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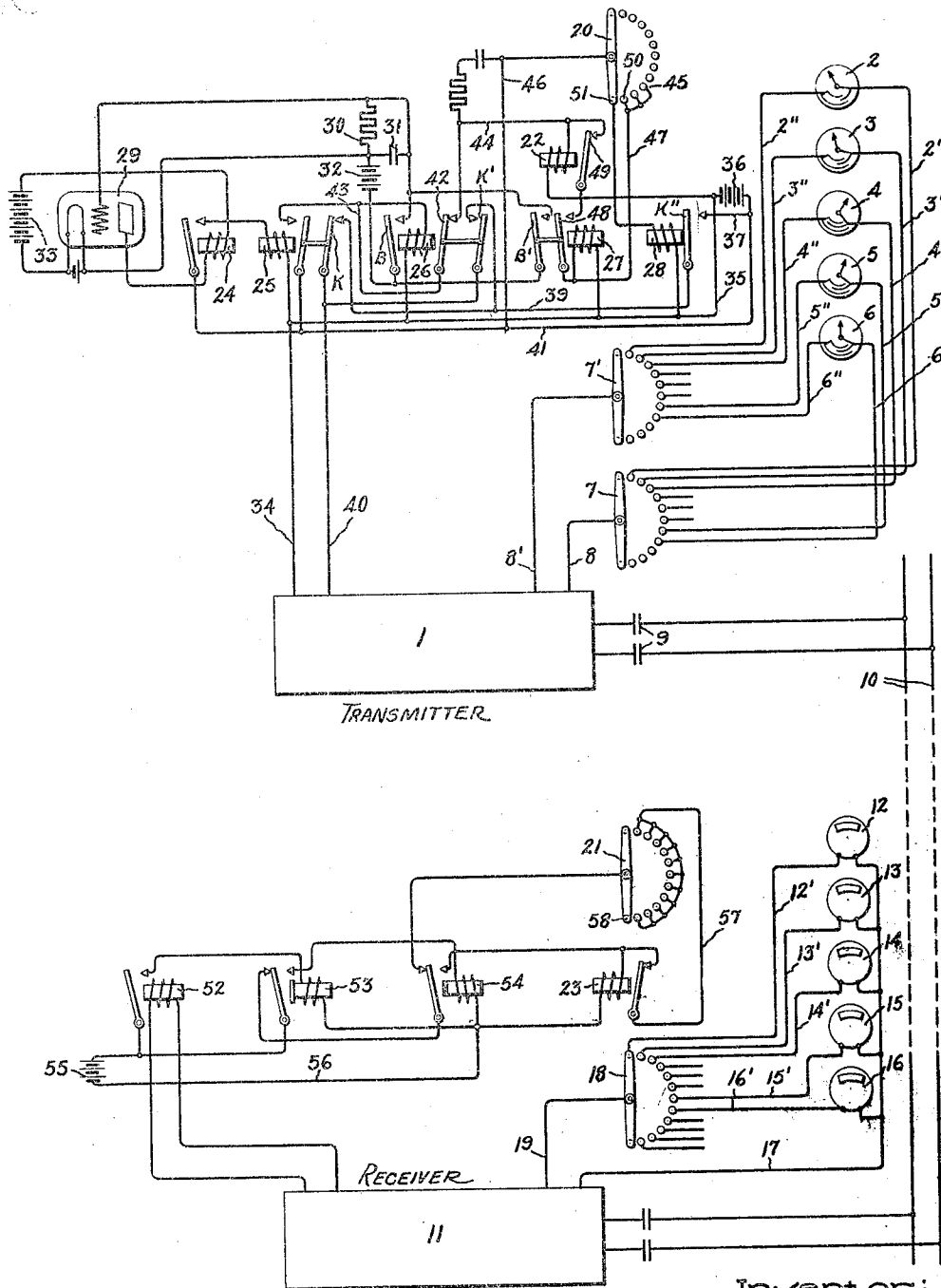
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A. S. FITZ GERALD
TELEMETRIC SYSTEM

Filed July 1, 1927



Inventor:
Alan S. FitzGerald,
by *Wyander S. Lewis*
His Attorney.

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UNITED STATES PATENT OFFICE

ALAN S. FITZ GERALD, OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK

TELEMETRIC SYSTEM

Application filed July 1, 1927. Serial No. 202,961.

My invention relates to telemetric systems and more particularly to systems in which the readings of a plurality of meters may be successively indicated at a remote point. In my copending application, Serial No. 194,468, filed May 26, 1927, telemetric systems, and which is assigned to the same assignee as the present application. I have disclosed a system whereby the position of a movable element, such as that of a meter, may be indicated at a remote point through the medium of frequency variations in the alternating current source produced in accordance with the position of the movable element of the meter. These variable frequency alternating currents may be transmitted over wires to a frequency indicating means at a remote point or they may be caused to modulate a high frequency supply, currents from this supply being transmitted either by radio or over wire line conductors to a remote point where they are demodulated and caused to actuate a frequency actuating device.

The purpose of my present invention is to provide means whereby a system of this kind, which employs only a single high frequency channel, may be employed to furnish remote indication of the position of a plurality of movable elements, or for remote indication of the readings of a plurality of meters.

Another purpose of my invention is to provide means whereby a corresponding frequency varying and frequency indicating means are simultaneously connected respectively to the transmitter and to the receiver in rotation without distinctive keying of the carrier for each of the separate meters.

A further purpose of my invention is to provide means, in a system of the type indicated, in which the connecting means at the transmitter and at the receiver are automatically synchronized and this without the use of a separate source of synchronizing power.

In accordance with my present invention I provide means at the transmitting station whereby the various frequency varying means are successively connected in rotation to the transmitter for a predetermined period

to control the frequency thereof, an interruption in the carrier being produced at the end of each period. At the receiving station I provide a step by step mechanism whereby first one frequency indicating means is connected to the conductor and then a second and third, etc., in rotation, each connection being made in response to the above-mentioned interruption in the carrier. Since this step by step method of selection is likely to get out of step permanently if one error occurs, I provide that at the end of each rotation the carrier will be keyed in a suitable manner, as by causing a long interruption therein, in response to which the step by step mechanism at the receiver will be returned from any position in which it may happen to be to an initial position corresponding to that simultaneously occupied by the connecting means at the transmitter. From this position both mechanisms will be operated step by step throughout the cycle of operations.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims. My invention itself, however, both as to its organization and method of operation, together with further objects and advantages thereof may best be understood by reference to the following description taken in connection with the accompanying drawing in which the single figure represents one embodiment of my invention.

Referring to the drawing, 1 represents a transmitter which is of the type fully set forth in my above-mentioned copending application and which comprises a transmitter of modulated high frequency currents such as that employed in the usual radio or carrier current communication system. This transmitter may, for example, be of the type indicated in Fig. 11 of Patent No. 1,702,423, Wensley, issued February 19, 1929. The modulating currents of this transmitter are preferably supplied from an alternating current source comprising two oscillators of different frequency, the output currents of which are caused to beat together to produce a beat frequency which is supplied to the modulating circuit of the transmitter. To the os-

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cillatory circuit of one of these oscillation generators is connected a variable condenser the movable element of which is associated with the movable element of a meter. In the drawing for purposes of illustration I have shown meters 2, 3, 4, 5, 6 with the movable element of each of which is associated the movable plate of a suitable condenser, this movable plate being connected through conductors 2', 3', 4', 5', 6' respectively, wiper 7 and conductor 8 to one side of the oscillatory circuit of one of the above-mentioned oscillation generators. The stationary plates of these condensers are likewise connected through conductors 2'', 3'', 4'', 5'', 6'', wiper 7' and conductor 8' to the opposite side of the above-mentioned oscillatory circuit. Thus frequencies of the modulating currents of the transmitter 1 are controlled over a range in accordance with the position of the movable element of the various meters, as determined by the range of variation in capacity of the condenser associated therewith.

High frequency currents from the transmitter 1 are supplied through coupling means 9 either to a radiating system or to wire line conductors 10, from which they are transmitted to a suitable detector or demodulator 11, 12, 13, 14, 15, 16 represent frequency responsive indicating means each of which corresponds to one of the meters 2, 3, 4, 5, 6. Each of these indicating means is adapted to be connected to the output circuit of the detector 11 through a circuit including a conductor 17, any one of the meters 12 to 16, and its associated conductor 12', 13', 14', 15', 16', wiper 18, and conductor 19. A detector of a type which may be employed is shown in Patent No. 1,522,581, Lloyd Espenschied. The rotary wipers 20, 7' and 7 at the transmitter and the wipers 21 and 18 at the receiver are adapted to be actuated synchronously, the former by a suitable motor magnet 22 and the latter by a similar motor magnet 23 to connect simultaneously corresponding frequency varying means to the transmitter and frequency responsive indicating means to the receiver, these connections being made in rotation, and each of them being for a definite predetermined interval.

For the purpose of actuating the rotary wipers 20, 7' and 7 by the motor magnet 22 in the manner set forth a series of relays 24, 25, 26, 27 and 28 and an electron discharge relay 29 is provided. The relay 29 comprises an electron discharge device of the three element type between the grid and cathode of which are connected a resistance 30 and a condenser 31, which are connected in parallel. The relays 26 and 27 are each provided with a pair of biasing contacts B and B' respectively which are connected in parallel and which are adapted when in their closed position to connect a source of potential 32 across the condenser 31. The actuating coil of the relay 24 is connected between the anode of

the electron discharge device and the cathode through a circuit including a suitable source of potential 33. With this arrangement when either of the contacts B or B' is in its closed position a strong negative charge will be placed upon the condenser 31 and hence upon the grid of the relay 29, thereby preventing a flow of current through the actuating coil of the relay 24. When these contacts B and B' are again moved to their open position the charge on the condenser 31 will leak off after a time interval through the resistance 30 and thereby permit the plate circuit of the relay 29 to pass current and thereby energize the actuating coil of the relay 24.

For the purpose of interrupting the carrier at the end of each metering period, as mentioned above, a keying circuit is provided which extends to the transmitter through conductor 34, conductor 35, source of potential 36, conductor 37, contacts K'' of the relay 28, conductor 39, either contacts K' of the relay 26 or contacts K of the relay 25, the latter two being connected in parallel, and conductor 40 to a keying device not shown which may be associated with the transmitter 1. At any time when the circuit is complete between the conductors 34 and 40 through the contacts K or K', K'' as mentioned above and the source of potential 36, the transmitter will be operative and will supply modulated high frequency currents to the conductors 10, whereas when this circuit is broken the transmitter is rendered inoperative.

A further understanding of the system associated with the transmitter 1 may best be had by reference to its operation. Assuming that the apparatus is in the position shown in the drawing, it will be seen that the keying circuit as traced above is interrupted at the contacts K'' and that the transmitter is therefore inoperative. The actuating coil of relay 28 is maintained energized by a circuit including source of potential 36, conductors 41, 46, wiper 20, relay 28 and conductor 35. It will likewise be noticed that the biasing contacts B and B' are both in their open position and that the relay 24 is deenergized indicating that a negative charge has been placed upon the condenser 31 and hence upon the grid of the device 29 such that no current flows in the anode circuit of this device. When a time interval has elapsed sufficient to permit the charge on the condenser 31 to leak off through the resistance 30 current will flow in the anode circuit of the device 29 and the relay 24 will close its contacts, thereby completing a circuit from one side of the source of potential 36 through the negative bus 35, actuating coil of the relay 25, contacts of the relay 24, the positive bus 41 back to the opposite side of the source of potential 36. The relay 25 then operates its armature to the left opening contacts K and, by means of its left-hand contacts, closing a circuit lead-

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ing from the bus bar 41 through the left-hand contacts of the relay 25, conductor 43, contacts 42 of the relay 26, conductor 44, actuating coil of the motor magnet 22, back to the negative side of the source of potential 36. As a result the motor magnet 22 is energized and opens its contacts but the wipers 20, 7', 7 which are associated therewith remain in their former position. Also by means of this left-hand contact it closes a circuit leading from the positive bus 41 through the left-hand contact of the relay 25, actuating coil of the relay 26 to the negative bus 35, causing the latter relay to be energized. This relay is slightly slow acting and its contacts, therefore, remain in the position shown for a predetermined time interval during which the operation of the transmitter is interrupted since both of the parallel keying contacts K and K' and the series keying contact K'' are still open. When this interval has elapsed the contacts K' close and the contacts 42 open. By means of the contacts 42 the energizing circuit of the motor magnet 22 which was previously traced is interrupted and the motor magnet is deenergized and thereby caused to actuate wipers 20, 7' and 7 one step in a clockwise direction. When this occurs the circuit of relay coil 28 is broken by wiper 20, the contacts K'' close and the transmitter is rendered operative. In this new position the wipers 7' and 7 will connect the condenser associated with the movable element of the meter 2 to the oscillatory circuit of the alternating current source mentioned above. Simultaneously therewith the biasing contacts B are closed placing a charge upon the condenser 31 and interrupting the flow of current in the plate circuit of the discharge device 29. When this occurs the relays 24, 25 and 26 are again deenergized and restored to the position shown in the drawing. In this position the keying circuit is closed through contacts K and K'' and the transmitter is operative to transmit a carrier frequency which is modulated by currents having frequency determined by the position of the movable element of meter 2.

When the charge on the condenser 31 has again leaked off through the resistance 30 the relay 24 will again be energized, closing its contacts and causing the above related cycle of operations to repeat itself. Since the energizing circuit of relay 28 can not again be closed until the wiper has completed, in the case shown, a half revolution the contacts K'' will remain closed. When relay 25 becomes energized, by means of its contacts K, it opens the keying circuit and interrupts the operation of the transmitter. At the same time, by means of its left-hand contacts, it closes the energizing circuit of the motor magnet 22. After a time interval the relay 26 operates to close its contacts thereby closing the keying circuit and at the same time

opening its contacts 42 thereby deenergizing motor magnet 22 and causing the wipers 20, 7' and 7 to move one position to the right. This operation will repeat itself until the last meter has been reached, the carrier being interrupted for an interval determined by relay 26, each time that the wipers 20, 7' and 7 are stepped to the right.

If it be assumed that the meter 6 is the last of the series to be connected by the wipers 7 and 7' to the source of alternating currents, then upon the completion of the next cycle of operations the wiper 20 will engage a contact 45 which is strapped to each succeeding contact except the last, thereby connecting a circuit leading from the bus bar 41 through conductor 46, wiper 20, contact 45, conductor 47, actuating coil of the relay 27 to the negative bus bar 35. This relay will then actuate its contacts to the right, the contacts B' placing a negative charge upon the condenser 31 and the contacts 48 closing a circuit leading from the positive bus 41 through conductor 46, wiper 20, contact 45, conductor 47, contacts 48, contacts 49 of the motor magnet 22, motor magnet 22, back to the negative bus bar 35. This magnet then causes its contacts to open, thereby deenergizing itself which again causes the contacts to close, this buzzer action repeating and the wipers 20, 7' and 7 being moved one position each time that the contacts 49 open. When the wiper 20 leaves the last of the strapped contacts 50, the energizing circuit of the motor magnet 22 is deenergized and the wiper 20 will engage the contact 51, thereby closing a circuit from the positive bus bar 41 through the conductor 46, wiper 20, contact 51, actuating coil of the relay 28 to the negative bus bar 35. The relay 28 will then actuate its contacts K'' to open the keying circuit of the transmitter and all of the apparatus will again be restored to the position shown in the drawing, the complete cycle of operations having been performed, all of the meters having been successively connected to the alternating current source and a negative bias having been placed upon the condenser 31 by the last operation of the contact B' to its closed position. Thus the transmission of carrier energy from the transmitter 1 to the receiver 11 is interrupted until the charge on the condenser 31 again leaks off through the resistance 31 to permit the operation of the relays to repeat itself.

It will thus be seen that each of the condensers associated with the meters 2, 3, 4, 5, 6 are connected in rotation to the transmitter during an operative period thereof, the length of each of these periods being determined by condenser 31 and resistance 30, and the length of each interruption in the carrier between each of these periods being determined by the slow acting relay 26. At the end of each complete rotation of the apparatus a long interruption in the carrier is

produced, the length of this interruption being determined by condenser 31 and resistance 30.

The relays which are associated with the circuit in the receiver are shown in the position which they occupy during the long interval when the transmission of carrier is interrupted, the wiper 18 connecting the meter 12 to the output circuit of receiver 11. All of these relays including the motor magnet 23 are deenergized. When carrier is received the relay 52, which is connected in the output circuit of the detector is energized and closes its contacts, thereby completing a circuit from one side of the source of potential 55 through the contacts of relay 52, actuating coil of relay 53 and conductor 56 to the other side of the source of potential. The relay 53 will then move its armature to the right, thereby completing a circuit leading from one side of the source of potential 55 through the right-hand contact of the relay 53, actuating coil of the relay 54 and conductor 56 to the opposite side of the source of potential. The relays 52, 53, 54 will then occupy this position with their respective armatures moved to the right, and the wipers 18 and 21 will occupy the position shown in the drawing, until the first interruption in the carrier occurs. In response to this interruption relay 52 and consequently relay 53 will be deenergized, the armature of relay 53 moving to the left, thereby deenergizing the relay 54. The relay 54, however, is slow to open and consequently a circuit will be closed leading from one side of the source of potential 55 through the armature and left-hand contact of relay 53, armature and right-hand contact of relay 54, motor magnet 23 and conductor 56 to the opposite side of the source of potential 55. The motor magnet 23 will then open its contacts but since the circuits in which these contacts are included is also broken by the wiper 21 nothing further occurs. If carrier is received again before the armature of relay 54 disengages its right-hand contact each of these relays 52, 53 and 54 will again be energized, the relay 53 moving its armature to the right breaking the circuit of the motor magnet 23, thereby causing the wipers 21 and 18 to be moved one position to the right, the latter connecting meter 13 to the receiver. Since the interruption in the carrier which is produced by the slow acting relay 26 in the transmitter is either less than or equal to the time which is required for the armature of relay 54 to disengage its right-hand contact, it will be seen that this operation will continue, that is, each time the carrier is interrupted the magnet 23 will be energized, and each time that the carrier is restored this magnet will be deenergized, thereby moving the wipers 21 and 18 one position to the right. This operation will continue until a long interruption, such

as that which occurs when the apparatus at the transmitter assumes the position shown in the drawing, has occurred. At this time the armature of relay 54 will engage its left-hand contact, thereby closing a circuit from one side of the source of potential 55 through the armature and left-hand contact of the relay 53, armature and left-hand contact of the relay 54, wiper 21 and any of the strapped bank of contacts which cooperate therewith, conductor 57, contacts of the motor magnet 23, motor magnet 23 and conductor 56 to the other side of the source of potential. The motor magnet 23 will then be energized, thereby opening its contacts which in turn causes it to become deenergized. This buzzer action continues until wiper 21 has reached the end of its rotation where it engages an unstrapped contact 58 thereby opening the buzzer circuit of magnet 23, and the apparatus then comes to rest in the position shown in the drawing.

Thus it will be seen that the meters 12, 13, 14, 15, 16, etc., corresponding respectively to the meters 2, 3, 4, 5, 6, etc., are successively connected simultaneously with the transmitter and receiver, and that after the last meter of each series has been connected accordingly, a long interruption in the carrier, determined by condenser 31 and resistance 30, occurs during which time the apparatus is restored to a predetermined initial position corresponding to that simultaneously occupied by the connecting means at the transmitter, and that this is accomplished without the use of any synchronizing power between the different connecting means and without any dialing or distinctive keying operation.

While I have shown and described a particular embodiment of my invention it will, of course, be understood that I do not wish to be limited thereto, since many modifications both in the circuit arrangement and in the instrumentalities employed may be made without departing from the spirit and scope of my invention as set forth in the appended claims.

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

1. In a telemetric system, the combination with a source of alternating currents, of a plurality of movable elements each of said movable elements having frequency varying means associated therewith, means for successively connecting said frequency varying means to said alternating current source to control the frequency thereof, a plurality of frequency responsive indicating means and means for supplying to said indicating means in succession currents having a frequency variable in accordance with the frequency of said source.

2. In a telemetric system, the combination with a source of alternating currents, of a

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plurality of movable elements each of said movable elements having frequency varying means associated therewith, means for successively connecting said frequency varying means to said alternating current source to control the frequency thereof and frequency responsive indicating means connected to be supplied with currents variable in frequency in accordance with the frequency of said source.

3. In a telemetric system, the combination with a source of alternating currents, of a plurality of movable elements each of said movable elements having frequency varying means associated therewith, means for successively connecting said frequency varying means to said alternating current source, a plurality of frequency responsive indicating means corresponding to said movable elements and means operable synchronously with said first connecting means for supplying to successive indicating means currents varying in frequency in accordance with said alternating current source.

4. In a telemetric system, the combination with a plurality of movable elements each of said movable elements having frequency varying means associated therewith, a transmitter of modulated high frequency currents, means for successively connecting said frequency varying means to said transmitter to control the frequency of the modulating currents thereof, demodulating means for said high frequency currents, a plurality of frequency responsive indicating means and means for successively connecting said indicating means to said demodulating means.

5. In a telemetric system, the combination with a plurality of movable elements each of said movable elements having frequency varying means associated therewith, a transmitter of modulated high frequency currents, means for successively connecting said frequency varying means to said transmitter to control the frequency of the modulating currents thereof, demodulating means for said high frequency currents, a plurality of frequency responsive indicating means and means for successively connecting said indicating means to said demodulating means the operation of said two connecting means being synchronous with each other.

6. In a telemetric system, the combination with a plurality of movable elements, each of said movable elements having frequency varying means associated therewith, a transmitter of modulated high frequency currents, means for successively connecting said frequency varying means to said transmitter to control the frequency of the modulating currents thereof, demodulating means for said high frequency currents, a plurality of frequency responsive indicating means and means for successively connecting said indicating means to said demodulating means,

both of said connecting means being periodically synchronized with each other.

7. In a telemetric system the combination with a plurality of movable elements each of said movable elements having frequency varying means associated therewith, a transmitter of modulated high frequency currents, demodulating means for said high frequency currents, a plurality of frequency responsive indicating means associated therewith, means for periodically connecting said frequency varying means in rotation to said transmitter to control the frequency of the modulating currents thereof, means for connecting said frequency responsive indicating means in rotation to said demodulating means, means for periodically interrupting the supply of currents to the demodulating means and means responsive thereto for restoring the connecting means to corresponding positions in rotation.

8. In a telemetric system, the combination with a plurality of movable elements each of said movable elements having frequency varying means associated therewith, a transmitter of modulated high frequency currents, means for successively connecting said frequency varying means in rotation to said transmitter to control the frequency of the modulating currents thereof and for interrupting said high frequency currents after each successive connection, demodulating means for said high frequency currents, a plurality of frequency responsive indicating means and means responsive to said interruptions for successively connecting said indicating means to said demodulating means in rotation, said last connecting means being adapted to be periodically restored to a position in said rotation corresponding to the simultaneous position of said first connecting means.

9. In a telemetric system, the combination with a source of alternating currents, of a plurality of movable elements each of said movable elements having frequency varying means associated therewith, means for periodically connecting said frequency varying means in rotation to said source to control the frequency thereof, means for impressing upon conductors at a remote point currents having frequency variable in accordance with said source, means for interrupting said currents after each successive connection of said connecting means, a plurality of frequency responsive indicating means each of said indicating means corresponding to one of said frequency varying means, and means responsive to said interruptions for connecting said frequency responsive indicating means in rotation to said conductors both of said connecting means being periodically restored to corresponding positions in said rotation.

10. In combination, a transmitting station

and a receiving station, an interconnecting circuit between said stations, a plurality of circuits at said transmitting station and a plurality of circuits at said receiving station, each of said latter circuits corresponding to one of said former circuits, step by step means at each of said stations for connecting in rotation each of said circuits to said interconnecting circuit and means for periodically producing an interruption in current supplied to said interconnecting circuit, and means responsive to said interruption for restoring said step by step means at the receiving station to a position in rotation corresponding to the simultaneous position of said step by step means at the transmitting station.

11. In combination, a transmitting station and a receiving station, interconnecting conductors extending between said stations, a plurality of control devices in the transmitting station and a plurality of controlled devices in the receiving station each of the former devices corresponding to one of the latter, means in each station for periodically connecting each of said devices in rotation to said interconnecting conductors whereby currents controlled by the control devices may be transmitted through said conductors to corresponding controlled devices, means for producing interruptions in the currents which are supplied through said conductors to the controlled devices and means responsive to the interruptions for causing synchronous operation of the connecting means.

12. In combination, a transmitting station and a receiving station, interconnecting conductors extending between said stations, a plurality of control devices in the transmitting station and a plurality of controlled devices in the receiving station each of the former devices corresponding to one of the latter, means in each station for periodically connecting each of said devices in rotation to said interconnecting conductors whereby currents controlled by a control device may be transmitted through said conductors to a controlled device, means at the transmitting station for interrupting said currents after each connection and for producing a distinctive interruption once in each rotation of the connecting means and means at the receiving station responsive to the former interruptions for causing successive operation of the connecting means in that station and responsive to the distinctive interruption for restoring said connecting means to a predetermined position in rotation.

13. In a telemetric system, a transmitting station, a receiving station, a path for alternating current joining said stations, said path being impenetrable to direct currents, a plurality of movable elements in said transmitting station, a source of alternating current, connections for supplying current from said source to said path, each of said elements

having means associated therewith for varying the frequency of said source, a plurality of frequency responsive indicating means in the receiving station, means for successively connecting said frequency varying means to said source, and means operable over said path successively to connect said indicating means in receiving relation to said path.

14. In a telemetric system, a transmitting station, a receiving station, a path joining said stations, a source of alternating current in said transmitting station connected to supply current to said path, a plurality of movable elements each of said elements having means associated therewith to control the frequency of said source, means for periodically connecting each of said last means to said source, a plurality of frequency responsive indicating devices in said receiving station, means for connecting each of said devices in succession in receiving relation with said path, and means controlled by said first connecting means over said path for operating said last connecting means thereby to maintain synchronism between said connecting means.

15. In a telemetric system, a transmitting station, a receiving station, a path joining said stations, a source of alternating currents in said transmitting station connected to supply current to said path, a plurality of movable elements each of said elements having means associated therewith to control the frequency of said source, means for periodically connecting each of said last means to said source, a plurality of frequency responsive indicating devices in said receiving station, means for connecting each of said devices in succession in receiving relation with said path, means controlled by said first connecting means over said path for operating said last connecting means, and additional means controlled over said path for restoring said connecting means to corresponding positions in rotation following a faulty operation resulting in said connecting means occupying non-corresponding positions in rotation.

In witness whereof, I have hereunto set my hand this 30th day of June, 1927.

ALAN S. FITZ GERALD.