lems related to the measurement and control of technological processes.

Fig. 2.

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HIGH-SPEED MULTIRANGE INSTRUMENTS FOR MEASURING AND RECORDING PRESSURE

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In studying an agglomeration process it is necessary to measure static gas pressure at various sections of the sintered layer. Such measurements are usually made in practical experiments by means of the simplest water-filled U-shaped manometers, thus requiring an operator for recurrent measurements and recording of results. This work is difficult, requires concentrated attention and does not eliminate the possibility of errors. The instruments produced by our industry for measuring and recording pressure, consisting of recording circular differential pressure gauges DKSV, can hardly be used for agglomeration research for two reasons: These instruments have a single channel and, therefore, as many instruments as measuring points will be required for continuous measurement of pressure and, what is even more important, these instruments have a considerable inertia (owing to the large capacity of the air ring) which is comparable to the time taken by pressure variations at the measured point, i.e., they produce a large error. This error increases if thin feed tubes are used or the instrument is moved away from the sintering installation.

The metallurgical department of the S. M. Kirov Ural Polytechnic Institute has developed an instrument which measures pressure simultaneously at several points and records the results on a single chart of a recording electronic potentiometer.

The pressure is measured by means of wire-wound strain-gauge transducers [1]. The device consists of a measuring box, an adjusting box, a multichannel recording electronic potentiometer EPP-09, a dry cell (of 1-2 V) a milliammeter or voltmeter, connecting leads and feed tubes.

The measuring box consists of several similar rectangular chambers measuring 90 x 50 x 20 mm. The side walls of each chamber have two inlets 1 (Fig. 1), for connecting them by means of feed tubes to the measured
area. The box is divided into half by a 2-mm thick rubber wall 2 which serves as the diaphragm of the instrument. Each chamber is hermetically sealed by careful grinding of the adjacent surfaces which are pressed together by bolts. Each chamber constitutes an independent measuring cell and contains a thin phosphor-bronze elastic strip 3 one end of which is rigidly fixed to the side surface of the chamber, and the other rests against the rubber diaphragm. Wire-wound strain-gauge transducers 4 are glued to each side of the strip and their leads are taken out through hermetic sealing to external terminals 5.

The adjusting box serves to set the zero at each measured point. The adjusting box has several similar devices (as many as there are chambers in the measuring box). Each device (Fig. 2) consists of strip 1 with transducers which are identical with those in the measuring box. One end of the strip is rigidly fixed to the box and the other rests against adjusting screw 2. The adjusting box panel also carries terminals 3 and switch 4.

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The device operates in the following manner.

The rubber diaphragm together with the elastic transducer spring is deformed by the difference in pressures on either side of it, thus producing a bridge unbalance which is measured on the potentiometer.

Contrary to other circuits [2, 3] in which all the bridge transducers are operating, and the zero is set by means of a special slide wire, in this circuit only two of the transducers are operating and there is no slide wire, which considerably simplifies the instrument and raises its reliability.

The measuring box is light and small and, therefore, convenient for placing close up to the sintering installation. The potentiometer can be at any distance from the measured object, since it is connected to the measuring box by electrical means. The chamber volume is less than a tenth of the volume of the ring used in a standard instrument. Both these circumstances reduce the inertia of the instrument to a minimum.

The instrument can measure various pressures according to the elastic properties of the rubber diaphragm and the current in the strain-gauge transducers. In our case the maximum measured rarefaction amounted to 1500 mm of water.

The error of the instrument is reduced and an approximately linear relationship between the pressure and the instrument readings is obtained when the thickness of the rubber diaphragm is selected and its tensioning is set in such a manner that its sagging does not exceed 3 - 5 mm. The range of measured pressure should then be set by changing the current through the strain-gauge transducers. By meeting this condition the hysteresis loop was completely eliminated, and the instrument provided the same readings for a rising and a falling pressure. The absolute error amounted to 5 mm of water in the range of mean pressures of 500 - 1000 mm of water. When the pressure was raised up to the top limit (1500 mm of water) the error rose to 10 - 15 mm of water. Thus, the relative measurement error was about 1%.

We made no special tests to determine the dynamic error of the instrument. However, it was established with precision that the diaphragm with its measuring strips and transducers, following a sudden change in pressure, returned to its balanced position in under 3 sec, which equals the spacing between the consecutive potentiometer measurements. For the purpose of using this instrument in testing sintering processes such a "dynamic" sensitivity is quite satisfactory.

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