Feb. 18, 1941. W. H. BENNETT 2,231,877

ELECTRODE ARRANGEMENT FOR ELECTRIC DISCHARGE SYSTEMS

Original Filed Feb. 4, 1939

FIG. 1

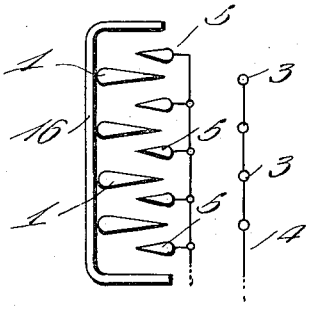


FIG. 2

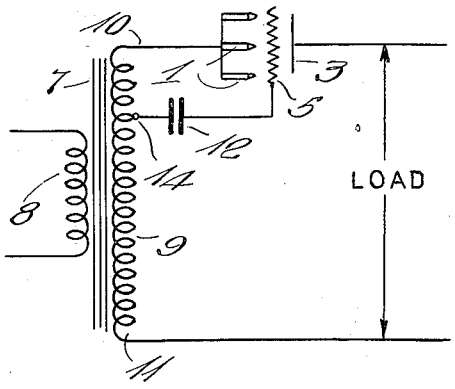


FIG. 3

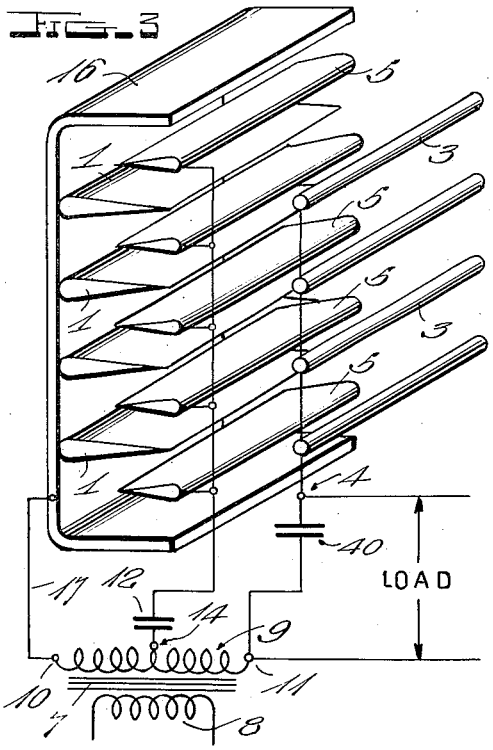


FIG. 4

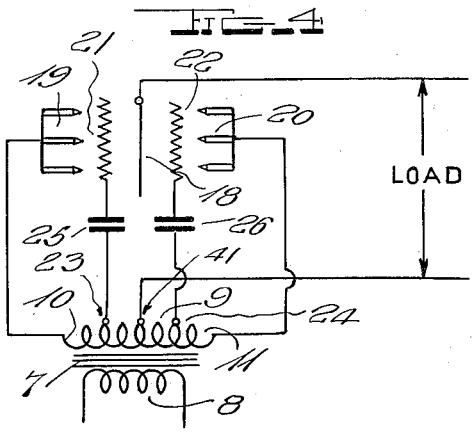


FIG. 5

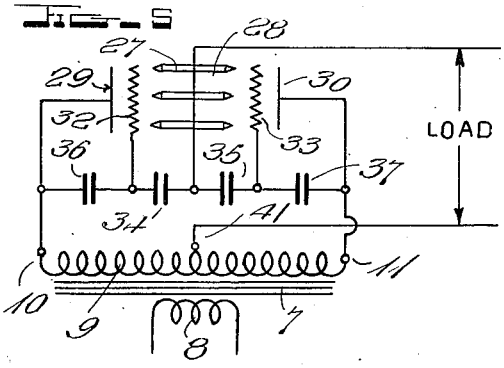
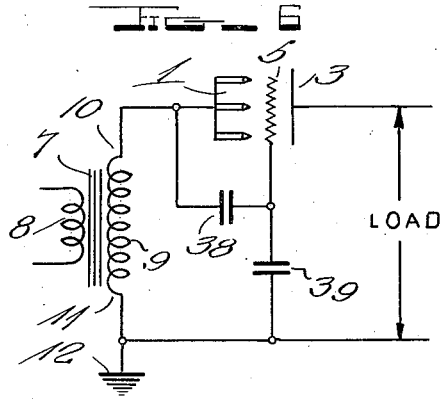


FIG. 6



INVENTOR
Willard H. Bennett,
BY John B. Brady
ATTORNEY

Patented Feb. 18, 1941 2,231,877

UNITED STATES PATENT OFFICE

2,231,877

ELECTRODE ARRANGEMENT FOR ELECTRIC DISCHARGE SYSTEMS

Willard H. Bennett, Newark, Ohio, assignor to Electronic Research Corporation, Newark, Ohio, a corporation of Ohio

Original application February 4, 1939, Serial No. 254,726. Divided and this application October 5, 1939, Serial No. 298,121

5 Claims. (Cl. 175—363)

My invention relates broadly to electric discharge systems and more particularly to a novel assembly of electric discharge electrodes.

This application is a division of my copending application Serial No. 254,726, filed February 4, 1939, for Electric discharge system.

One of the objects of my invention is to provide an assembly of electrodes operating at substantially atmospheric pressures and having means for self bias in operation.

Another object of my invention is to provide an arrangement of emitters and control electrodes in coaction with a target wherein the control electrodes are alternately disposed between the emitters.

A further object of my invention is to provide an electrode arrangement of emitter and target electrodes with a control electrode constituted as an emitter to produce rectification in the control circuit for bias purposes.

Still another object of my invention is to provide an electrode arrangement including a control electrode constituted as an emitter, and an auxiliary electrode constituted as a target for the emission from the control electrode, for deriving a bias potential for the control electrode.

A still further object of my invention is to provide an electrode arrangement of emitter and target electrodes with a control electrode constituted as an emitter, and an auxiliary electrode constituted as a target for the emission from the control electrode and mounted in conjunction with the main emitter electrode, whereby bias potentials for the control electrode are obtained in the operation of the electrode arrangement.

Other and further objects of my invention reside in an arrangement of electric discharge electrodes as set forth more fully in the specification hereinafter following by reference to the accompanying drawing, in which:

Figure 1 schematically shows the electrode assembly of my invention; Fig. 2 is a schematic circuit arrangement of the electrode assembly illustrated in Fig. 1; Fig. 3 shows a schematic arrangement of electrode assembly embodying the principles of my invention; Fig. 4 illustrates the self biasing electrode arrangement of my invention applied to a full wave rectification system; Fig. 5 shows a modified circuit arrangement for a full wave rectification system utilizing the electric discharge system of my invention; and Fig. 6 shows a further modified form of half wave rectifier embodying the principles of my invention.

Referring to Fig. 1 of the drawing, the electrode assembly of my invention includes a bank of primary emitters located at 1, which are electrically connected together through the member 16. The primary emitters 1 are stream-lined in contour and are directed toward the target rod-like electrodes 3, electrically connected through bus 4. Alternately positioned with respect to the emitters 1, I provide a bank of emitters 5. The bank of emitters 5 are stream-lined in contour but have their emitting edges directed away from the target members 3 and in the direction of the emitters 1 toward the member 16. The emitters 5 are electrically connected together through lead 6 as shown. The emitters 5 serve as control electrodes with respect to primary emitters 1 as will be more fully understood by consideration of the schematic circuit diagram illustrated in Fig. 2.

The arrangement of the electrode assembly in a rectifier circuit has been shown in Fig. 2. The rectifier circuit includes an input transformer 7 having primary winding 8 and secondary winding 9. The alternating current to be rectified is impressed upon primary winding 8 and delivered to secondary winding 9. The end 10 of the secondary winding 9 connects to the bank of primary emitters 1 through member 16 shown in Fig. 3. The member 16 is formed from conductive material and is substantially U-shaped in section with the sides thereof substantially embracing or extending around the bank of primary emitters 1. The opposite end of secondary winding 9, shown at 11, connects to one side of the load. The target constituted by target members 3 connects to the opposite side of the load. The control electrode constituted by emitters 5 connects through a condenser 12 to a tap 14 on the secondary winding 9.

Referring to Fig. 3 the tendency of the emitters or control electrodes 5 is to swing to a voltage like that of the targets 3 with respect to the emitters 1 which causes the emitters or control electrodes 5 to fire toward the emitters 1 and member 16. As a consequence of this tendency, when adequate voltage is being applied from the secondary of the transformer 9 the emitters or control electrodes 5 will swing to the intermediate bias voltage characteristic of the discharge, namely, a positive potential with respect to the emitters 1. The emitters 1 are all connected at the back thereof by the backing member 16, as shown. The emitters or control electrodes 5 are all connected to a common bus and to an electrical connection into a rectifier as shown in Figs. 4, 5 and 6. The emitters or control electrodes

5 constituting the control electrode emit electric discharges toward the emitter electrodes 1 and the member 16 in the area thereof intermediate the emitter electrodes 1 on those half cycles of the alternating current when electrodes 1 are positive with respect to control members 5 until the condenser 12 becomes sufficiently charged. On the other half cycles, the rear edges of the control members 5, that is the rounded edges thereof as distinguished from the emitting edges to which the stream-lined members taper, are more positive than the emitter eelctrodes 1 by the amount of the D. C. charge on the condenser 12. The position of emitters 1 is so selected with respect to members 3 constituting the target electrode that the emitters 1 emit negative charges toward the members 3 constituting the target. When the emitter constituted by electrodes 1 swings positive with respect to target 3, the direct current positive potential of control electrodes 5 suppresses the emission, thus giving rectification. Current flows to the load only on those half cycles when the emitters 1 are negative with respect to target 3. The suppression action occurs during those half cycles when control electrodes 5 are more positive than the emitter electrodes 1. A suitable filter such as represented by condenser 40 may be provided between the rectifier and the load circuit.

In Fig. 4 I have shown the self biasing method heretofore explained applied to a full wave rectifier circuit in which a common target electrode 18 receives discharges from sets of discharge electrodes 19 and 20 directed toward opposite sides of target electrode 18. Control electrodes 21 and 22 are disposed between the common target electrode 18 and the associated emitters. That is to say, control electrode 21 is interposed between target electrode 18 and set of emitters 19, while control electrode 22 is interposed between target electrode 18 and set of emitters 20. The input transformer 7, including the primary winding 8 and secondary winding 9 is connected as shown, that is, with opposite ends 10 and 11 connected respectively with groups of emitters 19 and 20. Mid-tap 41 connects to one side of the load and target electrode 18 connects to the other side of the load. Intermediate taps 23 and 24 are provided on the secondary windng 9. Intermediate tap 23 connects through condenser 25 to control electrode 21. Intermediate tap 24 connects through condenser 26 with control electrode 22.

On the alternate cycles, self bias is produced by the coaction of the respective control electrodes with their associated emitters while rectification takes place when the emitter swings positive with respect to the collector so that the D. C. positive potential of the control electrode suppresses the emission, thus giving rectification.

I may employ the self bias arrangement in a circuit as illustrated in Fig. 5 wherein two sets of discharge electrodes emit toward two opposite targets. In this arrangement two sets of emitters, shown at 27 and 28 emit toward opposite targets 29 and 30. Target 29 is connected to the end 10 of secondary winding 9 of transformer 7 while target 30 is connected to the end 11 of secondary winding 9. The alternating current to be rectified is supplied to the transformer through winding 8. The connection to the load is taken from mid-tap 41 on secondary winding 9 and from sets of emitters 27 and 28 as shown. The self biasing circuits are completed from control electrodes 32 and 33 through condensers 36 and 37 to the terminals 10 and 11 as shown. Smoothing condensers 34 and 35 are connected between the control electrodes and their associated target electrodes, the emitters 27 and 28.

A similar arrangement may be provided in a half wave rectifier as illustrated in Fig. 6 wherein self bias is obtained through a condenser path 39 in circuit with sets of discharge electrodes 1 and control electrode 5 arranged as shown in relation to target 3. Alternating current to be rectified is supplied to primary winding 8 of transformer 7 and impressed through secondary winding 9 from terminal 10 to the discharge electrodes 1 and from terminal 11 to the load. Terminal 11 is grounded at 12. Smoothing condenser 38 is connected between the control electrode 5 and the electrode 1 as shown. In this arrangement as in the several circuits heretofore explained, the emitter swings positive with respect to the collector while the D. C. positive potential of the control electrode suppresses the emission, thus giving rectification. The control electrode is spacially related to the emitting electrodes at such a distance that for all normal values of potential with which the system is intended to function there will be no arcing. A safe spacial relation is employed to insure discharge without arcing in the atmospheric pressures at which the apparatus of my invention is designed to function. It is unnecessary to enclose the electrode assembly in an envelope of any kind. However, if the electrode assembly is enclosed in an envelope, the pressures therein may be substantially atmospheric.

The self biasing arrangements for rectifiers as set forth herein have been found to be highly successful in operation and while I have thus described preferred embodiments of my invention, I realize that my invention may be modified in form and embodied in other circuits and I do not intend by the disclosures herein presented to limit my invention to any particular form of circuit, but intend that all modifications and applications of my invention shall be included within the scope of the appended claims.

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

1. An electrode arrangement for an electric discharge system comprising a relatively flat member, a plurality of stream-lined emitting electrodes having their rear edges in electrical contact with said member and their emitting edges directed away from said member, target electrodes substantially aligned with the emitting edges of said emitting electrodes, and control electrodes interposed between the stream-lined emitting electrodes and having emitter portions disposed in cooperative relation to said member.

2. An electrode arrangement for an electric discharge system comprising a relatively flat member, a plurality of stream-lined emitting electrodes having their rear edges in electrical contact with said member and their emitting edges directed away from said member, target electrodes substantially aligned with the emitting edges of said emitting electrodes, said member having a substantially U-shaped section having substantially parallel extending side portions substantially surrounding the stream-lined

emitting electrodes and spacially related to the emitting edges thereof, and a plurality of stream-lined control electrodes interposed between the emitting electrodes and directed towards said member.

3. In an electric discharge system, a multiplicity of longitudinally extending discharge electrodes, each having substantially parallel extending emitting edges, a multiplicity of target electrodes aligned with the edges of said discharge electrodes, a plate member substantially embracing said discharge electrodes and having portions extending substantially parallel with the emitting electrodes and spacially related to the discharge edges thereof, and control electrodes interposed between said discharge electrodes and having emitter portions disposed in cooperative relation to said member.

4. In an electric discharge system, a multiplicity of stream-lined emitting electrodes, a target electrode, said emitting electrodes being directed toward said target electrode, and a plurality of stream-lined control electrodes interposed between the emitting electrodes and directed away from said target.

5. In an electric discharge system, an electrode arrangement for self-biasing operation comprising target electrodes, stream-lined electric discharge electrodes having tapered edge discharge portions directed towards said target electrodes for cooperation therewith, stream-lined control electrodes constituted as emitters disposed substantially intermediate said discharge electrodes and having tapered edge emitting portions directed away from said target electrodes, and a backing member for said discharge electrodes including a plane portion connected with the discharge electrodes at the rounded edge portions thereof and constituting target means for emission from said control electrodes.

WILLARD H. BENNETT.