MECHANICAL MEASUREMENTS

A DYNAMOMETER TABLE WITH A SMALL INERTIA

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The dynamometer single-component table, described below, is typical of the instruments used at present for measuring separate components of the cutting force in grinding, planing and other technological operations.

The object of this article is to draw the attention of experimenters to the character and the size of certain errors peculiar to these operations and thus prevent the possible spreading of incorrect methods of their utilization.

The present author has investigated the characteristic of a typical single-component dynamometer type DOS-1 shown in Fig. 1.

The body of the dynamometer is made out of a single piece of steel, which possesses good elastic properties. Webs 3 of the body connect the upper mobile plate 1 to the lower stationary plate 2. The shape and position of the elastic webs provides the possibility of a relatively easy elastic displacement of the upper plate in the longitudinal direction (in the direction of the measured force).

The elastic displacement of the upper plate is recorded by means of two inductive transducers 5, which are placed inside special nonmagnetic bodies 6 on the lower plate, to the right and left of the common armature, 7, fixed by means of screws to the upper plate.

The sensitivity of the dynamometer can be set by means of screws 4 which alter the initial gaps between the transducers and the armature. Both the transducers and the gaps are securely protected from dust or dirt by means of a cover with a door.

The variation of the above gaps under the action of the grinding forces alters the electrical parameters of the input amplifier bridge, whose adjacent arms consist of the inductive transducers. The recording of the output signal is carried out by means of loop oscilloscope type MPO-2 (vibrator type IV).

The dynamometer is intended for measuring forces in the range of 20-1000 kg-wt; the natural frequency of the dynamometer is about 450 cps; its stiffness in the direction of measurement is $j = 45,000$ kg-wt/mm.

*In the books of P. A. Markelov "Speed grinding of steel by face milling machines," and V. V. Kuvshinskii, "Grinding," Mashgiz, 1955, and some other books, incorrect methods of using dynamometer tables are given.
In order to establish the relation between the nature and value of the dynamometer reading and the load, a special calibrating device was used which made it possible to simulate the above conditions.

By means of this device the dynamometer can be loaded with three static forces applied to various points of the working surface of the table as shown in Fig. 2.

During testing, dynamometer readings were taken for various conditions of loading. From these readings the character and absolute values of the relation of the readings to the load conditions were established.

Figure 3 shows these relations. The readings of the microammeter are plotted along the y axis when force $P_h = 350$ kg-wt was measured. The load was applied at three points along the length of the table as shown in Fig. 2. In addition, some of the curves correspond to various relations among the components $P_v$, $P_h$ and $P_o$.

The study of the curves shows that if the dynamometer table measures component $P_h$ when the other two components are equal to zero, its sensitivity remains practically constant, irrespective of the displacement of the point of application of the force along the table. In reality the components $P_v$ and $P_o$ are never equal to zero, and can have values relative to $P_h$ shown in Fig. 3. In this instance the sensitivity of the dynamometer varies considerably when the point of application of the force is changed in one direction or the other with respect to the middle of the table. Thus, at point $A_2$ the variation of the sensitivity and hence of the error of measurement attains $19\%$. At point $A_3$ the variations in the reading of the dynamometer amount to $\pm 25\%$. A similar type of variation in the dynamometer reading occurs when the point of application of the resultant force is placed in another plane determined by points $A'_1$, $A'_2$ and $A'_3$ (Fig. 4).

Tests have shown that displacement of the point of application of the resultant force in the transverse direction or its displacement away from the surface of the table has hardly any effect on the readings of the instrument (Fig. 5).