Under the effect of force $P_z$ the upper portion of the body to which the cutter is fixed is displaced downward. This is attained by means of slot 4. The displacement of the upper part of the dynamometer with respect to the lower part is recorded by indicator 7, whose pointer carries mirror 8. A beam of light from the illuminator is reflected from mirror 8 onto scale $P_z$ which is also placed at a distance of 2 m from the dynamometer.

Since the inclined portion of the slot 4 is placed at the height of the lathe centers, effort $P_y$ does not affect the reading of indicator 7, and the choice of an appropriate sweep for the cutter makes the reading of indicator 5 independent of the effect of $P_z$.

The dynamometer with the optical display has a strictly linear calibration characteristic. It displayed in use complete reliability at cutter speeds of 30-40 m/min.

Particularly good results were obtained with this dynamometer, owing to its high precision in measuring efforts $P_z$ and $P_y$, when thin turnings were being cut.

**LITERATURE CITED**

2. V. I. Melamed and V. I. Davidyuk, Trudy ChMgSKh, Chelyabinsk, No. 7 (1959).

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**PROTECTION OF MANOMETERS WHEN MEASURING PULSATING PRESSURES**

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Translated from Izmeritel'na Tekhnika, No. 6, pp. 20-22, June, 1960

Periodic (pulsating) variations in the pressure of the working substance (gas or liquid) occurs in the operation of many machines. This pressure (its mean value) is measured by a manometer of some type or other consisting of a sensitive element (tube, bellows, diaphragm, etc) and a transmitting mechanism, which actuates a pointer or a remote operating unit. The peculiarity of such instruments consists in the existence of one or several resonance frequencies which produce oscillations of separate components, at a large amplitude when the pulsation frequency coincides with their natural frequency. Usually these oscillations lead to a rise in the measurement errors and even to the breaking of the instrument.

The natural frequencies of the measuring systems which consist of diaphragm electrical transducers of pressure, transmission mechanisms (which may be lacking) and remote transmission units, lie in the range of 500-1000 cps for pressures of 5 to 200 kg-wt/cm².

In order to avoid oscillations, manometer pointers are supplied with dampers usually consisting of chambers, with one or several diaphragms whose holes vary in size according to the required degree of damping.

The defect of such a damper consists in the residual pointer pulsations which normally cannot be eliminated since a large decrease in the size of diaphragm holes would lead to a far too large lag in the instrument readings and would increase the probability of the holes becoming blocked with dirt.

The author of this article has proposed a damper (Fig. 1) which will protect the manometer from pulsating...
pressures. The damper consists of a chamber 1 with diaphragm 3 and a pipe 2, which connects the two cavities of the damper otherwise separated by the diaphragm. The dimensions of the chamber with the diaphragm and the pipe are selected in such a manner that their amplitude-frequency characteristics in the range of the resonance frequency of the manometer are similar. With a correctly selected length of the pipe the phase shift in it is such that the pressure oscillations at the fundamental resonance frequency of the manometer, having passed through the pipe, arrive at the diaphragm in phase opposition to the original oscillation and suppress them.

![Diagram of the damper](image)

*Fig. 4. A version of the damper design with the additional pipe. 1) Pipe, 2) capillary diaphragm, 3) connecting pipe.*

The phase shift \( \varphi \) provided by pipe 2 is represented by

\[
\varphi = 180^\circ + \varphi_p,
\]

where \( \varphi_p \) is the phase shift of the pressure oscillations which have passed through the chamber with the diaphragm characterized by the transfer constant \( S = 1/(1 + j\omega \tau) \) \( \tau \) being the time constant of the diaphragm).

Thus, the frequency characteristic shown in Fig. 2 is obtained; the characteristic was obtained experimentally by means of a damper model, tested on an air pulsating installation.

It follows from the principle of operation of the proposed damper that its frequency characteristic should in theory have an infinite number of minima which is partly shown in Fig. 2.

The damper with the additional pipe has a considerably smaller inertia (time constant) than the normal damping devices, which provide the same degree of pulsation suppression at the transducer's resonant frequency. The experimental amplitude-frequency characteristic of the damper with the additional pipe and its theoretical characteristic plotted from the transfer constant \( S = 1/(1 + j\omega \tau) \) of a normal plastic damper are shown in Fig. 3.

![Graphs of the amplitude-frequency characteristics](image)

*Fig. 3. 1) The amplitude-frequency characteristic of the damper with an additional pipe, \( \omega_1 = 188.4 \text{ sec}^{-1} \); 2) the amplitude-frequency characteristic of a damper with a diaphragm, \( \omega_2 = 50.24 \text{ sec}^{-1}; \tau_2/\tau_1 = 3.77.\*)

The required length of the pipe is determined from formula

\[
\ell = \frac{\varphi}{360} \lambda = \left( \frac{1}{2} + \frac{3}{4} \right) \lambda,
\]

where \( \lambda \) is the length of the sound wave equal to \( c/f_0 \); \( c \) is the speed of sound; \( f_0 \) is the resonance frequency of the manometer.

Thus, the frequency characteristic shown in Fig. 2 is obtained; the characteristic was obtained experimentally by means of a damper model, tested on an air pulsating installation.

The damper with the additional pipe has a considerably smaller inertia (time constant) than the normal damping devices, which provide the same degree of pulsation suppression at the transducer's resonant frequency. The experimental amplitude-frequency characteristic of the damper with the additional pipe and its theoretical characteristic plotted from the transfer constant \( S = 1/(1 + j\omega \tau) \) of a normal plastic damper are shown in Fig. 3.