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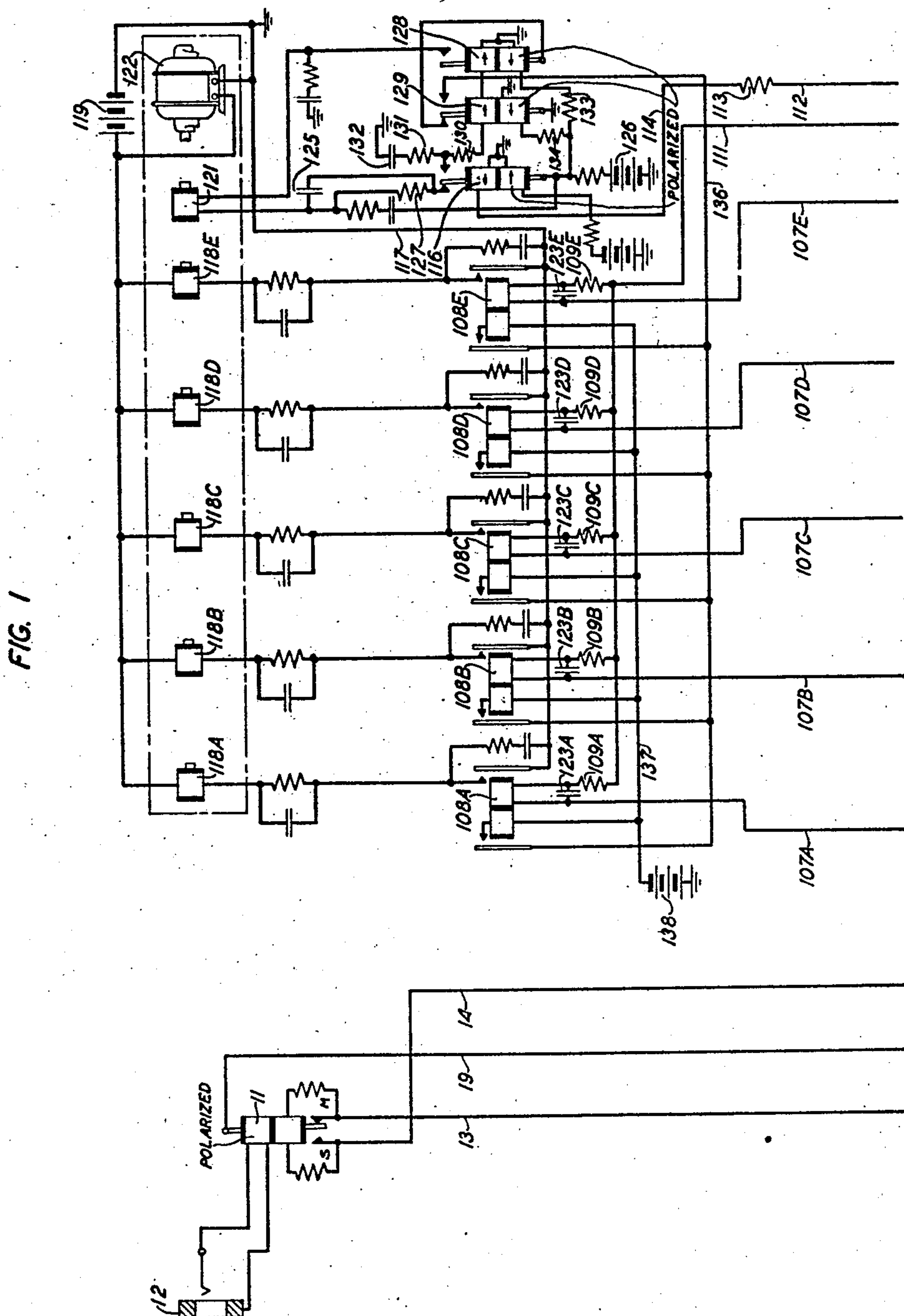
W. T. REA ET AL

2,400,574

START-STOP RECEIVING SELECTOR MECHANISM

Filed Dec. 11, 1943

3 Sheets-Sheet 1



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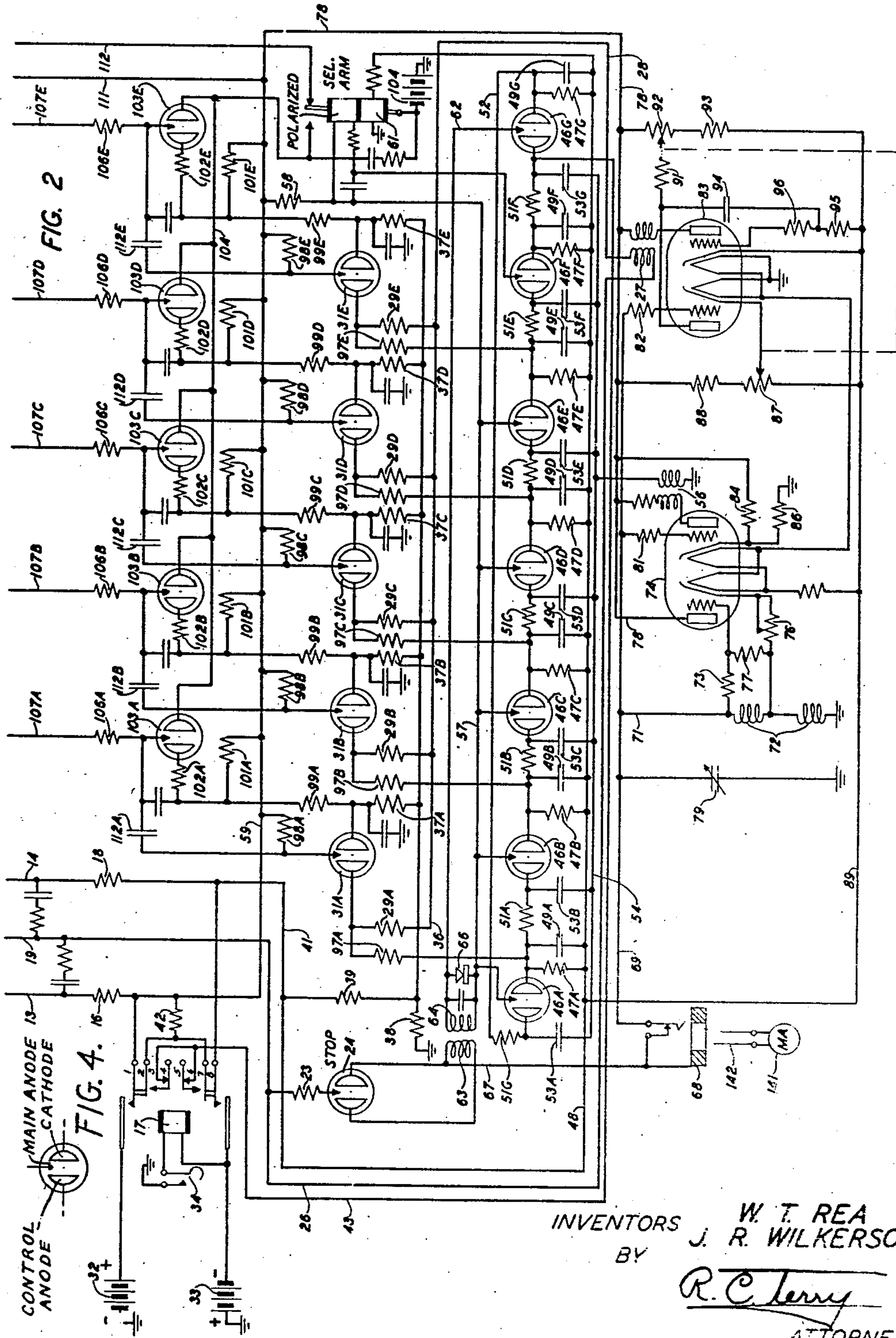
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START-STOP RECEIVING SELECTOR MECHANISM

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3 Sheets-Sheet 2



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START-STOP RECEIVING SELECTOR MECHANISM

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3 Sheets-Sheet 3

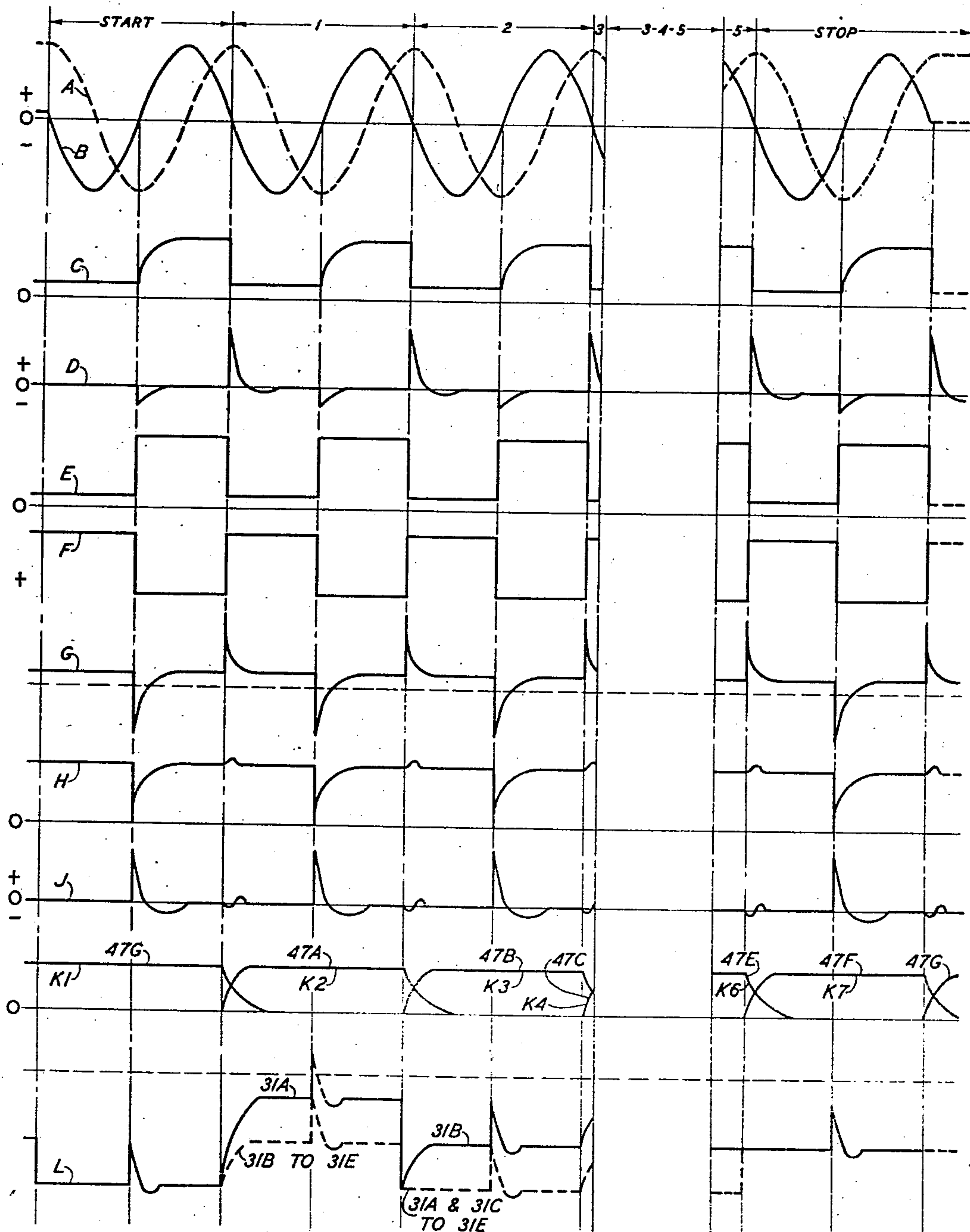


FIG. 3

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2,400,574

START-STOP RECEIVING SELECTOR
MECHANISM

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Application December 11, 1943, Serial No. 513,828

31 Claims. (Cl. 178—33)

This invention relates to telegraph signal receiving apparatus and particularly to signal responsive selector mechanisms for receiving recorders such as teletypewriter printers and reperforators.

An object of the invention is to provide a non-mechanical substitute for mechanical and electromechanical receiving telegraph signal distributors.

Another object of the invention is to distribute successively received impulses of a telegraph signal combination by electron discharge instrumentalities.

Another object of the invention is to operate the distributing electron discharge instrumentalities in start-stop manner.

Another object of the invention is to control the operation of the distributing electron discharge instrumentalities by an electron discharge generator of timing impulses.

Another object of the invention is to provide cyclic overlap between an electronic receiving selector mechanism and a teletypewriter recorder.

Another object of the invention is to provide a simple and effective method and means for accurately checking the timing of an electronic receiving distributor.

The invention features an electronic oscillator circuit for timing the impulse interval allotted to each received impulse of telegraph signal.

The invention also features a chain circuit of electron discharge tubes operable in start-stop manner for distributing received telegraph impulses and for timing the interval allotted to each received code combination of telegraph signals.

The invention also features electron discharge means for storing the successively received telegraph impulses.

The invention also features means for transferring the selective conditions stored in the electron discharge storing means to mechanical selector elements.

In accordance with the preferred embodiment of the invention, telegraph signals are received by a line relay having an armature operable between marking and spacing contacts. With the armature held steadily on the marking contact a circuit is completed through the discharge path of an electron discharge tube and through a resonant circuit, causing steady current to flow in the resonant circuit and preventing oscillation of the circuit. When the receiving relay responds to the start pulse of a permutation code telegraph signal combination the armature of the receiving relay goes to the spacing contact, interrupting the cir-

cuit through the electron discharge tube and through the resonant circuit and permitting the circuit to oscillate. An electron discharge tube associated with the resonant circuit feeds back energy into the circuit to compensate for resistive losses and to maintain constant amplitude of oscillation.

A counting chain of electron discharge tubes is controlled by the oscillatory circuit, the tubes being fired in succession one for each cycle of current in the oscillatory circuit. Each cycle of the oscillatory current has a duration equal to one impulse interval of the telegraph signals so that the tubes in the counting chain are rendered conductive in succession in timed relation to received impulses. Five of the tubes in the counting chain, upon being fired, prime five electron discharge tubes, the function of which is to store selective conditions corresponding to the marking or spacing character of received significant impulses of the telegraph signals. Subsequent to the priming of each of the storing tubes, a detector device derives an impulse from the oscillatory circuit for additionally priming the storing tubes. This impulse is applied to all of the tubes but since they are individually primed in succession by the counting tubes only one storing tube at a time is primed additively by the derived impulse and by a counting tube. If the armature of the receiving relay is on the marking contact at the time the derived impulse additively primes a tube, that one of the storing tubes which is then primed by a counting tube is rendered conductive. If the armature of the receiving relay is on the spacing contact at the time that the derived impulse primes the storing tubes, none of the tubes which is then non-conductive will be rendered conductive. From this it will be apparent that a storing tube is rendered conductive by the conjoint occurrence of three conditions, namely, priming by a counting tube and further priming by the derived impulse with the armature of the receiving relay then presented on the marking contact. Each of the storing tubes upon being rendered conductive remains conductive.

Following the selective firing or non-firing of the last of the five storing tubes a transfer relay is operated under the control of the counting chain of tubes to transfer the selective condition of the five storing tubes to another set of five electron discharge tubes which upon being rendered conductive quench the five storing tubes. The anode circuits of the five tubes to which the selective condition is transferred include relays which become selectively energized and locked.

The five relays selectively complete the energizing circuits of the five selector magnets of a printing telegraph receiving recorder of the type having its selector elements controlled by individual selector magnets, as will be identified hereinafter. The printing telegraph receiving recorder is provided with a sixth magnet, the function of which is to set in operation mechanism for giving effect to the selective condition established in the selector elements and for performing the recording or other function represented by the selection. Apparatus is provided operable under the control of the transfer relay for operating the sixth magnet. Upon the restoration of the transfer relay to its normal condition the selective condition established in the selector magnets, in the relays which control the selector magnets, and in the electron discharge tubes which control the relays is deleted in preparation for reception of the next signal combination, which may proceed while the recording or other function is being performed in the printing telegraph receiving recorder, thus providing for cyclic overlap as between the electronic receiving distributor and transfer mechanism and the recorder.

The last tube in the counting chain of electron discharge tubes represents the stop condition which is the final pulse of start-stop permutation code signals and this tube, upon being activated, reactivates the electron discharge tube which was quenched under the control of the receiving relay upon the response thereof to the start signal. The discharge current in the latter tube again flowing through the resonant circuit of the oscillator stops oscillation in that circuit, and the counting operation in the counting chain is arrested until the start pulse of the next code combination is received.

The invention includes provision of simple and efficient means for timing the operation of the oscillatory circuit to a frequency such that each cycle has a duration equal to the signaling impulse interval. This means comprises a milliammeter which may be connected between the resonant circuit and the electron discharge tube which starts and stops the oscillatory current in that circuit. When signals are to be received continuously the interval during which the generator of oscillatory current is stopped and current flows in the electron discharge tube which starts and stops the oscillatory circuit should bear a predetermined relation to the interval during which the oscillatory circuit is in operation and no current flows in the electron discharge tube. If a slow meter is employed for measuring the current through the electron discharge tube it will be incapable of rising to registration of the full current value during the interval that current flows and will be incapable of falling to zero during the interval that no current flows but will register a substantially steady value of current representing an average of the current over the whole period of stopped and running conditions of the oscillator. The proper value of average current may be calculated by multiplying the value of current which flows when a steady marking condition is being received and the oscillator is stopped by the ratio of the interval during which the oscillator is to be stopped in each cycle when signals are being received continuously to the sum of the desired stopped time and the running time of the oscillator for one cycle. This calculation having been made the constants of the resonant circuit may be adjusted until the meter registers the

calculated average value of current. The oscillator will then be timed so that each cycle has a duration equal to one impulse interval of the telegraph signals to be received and the oscillator will be stopped for the desired interval.

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:

Figs. 1 and 2, when arranged with Fig. 1 above Fig. 2, show schematically the complete signal receiving, distributing, transferring and recording system;

Fig. 3 is a chart of timing curves showing the operating relations among several of the components of the system; and

Fig. 4 is an isolated representation of a cold cathode gas-filled tube having legends applied to the electrodes thereof to facilitate comprehension of the cold cathode electron discharge tube circuits of Fig. 2.

Referring to the drawings and particularly to Fig. 1, the reference numeral 11 designates a biased polar receiving relay having its operating winding connected to the tip and sleeve terminals of jack 12. The biasing circuit is connected to conductors 13 and 14 which receive positive and negative battery connection as will presently be described, and the polarity and voltage on the biasing winding are such that they seek to operate the armature of relay 11 to the spacing contact but are prevented from so operating the armature when marking current flows through the operating winding. Connection of the operating winding of relay 11 is made by the insertion into jack 12 of a plug connected to the two sides of a telegraph circuit.

The marking contact of relay 11 is connected through conductor 13 and resistor 16 (Fig. 2) to front contact spring 1 engageable by the upper armature of a relay 17. The spacing contact of receiving relay 11 is connected through conductor 14 and resistor 18 to front contact spring 8 operable by the lower armature of relay 17. The armature of relay 11 is connected through conductor 19 and resistor 23 to the main anode of cold cathode gas-filled electron discharge tube 24, and in parallel therewith through conductor 26, secondary winding of transformer 27, conductor 28, and resistors 29A, 29B, 29C, 29D and 29E to the control anodes of five cold cathode gas-filled electron discharge tubes 31A, 31B, 31C, 31D and 31E.

The upper and lower armatures of relay 17 are connected respectively to the positive and negative poles of batteries 32 and 33 which have their other poles grounded. One terminal of the winding of relay 17 is connected to battery 33 and the other terminal is connected to one spring of locking key 34, the other spring of which is connected to ground. Upon the operation of key 34 relay 17 becomes energized and connects positive and negative potentials from batteries 32 and 33, respectively, through its upper and lower armatures respectively, to conductors 13 and 14 respectively. Assuming that receiving relay 11 (Fig. 1) has been connected to a telegraph line circuit which is in the marking condition, the armature will be on the marking contact and will remain there because the current in the biasing winding resulting from the connection of potentials to conductors 13 and 14 is insufficient to move the armature to the spacing contact. Thus positive potential from battery 32 will be connected through the marking contact and arma-

ture of relay 11 and through conductor 19 and resistor 23 to the main anode of tube 24, and through conductors 26 and 28 and resistors 29A to 29E to the control anodes of tubes 31A to 31E. Tube 24 will not be fired as a result of the operation of relay 17 because the potential is insufficient to break down the tube across its main gap. Neither will the tubes 31A to 31E be fired because their cathodes are connected through individual cathode resistors 37A, 37B, 37C, 37D and 37E to conductor 36 which is connected to the junction of resistors 38 and 39 which comprise a potential divider connected between ground and the negative terminal of battery 33, the battery connection being established through the lower armature and front contact spring 8 of relay 17 and conductor 41 to resistor 39. The potential difference between the junction of resistors 38 and 39 and the control anodes of tubes 31A to 31E is insufficient to fire these tubes.

Springs 2, 3, 4 and 5, 6, 7 of relay 17 operated by the upper and lower armatures through springs 1 and 8 respectively, are arranged to provide a momentary closure of a conductive path when the relay is operated. Springs 2 and 7 are connected through resistor 42 to spring 1 of relay 17 and thus become connected to positive battery 32 as relay 17 is operated. Springs 3 and 6 are connected by conductor 43 to the control anode of the last tube 46G of a counting chain of cold cathode gas-filled electron discharge tubes 46A, 46B, 46C, 46D, 46E, 46F and 46G. At the instant in the operation of relay 17 when springs 2 and 7 have engaged springs 4 and 5 respectively, and have not yet disengaged the latter springs from springs 3 and 6 respectively, battery 32 will be connected through resistor 42 to the control anode of tube 46G for firing that tube as will now be described.

The chain of counting tubes 46A to 46G is similar to a counting chain of cold cathode tubes shown and described in copending application, Serial No. 460,948, filed October 6, 1942, by W. T. Rea et al. These tubes have their cathodes connected through individual cathode resistors 47A, 47B, 47C, 47D, 47E, 47F and 47G to conductor 43 which extends to negative battery 33 through conductor 41 and spring 8 and lower armature of relay 17. The cathode resistors are shunted by individual condensers 49A, 49B, 49C, 49D, 49E, 49F and 49G. The cathode of each of the tubes is connected to the control anode of the tube following it through a resistor, and beginning with the resistor connected between the cathode of tube 46A and the control anode of tube 46B and ending with the resistor connected between tubes 46F and 46G, these resistors are designated 51A, 51B, 51C, 51D, 51E and 51F. The cathode of tube 46G is connected to the control anode of tube 46A through conductor 52 and resistor 51G thus establishing a closed ring of interconnections. The control anode of each tube is connected through an individual condenser designated 53A, 53B, 53C, 53D, 53E, 53F and 53G to a conductor 54 which is connected to one terminal of the secondary winding of transformer 56, the other terminal of which is connected to ground. The anodes of tubes 46A to 46E are connected through conductor 57, resistor 58 and conductor 59 to contact spring 1 of relay 17 which receives positive battery connection from battery 32 through the upper armature of relay 17 when the relay is operated. The anode of tube 46F is connected through the operating winding of a relay 61 and through resistor 58 to conductor 59. The anode

of tube 46G is connected through conductor 62, primary winding of transformer 63 which is shunted by condenser 64 and varistor 66, to conductor 57 from which a previously traced path extends to contact spring 1 of relay 17.

Since the cathode of tube 46G receives negative battery connection from battery 33 as the lower armature of relay 17 engages spring 8 and the control anode of this tube receives positive battery connection from battery 32 momentarily during the interval of interengagement of springs 2, 3 and 4 and springs 5, 6 and 7, the voltage of batteries 32 and 33 in series-aiding relation is connected across the control gap of tube 46G momentarily. This voltage is sufficient to break down the control gap which fires and ionizes the main gap so that the discharge transfers to that gap and current flows between the cathode and main anode. The anode circuit of tube 46G includes the primary winding of transformer 63 and the rising current in the primary develops a voltage in the primary of the transformer. The voltage developed in the primary is of such polarity that varistor 66 offers high resistance to flow of current by such voltage. Accordingly, this voltage is not dissipated and a voltage is induced in the secondary of the transformer.

The secondary of transformer 63 is connected between the control anode and the cathode of tube 24. The voltage induced in the secondary winding of transformer 63 is sufficient to break down the control gap of tube 24 which fires and the discharge transfers to the main gap, the current flowing from the positive terminal of battery 32 through the upper armature and front contact spring 1 of relay 17, resistor 16, conductor 13, marking contact and armature of line relay 11, conductor 19, resistor 23, main gap of tube 24, conductor 67, closed circuit contacts of a jack 68, conductors 69 and 71 and upper and lower windings of inductance 72 to ground.

The upper end of the upper winding of inductance 72 is connected through resistor 73 to the grid of the left-hand triode section of twin triode electron discharge tube 74. The cathode of the left-hand triode section of tube 74 is connected through variable resistor 76 to the junction of the upper and lower windings of inductance 72. A resistor 77 is connected between the grid of the left-hand triode section of tube 74 and the junction of the upper and lower windings of inductance 72. The anode of the left-hand triode section of tube 74 is connected through conductors 78 and 59 and through front contact spring 1 and upper armature of relay 17 to the positive terminal of battery 32. A variable condenser 79 is connected in parallel with inductance 72 between conductor 69 and ground.

Inductance 72, condenser 79 and the left-hand triode section of tube 74 comprise a start-stop oscillatory circuit. With the armature of line relay 11 on its marking contact and steady current flowing through discharge tube 24 and inductance 72, condenser 79 is charged to a steady value and the circuit does not oscillate. When the armature of relay 11 is operated to spacing, as in response to the start impulse of a received start-stop telegraph signal, the discharge circuit of tube 24 is interrupted and the tube is quenched. Thereupon the resonant circuit comprising inductance 72 and condenser 79 begins to oscillate. The cathode return circuit of the left-hand triode section of tube 74 is through a part of variable resistor 76 and through the lower winding of in-

ductance 72 to ground. The current in the left-hand triode section of tube 74 is varied in accordance with the oscillatory current in the resonant circuit since the grid of the tube is connected to the upper end of the upper winding of inductance 12. The lower winding of the inductance feeds energy back into the upper winding and thus into the resonant circuit and the variable resistor 76 is preferably adjusted so that the energy fed back into the oscillatory circuit just compensates for the resistive losses in the circuit and maintains oscillation at constant amplitude. Condenser 79 is preferably adjusted so that the resonant circuit oscillates at a frequency of one cycle per impulse interval of received telegraph signals.

The voltage that is developed across the resonant circuit is applied through the resistor 81 to the grid of the right-hand triode section of tube 74, which operates as a detector, and through the resistor 82 to the grid of the left-hand triode section of twin triode electron discharge tube 83 which also operates as a detector. The cathode of the right-hand triode section of tube 74 is connected to the junction of resistors 84 and 86 which form a potential divider between positive conductor 78 and ground. The anode of the right-hand triode section of tube 74 is connected through the primary winding of transformer 56 to positive conductor 78.

The cathode of the left-hand triode section of tube 83 is connected to the adjustable contactor of a potential divider resistor 87 which is connected in series with a fixed resistor 88 between positive conductor 78 and a conductor 89 which is connected to conductor 48 and thus receives negative potential from battery 33. The anode of the left-hand triode section of tube 83 is connected through resistor 91 to the adjustable contactor of a potential divider resistor 92 which is connected in series with a fixed resistor 93 between positive conductor 78 and negative conductor 89. The anode of the left-hand triode section of tube 83 is also connected through condenser 94 to the junction of resistors 95 and 96 connected in series between the grid of the right-hand triode section of tube 83 which operates as an amplifier and negative conductor 89. The cathode of the right-hand triode section of tube 83 is connected to negative conductor 89 and the anode of the right-hand triode section of the tube is connected through the primary winding of transformer 27 to positive conductor 78.

When the voltage across the resonant circuit is more negative than the cathode potentials of the right-hand triode section of tube 74 and the left-hand triode section of tube 83, no anode current flows in these tube sections. When the voltage across the resonant circuit is more positive than these cathode potentials anode current flows. At the end of each odd half cycle of the oscillator the initiation of plate current in the right-hand triode of tube 74 causes an impulse to be formed in the primary winding of transformer 56. At the end of each even half cycle the decay of anode current produces a larger impulse of opposite polarity to occur in the primary winding of transformer 56. Near the end of each odd half cycle the initiation of plate current in the left-hand triode of tube 83 applies a negative impulse through condenser 94 to the grid of the right-hand triode of tube 83, thus momentarily cutting off the flow of plate current in this triode and producing an amplified impulse in the primary winding of transformer 27. Near the end of each even half cycle the decay of plate current

in the left-hand triode of tube 83 applies a positive impulse through condenser 94 to the grid of the right-hand triode thus momentarily slightly increasing the flow of plate current in the latter triode and producing in the primary winding of transformer 27 an amplified impulse of smaller magnitude and of opposite polarity to that produced at the end of the odd half cycle.

By virtue of the connection of the cathode of the left-hand triode of tube 83 to potential divider 87 and the connection of the anode of that section to potential divider 92, the potential of the cathode with respect to negative conductor 89 may be varied without changing the anode-to-cathode potential. By varying the settings of the two potentiometers, which may be gauged for simple control, the impulses produced by the left-hand triode of tube 83 may be oriented with respect to the start transition of the received signals. For example, when the cathode potential is made more positive the impulses produced at the ends of the odd half cycles are delayed and those produced at the ends of even half cycles are advanced.

At some time near the center of the received start impulse, depending upon the adjustments of potential dividers 87 and 92, an impulse is produced in the primary winding of transformer 27. The voltage of this impulse in series with the voltage supplied over conductors 19 and 26 from the armature of receiving relay 11 is applied through resistors 29A to 29E inclusive, to the control anodes of tubes 31A to 31E inclusive. At this time the armature of relay 11 is on the spacing contact and negative potential is supplied over conductors 19 and 26 so that none of the tubes 31A to 31E inclusive, can be fired by the voltage induced in the secondary winding of transformer 27.

At the end of the start pulse the right-hand triode section of tube 74 produces a positive impulse in the secondary winding of transformer 56 which is applied through condensers 53A to 53G inclusive, to the control anodes of the tubes 46A to 46G inclusive. With tube 46G having been rendered conductive as previously described, the tube 46A is primed by virtue of the connection of the cathode of tube 46G to the control anode of tube 46A through conductor 52 and resistor 51G. The impulse generated in the secondary of transformer 56 is of sufficient voltage to fire only any one of the tubes 46A to 46G which has been primed and accordingly only the tube 46A becomes conductive in its control gap. The discharge transfers immediately to the main gap and the discharge current flows through cathode resistor 47A and common anode resistor 58.

The initial discharge current in tube 46A flows to charge condenser 49A and for this reason a potential difference across the cathode resistor 47A builds up slowly. It is a characteristic of cold cathode gas-filled tubes of the type employed for the tubes 46A to 46G inclusive, that as soon as the main gap fires the potential difference between the cathode and main anode decreases to the discharge sustaining potential, which is considerably less than the main gap firing potential. This occurs before the potential of the cathode has risen appreciably above the potential of negative conductor 48 due to the delay afforded by condenser 49A. Accordingly, the decrease in potential in the main gap of tube 46A is accompanied by reduction in the potential of conductor 57 to a less positive value, the com-

mon anode resistor 53 accommodating this decrease by exhibiting an increase in the potential across it. Since the main anodes of tubes 46B to 46G inclusive, are also connected to condenser 57, tubes 46B to 46E being connected directly, tube 46F being connected through the operating winding of relay 61 and tube 46G being connected through the primary winding of transformer 63, the main anodes of these tubes suffer a corresponding decrease in potential. None of the tubes 46B to 46F inclusive, is conductive at this time so that no change occurs in these tubes. Tube 46G is conductive and a potential difference exists across its cathode resistor 47G and its cathode condenser 49G due to the discharge current through the tube. The potential difference between the main anode and the cathode of tube 46G while the tube is conductive is the discharge sustaining potential and with the decrease in the potential of the main anode the potential difference becomes less than sufficient to sustain the discharge so that tube 46G is automatically quenched. Following the quenching of tube 46G the charge on condenser 49G leaks off through cathode resistor 47G and the potential of the cathode gradually returns to the potential of negative conductor 48. By virtue of this delay in lowering the potential of the cathode of tube 46G, time is afforded in which the tube may become completely deionized so that it will not be refired when the normal potential is restored to the main anodes of all of the tubes 46A to 46G, inclusive, which occurs when condenser 49A becomes charged to the potential produced by the full discharge current of tube 46A flowing through cathode resistor 47A. In this way the firing of any one of the tubes 46A to 46G inclusive, automatically accomplishes the quenching of any other one of the tubes through which a discharge current is then flowing.

As the current dies out in tube 46G, a voltage is developed in the primary of transformer 63 which is of the opposite polarity of that which previously induced a voltage in the secondary to fire tube 24. Varistor 66 provides a low resistance path for current flowing as a result of the development of this voltage and thus the primary of transformer 63 is substantially short-circuited with respect to a voltage of this polarity and no impulse is induced in the secondary of the transformer so that tube 24 does not become refired.

The cathode of each of the tubes 46A, 46B, 46C, 46D and 46E is connected by an individual resistor 97A, 97B, 97C, 97D and 97E respectively, to the control anode of each of the tubes 31A, 31B, 31C, 31D and 31E respectively. Thus as tube 47A becomes conductive, the control anode of the tube 31A is made more positive with respect to the cathode of that tube.

As previously described the impulse in the secondary of transformer 56 which effected the firing of tube 46A occurred substantially at the end of the start pulse. Thereafter about the middle of the first significant pulse of the signal being received the right-hand triode section of tube 83 induces a second impulse in the secondary of transformer 27 under the control of the left-hand triode of tube 83. This impulse is applied through the resistors 29A to 29E inclusive, to the control anodes of all of the tubes 31A to 31E inclusive. If the signaling impulse to which line relay 11 is then responding is of marking nature, positive polarity will be applied through the secondary of trans-

former 27 to the control anodes of the tubes 31A to 31E, and this voltage will be in aiding relation to the impulse induced in the secondary of transformer 27. These voltages in aiding relation are sufficient to fire one of the tubes 31A to 31E only if such tubes are already primed under the control of tubes 46A to 46E inclusive. Since tube 31A is the only one which is so primed at this time only the tube 31A will be rendered conductive. If instead of a marking signal the relay 11 is at this time responding to a spacing signal the voltage applied over conductor 26 and through the secondary of transformer 27 to the control anodes of the tubes 31A to 31E inclusive, will be negative and will be in opposition to the positive impulse induced in the secondary of transformer 27 thus preventing the firing of any one of the tubes 31A to 31E inclusive, even though such tube is at that time primed by the corresponding one of the tubes 46A to 46E inclusive. By way of recapitulation it may be stated that three conditions must obtain simultaneously in order for one of the tubes 31A to 31E inclusive, to be fired. The tube must be primed under the control of its associated tube in the counting chain of tubes 46A to 46G inclusive, the armature of receiving relay 11 must be on its marking contact to supply a positive voltage to the control anode of the tube and a positive impulse must be induced in the secondary of transformer 27 under the control of the right-hand triode of tube 83. The tubes 46A to 46E inclusive, prepare the tubes 31A to 31E inclusive, to be fired in the proper order, the receiving relay 11 determines whether or not a prepared one of the tubes 31A to 31E will be fired in accordance with reception of marking and spacing signals and the right-hand triode section of tube 83 determines the instant at which firing impulses are produced.

The curves shown in Fig. 3 illustrate graphically the voltage and current conditions which give rise to the operation of the counting tubes 46A to 46G and storing tubes 31A to 31E under the control of the oscillator, and the several curves will now be described.

Curve A represents the current in the oscillatory circuit, which has a steady value prior to the beginning of the start pulse and as oscillation begins the current rises slightly and falls to zero in the first quarter cycle following reception of the start pulse.

Curve B represents the voltage across the condenser 79, having a small positive value during the steady current due to the resistive drop across inductance 72, and decreasing to negative maximum in the first quarter cycle. This curve also represents the potential applied to the grid of the right-hand triode of tube 74 and to the grid of the left-hand triode of tube 83. These grid potentials are expressed by curve B with respect to ground and not with respect to their cathodes, which are more positive than ground.

Curve C represents current in the right-hand triode of tube 74. Due to the presence of the inductive primary of transformer 56 in the plate circuit, the current rises gradually from its normal value at the beginning of each positive half cycle of curve B and falls sharply to its normal value at the end of each positive half cycle.

Curve D represents voltage induced in the secondary of transformer 56 due to current in the primary in accordance with curve C. For each gradual rise in the primary current, indicated in curve C, a small negative pulse is induced in the secondary, and for each abrupt fall in the primary

current a large positive pulse is induced in the secondary.

Curve E represents the plate current in the left-hand triode of tube 83 as the grid voltage is varied according to curve B. As there is no inductance in the plate circuit of this section of the tube, the current rises and falls with equal sharpness, differing from the current in the right-hand triode of tube 74 as represented by curve C. All parts of curve E are positive.

Curve F represents the plate potential of the left-hand triode of tube 83. All values are positive and the changes are opposite to those of curve E.

Curve G represents the potential of the grid of the right-hand triode of tube 83 relative to its cathode potential, which is represented by the dash line. The changes of potential are momentary due to the fact that the plate potentials of the left-hand triode of the tube are impressed on the grid of the right-hand triode through condenser 94 which readjusts itself after a moment to the new potential on the plate of the left-hand triode section, thus restoring the grid of the right-hand triode to its normal potential. Considering the cathode as a reference potential, the grid goes negative momentarily about the end of each odd or negative half cycle of the oscillator voltage and goes more positive than normal momentarily about the end of each even or positive half cycle. The changes in curves E, F and G may be varied relative to the cycles of oscillatory current by varying the potential dividers 87 and 92, but for the purposes of the present description they are presumed to coincide with the ends of half cycles.

Curve H represents the plate current in the right-hand triode of tube 83. It indicates that the conductivity drops sharply as the grid potential decreases, and rises slowly due to the presence of the primary of transformer 27 in the plate circuit. The right-hand triode is operated well up toward saturation, so that when the grid potential goes more positive than normal, the increase in current is much smaller than the decrease produced by a decrease in grid potential of the same magnitude as the grid potential increases.

Curve J represents the potentials induced in the secondary of transformer 27 as a result of the changes in primary current represented in curve H. The positive impulses at the ends of odd half cycles produced by the decrease in current are momentary and large, with a small negative swing immediately following the positive swing due to the rise in plate current in the primary. At the end of each even half cycle there is a small negative pulse induced in the transformer secondary followed by a small positive pulse produced by the small momentary rise in primary current.

Curves K—1, K—2, etc., are individual curves each representing the potential across the cathode resistors associated individually with the tubes 46G and 46A to 46F. Tube 46G is conductive during idle intervals and during the start pulse, and tubes 46A to 46G are fired in succession at the end of each even or positive half cycle by the successive positive pulses represented in curve D. Since each tube quenches the one preceding it, the curves of the potentials of any two successive ones of the resistors intersect due to the fact that a rise in potential in one overlaps a fall in potential of the other.

Curve L represents the application of potentials across the control gaps of tubes 31A to 31E and

the relation of these potentials to the control gap firing threshold is represented by the straight dash line. The potential across the control gaps of all of these tubes rises and falls as the receiving relay goes marking and spacing respectively. At the beginning of the start pulse of spacing nature the potential across these gaps decreases. About the middle of the start pulse the first positive and immediately following small negative pulses represented in curve J cause the potential across the control gaps to rise momentarily then to fall momentarily below the immediately preceding previous steady or spacing value, and to return to that value.

Assuming that the first selecting pulse is marking, the control gap potential for a marking condition is restored at the end of the start pulse, and about the same time tube 46A is fired, giving a further rise to the potential across the control gap of tube 31A by virtue of the increased potential across resistor 47A (curve K—2). At this time the small negative pulse occurring in the secondary of transformer 27 and represented in curve J tends to reduce slightly the potential increasing effects of restoration of the receiving relay to marking, and in the case of tube 31A, by the potential across resistor 47A, but this opposing effect is negligible. About the middle of the first selecting pulse the second large positive pulse represented in curve J momentarily raises the control gap potentials of all of the tubes 31A to 31E. In the case of tube 31A the potential rises above the control gap firing threshold as indicated by the solid line of the curve, and the tube fires. In the case of the other four tubes, the potential does not rise to the firing threshold as indicated by the dotted line portion of the curve, and they remain unfired.

Assuming that the second selecting pulse is of spacing nature, the potentials of the control gaps fall, under the control of the receiving relay, but tube 46B is fired and the potential across cathode resistor 47B increases, as represented by curve K—3, thus partially or completely counteracting the decrease in potential across the control gap of tube 31B. About the middle of the second selecting pulse the control gap potentials of the tubes 31A to 31E are increased by the third large positive pulse represented in curve J, but in no case does the potential rise to the control gap firing threshold, so tubes 31B to 31E remain unfired. Of course, tube 31A, already conductive in its main gap, remains conductive so that potential variations across its control gap during the remainder of the impulse intervals have no effect upon it.

Neither of the cathode resistors 47F nor 47G of tubes 46F and 46G exercises any control over the control gap potentials of tubes 31A to 31E so that about the beginning of the stop pulse these gaps are restored to their initial potentials. At about the same time the main gaps of those of the tubes 31A to 31E that are conductive are quenched under the indirect control of tube 46F. About the middle of the stop pulse the last large positive pulse represented in curve J momentarily raises the potentials of the control gaps, but these potentials do not reach the firing threshold, and the control gaps do not fire.

One oscillator cycle after the firing of tube 46F, tube 46G fires, and in turn fires tube 24. At this time the current in the oscillatory circuit and the voltage across the condenser 79 have reached their initial values, and the direct current flowing through tube 24 and inductance 72 sus-

tains them at these values, thereby stopping oscillation.

Each of the tubes 31A to 31E inclusive, has its anode connected through an individual load resistor 98A, 98B, 98C, 98D and 98E to positive conductor 59. By virtue of the provision of individual anode load resistors the tube 31A or any other one of the tubes in the series does not reduce the potential of conductor 59 as the potential across the main gap of the tube decreases from the firing potential to the discharge sustaining potential so that the firing of any of the tubes does not result in the quenching of any other one of the tubes that is then conductive. Thus as the reception of telegraph impulses continues and tubes 46B, 46C, 46D and 46E are fired in turn and prepare the tubes 31B, 31C, 31D and 31E to be fired and these latter tubes are fired selectively in accordance with the reception of marking signal impulses, they remain conductive.

The cathode of tube 31A is connected through resistors 99A and 101A in series to positive conductor 59. Similarly, the cathodes of tubes 31B, 31C, 31D and 31E are connected through individual pairs of series resistors 99B and 101B, 99C and 101C, 99D and 101D and 99E and 101E to positive conductor 59. The junction of resistors 99A and 101A is connected through a resistor 102A to the control anode of a cold cathode gas-filled tube 103A. Similarly, the junctions of resistors 99B and 101B, 99C and 101C, 99D and 101D and 99E and 101E are connected through individual resistors 102B, 102C, 102D and 102E respectively, to the control anodes of cold cathode gas-filled tubes 103B, 103C, 103D and 103E respectively. The resistors 101A, 99A and cathode resistor 37A associated with tube 31A and corresponding resistors associated with the cathodes of each tube 31B, 31C, 31D and 31E form potential dividers to establish the potentials of the cathodes at predetermined equal values below the potential of positive conductor 59 when the tubes 31A to 31E are not conductive. When these tubes are rendered conductive selectively the cathodes become less negative with respect to conductor 59 by the increase in potential difference across their cathode resistors 37A to 37E inclusive, resulting from the flow of discharge current. This correspondingly reduces the potential difference across the series of resistors 101A and 99A associated with tube 31A and corresponding resistors associated with tubes 31B to 31E inclusive, and renders the junction of these resistors less negative with respect to positive conductor 59 than when the tubes were non-conductive. Thus as each of the tubes 31A to 31E inclusive, is selectively rendered conductive the potential of the control anode of the associated tube 103A to 103E inclusive, is rendered more positive than it previously was.

The cathodes of tubes 103A to 103E inclusive, are connected in multiple to conductor 104 which extends to the left-hand or off-normal contact of relay 61. The armature of this relay at this time engages its normal or right-hand contact, being operated to that contact by current through the biasing winding for the reason that there is no current in the operating winding, this winding being included in the anode circuit of tube 46F in the counting chain which has not yet been activated. Thus as the control anodes of tubes 103A to 103E inclusive, are selectively rendered more positive under the control of tubes 31A to 31E inclusive, the tubes 103A to 103E will be primed but will not be rendered conductive because their cathode circuits are open.

As the reception of telegraph impulses proceeds the third, fourth, fifth and sixth of the positive impulses induced in the secondary of transformer 27 about the middle of the second, third, fourth and fifth of the significant impulse intervals cause the firing of tubes 31B, 31C, 31D and 31E if the armature of receiving relay 11 is on the marking contact at the instant that the impulses are induced in the secondary of transformer 27. About the end of the impulse interval corresponding to the last significant element of the received code, at which time tube 46E is conductive and tube 46F is primed, the sixth positive impulse is induced in the secondary of transformer 56 which fires tube 46F which in turn quenches tube 46E. The discharge in tube 46F transfers to the main gap, the circuit of which includes the operating winding of relay 61, so that the armature of that relay is moved to the off-normal or left-hand contact. The armature of relay 61 is connected to the negative terminal of battery 104, the positive terminal of which is connected to ground and the potential applied through the armature and off-normal contact of relay 61 to the cathodes of tubes 103A to 103E inclusive, is sufficiently negative to fire simultaneously those of the tubes 103A to 103E which have been primed. Those of the tubes 103A to 103E which have their control anodes associated with the tubes in the series 31A to 31E which have not been fired are not primed and accordingly such tubes in the series 103A to 103E are not fired.

The main anodes of tubes 103A to 103E are connected through individual resistors 106A, 106B, 106C, 106D and 106E respectively, and conductors 107A, 107B, 107C, 107D and 107E respectively, extending into Fig. 1 to one terminal of the operating winding of each of the relays 108A, 108B, 108C, 108D and 108E respectively. The other terminal of the operating winding of each of the relays 108A to 108E is connected through an individual resistor 109A, 109B, 109C, 109D or 109E to conductor 111 which extends into Fig. 2 and is there connected to positive conductor 59. Thus the relays 108A to 108E become selectively operated in the anode circuits of the tubes 103A to 103E inclusive, when those tubes are selectively activated.

The main anode of tube 103A is connected through a condenser 112A to the main anode of tube 31A. Similarly, the main anodes of tubes 103B, 103C, 103D and 103E are connected through individual condensers 112B, 112C, 112D and 112E to the main anodes of tubes 31B, 31C, 31D and 31E. As the discharge in each of the tubes 103A to 103E which becomes selectively activated transfers to the main discharge path an impulse is transmitted through the associated condenser 112A to 112E, inclusive, which lowers the potential of the main anodes of the associated tubes 31A to 31E with respect to their cathodes below the discharge sustaining potential and quenches the tubes. In this way the received signal conditions stored in the tubes 31A to 31E are transferred to the tubes 103A to 103E and the tubes 31A to 31E are restored to non-conductive condition in preparation for reception of the next code signal combination.

One impulse interval after the firing of tube 46F, tube 46G which has been primed by tube 46F is fired by an impulse induced in the secondary of transformer 55. As the discharge transfers to the main gap current rises in the primary winding of transformer 63 and induces a voltage in the secondary winding which refires tube 24. The

steady anode current in tube 24 flows through inductance 72 charging condenser 79 and stopping oscillation in the resonant circuit. Since tube 24 fires at the end of the seventh cycle produced by the oscillator, the currents and voltages in the oscillatory circuit have at that instant returned to their initial values, provided the decrement of the oscillation is zero, and hence the oscillator stops without a transient. If, however, the decrement is other than zero, the final voltages and currents will have values greater or smaller than the initial values, and a small stopping transient will result. The value of resistor 23 is so chosen that the oscillator circuit is critically damped after tube 24 has fired, and hence the stopping transient is as short as possible in duration. The firing of the main gap of tube 24 and stopping of the oscillator occurs only if the line relay 11 is responding to the stop signal of marking nature and has its armature operated to the marking contact because the main anode of tube 24 receives positive potential through the armature and marking contact of relay 11. Tube 46G upon firing quenches tube 46F and thus the counting chain of tubes 46A to 46E completes a receiving cycle and is in the condition which existed prior to the reception of the start signal.

With the quenching of tube 46F current ceases to flow in the operating winding of relay 61 and the biasing winding restores the armature to the right-hand or normal contact. This causes battery 104 of negative polarity to be connected over conductor 112 extending into Fig. 1 from which a path is traced through resistor 113, conductor 114 and upper winding of relay 116 to ground. The function of completion of the circuit of the upper winding of relay 116 will be described hereinafter.

Referring again to the relays 108A to 108E, inclusive, it will be noted that their right-hand armatures are connected over conductor 117 to ground and that the front contacts with which the right-hand armatures cooperate are connected to individual electromagnets 118A, 118B, 118C, 118D and 118E. The other terminal of each of these electromagnets is connected to one terminal of battery 119 the other terminal of which is connected to ground. As the relays 108A to 108E, inclusive, became selectively operated the associated ones of the electromagnets 118A to 118E were selectively energized. Electromagnets 118A to 118E represent the selecting magnets of a permutation code selector mechanism in which the code bars, discs or other selecting elements are operated by individual magnets. For example, the electromagnets 118A to 118E may be the five selector magnets of a permutation code operated printing telegraph receiving recorder such as that disclosed in Patent 1,665,594, granted April 10, 1928, to H. L. Krum, and the disclosure of this patent is incorporated herein by reference as part of the present specification. Magnets 118A to 118E operate to set permutation code selector elements in combinational positions corresponding to the selectively energized magnets. A sixth magnet 121, the energization of which will be described later, is operable as is fully disclosed in the Krum patent for establishing a driving connection between motor 122 and apparatus not disclosed herein but fully disclosed in the patent for giving effect to the selective setting of the code elements and for performing the recording or functional operation corresponding to such selection.

Reference is made to the previously described

conductive path from the right-hand or normal contact of relay 61 to the operating winding of relay 116. When the armature of relay 61 was operated to the left-hand contact by tube 46F, this circuit of the operating winding of relay 116 was interrupted, permitting the biasing winding of this relay to operate the armature to the right-hand contact. The armature of relay 116 is connected to battery 126 and the left-hand contact is connected through resistor 127 shunted by condenser 128 to one terminal of printer controlling magnet 121 the other terminal of which is connected to the right-hand contact of a relay 128. The operating winding of relay 128 and of a relay 129 in series with it are connected between ground and the right-hand contact of relay 116 from which there is also a connection through resistor 131 and condenser 132 to ground. Thus, when the armature of relay 116 is on its left-hand contact the circuit of the operating windings of relays 128 and 129 is opened. The biasing windings of relays 128 and 129 which urge the armatures of those relays to the left-hand contacts when the circuit of the operating windings of the relays is opened are connected through individual resistors 133 and 134, respectively, to battery 126. Resistor 133 has a higher value than resistor 134 so that the biasing winding of relay 129 carries a larger biasing current than the biasing winding of relay 128. Thus the conductive path through magnet 121 is closed at the armature and left-hand contact of relay 116 but is opened at the right-hand contact and armature of relay 128 while the armature of relay 61 is on its right-hand contact.

When the armature of relay 61 leaves its right-hand contact, opening the circuit of the operating winding of relay 116, and completes the circuits of selected ones of the relays 108A to 108E through its left-hand contact and the tubes 103A to 103E as previously described, the armature of relay 116 is moved by its biasing winding to its right-hand contact connecting battery 126 to the operating windings of relays 128 and 129 and through resistor 131 to condenser 132 to operate the armatures of relays 128 and 129 to their right-hand contacts and to charge condenser 132. Although the relays 128 and 129 have current of different values in their biasing windings the current through the operating windings has a value which produces magnetic fields sufficiently exceeding the magnetic fields produced by the biasing windings to operate the two relays substantially simultaneously to their right-hand contacts.

The armature of relay 129 is connected to ground and its right-hand contact is connected over conductor 136 to the left-hand armature of each of the relays 108A to 108E. The left-hand front contacts of these relays are connected through the left-hand or locking windings to conductor 137 which is connected to one terminal of battery 138 the other terminal of which is grounded. Thus the relay 129 completes locking circuits for those of the relays 108A to 108E which have been selectively operated.

The armature of relay 128 is connected to the left-hand contact of relay 129. Thus although the relay 128 extends the conductive path of the winding of magnet 121 through the armature and right-hand contact of relay 128 to the left-hand contact of relay 129, the circuit of magnet 121 is not completed at this time because the armature of relay 129 is engaging its right-hand contact and the armature of relay 116 is on its right-hand contact. Upon the reoperation of the armature

of relay 61 to the right-hand contact due to the firing of tube 46G and consequent quenching of tube 46F the circuit of the operating winding of relay 116 is reestablished and the armature is restored to the left-hand contact, removing battery 126 from connection to the operating windings of relays 128 and 129 and again connecting the battery to the left-hand terminal of magnet 121. Condenser 132, which is now charged, begins to discharge through resistors 131 and 130 and the operating windings of relays 128 and 129 holding the armatures of these relays on their right-hand contacts after battery 126 has been disconnected from the operating windings. As the discharging current of condenser 132 decreases it reaches a value at which it is no longer able to hold the armature of relay 129 on the right-hand contact but is still able to hold the armature of relay 128 on the right-hand contact, this being due to the larger biasing current in relay 129 than in relay 128. Accordingly, the armature of relay 129 is restored to its left-hand contact thereby connecting ground through its armature and left-hand contact and through the armature and right-hand contact of relay 128 to complete the energizing circuit for magnet 121 which sets in operation the selecting and recording mechanism of the printer by tripping a clutch as is disclosed in the Krum patent. Only a momentary energization of magnet 121 is necessary to accomplish this, and after the necessary interval the discharge current of condenser 132 falls to a value such that the operating winding of relay 128 cannot hold the armature on the right-hand contact and, accordingly, the biasing winding restores the armature to its left-hand position opening the circuit of magnet 121. It will be noted that when the armature of relay 129 was restored it interrupted the circuit of the locking windings of relays 108A to 108E. The circuits through the operating windings of these relays were opened at the cathodes of tubes 103A to 103E when the armature of relay 61 was restored to its normal or right-hand contact so that these relays release and in turn release the selector magnets 118A to 118E. By reference to the Krum patent it will be found that it is not necessary for the selector magnet to remain energized during the selecting and printing cycle for the reason that the selector elements which they control become locked in the selective setting established by the magnets and the release of the magnets has no effect on the selector elements. In fact the selector magnets shown in the Krum patent merely trip latches which permit the selector elements to be moved by springs to their marking positions so that it is not necessary that the selector magnets remain energized until the selector elements are actually locked. Mechanism operated by the operating motor of the printer which is designated 122 in the present specification restores the selector elements to latched condition in the spacing position after a selection has been made and the recording or functional operation has been initiated preparatory to control of the selector elements by the selector magnets 118A to 118E in response to the next received telegraph code combination.

With the operation of magnet 121 and the re-firing of counting chain tube 46G one full receiving cycle of the electronic receiving distributor and transfer mechanism has been completed. The apparatus is in condition to respond to the next telegraph signal combination which will be preceded by a start signal which will quench tube

24. This tube will start the oscillator circuit comprising inductance 72, condenser 79 and the left-hand triode section of tube 74 which will cause the counting chain of tubes 46A to 46G to be activated and quenched in succession at intervals corresponding to one impulse interval of the telegraph signal. It will be noted that as between the electronic receiving distributor mechanism and the printing telegraph recorder substantially a full cycle of overlap is provided. Received telegraph impulses are distributed by the tubes 46A to 46G, inclusive, to the tubes 31A to 31E, inclusive, and are stored in those tubes. After the last significant impulse of a telegraph signal combination has been received the selective conditions stored in the tubes 31A to 31E are transferred to the selector magnets 118A and 118E through the tubes 103A to 103E and the relays 108A to 108E. This selective condition is locked in the selector elements controlled by the selector magnets and is deleted from the tubes 31A to 31E by the tubes 103A to 103E. Thereafter, the selective condition is deleted from the tubes 103A to 103E by relay 61 and finally is deleted from the relays 108A to 108E and the selector magnets 118A to 118E by the relay 129 upon restoration of that relay to normal and opening of the locking circuits of relays 108A to 108E. The completion of the selecting operation in the printing telegraph recorder and the performance of the recording or functional operation may proceed during the storing of the next received signal combination in the tubes 31A to 31E.

In Fig. 2 there is shown a simple and effective means for accurately checking and adjusting the timing of the receiving distributor. This means comprises jack 68 and a milliammeter 141 connected to the terminals of a plug 142 adapted to be inserted into jack 68. Upon insertion of the jack into the plug the closed circuit contacts of the jack are opened and milliammeter 141 is connected into the discharge circuit of tube 24 between the cathode of the tube and inductance 72.

It is a characteristic of start-stop telegraph systems that the receiving distributor operates slightly faster than the transmitting distributor in order that the receiving distributor shall complete its cycle and actually be stopped before the transmitting distributor completes its cycle. For purposes of illustration let it be assumed that the timing of the counting chain of tubes 46A to 46G is to be adjusted to a cycle of duration 7.00 to receive signal combinations transmitted by a transmitter in a cycle of duration 7.42. The time during which the counting chain should be in operation and current in tube 24 will be at zero value will be an interval of duration 7.00 and the time during which tube 24 should be conductive and the oscillator should be stopped will be an interval of duration $7.42 - 7.00 = .42$. In other words the counting chain is to be in operation counting seven impulse intervals of duration 1 in a total interval of duration 7.00 and is to be at rest for an interval of duration .42 of one impulse interval. The average current for the full period of time from one firing of tube 24 to the next as signals are received continuously would be the full or steady state current multiplied by the interval during which the current flows and divided by the interval during which the current flows plus the interval during which no current flows. This may be expressed by the equation

$$I_{AV} = \frac{.42I}{7.00 + .42}$$

In order to adjust the timing of the counting chain plug 142 is inserted into jack 68 to connect milliammeter 141 in the circuit of tube 24 and with line relay 11 responding to a steady marking signal the value of the current flowing in tube 24 should be read from the milliammeter. This value of current should be substituted for I in the above equation and the value of the average current (I_{AV}) should be computed.

Following the computation of the theoretical average current start-stop permutation code signals generated by a tape transmitter should be fed into line relay 11 and the milliammeter 141 should be read. If milliammeter 141 is slow, which is desirable, it will be unable during continuous reception of signals to rise to registration of full current in the tube 24 during the interval of duration .42 and will be unable to fall to zero during the interval of duration 7.00. Instead, it will register a substantially steady lesser value which is approximately the average value of current for the total interval of current on and current off in tube 24. The average current read from the meter will be higher than the computed average current if the frequency of the oscillator is such as to operate the counting chain through one cycle in an interval of less than duration 7.00 and the reading of the meter 141 will be less than the calculated average if the frequency of the oscillator is too low. By changing the value of condenser 79 the frequency of the oscillator may be varied until the substantially steady reading of the milliammeter 141 for continuous signal reception is equal to the calculated value of average current. The oscillator will then be correctly timed to provide an operating cycle of the counting chain of tubes 46A to 46G of duration 7.00 and a rest interval of duration .42 for continuous signal reception.

Although a particular embodiment of the invention has been shown in the drawings 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, rearrangement and substitution of parts and elements without departing from the spirit of the invention and within the scope of the appended claims.

What is claimed is:

1. In a telegraph signal receiving device, signal responsive means, a normally inactive impulse generator, means controlled by said signal responsive means for setting said generator in operation, means for counting the impulses produced by said generator, means controlled jointly by said generator, said counting means and said signal responsive means for storing selective conditions corresponding to the signal responsive operations of said signal responsive means, and means controlled by said storing means for making a selection.
2. In a telegraph signal receiving device, signal responsive means, a normally inactive impulse generator, means controlled by said signal responsive means for setting said generator in operation, means for counting the impulses produced by said generator, means controlled jointly by said generator, said counting means and said signal responsive means for storing selective conditions corresponding to the signal responsive operations of said signal responsive means, a selector mechanism, and means for transferring said selective conditions from said storing means to said selector mechanism.
3. In a telegraph signal receiving device, a signal responsive means, a normally inactive im-

pulse generator, means controlled by said signal responsive means for setting said generator in operation, means for counting the impulses produced by said generator, means controlled jointly by said generator, said counting means and said signal responsive means for storing selective conditions corresponding to the signal responsive operations of said signal responsive means, a selector mechanism, and means controlled by said counting means for transferring said selective conditions from said storing means to said selector mechanism.

4. In a telegraph signal receiving device, signal responsive means, a normally inactive impulse generator, means controlled by said signal responsive means for setting said generator in operation, means for counting the impulses produced by said generator, means controlled jointly by said generator, said counting means and said signal responsive means for storing selective conditions corresponding to the signal responsive operations of said signal responsive means, a selector mechanism, means for transferring said selective conditions from said storing means to said selector mechanism, and means controlled by said counting means for restoring said impulse generator to inactive condition.

5. In a telegraph signal receiving device, signal responsive means, a normally inactive impulse generator, electron discharge means controlled by said signal responsive means for setting said generator in operation, means for counting the impulses produced by said generator, means controlled jointly by said generator, said counting means and said signal responsive means for storing selective conditions corresponding to the signal responsive operations of said signals responsive means, a selector mechanism, means for transferring said selective conditions from said storing means to said selector mechanism, and means controlled by said counting means upon counting a predetermined number of impulses for causing said electron discharge means to restore said impulse generator to inactive condition.

6. In a telegraph signal receiving device, signal responsive means, a normally inactive impulse generator, normally conductive electron discharge means rendered non-conductive by said signal responsive means upon response thereof to a start signal for activating said impulse generator, means for counting the impulses produced by said generator, means controlled jointly by said generator, said counting means and said signal responsive means for storing selective conditions corresponding to the signal responsive operations of said signal responsive means, a selector mechanism, means for transferring said selective conditions from said storing means to said selector mechanism, and means controlled by said counting means upon counting a predetermined number of impulses for reactivating said electron discharge means to cause said impulse generator to be restored to inactive condition.

7. In a telegraph signal receiving device, a signal responsive means, a normally inactive electronic generator of oscillatory current, means controlled by said signal responsive means for setting said generator in operation, means controlled by said generator for deriving impulses at the rate of at least one impulse per cycle of oscillatory current, means for counting said impulses, second means controlled by said generator for deriving impulses at the rate of at least one impulse per cycle of oscillatory current, means controlled jointly by said signal responsive means,

said counting means and said second impulse deriving means for storing selective conditions corresponding to the signal responsive operations of said signal responsive means, a selector mechanism, means controlled by said counting means for transferring said selective conditions from said storing means to said selector mechanism, and means also controlled by said counting means for restoring said generator of oscillatory current to inactive condition.

8. In a telegraph signal receiving device, a plurality of cold cathode electron discharge tubes having main and control discharge paths, means for priming the control discharge path of each of said tubes in succession at predetermined intervals, means for priming the control discharge paths of all of said tubes momentarily during the priming of each of said tubes by said first-mentioned priming means, said second-mentioned priming means operating in aiding relation to said first-mentioned priming means, and signal responsive means operable to aid or oppose the priming of all of said tubes and effective when aiding said priming to fire the particular tube then primed by said first and second-mentioned priming means.

9. In a telegraph signal receiving device, a plurality of cold cathode electron discharge tubes having main and control discharge paths, a plurality of other electron discharge tubes operable in succession at predetermined intervals for priming the control discharge path of each of said cold cathode tubes individually, means for priming the control discharge path of all of said cold cathode tubes momentarily during the priming of each of said tubes by said other electron discharge tubes, said momentarily operable priming means operating in aiding relation to the priming by said other electron discharge tubes, and signal responsive means operable to aid or oppose the priming of all of said tubes and effective when aiding said priming to fire the particular tube then primed by said other electron discharge tube and said momentarily operable priming means.

10. In a telegraph signal receiving device, a plurality of cold cathode electron discharge tubes having main and control discharge paths, a plurality of other electron discharge tubes operable in succession at predetermined intervals for priming the control discharge path of each of said cold cathode tubes individually, means for activating said other electron discharge tubes successively, means controlled by said activating means for priming the control discharge paths of all of said cold cathode tubes momentarily during the priming of each of said tubes by said other electron discharge tubes, said momentarily operable priming means operating in aiding relation to the priming by said other electron discharge tubes, and signal responsive means operable to aid or oppose the priming of all of said cold cathode tubes and effective when aiding said priming to fire the particular tube then primed by said other electron discharge tubes and said momentarily operable priming means.

11. In a telegraph signal receiving device, signal responsive means, a normally inactive impulse generator, means controlled by said signal responsive means for setting said generator in operation, a series of electron discharge tubes operable successively by said impulse generator, a plurality of electron discharge tubes controllable jointly by said signal responsive means and individual ones of said first-mentioned electron discharge tubes for storing selective conditions cor-

responding to signaling impulses received by said signal responsive means, and means controlled by the last electron discharge tube of said first-mentioned series of electron discharge tubes for deactivating said impulse generator.

12. In a telegraph signal receiving device, signal responsive means, a normally inactive impulse generator, means controlled by said signal responsive means for setting said generator in operation, a series of electron discharge tubes operable successively by said impulse generator, a plurality of electron tubes controllable jointly by said signal responsive means and individual ones of said first-mentioned electron discharge tubes for storing selective conditions corresponding to signaling impulses received by said signal responsive means, a recorder having selector elements, means controlled by one of the electron discharge tubes in said first-mentioned series of tubes for transferring selective conditions stored in said storing electron discharge tubes to said selector elements, and means controlled by the last electron discharge tube in said first-mentioned series of electron discharge tubes for deactivating said impulse generator.

13. In a permutation code signal receiver, signal responsive means, means for locally generating impulses in timed relation to signaling impulses received by said signal responsive means, electron discharge means for counting said locally generated impulses, trigger action electron discharge means controlled jointly by said signal-responsive means and said electron discharge counting means for storing selective conditions corresponding to impulses received by said signal responsive means, a recording mechanism, a plurality of selector elements for controlling said recording mechanism, means controlled by said counting means for transferring selective conditions stored in said electron discharge storing means to said selector elements, and means also controlled by said counting means upon counting a predetermined number of locally generated impulses for stopping said impulse generating means.

14. In a permutation code signal receiver, signal responsive means, normally inactive means for locally generating impulses in timed relation to telegraph signaling impulses received by said signal responsive means, means controlled by said signal responsive means for setting said impulse generating means in operation, electron discharge means for counting said locally generated impulses, trigger action electron discharge means controlled jointly by said signal-responsive means and said electron discharge counting means for storing selective conditions corresponding to impulses received by said signal responsive means, a recording mechanism, a plurality of selector elements for controlling said recording mechanism, means controlled by said counting means for transferring selective conditions stored in said electron discharge storing means to said selector elements, and means also controlled by said counting means upon counting a predetermined number of locally generated impulses for restoring said impulse generating means to inactive condition.

15. In a permutation code signal receiver, signal responsive means, electron discharge means for counting impulse intervals of signals received by said signal responsive means, first electron discharge storing means for successively storing selective conditions corresponding to impulses received by said signal responsive means, second

electron discharge storing means, means controlled by said electron discharge counting means for transferring to said second electron discharge storing means selective conditions stored in said first electron discharge storing means, a recording mechanism, a plurality of selector elements for controlling said recording mechanism, and means controlled by said second electron discharge storing means for actuating said selector elements in accordance with selective conditions stored in said second electron discharge storing means.

16. In a printing telegraph receiver, signal responsive means, a first plurality of electron discharge tubes arranged in a counting chain, means for activating said tubes successively in timed relation to signaling impulses received by said signal responsive means, a second plurality of electron discharge tubes operable selectively in succession under the joint control of said signal responsive means, said counting chain of electron discharge tubes and said counting chain activating means for storing selective conditions corresponding to signaling impulses received by said signal responsive means, a third plurality of electron discharge tubes, means controlled by said counting chain of electron discharge tubes for simultaneously transferring to said third plurality of electron discharge tubes the selective conditions stored in said second plurality of electron discharge tubes, a recording mechanism, a plurality of selector elements for controlling said recording mechanism, and means controlled by said third plurality of electron discharge tubes for controlling said selector elements.

17. In a printing telegraph receiver, signal responsive means, means for locally generating oscillatory current in cycles equal in duration to telegraph signaling impulse intervals, means for deriving impulses from said cycles of oscillatory current in fixed time relation to said cycles, electronic means for counting said derived impulses, means for deriving impulses from said cycles of oscillatory current in variable time relation thereto, electronic means controlled jointly by said signal responsive means, said impulse counting means and said second-mentioned impulse deriving means for storing selective conditions corresponding to impulses received by said signal responsive means, a recording mechanism, a plurality of selector elements for controlling said recording mechanism, and means controlled by said counting means for transferring selective conditions stored in said electronic storing means to said selector elements.

18. In a printing telegraph receiver, signal responsive means, means for generating oscillatory current in cycles having a duration equal to the impulse intervals of received telegraph signals, first impulse deriving means for deriving impulses from said cycles of oscillatory current in fixed time relation thereto, electronic means for counting said impulses, second impulse deriving means for deriving impulses from said cycles of oscillatory current, means for varying the time relation of impulses derived by said second impulse deriving means to said cycles of oscillatory current, electronic means controlled jointly by said signal responsive means, said impulse counting means and said second impulse deriving means for storing selective conditions corresponding to impulses received by said signal responsive means, a recording mechanism, a plurality of selector elements for controlling said

recording mechanism, and means controlled by said counting means for transferring selective conditions stored in said electronic storing means to said selector elements.

19. In a telegraph signal receiving device, signal responsive means, a start-stop oscillator, means controlled by said signal responsive means for starting said oscillator, means for counting the cycles of oscillatory current generated by said oscillator, means controlled by said counting means for storing selective conditions corresponding to telegraph impulses received by said signal responsive means, and means also controlled by said counting means upon counting a predetermined number of cycles for stopping said oscillator.

20. In a signal receiving device, signal responsive means, a normally conductive electron discharge device adapted to be deactivated by said signal responsive means upon response thereof to signals, an oscillatory circuit connected to conduct the discharge current of said tube and adapted to generate oscillatory current upon the deactivation of said tube, means for counting the cycles of oscillatory current generated by said oscillatory circuit, means controlled by said counting means for storing selective conditions corresponding to signal impulses received by said signal responsive means, and means also controlled by said counting means upon counting a predetermined number of cycles of oscillatory current for reactivating said electron discharge tube whereby to stop the generation of oscillatory current by said oscillatory circuit.

21. In a signal receiving device, signal responsive means, a normally conductive electron discharge tube adapted to be deactivated by said signal responsive means upon response thereof to signals, an oscillatory circuit connected to conduct the discharge current of said tube and adapted to generate oscillatory current upon the deactivation of said tube, means for counting the cycles of oscillatory current generated by said oscillatory circuit, means controlled by said counting means for storing selective conditions corresponding to signal impulses received by said signal responsive means, means controlled by said counting means upon counting a predetermined number of cycles of oscillatory current for reactivating said electron discharge tube whereby to stop the generation of oscillatory current by said oscillatory circuit, and means for measuring the average value of the discharge current of said tube over a period of a plurality of alternate conditions of activation and deactivation of said tube.

22. In a signal receiving device, signal responsive means, a normally conductive electron discharge tube adapted to be deactivated by said signal responsive means upon response thereof to signals, an oscillatory circuit connected to conduct the discharge current of said tube and adapted to generate oscillatory current upon the deactivation of said tube, means for counting the cycles of oscillatory current generated by said oscillatory circuit, means controlled by said counting means for storing selective conditions corresponding to signal impulses received by said signal responsive means, means also controlled by said counting means upon counting a predetermined number of cycles of oscillatory current for reactivating said electron discharge tube whereby to stop the generation of oscillatory current by said oscillatory circuit, means for measuring the average value of the discharge current of said tube over a period of a plurality of alternate con-

ditions of activation and deactivation of said tube, and means for varying the frequency of oscillatory current generated by said oscillatory circuit whereby to vary the period of activation of said electron discharge tube and to bring said average value of the discharge current to a predetermined value characteristic of the desired frequency of said oscillatory current.

23. In a signal receiving device, signal responsive means, a normally conductive electron discharge tube adapted to be deactivated by said signal responsive means upon response thereof to signals, an oscillatory circuit connected to conduct the discharge current of said tube and adapted to generate oscillatory current upon the deactivation of said tube, means for counting the cycles of oscillatory current generated by said oscillatory circuit, means controlled by said counting means upon counting a predetermined number of cycles of oscillatory current for reactivating said electron discharge tube whereby to stop the generation of oscillatory current by said oscillatory circuit, means for measuring the average value of the discharge current of said tube over a period of a plurality of alternate conditions of activation and deactivation of said tube, and means for varying the frequency of oscillatory current generated by said oscillatory circuit whereby to vary the period of activation of said electron discharge tube and to bring said average current to a predetermined value characteristic of the desired frequency of said oscillatory current.

24. In an electrical system, a normally conductive electron discharge tube, an oscillatory circuit connected to conduct the discharge current of said tube and adapted to generate oscillatory current upon the deactivation of said tube, means for deactivating said tube, means for counting the cycles of oscillatory current generated by said oscillatory circuit, means controlled by said counting means upon counting a predetermined number of cycles of oscillatory current for reactivating said electron discharge tube whereby to stop the generation of oscillatory current by said oscillatory circuit, means for measuring the average value of the discharge current of said tube over a period of a plurality of alternate conditions of activation and deactivation of said tube, and means for varying the frequency of oscillatory current generated by said oscillatory circuit whereby to vary the period of activation of said electron discharge tube and to bring said average current to a predetermined value characteristic of the desired frequency of said oscillatory current.

25. In an electrical system, a normally conductive direct current path, an oscillatory circuit connected to said path and adapted upon interruption of said path to generate oscillatory current, means for interrupting said path, means for counting the cycles of oscillatory current generated by said oscillatory circuit, means controlled by said counting means upon counting a predetermined number of cycles for reclosing said direct current path whereby to stop the generation of oscillatory current by said oscillatory circuit, means for measuring the average value of direct current in said path over a period of a plurality of alternately closed and interrupted conditions of said path, and means for varying the frequency of oscillatory current generated by said oscillatory circuit whereby to vary the period of closure of said path and to bring said average current to a predetermined value charac-

teristic of the desired frequency of said oscillatory current.

26. In an electrical system including a resonant circuit adapted to conduct direct current for a part of a predetermined interval and to conduct oscillatory current for the remainder of said predetermined interval, the method of establishing a predetermined ratio between the two parts of said interval which comprises measuring the value of said direct current, computing the average value of direct current as if spread over said predetermined interval, measuring the average value of direct current during said predetermined interval, and adjusting the constants of said resonant circuit until said measured average value of direct current equals said computed value.

27. In an electrical system including a resonant circuit adapted to conduct direct current for a part of a predetermined interval and to conduct oscillatory current for the remainder of said interval, the method of establishing a predetermined ratio between the two parts of said interval which comprises measuring the value of said direct current, computing the average value of said direct current as if spread over said predetermined interval as the product of said measured value of current and the ratio of the desired duration of said direct current flow to said predetermined interval, measuring the average value of direct current during said predetermined interval, and adjusting the constants of said resonant circuit until said measured average value of direct current equals said computed value.

28. In an electrical system including a resonant circuit adapted to conduct direct current from an external source for a part of a predetermined interval and to conduct self-generated oscillatory current for the remainder of said predetermined interval, said periods of conductivity of direct and oscillatory current occurring alternately, the method of establishing a predetermined ratio between the two parts of said predetermined interval which comprises measuring the value of direct current flowing into said circuit, computing the average value of said direct current as if spread over said predetermined interval as the product of said measured value of current and the ratio of the desired duration of said direct current flow to said predetermined interval, measuring the average value of direct current during said predetermined interval, and adjusting the constants of said resonant circuit until said measured average value of direct current equals said computed value.

29. In an electrical circuit including a resonant circuit adapted to conduct direct current from an external source for a part of a predetermined interval and to conduct self-generated oscillatory current at a predetermined frequency for the remainder of said interval, said periods of conductivity of direct and oscillatory current occurring alternately, the method of establishing said predetermined frequency of said oscillatory current which comprises measuring the value of direct current flowing into said circuit, computing the average value of said direct current as if spread over said predetermined interval as the product of said measured value of current and the ratio of the desired duration of said direct current flow to said predetermined interval, measuring the average value of direct current during continuous alternation of periods of direct current flow and oscillatory current generation, counting the cycles of oscillatory current, and adjusting the constants of said resonant circuit

until the measured average value of direct current equals said computed value during repetitious counting of a fixed number of cycles of oscillatory current.

30. In a telegraph signal receiving device, signal responsive means, a start-stop oscillator, a chain of cold cathode electron discharge tubes for counting cycles of said oscillator, an oscillator controlling cold cathode electron discharge tube controllable by said signal responsive means and effective when conductive in its main gap to maintain said oscillator stopped, sources of electrical potential for said oscillator and said tubes, means for connecting said sources of potential to said oscillator and said tubes, means effective momentarily upon operation of said counting means for connecting a breakdown potential across the control gap of one of the tubes of said chain to cause said one tube to become conductive in its main gap, and means connected between said one tube and said oscillator controlling tube

for firing the control gap of said oscillator controlling tube to cause said oscillator controlling tube to become conductive in its main gap and estop operation of said oscillator.

31. In a telegraph signal receiving device, signal responsive means, a start-stop oscillator, a chain of cold cathode electron discharge tubes controlled by said oscillator for distributing the signal impulses received by said signal responsive means, sources of electrical potential for said tubes, means for connecting said sources of potential to said tubes, and means effective momentarily upon operation of said connecting means for connecting a firing potential across the control gap of one of said tubes to cause said one tube to become conductive in its main gap in preparation for distributive operation of said chain of tubes.

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