AUTOMATIC STABILIZATION OF PRODUCT THICKNESS
ON PRESS P907

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Two methods of stabilizing the thickness of the green product are possible in principle on the hydraulic press. With the first method pressing is done until the pressing system develops the maximum pressure, which is released after a certain holding period; when the thickness of the pressed article shows certain deviations in value, the filling has to be regulated. The second method consists in the fact that pressing is done to obtain a constant size of green article, after which the pressure is released. If the pressure obtained in the system deviates from the prescribed level, the filling is regulated.

From the point of view of the quality of the green brick pressed with deviations of the filling, these two methods have a fundamental difference consisting in the following:

when pressing is done to constant pressure, among the articles having identical apparent density, due to variations in the properties of the body, there will be green brick with size deviations;

during pressing to constant dimensions, among the products having identical thickness, due to variations in the properties in the body, there will be green brick with deviations in apparent density, that is, underpressed products.

The quantity and magnitude of the deviations in both cases will be determined by the quality of preparing the body, the work of the filling device on the press, and the system of regulating the filling operation. With the existing system of controlling the green product and the finished article some of the refractories with deviations will be of necessity delivered to the consumer. Therefore, in selecting the method of stabilizing the thickness, the question arises as to which deviations are more admissible in the service of the refractories.

In developing a system of stabilizing press P907 it was decided to use the first method. The taking of such a decision was helped by the hydraulic system already connected to the press, specifying pressing to constant pressure, and also by the fact that the stability of the apparent density and mechanical properties of the green brick are more important than the stability of the thickness of the brick.

The following principles were incorporated into the newly developed system:

the thickness of the article is measured indirectly by checking the extreme upper position of the pressing plunger at the moment of termination of the pressing;

when there is a deviation in the thickness from the prescribed level the system records its sign and magnitude, and then changes the depth of filling by a magnitude proportional to the deviation. The measurement of the products for the purpose of regulation is done only in one out of every four molds. By "depth of filling" we understand the depth of the mold at the moment of entry of body into it.

The work of the regulating system is described by the following equation

$$\Delta H = H_1 + a - H_1 = K_c (h_0 - h_1).$$

where $\Delta H$ is the value of the change in the depth of the filling, mm; $H_1 + a$ is the height of correction of the filling, mm; $H_1$ is the depth of filling in the mold in which the article is pressed, mm; $K_c$ is the compression coefficient; $h_0$ is the nominal stated dimension of the product, mm; $h_1$ is the dimension of the pressed article, mm; $a$ is the number of molds into which at the moment of pressing of the article of thickness $h_1$, the filling has already been made or is being made.
On the 4-position press P907 when pressing is going on in the press mold 1 (Fig. 1), the press mold 2 is located at the position of equilibrium, and the press mold 3 is already filled or being filled and is located at the filling position, so a change in the filling can be done only as the filling position for press mold 4, that is, \( \alpha = 2 \), is being approached.

The system of automatic stabilization of product thickness (Fig. 2) consists of:
- the meters SI, designed for measuring the displacement of the plungers;
- the memory device, consisting of a process meter SO, and an electromagnetic clutch EM, designed for recording the deviation of thickness and for measuring the change in the filling;
- the indicator SU, serving to record visual observations of the thickness of the pressed green product and to determine the prescribed thickness;
- the sensor SZ designed for sending signals into the system;
- the amplifier UE which amplifies the signal received from SZ;
- terminal switches KV in accordance with the operation of the system of the press;
- the control circuits Sx;
- the slave mechanisms IM, which are drives for the MIZ;
- the mechanism for changing the filling MIZ.

Selsyns are used in the system as the SI, SO, SU, and SZ units.

The system operates as follows. The meter SI during completion of the pressing over a distance of 50 mm measures the rise of the plunger, transmitting it to the electric connections 1 and 2 in the form of an angle of rotation \( \alpha_1 \), on the armature SI to the memory device SO. The angle of rotation \( \alpha_0 \) of the armature SO, equal to \( \alpha_1 \) and the corresponding thickness of the article being pressed, is fixed by switching on the electromagnetic clutch EM, closing the mechanical connections 11 and 15. Simultaneously the connections 1 and 2 are broken, and the connections 3 and 4 are closed. By means of the connections 3 and 4 it is possible to compare the positions of the armatures SO and SZ. The position of the armature SZ is used to record the required value of \( \alpha_3 \).

When \( \alpha_0 \) does not equal \( \alpha_3 \), the input of UE receives from SZ a signal, the phase of which depends on the sign of the difference \( \Delta \alpha = \alpha_3 - \alpha_0 \). In this case the IM unit is switched on so as to act on the MIZ unit and alters the filling by a magnitude proportional to the difference. Simultaneously the IM unit through the appropriate transmitter rotates the armature SO until the equality of the angles \( \alpha_0 \) and \( \alpha_3 \) operates.

In the system there are two reversible connection circuits: the first controls the stabilization of the thickness, and is effected through the connections 10, 12, 14, 1, 2, 3, and 4; the second controls the relationship between the change in the filling for the difference \( \Delta \alpha \), and is effected through the connections 11, 3, and 4. The connection 11 is closed at the moment of termination of the pressing, and is opened soon after the treatment of the difference \( \Delta \alpha \) by the slave mechanism. Therefore in each control cycle the position of MIZ, for which the body of the article being pressed has been filled in, is that starting position relative to which the change is being made.