

METHOD OF MEASURING TORQUE-SPEED CHARACTERISTICS OF FRACTIONAL HORSEPOWER MOTORS

K. MURARI

Indian Institute of Technology, Kharagpur

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In determining experimentally the speed-torque characteristics of fractional horsepower servomotor, accurate measurement of small torques is necessary. The paper here describes the accurate measurement of small torques of the order of 50 gm-cm or even less. Principle of eddy-current damping is used on a thin metallic disc rotating in the air-gap of an electromagnet and the reaction torque due to eddy-currents in the metallic disc is balanced with the standard weights placed in a scale-pan.

NOMENCLATURE

a —The distance in centimetre from the centre of the spindle to the centre of the pole face.

F —Force in grams on the electromagnet, which acts at the centre of the pole face.

l_1 —The length in centimetres from the centre of the pole shoe to the pivoted point.

l_2 —The length of the lever arm in centimetres from the pivoted point to the point where the scale pan is hung.

W —Weight in the scale pan.

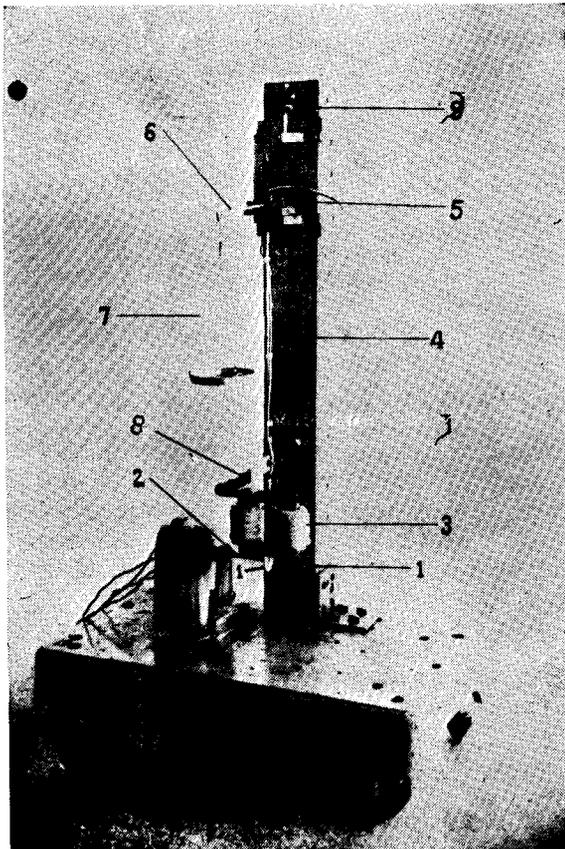


Fig. 1—Torque measuring device.

Accurate measurement of small torques is necessary in determining experimentally the speed-torque characteristics of fractional hp motors. It is possible to measure accurately small torques of the order of 50 gm-cm to 1 gm-cm or even less by means of an apparatus developed by author. Principle of eddy-current damping is used on a thin metallic disc rotating in the air gap of an electromagnet and the reaction torque due to eddy-currents in the metallic disc is balanced with standard weights placed in a scale pan.

EXPERIMENTAL PROCEDURE

The set-up used is shown in Fig. 1. A very thin duminium or copper disc (1), whose moment of inertia is about 0.05 times that of the rotor assembly, (to minimize the loading effects on the bearing) is mounted on the spindle (2) of the motor under test. This disc rotates in the small air gap of electromagnet (3). The electromagnet is screwed to a vertical rod (4) with a knife edge (5) which rests on a knife edge groove. A lever arm (6) is attached perpendicular to the vertical rod which carries a scale pan (7) in which the standard weights can be placed. A spirit level with magnifying attachment (8) is fixed to the vertical rod such that the spirit level remains in the horizontal position.

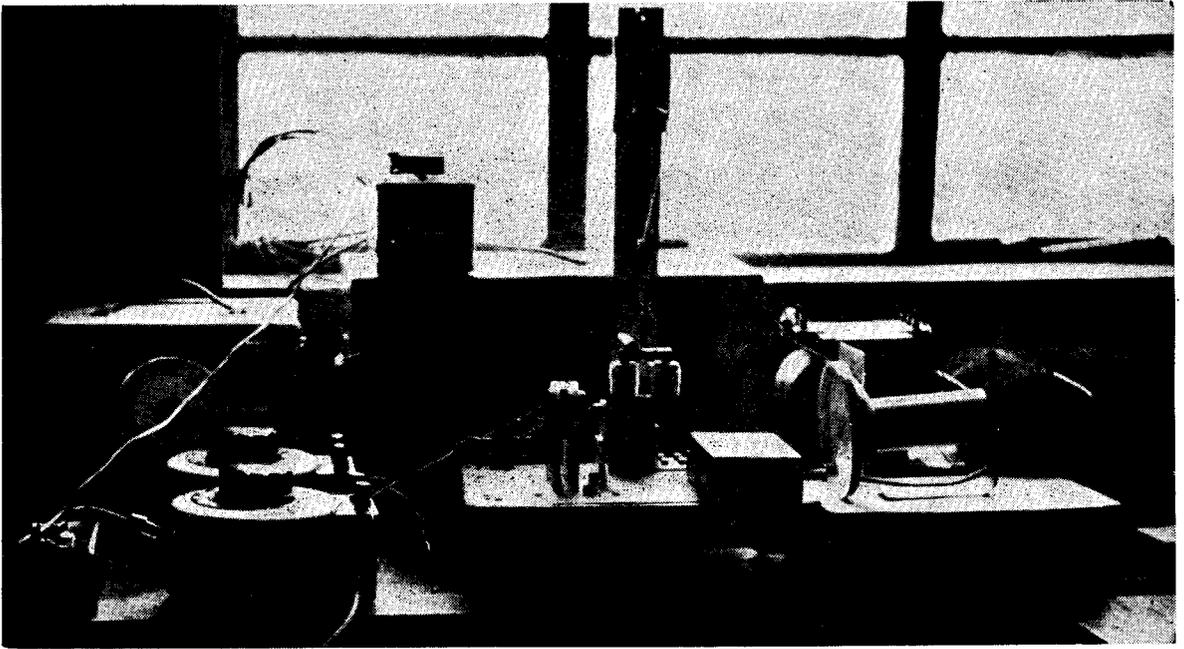


Fig. 2 — Experimental set up for obtaining the torque-slip characteristics.

As the disc rotates in the narrow air gap of the electromagnet currents are induced in the disc so that a force is experienced by the disc in a direction opposite to that of the speed of rotation (Fig. 2). As a result, a reaction torque is experienced by the electromagnet, which is equal and opposite to that on the disc. This force tilts the electromagnet from its vertical position, which results in displacing the bubble in the spirit level from its original position. Weights are placed in the scale pan to bring the bubble back to its original position, thus again making the rod vertical.

The torque acting on the disc can be readily calculated to be $F \times a$ (see Appendix 1).

Variation in the force acting on the disc is obtained (i) by varying the current in the winding of the electromagnet and (ii) by varying the position of the electromagnet on the surface of the disc by means of a lead screw arrangement (9).

RESULTS OF OBSERVATION

The torque-slip characteristic of a two phase servomotor obtained with the help of this device is shown in Fig. 3. At lower speeds (or higher slips), the torque-slip characteristic is almost straight. It can be seen from the graph (Fig. 3) that the maximum stall torque is 22.5 gm-cm.

DISCUSSION

The following points are found very essential in the measurement of small torques :

- (i) The measuring device should not load the spindle in which case the torque measured does not correspond to the real output torque of the motor,
- (ii) There must be an accurate means of measuring the reaction torques,

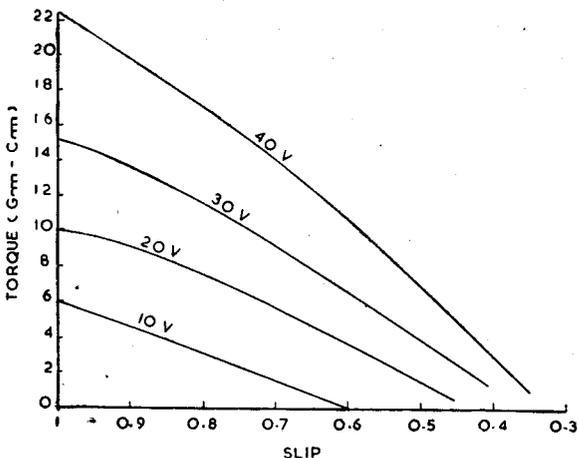


Fig. 3—Torque-slip characteristics of 400 Hz-2-phase servomotor (fractional horsepower).

(iii) The spindle of the motor must be of non-magnetic material to eliminate the attraction between the spindle and the electromagnet, and

(iv) The weight of the moving assembly must be as small as possible.

Care should be taken in handling the light disc on and off rotor shaft as it is susceptible to damage.

APPENDIX I

When the reaction torque on the electromagnet is balanced, then (see nomenclature) taking moments about the pivoted point,

$$W l_2 = Fl$$

$$F = \left(\frac{l_2}{l_1} \right) W$$

and the torque acting on the disc is $F \times a$.

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REFERENCE

1. DRYSDALE, A. C. & JOLLY, C.V., "Electrical Measuring Instruments Part I" (Chapman Hall Co., London), 1952.