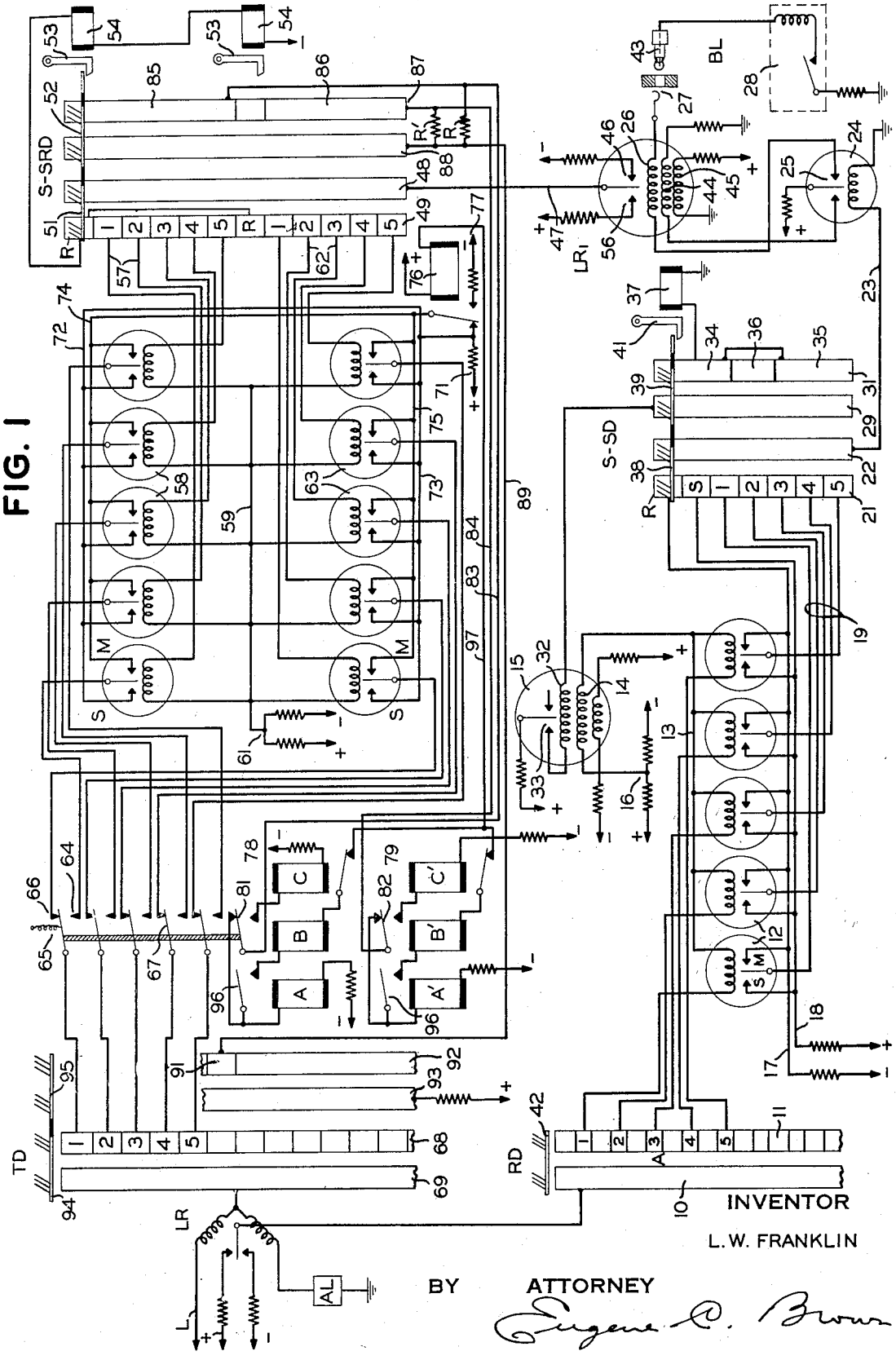
Oct. 11, 1932. L. W. FRANKLIN 1,881,453

TELEGRAPH PRINTER EXCHANGE SYSTEM

Filed Aug. 1, 1931 2 Sheets-Sheet 1

FIG. 1



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Filed Aug. 1, 1931 2 Sheets-Sheet 2

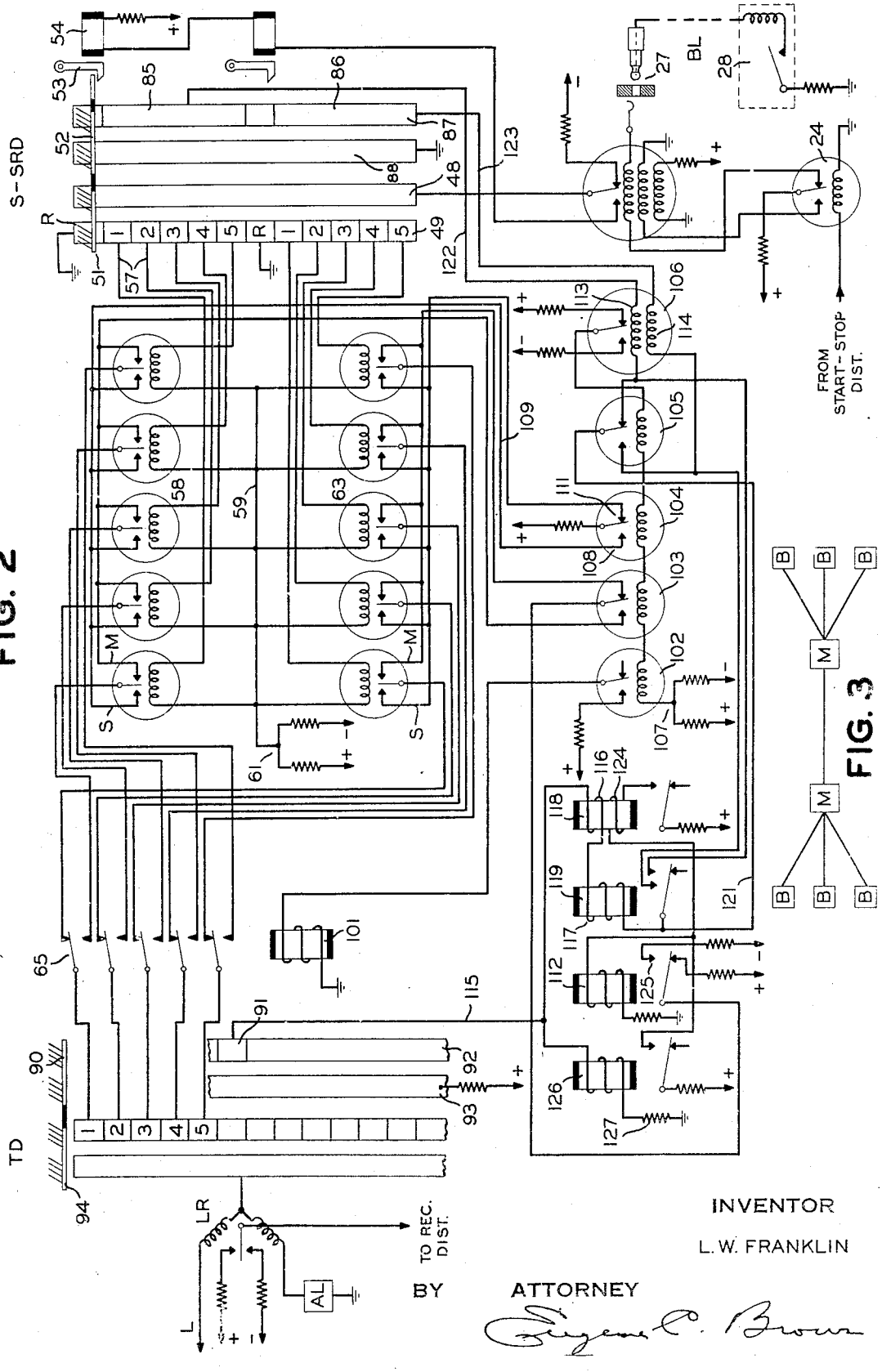

FIG. 2

FIG. 3

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UNITED STATES PATENT OFFICE

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TELEGRAPH PRINTER EXCHANGE SYSTEM

Application filed August 1, 1931. Serial No. 554,552.

This invention relates to a multiplex extended channel system and comprises means whereby any one or more channels of a multiplex circuit may be extended to or continued from a start-stop telegraph system, which for instance may connect the multiplex terminal with a branch office or subscriber's station.

The system is particularly adapted to printing telegraph exchange systems in which it is desired to connect any one of a group of subscriber's stations connected to a central telegraph office over a simplex line, with any one of another group of subscribers' stations similarly connected to another central telegraph office. In telegraph exchange systems as heretofore proposed, in establishing direct connections between subscribers' stations through central offices, it has been necessary to employ individual trunk lines extending between the central stations.

It is not feasible to employ multiplex telegraph equipment at subscribers' stations or at small branch telegraph offices since the volume of business done does not warrant the use of such equipment which is expensive to install and maintain. It is a practice, therefore, to provide each subscriber station with simplex or start-stop printing telegraph apparatus. On the other hand it is not economical to employ a simplex circuit between central offices, since ordinarily the volume of business between such offices is sufficient to fill the channels of one or more multiplex circuits. In order that the multiplex circuits between central offices may be utilized for business originating at the subscriber's station or at a branch office, it has been common practice to receive the messages at the central office from the branch office on simplex printers, receiving perforators or storage transmitters and to retransmit them over available multiplex channels to the distant central office, at which point they were again retransmitted to their final destination or sent over an extended channel arrangement as disclosed in patent to Dudley, et al., 1,617,993, granted February 15th, 1927. While the transmisison of intelligence signals from one channel of a multiplex circuit over a simplex circuit may be readily accomplished in the manner disclosed in the above patent, difficulty has been experienced in attempting to transmit directly from a simplex circuit over a multiplex circuit, due to the difference in speed of operation of the two systems and the difficulty of properly maintaining synchronism between the received signals at the central office and the transmitting multiplex equipment. In a co-pending application of Duerr and Broyles, filed July 9, 1931, Serial Number 549,762, entitled Extended channel operation, a simplex circuit is shown operating into one channel of a multiplex system through a storage transmitter at the central office, upon which the start-stop signals received from the simplex circuit are set up at one rate and from which they are transmitted to the multiplex circuit at a different rate. This system is extremely flexible, permitting wide differences in the speed of the simplex and multiplex apparatus, but it is necessary to interrupt either one system or the other at intervals to enable the slower system to catch up with the faster one. Moreover, storage transmitters are relatively expensive and require maintenance. If the storage transmitter is operated near its full storage capacity there is an inherent delay of a large number of characters, possibly a hundred or more at the central office.

One of the objects of the present invention, therefore, is to provide a telegraph system in which signals received over a simplex circuit, or originating at simplex equipment, may be automatically transmitted over a single multiplex channel without the employment of intermediate metallic storage transmitters, perforated tapes or the like.

Another object is to enable the signal to be transmitted between a simplex and a multiplex circuit without substantial delay and at high signaling speeds.

Another object is to permit the channels of a multiplex circuit to be controlled directly through start-stop transmitting apparatus.

A further object is to provide a printing telegraph exchange system in which any subscriber's line, terminating at a central office, may be directly connected to a remote station

or subscriber's line through one channel of a multiplex circuit.

Other objects and advantages of the invention will appear as the description proceeds.

In accordance with one preferred embodiment of the invention I employ at the central station, in connection with each multiplex channel to be used in the telegraph exchange system, a start-stop receiving distributor having a double set of contacts, each set being associated with an individual bank of polarized relays. Suitable switching means is provided whereby any subscriber's line may be connected to the receiving distributor, the sets of contacts acting alternately to receive the signal groups and distribute them to the polarized relays from which they are repeated to the multiplex transmitting distributor. The multiplex circuit is operated at a channel speed slightly greater than the maximum speed of the start-stop system, so that each character code as it is received will be immediately retransmitted over the multiplex circuit. By way of example, the simplex transmitting apparatus may be operated at a speed of about sixty-five words per minute and the multiplex apparatus operate at a channel speed of about seventy words per minute. As a result the multiplex distributor gradually gains on the simplex transmitter and at appropriate times is permitted to make a free revolution to restore synchronism. The simplex transmitter may, of course be operated at any lower speed, or at uneven speeds, resulting from hand transmission.

The signals received over the multiplex channel destined for a subscriber's station or branch office, are repeated from the multiplex distributor through a bank of polarized relays to a start-stop transmitting distributor which operates whenever an intelligence group is received, to repeat the same over the simplex line. The simplex printer must be adjusted to respond to signal at the maximum speed of the multiplex circuit, say seventy words per minute, when the simplex transmitter operates at sixty-five words per minute. This condition obtains in the conventional type of simplex printer.

In order that the invention may be more fully understood reference will be had to the accompanying drawings in which:

Figure 1 is a diagrammatic view of the apparatus and circuit arrangement at a central station embodying the present invention;

Figure 2 shows a modified arrangement for repeating signals directly from a simplex apparatus into a multiplex line, and

Figure 3 is a schematic view showing the relationship of the main and branch offices.

Referring first to Figure 1, it will be seen that the incoming line L which connected the central office with a distant central office is terminated in a line relay LR, which is shown duplexed. The marking and spacing contacts of the relay LR are connected respectively to negative and positive battery and the tongue of the relay is connected to the solid ring 10 of a receiving multiplex distributor RD. The multiplex distributor may provide for any desired number of channels, usually three or four. One channel only is shown complete, which for convenience may be termed the A channel, this channel being utilized for messages which are to be extended directly to the subscriber's station. The other channels of the multiplex distributor, ordinarily termed the B, C and D channels, may be operated in connection with regular multiplex equipment, or may be provided with extended channel equipment in the same manner as channel A. The segmented ring 11 of the distributor RD is provided with five segments for each channel, the segments for the A channel being shown connected individually to one terminal of the windings of a bank of polarized relays 12. The opposite terminal of each of the windings of these relays is connected by a conductor 13 to the operating winding 14, of a polar relay 15 and thence to the midpoint of a potentiometer 16, the terminals of which are connected to positive and negative battery respectively.

The marking and spacing contacts M and S, of each of the relays 12 are provided with negative and positive battery, respectively, through the bus bars 17 and 18, and the tongue of each of these relays is connected by individual conductors 19, to segments numbered one to five, of ring 21 of a start-stop distributor S—SD. The ring 21 is also provided with a rest segment R connected to marking or negative battery and a stop segment S connected to spacing or positive battery.

The solid ring 22 of the start-stop distributor S—SD is connected by a conductor 23 to the winding of a repeating relay 24, the marking contact 25 of which is connected through the line winding 26 of the line relay LR1, and thence to the tip contact of a jack 27. Any one of a number of branch lines BL may be connected to the jack 27 through a suitable switchboard arrangement, these lines terminating at the distant station in simplex printing and receiving apparatus, indicated at 28.

The start-stop distributor S—SD is also provided with a solid local ring 29 and a segmented local ring 31, the former being connected to one terminal of the locking winding 32 of relay 15, the opposite terminal of which is connected to the marking contact 33 of the relay. When the relay 15 is energized by marking signals, the circuit to the locking winding 32 is completed to positive battery through the tongue of the relay. The

live segments 34 and 35 of ring 31 are strapped together and are separated by a dead segment 36. They are connected through the winding of the start magnet 37 to ground. The brushes 38 and 39 of rings 21, 22 and 29, 31 respectively, are normally held at rest by a latch 41.

The operation of the extended channel equipment so far described is as follows. Assuming the brush 42 of the receiving multiplex distributor RD to be rotating in synchronism with the transmitting distributor at the distant end of the line L, and further assuming the A channel to be idle, that is, to be transmitting spacing signals only, the brushes 38 and 39 remain at rest upon the rings of the start-stop distributor S—SD, since the winding of relay 14 is held on its spacing or insulated contact by spacing battery repeated by the line relay LR. At this time marking battery is supplied to the outgoing simplex line BL by relay 24, this relay being held on its marking contact by battery supplied from bus bar 17, segment R of ring 21, brush 38, ring 22, conductor 23 and winding of relay 24 to ground. The tongue of relay 24 is connected through the line coil 26 of relay LR1, jack 27 and plug 43 to the line BL. It should be noted that spacing battery represents the idle condition of the multiplex channel and marking battery the idle condition of the simplex line.

If intelligence signals are transmitted over the multiplex line L through channel A the marking and spacing signals will be repeated by the relay LR to the segments 1 to 5 of channel A, windings of the relays 12 and winding 14 of the relay 15 to the potentiometer 16. These signals are set up by the relays 12, on the segments of the ring 21 of the start-stop distributor. The first marking signal of the intelligence group actuates the relay 15 closing its contact 33 and completing a locking circuit through the winding 32, local rings 29 and 31 by way of the brush 39, to the start magnet 37 and thence to ground. Upon energization of the start magnet the latch 41 is attached to release brushes 38 and 39 for one revolution. As the brush 38 passes on to the start segment S a start or spacing signal is transmitted over the conductor 23 to the repeating relay 24 and as the brush continues to advance across segments 1 to 5 the intelligence signals set up thereon are also transmitted to the relay 24 and thereby repeated to the simplex line BL to actuate the printing mechanism 28.

The circuit for the locking winding 32 of relay 15 is interrupted at the dead segment 36 of ring 31. Since the multiplex distributor brush crosses its segments in a much shorter period than the brushes of the start-stop distributor, brush 42 will have passed off of the segments of the A channel before brush 39 leaves the dead segment 36. Consequently the magnet 15 will not be energized again by marking signal until the next signal group is received at which time the brushes 38 and 39 of the start-stop distributor will have again come to rest on the rest segment.

The branch line BL has been shown arranged for single or half-duplex communication but it is to be understood that a duplex arrangement may be employed or the A channel of the multiplex circuit may be associated with one branch line for one direction of communication and with a separate branch line for communication in the opposite direction.

In the form shown when the A channel of the receiving distributor is idle, the steady marking battery supplied over the conductor 23 to the relay 24 holds the tongue thereof upon its marking contact 25 applying line battery to the branch line BL so as to enable the operator at the subscriber station to transmit over the branch line by making and breaking the circuit either through a keyboard transmitter or automatic transmitter in the usual manner. At this time the circuit for winding 44 of the line relay LR1 is interrupted at the left hand contact of relay 24 and the tongue of the relay LR1 is biased to its spacing side by means of the biasing winding 45. Consequently the line relay follows the make and break signals transmitted from the simplex apparatus 28.

The marking contact 46 of relay LR1 is connected to marking battery and the tongue of the relay is connected by conductor 47 to the solid ring 48 of the start-stop receiving distributor S—SRD. The segmented ring 49 of this distributor is provided with two sets of segments each including a rest segment R and five code segments numbered 1 to 5. The brush 51 is normally held at rest upon one or the other of the rest segments R by latches 53. Each latch is provided with a start magnet 54, the circuit of which is completed from negative battery, through the magnets 54 in series, one of the rest segments R, the solid receiving ring 48, tongue of relay LR1, and spacing contact 56 to positive battery. During transmission from the multiplex circuit into the simplex circuit the tongue of relay LR1 is held on its marking contact 46, by winding 26 when marking signals are being transmitted over the branch line BL or by locking winding 44 when spacing signals are being transmitted. Therefore, regardless of the position of the tongue of relay 24, positive potential is supplied from the tongue thereof through winding 26 or 44 in a marking direction. Consequently when the multiplex channel is repeating into the simplex line the circuit for the start magnets 54 of the start-stop receiving distributor S—SRD is held open and the distributor remains idle.

When transmission proceeds in the oppo-

site direction, however, that is, from the subscriber's station over the multiplex circuit, the first or start signal of each group, always being of spacing character, operates the line relay LR1 to its spacing contact, thereby energizing the start magnets 54 and releasing the brushes for half a revolution at which time they come to rest against the succeeding latch 53.

The contacts 1 to 5 of the first or upper set of segments of ring 49 are connected by a group of conductors 57, individually to the windings of a group of five polarized relays 58 and thence through a common conductor 59 to the midpoint of a potentiometer 61, the opposite terminals of which are joined to positive and negative battery respectively. The contacts 1 to 5 of the lower or second set of segments of ring 49 are similarly connected to the windings of a group of five polarized relays 63 and thence to the potentiometer 61. The tongues of the relays of group 59 are connected individually to the lower contacts 64 of a gang switch 65 and the tongues of the relay group 63 are connected to the upper contacts of the switch 65. The tongues of the switch 65 are individually connected to the segments 1 to 5 of one channel of the ring 68 of a multiplex transmitting distributor TD. The solid ring 69 of the distributor is connected to the apex of the line L.

Spacing battery is supplied to the spacing contacts S of relay groups 58 and 63 from a source of potential 71 through the spacing bus bars 72 and 73. Either spacing or marking battery may be applied to the marking contacts M of both relay groups from the bus bars 74 and 75 through the tongue of a neutral relay 76, the back contact of which is connected to the spacing battery 71, and the front contact to the marking battery 77.

When the simplex circuit is idle and the brushes 51 and 52 of the distributor S—SRD are at rest, relay 76 is re-energized and spacing battery from the source 71 is applied to both the marking and spacing contacts of relay banks 58 and 63, and thence to the segments of the distributor TD, irrespective of the position of the gang switch 65.

Relay 76 is controlled by two groups 78 and 79 of three neutral relays each designated A, B, C, and A'O, B', C' respectively. These groups are identical with the exception that the B relay of group 78 serves to operate the gang switch 65.

One terminal of the windings of the relays A and A' are connected to a source of negative potential and the opposite terminals are connected to the back contacts of the relays B and B', respectively. One terminal of the windings of the relays C and C' are similarly connected to negative potential and the opposite terminals to the back contacts of the relays B and B', respectively. The tongues 81 and 82 of relays B and B' are joined by conductors 83 and 84, respectively, to the segments 85 and 86 of local ring 87 of the start-stop receiving distributor S—SRD. The opposite local ring 88 is connected by conductor 89 to a segment 91 of a local ring 92 of the multiplex transmitting distributor TD. The opposite local ring 93 has positive potential applied thereto. The rings 68, 69 and 92, 93 are traversed by brushes 94 and 95 respectively, operating in synchronism with a receiving distributor at the opposite end of the line L. Resistances R and R' are connected between the conductor 89 and the conductors 83 and 84, as shown.

The A and A' relays are each provided with a locking contact 96 connected through the winding of the B and B' relays to the tongue of the C and C' relays. The back contacts of the C and C' relays are connected by a common conductor 97 to one terminal of the winding of the neutral relay 76 and thence to positive potential.

The operation of the system when repeating signals from the simplex circuit into the multiplex circuit is as follows. Assume the brushes 51 and 52 to be at rest in the position shown and the switch 65 to be resting against its upper contacts. Upon the arrival of the first or start signal of a code combination over the simplex circuit, the brushes 51 and 52 are released as previously explained and pass over the segments 1 to 5 in synchronism with the arrival of the five selecting impulses of the code combination. These impulses set up the tongues of the relay group 58 to correspond therewith but since the tongues of these relays are disconnected from the transmitting distributor TD at the lower contacts of switch 65 the signals are not immediately placed on the segments of the distributor. Moreover, at this time spacing battery is applied to both contacts of the relay groups.

Inasmuch as the brushes of the multiplex distributor operate at a channel speed equal to or slightly greater than the character speed of the simplex circuit, these brushes make a complete revolution during the time the brushes of the distributor S—SRD are passing across the segments 1 to 5. During this revolution brush 95 passes on to segment 91 at least once completing a circuit from positive battery at ring 93, brush 95, segment 91, conductor 89, ring 88 of the start-stop receiving distributor, brush 52, segment 85, conductor 83, tongue 81 of relay B, and the winding of relay A to negative battery. The contact 96 of relay A closes thus completing a circuit from positive battery through the winding of relay 76, conductor 97, back contact and tongue of relay C, winding of relay B to the tongue 96.

The relay B does not operate at this time, however, since the tongue 76 is also connected to positive battery of equal potential as the local ring 93 of the distributor TD. As soon

as the brush 95 passes off of the segment 91, however, current flows through the winding of relay B and the winding of relay A to negative battery, thus operating the relay and locking up the same through the tongue of relay A. The relay B operates the gang switch 65 to connect the segments of the ring TD to the tongues of the relays of group 58 and the simultaneous operation of relay 76 applies marking battery to the marking contacts of these relays. Consequently, as the brush 94 continues its revolution it crosses the segments 1 to 5 and transmits the combination over the line L.

As the brush 95 again passes on to segment 91 a circuit is completed through the conductor 89, resistance R, conductor 83, tongue 81 of relay B and the front contact thereof to the winding of relay C.

The A and A′ relays are adjusted so that they will not operate by the reduced current supplied through the resistances R and R′ but the relays C and C′ are adjusted so as to be operated by the lesser current supplied through the resistances when the tongues of relays B and B′ are on their front contacts.

The operation of the C relay interrupts the locking circuit for the B relay, thereby releasing gang switch 65 so as to connect the tongue of the relay group 63 to the distributor TD. At the same time the circuit to the relay 76 is interrupted, thereby restoring spacing battery to the contacts of both relay groups 58 and 63. Consequently if no further simplex signals are received the usual spacing conditions are maintained on the idle multiplex channel. However, if at the time the brush 95 engages the segment 91, on its second revolution, another signal combination is being supplied over the simplex circuit, so that brushes 51 and 52 are passing over the lower group of segments 1 to 5, a second circuit will be established from the conductor 89, ring 88, brush 52, segment 86, conductor 84, tongue 82 and winding of the A′ relay to negative battery. Relay B′ is therefore caused to operate as the brush 95 passes off of segment 91, in a manner similar to relay B and at the same time the relay 76 operates to restore marking battery to the contacts of the relay bank 63 so that the signals set up upon this relay group will be repeated to the segments of the transmitting distributor TD and thence to the line L.

It will be noted, therefore, since the brush of the multiplex distributor makes slightly more than one complete revolution during the time required for the brush of the distributor S—SRD to pass over one set of segments, that the signals received over the simplex line will be immediately repeated over the multiplex circuit. The time interval between successive groups of simplex signals is immaterial, since during such periods spacing or idle line conditions are applied to the multiplex channel.

It might be assumed, since the multiplex distributor operates at a greater speed than the simplex transmitter, that signals sent in the opposite direction, that is, repeated over the multiplex distributor to the simplex circuit, would proceed at a faster rate than they could be received upon the simplex receiving apparatus. This matter is taken care of, however, in the design of the simplex apparatus which is adjusted to receive at a slightly faster rate than it transmits, the ratio being approximately 13/12ths. Consequently, if the simplex transmitter is set to operate at about sixty-five words per minute, the receiving apparatus of the printer will satisfactorily record up to about seventy-one characters per minute. Therefore, by operating the multiplex apparatus at a speed of between sixty-five and seventy-one characters a minute, preferably about sixty-seven or sixty-eight, the transmission may be repeated directly from one system to the other without the use of intermediate storage transmitters or similar mechanism. It is obvious, however, if the multiplex channel is receiving its signals from a simplex transmitter associated with the other main station, that the maximum signaling speed of the multiplex circuit will not be over sixty-five characters per minute. That is, signals will be repeated from the multiplex system to the receiving simplex system at a rate not greater than sixty-five words per minute.

In Figure 2 I have shown a modification arranged for repeating signals from the simplex into the multiplex system. The parts bearing corresponding reference numerals are similar in Figures 1 and 2. In the latter modification, however, the gang switch 65 is operated by a neutral relay 101 controlled from a polarized relay 102 forming one of a group of five relays 102 to 106.

The windings of relays 102, 103, 104 and 105 are completed in series from the midpoint of a potentiometer 107 through the tongue of relay 106 the opposite contacts of which are connected to positive and negative potentials respectively. The lefthand contact 108 of relay 104 is connected by conductor 109 to the left hand or spacing contacts of each of the relays of group 58 and the righthand contact 111 of relay 104 is similarly connected to the spacing contacts of relay group 63. The tongue of relay 104 is connected to the spacing battery and serves alternately to apply spacing battery to the spacing contacts of relay banks 58 and 63.

Similarly the left and right contacts of relay 103 are connected, respectively, to the marking contacts of relay banks 58 and 63. The tongue of the relay 103 is connected to either marking or spacing battery through

the tongue and contacts of a neutral relay 112, as will presently appear. When no signals are being transmitted from the subscriber station, the tongue of relay 112 rests on its back contact, supplying spacing battery to the tongue of the relay 103. Consequently spacing battery is applied to both contacts of either one or the other of the relay banks 58 and 63, and thence to the segments of the transmitting distributor TD, for transmission over the multiplex line.

Relay 106 has two windings 113 and 114 each having one terminal thereof connected to the opposite contacts of relay 105. The opposite terminals of winding 113 and 114 are connected to the segments 85 and 86 respectively, of the local ring 87 of the start-stop receiving distributor S—SRD. The opposite local ring 88 is connected to ground.

The relay 106 is adapted to be actuated from the segment 91 of local ring 92 of the multiplex transmitting distributor TD, the circuit being completed each time the brushes 94 and 95 make a revolution. The circuit may be traced from positive battery at the solid local ring 93, brush 95, segment 91, conductor 115, windings 116 and 117 in series of relays 118 and 119, thence by conductor 121 to the tongue of relay 105. The current then passes either through the right or left contact of this relay, through the windings 113 or 114 of relay 106 and by conductors 122 or 123 to the segments 85 or 86 of ring 79 of the start-stop distributor S—SRD. With the brushes 51 and 52 at rest this circuit is incompleted. However, as soon as the brushes 51 and 52 start rotating, the circuit just traced is completed by means of brush 52 and solid ring 88 to ground. The operation of relay 106 from one side to the other reverses the battery connections through the windings of relays 102 to 105 and shifts the tongues thereof to their opposite contacts.

The operation of the system will be best understood by reference to the transmission of a group of code signals from the subscriber's apparatus 28. Assume the transmitter 28 to be idle with the brushes 51 and 52 in the position shown and the tongues of relays 102 to 106 to be on the righthand contacts. If signals are now transmitted from the apparatus 28 consisting of a start impulse followed by five intelligence impulses, the brushes 51 and 52 will be released by the first or start impulse allowing the same to move across the rings so as to set the relay tongues in accordance with the received code combination. It is also assumed in this case that the brushes of the multiplex transmitter TD are operating at a speed slightly greater than the speed of transmission of the simplex signals. Consequently as the brush 95 passes on to the local segment 91 a circuit, previously traced, is completed from battery, at solid ring 93 through the operating windings of relays 118 and 119, tongue and right-hand contact of relay 105, winding 113 of relay 106, conductor 122 and segment 85 of ring 87. Since the brush 52 is now in motion between the upper and lower rest segments this circuit is completed through the solid ring 88 to ground. Relay 106 thereupon moves to its left contact, reversing the relays 102 to 105. At the same time, the relay 118 upon operating completes a locking circuit from positive battery through its front contact, locking winding 124, and winding of relay 112 to ground. The tongue of relay 112 thereupon moves to its marking contact 125 applying marking battery to the tongue of relay 103. The relays 103 and 104, therefore, apply spacing and marking battery to the spacing and marking contacts of relay group 58. Relay 102 reverses the position of the gang switch 65 thereby connecting the tongue of relays 58 to segments 1 to 5 of the distributor TD. Consequently, as the brush 94 sweeps over these segments, the signal combination set-up thereon is repeated over the multiplex line L.

The relay 119 serves to short circuit the contacts of relay 105 during the passage of its tongue from one to the other, thereby preventing false operation of the relay 106.

If a second signal group is transmitted from the subscriber's station immediately following the first group, the brushes 51 and 52 are again released to pass over the lower half of the distributor to set up the second signal group upon the contacts of relay group 63. This may occur, of course, during the time that the preceding group is being repeated by the relay bank 58. As the brush 95 of the distributor TD engages the segment 91 a second time, a circuit is completed through the left contact of relay 105 to the opposite winding 114 of relay 106, conductor 123 and segment 86 of local ring 87, to ground, thus again reversing the relays 102 to 105 and applying marking and spacing battery respectively to the contacts of relay group 63.

Since the brushes of the multiplex distributor TD are rotating at a slightly faster speed than signals are being received over the simplex line, they change the angular position relative to the brushes of the start-stop distributor and consequently brush 95 may engage contact 91 either when the brush is at rest or in some cases twice during a single movement of the brushes 51 and 52. In the first case, the circuit through the relays 118 and 119 from the segment 91 is interrupted at the local ring 87 of the start-stop receiving distributor. In this event no code combination will be set up upon either relay bank when the brush of the distributor TD next crosses the transmitting segments and it is necessary, therefore, to apply spacing battery

to each of the segments at this time. This is accomplished by means of a relay 126 also connected to contact 91 through a resistance 127 of such value that the relay only operates when the circuit for relays 118 and 119 is uncompleted. Therefore if the circuit to these latter relays is open when the brush crosses segment 91, relay 126 is operated, thereby unlocking relay 118. As the brush 90 passes off of its contact 91, relay 118 drops back, deenergizing relay 112 thereby causing the tongue of this relay to return to its spacing contact, again applying spacing battery to both contacts of one of the relay banks 58 or 63 and thence to the segments of the transmitting distributor.

The brush 95 may engage the segment 91 just at the start of the movement of the brushes 51 and 52 of the start-stop distributor, in which case the segment 91 may again be closed during the latter part of the movement of the brushes 51 and 52. When this occurs, it is necessary to apply spacing battery to the segments of the multiplex channel following the second crossing, otherwise the same character will be repeated. Assuming this occurs while the brush 52 is on segment 86, upon the first engagement of the multiplex brush with the local segment 91, the circuit for winding 114 of relay 106 will be completed, moving the tongues of all the relays 102 to 105 to their righthand side. Consequently upon the next engagement of brush 95 with segment 91, the circuit to winding 14 will be interrupted at the lefthand contact of relay 105 and the circuit to winding 113 will be open at segment 85 of the start-stop distributor. Consequently the circuit through the windings of relay 118 and 119 is interrupted, thereby causing relay 126 to operate and restore spacing conditions to the transmitter segments. The multiplex distributor is therefore allowed to make an idle revolution restoring the proper phase relation of the simplex and multiplex distributors.

It will be noted, by virtue of the inherent speeds of rotation of the simplex and multiplex apparatus, and the ability of the simplex apparatus to receive at a slightly greater rate than it transmits, that a system has been provided in which signals may be repeated directly between simplex and multiplex apparatus without intermediate storage transmitters or equivalent apparatus.

It is obvious, of course, that numerous modifications and changes in the apparatus and circuit arrangements may be made without departing from the invention, and I contemplate all such changes as come within the scope of the appended claims.

What I claim is:

1. In a telegraph system, a multiplex system terminating at a main station, a simplex system extending from said main station to a distant station, means at the main station for storing each code combination of impulses received over a channel of the multiplex system, and means for starting the repeating of such stored code combination of impulses over the simplex system, upon reception of the first marking impulse of the combination.

2. In a telegraph system, a multiplex system terminating at a main station, a simplex system extending from said main station to a distant station, means at the main station for storing each code combination of impulses received over a channel of the multiplex system, a start-stop apparatus for repeating each signal combination of impulses over the simplex system, said apparatus starting its cycle of operation during the period of reception of said combination over the multiplex channel and being rendered inoperative when said multiplex channel is idle.

3. In a telegraph system, a multiplex system terminating at a main station, a simplex system extending from said main station to a distant station, means at the main station for storing each code combination of impulses received over a channel of the multiplex system, a start-stop apparatus for repeating each signal combination of impulses over the simplex circuit, and means responsive to signal current for starting said apparatus into operation.

4. In a telegraph system, a main station, a multiplex receiving distributor at said station having a plurality of receiving segments for each channel, a start-stop apparatus at said station, means for repeating signals received over one channel of said multiplex distributor to said start-stop apparatus, and means comprising a circuit established through a receiving segment of said multiplex distributor for starting said start-stop apparatus into operation.

5. In a telegraph system, a main station, a multiplex receiving distributor at said station, a start-stop apparatus at said station, electro-magnetically controlled storage means responsive to signals received on one channel of said multiplex distributor, a start magnet for said start-stop apparatus and a control relay in circuit with said electro-magnetic storage means for operating the start magnet in response to a marking condition received on said multiplex distributor.

6. In a telegraph system, a main station, a multiplex receiving distributor at said station, a start-stop apparatus at said station having a normal rest position, electro-magnetically controlled storage means responsive to signals received on one channel of said multiplex distributor, a start magnet for said start-stop apparatus, a control relay in circuit with said storage means for completing a circuit to said start magnet to operate said start-stop apparatus from rest position in

response to a marking condition received on the multiplex channel, and means for interrupting said circuit before the start-stop apparatus again reaches its rest position.

7. In a telegraph system, a branch station, a main station, simplex transmitting apparatus at the branch station, a multiplex transmitting apparatus and simplex receiving apparatus at said main station, a line connecting said main and branch stations, means for repeating signals from said simplex receiving apparatus to the multiplex apparatus, said latter apparatus completing each cycle of operation in a time not greater than that required to transmit a single character combination of impulses by said simplex transmitting apparatus.

8. In a telegraph system, a branch station, a main station, a line connecting said stations, simplex transmitting apparatus at the branch station, a multiplex transmitting apparatus and a simplex receiving apparatus at said main station, means for repeating signals from the simplex receiving apparatus to one channel of the multiplex apparatus, the character frequency of the multiplex channel being not less than the maximum character frequency of said simplex transmitting apparatus.

9. In a telegraph system, a branch station, a main station, a line connecting said stations, simplex transmitting apparatus at the branch station, a multiplex transmitting apparatus and a simplex receiving apparatus at said main station, means for repeating signals from the simplex apparatus to one channel of the multiplex apparatus, the character frequency of the multiplex channel being up to about 10% greater than the maximum character frequency of said simplex transmitting apparatus.

10. In a telegraph system, a main station, a multiplex transmitting distributor at the main station, a receiving distributor also at said main station, said multiplex transmitting distributor operating at a speed sufficient to make at least one complete revolution during the period of reception of a single code combination of impulses by said receiving distributor, and means for repeating signals from said receiving distributor to said transmitting distributor.

11. In a telegraph system, a main station, a multiplex apparatus at said station, a simplex system terminating at said station, and means for repeating to one channel of the multiplex apparatus each character combination substantially as soon as received at the main station over said simplex system, said simplex system being independent of control by said multiplex apparatus.

12. In a telegraph system, a main station, a multiplex transmitting distributor at said station, a simplex system terminating at said station, means for applying to one channel of said multiplex distributor each character code combination of impulses during the period of its reception at the main station over the simplex system, said simplex system operating independent of phase relation with said multiplex distributor.

13. In a telegraph system, a main station, a multiplex transmitting distributor at said station, a simplex system terminating at said station, means for applying to one channel of said multiplex distributor each character code combination of impulses substantially as soon as received at the main station over said simplex system, and means for receiving a succeeding character code combination of impulses over said simplex system during the period of transmission of the preceding combination by said multiplex distributor.

14. In a telegraph system, a main station, a multiplex apparatus at said station, a simplex system terminating at said station, a start-stop apparatus for receiving character code combinations of impulses in continuous succession over said simplex system, and means for transmitting each combination over one channel of said multiplex apparatus before a completion of the reception of the succeeding code combination over the simplex system.

15. In a telegraph system, a main station, a multiplex apparatus at the main station, a simplex system terminating at the main station, a start-stop receiving distributor for the simplex system having two groups of receiving elements, means for causing said groups of receiving elements to respond alternately to code combinations of impulses transmitted over the simplex system, and means for repeating said code combinations from said receiving elements to one channel of the multiplex apparatus.

16. In a telegraph system, a main station, a multiplex apparatus at the main station, a simplex system terminating at the main station, a start-stop receiving distributor for the simplex system having a plurality of groups of receiving elements, means for causing one of said groups of receiving elements to respond to each code combination of impulses transmitted over the simplex system, and means for repeating said code combinations from the receiving elements to one channel of the multiplex apparatus.

17. In a telegraph system, a main station, a multiplex apparatus at the main station, a simplex system terminating at the main station, a start-stop receiving distributor for the simplex system, two groups of storage elements operable alternately through the receiving distributor to store up code combinations of impulses received by said distributor and means for repeating said code combinations of impulses from the storage element over one channel of said multiplex apparatus.

18. In a telegraph system, a main station, a multiplex apparatus at the main station, a simplex system terminating at the main station, a start-stop receiving distributor for the simplex system, a plurality of groups of storage elements, one of said groups being operable through the receiving distributor in response to each character code combination received over the simplex system to store up said code combination of impulses, and means for repeating said code combinations in proper order from said storage elements over one channel of said multiplex apparatus.

19. In a telegraph system, a main station, a multiplex distributor at the main station, a simplex system terminating at the main station, a plurality of groups of storage elements, one of said groups being operable in response to each character code combination of impulses received over the simplex system to store up said code combination, and means for selectively associating said storage elements in proper order with one channel of said distributor for repeating said code combination over said channel.

20. In a telegraph system, a main station, a multiplex transmitting distributor at said station, a simplex system terminating at said station, means for applying to one channel of said multiplex distributor each character code combination of impulses during the period of its reception at the main station over the simplex system, said simplex system operating independent of phase relation with said multiplex system, said multiplex distributor operating at a slightly higher character frequency than said simplex system, and means for permitting said multiplex channel to idle at required intervals to restore the proper phase relation with said simplex system.

21. In a telegraph system, a main station, a multiplex line extending from said main station, a multiplex distributor associated with said line, a simplex system terminating at the main station, means for applying a code combination received over said simplex system to one channel of said multiplex distributor for transmission to said line, and means for applying spacing conditions to said multiplex channel after the transmission of said code combination.

22. In a telegraph system, a main station, a multiplex system having a transmitting distributor at said station, a simplex system terminating at said station, a signal storage device having marking and spacing contacts, said storage device being responsive to signals received over said simplex system, means for normally applying spacing potential only to said contacts, and means responsive to a code combination of impulses received over said simplex system for applying marking potential to said marking contacts, connecting said contacts to one channel of said multiplex distributor in accordance with the received combination for repeating the same over the multiplex system and after transmission of said signal combination, restoring spacing potential to said marking contacts.

23. In a telegraph system, a multiplex system terminating at a main station and having a multiplex distributor, a simplex apparatus at said main station, means for operating said simplex apparatus independently of said multiplex system, a storage element operable by said simplex apparatus for storing up code combination of impulses, means for applying said code combination from the storage element to one channel of the multiplex distributor in proper phase relation thereto, for transmitting said code combination over said multiplex system, and means for removing said combination from the distributor after transmission thereof.

24. In a telegraph system, a main station, a multiplex system terminating at said station, a simplex system also terminating at said station and having a receiving distributor and a transmitting distributor, means for repeating code combinations of impulses in either direction between said simplex and multiplex systems, said transmitting distributor being arranged to send signals at a rate slightly greater than the rate of reception of signals by said receiving distributor.

25. In a telegraph exchange system, a plurality of main stations, multiplex circuits extending between said main stations, a plurality of branch stations associated with each main station over simplex circuits, means for making connections between a branch station associated with one main station and a branch station associated with another main station whereby signals transmitted from apparatus at one of said branch stations will be communicated partially over a simplex circuit and partially over a multiplex circuit and received upon simplex recording mechanism at the other branch station, said recording mechanism being operable with a slightly shorter signal period than said transmitting apparatus.

In testimony whereof, I affix my signature.

LAURENCE W. FRANKLIN.