E. F. W. ALEXANDERSON.

SYSTEM OF ELECTRIC DISTRIBUTION.

APPLICATION FILED JAN. 7, 1908.

921,786. Patented May 18, 1909.

Fig. 1.

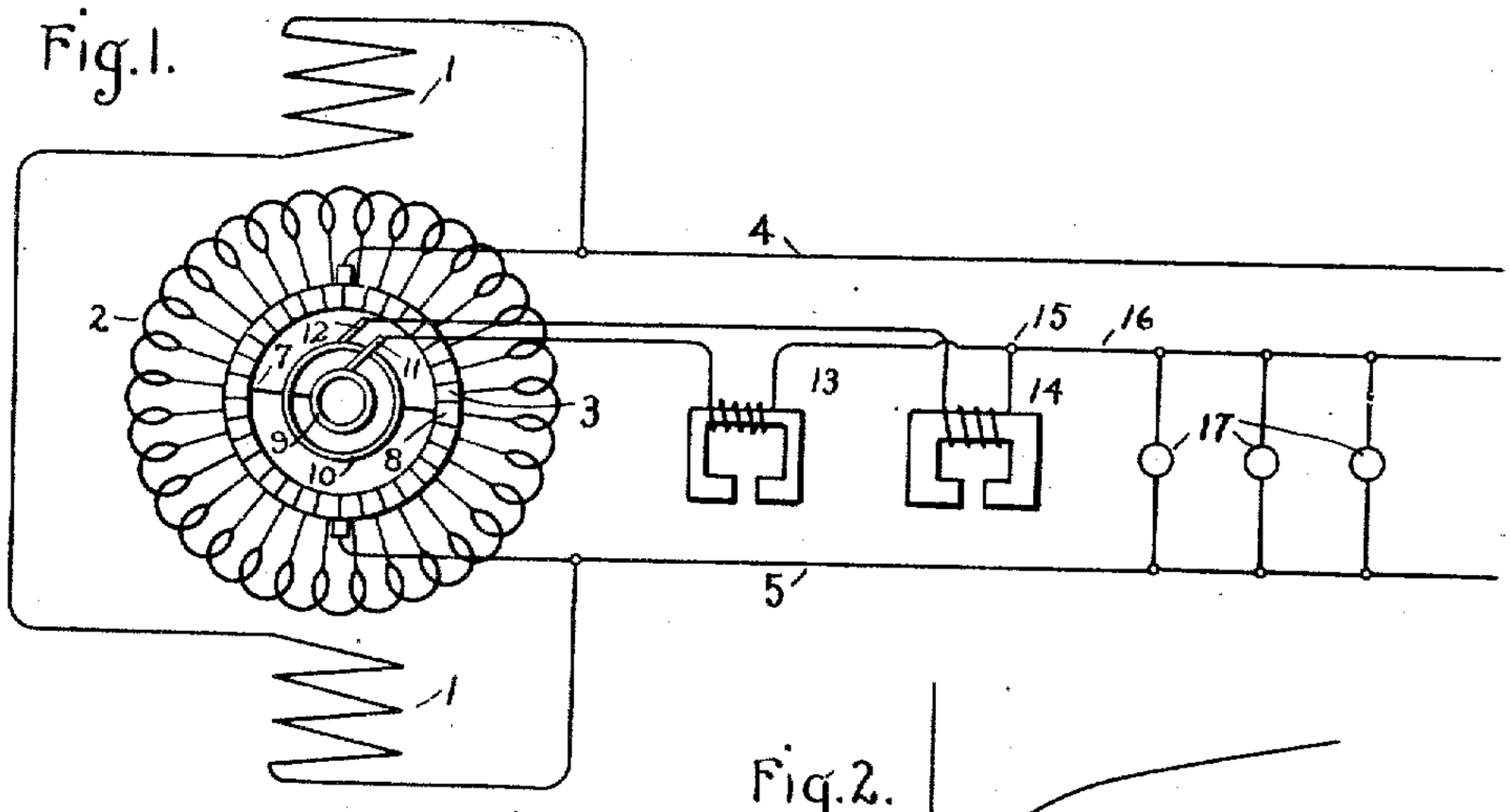


Fig. 2.

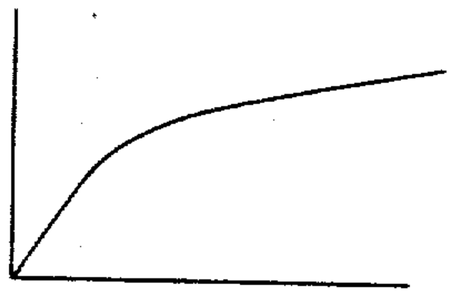


Fig. 3.

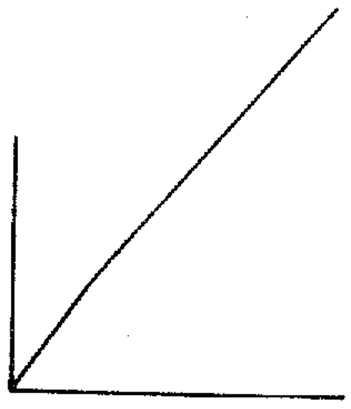


Fig. 4.

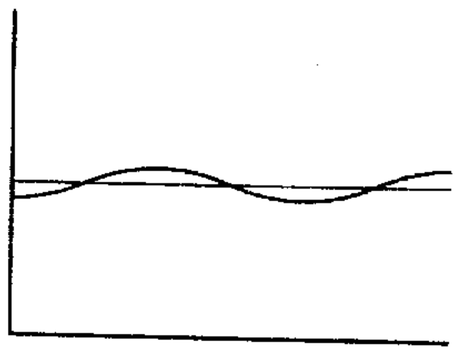
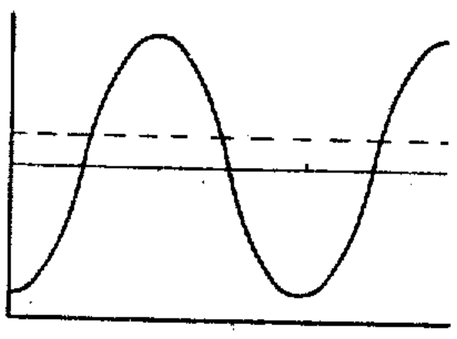


Fig. 5.



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UNITED STATES PATENT OFFICE.

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SYSTEM OF ELECTRIC DISTRIBUTION.

No. 921,786. Specification of Letters Patent. Patented May 18, 1909.

Application filed January 7, 1908. Serial No. 409,698.

To all whom it may concern:

Be it known that I, ERNST F. W. ALEXANDERSON, a citizen of the United States, residing at Schenectady, county of Schenectady, State of New York, have invented certain new and useful Improvements in Systems of Electric Distribution, of which the following is a specification.

My invention relates to multiple conductor direct current systems of distribution such as three wire systems, and more particularly to generators for supplying such systems.

The generators ordinarily used for three-wire and similar systems are unsatisfactory for systems which may be unbalanced because even a comparatively slight difference in load between the two sides of the system causes the potential on the side having the greater load to drop very rapidly so that if the difference in load becomes as great as 25 per cent. the potential on the side having the greater load becomes too low for satisfactory operation of incandescent lamps. Compounding the generator in the ordinary way does not overcome the difficulty, which is not due to decrease in potential between the outside wires but results from the potential between the neutral and one outside wire being different from the potential between the neutral and the other outside wire.

My invention consists in providing means for automatically compounding the voltage between the neutral and an outside wire with varying load.

More specifically stated, my invention consists in providing automatic means for impressing an alternating voltage, increasing with increasing load, upon the neutral; which voltage combines with the constant voltage between the neutral and an outside wire in such a manner that a resultant pulsating voltage is produced between the neutral and outside wire, the effective value of which is greater than that of the constant voltage alone.

The above described method of compounding the neutral to regulate the voltage may be applied to any multiple conductor system in a great variety of ways but is preferably carried out by means of the generator, in which as commonly constructed for three-wire systems, a reactance or compensator connected to points on the armature 180 electrical degrees has a tap at the middle for connecting the neutral to the generator. In case the alternating voltage is derived from the generator, my invention contemplates the shifting, either actually or in effect, of the point of connection of the neutral away from the middle of the reactance in proportion to the extent of the unbalancing of the system until at the limit of unbalancing the result is the same as though the neutral were connected to a segment of the commutator during a complete revolution of the armature.

The alternating voltage impressed on the neutral combines with the steady voltage of the neutral in quadrature to produce a pulsating voltage between the neutral and the outside wires varying in amount with the amount of current in the neutral. Since the effective voltage is the square root of the average square of the momentary voltages, the potential between the neutral and outside wires becomes greater than the normal and compensates for the drop caused by the unbalancing of the system. This result may be obtained in many different ways but in the preferred arrangement two reactance coils with separate cores are connected in series across the armature between points 180 electrical degrees apart and the neutral is connected to a point between the coils. The two coils have different characteristics, the saturation curve of one being nearly straight while the curve of the other has a sharp bend in it. The coils are so proportioned that under normal conditions, both have the same reactance but as the current in the neutral increases the reactance of the one coil changes and that of the other remains practically unchanged. When the system is balanced the neutral wire is connected to the neutral point of the armature, while as the system becomes unbalanced the two coils cooperate to cause an effect which is the equivalent of connecting the neutral to a segment of the commutator to cause a pulsating voltage between the neutral and the outside wire on that side of the system carrying the greater load.

One form in which my invention may be embodied is shown in the accompanying drawings in which—

Figure 1 is a diagram showing a generator and three-wire system embodying one form of my invention; Figs. 2 and 3 are curves showing the characteristics of the two reactance coils shown in Fig. 1; and Figs. 4

and 5 are diagrams showing the relation of the alternating voltage generated when the system is unbalanced to the average voltage on the neutral.

In the form of the invention shown in Fig. 1, the generator comprises field magnets 1 and an armature 2 of the usual type having a commutator 3 connected to the outside wires 4 and 5 of the system. The neutral on the system is derived by connecting points 7 and 8 on the armature, which are 180 electrical degrees apart, to collector rings 9 and 10 engaged by brushes 11 and 12 which are connected to each other through two reactance coils 13 and 14 in series with each other. A neutral point 15 exists between the two reactance coils and to this point the neutral wire 16 of the system is connected. When the system is balanced no current flows in the neutral wire 16, but when the system is unbalanced the excess load, represented by the lamps 17, appears on one side of the system, as for instance between the neutral and the outside wire 5, and causes current in the neutral and also a drop in voltage between the wires, which is compensated by varying the voltage on the neutral, preferably by deriving an alternating voltage from the armature 2 and superposing it on the steady voltage of the neutral in such a way that the effective voltage between the neutral and the outside wires is varied. In the arrangement shown in the drawing, the two reactance coils constitute a device which will vary automatically the effective voltage between the neutral and the outside wires to the same extent as the current between those wires varies, if the reactance between the points 7 and 8 is made to vary in response to the current. An automatic variation of the reactance, in response to current, is secured in the specific arrangement shown in the drawings by proportioning the coils to have different characteristics and connecting them in series between the points 7 and 8 with the neutral wire connected to a point between the coils.

The coils are preferably so proportioned that the core of coil 13 becomes saturated with a current which is only a small fraction of the current required to saturate the core of the coil 14. The characteristic of the coil 13, as shown in Fig. 2, has a sharp bend in it, while that of coil 14 as shown in Fig. 3 is practically a straight line. The reactance of the coils varies unequally with the same variations in current because the reactance of coil 13 becomes practically constant as soon as the current through it reaches the small amount required to saturate its core, while the reactance of coil 14 increases with the current. The effect of this arrangement of reactance coils is the same as though under normal conditions the neutral wire were connected to a point in the middle of the reactance connected between different points on the armature, while an increase of current between the neutral and either of the outside wires, for instance between the neutral 16 and outside wire 5, caused by an unbalancing represented by lamps 17, moves the connection of the neutral 16 away from the middle of the reactance a distance proportional to the increase of current and in effect connects it to a point of variable and alternating voltage or to some segment of the commutator.

When the alternating voltage is superposed on the constant voltage of the neutral a pulsating voltage appears between the neutral 16 and outside wire 5, as shown in Figs. 4 and 5. The effective value of a pulsating voltage, as of an alternating voltage, is equal to the square root of the means or average square of the momentary voltages, and this is in excess of the average of the momentary voltages, and may consequently be represented by the dotted line in Fig. 5. In other words, the effective value of the voltage between the neutral 16 and outside wire 5 is raised enough to compensate for the drop caused by the unbalancing of the system.

My invention may be embodied in many other forms than that shown and described, and I therefore do not wish to be restricted to the exact form shown but intend to cover by the appended claims all changes and modifications within the spirit and scope of my invention.

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

1. The combination with a dynamo-electric machine having an armature with a commutator connected to outside wires, a neutral wire, and automatic means for compounding the voltage between the neutral wire and an outside wire with varying current in said neutral wire.

2. The combination with a dynamo-electric machine having an armature with a commutator connected to outside wires, of means connected to said armature and responsive to current in a neutral wire for varying the effective voltage between either outside wire and said neutral wire.

3. The combination with a dynamo-electric machine having an armature with a commutator connected to outside wires, of a variable reactance connected to different points on said armature and to a neutral wire and variable in response to current between either outside wire and the neutral wire to vary the effective voltage between said wires.

4. The combination with a dynamo-electric machine having an armature with a commutator connected to outside wires, of two reactance coils having different characteristics connected to different points on said ar-

mature, and a neutral wire connected to a point between said coils.

5. The combination with a dynamo-electric machine having an armature with a commutator connected to outside wires, of two reactance coils connected from different points on the armature to a neutral, said coils being proportioned to change their reactance unequally as the current in the neutral changes.

6. In a dynamo-electric machine the combination with an armature having a commutator, of two reactance coils connected in series between different points on the armature and proportioned to vary unequally in reactance in response to changes in current through the coils.

7. In a dynamo-electric machine the combination with an armature having a commutator, of two reactance coils connected in series between different points on the armature, one of said coils having a core saturated by a fraction of the current required to saturate the core of the other coil.

In witness whereof, I have hereunto set my hand this 6th day of January, 1908.

ERNST F. W. ALEXANDERSON.

Witnesses:

BENJAMIN B. HULL.

HELEN ORFORD