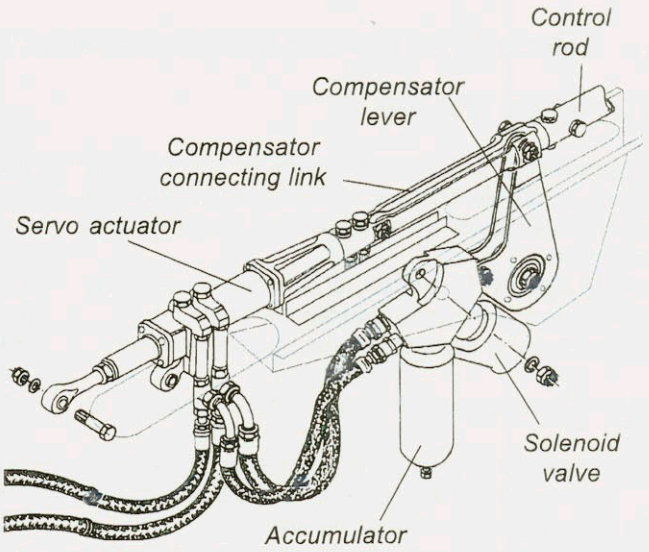
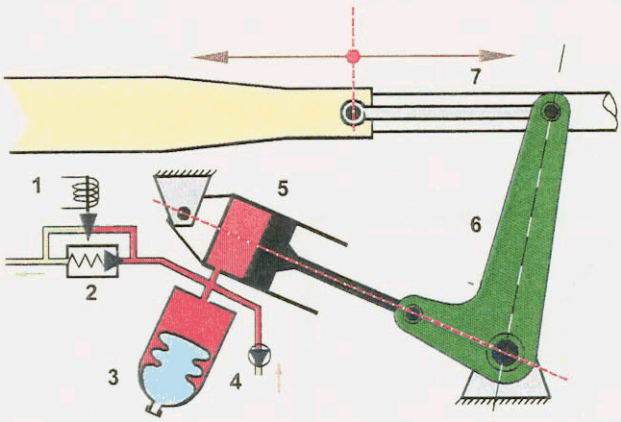
8.1.3. YAW LOAD COMPENSATOR ON VERSIONS B1 & B2

Moving the yaw pedals from stop to stop varies the pitch of the tail rotor blades from - 8° to + 23°.
In flight when the rotor thrust is non-zero (i.e. the pitch is not 0°), the zero pitch return moment of the blades (partly compensated by the boss-type "Chinese" weights) tends to bring the pitch back to zero. The servo actuator hydraulic pressure overcomes the rotor's zero pitch return moment and cancels out the control reversal.
Without any hydraulic pressure, the pedal operating force is very high on the B1 and B2 versions.
This is why a hydraulic device or "load compensator" has been mounted in parallel with the tail rotor servo actuator.



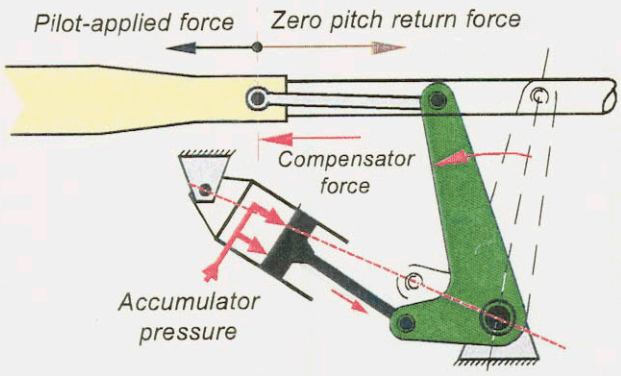
PRINCIPLE OF YAW LOAD COMPENSATOR



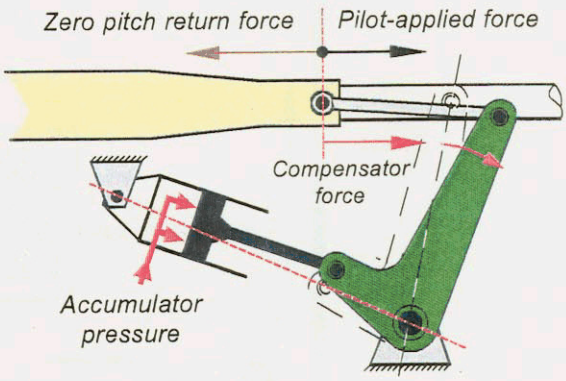
In flight the helicopter's hydraulic system charges an accumulator (3) and an actuator (5).
Any pedal movement acts on the servo actuator.

In case of hydraulic failure (pump inoperative, leakage, etc.), the accumulator is kept charged by:
- non-return valve (4) in the pressure circuit
- pressure relief valve (2) set at 55 bar (N.B. The system's operating pressure is 40 bar)
- solenoid valve (1) always closed and opened by the pilot.

Moving to low pitch



Moving to high pitch



The total force applied by the pilot and by the compensator actuator is equal to the zero pitch return force

8.2 SERVO ACTUATOR HYDRAULIC SYSTEM

8.2.1. OVERVIEW OF PRINCIPLES OF HYDRAULIC SYSTEM

(1) Principle of system

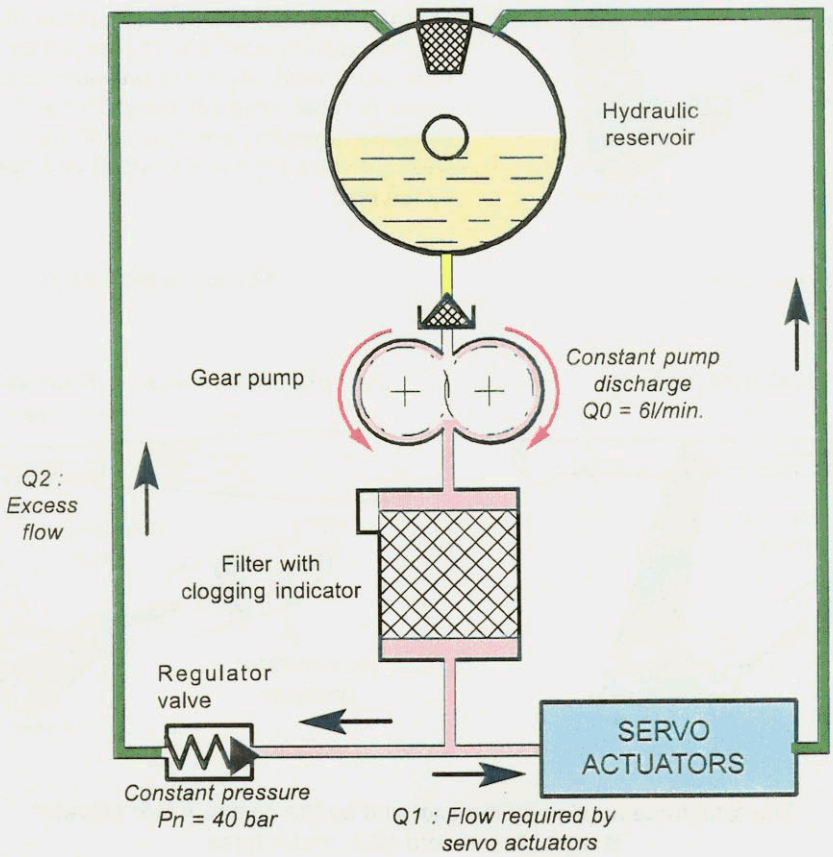
The hydraulic system supplies hydraulic power to the servo actuators. Always bear in mind that the hydraulic power is related to the pressure (P) and flowrate (Q) by the equation:
Power = P x Q which means, at constant power, that:
- any increase in flowrate reduces the pressure
- any decrease in flowrate increases the pressure.

The AS 350 has a constant-power hydraulic system, including:
- a gear pump driven at constant speed by the MGB and with a constant discharge flow of 6 l/min.
- a 3µ filter with a visual clogging indicator
- a regulator valve to keep the pressure at its rated value of P_N = 40 bar.

The pump discharge flow is designed to satisfy the demands of the servo actuators in all conditions, which results in an excess flow in normal flight conditions. The excess flow is bypassed into the hydraulic reservoir by the regulator valve, which opens when the pressure exceeds 40 bar.
Let:
- Q_0 be the pump's constant discharge flowrate
- Q_1 be the flowrate demanded by the servo actuators (which varies with their workload)
- Q_2 be the excess flow bypassed by the regulator valve.

These flowrates are related as follows: $Q_0 = Q_1 + Q_2$.
If Q_1 increases, the system pressure drops and the valve starts to close and decrease the flow Q_2 in order to bring the pressure back to its rated value. If Q_1 decreases, the opposite occurs.

VALVE OPENING DESIGNED TO KEEP P CONSTANT AT EACH VALUE OF Q_1



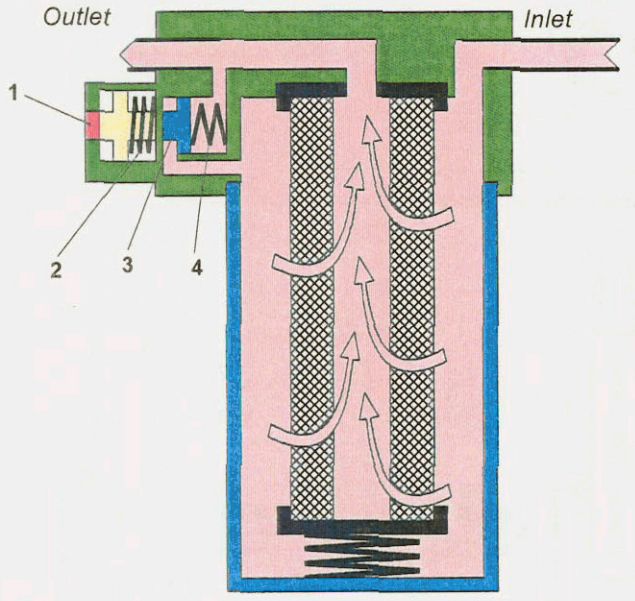
8.2.1. OVERVIEW OF PRINCIPLES OF HYDRAULIC SYSTEMS (Cont'd)

(2) Before looking at the system in detail.....a few precautions with hydraulic fluids

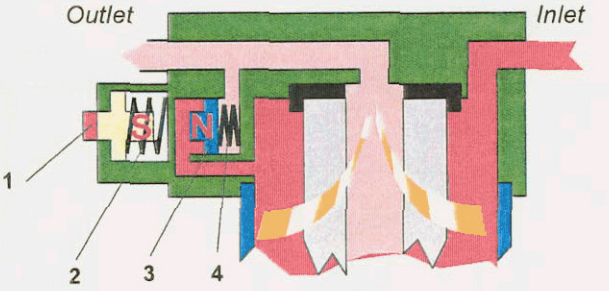
ALWAYS:
- Use only the hydraulic fluid specified by the manufacturer (See Flight Manual) since its properties guarantee correct and reliable system operation (e.g. satisfactory performance of seals and packings).
- Despite excellent stability, hydraulic fluid deteriorates with time and must be replaced at the intervals stipulated by the manufacturer. Refer to the Master Servicing Recommendations (MSR).
- Contaminated fluid = premature wear of the servo actuators (e.g. erosion, risk of distributor seizure, filter clogging). Hence:
- Only top up with ABSOLUTELY CLEAN fluid.
- Check the filters according to the MSR.

HYDRAULIC FILTER WITH CLOGGING INDICATOR

UNCONTAMINATED HYDRAULIC FLUID



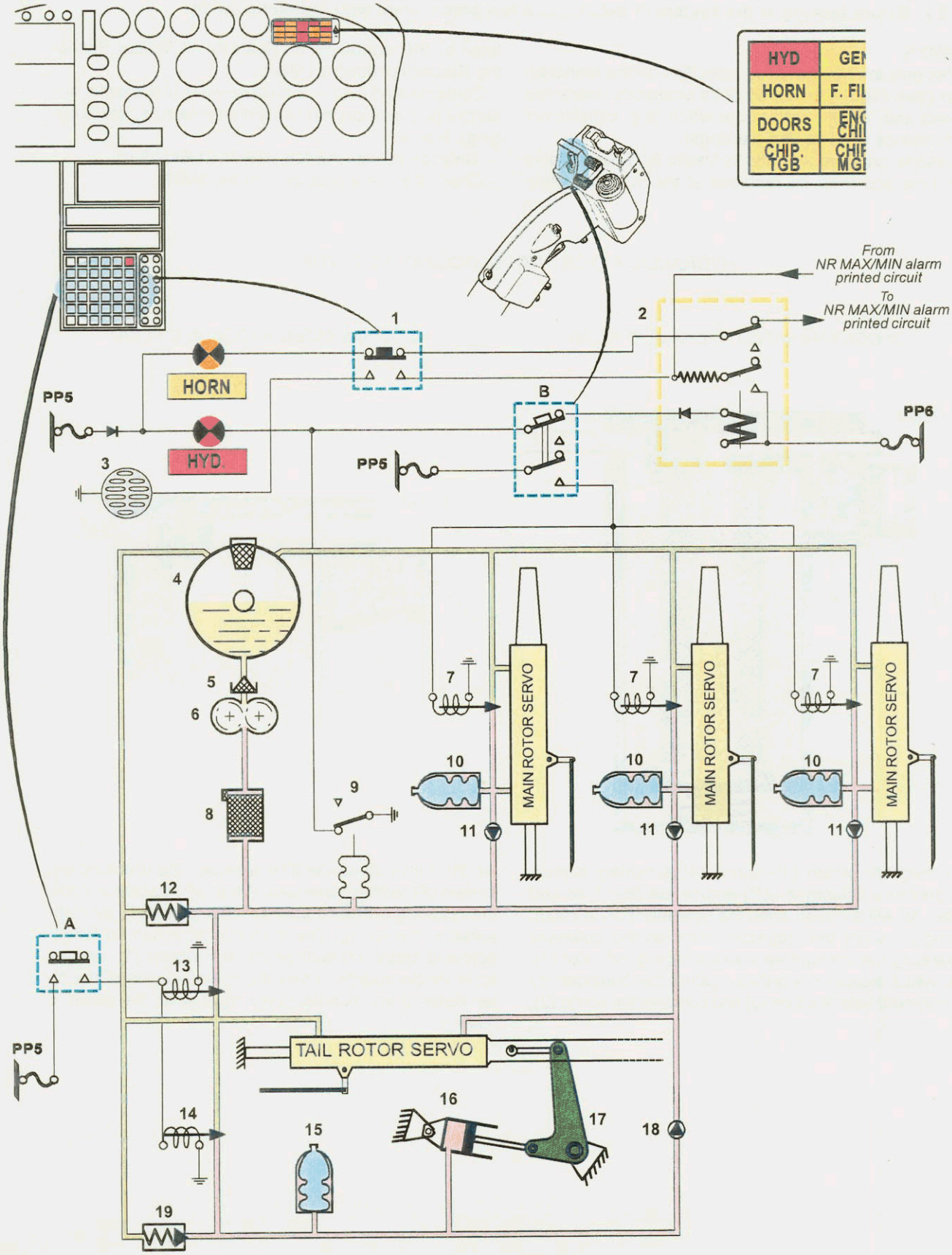
CONTAMINATED HYDRAULIC FLUID



The magnetic piston (3) -spring (4) assembly detects the pressure difference (ΔP) across the filter inlet and outlet. ΔP will be small when the hydraulic fluid is clean. Spring (4) seats the magnetic piston on the bulkhead separating the spring from visual clogging indicator (1). The visual indicator is pulled against the bulkhead by the magnetic field of piston (3) and compresses spring (2).

As dirt builds up on the filter element, the pressure upstream of the filter increases. When ΔP reaches 2.7 bar, the resulting pressure pushes back piston (3) by compressing the spring. The magnetic attraction no longer acts and spring (2) pushes visual indicator (1) until its tip is visible outside, indicating contamination of the filter. Refer to the manufacturer's manual for the action to take.

8.2.2. HYDRAULIC SYSTEM COMPONENTS AND THEIR FUNCTIONS

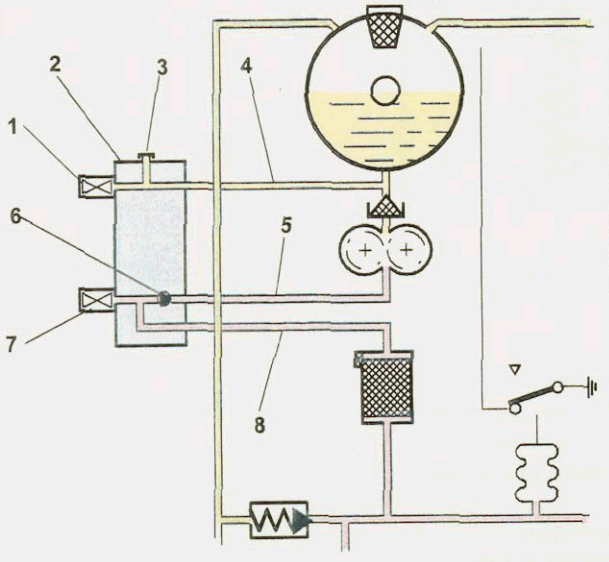


8.2.2. HYDRAULIC SYSTEM COMPONENTS AND THEIR FUNCTIONS (Cont'd)

1 **HORN pushbutton** on control pedestal. Used to disable the horn.
2 **Control relay**, energized in case of hydraulic pressure drop or loss of NR.
3 **HORN** providing aural alarm in case of loss of hydraulic pressure or drop in NR.
4 **Hydraulic fluid reservoir**
5 **Strainer** (mesh size = 0.8-1 mm) on pump inlet.
6 **Gear pump** driven by MGB, with flowrate = 6 l/min.
7 **Main rotor servo actuator solenoid valves,** controlled by pushbutton B. Used in case of hydraulic failure or seizure of a servo actuator distributor to route the servo pressure inlet line back into the reservoir; this eliminates back pressure in manual control and hence reduces the control loads.
8 **Filter unit** with clogging indicator. Filtering capacity = 3µ.
9 **Pressure switch,** which closes the "HYD" light circuit when P < 30 bar.
10 **Backup accumulators** on main rotor servo actuators. Used in case of hydraulic failure to provide a small energy reserve so that the pilot can attain a "least load" fallback speed for manual control.
11 **Main rotor servos non-return valves**, which are closed in case of hydraulic failure by the accumulators' pressure (the flow from the accumulators is only used by the servo actuator).
12 **Regulator valve,** which keeps the system pressure at 40 bar.
13 **"Hydraulic Test" solenoid valve,** controlled by pushbutton A. When energized it opens to route the servo actuator supply circuit back into the reservoir. This depressurizes the system and allows the backup accumulators (10) to be tested on the main rotor servo actuators.
14 **Solenoid valve** for discharging accumulator (15). When open, the valve allows the pedals to be operated with the rotor stopped.
15 **Accumulator,** which provides a power reserve for load compensator actuator (16).
16 **Hydraulic actuator,** which together with lever (17) facilitates tail rotor pitch changes in case of loss of hydraulic power.
17 ***Multiplying lever***, *which magnifies a small displacement of the actuator piston into a large movement of the servo actuator rod connecting point.*
18 **Non-return valve,** which keeps accumulator (15) charged in case of loss of hydraulic pressure.
19 **Pressure relief valve,** which partially bleeds off the hydraulic fluid when the compensator piston returns from the extreme extended position; this eliminates hydraulic locking when the system is pressurized.
A **"HYDRAULIC TEST" pushbutton** (on control pedestal) which activates solenoid valves (13) and (14).
B **"Hydraulic cutoff" pushbutton** (on collective lever) which activates solenoid valves (7).

OPTION

INSTALLATION OF GROUND POWER CONNECTION



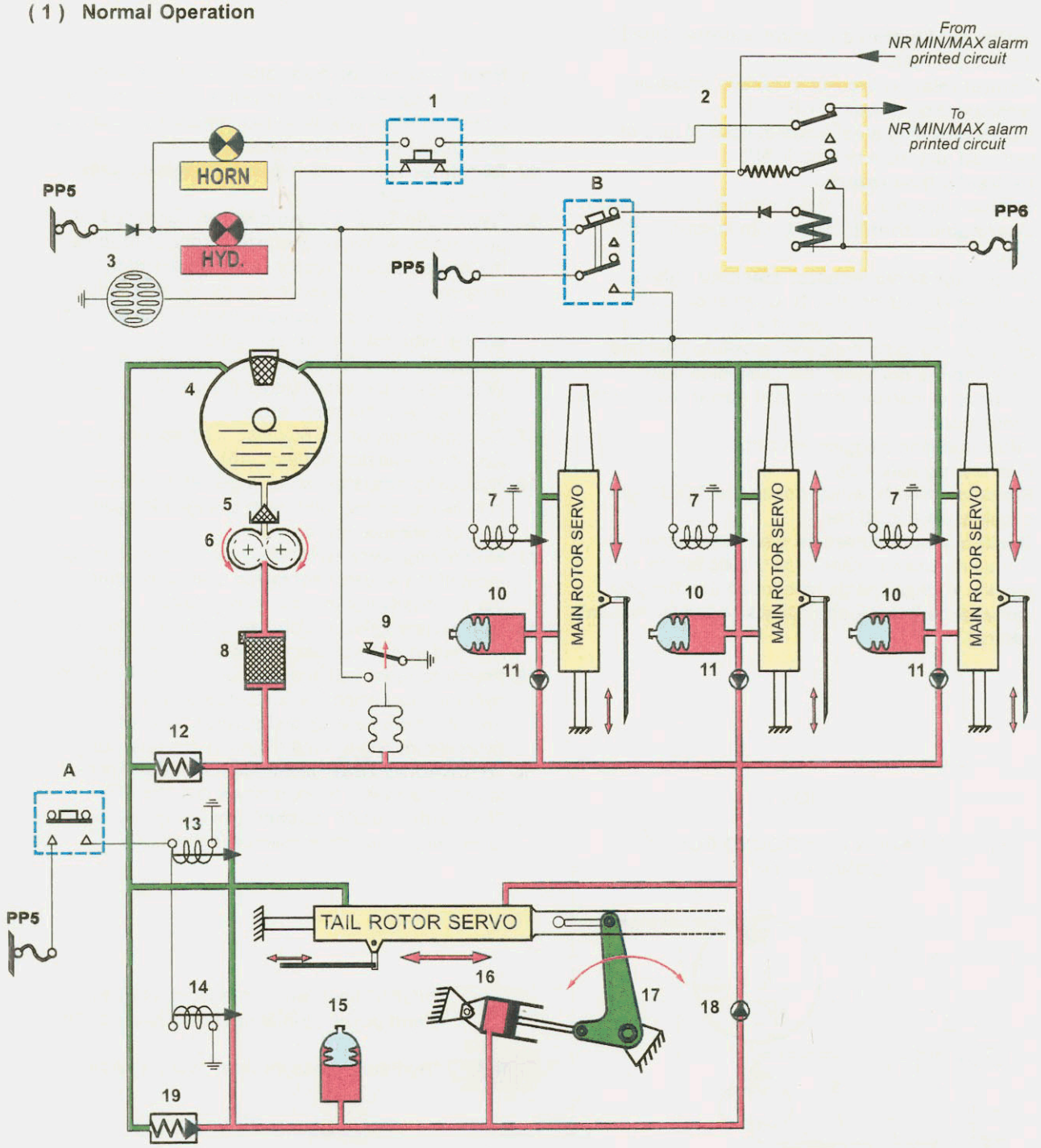
1 - Self-sealing suction ground connection
2 - Manifold on RH side of transmission deck
3 - Drain plug
4 - Suction pipe
5 - Helicopter pump delivery pipe
6 - Non-return valve
7 - Ground pressure quick release coupling
8 - Ground or pump delivery pipe

HORN "HORN" light; when lit indicates the aural alarm pushbutton is not in working position

HYD. "Hydraulic pressure drop" warning light

8.2.3. HYDRAULIC SYSTEM OPERATION

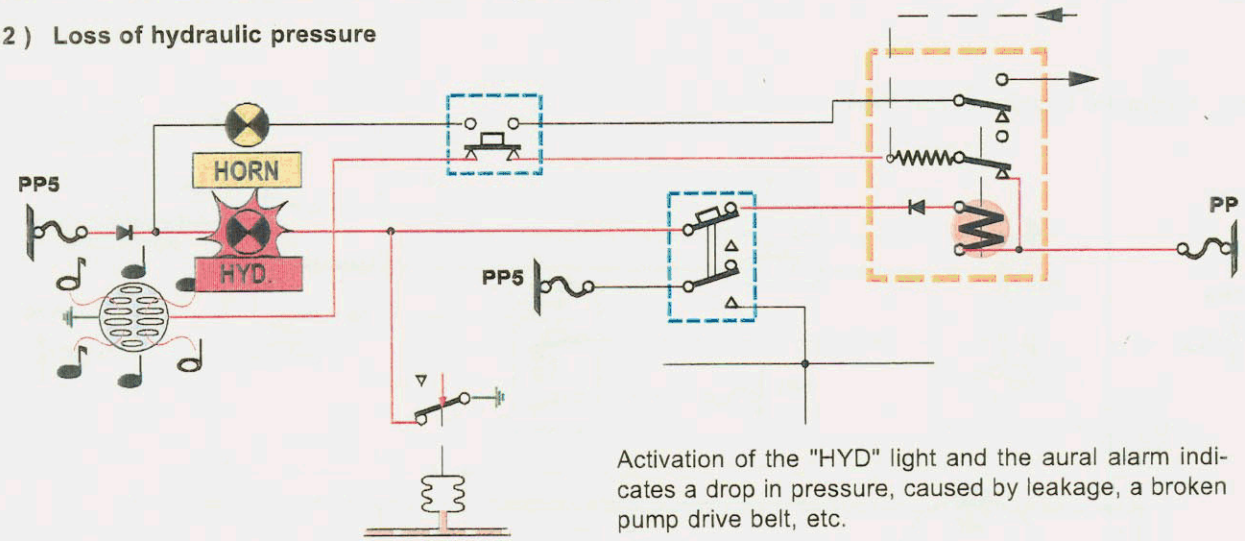
(1) Normal Operation



- When pusbuttons A and B are released:
  De-energized solenoid valves (7, 13, 14) are closed.
- Hydraulic pump (6) is running (rotor spinning).
- Regulator valve (12) holds the pressure at 40 bar:
  HYD light is off and horn is silent.
- Servo actuators are pressurized normally.
- Hydraulic fluid compresses the nitrogen in the accumulators.

8.2.3. HYDRAULIC SYSTEM OPERATION (Cont'd)

(2) Loss of hydraulic pressure



Activation of the "HYD" light and the aural alarm indicates a drop in pressure, caused by leakage, a broken pump drive belt, etc.

This informs the pilot that manual control is necessary.

PURPOSE OF MAIN ROTOR SERVO ACTUATORS BACKUP SYSTEM

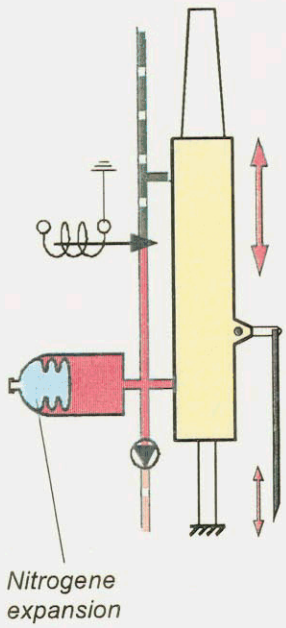
The main rotor control forces vary with the helicopter's airspeed. Above a certain speed, they increase as the helicopter flies faster. In case of hydraulic pressure loss the pilot should therefore decrease the airspeed by reducing collective pitch so that the control loads are acceptable for manual piloting.

OPERATION OF BACKUP SYSTEM

As soon as the system pressure drops, the accumulators release their stored pressure as the nitrogen expands.

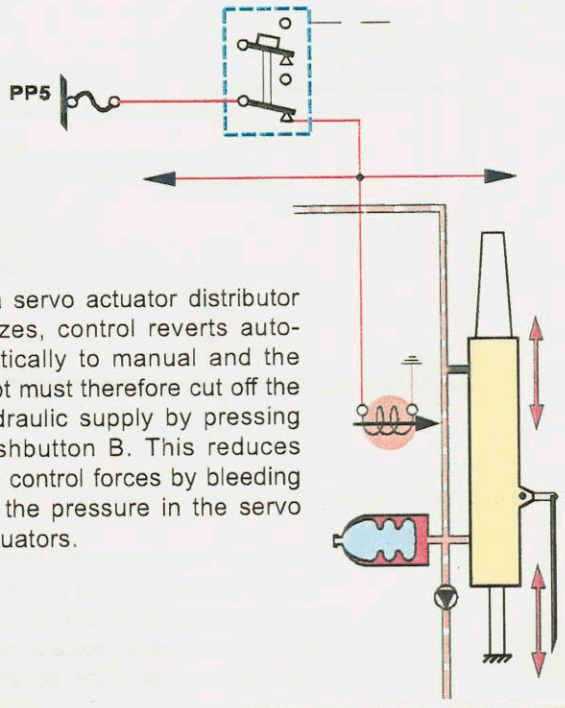
The non-return valves are closed and the servo actuators are kept pressurized until the accumulators are fully discharged.

THE PILOT MUST REDUCE THE COLLECTIVE PITCH BEFORE THE ACCUMULATORS HAVE FULLY DISCHARGED.



Once the safe fallback speed is reached, the pilot is in manual model (accumulators discharged). The pilot opens solenoid valves (7) via "Hydraulic Cutoff" pushbutton (B) to eliminate any residual and back pressure on both sides of the servo actuator piston (this reduces the forces required to move the servo actuators).
NOTE: When pushbutton B is pressed, the horn stops (the horn circuit is wired through a pushbutton stage).

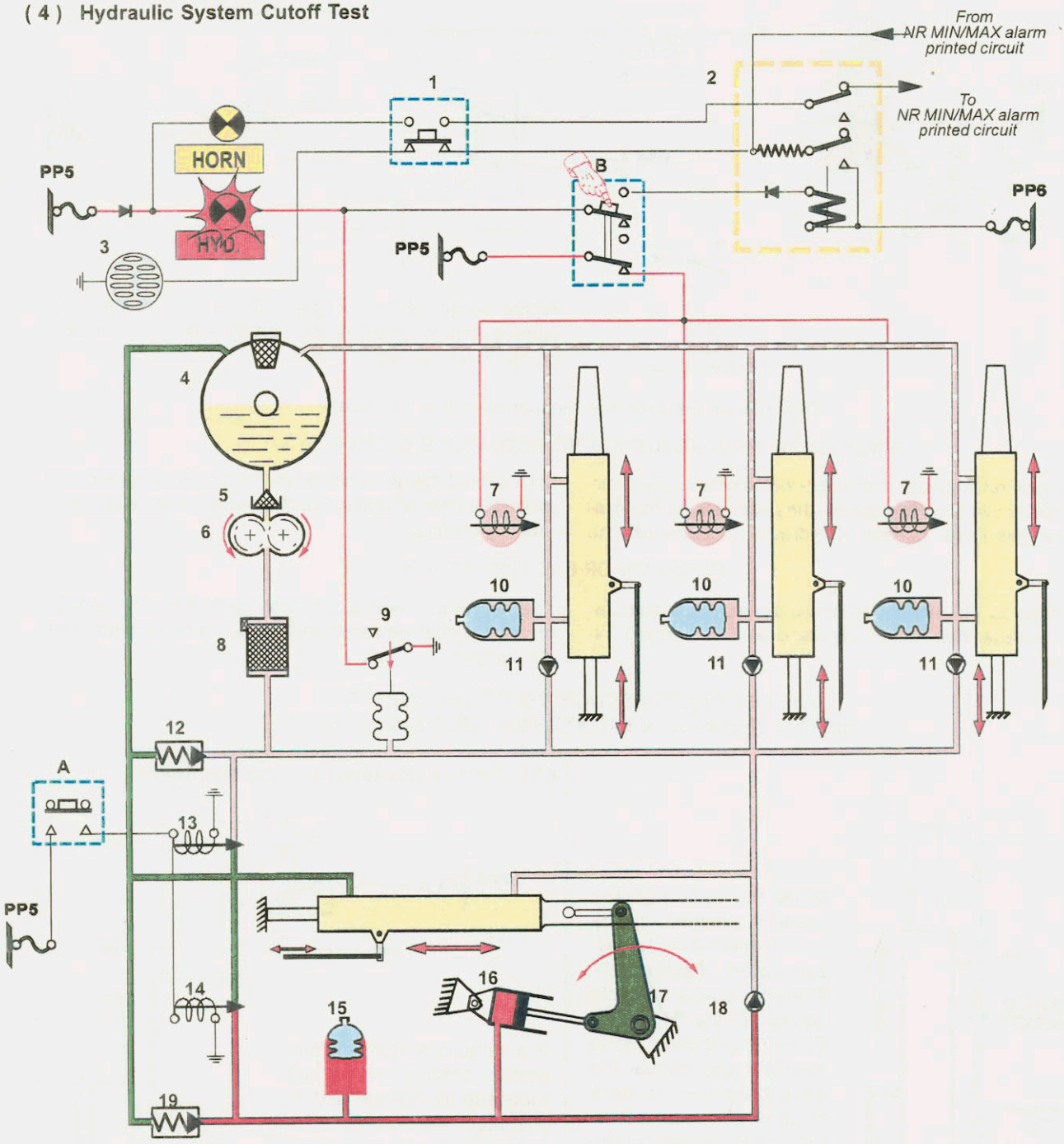
(3) Seizure of a servo actuator distributor



If a servo actuator distributor seizes, control reverts automatically to manual and the pilot must therefore cut off the hydraulic supply by pressing pushbutton B. This reduces the control forces by bleeding off the pressure in the servo actuators.

8.2.3. HYDRAULIC SYSTEM OPERATION (Cont'd)

(4) Hydraulic System Cutoff Test

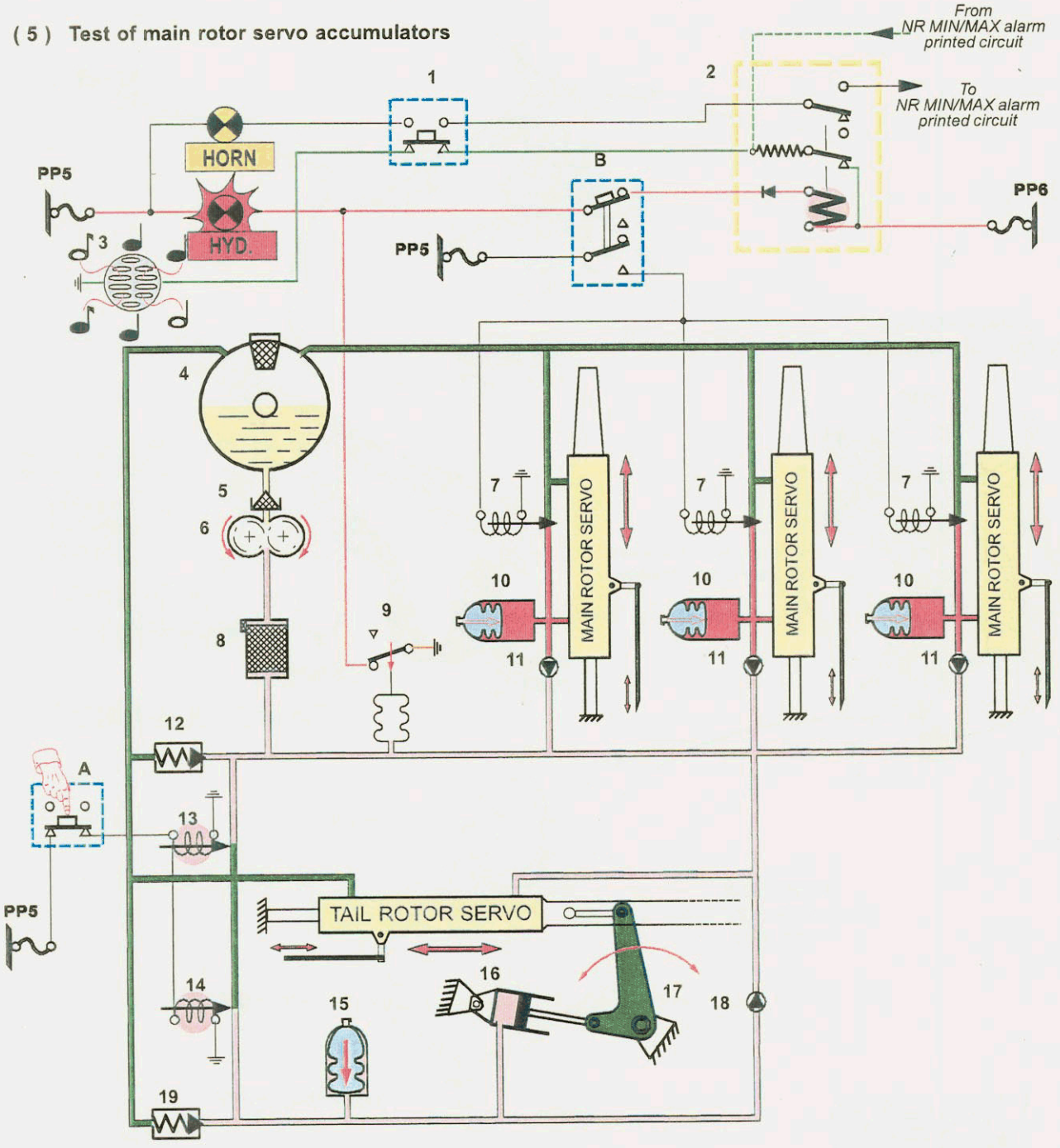


The hydraulic system components can be checked for correct operation :

With the rotor spinning, pressing pushbutton B opens solenoid valves (7). The pressure then drops, the "HYD" light illuminates and the control operating loads are instantaneously perceptible, except on the yaw pedals where they remain low due to the action of the compensator.

8.2.3. HYDRAULIC SYSTEM OPERATION (Cont'd)

(5) Test of main rotor servo accumulators



On the ground with the rotor spinning, pressing "HYD TEST" pushbutton A causes:

Solenoid valves (13 and 14) to open, which immediately depressurizes the system, illuminates the "HYD" light and triggers the horn.
At this time the pilot should be able to move the cyclic stick without any effort until a resistance is subsequently felt, indicating the accumulators have discharged.

CAUTION

To operate or center the yaw pedals on the ground with the rotor stopped, pushbutton A must be pressed for a few seconds to open solenoid valve (14) and discharge accumulator (15).