

June 2, 1942.

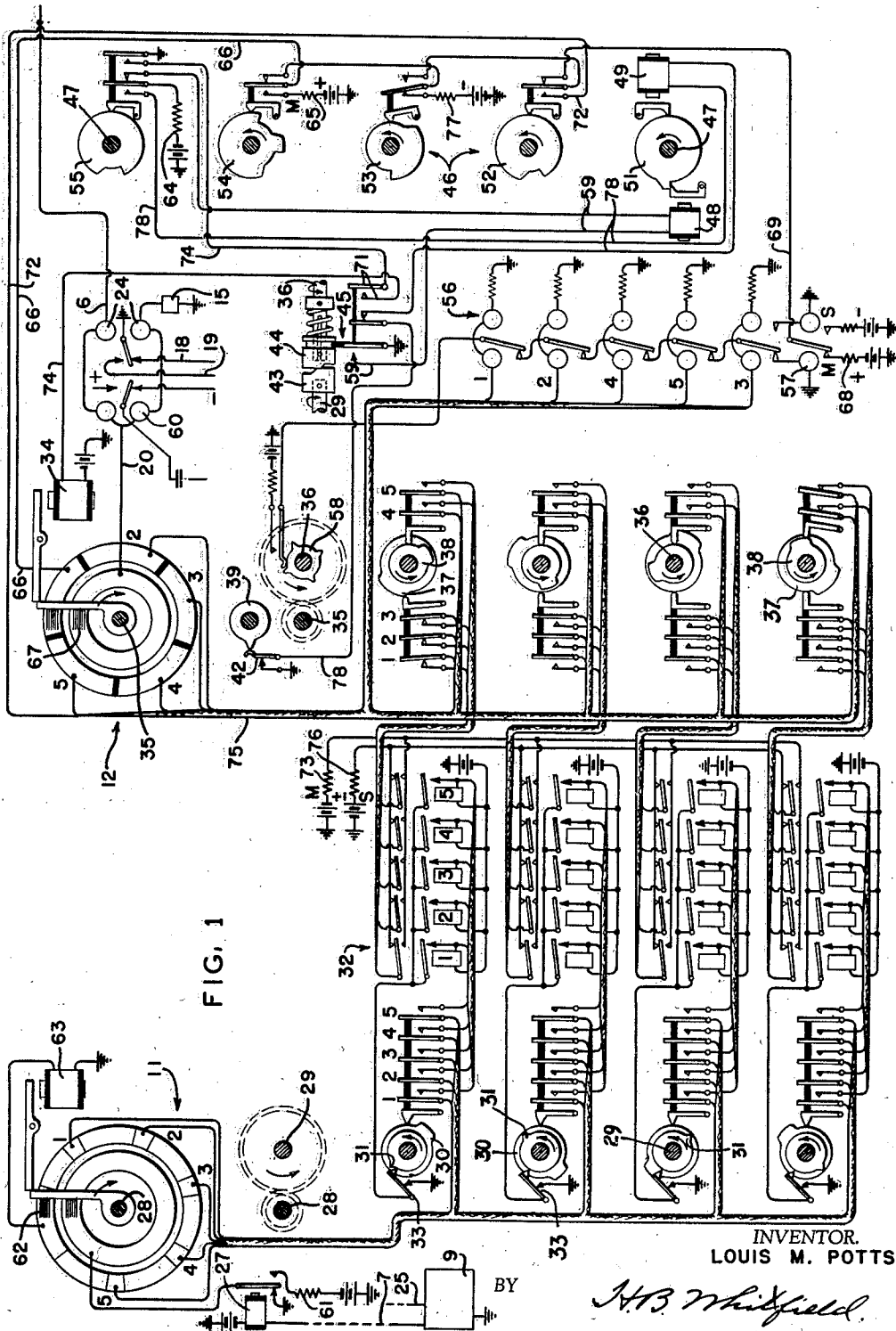
L. M. POTTS

2,284,680

SYNCHRONOUS SIMPLEX TELEGRAPH SYSTEM

Filed Oct. 4, 1937

2 Sheets-Sheet 1



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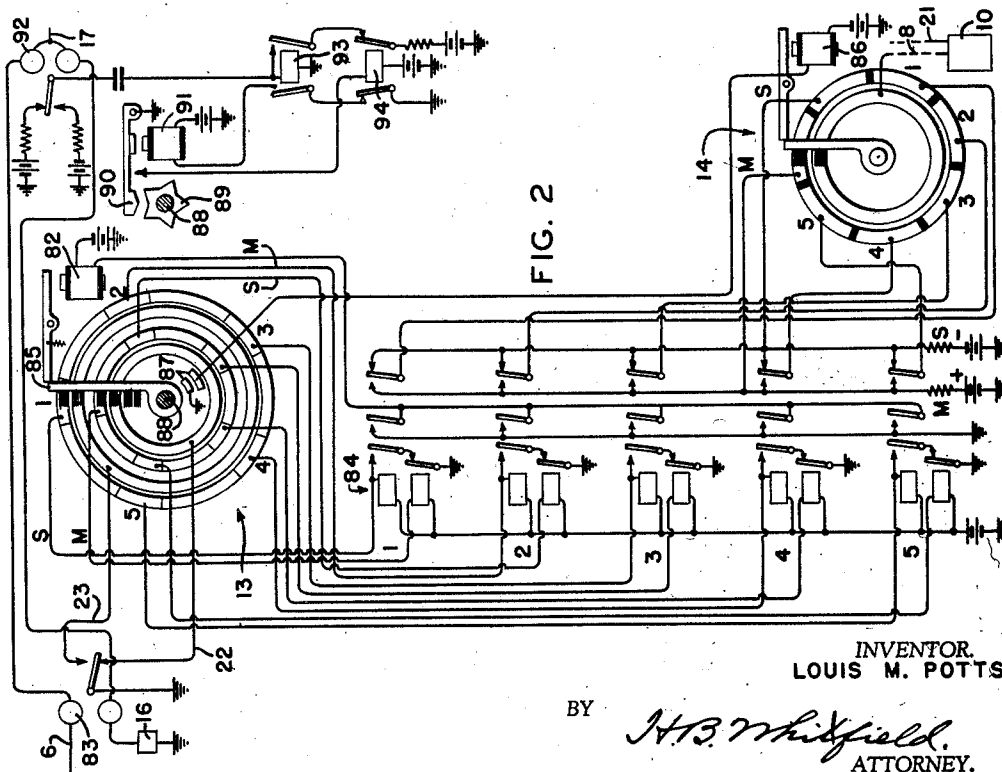
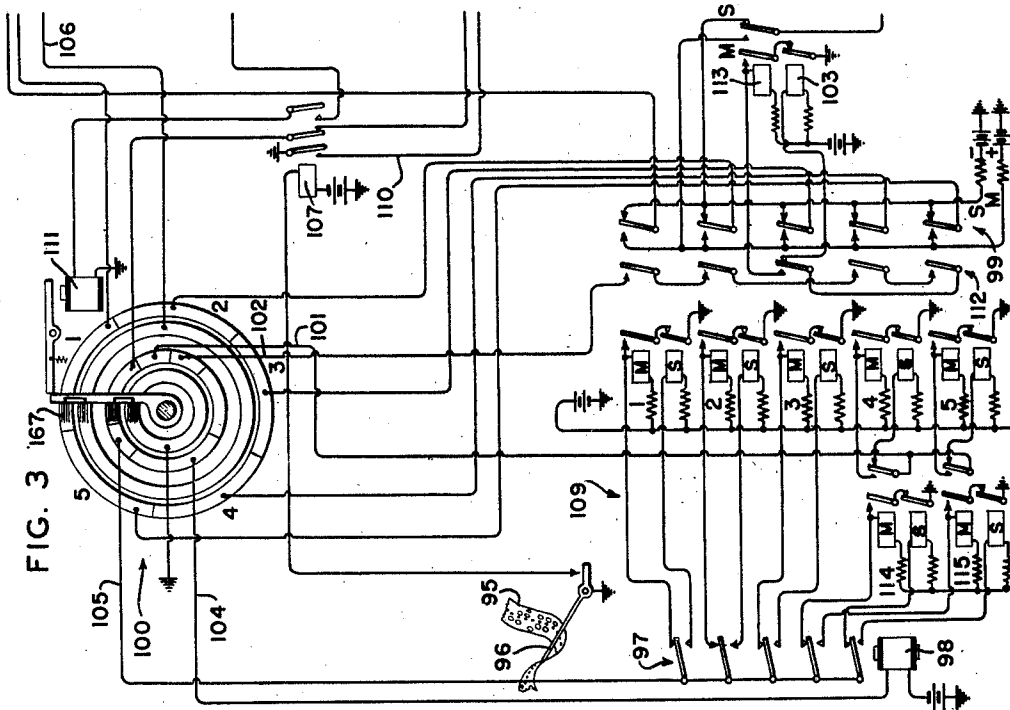
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SYNCHRONOUS SIMPLEX TELEGRAPH SYSTEM

Filed Oct. 4, 1937

2 Sheets-Sheet 2



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## UNITED STATES PATENT OFFICE

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## SYNCHRONOUS SIMPLEX TELEGRAPH SYSTEM

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32 Claims. (Cl. 178—53.1)

This invention pertains to telegraphic systems utilizing permutation code signals of equal length transmitted continuously in uniform time intervals.

An object of the invention is the provision of a telegraph system which is relatively simple, extremely flexible, and capable of operating at high speeds to effect maximum line efficiency at low line frequency.

Another object of the invention is the provision of a telegraph system with start-stop conditions accompanying each character operating in conjunction with a system wherein transmission of signal impulses, which do not include start-stop conditions, ceases under predetermined conditions and is started and continues under other predetermined conditions without further supervisory control for each character code.

A still further object of the invention is the provision of a telegraph system which involves instrumentalities embodying the advantages of both start-stop and synchronous telegraph systems, which are attainable in an extremely simple and inexpensive system.

A feature of the invention is the provision of instrumentalities whereby transmitting and receiving distributors are started initially in phase relation in response to non-character impulses and are thereafter maintained in synchronism in response to character code impulses.

Another feature of the invention is the provision of a transmission system equipped with distributors normally stopped which are started in response to non-character full length code signals and which thereafter are maintained in synchronism by locally generated conditions in response to received character transmission.

Another feature of the invention is provision of means for generating synchronizing or start-stop signals of non-character or non-recording nature preceding and following an indefinite plurality of character-code impulses.

Another feature of the invention is the provision of a transmission system equipped with distributors normally stopped which are started in response to a code signal, and which will be stopped automatically only upon a predetermined cessation in the transmission of character signals.

The above and other objects and features are attained by providing a transmission channel equipped with distributors maintained continuously in synchronism during transmission of intelligence, over which channel a continuous sequence of significant intelligence signal impulses

is propagated without periodic interruption by directing impulses of start-stop nature and with stop-start phasing aperiodically concomitantly with cessation and resumption of transmission of message impulses to be effective upon a single recording receiver.

For a point-to-point transmission from an originating substation to destination substation, the originating substation is connected by a subchannel or local line to a first central station which is connected by a line channel to a second central station which is also connected by a further subchannel or local line to a destination substation. A subchannel transmitter is located at the originating substation, at the first central office a subchannel receiver, a signal storage device, and a line channel transmitter are provided, at the second central office a line channel receiver and a subchannel retransmitter are arranged, and at the destination substation there is provided a final receiver or recorder with its usual start-stop distributor.

Operation of starting the mechanisms of such a system in initially phased relation is accomplished by providing a separate starting mechanism associated with a line channel which connects a line channel transmitter and a line channel receiver, the starting mechanism being set into operation by a received subchannel electrical signal or by a taut-tape switch and operating first over the line channel to start its associated remote line channel receiver and subsequently over local circuits to start its associated adjacent line channel transmitter in phase with the instantly operating remote line channel receiver. Having been started in proper phase relation, the line channel transmitter operates as a controlling synchronizing unit and the line channel receiver operates as a controlled synchronized unit through the medium of any conventional principle of synchronous phasing. Since all transmitted code signals pertain to one message, the speed of transmission is maintained within the capacity of a single recording receiver. Starting of the line channel receiving distributor is effected by the reception of a line channel impulse of marking nature corresponding to a predetermined element of the code, and other impulses of marking or spacing nature according to the instant condition of operation, may be generated in the transmission line channel by the starting means for subsidiary control of the remote apparatus after starting. Subsequent starting of the adjacent transmitter in phase with the remote receiver is effected under control

of the starting mechanism at an instant when the remote receiver has been operating for a time period calculated to position its distributor in a phase relation to the idle transmitter distributor preparatory to the starting of the transmitting distributor. Stopping of the remote receiver is effected in response to a spacing signal in the line channel throughout one code signal time period of the line channel receiver, the starting mechanism being arranged to transmit such a spacing signal in response to cessation of received subchannel signals or in response to control by a taut-tape switch.

Since start and stop signals form no part of the transmitted intelligence of a message between the central stations, it is a requisite that start and stop signals shall not modify any record made by code signals pertaining to the intelligence of the message. Each start or stop signal involves one revolution of a receiving distributor and is applied from the distributor to the selector of the final recorder, hence must be of such nature that the selector will not respond to modify the intelligence recorded or to be recorded. This is produced by transmitting selected code signals to have an effect as start and stop signals, the selected code signals being such that the record of intelligence is not modified thereby. To this end, the natural stop condition or non-transmitting condition of the channel is utilized to produce a "stop" signal in a remote receiver. This condition is that of a continuous spacing signal, which, when applied by a receiving distributor to a recorder, has the effect of a "blank" code signal and is without record in the recorder. In the receiving distributor, the "blank" code signal arrests the distributor member in a predetermined stop position.

For use as starting signals, the two "case shift" code signals have been selected since repetition of a case shift code signal does not change the case shift condition of a receiver. Accordingly, a starting mechanism associated with a line channel transmitter registers automatically the "letters case" or "figures case" nature of each transmitted case shift code and from this registration retransmits the last transmitted case shift code signal as a starting signal.

The invention will be better understood in view of the following detailed description and by reference to the drawings accompanying and forming a part of this description, in which,

Fig. 1 illustrates an originating substation, a subchannel or local line, and a first-central-office equipment arranged to receive a series of start-stop code signals and to retransmit a corresponding series of code signals in accordance with principles of continuously synchronous simplex transmission;

Fig. 2 illustrates a second-central-office equipment associated with a further subchannel and a destination substation; and

Fig. 3 illustrates a tape controlled line channel transmitter arranged to transmit a series of code signals in the manner of continuously synchronous simplex transmission.

In the drawings, like numerals denote identical parts except that numerals 1, 2, 3, 4, 5, and letters M, S, are not labels of identification but are descriptive labels of the numerical position of a structural element in a code signal series of five such elements or respectively describe the marking-signal or spacing-signal nature of a structural element.

### General arrangement of system

Line channel 6, Figs. 1 and 2, represents a synchronous simplex circuit connecting two central offices, which are connected further respectively over local lines or subchannels 7 and 8 to substations 9 and 10 of message origin and destination, respectively. Substation 9, Fig. 1, is equipped with a subchannel transmitter (not shown) operating according to start-stop five unit code signals and connected to transmit over subchannel conductor 7. Destination substation 10, Fig. 2, is equipped with a final recording receiver (not shown) operating in response to start-stop five unit code signals received over subchannel conductor 8. First central office, Fig. 1, is equipped with subchannel distributor 11 and line channel transmitter distributor 12, while the second central office, Fig. 2, is equipped with line channel receiving distributor 13 connected to line channel 6 and subchannel retransmitter 14 connected to subchannel 8.

Duplex transmission over line channel 6 is indicated by the balancing networks 15, Fig. 1, and 16, Fig. 2, and by connections 17, 18, and 19. Connection 17, Fig. 2, corresponds to conductor 20, Fig. 1, and indicates a transmission path from substation 10 over a subchannel conductor 21, Fig. 2, corresponding to conductor 7, Fig. 1, through additional equipment duplicating distributors 11 and 12. Connection 18, Fig. 1, and connection 19, Fig. 1, corresponds to conductor 22, Fig. 2, and to conductor 23, Fig. 2, respectively, to extend a receiving path from contacts of receiving line channel relay 24 through additional equipment duplicating receiving line channel distributor 13 and subchannel retransmitter 14, and thence over subchannel conductor 25 to a final recorder (not shown) in substation 9.

### First central station

Referring to Fig. 1, a start-stop receiving distributor 11 is controlled by a receiving line relay 27 in the circuit of subchannel 7 and has a rotational speed faster than the rotational speed of its controlling subchannel transmitter at substation 9. However, the number of revolutions is the same for transmitter and receiving distributor by virtue of start-stop control. Its start-stop shaft 28 is geared in ratio of one to four to sequence shaft 29 which carries four pairs of cams each pair comprising a cam 30 controlling five normally open pairs of contact members and a companion cam 31. The four cams 30 are set at 90° and are associated with four sets of storage relays 32 comprising five locking relays per set. The companion cam 31 controls one normally closed pair of contacts 33.

A line channel transmitting distributor 12 having five equal segments is provided with a stop magnet 34 and with a slip-clutch driven shaft 35 which rotates continuously during periods of transmission of a plurality of code signals and which is stopped by the armature of magnet 34 only when transmission is to be interrupted. Rotational speed of the subchannel transmitter at originating substation 9 is slightly slower than rotational speed of shaft 35. Shaft 35 is geared in ratio of one to four to a sequence shaft 36 carrying four pairs of cams, the pairs set at 90° and one cam 37 of each pair controlling three pairs of normally open contact members while the companion cam 38 controls two pairs of similar contact members. On the distributor

shaft 35 is a cam 39 which closes a contact pair 42.

The sequence shafts 29 and 36 are mechanically related through a pair of mutually engaging crown cams, cam 43 pinned on shaft 29 and cam 44 splined on shaft 36 and controlling an electrical switch 45.

A starting device 46 comprises a start-stop shaft 47 and stop disk 51 having two stop positions from one of which it is released by magnet 48 and from the other by magnet 49, which shaft carries operating cams 52 to 55 inclusive for controlling contact members.

Associated with the starting device 46 and forming a part thereof is a polarized case-shift register relay 57. A relay set 56 comprising five polar code relays, the sixth polar register relay 57, and contacts operated by a cam 58 on shaft 36 cooperate to register upon relay 57 at all times the nature of the case-shift code signal currently being transmitted or last transmitted by line channel distributor 12. Windings of code relays 56 are connected from segments of distributor 12 to ground and accordingly register by the position of their armatures the signals currently impressed upon the segments of distributor 12. After the brush of distributor 12 has passed segment 5, the relay 56 will register upon its code relays 1 to 5, the full code signal transmitted, and thereafter the cam 58 will close its contacts to apply current to the armatures and contacts of code relays 56. Should a currently transmitted code signal be all marking or letters-shift code signal, all contacts of code relays 56 will be closed as shown and operation of contacts of cam 58 will energize register relay 57 to move its armature into the position shown whereby its armature is connected to battery of marking nature, or should the currently transmitted code signal be marking upon relays 1, 2, 4, and 5 but spacing upon relay 3, then operation of contacts of cam 58 will energize the register relay 57 alternatively to operate its armature to engage the contact connected to spacing battery. Relay 57, being of the polar type, when thus operated retains its adjustment until reversed by current under control of cam 58 in cooperation with a reversing case-shift code signal.

While moving from its normal stop position, as shown, into its off-normal stop position, a rotation of 180°, the starting device 46, by operation of its contacts, transmits to line channel 6 a starting signal equivalent to a case-shift code signal corresponding to that case-shift code signal last transmitted, the code signal being compiled from impulses obtained in part by operation of contacts controlled by cams in the starting device and in part from an impulse through closed contacts of the case-register relay 57.

Immediately after starting of the cam shaft 47 in the starting device 46, cam 54 will permit operation of its contacts under their inherent spring tension to change the signal over line channel 6 from spacing to marking characteristic. The line channel now includes grounded battery of marking nature, resistor 65, operated contacts of cam 54, conductor 66, brush 67 inert, line 20, winding of corrector relay 60, winding of duplexing relay 24, and line channel conductor 6. This condition continues for a time period equal to exactly  $\frac{2}{3}$  revolution of shaft 35 during which time the cam 53 reverses its contacts. The cam 54 then restores its contacts,

changing the circuit of line channel conductor 6 to include grounded marking battery, resistor 68, closed contacts of relay 57, conductor 69, contacts of cams 52, 53, 54, conductor 66, brush 67, conductor 20, windings of relays 60, 24, and line channel 6. This condition of marking or spacing signal nature continues for a time period equal to exactly  $\frac{1}{3}$  revolution of shaft 35, when the cam 54 again operates its contacts to form the noted circuit of resistor 65, further continuing the signal of marking nature if relay 57 is set as shown or restoring the signal to marking if relay 57 is instantly in reversed contactual condition. This further signal of marking nature continues during a time period equal to exactly  $\frac{2}{3}$  revolution of shaft 35 in which period cam 52 reverses its contacts. Cam 54 now restores its contacts, thus completing transmission of a code signal equivalent to one revolution of shaft 35 and brush 67 and constituting at once a starting signal for a remote receiving distributor 13 and a "letter-case" case-shift signal without effect upon the remote recorder at substation 10. Were the case-register relay 57 in its alternative position, the code signal transmitted would have been "figure-case." The line channel 6 now is connected through windings of relays 24 and 60, conductor 20, brush 67, conductor 66, contacts of cam 54 as shown, contacts of cam 53 in reversed position, contacts of cam 52 in reversed position, and conductor 72 which is conductor 1 of a five-conductor cable 75, four of whose conductors serve distributor 12 directly. Conductor 1 and the line channel 6 now are connected through contacts 1 of cam 37 to top armature of relay 1 of storage relays 32 and to marking or spacing resistor 73 or 76 according to the code signal instantly registered in relays 32.

In Fig. 1, all parts are shown in starting condition in readiness to respond to a message to be originated in subchannel 7 to control the receiving relay 27. A "holding" signal or "stop" signal of marking nature is continuously impressed upon subchannel 7 and a "holding" signal of spacing nature is continuously impressed upon line channel 6.

When beginning operation, an operator at substation 9, operating in accordance with general custom, will transmit a "letter shift" code signal to insure that the remote responsive recorder is in known case condition, and will follow this shift code signal with character code signals.

Upon receipt of a starting impulse of spacing nature from subchannel 7, the line relay 27 reverses its armature to energize the starting magnet 63 of receiving subchannel distributor 11 over a circuit including grounded battery, resistor 61, contacts of relay 27, brush 62, and starting magnet 63 to ground, thus releasing shaft 28 to be driven by its motor and to drive shaft 29 and its cams 30, 31, and 43. Cam 31 opens momentarily the locking circuits of the top set of signal storage relays 32 then cam 30 connects all operating windings of the top set of storage relays to code signal segments in distributor 11 and the first received code signal; namely, a "letters shift" or all-marking code signal, will be registered in the relays 32 which operate and lock in response to signal impulses of marking nature under the control of contact 33. Moving cam 43 now moves its higher crown face away from the higher crown face of motionless cam 44 thus permitting cam 44 to slide on shaft 36, by the action of its spring, reversing

contactual relations in switch 45 to initiate rotation of shaft 47 by closing a circuit including grounded battery, resistor 64, normally closed contact of cam 55, conductor 59, starting magnet 48, an extension of conductor 59, and contacts of operated switch 45 to ground, to energize magnet 48 and thus to release shaft 47 which immediately starts by motor power applied through a friction clutch. The starting device 46 rotates through 180° and is stopped by engagement of cam 51 with the armature of magnet 49. During this half-revolution, the cam 54, cooperating with closed contacts of relay 57, as described in detail above, has transmitted either "letters-case" or "figures-case" shift code signal according to the position of the armature of relay 57 as adjusted in its last occasion of use.

As the contacts of cams 52 to 54 conclude their operations, the line channel 6 is connected through windings of relays 24 and 50, conductor 20, brush 67, conductor 66, closed normal contacts of cam 54, closed reversed contacts of cam 53, closed reversed contacts of cam 52, conductor 72, conductor 1 in cable 75, closed contacts 1 of cam 37, top armature of energized relay 1 of relays 32 and to marking battery 73, since "all marking" is registered in the top set of relays 32.

At the time that contacts of cam 54 conclude the cycle of their operations, cam 55 operates its contacts and forms a starting circuit for distributor 12 including grounded battery, starting magnet 34, conductor 74, closed contacts 71 of switch 45, an extension conductor 74, and closed contacts of cam 55 to ground. Shaft 47 now stops subject to control by magnet 49, while magnet 34 remains energized subject to control by contacts 71.

Thereafter shaft 47 remains inert, while shafts 28 and 35 rotate at different speeds with shaft 35 slightly faster and with the crown face of cam 44 approaching the crown face of cam 43.

In continuous cyclic operation, each energization of starting magnet 63 permits a revolution of shaft 28 and a quarter revolution of shaft 29. In the initial angle of movement of shaft 29, a cam 31 opens momentarily all holding circuits of an associated set of five storage relays 32, and a cam 30 then operates contacts to connect all operating windings of the set of relays 32 to receiving segments of distributor 11. In successive quarters of rotation of shaft 29, four such pairs of cams and sets of relays in the storage device 32 are used in turn. Energized relays of sets 32 connect marking potential to corresponding contact members controlled by cams on shaft 36 while unenergized relays in device 32 connect spacing potential similarly.

Distributor 12 in continuous cyclic operation transmits to line channel 6 all signaling potentials impressed upon its segments, the sequence of signals being controlled by shaft 36 and cams 37 and 38. With brush 67 at zero angle as shown, a cam 37 operates contacts to connect segments 1, 2, and 3 to contacts of corresponding storage relays in storage device 32 and to marking and spacing batteries through resistors 73 and 76, when brush 67 has passed segment 3, cam 38 connects segments 4 and 5 similarly, and when brush 67 has passed segment 5, a succeeding cam 37 connects segments 1, 2, and 3 to contacts of storage relays of a succeeding set 32.

Every transmitted code signal is impressed upon the five code relays of set 56 and relay 57 is operated whenever the instantly transmitted

code is a case-shift code signal differing in its No. 3 impulse from the No. 3 impulse of the last prior case-shift code signal.

When transmission over subchannel 7 stops and accordingly shafts 28 and 29 stop, distributor 12 continues retransmission thus exhausting the signals stored in storage relays 32 and bringing cams 43 and 44 into the angular relation shown in the drawings. The same result is attained if cam 44 overtakes cam 43 while transmission over subchannel 7 is in progress. Cam 44 operates to reverse the switch 45 at a median instant in the last code signal of retransmission of stored code signals, deenergizing magnet 34 by opening contacts 71. Just before completion of retransmission of all received code signals stored in relays 32, cam contacts 42 close a circuit including grounded battery, resistor 64, operated contacts of cam 55 at 180°, conductor 78, starting magnet 49, an extension of conductor 78, contacts in switch 45, a further extension of conductor 78, and cam contacts 42 to ground, thus energizing magnet 49 to release cam shaft 47 for its second half-revolution.

Immediately upon starting of shaft 47 from this position, a cam 53 operates its contact, the noted "just before completion" closing of contacts 42 being adjusted to start shaft 47 in such phase relation to brush 67 that the contacts of cam 53 operate at about the time that brush 67 leaves segment 5 of distributor 12. Also immediately after starting of shaft 47, cam 55 restores its contacts, and cam 52 restores its contacts. Shaft 47 stops when cam 51 engages the armature of magnet 48. Cam 53 retains its contacts in operated condition and all equipment illustrated in Fig. 1 is in state of beginning, and with the nature of the last transmitted case-shift code signal registered in relay 57 by virtue of position of its armature.

When brush 67 engages segment 1 and stops under control of deenergized magnet 34, a line signal of spacing nature will be impressed upon line channel 6 over a circuit including grounded battery of spacing nature, resistor 77, contacts of cam 53, as shown, normally closed contacts of cam 54, conductor 66, brush 67, conductor 20, windings of relays 60 and 24, and line channel 6.

In the above traversal of operation, all apparatus illustrated in Fig. 1 has been traced through a cycle of operation of the starting-control device 46 and has been returned into its condition of inactivity shown.

#### Compensation

To insure that line channel transmitter 12 shall retransmit all code signals registered in relays 32 by subchannel receiving distributor 11 without permitting an accumulation of stored code signals beyond the capacity of relays 32, rotational speed of shaft 35 is adjusted to be faster than rotational speed of the remote subchannel transmitter (not shown) at substation 9. Accordingly, when both shafts 29 and 36 are operating, cam 44 will have creeping gain upon cam 43, resulting in restoration of switch 45 into position shown to stop rotation of shaft 35 by opening contacts 71 and deenergizing magnet 34, and to initiate rotation of shaft 47 in device 46 as described above. Cam 44 stops and shaft 47 starts at 180° from the position shown. Cam 43 continues and reoperates switch 45 to close its contact 59 so that when shaft 47 is rotated a further 180° into the position shown it will continue without pause because magnet 48 will be ener-

gized by a circuit through resistor 64, contacts of cam 55, winding of magnet 48, and contact 59. In the first half of this revolution of shaft 47, contacts of cam 53 will transmit to line channel 6 a continuous signal of spacing nature to stop the remote line channel receiving distributor 13, and in the second half of the revolution, contacts of cam 54 will transmit to line channel 6 a code signal for case shift to restart the distributor 13. During the stop period thus effected for shaft 35, two or three code signals may have been stored in relays 32 due to rotation of distributor 11 thus compensating for difference in speeds of shafts 28 and 35.

In case of transmission into subchannel 7 directly from a keyboard transmitter at substation 9, irregular operation of the keyboard at 9 will cause the stop impulses in subchannel 7 to have variant time values. This will cause irregular rotation of cam 43 but the irregularity will be absorbed in an increase of the creeping gain by cam 44 upon cam 43 as described above and the effect of irregular operation of a keyboard at substation 9 will have no effect further than to make more frequent the overtaking of cam 43 by cam 44 to operate switch 45. At each such overtaking, a correction or rephasing of the two lines channel distributors 12 and 13 is effected by stopping and restarting as described above under the caption "Compensation."

#### Second central station

Referring to Fig. 2, a translating receiver is illustrated responsive to code signals from line channel 6, as transmitted to that line conductor by the mechanisms of Fig. 1. Local line or subchannel 8 extends to a start-stop five unit recording receiver either immediately adjacent or in substation 10 at the distal end of subchannel 8.

Receiving distributor 13 has a control magnet 82 which is continuously energized while distributor 13 is operating to receive signals and under such conditions the distributor operates in continuous synchronism with its received signaling impulses. Between periods of code-signal reception, the control mechanism becomes effective and the brushes of the distributor are held stopped in the position shown.

The receiving distributor cooperates with contacts in receiving line relay 83 and distributes all received signal impulses to five pairs of storage relays 84, in each pair of which the upper relay responds to a signal impulse of marking nature and forms its own holding circuit through contacts of its companion lower relay, and the lower relay responds to a subsequent received signal impulse of spacing nature to deenergize the upper relay. All upper relays 84 have contacts in parallel to energize start magnet 82 and each upper relay has a tongue plying between contacts of spacing and marking potentials and connected to a code-signal segment in a start-stop subchannel retransmitting distributor 14 whose starting magnet 86 is controlled by contacts 87 in distributor 13.

Synchronism of distributor 13 is secured by attaching fixedly upon its brush shaft 88, friction driven at approximately correct speed, a star wheel 89 which is engaged and controlled by a correcting member 90 carried by the armature of a synchronizing magnet 91. A synchronizing line relay 92 delivers an impulse of current through a condenser to a synchronizing local relay 93 at each and every reversal of the signal current in the line conductor 6 whether from

marking to spacing nature or reverse. Relay 93 closes its holding circuit through contacts of a release relay 94 and also closes an energizing circuit for the correcting magnet 91 whose armature operates to correct the angular position of the shaft 88 and also to close a contact to energize relay 94 whose operation results in deenergizing relay 93 and in turn deenergizing the magnet 91.

In operation, the distributor 13 is started in response to an initial signal of marking nature received over line channel 6. The initial impulse of starting signal energizes an upper registering relay 84 according to the stop position of the brush arm 85 thus energizing magnet 82 and starting the distributor 13 which, by its rotation and under control of the remaining portions of the starting signal, may energize further storage relays. As the brushes of distributor 13 pass segment No. 3, the contacts 87 are closed momentarily to energize magnet 86 and to start the distributor 14 which then repeats the received starting case-shift code signal into subchannel 8 in start-stop manner. Subsequent code signals received by line relay 83 are distributed to registering relays 84 and as each such code signal contains at least one signal impulse of marking nature, there will be at least one registering relay energized at the time that the brushes of distributor 13 leave segment No. 5 and resultantly the distributor 13 will not be arrested between code signal cycles and will rotate continuously until a definite and predetermined stop code signal is received.

The predetermined stop signal comprises an extended signal interval of spacing nature received over line channel 6, the signal being effectively the equivalent of five or more successive spacing impulses. Such a signal obviously will energize successively the five lower relays of the five pairs in the storage set 84, releasing all holding circuits of the five upper relays and resultantly deenergizing magnet 82 to stop the distributor 13 thus restoring all apparatus illustrated in Fig. 2 to the condition shown.

#### Tape-controlled transmission

Referring to Fig. 3, there is illustrated a structure for transmission upon conductor 106 corresponding to conductor 20, Fig. 1, of signals equivalent to signals described in connection with Fig. 1, but generated locally under control of a perforated tape, which may be prepared by a keyboard perforator or a reperforator by signals impressed on an interconnecting line conductor.

A starting control device as 46, but not shown, is controlled to start and stop by a tape relay 107 and in turn controls the starting and stopping of a transmitting distributor 100 which transmits signals to conductor 106 in accordance with the setting of armatures 99 of storage relays 1 to 5 in relay set 109. A tape 95 passes a tape follower arm 96 to a tape sensor 97, which may be as illustrated in Patent No. 1,298,440 granted to G. R. Benjamin. A stepping magnet 98 controls contacts of the tape sensor which are connected to relays 1, 2, 3, 114, 115 of relay set 109 and the registrations of relays 114 and 115 are transferred to relays 4 and 5 to control signals to be transmitted by distributor 100.

In operation, provision of a supply of perforated tape for slackness causes movement of tape arm 96 and energization of relay 107 over an obvious circuit. Relay 107 closes a circuit 110 to initiate rotation of a starting device as

46 (not shown) which transmits a starting code upon conductor 106 and then energizes magnet 111 to start the distributor 100. A first code signal has been set upon relays 109 by preliminary adjustment of tape 95 in senser 97 and distributor 100 now transmits signals to conductor 106 in accordance with contact setting of storage relays 1M, 2M, and 3M.

Concurrently with transmission of first half of signal impulse No. 2, the distributor 100 completes a circuit over conductors 101, through closed contacts of relays 114M and 115M and windings of associated relays 4M, 4S, 5M, and 5S for transference to relays 4M and 5M of signals stored in relays 114M and 115M respectively, thus completing upon relays 1 to 5 a registration of that code signal currently sensed by the senser 97, and concurrently with transmission of second half of signal impulse No. 2, the distributor 100 completes a circuit, if a case-shift code signal is being transmitted, including ground, a distributor segment, conductor 102, through series contacts 112 of relays 1 to 5 of set 109, thence either through winding of case-shift register relay 113 to energize relay 113, if a letter-case code signal is being transmitted with relay 3M energized, or through winding of relay 103 to operate relay 103 and deenergize relay 113 if a figure-case code signal is being transmitted with relay 3M deenergized.

Concurrently with transmission of signal impulse No. 4, distributor 100 energizes magnet 98 over a circuit including conductor 104, thereby withdrawing the sensing pins from tape 95 and stepping the tape. Upon interruption of the circuit of conductor 104, magnet 98 releases the sensing pins to rise through or against tape 95. Concurrently with transmission of last half of signal impulse No. 5, distributor 100 connects ground to conductor 105. Where a sensing pin rises through the tape, ground connection is extended from conductor 105, through an M relay to battery, energizing the M or marking relay of a storage pair of relays, the energized M relay then forming its holding circuit through contacts of its associated S relay. When a sensing pin rises only to the surface of tape 95, ground connection is extended from conductor 105, through an S relay which, when energized, acts to deenergize its associated M relay. In this manner, the code signal currently sensed in tape 95 is registered in storage relays 1, 2, 3, 114, 115 and no change is made as yet in relays 4 and 5 whose contacts are currently effective in transmitting a preceding code signal.

To stop transmission, taut tape lifts arm 96 or arm 95 is manually lifted, deenergizing relay 107 resulting as described for equivalent operation of switch 45, Fig. 1.

The present invention, having been described specifically herein, will be more broadly considered in the appended claims without limitation to the specific embodiments used above for illustration.

What is claimed is:

1. In a telegraph system, a transmitter, a distant receiver, a signal storage device intermediate said transmitter and said distant receiver, means to store a plurality of code signal combinations in said device, means to transmit the stored signal combinations in the order stored, means to transmit a code signal combination for stopping the distant receiver when all stored signal combinations have been transmitted, and means to transmit a different code signal com-

bination to start the distant receiver when additional signals are stored.

2. The method of operating printing telegraph systems which comprises the steps of, transmitting code signal combinations of a message each accompanied by a start and a stop impulse, storing the character code parts of the signal combinations, and subsequently transmitting according to the stored signals other code signals in which the first element of one character signal of the message immediately follows the last element of a preceding character signal of the message.

3. In a telegraph receiving device, a rotary receiving element, signal controlled means effective at the beginning of transmission to start the rotary element in a predetermined phase of rotation with respect to the transmitted signals, and means effective during transmission to maintain the correct phase of rotation controlled by the reversal of the current between successive elements of the code signals.

4. In a telegraph system, a rotary receiving element, a signaling circuit, means to transmit code signals on the circuit, means controlled over the circuit to start the rotary element into rotation at substantially uniform speed and in a selected phase position with respect to the transmitted code signals, and means controlled by the reversals of current in the code signals subsequently effective to maintain the selected phase relation.

5. In a telegraph transmitter, means to maintain a continuous record indicating which one of a plurality of selected signals was last transmitted, and means to transmit a special full code control signal varied according to the record.

6. In a telegraph system, means to transmit code signals, means to transmit start and stop signals, means to operate the second transmitting means preceding a single code signal or the first of a plurality of code signals, and means to operate the second transmitting means after a single code signal has been transmitted or after a group of code signals have been transmitted.

7. In a telegraph system, means to transmit character code signals, means to transmit predetermined code signals to serve as start signals, and means for initiating the operation of said last mentioned means preceding the first only of a plurality of character code signal transmitting operations of said first mentioned transmitting means.

8. In a telegraph system, a receiving device, means to operate the receiving device continuously in the manner of a synchronous telegraph during continuous message transmission, and means to operate the receiving device in the manner of a start-stop telegraph during intermittent message transmission.

9. In a telegraph system, a signal distributing device, means to operate the device continuously in synchronism with received signals, and means operable upon the cessation of signals to stop the device in predetermined position.

10. In a telegraph receiving device, two magnets, means to start the device into operation in correct phase position with respect to received signals under control of one magnet, and means to maintain the correct phase condition under the control of the other magnet.

11. In a telegraph system, means to transmit permutation code signals, a signal distributing receiving device, means to maintain the receiving device in continuous rotation when at least

one impulse element in each cycle of operation is of marking nature, and means to arrest its rotation when all impulses in a cycle are of spacing nature.

12. In a telegraph system, a receiving device, means to rotate the receiving device with uniform motion approximately in synchronism with the received signal, a correcting circuit, means controlled by the signal to condition the correcting circuit and correct the synchronism, and means controlled by the signal to start and stop the rotation according to the rate of reception of signals.

13. In a telegraph system, a line channel, two permutation code signal-transmitting devices connected to said line channel, recording means connected to said line channel responsive to permutation code signals received over said line channel from one of said signal-transmitting devices, and phasing means for phasing said recording means operable over said line channel responsive to the other of said permutation code signal-transmitting devices.

14. The method of operating printing telegraph systems including a transmitting distributor and a receiving distributor which comprises the steps, starting a receiving distributor, and starting subsequently a transmitting distributor in phase with said receiving distributor.

15. The method of phasing printing telegraph apparatus including a transmitting distributor and a receiving distributor which comprises the steps, stopping a receiving distributor by control over a transmission channel, stopping the transmitting distributor, subsequently restarting the receiving distributor by control over the transmission channel, and subsequently restarting the transmitting distributor in phase with the receiving distributor.

16. In a printing telegraph system, a transmitting distributor and a remote receiving distributor, transmitter means supplemental to said transmitting distributor for starting said remote receiving distributor, and means controlled by said last mentioned means for subsequently starting said transmitting distributor in phase with said remote receiving distributor.

17. In a printing telegraph system, a transmitter, a receiving recorder, a connecting line, means in said receiving recorder responsive to cessation of signaling for stopping said receiving recorder, means in said receiving recorder responsive to receipt of a code combination for case shift to restart said receiving recorder, means in said transmitter for transmitting over said line as a starting signal to said recorder a repetition of that code combination for case shift last transmitted, and means in said transmitter for registering an identification of that case shift code combination last transmitted.

18. In a telegraph system, transmitting means to transmit a sequence of code signals including letter-case shift code signal and figure-case shift code signal, registering means responsive to transmission of either one of said shift code signals to register the letter-case or figure-case nature of the transmitted code signal, and further transmitting means operable to control said first mentioned transmitting means to start and operating to transmit a shift code signal according to registration in said registering means.

19. In a telegraph system, a line channel, means for transmitting over said line channel an indefinite plurality of character-code combinations of recording nature, and means for

transmitting starting and stopping signal impulses of non-recording nature additional to said plurality of character-code combinations and preceding and following respectively said plurality of character-code combinations.

20. In a telegraph system, first means for receiving a "blank" code signal composed wholly of signal impulses of spacing nature, and second means responsive to said first means upon receipt of a "blank" code signal and operative to render said first means unresponsive to an ensuing received signal of spacing nature.

21. In a telegraph system, first means to retransmit continuously a plurality of received code signals of recording nature, and second means to transmit signals of non-recording nature, said second means responsive to an interruption in receipt of said code signals of recording nature and operative to transmit a signal of non-recording nature prior to beginning of retransmission by said first means.

22. In a telegraph system, a signal storing receiver, a transmitting device operable continuously when signals are in storage to transmit the signals more rapidly than they are placed in storage in said receiver, a receiving device in signal receiving relation to said transmitting device and operable continuously when said transmitting device is operating, and means controlled jointly by said signal storing receiver and said transmitting device and operable when said transmitting device overtakes said signal storing receiver for arresting said transmitting device and said receiving device and for restarting them in predetermined phase relation after an interval.

23. In a telegraph system, a signal storing receiver, a signal transferring device, a signal transmitting device including code segments, certain of which have direct connection to said signal transferring device and another of which has indirect connection to said signal transferring device, a supplementary transmitting device operable in said indirect connection to impress upon said other segment signals originating under predetermined conditions in said supplementary transmitting device, a telegraph line connected to said first mentioned signal transmitting device, and a telegraph receiving device connected to said telegraph line at the opposite end thereof.

24. In a telegraph system, means for transmitting a succession of code signals in which the first impulse of one signal immediately follows the last impulse of the preceding signal, and means operable following an interval in which no signals have been transmitted for invariably transmitting a first signal having predetermined characteristics.

25. In a telegraph system, means for transmitting a succession of code signals in which the first impulse of one signal immediately follows the last impulse of the preceding signal, and means operable upon interruption of a succession of code signals for invariably transmitting a signal having a predetermined characteristic to denote cessation of transmission.

26. In a telegraph system, means for storing code signals, means for transmitting code signals under the control of stored signals in which the first impulse of one signal immediately follows the last impulse of the preceding signal, and means operable in response to a depletion of stored signals for transmitting a special signal to denote cessation of transmission.

27. In a telegraph system, means for storing code signals, means for transmitting code signals under the control of stored signals in which the first impulse of one signal immediately follows the last impulse of the preceding signal, means operable in response to a depletion of stored signals for transmitting a special signal to denote cessation of transmission, and means operable in response to a condition of renewed storage of signals for transmitting a special signal to denote resumption of transmission.

28. In a telegraph system, means for storing signals, means for transmitting signals predicated upon signals stored in said storing means, and means controlled by the initial storage of signals in said storing means for transmitting a special signal independent of the storage of signals of particular characteristics.

29. In a telegraph system, means for storing a plurality of signals to be transmitted, means for transmitting said signals in succession, means for initiating the operation of said transmitting means, and additional transmitting means for transmitting in advance of the first only of a succession of signals a special signal to denote initiation of transmission.

30. In a telegraph system, means for storing a plurality of signals to be transmitted, means for transmitting said signals in succession, means controlled by said storing means for initiating

the operation of said transmitting means, and additional transmitting means for transmitting in advance of the first only of a succession of signals a signal to denote initiation of transmission.

31. In a telegraph system, means for storing a plurality of signals to be transmitted, means for transmitting said signals in succession, receiving means connected to said transmitting means to be controlled thereby, means for transmitting to said receiving means a start signal in advance of the first only of a succession of signals, and means controlled by said storing means for setting in operation said start signal transmitting means.

32. In a printing telegraph system, a transmitting station having a principal transmitting instrumentality and a supplemental transmitting instrumentality, a remote receiving station having a receiving instrumentality responsive to a signal received from said supplemental transmitting instrumentality, means to effect the operation of the principal transmitting instrumentality subsequent to the response of said receiving instrumentality, and means responsive to character code impulses to operate said principal transmitting instrumentality and said receiving instrumentality thereafter in synchronism.

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