Testing the static characteristics of semiconductor power rectifiers is a very important operation both in their production and utilization.

The basic static characteristics subject to measurements and testing can be divided into two groups:

a) forward volt-ampere characteristics of blocked thyristors and inverse volt-ampere characteristics of thyristors and diodes;

b) forward volt-ampere characteristics of conducting diodes and thyristors.

The utilization in modern conversion techniques of high-power semiconductor rectifiers with currents of the order of hundreds of amperes and voltages up to several kilovolts [1] produces certain difficulties in applying traditional methods for measuring their static characteristics.

In plotting the volt-ampere characteristics of blocked rectifiers it is customary to measure the mean current through them [2], as well as the instantaneous current and voltage by means of an oscillograph. Errors in direct measurements on the oscillograph screen are relatively large. The certified records of the majority of oscillographs specify an error of the order of 10% for amplitude measurements.

Below we describe a technique for obtaining volt-ampere characteristics of blocked high-power semiconductor rectifiers under pulsed operating conditions, with the voltage and current being read off a pointer indicator. The maximum power dissipated in the rectifier during measurements can be limited to a given predetermined level.

The schematic of a measuring device for obtaining group a) characteristics is shown in Fig. 1. It consists of the following basic units: the supply source E, the current limiter CL, the cut-off rectifier T, the rectified current meter A, and the rectified voltage meter V.

A voltage consisting of half waves at the mains frequency is supplied from the source E to the tested rectifier connected to the posts P1 and P2. The supply source E can be adjusted from zero upwards. The current and voltage amplitudes of the rectifier (I_{RM} and V_{RM}) are measured with the peak milliammeter A and the peak voltmeter V. Thus the pointer meters M1 and M2 measure the current and voltage amplitudes of the rectifier. The rectifier's volt-ampere characteristic can be obtained by varying within certain limits the source voltage E. In testing thyristors the forward or inverse branch of their volt-ampere characteristic is obtained by changing the polarity of their connection to the posts P1 and P2. In measuring the rectified current I_r (forward or inverse), it cannot exceed, irrespective of the reasons for its rise, the value of I_{R, max} which is set on the limiter CL. The limiting element consists of a high-power generator pentode (GK-71), which sets the maximum value of the current flowing through the tested rectifier. The desired value of I_{R, max} can be set by changing the bias voltage V_{b1} of the pentode control grid. Thus, the limiter sets the value of the maximum power dissipated in the rectifier structure for a given maximum supply voltage E. The cut-off rectifier T, which is connected in parallel with the tested rectifier in the control system, serves to reduce the mean power dissipated by the rectifier while its volt-ampere characteristic is being measured. The control system feeds a controlling pulse to the thyatron grid a little later than the instant at which the supply voltage E passes through the maximum. As a result of this the thyatron T shunts the tested rectifier, thus reducing its power.

Forward volt-ampere characteristics of conducting rectifiers [group b) characteristics] obtained with direct current or half-wave mains-frequency current produces indeterminate results, owing to the considerable heating of the
Some of the following Russian abbreviations may be found in the figure: \( J \) = tube, \( D \) = diode, \( Tp \) = transformer, \( Ap \) or \( 0p \) = choke, \( Bk \) = switch, \( s \) = V, \( M \) = MΩ, \( k \) = kΩ, \( \mu \) = μF or μH, \( n \) = pF or pH, and \( u \) = nF or nH.

rectifier and the related changes in the forward voltage drop. For this reason it is advisable to use a pulse method in which the rectifier heating is reduced to a minimum. The pulse circuit shown below is suitable for obtaining forward volt-ampere characteristics of conducting rectifiers in terms of instantaneous values read off the pointer or digital indicator. Figure 2 shows a circuit for shaping the current pulses of the tested rectifier (diode \( D_1 \)). It will be clearly seen that the schematic represents an oscillator with a circuit for periodic boost charging of a capacitor.

The circuit operates in the following manner. At first the oscillator capacitor \( C_0 \) is charged from the dc supply source \( V_{dc} \). When the thyristor \( D_2 \) receives the control pulse, the capacitor \( C_0 \) discharges through the inductance \( L_0 \) (thus forming the oscillatory circuit) and shapes a dc half wave which is transmitted through the tested rectifier \( D_p \). The capacitor \( C_0 \) is then recharged through the diode \( D_3 \). It is obvious that after a complete cycle of the capacitor \( C_0 \) recharging, the voltage across it will be lower than \( V_{dc} \). The booster charging of the capacitor \( C_0 \) up to \( V_{dc} \) is made through the controllable rectifier \( D_4 \) and the charging resistor \( R_{ch} \). The control pulse is fed to the rectifier \( D_4 \) a little later (~1 msec) than the blocking of the rectifier \( D_3 \). The control system shapes two staggered control pulses for the rectifiers \( D_2 \) and \( D_4 \) at the repetition frequency of 50 Hz. Thus, having selected the duration \( \Delta t_p \) of the current pulse flowing through the rectifier to be sufficiently small (we adopted \( \Delta t_p = 700 \mu \text{sec} \)), it is possible to neglect within certain limits the thermal effect produced by this current. The thyristor must be permanently conducting when its forward volt-ampere characteristic is measured.

It is assumed for computing circuit elements that in the first approximation the duration \( \Delta t_p \) and the amplitude \( I_m \) of the current pulse flowing through the tested rectifier are

\[
\Delta t_p = T/2 = \pi \sqrt{L_0 C_0},
\]

\[
I_m = U_c \sqrt{C_0/L_0},
\]

where \( T \) is the oscillation period in the \( L_0C_0 \) circuit. It will be seen from (2) that the amplitude of the current flowing through the tested rectifier is regulated by varying the supply voltage \( V_{dc} \). The amplitude value of the current through the rectifier is measured with a peak ammeter whose schematic is identical to the circuit shown in Fig. 1 (unit A). The voltage drop across the shunt \( R_{sh} \) (Fig. 2) is fed to the peak ammeter circuit and the value of \( I_m \) is read straight off the pointer indicator (microammeter). The voltage across the rectifier \( D_1 \) is measured at the instant of the maximum current by means of a special circuit (Fig. 3). This measuring circuit comprises the following basic units: the transistor switch \( S \), the pulse amplifier \( A \), the conversion circuit \( CC \), the circuit \( \Phi_1 \) for registering the maximum current which flows through the rectifier, the circuit \( \Phi_2 \) for shaping the switch \( S \) control pulse, and the pointer or digital indicator meter \( M \).

The circuit operates in the following manner. At the instant when the rectifier current attains its maximum, the rectifier dc voltage \( V_{dc} \) is fed instantaneously through the transistor switch \( S \) to the input of the amplifier \( A \).