After selecting the required voltage the rectifier is connected in parallel to the motor and into the ac network while the ballast resistor, which takes the surplus direct voltage, is connected in parallel to the specimen.

Cast iron disc 10 has a shallow central ring groove whose diameter depends on the size of the specimen. During the forward motion of the disc part of the specimen moves over the edge of the disc behind the central groove while the central portion of the specimen's surface remains in contact with the disc surface. A shorter duration of contact of the peripheral parts of the specimen's surface with the working surface of the disc compensates for the higher rate of removal of the material near the edges due to higher peripheral speed and to higher current density near the edges.

The high productivity of the apparatus is due to the favorable combination of surface wear and anode dissolution of the specimen's surface. The electrolytic dissolution of the specimen is apparently accompanied by the removal of reactive products by abrasive friction. The continuous removal of sludge from the contact zone explains, apparently, the acceleration of the process. For example, with a current density of 2-2.5 A/cm^2 using M20 abrasive powder and a 10% solution of sodium chloride, a layer of 15 μ can be removed from a molybdenum specimen in 30 sec. The thickness of a layer removed from the same specimen by purely mechanical friction in 30-40 min is never more than a few microns. On the other hand, if voltage is applied to the system while the mechanism is not started the electrolytic dissolution of the layer is very slow.

The overall size of the apparatus is 360 x 200 x 440 mm, its weight is 12 kg.

AN ELECTRONIC POTENTIOSTAT WITH A HIGH OUTPUT CURRENT

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The electrolysis at a controlled potential is a promising method for the investigation of anode dissolution. In this method an electrolytic cell is connected into an automatic control circuit whose main element is a potentiostat. However, the use of potentiostats developed for the plotting of polarization curves, the investigation of unsteady processes, and the intercrystalline corrosion in the phase-structural analysis is limited by their small output current and by the drift of the zero level in these specimens [1].

The device suggested here is based on an intermediate conversion of the error signal into alternating voltage followed by its detection. The necessary voltage is produced by a set-point unit in the form of input voltage to the comparison circuit. The voltage from the measuring element of the system, the standard cell, is connected to the same point. The unbalance voltage produced by the comparison circuit acts on the output of the amplifier and modulator. The amplified voltage is received by the phase-sensitive circuit which operates on the principle of a synchronous detector. The anode circuits of this stage and the modulator are connected to the same 50-Hz carrier-frequency generator (power transformer).

The voltage from the phase-sensitive circuit, which is also the power multiplier, is rectified, passed through a filter for smoothening the pulsations, and then arrives at the electrolytic cell. The phase ratio of the modulator and the synchronous detector is selected in such a manner that the control system has only a negative feedback, i.e., the positive error of the specimen's potential reduces the output current and vice versa. An advantage of this circuit is its insensitivity to the variation of the amplification factor of the amplifier and to the fluctuations of network voltage.

The electric circuit of the device is shown schematically in Fig. 1. The input current flows through terminals 1-0 of plug contact PC_1 to the two-position switch T_1. In one of its positions voltage is fed onto the reference circuit (comparison circuit), which consists of resistors R_1, R_2, R_3, R_4, and R_5 and dry battery B, to the contacts of the pulse-forming device PD (RP-4 polarized relay). In the other position of the switch the amplifier input is short-circuited and the voltage produced by the dividing circuit is passed through terminals 0-2 of the plug contact onto the input of the tube voltmeter which indicates, during etching, the potential on the specimen. With this circuit it is possible to set, in advance (before connecting the cell), the necessary potential of the specimen and to maintain it constant for several hours.

The voltage amplifier of the potentiostat is based on double triodes 6N9. The first stage (tube Tu_1) consists of a cathode repeater. The grid of the tube is free; a smoothing RC circuit is connected to it. The second stage has a selective rheostat-capacitor feedback filter (C_1, C_2, C_3, R_6, R_7, R_8) tuned to the basic harmonic of 50 Hz. The filter transforms square pulses received from the vibrapack output into sine voltage. The next two circuits (Tu_3 and Tu_4) consist of amplifier circuits with resistors. The anode of the third stage (Tu_3) is connected to the control grid of the electronic-optical indicator Tu_5 (6E5 tube) which shows the quality of control. When the process is normal the error signal at the amplifier input is never more than 1 mV and the screen shows a dark sector. The absence of this sector shows that the balancing in the automatic control system is not complete.

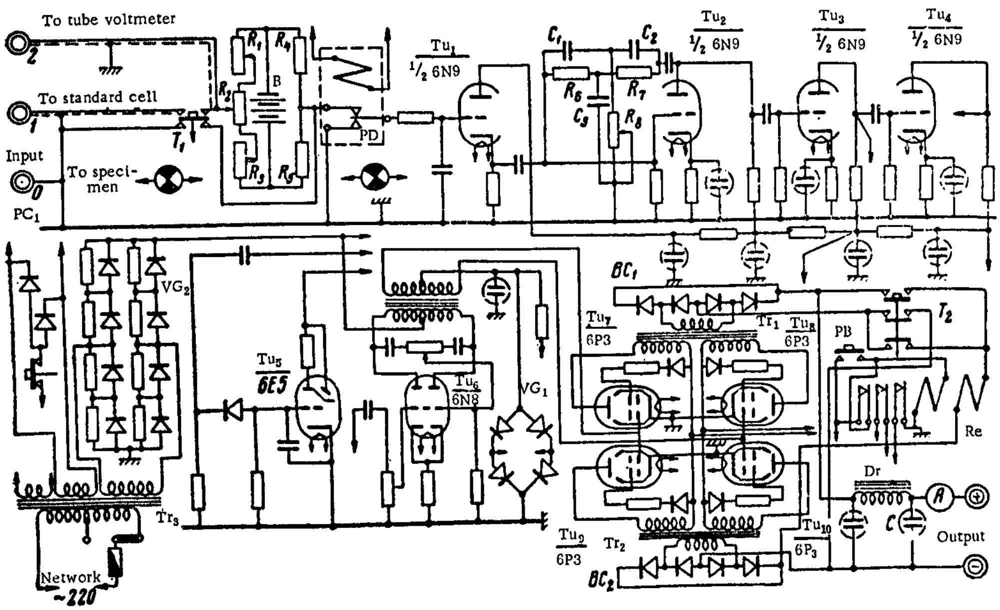

Fig. 1. Simplified electrical circuit of the potentiostat.

A phase-shifting transformer connected into the anode circuit of 6N8 (Tu_6) tube is used for starting the input stage. The grid of the tube of the penultimate stage is fed through the slope regulator. The recorded shift on power circuit grids is obtained by means of rectifier VG_1 which has a capacity filter. The output circuit has four 6P3 tetrodes loaded by two output transformers Tr_1 and Tr_2. The tubes are connected to a differential circuit; in order to avoid reverse currents the bias on the screen of the grid is fed through DGTs-27 germanium triodes. The anodes of the output circuit are fed from the separate winding of the power transformer. Since the winding has no central point it is grounded through diode keys.

The secondary windings of the output transformers are loaded by two bridge rectifiers BC_1 and BC_2 made from 100 mm diameter selenium discs. For a better adjustment of the output resistance of the device to the resistance of the electrolytic cell the current rectifier circuit contains a commuting switch T_2. The output rectifier can be connected by this switch in series or in parallel with the corresponding resistance of the device; being 3.5 or 1.5 Ω respectively. The output current of the device is fed to the load through a RC-filter and ammeter. Push-button PB is operated for starting the system; this is done after the required potential has been reached.

Since during the operation the output wires can be short-circuited the selenium rectifiers are protected by an RKM-type relay Re which has two windings. One of them carries the current from the bias rectifier. The circuit of this winding contains a tuning resistor for setting the required magnetic flux in the magnetic circuit of the relay. The winding is connected in series to the output circuit of the device. The direction of the magnetic flux of this winding opposes the current of the first winding. When the circuit is in operation the relay is energized by the bias rectifier current. If, for one reason or another, the output current of the potentiostat exceeds the set value, the magnetic fluxes become equalized and the armature descends to disconnect the anode feed of the output circuit. After the fault has been corrected the device can be restarted by push-button PB. The system is tuned for a current of 6 A.

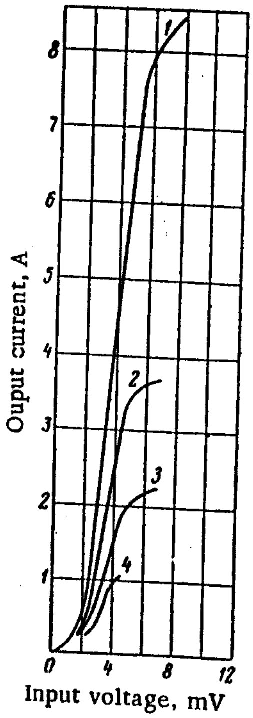

Fig. 2. Potentiostat curves: 1-4) load resistance is 0.25; 2; 4; and 10 Ω respectively.

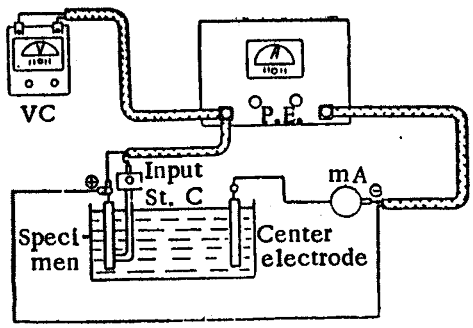

Fig. 3. Circuit with potentiostat.

The general power transformer Tr_3 feeds all elements of the system. The anode voltage rectifier VG_2 is a bridge with DGTs-27 diodes. The anode circuit of the amplifier tubes also contains RC disconnecting filters. The use of a modulator and variable anode voltage in the output circuit made the system very economical. With a power consumption of 165 W the power supply to the load is 48 W. The device takes 1-1.5 min to warm up.

The experimental curves of the device (Fig. 2) show that the slope of the amplifier can be as much as $2.25 \cdot 10^6$ mA/V. Experience shows that this considerable amplification reserve can ensure satisfactory operation with a specimen area of several tens of cm^2.

Figure 3 shows how the device is connected in use. The control circuit of the main test contains the potentiometer PE and the electrolyte cell with specimen, counter electrode, and the instrument for measuring current. Parts of the circuit are connected by flexible screened cables with prepared ends.

In order to avoid self-oscillations a slightly different circuit is used with specimens whose area is small; in this case the output of the device is connected to a low-ohmic potentiometer while the shift of the above voltage is fed into the cell. The amplification factor of the device is adjusted by means of an additional regulator.

In a work involving the separation of carbides, which requires a high dc output current, a circuit can be used in which additional current is obtained from storage batteries of adequate capacity, or from a rectifier with a filter. The storage battery output is connected in parallel to the output of the potentiostat through an additional variable resistor. This circuit can produce an output of several tens of amperes.

If the test is carried out correctly, the error in maintaining the potential never exceeds ±5 mV. The potentiostat can be used with automatic recording of output current potential. The testing of the device showed that the use of an electronic potentiostat in the phase analysis enables easy control of the electrochemical dissolution process and automatic maintenance of the desired conditions of the electrolysis. This eliminates subjective errors and the need for continuous observation and adjustments of the process.

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APPARATUS FOR HIGH-TEMPERATURE TENSILE TESTING OF MATERIALS IN VACUUM (at 2000°C)

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The mechanical testing of materials at temperatures exceeding 1000°C involves considerable methodical difficulties caused by the need to maintain a uniform temperature over the entire length of the specimen, to protect it against oxidation, to measure temperature with a high accuracy, etc.

The authors developed, for determining the mechanical properties of high-melting-point metals and alloys by tensile test in vacuum at 800-2000°C, a vacuum chamber with a high-temperature furnace for use with a small RM-500 testing machine fitted with a recording unit. A special feature of this machine, which distinguishes it from other similar machines [1, 2], is a cylindrical tantalum-sheet heater which prevents the specimen from being contaminated by carbon, which is the case with graphite heaters.

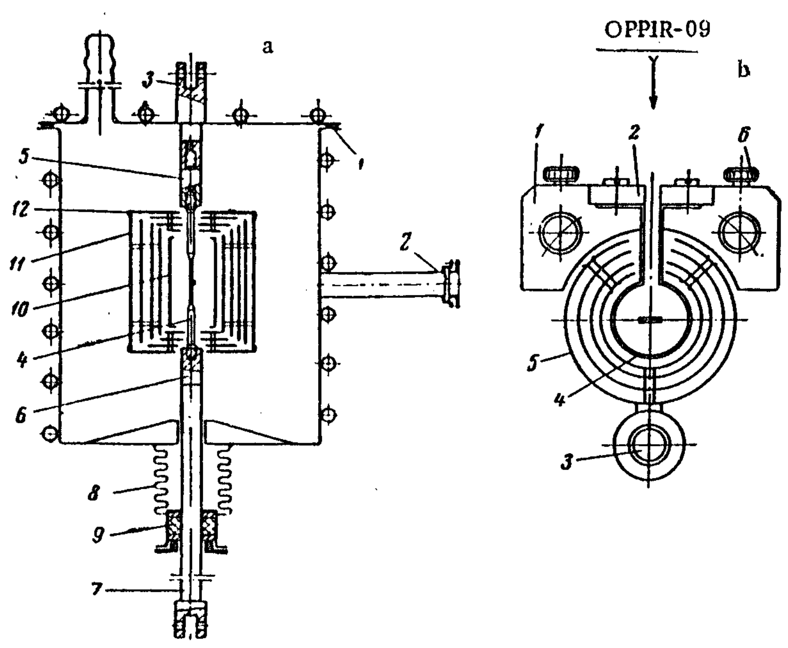

Fig. 1. Schematic diagram (a) and the heater (b) of the apparatus; 5) screen; 6) screw (for other designations see text).

The main part of the apparatus is a 100 mm-diameter and 140 mm-high vacuum chamber which contains the heater unit (Fig. 1,a). The chamber consists of a water-cooled steel cylinder and a cover which is pressed against the cylinder by two bolts and tightened by the rubber vacuum gasket 1. Window 2 is intended for measuring the specimen temperature; it is outside the high-temperature zone. A pipe connection is provided on the cover for evacuating the system and also the supports 3 for the heater unit and the stationary connecting member of the upper pivot of the