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CONTROLLER FOR RESONANCE FATIGUE TEST OF HELICOPTER STRUCTURE ELEMENTS IN THE CONFIGURATION SIMULATING TAKE-OFF-FLIGHT-LANDING

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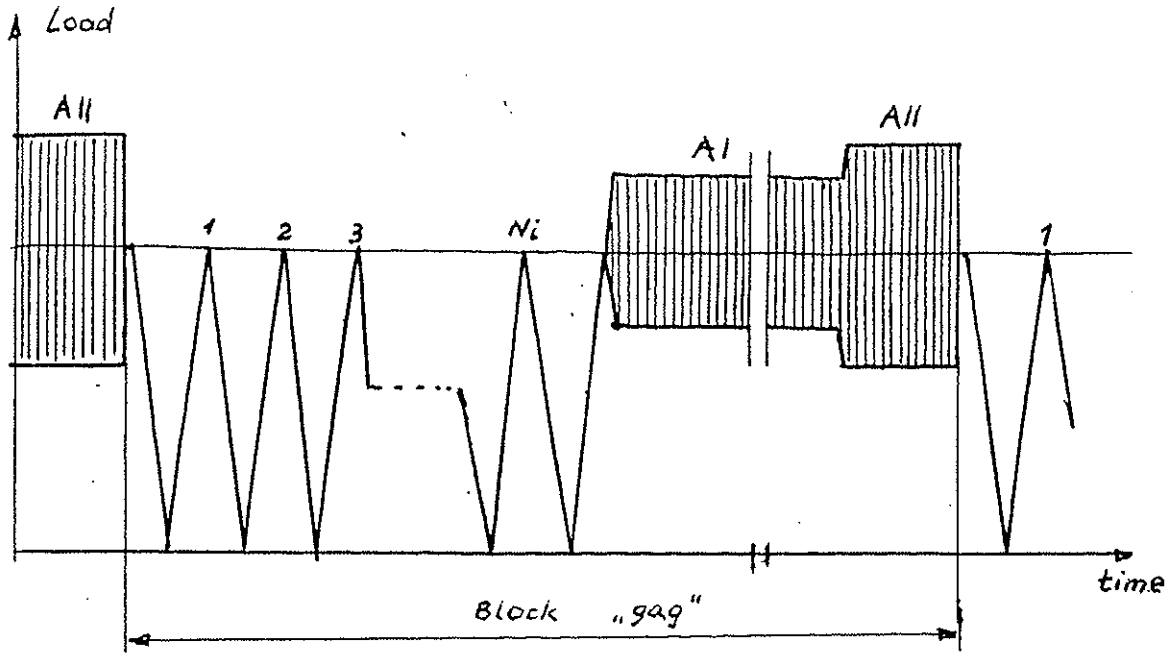
T.B.O /Time Between Overhauls/ for such elements like: main rotor blades and tail rotor blades is established according to the conventional method after the test on the test stand to provide as follows:

- input constant static load /pull/
- input constant, sinusoidal dynamic loads /amplitude/

A test parameter is amplitude of dynamic loads. The pull /tension/ during the test is to be constant. The T.B.O is determined after performing the required quantity of cycles on the I-st operation range /smaller load/ then on the II-nd operation range /higher load/. Such system of the T.B.O determining does not take into account subsequent take-offs-landings and it is not approached to real flight conditions.

The method simulating the take-off-landing /called "gag" method - derived from the words "ground-air-ground"/ enables to omit an additional factor of 2 utilized in the conventional method and makes possible to determine the T.B.O in a manner assuring better safety. This results from referring to real loads in flight where there are various levels of dynamic loads. Method of load realization in the "gag" method is shown in Fig. 1.



Example: AII = 1,5 · AI

Ni = 9

Fig. 1. Loads realization in "gag" method.

A single block corresponds to a single take-off-landing of helicopter. Level AI corresponds to two times loads increase in relation to loads in flight obtained. Level AII corresponds to three times loads increase in relation to loads in flight obtained. No. of cycles for individual levels is such calculated that the load of level AII give for the T.B.O as many as loads of level AI.

Exemplary test parameters confirming 4500 hrs. T.B.O for six samples tested - for the single "gag" block are as follows:

Loads AI	5112 cycles
Loads AII = 1,5 AI	445 cycles
No. of pull cycles	Ni = 9
No. of "gag" blocks to be realized	9000

It should be noted that when T.B.O is calculated an amplitude of dynamic loads is to be risen to power of six,

so obtaining a very high stability of the sample is essential. How important it is, let us know that the amplitude change by 3 % gives the resultant error of about 20 %.

To input the loads in accordance with the "gag" method two separate hydraulic trains with appropriate control can be utilized. One train is for the static load /pull/ realization, the other is for dynamic loads /amplitude/. Such systems offers MOOG Firm. This is very expensive solution, having individual configurations, however it provides a high stability of the test parameters and quick transition to subsequent operation modes. It requires use of complicated controllers and feeders for the hydraulics.

Scheme of loads shown in Fig. 1 can also be obtained utilizing a typical test stand for fatique tests. The idea depends on connecting the static loads input system /pull/ with a serwo-motor with solenoid valves, and with the dynamic loads input /amplitude/ - input by an inertial shaker driven by DC motor as shown in Fig. 2. Both systems are connected in the controller with the positive feedback loop, compensating influence of the pull path on the amplitude circuit.

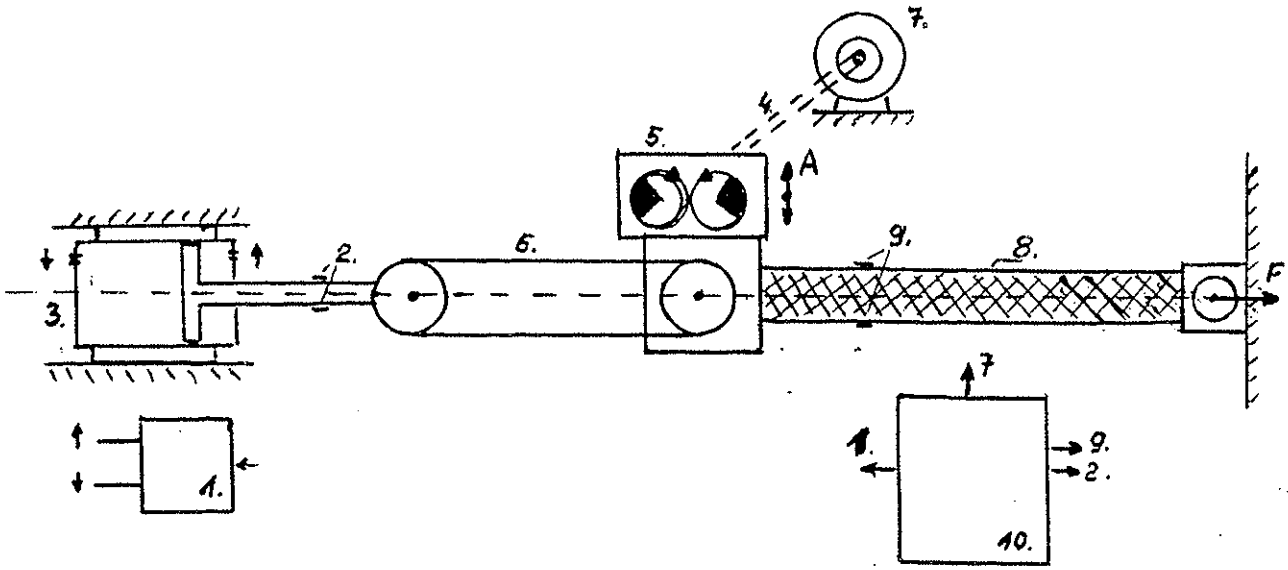


Fig. 2. Test stand for fatigue tests acc. to "gag" method.

1 - Hydraulic pump
2 - Pull sensor
3 - Hydraulic servo-motor /actuator/
4 - Flexible shaft
5 - Inertial shaker
6 - Cables
7 - DC motor
8 - Sample to be tested
9 - Amplitude sensor
10 - Controller "gag"
11 - Sensors A,S

The intertial shaker consists of two spinning weights in opposite directions /elimination of the specimen stretching/ connected to DC elec. motor with the flexible shaft. Regulation of the dynamic loads is carried out through the operation on the edge of the resonance characteristics of an element tested. Maintaining the constant amplitude is realized through appropriate change of voltage supplying the DC motor. The electric motor is supplied from industrial power supply network 220V 50Hz.

Due to the adjusting - the rotational speed of the motor is being changed. Frequency of the dynamic loads is close to the resonance frequency of the specimen tested. For such method of adjusting and the device for resonance parameters adjustment of fatigue test, a patent from the Patent Office No. 154835 has been obtained on 1989.

This is reasonable solution economically because the existing stands can be utilized with small modifications implemented /installation of the hydraulic servo-motor/. It assures to obtain satisfactory technical parametres. The electronic controller itself is constructed for concrete technical needs, i.e method of loads input in the block. Cost of the controller is small in relation to the MOOG controller one.

The controller technical parameters are as follows:

For the static loads block /pull/:

- hydraulic servo-motor controlled through two systems of the solenoid valves providing increase and decrease of the pull force,
- tolerance of static loads maintaining $\pm$ 2 %,
- strain gauges in stabilizing and pull check system,
- digital setting the cycles quantity in the block /unit/ N=0...99,
- automatic switching on/off the alert
  delay protection 1....10 sec.
  immediate protection - when exceeding threshold of 110 %,
- parameters displayed on digital voltmeter.

For dynamic loads block /amplitude/:

- inertial shaker driven by DC elec. motor 5 kW,
- tolerance of parameters maintaining $\pm$ 3 %,
- digital setting the AI and AII 0....9999 /99990/ of cycles quantity,
- strain gauges in stabilizing and amplitude check system,
- automatic switching on/off the alert
  delay protection 2....10 sec.
  immediate protection - when exceeding threshold of 110 %,
- separate settings the start parameters of I and II range,
- memory of amplitude cycles counted in a given range,
- mechanical counter of whole "gag" blocks,
- possibility of manual parameters setting prior to the test,
- LED's signalling state of sample operation,
- transoptors feedback /voltage and current/,
- parameters displayed on digital voltmeter.

The next step in the controller design will be use of the single hydraulic servo-motor unit /pump of high power/ for several separate stands, use computer for the cycles and amplitude counting function and control of several test stands operation.
It should be noted that use of the computer will not cause "slim" of the controller because the strain gauge amplifier paths, regulators and supply and power control systems will not be changed.

Moreover, it is assummed an additional hydraulic path introducing to obtain the torsional load cycles of a sample tested.