

April 5, 1938.

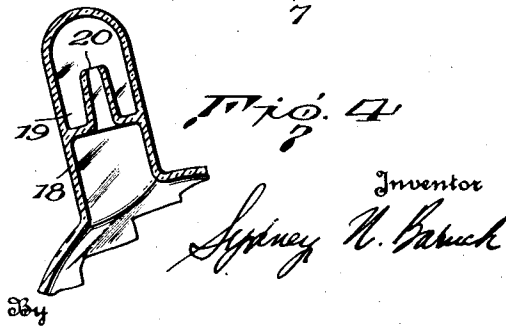
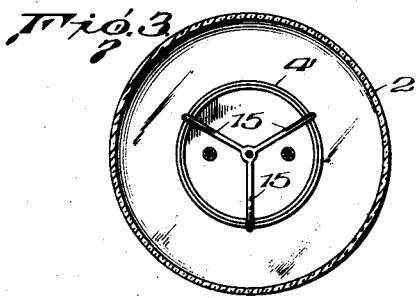
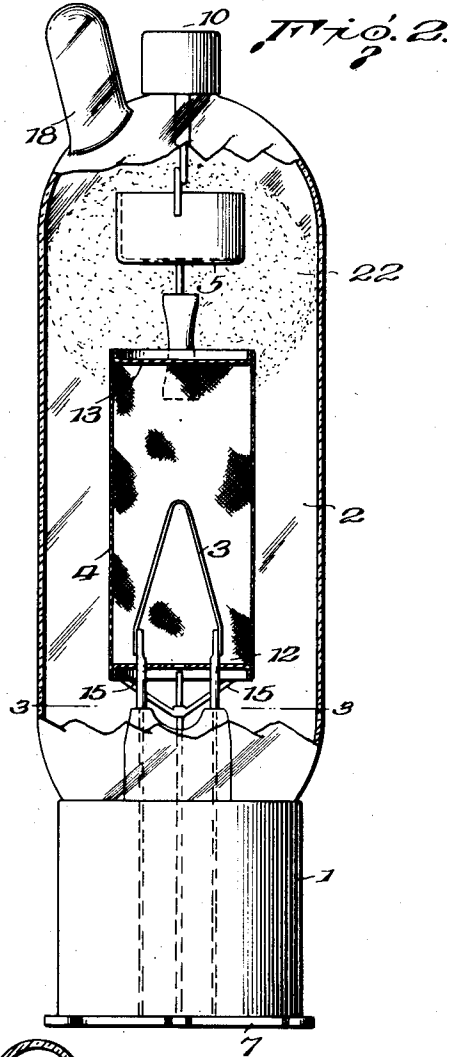
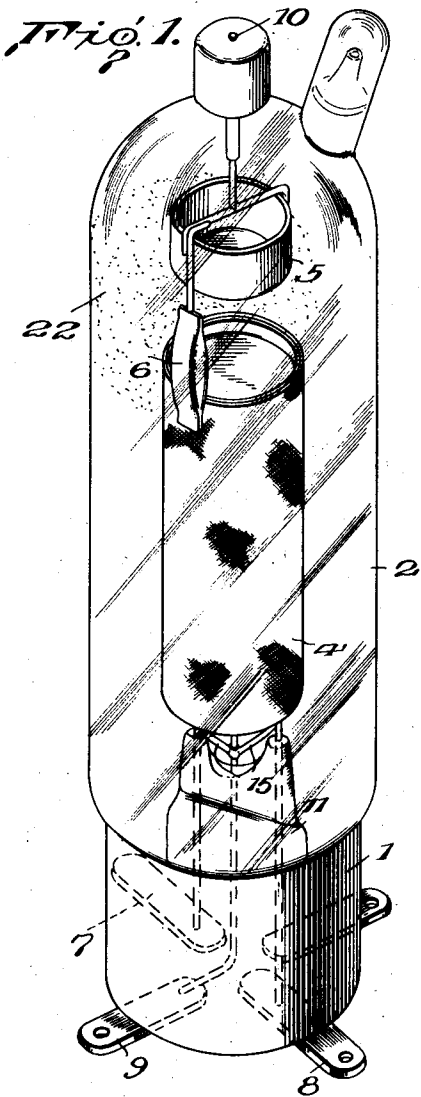
S. N. BARUCH

2,113,392

POWER TRANSLATING APPARATUS

Filed Oct. 8, 1931

2 Sheets-Sheet 1



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Fig. 5.

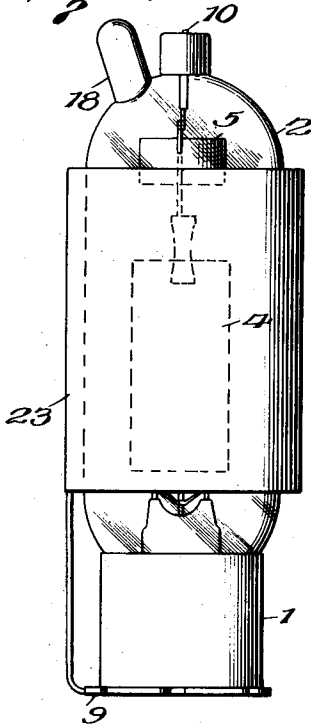


Fig. 6.

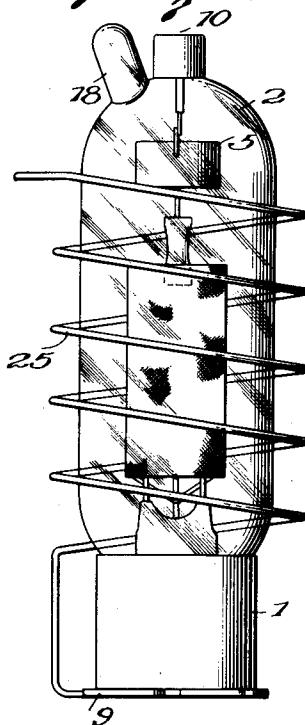


Fig. 7.

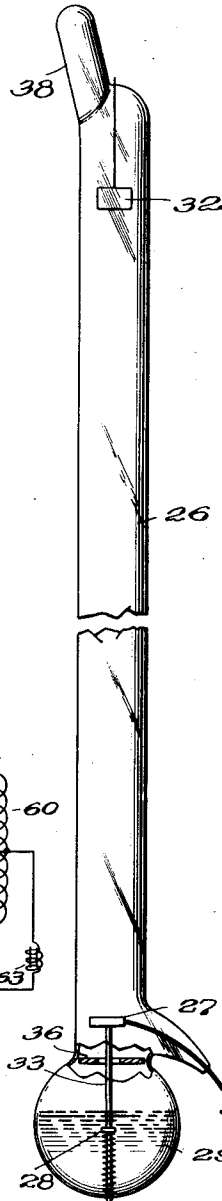


Fig. 8.

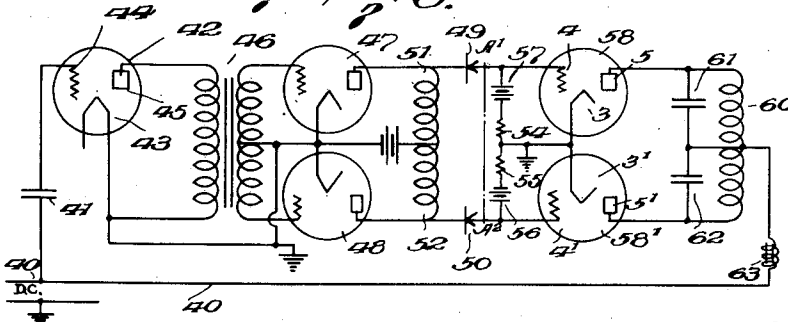
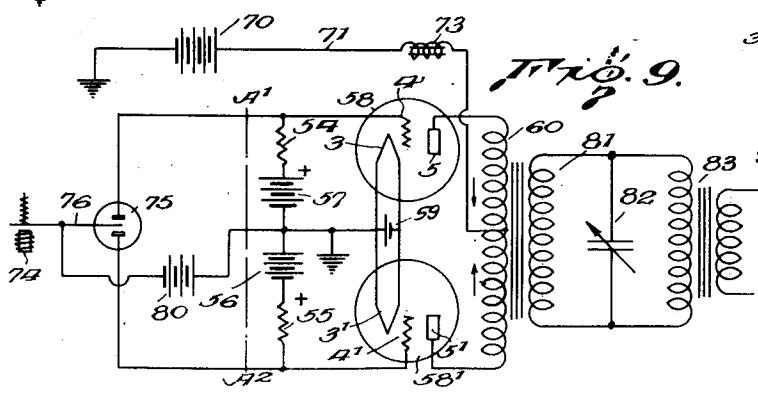


Fig. 9.



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UNITED STATES PATENT OFFICE

2,113,392

POWER TRANSLATING APPARATUS

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Application October 8, 1931, Serial No. 567,735

22 Claims. (Cl. 250—27.5)

This invention relates to electrical translating systems and to particular means for effecting said translation in a highly efficient manner.

It is an object of my invention to provide an improved electron emitting relay or control switch which is capable of many applications. More particularly this switch is adapted to control high voltages which renders the same practicable for the transformation of high voltage direct current energy to alternating current energy.

It is a further object of my invention to make possible the conversion of A. C. energy to D. C. energy for transmission purposes and to translate the D. C. energy back to A. C. energy at a distant point. In one form of my invention, I utilize the ripples caused by the original rectification of the energy to synchronize the A. C. energy obtained at the final point of consumption. I furthermore provide that alternating current of any frequency may be obtained irrespective of the original frequency of the A. C. energy before rectification.

It is a further object of my invention to present a new form of mercury vapor arc rectifier which is specially adapted to rectify high voltages as is contemplated in the system of my designs.

It is a further object of my invention to provide an electronic relay which is adapted to be controlled by the grid to perform its many functions. The control exercised by this relay may be such as to give rise to a square shaped alternating wave, resulting in a minimum of heat losses and thereby a maximum of efficiency.

My invention will be better understood from the following description taken in connection with the accompanying drawings, and its scope will be pointed out in the appended claims.

Fig. 1 shows a perspective view of my improved electronic switch or relay.

Fig. 2 is a front elevation thereof partly shown in section.

Fig. 3 is a sectional view along line 3—3 of Fig. 2.

Fig. 4 is a detailed sectional view of the mercury condenser trap at the top of the relay.

Fig. 5 is a front elevation of my electron relay with an additional control grid cylinder upon its exterior.

Fig. 6 is a modification of Fig. 5 having a coil of wire as a supplementary control grid.

Fig. 7 is a front elevation of a mercury arc rectifier particularly adapted for application in my system.

Fig. 8 is a circuit diagram embodying my electron relay.

Fig. 9 is another circuit diagram embodying my electron relay wherein high voltage D. C. energy is transformed to A. C. energy.

My electronic relay consists of a base 1 of insulating material in which is fixed a glass tube 2 which is rarefied to a suitable degree and which contains a certain degree of mercury. Terminals 7 and 8 attached to the base connect with a filament 3 disposed centrally at one end of the tube. This filament is of heavy form in order to be capable of carrying its current load. A grid of fine mesh, which may be of nickel, surrounds the filament. The grid element is closed upon both its ends by solid plates 12 and 13, in order to confine the path of the electrons emitted from the filament through the laterally disposed grid element. The grid element with its two closures is supported by three branches 15 which are commonly connected to a terminal 9 attached to the base. An anode 5 of cylindrical shape is disposed above the grid element and connects with external connections through lead 10 opening at the top of the tube.

An auxiliary electronic discharge attracting plate 6 is attached to the main anode 5 and is spaced closer to the grid 4 than is the main anode. At the start of operations the filament 3 is energized and the grid 4 is biased with a positive potential which serves to heat the same since it acts in the capacity of an attracting anode. The auxiliary plate 6, having a positive potential upon it is capable of attracting the electrons in the vicinity of grid 4 in view of the close spacing thereof to the grid, even after the positive potential is removed from the grid, which is the condition of the grid after the starting operation. The positive potential upon the grid may be left thereupon to ensure starting in case of failure. Of course during the operation the main anode 5 carries the main load of electrons which are emitted from the lateral sides of the grid element. The closure 13 prevents any short path of the electrons from the filament to the anode.

The base carries a glass support or a plurality of them, in case the leakage through the glass at high voltages proves objectionable, when two or more conductors are passed through a single stem.

The mercury present in the tube finds itself at a balanced pressure during operation. In order to take care of excess pressure a condenser trap is provided at the top of the tube which acts as a reservoir for the excess mercury. The gaseous mercury enters the reservoir through port 20 and settles in chamber 19. This ensures a certainty

and reliability in operation since the excess mercury is definitely taken away from the path of the electronic stream. 22 indicates a slight degree of the mercury coating on the surface of the tube.

In order to render the action of the grid more critical, a cylindrical electrical terminal 23 surrounds the tube and is connected to the terminal 9 which is connected to the grid 4. This modification is illustrated in Fig. 5.

Fig. 6 illustrates a coil of wire 25 connected in series with terminal 9 which in turn is connected to grid 4. The action is similar to that of the showing of Fig. 5.

Fig. 7 illustrates a type of mercury arc rectifier which is especially adapted to rectify high voltages, for local use, or for transmission purposes as more fully described in conjunction with Figs. 8 and 9. The chamber 26 is of great length compared to its diameter. A contact 27 is disposed above the mercury pool 29 and a contact 28 is within the pool 29. Conductors 30 and 31 are connected to contacts 28 and 29 respectively and form an exciting circuit for the mercury pool. A plate 32 is disposed at the top of the rectifier and a condenser trap 38 resembling that illustrated in Fig. 4 is also provided integral with the tube. Conductor 33 extends between contact 27, which has a substantial surface area, and contact 28, intercepting apertured plate 36. Contact 28 within the tube facilitates the connection of conductor 33. The vapor current operates between contact 27 and plate 32, yet the arrangement at the lower end of the tube allows an exciting circuit to strike up. Since my current does not include the mercury pool, a steady operation is obtained with a minimizing of the possibilities of breakage, since contact 27 remains fixed. The contact 27 above the surface of the pool acts to strike up a quick arc through the constriction formed by the aperture of plate 36.

My improved electronic relay finds a special application in the translation of energy. Fig. 8 shows the electronic relays associated in a system wherein the high voltage power of a direct current energy line is used to synchronize the power at an ultimate point of consumption whereat the direct current energy is inverted to alternating current energy of the same frequency as the generated power at the source. The specific features of this control will be explained hereinafter. Fig. 9 shows the electronic switches associated in an energy converting system wherein the frequency of alternating current energy output is independent of the frequency of the original power.

In Fig. 9, 70 may represent the high direct current potential on a transmission line 71. The stages of energy conversion resulting in this high direct current potential does not constitute a feature of my invention and is therefore not illustrated. Normally the output of a high powered alternating current generator is passed through a power transformer to step up its voltage. This alternating current energy of high potential is then rectified and impressed upon the transmission lines. Such rectifiers as are illustrated and explained in conjunction with Fig. 7 are particularly suited for this purpose. The transmission of the direct current energy results in the elimination of corona losses, which attends high voltage alternating current energy transmission. The electron relays of the type disclosed above are represented by 58 and 58', each having the

respective cathode, grid, and anode elements 3, 3', 4, 4' and 5, 5'. The anodes are energized by the high direct current potential through the two halves of the primary winding 60. The filaments are suitably heated by energy source 59. A potential source 80, of a reduced range from that of 70, which may be derived from the power line by a potentiometer connection, serves to impose a negative blocking potential alternately upon the grids of the tubes 58 and 58'. This potential is alternately imposed by the vibrating contact 76, which is actuated by relay 74 at any desired frequency, which may be 60 cycles if such an inversion is desired. The armature 76 cooperates with two contacts in an evacuated bulb to obtain a clear and distinct action. The make and break device may assume the form of any chopper or commutator, the speed of which or the number of segments of which may be chosen for each specific application. Biasing batteries 57, 56 connected to relays 58 and 58' respectively through resistors 54 and 55 render the relays normally conducting. Connection with potential source 80 serves to block the tubes alternately. The cut-off action thus obtained is a sharp one resulting in the transference of an alternating wave form of square shape from the primary coil 60. Choke coil 73 excludes the alternating current energy from the direct current energy line. A square wave form results in a high efficiency since no heat is wasted in the electron relay system. The output circuit coupled to primary coil 60 is tuned to resonance by means of variable condenser 82 to the natural frequency at which relay 74 is operating. This tuned circuit serves to modify the alternating current wave into a sinusoidal form. An iron core transformer may be inserted into the system at this point to reduce the alternating current energy to a lower potential. My tubes are practical for extremely high capacities and potentials.

Referring to Fig. 8, condenser 41 is connected to the high potential direct current line 40. The ripples which are present to a small degree in the continuous current energy are by-passed by this condenser. An amplifier 42 comprising cathode 43, grid 44, and anode 45, amplifies these ripples and they are then passed through a push pull amplifying system 47, 48. The output from this amplifying system, impressed across coils 51, 52, are rectified by rectifiers 49, 50, which may be of a type well known in the art. The connection beyond line A1, A2, is the same as the corresponding showing in Fig. 9 with the exception that high voltage condensers 61 and 62 are utilized to obtain a smooth sinusoidal wave of the operating frequency. The action of the tubes 58 and 58' is similar to that described in conjunction with Fig. 9, although the alternating blocking action exercised through rectifiers 49 and 50 do not give the sharp cut-off action which the corresponding relay 75 in Fig. 9 does. Choke coil 63 blocks the alternating current energy from the direct current energy line.

My invention is capable of other applications. Several other modifications of the embodiments of my invention may be made; but no limitations upon the invention are intended, other than those imposed by the scope of the appended claims.

Having described my invention,

What I claim is:

1. An electronic control switch comprising a rarefied tube containing mercury, an electron

emitting cathode disposed substantially centrally in said tube, a control grid of substantially cylindrical shape surrounding said cathode, closures for said grid element at the ends thereof and a plate disposed beyond the closure at the end opposite the cathode conductors.

2. In the combination claimed in claim 1 wherein is provided an auxiliary electronic discharge attractor connected to the plate and disposed in closer relationship with said grid than said first mentioned plate with said grid.

3. An electronic control switch comprising a rarefied tube containing mercury, an electron-emitting cathode disposed substantially centrally in a vertical axis in said tube, a control grid of substantially cylindrical shape surrounding said cathode, closures for said grid element at the ends thereof, a plate disposed above the closure at the upper end, and a mercury condenser reservoir at the top of the rarefied space.

4. In the combination claimed in claim 1 wherein an auxiliary grid consisting of a cylindrical plate surrounds the tube and is electrically connected with said first mentioned grid.

5. In the combination claimed in claim 1 wherein an auxiliary grid consisting of a cylindrical coil of wire surrounds the tube and is electrically connected in series with said first mentioned grid.

6. In the combination claimed in claim 1 wherein an auxiliary grid consisting of a concentrically disposed conductor surrounds the tube and is electrically connected in series with said first-mentioned grid.

7. An electronic control switch comprising a space having a rarefied gas containing mercury vapor therein, a solid electron emitting cathode disposed in said space, an anode element disposed in said space, and a control grid totally surrounding and enclosing said cathode and having no opening substantially greater than the mesh openings of said grid.

8. The method of controlling the duration of an arc discharge in a gas which consists in rendering conductive the arc path between two electrodes, establishing in the arc path a negative electric field which completely envelopes one electrode and having a potential high enough to extinguish the arc.

9. The method of controlling the duration of an arc discharge in a gas which consists in rendering conductive the arc path between two electrodes, setting up in the arc path a negative electrostatic field which completely envelopes one electrode and so intensified that at a critical value the arc is extinguished.

10. A thermionic device comprising an electron-emitting cathode, an anode, a grid element and enclosing envelope, a gaseous medium containing mercury vapor within said envelope, said grid element consisting in part of fine wire mesh in its structure and completely enclosing said cathode, the apertures of the said grid element which confine the path of the electrons being of such size as to block the passage of the electrons upon the application of a critical negative voltage to the grid element.

11. A thermionic device comprising an electron-emitting cathode, an anode, a grid element and enclosing envelope, a gaseous medium containing mercury vapor within said envelope, said grid element having openings in its structure and

completely enclosing said cathode, said openings being of such size as to block the passage of the electrons upon the application of negative voltage to the grid element, said negative voltage being less than that between the anode and cathode.

12. An arc discharge device consisting of a receptacle, an anode, a solid cathode, and a metallic control grid structure completely enclosing the cathode and insulated therefrom at the lead-ins through said grid structure.

13. An arc discharge device comprising a receptacle, a solid cathode, a control grid structure completely enclosing the cathode, and a cylindrical anode in said receptacle, said anode being opposite said solid cathode and insulated therefrom.

14. An arc discharge device having an envelope, an anode, a solid cathode, and two control grids, one of said grids completely enclosing said cathode.

15. An arc discharge device comprising an envelope, an anode, a cathode, and a cylindrical grid structure within said envelope, said cathode being completely surrounded by said grid structure within said envelope.

16. An electronic arc discharge device comprising a sealed envelope, an electron-emitting cathode, a control grid completely enclosing said cathode, an anode, and an electrostatic shield outside of said envelope.

17. An arc discharge device comprising a receptacle, a charge of metal vapor contained therein of sufficiently high pressure to allow a discharge therethrough of arc-like characteristics, an anode, a cathode, a control electrode enclosing said cathode whereby when said control electrode is negatively charged it will extinguish the arc.

18. An arc discharge device comprising an evacuated tube containing mercury, an anode, a solid cathode, and a control grid with small openings, enclosing the cathode, whereby the arc is extinguished when a critical negative voltage is applied to said control grid.

19. An electrostatically controlled arc discharge device having electrodes, including a thermionic cathode, a cylindrically shaped control electrode enclosing said cathode and having a plurality of holes therein, and means supporting said electrode.

20. An arc discharge device comprising an envelope, a charge of metal vapor contained therein of sufficiently high pressure to cause a discharge therethrough of arc-like characteristics, an anode, a cathode positioned at the opposite end of the envelope from the anode, a shield grid surrounding said envelope, and a control grid enclosing the cathode in a space adjacent thereto.

21. An arc discharge device having electrodes, including a thermionic cathode, and a control grid enclosing said cathode, said grid having a plurality of holes whereby the arc is ignited when a positive charge is placed thereon.

22. An electrical discharge device comprising a receptacle, a charge of metal vapor contained therein of sufficiently high pressure to permit a discharge therethrough of arc-like characteristics, an anode, a cathode, and a closely perforated control electrode enclosing said cathode.

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