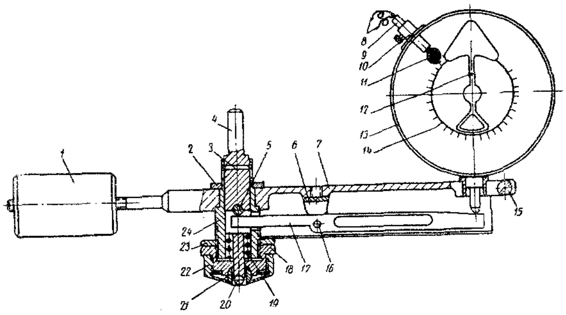

Fig. 4. Indicator attachment KLD-1

readings.

The lack of horizontality in the position of the plane surface of the bolt's head is compensated for by the turn of the spherical prop (21) [within 5°] and is not reflected in the results of the test.

The indicator head carries the box (13), which can turn around the scale (14), which in its turn can be turned in relation to the center of the arrow (12).

On the box (13) is fixed the induction recorder, consisting of an induction coil (11) which consists of two sections with a clearance for the passage of the flag-screen of the arrow (12).

The trapezoidal shape of the flag-screen (12) allows variation of the range of allowances for the deviations from the nominal by shifting the rod (9) of the inductive coil (11) in its bushing. The conduits (8) to the induction coil are connected to a high-frequency generator.

The circuit diagram (Fig. 5). The cycle of automatic operation begins with the switching on of the interrupter BA of the coil K of the magnetic starter and this switches on the electric motor by three contacts KP. The fourth contact BK closes the circuit that blocks the interrupter BA. The contact MK is enclosed within the Brinell press.

When the testing proceeds by individual pieces, the electric motor M is started by the foot pedal P. After the completion of a cycle the press breaks the contact and the motor stops.

The principle of the action of the part controlling the solenoids, in connection with the pulses transmitted by the induction recorder, is based on the change of the inductive capacity of the coils in the network on the entrance and exit of the flag-screen from the clearance between the coils. The magnitude of the induction is determined from the presence or absence of generation in the master oscillator.

The circuit of the oscillator is tuned so that on the entrance of the flag into the clearance between the sections of the oscillator coils L_1 and L_2 self-induction and generation of high frequency oscillations takes place (15–20 Mc). Then, due to the appearance of the grid-current a negative voltage is placed onto the grid of the vacuum tube, and the anodic current drops sharply. The relay P cuts out the mercury contact (PK_1) and cuts in the other one (PK_2).

The switchover of the mercury contact controls the work of the solenoids l_1 and l_2, fed by direct current of 110 from a selenium rectifier.

The circuit of the solenoids contains a microinterrupter Mi, which switches on this circuit (only at the moment of measuring the hardness) by means of a cam placed on the axle of the press crank.

On return of the arrow-flag to its original position, the switchover of the solenoids becomes impossible.

The introduction of the automatic device KLD-2 for the control of the hardness of bolts increased efficiency by 8 times, and made the precision of the work much higher. One device frees 7 operators and saves 10, 000 rubles annually.

The introduction of these devices should be highly effective in plants producing standard pieces. A slight change in the charging system of the device makes possible its use for hardness measurements on any standard piece, on any mass-produced part and ensures high precision of work at considerable savings.

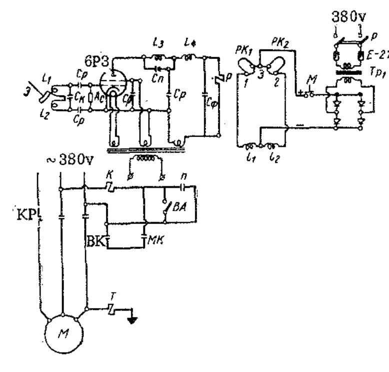

Fig. 5. Electric diagram of the device

AUTOMATIC TEMPERATURE CONTROL BY HIGH FREQUENCY CURRENTS IN THE HEATING OF PIECES FOR QUENCHING

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This paper describes a new principle of automatically controlling the heat treatment of parts for quenching. It is based on the application of the sudden change in magnetic permeability and electrical resistance of steel (Fig. 1) at

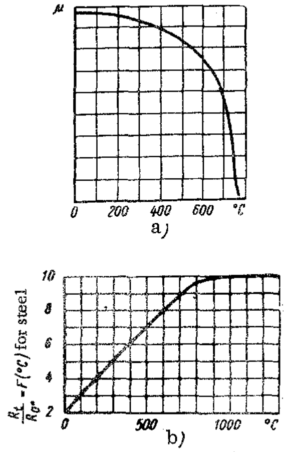

Fig. 1. Changes in magnetic permeability (a) and electrical resistance (b) near the Curie point

temperatures close to the Curie points. For the majority of steels the Curie points lie at 760–780°C. The location of these points does not depend on 1) the rate of heating, 2) the voltage and frequency of the feeding circuit, 3) the shape of the part to be treated, or 4) the method of heating.

Figure 2 shows the circuit diagram of the induction heating of parts before quenching. The stepdown transformer (1) fed from the HF generator (2) (10, 000 cycles) transmits energy to the inductor (3) with the treated part (4) inside it.

At the start of heating, when the temperature of the piece is still low and still possesses high permeability and high induction, the primary coil of the transformer carries a relatively strong current. However, as soon as some points of the surface of the piece reach the Curie points, permeability and induction weaken and the current in the primary coil drops.

When all points of the piece heated reach the critical point, the primary current becomes stabilized. Its intensity corresponds then to the idling run of the inductor.

Figure 3 shows the oscillogram of the current in the coil of the inductor during the heating of the tooth of a cultivator (at the "Krasnyi Aksa" machinery plant).

Before heating starts, the current in the inductor is 250 amp at 500 volts and a frequency of 10, 000. Toward the end of the heating process it drops to 150 amp, while the idling current amounts to 110–120 amp.

The point where the current intensity starts dropping corresponds to the beginning of the magnetic transformation (point a); the end of the current drop (point b) corresponds

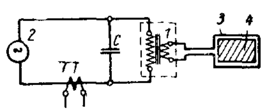

Fig. 2. Circuit diagram of the induction heater

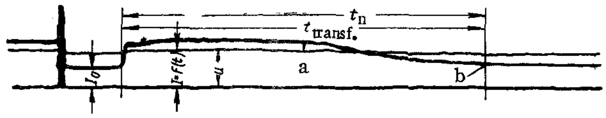

Fig. 3. Oscillograms of the changes in current intensity during the heating process

to the reaching of the Curie point by the whole piece (750°C).

The initial and final values of current in the inductor depend on the voltage applied to the transformer, but the moments of the beginning and end of current falls depend only on the temperature cycle in the part treated.

Therefore, the record of the beginning and especially of the end in the current fall indicates that the Curie point (780°C) was reached by the whole surface of the treated part.

The most convenient way of observing the current consists of following the first derivative di/dt of intensity with respect to time. Beyond point b this function becomes zero.

The impulse which will automatically control the heating process of the part prepared for quenching can be obtained by using the functional scheme (Fig. 4), which consists of the following blocks.

Block 1. The technological machine KA-11 performs the automatic insertion of the part into the inductor and its ejection into the quenching bath.

Block 2. Input block, where the high-voltage, high-frequency current arrives from the transformer and varies during the heat treatment. This alternating current is turned into the proportional D. C. voltage under the action of a crystal rectifier, and is smoothed by the RC filter. At the output from block 2 the voltage U(t) = K · i(t) obtains, where K is the proportionality factor.

Block 3. This is the differentiating block, producing the first derivative of the current with respect to time. Here dU/dt = K di/dt, which is proportional to the first derivative of the basic current.

Block 4. This is the amplifier of the derivative and at its output is placed the П, which is operated on the appearance of the above function, which corresponds to the moment of the drop in current intensity (point a in Fig. 3).

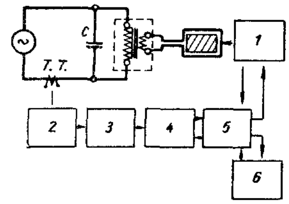

Fig. 4. Functional diagram showing the production of the control pulse from the first derivative of the current in the primary circuit with respect to time

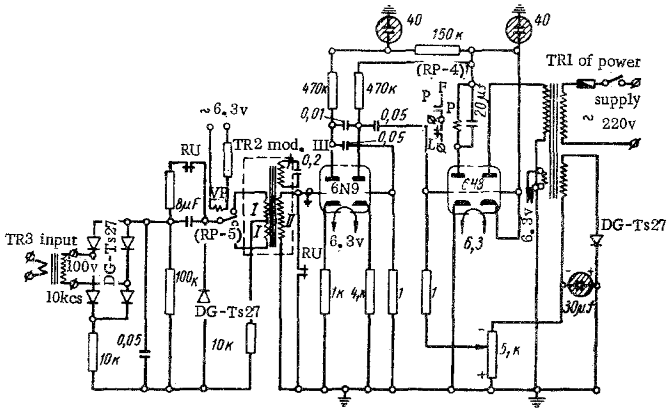

Fig. 5. Principal diagram of block 2–4, which produce the first derivative with respect to time

The relay releases when the point b of the end of the drop is reached at dU/dt = 0.

Block 5. The circuit diagram of the automatic device controlling the process. The controlling pulse, produced by this block and transmitted to the blocks, is coordinated by block 6.

Block 6. This block controls the length of time of the return connections and of the blocking process.

The basic circuit diagrams of blocks 2–4 are presented in Fig. 5; the diagram of blocks 5 and 6 are presented in Fig. 6.

For quenching purposes the piece must be heated to 900–910°C, and the piece has to stay for a certain additional length of time within the inductor. This part of the process can be controlled independently.

If we assume the required temperature (900°) of pre-quenching to be 100%, then the control of temperature in relation to the observed Curie point (780–800°C) will, with sufficient precision, determine the temperature reached. The final heating can be assured by the control of time to the extent of about 10%. An error of 20–30% in this control is permissible. The error in determining the true temperature may total (0.2–0.3) · 0.1 = 0.02–0.03, i.e., 2–3%.

The system described, developed at the Rostov Institute for Agricultural Machine Construction, in the form of an attachment to the treating-quenching apparatus KA-11, was composed of two parts. One is intended for the production of the controlling impulse, the other for heating from the Curie point to the quenching temperature.

Summary. 1. The described method of automatic control of the process of heating and quenching of steel parts ensures a reliable temperature control, which is independent of the type of current in the electric network, of the shape of the part, and of the rate of the process.

2. The same system can be used for the automatic control of temperature with any other method of heating (gas flame, furnace, etc.).

3. The same system can find application in the automatic checking of many technological parameters that can be controlled by electric measurements.

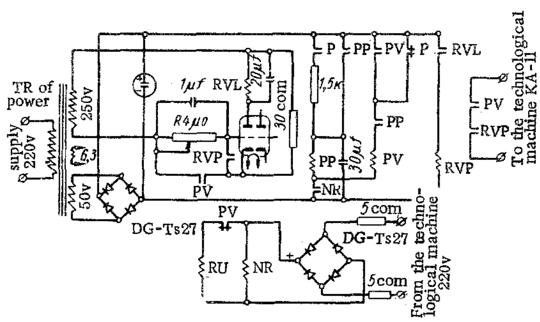

Fig. 6. Block that determined time and the diagram of automatic delivery of the control signal into the diagram of the technological machine. RBL relay of type RP–4; PP, PV, RVP, RU, and NR relay of type RPN

CONVEYOR PRE-QUENCHING ELECTRIC FURNACES OF A NEW SERIES

V. I. FILIPPOV, Engineer
OK5 "Electropech'"

The main defect of the heating-quenching conveyor electric furnaces built by the enterprises of this branch of industry is their unsuitability for work in a protective atmosphere. This causes loss by oxidation, loss of strength, and additional cost in later machining.

Using the same series of sizes of the new series of quenching-tempering alloys, Metallovedenie i Termicheskaya Obrabotka Metallov, see 10 (1960) the OKB "Elektropech'" has developed new electric furnaces that differ from the previous series in the following advantages: