AN AIR-BLAST RECTIFIER OF HIGH TENSION ALTERNATING CURRENTS.

BY E. R. WOLCOTT AND C. J. ERICKSON.

THAT a partial rectification of a high-tension alternating current occurs on the passage of a discharge from a point to a plate, has been known for many years. However, difficulty has been encountered in attempting to utilize this rectification, particularly if any considerable current flows, as there then results a heavy arc which rectifies but little.

An examination of the effect of a blast of air on this discharge showed that complete rectification and smooth operation could be obtained by means of a current of air flowing from the point to the plate.[1] A method of accomplishing this is illustrated diagrammatically in Fig. 1.

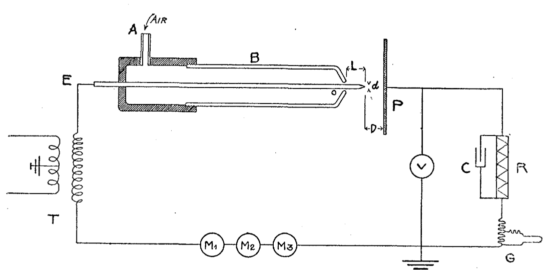

Fig. 1.

A pointed metallic electrode E is mounted coaxially within the tube B, which is restricted at one end so that a gas entering at A is blown through the opening O toward the plate P. Rectification occurs when the point is some distance within the tube, at the opening of the tube, or extending some distance outside of the tube as shown. In the first two cases, the tube B must be made of some insulating material, as of glass; in the last case it may be of metal.[2]

Mounted for use, this rectifier was connected to one terminal of the secondary of a 2 K.W., 40,000-volt transformer T, the other terminal being grounded. The positive current flows from the point to the plate,

[1] E. R. Wolcott and F. Rieber, U. S. Patent No. 1,188,597.

[2] S. D. Browning and C. J. Erickson, thesis University of California, under direction of Prof. Harmon F. Fischer.

and no discharge results in the opposite direction when the distance between the point and plate, that between the point and air outlet, the air pressure and the voltage are suitably adjusted.

Connected between the other terminal of the transformer and the ground were three milliammeters: M_1 was of the electro-dynamometer type; M_2 was a direct-current instrument of the D'Arsonval permanent field type; M_3 was a hot-wire instrument.

The secondary voltage from the plate P to ground was measured by an electrostatic voltmeter. A General Electric oscillograph was mounted directly in the high-tension circuit between the water resistance R and the ground.

The air condenser C consisted of eleven plates 8 by 3 feet (2.44 by 0.91 meters) and 8 inches (20.3 cm.) apart. Its capacity was 0.00095 microfarads and it was connected in parallel with the water resistance when desired.[1]

The diameter of the plate P should be large enough to prevent a discharge from the point to its edges. In the arrangement here described, its diameter was 4 inches (10.16 cm.). The diameter of hole O in the tube B was 0.157 inches (4 millimeters). d, the diameter of the metallic electrode E, was 0.0625 inches (1.57 millimeters). L, the distance between the opening O and the point of the electrode E, was 0.375 inches (9.54 cm.). D, the distance between the plate and the point, was 0.68 inches (1.76 cm.). The frequency of the alternating current was 60 cycles per second.

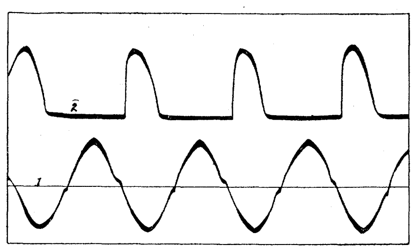

Fig. 2.

With no air flowing out of the opening O of the tube B, curve 1 was obtained at 25 kilovolts. The discharge in this case was an alternating current arc. With air flowing out of the opening O, under a pressure of

[1] The curves shown in Figs. 2 and 3 were obtained with no condenser, those shown in Figs. 4 and 5 were obtained with the condenser connected in parallel with the resistance. One vibrator was connected, in series with a suitable resistance, in the condenser circuit to show the condenser load current. The discharge of the condenser through the parallel resistance is indicated by the drop of the condenser load current curve below the zero line.

2 inches (5.08 cm.) of mercury, curve 2 was obtained. These two curves were not obtained simultaneously so the phase relations as shown are not correct. The direct current reading was 12.3 milliamperes, and the voltage 14.5 kilovolts.

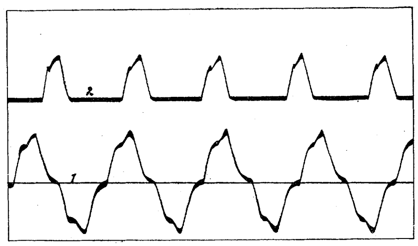

Fig. 3.

This curve differs from Fig. 2 in that a different alternating current generator was used. It will be noticed that the half wave passed by the discharge follows, in general, the wave form of the alternator; but, since a certain voltage is required to start the discharge, it does not include the whole of the half wave. The rise of the rectified wave is more abrupt than that of the original wave.

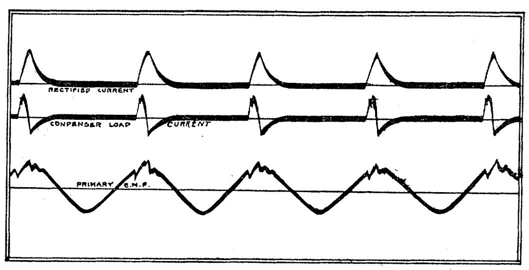

Fig. 4.

These curves were not taken under exactly identical conditions of Figs. 2 and 3 but all three were taken simultaneously and are in phase. The primary electromotive force (E.M.F.) was 241 volts; the secondary voltage was 15,250 volts; the rectified current was 25 milliamperes.

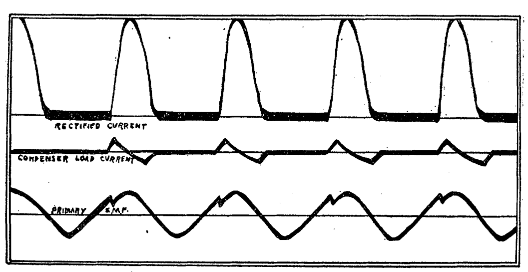

Fig. 5.

These curves were taken under the same conditions as those of oscillogram Fig. 4 except the load was heavier, that is, 104 milliamperes. The sudden drop in primary voltage, at the moment of the application of the load, is plainly evident.

The discharge, when rectification results, is white, rhythmic and snappy, as distinguished from the colored arc which results when no air is flowing. The latter rectifies to a small extent, but in the opposite direction.

Difficulties are encountered trying to operate at too low voltages, say only a few thousand volts. A certain voltage is required to jump the air gap. Likewise there is a drop in voltage across the rectifier in actual operation. Satisfactory rectification has been obtained up to 350 kilovolts, and also at frequencies up to 500 cycles per second.[1]

With the point inside of a glass tube B, the discharge is more snappy, but the tendency to surge is greater. In this case aluminum electrodes seemed preferable, a larger plate P was necessary, and a greater air pressure required.

With the point outside of the tube, satisfactory results were obtained with iron and brass electrodes.

As the gas pressure increases from zero during the discharge, the rectification increases to a maximum, the value of which depends upon the setting of the electrodes and the diameter of the gas outlet.

A further increase of gas pressure beyond this value which gives maximum rectification, produces irregular operation.

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[1] K. V. Laird, Fog Dispersion Tests, Panama-Pacific International Exposition, under the direction of Dr. F. G. Cottrell.