

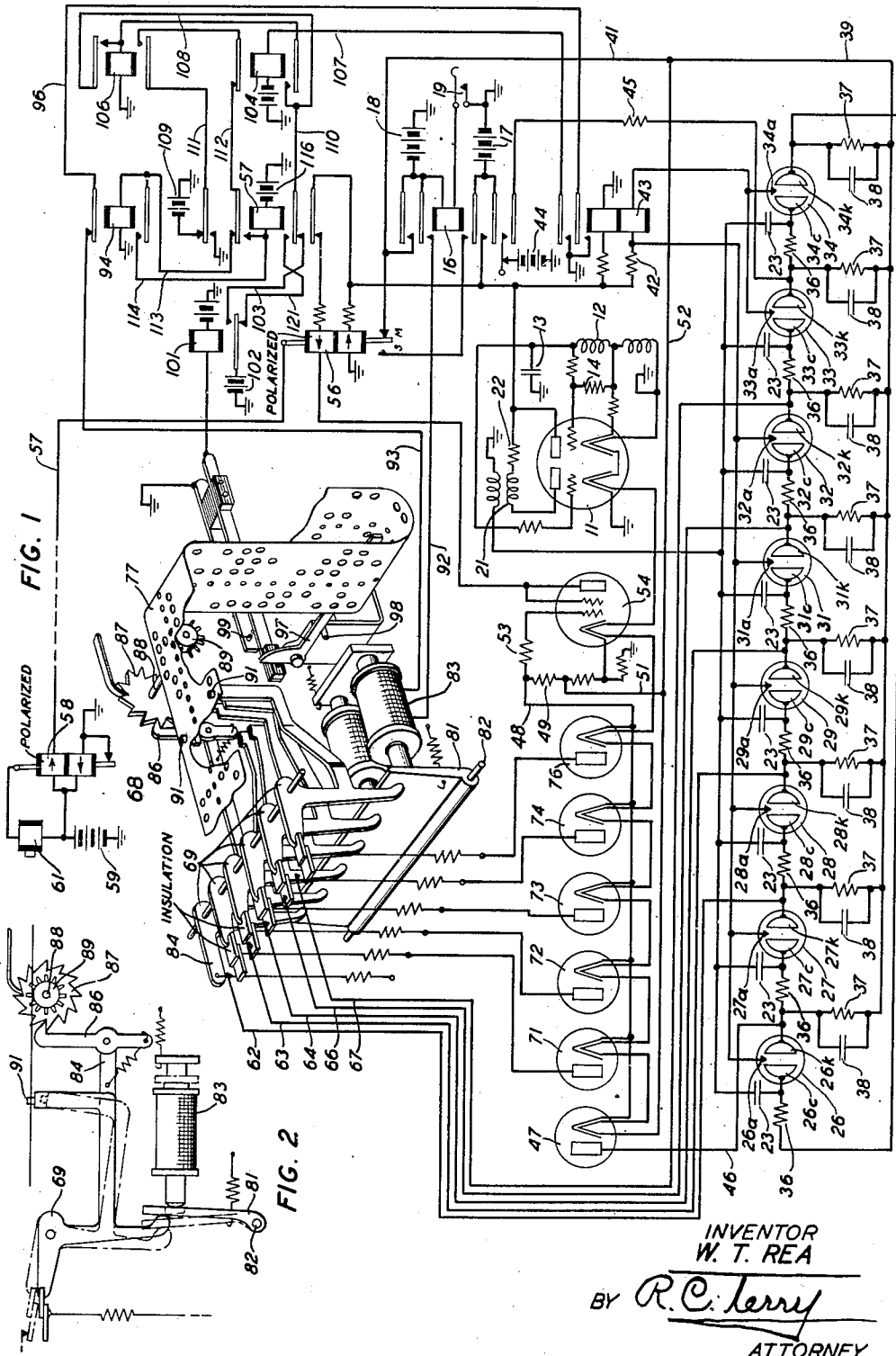
April 26, 1949.

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2,468,462

TELEGRAPH TRANSMITTER CONTROL MECHANISM

Filed July 4, 1945



UNITED STATES PATENT OFFICE

2,468,462

TELEGRAPH TRANSMITTER CONTROL
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Application July 4, 1945, Serial No. 603,207

8 Claims. (Cl. 178-17)

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This invention relates to telegraph transmitters and particularly to electronic transmitters and still more particularly to electronic transmitters controlled by perforated tape.

An object of the invention is to coordinate the tape sensing and tape feeding operations of a tape controlled telegraph transmitter with the operation of a transmitting distributor which operates continuously during transmission and during minor interruptions in transmission due to exhaustion of the supply of tape containing perforated signals to be transmitted.

Another object of the invention is to provide a taut tape control for an electronic transmitter having a continuously running electronic distributor.

Another object of the invention is to assure that there shall be no mutilation of a telegraph signal combination in process of being transmitted at the time that the taut tape mechanism becomes operated to suspend transmission of signals.

Another object of the invention is to assure that the taut tape mechanism, upon responding to a slack tape condition, shall permit transmission to resume only when the electronic distributor is about to begin a cycle, thereby to prevent mutilation of the first code combination to be transmitted.

Another object of the invention is to preclude alteration of the rest condition of the telegraph line by the continuously running distributor during the interval in which signal transmission is suspended.

In the preferred embodiment of the invention, an electronic distributor comprising a chain of electron discharge tubes interassociated in a closed ring relationship is operated by an oscillator at the rate of one step of the distributor per cycle of the oscillator. The frequency of the oscillator is such that each cycle has a duration of one impulse interval of telegraph signals to be transmitted. One tube of the distributor chain is allocated to timing the transmission of the start impulse of start-stop telegraph signals, several tubes, equal in number to the significant impulses of the code combinations, are allocated to timing the transmission of those impulses, and one or two tubes are allocated to timing the transmission of the stop impulse, depending upon whether that impulse is to be of equal duration with the start and significant impulses or is to be of twice the duration of any of those impulses.

A tape sensing mechanism is provided with transmitting contacts arranged on an inverse basis, to be open when the associated tape sensing element engages a perforation, representing a marking signal in a perforated tape, and to be

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closed when the associated tape sensing element engages an imperforate section of the tape, representing a spacing condition. The contacts associated with the tape sensing elements, when closed, complete conductive paths from the cathodes of the tubes in the counting chain allocated to the significant impulses of the code combination to the anodes of individual diode electron discharge tubes. The cathode of the tube in the counting chain allocated to the start impulse is connected directly to the anode of a diode electron discharge tube. As each tube in the counting chain is rendered conductive under the control of the oscillator, its cathode becomes more positive by virtue of the drop across a cathode resistor, and accordingly the anode of the diode electron discharge tube to which it is related is made correspondingly more positive if connected either directly or through the tape sensing contacts. The diode tubes are accordingly rendered conductive selectively under the joint control of the counting or distributor chain and the tape sensing contacts, the diode tube associated with the distributor tube representing the start impulse being rendered conductive invariably in each cycle of the distributor.

The control grid of a vacuum electron discharge tube is connected to the cathodes of all of the diode tubes, which become more positive as the diode tubes are rendered conductive by virtue of a common cathode resistor for the diode tubes. The grid controlled tube is normally biased to plate current cut-off, but as any one of the diode tubes is rendered conductive, the grid of the grid-controlled tube is made more positive and is rendered conductive. A transmitting relay has its operating winding included in the plate circuit of the grid-controlled tube and this relay has its biasing winding energized by current flowing in the direction to operate the armature of the relay to the marking contact, and when the grid-controlled tube is cut off, the armature engages the marking contact which is connected to telegraph signaling battery of marking polarity. The operating winding, upon being energized by plate current flowing in the grid-controlled tube, operates the armature to the spacing contact which is connected to telegraph signaling battery of spacing polarity. The armature of the transmitting relay is connected to a telegraph line over which signals are to be transmitted. With this arrangement, diode tubes are provided only for those tubes of the distributor chain representing signaling impulses which may be of spacing nature. The stop impulse is invariably of marking nature and accordingly no diode tubes are associated with the tube or tubes in the

counting chain allocated to timing the transmission of the stop impulse, the transmitting relay being operated to marking under the control of its biasing winding because none of the diode tubes can be conductive and the grid-controlled tube is cut off.

The tubes in the distributor chain allocated to the stop impulse are connected to the operating winding of a relay which is energizable to control a tape stepping magnet of the tape sensing mechanism. This magnet upon being energized retracts the tape sensing elements and advances the tape one step in well-known manner, and upon being released permits the tape sensing elements to sense the new signal combination presented to them. The tape sensing mechanism is provided with a pair of contacts controlled by a taut tape arm which permits the contacts to remain open when a supply of perforated tape is available to the transmitter, and which is lifted by the tape as it becomes taut, and closes the contacts. The taut tape contacts, upon being closed, set in operation a sequence circuit of relays the ultimate function of which is to interrupt the energizing circuit for the tape stepping magnet so that further advancement of the tape while the electronic distributor continues to run will be prevented, and to impose a steady marking condition on the transmitting relay, so that start impulses will not be impressed on the telegraph line as the distributor continues to run.

Since the taut tape controlled contacts are under the control of a tape, those contacts may become closed incident to a tape stepping operation, which occurs during the transmission of a stop impulse. The relay sequence system is first effective to disable the energizing circuit of the tape stepping magnet. If the closure of the taut tape contacts occurs during the transmission of a code combination, the energizing circuit of the tape stepping magnet will not be disabled until the tape has been advanced another step during the transmission of the stop impulse at the end of the code combination. If the closure of the contacts is coincident with a tape stepping operation, that operation will be completed before the disablement of the energizing circuit of the tape stepping magnet. The tape stepping operation is completed by the release of the tape stepping magnet as the distributor advances from its stop impulse condition to its start impulse condition. The relay sequence system is next effective to impose a steady marking condition on the transmitting relay. This occurs when the distributor has completed transmission of the last code combination presented to the tape sensing elements before the disablement of the stepping magnet circuit. The relay sequence circuit is also effective to reverse the relation of itself with respect to the taut tape contacts, in preparation for the re-starting of signal transmission when tape becomes available.

As long as the taut tape contacts remain closed, the energizing circuit for the stepping magnet remains disabled and the steady marking condition remains imposed on the transmitting relay, although the distributor continues to run, activating the diode tube corresponding to the start impulse and those corresponding to spacing signals sensed by the tape sensing mechanism, and also operating the control relay for the tape stepping magnet circuit once in each cycle of the distributor as it continues to run.

Tape may become available and cause the re-opening of the taut tape contacts independently

of the distributor and without regard to its condition at the instant of opening of the contacts. The opening of the taut tape contacts again brings into operation the relay sequence system. The relay sequence system is brought into operation as the distributor passes through its stop impulse condition, and is first effective upon the transition of the distributor from its stop impulse to its start impulse condition to restore the circuit of the tape stepping magnet to operative condition. Due to the fact that this restoration occurs after the distributor leaves its stop impulse condition, the release of the control relay for the tape stepping magnet occurs before the restoration of the stepping magnet circuit, so that the tape is not advanced until the distributor again enters the stop impulse portion of its cycle. The relay sequence system is next effective to remove the previously imposed steady marking condition on the transmitting relay. This occurs as the distributor advances from its stop impulse condition to its start impulse condition incident to which the tape stepping operation has been completed. The transmitting relay is thus restored to control by the electronic distributor. Also the relay sequence system again reverses its relation with respect to the taut tape contacts, thus reestablishing the original relationship so that it is prepared to respond to subsequent closure of the taut tape contact in the manner already described. In this way the interruption and resumption of signal transmission in response to alternate taut and slack tape conditions is coordinated with the operation of the continuously running distributor so that there is no loss or mutilation of a signal.

For a complete understanding of the invention, reference may be had to the following detailed description to be interpreted in the light of the accompanying drawings wherein:

Fig. 1 is a diagrammatic view showing an electronic distributor and taut tape stop control mechanism in accordance with a preferred embodiment of the invention; and

Fig. 2 is an elevational view showing in schematic form the mechanical details of the tape sensing and tape advancing mechanism.

Referring now to the drawing the electronic distributor and signal transmitting system which is about to be described in complete detail, and with which the taut tape controlled tape sensing mechanism is associated, is disclosed in copending application Serial No. 499,949, filed August 25, 1943, by J. R. Wilkerson, which has matured into Patent 2,412,642, granted December 17, 1946. In Fig. 1, the reference numeral 11 designates an electron discharge tube of the vacuum type comprising two triode sections in one envelope which serve as oscillator and detector. It will be understood that two single triode tubes could be employed if desired instead of one double triode tube. The right-hand triode section of the tube is the oscillator section and the upper portion of a tapped inductance 12 is connected between the control grid and the cathode of the right-hand triode section of the tube. The lower portion of the inductance 12 is connected between the cathode and ground. A condenser 13 is connected in parallel with the inductance 12, and the inductance 12 and condenser 13 have such inductive and capacitive values respectively that the resonant frequency of the network is equal to the impulse frequency of telegraph signals to be transmitted, from which it follows that the duration of one cycle of the frequency to which the

network is tuned is equal to the duration of one impulse to be transmitted. A leakage resistor 14 is connected between the control grid and the cathode of the right-hand triode section of the tube.

The right-hand anode of the tube is connected to the middle lower front contact of a relay 16, the middle lower armature of which is connected to positive battery 17. Relay 16 is energizable over a circuit including a battery 18 and a manually operable locking key 19. Relay 16 is operable to establish all power connections to the apparatus shown in Fig. 1, and when the relay is energized, the positive terminal of battery 17 is connected to the anode of the right-hand triode section of tube 11. Since the lower section of the inductance 12 is connected in the cathode return circuit of the right-hand triode section of tube 11, between the cathode and ground, it serves to induce energy into the upper section of the inductance and thus to sustain oscillation, so that with relay 16 energized the right-hand triode section of tube 11 oscillates continuously at the frequency to which the network comprising inductance 12 and condenser 13 is tuned.

The grid of the left-hand or detector section of the tube 11 is connected to the upper terminal of inductance 12 so that the potential of the grid of the left-hand triode section is varied in accordance with the oscillatory operation of the network comprising inductance 12 and condenser 13. The cathode of the left-hand triode section of the tube is connected to ground and the anode is connected through the primary winding of a transformer 21, load resistor 22, and lower middle front contact and armature of relay 16 to positive battery 17. During the portion of each cycle of oscillation in which the upper terminal of inductance 12 is positive with respect to ground, the grid of the left-hand triode section of the tube will be positive with respect to the cathode and the tube will be conductive. During the rising portion of the positive half cycle a voltage at one polarity is induced in the secondary winding of transformer 21 and during the falling portion of the half cycle a voltage of the opposite polarity is induced in the secondary of the transformer. During the negative half cycle no voltage of any significance is induced in the secondary winding of transformer 21 because the grid of the left-hand or detector section of tube 11 is negative with respect to the cathode and little or no anode current flows, depending upon whether anode current is completely cut off.

The secondary of transformer 21 has one terminal connected to ground and the other terminal connected through eight condensers 23 in parallel to the control anodes 26c, 27c, 28c, 29c, 31c, 32c, 33c and 34c of eight gas-filled cold cathode electron discharge tubes designated by the reference numerals 26, 27, 28, 29, 31, 32, 33 and 34. The cathode 26k of tube 26 is connected through a resistor 35 to the control anode 27c of tube 27. The cathode 27k of tube 27 is connected through a similar resistor 35 to the control anode 28c of tube 28. In like manner the cathodes 28k, 29k, 31k, 32k and 33k of tubes 28, 29, 31, 32 and 33, inclusive, are connected through individual resistors 36 to the control anodes 29c, 31c, 32c, 33c and 34c of the tubes 29, 31, 32, 33 and 34, respectively. Finally, the cathode 34k of tube 34 is connected through a resistor 36 to the control anode 26c of tube 26. Thus there is a closed ring of interconnections between the cathodes and control anodes of the eight cold cathode tubes. The

cathode of each of the cold cathode tubes is also connected through an individual resistor 37 shunted by an individual condenser 38 to a conductor 39 which connects through conductor 41 and the outer upper front contact and armature of relay 16 to the negative terminal of battery 18.

The main anodes 26a, 27a, 28a, 29a, 31a and 32a of tubes 26, 27, 28, 29, 31 and 32, respectively, are connected to one terminal of a resistor 42, the other terminal of which is connected to the middle lower front contact of relay 16. The main anodes 33a and 34a of tubes 33 and 34, respectively, are connected through the operating winding of a relay 43 to the same terminal of resistor 42 to which the main anodes of tubes 26 to 29, 31 and 32 are directly connected. Thus the resistor 42 is common to the anode circuits of all of the tubes.

Upon the closure of manually operable key 19 relay 16 operates and connects the batteries for operating tube 11 and the cold cathode tubes. The right-hand triode section of tube 11 at once begins to oscillate at the desired frequency, and the detector section of tube 11 generates one positive and one negative impulse in the secondary of transformer 21 per cycle of oscillation of the oscillator section of tube 11. These potentials are applied through all of the condensers 23 simultaneously to the control anodes of the eight cold cathode tubes. As a result of each positive impulse, the control anode of each of the cold cathode tubes is made more positive with respect to the cathode than it previously was. However, the potential of such positive impulse is insufficient to fire the cold cathode tubes.

It is necessary to prime one of the cold cathode tubes in order to set the distributor chain in operation, and for this purpose the outermost lower armature and make-before-break contact combination of relay 16 is employed. The armature is connected through resistor 45, to the cathode terminal of resistor 36 connected between the cathode of tube 33 and the control anode of tube 34. The make-before-break contact is left unconnected and the stationary contact with which it cooperates is connected to the positive terminal of battery 44. When relay 16 is operated there is an instant when the outermost lower armature of relay 16 has engaged the movable front contact and has not disengaged it from the stationary contact. During this instant battery 44 is connected over the path extending from the armature, and applies a positive potential to the control anode of tube 34 which fires the tube. The discharge transfers to the main gap, and as the outermost lower armature of relay 16 completes its operation the battery 44 is disconnected from the control anode 34c of tube 34. The firing potential could be applied to any one of the cold cathode tubes but when applied as hereinbefore described it avoids starting the distributor chain in the middle of a cycle.

The discharge current in tube 34 flows through the cathode resistor 37 associated with the cathode 34k of the tube and raises the potential of this cathode with respect to the cathodes of all of the other cold cathode tubes, since no current is flowing in their cathode resistors. Since the control anode 26c of tube 26 is connected to the cathode 34k of tube 34 through the intervening resistor 36, the potential of the control anode 26c of tube 26 is made correspondingly more positive than the cathode 26k of that tube but this increase in potential is a priming potential only and is insufficient to fire tube 31. The condition

now existing is that tube 34 is conductive and tube 26 is primed. Upon the production of the next positive impulse in the secondary of transformer 21 the positive voltage is impressed upon the control anodes of all of the tubes through condensers 23. In the case of tube 26 this positive potential further raises the potential of the control anode 26c with respect to the cathode 26k and the tube 26 fires, the discharge transferring at once to the main anode 26a. None of the tubes 27 to 29 and 31 to 33 is fired because they are not primed.

The initial space current in tube 26 does not immediately develop a potential difference across the cathode resistor 37 associated with that tube, as the current initially flows to charge condenser 38, which delays the development of full potential difference across the cathode resistor 37 with which the condenser is associated. Thus even though tube 26 is conductive between its cathode and main anode there is a momentary interval during which the cathode 26k remains at substantially the same potential as the cathodes of all of the other tubes except tube 34, the cathode 34k of which is more positive than the cathodes of the non-conductive tubes because the condenser associated with its cathode resistor has become charged by this time and there is a potential difference across its cathode resistor. It is a characteristic of cold cathode gas-filled electron discharge tubes that as soon as the tube becomes conductive in its main gap, the potential difference between the main anode and the cathode decreases to the discharge sustaining potential, which is considerably less than the potential difference which must exist between the main anode and the cathode in order to establish a discharge between those electrodes. Since the main anode 26a of tube 26 is connected directly to the main anodes of tubes 27 to 29, 31 and 32, and is connected to the main anodes of tubes 33 and 34 through the winding of relay 43, which is a low resistance winding, the potential difference between the main anode and the cathode of each of those other tubes is correspondingly decreased. The decrease occurs as a lowering of the anode potential with respect to the cathode, because all of the cathodes momentarily remain at the same potentials, while the drop across anode resistor 42 increases due to the anode current of tube 26 added to that of tube 34. The potential difference between the main anode 34a and the cathode 34k of tube 34 at this time is less than the potential difference between the main anode and cathode of any other tube due to the potential difference across the cathode resistor 37 associated with the tube 34, and the decrease in potential difference as tube 26 adjusts itself to the steady operating condition reduces the potential difference in tube 34 below the discharge sustaining potential. This causes tube 34 to be quenched. Thereafter the potential difference across the main gap of tube 34 increases as the drop across anode resistor 42 is decreased due to the cutting off of anode current through tube 34, as the condenser 38 associated with its cathode resistor discharges through the cathode resistor and as the condenser 38 associated with the cathode resistor 37 of tube 31 charges through the main gap of tube 26. The value of these condensers is so chosen as to allow the extinguished tube time in which to deionize before the voltage across its main gap rises to full value. As the condenser 38 associated with the cathode resistor 37 of tube 26 becomes charged the voltage across

the cathode resistor rises to a value which is the difference between the discharge sustaining potential across the main gap of the tube and the voltage across resistor 42 and batteries 17 and 18 in series. Had any other tube or tubes than the tube 34 been conducting at the time that tube 26 was fired the voltage across the main gap of such other tube or tubes would have decreased below the discharge sustaining potential and such tube or tubes would have been quenched in the same manner that tube 34 was extinguished. In this way the circuit is so arranged that any tube upon being rendered conductive quenches the tube preceding it in the chain or any other tube that may have been conducting at that time.

With the development of a voltage across the cathode resistor 37 associated with tube 26, the tube 27 is primed by having the potential of its control anode 27c raised above the potential of its cathode 27k to the same potential as the cathode 26k of tube 26. The next positive impulse generated in the secondary of transformer 21 and applied to all of the condensers 23 will cause the tube 27 to become conductive and this tube, in becoming conductive, will quench tube 26 in the manner that tube 26 quenched tube 34. As the detector section of tube 11 continues to generate impulses the cold cathode tubes are fired in succession and when tube 34 is fired it primes tube 26 by virtue of the connection between the cathode 34k of tube 34 and the control anode 26c of tube 26. From this it will be apparent that the counting chain of cold cathode gas-filled tubes goes through repeated cycles of counting operations as long as power remains connected to the oscillator and rectifier tube 11 and to the cold cathode tubes. In each cycle of the chain of cold cathode tubes eight intervals are counted. The interval between the firing of tube 26 and the firing of tube 27 is allotted to the start impulse, the interval between the firing of tube 27 and tube 28 is identified with the first code impulse, the interval between the firing of tube 32 and tube 33 is identified with the fifth code impulse and the interval between the firing of tube 33 and the refiring of tube 26 is identified with the stop impulse, which has a duration twice as great as the start impulse and the code impulses by virtue of the provision of the two tubes 33 and 34.

The cathode of tube 26 is connected through conductor 46 to the anode of an electron discharge tube 47 which is a diode or half wave rectifier tube. The cathode of diode tube 47 is connected through conductor 48, resistor 49 and conductors 51 and 52 to conductor 41 to which the cathodes of the cold cathode tubes are connected through their respective cathode resistors as previously described. When tube 26 is not conducting its cathode 26k is at the potential of conductor 41 and the anode of rectifier tube 47 is at this potential. The cathode of tube 47 is also at the potential of conductor 41 so that no current flows in tube 47. When cold cathode tube 26 becomes conductive and its cathode 26k becomes more positive than conductor 41 by the potential difference across its cathode resistor 37, the anode of tube 47 becomes more positive than the cathode of that tube and tube 47 draws current.

The cathode of tube 47 is connected through resistor 53 to the grid of electron discharge tube 54 which is preferably a vacuum tube. Due to the flow of current through the cathode resistor 49 of rectifier tube 47, the cathode becomes more positive when the tube draws current than it previously was. Thus the grid of tube 54 is ren-

dered more positive with respect to its cathode and the conductivity of tube 54 is increased.

The anode of tube 54 is connected through the operating winding of a transmitting relay 56, the outer lower back contact and armature of a relay 57 to the middle lower front contact of relay 16, which receives positive battery connection from battery 17 through the associated armature. Relay 56 is a biased polar relay and the current through the biasing winding is in the direction to drive the armature into engagement with its marking contact which receives negative battery connection from battery 18 through the outer upper front contact and armature of relay 16. The anode current of tube 54 flowing through the operating winding of relay 56 drives the armature to the spacing contact, which has positive potential applied to it from battery 17 through the innermost lower armature and front contact of relay 16. The armature of transmitting relay 56 is connected to a telegraph line 57 which extends to a remote station to which signals are to be transmitted, and is there connected through the operating winding of a biased polar relay 58 to positive battery 59. The marking contact of relay 58 is connected to ground and the armature is connected through the winding of the selector magnet 61 of a teletypewriter printer to battery 59. The teletypewriter printer may be of the type shown in Patent 1,904,164 granted April 18, 1933, to S. Morton et al., and the disclosure of that patent is incorporated herein by reference to the same extent as if it had been included herein in its entirety. For the purposes of the present disclosure selector magnet 61 will be understood as representing the teletypewriter printer. When transmitting relay 56 is on the marking contact battery 18 is connected in series aiding relation to battery 59 and current flows in the operating winding of receiving relay 58, operating the armature of that relay to marking and energizing the winding of selector magnet 61. When relay 56 operates to spacing, battery 17 is connected in series opposition to battery 59, current in the operating winding of relay 58 is diminished or substantially cut off and the biasing winding of that relay operates the armature away from the marking contact, interrupting the circuit of the selector magnet 61 and producing a spacing condition thereof. The spacing condition impressed on line 57 while rectifier tube 47 is conductive represents the start impulse of a telegraph code signal.

The cathodes 27k, 28k, 29k, 31k and 32k of tubes 27, 28, 29 31 and 32, respectively, are connected by conductors 62, 63, 64, 65 and 67 respectively, to five contact elements of a tape transmitter designated generally by the reference numeral 68. The cooperating contact elements which are controlled by five tape-sensing levers 69 are connected to the anodes of five diode rectifier tubes 71, 72, 73, 74 and 76. These diode tubes have their cathodes connected to the cathode of tube 47 and to the grid of tube 54 through resistor 53 so that when conductive they control tube 54 in the same manner as tube 47, to energize the operating winding of relay 56 and operate the armature to spacing.

The tape sensing levers 69 are arranged to sense the code perforations in a perforated tape 77 and the contacts associated with tape sensing levers 69 are so related to the levers that the contacts are open when a tape sensing lever senses a perforation in the tape, and are closed when a tape-sensing lever engages an imperforate

portion of the tape. The imperforate portions of the tape represent spacing conditions whereas the perforations represent marking conditions, so that the transmitting contacts are closed for the spacing condition and tubes 71, 72, 73, 74 and 76 are rendered conductive for a spacing condition, corresponding to the conductivity of tube 47 for the start impulse. As each of the tubes 27, 28, 29, 31 and 32 in the distributor chain is rendered conductive it renders its associated diode tube conductive if the transmitting contacts intervening the cold cathode tube and the diode tube are closed.

The tape sensing levers 69 are provided with depending arms engaging a bail 81 pivoted at 82. A solenoid magnet 83 is provided for rocking bail 81 in counter-clockwise direction to rock the tape sensing levers 69 in clockwise direction, thereby retracting the tape sensing levers from engagement with tape 77.

Bail 81 also controls a lever 84 pivoted on the same axis as tape sensing levers 69 and provided with a pivoted pawl 86 which engages a ratchet 87 secured to a shaft 88. Shaft 88 also has secured thereto a feed wheel 89 provided with radially extending pins which engage the feed perforations in tape 77. Each time that electromagnet 83 is energized and rocks the tape sensing levers 69 in clockwise direction, it also rocks tape feed lever 84 in clockwise direction, causing pawl 86 to advance ratchet 87 a distance of one tooth. Ratchet 87 rotates feed wheel 89 through shaft 88 and advances perforated tape 77 one step to bring the next code combination into registry with the tape sensing pins 91 carried by tape-sensing lever 69. When electromagnet 83 is released tape sensing levers 69 are permitted to rock counterclockwise and sense the new combination in the tape, and tape feed lever 84 is permitted to rock in counter-clockwise direction, the pawl 86 picking up the next tooth on ratchet 87.

Electromagnet 83 is energizable in a circuit from the negative terminal of battery 18 through the inner upper armature and front contact of relay 16, conductor 92, energizing winding of the electromagnet, conductor 93, back contact and upper armature of a relay 94, conductor 96 and inner armature and front contact of relay 43 to ground. As previously described the energizing winding of relay 43 is included in the anode circuit of tubes 33 and 34 in the distributor chain, so that relay 43 becomes energized upon the activation of tube 33 at the beginning of transmission of the stop impulse and remains energized until tube 34 is quenched upon the firing of tube 26 at the beginning of the start impulse. Relay 43 in turn energizes and releases electromagnet 83 providing relay 94 is released.

Perforated tape 77 is prepared in a perforator which may be of the type shown in Patent 1,182,179, granted May 9, 1916, to C. L. Krum et al. As the tape issues from the perforator (not shown) it passes under a pivoted taut tape arm 97 which is disposed between the perforator and the tape sensing mechanism. As long as the supply of tape between the perforator and the tape sensing mechanism exceeds a predetermined minimum, taut tape lever 97 will rest against a stop 98 and contacts 99 which lever 97 is arranged to close will remain open. As soon as the supply of tape decreases below the predetermined minimum, which may occur if the tape 77 issues from the perforator more slowly than it is advanced by feed wheel 89, or if the operation of the perforator is suspended, tape 77

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will lift lever 97 and close contacts 99. These contacts complete the energizing circuit of a relay 101. Relay 101 completes a conductive path from battery 102 through the armature and front contact of the relay, conductor 103, lower inner armature and back contact of relay 57, and conductor 110 to the lower front contact of a relay 104. A conductive path extends from the lower armature of relay 104 through the winding of a relay 106 to ground. From this it will be apparent that relay 106 will become energized from battery 102 under the joint control of relays 101 and 104. Relay 104 is energizable over a circuit including conductor 107 and the outer armature and front contact of relay 43. As previously described, relay 43 is energized during the transmission of the stop impulse when tube 33 and thereafter tube 34 are energized. From this it will be apparent that under the control of relay 43, relay 104 and the electromagnet 83 will be energized simultaneously. Since electromagnet 83 effects the advancement of tape 77 and therefore is likely to be the instrumentality which will cause contacts 99 to close, it is probable that relay 104 will be energized at the time contacts 99 close and will have prepared the energizing circuit for relay 106 so that relay 106 will become energized immediately following the energization of relay 101. If relay 104 should not be energized at the time relay 101 becomes energized, the energization of relay 106 will await the energization of relay 104 during the transmission of a stop impulse.

The relay 106, upon being energized, completes its holding circuit through its upper front contact and armature, conductors 108 and 110, inner lower armature and front contact of relay 57, conductor 103 and front contact and armature of relay 101 to battery 102. Relay 106 also completes a conductive path from battery 109 through the back contact and outer upper armature of relay 57, conductor 111, lower armature and front contact of relay 106 to the upper armature of relay 104. Upon the release of relay 104 under the control of relay 43, after relay 106 has operated, this path is extended over conductor 112, the inner upper armature and back contact of relay 57, conductor 113 and winding of relay 94 to ground, and the relay 94 becomes energized over this circuit. At its upper armature and back contact, relay 94 interrupts the energizing circuit for electromagnet 83. The electromagnet will not have been in the energized condition at the time of interruption of its energizing circuit by relay 94 because relay 94 could not become energized until relay 104 had been released by relay 43 and the latter relay releases electromagnet 83 at the same time that it releases relay 104. As long as relay 94 remains energized it will prevent the energization of electromagnet 83 and the advancement of tape 77, although the electronic distributor chain continues to operate and relay 43 is operated each time tubes 33 and 34 are rendered conductive.

The lower armature of relay 94 is connected to conductor 113 and the front contact with which it cooperates is connected through conductor 114 and the winding of relay 57 to battery 116. It follows from this that upon the operation of relay 94, connection from battery 109 is extended through the outer upper armature and back contact of relay 57, conductor 111, lower armature and front contact of relay 106, upper armature and back contact of relay 104, conductor 112, inner upper armature and back contact of relay 57, conductor 113, and over the lower

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armature and front contact of relay 94, conductor 114 and the winding of relay 57 to battery 116. The batteries 109 and 116 have like poles grounded and so are connected in series opposition through the winding of relay 57 and this relay does not become energized as an immediate result of the energization of relay 94. Relay 94 remains energized and relay 57 remains released while the code combination advanced to the tape sensing pins just prior to the interruption of the energizing circuit of electromagnet 83 at the upper armature and back contact of relay 94 is transmitted. Following the transmission of the last significant impulse of this code combination under the control of tube 32, tube 33 is activated and operates relay 43 which in turn operates relay 104 but not electromagnet 83. At its upper armature and back contact, relay 104 disconnects battery 109 from conductor 113 but relay 94 does not release because an energizing circuit is now traced from ground through the winding of the relay, the lower armature and front contact, conductor 114 and winding of relay 57 to battery 116. Thus the relay 57 becomes energized in series with relay 94. At its outer upper armature ground on the front contact is substituted for battery 109 on the back contact and this connection is extended over conductor 111. At this time this connection is extended only to the upper armature of relay 104 because that relay is energized and the armature is disengaged from its back contact. At its inner upper armature, the relay 57 disconnects conductor 112 from conductor 113 and connects conductor 112 directly to the winding of relay 57 on the ground side thereof, which is the terminal remote from that to which battery 116 is connected. Since conductor 112 extends to the upper back contact of relay 104 which is not at this time engaged by its armature, the operation of the inner upper armature of relay 57 has no immediate effect. At its inner lower armature the relay 57 interrupts the holding circuit for relay 106 and prepares an energizing circuit for relay 106 from the back contact of relay 101. Since relay 101 remains energized while the tape contacts 99 remain closed, relay 106 cannot be reenergized until these contacts open. With relay 106 released, the ground connection extended through the outer upper front contact and armature of relay 57 and conductor 111 terminates at the lower armature of relay 106 so that this connection will not be extended to the ground terminal of the winding of relay 57 when relay 104 is released at the end of transmission of the stop impulse. Finally, relay 57, at its outer lower armature and back contact interrupts the anode circuit of tube 54 including the operating winding of transmitting relay 56. Tube 54 is thereby disabled along with the operating winding of transmitting relay 56, and the biasing winding holds the armature on the marking contact, transmitting a steady marking condition over line 57.

As another cycle of the distributor chain is initiated by the activation of tube 26 and the quenching of tube 34, relay 104 releases. This has no effect on the relays 57 and 94 which remain energized in series, nor on the relay 106 which remains released. With tube 26 rendered conductive, diode tube 47 becomes conductive, representing the start impulse, but with tube 54 disabled this impulse is not made effective upon transmitting relay 56. Likewise, as tubes 27, 28, 29, 31, and 32 are rendered conductive, the tubes

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71, 72, 73, 74, and 76 corresponding to the code combination sensed by the tape sensing levers 69, the electromagnet 83 being in the released condition, are rendered conductive in succession, but they likewise have no effect on tube 54 or relay 56. Each time that tube 33 is rendered conductive as the distributor chain continues to operate, relay 43 is operated and in turn operates relay 104 and each time tube 34 is quenched, these relays are released. The energization and release of these relays effects no change in the condition of relays 57, 94 and 106 nor does it effect any change in the condition of electromagnet 83 which remains released due to the interruption of its energizing circuit at the upper back contact and armature of energized relay 94. The condition of the transmitter is that the code combination which is at this time presented to and being sensed by the tape sensing lever 69 has been transmitted, and the tape remains at rest.

As soon as the supply of tape for the transmitter is increased by the perforation of additional signals therein, the tape loop passing under the taut tape lever 97 will increase and permit that lever to rock in clockwise direction so that taut tape contacts 99 open. This may occur at any time in the cycle of the distributor chain, by which is meant that any one of the cold cathode tubes may be conductive at the instant of the opening of contacts 99.

Upon the opening of the contacts 99, relay 101 releases. A conductive path is now extended from battery 102 through the armature and back contact of relay 101, conductor 121, inner lower front contact and armature of relay 57, which is operated, and conductor 110 to the lower front contact of relay 104. Thus a circuit is prepared for the operation of relay 106 but the completion of this circuit awaits the operation of relay 104 by relay 43 when tube 33 is rendered conductive. When this occurs relay 106 is energized. This relay again completes its holding circuit in the previously described manner through its upper front contact and armature, conductor 108, conductor 110, the inner lower armature and front contact of relay 57, conductor 121 and the back contact and armature of relay 101 to battery 102. Due to the fact that relay 57 is operated, relay 106 extends a ground connection from the outer upper front contact of relay 57 through the associated armature, conductor 111 and the lower armature and front contact of relay 106 to the upper armature of relay 104 which is out of engagement with its back contact because relay 104 is operated. Upon the release of relay 104 as distributor tube 34 is quenched, this ground connection is now extended over conductor 112, the inner upper armature and front contact of relay 57, directly to the ground terminal of the winding of that relay, holding the relay energized but short-circuiting the winding of relay 94 which thereupon releases. At its upper armature and back contact, relay 94 prepares the energizing circuit for electromagnet 83, but this magnet does not become energized because prior to the release of relay 94, relay 43 released and disconnected ground from conductor 96 extending to the upper armature of relay 94. Since relay 57 remains energized while the distributor chain operates through this cycle, tube 54 remains disabled and the previously transmitted code combination presented to the sensing pins, not yet advanced out of registry with the pins, is not retransmitted.

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Upon the activation of tube 33 at the end of the cycle of the distributor, relay 43 is again operated and the conductive path from its outer armature to electromagnet 83 now being complete, the magnet 83 is operated to advance tape 77. Relay 104 is also operated by relay 43 and interrupts at its upper armature and back contact the circuit of relay 57, so that this relay releases. As the relay 57 releases, it performs the reverse of all the operations it previously performed. At its outer lower armature, it re-connects positive battery through the operating winding of transmitting relay 56 to the anode of tube 54 thereby restoring tube 54 and relay 56 to control by the diode tubes. At its inner lower armature, the relay 57 interrupts the holding circuit of relay 106 around the lower armature and front contact of relay 104 and the energizing circuit for relay 106 through the lower armature and front contact of relay 104, thereby releasing the relay 106, and prepares an energizing circuit for the relay 106 from the front contact of relay 101. At its inner upper armature, the relay 57 disables its holding circuit which previously had been interrupted at the upper armature and back contact of relay 104 and prepares the energizing circuit for relay 94. At its outer upper armature, the relay 57 substitutes the battery 109, necessary to the subsequent energization of relay 94, for the ground connection which previously was employed to short-circuit and thereby release relay 94 and to hold relay 57 alone.

By the foregoing operations, the tape stop control mechanism has been restored to its initial condition, and as the distributor chain continues to operate, the signals contained in tape 77 will be transmitted as long as there is a sufficient supply of tape available to permit contacts 99 to remain open. By virtue of the hereinbefore described relay sequence system comprising relays 57, 94, 104 and 106, transmission of signals may be stopped and restarted under the control of taut and slack tape conditions, respectively, in timed relation to the operation of the continuously running electronic distributor so that code combinations are not mutilated as transmission is interrupted or as it is resumed, no code combination is lost and none is transmitted twice. Furthermore, during intervals when transmission is suspended, the transmission of start impulses and code impulses by the continuously running distributor is precluded and the telegraph line is maintained in the steady marking condition, thereby maintaining the receiving printer at the remote terminal of the line at rest.

Although a particular embodiment of the invention has been disclosed herein and described in the foregoing specification, it will be understood that the invention is not limited to such specific embodiment but is capable of modification and rearrangement without departing from the spirit of the invention and within the scope of the appended claims.

What is claimed is:

1. In a tape controlled telegraph transmitter, a distributor running continuously during message transmission and during no-message transmission, a tape stepping mechanism, means controllable by said distributor for operating said tape stepping mechanism once for each cycle of said distributor, means responsive to a predetermined minimum of tape available to said transmitter for estopping operation of said tape stepping mechanism by said operating means and for suppressing

signal transmission, and means for causing said last-mentioned means to become effective only at a predetermined time relative to a cycle of said distributor.

2. In a tape controlled telegraph transmitter, a continuously running distributor, a tape stepping mechanism, means controlled by said distributor for operating said tape stepping mechanism once for each cycle of said distributor, means for disabling said tape stepping means, means for suppressing signal transmission, means responsive to a predetermined minimum of tape available to said transmitter for controlling said disabling means and said signal transmission suppressing means, and means for causing said signal transmission suppressing means to become effective one cycle of said distributor after said disabling means.

3. In a tape controlled telegraph transmitter, a distributor running continuously during message transmission and during no-message transmission and adapted to transmit start, code and stop impulses, a tape stepping mechanism, means controllable by said distributor for operating said tape stepping mechanism once for each cycle of said distributor, means for disabling said tape stepping means without inhibiting the operating means for said tape stepping mechanism, means for suppressing signal transmission, means responsive to a predetermined minimum of tape available to said transmitter for controlling said disabling means and said signal transmission suppressing means, and means controlled by said distributor for causing said disabling means and said signal transmission suppressing means to operate in succession during non-code impulse transmitting portions of successive cycles of said distributor.

4. In a tape controlled telegraph transmitter, a continuously running distributor adapted to transmit telegraph impulses, a tape stepping mechanism, means controlled by said distributor for operating said tape stepping mechanism once in each cycle of said distributor, means for disabling said tape stepping mechanism, means for suppressing signal transmission, circuit controlling means responsive to a predetermined minimum of tape available to said tape stepping mechanism, a relay controlled by said circuit controlling means, and sequence means controlled jointly by said relay and said distributor for causing said disabling means and said transmission suppressing means to be operated in successive cycles of said distributor.

5. In a tape controlled telegraph transmitter, a continuously running distributor adapted to transmit telegraph impulses, a tape stepping mechanism, means controlled by said distributor for operating said tape stepping mechanism once in each cycle of said distributor, means for disabling said tape stepping mechanism, means for suppressing signal transmission, control means responsive to a predetermined minimum of tape available to said tape stepping mechanism, sequence means controlled jointly by said control means and said distributor for causing said disabling means and said suppressing means to be operated in successive cycles of said distributor, and means controlled by said sequence means for causing said sequence means to restore said disabling means and said suppressing means in successive cycles of said distributor upon response of said control means to availability of tape in excess of said predetermined minimum.

6. In a tape controlled telegraph transmitter,

a continuously running distributor adapted to transmit telegraph impulses, a tape stepping mechanism, means controlled by said distributor for operating said tape stepping mechanism once in each cycle of said distributor, means for disabling said tape stepping mechanism, means for suppressing signal transmission, switching means operable in response to a predetermined minimum of tape available to said tape stepping mechanism and restorable in response to availability of tape in excess of said predetermined minimum, a relay sequence system controlled jointly by said operated switching means and said distributor for causing said disabling means and said suppressing means to be operated in successive cycles of said distributor, and means controlled by said relay sequence system for conditioning said relay sequence system to operate in response to restoration of said switching means to restore said disabling means and said suppressing means in successive cycles of said distributor.

7. In a tape controlled telegraph transmitter, a continuously operating oscillator, an electronic distributor operable in repetitious cycles and comprising a plurality of electron discharge tubes adapted to be activated successively by said oscillator, a tape sensing mechanism, a transmitting mechanism controlled jointly by said distributor and said tape sensing mechanism, a tape stepping mechanism operable by said distributor once per cycle thereof, means for disabling said tape stepping mechanism, means for suppressing operation of said transmitting mechanism, control means responsive to a predetermined minimum of tape available to said tape sensing mechanism, sequence means controlled jointly by said control means and said distributor for causing said disabling means and said suppressing means to be operated in successive cycles of said distributor, and means controlled by said sequence means for causing said sequence means to restore said disabling means and said suppressing means in successive cycles if said distributor upon response of said control means to availability of tape in excess of said predetermined minimum.

8. In a telegraph signal transmitter, a tape sensing mechanism including tape advancing means, a distributor operating continuously during message transmission and during no-message transmission and including means for causing the generation of a start impulse of spacing nature once in each cycle of said distributor, means in said distributor for supplying tape advancing pulses to said tape advancing means, means responsive to a taut condition of said tape for preparing to disable said tape advancing means, means controlled jointly by said preparing means and said pulse supplying means for disabling said tape advancing means, and means for causing the transmission of a steady marking signal while said tape advancing means is disabled and irrespective of the start impulse generating means in said continuously running distributor.

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