The mechanization and automation of the operations of preparing the green silicon carbide heater blanks for roasting, roasting and extracting them from the furnace can be maximized when use is made of the newly developed car-bottom type furnace for direct silicidizing roasting. A total of 12-18 specimens can be roasted in these furnaces simultaneously.

The heater blanks are loaded into roasting beds consisting of lined steel troughs and graphite current conductors after which they are covered with the silicidizing and heat-insulating materials. Roasting is accomplished by passing electric current through the blank which is connected into the circuit of an automatically controlled USO-80 type magnetic booster unit.

The heat conditions must be regulated during the roasting process in accordance with a program which depends on the technological requirements. The temperature of the specimens being roasted cannot readily be controlled and regulated directly. Taking into account, however, that when roasting single-type heaters the total heat capacity of the roasting beds remains approximately constant, the programmed regulation of the heat conditions can be replaced with the programmed regulation of the power dissipated on the specimen by the current passing through it.*

This method is successful for furnaces for indirect roasting but cannot be used for controlling car-bottom furnaces for direct silicidizing roasting owing to the slow response and difficulties arising from the manual resetting of the program cams.

*R. S. Bernshtein and E. G. Kazachek, Ogneupory, No. 11, 8-12 (1968).

Fig. 1. The cycle of power (P) consumption: 1) given; 2) actual, with manual control.
In the car-bottom furnace currently in use at the Podol'sk refractories plant the current in the circuit of the specimen being roasted is maintained constant automatically but is set to the required magnitude during the roasting process in conformity with the programmed power changes by an operator manually from the readings of an ammeter and voltmeter.

The initial characteristics and consequently the period in which maximum heating is reached vary from blank to blank so that with a large number of heater blanks being roasted simultaneously the manual programming of the roasting of each blank separately becomes difficult and may result in an infringement of the process specifications.

A roasting-power program is shown in Fig. 1 together with a recording of the executed program which demonstrates the inadequacy of manual control.

The maintenance of a normal power cycle in the roasting process calls for a fully automatic programmed control system as an indispensable part of a modern car-bottom furnace for silicidizing silicon carbide heaters. Such a system has been developed by the automation laboratory of the All-Union Institute of Refractories. Its block-diagram is shown in Fig. 2.

The equipment consists of a current transformer CT which transforms the current in the heater circuit in accordance with a standard range of 0–5 A; a measuring power transformer MPT for the continuous control of the power dissipated over the specimen; a master power transformer MT for presetting the power in the control system; a UPD1-03 type electronic booster EB; a final control element FCE which controls the magnetic booster MB; a current relay CR which switches the automatic control of the roasting program; a terminal switch TS which disconnects the regulation of the current in the heater circuit prior to the cutting-in of the program; a voltage divider VD with which the prescribed maximum roasting power is divided into equal parts; a voltage stabilizer VS which feeds the divider (a variation of this voltage determines the maximum power for a given heater type); a step relay SR intended for transmitting the voltage from the divider to the master transformer; and a pulse generator PG which regulates the speed of the step relay SR.

The measuring and master transformers are three-phase P005 power transformers with two single-phase circuits the emf of which are counterposed.

The action of the master consists of the programmed actuation of the SR brushes which take the voltage from the divider and transmit it to the master section of the power transformer. Its circuit is fed by a stabilized current source.

The frequency of the pulses from the pulse generator PG determines the timing of the maximum roasting power. The power is increased stepwise to the required magnitude at the rate of 4% of the maximum power per step.

The initial resistance and consequently the initial rate of heating varies from blank to blank so that the circuit of each blank contains a current relay the contacts of which switch the automatic control system for a given current (which is the same for all heaters being roasted simultaneously in the furnace).