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A. H. ARMSTRONG & J. E. WOODBRIDGE.
MEANS FOR VARYING DELTA CONNECTED VOLTAGES.

APPLICATION FILED DEC. 16, 1901.

NO MODEL.

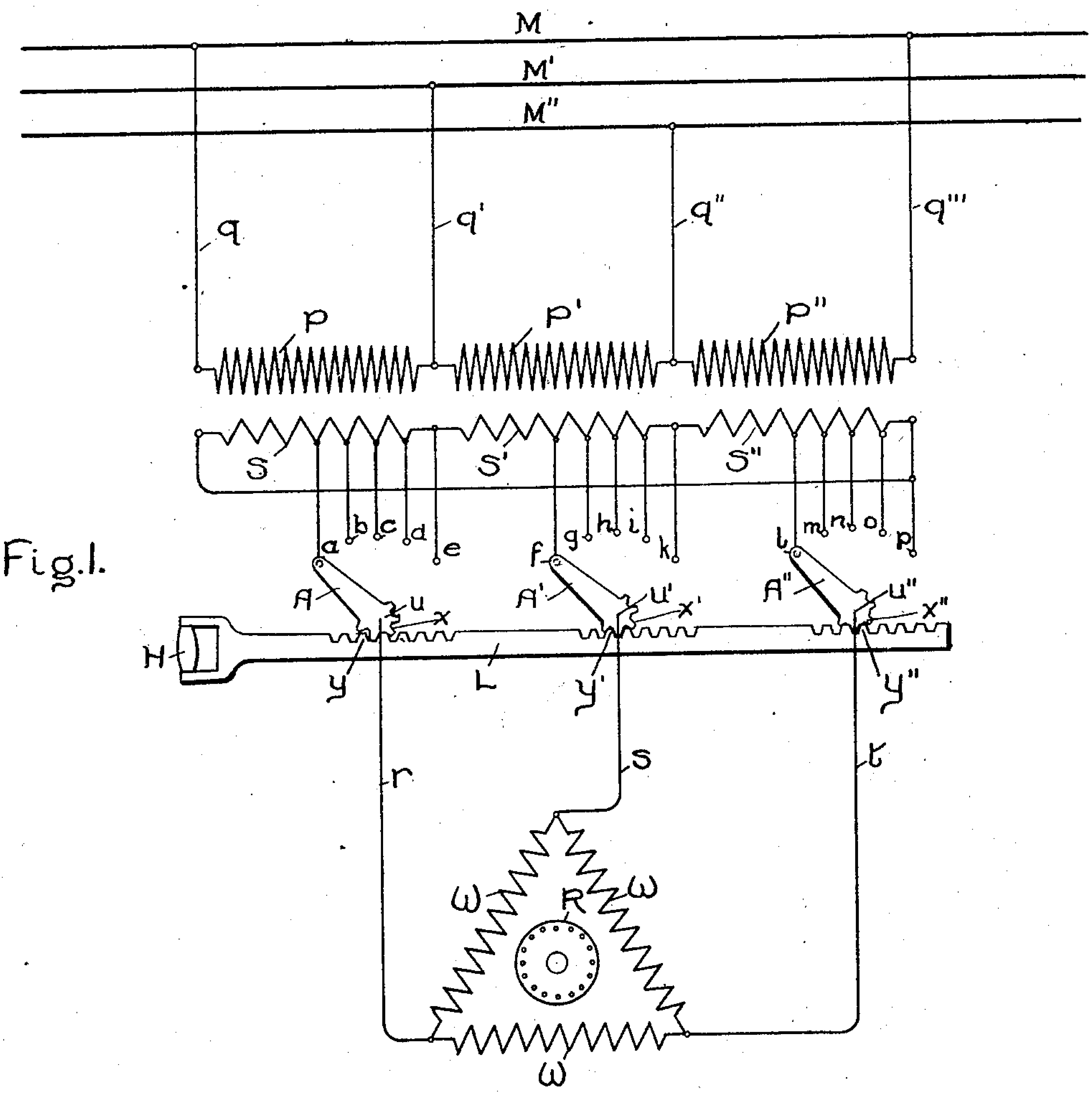

Fig. 1.

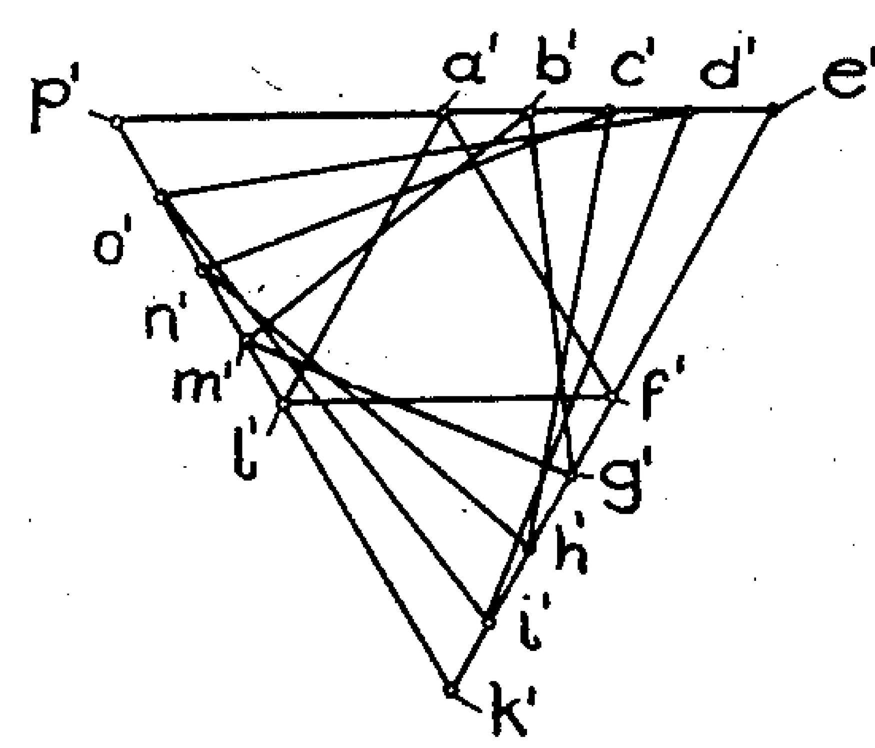

Fig. 2.

Witnesses.
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UNITED STATES PATENT OFFICE.

ALBERT H. ARMSTRONG AND JONATHAN E. WOODBRIDGE, OF SCHENECTADY, NEW YORK, ASSIGNORS TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

MEANS FOR VARYING DELTA-CONNECTED VOLTAGES.

SPECIFICATION forming part of Letters Patent No. 726,391, dated April 28, 1903.

Application filed December 16, 1901. Serial No. 86,015. (No model.)

To all whom it may concern:

Be it known that we, ALBERT H. ARMSTRONG and JONATHAN E. WOODBRIDGE, citizens 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 Delta-Connected Voltages, of which the following is a specification.

This invention relates to electrical translating devices which are connected in delta, and has for its object the provision of means whereby fractions of the maximum voltage may readily be obtained without changing the connections between the several translating devices. We accomplish the desired result by bringing out interior taps from a plurality of translating devices permanently connected in delta and connecting the conductors of a multiphase system to the said taps or to certain of them. By an "interior" tap is meant one which is not at an extremity of a winding. The devices may thus be connected in such manner as to produce a resultant voltage which is a fraction of the maximum, and by providing a number of taps from each device and furnishing switching mechanism to connect the conductors to different sets of taps successively various values of voltage may be obtained.

We have chosen to illustrate our invention in connection with transformers in a three-phase system; but it may be applied to other translating devices and to a system of any number of phases. When we speak of windings as connected in delta, we do not intend to limit ourselves to three-phase connections, but mean to include any similar connection of any number of phases.

Referring to the drawings, Figure 1 is a diagrammatic illustration of our invention as applied to the windings of a three-phase transformer, and Fig. 2 is a diagram showing the relative values and phases of the voltage.

Referring to Figs. 1 and 2, we may consider that M, M′, and M″ are the supply-mains of a three-phase system. P, P′, and P″, connected to them by leads *q q‴*, are the primary windings, and S, S′, and S″ are the secondary windings of a three-phase transformer. From like points of the latter are taken, respectively, the taps *a e*, *f k*, and *l p*, which at their outer ends terminate in contacts or are otherwise adapted to connect with conducting-arms A, A′, and A″. These arms, pivoted at *u*, *u′*, and *u″*, are insulated from each other and provided with gear-teeth *x*, *x′*, and *x″*, as shown. The member L, which may be operated by handle H and carries gear teeth or racks *y*, *y′*, and *y″*, adapted to engage, as shown, with the teeth upon the arms A, A′, and A″, provides a means for simultaneously operating the arms and maintaining them in their proper relative positions. The arms A, A′, and A″ are connected by conductors *r*, *s*, and *t* with the apparatus to which the secondary windings supply energy and which in this case is diagrammatically represented as a motor with stationary windings W and rotating member R. The voltage upon mains M, M′, and M″ is impressed on primaries P, P′, and P″, and the voltage generated in the secondaries S, S′, and S″—that is to say, between the taps *p*, *e*, and *k*—is proportional thereto and may be represented by the equilateral triangle *p′ e′ k′*. The arms A, A′, and A″ are shown as resting upon the left-hand set of taps *a*, *f*, and *l*, which in this case are taken from the middle points of the secondaries. The taps are thus connected to the windings W, and the voltage impressed upon those windings may be represented by the equilateral triangle *a′ f′ l′*, for the voltage between leads *r* and *s*, which is represented by line *a′ f′*, is the vector sum of the voltages between taps *a* and *e* and *a* and *f*, which are represented by the lines *a′ e′* and *e′ f′*. In a similar manner the voltages between conductors *s* and *t* and *t* and *r* may be shown to be represented by the lines *f′ l′* and *l′ a′*, respectively. Now if the member L be moved to the left arms A, A′, and A″ will be moved until they engage with the taps *b*, *g*, and *m*. The component voltages between conductors *r* and *s* are now represented by lines *b′ e′* and *e′ g′*, the resultant of which is represented by the line *b′ g′*. In a similar way the voltage between conductors *a* and *t* and *t* and *v* can be shown to be represented by the lines $g' m'$ and $m' b'$, so that the voltage impressed upon windings W is represented by the equilateral triangle $b' g' m'$. In the succeeding positions when the arms are in contact with the sets of taps including c, h, and n and d, i, and o, respectively, the voltages impressed upon windings W are respectively represented by equilateral triangles $c' h' n'$ and $d' i' o'$, and in the last position where the arms rest upon the taps p, e, and k at the extremities of windings S'', S, and S' full voltage represented by equilateral triangle $p' e' k'$ is impressed on windings W. Comparison of triangles $a' f' l'$ and $p' e' k'$ will show that the voltage impressed upon the conductors r, s, and t is one-half as great at the beginning as at the end of the variation.

While the primaries are shown as being connected in delta, it is evident that so far as our invention is concerned they might in this case be connected in any other practicable way.

It is to be noted that at all steps the triangles of voltage are equilateral, thus showing that a balance voltage is impressed upon windings W. This condition is brought about by connecting corresponding taps in the several translating devices to the conductors r s t of the multiphase system to which the windings W are connected. The voltages between the conductors of the multiphase system are balanced voltages.

It is probable that our invention will find the widest use under these circumstances; but it is evident that it can be as well applied to systems upon which unbalanced voltages are impressed and that any desired combination of taps can be made.

In view of the numerous means which may be employed and applications which can be made without departing from our invention we do not wish to be limited to those shown in the drawings.

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

1. The combination of a plurality of translating devices connected in delta, interior taps from said devices, and a plurality of conductors constituting a multiphase system of distribution connected to said taps.

2. The combination of a plurality of translating devices connected in delta, a series of interior taps from each of said devices, a plurality of conductors constituting a multiphase system of distribution, and means for connecting the conductors of the multiphase system to different sets of said taps.

3. The combination of a plurality of translating devices connected in delta, a series of interior taps from each of said devices, a plurality of conductors constituting a multiphase system of distribution, and a switch having its contacts arranged to connect the conductors of the multiphase system successively to different sets of said taps.

In witness whereof we have hereunto set our hands this 13th day of December, 1901.

ALBERT H. ARMSTRONG.
JONATHAN E. WOODBRIDGE.

Witnesses:
BENJAMIN B. HULL,
FRED RUSS.