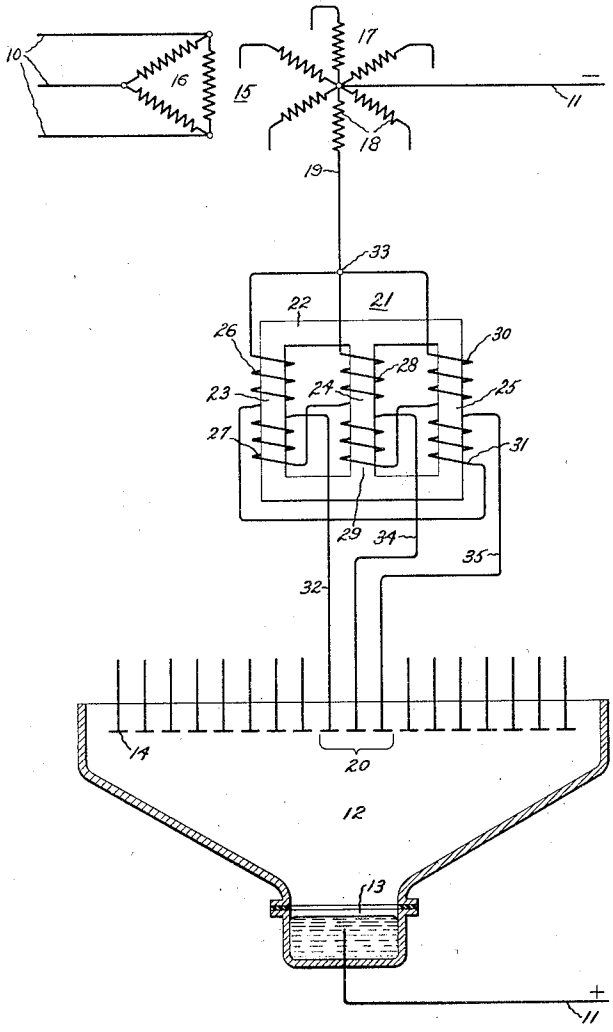
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PARALLEL MULTIANODE TRANSFORMER CONNECTION

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PARALLEL MULTIANODE TRANSFORMER CONNECTION

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My invention relates to electric current rectifier systems for supplying load circuits requiring large currents at low voltages. The invention relates particularly to such systems characterized by parallel operation of anodes, and its object is to provide improved means for operating the anodes in groups each comprising a relatively large number of anodes in parallel.

In mercury arc rectifier and similar circuits the usual arrangement is to connect each anode of the rectifier to a separate terminal of the supply transformer secondary windings. Thus in a six-anode rectifier system, six-phase transformer secondaries having six anode terminals are used, and similarly, in a twelve-phase rectifier system, twelve phase secondaries having twelve anode terminals are used, there being, therefore, an electrical displacement between the anodes. It is an advantage of this large number of anodes with a phase displacement between them that a smooth D. C. output voltage is obtained.

One disadvantage of this usual arrangement is that a complicated transformer connection is required, such a transformer being especially difficult to build when the D. C. output voltage required is only a few hundred volts and the current required is large, as in electric furnaces or in electrolytic work. In such cases it is desirable to connect several anodes in parallel to each transformer secondary terminal, but due to the negative characteristics of the arc drop in the rectifier, anodes will not operate in parallel without the use of a balancing resistance or reactance, the latter being preferable. For paralleling only two anodes, it is common to use an auto-transformer with a midde tap, the middle tap being connected to the corresponding supply transformer terminal and the two ends of the autotransformer winding being connected respectively to the two anodes which it is desired to parallel, such an autotransformer constituting an anode transformer.

In accordance with my invention, I provide means for the effective paralleling, in a rectifier system, of the anodes in groups of three each or of any higher desired number of anodes in each group, without the objectionable features of the balancing resistances or similar means heretofore employed.

In carrying my invention into effect I provide a chain arrangement of auxiliary coupled circuits for each group of anodes whereby all of the anodes of a given group are forced to conduct current simultaneously if any one of the group conducts current.

My invention will be better understood from the following description when considered in connection with the accompanying drawing and its scope will be pointed out in the appended claims.

Referring to the drawing, the single figure thereof is a diagrammatic representation of a rectifier system in which my invention has been embodied.

In the figure the numerals 10 and 11 designate respectively alternating current and direct current circuits between which power is transferred by means of a vapor electric apparatus or rectifier 12 including a cathode 13 and a plurality of anodes 14, and a voltage supply means or transformer 15 including primary winding 16 and secondary winding 17. In the present embodiment of the invention the secondary 17 is shown as 6-phase, each of the phases 18, having anode terminals 19, connected to a group of three anodes. To simplify the drawing the connections between secondary 17 and the anodes 14 are shown for only one of the phases 18.

The connections for insuring the parallel operation of a given group, as the three anode group 20, of the anodes 14 from any given one of the phases 18 of secondary 17 comprise an anode transformer apparatus 21 which includes a core member 22 having three legs 23, 24, 25 corresponding respectively to the anodes of the given group, two coils, 26 and 27, 28 and 29, or 30 and 31, being wound on each leg of the core member. A coil, as 27 on core leg 23, connected through lead 32 to a given anode of the group 20, is in series with a coil 28 which is on a second core leg 24 and is connected through a common lead 33 to the given one of the phases 18. The other coil, 29, which is on this second core leg 24 is connected to a second anode of the group 20 through a lead 34 and is in series with a coil, 30, which is on the third core leg, 25, and is connected through the common lead 33 to the given one of the phases 18. Likewise, the other coil, 31, which is on this third and last core leg 25 is connected through a lead 35 to a third anode of the group 20 and is in series with a coil, 26, which is on the first core leg 23 and is connected through the common lead 33 to the given one of the phases 18. The arrangement of the coils 26 to 31 is such that when all the anodes of the group 20 are conducting current the two coils on each core leg, as coils 26 and 27 on leg 23, carry currents in opposite directions, that is, in a primary and secondary relation.

In operation of the system illustrated in the

drawing, all of the anodes of a given group, as **20**, should fire, or begin to conduct current at the same time in each cycle of the voltage impressed on the group from the given one of the phases **18** of the supply transformer secondary. If, however, one of the anodes of the given group fails to start conducting current at the proper time the corresponding coils, as **27** and **28**, connected in series on two of the core legs, **23** and **24**, carry no current. But the other coils **26** and **29** on these core legs carry current at this time and this current encounters magnetizing reactance of the core legs. The current in coils **26** and **29**, therefore, induces a voltage in the idle coils **27** and **28** which raises the potential of the anode failing to conduct current, and causes the latter anode to start conducting, all of the group **20** thereupon operating in parallel.

Since, when all of the anodes of the group are conducting the two coils on each core leg carry current in opposite directions, these currents then encounter only the leakage reactance. This reactance can be made low, and thus under normal operation of the system, with the anodes of the group conducting current in parallel, negligible voltage regulation is introduced into the circuit by the anode transformer apparatus **21**.

It will be understood that while connections for paralleling a single group of anodes from one of the single phases of an alternating current supply means have been described, like connections are provided for each group of anodes, the other groups being supplied from the corresponding other phases of the voltage supply means.

In the present embodiment of the invention the groups of the parallel anodes include three anodes, the anode transformer apparatus having, correspondingly, three core legs and three pairs of windings thereon. It is to be understood, however, that the invention is not to be thus limited but that similar connections may be employed for paralleling not only three anodes in each group but also any other desired larger number by utilizing the herein described chain connection of auxiliary coupled circuit windings which forces parallel operation of groups of at least three anodes or any larger number operating from the single phases of the voltage supply means.

My invention has been described herein in a particular embodiment for purposes of illustration. It is to be understood, however, that the invention is susceptible of various changes and modifications and that by the appended claims I intend to cover any such modifications as fall within the true spirit and scope of my invention.

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

1. In a system for transferring power between an alternating current circuit and a direct current circuit, a vapor electric apparatus including a cathode and a plurality of anodes, polyphase windings associated with said alternating current circuit, and means to connect a given single one of the phases of said windings to a group of said anodes in parallel, said means comprising a core having a plurality of legs, and a plurality of pairs of coils, each anode of said group being connected to said phase through one of the coils on one of said legs and through one of the coils on another of said legs, said two last-named coils being in series, the two coils on any given one of said legs being arranged in opposing relation, whereby parallel operation of said group is forced upon failure of one of the anodes of said group to start conducting current.

2. In a system for transferring power between an alternating current circuit and a direct current circuit, a vapor electric apparatus including a cathode and a plurality of anodes, polyphase windings associated with said alternating current circuit, and means to connect one of the phases of said windings to a group of said anodes for parallel operation of said group, said means comprising an anode transformer apparatus including a core having a plurality of legs each wound with two coils, each anode of said group being connected to said phase through one of the coils on one of said legs and through one of the coils on another of said legs, said two last-named coils being in series, said coils being so arranged that upon failure of current to start in one anode of said group voltage is induced in the two coils connected to said one anode by coils connected to those anodes of said group which have commenced to conduct current.

3. In an electric system comprising a vapor electric apparatus including a plurality of anodes, and a polyphase alternating current source, means to impress voltages from the respective phases of said source on groups of said anodes constituted by at least three of said anodes in parallel, said means comprising for each of said groups an anode transformer apparatus including a core member having as many legs as the anodes of a group, each leg having two coils wound thereon, the first anode of a group being connected to the corresponding phase of said source through one of the coils on a corresponding leg and a coil on a second leg, succeeding anodes of a group being connected respectively to said phase through a coil on the corresponding leg and a coil on the succeeding leg, the last anode of the given group being connected to said phase through a coil on the last leg and a coil on the first leg, said coils being so arranged that upon failure of one anode of said group to start conducting current operation of said one anode is forced by voltage induced in the coils connected to said one anode by coils connected to other anodes of the group.

4. In an electric system comprising a vapor electric apparatus including a plurality of anodes, and a polyphase alternating current source, means to connect the respective phases of said source to groups of three of said anodes, said means comprising for each of said groups a three-legged core member having two coils on each leg, the first anode of a group being connected to a single phase of said source through one of the coils on the first leg of said core and through one of the coils on the second leg of said core in series, the second anode of said group being connected to said single phase through one of the coils on the second leg of the core and one of the coils on the third leg of the core in series, the third anode of said group being connected to said single phase through one of the coils on the third leg of the core and one of the coils on said first leg of the core in series, the two coils on each leg of said core being arranged to carry current in opposite directions.

EARL V. DE BLIEUX.