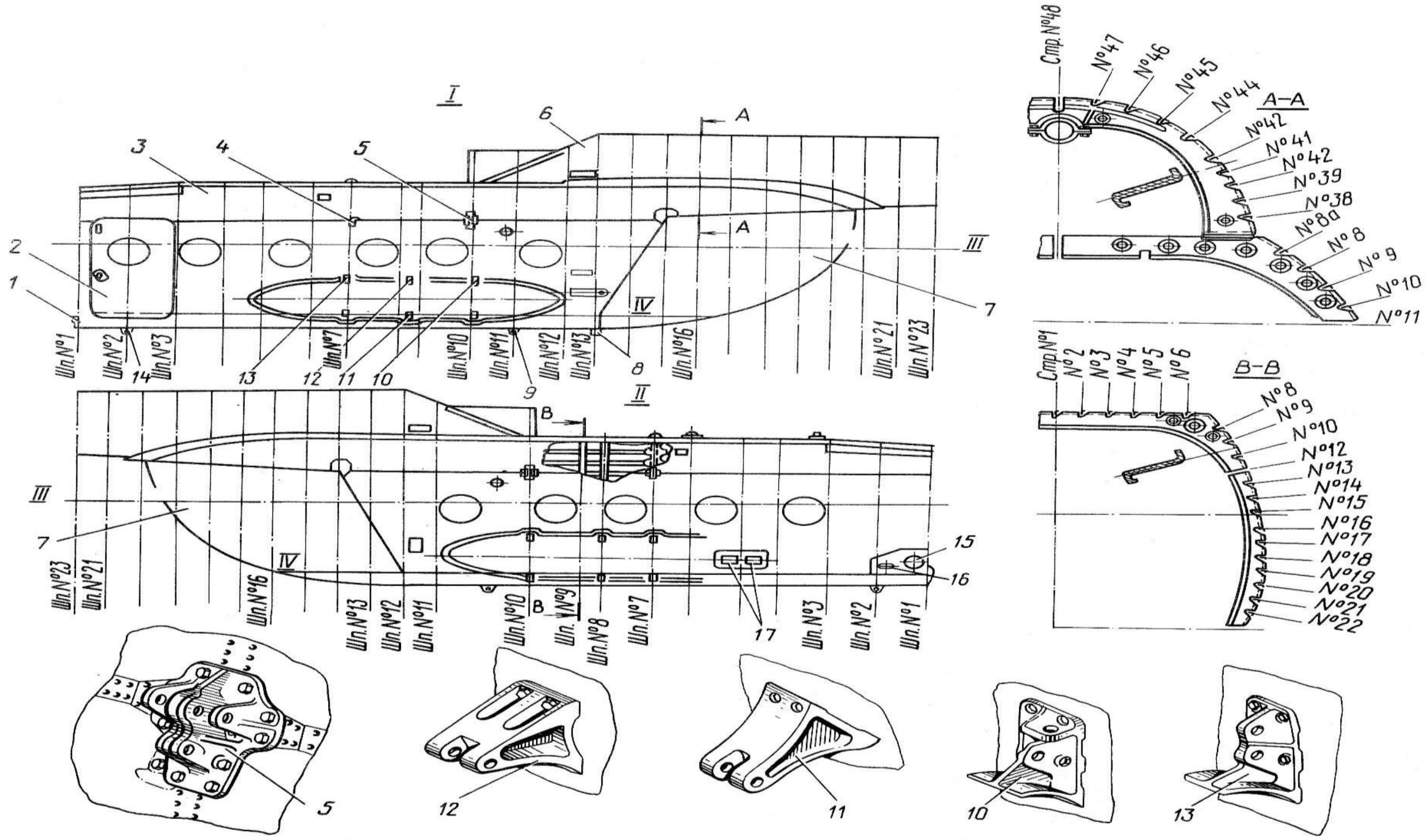
**Measures for the release of petrol and lubricants:**

1) identify all consumables used and related hazards.
2) Select consumables to be recommended for maintenance due to environmental and health/safety hazards.
3) When required, conduct appropriate user training.
4) Identification of materials required to control spills, leaks, emissions, etc.
5) application of new environmentally friendly materials.

## Conclusion to part 5

In conclusion, we identified key problems of pollution, emissions during maintenance. And we can say that today many procedures and rules are violated, which leads to non-convertible damage to the environment. Therefore, the environment should be monitored for harmful production factors specific to the project. In the process of control, authorized experts should be invented and implemented as part of the program to monitor compliance with labor protection and safety standards. Enterprises are also obliged to keep records of industrial injuries and occupational diseases, as well as dangerous incidents and accidents.

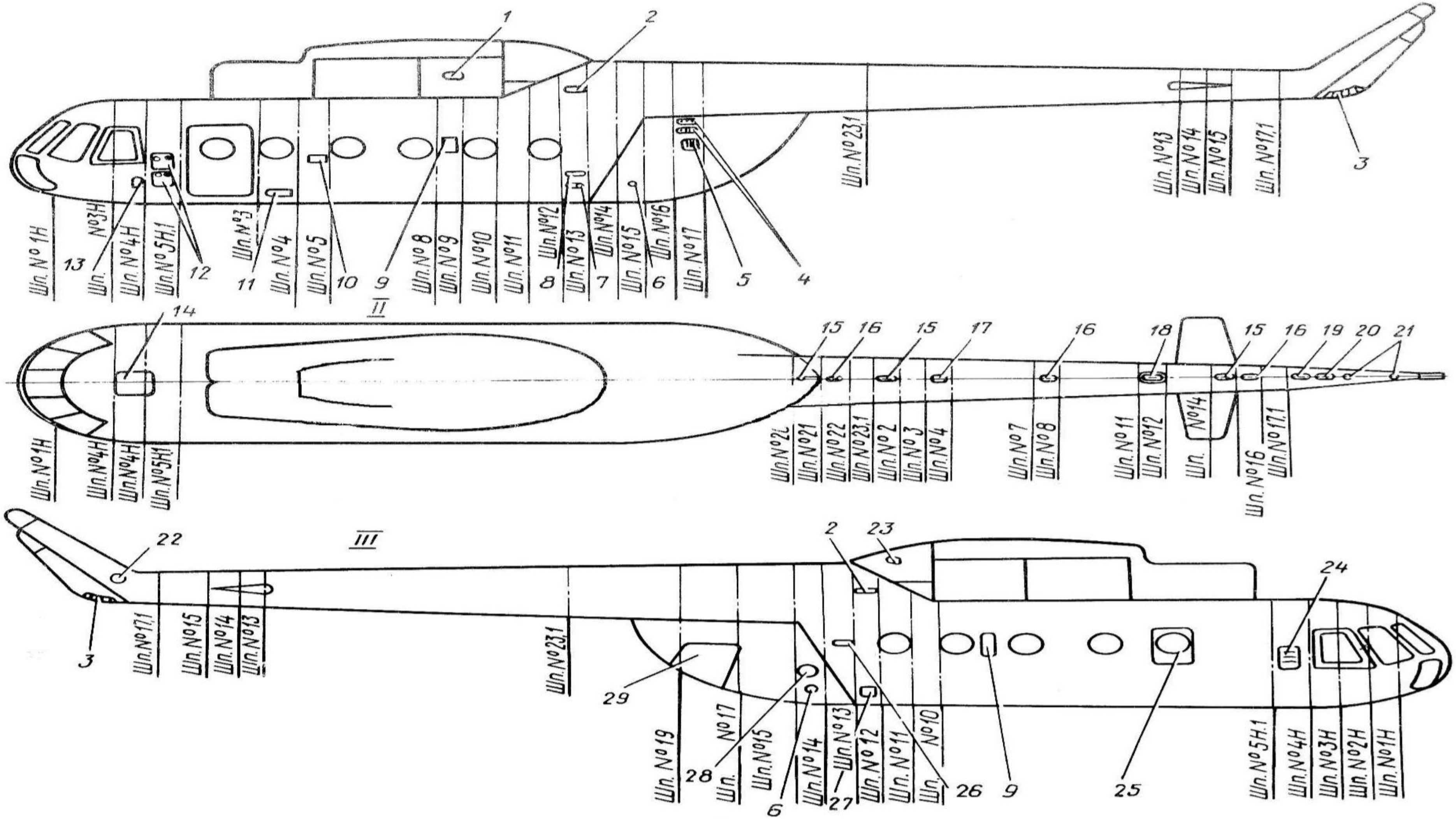
## Attachment A




1. Attachment unit of LG front leg shock absorber; 2. Sliding door; 3. Onboard panel;

4. Special installation truss attachment unit; 5. LG main leg shock absorber attachment unit; 6. Superstructure; 7. Cargo flaps; 8. Attachment unit of MLG brace; 9. Attachment unit of MLG axle; 10. Upper rear attachment unit of suspended fuel tank; 11. Lower middle attachment unit of suspended fuel tank; 12. Upper middle attachment unit of suspended fuel tank; 13. Upper front attachment unit of suspended fuel tank; 14. Attachment unit of LG front leg brace; 15. Hole for air intake pipe from cargo cabin; 16. Holes for warm air supply to the crew cabin; 17. A hole for supplying warm air from the KO-50.

**Attachment B**




1. Panels for connection of hose at heating of reduction gear box; 2. Panels: right - for installation of fuel system pipelines, left - for hydraulic;

3. Hatch for air outlet cooling the intermediate reducer; 4. Hatches for rocket launchers; 5. Manhole with ventilation gills; 6. Hatches for exhaust gas removal of vehicles; 7. Panel panel of hydraulic system; 8. Aircraft panel hatch of air system; 9. Hatch for filler neck of additional fuel tank; 10. Panel for fuel drain valve from drain tank; 11. Panel for fuel drain valve from additional fuel tank 12. Panels for accumulators; 13. Panel for connection of ground power supply sources; 14. Access hatch to engines;
15. Panel for inspection and lubrication of splined joint of tail shaft; 16. Cut-out for line fire; 17. Cut-out for flashing beacon;
18. Cut-out for heading system sensor; 19. Manhole with gills for air intake for intermediate reduction gear box cooling, for inspection and lubrication of splined joints; 20. Hatch with gills for air intake for intermediate reduction gear box cooling, for oil filling into intermediate reduction gear box; 21. Panels for end shaft inspection; 22. Panel for oil level check in intermediate reduction gear box; 23. Hatch for filling neck of service fuel tank; 24. Manhole with gills for cooling rectifiers; 25. Emergency panel-window; 26. Manhole under the socket; 27. Panel for fuel drain valve from service tank; 28. Hatch for connection of air conditioner hose; 29. Emergency hatch in RH cargo flap.

## GENERAL CONCLUSIONS

The helicopter is widely used in the post-Soviet space. This machine was originally made for the military, which means that it has a significant reserve of survivability and some reserves for reserving critical systems. However, there are no fail-safe systems. After talking with representatives of some operators of this technique, I came to the conclusion that some maintenance elements require changes. These elements, namely landing gear, main parts of the fuselage, components of the pneumatic system are described in 2 part.

I consider it inappropriate to modify the fuselage itself, since its design, with proper maintenance, is quite capable of maintaining sufficient reliability during long-term operation. To improve service, one of the methods of nondestructive testing of bolted connections of the fuselage process joints must be implemented. The most suitable method for this purpose is ultrasonic inspection, since there is limited space and the need to use portable equipment, which can rarely be used in other non-destructive testing methods. method of monitoring the bolted connections will prevent fatigue failures of the structure, which can lead to the loss of the machine and, accordingly, death.

From the point of view of chassis modification, it is necessary to slightly change the schedule of maintenance of the immortization struts liquid from 4 to 2 years in case of absence of comments from the crew and replace the obsolete working fluid AMG-10 in the amphortization struts as there are more frequent cases of forgeries of this liquid and due to its toxicity. These actions will increase the effectiveness of amphortisers and protect the health of personnel.

As for improving the control and control systems for the cleanliness of hydraulic fluid, these methods of improving the above parts and systems will increase the reliability of the booster control system, which accordingly will allow the crew not to lose control over the equipment even in case of an emergency.

The improvement of the pneumatic system consists in changing the position of the Ak-50 compressor. In its current form, it performs work throughout the flight - from the moment the engines are promoted to the moment the main rotor stops, which inevitably affect the resource of this unit. Its overhaul resource is 750 hours. To reduce the expiration rate of this time, it is necessary to change the position of the compressor, namely: remove it from the main reduction gear box and install number 10 on the wall of the frame, and use a three-phase electric motor at 36/208 volts with a power of 2.3 horsepower to drive.

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