Aug. 20, 1929. H. A. AFFEL 1,725,691

SYSTEM OF ELECTRICAL DISTRIBUTION

Filed Oct. 24, 1921

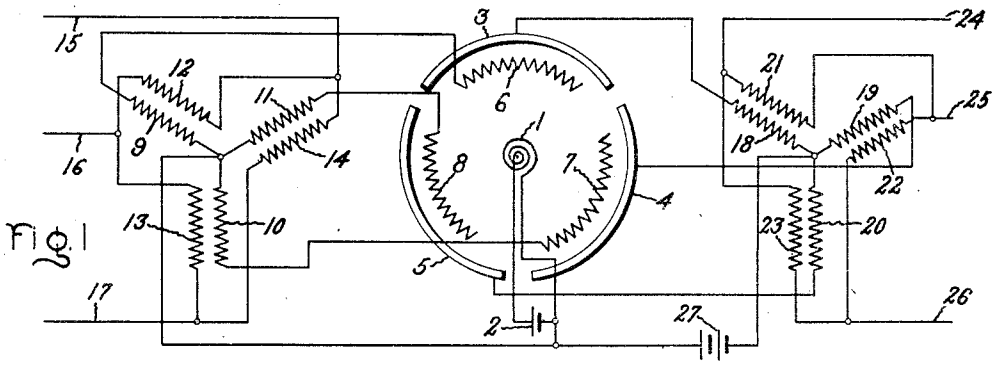


Fig. 1

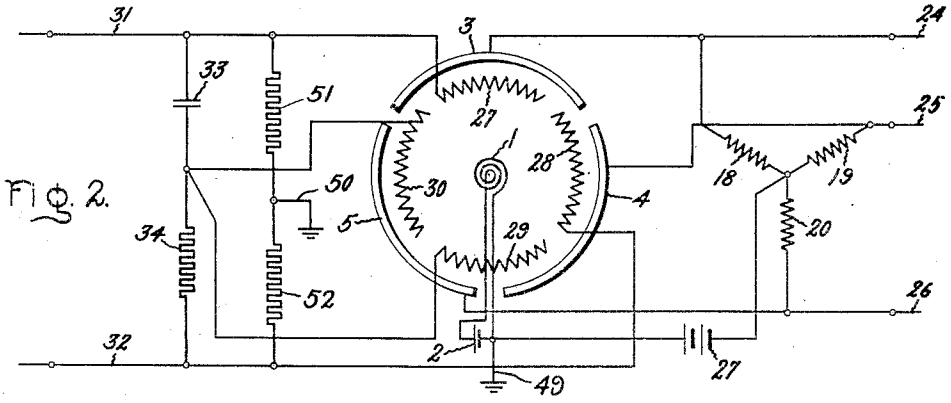


Fig. 2.

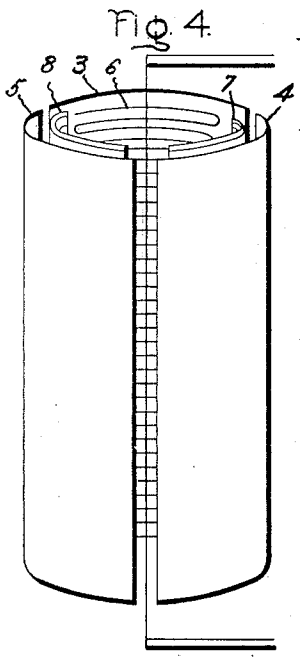


Fig. 4.

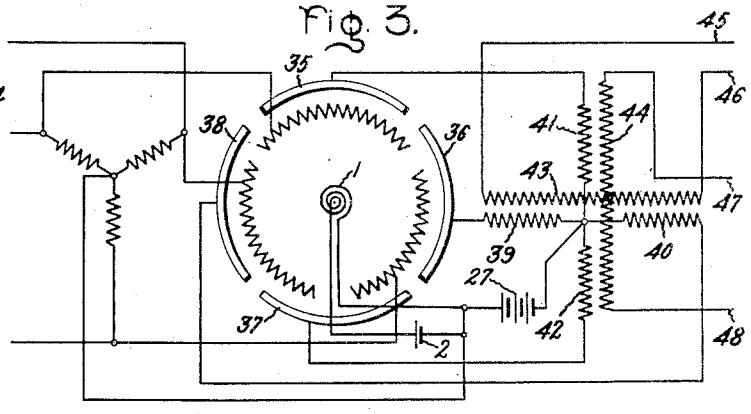


Fig. 3.

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UNITED STATES PATENT OFFICE.

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SYSTEM OF ELECTRICAL DISTRIBUTION.

Application filed October 24, 1921. Serial No. 510,136.

My present invention relates to systems of electrical distribution, and more particularly to a method of and means for supplying current to a polyphase distribution system.

The object of my invention is to provide a simple and convenient method of and apparatus for controlling the flow of current from a direct current source in such a way that polyphase alternating current may be supplied to a system of distribution.

In carrying my invention into effect, I provide a plurality of space current paths through which the current from a direct current source may be caused to flow between an electron emitting cathode and a cooperating anode. All of these paths may conveniently be provided in a single device which includes a common cathode and separate anodes for each of the space current paths. I also provide means for producing a rotating electrical field, preferably electrostatic although an electromagnetic field may be employed, and separately and simultaneously controlling the flow of current in each of the paths to produce successively corresponding variations in all of the paths. The variable currents thus produced in the different paths may by suitable connections then be supplied to a distribution system to produce the desired polyphase currents therein.

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 best be understood by reference to the following description taken in connection with the accompanying drawing in which Fig. 1 shows diagrammatically one way in which my invention may be carried into effect for the amplification of a three phase current; Fig. 2 shows a modification in which a single phase current is employed to produce a rotating electro-static field by means of which three phase current may be supplied to a distribution system; Fig. 3 shows a further modification in which the rotating field is produced by three phase current and quarter phase current is supplied to the distribution system and Fig. 4 is a partial perspective showing one way in which the elements of an electron discharge device may be arranged to provide a plurality of space current paths in one device.

As indicated in the drawing, I provide an electron discharge device having a filamentary cathode 1 adapted to be heated by a current source 2 to cause it to emit electrons. This electron discharge device is claimed in my divisional application, Serial No. 354,102, filed April 10, 1929. In the form of my invention shown in Fig. 1 the electron discharge device includes three separate anodes 3, 4, and 5 and corresponding grid or control electrodes 6, 7 and 8 for separately controlling the current to each of the anodes. The anodes and grids are preferably symmetrically disposed about the cathode, which may be conveniently in the form of a straight filament as indicated in Fig. 4. In the form of device illustrated each of the anodes constitutes a segment of a hollow cylinder surrounding the cathode and each of the grids constitutes a separate portion of a cylindrical grating surrounding the cathode. While this symmetrical cylindrical construction is preferable it is obvious that many modifications in the form and arrangement of the electrodes may be made without changing the fundamental operation of my invention. The electrodes indicated should preferably all be enclosed in a highly evacuated receptacle which, for convenience in illustration, is omitted from the drawings.

Separate input circuits for the three space current paths are provided by connecting each of the grids through one of the secondary windings 9, 10 and 11 of a Y-connected three phase transformer to the cathode 1. The primary windings 12, 13 and 14 of this transformer are delta connected to the three phase supply circuit conductors 15, 16 and 17 for supplying to the input circuits the desired controlling current.

Separate output circuits for the three space current paths are provided by connecting each of the anodes through one of the primary windings 18, 19 and 20 of a Y-connected transformer. The secondary windings 21, 22 and 23 of this transformer are delta connected to the three conductors 24, 25 and 26 of a three phase distribution system. Each of the output circuits also includes a common source 27 of direct current. While the particular transformer

connections indicated are convenient for the desired purpose any other connection may be employed if desired.

The arrangement which I have described constitutes a simple and convenient three phase amplifier the method of operation of which is apparent. A rotating electrostatic field is produced upon the three grids which produces corresponding variations in the currents in the three space current paths, the current variations produced in the different paths being displaced in phase 120 electrical degrees from the currents in the paths to adjacent electrodes. While a separate device might be provided for each of the space current paths without departing from the scope of my invention the arrangement shown is preferable as it permits of the utilization of substantially the maximum electron emission of the cathode at all times.

In the arrangement shown in Fig. 2, four grids 27, 28, 29 and 30 are provided each forming substantially 90° of the circumference of the cylindrical grating while each of the anodes 3, 4 and 5 forms substantially 120° of the circumference of the hollow cylinder. The desired rotating electrostatic field is derived from a source of single phase current supplied from supply conductors 31 and 32. The supply circuit is shunted by a capacity 33 and resistance 34 and grids 28 and 29 are connected across the resistance and grids 27 and 30 are connected across the capacity. With these connections, potentials which differ in phase from one another are applied to the grids 27, 28 and 29 and 30. In order that the polyphase potentials applied to the conductors 24, 25 and 26 be balanced, it is necessary that the effective electrostatic fields between the cathode and the different anodes differ in phase by 120 electrical degrees. This result is accomplished partly by the impedance apparatus comprising the condenser 33 and the resistors 34, 51 and 52 and partly by the arrangement of the grids with respect to the anodes. Thus the effective electrostatic field between the cathode 1 and the anode 3 is dependent on the potentials of grids 27, 28 and 30; the effective electrostatic field between the cathode 1 and the anode 4 is dependent on the potentials of grids 28 and 29; and the effective electrostatic field between the cathode 1 and the anode 5 is dependent on the potentials of grids 29 and 30. The distances by which the different grids overlap the different anodes in any given case will of course depend on the phase difference between the voltages produced at the conductors 31 and 32 and at the junction point between the condenser 33 and the resistor 34. The secondary of the transformer in the distribution circuit is omitted, an auto-transformer connection of the windings 18, 19 and 20 being shown. The input circuits in this case are completed by grounding the cathode 1 at 49 and by providing a ground connection 50 at a point in the supply system so chosen that the admittance between the two sides of the supply system and this ground connection are equal. In the present case the desired point is obtained by connecting the two sides of the supply system to ground point 50 through two equal impedances 51 and 52.

In the system shown in Fig. 3 three grids and four anodes 35, 36, 37 and 38 are provided. The input circuits are excited by three phase current to produce the desired rotating field. The output circuits include the primary windings 39, 40, 41 and 42 of a quarter phase transformer having secondary windings 43 and 44 for supplying quarter phase current to the conductors 45, 46, 47 and 48 of a quarter phase system of distribution. The primary windings of the output circuits of oppositely located anodes 35 and 37 are oppositely connected to the secondary winding 44 as the current in one of these output circuits increases at the same time that the current in the other decreases. Similarly, the primary windings of the output circuits of oppositely located anodes 36 and 38 are oppositely connected to the secondary winding 43.

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

1. The combination of a pair of electrical circuits each comprising a plurality of conductors, and a space discharge device provided with a cathode, with a plurality of anodes each connected to a different conductor of one of said circuits and with a plurality of grids connected to the other of said circuits and arranged to produce between said cathode and each of said anodes an electrostatic field which is the resultant effect of more than one of said grids.

2. The combination of a pair of electrical circuits each comprising a plurality of conductors, and a space discharge device provided with a cathode, with a plurality of anodes arranged concentrically about said cathode and each connected to a different conductor of one of said circuits and with a plurality of grids arranged concentrically about said cathode and out of radial alinement with said anodes, and means interconnecting said grids with the other of said circuits.

3. The combination of a pair of electrical circuits each comprising a plurality of conductors, and a space discharge device provided with a cathode, with a plurality of anodes arranged concentrically about said cathode and each connected to a different conductor of one of said circuits and with a plurality of grids arranged concentrically about said cathode and out of radial alinement with said anodes, and impedance means

connected to the other of said circuits between said grids and said cathode for producing a rotating electrostatic field between said cathode and said anodes.

4. The combination of a plurality of alternating circuits each comprising a plurality of conductors, a space discharge device provided with a cathode, with a plurality of anodes each connected to a different conductor of one of said circuits and with a plurality of grids connected to the other of said circuits and arranged to produce between said cathode and each of said anodes an electrostatic field which is the resultant effect of more than one of said grids, and a source of current connected between said cathode and the neutral connection of the circuit which is interconnected with said anodes.

5. The combination of a polyphase circuit, a single phase circuit, impedance means connected to said single phase circuit for producing a rotating electrostatic field, and a space discharge device comprising a cathode, a plurality of anodes arranged concentrically about said cathode and each connected to a different phase of said polyphase circuit, and a plurality of grids connected to said cathode through said impedance means and so arranged with respect to said anodes as to cause polyphase voltages to be applied to said polyphase circuit.

6. The method of balancing the voltages applied to a polyphase circuit through means comprising a space discharge device provided with a plurality of grids arranged to control the current transmitted between its cathode and anodes, which comprises applying unbalanced voltages to said grids, and producing between said cathode and each of said anodes an electrostatic field which is the resultant effect of more than one of said grids.

7. The method of producing balanced polyphase voltages through means comprising a single phase circuit and a space discharge device provided with a plurality of grids arranged to control the current transmitted between its cathode and anodes and connected to said single phase circuit through means for producing unbalanced electrostatic fields, which comprises producing between said cathode and each of said anodes a resultant electrostatic field dependent on the electrostatic fields of a plurality of said grids.

In witness whereof, I have hereunto set my hand this 21st day of October, 1921.

HERMAN A. AFFEL.