A CHANGE IN THE ELECTRICAL CIRCUIT OF THE
"RITM-1" UNIT BTM-1 REMOTE CONTROL

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In iron and steel plants wide use is made of dispatcher control of power equipment equipped with modern technical means of transmitting, processing, and presenting information.

In Magnesite Combine the "Ritm-1" unit is used for remote control of heat and water supply equipment.

The "Ritm-1" remote control unit is a combination of technical means for automated information systems for control of production processes and includes everything necessary for this means of automation, remote control, and communication and an IKM-1 control computer of the centralized control computer class.

Composite tests of the "Ritm-1" remote control unit under laboratory and production conditions in 1981 [1, 2] with efficient and accurate operation of the telemechanical, remote control, and television channels revealed significant deficiencies in the electrical circuit of the telemeasurement channel. The telemeasurement channel operates unstably and has a low accuracy. The error in telemeasurement is not less than ±15%.

Careful analysis of the operating principle of the "Ritm-1" shows that the low telemetering accuracy is related to imperfections in the electrical circuit of the peripheral BTM-1 remote control units. Figure 1 shows the block circuit of the BTM-1.

To the input of the amplifier are supplied two voltages, the voltage from the sensor and the voltage from the compensating transformer CT. The double compensator, consisting of the compensating transformer CT and the circuit controlling it, accomplishes successive balancing of the sensor signal by the controlling voltages taken from the windings of the compensating transformer CT. The amplitudes of the controlling voltages are proportional to the numerical values of the first six terms of the geometric progression 1, 2, 4, 8, 16, and 32 and are 10, 20, 40, 80, 160, and 320 mV.

The difference signal from the output of the double compensator and the sensor is fed to the input of the amplifier, which is connected to the signal modulator.

The signal modulator includes a two-stage voltage transistor amplifier, a phase-sensitive power modulator consisting of the transistor T3, and the modulation relay MR on the output.

Fig. 1. Block circuit of the BTM-1 remote control block.

The double compensator with the contacts of the relays RN1-RN6, the signal modulator, the pulse generator, and the distributor—hold element, which is controlled by the contact of the generator RG, forms an analog-to-digital converter, which acts by the method of successive compensation.

With prevalence of the sensor voltage the relay MR is engaged, while with prevalence of the compensating voltage it is not engaged.

The remotely measured value is transmitted by a six-pulse polar code. Pulses of positive polarity correspond to the engaged condition of the MR; negative, to the disengaged condition of the MR.

The contact MR in the distributor—hold element locks those of the relays RN1-RN6 which correspond to transmission of a positive pulse.

Switching of the BTM-1 from receiving to transmitting is done by the contacts of the relay CR of the command unit in accordance with the address of the VTM-1 written in its command unit.

This electrical circuit possesses the following shortcomings:

- comparison of the voltages of the sensor and the compensating transformer occurs on the low-resistance input resistance of the amplifier. As the result of this a circulating current having the phase of the larger voltage flows in the comparison circuit during measurement. This current creates a drop in voltage in the internal resistance of the sensor and the compensating transformer. The phases of these voltages are such that the greater voltage decreases and the lesser increases;

- during transmission of the pulse the contact SR in the emitter-base circuit of T3 is closed. The cutoff voltage at the emitter-base junction of T3 increases from 0.8-1.0 to 7-8 V. However, the transistor T3 is not closed, since the matching transformer MT changes to a condition close to the no-load condition and the voltage on its secondary winding increases to 8-9 V. As the result of this, during switching of the contacts of the relays RN1-RN6 false engagement of the relay MR occurs if before this it was disengaged;

- the presence of the condenser C2 in the power circuit of the relay MR slows engagement of it with low voltages on the input of the amplifier. As the result of this, sharpness in operation of the relay MR is lost and the latest digits of the code are dropped;

- a phase shift between the sensor voltage and the line voltage of 60-70 electrical degrees requires, for normal operation of the photosensitive stage, a bias voltage on the base of the transistor T3 ($U_{b1} = 2.0-2.5$ V), which reduces the sensitivity of the stage.

Figure 2 shows the changed portion of the electrical circuit of the BTM-1.

The semiconductor amplifier is supplemented on the input by a stage made up of the field effect transistor $T_0$. Engagement of this stage with the input resistance $R_{in}$ ($R_{in} = 220$ kΩ) eliminates the circulating current and the mutual influence of the sensor and the compensating transformer.