

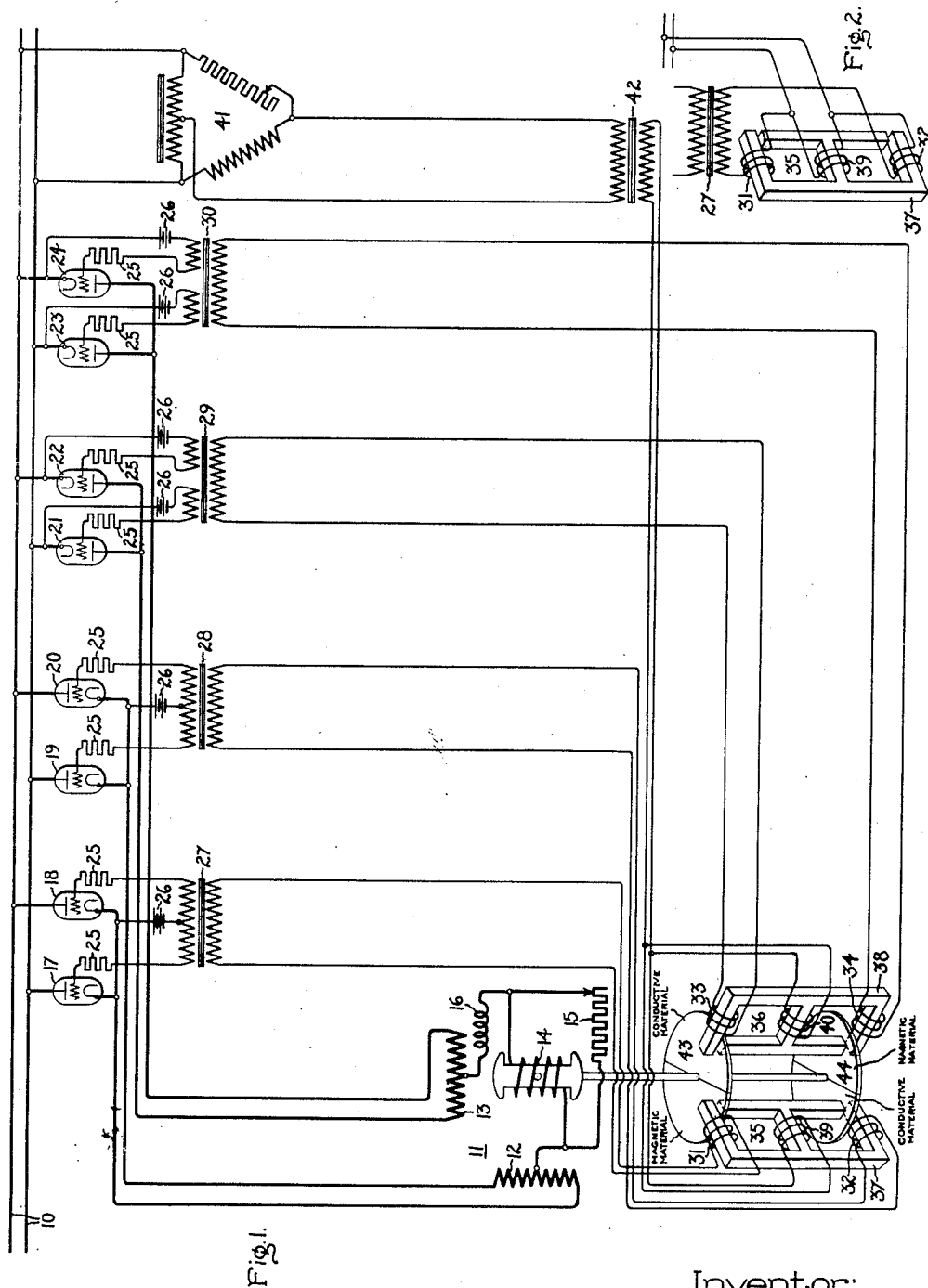
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ELECTRIC VALVE CONVERTING SYSTEM AND EXCITATION APPARATUS THEREFOR

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ELECTRIC VALVE CONVERTING SYSTEM
AND EXCITATION APPARATUS THERE-
FORBurnice D. Bedford, Schenectady, N. Y., assignor
to General Electric Company, a corporation
of New York

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11 Claims. (Cl. 172-120)

My invention relates to electric valve converting systems and more particularly to new and improved apparatus for exciting the control elements of the electric valves of such converting systems.

Heretofore, there have been devised numerous electric valve converting systems for transmitting energy between direct and alternating current circuits, direct current circuits of different voltages, or independent alternating current circuits of the same or different frequencies. Many of these systems have included a distributor apparatus effective to render conductive the several electric valves in a predetermined sequence to transfer the current between the several terminals of the load circuit of the system. In many cases, however, it is desirable to eliminate the moving contacts and other disadvantages inherent in a mechanical distributing apparatus. My invention relates more particularly to an excitation apparatus which may replace the conventional mechanical distributor in the arrangements of the prior art.

It is an object of my invention, therefore, to provide an improved electric valve converting system and an excitation apparatus therefor which will overcome the disadvantages inherent in the mechanical distributor apparatus of the prior art and which will be simple and reliable in operation.

It is another object of my invention to provide an improved electric valve converting system and an excitation apparatus therefor which will render conductive the several electric valves in a predetermined sequence and which will eliminate all moving contacts.

In accordance with one embodiment of my invention, each of the several terminals of a load circuit is interconnected with the supply circuit through a group of one or more electric valves each provided with a control circuit. There is also provided one or more magnetic core members having a pair of parallel magnetic paths each including an air gap. Each of these magnetic core members may constitute the core of a transformer provided with an exciting winding on a common portion of the core and secondary windings mounted on one or both of the parallel magnetic paths of the core member. Associated with the magnetic core members is a reluctance modifying means, such for example, as a pair of coaxially mounted disks, each disk comprising complementary segments of magnetic and conductive materials, respectively, and these disks are arranged in the air gaps of the parallel paths

of the magnetic core members, the disks and the core members being arranged for relative rotation. The corresponding conductive and magnetic segments of the two disks are angularly displaced so that when the air gap of one of a pair of parallel magnetic paths is closed by a magnetic segment, the other is closed by a conductive segment. The magnetic segment acts to lower the reluctance of the magnetic path in which it is included, while the conductive segment, due to the eddy currents induced therein, increases the effective reluctance of the magnetic path in which it is included. In this way, the main flux of the magnetic core member is periodically shifted between the parallel magnetic paths, the potentials induced in the winding associated with the path including a magnetic segment having its maximum or normal value, while that induced in the winding associated with the path including a conductive segment being negligible in magnitude. Each of the control circuits of the electric valves includes one of the secondary windings associated with the magnetic core members and, by rotating the disks relative to the core members, the grids of the several electric valves are excited in a predetermined sequence to control the flow of current in the system.

For a better understanding of my invention, together with other and further objects thereof, reference is had to the following description taken in connection with the accompanying drawing and its scope will be pointed out in the appended claims. Fig. 1 of the drawing illustrates diagrammatically an electric valve converting system for transmitting energy from a single phase alternating current supply circuit to a quarter phase alternating current motor to which is applied my improved valve excitation apparatus.

Fig. 2 of the drawing illustrates a modified connection of the windings of the transformer in Fig. 1.

Referring now more particularly to Fig. 1 of the drawing, there is illustrated an arrangement for transmitting energy from a single phase alternating current supply circuit 10 to a quarter phase alternating current motor 11 of the synchronous type comprising armature phase windings 12 and 13 and a rotatable field winding 14. The field winding 14 may be connected in series with the armature winding, as illustrated, in case it is desired to give the motor series characteristics, or in case shunt characteristics are desired the field winding 14 may be separately excited in any

well known manner. As illustrated, the field winding 14 is connected between the electrical neutrals of the phase windings 12 and 13, a circuit which carries unidirectional current, as will be explained more fully hereinafter. A variable resistor 15 may be connected across the field winding 14 to regulate the speed torque characteristics of the motor, in which case it is preferable also to include a reactor 16 in series with the parallel connected winding 14 and resistor 15.

The terminals of the armature phase winding 12 are connected to the supply circuit 10 through two pairs of similarly connected electric valves 17 and 18, and 19 and 20, respectively. Similarly the armature phase winding 13 is connected to the supply circuit 10 through two pairs of electric valves 21 and 22, and 23 and 24, connected to the circuit 10 with a polarity opposite to that of the electric valves 17-20, inc. Each of the electric valves 17-24, inc., is provided with an anode, a cathode and a control electrode or grid and may be of any of the several types well known in the art, although I prefer to use valves of the vapor or gaseous electric discharge type.

In order to render the valves conductive in a predetermined sequence, the control electrodes, or grids, of the pairs of valves 17-18, 19-20, etc., are connected to their respective cathodes through current limiting resistors 25, negative bias batteries 26 and secondary windings of grid transformers 27, 28, 29 and 30, respectively, although in some instances, the negative bias batteries 26 may be satisfactorily omitted. In order to excite the grid transformers 27-30, inc., in a predetermined sequence their primary windings are energized from the secondary windings 31-34, inc., respectively, of the transformer devices 35 and 36.

The transformer devices 35 and 36 are provided with magnetic core members 37 and 38, respectively, each comprising parallel magnetic paths, as illustrated, and provided with exciting windings 39 and 40, respectively, mounted on a common portion of the parallel magnetic paths. The windings 39 and 40 are energized from the alternating current supply circuit 10 through a suitable phase shifting arrangement, such as an impedance phase shifting circuit 41, and a self-saturating, or peaking, transformer 42, although the transformer 42 may be omitted if desired. As illustrated in the drawing, each of the secondary windings of the transformer devices 35 and 36 is mounted on one of the parallel magnetic circuits, each of the magnetic circuits being constructed with an air gap. Mounted in the air gaps of the magnetic core members 37 and 38 are reluctance modifying means, such for example, as discs 43 and 44, coaxially mounted and connected for rotation by the motor 11. Each of the disks 43 and 44 is made up of complementary segments, one of conductive material, and the other of magnetic material, and the corresponding segments of the two disks are angularly displaced, in the particular embodiment by 180 electrical degrees. However, this feature of controlling the conductivity of a group of electric valves by a distributor mechanism driven by a motor energized through the valves forms no part of my present invention, but is disclosed and broadly claimed in a copending application of E. F. W. Alexanderson, Serial No. 638,361, filed May 11, 1923, and assigned to the same assignee as the present application.

The general principles of operation of the above-described apparatus for transmitting en-

ergy from the alternating current circuit 10 to the motor 11 will be well understood by those skilled in the art, or may be found explained in detail in the copending application of E. F. W. Alexanderson, Serial No. 598,380, filed March 12, 1932 and assigned to the same assignee as the present application. That application discloses and broadly claims the above described power circuit, which forms no part of my present invention. Assuming that the motor field winding 14 and the rotatable disks 43 and 44 are in the positions illustrated, and that the phase shifting circuit 41 is so adjusted that the potentials impressed upon the primary windings of the transformer devices 35 and 36 are substantially in phase with the potential of the alternating current circuit 10, it will be seen that the effective reluctance of the magnetic paths linking the windings 32 and 33 are very high because of the conductive material closing their air gaps. Under these conditions, the potentials induced in the windings 32 and 33 of the primary windings 39 and 40, respectively, will be negligible and will be inadequate to excite the grid transformers 28 and 29 sufficiently to render conductive the pairs of electric valves 19 and 20, and 21 and 22. At the same time, the air gaps of the magnetic paths linking the windings 31 and 34 will be closed by the segments of the disks 43 and 44 composed of magnetic material and these windings will be excited at substantially normal potential to excite their associated grid transformers 27 and 30 to render conductive the pairs of electric valves 17 and 18, and 23 and 24. The two pairs of electric valves 17 and 18, and 23 and 24, comprise a full wave rectifying circuit of which the unidirectional load circuit comprises the lower portion of the armature phase winding 12, the field winding 14, reactor 16 and the right-hand portion of the armature phase winding 13. The resultant armature magnetomotive force created by current flowing in the armature windings 12 and 13 will be in such a direction as to produce a torque upon the motor field 14 and initiate rotation of the motor, which, it will be assumed, is in a counter-clockwise direction.

When the motor 11 has rotated through approximately 90 electrical degrees, the air gap of the magnetic path linking the winding 33 will be closed with magnetic material rather than conductive material, while that included in the magnetic path linking the winding 34 will be closed with conductive material rather than magnetic material so that the winding 33 will be energized while the winding 34 will be deenergized, and the grid excitation shifted from the transformer 30 to the transformer 29. Under these conditions the electric valves 23 and 24 will be rendered nonconductive, while the valves 21 and 22 will be rendered conductive and current will be transferred from the right-hand terminal to the left-hand terminal of the armature phase winding 13. The armature magnetomotive force of the motor 11 is thus advanced 90 electrical degrees and again produces a torque upon the motor field 14 to rotate it through an additional 90 degrees. In this manner, current is successively commutated between the several terminals of the armature windings 12 and 13 to produce a rotating magnetomotive force and rotation of the motor 11. The disks 43 and 44 are effective to control the reluctance of the magnetic paths linking the windings 31 to 34, inc., to energize only those windings connected to excite the valves associated with the terminals of the armature

windings which are in torque producing position with respect to the motor field 14 at any particular instant. The speed of the motor may be controlled by adjusting the phase shifting circuit 41 or the field shunting resistor 15, or both, as is well understood by those skilled in the art.

Thus it is seen that the several pairs or groups of electric valves are rendered conductive in a predetermined sequence to transfer the current between the several terminals of the load circuit without the aid of any moving contacts or any moving parts other than the simple, rugged disks 43 and 44 attached directly to the motor shaft.

In the above-described apparatus, it is desired to transfer the current between the pairs of valves 17 and 18, and 19 and 20, and between the pairs of valves 21 and 22, and 23 and 24, every 180 electrical degrees when supplying current to the quarter phase motor 11. However, it will be well understood by those skilled in the art, that, in case it is desired to supply current to a motor or a load circuit of any other number of phases requiring different periods of excitation of the electric valves, the angular length of the segments of magnetic and conductive material of the disks 43 and 44 may be varied accordingly. Also it will be understood that, under certain circumstances, it may be desirable to utilize only one winding linking a single one of the parallel magnetic paths of each transformer device, in which case the number of transformer devices or magnetic core members may be increased accordingly.

In certain applications requiring a considerable amount of energy from the transformer devices 35 and 36 their windings may be reconnected as shown in Fig. 2. In this arrangement, the secondary windings 31 and 32 are connected in series opposition and in series with the voltage supplied to the primary winding 39. The secondary voltages of the windings 31 and 32, when their respective magnetic paths are closed by a magnetic portion of the disk, are approximately equal to the primary voltage. Under these conditions, when the magnetic material closes the magnetic path of the winding 31, as illustrated in Fig. 1, it will be assumed that the voltage of this winding is in opposition to that of the primary voltage and, since the voltage in the winding 32 is substantially zero, the total circuit voltage applied to the primary winding of the transformer 27 will be substantially zero. When the disks 43 and 44 have rotated to opposite positions, however, the bucking voltage of the winding 31 will be substantially zero while the voltage of the winding 32 will be cumulative with respect to the primary voltage, and substantially twice the primary voltage will be supplied to the primary winding of the transformer 27. With such a circuit connection only half of the energy supplied to the transformer 27 is transformed through the device 35, the remaining portion being supplied directly by the primary circuit. As suggested in the preceding paragraph, with this arrangement a separate transformer device will be required for each control transformer.

While I have described what I at present consider the preferred embodiments of my invention, it will be obvious to those skilled in the art that various changes and modifications may be made without departing from my invention, and I, therefore, aim in the appended claims to cover all such changes and 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 controlled electric valve converting system, apparatus for exciting the control elements of the valves of the system in a predetermined sequence comprising a control circuit for each of said valves, magnetic core means provided with parallel magnetic paths each having an air gap, exciting means for said core means, a winding included in each of said control circuits and linked by one of said parallel magnetic paths, reluctance modifying means mounted in said air gaps and comprising a magnetic portion and a conductive portion, and means for producing relative rotation between said reluctance modifying means and said magnetic core means.

2. In a controlled electric valve converting system, apparatus for exciting the control elements of the valves of the system in a predetermined sequence comprising a control circuit for each of said valves, magnetic core means provided with parallel magnetic paths each having an air gap, exciting means for said core means, a winding included in each of said control circuits and linked by one of said parallel magnetic paths, a plurality of disks mounted in the air gaps of said parallel magnetic paths, each disk comprising a segmental magnetic portion and a segmental conductive portion, corresponding portions of said disks being angularly displaced, and means for producing relative rotation between said disks and said magnetic core means.

3. In a controlled electric valve converting system, apparatus for exciting the control elements of the valves of the system in a predetermined sequence comprising a control circuit for each of said valves, magnetic core means provided with parallel magnetic paths each having an air gap, exciting means for said core means, a winding included in each of said control circuits and linked by one of said parallel magnetic paths, a plurality of coaxially arranged rotatable disks mounted in the air gaps of said parallel magnetic paths, each disk comprising a segmental portion of magnetic material and a segmental portion of low resistance conductive material, corresponding portions of said disks being angularly displaced, and means for rotating said disks.

4. In a controlled electric valve converting system, apparatus for exciting the control elements of the valves of the system in a predetermined sequence comprising a control circuit for each of said valves, a plurality of magnetic core members each provided with a pair of parallel magnetic paths having air gaps, an exciting winding for each of said core members, a winding included in each of said control circuits and linked by one of said parallel magnetic paths, reluctance modifying means mounted in said air gaps and comprising a magnetic portion and a conductive portion, and means for producing relative rotation between said reluctance modifying means and said magnetic core members.

5. In a controlled electric valve converting system, apparatus for exciting the control elements of the valves of the system in a predetermined sequence comprising a control circuit for each of said valves, a pair of coaxially arranged rotatable disks each comprising a segmental portion of magnetic material and a segmental portion of conductive material, corresponding portions of said discs being angularly displaced, a plurality of magnetic core members each provided with a pair of parallel magnetic paths having air gaps, said core members being spaced about the

- path of rotation of said disks and said pair of disks rotating in said pair of air gaps, an exciting winding for each of said core members, a winding included in each of said control circuits 5 and linked by one of said parallel magnetic paths and means for rotating said disks.
6. Apparatus for generating an intermittent periodic potential comprising magnetic core means provided with parallel magnetic paths 10 each having an air gap and with an exciting winding for connection to a source of periodic current, an output winding linked by one of said parallel magnetic paths, reluctance modifying means mounted in said air gaps and comprising a magnetic portion and a conductive 15 portion, and means for producing relative rotation between said reluctance modifying means and said magnetic core means.
7. Apparatus for generating an intermittent alternating potential comprising a magnetic core member provided with a pair of parallel magnetic paths each having an air gap, an exciting winding mounted on said core member 20 for connection to a source of alternating potential, an output winding linked by one of said parallel magnetic paths, a pair of coaxially mounted discs each comprising complementary segments of magnetic material and conductive material, corresponding segments of said disks 25 being angularly displaced, said disks being rotatably mounted in said air gaps, and means for rotating said disks.
8. Apparatus for generating an intermittent periodic potential comprising magnetic core means provided with parallel magnetic paths 30 each having an air gap and with an exciting winding for connection to a source of periodic current, a plurality of secondary windings, each linking one of said magnetic paths, an output circuit including said secondary windings connected in series opposition and in series with said exciting winding, reluctance modifying means 35 mounted in said air gaps, and means for producing relative rotation between said reluctance modifying means and said magnetic core means.
9. Apparatus for generating an intermittent periodic potential comprising magnetic core means provided with parallel magnetic paths 40 each having an air gap and with an exciting winding for connection to a source of alternating current, a plurality of secondary windings, each linking one of said magnetic paths, and having the same number of turns as said exciting winding, an output circuit including said windings connected in series opposition and in series with said exciting winding, reluctance modifying means rotatably mounted in said air gaps, and means for rotating said reluctance modifying means. 80 85
10. In a controlled electric valve converting system for transmitting energy from a supply circuit to a load circuit including an alternating current motor, said system including a plurality of valves interconnecting said supply circuit with the several terminals of said load circuit, apparatus for exciting the control elements of the valves to render said valves conductive in a predetermined sequence comprising a control circuit for each of said valves, magnetic core means provided with parallel magnetic paths each having an air gap, exciting means for said core means, a winding included in each of said control circuits and linked by one of said parallel magnetic paths, and reluctance modifying means 90 95 rotatably mounted in said air gaps, said reluctance means comprising a magnetic portion and a conductive portion and connected to be driven by said motor. 100 105
11. In combination, a supply circuit, a load circuit provided with a plurality of terminals, a plurality of electric valves interconnecting said supply circuit and the several terminals of said load circuit, each of said valves being provided 110 with a control element, a control circuit for each of said control elements, magnetic core means provided with parallel magnetic paths each having an air gap, exciting means for said core means, a winding included in each of said control circuits and linked by one of said parallel magnetic paths, reluctance modifying means mounted in said air gaps and comprising a magnetic portion and a conductive portion, and means for producing relative rotation between said reluctance modifying means and said magnetic core means. 115 120

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