

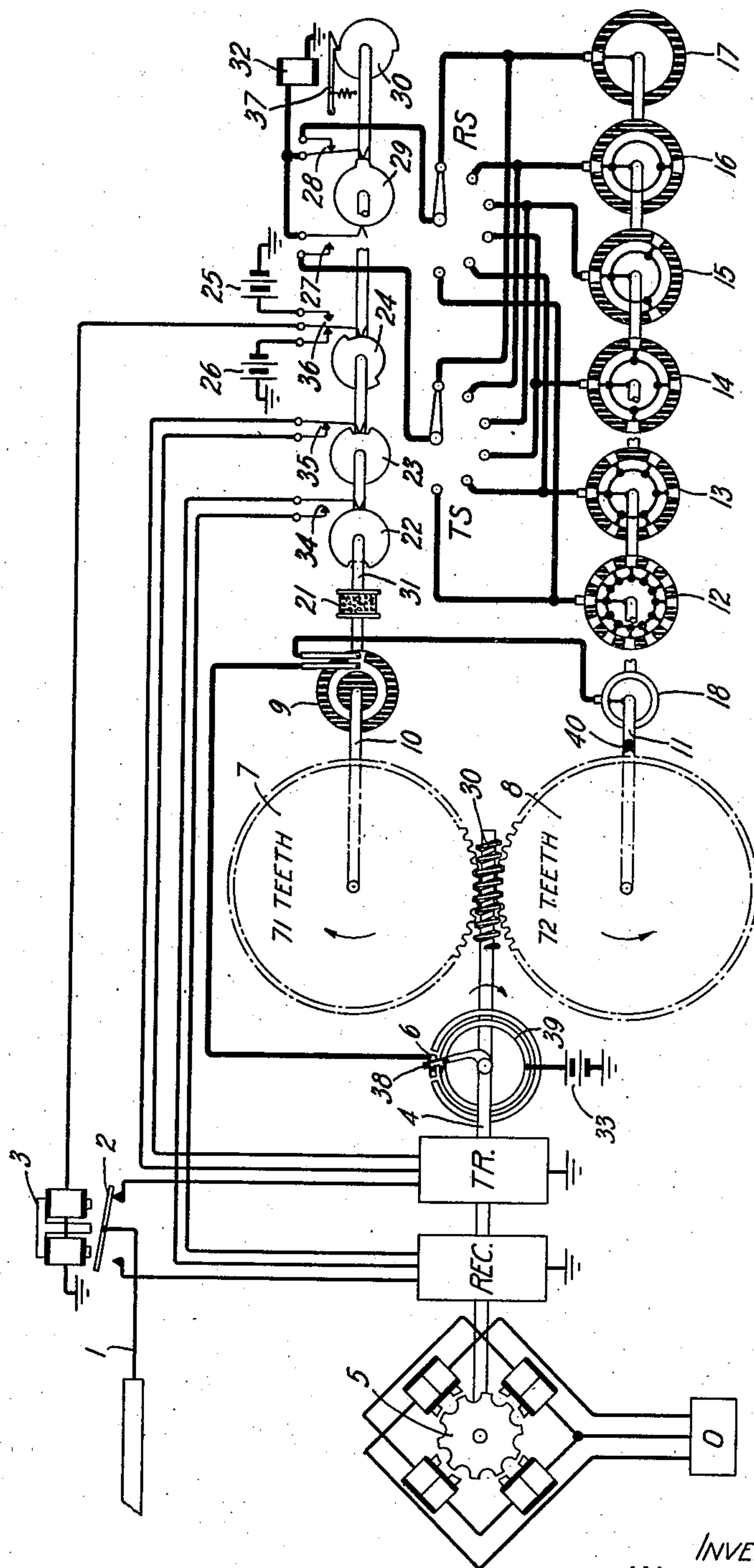
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TIMING CIRCUIT

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TIMING CIRCUIT

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This invention relates to synchronous communication systems and particularly to synchronous telegraph systems in which transmission is effected in only one direction at a time and the direction is reversed automatically at intervals under the control of a timing switch driven from the synchronous distributing apparatus at each station.

An object is to close an electric circuit at relatively long, adjustable, accurately measured intervals under the control of a rapidly rotating shaft.

A more specific object is to periodically perform a switching operation in a synchronous telegraph system at time intervals which are large compared to the time required for the synchronous distributing equipment to complete a cycle of operation.

A particular object is to simplify mechanically the mechanism employed for timing reversals of direction of signaling in a telegraph system functioning to transmit alternately in opposite directions.

Heretofore in synchronous simplex telegraph systems adapted for transmission alternately in each direction it has been customary to reverse the direction of transmission by switches controlled from the main distributor shaft at each station. Since in such a system it may be desirable to transmit continuously in one direction for a period of at least several minutes, and since rotary distributor shafts commonly operate at speeds of the order of several hundred revolutions per minute, it has been the practice to use switches operated by cams driven at a reduced speed from the distributor shaft through a rather complicated gear train. In order to provide means for varying the transmission time in one direction relative to the transmission time in the other direction it was necessary to provide several gear trains, or several interchangeable cams.

By the present invention two shafts geared directly to the distributor shaft are substituted for the previously employed complicated gear trains and cam switches. The two shafts are geared to run at slightly different speeds, for example, one may complete a revolution while the other is completing $\frac{71}{72}$ of a revolution.

Each shaft closes an electrical contact at a particular point in its rotation and the two contacts are connected in series in the circuit to be controlled. In operation the two contacts are closed simultaneously once only during each 71 revolutions of the first shaft thus giving a circuit closure at relatively long intervals without resorting to a speed reducing gear train with a multiplicity of parts. By arranging one of the shafts to close several contacts in succession at intervals during a revolution, the time between successive simultaneous closures of the contacts on the two shafts may be reduced. By switching to different sets of contacts on one or both of the shafts many different timing periods may be obtained.

The drawing discloses in highly schematic form the apparatus at one terminal of a synchronous telegraph system adapted for transmission alternately in each direction with switching apparatus in accordance with this invention for periodically automatically reversing the direction of transmission.

Referring to the drawing a synchronous motor 5 drives receiving and transmitting distributors which are not shown but which would be located on the synchronous motor shaft 4 and the existence of which, together with that of other necessary receiving and transmitting equipment, is indicated by the rectangles marked "REC." and "TR." The synchronous motor also drives two gears 7 and 8 which have 71 and 72 teeth respectively and which drive two shafts 10 and 11 respectively. On the shaft 10 is mounted a segmented ring 9 having a single segment and on shaft 11 are mounted several segmented rings 12 to 17 inclusive. The segments in each ring on shaft 11 are electrically connected to a common ring 18 through shaft 11, which is electrically insulated from gear 8 by insulation 40. A brush 38 is mounted on the main distributor shaft 4 and makes contact momentarily once during each revolution between the segment 6 and a common ring 39 connected to a battery 33. In practice segment 6 and its associated common ring would be mounted on one of the regulator distributor faces.

Common ring 39, brush 38, segment 6, ring 9, and the segmented rings 12 to 17 inclusive cooperate to supply current from battery 33 at various periodic intervals to the brushes resting on the rings 12 to 17 and thence through a transmitting time control switch TS or a receiving time control switch RS to the switching equipment for reversing the direction of transmission.

This switching equipment comprises a shaft 31, connected by means of a friction clutch 21 to shaft 10, upon which are mounted various switching cams 22, 23, 24 and 29 and a disc 30 having two diametrically opposite projections adapted to normally engage with a detent lever 37 and arrest the motion of shaft 31 in either of two positions. Cam 22 serves to open contacts 34 and render the receiving apparatus REC. inoperative except when shaft 31 is in one position of rest. Cam 23 serves to open contacts 35 and prevent the transmission of signal impulses by the transmitter TR. except when shaft 31 is in the other position of rest. Cam 24 serves to apply to polar relay 3 current of one polarity when shaft 31 is in one position of rest and current of opposite polarity when the shaft is in the other position of rest. Polar relay 3 responds to currents of opposite polarity to reverse the position of its armature and connect the signaling conductor from the receiver REC. to the transmitter TR. and vice versa. Cam 29 in one position of rest of shaft 31 connects a release magnet 32 associated with detent lever 37 to the movable contact of transmitting time control switch TS and in the other position of rest of shaft 31 connects magnet 32 to the movable contact of receiving time control switch RS.

The use of cams 22 and 23 in connection with local circuits in the receiving and transmitting equipment respectively has not been explained in detail since it is not a part of this invention. For a complete description of such equipment reference is made to an application of G. A. Locke, Serial No. 205,544, filed July 14, 1927.

Operation of system

With the apparatus in the position shown a circuit is closed from battery 33, through the common ring 39, brush 38, segment 6, the single segment and associated brushes on ring 9, through ring 18 to shaft 11 and thence through the segment on ring 17 through the right hand contact of receiving switch RS, contacts 28 and the winding of magnet 32 to ground. Magnet 32 operates in response to the current therethrough to lift the detent lever 37 and release the stop on disc 30 which permits shaft 31 to rotate with shaft 10. Cam 23 on shaft 31 thereupon opens contacts 35 which locks up transmitter TR. Immediately thereafter cam 24 reverses the polarity of the current applied to the polar relay 3

and reverses the position of armature 2, which disconnects the line conductor 1 from the transmitter TR. and connects it to the receiver REC. Following the connection of the conductor 1 to the receiver by cam 24, cam 22 closes contacts 34, which releases the receiver REC. so that it is in condition to receive and record signals. The circuit for energizing electromagnet 32 was only closed momentarily, since the brush 38 rotates at a relatively rapid rate and contacts only momentarily with segment 6. Magnet 32 therefore releases lever 37 before disc 30 has completed half a revolution and the cam is accordingly stopped by lever 37 when it has completed a half revolution, which is the position in which cam 22 has closed contacts 34.

The apparatus will remain in this condition until the circuit from battery 33 to magnet 32 is again closed, this time through brush 38, and segment 6, ring 9, rings 18 and 17, switch TS, and contacts 27 on cam 29.

Since gear 7 has 71 teeth and gear 8 has 72 teeth, gear 7 will make one revolution while gear 8 makes $\frac{71}{72}$ of a revolution, and since the segments are made sufficiently short so that contact between the segment of ring 9 and its associated brush is broken by the time segment 17 next contacts with its brush, gear 8 must turn through 71 revolutions before the segment of ring 17 and that of ring 9 again make contact with their respective brushes simultaneously and complete a circuit from battery 33 to magnet 32.

If it is assumed that the distributor shaft 4 rotates at 360 revolutions per minute, then gear 8 and shaft 11 will rotate at $\frac{71}{72}$ of that speed or five revolutions per minute. Since, as pointed out above, 71 revolutions of gear 8 elapse between successive simultaneous closures of segments 9 and 17 with their respective brushes, the direction of transmission will be reversed every 14.2 minutes. By connecting the switches TS and RS to contacts associated with other rings on shaft 11 the time between successive contact closures may be reduced. For instance a segment in ring 16 will close on its brush simultaneously with the segment in ring 9 in half the time, or every 7.1 minutes; the segment in ring 15 in a third of the time or every 4.73 minutes; the segment in ring 14 in a fourth of the time or every 3.55 minutes; the segment in ring 13 in $\frac{1}{5}$ the time or every 2.36 minutes; and the segment in ring 12 in $\frac{1}{6}$ the time or every 1.18 minutes. Furthermore, by setting switches TS and RS on contacts associated with different rings, different periods of transmission in each direction may be obtained. In case of extremely heavy traffic in one direction, compared with that in the other, it may be desirable to transmit for only 1.18 minutes in one direction as against 14.2 minutes in the other direction.

It is not essential that the two gears have

71 and 72 teeth respectively nor that the rings on shaft 11 have 1, 2, 3, 4, 6, and 12 segments respectively but it is necessary that the segments of any ring on shaft 11 be so spaced as to effect a circuit closure simultaneously with the segment 9 on shaft 10. Since shaft 10 makes 72 revolutions while shaft 11 makes 71, in order to meet the above requirement the number of segments in any ring of shaft 11 must be an even divisor of 72, i. e., 1, 2, 3, 4, 6, 8, 9, 12, 18, 24, 36 or 72.

In general if $\frac{A}{B}$ represents the ratio, reduced to its lowest terms, of the speed of shaft 10 to that of shaft 11, then any even divisor of A represents a possible number of segments that can be used in a ring on shaft 11 and there may be as many rings as there are divisors. Furthermore, the time between successive simultaneous closures of a segment in a ring on shaft 11 and the segment on shaft 10 will be represented by $\frac{AC}{D}$ where A is the numerator of the ratio $\frac{A}{B}$ when reduced to its lowest terms, C is the time of one revolution of shaft 10, and D is the number of segments in the ring on shaft 11.

Although shaft 31 has been shown coupled to shaft 10 it may be driven from a separate motor if desired. The speed at which shaft 31 should be rotated depends chiefly on the time required for a signal to traverse the line conductor and may be such that it can be driven from shaft 10 or 11 as has been shown, in which case the need for a separate source of motion of constant speed is dispensed with.

It should be understood that in a simplex communication system with which this invention would be used, exactly similar equipment is located at the distant station and the segments 9 at each station are set to close simultaneously. Thereafter, of course, they will remain in synchronism as long as the synchronous distributors from which they are driven remain in synchronism. The shafts 31 at the two stations are initially set 180° apart and if the transmitting time in one direction is different from that in the other, the setting of switch TS at one station must correspond to that of RS at the other, and vice versa, since one station receives while the other transmits.

What is claimed is:

1. In a time switch comprising two normally open contacts in series in an electric circuit, the method of closing said circuit at long intervals which comprises closing one of said contacts periodically and closing said other contacts periodically at a time rate slightly different from that at which said first contacts are closed and at such a rate that the time between successive simultaneous closures is greater than the time between successive closures of each contact.

2. Circuit closing means comprising a plurality of periodically operated circuit closing means in series relationship characterized in that the periods between said successive closures of the different means are slightly different and such that simultaneous closures of all the contacts occur at intervals several times greater than the intervals between successive closures of each contact.

3. In a timing system, a plurality of electric circuit closing devices, a master driving element, means actuated by said element for closing said devices at different intervals proportional to the speed of the master driving element and such that simultaneous closures of all the circuit closing devices occur at intervals greater than the intervals between successive closures of any one of the devices, and an electrical circuit comprising a source of electric energy, an electro-responsive device and said plurality of electric circuit closing devices in series.

4. In a timing system, a rotating shaft and means comprising a pair of conductors associated therewith whereby electrical contact is established between said conductors at uniform intervals dependent on the speed of the shaft, a second shaft inflexibly coupled to the first shaft, means comprising a plurality of pairs of conductors associated with the second shaft whereby electrical contact is established between each pair of conductors at intervals which are different for each pair and such that each interval is equal to $\frac{A}{B} \times \frac{C}{D}$ where $\frac{A}{B}$ is the ratio reduced to its lowest terms of the speed of the first shaft to the speed of the second shaft and both A and B are greater than unity, C is the time of one revolution of the first shaft, and D is any equal divisor of A, a source of electric energy, an electro-responsive device, and means comprising manually operable means for connecting said source of electric energy, said electro-responsive device, said pair of conductors associated with the first shaft, and any one pair of contacts associated with the second shaft in a series circuit.

5. In a timing device, a master driving shaft, a second and a third shaft geared to the master shaft to run at reduced, different speeds, a segmented ring on the master driving shaft, having a single short segment, a segmented ring on the second shaft having a single short segment, a plurality of segmented rings on the third shaft, each ring having a different number of segments so spaced that the time between contacts of a segment of each ring, with its associated brush, is equal to $\frac{A}{B} \times \frac{C}{D}$ where $\frac{A}{B}$ is the ratio reduced to its lowest terms of the speed of the second shaft to that of the third shaft and both A and B are greater than unity, C is the time of one revolution of the second shaft,

and D is any equal divisor of A, a brush associated with each ring, a source of electric energy, an electro-responsive device, and means comprising manually operable means for connecting said source of electric energy, said electro-responsive device, said brush and segments associated with the first shaft, and any one brush and its associated segment on the second shaft in a series circuit.

6. In a timing system, a control shaft to be rotated at a definite speed through a revolution in two or more steps, and stopped for measured intervals between turning periods, a primary shaft turning at constant speed and driving a plurality of secondary shafts at reduced different speeds, one of said secondary shafts being coupled by a clutch to said control shaft, segmented rings on the secondary shafts with different numbers of live segments on each ring on each shaft, a plurality of switching means on the control shaft, each adapted to be closed in one position of rest of said control shaft, an electro-responsive device, a source of electric energy, and means for closing an electric circuit from said source of energy through a live segment of a ring of one secondary shaft and a live segment of any ring on another secondary shaft, through one switching circuit associated with said control shaft to said electro-responsive device.

7. In a synchronous communication system, a synchronous distributor and driving shaft therefor, a second shaft mounting an insulated collector ring having one live segment and geared through the distributor shaft to run at a reduced speed, a third shaft mounting a plurality of insulating rings having different numbers of live segments also geared to the distributor shaft to run at a reduced speed different from that of the second shaft, a fourth shaft frictionally coupled to the second shaft, electromagnetically operated stop means whereby said fourth shaft may be restrained from rotation at two positions in each revolution, cams on said shaft and two pairs of contacts operated by the cams whereby a different pair of contacts is closed in each position of rest, and means for connecting either of said pair of contacts to a brush of any one of the rings on said third shaft, connecting means from the live segments on the third shaft to a brush contacting with the segment on the second shaft, a source of electric energy and connecting means between the segment on said second shaft, said source and said electromagnetic stop means whereby said fourth shaft may be released to complete a half revolution of motion at different measured intervals.

8. In a synchronous communication system, a line conductor, receiving apparatus, transmitting apparatus, synchronous driving means associated with said receiving and transmitting apparatus, switching means

normally operable from one to the other of two positions, means associated therewith for connecting said line to the receiver in one position and to the transmitter in the other position, electro-responsive means for restraining said means in each position, a source of electric current, circuit closing means comprising a plurality of periodically operated circuit closing means in series relationship characterized in that the periods between successive closures of the different means are different and such that simultaneous closures of all the circuit closing means occur at intervals greater than the intervals between successive closures of any one of the means, said electro-responsive means and source of current being connected in series with said circuit closing means.

9. Means as defined in claim 8 further characterized in that said plurality of periodically operated circuit closing means are controlled by said synchronous driving means.

10. In a synchronous communication system, a line conductor, receiving apparatus, transmitting apparatus, synchronous driving means associated with said receiving and transmitting apparatus, switching means normally stopped in either of two positions, means associated therewith for connecting said line to the receiving apparatus in one position and to the transmitting apparatus in the other position, means for moving said switching means from one position to the other comprising an electro-responsive starting means, a source of electric current, and means for connecting said source to said electro-responsive means comprising a plurality of moving elements inflexibly coupled to said synchronous driving means and driven at different speeds thereby, means comprising a pair of conductors associated with one of said moving elements, whereby electrical contact is periodically, momentarily established between said conductors, means comprising a plurality of pairs of conductors associated with another of said moving elements, whereby electrical contact is momentarily established between each pair of conductors simultaneously with the contact of the first pair at intervals different for each pair and greater than the interval between successive contacts of any one pair of conductors, circuit closing means associated with said switching means comprising a pair of conducting elements closed only in one position of rest of said switching means, and another pair of conducting elements closed only in the other position of rest of said switching means, and two series circuits, one comprising said electro-responsive device, said source, said pair of conductors associated with the first of said moving elements, one pair of the plurality of pairs of conductors associated with the other of said moving elements, and one pair of conducting elements associated with said switching

means, and the other series circuit comprising said electro-responsive device, said source, the pair of conductors associated with the first of said moving elements, one pair of the plurality of pairs of conductors associated with the other of said moving element, and another pair of conducting elements associated with said switching means.

11. Mechanism for closing a circuit at relatively long and uniformly spaced intervals determined by a rotating device revolving at high speed without the use of complex speed reduction trains, which mechanism comprises a plurality of rotating devices operated directly by said high speed device so that the difference in their number of revolutions per unit of time is a small fraction of the number of revolutions of each, each of said devices closing said circuit at least once in its revolution.

12. Device as defined in claim 11 characterized in this that one element of one of the contacts is a conductive portion of one of the rotating devices.

In witness whereof, I hereunto subscribe my name this 28th day of February, 1928.

WILLIAM A. KNOOP.