E. D. CARTER.

SYNCHRONISM INDICATOR.

APPLICATION FILED FEB. 25, 1914.

1,145,348.

Patented July 6, 1915.

Fig. 1

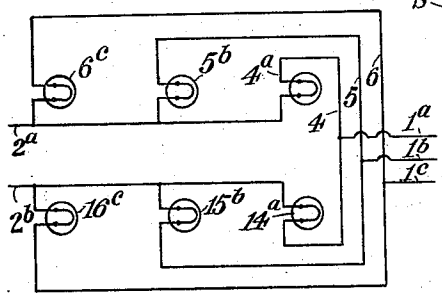


Fig. 2

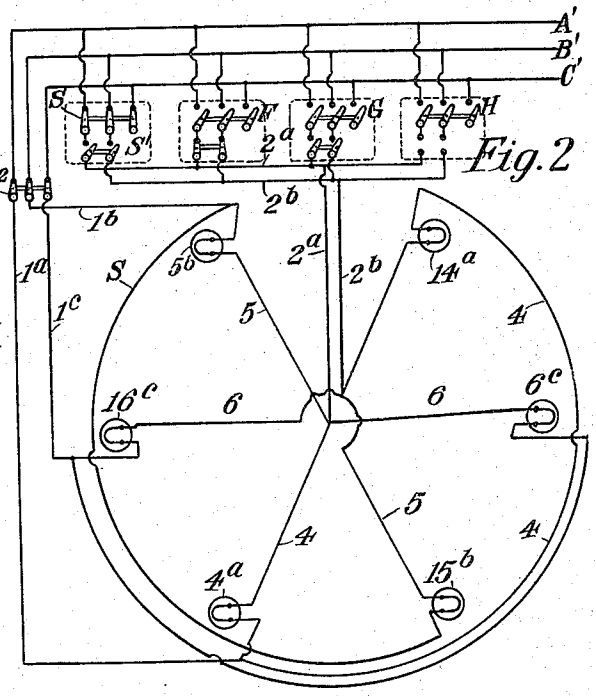


Fig. 3

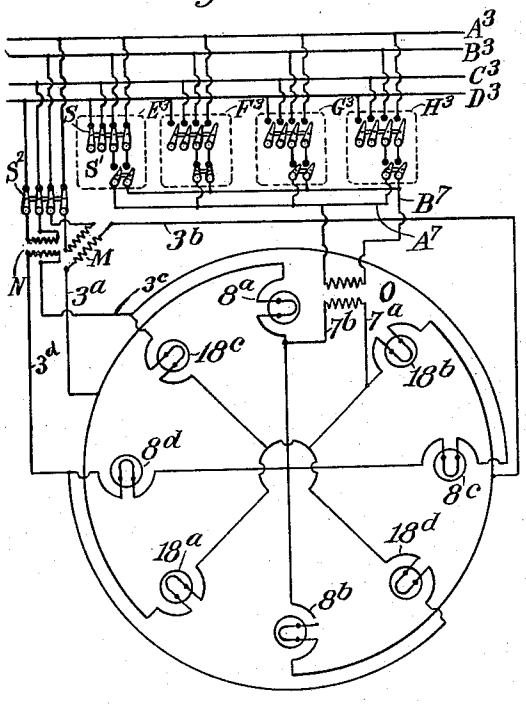
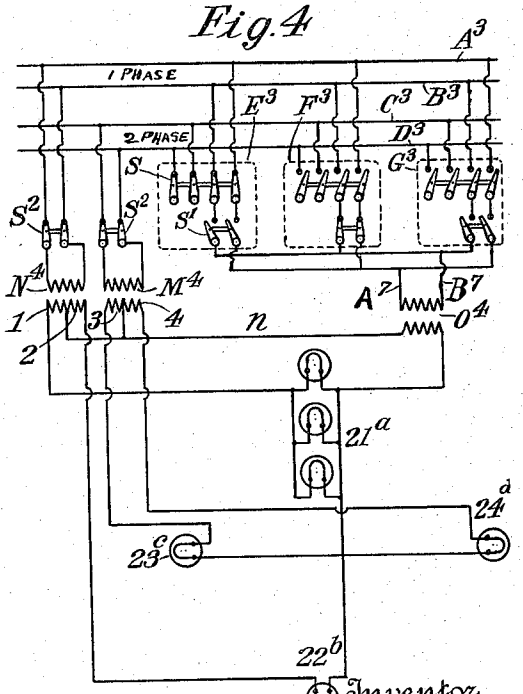


Fig. 4



Witnesses:
M. F. Eveland
S. J. Robinson

Inventor
Edward D. Carter
By his Attorneys
Merwin & Stevenson

COLUMBIA PLANOGRAPH CO., WASHINGTON, D. C.

UNITED STATES PATENT OFFICE.

EDWARD D. CARTER, OF MONTCLAIR, NEW JERSEY.

SYNCHRONISM-INDICATOR.

1,145,348. Specification of Letters Patent. Patented July 6, 1915.

Application filed February 25, 1914. Serial No. 821,103.

To all whom it may concern:

Be it known that I, EDWARD D. CARTER, a citizen of the United States, residing in the town of Montclair, county of Essex, and State of New Jersey, have invented new and useful Improvements in Synchronism-Indicators, of which the following is a specification.

This invention relates to electric indicating devices and to the method of using such devices whereby they may be used as a synchronizer for two or more alternating current machines, or for producing flashing electric signs.

One object of the invention is to provide an apparatus of this class which may be made up of electrical elements of ordinary construction not requiring special windings, whereby the cost of manufacture is greatly reduced.

A further object of the invention is to provide an apparatus and method whereby the relation of the cycles of the currents to be synchronized is indicated by the relative brilliancy of two lights as distinguished from the greater brilliancy of a particular light. By this construction the device is much more sensitive, that is, smaller departures from the exact synchronism and step will be indicated, for a very slight difference in the brilliancy of two lights will be evident where the slight departure from maximum brilliancy of a single light cannot be distinguished.

A further object of the invention is to provide an apparatus and method in which the lights are gradually brought from darkness to maximum brilliancy, and vice versa, as distinguished from merely turning off and on as is the present custom in the electric signs. By this method a much more perfect simulation of motion is produced than with the construction heretofore used.

With the above objects in view my invention consists in the hereinafter described apparatus and method of procedure which apparatus I have illustrated in the accompanying drawings wherein—

Figure 1 represents a simple form of construction designed to show the principle of operation of my invention. Fig. 2 shows a diagrammatical construction whereby a plurality of generators of the three phase type may be successively synchronized with the three bus-bars to which they supply current. This figure also shows a construction which may be employed for electric signs, as will be hereinafter described. Figs. 3 and 4 show different arrangements of my invention as adapted to the two phase current.

Referring first to Fig. 1, the reference characters 1^a, 1^b, 1^c, indicate leads from the bus-bars carrying a three-phase alternating current. The leads 2^a, and 2^b indicate leads from the terminals of an incoming machine corresponding with the terminals of the leads 1^a, and 1^b. The leads 2^a and 2^b are connected by three parallel circuits 4, 5, and 6 respectively, each carrying two lamps in series as indicated at 4^a and 14^a for the circuit 4,—5^b and 15^b for the circuit 5, and 6^c and 16^c for the circuit 6. The lead 1^a from the bus-bars is connected to circuit 4, and lead 1^b to circuit 5, and lead 1^c to circuit 6, each connection being between the lamps of the circuit. In considering the operation of this arrangement let us assume that the two machines are in synchronism and that at a given instant 1^a and 2^a are both positive. The current from 1^a tends to go through the lamps 4^a and 14^a equally, but through the lamp 4^a it meets another positive voltage from 2^a and is neutralized to a certain extent, while passing through lamp 14^a it encounters a negative voltage from 2^b and is correspondingly increased. The current will therefore take the path through lamp 14^a, through the incoming machine, then back through lead 2^a and through lamps 5^b and 6^c to the negative terminals 1^b and 1^c of the bus-bars. The lamp 14^a will therefore burn brightly under the combined voltage of the two machines. Lamps 6^c and 5^b will divide the voltage from the positive of the incoming machine to the negative of the bus-bars and burn dimly, and lamps 4^a, 15^b and 16^c will receive their minimum current at this instant. At the next instant in the rotation of the machines, the leads 1^b and 2^b will both become positive so that the current will be opposed through lamp 15^b but will pass from 1^b through lamp 5^b, through the incoming machine and back through 2^b dividing through lamps 16^c and 14^a. At the next instant 1^c becomes positive, but as there is no lead from the third phase of the incoming machine the voltage will be divided between lamp 6^c and 16^c lighting neither of them to maximum brilliancy. At this instant neither 2^a or 2^b is positive so none of the other lamps receive voltage. As long as the two machines are in synchronism the same lighting

will occur. Considering a complete rotation of the machine as comprising the three instants described, lamps 14^a and 5^b will each receive maximum voltage at one instant, divided voltage at one instant and opposed voltage at the third instant. Lamps 6^c and 16^c will receive divided voltage at two instants and lamps 4^a and 15^b will receive divided voltage at one instant only. Lamps 14^a and 5^b will therefore be bright, lamps 6^c and 16^c will receive sufficient current to be dimly lighted and lamps 4^a and 15^b will not receive sufficient current to be visible.

Let us now assume that the machines are not in synchronism and that the lead 1^b from the bus-bars becomes positive while the lead 2^a from the incoming machine is positive. The current will then tend to flow through lamps 5^b and 15^b, but through lamp 5^b it will meet the positive voltage from lead 2^a extinguishing that lamp, while through lamp 15^b it will meet the negative voltage from the lead 2^b thereby causing lamp 15^b to burn brightly. The current will pass through the lamps 6^c and 4^a of the then negative leads from the bus-bars giving these lamps divided voltage. At the next instant when 2^a is negative, 1^c will be positive hence lamp 6^c will be bright, while at the third instant when 1^a is positive the voltage will be divided between lamps 4^a and 14^a. For this rotation of the two machines 15^b and 6^c are bright, 4^a and 14^a dim, and 16^c and 5^b dark.

At the next step 1^c of the bus-bars will become positive in conjunction with 2^a of the incoming machine thereby lighting lamps 16^c and 4^a brightly and lamps 5^b and 15^b dimly, and extinguishing the other two lamps. In this way a regular sequence may be given the lighted lamps and by positioning the lamps in the form of a letter or other sign to be illuminated a very effective sign can be produced by maintaining the two machines out of synchronism.

As a synchronizing device the rapidity in change in lighting will indicate the extent the machines are out of synchronism, and the sequence in which the lighting takes place will indicate whether the incoming machine is faster or slower than the bus-bars.

In Fig. 2 I have shown the same system disclosed in Fig. 1, applied in a practical manner to give a regular sequence of lighting to the lamps arranged in a circle and provided with proper switch connection so that a number of generators may be synchronized with the same bus-bars. In this figure I have applied the same letters as used in Fig. 1 to the corresponding lamps and circuits,—the bus-bars I have indicated as A′, B′, and C′ and I have indicated four machines to be synchronized at E, F, G, and H. Each machine is provided with a three pole switch S whereby it may be connected to the bus-bars, and a two-pole switch S′ by which it may be connected to the leads 2^a and 2^b of the synchronizing device. A three pole switch S^2 is also provided between the bus-bars and the leads 1^a, 1^b, and 1^c of the synchronizing device. Circuit 4 contains lamps 4^a and 14^a, circuit 5 lamps 5^b and 15^b and circuit 6 lamps 6^c and 16^c arranged just as shown and described in connection with Fig. 1. When the machines are in exact synchronism and in step, lamps 14^a and 5^b will be brilliant, lamps 6^c and 16^c will be equally and partially illuminated and lamps 4^a and 15^b will not be visible. If the frequency of one machine is slightly faster or slower than the other the sequence of the lighting will be continuous around the circle. At the first lag of one machine of a complete phase 6^c and 15^b will be bright and 14^a and 4^a dim, and at the next lag 4^a and 16^c will be bright and 5^b and 15^b dim. At the next change of a complete phase the lagging machine has lost a complete cycle and the machines are momentarily in synchronism with 1^a and 2^a of the same polarity. Lamps 14^a and 5^b then become bright and so the rotation of the lighted lamps continues as long as the relative frequencies of the machines is unaltered. Should the lagging machine now change to have the greater frequency the sequence of lighting will be reversed producing an appearance of rotation in the opposite direction. The time of complete rotation of the lighted lamps indicates the time in which a complete cycle is gained or lost and the direction of rotation indicates which machine is the lagging machine. When the lighting remains the same it indicates that the frequency of the machines is the same and the particular lights which are bright indicate the angular departure of the machines from being in step. I have described the operation of the machine by steps of angular displacement, but it will of course be understood that lights do not change suddenly as described, but instead as the relative positions of the machines gradually change the brightly lighted lamps gradually become dim, and the dark or dimly lighted lamps gradually become bright. When the machines are in exact synchronism and in step the lights 6^c and 16^c are equally illuminated and the comparison of these two lights will show deviation from synchronism and step which is too small to be shown by a falling off in brilliancy in lights 14^a and 5^b.

In Figs. 3 and 4 is shown my improved apparatus applied to a two phase instead of a three phase current. As shown in Fig. 3, A^3 B^3 indicate the bus-bars for one phase and C^3 and D^3 indicate the bus-bars for the other phase. The generators are indicated at E^3 F^3 G^3 and H^3 and as shown the generator E^3 is energizing the bus-bars through

the switch S while generator F^3 is connected to the synchronizing device through the switch S'. In this view I have shown the incoming machine as connected to the synchronizing device through the transformer O arranged between the leads A^7 and B^7 from the generator and the leads 7^a and 7^b of the synchronizing device. The bus-bars are connected to the synchronizing device through transformers, the transformer M being arranged between the bus-bars A^3 and B^3 and leads 3^a and 3^b of the synchronizing device, while the transformer N is similarly arranged between the other bus-bars and the leads 3^c and 3^d of the synchronizing device.

The lead 7^b of the transformer O branches beyond the transformer, one branch passing through lamps 8^a and 18^a in series and thence back to the lead 7^a. The other branch divides into three circuits as indicated at the center of the diagram, one of which passes through the lamps 8^b and 18^b in series and thence back to the lead 7^a. The second branch passes through lamps 8^c and 18^c in series and thence back to 7^a while the third branch passes through lamps 8^d and 18^d and also back to lead 7^a.

The lead 3^a from the transformer M is connected to the common circuit of lamps 8^a and 18^a and in the same manner the leads 3^b, 3^c and 3^d are connected respectively to the common circuits of lamps 8^b and 18^b, 8^c and 18^c and 8^d and 18^d.

In describing the operation of this machine it is assumed that the two machines are in synchronism with A^3 and A^7 positive at any given instant. The current from the bus-bar A^3 will pass through transformer M inducing a positive current of proper voltage in the lead 3^a of the synchronizing device, which current will obviously tend to pass equally through lamps 8^a and 18^a. At the same time the current through transformer O from the incoming machine induces a positive current of equal voltage in the lead 7^a which will neutralize the current through lamp 18^a causing that lamp to be dark. The current through lamp 8^a however is met by a negative voltage from the transformer O through the lead 7^b thereby increasing the voltage through lamp 8^a and causing that lamp to attain its maximum brilliancy.

The positive voltage from 7^a passes through lamp 18^b and thence back to the negative lead 3^b of the transformer M lighting lamp 18^b. At the instant that 7^a and 3^a become negative 7^b and 3^b will become positive and the current will flow through the same circuit but in the opposite direction lighting the same lamps, hence as long as the machines remain in synchronism these lamps will have their maximum voltage. When the machines are in step the current from the second phase of the bus-bars through the transformer N and leads 3^c and 3^d will pass equally through the four lamps 8^c, 18^c, 8^d and 18^d and will be neither increased nor decreased directly by the voltage from the incoming machine. These lamps will therefore glow dimly and equally as long as the machines are in exact step.

Assuming that the machines are out of synchronism and the bus-bar C^3 is positive at the same time that A^7 of the incoming machine is positive, the current from the bus-bar will pass through transformer N to the connection between the lamps 8^c and 18^c. Through lamp 18^c however the current from the bus-bar is met by the positive current from the incoming machine through lead 7^a thereby extinguishing that lamp, while the current through 8^c meets the negative current from 7^b causing lamp 8^c to attain its maximum brilliancy. The positive current from 7^a passes through lamp 18^d and thence back to the negative 3^d of transformer N, thence through the transformer back to negative bus-bar D^3. As long as the machines remain in this relative position lamps 8^c and 18^d will be bright and lamps 18^c and 8^d will be dark and the remaining lamps will glow equally. In like manner as the angular relation of the two machines alters lamps 8^b and 18^a become bright, followed at the next change by lamps 8^d and 18^c thus producing a regular rotation of lighted lamps as long as the machines are out of synchronism.

In Fig. 4 I have illustrated a modified form of synchronizing device for two phase currents which is especially adapted for sign work as any number of lights may be used at any one point of the circuit without necessitating an equal amount of resistance in the opposite circuits. I obtain this result by locating the neutral of the two phase system in the secondary circuit by means of suitable transformers. Referring to Fig. 4 the machine E^3 is energizing the bus-bars and the machine F^3 is the incoming machine to be synchronized. The phase 1 of the bus-bars is connected to the synchronizing device through transformer N^4 and phase 2 is connected to the synchronizing device through similar transformer M^4. The middle points of the secondary windings of these transformers are connected to form the neutral n of the secondary circuit, the neutral n being connected to the transformer O^4 through which the current is received from the incoming machine. Let us assume at a given instant that bus-bar A^3 is positive at the same time that lead A^7 of the incoming machine is positive. The positive current passes through transformer N^4 winding 1, through lamps 21^a thence through transformer O^4 to the negative lead B^7 of the incoming machine. The current then passes through this ma-

chine to the positive lead A^7, through the transformer O^4 to the neutral n thence returning to winding 1 of the transformer N^4 and to the negative B^3 of the bus-bars. These currents being in the same direction lamps 21^a will light. At the same time the positive current of the bus A^3 passes through winding 2 of the transformer N^4 to the neutral n, thence through transformer O^4 to positive lead A^7 of the incoming machine, through the incoming machine against its voltage to lead B^7, thence back through transformer O^4 to lamp 22^b, and through transformer N^4, winding 2, to negative lead B^3 of the bus-bar. The voltages of the bus-bars and the incoming machine are thus opposed through lamp 22^b and this lamp will remain dark.

When the machines are in step the transformer O^4 is out of phase with bus-bars C^3 and D^3 whereby the voltage through lamps 23^c and 24^d will be neither increased nor decreased directly by the incoming machine and will receive equal and partial voltage. As long as the machines remain in synchronism the lead A^7 will become negative at the same time that the bus-bar A^3 becomes negative and the path of the current will remain the same and will continue to light the same lamps. If we now assume that the incoming machine has changed its relative position to the bus-bars by 90° the lead A^7 will be positive at the same time that bus-bar C^3 is positive and B^7 and D^3 will be negative. The positive current from the bus-bar C^3 will pass through transformer M^4, winding 3 through lamp 23^c through transformer O^4 to negative lead B^7 of the incoming machine, thence through the machine in the direction of its voltage to positive lead A^7 through transformer O^4 to the neutral n, thence through transformer M^4, winding 3, to bus D^3. These voltages being in series will light lamp 23^c. At the same time the voltage from the bus-bar C^3 passes through winding 4 of transformer M^4 through neutral n, through transformer O^4 meeting positive lead A^7 of the incoming machine, and passing through the machine against its voltage leaving by the negative lead B^7, whence it passes through transformer O^4 through lamp 24^d, returning through transformer M^4, winding 4 back to negative bus D^3. These voltages being opposed lamp 24^d remains dark. At the same time transformer O^4 neither opposes nor adds to transformer M^4 directly and lamps 21^a and 22^b will get equal and partial voltages.

It is obvious that when the machines have changed another 90° the current through the bus-bars will be exactly reversed from that first described, hence lamp 22^b will light and lamps 21^a will remain dark through the same circuit that lights lamps 21^a and extinguishes 22^b when the machines were in step. So too when the machines have changed a third 90° lamps 24^d will be lighted and 23^c will remain dark.

By the expression "approximately equipotential points" as employed in the following claims, I mean sufficiently near equipotential to produce the sequence of lighting described although the variance in resistance of the two indicators may be such that neither lamp of the pair attains its maximum brilliancy.

As explained above this system is particularly applicable for sign work for the reason that the neutral of the circuit is located by means of transformers and hence the resistance of one light or group of lights has no effect on the lighting of the other lamps of the device. The lamps may therefore be arranged in groups of any number and in various relative positions to get any flashing effect desired.

As stated above one of the chief objects of the present invention is to provide a synchronizing indicator which does not require transformers or other device of special winding and expensive construction. To this end the lamps are arranged to be connected directly to the leads from the several machines, although of course where the voltage of the machines is not suited for the lamps, ordinary voltage changing transformers may be supplied in the circuits, and it is to be understood that in the appended claims where the indicating devices are described as "directly energized, or having interconnecting conductors," the expressions are intended to cover either ordinary conductors or conductors including voltage changing transformers.

While I have illustrated and described certain specific embodiments of my invention and particularly with polyphase currents it will be understood that I do not wish to be limited to these exact constructions, but that various changes and modifications may be made without departing from the spirit of my invention.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:—

1. The combination with a plurality of sources of electromotive force at least one of which is polyphase, of a plurality of pairs of electro-responsive devices at least one of which is an indicator, leads connecting each of said pairs of devices to form a series circuit across one of said sources, and leads connecting points in the circuits between the devices of each of said several series circuits in different phases of said polyphase source.

2. The combination with a plurality of sources of electromotive force at least one of which is polyphase, of a plurality of pairs of electro-responsive devices at least one of which is an indicator, leads connecting each

of said pairs of devices to form a series circuit across one of said sources, and leads connecting approximately equi-potential points in said several series circuits to different phases of the other source.

3. The combination with a plurality of sources of current at least one of which is polyphase, of a plurality of groups of electric indicating devices bridged in multiple across one phase of one of said sources, and independent connections from a mid-point in each of said bridges to a different phase of said polyphase source.

4. The combination with a plurality of sources of current at least one of which is polyphase, of a plurality of groups of resistance devices one of each group being an indicator bridged in multiple across one phase of one of said sources, and independent connections from a point in each of said bridges to at least two different phases of said polyphase source.

5. The combination with a source of alternating current having a pair of terminals and a second source of alternating current having a plurality of terminals of a plurality of groups of resistance devices one of each group being an indicator, common connections between said groups and said pair of terminals and independent connections from each group to a separate terminal of said second source.

6. The combination with two sources of alternating current each having a plurality of leads connected to points of different phase, a plurality of bridges across two of the leads of one of said sources, a pair of resistance devices one of which is an indicator, in each of said bridges and a connection from a point in each of said bridges between said resistance devices to a different one of the leads connected to said second source.

In witness whereof, I have hereunto set my hand at Montclair, N. J. aforesaid, this 16 day of February 1914.

EDWARD D. CARTER.

Witnesses:
Mrs. F. P. Reagle,
Fred P. Reagle.

Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."