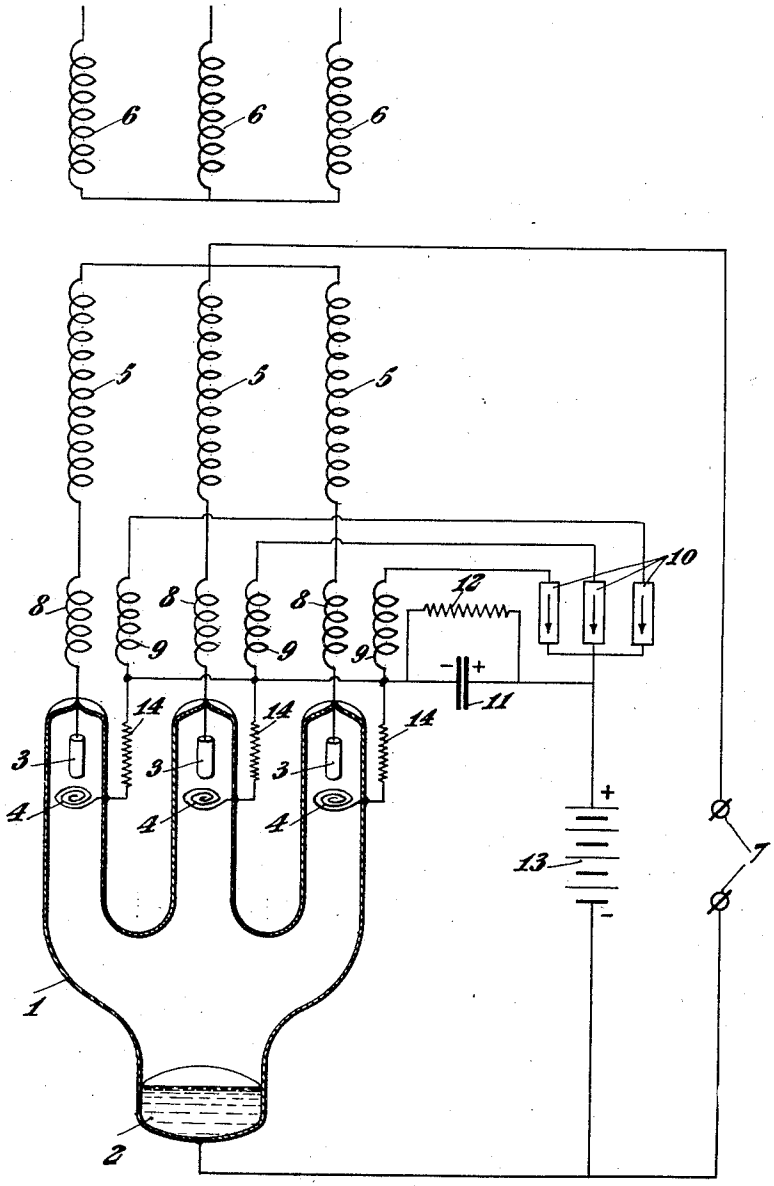
Dec. 3, 1935. W. DÄLLENBACH 2,023,166

RECTIFIER

Filed Sept. 30, 1930



W. Dällenbach
INVENTOR

By: Marks & Clark
Attys.

Patented Dec. 3, 1935 2,023,166

UNITED STATES PATENT OFFICE

2,023,166

RECTIFIER

Walter Dällenbach, Zurich, Switzerland

Application September 30, 1930, Serial No. 485,569
In Germany October 3, 1929

10 Claims. (Cl. 175—363)

This invention relates to a method of and means for protecting rectifiers filled with a rarefied gaseous medium against disturbances caused by short-circuits in the continuous current network. Short-circuits in the continuous current network result in excess currents which in rectifiers filled with a rarefied gaseous medium may cause disturbances, for instance back-arcing, and in the case of rectifiers having a hot cathode lead to the destruction of the hot cathode.

By negatively charging controlling grids placed before the anodes the reception of current by the anodes may be retarded. The anodes will then not ignite when the poles are changed from minus to plus, as is the case with neutral grids, but later, namely after a positive voltage value has been reached. This positive voltage value to which the anode must rise in order to overcome the blocking influence of the negatively charged grid will hereinafter be referred to as the "ignition retardation of the anode". By controlling the grid in the interval of time from the change of pole from minus to plus to the moment of ignition of the anode, the ignition retardation of the anode can be varied within wide limits. The greater the ignition retardation, the lower lies the current voltage characteristic of the rectifier. With a constant continuous current voltage, the intensity of the continuous current decreases as the ignition retardation increases. With a constant current intensity the continuous current voltage decreases as the ignition retardation increases.

The method for protecting rectifiers filled with a rarefied gaseous medium against disturbances caused by short-circuits in the continuous current network consists in this, that the control grids are controlled in dependence on the load on the rectifier automatically in such a manner that on overloads occurring the ignition retardation of the anode increases with the intensity of the continuous current.

After the change of pole from plus to minus, that is to say, on the main arc becoming extinguished, the anodes do not pass gradually but suddenly with a finite voltage jump to negative potential values. The greater this voltage jump, the sooner may back-arcing occur. Without the influence of the control grids this voltage jump is for idle running and short-circuit equal to zero and has a maximum value for a definite loading between idle running and short-circuit. With an otherwise unchanged condition of the rectifier, the danger of back-arcing has a similar course, being negligibly small in the case of idle running and short-circuit, while reaching a maximum for intermediate values. The definite load at which the voltage jump of the anode reaches its maximum value lies in general above the normally admissible loads on the rectifier in the region of the excess loads.

With regard to the safety from back-arcing, it is of advantage that the control grids associated with the anodes are automatically controlled in dependence on the load on the rectifier in such a manner that the ignition retardation of the anodes will increase with the intensity of the continuous current already at excess loads lying below the load at which, without the influence of the control grids, the greatest voltage jump occurs after the change of pole of the anodes.

It is also possible so to control the control grids automatically in dependence on the load on the rectifier that the greatest continuous current intensity normally possible is smaller than the normal short-circuit current without the influence of the control grids. If the load is increased, the continuous current is increased to a certain limit. An unvarying load condition above this limit is no longer possible because above this point the reaction of the load current on the control grids and the effect thereof always disconnects the rectifier. This load limit is evidently the greatest continuous current intensity which is normally possible. Greater continuous current values are therefore only abnormal and temporary.

The control grids may also be automatically controlled in dependence on the load on the rectifier that the greatest continuous current intensity normally possible is smaller than the continuous current intensity at which, without the influence of the control grids, the greatest voltage jump occurs after the change of pole of the anodes.

The accompanying drawing shows an example of the arrangement for carrying out the method.

1 is a three-phase mercury vapour rectifier, 2 the mercury cathode, 3 are the anodes, 4 are the control grids, 5 the secondary windings, 6 the primary windings of the rectifier transformer, and 7 the continuous current terminals of the rectifier. 8 are the primary windings, through which the anode currents flow of an auxiliary transformer having the secondary windings 9 which in transformer connection feed an auxiliary rectifier formed by the valve cells 10. This auxiliary rectifier serves the purpose of charging a condenser 11. Parallel to this condenser is a resistance 12. A source of continuous cur-

rent voltage, namely the battery 13, is connected up in opposition to the condenser. The condenser 11 and the battery 13 together form the "source of voltage for charging the control grids" 4. The control grids 4 are each connected over an impedance, preferably a high ohmic resistance 14, to the negative pole of the condenser, while the negative pole of the battery 13 is connected to the cathode of the main rectifier. The battery 13 supplies a "positively controlling voltage" which is independent of the load on the main rectifier and seeks to charge the control grids positively. The condenser on the other hand supplies a "negatively controlling voltage" which is dependent on the load on the rectifier and seeks to charge the control grids negatively. The transformer windings 8 and 9, the resistance 12 and the battery 13 are so selected that, at normal loads and normally permissible excess loads, the positively controlling voltage of the battery 13 outweighs the negatively controlling voltage of the condenser 11. Only when inadmissible excess loads occur, the condenser 11 is to be charged so strongly that, during the blocking intervals of the associated anodes, the grids assume a negative potential and retard the moment of ignition of the anodes, in other words, choke the passage of current through the rectifier. This choking can be made so intensive that the greatest normal current strength of the rectifier passing through the short-circuit is considerably smaller than the normal short-circuit current without the influence of control grids.

By a suitable selection of the capacity 11 and the resistance 12 and 14 it is possible to maintain a charging of the grids due to a sudden short-circuit in an anode conductor for an extended period of time so that the rectifier can be choked for instance by a current surge during a single half-wave over several alternating current periods. The valve cells 10 of the auxiliary rectifier are preferably so connected up that the condenser 11 is charged by the increase in the anode currents of the main rectifier.

The auxiliary rectifier 10 and the auxiliary transformers 8 and 9 can also be connected together in another way than the ordinary transformer connection. It is also not necessary that the anode currents flow directly through the primary windings 8; it is sufficient for them to be induced by them.

What I claim is:

1. A rectifier filled with a rarefied, gaseous medium, comprising a cathode, anodes, controlling grids, impedances connected to the controlling grids and a source of voltage, to one pole of which the controlling grids are connected over the said impedances, which source of voltage comprises means for supplying a positive controlling voltage and means for supplying a negative controlling voltage which increases with the load, the said two means being connected to act in opposition to one another and determining the voltage of the said pole of the source of voltage relatively to the cathode, as set forth.

2. A rectifier filled with a rarefied, gaseous medium, comprising a cathode, anodes, controlling grids, impedances connected to the controlling grids and a source of voltage, to one pole of which the controlling grids are connected over the said impedances, which source of voltage comprises means for supplying a positive controlling continuous current voltage and means for supplying a negative controlling continuous current voltage which increases with the load, the said two means being connected to act in opposition to one another and determining the voltage of the said pole of the source of voltage relatively to the cathode, as set forth.

3. A rectifier filled with a rarefied, gaseous medium, comprising a cathode, anodes, an impedance, a voltage source, control grids connected over said impedance to a pole of a voltage source whose voltage relative to the cathode results from the opposite connection of a positively controlling continuous current voltage and a negatively controlling continuous current voltage which latter is produced by at least a series connection of a valve cell and a secondary winding of an auxiliary transformer which is induced primarily by at least an anode current of the rectifier.

4. A rectifier filled with a rarefied, gaseous medium, comprising a cathode, anodes, an impedance, a voltage source, control grids connected over said impedance to the pole of a voltage source common to all grids, the voltage relative to the cathode resulting from the opposite connection of a positively controlling continuous current voltage and the negatively controlling continuous current voltage of a condenser which is connected to the continuous current terminals of an auxiliary rectifier which is connected in transformer connection to the secondary windings of an auxiliary transformer, the primary windings of which are excited in dependence on the anode current of the main rectifier.

5. A rectifier filled with a rarefied, gaseous medium, comprising a cathode, anodes, an impedance, a voltage source, control grids connected over said impedance to the pole of a voltage source common to all grids, the voltage relative to the cathode resulting from the opposite connection of a positively controlling continuous current voltage and the negatively controlling continuous current voltage of an auxiliary rectifier which is connected in transformer connection to the secondary windings of an auxiliary transformer, the primary windings of which are excited in dependence on the anode current of the main rectifier.

6. A rectifier filled with a rarefied, gaseous medium, comprising a cathode, anodes, an impedance, a voltage source, control grids connected over said impedance to the pole of a voltage source common to all grids, the voltage relative to the cathode resulting from the opposite connection of a positively controlling continuous current voltage and the negatively controlling continuous current voltage of a condenser to which a resistance is connected in parallel and which is connected to the continuous current terminals of an auxiliary rectifier which is connected in transformer connection to the secondary windings of an auxiliary transformer, the primary windings of which are excited in dependence on the anode current of the main rectifier.

7. An arrangement for protecting a rectifier filled with a rarefied gaseous medium and having at least three phases, the said rectifier being supplied from an alternating current network and working on a direct current network with variable load subject to excess load disturbances, comprising control grids associated with the anodes of the rectifier, a first voltage source which imparts to said control grids a potential which permits the passage of the anode current through the grid and the introduction of the discharge, and a second voltage source controlled in dependence on the load in the direct current network for limiting the flow of current which means vary electrically

and gradually the grid potentials with respect to the cathode, the potential of the second voltage source being in opposition to the potential of the first voltage source and being of such nature as to tend to render the tube non-conducting.

8. In an arrangement according to claim 7, means controlled in dependence on the load in the continuous current network which are adjusted and adapted to vary the grid potentials in accordance with an increasing ignition retardation of the anodes in the case of loads which are below the load determined by calculation at which without the influence of the control grids the greatest voltage jump would occur at the change of poles of the anodes.

9. In an arrangement according to claim 7, means controlled in dependence on the load in the continuous current network which are adjusted and adapted to provide the grid potentials with voltage values which by increasing the ignition retardation of the anodes limit the greatest possible stationary load of the controlled rectifier to a value which is below the short-circuit current determined by calculation of a rectifier without control grid.

10. In an arrangement according to claim 7, means controlled in dependence on the load in the continuous current network, which are adjusted and adapted to provide the grid potentials with voltage values which by increasing the ignition retardation of the anodes limit the greatest possible stationary continuous current intensity to a value which is below the continuous current intensity determined by calculation at which without the influence of the control grids the greatest voltage jump occurs at the change of poles of the anodes.

WALTER DÄLLENBACH.