

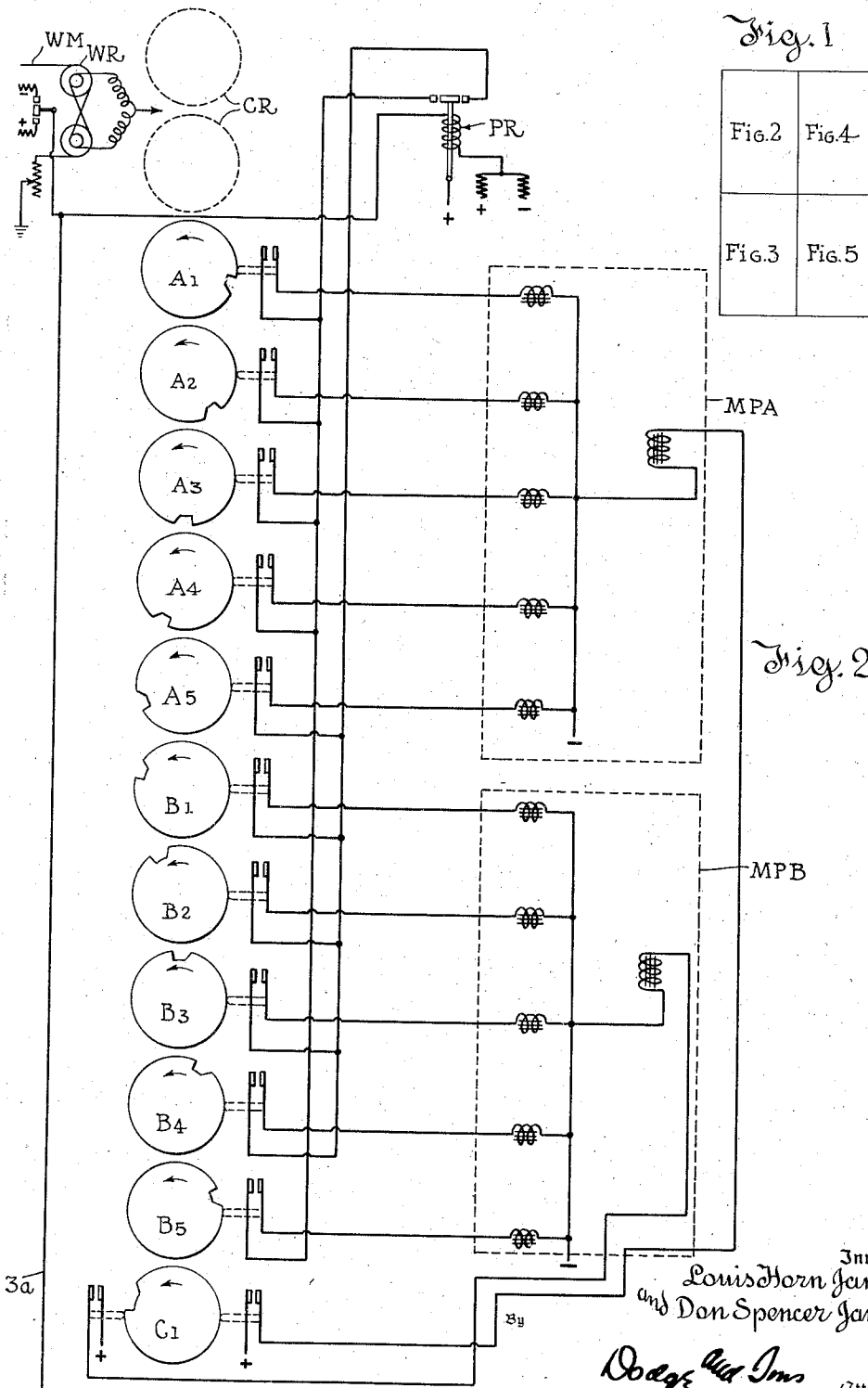
Nov. 1, 1938.

L. H. JAMES ET AL
PRINTING TELEGRAPH

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Filed April 6, 1938

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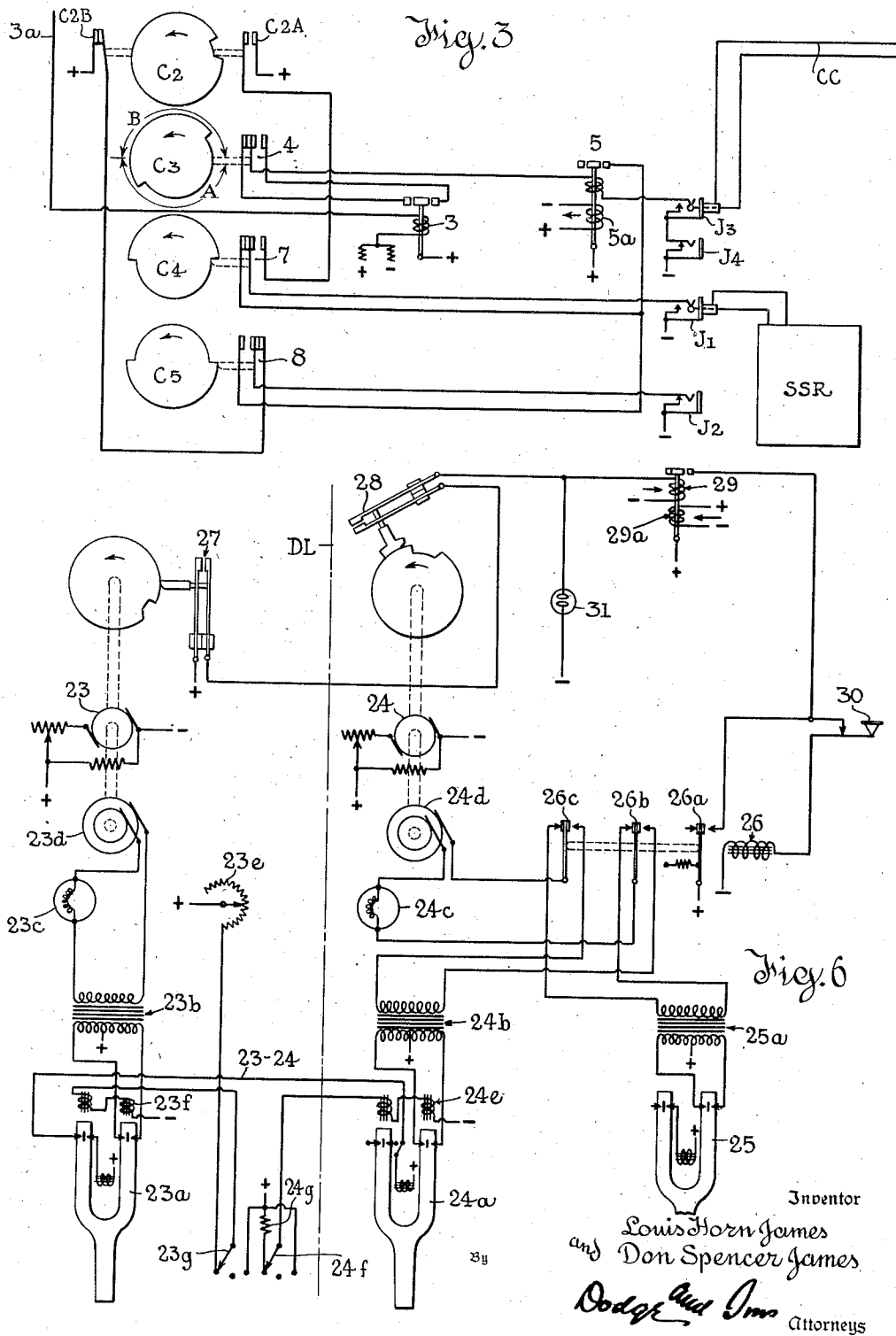
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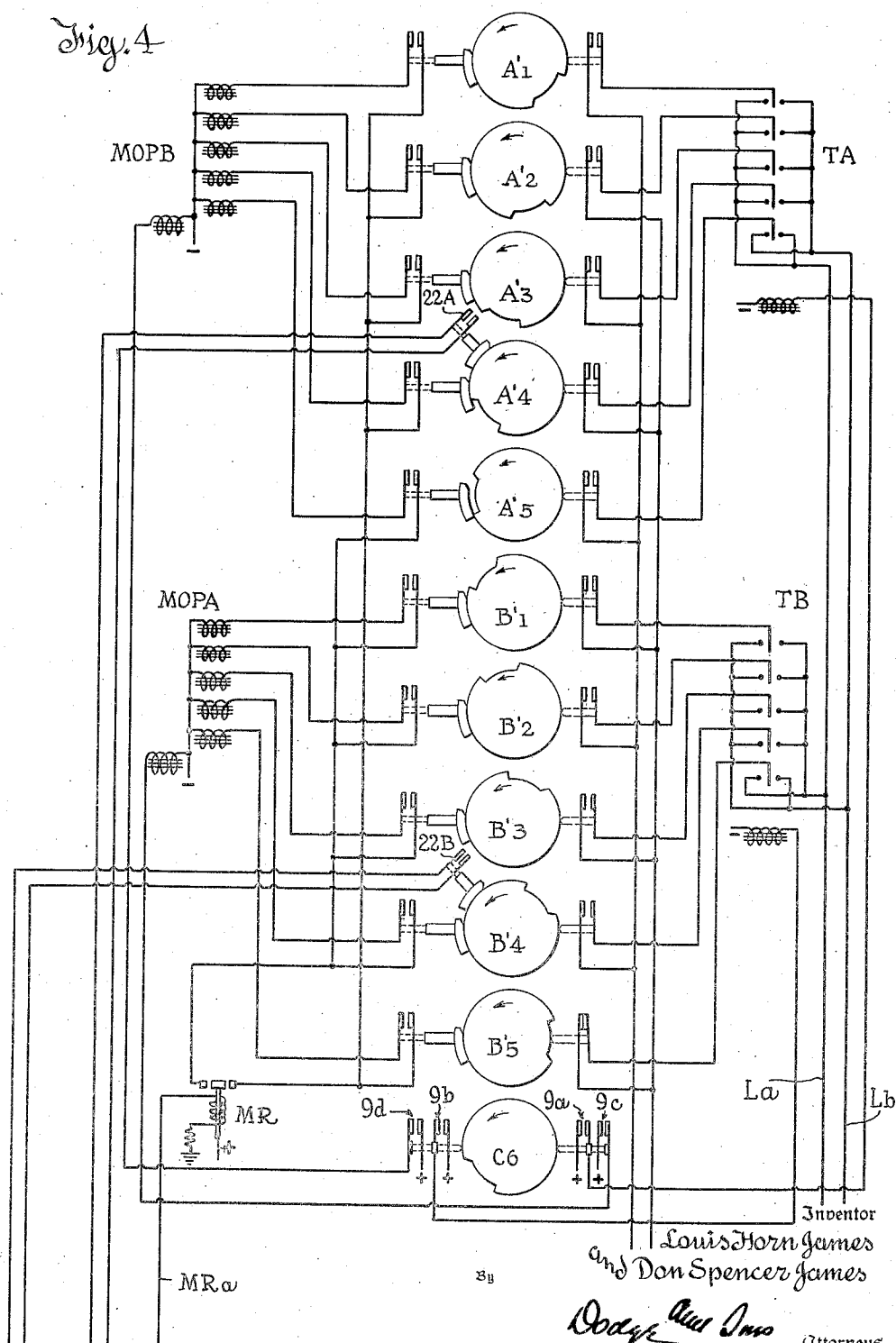
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Fig. 4



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Nov. 1, 1938.

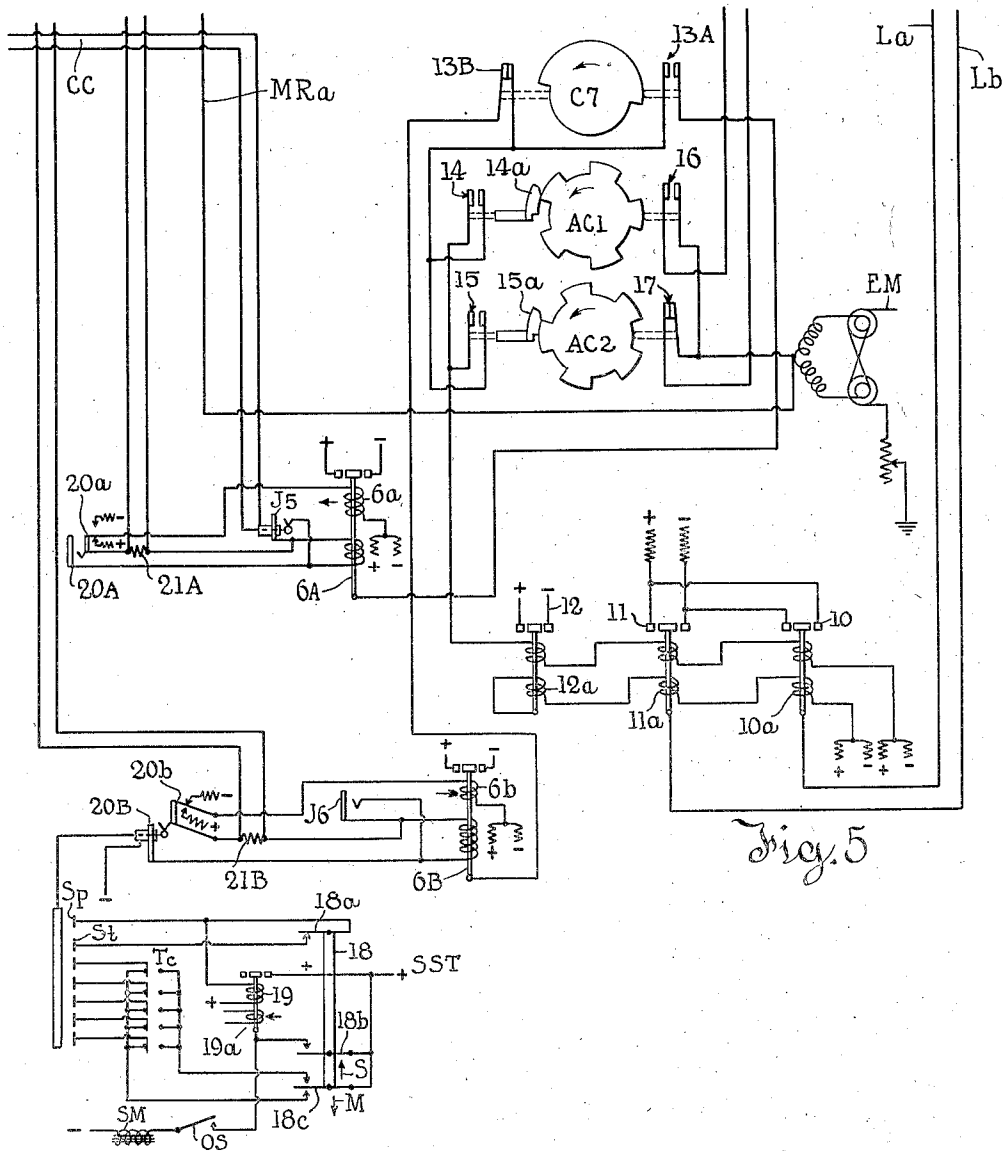
L. H. JAMES ET AL

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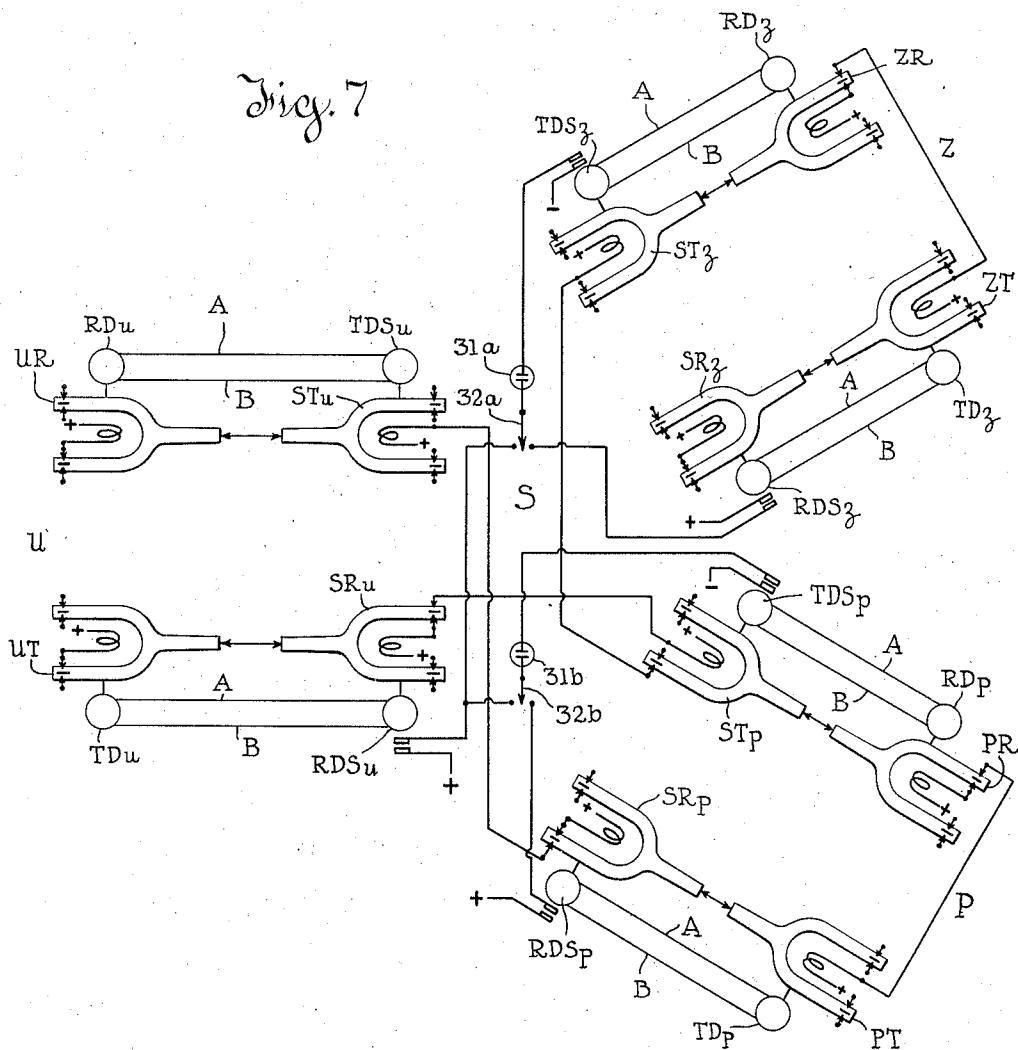
L. H. JAMES ET AL

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Filed April 6, 1938

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2,135,398

PRINTING TELEGRAPH

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Application April 6, 1938, Serial No. 200,540

30 Claims. (Cl. 178—52)

This invention relates to printing telegraph systems, and in particular to arrangements for repeating or relaying signals from one multiplex system to another or from a multiplex system to a start-stop system and vice versa, and without the necessity for manual operation in the relaying process.

In existing printing telegraph systems where two independent multiplex systems terminate in a common station, and it is desired to relay a message from one system onto the other, it is now common practice to receive the message on the incoming system, perforate a tape according to the received message, and then run the tape through a tape transmitter on the outgoing system. This necessitates considerable delay in transmission of the message and also involves manual control of the apparatus. Generally, the same operations are required to relay a message from a start-stop circuit onto a multiplex system or vice versa.

The present invention is particularly concerned with multiplex systems of the "Morkrum" type now in common use and in which the signal combinations consists of five-unit impulses varying in polarity according to the character being transmitted, and in which the idle signals are formed of four impulses of one polarity and a fifth impulse of opposite polarity. The invention is not limited to systems employing this particular type of idle signal but may be adapted for idle signals of a different combination of positive and negative impulses. The start-stop systems involved in the present invention are of the type employing a normally closed transmission circuit and in which the circuit is opened to start the receiving printer in operation, and thereafter the circuit is closed for marking impulses and opened for spacing impulses.

An object of the invention is to devise an arrangement whereby the signals received on a multiplex system will directly control the circuit of an outgoing start-stop system.

A further object is to provide relaying means by which signals received on an incoming multiplex system may directly control the transmitting apparatus on an outgoing multiplex system and in which the incoming signal is re-formed or regenerated in the relaying process.

Another object is to devise arrangements for directly relaying the message from a start-stop circuit onto an outgoing multiplex system.

Still another object is to devise arrangements for maintaining two independent multiplex systems in synchronous operation and to secure

proper phasing adjustment between the distributors on the two systems.

A further object is to provide monitor printers at the multiplex relay or central station whereby all messages transmitted out of the station over a multiplex system may be supervised and whereby copies of all messages relayed over the multiplex system or transmitted therefrom may be retained at the station.

A further object is to devise an arrangement whereby the signals received on a multiplex system will operate the local printer and directly control the circuits of an outgoing start-stop system and an outgoing multiplex system simultaneously.

It is a further object of the present invention to carry out the foregoing objects by simple changes or additions to existing apparatus now in common use in multiplex systems of the "Morkrum" type and in start-stop systems now in common use.

Fig. 1 of the drawings shows the relation between the four sheets containing Figs. 2, 3, 4 and 5 which constitute a schematic circuit diagram of a system according to the invention for repeating from one multiplex system to another or for repeating from one multiplex system to a start-stop system and vice versa;

Fig. 2 is a circuit diagram showing part of the apparatus located at a central office and associated with a west multiplex system WM;

Fig. 3 shows the remaining apparatus located at the central station and associated with the system WM, and also illustrating a start-stop receiver SSR located at a distant substation;

Fig. 4 shows part of the apparatus located at the central station and associated with an east multiplex system terminating in the station;

Fig. 5 shows the remaining apparatus located at the central station and associated with the east multiplex system EM, and also illustrating a start-stop transmitter SST located at a distant substation;

Fig. 6 is a schematic circuit diagram illustrating the arrangement for synchronizing two multiplex systems and for securing proper phasing between distributors of the two systems;

Fig. 7 is a schematic circuit diagram illustrating how the various channels on three multiplex systems may be interlocked and maintained in synchronism for repeating messages from one system to another.

Referring to Fig. 2 of the drawings, the incoming line from the west multiplex system WM terminates in the central station and operates

receiving relay WR which in turn controls the multiplex printer relay PR which controls circuits of the printer magnets in two multiplex printers represented in the dotted rectangles MPA and MPB. The circuits of the printer magnets of printer MPA in the A channel are controlled by the distributor switches operated by multiplex distributor cams A1 to A5 inclusive, and the circuits for the selecting magnets of printer MPB in the B channel are controlled by switches operated by distributor cams B1 to B5 inclusive. The sixth pulse for operating each of the printers MPA and MPB is supplied by switches operated by distributor cam C1 driven synchronously with the cams A1 to A5 and B1 to B5 inclusive. The multiplex distributor is also provided with corrector cam CR for maintaining proper phase relation for this distributor and since corrector apparatus is well known, it is not being shown.

The apparatus illustrated in Fig. 2 is standard multiplex apparatus now in common use in printing telegraph systems, except that normally the sixth impulse for the two printers is supplied by switches controlled by separate cams, but in order to reduce the number of cams, it is preferred to use the C1 cam for supplying the sixth pulse to both printers.

Referring to Fig. 3, the multiplex distributor associated with the west multiplex WM is provided with four specially formed cams C2, C3, C4 and C5. These cams replace standard cams for the purpose of the present invention. It will be understood that in the standard multiplex apparatus of the prior art a cam normally in the position of C2 is employed for supplying the sixth impulse to printer MPB.

The present invention involves a polarized repeater relay 3 shown in Fig. 3 controlled by the receiving relay WR of Fig. 2 through the connection 3a, and the tongue of relay 3 operates between fixed contacts which are connected respectively to fixed contacts of a switch 4 controlled by cam C3, and the tongue of switch 4 controls the operating circuit of a start-stop repeater relay 5. Relay 5 is provided with biasing winding 5a which normally maintains the relay tongue on the left contact or in the spacing position but is operated to the marking position when positive battery is supplied to the relay winding by relay 3 through the cam switch 4. Cam C4 operates a switch 7 for controlling the start-stop channel A, and the cam C5 operates the switch 8 for controlling the start-stop channel B. One stationary contact of switch 7 is connected to positive battery through a normally closed start switch C2A controlled by cam C2, and the other stationary contact of switch 7 is connected to the stationary contact of relay 5. In a like manner, one stationary contact of switch 8 is connected to positive battery through a normally closed start switch C2B controlled by cam C2 and the other stationary contact of switch 8 is connected to the stationary contact of relay 5. It will be understood that switches C2A and C2B associated with cam C2 provide the start impulse for the start-stop apparatus on the two channels. The rectangle SSR represents a start-stop receiver connected to channel A by jack J1, and it will be understood that this receiver may be located at a distant sub-station. The jack J2 is provided so that a message received on the multiplex channel B may be relayed to a start-stop receiver at a distant sub-station.

The cam C3 is so positioned with respect to the

printer cams on the multiplex receiving distributor that it operates a switch 4 from one position to the opposite position between the fourth and fifth pulses of the multiplex signal combination, and this occurs for both channels. In Fig. 3, the arrows associated with the letter A indicate the period during which the channel A is operative and the arrows associated with the letter B indicate the period when the channel B is operative. The object in providing cam C3 to operate switch 4 in the manner described is to convert the received multiplex signal into a signal for operation of the start-stop signalling circuit in which the circuit is to be closed for "marking" impulses and is to be open for spacing impulses. Cam C3 operates switch 4 from one position to the other between signal units in which marking impulses are of opposite polarity.

Relaying signals from multiplex to start-stop receiver

The operation involved in relaying signals from the multiplex system WM to a start-stop receiving apparatus SSR located at a distant sub-station is as follows:

With the apparatus as shown in Figs. 2 and 3, the cam C4 has operated switch 7 to a position such that the line connecting the start-stop receiver SSR at a distant sub-station is controlled by the relay 5, and the cam switch C2A has opened the circuit to the sub-station in order to supply the "start" impulse for initiating the operation of the start-stop receiver. After momentary opening of the circuit for the start impulse, cam C2 has no further control of the circuit due to the operation of switch 7, but the start-stop circuit is controlled in accordance with the operation of the relay 5 which in turn is controlled by cam switch 4 and by polarized relay 3.

Assume that idle signals are being transmitted from multiplex line WM, then the signal impulses on channel A will consist of four negative impulses followed by a fifth positive impulse, all five impulses being spacing impulses. During the time that these five signal impulses are transmitted, cam C3 rotates through the angle A in Fig. 3, and for the four negative impulses, the switch 4 is connected as shown in Fig. 3, but since the tongue of relay 3 is held against the right-hand contact by the negative impulses, relay 5 remains in the "spacing" position and the start-stop line remains open. Just prior to receipt of the fifth or positive impulse, cam C3 shifts the tongue of switch 4 to the right-hand contact and prevents operation of relay 5 when the tongue of relay 3 is operated to the left-hand contact by the positive impulse. Thus only spacing impulses will be transmitted to the start-stop line when idle signals are received over the multiplex system. Also all negative impulses received over the multiplex system during the first four impulses of a signal combination, and a positive fifth impulse, will be repeated to the start-stop line for channel A as spacing impulses, and all positive impulses received over the multiplex channel A during the first four impulses of a combination, and a negative fifth impulse, will be repeated to the start-stop line as marking impulses. It should be noted that the starting of the start-stop receiver is controlled from the multiplex distributor by means of cam switches C2A and C2B controlled by cam C2. The start-stop distributor for the receiver SSR is arranged to operate at such speed that it makes a complete

cycle of operation during one-half revolution of the multiplex distributor, and during the time that channel A is operating, the start-stop line for channel B is closed through cam switches C2B and 8. In a like manner when start-stop channel B is operating, the line for channel A remains closed through cam switches C2A and 7. If desired, cam switches 7 and 8 may be arranged on opposite sides of a single cam and operated thereby.

Relaying signals from one multiplex system to another multiplex system

The present invention involves arrangements for repeating signals received on one multiplex system onto another multiplex system and in which the standard multiplex tape transmitters and distributors on the outgoing system are utilized for re-forming or regenerating the signal impulses as they pass from one system to the other.

Figs. 4 and 5 show the transmitting apparatus associated with an east multiplex system EM and located in the same central station with the receiving apparatus shown in Figs. 2 and 3 and associated with the west multiplex system WM. It will be understood that the drawings illustrate apparatus for transmission over two multiplex channels from the west system to the east system only, but duplicate apparatus (not shown) is provided for transmission in the opposite direction.

For the purpose of controlling the transmitter on the east multiplex system in accordance with signals received on a channel A of the west multiplex system, the energizing circuit of relay 5 is extended through jack J3, through cord circuit CC and through jack J5 to operate a relay 6A (Fig. 5) which in turn controls the transmitting apparatus on the east system EM, as will be described in greater detail below. In a like manner, signals received over channel B of the west system may be relayed to the east system by extending the circuit of relay 5 to control the operation of relay 6B (Fig. 5) by means of a cord circuit joining jacks J4 and J6.

Referring to Fig. 4, the two tape transmitters of the two multiplex channels on the east system are shown at TA and TB respectively. These transmitters are of standard construction, and it will be understood that normally when the transmitters are idle the tongues of the transmitters will lie against the left-hand contacts. The impulse transmitting circuits for transmitter TA are controlled by the cam switches operated by cams A'1 to A'5 inclusive on the multiplex distributor and the impulse transmitting circuits of transmitter TB are controlled by the cam switches operated by cams B'1 to B'5 on the multiplex distributor. The sixth impulse for transmitter TA is supplied by cam switch 9a operated by distributor cam C6 while the sixth impulse for transmitter TB is supplied by cam switch 9b operated from the same cam C6. In the standard equipment, the switch 9b is operated by a separate cam on the distributor corresponding to the cam C7, but for the purpose of this invention, cam C6 is employed to operate both switches 9a and 9b, and cam C7 is modified for another purpose described below. The standard multiplex distributor also includes two cams AC1 and AC2 for alternately operating switches 16 and 17. The distributor contacts associated with the odd numbered cams on the transmitting distributors are connected to the split or midpoint of the ammeter on the multiplex system EM through the cam

switch 16 and the distributor contacts associated with the even numbered cams on the multiplex distributor are connected to the ammeter split through cam switch 17.

In the standard multiplex transmitters, the stationary contact leads Lb and La are normally permanently connected to plus and minus battery, but for the purpose of this invention, the contact leads La and Lb are connected to the tongues of two pole changing relays 10 and 11 respectively, the tongues of these two relays operating between fixed contacts of plus and minus battery, and operation of the relays from one position to the other effects reversal of the polarity of the battery applied to the leads La and Lb.

Relays 10 and 11 are polarized relays and are locked in the operated position by a polarized relay 12 which closes a circuit to energize holding coils 10a, 11a and 12a on relays 10, 11 and 12, respectively. The common energizing circuit for relays 10, 11 and 12 is controlled by input relay 6A and the circuit extends from the tongue of relay 6A through cam switch 13A controlled by cam C7 and through either cam switch 14 or cam switch 15 operated alternately by cams AC1 and AC2. Cam C7 closes switch 13A for transmitting over multiplex channel A and closes switch 13B for operating over multiplex channel B. The indentations in cams AC1 and AC2 are arranged to operate switches 14 and 15 alternately, and each switch is closed for only a short interval compared to the length of one signal unit or impulse and at a time to pass the best part of the signal impulse, thus avoiding the possibility of false operation of the pole changers 10 and 11 in case of slight de-phasing of the signal with respect to the distributor. Cams AC1 and AC2 form a part of the regular multiplex transmitting distributor, and in order to utilize the existing cam surface on these cams the plunger shoes 14a and 15a have an extended contact area of the shape shown in Fig. 5, so that the plungers will remain in the cam indentations only a short time. The trailing edge of the face of the plunger shoes is cut away to such position that the plunger operates at a time to compensate for the delay or lag in operation of pole changers 10 and 11 and locking relay 12. This insures identical phasing of operation between pole changing relays 10 and 11 and the AC distributor contacts 16 and 17 controlled by cams AC1 and AC2.

Relays 6A and 6B for controlling the energizing circuit of relays 10, 11 and 12 are provided with biasing windings 6a and 6b respectively, which normally maintain the tongues of these relays on the left-hand contact or in the spacing position and normally apply positive battery to the operating circuit of relays 10, 11 and 12. Normally, relay 10 applies negative battery to transmitter lead La and relay 11 supplies positive battery to transmitter lead Lb.

Assume that it is desired to relay signals arriving on channel A of the west system onto the corresponding channel in the east system, the energizing circuit of relay 5 is extended to operate relay 6A over the cord circuit CC as shown in Figs. 3 and 5.

Assume for the time being that idle signals are being received over the west system consisting of four negative impulses followed by a fifth positive impulse. The first four negative impulses cause relay 3 to operate to the right-hand contact, and since cam switch 4 is open during the first four impulses on channel A, the energizing circuit of relay 6A extending through the

winding of relay 5 remains open, and the tongue of relay 6A continues to apply positive battery to the windings of relays 10, 11 and 12 through contact 13A and alternately operating switches 14 and 15. Since the relays 10 and 11 remain in the left-hand position during the first four impulses on channel A, relay 10 applies negative battery to the first four contacts on transmitter TA and relay 11 applies positive battery to the fifth contact on transmitter TA. Accordingly, the first four negative impulses received on the west system will be transmitted as negative impulses on the east system. The fifth positive impulse received on the west system operates relay 3 to the left-hand position, but just prior to its operation, switch 4 is operated to the opposite position by cam C3 and the energizing circuit to relay 6A remains open and relays 10, 11 and 12 remain in their locked position. Accordingly, the fifth impulse transmitted over the east system is determined by the polarity of transmitter lead Lb which under this condition is positive.

Assume now that a positive impulse is received over the west system during the first four impulses on channel A, relay 3 will be operated to the left and thereby apply positive battery to the energizing circuit of relay 6A through the winding of relay 5, and relay 6A will apply negative battery to the common operating circuit of relays 10, 11 and 12 through switch 13A and through one of the switches 14 or 15. This causes operation of all three relays to the right-hand position and relay 12 closes a holding circuit for all three relays to maintain the relays in operated position after the momentary closing of the switch 14 or 15. Operation of relay 10 to the right reverses the polarity of the battery applied to the first four contacts of transmitter TA, and this results in the transmission of a positive or marking impulse to the east system in response to the marking impulse received on the west system.

By the use of pole changing relays 10 and 11 controlled by the locking relay 12, and by controlling all three relays by the alternate momentary closing of switches 14 and 15, all signal impulses which are relayed from the west system to the east system are completely reformed or regenerated at the central station in the process of being relayed to the east system.

In case it is desired to relay signals from the west system to the east system on both channels, a cord circuit similar to circuit CC will be employed to connect jack J4 with jack J6 so that relay 6B is energized in a circuit in series with relays 5 and 6A. Under this condition, signals received over channel B will be relayed through the apparatus shown in Figs. 4 and 5 during the time that distributor contact 13B is in closed position.

It will be understood that transmitters TA and TB may be employed in the ordinary manner for transmitting multiplex signals from the central station over the east system to a distant multiplex station, and this may be done without any change in the arrangement shown. For example, when channel A of the east multiplex system is idle, signals may be transmitted over this channel from the central station by passing perforated tape through the transmitter TA in the usual manner. It will be understood that normally when no signals are being relayed through the transmitter equipment, the relay 6A remains on the left-hand contact and applies positive

battery to relays 10, 11 and 12 so that these relays remain in locked position on the left contacts during transmission of multiplex signals through transmitter TA. Obviously, both transmitters TA and TB may be operated simultaneously, if desired.

Relaying signals from a start-stop system to a multiplex system

The present invention also provides arrangements at a multiplex terminal station or central station for relaying onto the multiplex system signals received at the station over a start-stop signalling system.

Start-stop transmitting apparatus SST located at a distant sub-station is shown in the lower left-hand portion of Fig. 5. This apparatus includes a distributor or commutator provided with a stop contact Sp which is normally closed when the transmitter is at rest, and a normally open start contact St followed by five contacts for transmitting the signal impulses. The transmitting apparatus also includes a tape transmitter Tc having five tape control tongues which normally lie against the left-hand stationary contacts and are operated to the right-hand contacts according to the signal perforated in the tape. The present invention contemplates the use of the start-stop transmitting apparatus for transmitting signals from a sub-station to a start-stop receiver at the central multiplex station, and also for the purpose of transmitting signals from the sub-station to the central station to be relayed onto a multiplex channel. In order to adapt the start-stop transmitting apparatus for transmitting signals to the central station to be relayed over the multiplex system, certain changes in the transmitting apparatus must be made in order to avoid the transmission of continuous marking signals to the multiplex channel when the start-stop transmitter at the sub-station is idle. The necessary changes for converting the start-stop transmitting apparatus from a condition for straight start-stop operation to a condition for relaying signals onto a multiplex system are secured by means of a switch 18 which when moved in the direction of the arrow S conditions the apparatus for start-stop transmission in the usual manner to a start-stop receiver at the central station, and when moved in the direction of the arrow M, conditions the apparatus for transmitting signals to the central station to be relayed onto the multiplex system.

For a straight start-stop transmission from the sub-station to the central station, switch 18 is moved in the direction S, and contact 18a opens and leaves the distributor contact St disconnected so that the starting impulse is transmitted over the line. Contact 18b supplies positive battery to the starting magnet SM through the operator switch OS. Contact 18c supplies positive battery to the right-hand stationary contacts of the transmitter Tc. It will be observed that with switch 18 in the upper position, the connections of the transmitting apparatus are according to standard connections for a start-stop transmitter, and by feeding a perforated tape through the transmitter Tc, start-stop signals will be transmitted to the central office where they will be received on a standard start-stop receiver. A standard start-stop receiver (not shown) is provided at the sub-station for receiving messages from the central station.

For transmission from the start-stop sub-station to the multiplex channel, the switch 18 is

5 moved to the lower position where contact 18a connects the starting contact St to the stop contact Sp, and contact 18b moves to open position so that the circuit to the start magnet SM is controlled by a polarized relay 19 which is controlled from the stop contact Sp. Relay 19 is provided with a biasing winding 19a which normally biases the relay to open position. Contact 18c applies positive battery to the left-hand contacts of the tape transmitter Tc.

10 At the multiplex station the line coming in from the start-stop sub-station is plugged in to the start-stop channel B through jack 20B, or to the multiplex channel A through jack 20A, depending upon which channel is available. Biasing coils 6a and 6b on relays 6A and 6B are normally supplied with positive current through jack contacts 20a and 20b to normally maintain the tongues of relays 6A and 6B on the positive terminal, but operation of jack contacts 20a and 20b by a plug inserted in these jacks reverses the polarity of the battery applied to biasing windings 6a and 6b whereby the tongues of relays 6A and 6B are biased to the negative contact.

15 The circuits completed from the start-stop lines to relays 6A and 6B include series resistances 21A and 21B which are selected with resistance values sufficiently large to prevent operation of relay 19 at the start-stop station by current supplied from positive battery at the sub-station through the operating winding of relay 19, but the current is sufficiently large to hold the tongues of relays 6A and 6B against their positive contacts in opposition to the action of biasing coils 6a and 6b. Upon short-circuiting of these resistances, the current increases to a value sufficient to operate relay 19 and thereby energize start magnet SM to start the start-stop transmitter. For the purpose of transmitting the start impulses at the proper time on the two channels, a pair of contacts 22A and 22B are associated with appropriate cams on the multiplex transmitting distributor, the two contacts being operated 180° apart and being adjustable in position about the axes of the cams to secure proper phasing of the operation of the start-stop transmitter with the multiplex distributor.

When the start-stop line is connected to one of the multiplex channels as shown in the case of the plug insert in jack 20B, the contact 20b on the jack is operated to change the polarity on the biasing winding 6b, so that relay 6B is biased towards the negative contact. When the start-stop transmitter is operated for transmission over the multiplex channel, the signal impulses transmitted by transmitter Tc vary from that of normal operation in that the circuit is opened for marking impulses and closed for spacing impulses. Thus, if the transmitter Tc opens the start-stop circuit during any one of the first four impulses of a signal combination, relay 6B is held against its negative terminal by biasing winding 6b, and this relay impressed negative battery on relays 10, 11 and 12 through distributor contact 13B and one or the other of contacts 14 or 15. Operation of relay 11 to the right impressed negative battery upon transmitter lead Lb and causes the transmission of a negative pulse to the east multiplex system through transmitter TB, it being noted that a negative pulse during the first four impulses of a signal combination is a "marking" impulse on channel B. If start-stop transmitter Tc should close the circuit during any of the first four impulses, relay 6B will be operated to its positive contact and

thereby operate relays 10 and 11 to the left. Relay 11 impresses positive battery on the first four contacts of multiplex transmitter TB and a positive "spacing" impulse will be transmitted over channel B. If the start-stop transmitter circuit is open on the fifth impulse, relay 6B remains on the negative contact and relay 10 supplies positive battery to the fifth contact of multiplex transmitter TB, and a marking impulse is transmitted to the east system. In case the start-stop line is closed on the fifth impulse, relay 6B operates to the positive terminal and causes relay 10 to operate to the left and impress negative battery on the fifth contact of multiplex transmitter TB and thereby transmit a negative or spacing impulse to the east system.

In case the operator at the sub-station opens the switch OS the start-stop transmitter at the sub-station will not be operated by the start impulses from the central station. Also, since the start impulses do not affect the operation of relay 6B, the tongue of this relay is held on the positive or spacing contact when the start-stop transmitter is idle. This prevents the transmission of continuous marking signals over the multiplex channel when the start-stop transmitter is idle.

Synchronous operation and phasing adjustment of two multiplex systems

When a message is relayed from one multiplex system to another as described above, the two systems must be maintained in synchronism and in proper phase adjustment.

Fig. 6 illustrates an arrangement according to the present invention for driving the two systems in synchronous relation and for securing proper adjustment in phase between the distributors on the two systems.

The parts shown to the left of the line DL are associated with the receiving channel on the west multiplex system and the parts shown to the right are associated with the transmitting distributor on the east multiplex system. The motor for driving the receiving distributor on the west system is shown at 23, and the speed of this motor is controlled by fork 23a operating through transformer 23b, stabilizing lamp 23c and the A. C. rings 23d. The speed of operation of the fork 23a is controlled in a well understood manner by the corrector circuit and the automatic speed control rheostat 23e which supplies current to the adjusting magnets 23f associated with fork 23a through the usual phasing switch 23g. The apparatus described above is standard.

The motor for driving the transmitting distributor on the outgoing or east multiplex channel is shown at 24 and is controlled by fork 24a operating through transformer 24b, through stabilizing lamp 24c and A. C. rings 24d. The fork 24a is driven from the fork 23a by a connection 23-24 added according to the present invention. This invention also adds adjusting magnets 24e for controlling the period of operation of the fork 24a, and the current supplied to these magnets is controlled by the phasing switch 24f arranged to be operated simultaneously with phasing switch 23g. A resistance 24g is provided to limit the current in the adjusting magnets 24e in the normal running position of the switch 24f. An additional fork 25 having a speed slightly higher than fork 24a is provided for controlling the speed of the motor 24 during the phasing operation through transformer 25a and through the back contacts on phasing relay 26.

A phasing contact 27 is added to the receiving distributor on the west system and is operated by one of the cams of this distributor. This contact supplies positive battery through a circuit including similar phasing contact 28 associated with a corresponding cam on the transmitting distributor for the east multiplex channel, the circuit continuing to the operating winding of relay 29 which is provided with a biasing coil 29a to maintain its tongue in open position. The added phasing contact 28 on the regular multiplex transmitting distributor is arranged so that it may be adjusted about the axis of the distributor to secure the desired adjustment in phase relation. Relay 29 controls the circuit to relay 26 through a phasing switch 30. Relay 26 is provided with a contact 26a which completes a locking circuit when energized, the locking circuit being controlled by the phasing switch 30.

The phasing operation is as follows:

It will be assumed that motor 24 is being controlled from the fork 24a and that the transmitting distributor on the east system is out of phase with the receiving distributor on the west system. Under this condition relay 26 is in locked position and fork 24a controls motor 24 through relay contacts 25b and 26c. In order to properly phase the transmitting distributor with respect to the receiving distributor, the switch 30 is momentarily depressed, thereby de-energizing relay 26 and connecting fork 25 to control the motor 24 instead of the fork 24a. This operates to increase the speed of the motor 25 and therefore speed up the transmitting distributor with respect to the receiving distributor. As soon as the two distributors attain the same phase relation, contacts 27 and 28 are closed at the same instant and the energizing circuit to relay 29 is closed, thus causing operation of this relay to complete the circuit to relay 26 which operates and disconnects fork 25 from the motor 24 and reconnects fork 24a to the motor. From this point the transmitting distributor will operate synchronously and in phase with the receiving distributor. Neon lamp 31 is connected across the energizing circuit to relay 29 for the purpose of giving a visual indication of the proper phasing condition of the two distributors.

If for any reason it becomes necessary to adjust the phase of the receiving distributor with respect to its transmitting distributor on the same channel and in the same system, the phasing switch 23g is operated for this purpose, and by interlocking this switch with the phasing switch 24f controlling the adjusting magnets on the fork 24a, a corresponding adjustment in the phase of the outgoing transmitting distributor is obtained without changing the proper phasing between the incoming distributor and the outgoing distributor.

The schematic diagram shown in Fig. 7 illustrates the manner in which three multiplex systems may be maintained in synchronous operation and in proper phase relation to repeat signals from any system to any other system in either direction. Three complete multiplex systems U—S, Z—S and P—S are represented connecting three different stations U, Z and P respectively to a common or central station S. The transmitting forks at the three outlying stations are indicated at UT, ZT and PT respectively, while the receiving forks are indicated at UR, ZR and PR respectively. The transmitting forks located at the central station S for the three systems are represented at STu, STz, and STp

respectively, while the three receiving forks at station S are represented at SRu, SRz and SRp. The transmitting and receiving distributors which are controlled by the various forks shown in Fig. 7 are represented by the circles which are joined to the respective forks by a single line, and the two lines A and B joining a transmitting distributor with its corresponding receiving distributor represent the two transmission channels.

As shown in Fig. 7, the receiving fork SRu on system U—S drives the transmitting fork STp on system S—P. The fork STp also drives the transmitting fork STz on system S—Z. The receiving fork PR at station P drives the transmitting fork PT at the station P, and receiving fork SRp at station S drives the transmitting fork STu at station S on the system U—S. If desired, instead of driving fork STz from fork STp, this fork may be driven directly from fork SRu by providing an additional contact on fork SRu. It will be understood that the driving connections between the various forks represented schematically by connecting leads in Fig. 7 will include apparatus for adjusting the phase relation between the connected distributors according to the arrangement illustrated in Fig. 6.

If it is desired to transmit from station U through station S to station P on channel B, it is necessary to secure proper phasing between transmitting distributor TDSp and receiving distributor RDSu. This is accomplished by the phasing connection illustrated in Fig. 6 and diagrammatically represented in Fig. 7 as a simple connection between the two forks controlling these distributors. Also, if it is desired to transmit from station U to station Z through station S on channel A, it will be necessary to secure proper phasing between transmitting distributor TDSz and receiving distributor RDSu, and this may be accomplished either by the connection from fork STp as shown in Fig. 7 or by a phasing connection direct from fork SRu to fork STz. With the two connections described above, station U may transmit to station Z or to station P on either channel as desired, or both channels may be used to transmit to one of the distant stations Z or P.

With the arrangement shown in Fig. 7, it is also possible to transmit from station P to station U over either or both channels, as will be understood. In order to permit transmission from station Z to station U or to station P, it will be necessary to make proper phasing adjustments in the connection between fork ZR and fork ZT and in the connection between fork PR and fork PT in order that proper phasing relation shall exist between transmitting distributor TDSu and the two receiving distributors RDSz and RDSp. The proper phasing relation will be obtained when receiving distributor RDSp is in phase with transmitting distributor TDSp, and when receiving distributor RDSz is in phase with transmitting distributor TDSz. Proper phasing relations are indicated by means of the neon lamps 31a and 31b controlled respectively by switches 32a and 32b. When switch 32a is moved to the left, lamp 31a is connected in circuit with contacts controlled by distributors RDSu and TDSz. With this connection, flashing of the lamp 31 indicates proper phasing between these two distributors as described above in connection with Fig. 6. When switch 32a is moved to the right, lamp 31a is connected in a circuit controlled by contacts operated by distributors TDSz and RDSz, and by adjusting the phasing connection between forks ZR and ZT, the lamp 31a will indicate the

proper phase condition between distributors TDSz and RDSz. In a like manner, when switch 32b is moved to the left, lamp 31b is employed to indicate the proper phase relation between distributors RDSu and TDSp, and when switch 32b is moved to the right, lamp 31b is employed to indicate proper phase relation between distributors TDSp and RDSp when the phasing is controlled by the connection between forks PR and PT.

Monitor printers at multiplex station

The present invention provides two monitor printers MOPA and MOPB (Fig. 4) at the multiplex central station for monitoring or supervising, and retaining copies of, all messages which are transmitted out of that station, regardless of whether the message originates in the central station or is relayed through the central station from another multiplex system or from a distant start-stop sub-station.

The two monitor printers are controlled by distributor contacts which are added to the regular multiplex transmitting distributor and are arranged on opposite sides of the cams from the distributor contacts controlling transmitters TA and TB. It will be noted that the added contacts for controlling monitor printer MOPA for channel A are associated with cams B'1 to B'5 which control the contacts of transmitter TB for channel B, and the added contacts which control monitor printer MOPB for channel B are associated with cams A'1 to A'5 which operate the contacts controlling the transmitter TA for channel A. The plungers for operating the monitor printer contacts are provided with elongated shoes engaging the respective cams in order to prevent overlapping of the printer contacts and to allow for delay in operation of the monitor relay MR.

The monitor relay MR which controls the circuit to the monitor printer distributor contacts is energized by a connection MRa to the split of the differential meter on the outgoing line. The monitor relay thereby supplies the monitor printers with signals as they are transmitted over the outgoing line. Contacts 9c and 9d are added to the distributor for supplying the sixth pulse on the two monitor printer magnets and are associated with cam C6 on opposite sides thereof.

By providing the monitor printers as shown, it is possible for the multiplex operator to make or print a copy of any message which may be relayed through his office, or any message which may originate from his office, thus avoiding the necessity of using a separate test set for this purpose. It is also used as a plant man's check as to whether the repeated signals or the local signals are properly transmitted to the line. With this arrangement it is possible to dispense with the usual test set provided at the multiplex station.

For the purpose of illustration, our invention has been shown and described herein as applied to multiplex systems having only two channels, but it will be understood that the invention may be used in multiplex systems having more than two channels.

Various modifications may be made in the arrangements illustrated without departing from the invention. For example, a single polarized relay may be employed to operate the two movable contacts which, in Fig. 5, are operated by separate polarized relays 10, 11 for reversing the polarity of the transmitter contacts, or a single

polarized relay may be employed to operate the three movable contacts which, in Fig. 5, are operated by three separate relays 10, 11 and 12.

In accordance with common usage, the term "battery" is used throughout the specification and accompanying claims to designate any suitable source of direct current.

What is claimed is:

1. In a telegraph repeating system, the combination of an incoming circuit transmitting multiple-unit signal combinations in which the marking impulses are of one polarity for certain units and of opposite polarity for at least one unit in each combination, a normally closed outgoing circuit for operation of a start-stop receiver, means controlled by the incoming signals for periodically opening said outgoing circuit to transmit a start impulse thereover, means responsive to the receipt of signal impulses of one polarity during the units in which marking impulses are of one polarity for closing said outgoing circuit, and means responsive to signal impulses of opposite polarity during units in which marking impulses are of opposite polarity for closing said outgoing circuit.

2. In a telegraph repeating system, the combination of an incoming circuit transmitting multiple-unit signal combinations in which marking impulses are of one polarity for certain units and of opposite polarity for at least one unit in each combination, an outgoing circuit for operation of a start-stop receiver, a synchronous distributor driven in synchronism with the incoming signals, contacts controlled by said distributor for supplying a start impulse to said outgoing circuit, a polarized relay responsive to signals received on said incoming circuit, means including said polarized relay and contacts controlled by said distributor for closing said outgoing circuit in response to marking impulses of either polarity.

3. In a telegraph repeating system, the combination of an incoming circuit transmitting multiple-unit signal combinations in which the marking impulses are of one polarity for certain units and of opposite polarity for at least one unit of a combination, a synchronous distributor driven in synchronism with signals received on said incoming circuit, an outgoing circuit for operating a start-stop receiver, means including contacts on said distributor for supplying a start impulse to said outgoing circuit, a polarized relay connected to said incoming circuit and having a tongue operating between two fixed contacts, and means controlled by said distributor during the units in which marking impulses are of one polarity for preparing a circuit through one of said fixed contacts to effect closing of said outgoing circuit in response to impulses of one polarity and for preparing a circuit through the other of said fixed contacts during the units when marking impulses are of opposite polarity to effect closing of said outgoing circuit in response to marking impulses of opposite polarity.

4. In a telegraph system, a transmitting station and a receiving station connected by a synchronous telegraph system transmitting five-unit signal combinations in which marking impulses are of one polarity for the first four units and of opposite polarity for the fifth unit, a synchronous distributor at said receiving station driven in synchronism with signals received over said synchronous system, a telegraph printer at said receiving station controlled by said distributor and operated by signals received over said

synchronous system, a distant sub-station provided with a start-stop printer, a start-stop circuit extending from said receiving station to said sub-station for operating said start-stop printer, means including contacts on said distributor for normally closing said start-stop circuit and for interrupting the same prior to receipt of a signal combination, a polarized relay connected to said synchronous system at said receiving station and having a tongue operating between two fixed contacts, a relay for closing said start-stop circuit, a circuit for energizing said relay including one of said fixed contacts and a contact operated to closed position by said distributor during the first four units of a signal combination, and a second circuit for energizing said relay including the second fixed contact on said polarized relay and a contact operated by closed position by said distributor for the fifth unit of a signal combination.

5. In a telegraph repeating system, the combination of an incoming circuit transmitting five-unit signal combinations in which the marking impulses are of one polarity for certain units and of opposite polarity for at least one unit, a receiving distributor driven in synchronism with signals received on said incoming circuit, an outgoing circuit including a tape transmitter and a transmitting distributor for controlling said transmitter, said tape transmitter including five tongue elements normally biased against contacts having one polarity for certain tongues and opposite polarity for at least one tongue, means for driving said transmitting distributor in timed relation with said receiving distributor, means for reversing the polarity on said transmitter contacts, means for normally biasing said polarity reversing means to one position for transmitting spacing impulses to said outgoing circuit, and means responsive to the receipt of marking impulses over said incoming circuit for operating said polarity reversing means from its biased position.

6. In a telegraph repeating system, the combination of an incoming circuit transmitting five-unit signal combinations in which the marking impulses are of one polarity for the first four units and of opposite polarity for the fifth unit, a receiving distributor driven in synchronism with signals received on said incoming circuit, an outgoing circuit including a tape transmitter and a transmitting distributor for controlling said transmitter, said tape transmitter including five tongue elements normally biased against contacts having one polarity for the first four tongues and opposite polarity for the fifth tongue, means for driving said transmitting distributor in timed relation with said receiving distributor, and means responsive to the receipt of a marking impulse over said incoming circuit for reversing the polarity of said transmitter contacts.

7. In a telegraph repeating system, the combination of an incoming circuit transmitting five-unit signal combinations in which the marking impulses are of one polarity for the first four units and of opposite polarity for the fifth unit, a receiving distributor driven in synchronism with signals received on said incoming circuit, an outgoing circuit including a tape transmitter and a transmitting distributor for controlling said transmitter, said tape transmitter including five tongue elements normally biased against contacts having one polarity for the first four tongues and opposite polarity for the fifth tongue, means for driving said transmitting distributor in

timed relation with said receiving distributor, a polarized relay for reversing the polarity on the first four contacts of said transmitter, a second polarized relay for reversing the polarity of the fifth contact of said transmitter, said polarized relays being provided with means for locking the same in operated position, a circuit for energizing said polarized relays including contacts operated by said transmitting distributor for closing said circuit for a portion of each signal unit period, a relay for controlling the polarity of current supplied to said energizing circuit, said relay being biased to a position to effect the transmission of spacing impulses over said outgoing circuit, and means responsive to receipt of a marking impulse over said incoming circuit for operating said relay to reverse the polarity of said energizing circuit and thereby operate said polarized relays from normal position to reverse the polarity on the transmitter contacts.

8. In a telegraph repeating system, the combination of an incoming circuit, a receiving distributor driven in synchronism with signals received on said incoming circuit, an outgoing circuit including a tape transmitter and a transmitting distributor for controlling said transmitter, said tape transmitter including five tongue elements normally biased against contacts having one polarity for the first four tongues and opposite polarity for the fifth tongue, means for driving said transmitting distributor in timed relation with said receiving distributor, and means for controlling the polarity of said transmitter contacts in accordance with signal impulses received on said incoming circuit.

9. In a telegraph system, the combination of an incoming circuit comprising a two-channel multiplex system including a receiving distributor operating in synchronism with incoming signals consisting of five-unit combinations in which marking impulses are of one polarity for the first four units and of opposite polarity for the fifth unit, a normally closed outgoing circuit for operating a start-stop receiver, means including contacts on said receiving distributor for opening said start-stop circuit to transmit a start impulse thereover, a second outgoing circuit including a tape transmitter and a transmitting distributor for controlling said transmitter, said tape transmitter including five tongue elements normally biased against contacts having one polarity for the first four tongues and opposite polarity for the fifth tongue, means for driving said transmitting distributor in timed relation with said receiving distributor, means including a relay for reversing the polarity of said transmitter contacts, a second relay for closing said start-stop circuit, a common circuit for energizing said first and second relays, a polarized relay operated by signals received on said incoming circuit and having a tongue operated between two fixed contacts, and contacts controlled by said receiving distributor for preparing said energizing circuit for completion through one of said fixed contacts during the first four signal units, and for preparing said energizing circuit for completion through the other of said fixed contacts for the fifth signal unit.

10. In a telegraph repeating system, the combination of an incoming circuit transmitting five-unit signal impulses and in which the circuit is normally closed and is opened for the transmission of marking impulses, an outgoing circuit including a tape transmitter and a transmitting distributor for controlling said transmitter, said

tape transmitter including five-tongue elements normally biased against contacts having one polarity for the first four tongues and opposite polarity for the fifth tongue, means for reversing the polarity of the tongue contacts of said transmitter, means including a relay operated by said incoming circuit for normally maintaining said reversing means in a position to transmit spacing impulses over said outgoing circuit and being responsive to receipt of marking impulses over said incoming circuit to reverse the polarity on said transmitter contacts.

11. In a telegraph repeating system, the combination of an incoming circuit including a start-stop transmitter and distributor for transmitting five-unit signal impulses in which the circuit is normally closed and is opened for marking impulses, an outgoing circuit including a tape transmitter and a synchronous distributor for controlling said transmitter, said tape transmitter including five-tongue elements normally biased against contacts having one polarity for the first four tongues and opposite polarity for the fifth tongue, means for reversing the polarity of said transmitter contacts, means including a relay operated by said incoming circuit for normally maintaining said reversing means in a position to transmit spacing impulses over said outgoing circuit and being responsive to receipt of marking impulses over said incoming circuit to reverse the polarity on said transmitter contacts, and means including contacts operated by said synchronous distributor for transmitting a start impulse to said start-stop distributor.

12. In a telegraph repeating system, the combination of a start-stop system including a start-stop transmitter having five tongues normally biased to spacing position against contacts for impressing battery of the same polarity upon said tongues, a start-stop distributor for successively connecting said tongues to the start-stop line, said distributor having a normally closed stop contact, a start magnet for said start-stop distributor having an energizing circuit including contacts on a control relay, means for impressing battery upon the normally closed start-stop circuit through the operating winding of said control relay and through the normally closed stop contact on said distributor, means for biasing said control relay to open position against the normal current in said start-stop circuit, a synchronous telegraph system having a transmitting terminal located at the receiving terminal of said start-stop system and including a tape transmitter having five tongue elements normally biased to spacing position against contacts for impressing battery of one polarity on the first four tongues and battery of opposite polarity on the fifth tongue, a synchronous distributor for successively connecting the tongues of said tape transmitter to the outgoing circuit of said synchronous system, means for reversing the polarity of said tape transmitter contacts, a relay for controlling said polarity reversing means and including means for biasing said relay to a position to transmit marking impulses over said outgoing circuit, said relay being energized by said normally closed start-stop circuit and being normally operated to a position for controlling said polarity reversing means to transmit spacing impulses to said outgoing circuit and being responsive to the opening of said start-stop circuit to reverse the polarity on said tape transmitter contacts, a resistance element included in the start-stop circuit at the receiving terminal, and

contacts controlled by said synchronous distributor for short-circuiting said resistance element to thereby increase the current flowing in said start-stop circuit and effect the operation of said control relay and to thereby start said start-stop distributor.

13. In a telegraph system, the combination of a start-stop transmitter having five tongue elements normally biased against five spacing contacts and adapted to be operated against five marking contacts, a start-stop distributor having a normally closed stop contact, a start contact and five transmitter contacts connected to the tongue elements of said start-stop transmitter, a start magnet for said distributor, a two-position switch for controlling the circuits of said transmitter and distributor and including a first contact operable in the first position to connect battery to the transmitter marking contacts and a second contact operable in the first position to connect battery to the start magnet, said first contact being operable in the second position of said switch to disconnect battery from the marking contacts and to connect battery to the spacing transmitter contacts, a third switch contact operable in the second position for connecting the start distributor contact to the stop distributor contact, said second switch contact being operable in the second position to open the circuit to the start magnet, a relay having contacts connected in shunt to the second switch contact, means for biasing said relay to open position, and means for energizing said relay in a circuit including the start-stop line, the stop contact on said distributor and the operating winding on said relay.

14. In a telegraph repeating system, the combination of an incoming circuit, a receiving distributor driven in synchronism with signals received on said incoming circuit, an outgoing circuit comprising a two-channel system including two tape transmitters and a synchronous distributor for controlling said transmitters in alternate relation, each of said transmitters including five tongue elements normally biased against spacing contacts, a pole changing relay for impressing battery of one polarity upon the first four spacing contacts of one transmitter and the fifth spacing contact of the other transmitter, a second pole changing relay for impressing battery of opposite polarity upon the fifth spacing contact of the first transmitter and the first four spacing contacts of the second transmitter, means for normally biasing said pole-changing relays to a position to transmit spacing impulses over both channels, means for driving said transmitting distributor in timed relation with said receiving distributor, means responsive to signals received on said incoming circuit during one-half cycle of operation of said transmitting distributor for operating said pole-changing relays to transmit signals over said outgoing circuit in accordance with signals received on the incoming circuit, a second incoming circuit, means responsive to signals received on said second incoming circuit and operable during the second half-cycle of operation of said transmitting distributor for controlling said pole-changing relays to transmit signals over the second channel of said outgoing circuit in accordance with signals received over said second incoming circuit.

15. In a telegraph system, the combination of a multi-channel synchronous telegraph system having a receiving terminal in a central

station including at least a pair of telegraph printers and a synchronous distributor for controlling said printers, a second multi-channel synchronous telegraph system having a transmitting terminal at said central station and including at least a pair of tape transmitters and a synchronous distributor for controlling said transmitters, means for driving said transmitting distributor in timed relation with said receiving distributor, an outgoing start-stop circuit connecting said central station with a distant start-stop receiving station, means including contacts controlled by said receiving distributor for transmitting a start impulse over said start-stop circuit, and means including contacts controlled by said receiving distributor for relaying messages received on any channel of said first synchronous system to said outgoing start-stop circuit, means for reversing the polarity of the potential applied to the spacing contacts of said tape transmitters and being normally biased to transmit spacing impulses over the second synchronous system, means including contacts controlled by said receiving distributor for operating said pole-changing means in accordance with signals received on any channel of said first synchronous system to relay signals onto any channel of the second synchronous system, an incoming start-stop circuit terminating at said central station, and means responsive to signals received on said incoming start-stop circuit for controlling said pole changing means to relay signals over any channel of said second synchronous system in accordance with signals received on said incoming start-stop circuit.

16. In a telegraph repeater system, the combination of a receiving distributor on an incoming circuit, a transmitting distributor on an outgoing circuit, a motor for driving each distributor, a pair of primary tuning forks of equal speed for controlling the speeds of said motors, a circuit for driving the fork of the transmitting distributor from the fork of the receiving distributor, an auxiliary tuning fork of higher speed than said primary forks, a switch for substituting said auxiliary fork for the primary fork controlling the transmitting distributor, and means responsive to a predetermined phase relation between said distributors for effecting operation of said switch to reconnect the primary fork for controlling said transmitting distributor.

17. In a telegraph repeater system, the combination of a receiving distributor on an incoming circuit, a transmitting distributor on an outgoing circuit, a motor for driving each distributor, a tuning fork for controlling the speed of the motor driving the receiving distributor, a primary tuning fork associated with the motor of the transmitting distributor and having a speed equal to the speed of the fork controlling the receiving distributor, a circuit for driving the primary fork of the transmitting distributor from the fork of the receiving distributor, an auxiliary tuning fork of higher speed than said primary fork, means including a switch normally biased to position for connecting said auxiliary fork to control the transmitting distributor, a relay for operating said switch to a position to disconnect said auxiliary fork and to connect said primary fork to control the transmitting distributor, and means responsive to a predetermined phase relation between said distributors for energizing said relay.

18. A telegraph repeater system according to

claim 17 in which a locking circuit is provided for said relay in the position connecting the primary fork for controlling the transmitting distributor, and in which the phase responsive means controlling said relay comprises a circuit for energizing said relay including in serial circuit relation phasing contacts operated by said transmitting and receiving distributors.

19. In a telegraph system, the combination of a multi-channel multiplex system including a plurality of transmitters, a synchronous distributor for controlling said transmitters to transmit signals over an outgoing line, a plurality of monitor printers corresponding in number to said transmitters and connected to said outgoing line, contacts on said synchronous distributor for controlling each of said monitor printers, the contacts for each monitor printer being controlled by the cams which operate the transmitter contacts for a transmitter on a channel different from the channel of the monitor printer.

20. In a telegraph system, the combination of a two-channel multiplex system including an A transmitter and a B transmitter, a synchronous distributor for controlling said transmitters to transmit signals over an outgoing line, a monitor printer for channel A connected to said outgoing line and having distributor contacts operated by the cams of said synchronous distributor which operate the B transmitter, and a monitor printer for channel B connected to said outgoing line and having distributor contacts operated by the cams on said synchronous distributor which operate the distributor contacts on the A transmitter.

21. A combination according to claim 19 in which the plungers for operating the distributor contacts of the monitor printers are provided with elongated shoes engaging the operating cams for preventing overlap of the distributor contacts controlling said printers.

22. A combination according to claim 19 in which the monitor printers are controlled by means of a polarized relay connected to the split of the differential meter on the outgoing line, the tongue of the polarized relay operating between fixed contacts according to the signals transmitted to the line to prepare a circuit for the operation of the selector magnets through the corresponding distributor contacts.

23. A telegraph repeating system according to claim 14 in combination with a monitor printer for channel A on the outgoing circuit and having distributor contacts operated by the cams of the synchronous transmitting distributor which operate the transmitter for channel B, and a second monitor printer for channel B connected to the outgoing circuit and having distributor contacts operated by cams on said synchronous distributor which operate the distributing contacts for the transmitter on the A channel.

24. A combination according to claim 19 in which the monitor printers are controlled by means of a polarized relay connected to the split of the differential meter on the outgoing line, the tongue of the polarized relay operating between fixed contacts according to the signals transmitted to the line to prepare a circuit for operation of the selector magnets through the corresponding distributor contacts, and in which the trailing edges of the plunger shoes operating the distributor contacts of the monitor printers are positioned to compensate for lag in operation of said polarized relay.

25. In combination, a rotary cam, a pair of

switches to be operated by said cam, a pair of plungers for operating said switches and having shoe elements engaging said cam, said shoe elements having different lengths along the periphery of said cam whereby said switches are operated for different periods of time by said cam.

26. In combination, a movable element having a cam surface, a pair of followers engaging said cam surface at spaced points thereon, a pair of switches operated by said cam followers, said cam followers having engaging surfaces of different lengths in the direction of movement of said cam whereby for uniform movement of said cam surface, one of said switches is operated for a longer period than the other switch.

27. In telegraphic apparatus, the combination of a switch, a cam for operating said switch from one position to another for the period of one signal unit, a second switch and a cam follower co-operating with said cam for operating said second switch, said cam follower for the second switch having a longer cam engaging surface than the follower for the first switch whereby said second switch remains operated for only a portion of the period of a signal unit.

28. In a telegraph repeating system, the combination of an incoming circuit, an outgoing circuit, a tape transmitter including a transmitting distributor for transmitting over said outgoing circuit multi-unit signal combinations in which marking impulses are of one polarity for certain units and of opposite polarity for at least one unit, said tape transmitter including a plurality of tongue elements normally biased against contacts having polarities corresponding to the polarities of idle signal combinations on said outgoing circuit, polarized relay means for reversing the polarity of said transmitter contacts, said polarized relay means being provided with means for locking the same in either operated position, a circuit for energizing said polarized relay means including contacts operated by said transmitting distributor for closing said circuit for only a portion of each signal unit period, a relay for controlling the polarity of current supplied to said energizing circuit, said relay being biased to a position to effect the transmission of spacing impulses over said outgoing circuit, and means responsive

to receipt of a marking impulse over said incoming circuit for operating said relay to reverse the polarity of said energizing circuit and thereby operate said polarized relay means from normal position to reverse the polarity on the transmitter contacts.

29. A telegraph repeating system according to claim 28 in which the transmitting distributor is provided with a pair of alternately operating switches controlled by cams thereon for alternately connecting the distributor contacts for said transmitter to the outgoing line, and in which the distributor contacts for momentarily closing the energizing circuit of the polarized relay means are operated by the same cams which operate said pair of alternating switches for said transmitter, and in which the engaging surfaces of the cam followers for operating said switches are positioned to compensate for lag in operation of said polarized relay means.

30. In a telegraph repeating system, the combination of an incoming circuit, an outgoing circuit, a tape transmitter including a transmitting distributor for transmitting over said outgoing circuit multi-unit signal combinations in which marking impulses are of one polarity for certain units and of opposite polarity for at least one unit, said tape transmitter including a plurality of tongue elements normally biased against contacts having polarities corresponding to the polarities of idle signal combinations on said outgoing circuit, pole-changing means for reversing the polarity of said transmitter contacts, means for locking said pole-changing means in either operated position, a circuit for energizing said pole-changing means including contacts operated by said transmitting distributor for closing said circuit for only a portion of each signal unit period, means for normally maintaining said pole-changing means in a position to effect transmission of spacing impulses over said outgoing circuit, and means responsive to receipt of a marking impulse over said incoming circuit for completing the energizing circuit of said pole-changing means through said distributor contacts.

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CERTIFICATE OF CORRECTION.

Patent No. 2,135,398.

November 1, 1938.

LOUIS HORN JAMES, ET AL.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 8, first column, line 18, claim 4, for the word "by" first occurrence, read to; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 6th day of December, A. D. 1938.

Henry Van Arsdale

(Seal)

Acting Commissioner of Patents.