Nov. 14, 1933. H. A. AFFEL 1,935,594

POLYPHASE CURRENT GENERATOR

Original Filed Oct. 24, 1921

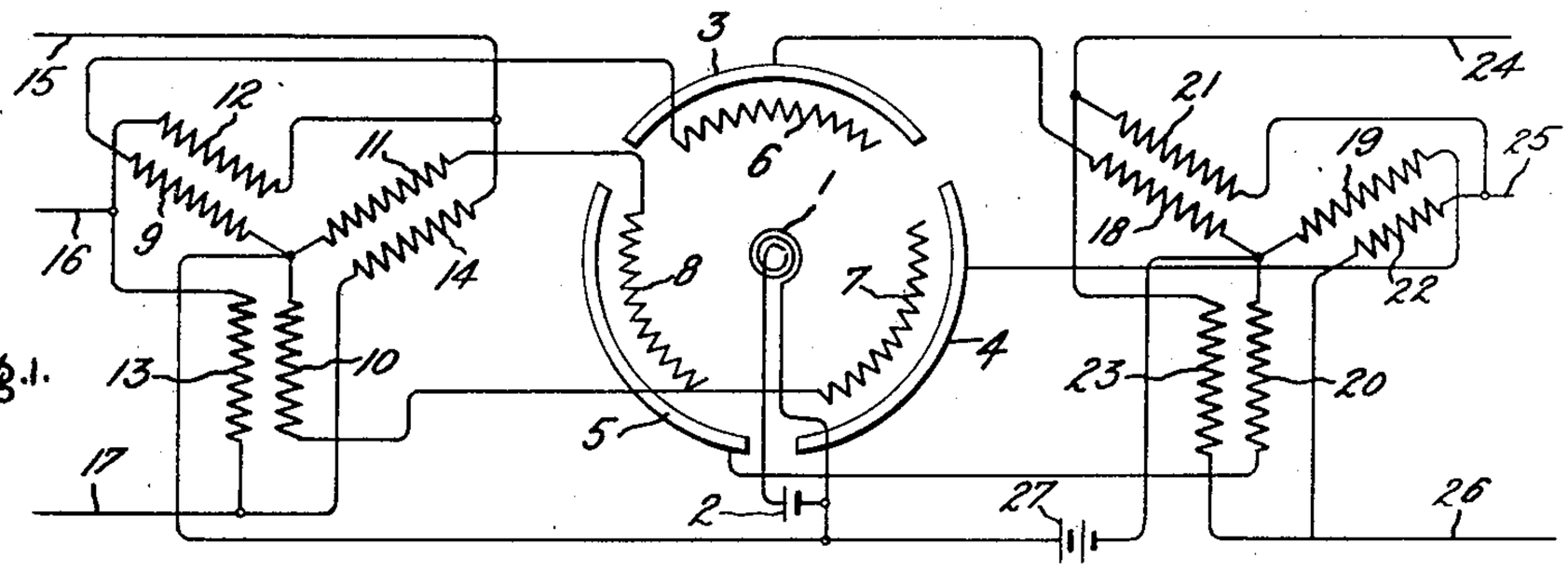


Fig. 1.

Fig. 2.

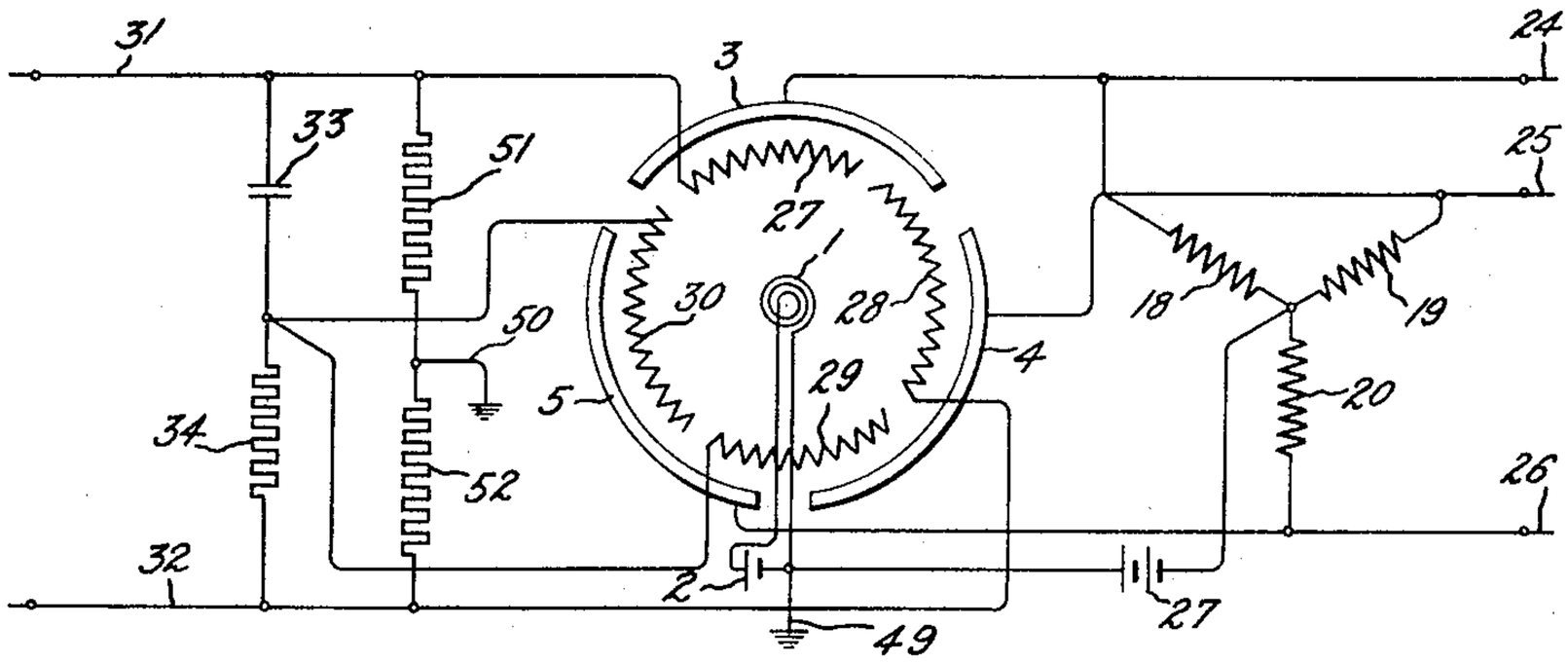


Fig. 4.

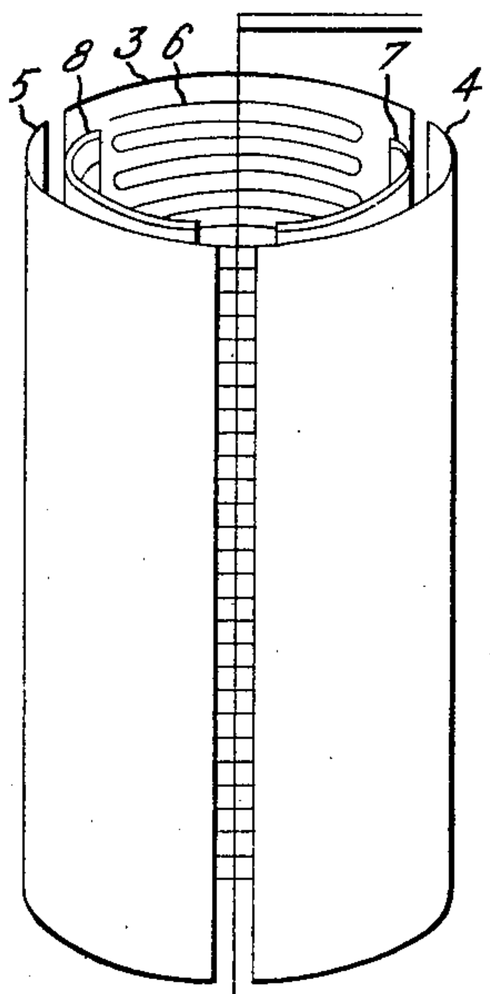
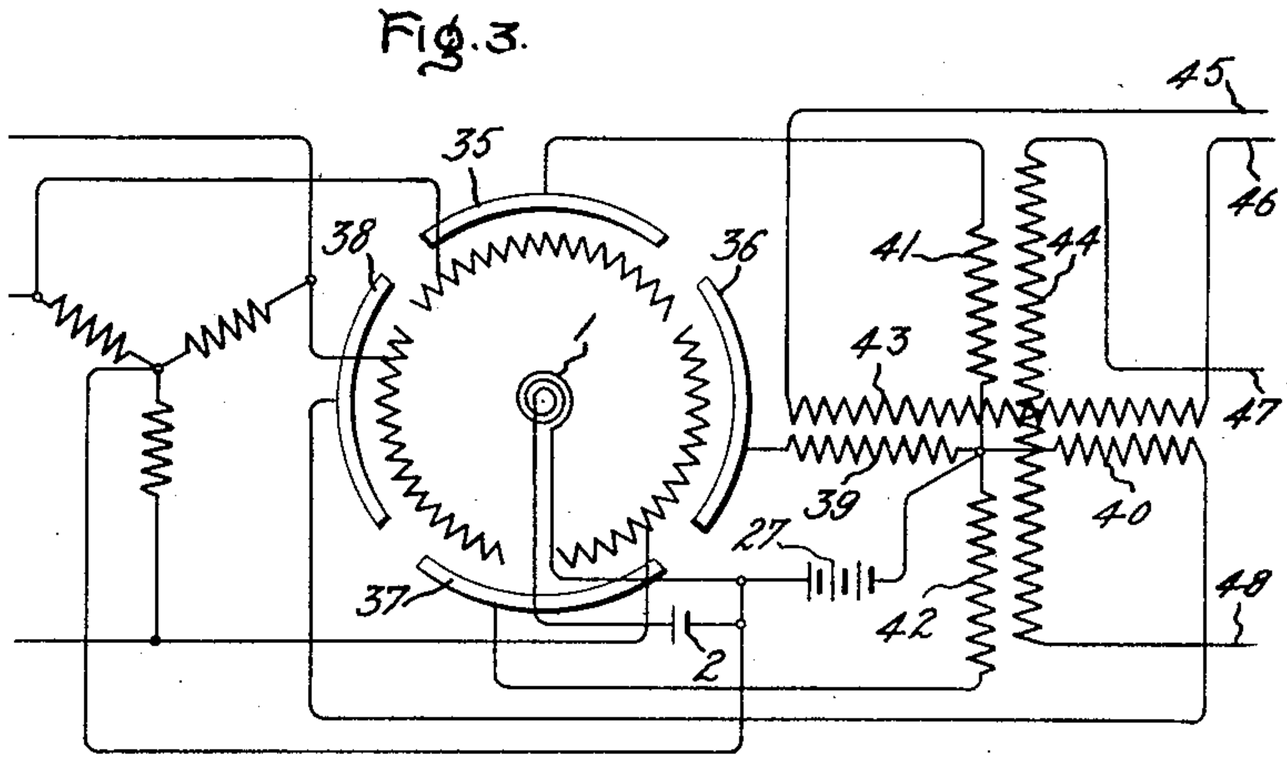


Fig. 3.



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UNITED STATES PATENT OFFICE

1,935,594

POLYPHASE CURRENT GENERATOR

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Original application October 24, 1921, Serial No. 510,136. Divided and this application April 10, 1929. Serial No. 354,102

2 Claims. (Cl. 250—27.5)

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. This application is a division of my copending application which matured into Patent No. 1,725,691, granted August 20, 1929, and assigned to the same assignee as the present application.

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 electrostatic 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. 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. The term "segment" as used in the previous sentence is intended to refer to a portion of a cylinder bounded in the direction of the main axis of the cylinder by two straight parallel edges. However, it will be understood that my invention is not limited to the segmental form of anode but contemplates the use of all portions or configurations which lend themselves to a symmetrical arrangement. It is also obvious that anode portions which are not symmetrical may sometimes be used to advantage as well as electrical arrangements different from that shown, without departing from the spirit of the invention. The electrodes indicated should preferably all be enclosed in a highly evacuated receptacle which, for convenience in illustration, is omitted from the drawing.

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 the utilization of substantially the maximum electron emission of the cathode at all times. While I have indicated that the current for producing the electrostatic field is supplied by a separate source the system may be made self-exciting if desired by providing any suitable form of feed-back connection from the output circuits to the input circuits.

In the arrangement shown in Fig. 2, four grids 27, 28, 29 and 30 are provided each forming substantially 90 degrees of the circumference of the cylindrical grating while each of the anodes 3, 4 and 5 forms substantially 120 degrees 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 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 betwen 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. An electron discharge device comprising a cathode adapted to emit electrons, a plurality of grids symmetrically disposed about said cathode and a plurality of anodes which constitute separated segments of a hollow cylinder surrounding said cathode, said grids being disposed between said anodes and the cathode.

2. An electron discharge device comprising a cathode adapted to emit electrons, a plurality of grids which constitute separated portions of a cylindrical grating surrounding said cathode and a plurality of anodes each of which constitutes a separate portion of a hollow cylinder surrounding said grids.

HERMAN A. AFFEL.

CERTIFICATE OF CORRECTION.

Patent No. 1,935,594. November 14, 1933.

HERMAN A. AFFEL.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 2, lines 125 and 126, claim 2, for "each of which constitutes a separate portion" read which constitute separated portions; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 26th day of December, A. D. 1933.

Richard Spencer

(Seal) Acting Commissioner of Patents.