June 7, 1938. U. LAMM 2,119,865

PROTECTING MEANS FOR IONIC VALVES

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Fig. 1

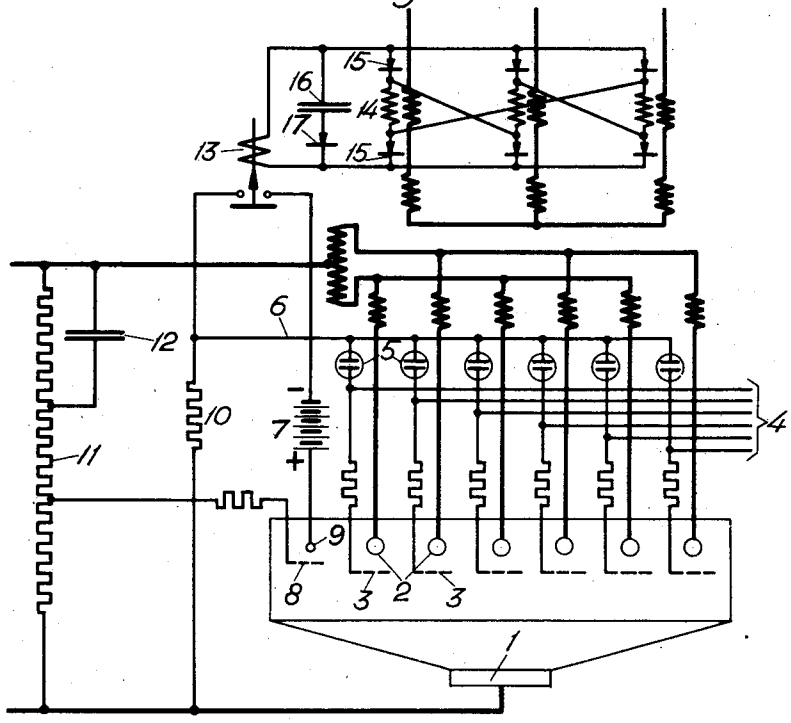
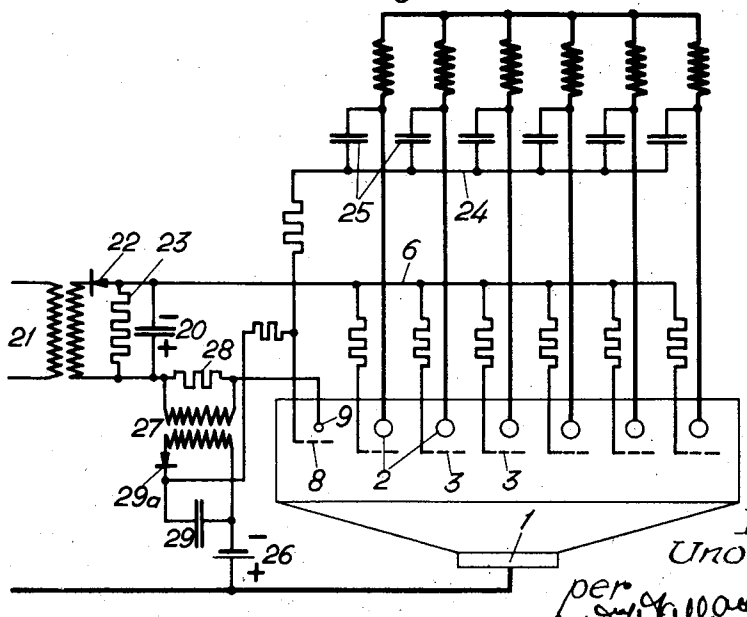


Fig. 2



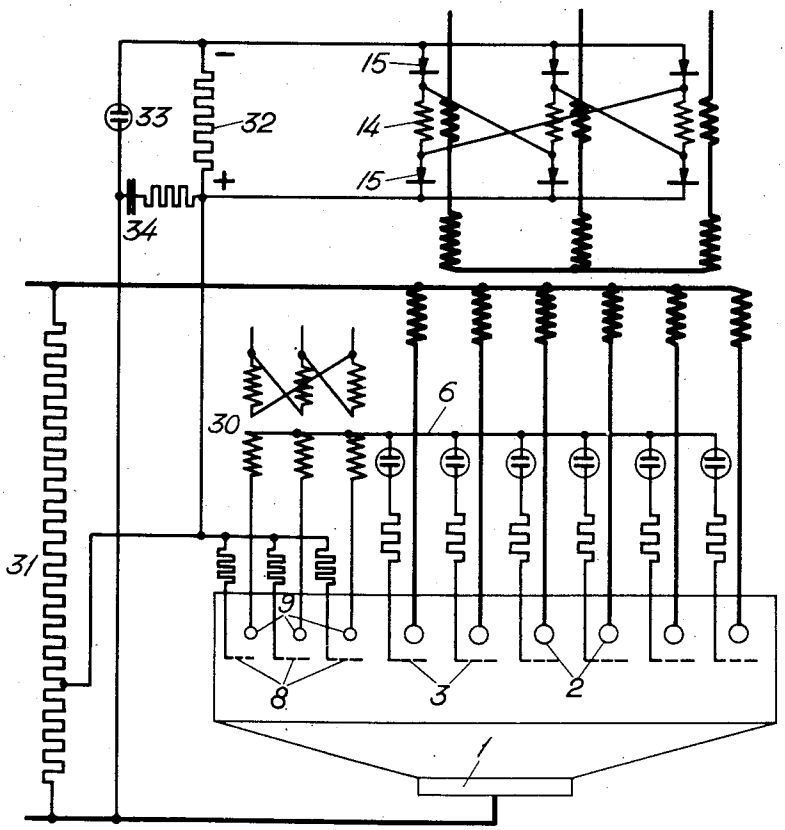
Inventor
Uno Lamm
per Wallace White.
Attorney

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Fig. 3



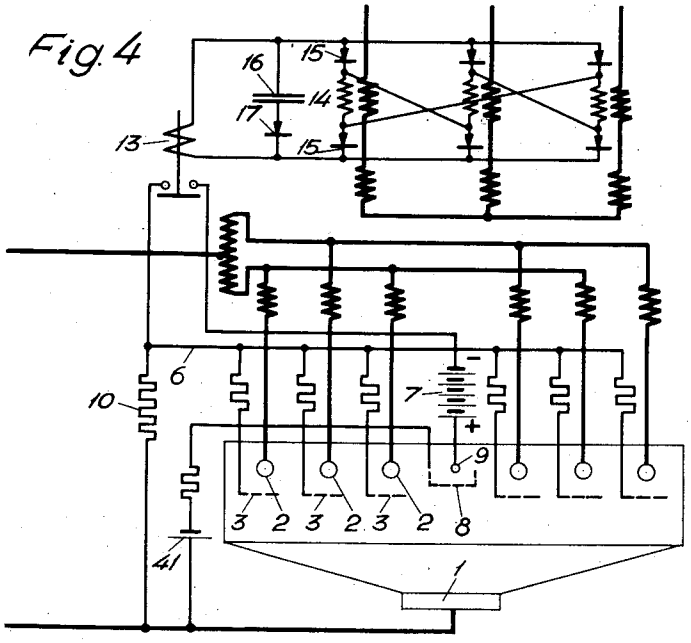
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Attorney.

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Fig. 4



Inventor
Uno Lamm.
per Wallace & White.
Attorney.

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PROTECTING MEANS FOR IONIC VALVES

Uno Lamm, Ludvika, Sweden, assignor to Allmänna Svenska Elektriska Aktiebolaget, Vasteras, Sweden, a corporation of Sweden

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5 Claims. (Cl. 175—363)

For protecting ionic valves having control grids on the occasion of an overload or back-arcing, it has often been proposed to impress on the grids by means of relays a blocking voltage causing all the anodes to be extinguished as soon as possible. It has also been proposed to use as such relays separate electronic or ionic valves having receptacles of their own. Pure electronic relays, generally called "hard" relay tubes, are however little suitable for such purposes for several reasons, and ion valve tubes, that is so-called "soft" hot cathode tubes with inert gas filling which during a long time must be kept ready for operation, that is, with the cathode heated, but not operate, show a marked tendency to "harden", that is, to loose their filling of inert gas which may result in a failure when their function is necessary.

On the other hand, a relay of the ionic valve type offers the advantage before a mechanical relay that its function will be much more rapid, and in order to utilize this advantage and at the same time to avoid the inconvenience adhering in separate valve tubes, there is according to the present invention employed as a relay one or more auxiliary valve paths in the main valve vessel. Four forms of the invention are diagrammatically illustrated in the accompanying drawings in Figs. 1–4.

In all the figures, 1 designates the cathode of the ionic valve, 2 its main anodes and 3 the grids thereof. In Fig. 1, the latter ones are connected not only to individual conductors 4, by which for instance control voltages for different purposes may be impressed, but also over glow lamps 5 to a grid busbar 6 for impressing a blocking voltage common to all the grids. The critical voltage of the glow lamps 5, below which they act as large resistances, should lie so high in relation to the individual control voltages as to enable the latter to act independently of one another to a certain extent. The blocking voltage impressed on the grid busbar must, on the contrary, be higher than the critical voltage of the glow lamps as only the difference between these voltages acts as an effective blocking voltage on the grids.

The voltage impressed on the bar 6 is in this form obtained from a D. C. current source indicated as a battery 7, the negative pole of which is connected to the bar over a relay 13, which will be described in detail hereinafter, while its positive pole is connected to an auxiliary anode 9 in the main valve vessel, said anode being provided with a grid 8. The grid busbar is also connected to the cathode over a large resistance 10. Normally the anode 9 is blocked by means of the grid 8 whence the grid busbar 6 is kept at cathode potential. When the anode 9 is released it will, on the contrary, obtain nearly the cathode potential (which in the following is counted as zero potential in the usual manner), and the bar 6 will then (if the relay 13 is closed) obtain a negative potential corresponding to that of the voltage source 7. The said negative potential is presumed to be sufficient for preventing the ignition of the main anodes next time the respective anode voltages reach the values otherwise sufficient therefor.

The release of the grid 8 is in this form effected by means of a voltage drop impulse from the D. C. side of the ionic valve, when the voltage on this side breaks down as a consequence of a short-circuit or a back-arcing. Between the D. C. terminals is connected a resistance 11 from which the grid 8 normally obtains a certain negative voltage sufficient for the blocking. In parallel to a portion of this resistance adjacent to the negative terminal is connected a condenser 12 which, on the breakdown of voltage, maintains the voltage on this portion during a certain time whereby the lower terminal of the condenser and thus also the connection point of the grid 8 to the resistance will obtain a positive voltage. If the design of the grid and the conditions of operation in the valve are such that the anode is released, at zero potential of the grid, the condenser 12 may be omitted.

When the anode 9 is released it impresses, as already mentioned, a negative blocking potential on the main grids and thereby successively extinguishes the main anodes. As soon as this has occurred, the grids will, however, cease to draw any current, but for maintaining the blocking potential during so long time that the conditions in the valve may stabilize for continued normal operation (by deionization etc.), the anode 9 should still continue to carry current during a certain space of time. This is possible thanks to the resistance 10 which then loads the auxiliary valve path sufficiently for maintaining the arc.

As soon as the conditions in the main valve paths have become normal again, the auxiliary valve path shall be extinguished, and this is effected by means of the aforesaid relay 13. This relay is energized from a combination of current transformers 14, connected with primary windings in the A. C. conductors of the rectifier or inverter, and small rectifiers 15 connected in the

secondary circuits of the current transformers, said combination producing a direct current through the relay coil which is substantially proportional to the total load current. The relay should be set to close its contacts for about ¼ of the normal current. Below this load limit, practically no back-arcing occurs, whence the anode 9 need not enter into function. When all the main anodes have been extinguished, the alternating current sinks to zero and the relay 13 then cuts off the current so that also the anode 9 will be extinguished. This should, however, take place with a certain retardation which may be obtained by the aid of a condenser 16 connected in parallel to the relay coil, said condenser being loaded to the voltage between the coil terminals and being unloaded through the coil when the current from the current transformer ceases. In order that the said condenser shall not retard the energizing of the relay if the load for instance rises rapidly from below ¼ load to a value causing risk of back-arcing, a small rectifier 17 with incomplete valve action is connected in series with the condenser 16 in such a manner as to enable the condenser to be rapidly discharged but only slowly charged.

A particular advantage of the said arrangement of a current responsive relay in the auxiliary valve path is that the blocking device is prevented from functioning in the case that an ionic valve operating as single rectifier should be extinguished at low load. Such an extinction causes, as well as a short-circuit or a back-arcing, a disappearing of the voltage on the D. C. side, but since the relay 13 then keeps the circuit through the anode 9 interrupted, no grid blocking will result from this.

In Fig. 2, no individual control of the main grids 3 is provided for, whence it is not necessary to introduce special voltage blocking between these grids and the grid busbar 6. As a voltage source of the auxiliary valve path through the anode 9 serves a condenser 20 which is kept loaded by means of a transformer 21 in series with a rectifier 22. Between the terminals of the transformer may also be connected a large loading resistance 23 for smoothing the voltage. The releasing impulse for the grid 8 of the anode 9 is here obtained from the A. C. side as a consequence of the rapid change of voltage in positive direction which a back-arcing anode is subjected to, being transferred from a negative potential, generally near the maximum value, to nearly cathode potential. For accomplishing this, the grid is connected to a busbar 24 which over condensers 25 is connected to the conductors of all the main anodes. Normally the potential of the grid is determined by the fact that it is connected to the negative pole of a D. C. voltage source 26, for instance a battery, the positive pole of which is connected to the cathode. It will thus obtain a feebly negative potential, and the capacitative connection with the, as a mean, more negative anodes cannot modify this mean potential. On the occasion of a back-arcing, when the potential of at least one anode is displaced from its value near the negative maximum in the positive direction to a value near the cathode potential, the corresponding condenser discharges through the grid 8 and thereby impresses a positive potential on the latter.

In this figure, no device is shown for maintaining the current through the auxiliary anode 9, after the main anodes have been extinguished and their grids have therefore ceased to draw an appreciable current. There is instead a special arrangement for maintaining, during a certain period thereafter, the positive voltage on the grid 8. The result will be the same because such a voltage on the grid implies that the anode 9 is kept in leading connection with the ionized vapor and is thus prevented from assuming an appreciable positive potential, and on account of the interconnected voltage source (the condenser 20) it then keeps the main grids negative. The arrangement for maintaining the positive voltage on the grid 8 mainly consists of a transformer 27, the primary winding of which is connected in the conductor leading to the anode 9 preferably as a shunt to a resistance 28, while its secondary winding is connected between the cathode and the grid 8 in parallel to a condenser 29. When the anode 9 draws a current from the condenser 20, the condenser 29 is simultaneously charged over the transformer 27, and then it is prevented by a rectifier 29a from discharging the same way. Therefore, it instead discharges over the grid 8 and is assumed to be so dimensioned as to keep the grid positive during so long time as is necessary for removing the consequences of the disturbance. The rectifier 29a should admit so much back current as not to prevent the negative charging of the grid 8 from the voltage source 26 in normal operation. The transformer 27 may instead be so connected as to charge the condenser 29, when the current in the anode 9 decreases, in which case the resistance 28 should be replaced by an inductance which may form part of the transformer.

In Fig. 3, the auxiliary anodes 9 are three in number and connected to the grid busbar 6 over a three-phase transformer 30 which serves as a voltage source for the blocking voltage on the main grids 3. The grids 8 of the auxiliary anodes are normally blocked by being connected to a potentiometer resistance 31 on the D. C. side and obtain their releasing voltage impulse from the A. C. side when an overcurrent occurs on the latter. The alternating current, by a combination of current transformers 14 and rectifiers 15 of the same kind as that shown in Fig. 1, acts on a load resistance 32, which is connected between the cathode 1 and the grids 8 in series with a glow lamp 33. The difference between the voltage on the resistance 32 and the voltage absorbed by the glow lamp 33 is thus impressed on the grids, and the arrangement is so dimensioned that this difference of voltage will be sufficient for releasing the anodes 9 only when the alternating current exceeds the permissible value. A condenser 34 may be connected in parallel to the resistance and the glow lamp for maintaining the voltage on the grids also after the alternating current has been reduced by the blocking action of the main grids.

In Fig. 4, there is illustrated a simplified form of the arrangement shown at Fig. 1, the parts 1, 2, 3, 6, 7, 10 and 13 to 17 corresponding in both these figures. In Fig. 4, however, the auxiliary anode 9 is placed centrally in the vessel and is protected by a grid or screen 8 on which a constant voltage is impressed from the source of voltage 41 conveniently shown as a battery connected between the said grid 8 and the cathode 1. The grid 8, as shown in Fig. 4, provides an obvious means of separating the auxiliary anode 9 from the main current paths.

The different methods illustrated for obtaining the primary grid blocking impulse, and the voltage on the main grids, for maintaining and final-

ly extinguishing the current in the auxiliary valve path may of course be combined with one another in other ways than those described. Also the arrangement for individually controlling the main grids may of course be employed in combination with any of the devices otherwise described.

A particular advantage of arranging the auxiliary valve path or paths in the main valve vessel besides those already mentioned, is that the conditions for ignition of the auxiliary anode will depend to a certain extent on the current of the main anodes. Thus it is for instance possible, by suitably adapting the screening of the auxiliary anode, to cause the latter not to be ignited even at a certain positive grid voltage if the main anodes operate at low load. Hereby a greater freedom in the choice in voltage source for the grid of the auxiliary anode is obtained, as an unintentional release at low load, which otherwise may happen on account of an instability in the arc, can at any rate be safely precluded. It may even under certain conditions be possible to omit entirely the control voltage for the grid or screening device of the auxiliary anode, which may be ignited exclusively as a consequence of the increased degree of ionization in the rest of the vessel caused by a disturbance, as a back-arcing or an overload. It is known, that the ignition voltage of an anode provided with a screening device is a function not only of the potential of the screening device, but also of the temperature and degree of ionization of the conducting gaseous medium, said latter factors depending in their turn partly on the current strength of the adjacent anodes, partly on the degree of screening against these. By adapting this screening in an appropriate manner, it is possible to keep the auxiliary anode blocked at constant grid voltage or even without a particularly impressed grid voltage as long as the total current in the vessel is kept below a certain permissible value, but automatically to release it as soon as this value is exceeded. The auxiliary anode or anodes should in such a case, in vessels containing several anodes, preferably be symmetrically arranged with respect to the anodes, for instance centrally in the vessel as shown at Fig. 4.

Independently of the place of the auxiliary anode, it may be desirable to keep it at a higher temperature than the saturation temperature of the conducting vapor at the highest prevailing pressure so as to avoid condensation on its surface. For this purpose it may for instance be placed immediately adjacent to an exciting anode, for instance in a sleeve common to both anodes. It may for instance be concentrically embraced by an annular exciting anode from which it should, however, be screened by a separate sleeve.

I claim as my invention:—

1. In ionic discharge valves, a valve vessel, a cathode and working anodes therein, grids for blocking said anodes, at least one auxiliary anode in said vessel, grid control for said auxiliary anode, means for impressing a blocking voltage on the grids of said working anodes over said auxiliary anode, and means for releasing the grid control of said auxiliary anode on the occasion of a disturbance.

2. In ionic discharge valves, a valve vessel, a cathode and working anodes therein, grids for blocking said anodes, at least one auxiliary anode in said vessel, grid control for said auxiliary anode, means for releasing said grid control, a current path leading from a source of blocking voltage over said auxiliary anode to the grids of said working anodes and a current path leading in parallel to said path from said auxiliary anode to the cathode over said source of blocking voltage and a resistance.

3. In ionic discharge valves, a valve vessel, a cathode and working anodes therein, grids for blocking said anodes, at least one auxiliary anode in said vessel, grid control for said auxiliary anode, means for releasing said grid control, a current path leading from a source of blocking voltage over said auxiliary anode to the grids of said working anodes, a current path leading in parallel to said path from said auxiliary anode to the cathode over said source of blocking voltage and a resistance, and means for automatically interrupting the current through said auxiliary anode at the cessation of the disturbance.

4. In ionic discharge valves, a valve vessel, a cathode and working anodes therein, grids for blocking said anodes, at least one auxiliary anode in said vessel, a control gride for said auxiliary anode, means for impressing a blocking voltage on the grids of said working anodes over said auxiliary anode, means for impressing a positive voltage on the control grid of said auxiliary anode on the occasion of a disturbance, and means for maintaining said positive voltage after said working anodes have been extinguished as a consequence of the said blocking.

5. In ionic discharge valves, a valve vessel, a cathode and working anodes therein, grids for blocking said anodes, at least one auxiliary anode in said vessel, a screen separating said anode from the main current paths, means for impressing such a potential on said screen as to block the auxiliary anode as long as the total current in said vessel is kept below a certain value but to release said anode as soon as this value is exceeded, and a current path leading over said auxiliary anode to the grids for the working anodes for impressing a blocking voltage on said grids.

UNO LAMM.