

B. G. LAMME.
SYSTEM OF ELECTRICAL DISTRIBUTION.

No. 559,721.

Patented May 5, 1896.

Fig. 1.

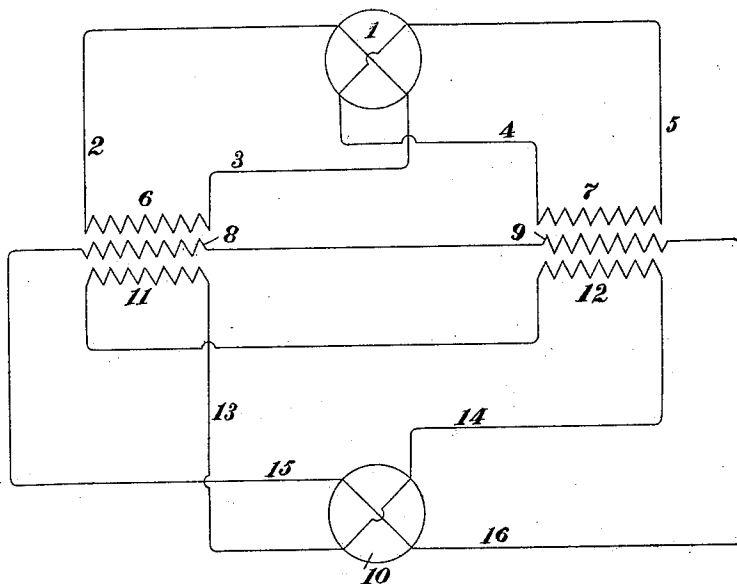
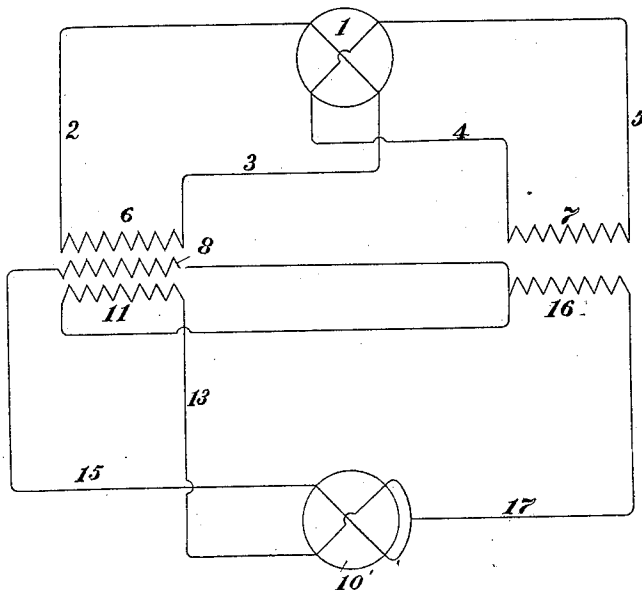


Fig. 2.



WITNESSES:

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Hubert C. Tener.

INVENTOR

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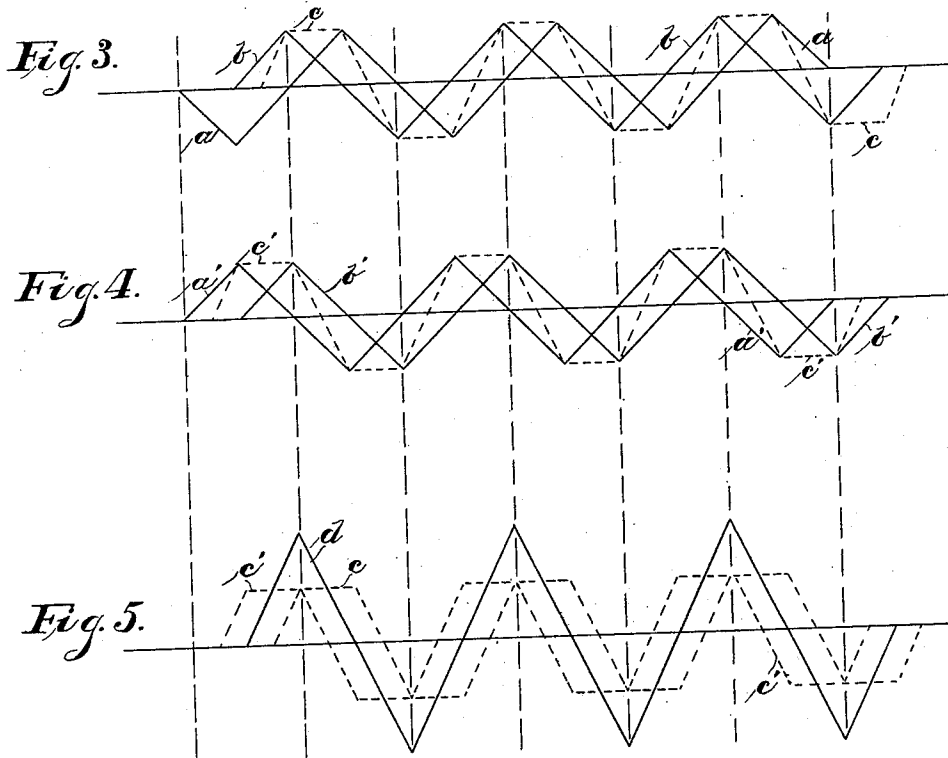
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UNITED STATES PATENT OFFICE.

BENJAMIN G. LAMME, OF PITTSBURG, PENNSYLVANIA, ASSIGNOR TO THE WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, OF SAME PLACE.

SYSTEM OF ELECTRICAL DISTRIBUTION.

SPECIFICATION forming part of Letters Patent No. 559,721, dated May 5, 1896.

Application filed April 11, 1895. Serial No. 545,295. (No model.)

To all whom it may concern:

Be it known that I, BENJAMIN G. LAMME, a citizen of the United States, residing in Pittsburg, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Systems of Distribution for Alternating Electric Currents, (Case No. 630,) of which the following is a specification.

My invention relates to systems of distribution for alternating electric currents and to apparatus employed in connection therewith; and it has for its object to provide such a system and apparatus for use in connection with multiphase distribution as will be effective in so changing the phase and wave form of transformed currents that they shall exactly conform to the demands of a working system.

It frequently becomes desirable in practice, by reason of the conditions imposed by particular translating apparatus employed, to modify either the wave form or phase, or both, of the generated currents. The modification of wave form is rendered necessary or desirable for the reason that while a pointed wave is suitable for transformers in which iron losses are an important consideration a flat-topped or approximately sinusoidal wave is more suitable for motors, particularly those in which a distributed winding is employed for the production of a uniform rotating magnetic field. The flattened wave is also more desirable for arc lighting.

It is the purpose of my present invention to produce the desired modification of phase and wave form by means of a special arrangement and connection of transformers.

It is generally understood that if two equal sine waves differing by ninety degrees be compounded the resultant will be a sine wave lying midway between the two. If, however, two waves which are more pointed than a sine wave and which differ in phase ninety degrees be compounded, the resultant will be a wave of different form lying between the two. This compounding of the two currents may be effected by means of two transformers having their primaries connected in the respective circuits differing in phase by ninety degrees, the secondaries of such transformers being connected in series. With this arrangement the electromotive force upon the termi-

nals of the secondaries will have the desired resultant wave form. This arrangement, however, is not practicable in operation by reason of the fact that if the system be put in operation and current be drawn from the secondaries of the transformers the result will be that each transformer will tend to have a current of one wave form at a certain time in its primary and one of a different form occurring at a different time in the secondary. In order to secure the desired wave form and at the same time preserve the proper working conditions in the transformers, I propose to provide each transformer with a second secondary and connect them in series, as above set forth, except that one of them is in a reversed direction. It will be readily seen that with this arrangement the currents in the two secondaries are now equal and differ in phase by ninety degrees, and the resultant effect of these two secondary currents is of approximately the same wave form as that of the primary and differs from it by one hundred and eighty degrees, this condition being the proper and practical one for working transformers. This system and arrangement of apparatus is specially applicable to two-phase circuits in which transformation is made to two secondary circuits differing ninety degrees and equally loaded.

Referring now to the drawings, Figure 1 is a diagram of a two-phase generator, a two-phase motor, and the connecting-circuits and intermediate transformers arranged in accordance with my invention, and Fig. 2 is a similar view of a modification. Fig. 3 is a diagram showing the wave forms in two of the connected secondaries shown in Fig. 1 and their resultant. Fig. 4 is a similar view illustrating the wave forms in the other two secondaries, and Fig. 5 represents the resultant effect of the combination of two sets of secondaries.

Referring now in detail to Figs. 1, 3, 4, and 5 of the drawings, 1 is a two-phase generator, and 2 and 3, 4 and 5 the circuits leading therefrom.

6 is the primary of a transformer included in series in circuit 2 3, and 7 is the primary of a transformer having the same relation to circuit 4 5.

8 and 9 are the secondaries of the respective transformers, they being connected in series, as shown, through a coil or coils of the two-phase motor 10.

11 and 12 are additional secondary coils upon the respective transformers, also connected in series through a coil or coils of the motor 10. The secondary 11 is, however, reversely wound and connected to the secondary 12.

In Fig. 3 the lines *a* and *b* represent, respectively, the current-waves in the secondaries 11 and 12, and the line *c* the resultant wave obtained by connecting the two secondaries in series with one of them reversed in direction, as indicated in Figs. 1 and 2. It is to be understood that the waves do not necessarily have the exact form represented in the diagram, the waves being there shown as bounded by straight lines merely for convenience of illustration. It is to be understood, however, that they are more pointed than sinusoidal waves.

In Fig. 4 the lines *a'* *b'* represent, respectively, the current-waves in the secondaries 8 and 9, and the broken line *c'* a resultant-wave obtained by connecting said secondaries in series, as shown in Figs. 1 and 2.

In Fig. 5 the resultant of the combination of the flat-topped waves represented by the lines *c c'* is shown at *d*. It will be seen that this resultant wave is pointed, as were those in the several coils of the transformers, that it has the same periodicity and substantially twice the height of the waves which produce it.

By this arrangement, as will be readily understood from the foregoing description, I am enabled to secure in the two circuits 13 14 and 15 16 currents differing ninety degrees in phase and having the desired wave form, and at the same time a magnetic condition in each of the transformers which is suitable for practical operative working.

This arrangement of apparatus just described is specially applicable for use in connection with motors having closed-coil windings. In the cases shown in Fig. 2 the same

apparatus is employed as that just described, except that in one of the transformers the two secondaries 9 and 12 are combined into a single secondary 16 and connected to each of the secondaries in the other transformer. In this form of apparatus it is of course necessary to employ a motor 10' in which the coils are separately wound and to connect them on one side by a single conductor 17 to the secondary 16.

While I have described a specific form and arrangement of apparatus for carrying out my invention, I desire it to be understood that it may be variously modified without departing from the spirit and scope of my invention.

I claim as my invention—

1. A means for changing the phase and wave form of alternating electric currents comprising two transformers each of which is provided with two secondaries, those of one being respectively connected directly and reversely in series with those of the other, substantially as described.

2. A system of distribution comprising a source of quarter-phase current, a transformer in each of the circuits having two secondaries, those of one being respectively connected directly and reversely in series with those of the other and translating devices connected in the secondary circuits, substantially as described.

3. A system of distribution comprising two circuits carrying currents differing approximately ninety degrees in phase, two transformers having their primaries respectively included in said circuits and their secondaries connected in series, one of said secondaries comprising two independent reversely-wound sections, substantially as described.

In testimony whereof I have hereunto subscribed my name this 5th day of April, A. D. 1895.

BENJ. G. LAMME.

Witnesses:

HARRY P. DAVIS,
JAS. WILLIAM SMITH.