Feb. 3, 1948. H. F. WILDER 2,435,257

START-STOP ELECTRONIC REGENERATIVE REPEATER

Filed Oct. 17, 1942 2 Sheets-Sheet 1

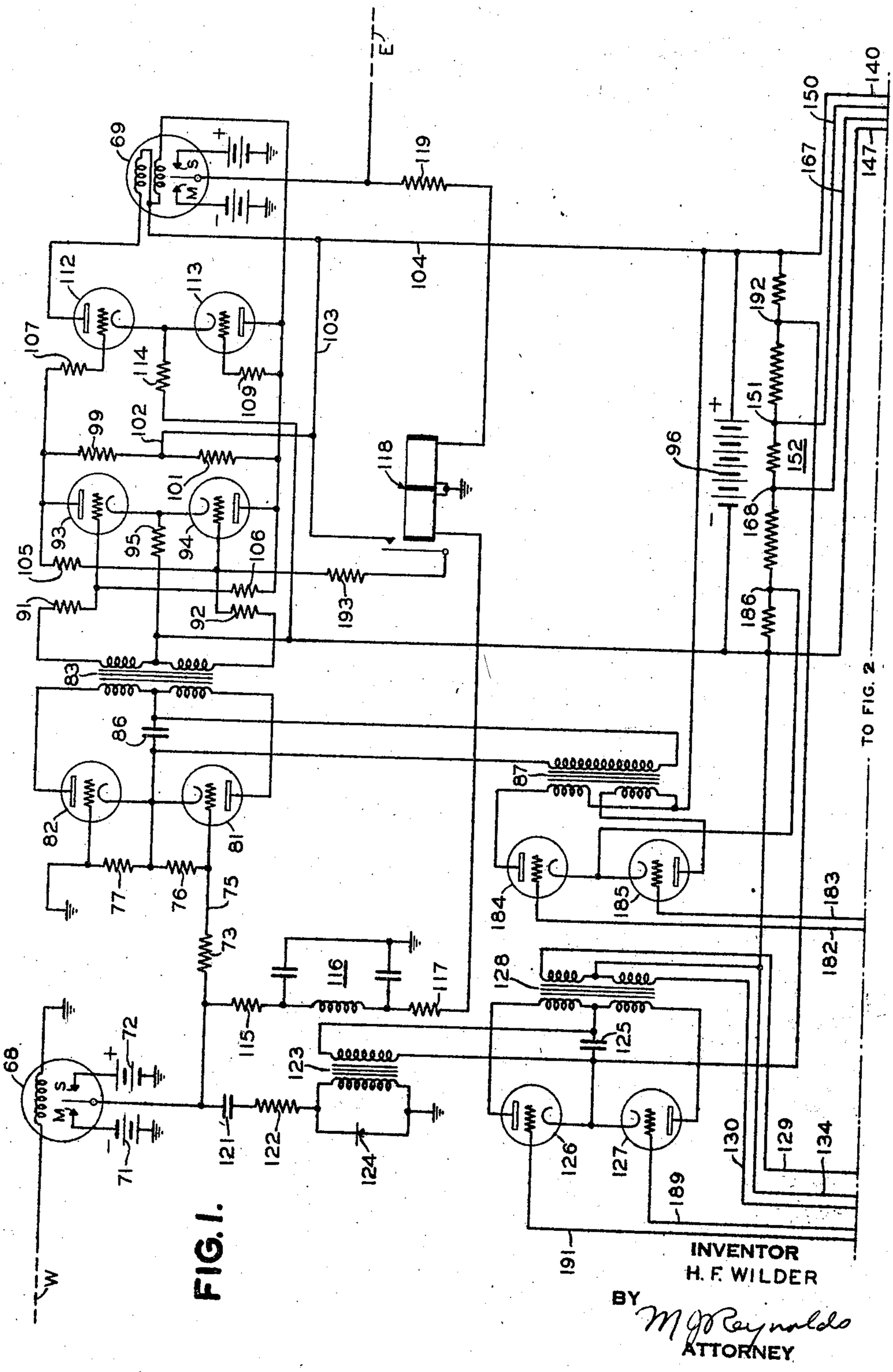

FIG. 1.

Feb. 3, 1948. H. F. WILDER 2,435,257

START-STOP ELECTRONIC REGENERATIVE REPEATER

Filed Oct. 17, 1942 2 Sheets-Sheet 2

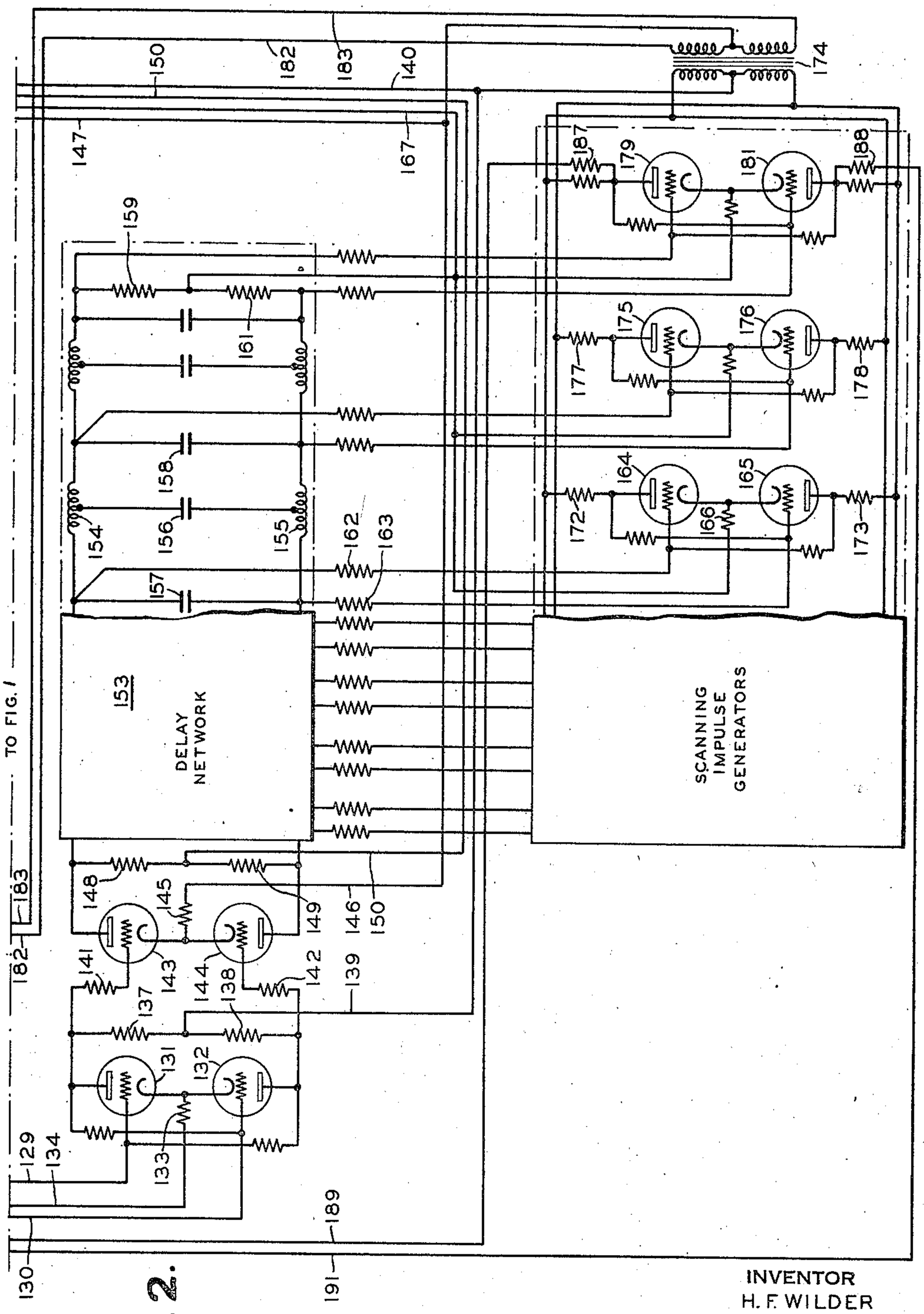

FIG. 2.

INVENTOR
H. F. WILDER

BY
M. J. Reynolds
ATTORNEY

Patented Feb. 3, 1948 2,435,257

UNITED STATES PATENT OFFICE

2,435,257

START-STOP ELECTRONIC REGENERATIVE REPEATER

Harold F. Wilder, Wyckoff, N. J., assignor to The Western Union Telegraph Company, New York, N. Y., a corporation of New York

Application October 17, 1942, Serial No. 462,368

20 Claims. (Cl. 178—70)

1

This invention relates to telegraph signal repeaters and has particular reference to start-stop regenerative repeaters.

An object of the invention is to provide an organization of instrumentalities to regenerate telegraph signals in phase which comprises novel means including a multi-section delay network.

Another object of the invention is to provide means for accurately timing the retransmission of signals which utilizes a series of voltages derived from successive sections of a multi-section delay network.

Still another object of the invention is to provide apparatus for the regeneration of start-stop signals which utilizes novel means including a multi-section delay network upon which is impressed a voltage in response to a "start" impulse for propagation through the network and which also employs voltages derived from successive sections of the network to time the retransmission of the intelligence impulses.

A further object of the invention is to provide means for impressing a voltage on one terminal of a multi-section delay network in response to the "start" impulse of a start-stop telegraph signal and for disabling temporarily said means to said intelligence impulses having the same marking or spacing character as the "start" impulses.

These and other objects of the invention are attained in the illustrative embodiment of the invention which will be described in connection with the accompanying drawings, in which:

Figs. 1 and 2 illustrate a start-stop regenerative repeater in which each of a series of voltages derived from successive sections of a multi-section delay network is employed to operate one of a pair of electron discharge devices individual thereto, by means of which a common pair of electron discharge devices is operated to generate the timing or scanning impulses.

In its general aspect the invention contemplates the use of a delay network made up of not less than as many similar sections as there are impulse units in the signals to be regenerated. In the case of a five-unit intelligence code employed in a start-stop signaling system, at least seven such sections are used, one for each unit of the intelligence signal plus one each for the "start" and "rest" impulses. In response to a "start" impulse received at the repeater station, a voltage is impressed upon one terminal of the network. This voltage is propagated through the network at a rate determined by the constants of the successive sections comprising the network. Preferably, this rate of propagation is such that a voltage to be used for the generation of a timing impulse appears at each section of the network at a time which corresponds approximately to the middle of a normal signal. Generally, at such a time, the received signal is an accurate representation of the transmitted signal. However, it is considered to be within the scope of the instant invention to adjust the constants of the network sections so as to generate the timing impulses at any other time relative to the arrival time of the received signals if it is found desirable to do so.

2

The received signals are also used to prepare for operation one or the other of a pair of electron discharge devices, depending upon the marking or spacing character of the signal. These two latter devices are rendered completely operative by the generated timing impulses and control retransmitting means whereby the signals which are retransmitted from the repeater station are completely regenerated both in amplitude and in phase.

Since the means employed for impressing a starting voltage upon one terminal of the delay network is continuously in a position to be influenced by all of the received signal impulses, there is provided an additional means responsive to the voltage derived from the last section of the network for biasing the voltage impressing means in such a manner that, after having initially impressed a starting voltage upon the network, it is disabled for the period of time required to retransmit the complete signal. Upon the termination of the signal transmitting period, the voltage impressing means is reconditioned to be responsive to the next "start" impulse whereby a similar cycle of operations is started.

Referring now to Fig. 1, the signals are received from line W by a receiving relay 68, the contacts of which control the repeater apparatus to operate the transmitting relay 69 whereby the signals are repeated into line E after being completely regenerated. Connected to the marking contact M and the spacing contact S of the receiving relay 68 are negative and positive batteries 71 and 72, respectively, whereby, depending upon the position of the armature of this relay, negative and positive potentials, according to the marking or spacing characteristics of the received signals, are impressed through a resistance 73 upon a voltage divider comprising a series connection of resistances 76 and 77. The input circuits of a pair of pickup tubes 81 and 82 are derived respectively from resistances 76

and 77. The output circuits of the pickup tubes include the two halves of the primary winding of a transformer 83. Space current for the output circuits of the pickup tubes is derived from a series of short unidirectional impulses impressed upon a condenser 86 by means of connections to the secondary winding of a transformer 87. The series of unidirectional scanning or timing impulses is generated under the control of a delay network and apparatus associated therewith in a manner to be described.

Short impulses of opposite polarity, depending upon the marking or spacing character of the signals impressed upon the input circuits of the pickup tubes 81 and 82, are induced in the secondary winding of transformer 83, the terminals of which are connected respectively through resistances 91 and 92 to the control grids of a pair of amplifier vacuum tubes 93 and 94, respectively. The cathodes of the amplifier tubes are connected through a common self-biasing resistance 95 to the negative terminal of a source of direct current 96. The output circuits of the amplifier tubes include resistances 99 and 101, which are connected by means of conductors 102, 103 and 104 to the positive terminal of the battery 96.

Since the potentials applied to the input circuits of the amplifier tubes 93 and 94 are of relatively short duration, the tubes are provided with feedback or inverse biasing circuits by means of which their sustained operation in response to the short impulses is secured. These biasing circuits comprise a connection from the anode of one tube to the grid of the other tube. Specifically, the anode of the tube 93 is connected through resistance 105 to the grid of tube 94. Similarly, the anode of tube 94 is connected through resistance 106 to the grid of tube 93.

The operation of the tubes provided with these inverse biasing circuits may be understood by assuming that the tube 93 is conducting and the tube 94 is non-conducting. If in these circumstances an impulse is induced in the secondary winding of the transformer 83 of such a character that the lower terminal of the winding is positive with respect to the upper terminal, the grid of tube 94 will be biased positively with respect to its associated cathode, thereby rendering this tube conducting. The negative potential from the upper terminal of the secondary winding of the transformer 83, which is applied at the same time to the grid of the amplifier tube 93 is effective to render this tube non-conducting. Consequently, the potential which is applied to the anode of this latter tube is raised to some high positive value approaching the full potential of the battery 96. This high positive potential is impressed by means of the connection including the resistance 105 upon the grid of the amplifier tube 94 which has just been rendered conducting. These circuits are so designed that positive feedback potential is supplied to the tube last operated before the operating potential derived from the transformer impulse falls to zero. Thus, it is seen that the tube which is non-conducting furnishes a biasing potential to the conducting tube to maintain these conditions. Hence, it become possible to operate the amplifier tubes alternately in response to impulses of very short duration and of opposite polarity. At the same time the wave form of the current flowing in the output circuits of the amplifier tubes is improved by steepening the wave front through the trigger operating characteristics of the tubes obtained by means of the inverse biasing circuits.

The potentials of alternately opposite polarity appearing at the terminals of resistances 99 and 101 are impressed by means of connections including resistances 107 and 109 upon the respective grids of a pair of power tubes 112 and 113. The cathodes of these tubes are connected through a common self-biasing resistance 114 to the negative terminal of the battery 96. The output circuits connected to the anodes of the power tubes include the oppositely poled operating windings of the transmitting relay 69, the common terminal of which is connected by means of connector 104 to the positive terminal of the battery 96.

By reason of this arrangement the amplifier tubes 93 and 94 and the power tubes 112 and 113 follow the operations of the pickup tubes 81 and 82 in a manner depending upon the marking and spacing character of the received signals, whereby the contacts of the transmitting relay 69 are operated to connect to line E negative battery for the transmission of marking signals and positive battery for the transmission of spacing signals.

The armature of the receiving relay 68 is also connected through a resistance 115, a delay network 116 and a resistance 117 to the left hand winding of a reading relay 118. The right hand winding of this relay is connected through a resistance 119 to the armature of the transmitting relay 69. The operation and function of this relay will be described in a later section of the specification.

Also connected to the armature of the receiving relay 68 is a circuit including a condenser 121 in series with a resistance 122 and the parallel connection of the primary winding of a transformer 123 and a rectifier 124. The secondary winding of the transformer 123 is connected across a condenser 125 included in the output circuit of a pair of latch tubes 126 and 127. The momentary voltages induced in the secondary winding of the transformer 123 supply anode potentials to the latch tubes through the two halves of the primary winding of a transformer 128. The input circuits of the latch tubes 126 and 127 are connected, in a manner to be described presently, to apparatus associated with one of a plurality of scanning impulse generators. The arrangement is such that the latch tubes are operated alternately for each group of signal impulses received. Consequently, there is induced in the secondary winding of the transformer 128 at the beginning of each signal to be repeated an impulse of short duration and of opposite polarity for each successive signal.

The terminals of the two halves of the secondary winding of transformer 128 are connected by conductors 129 and 130, respectively, to the grids of a pair of network drive tubes 131 and 132. The cathodes of these tubes are connected through a common self-biasing resistance 133 and over a conductor 134 to the midpoint of the secondary winding of transformer 128 and to the negative terminal of battery 96. Both of these tubes are also provided with inverse biasing circuits whereby they are provided with trigger operating and banking operating characteristics. The output circuits of the network drive tubes include resistances 137 and 138, the common terminals of which are connected by conductors 139 and 140 to the positive terminal of battery 96.

The potentials impressed upon the terminals of the resistances 137 and 138 by the network drive tubes are also impressed through resistances 141 and 142, respectively, upon the grids of a pair of power tubes 143 and 144, respectively. The cath-

odes of the power tubes are connected through a common self-biasing resistance 145, conductors 146 and 147 to the negative terminal of the battery 96. The output circuits of the power tubes include resistances 148 and 149, the common terminals of which are connected by conductor 150 to a point 151 on a voltage divider 152 connected across the terminals of the battery 96. This point is positive with respect to the connection made by means of conductors 146 and 147 to the cathodes of the power tubes.

The voltages appearing at the terminals of resistances 148 and 149 are connected to a multisection delay network 153. This network comprises seven similar sections connected in cascade. Only the sixth and seventh sections of the network are shown in complete detail, and each, such as the sixth section, comprises a parallel connection of two inductive elements 154 and 155. Connected between the midpoints of each of the inductances, both halves of each of which are wound on the same core, is a condenser 156. Also, condensers 157 and 158 are connected between corresponding terminals of the inductances 154 and 155. A potential having a polarity opposite to the previously applied potential is impressed upon the first section of the network 153 substantially at the beginning of the received "start" impulse, and since it is desired to generate the scanning or timing impulses to coincide with the middle of each normal signal, the parameters of the network are adjusted to introduce a delay in the propagation of the applied voltage of approximately half the time required to transmit a full signal impulse. If it is assumed that the rate of signaling is approximately 390 letters per minute, the length of a single signal impulse is approximately 22 milliseconds, and the delay produced by the first network section should be approximately 11 milliseconds. The delay which is introduced by each of the succeeding sections will then be equal to a full signal impulse or 22 milliseconds. The circuit constants for each of the sections 2 to 7, inclusive, are therefore such as to produce a delay in the propagation of the impressed voltage of 22 milliseconds per section, in the case where the signaling is effected at the assumed rate of 390 letters per minute, and the constants of the first section of the delay network are such as to produce a delay of 11 milliseconds. The energy which is transmitted through the delay network is dissipated in a terminating resistance comprising two equal resistances 159 and 161.

Connections are made from corresponding points on the two parallel conductors of the delay network at the end of each section by means of which voltages are impressed upon the input circuits of a plurality of pairs of vacuum tubes, each of which constitutes a scanning or timing impulse generator. For example, between the fifth and sixth sections of the delay network connections are made through resistances 162 and 163 to the control grids of tubes 164 and 165, respectively. The cathodes of this pair of scanning impulse generators are connected through a resistance 166 and conductor 167 to a point 168 on the voltage divider 152. These tubes are also provided with inverse biasing circuits similar to those previously described. The anodes of the scanning generator tubes 164 and 165 are connected through resistances 172 and 173, respectively, to the terminals of the upper and lower halves of the primary winding of a transformer 174. The midpoint of the transformer primary

winding is connected by means of conductor 140 to the positive terminal of the battery 96.

The input circuits of each of the pairs of scanning impulse generators are connected in a manner similar to that described to individual sections of the delay network 153 so that, as the transient voltage progresses through the network, one tube of each of the scanning impulse generators is operated in response to the particular polarity of the transient voltage. The output circuits of alternate pairs of the scanning impulse generators are connected to the primary winding of transformer 174 as described. The output circuits of the other scanning impulse generators are connected to the primary winding of transformer 174 in a reverse manner. For example, the output circuits of the tubes 175 and 176 are connected respectively through resistances 177 and 178 to the terminals of the lower and upper halves of the primary winding of transformer 174 in contrast to the connections of the output circuits of the preceding tubes 164 and 165 and also the succeeding tubes 179 and 181.

Since, during a given cycle of operation, points on the upper conductor of the delay network 153 are of a positive polarity with respect to corresponding points on the lower conductor of the network, the upper tube of each of the pairs of scanning impulse generators will be rendered conducting. By reason of the alternate reverse connection of the output circuits of these tubes, there are generated in the secondary winding of the transformer 174 impulses of alternating polarity. The midpoint of the secondary winding is connected by means of conductor 147 to the negative terminal of battery 96. The cathodes of tubes 184 and 185 are connected to a point 186 on the voltage divider 152. Since this point is positive with respect to the negative terminal of the battery 96 which is connected over conductor 147 and the two halves of the secondary winding of transformer 174 to the control grids of the tubes 184 and 185, the input circuits of these tubes are biased normally below the cut-off potential. Thus, the impulses of alternate polarity which are derived from the secondary winding of transformer 174 serve as control potentials for the input circuits of tubes 184 and 185, whereby these tubes are conditioned for alternate operation for short periods of time.

The anodes of the tubes 184 and 185 are connected respectively to the upper and lower halves of the primary winding of transformer 87. The common terminals of the two halves of the primary winding are connected to the positive terminal of battery 96, which supplies space current to the tubes 184 and 185 through the primary winding of the transformer. The connections between the anodes of the tubes and the transformer primary winding are such that unidirectional impulses of short duration are induced in the secondary winding of the transformer 87 irrespective of which tube energizes the primary winding. Thus, the tubes 184 and 185 together with the transformer 87 constitute a rectifier. As previously described, the series of unidirectional impulses induced in the secondary winding of the transformer supplies space current at accurate periodic intervals to the pickup tubes 81 and 82 whereby phase distortion in the received signals is corrected before the signals are retransmitted.

Connections are made from the anodes of the scanning impulse generator tubes 179 and 181 through the respective resistances 187, 188 and

conductors 189, 191 to the control grids of the respective latch tubes 127 and 126. These connections are for the purpose of conditioning for operation one of the latch tubes as soon as a signal has been repeated so that the conditioned tube may respond to the "start" impulse of the following received signal. Since the polarity of the potential applied to the input circuits of the latch tubes is not changed until a transient voltage, which is applied to the delay network under the control of the operatively conditioned latch tube in response to a "start" impulse, has completely traversed the network to operate one of the tubes 179 or 181 of the seventh scanning impulse generator, any intelligence signal impulses of a spacing character will not reverse the polarity of the potential induced in the secondary winding of transformer 128 from that resulting from the reception of the "start" impulse.

The following portion of the specification describes in sequence the operation of the various elements comprising the repeater in repeating a group of marking and spacing impulses constituting a start-stop signal. For the purposes of the description, assume that when no signals are being transmitted marking potentials are applied to the lines W and E and that steady state conditions exist at the repeater. The armature of the receiving relay 68 is engaged with its marking contact M to apply negative battery to the various circuits connected thereto. This negative battery conditions the input circuit of the pickup tube 82 for operation. The amplifier tube 94 is banked in a conducting condition, and amplifier tube 93 is non-conducting, thereby rendering the power tube 112 conducting and the power tube 113 non-conducting. Current flows from the positive terminal of the battery 96 through the upper winding of the transmitting relay 69 in a direction to operate the armature of this relay to its marking contact M and thereby connect negative battery to line E. The input circuit of the latch tube 126 is conditioned for operation by reason of the positive potential appearing on conductor 191. The network drive tube 131 is assumed to be banked in a conducting condition, and drive tube 132 is non-conducting, thereby effecting the operation of power tube 144 and the non-operation of power tube 143. This condition applies a voltage upon the input terminals of the delay network 153 in such a manner that all points on the upper conductor thereof are of a positive polarity with respect to corresponding points on the lower conductor. Consequently, the upper tubes such as 164, 175 and 179 of the seven pairs of scanning impulse generators are banked in conducting conditions. All of the lower tubes such as 165, 176 and 181 of the scanning impulse generators are non-conducting. Consequently, the anode of tube 181 is more positive than the anode of tube 179 whereby conductor 191 is positive with respect to conductor 189. The effect of this condition is that the grid of the latch tube 126 is positive with respect to its associated cathode, and the grid of the latch tube 127 is negative with respect to its associated cathode. Neither of the rectifier tubes 184 or 185 is conditioned for operation at this time because of the negative bias which is applied to the respective grids by means of the previously described connection to the voltage divider 152.

In response to the spacing signal representing a "start" impulse, the armature of the receiving relay 68 is moved to its spacing contact S, thereby

applying positive battery to the circuits connected thereto. Pickup tube 81 is conditioned for operation, and pickup tube 82 is biased to cut off. The condenser 121 is charged to a positive potential through the primary winding of transformer 123. The impulse which is induced in the secondary winding of this transformer by the surge of charging current through the primary winding causes the momentary conduction of space current in the latch tube 126 through the upper half of the primary winding of transformer 128. A voltage is induced in the secondary winding of this transformer of such a polarity that the network drive tube 132 is rendered conducting and the drive tube 131 is rendered non-conducting. Resulting from this operation, conduction of space current is started in the power tube 143 and is discontinued in the power tube 144 whereby the polarity of the voltage which is impressed upon the input terminals of the delay network 153 is reversed fom that previously existing.

As this voltage is propagated through the successive sections of the delay network, the conductors thereof are conditioned in such a manner that points on the upper conductor are negative with respect to corresponding points on the lower conductor. Consequently, the scanning impulse generator tubes controlled by voltages appearing at these spaced points are operated successively to interrupt the flow of space current in the upper tubes such as 164, 175 and 179 and to initiate the conduction of space current in the lower tubes such as 165, 176 and 181. With the operation of each pair of scanning impulse generator tubes, impulses of short duration and alternating in polarity are induced in the secondary winding of transformer 174. These impulses are rectified by means of the tubes 184 and 185 and the transformer 87, inducing in the secondary winding of the transformer a series of short unidirectional impulses. As previously described, these impulses serve to operate the amplifier and power tubes 93, 94 and 112, 113, respectively, in a manner determined by the marking or spacing character of the signal impulses whereby either the upper or the lower winding of the transmitting relay 69 is energized to retransmit the signals into line E. Specifically, in the case of the spacing impulse representing the "start impulse," amplifier tube 93 is rendered conducting, and amplifier tube 94 is rendered non-conducting, and power tube 112 is rendered non-conducting and power tube 113 is rendered conducting. Current is thus caused to flow through the lower winding of transmitting relay 69 in a direction to move the armature thereof into engagement with is spacing contact S whereby positive battery is connected to line E to retransmit the spacing "start" impulse.

Succeeding impulses of the signal cause the operation of the repeater apparatus in a manner which should be obvious in view of the foregoing description. Finally, the marking "rest" impulse is received and retransmitted in the manner described, after which the apparatus is left in the condition assumed at the outset of this description, with the exception that the latch tube 127 is now conditioned for operation, the network drive tube 132 and the power tube 143 are in conducting conditions, and also the lower tubes of the scanning impulse generators are now conducting.

It has been found in practice that there is encountered occasionally a condition which would result in the operation of the transmitting relay

69 in a manner to leave the armature thereof engaged with its spacing contact S during periods of no signal transmission if precautions were not taken to prevent such an occurrence. Such a condition would occur during an idle period by the establishment of a spacing signaling condition on the line W which positions the armature of the receiving relay 68 on its spacing contact S. As described, such an operation reverses the polarity applied to the delay network 153 whereby subsequently a series of scanning impulses are generated. Also, the pickup tube 81 is operated by each scanning impulse and effects the operation of amplifier tube 93 and power tube 113 whereby the lower winding of the transmitting relay 69 is energized to connect positive spacing battery to line E through the armature and spacing contact S of the relay. If the spacing line condition lasts for a time longer than that required to transmit a start-stop signal, the delay network 153 would be in a steady state condition so that no further scanning impulses are generated. If now a marking signaling condition be applied to the line W, the armature of relay 68 would move to its marking contact M and thereby condition the pickup tube 82 in preparation for the repetition of a marking signal into line E. However, the connection of the negative battery 71 to the charging circuit of the condenser 121 results in a current flow through the rectifier 124, thereby by-passing the primary winding of transformer 123. Consequently, there is not generated in the secondary winding of transformer 128 an impulse necessary for the reversal of polarity on the delay network 153. Hence, there is not generated a scanning impulse under the control of the delay network 153 whereby the pickup tube 82 may be completely conditioned for operation to relay the marking condition to the transmitting relay 69 and thereby apply negative marking battery to line E. Thus, it is seen that the receiving relay 68 would be left in its normal marking "rest" condition, and the amplifier tube 93, the power tube 113 and the transmitting relay 69 would be left in abnormal spacing conditions whereby positive spacing battery would be applied to line E. Such a condition is undesirable for the reason that the effect is to leave the line E in a spacing or open condition so that any start-stop apparatus responsive to signals received over this line would be kept continuously cycling, since the steady spacing condition has the effect of a "start" signal on such apparatus. Such a line condition could exist, if steps were not taken to prevent its occurrence, until start-stop signals were again received from the line W, and in this case the first of such signals in all probability would be mutilated because of an asynchronous relation between the signals and the start-stop printing apparatus connected to line E.

Relay 118 serves to prevent the occurrence of the described possible line condition. This may be seen by considering the receiving relay 68 as positioned on its marking contact M and the transmitting relay 69 as positioned on its spacing contact S. In this case negative battery is connected through the marking contact M of receiving relay 68 and the delay network 116 to the left hand winding of relay 118. The right hand winding of this relay is connected through resistance 119 and the spacing contact S of the transmitting relay 69 to positive battery. The relay is differentially wound so that under the described conditions the fluxes generated by the two windings are additive and cause the closure of the make contact. This operation results in the connection of the positive terminal of battery 96 over conductors 104 and 103, the make contact of relay 118 and resistance 193 to the grid of the amplifier tube 94. This tube is, therefore, operated, and the amplifier tube 93 is rendered non-conducting. Consequently, the power tube 112 is operated, and the power tube 113 is rendered non-conducting to energize the upper winding of the transmitting relay 69 whereby the armature thereof is moved into engagement with its marking contact M. Thus, the desired marking "rest" condition is applied to the line E.

It will be seen that the relay 118 is not operated during the repetition of normal start-stop signals for the reason that the half-signal delay normally occurring between corresponding operations of the receiving relay 68 and the transmitting relay 69 is compensated for by the delay network 116. The parameters of this network are adjusted to introduce a delay of 11 milliseconds in the impression of the potentials of batteries 71 and 72 upon the left hand winding of relay 118. Thus, by the time that the receiving relay contact potentials are applied to the left hand winding of the relay, similar potentials are applied to the right hand winding thereof from the contacts of the transmitting relay. The polarity of these potentials will agree at all times so that the fluxes generated in the two relay windings will be in opposition, thereby preventing the closure of the relay contacts.

While the power supply for the various electronic elements of the repeater is shown as a single battery 96, it is contemplated to be within the scope of the invention to provide individual batteries, if desired. Also, the potentiometer 152 may include the heater elements of the tubes in any well-known arrangement whereby the desired potentials may be secured for tube biasing, and so forth.

The nature of the invention may be ascertained from the foregoing description of an illustrative embodiment, it being understood that changes in the invention herein disclosed may be made within the scope of what is claimed without departing from the spirit of the invention.

What is claimed is:

1. A regenerative telegraph repeater comprising a signal receiving device, a signal transmitting device, means prepared for operation by said signal receiving device in accordance with the character of the received signals and operable to control said signal transmitting device, a delay network having a plurality of sections connected in cascade, means controlled by said receiving device for impressing a voltage on one terminal of said network preceding the receipt of a group of intelligence signals, and means controlled by voltages derived from succeeding sections of said network for timing in a predetermined manner the operation of said transmitting device control means.

2. A regenerative repeater for start-stop telegraph signals comprising a signal receiving device, a signal transmitting device, means for controlling the operation of said signal transmitting device in accordance with the character of said received signals, said controlling means being partially operatively conditioned by said signal receiving means, a delay network having a cascaded connection of a plurality of sections, means controlled by said signal receiving means in response to a "start" signal to impress a voltage

upon one terminal of said delay network for propagation through successive sections thereof, and means utilizing the transient voltages appearing in successive sections of said network for completing the operative conditioning of said transmitting device control means at predetermined time intervals.

3. A regenerative repeater for start-stop telegraph signals comprising a relay for receiving signals from an incoming line, a second relay for transmitting signals to an outgoing line, electronic means prepared for operation by said receiving relay in accordance with the character of said received signals and operable to control the operation of said transmitting relay correspondingly, a delay network comprising a cascaded connection of a plurality of reactive sections, means controlled by said receiving relay in response to a "start" signal for impressing a voltage upon the first of said sections for propagation through successive sections of said network, and means including connections from successive sections of said network for timing the operation of said electronic means in a predetermined manner.

4. A regenerative repeater for start-stop telegraph signals comprising a relay for receiving signals from an incoming line, a second relay for retransmitting regenerated signals to an outgoing line, a pair of electronic devices arranged to be prepared for alternate operation by said receiving relay in accordance with the character of said received signals and operable to control the operation of said transmitting relay correspondingly, a delay network comprising a cascaded connection of a plurality of sections each including a series inductance and a parallel capacity, a pair of electronic devices controlled by said receiving relay in response to a "start" signal to impress a voltage upon the first of said sections, and means utilizing the transient voltages propagated through successive sections of said network for timing in a predetermined manner the operation of said first named pair of electronic devices.

5. In a regenerative repeater for start-stop telegraph signals, a signal receiving device, a signal transmitting device, a delay network comprising a plurality of reactive sections corresponding in number to the impulse units in the signals to be retransmitted for timing the operation of said transmitting device to regenerate the signals received by said receiving device, means responding to a "start" signal and tending to respond to succeeding intelligence signals of a like character for impressing a voltage upon one terminal of said network, and means responsive to a voltage derived from the other terminal of said network for rendering said first named means responsive only to the following "start" signal.

6. In a regenerative repeater for telegraph signals of marking and spacing characteristics according to a prearranged code, a signal transmitting device, a delay network comprising a cascaded connection of a plurality of reactive sections, means for impressing a voltage upon one terminal of said network for propagation through successive sections thereof at a rate determined by the electrical constants of said sections, means prepared for operation by and in accordance with the marking or spacing character of telegraph signals, a pair of electronic trigger devices to operate said transmitting device, means utilizing the transient voltages derived from successive sections of said network for generating a series of unidirectional impulses, and means utilizing said series of impulses to operate said signal prepared means whereby one or the other of said trigger devices is operated depending upon the marking or spacing character of the signal.

7. The invention as defined in claim 6 further characterized in that said impulse generating means includes a pair of electronic trigger devices having the input circuits thereof connected to the junction points of successive sections of said network.

8. The invention as defined in claim 6 further characterized in that the impulse generating means includes a pair of gaseous arc conduction tubes having the control grids thereof connected to alternate junction points of the sections of said delay network.

9. The invention as defined in claim 6 further characterized in that the impulse generating means includes a plurality of pairs of electronic trigger devices, one pair for each of the sections of said network, and each pair having its input circuits connected to the junction point between two successive sections of said delay network.

10. In a regenerative repeater for the retransmission of received telegraph signals, a repeating device, means for preparing said device for operation in accordance with the marking and spacing character of the received signals, and means including a delay network comprising a plurality of reactive sections corresponding in number to the impulse units in the signals to be retransmitted for accurately timing in a predemined manner the operation of said repeating device.

11. In a regenerative repeater for the retransmission of received telegraph signals, a repeating device having input and output circuits, means for conditioning the input circuit of said device in accordance with the marking or spacing character of the received signals, and means including a delay network comprising a plurality of reactive sections corresponding in number to the impulse units in the signals to be retransmitted for operatively conditioning the output circuit of said device at predetermined accurately timed intervals whereby said signals are retransmitted free from amplitude and phase distortion.

12. In a regenerative repeater for the retransmission of received telegraph signals, repeating apparatus including a pair of electronic devices each having input and output circuits, means controlled by the received signals for conditioning the respective input circuits of said electronic devices in accordance with the marking or spacing character of the received signals, a delay network comprising a cascaded connection of a plurality of reactive sections, and means controlled by voltages derived from succeeding sections of said network to furnish space current for the output circuit of the operatively conditioned one of said electronic devices whereby the signals are retransmitted at accurately timed intervals.

13. In a regenerative repeater for the retransmission of received telegraph signals, a repeating device, means controlled by said received signals for preparing said device for operation in accordance with the marking or spacing character of the received signals, a delay network comprising a cascaded connection of a plurality of reactive sections, means for impressing a voltage upon one terminal of said network in advance of the receipt of the intelligence signals, and means controlled by voltages derived from succeeding sections of said network for accu-

rately timing in a predetermined manner the operation of said repeating device.

14. In a telegraph repeater, a signal receiving device, a signal transmitting device, means controlled by said receiving device for correspondingly operating said transmitting device, means for delaying the response of said transmitting device to the operations of said receiving device for a predetermined time, and means jointly controlled by said receiving device and said transmitting device for insuring the operation of said transmitting device in correspondence with the operation of said receiving device.

15. In a telegraph repeater, a receiving relay associated with an incoming line, a transmitting relay associated with an outgoing line, means controlled by the contacts of said receiving relay for correspondingly operating the contacts of said transmitting relay after the lapse of a predetermined time interval, an auxiliary relay controlled jointly by the contacts of said receiving relay and the contacts of said transmitting relay, means including contacts of said auxiliary relay when operated to condition said transmitting relay for the impression upon the outgoing line of a marking signaling condition, and a delay network included in the connection of the contacts of said receiving relay to the auxiliary relay to delay the control of said auixiliary relay effected by the receiving relay for the predetermined time necessary for the corresponding operation of the contacts of the transmitting relay whereby a conformity in the operations of the receiving and transmitting relays is ineffective to operate the auxiliary relay.

16. A regenerative telegraph repeater comprising a signal receiving device, a signal transmitting device, means prepared for operation by said signal receiving device in accordance with the character of the received signals and operable to control said signal transmitting device, a delay network having a plurality of sections connected in cascade, means controlled by said receiving device for impressing a voltage upon the first of said sections preceding the receipt of a group of intelligence signals, and means controlled by voltages derived from succeeding sections of said network for timing in a predetermined manner the operation of said transmitting device control means, the constants in said first section causing the section to introduce a delay in the propagation of the applied voltage of approximately half the time required to transmit a full signal, thereby to generate the timing impulses to coincide with the middle of each normal signal.

17. In a telegraph signal repeater, a signal responsive relay, a normally inactive impulse generator, means controlled by said relay for setting said generator in operation upon the reception of a start signal impulse by the relay, a signal transmitting relay, means controlled jointly by said signal responsive relay and said impulse generator for operating said transmitting relay, a plurality of electron discharge devices operable successively by said impulse generator and means controlled by the last operated one of said electron discharge devices for causing said impulse generator to restart its pulsing cycle upon the reception of the next start signal impulse by said signal responsive relay.

18. In a telegraph signal repeater, a signal responsive relay, a normally inactive impulse generator, means controlled by said relay for setting said generator in operation upon the reception of a start signal impulse by the relay, a signal transmitting relay, means controlled jointly by said signal responsive relay and said impulse generator for operating said transmitting relay, a series of electron discharge devices operable successively by said impulse generator and means controlled by the last electron discharge device in said series for causing said impulse generator to restart its pulsing cycle upon the reception of the next start signal impulse by said signal responsive relay.

19. In a regenerative repeater for start-stop telegraph signals, a signal receiving device, a signal transmitting device, a timing network comprising a plurality of timing sections corresponding in number to the impulse units in the signals to be retransmitted for timing the operation of said repeater in cycles corresponding to the intervals of start-stop telegraph signal combinations, means responsive to a start signal for impressing a voltage upon one terminal of said network, and means responsive to a voltage derived from the other terminal of said network for rendering said first named means responsive only to the following start signal.

20. In a regenerative repeater for the retransmission of received telegraph signals, a repeating device, means for preparing said device for operation in accordance with the marking and spacing character of received signals, and means including a timing network comprising a plurality of timing sections corresponding in number to the impulse units in the signals to be retransmitted for timing the operation of said repeating device in cycles corresponding to the intervals of telegraph signal combinations.

HAROLD F. WILDER.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,133,456	Kinkead	Oct. 18, 1938