

EQUIPMENT FOR TESTING THE TIGHTNESS, THE ALTIMETERS AND THE SPEEDOMETERS FROM AIRCRAFT'S BOARD

**Ph.D.Eng. Diana Mura BADEA, CSPgr.I - I.N.C.D for Fine Mechanics, Bucharest,
ing. Tudor Guta, CSPgr.III, - I.N.C.D. for Fine Mechanics, Bucharest,
Ph.D.Eng. Dumitru Vlad, CSPgr.I - I.N.C.D. for Fine Mechanics, Bucharest,
Ph.D.Eng. Petre Munteanu, CSPgr.I - I.N.C.D. for Fine Mechanics, Bucharest.**

Abstract: The equipment is dedicated to the effectuation of the tests of tightness of pneumatic system of the catchment (Pitot tube), transmission (pneumatic routes) and the processing (aircraft-type instruments) of air pressures (total and static) for the determination of principal parameters of flights, concomitantly with the verification of the correctness of the indications (error) of the afferent aircraft instruments: the altimeter and the speedometer.

Keywords: Pneumatic circuits aircrafts - verification

The utilization of the equipment will lead to the considerable growth of the safety fly, because it will permit the quick and efficient effectuation of checking to soil of principal aircraft-type instruments, before effectuation fly. Because this checkings must be quick realized (it can be done between flights) and direct on aircraft(without take down the apparatus from the board of aircraft), it felt the necessity of one autonomous equipment of testing and checking capable to operate at the place of location of the aircraft.

Why an apparatus for testing the tightness? Answered to this question arises from the oneself principal-constructive solutions what underlie the operation of the mentionate aircraft instruments. Their operation is based on the measurement of the caught pressures of the transducer of pressure (the Pitot tube).

The Pitot tube captures simultaneously the total and the static pressures, transmitting them through the pneumatic afferent routes to the aircraft instruments.

We remind that the operation of an altimeter is based on conversion of static pressure (relized as a vacuum against the atmospheric pressure), and one speedometer on conversia of dynamic pressure

consequential as the difference between the total pressure (relized as an additional pressure against the atmospheric pressure) and one static.

It is easy to understanding the importance of testing tightness of pneumatic system mentioned, in entire ensemble. Any leakiness will lead to the distortion of the processed pressures, challenging through this false indications ale of the apparatus of board.

We will give as example the influence of the leakages on the afferent route of static pressure, indifferent where is produced (Pitot tubes, piping, apparatus).

The adequate vacuum to the true altitude will be less than one correct, therefore the altitudinal indication will be wrong (less than one real). It can deduce the disastrous effects it can appear to the crossing mountains or landing, especial in conditions of reduced visibility.

Similar effects appear and on the afferent route of the total pressure. Any escape of additional pressure will distort the indication of speed on speedometer (indicated speed will be less than one real).

Knowing that the tightness to vacuum differs against one to additional pressure, is natural

that his verification is done both at vacuum and additional pressure.

On the other hand, the testing methods internationally used and according to the standards and the normative papers in force, use right indications of the leakage the equivalences in loss of altitude (for vacuum) and in loss of speed (for the the total pressure), registered on altimeter for vacuum, respectively on speedometer for additional pressure.

Taking count of these equivalences and, in fact, anyhow must also certified the indications of the apparatus, results the logical conclusion of one equipment able to execute the leakage tests concomitantly with the verification of the indications of the aircraft instruments.

To realise this desideratum the equipment will be endowed with:

- A source of vacuum with the possibility of adjustment and stabilization of the vacuum, for the static route (pump of vacuum, accumulator chamber, control valves for fine dosage and for ventilation to atmosphere).
- A source of additional pressure with the possibility of adjustment and stabilization of the additional pressure, for the route of the total pressure (pressure pump, accumulator chamber, control valves for fine dosage and for ventilation to atmosphere).
- Absolute and relative pressure transducers compensated for thermal effects
- Standard altimeter and speedometer apparatus for displaying the altitude and speed, respectiv of loss in altitude or speed (containing the converters of pressure, adder and differential blocks for signals, analogue-digital converters and digital display), used as reference for the verification of tightness and the correctness of the indications of the apparatus of board.
- The automatic effectuation of the cycles of leaking tests (in the basis of time prescribed, the display of the loss of pressure transformed in loss of altitude or speed).
- The endowment with an variometric indicator (apparatus for the mensuration of ascensional or descensionale speed of aircrafts), necessary for limitation of the growth rate of vacuum or the additional pressure to the prescribed rate of the builder of the aircraft instruments, in the purpose of protection of the aircraft instruments during the tests (a suddenly growth of vacuum or additional pressure can lead to the deterioration of respective instruments).
- Electric supply to 24 his 28 Vcc, from his own source with the possibility of coupling to aircraft's source.
- Mounting in an equipment box, so that it can work in outer conditions.

The equipment consists in two sections, whom configurations are represented schematically in fig. 1 and whom components and operation are precised in continuance:

- PITOT- intended for effectuation of the tests of tightness to overpressure of pneumatic system and to make the verifications of the errors of indication of the speedometer. The operation is based on the simulation of a desirable speed by creating an equivalent overpressure by the operation of the air pump (1) and of the accumulator chamber of pressure with incorporated vent (2), her adjustment to the desirable value by operation of control valve for fine adjustment (4) and ventilation (5), pressure intimated by the transducer of differential pressure (7) whom signal of exit is processed and transformed by the electronic block formed by the multiplexer (8), the analogue-digital converter (9) and control unit (10) in pressure values, leakage or speeds, depending on the operation way prescribed through keyboard (11) and displayed by digital display (13).

- STATIC- intended for effectuation of the tests of tightness to vacuum of pneumatic system and to make the verifications of the errors of indication of the altimeter. The operation is based on the simulation of a desirable altitude by creating the equivalent vacuum by the operation of the vacuum pump (14) and of the accumulator chamberl of vacuum with incorporated vent (15), her adjustment to the desirable value by operation of control valve fot fine adjustment (17) and ventilation (18), pressure intimated by the tranducer of absolute pressure (20) whom signal of exit is processed and transformed by the electronic block formed by the multiplexer (8), the analogue-digital converter (9) and control unit (10) in pressure values, leakage or altitudes, depending on the operation way prescribed through keyboard (11) and displayed by digital display (13).

The accumulator chamber of vacuum with incorporated vent (15) (fig. 2) it is designed to create a reserve of vacuum for variation of vacuum without sudden fluctuations, and his operation is based on the creation of some forces to open the vent, resulted from the differences of existing pressures on both sides of the the vent (27) through baffling of the vacuum route existing between central drain (26) and the seat of the vent (29) concomitantly with the compression of the spring (28), whereat is added the atmospheric pressure, and vacuum's maintenance in the closed volume determinated by the inside of the accumulator chamber together with the connected circuits to the air fittings (25) it is ensured by the relaxion of the spring and his come back in the initial position, combined with vacuum already realized, who maintain themselfe in position.

The accumulator chamber of pressure with incorporated vent (2) it is designed to create a reserve of pressure for variation without sudden fluctuations, and his operation is similar to vacuum accumulator chamber.

TECHNICAL CHARACTERISTICS

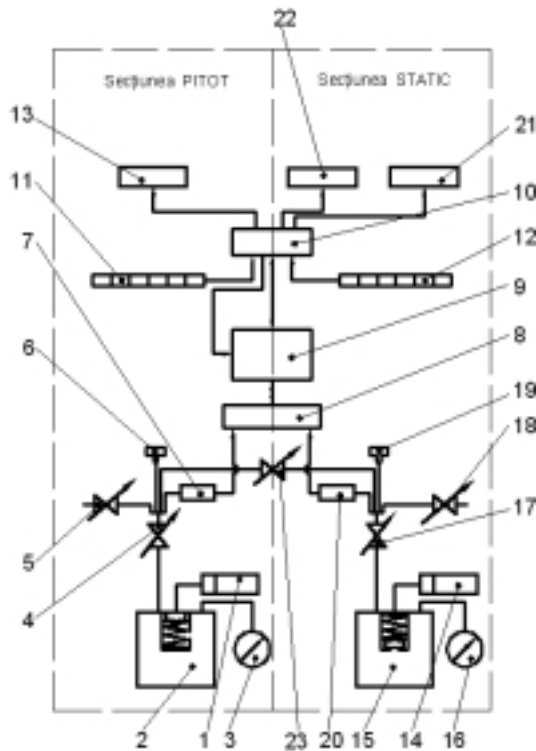


Fig. 1

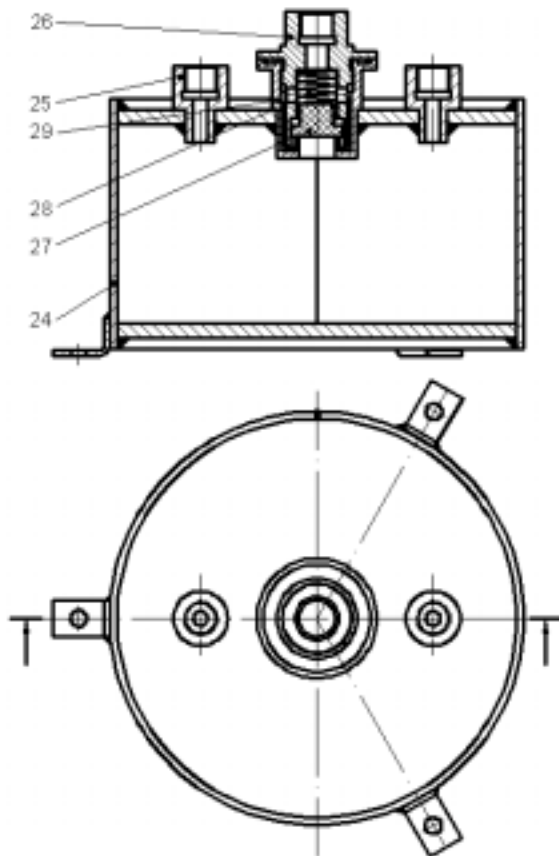


Fig. 2

- absolute limit pressure to STATIC connection: ≤ 200 mbari;
- maximal pressure to PITOT connection: 1 bar;
- Altimeter: -operating range: -300... + 11. 000 m against the sea level;
 - maximal error: $\pm 0,5$ % from indicated value, respectively ± 2 m for altitudes less than 100 m;
- Speedometer: - operating range: 0...1.100 km/h;
 - maximal error: $\pm 0,5$ % from indicated value, respectively ± 3 km/h for speeds less 100 km/h;
- endowed with variometric indicator;
- operating temperature: + 5°... + 40°C;
- supply: 24 Vdc or 28 Vdc



Fig. 3: Equipment for testing the tightness, the altimeters and the speedometers from aircraft's board.

REFERENCES

- Ph.D. Eng. T. Penescu, Phisicist V. Petrescu (1968)
 „*Pressure measurement in tehcnical*” Publisher
 and Place of publication: Technical publishing
 house, Bucharest;
- Federal Aviation Regulation (FAR 91.411)
 „*Altitude gauge and equipments of testing
 and verify the altitude gauge*”
- Federal Aviation Regulation (FAR 43) Apendice E
 „*Systems for altitude verification*”
- Aviation publication 970
 „*Pneumatics instalation*” – normativ Anglia
 for military aviation