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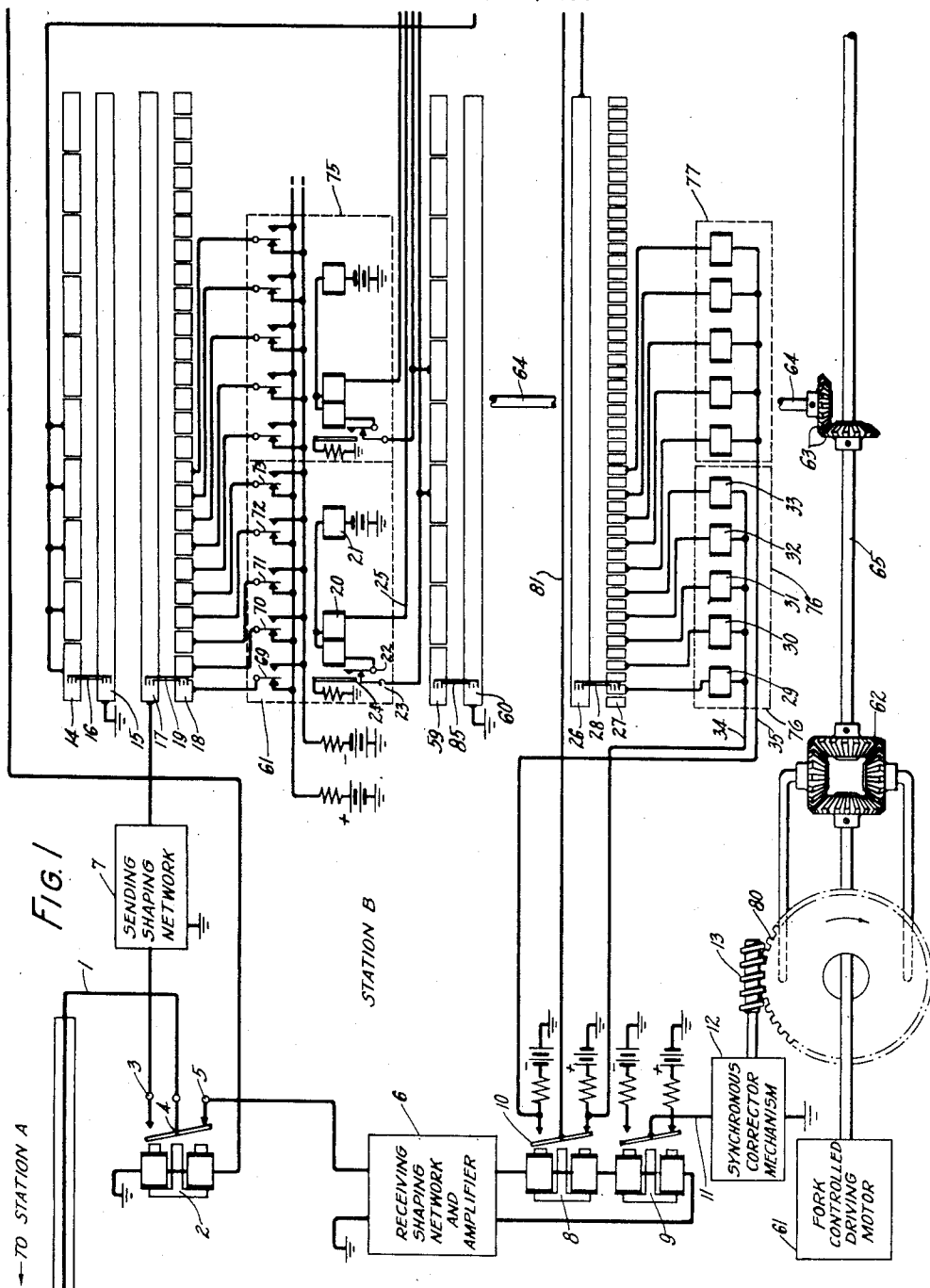
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SYNCHRONOUS TELEGRAPH SYSTEM

Filed July 14, 1927

2 Sheets-Sheet 1



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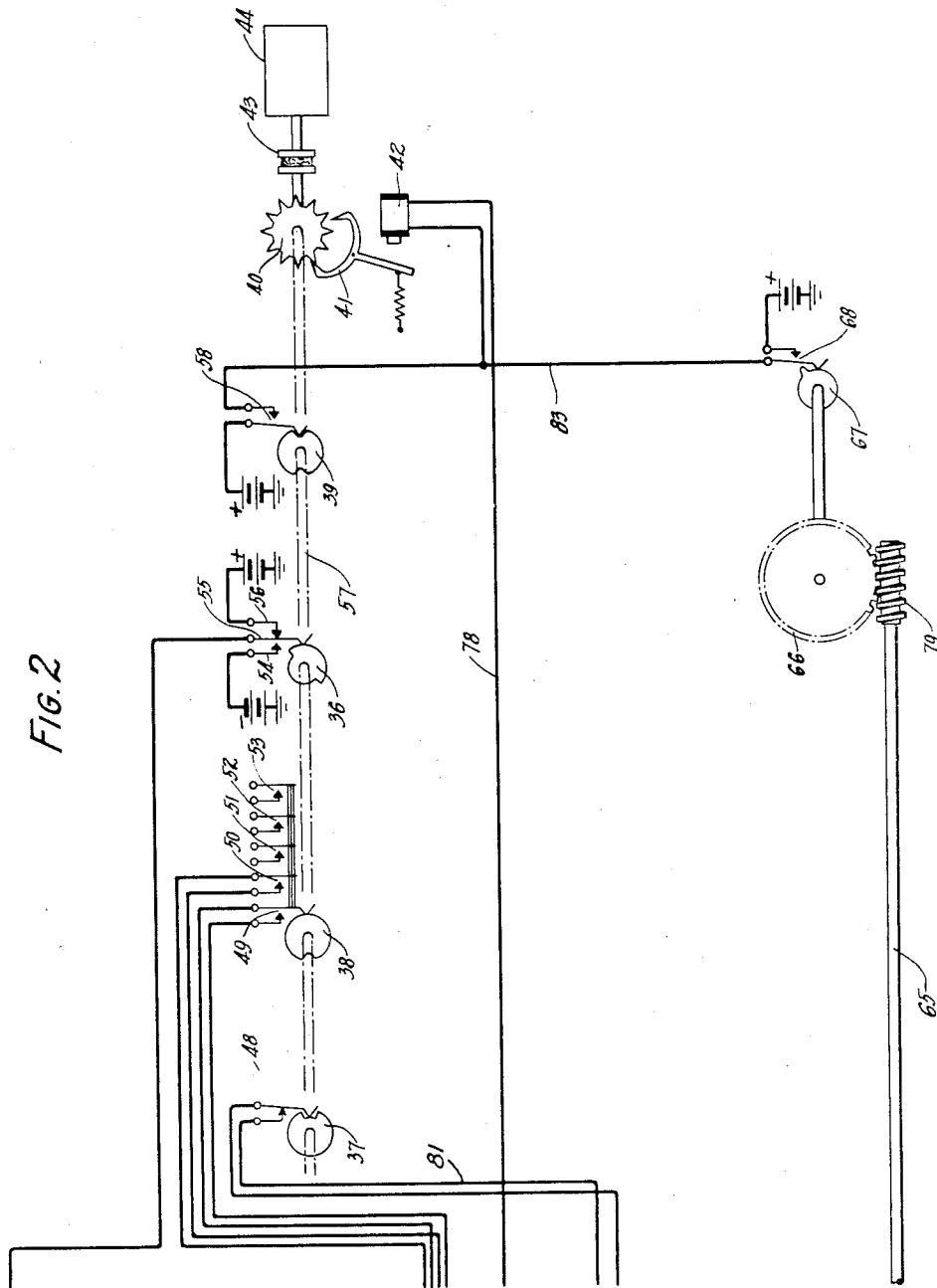
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SYNCHRONOUS TELEGRAPH SYSTEM.

Application filed July 14, 1927. Serial No. 205,544.

This invention relates to synchronous signaling systems and particularly to synchronous telegraph systems adapted for transmission alternately in each direction.

5 A broad object of the invention is to insure the proper synchronization of sending and receiving equipment before the transmission of signaling impulses is begun. A more specific object is to synchronize transmitting and receiving stations in a system following a reversal of the direction of transmission.

10 In a synchronous telegraph system adapted for transmission alternately in each direction, there is a period of time following the completion of transmission in one direction and preceding the resumption of transmission in the reverse direction when no correcting impulses are transmitted over the line. At such times the two distributors may tend to fall out of synchronism and although the time occupied in reversing the direction of transmission is of brief duration the distributors at different stations may drift out of phase sufficiently to require several corrections to restore them to their proper relative positions, and they may be sufficiently out of phase to interfere with the proper reception of signaling impulses for the brief period before the correcting mechanism has restored synchronism.

25 This invention eliminates the difficulty described above by the use of automatic switching means to lock up the transmitting and receiving apparatus following reversal of direction, while transmitting synchronizing impulses for a brief period to restore the receiving station to synchronism with the transmitting station.

40 Referring to the drawings, Figs. 1 and 2, when arranged side by side with Fig. 1 on the left, disclose the arrangement of apparatus at a telegraph station incorporating applicant's invention. This station will hereafter be known as station B and a similar station at a distant point on the line conductor will be known as station A.

50 Briefly, as illustrated in the drawing, the invention comprises direction-reversing switches operated by cams 37, 38, and 36 for connecting or disconnecting the line conductor 1 to the transmitting distributor or a receiving distributor, shown in the upper and lower parts of Fig. 1, respectively, and for properly conditioning the receiving and

transmitting equipment before and after each line switching operation so that no signal impulses are lost or mutilated.

Referring to the drawing in detail, a line conductor 1, which in this case is shown as a submarine cable, is connected to armature 4 of a switching relay 2, which serves to connect it to either sending apparatus or receiving apparatus under the control of switching cam 36. Rectangle 6 represents a receiving shaping network and amplifier and since a detailed knowledge of that apparatus is not necessary for a full understanding of the present invention, its position in the circuit has merely been indicated. For a complete description of a shaping network and amplifier of this type applicant is referred to a copending application of A. M. Curtis, Serial No. 119,537, filed June 30, 1926. In the output of the amplifier circuit are shown two polar relays 8 and 9 which serve to repeat received impulses to the receiving distributor ring 26 and the synchronous correcting mechanism represented by rectangle 12, respectively. Synchronous driving and correcting apparatus which is suitable for use in a system of this type, is disclosed in the above mentioned application, Serial No. 119,537, and also in applicant's copending application Serial No. 123,328, filed July 19, 1926. In brief, the synchronous correcting mechanism comprises means for automatically orienting the distributor shaft 65, which revolves the brushes 16, 19, 85 and 28 over their respective segments through gears 63 and shaft 64, to maintain the brushes at the receiving station exactly in phase with the distributor brushes at the transmitting station. In practice, it is customary to set the distributor driving motors at the two stations to run at slightly different speeds so that an intermittent correction of the distributor shaft at the receiving station is required to maintain it in synchronism with the distant transmitting distributor. 14, 15, 17, 18, 59, 60, 26 and 27 represent rings on the synchronous distributor. These would ordinarily be arranged on a circular face, but for convenience are shown in the drawings as developed into a plane surface. Of these rings, 14 and 15 control the rotation of shaft 57 and the automatic switching cams which reverse the direction of transmission. Rings 17 and 18 are the transmitting rings, each segment of

ring 18 being connected to a transmitting tongue arranged to be connected to positive or negative battery under the control of a tape transmitter. Rings 59 and 60 control the operation of the transmitter, which will be described below. Rings 26 and 27 constitute the receiving rings, each segment of ring 27 being connected to a printing magnet. The drawing discloses a distributor for a five-channel system, but to simplify the drawing, the transmitting and receiving equipment for only two channels is shown.

Considering the impulse transmitter for channel 1, which is shown enclosed in dotted rectangle 61; 69, 70, 71, 72, and 73 represent tongues arranged to be operated by a perforated tape. When transmitter control magnet 21 is released, the tongues move under control of the tape and retain their positions until magnet 21 energizes when the tongues are restored to their normal position (closed on their left contacts as shown) and the transmitting tape is advanced to the next position. It should be noted that as long as magnet 21 is energized the transmitting tape is held stationary and the transmitting tongues are held locked against their left contacts. A differential relay 20 operates in response to current in one of its windings, but is not affected by current flowing in both of them. Ordinarily, during a transmitting period, conductors 25 and 23 are short circuited through contacts 49 on cam 38 and, therefore, relay 20 cannot operate. Whenever contacts 49 are opened, however, no current can flow through the right winding of relay 20, which thereupon locks up to contact 24 and holds magnet 21 operated until contacts 49, operated by cam 38, again close. The dotted rectangle 75 represents the transmitter in channel 2. It is similar in all respects to the apparatus in channel 1, except that the left contacts of the transmitting tongues are connected to negative battery instead of positive, and the right contacts are connected to positive instead of negative. Likewise, the control magnet and differential relay are controlled from contacts 50 operated by cam 38. The transmitting equipment in channels 3 and 5 is identical with that in channel 1 and the equipment in channel 4 is identical with that in channel 2. The transmitters for the last three channels are controlled, respectively, by contacts 51, 52 and 53.

The receiving printing magnets for channel 1 are shown enclosed in rectangle 76 and those for channel 2 in rectangle 77. Each of the five magnets in channel 1 has one of its terminals connected to a segment in receiving ring 27 and its other terminal connected to positive battery, whereas the magnets in channel 2 have their common terminal connected to negative battery. The magnets in channels 3 and 5 are connected to positive battery like channel 1 and the magnets

in channel 4 have their common terminal connected to negative battery, like channel 2. When transmitting tongues in channels 1, 3 and 5 at the distant station (station A) are in their normal positions, they will send only positive impulses, which will not affect the receiving printers at station B in those channels since their common return is also connected to positive battery. Likewise, channels 2 and 4 at station A will transmit only negative impulses which will not affect the printers in those channels at station B, since their common return is connected to negative battery. Hence, whenever the transmitting tongues lie on their left contacts, as shown in the drawings, the impulses transmitted will have no effect on the receiving printers.

Cams 37, 38, 36 and 39 mounted on shaft 57 control the operation of contacts for performing in proper sequence different switching operations necessary to change the apparatus from the sending to receiving condition, or vice versa. Shaft 57 is driven from motor 44 through a friction clutch 43 under the control of the escapement mechanism comprising escapement wheel 40 and magnet 42, which operates under the joint control of timing rings 14 and 15 on the distributor, and cam 58.

A clear conception of this invention can now best be obtained by following through in detail the actual functioning of the apparatus during a reversal of the direction of transmission. With the apparatus in the drawing in receiving position as shown, and identical station A at the distant end of the cable transmitting, received impulses arrive over the cable, pass through the armature 4 and contact 5 of switching relay 2 to the receiving shaping network and amplifier 6, where they are corrected and amplified and thereafter operate receiving relay 8, and corrector relay 9. The armature of relay 9 vibrates on each reversal of current and in turn transmits a current reversal to the synchronous corrector mechanism 12. If station B is in phase with station A, these reversals will produce no effect in the synchronous corrector mechanism, but whenever station B gets slightly out of phase with station A the reversals cause mechanism 12 to step the main drive shaft 65 backward or forward, as required to restore synchronism, by means of the worm 13, gear 80 and differential 62.

The current reversals through relay 8 actuate its armature 10 to contact with positive and negative battery in accordance with the character of the received signals and thus impulses are applied through conductor 81, contacts 48, to the common receiving ring 26, whence they are distributed to the receiving magnets in the various channels.

At the end of a receiving period, the length of which is determined by the rate of rotation of cam 67, which is driven at reduced

speed from shaft 65, cam 67 momentarily closes contacts 68 which supplies battery through conductor 83, magnet 42, conductor 78 and, on the next rotation of brush 16 over the connected segments in ring 14, to ground on ring 15. This energizes magnet 42 and permits escapement wheel 40 on cam shaft 57 to rotate through a small angle sufficient to close contacts 58, which supply current to operate magnet 42 after contacts 68, which were only closed momentarily, have opened. Hence shaft 57 will continue to rotate, under control of magnet 42, until contacts 58 are again opened by a rotation of the shaft 57 through 180°. During this rotation cam 37 first operates to open contacts 48 and cut off the receiving printer. Thereafter cam 36 operates to transfer contact 55 from the connection to positive battery on contact 56 to the connection to negative battery on contact 54, which reverses the position of relay 2 and connects cable conductor 1 through contact 3 and sending shaped network 7 to the sending distributor ring 17. The transmitting tongues of the transmitters are in their normal position at this time because the transmitter control magnets, as represented by 21 in channel 1, are locked up through the operation of the differential relays, since the transmitter control contacts 49 to 53, respectively, are held open by cam 38. Thus, while the transmitting brush 17 is passing over the segments of channels 1, 3 and 5, only positive impulses are transmitted to the line, and when passing over the segments of channels 2 and 4 only negative impulses are transmitted to the line. As pointed out before, these impulses will not operate the associated printing mechanisms at station A, but the current reversals which occur as the brush 17 passes from channel 1 to channel 2, from channel 2 to channel 3, from channel 3 to channel 4, and from channel 4 to channel 5, will cause reversals of the synchronizing corrector relay 9 at station A and will bring the distributors at that station back into proper phase relation with the distributors at station B if any relative displacement may have occurred since the direction of transmission was reversed by cams 36 at each station.

When the shaft 57 has rotated through 180° cam 38 operates to close transmitter control contacts 49 to 53, respectively, which releases the locking magnets 21 and permits the transmission of signal impulses. The period of time between the operation of the direction reversing magnet by cam 36 and the closure of contacts 49 to 53 by cam 38 affords sufficient time to fully correct the distant station to synchronism with station B before the resumption of signal transmission. In practice, the total time required for a half-revolution of shaft 57 may be in the neighborhood of six seconds, and the synchronizing time between the operation of switch 55 by cam 36

and the operation of switches 49 to 53 by cam 38 may be about four seconds.

Station B will now continue to transmit signal impulses until cam 67 has completed a revolution, when it will again close contacts 68 to begin the rotation of shaft 57 under the control of contacts 58 and the connected segments on ring 16. Immediately shaft 57 begins to rotate, cam 38 opens the contacts 49 to 53, respectively, which locks up the transmitters after each has transmitted a signal impulse, under the control of brush 85. For a brief period thereafter the transmitters send spacing impulses, which have no effect on the printers at station A, until the rotation of cam 36 again moves contact 55 from connection with negative battery to connection with positive battery and reverses the position of line switch relay 2 to disconnect the cable conductor from the sending distributor and connect it to the receiving shaping network and amplifier. At the same time the reversing relay at station A has connected the cable conductor 1 to the sending distributor at that station which thereupon transmits spacing impulses in the same fashion that station B did during the first half of the send-receive cycle. These spacing impulses actuate relays 8 and 9, but they are prevented from operating the receiving printers because the contacts 48 operated by cam 37 are open, which disconnects armature 10 of relay 8 from the common ring 26 of the receiving distributor. Relay 9, however, vibrates in response to received channel current reversals and repeats reversals over the conductor 11 to the synchronous corrector mechanism 12, causing it to properly orient shaft 65 and shaft 64. This correcting period obtains until shaft 57 has almost completed its half-revolution when cam 37 closes contacts 48 and received impulses from the line relay 8 are transmitted to the sending-receiving ring 26. Cam 37, as shown, connects the receiving distributor to the line relay slightly before cam 38 at station A connects the impulse transmitters at that station. This is to insure that signal transmission will not be begun before the receiving equipment is connected to the line. This early connection of the receiving distributor is permissible because at that time the two stations are in phase and the distant station is transmitting only spacing impulses, which will have no effect on the receiving printer magnets at station B.

It should be noted that the locking magnets, represented by 21 in channel 1, can never be locked up until brush 85 contacts with a segment in ring 59, which always occurs following the passage of sending brush 19 over the segments of the associated channel. Hence, no matter when contacts 49, 50, 51, 52 and 53 open, each channel completes the transmission of any character that has been set up and then locks its tape until transmis-

sion is again reversed, when it commences transmitting from the exact point at which it stopped.

The invention claimed is:

5 1. In synchronous telegraphy, the method of signaling which comprises transmitting signal impulses alternately in either direc-
tion and transmitting synchronizing im-
pulses only, for a brief period following
10 each reversal of the direction of transmis-
sion and preceding the transmission of sig-
nal impulses.

2. In synchronous telegraphy, the method
of signaling which comprises transmitting
15 signal impulses and utilizing them at a re-
mote point for both signaling and syn-
chronizing purposes, reversing the direction
of transmission and preventing the trans-
mission or reception of signal impulses for
20 a period of time during which synchroniz-
ing impulses are transmitted and received
for synchronizing purposes and thereafter
transmitting and receiving signal impulses
for both signaling and synchronizing pur-
25 poses.

3. In a synchronous telegraph system com-
prising a line conductor, a transmitter
and a receiver at each terminal thereof,
switching means operating to connect the
30 transmitter at one terminal to said con-
ductor and to cause the transmitter to trans-
mit spacing impulses for a period of time
and thereafter to transmit signal impulses.

4. In a synchronous telegraph system, a
35 line conductor, a transmitter adapted to
transmit special synchronizing impulses,
or signaling impulses, at one terminal
thereof, a receiver at the distant end of
the conductor comprising signal recording
40 apparatus responsive only to signaling
impulses and synchronism correcting ap-
paratus responsive to both the special syn-
chronizing impulses and to the signaling
impulses transmitted by said transmitter,
45 switching means to connect the transmitter
and the receiver to the conductor terminals
and to cause the transmitter to transmit only
synchronizing impulses for a period of time
thereafter, whereby the receiver is synchro-
50 nized with the transmitter, and thereafter
cause the transmitter to transmit signal im-
pulses.

5. A system as defined in claim 4, char-
acterized in that said switching means also

operates to prevent the functioning of said 55
signal recording apparatus until the trans-
mitter is conditioned to transmit signal im-
pulses.

6. In a synchronous telegraph system, a
line conductor, a transmitter and a receiver 60
at each terminal thereof, each transmitter
being adapted to transmit special synchro-
nizing impulses or signaling impulses, and
each receiver comprising signal recording
apparatus responsive only to signaling im- 65
pulses, and synchronism correcting appa-
ratus responsive to both the special syn-
chronizing impulses and to the signaling
impulses transmitted by a transmitter,
switching means at each terminal of a con- 70
ductor adapted to periodically reverse the
direction of transmission by operatively as-
sociating the transmitting or receiving
equipment at each end of the conductor, said
means functioning after each reversal to 75
cause the transmitter to transmit only syn-
chronizing impulses for a period of time,
whereby the receiver is synchronized with
the transmitter, and thereafter to cause the
transmitter to transmit signal impulses. 80

7. In a synchronous telegraph system, a
line conductor, a synchronous transmitter
comprising distributor segments with im-
pulse transmitters connected thereto, means
for locking said impulse transmitters where- 85
by they are prevented from transmitting sig-
nal impulses and caused to transmit only
spacing impulses, a receiver comprising dis-
tributor segments connected to automatic
printing apparatus adapted to be locked 90
whereby it cannot respond to received im-
pulses, and synchronous correcting appa-
ratus responsive to both spacing impulses
and to signal impulses, switching means
operating to connect said transmitter seg- 95
ments to the line conductor and to lock said
impulse transmitter whereby only spacing
impulses are transmitted for a period of time
and to subsequently release said impulse
transmitter whereupon signal impulses are 100
transmitted, said switching means also
operating to lock said printer at the receiv-
ing station while spacing impulses are trans-
mitted.

In witness whereof, I hereunto subscribe 105
my name this 9th day of July, A. D., 1927.

GEORGE A. LOCKE.