

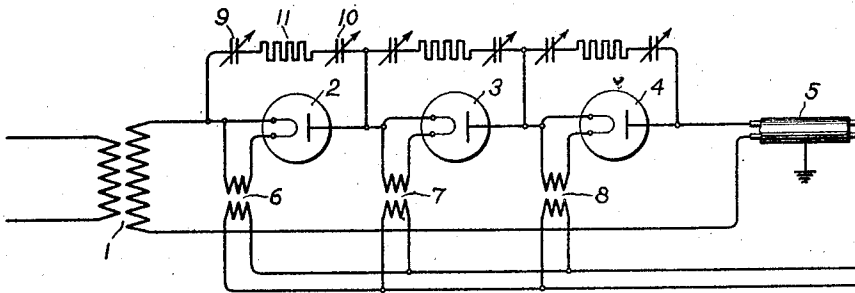
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OPERATION OF SERIES CONNECTED VACUUM VALVES

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UNITED STATES PATENT OFFICE

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OPERATION OF SERIES CONNECTED VACUUM VALVES

Application filed January 27, 1927. Serial No. 164,033.

This application is a continuation in part of my copending application Serial No. 758,913, filed Dec. 30, 1924 and relates to the operation of a plurality of series-connected, electric valves, such for example two element vacuum tube rectifiers of the type described in Dushman Patent No. 1,286,265.

When such valves are connected in series and employed in high voltage, cable testing outfits or otherwise, considerable difficulty has been encountered owing to the fact that the valves do not assume equal proportions of the voltage impressed upon them. In such outfits an alternating electromotive force is supplied to the valves and cable, and owing to the fact that the valves offer practically no impedance for current flow in one direction and substantially infinite impedance to reverse flow of current, the voltage which will appear across the valves during one portion of the alternating current wave will be substantially double the voltage of the alternating current source. A large proportion of this voltage usually appears across one of the valves causing it to flash over as soon as its rated voltage is reached. For example, when valves of this type are connected in series with a capacity load, such as two conductors in a cable, and an alternating electromotive force is supplied to the load, the valves will have very little voltage across them during the portion of the wave in which current is following through the tube. During this period the cable is charged to full voltage. During the next half cycle current will not flow through the valves and the voltage appearing across the valves will be the voltage across the load plus the line voltage. Thus, if 100,000 volts were normally supplied to the circuit, the cable would be charged to that value, there being no appreciable drop in the valves. On the reverse portion of the wave, however, the voltage impressed on the valves would be the sum of the voltage, due to the charge on the cable, and the inverse voltage supplied from the alternating current system, that is, 200,000 volts.

I have found that if series connected valves are connected in parallel with capacities which are generally relatively large in com-

parison with the internal capacity of the valves, that the voltage assumed by each of the valves on either portion of the alternating wave may be equalized or that if variable condensers are used the voltages assumed by the valves may be balanced or the voltages appearing across any valve may be made any value desired.

The balancing or equalizing action of the condensers may be explained by assuming that each valve and its auxiliary apparatus, such as the filament transformer are, in effect, capacitances. That is each valve has a certain internal capacity and a capacity to ground which comprise the capacitance of that valve. Since these capacitances and the charges which may accumulate upon them are generally unequal and control the voltage distribution between the series connected valves, it is important that the capacitance associated with each valve be so proportioned so that the valve will take its share of the voltage. By placing the proper impedances in multiple with the valves, it is possible to make the voltage drops across the valves equal or any value desired. In referring to the capacity of the valve, it should be noted that while there is a capacity of the valve to ground as well as a capacity between the elements of the valve, that the capacity to ground has much the greater influence in causing voltage unbalance in the system.

In my copending application Serial No. 758,913, I have disclosed a plurality of series connected valves which are connected in parallel with condensers having relatively large capacities compared with the internal capacity of the valves. While such an arrangement will permit a desired division or equalization of the voltages assumed by the valves, it is frequently desirable and convenient to employ variable condensers instead of fixed condensers in order that the voltage assumed by any one of the valves may be more readily controlled or in order to determine the value of the fixed condenser to be employed in parallel with any valve.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims.

My invention itself, however, will best be understood by reference to the following specification taken in connection with the accompanying drawing in which the single figure represents diagrammatically a circuit organization whereby my invention may be carried into effect.

In the figure a transformer 1 is employed to supply a high, alternating electromotive force to a circuit comprising a plurality of series connected valves 2, 3 and 4, and a capacity load device 5 which, in the present instance, is a portion of a cable, the insulation of which it is intended to test. The cathode elements of the various valves are connected to the secondary windings of the filament transformers 6, 7 and 8. The primary windings of these transformers may be supplied from the same source as the primary winding of transformer 1, or from any other suitable source. A plurality of variable condensers 9 and 10 and a resistance element 11 are connected in parallel with each of valves 2, 3 and 4. By varying these condensers the voltage assumed by the valves may be equalized or made any value desired. The resistance elements 11 are introduced in the parallel circuit mainly to limit the current in the event that the condensers should become punctured. The high resistance elements alone or impedances might be used in the parallel circuit, although such means perhaps generally are not as satisfactory as capacities. While I have shown a plurality of condensers in parallel with each valve a single condenser could, of course, be substituted if desired.

What I claim as new and desire to secure by Letters Patent of the United States, is:—

1. In combination, a plurality of vacuum tube rectifiers connected in series with a capacity load, and a capacity unit connected in parallel with each of said rectifiers.

2. In combination, a circuit comprising a plurality of vacuum tube rectifiers and a load device all connected in series, means whereby an alternating electromotive force may be impressed on said circuit, and means whereby the voltages assumed by the rectifiers may be equalized.

3. In combination, a circuit including a plurality of vacuum tube valves connected in series, means for impressing an electromotive force on said circuit, and means including capacity units for equalizing the voltages assumed by said valves.

4. In combination, a circuit comprising a plurality of vacuum tube rectifiers adapted to be connected in series with one another and with a load device, means whereby an alternating electromotive force may be supplied to said circuit, and means connected in parallel with said rectifiers whereby the voltages assumed by said rectifiers may be equalized.

5. In combination, a plurality of vacuum

tube rectifiers connected in series with each other and with a capacity load, means for supplying an alternating electromotive force to said vacuum tube rectifiers and load, and means comprising impedance units for balancing the voltages assumed by each of said rectifiers.

6. In combination, a plurality of two element vacuum tube rectifiers connected in series with one another and with a load, means whereby an alternating electromotive force may be supplied to said rectifiers and load, and adjustable means controlling the voltages assumed by each of said tubes.

7. In combination, a circuit including a plurality of vacuum tube valves connected in series, means for impressing an electromotive force on said circuit, means including a condenser in parallel with each of said tubes for equalizing the voltage assumed by each of said tubes, the capacity of said condensers being relatively large compared with the internal capacity of a valve.

8. In combination, a plurality of vacuum tube rectifiers connected in series with one another and adapted to be connected in series with a capacity load, means whereby an alternating electromotive force may be supplied to said rectifiers and load, and means for balancing the voltages assumed by each of the rectifiers during both portions of the alternating wave.

9. In combination, a plurality of vacuum tube rectifiers connected in series with one another and adapted to be connected in series with a capacity load, means whereby an alternating electromotive force may be supplied to said rectifiers and load, and capacity means for balancing the voltages assumed by each of the rectifiers during both portions of the alternating wave.

In witness whereof, I have hereunto set my hand this 24th day of Jan., 1927.

FRANK W. PEEK, JR.