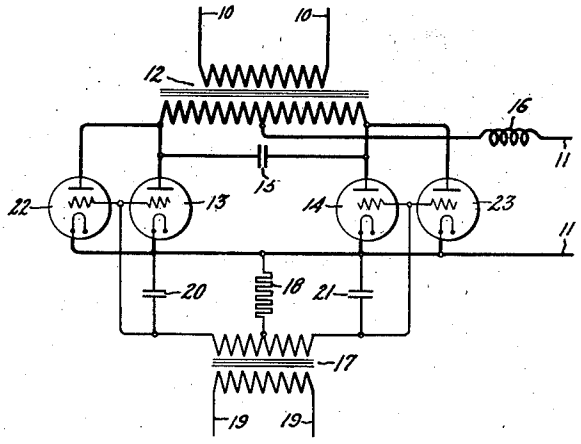
Feb. 9, 1937. W. C. WHITE 2,070,462

PARALLEL OPERATION OF THYRATRONS

Filed Jan. 17, 1935



Inventor:
William C. White,
by Harry E. Dunham
His Attorney

Patented Feb. 9, 1937 2,070,462

UNITED STATES PATENT OFFICE

2,070,462

PARALLEL OPERATION OF THYRATRONS

William C. White, Schenectady, N. Y., assignor to General Electric Company, a corporation of New York

Application January 17, 1935, Serial No. 2,886

2 Claims. (Cl. 175—363)

My invention relates to electric valve translating apparatus and more particularly to such apparatus including electric valves containing an ionizable medium.

Heretofore in electric power translating apparatus utilizing electric valves it has generally been customary to select valves having a capacity rating so that these valves would operate at or near this rating. In such types of apparatus, these valves are called upon to carry overloads or high peak currents for short intervals of time. While these valves can carry a certain amount of overload, conditions occur which often require these valves to carry high peak currents which tend to shorten the useful life of the valve. In such an arrangement it would be highly desirable if the peak load current could be carried by auxiliary apparatus or additional valves. In other apparatus it is often desirable to obtain a high degree of reliability of operation without interruption and hence it would be highly desirable to have apparatus which would take up the load in case of failure of any of the electric valves.

It is, therefore, among the objects of the present invention to provide an improved electric valve arrangement for converting systems and translating apparatus which will overcome the disadvantages of the prior art and which will be simple and reliable in operation.

It is a further object of my invention to provide an electric valve arrangement for converting apparatus wherein certain valves operate to carry current only during the periods of peak load of said converting apparatus.

It is a still further object of my invention to provide an improved electric valve arrangement wherein electric valves are arranged to maintain continuous operation of the apparatus upon failure of the normally operating valves.

It is still another object of my invention to provide an improved electric valve arrangement wherein electric valves are so arranged as to increase the overload rating of the valve arrangement without increasing the normal load rating.

In accordance with my invention I connect to the valve normally operating in the converter or translating circuit in like manner in parallel a second electric valve having a load rating the same as the first valve. By connecting the electrodes of the second valve directly to like electrodes of the first valves, I am able to provide an electric valve arrangement wherein the second auxiliary set of valves operate to take on the peak or overload current and also operate as auxiliary apparatus which will take over the entire load upon failure of the normally operating electric valves.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims. My invention itself, however, both as to its organization and method of operation, together with further objects and advantages thereof, will be better understood by reference to the following description taken in connection with the accompanying drawing in which the single figure of the accompanying drawing is a diagrammatic representation of an electric power converting apparatus which embodies my invention.

Referring now to the drawing, I have illustrated an electric valve converting apparatus for transmitting energy between an alternating current circuit 10 and a direct current circuit 11. This electric valve translating device may be any of the several types well known in the art, but I have illustrated by way of example a parallel type converter such as that disclosed and claimed in the United States Letters Patent No. 1,800,002, granted April 7, 1931, to E. F. W. Alexanderson, and assigned to the same assignee as the present invention. This converter comprises a transformer 12 having one winding connected to the alternating current circuit 10 and a second winding connected to the direct current circuit 11 through a pair of electric valves 13 and 14, and a commutating capacitor 15 connected between the electric valves. If desired, a smoothing reactor 16 may be connected in series with the direct current circuit 11. Although the electric valves 13 and 14 are illustrated as having an anode, a cathode and a control grid, they may be of the two-element type, and furthermore may be of any of the several types well known in the art which contain an ionizable medium. The grids of the electric valves 13 and 14 are connected to their common cathode circuit through opposite halves of the secondary winding of the grid transformer 17 and a common current limiting resistor 18. The grid transformer 17 is connected to a suitable source of grid excitation potential 19 which may be any of the various types well known in the art which operates in the case of an inverter to determine the frequency of the alternating current delivered by the apparatus to the alternating current circuit or in the case of a rectifier to determine the amount of power delivered to the direct current circuit. In order to improve the operation of the converter apparatus a pair

of capacitors 20 and 21 may be connected between the grids or control elements and the cathodes of the valves 13 and 14. The purpose and operation of these capacitors is set forth in greater detail in the U. S. Letters Patent No. 1,965,416, granted July 3, 1934, upon an application of Alan Howard and which is assigned to the same assignee as the present application.

In practicing my invention I connect a pair of electric valves 22 and 23 in like manner in parallel to the valves 13 and 14. By the expression "in like manner in parallel thereto" it is to be understood that this means that the like electrodes of the valves 22 and 13, for example, are connected directly together. These valves 22 and 23 preferably have the same load rating as the valves 13 and 14.

When two electric valves of the type containing an ionizable medium have been connected in like manner in parallel for the purpose of simultaneous operation, it has been customary to provide circuit arrangements such as a current dividing reactor connected to the anodes of the valves to cause these valves to carry equal proportions of the load current. Theoretically it should appear possible to take two of these valves containing an ionizable medium and having the same operating characteristics and cause them to operate simultaneously in parallel by so balancing the circuit arrangement that the circuit associated with each of the valves would have like values of inductance and capacitance. However, the necessity of providing means for insuring the simultaneous operation of such valves is probably due to the voltage-drop current characteristic of the valves. As is well known by those skilled in the art, the initial starting voltage drop of the valve is considerably greater than the normal operating voltage drop and hence it will be apparent that if one of the valves starts a minute fraction of a second sooner than the other valve, the voltage drop across the first valve will be less than the initial starting voltage drop of the other valve. In accordance with my invention I avoid any circuit arrangement wherein there would be a possibility of the valves starting simultaneously. These valves have a certain normal load rating and an overload rating. By connecting these valves in like manner in parallel it is possible to increase the load rating of the converting apparatus to a value which is twice that of an apparatus using but a single valve in each position.

The general principles of operation of the converter as described above will be well understood by those skilled in the art or may be found in detail in the above Alexanderson patent. In brief, while one of the valves 13 or 14 is conductive the capacitor 15 becomes charged to substantially twice the potential of the direct current circuit when the apparatus is operating as a valve inverter. When the other valve is made conducting the capacitor 15 is short circuited through the two valves in such a way as instantly to interrupt the current in the first valve, thus transferring the load current from one valve to the other, and reversing the direction of its flow through the transformer 12. The frequency of these reversals, and thus the frequency of the alternating current delivered by the transformer 12 to the alternating current circuit 10 is determined by the circuit constants and the frequency of the alternating current supplied to the grid transformer 17 from the circuit 19. If it is now assumed that the converting apparatus is transmitting current between the direct current and alternating current circuits which corresponds to the normal load rating of the valves, only one of the valves in each of the groups 13, 22 and 14, 23 will be in conductive condition because of the fact that the starting characteristics of the valves are such that one of valves in each group will not be conductive at this time. For convenience in explanation, it may be assumed that only the valves 13 and 14 have become conductive. If at any time either or both of the valves 13 and 14 should fail, the valves 22 and 23 will take up the load and operate and the converter will continue without interruption.

When an abnormal or peak load is to be carried by the valve converting apparatus all of the valves 13, 14, 22, and 23 will be conductive for a certain time interval. If this peak load is not very great the valves 22 and 23 may be conductive for a short period of time, as for example, three or four minutes, at which time the valves 13 and 14 may assume this additional load, or as the case may be, the peak load demand may have ceased. If, for instance, a still greater overload should occur, the valves 22 and 23 will again be conductive and would carry their share of this overload for a longer period of time, as for example, ten to fifteen minutes, when the load may again transfer to the valves 13 and 14. It is therefore apparent that the length of time which the valves 22 and 23 carry a peak load depends upon the value of current demanded by the load. It will be furthermore apparent to those skilled in the art that if a tube, for example, with a 15 ampere peak rating and a two and a half ampere average rating, were utilized in the position occupied by the valves 13 and 14 and similarly rated valves were utilized in the positions occupied by the valves 22 and 23, it would be possible to obtain an electric valve converting apparatus having a rating of an average current of two and a half amperes with a 30 ampere peak current load rating. Obviously, such an arrangement is highly desirable for certain types of converter or electric valve translating operation.

The following is a possible theoretical explanation of the operation of the apparatus as given above, but I do not wish to be limited thereto. It is well known by those skilled in the art that the initial voltage drop across one of these valves to start the discharge is somewhat higher than the voltage drop at the normal current carrying value. When, however, this current carrying value is exceeded the voltage drop across the valve again increases and this may reach a value which is considerably in excess of the value at the initial starting moment. Thus, for instance, if an overload occurs on the valve 13 and it is forced to operate on a portion of its characteristic curve so that the voltage drop across the valve 13 is in excess of the starting voltage, it will be apparent that the voltage across the valve 22 will be such as to cause the valve 22 to become conductive. It is furthermore well known by those skilled in the art that the voltage-drop current characteristic of these valves is not a stable one but one which changes not only during the life of the valve but also during the operation time of the valve. It is believed to be due to this change in the voltage-drop current characteristic of the valve that after a certain period of overload current has been carried by the valves 13 and 22 that the current may then again transfer to the valve which originally was conductive at normal load current.

While I have shown a particular application of my invention to an electric valve converting ap-

paratus, it is to be understood that this is merely illustrative as one of the number of electric valve converting or translating apparatus to which my invention may be applied. Furthermore, while I have shown electric valves of three-element type, it is to be understood that the valves of the two-element as well as the multi-element type, if arranged in accordance with my invention, will operate in like manner.

While I have shown and described my invention in connection with a certain specific embodiment, it will, of course, be understood that I do not wish to be limited thereto, since it is apparent that the principles herein disclosed are susceptible of numerous other applications, and modifications may be made in the circuit arrangement to which my invention may be applied without departing from the spirit and scope of my invention as set forth in the appended claims.

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

1. In an electric valve converting apparatus, an inductive winding, means for commutating current between said winding terminals, a pair of valves connected to each winding terminal, said pair of electric valves each having a control electrode and containing an ionizable medium and being connected in like manner in parallel to each other, like electrodes of said valves being connected directly together, means for energizing simultaneously said control electrodes, said valves being characterized in that the starting voltage drop across each valve is higher than the normal operating voltage drop whereby only one of said valves operates to carry the normal load current of said converting apparatus and both of said valves operate to carry current in excess of said normal load current.

2. In an electric valve converting apparatus including an inductive network, commutating means connected thereto, each terminal of said network being provided with an electric valve having a control electrode and containing an ionizable medium, said electric valve having higher voltage drop during the initial starting period and the overload current period than during normal operating current periods, said valve converting apparatus being subject to overload current in excess of the normal overload rating, means for energizing said control electrodes, a second similar electric valve containing an ionizable medium connected in like manner in parallel directly with each of said first valves and having a voltage drop at the initial starting period in excess of the voltage drop at the normal operating current period whereby said second valve operates to carry current only during overload current periods.

WILLIAM C. WHITE.