No. 768,354. PATENTED AUG. 23, 1904.

J. E. WOODBRIDGE.

MEANS FOR VARYING THE VOLTAGE OF ALTERNATING CURRENTS.

APPLICATION FILED OCT. 28, 1902.

NO MODEL.

Fig. 1.

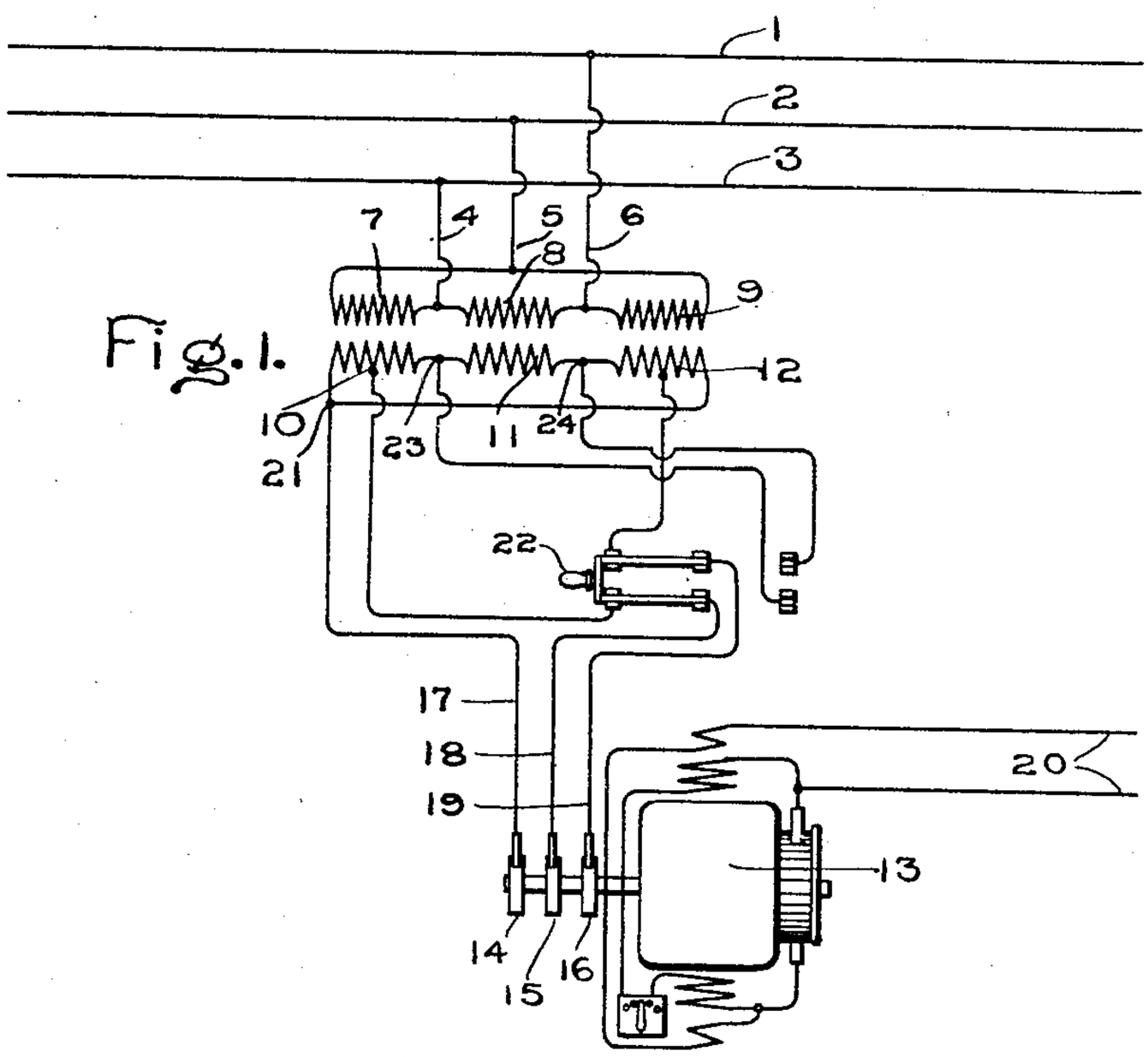
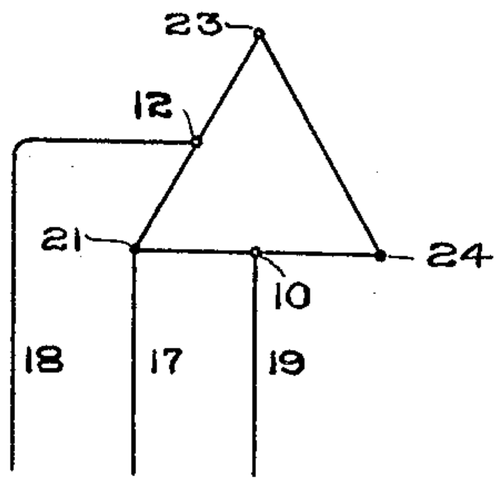


Fig. 2.



Witnesses:
George A. Thornton.
Benjamin B. Hauer

Inventor:
Jonathan E. Woodbridge,
by Allen & Davis
Att'y.

No. 768,354. Patented August 23, 1904.

UNITED STATES PATENT OFFICE.

JONATHAN E. WOODBRIDGE, OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

MEANS FOR VARYING THE VOLTAGE OF ALTERNATING CURRENTS.

SPECIFICATION forming part of Letters Patent No. 768,354, dated August 23, 1904.

Application filed October 28, 1902. Serial No. 129,128. (No model.)

To all whom it may concern:

Be it known that I, JONATHAN E. WOODBRIDGE, a citizen of the United States, residing at Schenectady, county of Schenectady, State of New York, have invented certain new and useful Improvements in Means for Varying the Voltage of Alternating Currents, of which the following is a specification.

My present invention aims to provide means for varying the voltage of an alternating-current source for starting rotary converters or for other purposes.

My invention is more particularly applicable to three-phase alternating-current systems, though not necessarily limited to use in this connection only.

In carrying my invention into practice I make use of delta-connected windings—such, for example, as delta-connected transformer secondaries—or, if desired, similarly-connected compensator-windings may be used. To obtain from windings thus connected a low voltage for purposes such as mentioned above, it has heretofore been suggested that to secure low or starting voltage current be taken from the middle or other intermediate points of the delta-connected windings, the connections of the consumption-circuit being then shifted to the ends of the windings in the usual three-phase relation to obtain full running voltage. This method of obtaining variable voltage is, however, open to various objections, among the more serious of which may be mentioned the excessive momentary flow of current as the connections are shifted from the starting position to the running position due to the shifting in phase relation of the currents of the consumption-circuit relatively to the currents of the supply-circuit, the change in phase angle being either sixty degrees or one hundred and eighty degrees, depending upon the manner in which the connections are shifted. To obviate this difficulty as well as others not necessary for the present purpose to mention, I have devised a system of connections wherein one terminal of the consumption-circuit—as, for example, a system of leads feeding a rotary converter—is permanently connected to the junction between two of the three three-phase windings, the other two terminals being arranged so that by throwing a switch they may be connected, respectively, to the middle or other suitably-chosen intermediate points of said two windings or to the extreme ends of said winding.

The features of novelty which characterize my invention I have set forth with particularity in the appended claims, while the invention itself is described in some detail in the following specification, which is to be taken in connection with the accompanying drawings, in which—

Figure 1 represents a system embodying my invention, while Fig. 2 is an explanatory diagram.

In Fig. 1 a source of three-phase current is represented conventionally by the three-phase mains 1, 2, and 3. Leads 4 5 6 extend therefrom to a set of three-phase step-down transformer-windings the primaries of which are indicated at 7, 8, and 9 and the corresponding secondaries at 10, 11, and 12.

A rotary converter (indicated diagrammatically at 13) is intended to represent any device or consumption-circuit to which it is desired for any purpose to supply a variable multiphase voltage. The leads by which current is supplied to the collector-rings 14, 15, and 16 of the rotary converter are indicated at 17, 18, and 19, respectively. The direct current derived from the rotary converter is fed to direct-current mains 20, by which it is conveyed to any suitable current-consuming devices.

One of the alternating-current leads of the rotary converter—as, for example, the lead 17—is permanently connected to the junction 21 between terminals of the transformer secondaries 10 and 12. By permanent connection I do not mean that the connection is never broken, but merely that it is retained or may be retained during the operation of changing the voltage of the three-phase current supplied to the rotary converter or other consumption-circuit. A two-pole double-throw switch 22 is arranged so that in one of its positions it connects the remaining three-phase leads 18 and 19 to the middle or other

intermediate points, respectively, of the aforesaid secondaries 10 and 12, while in the other position the connection of these leads is shifted from the middle of these secondaries to points farther away from the junction 21. The final position may correspond with the remaining terminals 23 24 of these windings, though this is not necessary so far as concerns the broader aspect of my invention.

The connections above mentioned may, perhaps, be rendered somewhat clearer by reference to Fig. 2, in which the three-phase voltages of the transformer secondaries are indicated by the sides of a triangle. In the starting position the leads 17, 18, and 19 are connected so that the voltages impressed thereon are represented by fractions of the total voltages between the points of connection 21 23 and 21 24. In changing from the starting to the running position the points of connection of the leads 18 and 19 are shifted from the middle or other intermediate points 10 12 in adjacent sides of the voltage triangle to the apexes 23 24 of the triangle, thereby impressing upon the leads the full three-phase voltage. By selecting the location of the intermediate connections for the leads 18 and 19 the three-phase voltage may be made anything desired within the limits of the maximum desired.

It is of course possible by the use of my invention to make a greater number of changes in voltage than as shown. Thus instead of making the single change from, say, half-voltage to full voltage it is quite within my invention to make a greater number of changes—as, for example, from one-third voltage to two-thirds and then to full voltage or the like.

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

1. The combination of multiphase supply-mains, primary windings symmetrically connected to said mains, secondary windings inductively related to the primary windings in series, a lead permanently connected to the junction of two of said secondary windings, other leads coöperating with the first-mentioned lead, and means for shifting the connections between said secondary windings and all of the leads except the permanently-connected lead so as to vary the electromotive forces between the leads without shifting the phases of the electromotive forces.

2. The combination of three-phase supply-mains, three primary windings connected respectively to said supply-mains, three secondary windings inductively related to said primary windings, connections joining said secondary windings in delta relation to each other, a lead connected to the junction of two of said secondary windings, two other leads coöperating with the first-mentioned lead, and a switch for connecting said two leads either to the remaining terminals of said two secondary windings respectively or to intermediate points thereof.

In witness whereof I have hereunto set my hand this 27th day of October, 1902.

JONATHAN E. WOODBRIDGE.

Witnesses:
BENJAMIN B. HULL,
HELEN ORFORD.