MEASUREMENTS OF MASS

TRANSDUCER FOR MEASURING THE WEIGHT OF LOADS ON A CONVEYER BELT

(UDC 621.317.39: 531.75)

B. V. Fadeev, K. N. Mamaev, and V. S. Volotkovskii

Translated from Izmeritel'naya Tekhnika, No. 2, pp. 31-33, February, 1965

Electrical methods for weighing loads on a conveyor belt are being used increasingly in recent years. Such methods provide records on instruments (for instance, oscillographs) of the weight of loads on the conveyor at any instant, which is very important in studying conveyor transport installations.

In such investigations it is required to know, as a rule, the amount of material on the conveyor at any given instant, and not the conveyor's efficiency; therefore, only weight transducers are normally used. Such studies require a high precision of measurements, whereas all the existing conveyor weight transducers have inherent errors due to the following causes.

Changes in the resistance of rotation of the measuring-support rollers with variations in the load, propulsion speed et al. According to published data this error for a normal operation of the conveyor amounts to approximately 2% and is considerably larger for transient conditions [1].

Sinking of the weighing platform under load. The displacement of the platform attains 0.5 mm, thus leading to errors up to 1% [1].

Inaccurate setting of the measuring roller support with respect to adjacent supports.

Effect on the weight transducer of transverse loading and vibrations.

The authors of this article have designed and tested out an electrical weight transducer in which part of the above errors has been eliminated, and the remaining errors reduced to a minimum. The weight transducer has a small over-all size and mass (80 kg). It can be mounted in any place along the conveyor at any angle on any of the existing belt conveyors with a rigid frame, including conveyor cantilevers of rotary escalators.

The weight transducer (Fig. 1) has two metal parallelograms which are fixed by their rear uprights 1 to both sides of a conveyor frame. The front uprights 2 of the parallelogram are fixed to the upper roller support of the conveyor. Gap h is left between the front uprights and the conveyor frame. Each parallelogram has four bearing units 3. Thus, the entire structure can change its slope angle with respect to the conveyor frame plane.

The weight transducer is provided with a single measuring element 4 located in the middle of the roller support when conveyors with a belt width of 1200 mm are tested. In this case the stiffness of the device in the direction perpendicular to the conveyor frame is provided by transverse coupling. The weight transducer for conveyors with a belt width of 2000 mm consists of two measuring elements located at the edges of the roller support. In this case, the stiffness of the device is provided automatically. The weight transducer can easily be used with any type of conveyor, since its width is not limited by design and is determined only by the length of the tested conveyor’s roller support. It is advisable to locate the transducer at the point where the transported material is loaded onto the conveyor and the stretching of the belt is at a minimum.

The pressure of the load is transmitted through the belt and the roller support to cantilever 5 with its cylinder 6, which is connected by a thread to nut 7. The rotation of nut 7 displaces rod 8, thus providing the precise setting of the measuring roller support with respect to the adjacent supports. The displacement of rod 8 amounts to 40 mm. The weight of the belt and the roller support can be compensated by a tare weight fixed to beam 9 of the transducer, thus providing for the complete utilization of the element's sensitivity. The tare weight is made 1.6 times smaller than that of the belt and the roller support, since the arms ratio is \( \frac{I_2}{I_1} = 1.6 \).
The parallelograms included in the transducer's structure eliminate the error due to changes in the resistance coefficient of the conveyer in the course of its operation.

Of the great variety of element types for measuring pressure, magnetoelastic and inductive transducers, as well as various types of dynamometers with resistance-wire strain gauges are used in conveyer scales. The first two types of transducers, in addition to a certain nonlinearity of their characteristic as compared with the dynamometers, are inconvenient, since their output signal is frequency-modulated. In studying conveyers it is often necessary to record the current and power of motors. The recording on a single tape of three frequency signals of current, power and weight is inconvenient owing to the difficulty of decoding oscillograms. Therefore, it is preferable to use dynamometers with resistance strain gauges as measuring elements.

A cylindrical element which measures compression is the simplest from the design point of view. However, tests have shown that it is very sensitive to transverse efforts, which frequently arise in measuring loads on a belt conveyer. The use of cylindrical dynamometers is only permissible with devices which prevent deformations of the component by transverse loading. For this reason annular elements [2] are often used as weight transducers, but they are difficult to mount.

The measuring element of the weight transducer described in this article consists of a flanged beam which is made of brand 65G steel and bends under load. The position of the beam in a weight transducer for loads of 600 kg is shown in Fig. 2. Four foil transducers which can carry 10-15 times larger currents than normal wire transducers are cemented to the beam. The resistance of these transducers is 50-60 Ω with an effective length of 20 mm. The use of foil elements in the elastic transducers which operate under high stresses of the order of 200 MN/m² and of highly-sensitive vibrators in oscillograph MPO-2 (N-102) provides recording without an amplifier. The method of cementing and connecting transducers eliminates the effect on their readings of the bearing-axle contact-line displacement with respect to the middle of the beam and the effect of twisting and lateral efforts, if they arise in measurements. Three types of beams interchangeable with respect to their dimensions were made for loads of 200, 600 and 1000 kg.