Checking procedures of spool valve overlap and ports opening timing for hydraulic servomechanism SMHR included in the aileron control chain of IAR 99

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Abstract: *This procedure was developed and used to provide laboratory measurements of spool valve overlap and ports opening timing in the framework of hydraulic servomechanism SMHR qualification tests, in the '80s.*

Key Words: hydraulic servomechanism SMHR, distributor, overlap

1. INTRODUCTION

In the Hydraulic Systems Laboratory of the former INCREST, now INCAS, in the 80's have been designed and tested hydraulic servomechanisms for the aircrafts IAR 93, IAR 99 and the helicopters IAR 330 Puma. These servomechanisms comprise hydraulic valves (distributors) whose role is to control the flow of hydraulic oil [1], [2], [3]. In general, distributors with four active edges and various overlaps or underlaps were studied in this Laboratory, as follows [4], [5]:

- for the SH.04 and SH.05 servomechanisms (of Dowty type) to be mounted on the IAR 93 aircraft for the aileron and stabilizer operation (the distributor was provided with four active edges and **underlap**); their production was taken over by Turbomecanica;
- for the SH.06 and SH.07 servomechanisms (of SAMM type) to be mounted on the IAR 330 Puma helicopter, on the main rotor, respectively, on the anti-torque rotor, the distributor was of **rotary** type; their production was also taken over by Turbomecanica;
- for the servomechanism SMHR acting the aileron of IAR 99, the distributor was with **overlap**.

The S.22.59.000 SMHR servomechanism was fully designed, approved and patented in INCREST, in 1985, and also the entire production was done here. The correction and laboratory verification of the sleeve-spool assembly − their pairing − was the most important operation.

In this framework, procedures was developed and used to provide laboratory measurements of spool valve overlap and ports opening timing.

In the 90's, specialists from the companies "Aeroteh" and "Avioane Craiova" tried to complete this operation but did not succeed. Therefore the just invoked qualification procedures were used further on for the SMHR S.22.59.010 distributor in the Laboratory of our Institute, being still operational.

THE CHECKING PROCEDURES

The distributor (part symbol S.22.59.010) is installed within the testing device (part symbol SDV 28.00), see Fig. 1 of Annex [6].

The device was designed to allow the checking procedures of spool valve overlap and ports opening timing. Fig. 2 of the Annex shows a section of the device for the overlap checking.

The following rules are to be fulfilled before of experiments:

a) To check the overlap only distributors with radial clearance between the sleeve and valve between of 4 to 7 microns are accepted.

b) Before checking, a hydraulic deburring of the SMHR hydraulic distributor is needed by passing hydraulic oil of 41 fluid Aeroshell type through each port at a pressure of 60-70 bars for 25-30 minutes.

c) The distributor and the device are washed with a solvent (for example, petroleum ether).

d) Between the sleeve and the spool in the assembling process a film of oil is formed to take the radial clearance.

METHOD OF WORK [5]-[6]

2.1 Determination of inlet spool valve overlap

The following working operations will be done:

2.1.1 The spool valve is fixed in a neutral position (the micrometer is brought to zero without moving the valve).

2.1.2 The compressed air supply is connected and the air pressure is adjusted to 0.5 daN/cm², by acting the adjustment screw of the pressure regulator RP (the supplying device is made through the feeding connection Po, Fig. 2). As the valve is fixed in a neutral position, the flowmeter floats remain stationary during the air pressure adjustment.

2.1.3 The valve is moved to the left by means of the the micrometer screw until at the left inlet port (2), Fig. 2, a rate of 3 l/h, read on the flowmeter, is obtained. The displacement of the spool (value given by the micrometer) is denoted by "b".

2.1.4 The valve is moved to the right by means of the micrometer until at the right plot (3) a rate of 3l/h, read on the B flowmeter, is obtained. The displacement of the valve is denoted by "c."

2.1.5 The valve is brought back in the neutral position. The valve spool overlap this case is defined as being equal to the sum of the maximum displacements in both directions (displacement at which the port opens and a constant flow of 3l/h is obtained. This value must fall between 0.15-0.17 mm. If it doesn't fit, corrections are calculated and the correction scheme presented in the appendix of Fig. 3 is completed. It is required to rectify the active shoulders of the valve. **Corrections will be made successively until the b + c displacement sum fit into the range of 0.15 to 0.17 mm (b + c = 0.15 to 0.17 mm).**

2.1.6. The valve is positioned so that the displacement value "b" is approximately equal to the amount "c" of displacement [(b + c) / 2, to initiate corrections].

2.2 Determination of outlet spool valve overlap

2.2.1 The valve is maintained in the position established to the inlet spool valve overlap measuring.

2.2.2 The compressed air supply is connected and the air pressure is adjusted to 0.5 daN/cm², by acting the adjustment screw of the pressure regulator RP (the supplying device is made through the feeding connection C, Fig.1).

2.2.3. The valve is moved to the left by means of the the micrometer screw until at the right inlet port (4) a rate of 3 l/h, value read on the flowmeter B is obtained. The displacement of the valve (value given by the micrometer) is denoted by "d".

2.2.4. The valve is moved to the right by means of the micrometer until at the left inlet port (1) a rate of 3l/h, read on the A flowmeter, is obtained. The displacement of the valve is denoted by "a."

2.2.5. The valve is brought back in the neutral position. The overlap is defined as in section 2.1.5 except that the amount of the overlap must be within 0.19 and 0.21 mm (a + d = 0.19 to 0.21). If the value is greater the correction scheme presented in the appendix (Fig. 3) is calculated. The scheme is needed to rectify the valve active shoulder. These iterations are repeated after each adjustment until the displacement sum of a + d fits into the range of0.19 to 0.21 mm.).

2.2.6. Corrections will be given so that the amount of displacement "a" is approximately equal to the amount of displacement "d", maintaining a neutral position established to the hydraulic inlet overlap determination (section 2.1.1).

2.2.7. Determination of hydraulic overlap at evacuations can be also obtained using the supplying in the EA points and collecting data from point "c".

2.2.8. On the completion of the correction scheme, the following issues will be taken into account: $b+c = 0{,}15 \div 0{,}17$mm; $a+d = 0{,}19 \div 0{,}21$mm; $a - c = 0{,}02 \div 0.025$ mm; $d - b = 0{,}02 \div 0.025$ mm; see [5]-[6]. In fact, the admission advance as compared to the evacuation advance should be of about 0.02 mm.

2.3 Checking ports opening timing for the SMHR distributor

In view of checking, the values obtained at points 2.1 and 2.2 above are utilized.

2.3.1. The valve is fixed in a neutral position so that for admissions to have equal displacements to the left and to the right.

2.3.2. The device containing the distributer is supplied in points Po and C at a pressure of 0.5 daN/cm² at a time.

2.3.3. By moving the valve to the left and to the right the successive opening of right admission and left exhaust and left admission, right exhaust respectively can be observed and thus one can check if the condition imposed under section 2.2.8 is verified.

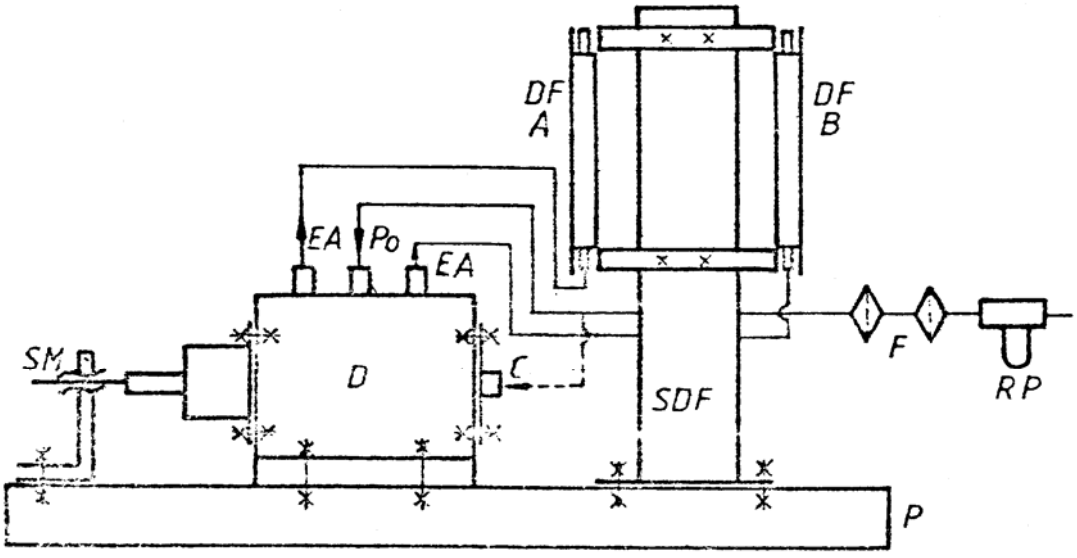

Fig. 1 − Device for laboratory measurements of spool valve overlap and ports opening timing:
P − base plate; RP − pressure regulator; DF − rotameter; SDF – flowmeter support; EA – exhaust nipple;
D − SDV device 2800; SM − micrometer screw; F − air filter

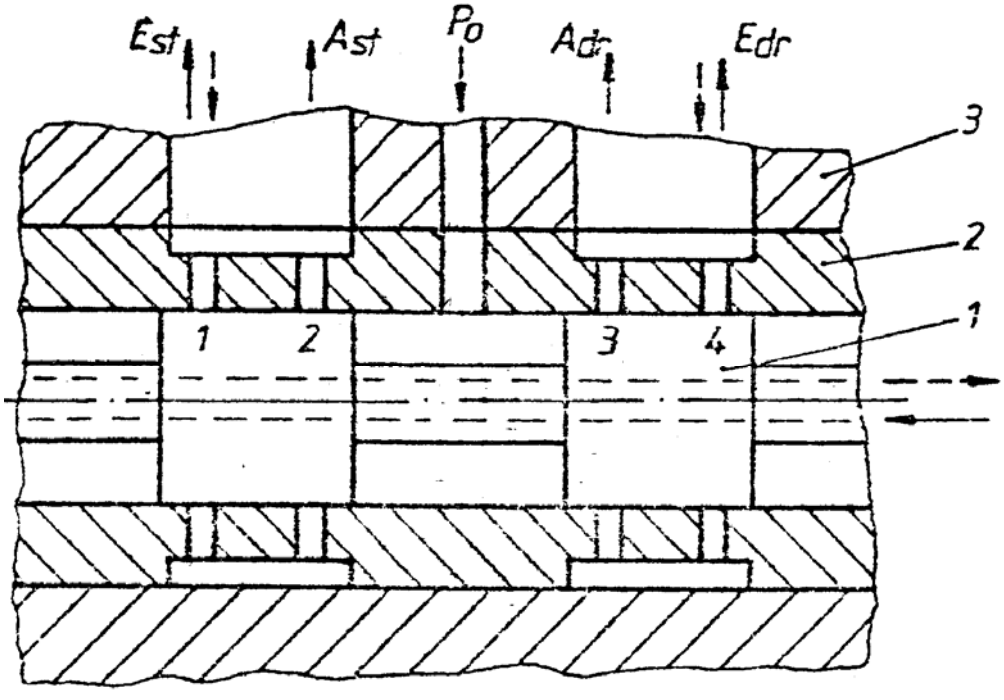

Fig. 2 − Detail of the device in Fig. 1: 1 − straight edges; 2 − sleeve; 3 − device body

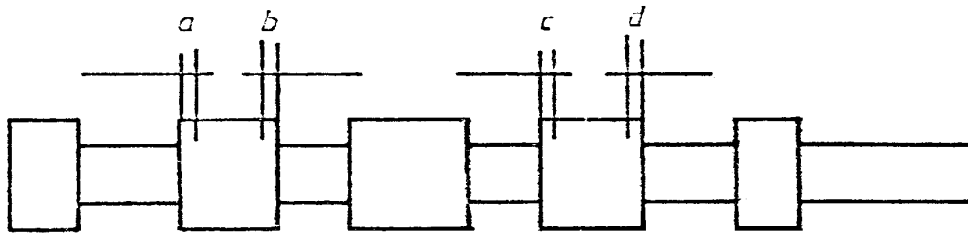

Fig. 3 − Sketch of SMHR spool valve: a, b, c, d − overlaps

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