DESIGN AND CALCULATION OF HYDRAULIC POWER SMALL PASSENGER AICRAFT TO TAKE-OFF WEIGHT 2000 kg

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Aircraft hydraulic power system is used to control the movement of aircraft on the ground but in the air. Hydraulic system of the each aircraft consists of one or two main lines of constant pressure which are connected to individual work areas. Task provides a comprehensive insight into the design and functionality of the principle of individual work streams. Work is an introduction clarify the issue of hydraulic systems, describe the basic concepts, cutting hydraulic systems and their advantages and disadvantages. The core of this work is the proposal itself and a description of the circuit constant pressure, work streams chassis control, flaps and wipers glasses.

Keywords: main circuit, control circuit work program, working circuit chassis wiper circuit.

1 INTRODUCTION

Working hydraulic circuits with pressure circuit to include a hydraulic system airframe, which serve to control the moving airframe structural components.
The work discusses the working hydraulic circuits and the various elements that are part of a system which energy is transmitted through hydraulic fluid. These elements have a broad representation of the current aircraft.
Diploma thesis in the introduction includes a description of the operation of hydraulic power systems used in today's airplanes, their advantages and disadvantages.
Increasing the weight of a hydraulic system has a negative effect on the flight characteristics of the airplane and operating costs. For this reason, should be designed so that the entire system as light as possible.
The core work is original proposal circuit constant pressure, which is the source of energy for individual work areas. The source of line pressure constant pressure is electric driven gear pump that pushes the hydraulic fluid through the filter return valves solenoid valve to the individual work streams.
Then work is proposing a control circuit Extension and retraction, flaps, and the proposal itself radius wiper glasses.
The conclusion summarizes the design and approximate calculation of the elements that are part of a hydraulic system. A description of the schemes of work streams.

2 HYDRAULIC POWER SYSTEM

Generally each aircraft hydraulic system consists of one, rarely two of several major (pressure, energy) lines that are connected to individual work areas. It is the HSS high pressures, while the operating pressure reaches values of 10 MPa (L-29), 15 MPa (L-39, L-410), 35 MPa (some commercial aircraft).

Hydraulic power system is designed to:

- Control of moving airframe structural components.
- Control of the aircraft control surfaces (called servo system) such as elevators, stabilizers, ailerons, spoilers, rudder.

2.1 Requirements for hydraulic systems, advantages and disadvantages

Requirements for hydraulic system: [1]

- Reliability in all flight regimes.
- Tightness.
- Sufficient supply of energy.
- Passed conditions for operation and maintenance.
- Easy filling, discharge, venting fluids.
- High efficiency, min. weight, simplicity.

Aircraft hydraulic system must meet the requirements associated with the construction and operation of the aircraft. These include: [1]

- The pressure in each system must show the flight crew.
- Hydraulic circuits shall be equipped with limiters max. working. pressure.
- Heading must include filters for cleaning fluids from mechanical impurities.
- Pipe joints shall be readily releasable without leak.
- The installation must not cause a fire or explosion.
- Failure of the main circuit should occur automatically switch to emergency circuit, the operation of which must be displayed in the crew.

Advantages of hydraulic systems: [2]

- Great performance and amplification with low weight and small dimensions and sources for energy.
- Short response time output member to the control signal of the order of hundredths of a second.
- The ability to easily regulate the speed of the output element and its reversal, fluidity of movement of natural damping of transients.
- The ability to easily change the gear ratio (output power) by changing the area of the power piston member.
- Easy fixation performance of members at the end positions and between positions.
- Special hydraulic connection with the members of the managing electrical and electronic systems (remote power distribution).

The disadvantages of hydraulic systems: [2]

- Great weight management (pressure and return line) and the working medium.

- Low operating temperatures (up to 125 ° C), fire hazard in the development of external leakage of working with mineral hydraulic fluid.
- Pressure losses in long lines, strict requirements on purity fluids.

2.2 Transfer of energy in the hydraulic system

Energy in the system is transmitted mainly through pressure energy. Other components of the power fluid, such as thermal, kinetic, deformation or potential to pressure energy is negligible.

Energy transfer can be expressed by three components: [1]

1. The energy required to overcome the flow resistance of liquid.
2. The energy required to change the speed at constant fluid flow.
3. The energy required to compress the fluid pressure change depending on the installation.

2.3 Hydraulic fluids

Pressure energy transfer between the source and the output member in the hydraulic system provides an energy carrier - hydraulic fluid. Liquid their characteristics and parameters greatly affects the static and dynamic characteristics of the aggregates. It also can identify characteristics of the liquid aggregate state.

The basic quality criteria liquids include: [2]

- Good lubricating properties due to friction material of the kinematic pairs (piston - case).
- Minimum dependence of viscosity on temperature.
- Resistance to mechanical destruction.
- Corrosive stability.
- Low foaming and thermal expansion.
- The low pour point and high working temperatures.

Types of hydraulic fluids:

a) Mineral (based on mineral oil, for example. Aeroshell 41).

b) Synthetic:
   - Siloxanes (silicone oils, less dependence of viscosity on temperature, inferior lubricating properties such as mineral oils, less sensitive to hot or cold, lower surface tension).
   - Liquids based on polyester or polyglycol (a high flash point, poorer lubricating properties degrade conventional sealing materials, toxic effects).

3 DESIGN HYDRAULIC POWER SYSTEM

One of the main criteria when designing a hydraulic system is the mass of the system, which has an impact on the total weight of the aircraft. I propose to apply pressure circuit for electrically powered pump with a working pressure of 10 MPa.

This circuit operates with great efficiency, but the work rolls must be sorted in the series and can not work simultaneously.

3.1 Heading constant pressure

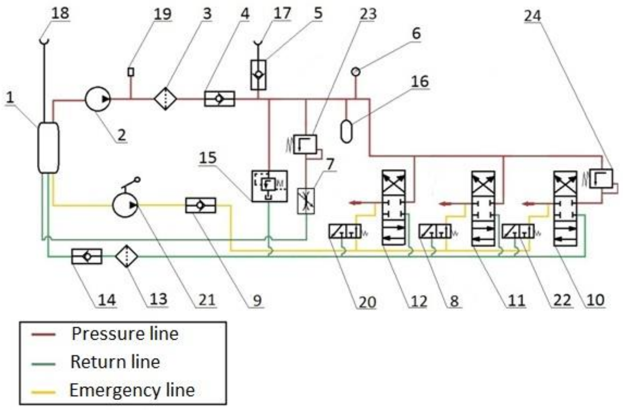

Figure 1Heading constant pressure

Legend to Figure. 1:

(1) The hydraulic tank, (2) hydraulic pump, (3, 13) filter, (4, 5, 9, 14) one-way valve (6), pressure gauge (7), throttle valve (8), manual valve Emergency eject flaps , (10, 11, 12) solenoid valve (15) safety valve, (16) the hydraulic accumulator (17) of the suction pressure connection, (18) Filling connection, (19) temperature sensor (20, 22) Emergency manual valve Extension chassis (21) emergency hand pump, (23) reducing valve.

For suction of fluid I use an electric driven pump (2) (Figure 1) made by Holley that is based on their parameters suitable for the circuit design of constant pressure. The pump sucks hydraulic fluid from the tank (1). The liquid from the pump discharge pipe temperature extruded through a filter (3) and the one-way valve (4) to the solenoid valve further EMV (10, 11, 12) (Figure 26). From there, the liquid is guided into different work streams. Solenoid valve (12) controls the circuit Extension and retraction. Emergency eject control program before the EMV included manual valve with emergency eject return valve. The source of hydraulic fluid in the emergency operation is manual hydraulic pump. EMV (11) controls the circuit Extension and retraction flaps. Emergency eject control flaps before that EMV is included manual valve Emergency eject with non-return valve. The source of hydraulic fluid from an emergency control is also used manual hydraulic pump. EMC (10) is used to control the main circuit braking wheels. For wiper control circuit serving glasses butterfly valve (7). The fluid circuit of constant pressure is supplied to the throttle valve through a pressure valve (23). The speed of the wipers will depend on the setting of throttle valve. Reusable branch pipe is connected to a separate hydraulic return line to the tank. Pressure branch pipe is connected to the return line pipe through the safety valve (15). This valve released liquid in the tank with an increase in pressure above the set value, to avoid damage to the discharge line.

Return branch pipes to pump fluid through a filter (13) and the one-way valve (14) back into the tank. For connection of ground source used suction pressure connection (17). For the implementation of the system is meant filling suction connection (18). The pressure in the circuit is controlled by the pressure gauge (6) located on the dashboard. To control the pressure in the main circuit and brake pressure transmitter serves a temperature sensor (19). Hand valve (22) is used for braking the wheels of the main landing gear and the parking brake needs.

3.2 Circuit of extension and retraction

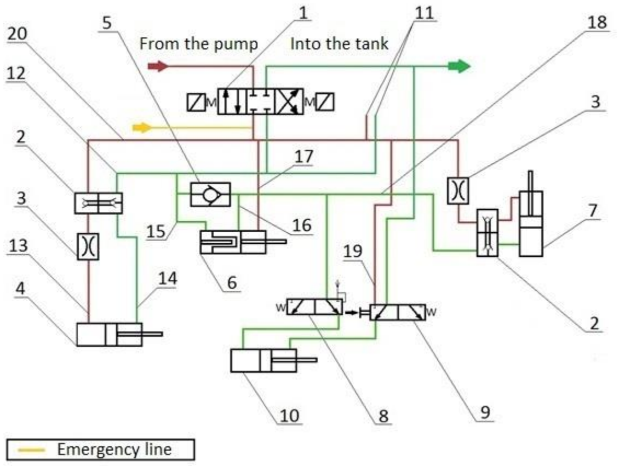

Figure 2 Circuit of extension and retraction

Legend to Figure 2:
(1) EHR (2) hydraulic lock, (3) flow control valve, (4) working cylinder front landing gear, (5) one-way valve, (6) working cylinder lock chassis (7) working cylinder head chassis (8) relief valve, (9) equalization valve (10) working cylinder housing program, (22) cylinder automatic braking system chassis.

Circuit is used for both normal and emergency control Extension and retraction. Schematic representation of Extension and retraction is on (Figure 2). Control program is implemented through an EHR (1). In the neutral position, the supply of pressurized fluid unlocked and branch circuit work program will be aligned with the tank. When ejecting the liquid to enter the chassis legs (12), further flows to one side hydraulic lock (2) and through the branch (15) enters the working cylinder front landing gear (4) (rod retracts, landing gear retracts). Liquid from the branch (12) enters the working cylinder lock chassis (6). Unlocking the main chassis arm (16) passes through the liquid bypass valve (8) into the working cylinder housing chassis (10). Through unilateral hydraulic lock (2) enters the working cylinder main landing gear (7). Opposite strands returns feedback liquid kind of roll back into the tank.
The retraction proceeds fluid branch (20) in a hydraulic lock (2) and, after it has been unlocked in the working cylinder (4) at the front landing gear. Liquid further progresses arm (17) to the working cylinder lock chassis (6), which moves to the left and prepare to lock the legs lock. Branch (19) enters into a liquid balancing valve (9), which is mechanically actuated undercarriage leg. After its insertion is reset and released fluid into the working cylinder (10) housing program. This will ensure the order of insertion chassis - Covers. Branch (11) is used for connecting the right landing gear.

3.3 Main wheel brake circuit

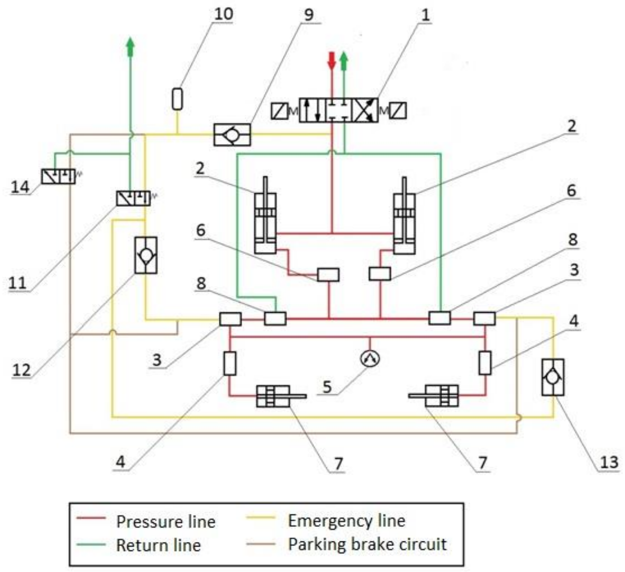

Figure 3 Main Wheel brake circuit

Legend to Figure 3:

(1) EMV (2) brake valve, (3) changing valve, (4) self-closing connection, (5) variable cabin pressure, (6) changing brake valve, (7) Brake cylinders, (8) EHR (9, 12, 13) one-way valve (10) hydraulic accumulator (11) Hand Brake Valve, (14) manual valve parking brake.

From reducing valve is a liquid fed to the two brake valve. When braking, aircraft continuous zošľapnutím pedal, the force of the spring is transferred to the valve. The slider connects the compressed fluid to the brake circuit. After leveling the pressure in the brake circuit with pressure zošľapnutej control valve spring to shut another fluid. After relieving the brake pedal connects gate circuit brakes with brake and reversible circuit unloaded. From brake valves (2) the hydraulic fluid fed to the changing brake valve (6) to stop the current disincentives to both pilots. By changing valves hydraulic fluid is fed to the EHR (8). EHR is controlled transmitter detection and, if wheel lock stops the flow of pressurized fluid from the brake valve and simultaneously connects the brake cylinder reciprocating circuit. EHR of liquid passes through the changing valve (3) self-closing connection (4) to the brake roller. Self-closing connection (4) are for the case of system maintenance (eg when replacing brake pads).

When emergency braking circuit connects the constant pressure of the emergency control circuit. Liquid flows through the one-way valve (9) for manual emergency brake valve (11). From there, the liquid is passed through one-way valves for changing valve (3) which enters through a self-closing connections directly to the brake cylinder. EHR (8) in this case will not allow liquid to get into the circle of constant pressure and the return circuit. When emergency braking is hampered both main landing gear wheel at the same time. To prevent wheels from locking, it is necessary to observe pressure. For this purpose we serve pressure gauge, which is located in the cab.

For parking, the manual switch valve (14) to STOP. The pressure needed to create parked hand pump (21) to (Fig. 26). The exclusion of the impact of temperature and internal battery serves leaks brake (10). Transferred to a parked manual switching valve to the starting position. This parking brake circuit connected to the return circuit. The pressure control circuit used pressure gauge (5).

3.4 Circuit of parking brake

We start from (Figure 3). Parked switches for manual valve (1) to STOP. The pressure needed to create parked hand pumps. The pressure fluid passes through a check valve (8), manual valve (1) for changing valve (4), which released the brake fluid roller. Parking brake circuit is protected by the overload relief valve (2), which is set to a pressure of 3.9 MPa. The exclusion of the impact of temperature and internal battery serves leaks brakes. Transferred to a parked manual switching valve to the starting position. This parking brake circuit connected to the return circuit. The pressure in the circuit is indicated on the pressure gauge (6).

3.5 Circuit of control flaps

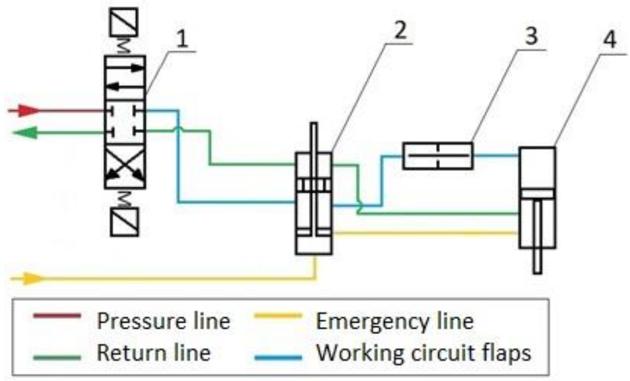

Figure 4 Circuit of control flaps

The legend of Fig. 29:

(1) EHR (2) emergency lock cylinder, (3) damping valve (4) cylinder flaps.

By moving the control lever to the desired position connects the EMV (1) pressurized liquid through the emergency cylinder lock chassis (2) and damping valve (3) with a working roller shutters (4). At the same time the other side of the cylinder connects via emergency lock cylinder (2) with EMV. After moving the piston in the retracted, retracted position limit switch is off and the piston in the cylinder lock.

Emergency eject: When the emergency eject lever-handle in position for ejection. Resetting the emergency eject lever to the lower position to supply hydraulic fluid released from the emergency hydraulic hand pump.

3.6 Glass wiper control circuit

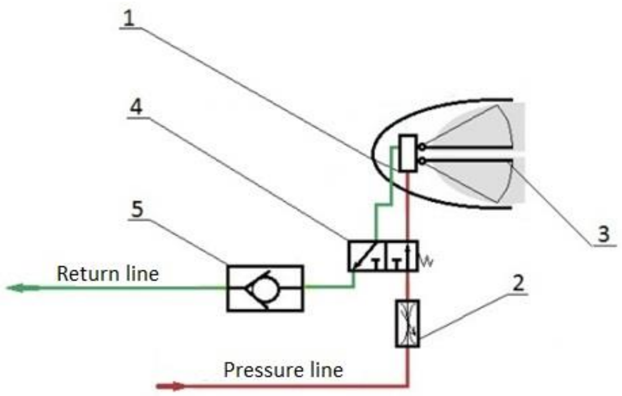

Figure 5 Glass wiper control circuit

Legend to Figure 5:

(1) rotary hydraulic motor, (2) flow control valve, (3) scraper, (4) manual flow control valve, (5) one-way valve.

Glass wiper control circuit is designed to drive hydraulic motor hydraulic wipers. Devices are located far forward. The liquid is fed from the circle of constant pressure through the flow control valve (2) (Fig. 30) and manual flow control valve (4) to the rotational motor. The butterfly valve (2) is reduced to a liquid pressure of 1.3 MPa. The speed of the hydraulic motor rotational position of the throttle butterfly valve. Safety valve (5) prevents the fluid to return from the return circuit back to the rotary hydraulic motor.

4 CONCLUSION

The main content of the thesis proposal and the approximate calculation of the hydraulic power system of small transport aircraft. In this work I have successfully implemented the proposal circuit of constant pressure and work streams Extension and retraction, flaps, brake wheel main landing gear and the wiper control circuit glasses. Part of the circuit braking wheel main landing gear is of interest emergency braking and parking brake circuit. In the design of hydraulic circuits work and their individual parts I was inspired from previous existing hydraulic circuits of small transport aircraft to take-off mass of 2000 kg.

Hydraulic power systems undergoing constant development. Development is moving in the direction of reducing the weight and dimensions and increasing reliability. Some systems such as glass wiper control system is possible, but not necessary to replace the power steering system. Continuous progress Aeronautical future case the possibility of replacing some of the components of a hydraulic system for other components that may not be hydraulic.

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