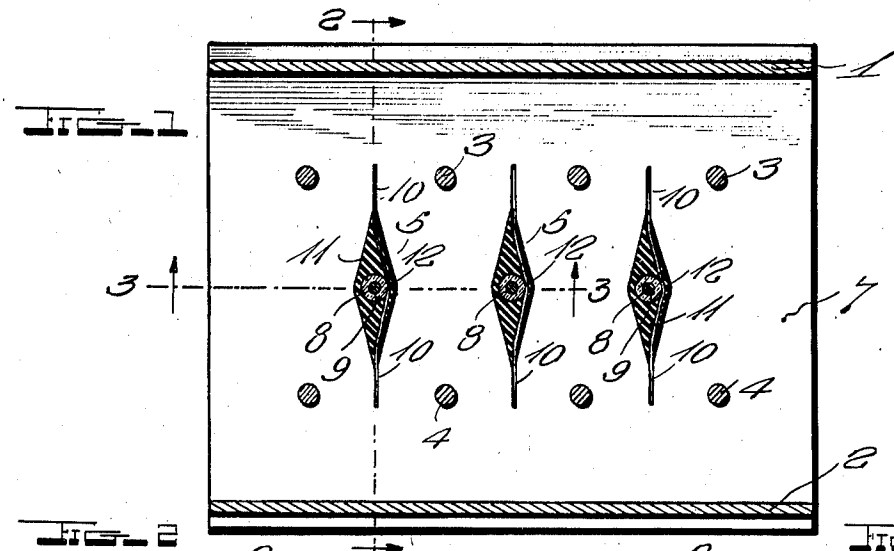
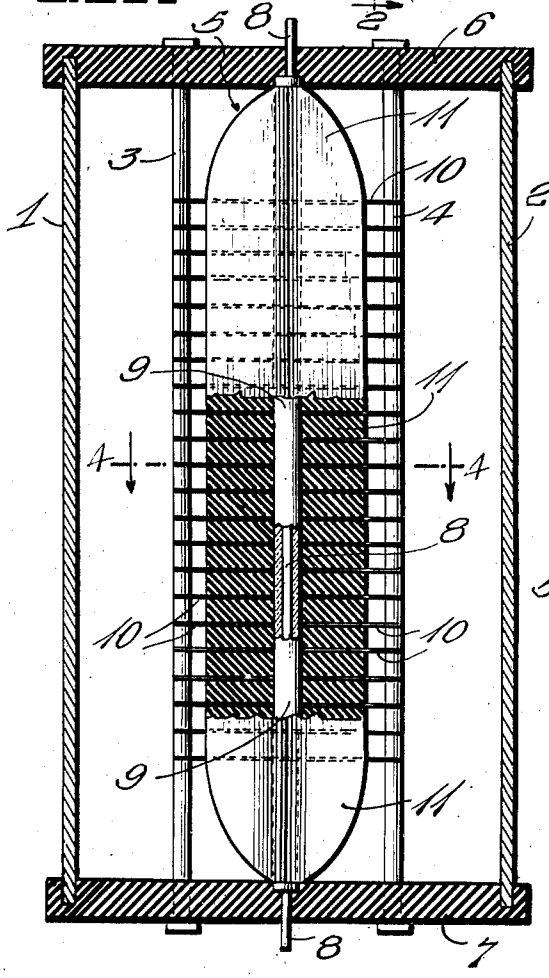
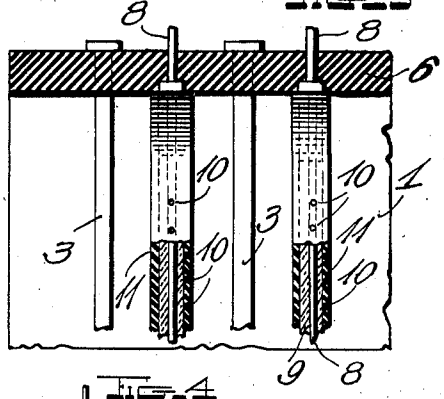
Oct. 7, 1941. W. H. BENNETT 2,257,728

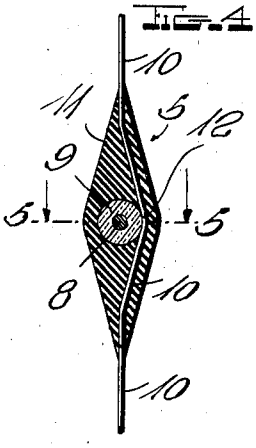
RECTIFIER

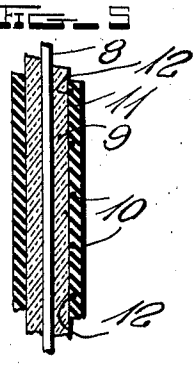
Filed April 5, 1939 3 Sheets-Sheet 1











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

Oct. 7, 1941. W. H. BENNETT 2,257,728

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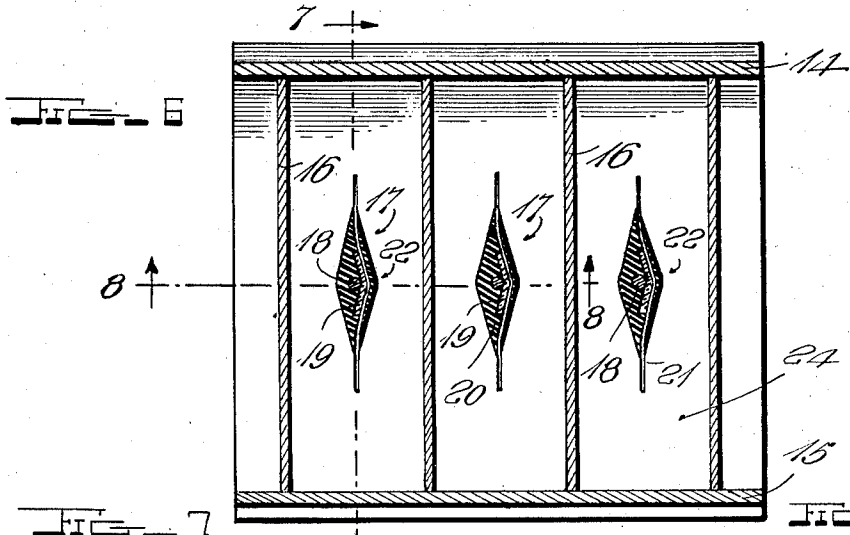


FIG. 6

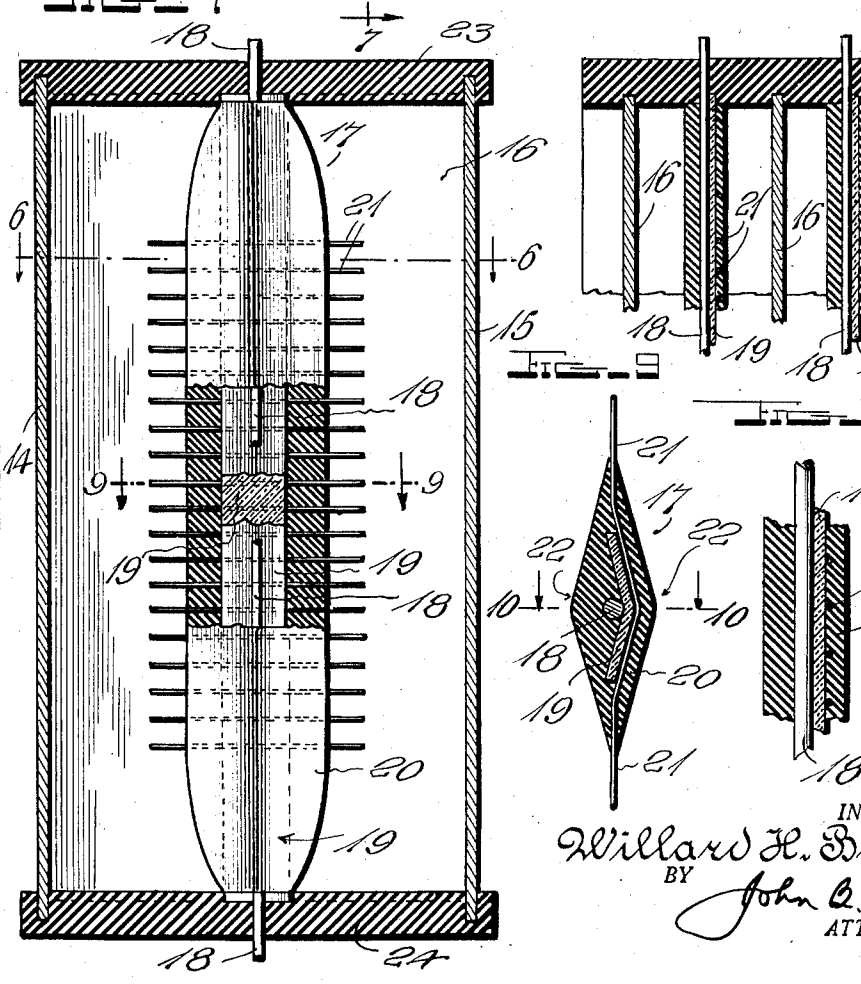


FIG. 7

FIG. 8

FIG. 9

FIG. 10

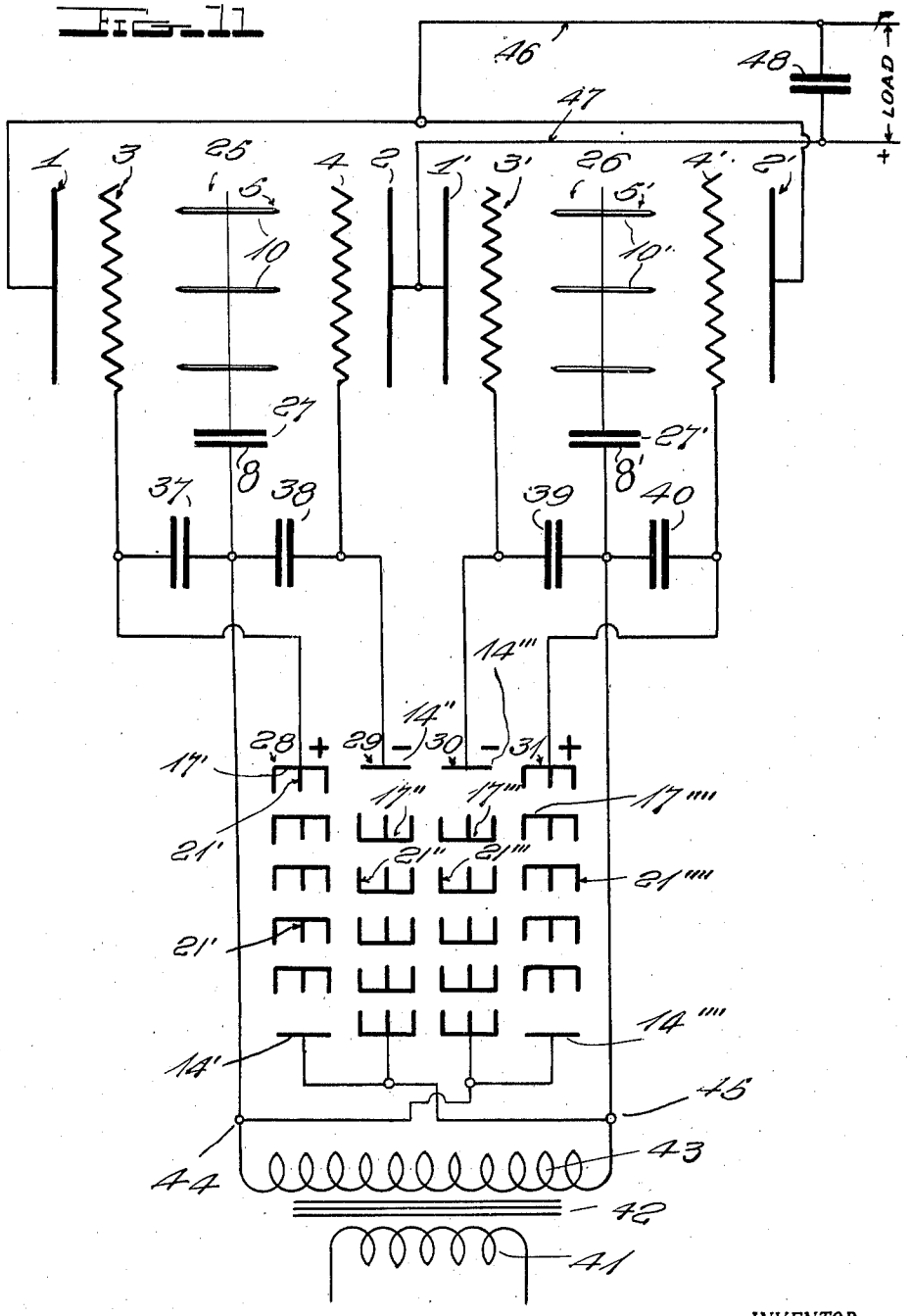
INVENTOR.
Willard H. Bennett,
BY
John A. Grady
ATTORNEY.

Oct. 7, 1941. W. H. BENNETT 2,257,728

RECTIFIER

Filed April 5, 1939 3 Sheets-Sheet 3

Fig. 11



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

Patented Oct. 7, 1941

2,257,728

UNITED STATES PATENT OFFICE

2,257,728

RECTIFIER

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

Application April 5, 1939, Serial No. 266,211

20 Claims. (Cl. 175—363)

My invention relates broadly to rectifiers for delivering direct current to a load from an alternating current source and employing electric emission apparatus operating at substantially atmospheric pressures.

One of the objects of my invention is to provide a system for rectifying alternating current in which electric emission apparatus is employed at substantially atmospheric pressure for obtaining uni-directional current from alternating current under control of suitable bias potentials obtained from electric emission apparatus and wherein the controlling capacity for the emission apparatus is built directly into the electrodes of the emission apparatus.

Another object of my invention is to provide a construction of rectifier for alternating currents employing capacitive types of emitting electrodes associated with control grid and target electrodes and in which the control grid electrodes are supplied with predetermined bias potential obtained from emission apparatus employing resistive emitting electrodes.

Still another object of my invention is to provide a circuit arrangement for a full wave rectifier of the electric emission type including emitting electrodes, associated control grid and target electrodes and auxiliary rectifiers including emitting electrodes and associated target electrodes and in which the emitting electrodes of the main rectifier are capacitively connected to the potential source by capacitive means built directly into the electrodes.

A further object of my invention is to provide a circuit arrangement for a full wave rectifier using capacitive emitting electrodes in association with target electrodes.

A still further object of my invention is to provide a construction of emitting electrode in which a multiplicity of emitting members are mounted in spaced relation in a mass of semiconductive or insulation material and potential applied thereto through high potential means capacitively related to the central portions of the emitting members for discharge from opposite ends of the emitting members.

Another object of my invention is to provide a construction of high potential discharge electrode in which localized capacitive connection from a high potential source is established with a plurality of emitting members adapted to discharge from opposite ends to an associated target.

Still another object of my invention is to provide a construction of electric emitter formed by discharge elements adapted to electrically discharge from opposite ends thereof and in which connection is established from a high potential bus with the central portions of the discharge members through a lumped capacity.

A further object of my invention is to provide a construction of electric emitter formed by a multiplicity of uniformly spaced discharge members arranged in capacitive relation to a high potential bus which extends in a direction substantially normal to the direction of the discharge members for distributing energy to the discharge members for discharge from opposite ends thereof.

Other and further objects of my invention reside in the construction of capacitive emitter and circuit arrangement therefor in a rectification circuit as set forth more fully in the specification hereinafter following by reference to the accompanying drawings, in which:

Figure 1 is a transverse sectional view taken through a rectifier embodying my invention and showing the arrangement of capacitive double ended emitters, control grid and target electrodes; Fig. 2 is a vertical sectional view taken substantially on line 2—2 of Fig. 1 with certain of the elements partially shown in side elevation; Fig. 3 is a fragmentary sectional view taken substantially on line 3—3 of Fig. 1 with certain of the parts shown partially in elevation; Fig. 4 is a transverse sectional view through one of the capacitive double ended emitters of the main rectifier taken on line 4—4 of Fig. 2; Fig. 5 is a fragmentary vertical sectional view through the capacitive emitter of the main rectifier on line 5—5 of Fig. 4; Fig. 6 is a transverse sectional view through the auxiliary rectifier for developing the biasing components for the control grids of the main rectifier; Fig. 7 is a vertical sectional view taken substantially on line 7—7 of Fig. 6 with certain of the elements illustrated in elevation; Fig. 8 is a fragmentary vertical sectional view taken on line 8—8 through the auxiliary rectifier; Fig. 9 is a transverse sectional view through one of the double ended discharge electrodes of the auxiliary rectifier taken substantially on line 9—9 of Fig. 7; Fig. 10 is a fragmentary vertical sectional view of the double ended emitter of the auxiliary rectifier taken substantially on line 10—10 of Fig. 9; and Fig. 11 is a diagrammatic circuit arrangement of the rectification system of my invention employing capacitive electrodes.

My invention is directed to a rectification system particularly adapted for rectifying high voltage alternating currents and deriving direct

current without the necessity of any rotating machinery or vacuum tubes. I provide a relatively inexpensive construction of emission apparatus which includes a main rectifier having double ended emitters and associated control and target electrodes and an auxiliary rectifier constituted by double ended emitting electrodes and associated target electrodes and wherein connection is established between a high potential source and the double ended emitters by resistive means built directly into the structure of the electrodes. In the main rectifier the double ended emitters are formed by a multiplicity of double ended emitter members which extend in directions normal to a high potential bus which extends through a mass of semi-conductive or insulation material in which the double ended emitters are supported. The double ended emitters are capacitively related to the high potential bus by reason of the arrangement of an insulated sheath which is interposed between the high potential bus and the double ended emitters allowing controlled transfer of potential from the bus to the double ended emitters for discharge from opposite ends thereof to associated target electrodes. In the arrangement illustrated herein, the main rectifier employs electrodes in which a tubular sheath of insulation material surrounds the high potential bus and against which the double ended wire-like emitters establish substantially tangent contact. In the electrode structure for the auxiliary rectifier, a strip of insulation material is interposed between the high potential bus and the central portion of the double ended emitters. The capacity between the high potential bus and the double ended emitters in the main rectifiers **25** and **26** is substantially lumped and has been illustrated in the circuit diagram as a series capacity. The capacity, while electrically in series with the emitters, is physically incorporated within the electrode structure of the double ended emitters and has an action for controlling the discharge which is much more effective than if a capacity were externally used in series with the bus as shown in Fig. 11. In the auxiliary components **28**, **29**, **30**, **31**, the insulating strip of material in the emitter **19** serves to allow current to pass from the bus to the double ended emitters only through the resistive material.

In the circuit arrangement employing the capacity electrodes, the biasing components for the control grids of the main rectifier are obtained from auxiliary rectifier units. The auxiliary rectifier units have the emitters of one unit connected with one set of the control grid electrodes of one main rectifier while the target electrode of another unit of the auxiliary rectifiers is connected with the other set of control grid electrodes of that main rectifier, whereby one set of control grid electrodes receives a positive bias while the other set of control grid electrodes in each instance receives a negative bias. Similarly the opposite portion of the main rectifier has one set of control electrodes therein connected to the emitters of a unit of the auxiliary rectifiers for receiving therefrom a positive bias, while the other set of control grid electrodes in the said main rectifier unit is connected to the target of another of the auxiliary rectifier units and receives therefrom a negative bias.

Both the main rectifier electrode assemblies and the auxiliary rectifier electrode assemblies operate at substantially atmospheric pressures.

Referring to the drawings in detail, reference characters **1** and **2** indicate the targets of the main rectifier having associated therewith, rows of control members or grid elements **3** and **4** and the emitting electrode assemblies shown generally at **5**. The targets **1** and **2**, control members or grid elements **3** and **4**, and the emitting electrode assemblies **5** are mounted in the spacial relationship shown by means of insulated supports **6** and **7**. The spacial relationship of the component parts is such that with the potentials employed there is no possibility of sparking, arc-over, streamers, surging or incipient arc discharge between the components. The emitting electrode assemblies **5** are constituted by a main high potential bus **8** which is surrounded by insulating material **9** such as a tubular sheath of glass or other material. A multiplicity of parallel extending emitting members or wires **10** are arranged in uniformly spaced positions substantially tangential to the surface of tubular sheath **9** and extending in directions normal to the axis of the bus **8**. The emitting members or wires **10** are embedded in a mass of semi-conducting or insulation material **11** which may be molded under pressure around the insulated sheath **9** and around the emitting members or wires **10**. The mass of semi-conducting or insulation material **11** may be stream-lined from the central portion toward opposite edge portions from which the emitting members or wires **10** extend. The emitting members or wires **10** are double ended so that discharge occurs at each end thereof in the direction of targets **1** and **2**. Transfer of energy from high potential bus **8** is effected through the capacity existing by reason of the insulated sheath **9** which surrounds high potential bus **8**. The emitting members or wires **10** which tangentially contact with the surface of insulated sheath **9** as indicated at **12** in Figs. 1, 4 and 5, receive their energy from main bus **8** by a capacity transfer of energy from high potential bus **8**.

The auxiliary rectifier or rectifier structure by which the required biasing components are obtained for predetermining the potential of the control members or grids **3** and **4** of the main rectifier has been shown in Figs. 6–10. The auxiliary rectifier comprises plate-like members constituting targets shown at **14** and **15** with intermediate conductive partitions illustrated at **16**. The emitting electrode assemblies are shown generally at **17** comprising central bus **18** having a strip of insulation material **19** substantially coextensive therewith and embedded in a mass of semi-conductive material **20** in which there is supported a multiplicity of substantially parallel extending emitting members or wires **21**. The emitting members or wires **21** are uniformly spaced along the length of the electrode assembly **17** and extend in directions substantially normal to the axis of the bus **18**. The insulated strip **19** has the surface thereof in contact with bus **18** at one side and in contact with emitting members or wires **20** at the opposite side. The insulated strip **19** serves as a dielectric intermediate the bus **18** and the emitting members or wires **21**. The transfer of current from bus **18** to emitting members or wires **21** is resistive and is regulated by the resistance of the material **20** between the bus and the emitting members. The mass of semi-conducting material **20** is stream-lined or tapered from the central position **22** to the opposite edges from which the emitting members or wires **21** extend. The spacial relation of the emitting electrode as-

semblies 17 with respect to the targets 14 and 15 and conductive partition members 16 is maintained by means of end supports 23 and 24 formed of insulation material. The emitting members or wires 21 are double ended and discharge toward targets 14 and 15 and conductive partition 16.

In Fig. 11 I have shown a schematic wiring diagram for the rectifier system of my invention employing the capacitive emitting electrodes in the main rectifier and the resistive emitting electrodes in the auxiliary rectifier. There are two sets of electrode assemblies constituting the main rectifier represented generally at 25 and 26. The main rectifier 25 contains the targets 1 and 2, the control members or grids 3 and 4 and the emitting electrode assembly 5, constructed and arranged as set forth in Figs. 1–5. The emitting electrode assembly includes the emitting members or wires 10 associated in capacitive relation to the bus 8. In order to electrically represent the capacity in the circuit, I have indicated this capacity at 27. The main rectifier 26 contains a similar arrangement of electrodes to which I have applied the related reference characters 1'—2' and 3'—4' designating the targets and control members or grids, respectively, and the emitting electrode assembly 5' including discharge members or wires 10' capacitively associated with bus 8' through a capacity which is the electrical equivalent of the capacity shown at 27'. While the capacities have been shown diagrammatically at 27 and 27', it will be understood that these capacities represent the inherent capacity within the emitting electrode assemblies between the emitting members or wires 10—10' and the high potential buses 8—8'.

The auxiliary rectifiers or rectifiers for securing the biasing components for the control members or grids 3 and 4 and 3' and 4' of the main rectifiers 25 and 26 are shown generally at 28, 29, 30 and 31. Each of the sets of auxiliary rectifiers includes emitting electrode and target assemblies of the type illustrated in Figs. 6–10. The emitting electrodes are shown at 17', 17'', 17''' and 17'''' having sets of emitting members or wires 21', 21'', 21''' and 21'''' corresponding to the discharge members or wires illustrated in the structure of Figs. 6–10 associated with target electrodes 14', 14'', 14''' and 14''''—and with opposite target electrodes 15', 15'', 15''' and 15'''', not shown. The bias supplied by the auxiliary discharge banks 28, 29, 30, 31 is maintained approximately smooth by the condensers 37, 38, 39, 40, respectively.

Alternating current to be rectified is supplied through primary winding 41 of transformer 42 to high potential secondary winding 43. Terminal 44 of high potential secondary winding 43 connects to the high potential bus 8 of the main rectifier of emitting electrode assembly 5 for supplying energy to the emitter members 10 through inherent capacity 27. Terminal 44 also connects to emitting electrode assembly 17''' of auxiliary rectifier 30 and to the target 14'''' of auxiliary rectifier 31. The opposite terminal 45 of secondary winding 43 connects to bus 8' of emitting electrode assembly 5' of main rectifier 26 for supplying energy to emitter members 10' through inherent capacity 27'. Terminal 45 also connects with the target 14' of auxiliary rectifier assembly 28 and to the emitting electrode assembly 17'' of auxiliary rectifier assembly 29 as shown.

A separate auxiliary rectifier assembly is provided for establishing a biasing potential for each of the control members or grids 3, 4 and 3', 4'. The auxiliary rectifiers are so connected with the control members or grids that control members or grids 4 and 3' receive a negative bias with respect to the associated emitting members or wires 10 and 10' from auxiliary rectifiers 29 and 30, while control members or grids 3 and 4' receive a positive bias with respect to the associated emitting members or wires 10 and 10' respectively from auxiliary rectifiers 28 and 31.

The rectifier of my invention operates as a full wave rectifier with each of the main rectifier units 25, 26, functioning alternately to produce a positive discharge and a negative discharge. On the half of the alternating current cycle when terminal 44 is positive, there is a positive emission from the emitters 10 on the discharge electrode 5, directed to the target 2 by reason of the attractive negative bias effective on the control or grid element 4 at the same instant. Simultaneously, a negative emission is produced from discharge electrode 5' directed to target 2' by virtue of the attractive positive bias effective on the control or grid element 4' at the same instant. Current flows, therefore, from terminal 44 through rectifier unit 25 from electrode 5 to target 2, through the conductor 47 to the load, and returns by conductor 46, rectifier unit 26 from target 2' to electrode 5' and back to terminal 45. The different character of the emission in the rectifier units determines the direction of current flow in the respective discharges.

When terminal 45 is positive, like conditions prevail but in displaced manner. Rectifier unit 26 produces a positive discharge directed to target 1', and unit 25 a negative discharge directed to target 1, the control or grid elements 3' and 3 being respectively negative and positive at the same instant to control the discharge. The direction of current flow through the load is the same as before, indicating that the system as a whole produces full wave rectification. It will be noted however, that each of the rectifier units 25, 26, as connected, functions as a full wave rectifier only in cooperation with the other unit, in a series relation, one of the units producing a positive discharge in cooperation with a negative discharge produced in the other during any half cycle of operation.

The auxiliary rectifier units are half wave rectifiers producing the required potentials in the proper sign, as noted on Fig. 11, and at the right time to produce the desired results. Thus, rectifiers 28 and 30 are simultaneously operable when terminal 44 is negative and terminal 45 is positive, and rectifiers 29 and 31 are operable on the other half of the cycle—the outputs of the auxiliary rectifiers are not interconnected for full wave rectification but are individually applied to the respective grid electrodes as bias potentials.

The rectified energy is delivered from targets 1 and 2' of the main rectifiers to the negative side of the load circuit as indicated at 46. The opposite side of the load circuit extends from targets 2 and 1' through lead 47. A suitable filter represented generally by condenser 48 may be arranged across the output of the load circuit.

The discharge electrodes and associated targets of both the main rectifiers and the auxiliary rectifiers operate at substantially atmospheric pressures and without the employment of rela-

tively expensive replaceable vacuum tubes. The main rectifier units are relatively inexpensive in construction and are readily replaceable at relatively low cost. I have described the emitting electrode assemblies as formed from resistive or insulating material in both the main rectifier and the auxiliary rectifier; in this connection I desire that it be understood that the plastic material from which the emitting electrode assemblies are formed may be rendered semi-conductive by the addition of semi-conductive material such as graphite or lucite.

I have described my invention in certain of its preferred embodiments, but I realize that changes may be made in the shape and form of the electrode assemblies and in the circuit arrangement in which such assemblies are employed and I desire that it be understood that no limitations upon my invention are intended other than may be imposed by 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. A rectifier comprising an alternating current input circuit, a direct current output circuit, and an electrode assembly interposed between said circuits which includes a double ended emitting electrode and a pair of coacting target electrodes, and a capacitive connection between said input circuit and said emitting electrode.

2. A rectifier comprising in combination, an alternating current input circuit, a direct current output circuit, and an electrode assembly interposed between said circuits comprising an emitting electrode and a target electrode, means for supporting said emitting electrode comprising a bus electrically connected with said input circuit, a multiplicity of discharge members and means for supporting said discharge members in capacitive relation to said bus and directed toward said target electrode.

3. A rectifier comprising in combination, an alternating current input circuit, a direct current output circuit, and an electrode assembly interposed between said circuits comprising an emitting electrode and a target electrode, said emitting electrode comprising a bus electrically connected with said input circuit, an insulated sheath enclosing said bus, a multiplicity of discharge members extending into surface contact with said sheath, and means for supporting said discharge members in uniformly spaced relation with respect to said bus and along said sheath.

4. A rectifier comprising in combination, an electrode assembly comprising an emitting electrode, a control electrode and a target electrode, a high potential connection for said emitting electrode, a capacity interposed immediately between said emitting electrode and said high potential connection, input and output circuits associated with said electrodes, a source of alternating current connected with said input circuit and a rectifying device constituted by a target electrode and an auxiliary emitting electrode, and a connection between said auxiliary emitting electrode and one of the aforesaid electrodes whereby a portion of the alternating current is rectified and impressed upon one of said first mentioned electrodes.

5. A rectifier comprising in combination, an electrode assembly comprising an emitting electrode, a control electrode and a target electrode, a high potential connection for said emitting electrode, a capacity interposed immediately between said emitting electrode and said high potential connection, input and output circuits associated with said electrodes, a source of alternating current connected with said input circuit and a rectifying device constituted by a target electrode and an auxiliary emitting electrode, and a connection between said auxiliary emitting electrode and said control electrode for impressing a bias potential on said control electrode.

6. In a rectifying system, an electrode assembly comprising a double ended discharge electrode, a pair of target electrodes, control electrodes interposed between opposite ends of said discharge electrodes and said target electrodes, a high potential connection, a capacity interposed immediately between said high potential connection and said double ended discharge electrodes, input and output circuits associated with said electrodes, a source of alternating current connected with said input circuit, a pair of auxiliary rectifier assemblies interposed in circuit with said source, said auxiliary rectifiers each including a target electrode and auxiliary emitting electrodes, a resistive connection to said auxiliary emitting electrodes, a connection through the resistive connection of one of the auxiliary rectifier assemblies and one of said control electrodes, and a connection from the target of the other auxiliary rectifier assembly to the other of said control electrodes.

7. A full wave rectifier system comprising a pair of rectifier units, each consisting of double ended emitting electrodes, coacting control electrodes and associated target electrodes, high potential connections for said emitting electrodes, capacitive connections interposed between said high potential connections and said emitting electrodes, input and output circuits associated with said electrodes, said output circuit having terminals each connected with a target electrode in each of said rectifier units; a power source of alternating current, auxiliary rectifier assemblies individual to each of said control electrodes and comprising a target electrode and an auxiliary emitting electrode, a connection from one control electrode of each of said rectifier units to the auxiliary emitting electrodes of certain of said auxiliary rectifier assemblies, connections between the target electrodes of said last mentioned auxiliary rectifier assemblies and opposite sides of said alternating current source, connections from the target electrodes of others of said auxiliary rectifier assemblies to the other control electrodes of said full wave rectifier units, and connections between the emitting electrodes of said last mentioned other auxiliary rectifier assemblies and opposite sides of said alternating current source.

8. A full wave rectifier system comprising a pair of rectifier units, each including double ended emitting electrodes, coacting control electrodes and associated target electrodes, a high potential connection for each of said double ended emitting electrodes, a capacity immediately disposed between the said high potential connection and the double ended emitting electrodes, input and output circuits associated with said electrodes, said output circuit having terminals each connected with a target electrode in each of said rectifier units, a power source of alternating current connected with said input circuits and independent auxiliary rectifier assemblies individually connected with each of said control electrodes, said auxiliary rectifier assem-

blies each including a target electrode, an auxiliary emitting electrode and a resistive connection to said auxiliary emitting electrode, the auxiliary rectifier assemblies being connected in reverse position with respect to the control electrodes of each of said rectifier units.

9. A full wave rectifier system comprising a pair of rectifier units, each including double ended emitting electrodes, coacting control electrodes and associated target electrodes, a high potential connection for each of said double ended emitting electrodes, a capacity immediately disposed between the said high potential connection and the double ended emitting electrodes, input and output circuits associated with said electrodes, said output circuit having terminals each connected with a target electrode in each of said rectifier units, a power source of alternating current connected with said input circuits and independent auxiliary rectifier assemblies individually connected with each of said control electrodes, said auxiliary rectifier assemblies each including a target electrode, an auxiliary emitting electrode and a resistive connection to said auxiliary emitting electrode, connections between a control electrode of each of said rectifier units and the resistive connections of separate auxiliary rectifier assemblies, connections between the target electrodes of other auxiliary rectifier assemblies and the other control electrodes of the rectifier units, a connection from one side of said alternating current power source to the target and the resistive connection of the auxiliary rectifier assemblies associated with one of said rectifier units, and a connection between the opposite side of said alternating current power source and the target and the resistive connection of others of said auxiliary rectifier assemblies associated with the other of said rectifier units.

10. In a full wave rectifier system, a pair of rectifier units, each including double ended emitting electrodes, a capacitive connection to said double ended emitting electrodes, control electrodes associated with said double ended emitting electrodes, and target electrodes coacting with the double ended emitting electrodes of each of said rectifier units, input and output circuits associated with said electrodes, said output circuit having terminals each connected with a target electrode in each of said rectifier units, a source of alternating current connected with said input circuits, auxiliary rectifier units interposed between said source of alternating current and the individual control electrodes of said rectifier units whereby opposite polarities are instantaneously impressed upon the control electrodes of each rectifier unit, and connections between opposite sides of said source of alternating current through the capacitive connections of the emitting electrodes of each of said rectifier units.

11. An emitting electrode comprising a longitudinally extending high potential bus, a strip of insulation material coextensive with said high potential bus, a multiplicity of double ended emitting members extending in surface contact with said strip of insulation material in central spaced relation, and a mass of semi-conductive material for maintaining said double ended emitting members in surface contact with said insulation strip and for making electrical connection thereto from said high potential bus.

12. An emitting electrode comprising a longitudinally extending high potential bus, a strip of insulation material coextensive with said bus and folded centrally thereof to partially embrace said bus, a multiplicity of double ended emitters extending in surface contact with said strip in uniformly spaced relation along said strip, and a body of semi-conductive material embracing said bus, said strip and said emitters for maintaining said double ended emitters in resistive relation to said bus.

13. An emitting electrode comprising a longitudinally extending high potential bus, a strip of insulation material coextensive with said bus and folded centrally thereof to partially embrace said bus, a multiplicity of double ended emitters extending in surface contact with said strip in uniformly spaced relation along said strip, and means for maintaining said double ended emitters in resistive relation to said bus comprising a mass of semi-conductive material tapered from a relatively wide transverse dimension to a relatively narrow dimension adjacent the discharge ends of said double ended emitters.

14. An emitting electrode comprising a longitudinally extending high potential bus, a strip of insulation material coextensive with said bus and folded centrally thereof to partially embrace said bus, a multiplicity of double ended emitters extending in surface contact with said strip in uniformly spaced relation along said strip, and a mass of resistive material surrounding said double ended emitters and said bus and stream-lined from a central position toward the discharge ends of the double ended emitters.

15. An emitting electrode comprising a longitudinally extending high potential bus, an insulated sheath substantially enclosing said bus, a multiplicity of double ended discharge members establishing contact with one side of said insulated sheath, and means for maintaining said discharge members in uniformly spaced position in capacitive relation to said bus.

16. An emitting electrode comprising a longitudinally extending high potential bus, an insulated sheath substantially enclosing said bus, a multiplicity of double ended discharge members establishing contact with one side of said insulated sheath, and means for maintaining said discharge members in uniformly spaced position in capacitive relation to said bus, said means being stream-lined from a central position toward opposite edges adjacent the discharge ends of said members.

17. A discharge electrode comprising a high potential bus, a tubular sheath of insulation material substantially enclosing said bus, a multiplicity of double ended discharge members establishing tangential connection with said tubular sheath at uniformly spaced intervals longitudinally thereof, and means for maintaining said double ended discharge members in capacitive relation to said high potential bus.

18. A discharge electrode comprising a high potential bus, a tubular sheath of insulation material substantially enclosing said bus, a multiplicity of double ended discharge members establishing tangential connection with said tubular sheath at uniformly spaced intervals longitudinally thereof, and means for maintaining said double ended discharge members in capacitive relation to said high potential bus, said means being tapered from a relatively wide central dimension toward opposite edges thereof adjacent the discharge ends of said double ended discharge members.

19. A discharge electrode comprising a high

potential bus, a tubular sheath of insulation material substantially enclosing said bus, a multiplicity of double ended discharge members establishing tangential connection with said tubular sheath at uniformly spaced intervals longitudinally thereof, and means for maintaining said double ended discharge members in capacitive relation to said high potential bus, said means comprising a molded mass of plastic material stream-lined from a central position toward opposite edges thereof adjacent the discharge ends of said double ended discharge members.

20. A full wave rectification system comprising emitter and target means for alternately producing positive and negative electric discharge including separate target electrodes for the respective discharges, a duplicate of said means, a load circuit, and means for supplying unidirectional current to said load circuit including connections from the target electrodes receiving positive discharge in each of said means to one terminal of said load circuit, connections from the target electrodes receiving negative discharge in each of said means to the other terminal of said load circuit, and a source of alternating current connected with said discharge means in opposite phase so that positive discharge in one of said means occurs simultaneously with negative discharge in the other of said means with each said discharge providing a path for the load current in the same direction.

WILLARD H. BENNETT.