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by

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TITLE : EXPERIMENTAL RESEARCH ON DIGITAL CONTROL OF
ENGINE JT15D-4

AUTHOR: MA REI, JINANG DAZHONG, LI YUANYE, LE HUACONG

SUMMARY This article carried out experimental research on digital control systems for the JT15D-4 engine. It probed into problems associated with the design and operation of digital control systems. In order to raise the reliability of digital control systems, in the systems, we selected for use duplex communications, condition performance monitoring, hydraulic mechanism reserve regulators, software malfunction diagnosis alarm, and other similar types of measures. Going through digital simulation, semi-physical simulations, and various phases of actual operation on test platforms, the correctness of the system structure and design were experimentally verified, and this supplied experience in actual use for research on a more advanced development of full-function digital control.

Key Terms reliability, fault diagnosis, digital control

Following along with the expansion of aircraft flight ranges, the requirement for comprehensive controls for aviation engine control systems became greater and greater, causing it to be difficult to realize ideal comprehensive control with hydraulic mechanical control systems. As far as the introduction to the world of microprocessors and the expansion of their use is concerned, the reliability of electronic components has continually increased as well as computer control weight, price, sensitivity, and other similar aspects which are advantages. The selection for use of digital computer controls on aviation power equipment along with a gradual replacing of hydraulic mechanical controls are already inevitable trends in development. However, at the present time, computer control systems have still not become as familiar and reliable as mechanical hydraulic type control systems. Because of this, we carried out, on the JT15D-4 engine, experimental studies on digital control, probing into the questions associated with digital systems' design and operation. In order to

improve and raise the reliability of the whole digital control system, the systems which were test produced adopted for use duplex communications, hydraulic mechanical type reserve regulators, condition performance control checks, software fault diagnosis and alarms, as well as similar types of measures. Semi-physical simulation tests and actual operations on test platforms are capable, for a more advanced development of full function digital control system test manufacture, of offering the experience of a number of actual utilizations.

I. JT15D-4 DIGITAL CONTROL SYSTEM

The digital control system in question still continues to use the original principles of control from the JT15D-4 hydraulic mechanical type regulators, causing the high voltage rotor rotation speed N_2 to maintain a constant value, that is,

$$N_2 = \text{const}$$

Moreover, they limit the low voltage rotor rotation speed N_1 , that is

$$N_1 \leq N_{1, \text{max}}$$

Use is made of the difference between the given high voltage rotor rotation speed $N_{2 \text{ Given}}$ and the actual measured high voltage rotor speed of rotation $N_{2 \text{ Measured}}$ to realize a closed loop circuit for control. When the absolute value of this difference is smaller than or equal to 2.5% of $N_{2 \text{ max}}$, the system carries out stable state adjustment programs. Digital control stable state regulators select for use PID control methods of calculation. When the absolute value of the difference is larger than 2.5% $N_{2 \text{ max}}$, on the basis of logic determinations, it carries out addition and subtraction programs of control. In stable state processes, it carries out observations of the engine's 10 principal operating parameters at fixed times. Along

with this, it takes a fixed frequency and displays it on a screen. During transitional state processes, 10 increments are selected for use (each increment is 15.95s). Five color parameter curves carry out the monitoring and control. Operational data (stable state or transitional state) is all capable of being put back onto the curves in order to facilitate the carrying out of data analysis. This is for the study of engine operating status to improve reliable basic material concerning control systems. When control parameters exceed their extreme limit values, besides the use of indicator lights as

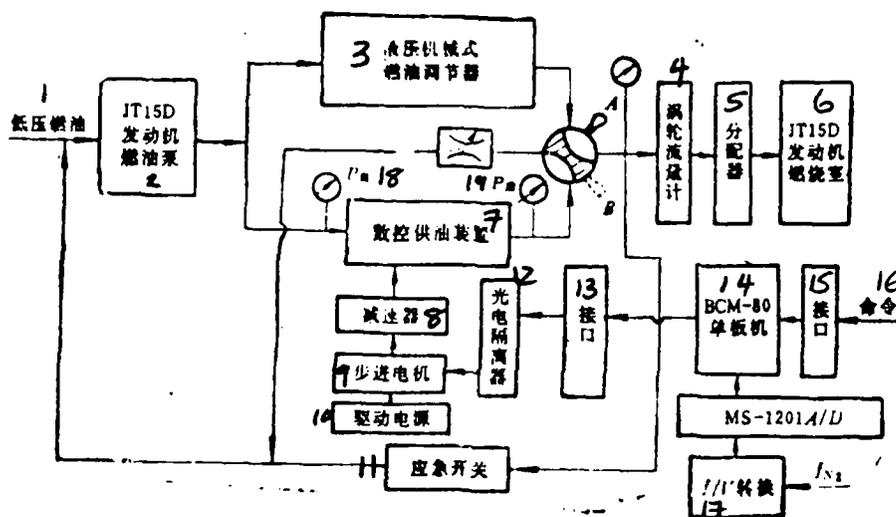


Table 1 System Diagram (1) Low Pressure Fuel (2) JT15D Engine Fuel Pump (3) Hydraulic Mechanical Fuel Regulator (4) Turbine Flow Meter (5) Distributor (6) JT15D Fuel Chamber (7) Digital Control Fuel Supply System (8) Speed Reduction Device (9) Step Motor (10) Drive Power Source (11) Emergency Switch (12) Photoelectric Isolator (13) Plug or Connector (14) BCM-80 Single Board Device (15) Plug or Connector (16) Commands (17) f/V Conversion (18) Before (19) After

alarms, the system, at the same time, goes into an oil supply limiting program or procedure. When digital control systems show the existence of a fault, it is possible to manually cut back to the original hydraulic mechanical control system. Test bed experiments demonstrate that the functions and redundancy or complementary nature are guarantees of the reliable operation of the system. The schematic diagram for the system is as shown in Fig.1.

The various main parts of the system are as described below.

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