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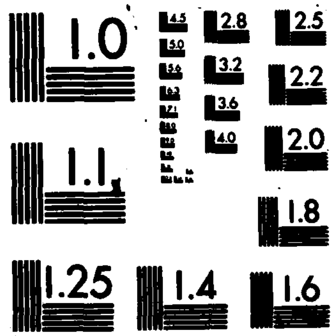

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JDF-1 SMALL LIGHT-WEIGHT ELECTRIC EDDY CURRENT OSCILLATOR

by

Ning Hang

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EDITED TRANSLATION

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JDF-1 SMALL LIGHT-WEIGHT ELECTRIC EDDY CURRENT OSCILLATOR

Ning Hang

Among the new oscillation equipment used for frequency measurement in current aeronautical research, the contactless type electric eddy current oscillator is the most promising. However, there is still no supplier of such equipment in the international market.

The Nanjing Aeronautical Engineering College has successfully developed a contactless type small light-weight electric eddy current oscillator, which has model number JDF-1. This oscillator can be used for measurement and testing of the static frequency of blades, disks, plates, pipes and other parts of aircraft engines made of magnetic and non-magnetic metal materials. In addition, the oscillator can be used to measure the oscillation of laser holography. The model JDF-1 has the following properties:

1. The oscillator does not come into contact with the tested specimen so there is no additional mass. Therefore, the accuracy of measurement and testing of static frequency is high.

2. The oscillation energy is quite high and the range of the response frequency is wide. A blade oscillation mode higher than 30,000 hertz has been excited.

3. The adaptation range of the oscillator is wide; it is capable of measuring and testing the static frequency of parts made of titanium alloy, aluminum alloy, stainless steel and nickel-base high-temperature alloy.

4. The operating efficiency is high, requiring only about 1 minute per blade during continuous measurement and testing of blades in serial production.

5. The oscillator is light in weight and small in size, with no moving parts. The structure is simple; it is convenient in manufacture, usage and maintenance. The energy consumption and the noise liberated by the equipment are low.

At present, the first batch of JDF-1 model eddy current oscillators was delivered to some colleges, research institutes and factories for their use with good results.

Operation Principle

The model JDF-1 eddy current oscillator operates on the electromagnetic induction principle, utilizing the electromagnetic force in the vertical direction (forming the source of oscillation) when a current-carrying conductor crosses a magnetic field. The oscillator has no moving parts and its main body is composed of a pair of alternating and direct current magnetic circuits (refer to Fig. 1). A rare-earth permanent magnetic body is utilized in the permanent magnetic circuit as a horizontal magnetic circuit. An alternately varying magnetic field appears in the vertical direction, producing an induced electric eddy current in blades as the alternately varying magnetic field penetrates the measured blades along the thickness direction. Then, the measured blades carrying an electric eddy current produce an electromagnetic force F,* which is perpendicular to the directions of the permanent magnetic field and electric eddy current while under the action of the permanent magnetic field. The magnitude of force F is proportional to the product of magnetic induction intensity of the permanent magnetic field and the eddy current; the direction of force F abides by the left-hand rule. It is assumed that the horizontal component of the permanent magnetic field is B (gauss); the eddy current of the measured blade is I (ampere); and the effecting acting force is L (centimeter). The electromagnetic force (in other words, the oscillation force F acting on the measured specimen) is

$$F = 0.102 \times 10^{-6}\,BIL \text{ (kg)}$$

Method of Use

For conducting frequency measurement testing of blades of aircraft engines, the connection of instruments is shown in Fig. 2.

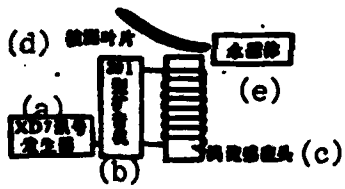

Fig. 1. Principle of model JDF-1 electric eddy current oscillator. Key: (a) Signal producer; (b) Model 301 amplifier; (c) Eddy current induction head; (d) Measured blade; (e) Permanent magnetic body.

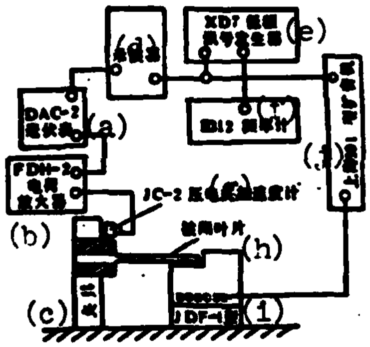

Fig. 2. Measurement and testing system of static frequency of blade. Key: (a) Millivoltmeter; (b) Electric charge amplifier; (c) Fixture; (d) Oscillograph; (e) Low frequency signal producer; (f) Frequency meter; (g) Piezoelectric type accelerometer; (h) Measured blade; (i) Model; (j) Shanghai model 301 amplifier.

The measured blades are placed horizontally above the induction head of the eddy current and beside the permanent magnetic body, maintaining a certain gap between blades. When there is an adjustable acoustical frequency signal current of energy amplification of the winding of the induction head, the same-frequency eddy current will be induced in the blades, producing forced oscillation on the blades. When the changed acoustic frequency signal attains the natural frequency of the blades, they produce resonance.

In order to obtain the optimal oscillation effect, in the frequency measurement process the relative position between oscillator and blades can be appropriately changed based on different oscillation types during the process of frequency measurement. The changing relative position can improve the layout of the alternating and direct current magnetic circuits. Besides, the adjustment of the power supply is an important means to enhance the oscillation effect. In the general situation, the measured specimens are close to the permanent magnetic body, and the closer the contact between the tested specimen and the eddy current induction head (but without contact), the better the oscillation effect.

Technical Properties

Beginning from 1976, the Nanjing Aeronautical Engineering College successfully developed three generations (76, 77 and 78) of gradually remodeled oscillators. In order to attain miniaturization and high effectiveness of the oscillators, in the development process the following test items were proceeded: comparison test of types of magnetic pole, electric simulation test of magnetic field, comparison test of air gap effect of magnetic poles, test of intensity of alternating and direct current magnetic excitation, optical relative position test between oscillator and blades, comparison test of model selection of permanent magnetic body, and the impedance matching tests of the eddy current oscillator and power amplification. In 1981, the model JDF-1 small light-weight contactless type electric eddy current oscillator (Fig. 3) was successfully developed. After certification by the related departments and experts, the model JDF-1 eddy current oscillator attains the following technical performance:

Range of response frequency	50 through 15,000 hertz;
Input power	50 watts (long-term operation)
	$\ngtr$ 1 ampere (operating current);

Noise index	$\ngtr$ 70 db (oscillator itself);
Operation time	8 hours of continuous operation;
Exterior dimensions	79x76x73 millimeters;
Weight	0.95 kg.

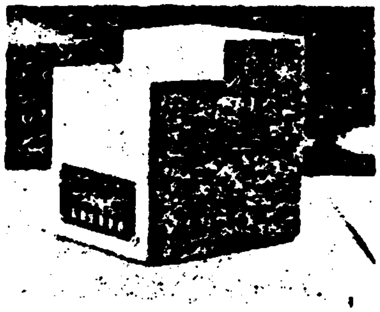

Fig. 3. Model JDF-1 contactless type eddy current oscillator.

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