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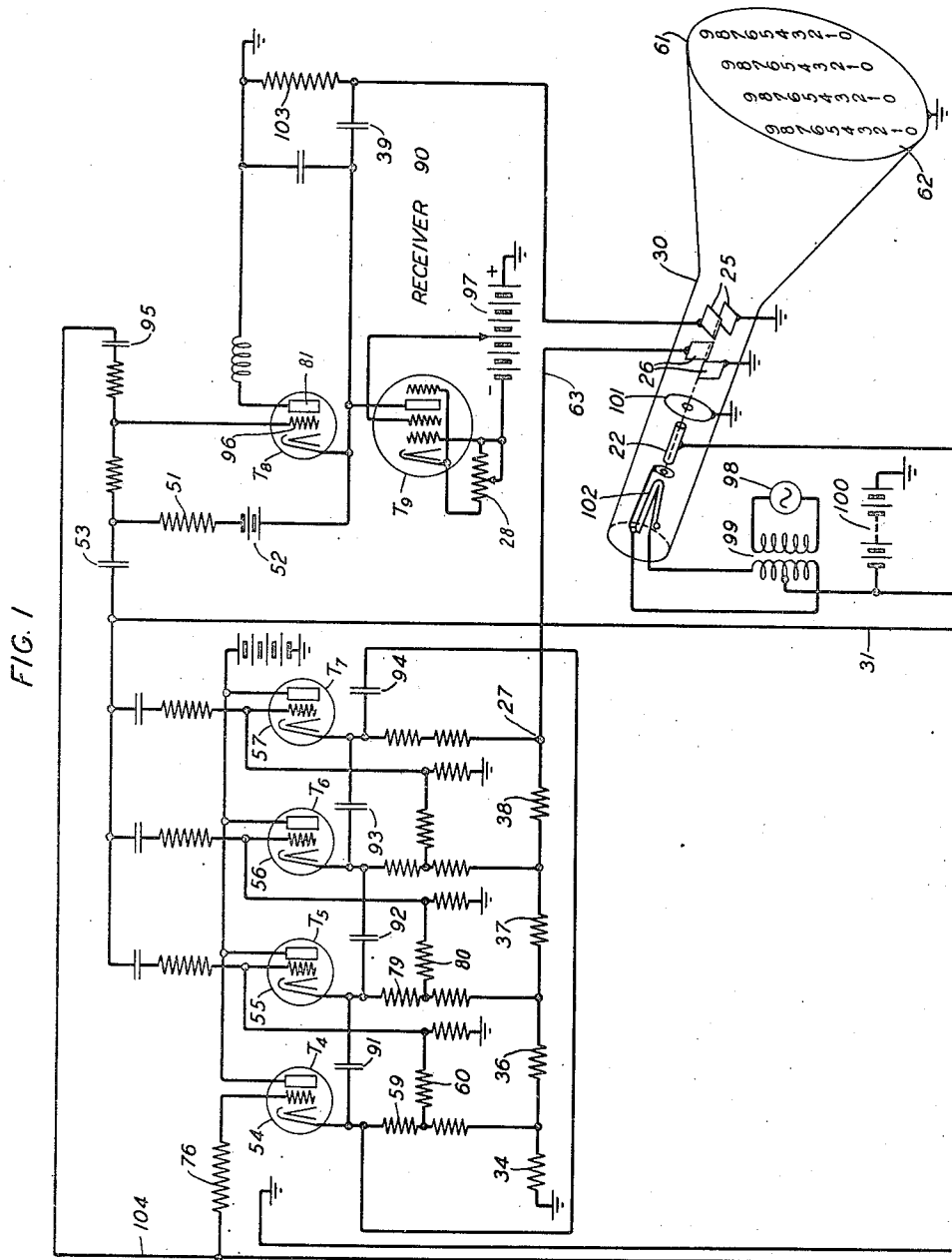
F. A. HUBBARD

2,267,827

ELECTRIC SIGNALING SYSTEM

Filed July 26, 1939.

2 Sheets-Sheet 1



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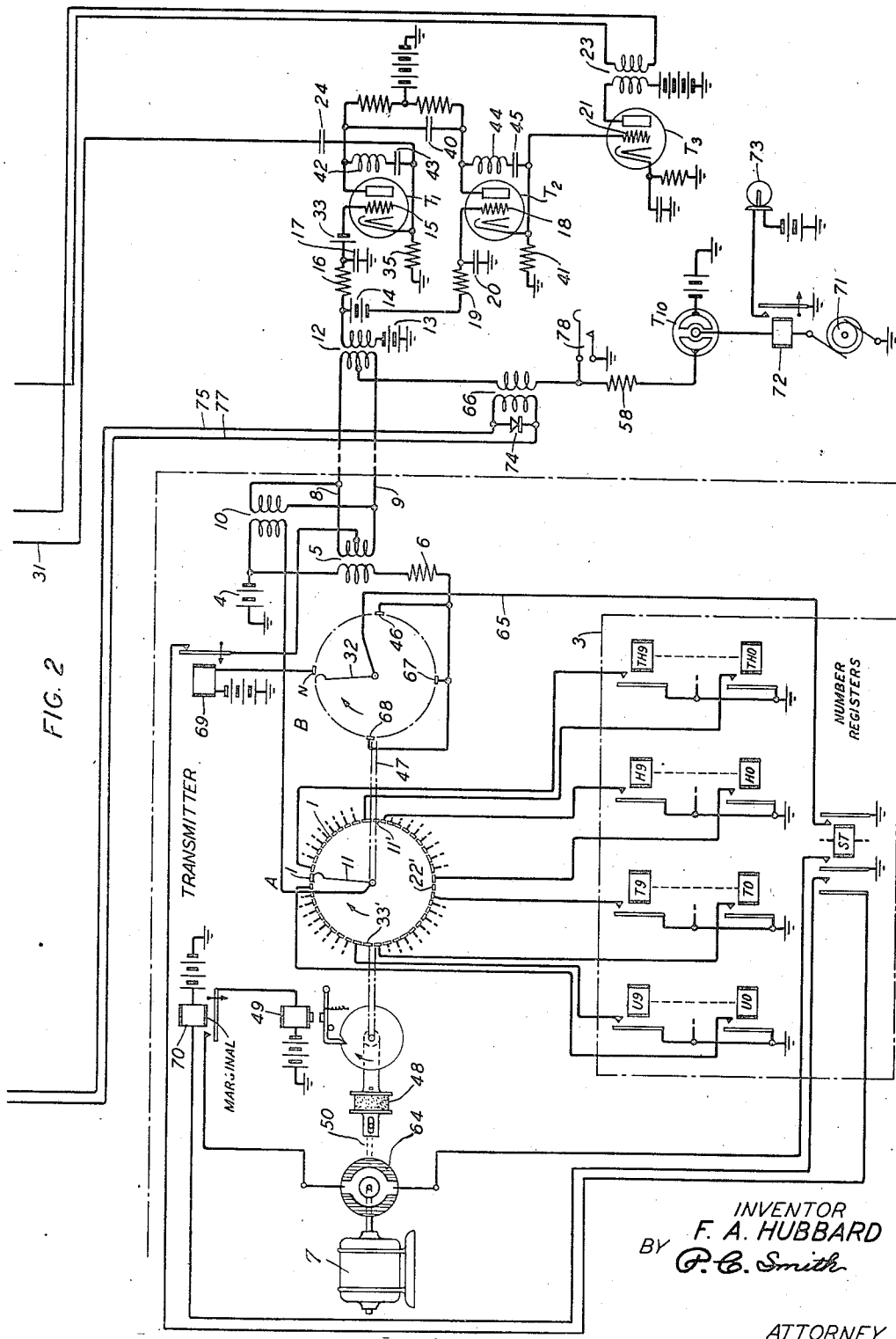
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UNITED STATES PATENT OFFICE

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ELECTRIC SIGNALING SYSTEM

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5 Claims. (Cl. 177—337)

The present invention relates to electric signaling systems and more particularly to an electric indicator in which the beam of a cathode ray tube, under the control of remote settable devices, is directable to and disposable upon the character-configured field of an associated fluorescent screen which is thus caused to be illuminated to display a plurality of characters indicative of those for which the settable devices are positioned. In one of its specific embodiments, the invention may be readily applied to a telephone system comprising two or more offices between which it is desirable to transmit numerical or character designations of called offices and of called subscribers' numbers therein, although it will be evident to those skilled in the art of signaling that the invention herein described and claimed is adaptable to a wide variety of applications.

In applying the principle of the present invention to an automatic telephone system, by way of illustrating one of its many embodiments, we may suppose the necessity of interconnecting a calling subscriber in an automatic office with a called subscriber in a manual office. For the establishment of such a connection, the calling subscriber dials the wanted number which may consist of the name or number of the called exchange and the number of the wanted subscriber therein, and these numbers are recorded in a controlling mechanism in the calling office which then operates to set a number of switching selectors directly between the terminals of the calling line and those of a trunk that terminates at an operator's position in the wanted office. In completing the call from this position to the terminals of the called line, the operator must, of course, be apprised of the wanted number, that is to say, of the number dialed by the calling subscriber and recorded in the controlling mechanism at the calling office which guided the operation of the switching selectors. According to the present invention, use is made of this record to attain this information by causing the mechanism to control devices that produce a series of impulses indicative of the record, which impulses are then transmitted into a circuit that directly influences the position of a cathode ray beam the envelope enclosing which has a fluorescent screen pattern of the digits or characters to be displayed. The direction of the beam is, of course, selectively positioned on the desired digit pattern and its impingement upon a numeral or character pattern of the screen causes the same to be illuminated. By shifting

the position of the beam back and forth successively over the numerals or characters to be displayed and shifting it with a speed greater than the persistence of vision, the numeral pattern of the wanted number will be visibly displayed to the operator.

In the call indicator system here described, I utilize a cathode ray tube or oscilloscope of the conventional type having two sets of deflecting plates set at right angles to each other, a cathode source of electrons which is adapted, in response to impulses characterizing the desired number, for directive emission through an anode cylinder for impingement upon a coated surface having four columns of numerals, and a grid for activating the electron beam in response to said impulses. The one set of deflecting plates which controls the vertical displacement of the beam for its directive impingement upon a particular numeral of a column is connected to a linear sweep circuit of known construction which is adapted to impress upon the plates increments of potential at a definite rate, while the other set of deflecting plates controlling the horizontal displacement of the beam is connected to a circuit which responds to a "shift" impulse between each digit impulse and effects a change in the horizontal position of the beam from one vertical column of numerals to the next and succeeding column in the order of the display. The electron beam is ordinarily suppressed by means of a grid whose potential is altered to render the tube emitting with each digit impulse so that no illumination of the screen is produced except when the grid is energized by a digit impulse. Thus, by causing four beam-releasing or digit impulses and four shift impulses to arrive at proper times and in the appropriate alternate sequence during the sweep cycle, four digits, one in each column of the screen, may be displayed to indicate the thousands, hundreds, tens and units digits of a four-figure telephone line number.

At the transmitting end of the indicator system, I provide a first commutator with forty-four conducting segments (for a four-figure number) having a rotor brush adapted for successive engagement therewith and a second commutator with four conducting segments each disposed, respectively, in the same relative position as the first, eleventh, twenty-second and thirty-third segments of the first commutator and having a rotor brush adapted for synchronous rotation with that of the first commutator and for rotative engagement with each of the four segments.

The segments of the first commutator, in groups of ten separated by a blank segment, are connected to the settable registers so that each segment in the group designates a digit in that group. The rotor brush is connected to a battery through a transformer, and when it sweeps into engagement with the segments connected to those elements in the settable register that have been operated to record a digit, an impulse is transmitted into an impulse receiving circuit which applies a potential to the grid of the cathode ray tube that causes the discharge thereof to be impinged upon a portion of its fluorescent screen. Each of three segments of the second commutator is joined and connected to a different transformer through a resistance and thence to the same grounded battery as the first transformer, and when the brush of this second commutator sweeps by one of these segments, (as well as a normal or starting segment), a low amplitude impulse is generated which effects a circuit that applies a potential to the horizontal deflecting plates of the tube, causing a shift to be made in the position of the beam to the succeeding column of numerals. Thus while one segment in each of the four groups of ten segments in the first commutator designates one of the ten digits in each group, each of the segments of the second commutator designates the shift of the beam from one group of digits to another.

At the receiving end of the system, I provide two thyratron impulse receiving tubes, one that breaks down and becomes conducting upon the reception of the numerical or "high" amplitude impulses and the other that breaks down and becomes conducting upon the reception of the shift or "low" amplitude impulses. Delay circuits cooperating with the input of each of the tubes insures that the high amplitude tube will respond more quickly than the low amplitude tube. On the other hand, the high amplitude tube is biased to be non-responsive to the low amplitude impulses while a commutating condenser disables the low amplitude tube from responding to the high amplitude impulses. Both of these tubes have series inductance and capacity shunts between anode and cathode in order to render them self-restoring to the non-conducting condition after an impulse has been received.

The two impulse receiving tubes are further provided with a cathode-to-ground circuit from which the received impulses are taken off as voltage drops, the high amplitude or numerical impulses being transmitted therefrom to the oscilloscope grid via a vacuum tube amplifier to release the electron beam for impingement upon the figure designated by each one of the impulses, the low amplitude or shift impulses being transmitted to a four-tube counting thyratron "ring" circuit of known construction which applies a potential on the horizontal deflecting plates of the oscilloscope to shift the position of the beam horizontally from one column of figures to the next. Thus the potential on the horizontal deflecting plates will assume four distinct and different values according to the tube operated in the counting ring, and the virtual electron beam in the oscilloscope is correspondingly shifted to successive horizontal positions in alignment with each of the four columns of figures, one after another.

A clearer conception of the scope and purpose of the invention may be obtained from the fol-

lowing description taken in connection with the appended claims and attached drawings Figs. 1 and 2 of which, when placed one above the other in the order named, represent schematically one embodiment of the invention. It will be noted from the figures that all electronic devices except the oscilloscope tube are of the so-called "heater" type, their respective cathodes being heated by any suitable source of power which is not shown.

Referring, now, to the drawings, the transmitter, shown in Fig. 2, comprises two commutators A and B having, respectively, rotor brushes 11 and 32 which are mounted on shaft 47 coupled to the constantly revolving shaft 50 of motor 7 through the friction clutch 48. The brushes are keyed to the shaft in the same relative positions and rotate synchronously over their respective commutating segments when the friction clutch is released in the manner shortly to be described. Commutator A is provided with forty-four segments divided into groups of ten segments, each group being separated by a spare segment from the preceding and succeeding group and each segment in each group being connected to one numerical recorder of the number register 3. Commutator B, on the other hand, is provided with four segments separated from each other by a band of insulation and arranged in quadrature in the same relative position as the spare segments on commutator A, that is, the first segment (N) corresponding to segment 1, the eleventh segment (46) corresponding to segment 11', the twenty-second segment (67) corresponding to segment 22' and the thirty-third segment (68) corresponding to segment 33'. The first segment N is connected to the winding of relay 69 while the other three are joined together and connected to the source of negative battery 4 via resistance 6 and the primary of transformer 5. The secondary winding of transformer 5 is connected to the trunk conductors 8 and 9 which extend to the distant office whereat they connect with the primary of transformer 12. Bridged across conductors 8 and 9 is the secondary winding of transformer 10, one side of whose primary winding is connected to the negative battery 4 and the other side to the rotor brush 11. The secondary winding of transformer 12 is connected, on the one side, to the negative terminal of battery 13 and, on the other side, to the positive terminal of battery 14 which is further connected, via resistance 16 to grounded condenser 17 and, through biasing battery 33, to the grid 15 of low impulse receiving thyratron T₁. The negative pole of battery 14 is connected to grid 18 of high amplitude receiving thyratron T₂ via resistance 19 and to grounded condenser 20.

The output of the high amplitude impulse receiving tube T₂ is connected to the grid of the thyratron tube T₃ which, through the output transformer 23, controls the bias of grid 22 of the cathode ray indicating tube 30. The output of the low amplitude impulse receiving tube T₁, on the other hand, is connected via condenser 24 and conductor 31 to the commoned grids of the impulse counting thyratrons T₅-T₇, inclusive, which, in combination with thyratron T₄ constitute a closed impulse counting ring. The output of tube T₁ is further extended to the grid 26 of thyratron tube T₈ which, through its output circuit, feeds power to the pentode vacuum tube T₉ that connects to the vertical control deflecting plates 25 of the tube 30, the horizontal control plates 26 being connected to the paralleled

cathodes of the counting thyratrons T₁-T₇, inclusive.

The numerical register 3 may be any settable device as, for instance, that portion of the register sender which, in an automatic telephone exchange of the panel type, is used to control, from an impulse record, the setting of switching selectors. Such a register sender is shown in Patent 1,862,549, granted June 14, 1932, to R. Raymond and W. J. Scully. It may, therefore, comprise a group of register relays for each of the digits to be displayed on the oscilloscope 30 and the individual relays of this register, when operated to record a designating digit, cause the grounding of corresponding conductors that extend to appropriate segments of commutator A. Since the operation of the invention is herein illustrated with respect to the visual display of a four-digit number, and since the numerical register 3 is of the above-described type, there will be in all forty conductors that extend from the individual relays of the register to as many segments of the commutator A. Thus, the ten conductors for the thousands digit extend between the ten relays TH₀-TH₉ in the register 3 and the ten segments of the commutator which lie in the first quadrant thereof between the normal segment N and the eleventh segment 11'; the ten conductors for the hundreds digit extend between the ten relays H₀-H₉ and the ten segments of the commutator which lie in the second quadrant thereof between the eleventh segment 11' and the twenty-second segment 22'; the ten conductors of the tens digit extend between the ten relays T₀-T₉ and the ten segments of the commutator which lie in the third quadrant thereof between the twenty-second segment 22' and the thirty-third segment 33', while the ten conductors of the units digit extend between the ten relays U₀-U₉ and the ten segments which lie in the fourth quadrant between the thirty-third segment 33' and the normal segment 1. The brush 32, being keyed to shaft 47 the equivalent of one segment on commutator A behind brush 11 so that when the former engages the normal segment N the latter will be engaging the segment immediately following the normal segment 1, said brush 32 will always engage one of its four commutating segments behind brush 11 engaging the first segment in the quadrant of the succeeding digit. The shaft 47, through a friction clutch 48 the right plate of which is notched at the point corresponding to the segment 1 on commutator A to engage the armature finger of start magnet 49, is coupled to shaft 50 of constantly revolving motor 7. While so engaged, the left plate of the clutch rotates with the shaft 50, but the pressure between the two plates is just sufficient to cause the armature finger to hold the right plate stationary against the rubbing action of the left plate, thereby keeping shaft 47 in a position of rest. When, however, start magnet 49 is operated, as will be described shortly, the right plate of the clutch is released to move in unison with the left plate, shaft 47 becomes coupled with shaft 50 and the brushes 11 and 32 are caused to revolve synchronously over their respective commutator segments. At the end of a revolution the brushes will or will not make a second revolution depending upon whether or not the start magnet 49 is still operated.

Main shaft 50 also carries a commutating switch 64 having two brushes which form an electrical path therethrough in the notched position of clutch 48 for the purpose of completing

a circuit path to the start magnet 49 from the register 3 when the register is set to cooperate with the commutator A to generate the pulses designating the recorded number.

The operation of the transmitter and receiver to produce a display of the wanted number on tube 30 in response to the setting of the registers 3 for the number to be indicated will now be described in detail.

When the numerical register 3 is set for any particular number record by the operation therein of a relay in each of the four groups of the numerical relays TH₀-TH₉-U₀-U₉, a start relay ST is energized therein in any suitable manner which, upon operating, connects ground to brush 32 via conductor 65 and further connects positive potential to the control electrode of thyatron T₁₀ over a path which extends from positive battery, winding of relay 70, left outer contacts of relay ST, contacts of relay 69, mid-point of the secondary winding of transformer 5, conductors 8 and 9, mid-point of the primary winding of transformer 12, primary of transformer 66, high resistance 58, to the control electrode of thyatron T₁₀. The connection of positive potential to the control electrode of thyatron T₁₀, in view of the negative potential connected to the cathode and the alternating source of power 71 connected to the anode, will cause the tube, when the positive cycle of the induced voltage is impressed upon the anode, to break down, thus producing a current flow through the previously described path including relays 70 and 72. However, due to high resistance 58, the quantity of current flowing through this path is insufficient to operate relay 70 but is sufficient to operate relay 72. As a result, relay 72 attracts its armature and causes the completion of an obvious circuit for lamp 73 which lights to signal the operator that a call is waiting. During the negative half-cycle of generator 71, at which time negative potential is impressed upon the anode of tube T₁₀, said tube will be extinguished, but since positive potential through the winding of relay 70 is maintained on the control electrode of the tube, it will reoperate again on the following positive half-cycle of the generator. This causes a pulsating current to flow through relay 72 but since this relay has slow-release characteristics, it will remain in an operated position, thereby causing no disturbance of the circuit of lamp 73.

It will be observed that the secondary winding of transformer 66 is bridged by rectifier 74 and that one side of the winding of the transformer is connected to the grid of thyatron T₁ via conductor 77 and resistance 76 while the other side is connected to ground via conductor 75. The rectifier is so connected as to oppose any current flowing therethrough produced by the voltage induced in the secondary of the transformer as the result of the closure of a circuit through the primary, at which time positive voltage is applied to conductor 77. Conversely, on the break of a circuit through the primary, the direction of current in the secondary is reversed and is in a direction to flow through the rectifier, thereby presenting very little or no potential on conductor 77. When, therefore, thyatron T₁₀ breaks down and a current flow is established through the primary winding of transformer 66, the voltage induced in the secondary thereof, while in the proper direction to present positive potential on conductor 77, yet, due to the high resistance 58 in the circuit of the primary wind-

ing, is insufficient to produce any effect on thyatron T₄.

The operator upon noting the lighted lamp 73, depresses key 78. Resistance 58 is now short-circuited, thyatron T₁₀ releases when generator 71 is on the negative half-cycle and relay 72 is caused to release, thereby extinguishing lamp 73. The current in the primary circuit of transformer 66 is now increased, causing thereby a heavy voltage to be induced in the secondary which is productive of strong positive potential on conductor 77 that is applied to the grid of thyatron T₄. This potential is sufficiently positive to render the tube conducting whereupon the increased current flow through its cathode circuit including resistances 34 and 59 will cause the voltage drop through the former resistance to be applied to one of the pair of deflecting plates 26 to shift the virtual beam of the tube 30 horizontally to the leftmost column 62 of the screen and another voltage drop through the resistance 60 and thereby to the grid 55 of thyatron T₃ to render said thyatron critically responsive and therefore conducting when there is any slight rise in the potential applied to its grid.

When the operator depresses key 78, not only will the operations described above take place but, due to the increase in current through the previously described circuit of relay 70, said relay operates. A circuit for start magnet 49 is now completed extending from ground on the left inner contacts of relay ST, through the contacts of the commutating switch 64, contacts of relay 70, winding of magnet 49 to battery. Magnet 49 operates and lifts its armature finger out of engagement with the notch in the right plate of clutch 48 causing thereby the engagement of motor shaft 50 with brush shaft 47 both of which now rotate together, the latter causing the two brushes 11 and 32 to rotate successively over the surface of their respective commutators, brush 11 successively engaging each of the forty-four segments of commutator A and brush 32 successively engaging the four separate segments N, 46, 67 and 68 of commutator B. When the switch 64 has been rotated beyond the point where its contacts make with the commutating surface of the disc, the start magnet 49 releases whereupon its armature drops to engage the notch of the clutch face at the end of the revolution. Should start magnet 49 reoperate before the notch is engaged, the brushes 11 and 32 will make another revolution. The operator must keep the key 78 operated in order that the relay 70 may remain operated, permitting the continued operation of the distributor and maintaining the cycle of operations just described until she has ascertained the line number desired from screen 62 where it is displayed. When she has determined the number she may release key 78, after which lamp 73 will again operate until the trunk has been connected and the signal transmitting apparatus released from the trunk circuit, by means not here shown or described. It will be noted that key 78 is non-locking. Hence when it releases, a break pulse will be induced in the secondary winding of transformer 66. However, since rectifier 74 is so bridged across said secondary winding that the induced current circulates through it, the negative potential applied to conductor 77 is inappreciable and will produce no effect upon thyatron T₄.

The ground on conductor 65 is applied to brush 32 and when said brush reaches its segment N, which is when brush 11 makes with the segment

connecting with the conductor extending to the contact of relay TH9, a circuit path is closed from ground on said brush and segment N, winding of relay 69 to battery. Relay 69 operates and opens the circuit through winding of relay 70 and the primary winding of transformer 66. The opening of the contacts of relay 69 and their subsequent reclosure when brush 32 advances beyond segment N produces, in succession, another break-and-make pulse in the secondary winding of transformer 66, the make pulse having the effect of supplying breakdown voltage once again to the grid of thyatron T₄. However, since this tube is already conducting, no further effect is produced thereon. This voltage is further applied via conductor 104 and condenser 95 to the grid 96 of the vertical sweep circuit thyatron T₃ which renders it conducting to operate the pentode T₂ as described hereinafter.

The space between normal segment N and the second segment 46 is an insulating medium so that, as brush 32 rotates from the former to the latter, electrical conditions are not disturbed except in so far as they will be altered by brush 11 when engaging a segment between segment 1 and segment 11' which has been grounded by a relay of the thousands digit register TH0-TH9 which designates the thousands digit to be displayed. When brush 32 engages segment 46 a circuit path is closed from ground on brush 32 and segment 46 engaged thereby, resistance 6, primary winding of transformer 5 to negative battery 4. This circuit persists while the brush engages the segment during which time a current impulse is generated in the closed loop traced through the secondary winding of transformer 5, conductors 8 and 9 and the primary winding of transformer 12, the latter being located at any desirable distance from transformer 5. In the case of a telephone system, for example, the transmitter, including transformer 5, would be located in the originating office while the receiver including the transformer 12 would be located in another and terminating office.

The impulse thus produced, which is of low amplitude because of resistance 6, is repeated into the secondary winding of transformer 12. Since the thyatron devices T₁ and T₂ are of the "heater" type which establish a space potential between their respective cathodes and anodes when there is no space current flowing therebetween, the current impulse is repeated through the secondary of transformer 12, the current dividing between the branch of the circuit which includes resistance 16, battery 33 and grid 15 of tube T₁ and the branch which includes battery 14, resistance 19 and grid 18 of tube T₂.

It will be observed that grid 15 is negatively biased by battery 33 and that grid 18 is negatively biased by the stronger battery 14. Inasmuch as the impulse generated by the brush 32 in passing over segment N is of low intensity because of the inclusion of resistance 6 in the primary impulse circuit, the potential created thereby is sufficient to overcome the negative bias of battery 33 but not that of battery 14, in consequence of which tube T₁ will strike an arc to cause the passage of space current between its cathode and anode while tube T₂ is not affected by the pulse and, therefore, will not be rendered conducting.

The operation of tube T₁ causes an impulse of current to be transmitted via condenser 24 and conductor 31 to the grid 96 of thermionic tube

T₃ via condenser 53 on one side and to the parallel grids 55 to 57, inclusive, of thyratrons T₃ to T₇, inclusive, and respectively on the other side. Because of resistance 35 which is connected between the cathode of the thyatron T₁ and ground, this impulse is positive in character and will overcome the bias of negative battery 52 to render thyatron T₃ conducting. The impulse will further cause the conduction of tube T₅ which was "primed" for breakdown condition when T₄ was rendered conducting as already described. Hence, the positive impulse produced in conductor 31 as a result of tube T₁ becoming conducting, will cause tube T₃ to become conducting, the effect of which is to cause the priming of tube T₅ by virtue of the drop in resistance elements 79 and 80 that is applied to grid 56 of said tube and to increase the voltage across the deflector plates 26 of the oscilloscope 30 by the value measured by the drop in resistances 34 and 36 consequent to the conduction of tube T₃. This causes the horizontal deflection of the virtual beam from the first numerical column to the next. When tube T₅ becomes conducting in the manner to be described herein-after, the deflector plate voltage is increased to that due to the drop in resistances 34, 36 and 37 while, when tube T₇ becomes conducting, the voltage is increased by the drop due to resistance 38. With each change in voltage applied to the deflector plates 26—26, the direction of the cathode beam is deflected horizontally by an amount sufficient to place the beam in alignment with each succeeding vertical column of figures on the fluorescent screen 61.

Furthermore, when each of the thyratrons T₄, T₅, T₆ or T₇ becomes conducting as already described, current in any other thyatron then conducting will be interrupted by the voltage surges transmitted through the commutating condensers 91, 92, 93 and 94. As the cathode of the tube which has just begun to conduct suddenly surges positive by the drop in the resistance between its cathode and the point of connection to the series of resistances 34, 36, 37, 38, this positive voltage impulse is applied to the cathodes of all other thyratrons, so that at the instant of breakdown in the tube which has become conducting, all cathodes are rendered positive at the same time and by the same amount. This has the effect of making the cathode positive to the anode in any tube which was already conducting, since the cathode is only twenty volts negative to the anode when a tube is conducting. It further prevents the discharge from starting in any tube other than the one primed, since the positive swing of the cathode is equivalent to a large negative bias and the instant of breakdown, in the case of other tubes not then conducting.

The progressive breakdown of each of the tubes T₄ to T₇, inclusive, occurs, of course, at each quadrant point of the spacing commutator B associated with brush 32 so that, while brush 11 is sweeping the quadrant reserved to a particular digit, the virtual beam of the cathode ray tube is aligned with the vertical column of figures assigned to that digit. Thus, the ten segments in the first quadrant of commutator A are reserved for the thousands digit and, therefore, the breakdown of tube T₄ produces a drop in resistance 34 which is applied to deflector plates 26—26 and causes the virtual beam of the oscilloscope to be directed to the thousands column of numerals as, for instance, column 62. In the second quadrant, signaled by brush 32 passing

the second segment 46, the pulse produced thereby results in the breakdown of tube T₅ and serves to shift the beam on the second or hundreds column of numerals by the application to plates 26 of the voltage drop through resistance 36.

The pulse which causes the breakdown of tube T₄ also renders tube T₃ conducting, the effect of which is to cause condenser 39 to discharge and thereby lower the voltage across the vertical deflector plates 25—25 and to reset the cathode beam vertically downward to its lowest or zero numeral in the column to which it is directed by the voltage to ground on conductor 63 through the conduction of any of the tubes T₃—T₇, inclusive, as already described. Tube T₃ will cease to conduct as soon as condenser 39 is discharged, at which time it starts recharging at a constant rate. Condenser 39 charges from battery 97 via the cathode of pentode T₉ to ground. The cathode of tube T₃ is connected to the anode of tube T₉, but tube T₃ is held in a non-conducting condition by biasing battery 52 applied from its cathode to its grid via resistance 51. When a positive impulse through condenser 53 causes tube T₃ to conduct, it discharges condenser 39 very rapidly. When this condenser is discharged below the minimum sustaining voltage of the arc in tube T₃, said tube will cease to conduct and the grid 96 thereof regains control, preventing conduction while condenser 39 is recharged. Owing to the constant current property of the anodes of pentodes such as T₉, the time rate of voltage charge in the condenser 39 is linear. The time rate of charge of condenser 39 is so adjusted by the leak resistance 103 and the bias applied to the grid of pentode T₉ by means of rheostat 40 that the virtual beam in the oscilloscope 30 will sweep upward at the same rate as that at which brush 11 traverses the ten terminals of a digit quadrant. As the vertical sweep is reset at the end of each quadrant, slight deviations between the two rates of movement will not be cumulative because condenser 39 is completely discharged in the resetting operation.

When brush 11 engages a segment to which a numerical register has connected ground, an impulse surge is produced in transformer 10 on the make of the brush with the grounded segment, and this impulse is repeated over the line conductors 8 and 9 into transformer 12. Inasmuch as resistance 6 is not a part of the impulse producing circuit, as it is when brush 32 sweeps over one of the quadrant segments of commutator B, the impulse will be of greater intensity than that produced by brush 32 and will be sufficient to overcome the bias of battery 14 on grid 18 of tube T₂ and cause the latter to become conducting. This impulse, however, will not operate tube T₁ due to the fact that the delay network made up of resistance 16 and condenser 17 as compared to the resistance network 19 and condenser 20 are so proportioned that on an impulse sufficient to break down tube T₂ this tube will operate a few microseconds sooner than tube T₁. But once tube T₂ becomes conducting, a negative impulse is transmitted into the anode circuit of tube T₁ via condenser 40 and renders the anode voltage of tube T₁ too low to cause it to conduct.

It may be stated that tube T₁ or T₂ when made conducting by the light and heavy impulses, respectively, do not remain in a conducting condition because of the current circulating through the oscillatory circuits comprising inductances and capacity 42 and 43 and 44 and 45, respec-

tively. As is well known, such an oscillatory circuit connected between the anode and cathode of a thyatron renders the tube non-conducting when the grid bias is restored, due to the fact that the anode voltage is reversed in one of the oscillations.

When tube T₂ becomes conducting and, as a result, current flows through resistance 41 in the path established therethrough by the cathode-anode space discharge circuit, the drop in potential through resistance 41 is applied to the grid 21 of vacuum tube T₃ whereby an impulse is transmitted through transformer 23 to the grid 22 of the cathode ray beam tube 30.

Generator 98, through transformer 99, supplies the cathode 102 of oscilloscope tube 30 with heating current. Negative battery 100, connected to the mid-point of the secondary of this filament heating transformer supplies the accelerating voltage to the anode 101 of the oscilloscope tube in the usual manner. The impulse applied to the grid 22 of the oscilloscope is applied by the secondary of transformer 23, between the cathode of 102 and grid 22. This impulse releases the beam to full intensity and illuminates the figure of the numeral corresponding to the digit in the numerical register which grounded the segment engaged by brush 11 and resulted in the production of the heavy impulse that initiated the operations described above. When brush 11 leaves the grounded segment of commutator A, a break impulse is generated and will be repeated through transformers 10 and 12 in the manner already described. However, since the transformers are so poled that positive impulses result from the make of brush 11 with a grounded commutator segment, the break impulses will be of negative polarity and substantially without effect on the thyatrons T₁ and T₂. But the oscillating circuit 44 and 45 will render thyatron T₂ non-conducting after an interval predetermined by the electrical period of inductance 44 and condenser 45. When thyatron T₂ becomes non-conducting, the positive voltage applied to the grid 21 of vacuum tube T₃ is removed and the previous make impulse generated in transformer 23 as a result of the make impulse transmitted from commutator A, is terminated. A negative impulse in the secondary of transformer 23 follows when the space current of vacuum tube T₃ drops back to its normal low value when thyatron T₂ ceases to conduct. However, the cathode ray beam in oscilloscope 30 passed only while the positive impulse activated vacuum tube T₃ so that the negative pulse serves no purpose other than to further suppress the beam current, the beam having been reduced from an actual to a virtual beam as soon as the positive impulse generated in the secondary of transformer 23 terminates. The beam in the oscilloscope becomes real again when brush 11 again strikes a grounded segment which will be in the second quadrant when it engages a segment grounded by one of the hundreds register relays H0-H9 at which time a numeral in the hundreds column of screen 61 will be illuminated. These operations are reproduced for the tens and units digits and repeated for the whole number as often as desired if, when switch 60 reaches the normal position, relay ST is still operated and key 78 is still depressed. The speed of the motor 7 is so controlled that the rotations of brushes 11 and 32 are of a frequency to produce one sweep of the oscilloscope beam within the persistence of vision so that repeated revolutions

of the brushes will produce a steady visual display.

To restore the circuit to normal it is only necessary to release relay ST which may be done by opening its circuit when and if desired.

While I have described my invention in connection with its specific application to an oscilloscope device controlled by a settable register of known construction to display a wanted number for a telephone connection, it is to be understood that various other applications and embodiments thereof may be made by those skilled in the art without departing from the spirit of the invention as defined within the scope of the appended claims. For instance, the vertical and horizontal sweep circuits may each be controlled from separate distributor commutators, both running synchronously with the numerical commutator A in which event the potentials applied to the two pairs of tube deflectors would be controlled through the respective segments thereof and the beam would be made luminous, as in the manner described, only when the distributor brush of the numerical commutator would strike a grounded segment.

What is claimed is:

1. In a telephone system, a call indicator device comprising in combination, a cathode ray tube having a fluorescent screen pattern of a plurality of columns of numerals, a numerical register adapted to register the number to be displayed, means controlled by said register for producing in sequence an impulse for each digit registered therein, means responsive to each of said impulses for making the electron beam of the tube emitting, means rendered operative between said impulses for suppressing said electron beam, other impulse producing means, and sources of potential controlled by said other impulse producing means for directing the electron beam upon the column of numerals which includes the digit to be displayed.

2. In a signal system, the combination with a group of settable devices comprising a plurality of relays operable to indicate a plurality of characters and means cooperating therewith to produce impulses characteristic of a setting, of an electron discharge device having an indicating screen comprising groups of fluorescent configurations of all characters for which said devices can be set, means for directing the discharge of the electron beam of said electron discharge device upon a given character in a group on said screen, and means responsive to said impulses for producing a corresponding number of discharges of the electron beam, each discharge impinging, respectively, upon the character in the group screen which corresponds to the impulse producing the discharge.

3. In a signal system, the combination with a group of settable devices comprising a plurality of relays operable to indicate a plurality of characters and means cooperating therewith to produce high intensity impulses characteristic of a setting and a low intensity impulse interspaced between each two successive high intensity impulses, of an electron discharge device having an indicating screen comprising groups of fluorescent configurations of all characters for which said devices can be set, means responsive to said low intensity impulses for impressing voltages on said electron discharge device for aligning the impingement of the discharge beam with that group of characters of the indicating screen designated by a high intensity impulse following a

low intensity impulse, and means responsive to said high intensity impulses for producing a corresponding number of discharges of the electron beam, each of said discharges impinging, respectively, upon the character of a group in the indicating screen which corresponds to the impulse producing the discharge.

4. In a signal system, the combination with a group of settable devices comprising groups of relays operable to indicate a character in each group and means cooperating therewith to produce high intensity impulses characteristic of a setting composed of a plurality of characters, and low intensity impulses interspaced between each two successive high intensity impulses, of an electron discharge device having an indicating screen comprising groups of fluorescent configurations of all characters for which said devices can be set, means responsive to said high intensity impulses for producing a corresponding number of discharges of the electron beam for impingement upon various characters of said screen, means for impressing voltages on said electron discharge device for aligning the impingement of the discharge beam with a character in a group of characters in said indicating screen, and a plurality of electron devices each responsive to one of said low intensity impulses for controlling said voltage impressing means to shift the position of said beam from one group of characters to the next.

5. In a signal system, the combination with a group of numerical registers settable to record a number consisting of a plurality of digits and means cooperating therewith to produce a high intensity impulse for each digit and a low intensity impulse between successive digits, of an electron discharge device having a fluorescent screen with numerical configurations thereon, said configurations being disposed as a row of numerals for each digit in the number for which said numerical registers can be set, a horizontal sweep circuit controlled by said register means and responsive to said low intensity impulses produced thereby for impressing voltages on said electron discharge device for shifting the electron beam horizontally from one row of numerals to the next, a vertical sweep circuit controlled by said register means and adapted to apply voltage to said electron device at a constant rate to produce a vertical shift in the beam from one numeral in a column to the next, means responsive to said high intensity impulses for producing a corresponding number of discharges of the electron beam, each discharge impinging upon a numeral in each digit row to produce a luminescence of said numeral and means responsive to a low intensity impulse for reducing said impressed voltage to zero for restoring the direction of the beam to the lowest numeral in the column.

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